Table 2.8.2 Temples in the Kathmandu Valley (Con't)

TEMPLES

PATAN

NO	TEMPLE	LOCATION	DESCRIPTION
1.	Krishna Mandir	Patan	Built in 17th century by King Siddha Narsingh Malla. It is completely made of stone having 21 shrines.
2.	Mahabaudha	Near Patan Durbar Square	A Buddhist temple made of clay bricks in which thousands of images of Lord Buddha are engraved. It is a 'Terracotta' structure, 14th century Temple.
3.	Kumbheshwor	Patan	Temple with five roofs and Lord Shiva. Built during the reign of King Jayasthiti Malla.
4.	Jagat Narayan	Situated on the bank of Bagamati River.	Lord Vishnu temple in red bricks.
5.	Rudra Varma Mahabihar	Patan	It is a Buddhist monastery. Kings in ancient times were crowned in this monastery.
6.	Accheshwar Mahabihar	Phulchowk	Established at the beginning of the 17th century.
7.	Machchhendranath (Red)	Tabahal	Built in 1408 A.D.
8.	Min Nath	Tengal, on way to Tabahal	It is older than the Red Machendra Nath temple.
9.	Ashokan stupas	Patan	Built in 250 B.C. by Indian Emperor Ashoka. There are four stupas at the four corners of Patan.
10.	Bajra Barahi	10 km. south of Patan near Chapagaon.	Situated in a small woodland park, also a picnic spot.

BHAKTAPUR

1.	Nyatapola	BKT	It is a five- storey pagoda, built in 1702 A.D. by King Bhupatindra Malla. It is one of the tallest pagodas, famous for its massive structure.
2.	Bhairav Nath	BKT	Built by King Jagat Jyoti Malla around 1718 A.D. It is the temple dedicated to Lord Bhairav, the god of Terror.
3.	Dattatraya	BKT	Built in 1427 A.D. by King Yakchya Malla.
4.	Suryabinayak	Bhadgaon	Situated in a sylvan setting to catch first rays of the rising sun. It is also a picnic spot.
5.	Changu Narayan		Built in 323 A.D. by King Hari Dutta Varma.

Table 2.8.2 Temples in the Kathmandu Valley (Con't)

DURBAR SQUARES

No.	ITEM	LOCATION	DESCRIPTION
1.	Kathmandu Durbar Square	Hanuman Dhoka, KTM	It is a complex of temples and monuments including the old royal palace, the magnificent Taleju temple and the Kashthamandap.
2.	Patan Durbar Square	6 km south from KTM, Patan	It includes Krishna Mandir and many other temples.
3.	Bhaktapur Durbar Square	16 km east from KTM, BKT	It includes the famous Golden Gate and the palace of 55 windows. Nearby is Dattatreya Square and the Nyatapola temple.

MUSEUMS

1.	The National Museum	Near Swayambhunath, KTM	It houses Nepalese arts, historic items and ancient military weapons.
2.	The Tribhuvan Museum	Hanuman Dhoka, KTM	It gives a glimpse of the life of Late King Tribhuvan in pictures and art works.
3.	The Museum of Natural History	Near Swayambhu KTM	It houses a collection of different living species preserved in chemicals and taxidermies, birds and butterflies.
4.	The National Art Museum	Bhaktapur	It displays ancient thangka arts and relics.

PARKS

1.	Gokarna Safari Park	10 km east of KTM	It provides elephant safaris for viewing wild animals and other game.
2.	Balaju water garden	5 km west of KTM	Built in the mid 18th century. It features 22 Makara - headed water spouts.
3.	Royal Botanical garden	Godavari, 19 km Southeast of KTM	It contains a variety of exotic plant and flower species.
4.	Jawalakhel zoo	Jawalakhel, Patan	It houses exotic animal and bird species.

Table 2.8.2 Temples in the Kathmandu Valley (Con't)

MAJOR SIGHT - SEEING PLACES

NO	ITEM	LOCATION	DESCRIPTION
1.	Dharahara	Near Sundhara, KTM	A 59 m tower built by Prime Minister Bhimsen Thapa in 1832 A.D.
2.	Sundhara	Sundhara, KTM	It has fountains with golden water spouts.
3.	Martyr's Memorial gate	Between Dharahara and Bhadrakali temple, KTM	The memorial arch contains the statue of the late King Tribhuvan Bir Bikarm Shah and busts of four Martyrs.
4.	Singha Durbar	Singha Durbar , KTM	A palace built by Rana Prime ministers.
5.	Narayanhity Durbar	Kingsway, KTM	Present Royal Palace.
6.	Sundari jal	Sundari jal, KTM	There are magnificent waterfalls, cota - rocks and rock formations.
7.	Phulchowki	10 km south-east of Patan	A 2759 m. high mountain. Good for hiking.
8.	Tundikhel	Kathmandu	It is a huge green field, used for parades, national celebrations, numerous colorful festivals and sports.

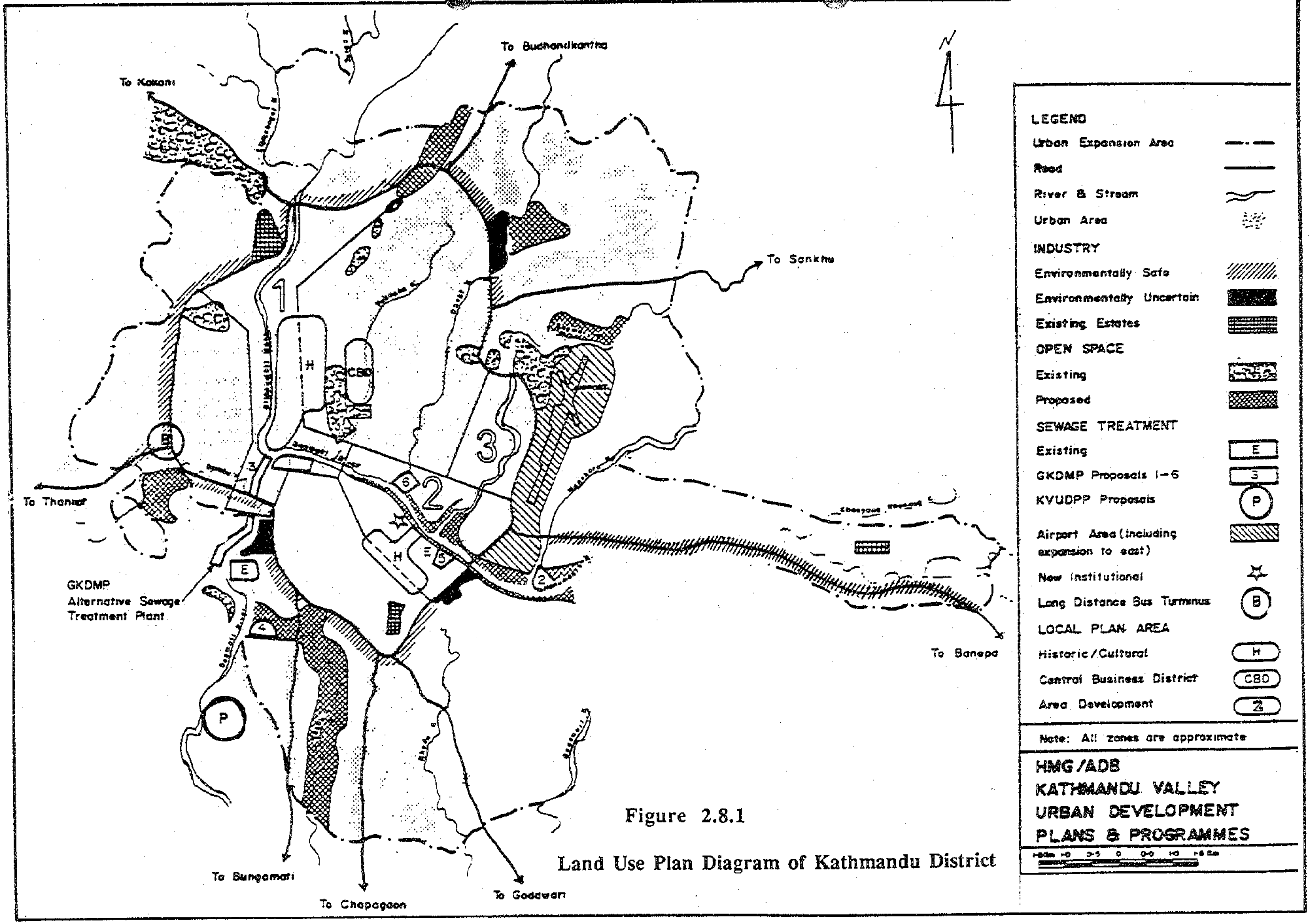

Figure 2.8.1

Land Use Plan Diagram of Kathmandu District

2.8.3 Natural Environment

Kathmandu is in a valley surrounded by four mountains which have a height of above 3,000 meters. The Bagmati, Bishnumati and Manohara rivers flow north to south from different parts of the valley.

As regards to the climate, it differs greatly according to the elevation, the topography etc., but as climatic classification, the dry season continues from October to May, and rainy season from June to September. The monthly rainfall and temperature are shown in Table 2.8.3.

Table 2.8.3 Monthly rainfall and Temperature in Kathmandu

Month	Temperature (°C)		Rainfall
	Max.	Min.	(mm)
January	22.2	3.2	0
February	19.9	5.2	42
March	22.1	7.0	60
April	26.2	10.8	116
May	27.1	16.1	108
June	29.2	19.6	286
July	27.6	20.1	346
August	28.3	19.4	308
September	27.5	18.5	188
October	25.6	13.0	79
November	24.4	7.3	0
December	20.2	3.7	3
Annual Total (a)			1,536
Monsoon Season (b)	(June - September)		1,128
(b)/(a)			73.4%

The wild life of Nepal remains rich compared to other parts of the world. Birds of approximately 800 species have been confirmed. 600 species have been confirmed in Japan. Regarding insects, butterflies have been investigated relatively well and more than 600 species have been confirmed. More than 200 species have been confirmed in Japan. But, on account of reduction in forest lands, landslides and floods etc., the living and breathing space in Nepal is decreasing, and as a result, the number of species is declining.

Additionally, as there is no production of energy resources such as fossil fuel, coal and natural gas in Nepal, the use of firewood as a fuel is prevalent even in the cities. Therefore, large areas of forest land is being used by Nepal's 19.0 million people, and given this extent of use, it is said that the forest reserve may be lost within 30 yeas. Recently, with improved ovens and the import of propane gas, the situation is being improved, but the danger of the forest being destroyed does still exist.

2.8.4 Pollution

In Kathmandu, the main pollution problems encountered are atmospheric pollution due to exhaust gas, water pollution of rivers, and an inefficient garbage disposal system.

The main problem of exhaust gas is on account of the rapid increase in the number of vehicles and their inadequate maintenance. Furthermore, river water pollution is due to waste water from factories, and garbage plus waste water from households.

In Kathmandu, garbage collection containers are located throughout the city and as 100% of the garbage cannot be disposed off, there are locations where there are bad smells.
It is anticipated that there shall be further increase in tourist arrivals once the Tribhuvan International Airport has been rehabilitated and expanded. Therefore, it is necessary that a basic treatment system is established for factory waste water and garbage.

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PART B.

AIRPORT MODERNIZATION PLAN

PART B-1 GROUND FACILITIES IMPROVEMENT PLAN

CHAPTER 3

EXISTING AIRPORT AND SURROUNDINGS

CHAPTER 3 EXISTING AIRPORT AND SURROUNDINGS

3.1 General

This chapter describes the history of the airport, and outlines the airport facilities, the characteristics of the airport traffic, the existing and planned land use surrounding the airport particular to Tribhuvan International Airport.

Layout plans of the existing Tribhuvan International Airport and its terminal area are shown in Figures 3.1.1 and 3.1.2.

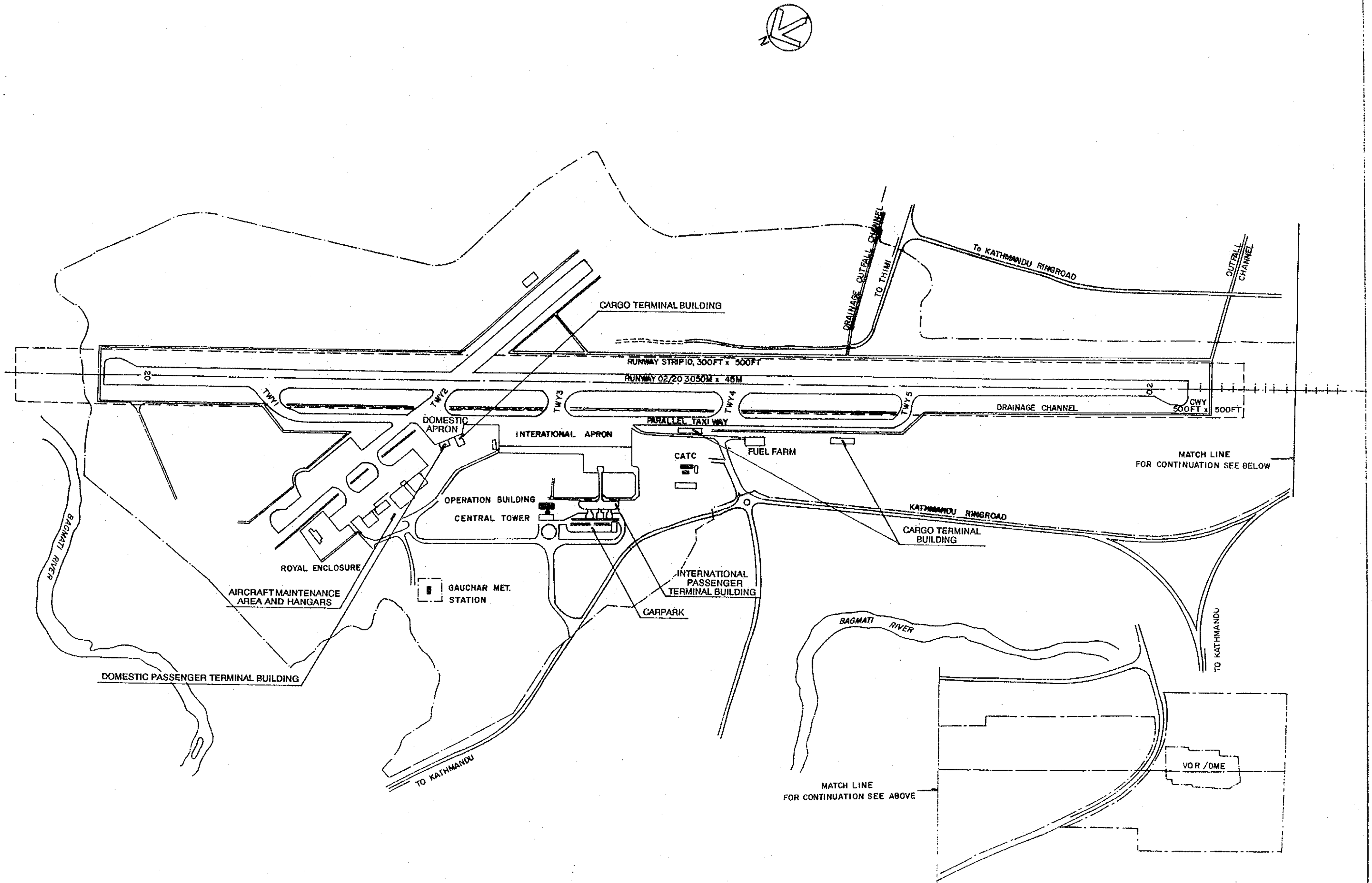


Figure 3.1.1 Layout Plan of Tribhuvan International Airport

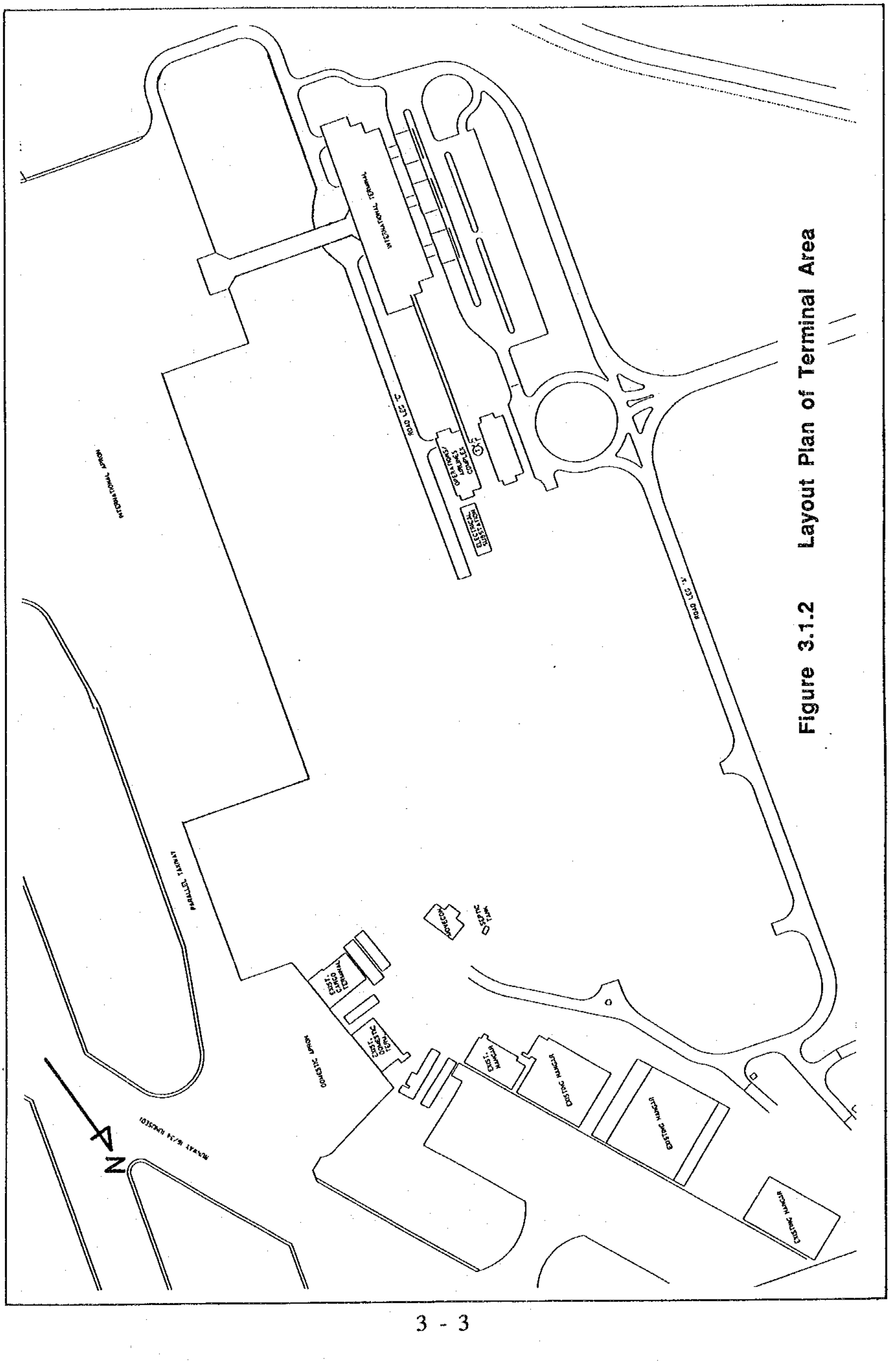


Figure 3.1.2 Layout Plan of Terminal Area

3.2 Airport History

Tribhuvan Airport commenced operations under the name of Gauchar Airport in 1951 and was used by 28-seater DC-3 aircraft. At that time scheduled domestic services operated from/ to Pokhara , Bhairahawa , Simara and Biratnagar and International services from/to Patna, Calcutta and Delhi. After that, it has been consistently developed and improved.

The development is summarized chronologically as follows:

1957 The grassy strip was converted into 3,750 ft concrete runway with the assistance of the Indian Government.

1966 A new realigned 6,600 ft asphalt concrete runway was constructed with assistance of US. Aid in order to cope with the increasing air traffic.

1975 Extension of the runway to a length 10,000 ft along with expansion works on a parallel taxiway and apron were constructed with an ADB loan. In the meantime, an extensive Australian Aid Programme in the fields of Communication & Radio Navigation Aids such as repeater stations, receiving and transmitting stations, NDBs, T-Vasis, runway lights, control tower equipment etc. was undertaken in order to modernize Air Navigation Systems at this airport.

1982 Runway and taxiway re-strengthening works were carried out.

1985 Runway overlay (south 1,000m) and north apron construction works were carried out.

1987 Taxiway overlay work was carried out.

1990 An Operation /Airlines complex and International Terminal Building were inaugurated with ADB and OPEC special funding in order to cope with the increasing number of passengers and air traffic demands.

1991 The airfield lighting system was installed with the aid of a French Project.

3.3 Airport Management

3.3.1 Organization

The existing agent for the airport operations, management and responsibility are summarized as follows:

- All of management and operations such as servicing for passengers, aircraft, cargo and articles, navigation aids, telecommunication, security, rescue and fire fighting, etc. are by the Tribhuvan International Airport Office (TIAO).
- Oil supply for aircraft is by the Nepal Oil Corporation (NOC)
- Meteorological observations and distribution of information is by the Department of Hydrology and Meteorology

3.3.2 Structure

The Department of Civil Aviation (DCA) is one of departments of the Ministry of Tourism and Civil Aviation. TIAO is a subsidiary of DCA.

The overall structure of His Majesty's Government, Department of Civil Aviation (DCA) and Tribhuvan International Airport Office (TIAO) is shown in Figure 3.3.1 through 3.3.3.

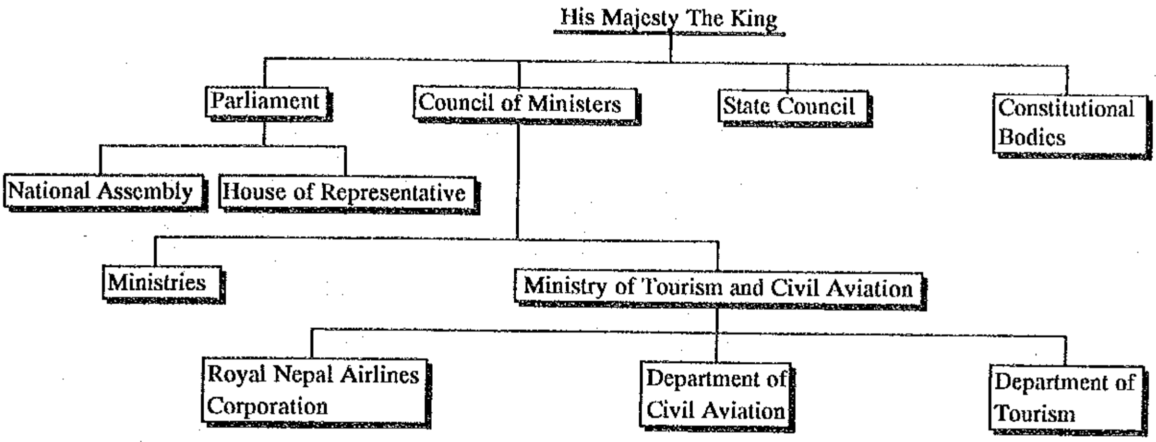


Figure 3.3.1 His Majesty's Government's Overall Organizational Structure

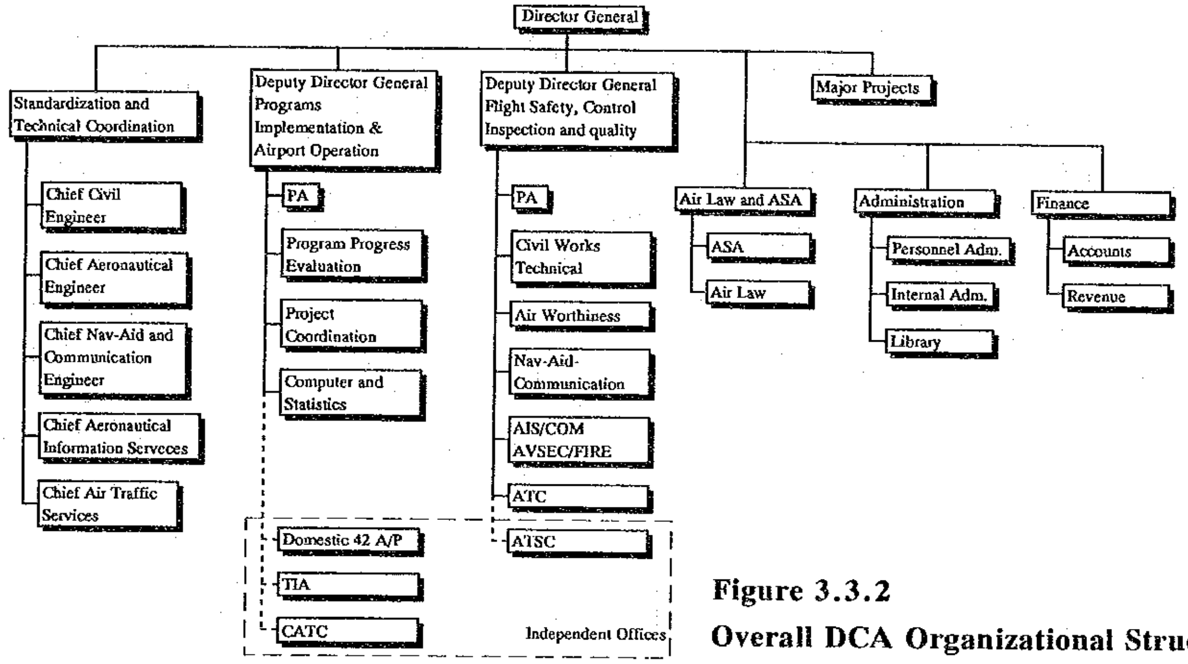


Figure 3.3.2
Overall DCA Organizational Structure

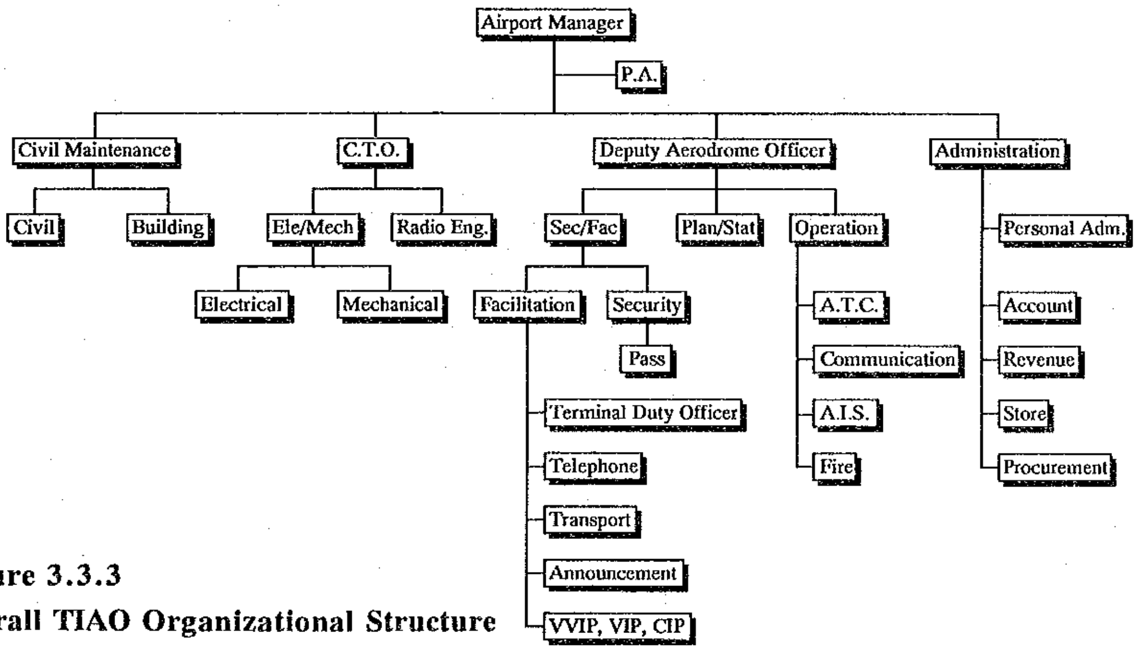


Figure 3.3.3
Overall TIAO Organizational Structure

3.4 Airport Inventory

An inventory of Tribhuvan International Airport is shown in Table 3.4.1.

Table 3.4.1 Inventory of Tribhuvan International Airport

Item	Description
Aerodrome Data	
- City/Aerodrome	Kathmandu / Tribhuvan
- International/Domestic	International and Domestic
- ICAO Reference Code	4D
- Aerodrome Reference Point	27°41'47"N, 85°21'42"E (Center of Runway)
- Distance and Direction from City	5.6 km east from the City
- Elevation	1338 m (4390 ft) AMSL
- Total Area	320 ha
- Reference Temperature	27.8 C (Source: AIP Nepal) *
- Magnetic Variation	1°00'W(May 1980)
- Operational Hours	from Sunrise to Sunset
- Seasonal Availability	All seasons
- Aerodrome Operator	Department of Civil Aviation (DCA)
- Transportation Available	Limousines and taxis
Aircraft Operational Data	
- Operational Category	Non-Precision Approach
- Established Procedure	VOR/DME for RWY 02
- Transition Altitude	Alt 13,500 ft
Runway	
- Designation	02 / 20
- Dimension	3,050m x 45m
- Longitudinal Slope	0.77% (Effective Gradient)
- Stopway	123 m (20)
- Surface	Asphalt concrete
- Strength	PCN 54/F/A/W/T
Runway Strip	
- Dimension	3,140 m x 150 m
Taxiway	
- Dimension	1,945 m x 23 m
- Surface	Asphalt concrete
- Strength	PCN 54/F/A/W/T

(Continued)

Table 3.4.1 (Con't.)

Item	Description
Apron	
- Aircraft Stands / Parking Configuration	DC-10 x 1, A300 x 2, B727 x 3 / Push back (for International) Self-maneuvering (for Domestic)
- Area	5,640 m² (for Domestic) 35,547 m² (for International) 3,800 m² (for Maintenance) 9,130 m² (for VVIP)
- Surface	Cement concrete
- Strength	PCN 53/R/B/W/T (Int'l)
- Aircraft Maintenance Hanger	2 hangers
Passenger Terminal Building	
- Total Floor Area	10,750 m² (Int'l) + 700m² (Dom)
- Structure	Reinforced concrete structure, 3 stories (Int'l) Reinforced concrete structure, 1 story (Dom)
Cargo Terminal Building	
- Floor Area	3,500 m²
- Structure	Reinforced concrete structure, 1 story
Control Tower Building	
- Floor Area (VFR Room)	390 m²
- Structure	Reinforced concrete structure, 7 stories
- Height	29.4 m above ground
Operations Building (in Complex)	
- Floor Area	2,100 m²
- Structure	Reinforced concrete structure, 3 stories
Airlines Building (in Complex)	
- Floor Area	2,100 m²
- Structure	Reinforced concrete structure, 3 stories
Car Parking	(Int'l)
- Area	17,000 m²
- Capacity	135 cars, 6 buses, 20 motorcycles
- Surface	Asphalt concrete

(Continued)

Table 3.4.1 (Con't.)

Item	Description
Air Navigation System	
- Radio Navigation Aids	- DVOR/DME - NDB, Locator (E,S,W) - Fan Marker Beacon
- Aeronautical Telecommunication System	Semi Automatic Message Switching System ATS direct speech HF (Point / Point) HF (Air / Ground) VHF (Air / Ground) Radio link
- Aeronautical Ground Lighting System	Precision Approach Light System PAPI Sequenced Flash Light System Runway Threshold Lights Runway Edge Lights Taxiway Edge Lights Apron Flood Lights Aerodrome Beacon Obstacle Lights
- Air Traffic Control System	Illuminated Wind Direction Indicator VHF / DF ATC console
- Meteorological System	- Observations by Department of Hydrology and Meteorology - Wind direction and velocity. Temperature and Pressure - Visibility and sky conditions by visual observations
- Emergency Power Supply System	Emergency generator = Capacity 360 KW Automatic operation
Rescue and Fire Fighting Facilities	
- Fire Vehicles	- 4 major vehicles and 1 Ambulance - Water tank capacity : 26,700 liter - Water reservoir : 45,000 liter - Type of foam : Protein
- Fire Station	800 m²
- Structure	Reinforced concrete structure, 2 stories
- Level of Protection	Category - 5
- Trained Personnel	53 persons

(Continued)

Table 3.4.1 (Con't.)

Item	Description
Airport Utilities	
- Power Supply System	- Receiving : 2- 11 KV 3 phase 50 Hz - Transformers : 2- 750 KVA
- Water Supply System	- City water supply: 25 ~ 45 m^3/day, 2 elevated water tanks - Total water tank capacity: 391 m^3 - Well : 2.7 *l*/sec
- Sewerage System	- Aeration lagoon : 672 m^3
- Telephone System	- Telephone service line : 200 lines PABX : 1000 lines
Other Facilities	
- Aviation Fuel Supply System	- fuel depot capacity, Jet-A1: 2,100 kl - Refueler: 1. 2- 27 kl 2- 16 kl 2- 12 kl
- Airport Vehicles	3 vehicles

* The aerodrome reference temperature is expected to be reviewed based on the latest data.

3.5 Air Traffic Characteristics

This section describes the traffic characteristics of Tribhuvan International Airport based on the historical record of DCA and the result of the traffic survey.

The air traffic characteristics at Tribhuvan International Airport are summarized below as for the following categories:

- Passengers
- Freight and mail
- Aircraft movement

3.5.1 Passengers

(1) Passengers

The number of international embarked and disembarked passengers at Tribhuvan International Airport amounted to 780,297 persons in 1992, and was as almost same as in 1991. However, the growth rate compared with 1990 was 30.2%, and the annual average growth rate for the last 10 years was 7.7%.

Domestic passengers amounted to 292,137 persons in 1992 with a growth rate of 35.3% compared with 1991, and the annual average growth rate for the last 10 years was 8.6%.

The total of international and domestic passengers was 1,072,434 persons in 1992 with a growth rate of 7.6% compared with 1991, and the annual average growth rate for the last 10 years was 7.6%.

Table 3.5.1 Passengers at Tribhuvan International Airport by Year

International Passengers

Unit : persons

Year	Embarked (1)	Disembarked (2)	Total (1)+(2)	Growth (%)
1983	210,462	204,379	414,841	
1984	235,784	229,556	465,340	12.2%
1985	256,044	226,814	482,858	3.8%
1986	267,460	255,785	523,245	8.4%
1987	278,909	294,235	573,144	9.5%
1988	312,741	315,627	628,368	9.6%
1989	313,445	300,134	613,579	-2.4%
1990	283,083	316,323	599,406	-2.3%
1991	388,806	392,127	780,933	30.3%
1992	400,063	380,234	780,297	-0.1%

Domestic Passengers

Unit : persons

Year	Embarked (1)	Disembarked (2)	Total (1)+(2)	Growth (%)
1983	76,463	76,167	152,630	
1984	86,400	86,756	173,156	13.4%
1985	94,575	92,453	187,028	8.0%
1986	101,259	101,259	202,518	8.3%
1987	109,585	108,953	218,538	7.9%
1988	133,692	130,735	264,427	21.0%
1989	102,339	101,963	204,302	-22.7%
1990	122,551	94,351	216,902	6.2%
1991	110,582	105,375	215,957	-0.4%
1992	144,745	147,392	292,137	35.3%

Total Passengers

Unit : persons

Year	Embarked (1)	Disembarked (2)	Total (1)+(2)	Growth (%)
1983	286,925	280,546	567,471	
1984	322,184	316,312	638,496	12.5%
1985	350,619	319,267	669,886	4.9%
1986	368,719	357,044	725,763	8.3%
1987	388,494	403,188	791,682	9.1%
1988	446,433	446,362	892,795	12.8%
1989	415,784	402,097	817,881	-8.4%
1990	405,634	410,674	816,308	-0.2%
1991	499,388	497,502	996,890	22.1%
1992	544,808	527,626	1,072,434	7.6%

Table 3.5.2 Passenger at Tribhuvan International Airport by Month

International Passengers

Unit : persons

	Year 1990			Year 1991			Year 1992		
	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)
Jan.	24,747	28,254	53,001	27,413	32,272	59,685	32,916	25,624	58,540
Feb.	27,580	26,333	53,913	29,523	26,608	56,131	27,100	30,429	57,529
Mar.	25,729	30,896	56,625	37,950	34,062	72,012	33,744	34,208	67,952
Apr.	18,100	21,468	39,568	33,827	35,988	69,815	36,105	33,534	69,639
May.	18,400	21,774	40,174	34,152	38,141	72,293	36,924	31,935	68,859
Jun.	18,331	21,122	39,453	32,801	35,686	68,487	33,217	27,236	60,453
Jul.	20,206	28,422	48,628	26,676	26,199	52,875	26,399	26,033	52,432
Aug.	24,170	27,956	52,126	28,864	27,345	56,209	33,394	33,186	66,580
Sep.	20,221	18,410	38,631	24,584	27,806	52,390	26,815	30,000	56,815
Oct.	29,882	28,086	57,968	35,807	42,888	78,695	39,623	46,433	86,056
Nov.	27,192	30,820	58,012	42,302	35,109	77,411	43,421	34,153	77,574
Dec.	28,525	32,782	61,307	34,907	30,023	64,930	30,405	27,463	57,868
Total	283,083	316,323	599,406	388,806	392,127	780,933	400,063	380,234	780,297

Domestic Passengers

Unit : persons

	Year 1990			Year 1991			Year 1992		
	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)
Jan.	45,831	11,851	57,682	7,749	8,308	16,057	9,296	9,099	18,395
Feb.	7,315	9,760	17,075	6,307	6,646	12,953	9,594	9,569	19,163
Mar.	9,333	10,183	19,516	9,659	10,268	19,927	11,295	10,893	22,188
Apr.	5,224	5,026	10,250	9,685	10,441	20,126	11,532	11,950	23,482
May.	6,585	6,124	12,709	9,304	8,870	18,174	10,140	10,785	20,925
Jun.	5,198	4,383	9,581	6,441	6,867	13,308	9,656	13,252	22,908
Jul.	4,148	4,438	8,586	5,370	5,761	11,131	7,665	7,920	15,585
Aug.	4,857	5,122	9,979	5,616	5,910	11,526	9,572	9,232	18,804
Sep.	4,183	5,668	9,851	7,612	6,924	14,536	12,517	10,680	23,197
Oct.	10,220	10,664	20,884	17,907	10,832	28,739	19,507	18,448	37,955
Nov.	11,725	10,907	22,632	13,967	13,781	27,748	18,330	20,844	39,174
Dec.	7,932	10,225	18,157	10,965	10,767	21,732	15,641	14,720	30,361
Total	122,551	94,351	216,902	110,582	105,375	215,957	144,745	147,392	292,137

Total Passengers

Unit : persons

	Year 1990			Year 1991			Year 1992		
	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)	Embarked (1)	Disembarked (2)	Total (1)+(2)
Jan.	70,578	40,105	110,683	35,162	40,580	75,742	42,212	34,723	76,935
Feb.	34,895	36,093	70,988	35,830	33,254	69,084	36,694	39,998	76,692
Mar.	35,062	41,079	76,141	47,609	44,330	91,939	45,039	45,101	90,140
Jun.	23,324	26,494	49,818	39,242	42,553	81,795	42,873	39,186	82,059
Aug.	29,027	33,078	62,105	34,480	33,255	67,735	42,966	43,971	86,937
Sep.	24,404	24,078	48,482	32,196	34,730	66,926	39,332	43,252	82,584
Oct.	40,102	38,750	78,852	53,714	53,720	107,434	59,130	55,665	114,795
Nov.	38,917	41,727	80,644	56,269	48,890	105,159	61,751	44,833	106,584
Dec.	36,457	43,007	79,464	45,872	40,790	86,662	46,046	42,183	88,229
Total	405,634	410,674	816,308	499,388	497,502	996,890	544,808	527,626	1,072,434

(2) Freight

The volumes of air freight for international, domestic and total amounted to 15,832.6 tons, 679.9 tons and 16,512.5 tons respectively in 1992, and growth rates were 11.0%, 108.8% and 13.1% compared with 1991. Annual average growth rates for the last 10 years were 18.5%, 13.0% and 15.6% respectively.

Table 3.5.3 Freight at Tribhuvan International Airport by Year

International — Unit : tons

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	1,673	2,346	4,019	
1984	2,400	2,860	5,260	30.9%
1985	4,172	3,795	7,967	51.5%
1986	4,450	4,289	8,739	9.7%
1987	5,917	6,486	12,403	41.9%
1988	7,664	7,782	15,445	24.5%
1989	8,811	8,400	17,211	11.4%
1990	5,218	7,735	12,953	-24.7%
1991	7,389	6,880	14,268	10.2%
1992	11,815	4,018	15,833	11.0%

Domestic

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	271	81	352	
1984	276	96	373	5.8%
1985	224	111	335	-10.2%
1986	280	89	369	10.3%
1987	474	81	554	50.2%
1988	92	438	530	-4.3%
1989	417	80	497	-6.2%
1990	173	280	453	-9.0%
1991	161	165	326	-28.1%
1992	605	75	680	108.8%

Total

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	1,944	2,427	4,371	
1984	2,677	2,956	5,633	28.9%
1985	4,396	3,906	8,302	47.4%
1986	4,730	4,379	9,108	9.7%
1987	6,391	6,566	12,957	42.3%
1988	7,756	8,219	15,975	23.3%
1989	9,227	8,481	17,708	10.8%
1990	5,391	8,014	13,406	-24.3%
1991	7,549	7,045	14,594	8.9%
1992	12,419	4,093	16,513	13.1%

Table 3.5.4 Freight at Tribhuvan International Airport by Month

International Freight

Unit : tonnes

	Year 1990			Year 1991			Year 1992		
	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)
Jan.	838	842	1,680	445	1,047	1,492	1,247	290	1,537
Feb.	597	866	1,463	332	791	1,123	1,043	324	1,367
Mar.	403	836	1,239	391	969	1,360	1,136	322	1,458
Apr.	266	558	824	361	811	1,172	967	318	1,285
May	469	1,109	1,578	280	660	940	911	289	1,200
Jun.	1,739	649	2,388	215	623	838	833	281	1,114
Jul.	240	609	849	325	546	871	766	331	1,097
Aug.	187	428	615	706	252	958	848	360	1,208
Sep.	78	188	266	928	327	1,255	915	405	1,320
Oct.	97	226	323	1,031	277	1,308	799	419	1,218
Nov.	163	625	788	1,093	273	1,366	1,014	341	1,355
Dec.	142	800	942	1,281	303	1,584	1,336	339	1,675
Total	5,219	7,736	12,955	7,388	6,879	14,267	11,815	4,019	15,834

Domestic Freight

Unit : tonnes

	Year 1990			Year 1991			Year 1992		
	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)
Jan.	74	39	113	3	14	17	16	5	21
Feb.	5	15	20	2	5	7	13	7	20
Mar.	10	20	30	3	12	15	17	4	21
Apr.	43	5	48	4	38	42	19	4	23
May	4	55	59	6	39	45	102	15	117
Jun.	10	22	32	4	19	23	71	9	80
Jul.	3	16	19	4	17	21	39	4	43
Aug.	10	22	32	18	3	21	76	9	85
Sep.	5	19	24	11	5	16	66	5	71
Oct.	3	19	22	21	4	25	59	7	66
Nov.	2	30	32	46	4	50	85	3	88
Dec.	4	17	21	37	5	42	42	5	47
Total	173	279	452	159	165	324	605	77	682

Total Freight

Unit : tonnes

	Year 1990			Year 1991			Year 1992		
	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)	Loaded (1)	Unloaded (2)	Total (1)+(2)
Jan.	912	881	1,793	448	1,061	1,509	1,263	294	1,557
Feb.	602	881	1,483	335	796	1,131	1,056	330	1,386
Mar.	412	856	1,268	394	981	1,375	1,153	326	1,479
Apr.	309	562	871	366	849	1,215	986	322	1,308
May	473	1,164	1,637	287	699	986	1,013	304	1,317
Jun.	1,749	671	2,420	219	642	861	903	290	1,193
Jul.	244	625	869	329	563	892	805	335	1,140
Aug.	197	450	647	724	255	979	924	369	1,293
Sep.	82	208	290	939	332	1,271	981	410	1,391
Oct.	99	245	344	1,052	281	1,333	857	425	1,282
Nov.	166	655	821	1,139	277	1,416	1,098	344	1,442
Dec.	146	817	963	1,318	308	1,626	1,379	344	1,723
Total	5,391	8,015	13,406	7,550	7,044	14,594	12,418	4,093	16,511

Table 3.5.5 Mail at Tribhuvan International Airport by Year

International Mail

Unit : tonnes

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	55.3	156.0	211.3	
1984	61.2	173.5	234.7	11.1%
1985	76.7	116.8	193.5	-17.6%
1986	72.3	112.9	185.2	-4.3%
1987	66.4	161.1	227.5	22.8%
1988	196.8	61.9	258.7	13.7%
1989	58.4	160.1	218.5	-15.5%
1990	71.9	43.2	115.1	-47.3%
1991	108.5	123.2	231.7	101.3%
1992	60.5	191.6	252.1	8.8%

Domestic Mail

Unit : tonnes

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	64.8	29.5	94.3	
1984	50.0	23.3	73.2	-22.3%
1985	49.8	29.6	79.4	8.4%
1986	50.3	27.3	77.6	-2.3%
1987	96.3	21.1	117.4	51.2%
1988	22.7	64.1	86.8	-26.0%
1989	58.3	24.5	82.8	-4.6%
1990	14.3	41.2	55.5	-33.0%
1991	24.6	20.8	45.4	-18.2%
1992	40.4	9.5	50.0	10.1%

Total Mail

Unit : tonnes

Year	Loaded (1)	Unloaded (2)	Total (1)+(2)	Growth (%)
1983	120.1	185.5	305.5	
1984	111.2	196.8	308.0	0.8%
1985	126.5	146.4	272.9	-11.4%
1986	122.6	140.2	262.8	-3.7%
1987	162.7	182.2	344.9	31.2%
1988	219.5	126.0	345.5	0.2%
1989	116.7	184.6	301.3	-12.8%
1990	86.2	84.4	170.6	-43.4%
1991	133.1	144.0	277.1	62.4%
1992	100.9	201.2	302.1	9.0%

(3) Aircraft Movement

Aircraft movements are shown in Table 3.5.5 and 3.5.6, by year and month respectively.

The share of international and domestic flights in the aircraft movements were 26.9% and 60.2% respectively as shown in Table 3.5.8.

Royal Nepal Airlines provided 39.1% of total international aircraft movements and 70.0% of domestic in 1992 as shown in Table 3.5.9.

Table 3.5.10 shows aircraft movements by aircraft type. The shares for A320, B727 and B757 were high with around 20% for international aircraft, and DHC6 was extremely high with 54.5% for domestic aircraft.

Table 3.5.6 Aircraft Movement at Tribhuvan International Airport by Year

Unit : Movement

Year	International		Domestic		Total	Growth (%)
	Departure	Arrival	Departure	Arrival		
1983	2,869	2,866	6,990	7,006	19,731	
1984	2,812	2,800	7,611	7,508	20,731	5.1%
1985	3,031	3,028	6,986	6,988	20,033	-3.4%
1986	3,161	3,153	5,117	5,730	17,161	-14.3%
1987	3,277	3,290	6,210	6,290	19,067	11.1%
1988	3,348	3,351	6,825	6,859	20,383	6.9%
1989	3,527	3,520	5,885	5,934	18,866	-7.4%
1990	3,541	3,585	5,511	5,495	18,132	-3.9%
1991	3,737	3,737	5,909	5,902	19,285	6.4%
1992	3,795	3,802	8,500	8,491	24,588	27.5%

Table 3.5.7 Aircraft Movement at Tribhuvan International Airport by Month

International Aircraft Movement

Unit : movements

	Year 1990			Year 1991			Year 1992		
	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)
Jan.	312	321	633	306	306	612	317	316	633
Feb.	271	272	543	257	256	513	272	273	545
Mar.	332	346	678	329	328	657	304	305	609
Apr.	291	295	586	331	330	661	331	332	663
May.	260	258	518	335	335	668	318	316	634
Jun.	249	252	501	312	313	625	291	293	584
Jul.	261	250	511	302	301	603	303	303	606
Aug.	302	314	616	294	294	588	323	325	648
Sep.	275	283	558	293	293	586	309	307	616
Oct.	334	346	680	346	347	693	382	386	768
Nov.	328	323	651	323	323	646	353	356	709
Dec.	326	325	651	309	311	620	292	290	582
Total	3,541	3,585	7126	3,737	3,737	7,474	3,795	3,802	7,597

Domestic Aircraft Movement

	Year 1990			Year 1991			Year 1992		
	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)
Jan.	545	543	1,088	446	443	889	453	452	905
Feb.	450	446	896	357	362	719	410	414	824
Mar.	578	576	1,154	583	586	1,169	644	639	1,283
Apr.	420	416	836	631	626	1,257	596	597	1,193
May.	396	399	795	547	544	1,091	658	657	1,315
Jun.	351	344	695	369	371	740	659	657	1,316
Jul.	334	343	677	350	349	699	555	556	1,111
Aug.	341	336	677	340	334	674	598	597	1,195
Sep.	346	350	696	410	410	820	739	741	1,480
Oct.	612	606	1,218	651	647	1,298	1,073	1,071	2,144
Nov.	630	630	1,260	692	693	1,385	1,185	1,179	2,364
Dec.	508	506	1,014	533	537	1,070	930	931	1,861
Total	5,511	5,495	11,006	5,909	5,902	11,811	8,500	8,491	16,991

Total Aircraft Movement

	Year 1990			Year 1991			Year 1992		
	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)	Departure (1)	Arrival (2)	Total (1)+(2)
Jan.	857	864	1,721	752	749	1,501	770	768	1,538
Feb.	721	718	1,439	614	618	1,232	682	687	1,369
Mar.	910	922	1,832	912	914	1,826	948	944	1,892
Apr.	711	711	1,422	962	956	1,918	927	929	1,856
May.	728	745	1,473	876	872	1,748	962	962	1,924
Jun.	600	596	1,196	681	684	1,365	950	950	1,900
Jul.	595	593	1,188	652	650	1,302	858	859	1,717
Aug.	643	650	1,293	634	628	1,262	921	922	1,843
Sep.	621	633	1,254	703	703	1,406	1,048	1,048	2,096
Oct.	946	952	1,898	997	994	1,991	1,455	1,457	2,912
Nov.	958	953	1,911	1,015	1,016	2,031	1,538	1,535	3,073
Dec.	834	831	1,665	842	848	1,690	1,222	1,221	2,443
Total	9,052	9,080	18,132	9,646	9,639	19,285	12,295	12,293	24,588

Table 3.5.8 Aircraft Movement by Type of Flights as of 1992

Unit : movement

Type of Flights		1992 Departure	1992 Arrival	Total	Share (%)
Commercial Flights					
International Flights					
Passenger Flights					
	Scheduled	3,471	3,474	6,945	24.6%
	Non Scheduled	171	175	346	1.2%
	Sub Total	3,642	3,649	7,291	25.8%
Cargo Flights					
	Non Scheduled	153	153	306	1.1%
	Total	3,795	3,795	7,590	26.9%
Domestic Flights					
	Scheduled	7,285	7,282	14,567	51.6%
	Non Scheduled	1,215	1,209	2,424	8.6%
	Sub Total	8,500	8,491	16,991	60.2%
Total of Commercial Flights		12,295	12,286	24,581	87.0%
Total of Army Flights		1,833	1,824	3,657	13.0%
Total		14,128	14,110	28,238	

Source : DCA

Note : Army Flight Movement Data is from June 1992 to December 1992 and January 1993 to April 1993.

Table 3.5.9 Aircraft Movements Classified by Airlines as of 1992

International

Unit : movement

Airlines		1992 Departure	1992 Arrival	Total	Share (%)
Royal Nepal Airlines	(RA)	1,484	1,483	2,967	39.1%
Indian Airlines	(IC)	815	816	1,631	21.5%
Druk Air of Bhutan	(KB)	215	215	430	5.7%
Biman Bangladesh Airlines	(BG)	221	221	442	5.8%
Pakistan International Airlines	(PK)	108	108	216	2.8%
China Southwest Airlines	(SZ)	52	52	104	1.4%
Aeroflot Soviet Airlines	(SU)	70	70	140	1.8%
Thai Airways International	(TG)	220	220	440	5.8%
Singapore Airlines	(SQ)	56	56	112	1.5%
Dragonair of Hong Kong	(KA)	132	132	264	3.5%
Lufthansa German Airlines	(LH)	204	20	224	2.9%
Others		218	409	627	8.3%
Total		3,795	3,802	7,597	100.0%

Table 3.5.9 Aircraft Movements Classified by Airlines as of 1992 (Con't)

Domestic

Unit : movement

Airlines		1992 Departure	1992 Arrival	Total	Share (%)
Nepal Airways	(7E)	747	744	1,491	8.8%
Everest Air	(E2)	1,172	1,169	2,341	13.8%
Royal Nepal Airlines	(RA)	5,949	5,946	11,895	70.0%
Necon Air	(3Z)	396	394	790	4.6%
Others		236	238	474	2.8%
Total		8,500	8,491	16,991	100.0%

Table 3.5.10 Aircraft Movement by Type of Aircraft as of 1991

Type of Aircraft	International		Total	Share	Domestic		Total	Share
	Departure	Arrival		(%)	Departure	Arrival		(%)
B767	16	16	32	0.4%				
B757	719	721	1,440	19.0%	24	22	46	0.3%
B737	226	227	453	6.0%				
B727	739	735	1,474	19.4%	105	105	210	1.2%
B707	123	123	246	3.2%				
A300	365	364	729	9.6%				
A310	97	97	194	2.6%				
A320	775	776	1,551	20.4%				
DC10	48		48	0.6%				
BATP	13	12	25	0.3%				
BA146	206	206	412	5.4%				
IL76	119	124	243	3.2%				
TU154	83	82	165	2.2%				
HS748	12	13	25	0.3%	1,460	1,461	2,921	17.2%
PC6					236	235	471	2.8%
BH06					65	67	132	0.8%
D228					1,105	1,103	2,208	13.0%
F28	172	172	344	4.5%				
DHC6	23	24	47	0.6%	4,631	4,626	9,257	54.5%
Y12					777	774	1,551	9.1%
Others	59	110	169	2.2%	97	98	195	1.1%
Total	3,795	3,802	7,597	100.0%	8,500	8,491	16,991	100.0%

Source : DCA

Table 3.5.11 Load Factor by Route by Type of Aircraft as of 1992

International

Route	Type of Aircraft	Capacity (seats)	Number of Flights	Number of Passengers	Passengers per Flight	Load Factor (%)	Route Share (%)
Bangkok	B-757	190	279	38,902	139	73.2%	
	B-727	119	96	8,002	83	69.7%	
	DC-8	234	4	723	181	77.4%	
	A-300	247	435	76,217	175	70.9%	
Sub Total			814	123,844			18.2%
Bombay	B-757	190	112	13,016	116	61.1%	
	B-727	119	40	3,388	85	71.4%	
	TU134	72	2	50	25	34.7%	
Sub Total			154	16,454			2.4%
Calcutta	B-727	119	250	23,536	94	79.0%	
	B-757	190	16	1,804	113	59.5%	
	A-320	162	352	40,980	116	71.6%	
Sub Total			618	66,320			9.7%
Delhi	B-727	119	1,040	11,392	11	9.2%	
	B-737	120	26	2,404	92	76.7%	
	B-757	190	454	67,933	150	78.9%	
	DC-8	234	11	1,825	166	70.9%	
	A-320	162	702	85,118	121	74.7%	
Sub Total			2,233	168,672			24.7%
Dhaka	DC-10	270	72	8,788	122	45.2%	
	A310	164	98	9,401	96	58.5%	
	A300	247	12	724	60	24.3%	
	B-737	120	264	13,710	52	43.3%	
	BATP	44	26	1,055	41	93.2%	
	F-28	85	334	16,462	49	57.6%	
	TU154	132	4	474	119	90.2%	
Sub Total			810	50,614			7.4%
Dubai	B-757	190	179	25,433	142	74.7%	
	A-310	164	4	644	161	98.2%	
	DC-8	234	15	2,607	174	74.4%	
Sub Total			198	28,684			4.2%
Hong Kong	B-757	190	326	40,312	124	65.3%	
	B-727	119	6	669	112	94.1%	
	B-767	235	2	365	183	77.9%	
	DC-8	234	8	1,068	134	57.3%	
Sub Total			342	42,414			6.2%

Table 3.5.11 **Load Factor by Route by Type of Aircraft as of 1992 (Con't)**

Karachi	A-300	247	152	21,135	139	56.3%	
	A-310	164	76	7,990	105	64.0%	
	B-707	200	58	5,208	90	45.0%	
	B-737	120	6	439	73	60.8%	
Sub Total			292	34,772			5.1%
Lhasa	B-707	200	156	13,006	83	41.5%	1.9%
Paro	BA-146	77	34	934	27	35.1%	0.1%
Singapore	A-310	164	4	679	170	103.7%	
	B-757	190	3	174	58	30.5%	
Sub Total			7	853			0.1%
Varanasi	B-737	120	167	14,656	88	73.3%	
	A-320	162	466	56,112	112	69.1%	
	HS748	44	14	415	30	68.2%	
Sub Total			647	71,183			10.4%
Sarjah	TU-154	132	128	11,028	86	65.2%	1.6%
Others			1,164	52,983			7.8%
Total			7,597	681,761			100.0%

Domestic

Route	Type of Aircraft	Capacity (seats)	Number of Flights	Number of Passengers	Passengers per Flight	Load Factor (%)	Route Share (%)
Bhairahawa	DHC6	18	182	2,920	16.0	88.9%	
	PC6	6	4	5	1.3	21.7%	
	D228	18	36	302	8.4	46.7%	
Sub Total			222	3,227			1.2%
Bharatpur	DHC6	18	693	10,424	15.0	83.3%	
	PC6	6	2	5	2.5	41.7%	
	D228	18	375	4,026	10.7	59.4%	
	Y-12	16	10	134	13.4	83.8%	
	HS748	44	70	1,802	25.7	58.4%	
Sub Total			1,150	16,391			6.2%
Biratnagar	DHC6	18	816	12,244	15.0	83.3%	
	PC6	6	9	18	2.0	33.3%	
	D228	18	446	6,174	13.8	76.7%	
	Y-12	16	321	4,236	13.2	82.5%	
	HS748	44	717	26,979	37.6	85.5%	
Sub Total			2,309	49,651			18.8%

Table 3.5.11 Load Factor by Route by Type of Aircraft as of 1992 (Con't)

Jumla	DHC6	18	73	886	12.1	67.2%	
	D228	18	59	622	10.5	58.3%	
Sub Total			132	1,508			0.6%
Lukla	DHC6	18	2,017	22,361	11.1	61.7%	
	PC6	6	8	15	1.9	31.7%	
	Y-12	16	502	4,833	9.6	60.0%	
Sub Total			2,527	27,209			10.3%
Mountain	DHC6	18	6	46	7.7	42.8%	
	PC6	6	46	206	4.5	75.0%	
	D228	18	536	7,364	13.7	76.1%	
	HS748	44	544	15,468	28.4	64.5%	
	B727	119	158	9,830	62.2	52.3%	
	B757	190	30	3,068	102.3	53.8%	
Sub Total			1,320	35,982			13.7%
Pokhara	DHC6	18	1,138	16,547	14.5	80.6%	
	PC6	6	8	17	2.1	35.0%	
	D228	18	534	7,312	13.7	76.1%	
	Y-12	16	468	5,041	10.8	67.5%	
	HS748	44	1,128	38,381	34.0	77.3%	
Sub Total			3,276	67,298			25.5%
Rumjatar	DHC6	18	360	5,891	16.4	91.1%	
	PC6	6	2	2	1.0	16.7%	
Sub Total			362	5,893			2.2%
Simra	DHC6	18	670	11,784	17.6	97.8%	
	HS748	44	12	260	21.7	49.3%	
Sub Total			682	12,044			4.6%
Tumlingtar	DHC6	18	426	6,774	15.9	88.3%	
	D228	18	2	19	9.5	52.8%	
	Y-12	16	4	41	10.3	64.4%	
Sub Total			432	6,834			2.6%
Jana Kpur	DHC6	18	271	4,182	15.4	85.6%	1.6%
Bhojpur	DHC6	18	227	3,688	16.2	90.0%	1.4%
Phapul	DHC6	18	276	4,342	15.7	87.2%	
	PC6	6	4	4	1.0	16.7%	
	D228	18	24	149	6.2	34.4%	
	Y-12	16	4	56	14.0	87.5%	
Sub Total			308	4,551			1.7%
Meghauli	DHC6	18	216	2,781	12.9	71.7%	
	D228	18	4	22	5.5	30.6%	
	HS748	44	26	762	29.3	66.6%	
Sub Total			246	3,565			1.4%

Table 3.5.11 Load Factor by Route by Type of Aircraft as of 1992 (Con't)

Ramechhap	DHC6	18	301	5,414	18.0	100.0%	2.1%
Lamidada	DHC6	18	228	3,870	17.0	94.4%	1.5%
Balewd	DHC6	18	66	984	14.9	82.8%	0.4%
Nepalgunj	DHC6	18	510	7,379	14.5	80.6%	
	D228	18	7	50	7.1	39.4%	
	Y-12	16	68	587	8.6	53.8%	
	HS748	44	58	1,164	20.1	45.7%	
Sub Total			643	9,180			3.5%
Dhangadhi	DHC6	18	98	1,518	15.5	86.1%	
	HS748	44	2	78	39.0	88.6%	
Sub Total			100	1,596			0.6%
Ru Kum Kot	DHC6	18	39	462	11.8	65.6%	
Total			14,841	263,529			100.0%

3.6 Rescue and Fire Fighting Service

3.6.1 Existing Vehicles

The following vehicles are operated;

a. Medium foam tender : 2-4, 100 liter (1975)
b. Medium foam tender : 1-6, 000 liter (1993)
c. Water tender : 1-16, 000 liter (1993)
d. Ambulance : 1 (1983)

A protein type foam is used.

3.6.2 Water Reservoir

At present, one water reservoir (45, 000 litter) is installed at the fire station site.

3.6.3 Well

A well is provided in the fire station site and well water is lifted to the elevated tank as required.

3.6.4 Operation

Rescue and fire fighting system is operated all day by one Station in charge and 53 staff in a three shift operation system as follows;

a. Morning shift : 22 staff
b. Day time shift : 22 staff
c. Night time shift : 9 staff

3.7 Security

3.7.1 Type and numbers of security system or facilities

At present, the following systems or facilities are installed in the airport ;

(1) Airside

a. Security fence

A security fence is installed along the airport boundary line, but some parts are broken or lacking.

b. Security walls

The security walls are installed in the terminal area and connected to each building to separate air side and landside.

(2) International passenger terminal

a. X-ray detectors

Two X-ray detectors are installed in the check-in lobby to check the passenger's luggage and four detectors are installed at the entrance to the departure lounge to check cabin baggage. One X-ray detector is for transit passengers.

b. Metal detector

Three walk through type metal detectors are installed at the entrance to the departure lounge. One walk through type metal detectors is for transit passengers.

c. Hand carry detector

Eleven hand carry type detectors are provided in the international passenger terminal and one in the VIP building.

d. CCTV system

The system consists of eleven monitor TVs, eleven color cameras and eight monochrome cameras.

(3) Domestic passenger terminal

Body inspection booths and cabin baggage inspection desks are provided in the domestic passenger terminal.

3.8 Airport Utilities

The section includes the following systems of the airport;

a. Electrical power supply system
b. Power supply to remote stations of NAVAID system
c. Telephone system
d. Water supply system
e. Sewerage system
f. Solid waste disposal system
g. Flight information system
h. Public address system

3.8.1 Electrical power supply system

The electrical power supply system of the airport consists of the following main items;

a. 11 kV Power service lines
b. Main substation
c. Emergency power supply
d. Power distribution lines

Outline of these facilities at present is as follows;

(1) 11 kV Power service lines

Electrical power is supplied from two separate substations belonging to the NEA (Nepal Electricity Authority), named CHAVEL substation and BANESWOR substation, in the manner of three phase three conductors, 11 kV, 50 Hz.

The type of 11 kV ring bus or service lines from these substations to the branch point of the airport main access road and Kathmandu ring road is by overhead line. At this point, overhead cables are connected to underground cables terminated at the main substation in the manner of an underground line.

(2) Main substation

The main substation is located next to the north side of the operation building and has the dimensions of 30m X 9m.

Not only the substation but also the emergency generator and aeronautical ground lighting CCRs are installed in this building.

The building is separated into five rooms, from north to south, the 11 kV switch gear room, main transformer room, low tension switch gear room, generator room and aeronautical ground lighting CCR room.

The main substation building and equipment were completed in 1984.

The main substation consists of the following main equipment;

a. Two 11 kV receiving switch gears specified as 11 kV, 250 MVA, 400A, oil circuit breakers

b. One 11 kV main switch gear specified as 11 kV, 250 MVA, 400A oil circuit breaker

c. Three voltage regulators specified as single phase, 11 kV, 400A

Note : At present, these voltage regulators are not used and 11 kv mains are directly connected to feeder panels through by path switch because capacity is smaller than the maximum load.

d. Two 11 kV feeder panels provided with three phase load break switches and power fuses

e. Two main transformers specified as 11 kV/ 400-230V, 750 kVA, oil immersed natural air cooling type

f. Two LT main switch gears specified as 600V, 1600A, air circuit breakers

g. LT bus separated into four sections as emergency bus, essential bus, non essential bus A and non essential bus B

The emergency bus is connected to the emergency generator, so that the consumers connected to this bus are supplied with power, even if both normal power supplies from NEA are interrupted.

The two non essential buses are only connected to the normal power supply, so that all consumers connected to these buses have power stopped during interruptions of normal power .

h. LT distribution boards connected to each LT bus and each distributor consists of one molded case circuit breaker, ammeter and ammeter switch rated to match the connected consumer loads

(3) Emergency power supply

One 360 kW (450 kVA) air cooled radiator type diesel engine driven generator is installed in the generator room and an extension for the new 500 kW emergency generator is under construction.

The existing generator will still supply power to emergency consumers, and the new one will be an alternative to the existing generator.

These two generators may be connected to each bus by a bus tie breaker when one generator is out of order, but these generators may not run in parallel.

A fuel service tank for the existing generator is installed in the generator room with a capacity of 1, 000 liters, for minimum of 17 hours operation.

(4) Power distribution lines

Power distribution lines from main substation to each consumer are composed as follows:

CIRCUIT SCHEDULE OF EMERGENCY POWER

Feeder Code	Branch Breaker	Conductor Size sq. mm	Consumer
AFL	400AT	22-150	AERONAUTICAL GROUND LIGHT
DP7	200	400	INT'L PAX TERMINAL
DP4	400	2-150	OPE. & AIRLINE BLDG.
PRA	40	16	PARKING LIGHTS
AEB	100	50	APRON LIGHTS
SEA	50	50	MAIN SUBSTATION
ARL	40	16	AIR SIDE ROAD LIGHTS
***	40	35	EXIST. FIRE STATION
***	100	50	MISCELLANEOUS PANEL
***	60	35	STP PANEL
	100		SPARE
	40		SPARE
	40		SPARE

CIRCUIT SCHEDULE OF ESSENTIAL POWER

Feeder Code	Branch Breaker	Conductor Size sq. mm	Consumer
DP5	400AT	2-400	INT'L PAX TERMINAL
DP3	200	150	OPE. & AIRLINE BLDG.
RLA	100	95	ROAD LIGHTS
***	30	16	SEWAGE LAGOON
	200		SPARE
	200		SPARE
	100		SPARE
	60		SPARE

CIRCUIT SCHEDULE OF NON-ESSENTIAL POWER

Feeder Code	Branch Breaker	Conductor Size sq. mm	Consumer
DP2	400AT	2X150	OPE. & AIRLINE BLDG.
DP6	600	3X150	INT'L PAX TERMINAL
***	800	2X400	EMERGENCY BUS
	200		SPARE
	200		SPARE
	200		SPARE
	200		SPARE
	200		SPARE
	200		SPARE
	100		SPARE
	100		SPARE
	100		SPARE
	100		SPARE
	100		SPARE
	60		SPARE
	60		SPARE

INT'L : INTERNATIONAL
PAX : PASSENGER TERMINAL
BLDG : BUILDING
OPE : OPERATION
*** : NO CODE

All feeder cables are 1100V class XLPE insulated aluminum conductor and armored type.

Feeder cables in external areas are installed by an underground direct burial system. However, some parts of the feeder cables crossing paved areas are installed in PVC conduits.

(5) Operation and maintenance

All electrical power supply systems mentioned above are operated and maintained by the electrical engineering division of the airport office, comprising of two engineers, ten technicians and four helpers in two shift operation as follows;

a. Morning time (6:00 to 12:00) : 5 persons
b. Day time (12:00 to 22:00) : 5 persons
c. Night time (22:00 to 6:00) : 1 person

During the morning and day time, five persons are on stand by.

3.8.2 Power supply to the remote stations of the NAVAID system

At present, seven NAVAID stations are located remotely from the airport and they are supplied with power from NEA's 11 kV, 3 phase, 3 wire 50 Hz distribution line or L.T. distribution lines in the manner of 3 phase, 4 wire, 400/230V and 50 Hz.

Each remote station is provided with an emergency generator unit with a suitable capacity and of a diesel engine driven type.

These generators will automatically start when normal power is interrupted and the main feeder of the equipment will automatically change over from normal supply to emergency supply.

A list of these stations is as follows;

EMERGENCY GENERATOR INSTALLED IN REMOTE STATIONS

STATION CODE	CAPACITY OF GENERATOR	STATION
VOR / DME	1-15 KW	KOTESWOR
RPT	1-25 KW	PHULCHAUKI
L / S	1-1.5 KW	THECHO
L / E	1-1.5 KW	NALINCHOK
RX (OLD) * 1	1-25 KW	SANOTHIMI
TX	1-100 KW and 1-56 KW	SINAMANGAL
L / W	Solar Power	DHARKE

Notes *1 : RX (OLD) station is not operated at present.

These power supply systems are operated and maintained by the electrical section of TIAO as mentioned in section 3.8.1.

BUS SCHEDULE

A = EMERGENCY BUS 400V 3Ø 4W 800A

B = ESSENTIAL BUS 400V 3Ø 4W 1600A

C = NON ESSENTIAL BUS- B 400V 3Ø 4W 1600A

D NON ESSENTIAL BUS-A 400V 3Ø 4W 1600A

NOTE:
*1 UNDER CONSTRUCTION

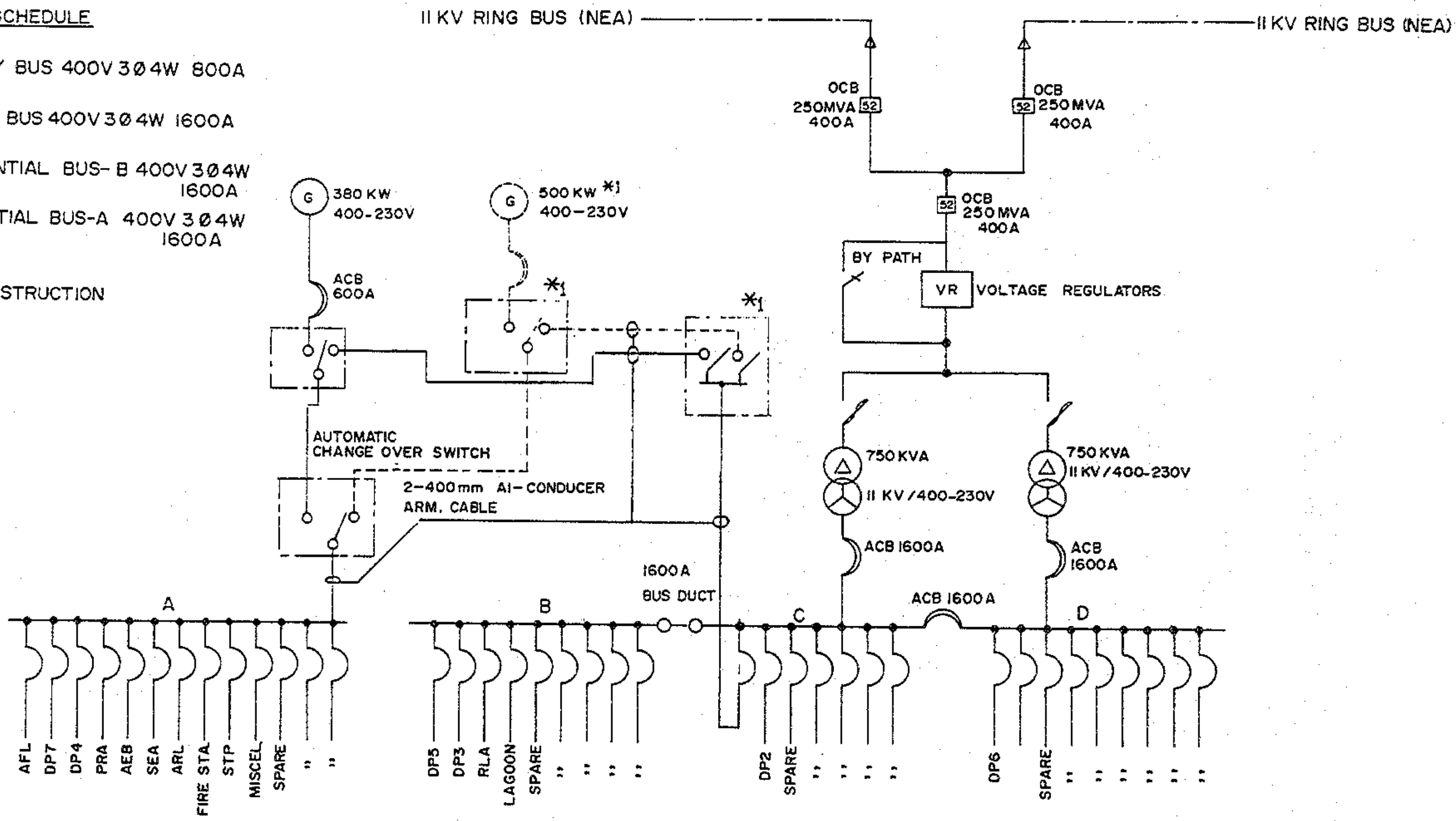


Figure 3.8.1 Main Substation Diagram

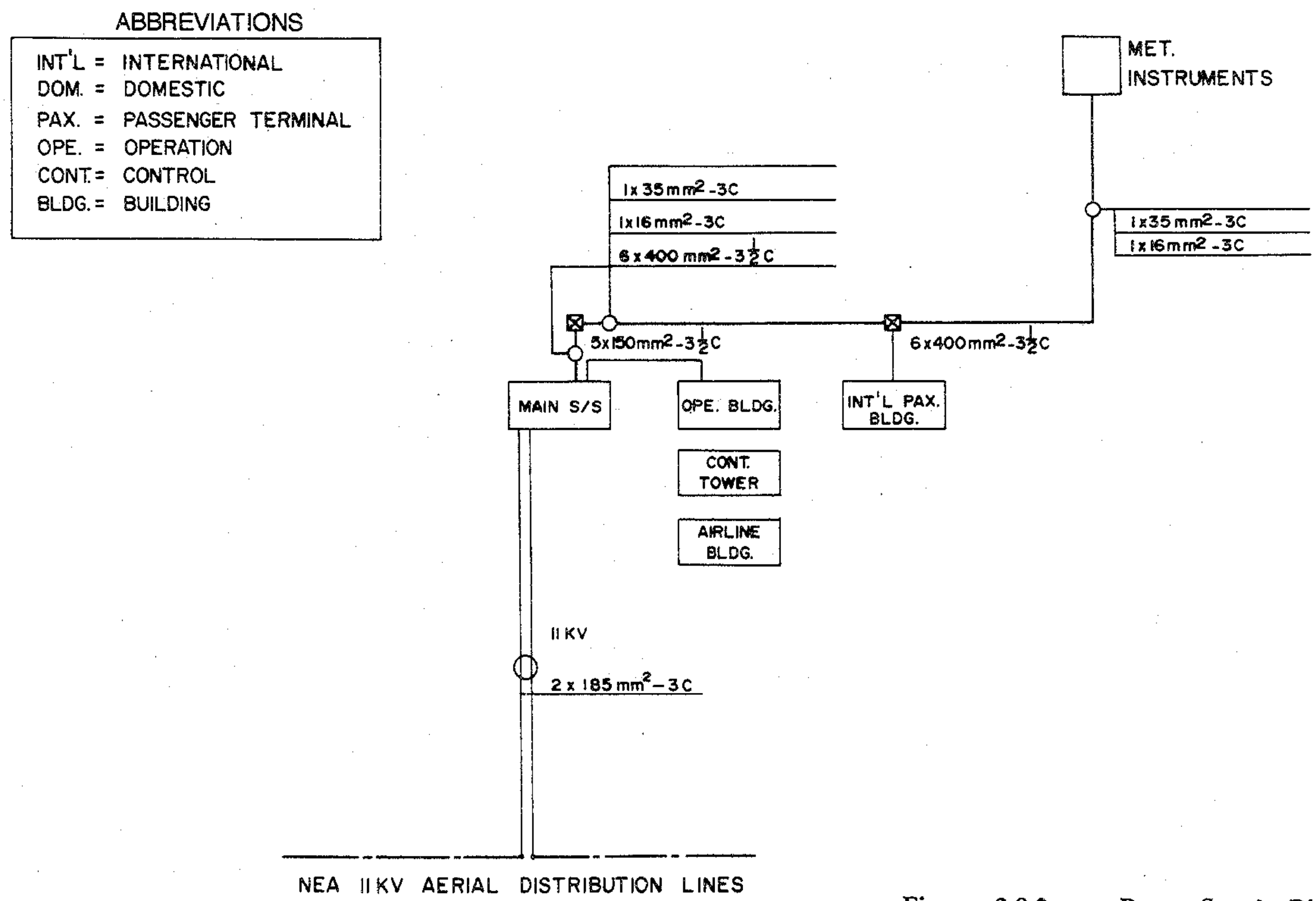


Figure 3.8.2 Power Supply Diagram

3.8.3 Telephone system

The telephone system of the airport consists of the following main items;

a. Telephone service lines
b. Private automatic branch exchange (PABX)
c. Branch cable lines

(1) Telephone service lines

Underground telephone cables, 2 no. 100 pair telephone cables, are installed between the end of pole mounted cables belonging to the Nepal Telecommunication Corporation (NTC) junction box on Kathmandu ring road and the PABX Room in the operation building.

(2) Private automatic branch exchange (PABX)

The PABX is installed in the PABX room in operation building.

Outline of the PABX is as follows;

a. City line capacity	: 200 lines
b. Branch line capacity	: 1000 lines
c. Connected branch lines	: 240 lines

(3) Branch cable lines

The following branch cables are installed to each facilities.

a. To International passenger terminal	: 2-100 pairs
b. To Fire station	: 1-50
c. To main substation	: 1-10
d. To Airline building	: 1-100

All branch cables in external areas are installed by an underground direct burial system. However, some parts of branch cables crossing paved areas are installed in PVC conduits.

(4) Telephone service lines to other buildings

The existing VIP building, domestic passenger terminal building and hangers are not included in the service area of the PABX, and separate telephone service cables are installed to these buildings by the NTC.

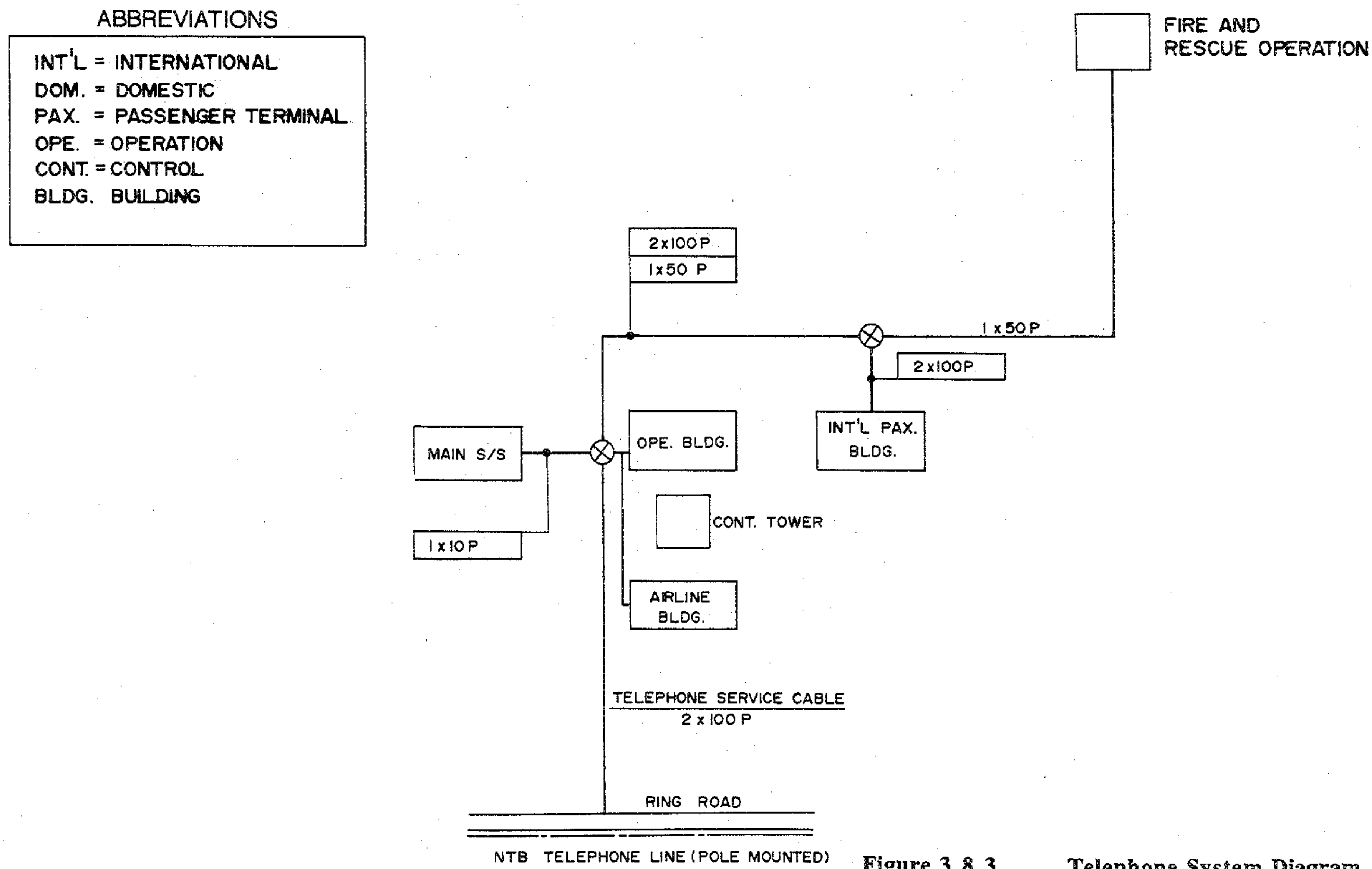


Figure 3.8.3 Telephone System Diagram

3.8.4 Water supply system

The water supply system of the airport consists of the following main items;

a. Kathmandu City water supply line
b. Wells in the airport
c. Elevated water tanks
d. Water supply pipe lines

(1) Kathmandu City water supply line

At present, Kathmandu city water is supplied to a booster pump station located on the western side about 650 m from the runway by a 200 mm dia. water main. The boosted water then goes into the airport's elevated tanks by a 100 mm dia. forced main line.

The daily supply capacity of the city water is between 25,000 liters and 45,000 liters.

(2) Well in the airport

At present, one well is constructed south of the international passenger terminal, with a capacity of 2.7 liters per second.

Water from the well is treated and transferred to the forced city main line.

(3) Elevated water tanks

There are two elevated water tanks in the airport, the capacity of one is 312,000 liters and the other is 79,000 liters.

Each tank is used in parallel operation.

(4) Water supply pipe lines

One 150 mm dia. water supply pipe is installed along the road leg of the airport, and supplies water to the operations and airlines building and the international passenger terminal.

For the existing VIP building, the domestic passenger terminal building and hangars, water is supplied from the big overhead tank.

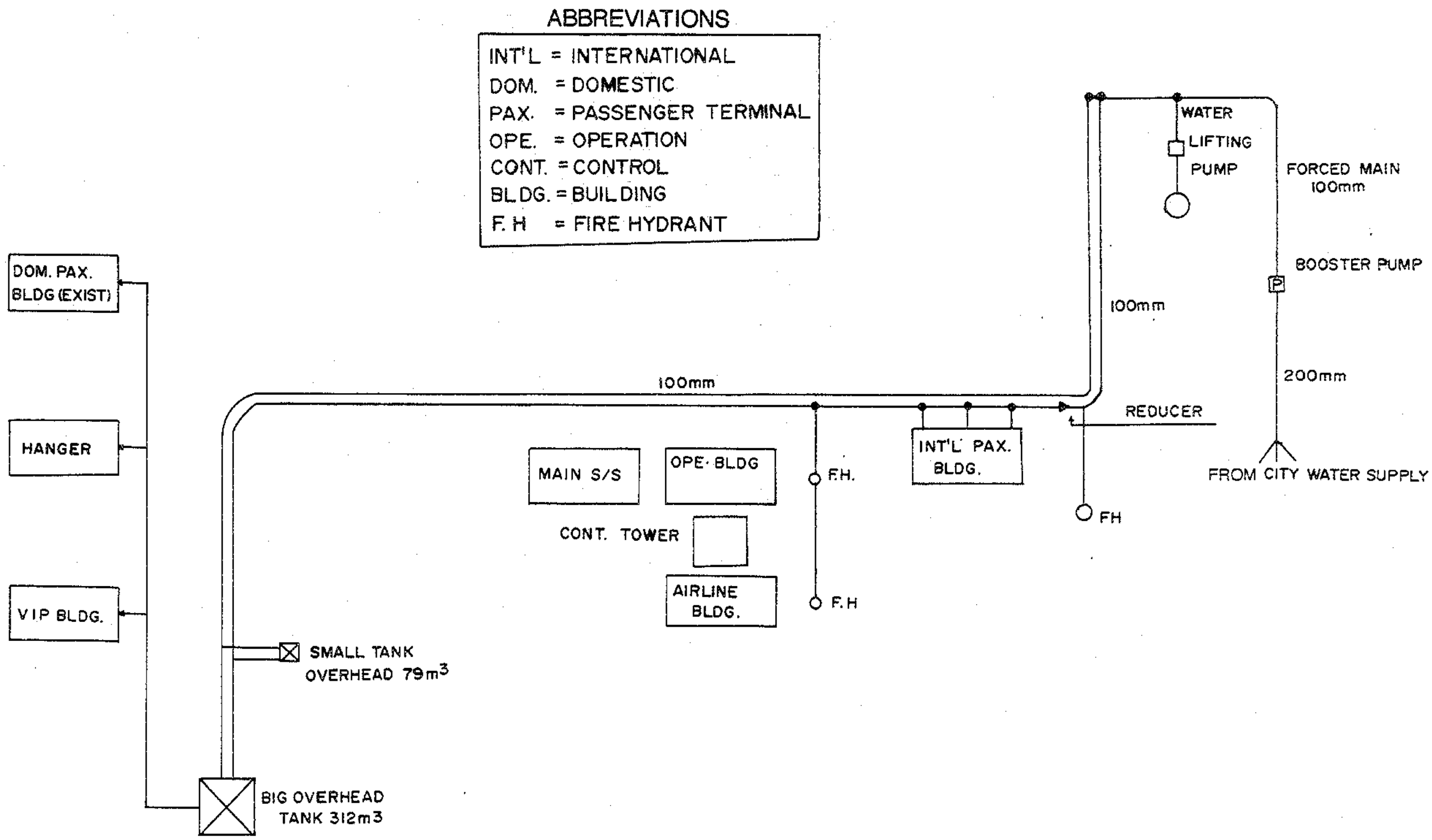


Figure 3.8.4 Water Supply Diagram

3.8.5 Sewerage system

The sewerage system of the airport consists of the following main items:

a. Sewage lagoon
b. Waste water pipelines

(1) Sewage lagoon

The sewage lagoon is located about 140m west of the international passenger terminal building.

The dimensions of lagoon are as follows;

a. Bottom area	:	12m x 12m = 144 sq. m
b. Top area	:	33m x 33m = 1, 089 sq. m
c. Usable depth	:	2m
d. Effective volume	:	672 cu. m

The system is a natural aired and percolation system.

(2) Waste water pipe lines

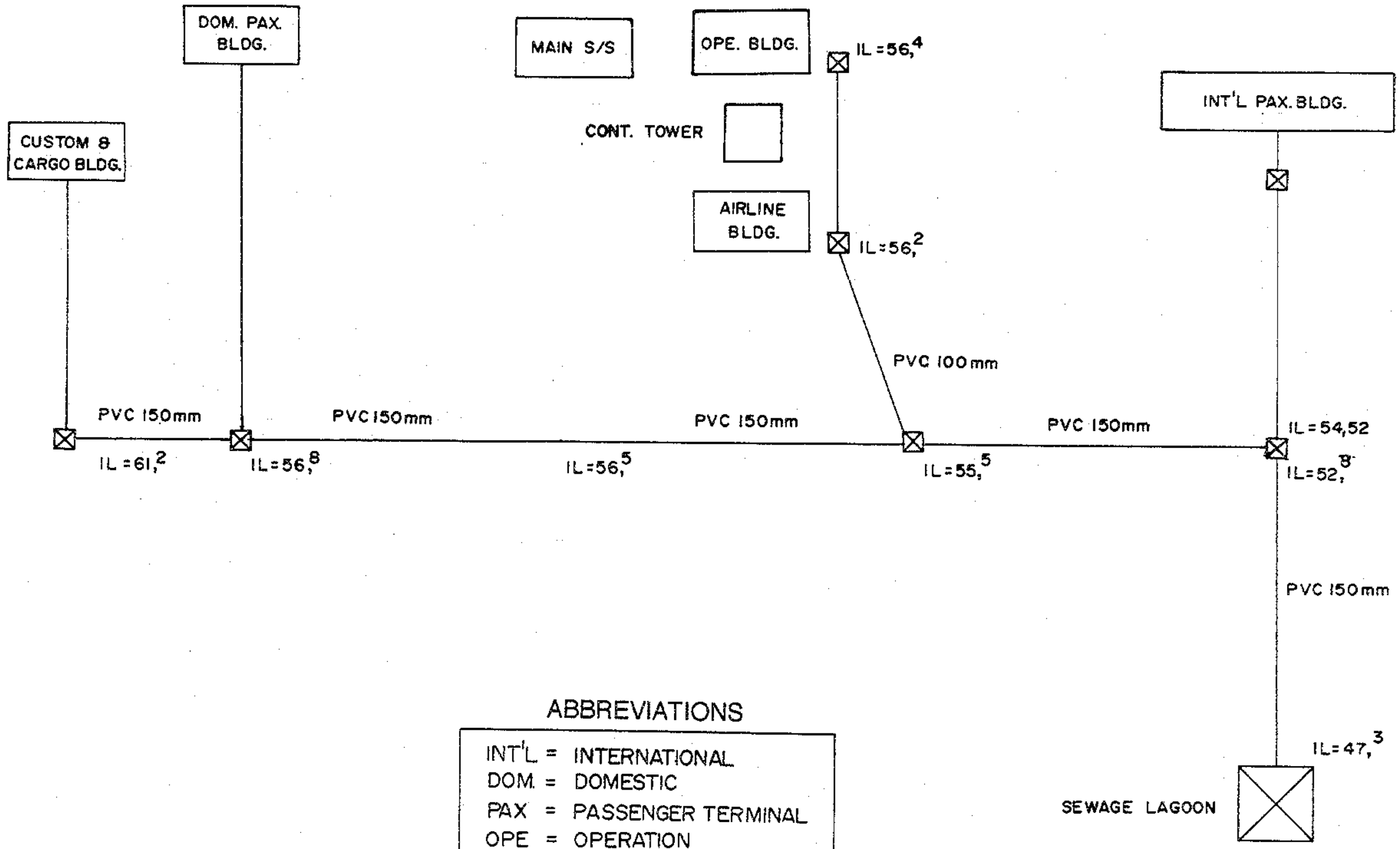
A waste water main pipe line is installed from the sewage lagoon to the first drop manhole located about 60 m west from the international passenger terminal and then, installed in parallel to the center line of the road leg A up to the fifth manhole located about 430 m north of the first manhole and 30 m west of the planned site of new cargo terminal building.

The main lines are PVC 150 mm dia.

The sewage branch pipe lines for the international passenger terminal and the operations and airlines building are installed from each building to the nearest manhole.

The branch lines are PVC 100 mm dia.

Manholes are installed for future connections from the planned domestic passenger terminal and custom/cargo building.



ABBREVIATIONS

INT'L = INTERNATIONAL
DOM. = DOMESTIC
PAX = PASSENGER TERMINAL
OPE = OPERATION
CONT = CONTROL
BLDG = BUILDING

Figure 3.8.5 Sewage System Diagram

3.8.6 Solid waste disposal system

All solid waste disposal is handled by contractors and carried out by their trucks every day.

3.8.7 Flight information system

The system consists of a control console, electric display boards and CRT displays.

Display systems are installed as follows;

a. Departure public lobby	:	1-Electric display (departure) 2-CRT displays (departure)
b. Check in lobby	:	1-CRT display (departure)
c. Departure lounge	:	1-Electric display (departure)
d. Baggage claim	:	4-CRT displays (arrival)
e. Arrival public lobby	:	2-CRT displays (arrival) 1-Electric display (arrival)

At present, the electrical display system is under maintenance.

3.8.8 Public address system

The international passenger terminal is provided with a public address system consisting of a main amplifier, control console and local speakers.

The system is operated under normal conditions.

3.8.9 Fire alarm system

The international passenger terminal, the operations and airlines building and the main substation are provided with a fire alarm system.

Each alarm station, which consists of an alarm bell and an alarm push button switch, are controlled by the central alarm panel in each building and also the main alarm panel in the fire station.

3.8.10 Paging system

The international passenger terminal, the operations and airlines building and the main substation are covered by a radio paging system.

The person in charge of each section, who carries a paging receiver, will be called to contact by the telephone when it is necessary.

3.8.11 Public address room

The public address room is located on the second floor of the international passenger terminal and is provided with the following equipment to operate and control each system.

a. Flight information boards and TV cameras
b. PA system rack and controller
c. Fire alarm panel for international passenger terminal
d. Paging system controller

3.8.12 CCTV system

The CCTV control monitoring and recording are located on the second floor of the ITB in the CCTV room.

3.8.13 Demand and extension capacity of utility system

Precise demand or consumption of electrical power, telephone lines, water, waste water and solid waste is not clear, however an average value for each system is as follows;

(1) Electrical power

The average electric power demand is estimated from the data of daily maintenance records as follows:

	Consumer	Emergency	Non-Emergency
1.	Passenger Terminal Building	66 kVA	235 kVA
2.	Operation/Airline Building	11	90
3.	Fire Station	12	90
4.	Aeronautical Ground Light	83	---
5.	Apron Flood Light	13	---
6.	Others	10	25
	Total	195 kVA	350 kVA

These data means average value of each consumer, then the peak load of the main transformers in established as 650 kVA as shown where load factor is 84 percent.

$$(195 + 350) / 0.84 = 649 \text{ (kVA)}$$

(2) Telephone

The capacity of branch lines of the existing PABX is 1000 lines with 240 lines used at present and 560 lines will be provided for the future extension.

(3) Water

The daily average water consumption of all facilities in the airport is 200 cu. m.

Supply capacity of each source is as follows ;

a. City water supply : 25 to 45 cu. m per day
b. Airport's well : 2.7 liter per second
or 9.7 cu. m. per hour
When well is operated 10 hours per day ;
97 cu. m. per day

Total 122 to 142 cu. m. per day

Short falls are supplied by tanker lorry, 78 to 58 cu. m. per day

For the future extension of the airport facilities, DCA has been studying to dig new wells.

(4) Waste water

Waste water volume is estimated at nearly equal to the supply water volume, that is about 200 cu. m.

(5) Extension capacity

Average demand or consumption and extension capacity of each utility system is as follows ;

SYSTEM	EXISTING CAPACITY	DEMAND / CONSUMPTION	EXTENSION CAPACITY
Electrical			
Transformers	1500 kVA	650 kVA	950 kVA
Emergency Generator	450 kVA	195 kVA	265 kVA
Extension Emergency Generator	625 kVA	149 kVA	476 kVA
Water			
City water	Max. 45 cu. m	200 cu. m/d	None
Well	97 cu. m	-	None
New wells	Under study		
Waste water Lagoon	672 cu. m	200 cu. m/d	

3.9 Fuel Supply System

Fuel tanks are located at the west side of the runway and at the south side of the international passenger terminal and are operated by the Nepal Oil Corporation Ltd. (NOC).

At present, three fuel tanks for aviation fuel (JET - A1) are installed. Each capacity is 700 kilo liters making the storage capacity 2100 kilo liters.

Daily fuel consumption is 84 to 140 kilo liters. This means 588 to 980 kilo liters in a week.

Fuel supply to aircraft is performed by refuelers and NOC possesses six refuelers as follows;

a. 27 kilo liter class : 2 cars
b. 16 kilo liter class : 2 cars
c. 12 kilo liter class : 2 cars

The fuel is transported by land and a minimum of 12 tank lorries are operated in a day.

The NOC is studying the following items;

a. Expansion of the storing capacity to 7,000 kilo liters by 1995
b. Estimated fuel consumption will be 4,100 kilo liters per month
c. Purchasing a 45 to 70 kilo liter class refueler or installation of fuel hydrant system for the operation of big aircraft in the future.
d. Acquisition of a new site in accordance with the relocation of the parallel taxiway.

3.10 Present Development Works

(1) The newest facilities of the airline/operation and international building complex, which has changed TIA into a modern international airport, were completed in 1989. These are the beginning of the modernization of TIA, and were mainly financed by the Asian Development Bank using a loan.

(2) The second package of projects is now under way by the same loan of ADB. It consists of the following works;

a. Apron expansion and road works

Expansion of the international apron to accommodate future larger types of aircraft such as B-747 in the year 2000. After the completion, it will be able to handle 2 no. B-747, 1 no. MD-11, 1 no. B-767 and 3 no. B-757.

An airside road, airline ground support storage and apron bus parking will also be provided.

One problem is that the tail of a B-747 in the parking position will not be able to clear the transitional surface.

b. Carpark

A carpark with a capacity of 96 cars and taxis, 13 buses and 17 motorcycles in front of the future domestic passenger terminal building

c. Runway and taxiway improvement

40 mm thickness asphalt concrete overlay on the runway and the parallel taxiway

Rubber deposit removal from the touch-down zone of RWY 02

d. Runway shoulder improvement

Widening the existing runway shoulder by 2 m to 7.5 m in order to meet the ICAO requirement

e. Water supply

Two (2) new wells.

These works are expected to be completed June 1994.

3.11 Land Use surrounding Airport

The present Tribhuvan International Airport is located approximately 7 km east of Kathmandu city. There are a great number of villages in the vicinity of the airport, and mainly rice plantation constitutes the central agriculture practice. Also there are several commercial shops and open air markets. The Ring Road runs near the west of the airport and the Arniko Highway runs to the south.

The Bagmati river runs on the west side and the Monohara river runs on the east side in a north to south direction from the airport. There is also a Holy Hindu temple to the west of the airport and covers a large area along both sides of the Bagmati river. The main temple lies on the west side bank. Additionally, to the south side and within the premises of the airport, a mini golf course, the Royal Nepal Golf Course, is located. Furthermore, on the west side of the golf course, and along the Ring Road, there is a garbage treatment plant but it's capacity is small.

The grassland within the airport is used as grazing land for goats and cows by the surrounding inhabitants. This is due to the destruction of the fencing wire that surrounds the airport.

3.12 Environmental Conditions

3.12.1 Social Environment

In this area has active social and economic activities. The Ring Road runs next westward from the airport, but presently, the effect of traffic noise pollution is not that pronounced.

There is no archeological and no cultural heritage around the airport, but one of the most important temples, the Pasupatinath Temple is situated 500 meters north-east of the airport terminal building.

3.12.2 Natural Environment

The airport itself is located 30 to 50 meters higher than the surrounding ground. The slope collapse on the eastern side is extremely bad, and when large amounts of precipitation occurs, sediment from the slope flows down. To the north, the Bagmati river is running nearby.

As for the surrounding area, the land is used for agriculture so that one can see little natural forest. However, around the Pasupatinath Temple, and in-between the river and the airport, a rich forest is located, and a few animals are present, especially being famous for it's monkeys.

Although, few flight hindrance cases on account of birds are reported annually, it is not a great problem. Even so, it is necessary to undertake investigations annually.

There is no special structure that is detrimental to the natural scenery.

3.12.3 Pollution

The airport and the road network are one of the factors which result in environmental damage to the surrounding area. It is anticipated that atmospheric pollution is generated by exhaust gas from aircraft and vehicles.

As regards the waste water drained out of the airport facilities and storm water, presently they are collected in a collecting pond located south of the terminal building, and made to flow out by natural percolation treatment.

There are 6 schools and 1 college lying in the southern area of the airport. Because of this either sound proofing measures have to be taken, or consideration be made to move them.

3.12.4 Environmental Legislation

In Nepal environmental legislation, and environmental standards are present under consideration, but so far they do not exist.

3.13 Soil Investigation

A soil investigation was carried out from 26 July to 23 August, 1993. The work items were as follows :

- Mechanical Boring
- Standard Penetration Test
- Thin - Wall Sampling
- Laboratory CBR Test
- Other Laboratory Tests

The summary and conclusions of the soil investigation are shown in Appendix 3.13.1.

CHAPTER 4

AIR TRAFFIC DEMAND FORECAST

CHAPTER 4 AIR TRAFFIC DEMAND FORECAST

4.1 General

4.1.1 Forecasting Conditions

(1) Forecast Year

For the annual air traffic forecast, the forecast years are assumed as 1995, 2000, 2003, 2005 and 2010.

(2) Forecast Method

The forecast method is by regression analysis.

4.1.2 Socio-economic Framework

In the regression analysis, some available data, i.e. GDP (Gross Domestic Product) of Nepal, GDP of OECD (Organization for Economic Co-operation and Development) members and GDP of India were utilized as variables.

(1) Actual Trends of GDP

The actual trends of the GDP data of Nepal, OECD members and India during 1983 - 1992 are shown in Table 4.1.1.

Table 4.1.1 Actual Trends of GDP Data

Year	GDP of Nepal 1974/75 Constant Price (Billion Rs.) 1)	GDP of OECD Members 1987 Constant Price (Billion US$) 2)	GDP of India 1987 Constant Price (Billion Rp.) 3)
1983	22.3	8,769	2,776
1984	23.6	8,946	2,879
1985	24.6	9,148	3,034
1986	25.6	10,951	3,171
1987	27.5	12,347	3,326
1988	28.7	13,394	3,651
1989	31.0	13,926	3,834
1990	32.4	14,318	4,013
1991	33.1	14,747	4,214
1992	34.1	15,190	4,424

Source: 1) Statistical Year Book of Nepal 1993
2) Estimated based on Statistics on Development Indicators (United Nations)
3) World Table 1992, World Bank

(2) Future Values of GDP

The future values of GDP data were estimated based on the assumed annual growth rates as shown in Table 4.1.2. The annual growth rates of Nepal's GDP during 1990 - 2000 are set up to be 5.1% based on the target value in the Eighth National Plan (1992 - 1997). After 2000, the annual growth rates are assumed to be 4.0%.

The annual growth rates of OECD member's GDP during 1990 - 2010 are assumed to be 3.0% on the basis of the projection of OECD ("Long-term Prospects for the World Economy" OECD, 1992).

The annual growth rates of India's GDP are assumed to be 5.0% for the period of 1990 - 2000 based on the projection by World Bank ("Global Economic Prospects and the Developing Countries, 1992", World Bank). Those for the period of 2000 - 2010 are assumed to be 4.0% (see Table 4.1.2).

Table 4.1.2 Assumed Annual Growth Rates of GDP

(%)

Period	GDP of Nepal		GDP of OECD Members		GDP of India	
1990-1995	1)	5.1%	3)	3.0%	4)	5.0%
1995-2000	1)	5.1%	3)	3.0%	4)	5.0%
2000-2005	2)	4.0%	3)	3.0%	5)	4.0%
2005-2010	2)	4.0%	3)	3.0%	5)	4.0%

Note: 1) Eighth National Plan of Nepal
2) Assumed
3) "Long-term Prospects for the World Economy" OECD, 1992
4) "Global Economic Prospects and the Developing Countries, 1992", World Bank
5) Assumed

The estimated results of future GDP values are shown in Table 4.1.3.

Table 4.1.3 Estimated Future GDP Values

Year	GDP of Nepal 1974/75 Constant Price (Billion Rs.)	GDP of OECD Members 1987 Constant Price (Billion US$)	GDP of India 1987 Constant Price (Billion Rp.)
1995	39.6	16,598	5,122
2000	50.8	19,242	6,537
2003	57.1	21,026	7,353
2005	61.8	22,307	7,953
2010	75.1	25,860	9,676

4.2 International Passenger Traffic

4.2.1 General

For the forecast of international passengers traffic, passengers are analyzed separately into foreigners and Nepalese.

According to the actual trend of major tourist arrivals in Nepal by nationality in recent years (refer to Table 2.5.4), the total number of tourist arrivals from regions/countries related to North America, Western Europe, Japan, Australia and India has occupied a share of nearly 90%. This trend is considered applicable also to air traffic movements. (And the regions/countries of North America, Western Europe, Japan and Australia are almost equivalent to the components of OECD members.) Consequently, for the forecast of passenger traffic of foreigners, GDP of OECD members and GDP of India were utilized as variables.

For the forecast of passenger traffic of Nepalese, the GDP of Nepal was adopted as a variable.

4.2.2 Regression Model

The models were formulated as below:

(For Foreigners)

$$Y = 0.007\,X1 + 0.137\,X2 - 156.59$$

where, Y : Number of international passengers (foreigners)
X1 : GDP of OECD members
X2 : GDP of India

(For Nepalese)

$$Y = 8.745\,X - 64.56$$

where, Y : Number of international passengers (Nepalese)
X : GDP of Nepal

4.2.3 Forecast Results

Adopting the future data of GDP (see Table 4.1.3) to the above formula models, the forecast was made, and the results are shown in Table 4.2.1 and Fig. 4.2.1. (As for the details of forecasting, refer to Table 4.1 in the Appendix. As for a comparison with the forecast results of the previous JICA study, refer to Fig. 4.1 in the Appendix.)

Table 4.2.1 International Passenger Traffic Forecast

(Unit: 1,000 persons)

Year	Foreigners	Nepalese	Total
1983	305	110	415
1984	300	165	465
1985	304	179	483
1986	365	158	523
1987	411	163	574
1988	470	158	628
1989	416	198	614
1990	453	146	599
1991	536	245	781
1992	601	179	780
1995	660	280	940
2000	870	380	1,250
2003	1,000	430	1,430
2005	1,090	480	1,570
2010	1,350	590	1,940

Note : The numbers of foreign international passengers during 1983 - 1992 were estimated based on the number of tourist arrivals by air (refer to Table 2.5.1). The number of Nepalese international passengers during 1983 - 1992 were estimated by deducting the foreign passengers estimated above from the total international passengers.

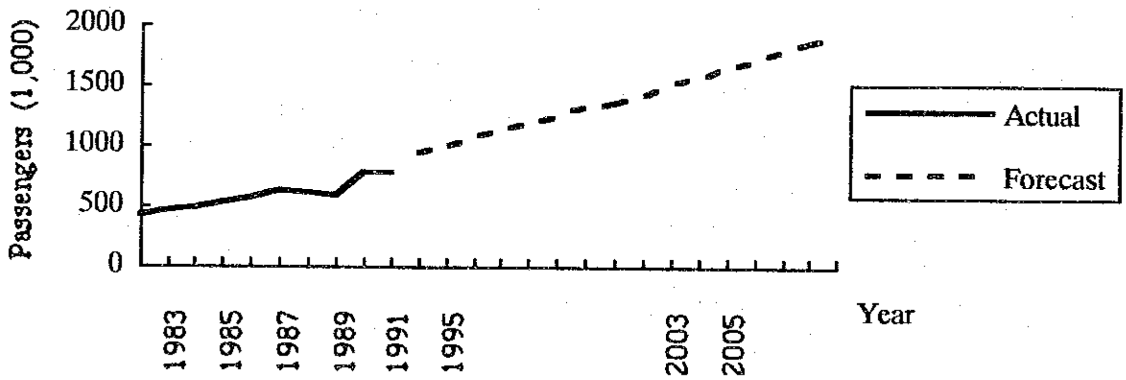


Fig. 4.2.1 International Passengers Traffic Forecast

4.3 Domestic Passenger Traffic

4.3.1 General

For the forecast of domestic passenger traffic, the Nepal GDP was utilized as a variable.

4.3.2 Regression Model

The model is formulated as below:

$$Y = 7.168\,X + 10.026$$

where, Y : Number of domestic passengers
X : GDP of Nepal

4.3.3 Forecast Results

Adopting the future data of GDP (see Table 4.1.3) to the above formula model, the forecast was made and the results are shown in Table 4.3.1. (As for the details of forecasting, refer to Table 4.2 in the Appendix. As for the comparison with the forecast results of the previous JICA study, refer to Fig. 4.2 in the Appendix.)

Table 4.3.1 Domestic Passenger Traffic Forecast

(Unit: 1,000 persons)

Year	Total
1983	153
1984	173
1985	187
1986	203
1987	219
1988	264
1989	204
1990	217
1991	216
1992	292
1995	290
2000	370
2003	420
2005	450
2010	550

As for the forecast value in 1995, in spite of the estimated result by regression analysis, some adjustment was made considering the actual trend in 1992; that is, the 1995 value was adjusted by interpolation between actual 1992 value and forecast 2000 value (See Table 4.3.2 and Fig. 4.3.1).

Table 4.3.2 Adjusted Domestic Passenger Traffic Forecast

(Unit: 1,000 persons)

Year	Total
(1992)	(292)
1995	320
2000	370
2003	420
2005	450
2010	550

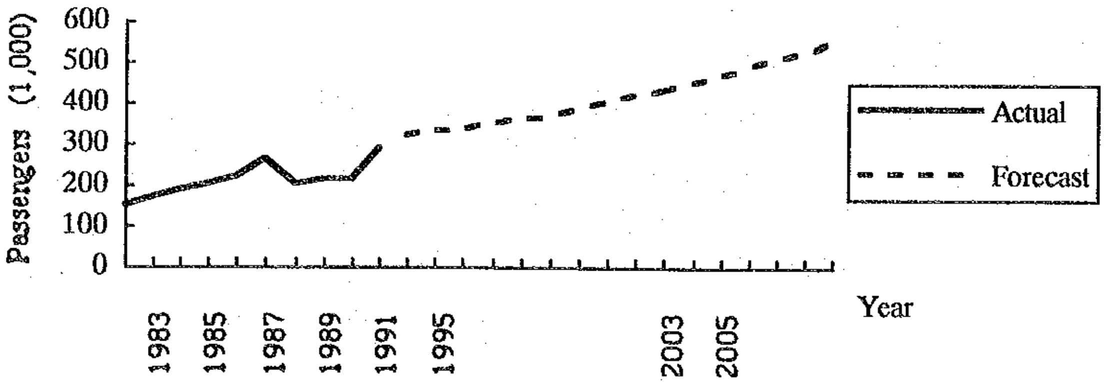


Fig. 4.3.1 Domestic Passenger Traffic Forecast

4.4 International Cargo Traffic

4.4.1 General

For the forecast of the international cargo traffic, cargoes were analyzed separately into loaded cargo and unloaded cargo.

Similarly to the case of international passenger traffic, the movement of loaded cargo in the international cargo traffic is assumed to be influenced mainly by the economic activities of the countries of OECD members and India. Consequently, for the forecast of international loaded cargo traffic, the GDP of OECD members and the GDP of India were utilized as variables.

For the forecast of international unloaded cargo traffic, the GDP of Nepal was adopted as a variable.

4.4.2 Regression Model

The models were formulated as below:

(For Loaded Cargo)

$$Y = 0.367\ X1 + 3.063\ X2 - 9334.014$$

where, Y : Volume of international cargo (loaded)
X1 : GDP of OECD members
X2 : GDP of India

(For Unloaded Cargo)

$$Y = 348.91\ X - 4411.558$$

where, Y : Volume of international cargo (unloaded)
X : GDP of Nepal

4.4.3 Forecast Results

Adapting the future data of GDP (see Table 4.1.3) to the above formula models, the forecast was made, and the results are shown in Table 4.4.1 and Fig. 4.4.1. (As for the details of forecasting, refer to Table 4.3 in the Appendix. As for the comparison with the forecast results of the previous JICA study, refer to Fig. 4.3 in the Appendix.)

Table 4.4.1 International Cargo Traffic Forecast

(Unit: tons)

Year	Loaded	Unloaded	Total
1983	1,673	2,346	4,019
1984	2,400	2,860	5,260
1985	4,172	3,795	7,967
1986	4,450	4,289	8,739
1987	5,917	6,486	12,403
1988	7,664	7,782	15,446
1989	8,811	8,400	17,211
1990	5,218	7,735	12,953
1991	7,389	6,880	14,269
1992	11,815	4,018	15,833
1995	12,450	9,400	21,850
2000	17,750	13,300	31,050
2003	20,900	15,510	36,410
2005	23,210	17,140	40,350
2010	29,790	21,810	51,600

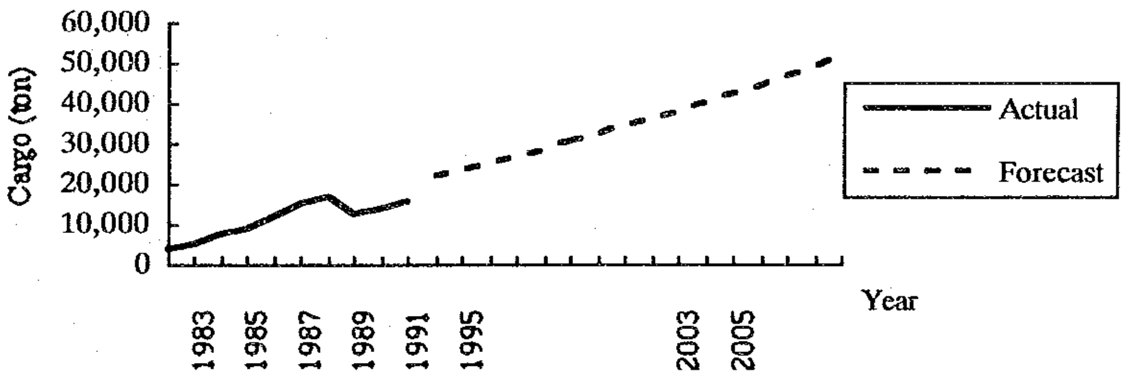


Fig. 4.4.1 International Cargo Traffic Forecast

4.5 Domestic Cargo Traffic

4.5.1 General

For the forecast of domestic cargo traffic, Nepal's GDP was utilized as a variable.

4.5.2 Regression Model

The model was formulated as below:

$Y = 22.755\,X - 171.249$
where, Y : Volume of domestic cargo
X : GDP of Nepal

4.5.3 Forecast Results

Adapting the future data of GDP (see Table 4.1.3) to the above formula model, the forecast was made and the results are shown in Table 4.5.1. (As for the details of forecasting, refer to Table 4.4 in the Appendix. As for the comparison with the forecast results of the previous JICA study, refer to Fig. 4.4 in the Appendix.)

Table 4.5.1 Domestic Cargo Traffic Forecast

(Unit: tons)

Year	Total
1983	352
1984	372
1985	335
1986	369
1987	555
1988	530
1989	497
1990	453
1991	326
1992	680
1995	730
2000	980
2003	1,130
2005	1,230
2010	1,540

Some domestic cargo transportation is conducted by the Air Transportation Support Center at (ATSC) and others are operated on a 9 9
Tribhuvan International Airport. According to information obtained in interviews with DCA staff, the transported volume by ATSC was estimated to be about 458 tons in 1992.

In the air traffic demand forecast study, it was assumed that such a trend in domestic cargo transportation will be continued in the future. Consequently, for the forecast of domestic cargo traffic, the transportation by ATSC was taken into consideration. That is, considering the estimated cargo volume in 1992, a cargo volume of 400 tons is assumed to be plus fixedly to the above forecast volumes for each forcast year. The adjusted forecast results are shown in Table 4.5.2 and Fig. 4.5.1.

Table 4.5.2 Adjusted Domestic Cargo Traffic Forecast

(Unit: tons)

Year	Total
1995	1,130
2000	1,380
2003	1,530
2005	1,630
2010	1,940

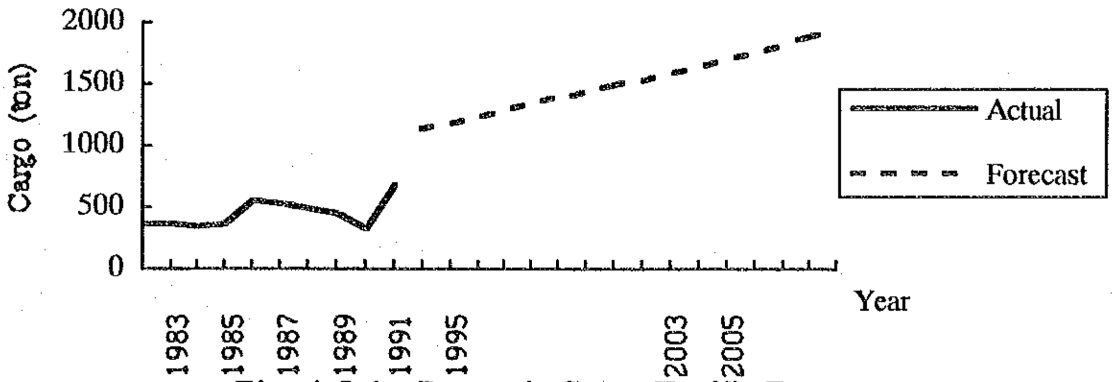


Fig. 4.5.1 Domestic Cargo Traffic Forecast

4.6 Summary of Forecast Results

Table 4.6.1 shows the summary of traffic forecast results on international passengers, domestic passengers, international cargo and domestic cargo.

Table 4.6.1 Summary of Forecast Results

Year	International Passengers (1,000)	Domestic Passengers (1,000)	International Cargo (ton)	Domestic Cargo (ton)
1995	940	320	21,850	1,130
2000	1,250	370	31,050	1,380
2003	1,430	420	36,410	1,530
2005	1,570	450	40,350	1,630
2010	1,940	550	51,600	1,940
(Annual Average Growth Rates)				
1995-2000	5.9%	2.9%	7.3%	4.1%
2000-2005	4.7%	4.1%	5.4%	3.5%
2005-2010	4.3%	4.1%	5.0%	3.5%

4.7 Break Down into Design Basis

The break down of the annual demand into design basis was principally made by the same method as the previous JICA Study in 1989. Some figures such as peak day coefficient were revised based on the recent traffic characteristics.

4.7.1 Type of Aircraft

(1) Aircraft Classification and Seating Capacity

Aircraft to be operated at TIA in the future were classified into several categories by seating capacity as follows:

a) International

Category	Aircraft Type	1995	2003	2010
J	B747-400	-	-	500
L	DC10, MD11, A330, B777	240	280	320
M	B767, A300, A310	230	260	280
N	B757, A320,	190	200	220
S	B737, B727,	140	140	160

b) Domestic

Aircraft Type	Seating Capacity
B757 Class	190
HS748 Class	50
DHC6 Class	20

(2) Load Factor

Present load factors of RNAC flights are 75 to 80% for international flights and 85% for domestic flights. Since these high values, however, will be lowered in future by an increase of capacity, the load factors for the future were established as follows:

International Flights	65 %
Domestic Flights	75 %

(3) Aircraft Mix

An aircraft mix in the future was assumed as shown below based on the aircraft mix established in the previous JICA Study (1989).

a) International

Unit : %

Aircraft Category	1995	2000	2003	2005	2010
J	0.0	0.0	0.0	5.0	10.0
L	12.5	15.0	15.0	15.0	15.0
M	7.5	10.0	12.5	12.5	15.0
N	22.5	25.0	27.5	27.5	30.0
S	57.5	50.0	45.0	40.0	30.0

b) Domestic

Unit : %

Aircraft Category	1995	2000	2003	2005	2010
B757 class	1.0	1.0	2.0	3.0	5.0
HS748 class	19.0	24.0	33.0	35.0	45.0
DHC6 class	80.0	75.0	65.0	62.0	50.0

4.7.2 Peak Hour Forecast

(1) Peak Month Coefficient

Peak month coefficients were established as follows from the traffic data at TIA between 1990 and 1992.

	Passengers	Aircraft Movements
International	1/9.6	1/10.4
Domestic	1/7.5	1/ 8.1

(2) Design Day Coefficient

Design day coefficients were calculated by dividing the peak month coefficient by the average number of days in a month (30.4).

	Passengers	Aircraft Movements
International	1/290	1/320
Domestic	1/230	1/250

(3) Peak Hour Coefficient

Same formula as the 1989 Study

The peak hour coefficients were calculated by the following formulae obtained from actual traffic data at TIA and foreign airports.

International $Y = 1.05/X+0.171$
Domestic $Y = 2.10/X+0.134$

(X = Aircraft movements in design day)

(4) Heavy Direction Ratio

The heavy direction ratio at TIA was estimated to be about 0.6.

4.7.3 Summary of Air Traffic Demand

Air traffic demand at TIA is summarized as shown Table 4.7.1.

Table 4.7.1 Summary of Air Traffic Demand

INTERNATIONAL

YEAR	PASSENGER	AIRCRAFT MOVEMENTS					
		J	L	M	N	S	TOTAL
ANNUAL							
2010	1,940,000	1,180	1,770	1,770	3,540	3,540	11,800
2005	1,570,000	520	1,560	1,300	2,860	4,160	10,400
2003	1,430,000	0	1,710	1,426	3,136	5,130	11,400
2000	1,250,000	0	1,530	1,020	2,550	5,100	10,200
1995	940,000	0	1,062	638	1,912	4,888	8,500
PEAK DAY							
2010	6,690	4	6	6	12	12	40
2005	5,410	2	4	4	8	14	32
2003	4,930	0	6	4	10	16	36
2000	4,310	0	4	4	8	16	32
1995	3,240	0	4	2	6	16	28
PEAK HOUR							
2010	1,320	0.8	1.2	1.2	2.4	2.4	8
2005	1,100	0.4	0.8	0.8	1.6	2.9	6.5
2003	990	0	1.2	0.8	2	3.2	7.2
2000	880	0	0.8	0.8	1.6	3.3	6.5
1995	680	0	0.8	0.4	1.3	3.3	5.8

DOMESTIC

YEAR	PASSENGER	AIRCRAFT MOVEMENTS			
		B757	HS748	DHC6	TOTAL
ANNUAL					
2010	550,000	880	7,880	8,750	17,500
2005	450,000	510	5,920	10,480	16,900
2003	420,000	340	5,540	10,920	16,800
2000	370,000	170	4,100	12,830	17,100
1995	320,000	160	2,960	12,480	15,600
PEAK DAY					
2010	2,390	4	32	36	72
2005	1,960	2	24	42	68
2003	1,830	2	22	44	68
2000	1,610	0	16	52	68
1995	1,390	0	12	50	62
PEAK HOUR					
2010	390	0.7	5.2	5.9	11.8
2005	320	0.3	4	6.9	11.2
2003	300	0.3	3.6	7.3	11.2
2000	270	0	2.6	8.6	11.2
1995	230	0	2	8.4	10.4

Note:
J : B747-400
L : DC10, MD11,A330, B777
M : B767, A300, A310
N : B757, A320
S : B737, B727

CHAPTER 5

AIRPORT FACILITY REQUIREMENTS

CHAPTER 5 AIRPORT FACILITY REQUIREMENTS

5.1 General

This chapter explains the airport facility requirements for Tribhuvan International Airport based on the air traffic demand forecasts in Chapter 4. The facility requirements were estimated basically in compliance with the relevant standards and recommended practices of the International Civil Aviation Organization (ICAO). Those of the Federal Aviation Administration (FAA) of the United States, Japan Civil Aviation Bureau (JCAB) and International Air Transport Association (IATA) are also referred to in areas where the ICAO does not cover or more practical planning is possible by using these standards. The facility requirements for Tribhuvan International Airport were established for the years of 1995, 2000, 2003, 2005 and 2010, and the results are summarized in Table 5.1.1.

5.2 Runway and Runway Strip

5.2.1 Runway

(1) Aerodrome Reference Code and Operational Category

The aerodrome reference code, i.e., code number and code letter will be as shown in Table 5.2.1 in accordance with the largest aircraft anticipated to serve the airport. The operational category of the main approach runway at Tribhuvan International Airport will be a non-precision approach runway.

Table 5.2.1 Aerodrome Reference Code and Operational Category

Year	1995	2000	2003	2005	2010
Reference Code	4D	4D	4D	4E	4E
Operational Category	Non -Precision Approach	ditto	ditto	ditto	ditto

5.2.2 Runway Strip

The runway strip should be extended before the threshold and beyond the end of the runway for a distance of at least 60 m where the aerodrome code number is 4.

As for the width of the runway strip, ICAO stipulates as a standard that at least a 300 m wide strip shall be provided for a precision runway of the code number 3 or 4, wherever practicable. This expression is toned down to a recommendation desirable in the interest of safety although the width of the runway strip for a non-precision instrument runway is the same 300 m as that of the precision runway.

Table 5.1.1 Summary of Airport Facility Requirements

Item	Unit	Year						Remarks
		Present	Future Demand					
		1992	1995	2000	2003	2005	2010	
1 Annual Passengers								
International		780,000	940,000	1,250,000	1,430,000	1,570,000	1,940,000	
Domestic		292,000	320,000	370,000	420,000	450,000	550,000	
Total		1,072,000	1,260,000	1,620,000	1,850,000	2,020,000	2,490,000	
2 Annual Cargo								
International	ton	15,833	21,850	31,050	36,410	40,350	51,600	
Domestic	ton	680	1,130	1,380	1,530	1,630	1,940	
Total	ton	16,513	22,980	32,430	37,940	41,980	53,540	
3 Annual Aircraft Movements								
International		7,597	8,500	10,200	11,400	10,400	11,800	
Domestic		16,991	15,600	17,100	16,800	16,900	17,500	
Total		24,588	24,100	27,300	28,200	27,300	29,300	
4 Maximum Aircraft Operated		DC10class	MD11 class	MD11 class	MD11 class	B747	B747	
5 Peak Day Passengers								
International		2,700	3,240	4,310	4,930	2,005	6,690	
Domestic		1,300	1,390	1,610	1,830	1,960	2,390	
Total		4,000	4,630	5,920	6,760	3,965	9,080	
6 Peak Day Aircraft Movements								
International		24	28	32	36	32	40	
Domestic		68	62	68	68	68	72	
Total		92	90	100	104	100	112	
7 Peak Hour Passengers								
International		580	680	880	990	1,100	1,320	
Domestic		210	230	270	300	320	390	
Total		790	910	1,150	1,290	1,420	1,710	
8 Peak Hour Aircraft Movements								
International		5	5.8	6.5	7.2	6.5	8.0	
Domestic		11	10.4	11.2	11.2	11.2	11.8	
Total		18	16.2	17.7	18.4	17.7	19.8	

Item	Unit	Year						
		Present	Future Requirement					
		1992	1995	2000	2003	2005	2010	beyond 2010
1 ICAO Aerodrome Reference Code		4D	4D	4D	4D	4E	4E	4E
2 Runway								
Length	m	3,050	3,050	3,050	3,050	3,050	3,050	3,050
Width	m	45	45	45	45	45	45	45
3 Runway Strip								
Length	m	3,140	3,140	3,140	3,140	3,140	3,140	3,170
Width	m	150	150	150	150	150	150	300
4 Parallel Taxiway								
System		Partial	Partial	Partial	Partial	Partial	Partial	Full
Width	m	23	23	23	23	23	23	23
Separation Distance with Runway	m	109	176	176	176	182.5	182.5	182.5
5 Apron (Number of Stands)								
International								
B747-400 class	no.	-	-	-	-	2	2	
MD11 class	no.	1	2	2	3	1	2	
B767/A300 class	no.	2	1	1	1	1	2	
B757/B737 class	no.	3	5	5	5	5	5	
Total	no.	6	8	8	9	9	11	
Domestic								
HS748 class	no.		2	2	3	3	3	
DHC6 class	no.	3	3	3	3	3	3	
Total	no.	3	5	5	6	6	6	
6 Passenger Terminal Building(Floor Area)								
International	sq.m	10,750	17,000	22,000	25,000	28,000	33,000	
Domestic	sq.m	700	4,200	5,000	5,400	5,800	7,100	
Total	sq.m	11,450	21,200	27,000	30,400	33,800	40,100	
7 Cargo Terminal Building								
International	sq.m	-	4,400	6,200	7,200	8,100	10,300	
Domestic	sq.m	-	250	300	300	350	400	
Total	sq.m	3,500	4,650	6,500	7,500	8,450	10,700	
8 Car Parking								
International	sq.m	17,000	9,500	15,400	17,500	19,300	27,700	
Domestic	sq.m	0	3,200	4,900	5,300	5,600	8,100	
Total	sq.m	17,000	12,700	20,300	22,800	24,900	35,800	
9 Rescue and Fire-Fighting Facilities								
Level of Protection		5	7	7	7	8	8	
Number of Vehicles (RIV)	no.	0	1	1	1	1	1	
(Major vehicles)	no.	4	2	2	2	3	3	
10 Airport Utilities								
Electricity	KVA	650	1,700	2,100	2,300	2,500	3,000	
Water Supply	t/day	130	330	410	460	500	600	
Sewage Disposal	t/day	130	330	410	460	500	600	
Solid Waste Disposal	kg/day	-	1,800	2,200	2,400	2,500	3,000	
11 Aviation Fuel supply								
Tank Capacity	KL	2,100	1,600	1,900	2,000	2,000	2,400	
Fuel Depot Area	sq.m		7,000	7,000	7,000	7,000	8,500	

5.3 Taxiway and Apron

5.3.1 Taxiway

(1) Taxiway System

A complete parallel taxiway with right angle exits is economically justified where the number of instrument approaches exceeds four during the normal peak hour. Based on this criterion, Tribhuvan International Airport should be provided with a complete parallel taxiway or equivalent taxiway system. It will be evaluated in Chapter 6 whether the existing partial taxiway will cope with future increases of peak hour aircraft movements in terms of capacity.

(2) Taxiway Width and Separation Distance

The width of the taxiway is 23 m where it is intended to be used by aircraft such as A-300 and B-747. The width of the shoulders for the aerodrome codes 4D and 4E are 7.5 m and 10.5 m respectively according to the ICAO.

The separation distance between centerlines of the runway and parallel taxiway for an instrument runway is stipulated to be 176 m and 182.5 m for the aerodrome codes 4D and 4E by ICAO. The FAA provides a smaller separation distance of 135 m for B-747 aircraft for airports between elevations of 410 m and 2000 m.

The distance from the taxiway (other than aircraft stand taxi lanes) centerline to objects such as parked aircraft is set at 40.5 m and 47.5 m for the aerodrome codes 4D and 4E by ICAO.

5.3.2 Apron

(1) Number of Aircraft Stands

The number of required aircraft stands for the loading/unloading of passengers was calculated using the following formula:

$$S = \sum_{i}^{n} \frac{Ti}{60} \times \frac{Ni}{2} \times a + b \qquad (5.3.1)$$

where,
- S : Number of loading stands
- Ti : Apron occupancy time of aircraft category (i) in minutes (International: 90, Domestic B757 class: 60, Domestic Small Aircraft: 30)
- Ni : Number of movements of aircraft category (i) during peak hour
- *a* : Allowance for special occasions (= 1.2)
- *b* : Extra stands for special occasions

The total number of aircraft stands by aircraft type was estimated as shown in Table 5.3.1. Since the B757 of RNAC are operated for both international and domestic (mountain) flights, the aircraft stands for B757 class aircraft may be used in common for international and domestic aircraft to reduce the total number of stands.

Table 5.3.1 Number of Aircraft Stands

Type of Stand	Aircraft Type	1995	2000	2003	2005	2010
International	B747-400 class	0	0	0	2(*)	2(*)
	MD11 class	2(*)	2(*)	3(*)	1	2
	B767 / A300 class	1	1	1	1	2
	B757 class	2	2	2	2	3
	B737 class	3	3	3	3	2
	Total	8	8	9	9	11
Domestic	HS748 class	2(*)	2(*)	3(*)	3(*)	3(*)
	DHC6	3	3	3	3	3
	Total	5	5	6	6	6

Note (*): Including one extra stand.

(2) Size of Aircraft Stands

The sizes of the aircraft stands for each category of aircraft are shown in Table 5.3.2.

Table 5.3.2 Size of Aircraft Stands

Category	Width of Stand*	Parking Configuration
B747-400 class	75 m	Nose-in
MD11 class	70 m	Nose-in
B767 / A300 class	60 m	Nose-in
B757 / B737 class	45 m	Nose-in
HS748 class		Self-maneuvering
DHC6 class		Self-maneuvering

Note*: Including wing tip clearance

5.4 Passenger and Cargo Terminal Buildings

5.4.1 Passenger Terminal Building

The floor area required for the passenger terminal building is estimated by using the following formula:

RTA = UA x PAX

where, RTA : Required floor area (sq.m)
UA : Unit floor area required per peak hour passenger
PAX : Number of peak hour passengers (2-ways)

A unit floor area of 25 sq.m/peak hour passenger for the international area and 18 sq.m/peak hour passenger for the domestic area were adopted for floor area required based on the applicable planning practice in Japan and other countries.

Table 5.4.1 Required Floor Area of Passenger Terminal Buildings

(Unit: sq.m)

Item	1995	2000	2003	2005	2010
a) International	17,000	22,000	25,000	28,000	33,000
b) Domestic	4,200	5,000	5,400	5,800	7,100

5.4.2 Cargo Terminal Building

The floor area required for the cargo terminal building was estimated based on the annual cargo volume and unit cargo handling capacity. For the calculation of the floor area of the cargo terminal building, the unit capacity of 5 ton/sq.m was adopted for both international and domestic cargo terminal building considering the improvement of efficiency of cargo handling system by further mechanization in the future. In addition airline offices, cargo agent offices, customs offices etc. were included in the required floor areas.

Table 5.4.2 Required Floor Area of Cargo Terminal Building

(Unit: sq.m)

Item	1995	2000	2003	2005	2010
a) International	4,400	6,200	7,200	8,100	10,300
b) Domestic	250	300	300	350	400
c) Total	4,650	6,500	7,500	8,450	10,700

5.5 Car Parking

The following formula was used to calculate the required number of parking lots:

LOT = PAX x PR -- (5.3.2)

where, LOT : Required number of parking lots
PAX : Number of peak hour passengers (2-way)
PR : Parking ratio (Number of parking cars / Peak hour passengers)

Parking ratios were assumed as shown in Table 5.5.1 considering the popularization of private cars in future. The required total car park area was estimated as shown in Table 5.5.1 by applying a unit space of 35m² for a parking lot which includes internal roads and a green zone in addition to net parking lots.

Table 5.5.1 Required Number of Parking Lots and Carpark Area

Item	1995	2000	2003	2005	2010
International					
Parking Ratio	0.4	0.5	0.5	0.5	0.6
Number of lots	270	440	500	550	790
Car Park Area (m^2)	9,500	15,400	17,500	19,300	27,700
Domestic					
Parking Ratio	0.4	0.5	0.5	0.5	0.6
Number of lots	90	140	150	160	230
Car Park Area (m^2)	3,200	4,900	5,300	5,600	8,100

5.6 Rescue and Fire-Fighting Facilities

The facility requirements for the rescue and fire fighting services were estimated in compliance with the ICAO Airport Service Manual. For the planning of rescue and fire fighting services, the levels of protection were be determined first. Those for B747 class aircraft are Category-9. However, these can be reduced to a lower level since the number of aircraft movements of Category-9 is less than 700 in a consecutive three months. Therefore, the levels of protection for year 2010 were estimated to be Category-8. The levels for 2003 were estimated to be Category-7. The requirements of fire fighting services for the corresponding levels of protection are shown in Table 5.6.1.

Table 5.6.1 Requirements of Rescue and Fire Fighting Services

Item	2003 (Category-7)	2010 (Category-8)
Principal Extinguishing Agent	Performance level B	Performance Level B
- Water (L)	12,100	18,200
- Discharge Rate (L/min) (*)	5,300	7,200
Complementary Agent	Dry Chemical Powder, or Halon	Dry Chemical Powder, or Halon
- Amount (kg)	225	450
Rescue and Fire Fighting Vehicles		
- Minimum Number of Vehicles	2	3
Fire Station		
- Floor Area	450 m^2	450 m^2

Note (*): 50% of this discharge rate should be attained by the RIV.

The location of the fire station should be planned to achieve a response time not exceeding three minutes to the ends of runway as well as any other part of the movement area. An ICAO recommendation states that the response time is considered to be the time when the first responding vehicle is in position to apply foam at a rate of at least 50% of the discharge rate specified in the above table.

5.7 Airport Utilities

The airport utility requirements were calculated based on the unit demand shown in Table 5.7.1.

Table 5.7.1 Unit Utility Demand

Utilities	Unit Demand		
Electricity	Passenger Terminal Building	:	100 VA/m^2
	Cargo Terminal Building	:	60 VA/m^2
	Administration Building and other	:	80 VA/m^2
	Equipment	:	Calculated by Equipment
Water and Sewage	Passenger Terminal Building	:	23 $L/m^2/day$
	Cargo Terminal Building	:	3 $L/m^2/day$
	Administration Building and others	:	10 $L/m^2/day$
Waste	Passenger Terminal Building	:	0.070 $kg/m^2/day$
	Cargo Terminal Building	:	0.140 $kg/m^2/day$
	Administration Building and others	:	0.140 $kg/m^2/day$

The demands of airport utilities anticipated at Tribhuvan International Airport were estimated as shown in Table 5.7.2 by multiplying the above unit demand by the required floor area of each building.

Table 5.7.2 Airport Utility Demands

Item		1995	2000	2003	2005	2010
a) Electricity Demand	(KVA)	1,700	2,100	2,300	2,500	3,000
b) Water Demand	(ton/day)	330	410	460	500	600
c) Sewage	(ton/day)	330	410	460	500	600
d) Waste Disposal	(kg/day)	1,800	2,200	2,400	2,500	3,000

5.8 Aviation Fuel Supply

The fuel supply requirements were calculated by multiplying the trip fuel by the number of departing flights for each route and aircraft type. The required fuel storage capacity was estimated based on the calculated fuel requirements and the assumption that the fuel for seven-days consumption will be stored. Tank capacity also includes the margin of 30 % of the stored fuel volume. The aviation fuel storage requirements as well as required area for a fuel depot for the year 2003 and 2010 were estimated as shown in **Table 5.8.1**.

Table 5.8.1 Requirements for Aviation Fuel Storage and Fuel Depot Area

	Item	1995	2000	2003	2005	2010
a)	Tank Capacity (KL)	1,600	1,900	2,000	2,000	2,400
b)	Fuel Depot Area (m^2)	7,000	7,000	7,000	7,000	8,500

CHAPTER 6

EVALUATION OF EXISTING AIRPORT

CHAPTER 6 EVALUATION OF EXISTING AIRPORT

6.1 General

Compared to the present conditions and the surrounding environment of TIA, the requirements described in Chapter 5 were analyzed and evaluated for planning.

Table 6.1.1 summarizes the comparison of the characteristics of the existing facilities and ICAO recommendations. Table 6.1.2 shows the capacity of the existing airport facilities and future demands.

6.2 Runway

6.2.1 Runway Classification

The operational category of the runway (runway classification) will remain a "NON-PRECISION APPROACH" as studied in Chapter 10.

6.2.2 Length

(1) The existing runway is capable of accommodating international long haul aircraft. However, some aircraft will be subject to weight restrictions when taking off at TIA due to the inadequate runway length.
Table 6.2.1 shows the take-off performances and flight distance with a full load of passengers for typical aircraft types on runway lengths of 3,050m (existing), 3,300m and 3,500m.

In this Table, it is shown that weight restriction will be imposed more or less on the operations of each aircraft because of runway length, the elevation, the airport temperature and the difference in the runway center elevation.

Table 6.2.2 shows Allowed Cabin Loads (ACL) for flights between Kathmandu and Bangkok. Even though weight restrictions remain, the flight operation works well.

From the viewpoint of aircraft operations, it is desirable to extend the runway length to utilize the full capacity of aircraft.

(2) However, the approach areas for RWY 20 and 02 will arise against the extension works, as follows;

i) Approach area for RWY 02

There are smokestacks, high broadcasting antennas and high hills in and around this area which are obstacles projecting into the obstacle limitation boundaries. Unless they can be removed and or reduced in height, these objects will become new obstacles for the southern-extended runway.

ii) Approach area for RWY 20

There is a steep cliff close to the runway end, and a river which runs across the approach area. Furthermore, there are high hills which stand closer. Thus, these topographical conditions will become critical for aircraft operation when the runway is extended to the north. Also, embankment modification will be difficult and costly work.

As a result, it is not recommendable to extend the runway under the present conditions. However, it may be continually studied in accordance with technological innovations of navigational aids and aircraft.

Table 6.1.1 Comparison of Existing Facility Characteristics with ICAO Recommendations

ITEM	Unit	PRESENT CONDITION	ICAO RECOMMENDATION		CONFORMITY WITH ICAO RECOMMENDATIONS		
					Present	2003	2010
Aerodrome Code		4D	4D	4E			
			Non-Precision Approach				
Runway							
Width	m	46	45	45	Y	Y	Y
Max. Slope(Longitudinal) (a quarter of runway length at each end)	%	1.25	0.8	0.8	N	N	N
(remaining section)	%	1.35	1.25	1.25	N	N	N
Max. Slope (Transverse)	%	N.A.	1.5	1.5			
Shoulder Width	m	2	7.5	7.5	N *1	N *1	N *1
Max. Shoulder Slope	%	2.5	2.5	2.5	N	N	N
Runway Strip							
Length	m	3,140	*2 3,170	*2 3,170	N	N	N
Width	m	150	300	300	N	N	N
Max. Slope(Longitudinal)	%	1.35	1.75	1.5	Y	Y	Y
Max. Slope (Transverse)	%	1.5	2.5	2.5	Y	Y	Y
Parallel Taxiway							
Width	m	23	23	23	Y	Y	Y
Max. Slope(Longitudinal)	%	1.312	1.5	1.5	Y	Y	Y
Max. Slope (Transverse)	%	1.5	1.5	1.5	Y	Y	Y
Overall Width incl.Shoulder	m	27	38	44	N	N	N
Separation Distance with;							
Runway Center Line	m	109	176	182.5	N	N	N
Object	m	30	40.5	47.5	N	N	N

Y : conforms with ICAO recommendation
N : does not conform with ICAO recommendation

*1 : This recommendation will be satisfied by the on-going project.
*2 : 3,050 m + 60 m x 2

Table 6.1.2 Capacity and Demand of Existing Facilities

Facility	Capacity	Demand 2003	Demand 2010	Serviceable Period (93 95 2000 03 05 10)
Runway		*	*	
Length	3050	(3050)	(3050)	————
Capacity				
Movement / Hour	19 (IFR)	18.4	19.8	————
Pavement		**	**	
PCN / ACN	54 PCN	53 ACN	52 ACN	————
Apron				
International Apron				
Number of Aircraft Stands				X
B747-400 class	-	-	2	
MD11 class	1	3	2	
A300 class	2	1	2	
B757 class	-	5	5	
B727 class	3	-	-	
Total	6	9	11	
Area (sq.m)	35,547			
Pavement				
PCN	53	53	52	————
Domestic Apron				
Number of Aircraft Stands				X
B757 class		*** (1)	*** (1)	
HS748 class		3	3	
DHC6 class	3	3	3	
Total	3	6	6	
Area (sq.m)	5,640			
Passenger Terminal Building	****			
Floor Area (sq.m) (Int'l)	10,750	25,000	33,000	X
(Dom)	700	5,400	7,100	X
Cargo Terminal Building				
Floor Area (sq.m)	3,500	7,500	10,700	—
Car Park				
Number of lots	141	650	1,020	X
Rescue and Fire				
Category	5	7	8	X

Note: X indicates that the facility has reached its capacity.
- * : Weight restriction is required.
- ** : ACN of Maximum aircraft operated.
- *** : Common use with international stands.
- **** : Unit floor area per a peak hour passenger for the int'l terminal building
  - Existing building : 13sq.m
  - New building : 25sq.m

PCN : Pavement Classification Number
ACN : Aircraft Classification Number
IFR : Instrument Flight Rules

Table 6.2.1 Takeoff Performance at TIA by Different Types of Aircraft

Aircraft Type	Runway Length (m)	Flap (deg)	MTOW (lbs)	AGTOW (lbs)	Weight Restriction (lbs)	Full PAX. @200 (lbs)	OEW plus Reserved Fuel (1.25h) (lbs)	Loading Fuel (lbs)	Flight Distance (mile)
DC-10-10	3,050	15°	443,000	384,900	58,100	54,000 (270)	263,300	66,700	2,220
	3,300			405,900	37,100			88,600	2,950
	3,500			420,000	23,000			102,700	3,420
B-747-200C Passenger	3,050	20°	785,000	638,000	147,000	100,000 (500)	407,900	130,100	2,760
	3,300			669,600	115,400			153,700	3,270
	3,500			677,700	107,300			169,800	3,610
B-767-300ER	3,050	20°	407,000	366,000	41,000	57,000 (290)	209,638	98,362	5,120
	3,300			379,000	28,000			111,362	5,800
	3,500			407,000	0			139,362	7,250

Note : The following conditions were assumed for calculation of this Table :

TIA Elevation - 1,338m / 4,390'

Temperature - 30°C / 86°F

Difference in Runway Centerline Elevations - 23.50m / 77.1'

Cargo was not considered in calculation for loading fuel and flight distance.
Takeoff Performance were calculated referring to FAA AC 150/5325 "Runway Length Requirement for Airport Design."

Abbreviations :

MTOW : Maximum Take Off Weight
AGTOW : Allowable Gross Take Off Weight
OEW : Operating Empty Weight
PAX : Passenger

Table 6.2.2 ACL Calculation for Aircraft Types on Kathmandu ~ Bangkok route

Aircraft Type	Runway Length	Flap	MTOW	AGTOW	Weight Restriction	OEW plus Reserved Fuel (1.25h)	Fuel Consumption	Distance of VNKT-VTBD	ACL
	(m)	(deg)	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)	(mile)	(lbs)
DC-10-10	3,050	15°	443,000	384,900	58,100	263,300	40,980 (30 lbs/mile)	1,366	80,620 (149%)*
B-747-200C Passenger	3,050	20°	785,000	638,000	147,000	407,900	64,202 (47 lbs/mile)	1,366	165,800 (165%)*
B-767-300ER	3,050	20°	407,000	366,000	41,000	209,638	26,227 (19.2 lbs/mile)	1,366	130,135 (224%)*

The conditions of the calculation for TIA is the same with Table 6.2.1.
* This shows the percentage to the full passenger weight.

(3) The runway length of RWY 02/20 is stated as 3,050 meters in the AIP of Nepal. However, the runway threshold marking for RWY 20 is set at 123 meters inside of the actual threshold. Accordingly, the distance between both runway threshold markings is 2,927 meters.

As there is no reason to displace the threshold of RWY 20 at present, it is recommended to relocate with the necessary arrangement of concerned equipment.

6.2.3 Runway Capacity

(1) The annual capacity of a single runway in general could exceed 195,000 operations with suitable taxiway, apron and air traffic control facilities.

ICAO's AIRPORT PLANNING MANUAL gives the following figures to this runway configuration.

- hourly capacity (ops/h)	VFR	51 - 98
	IFR	50 - 59
- annual service volume	195,000 - 240,000	

However, the specific topographical condition around TIA casts restrictions on the aircraft and airport operations, such as the preferential runway operation from and to the south particularly by large aircraft using VOR/DME.

Therefore it is assumed that the runway capacity in the IFR condition will be almost half of the figures above.

However, most of the aircraft operations are and will be conducted by small aircraft for domestic flights under the VFR condition.

(2) The basis of the calculation was as follows.

a. The parallel taxiway does not link with the end of the runway at present. However, it will be planned to be connected to the end of RWY 20.

b. The number of parking spots will be planned to meet the demand.

c. The instrument flight rule (IFR) is performed with VOR/DME at present. In the master plan of air safety improvement, a radar system is planned to be installed. It is primarily intended for monitoring aircraft position at the beginning. If the necessary circumstances for radar control is arranged, radar approach control will be introduced to TIA for the first time in Nepal. The runway capacity will be basically dependent on the system and the human capacity there.

Based on the forecast demand and aircraft mix, the runway capacity in the year 2010 was estimated as shown in Table 6.2.3.

Table 6.2.3 Runway Capacity in 2010 (IFR)

Taxiway utilization	Hourly capacity	Annual service volume
Full length of the existing parallel taxiway serviceable to all aircraft (after 1994)	19	57,000
Full length of the existing parallel taxiway serviceable to all aircraft, with radar control	25	75,000

Note : Detail is given in Appendix.

(3) Accordingly the runway capacity will be sufficient even after the year 2010 at the peak hour. This comes from the IFR condition. However, most of the operations consists of small aircraft for domestic use under the VFR condition and disregards the preferential runway operation.

However, the calculation has been performed based on certain assumptions. There also will be the changes in the socio-economic conditions. There will be technical innovations. All of these factors may influence and may change the results of the calculations. Thus it is requested to continually review the forecast, because of uncertainty due to the nature and the limitations.

6.2.4 Slope

(1) The runway longitudinal slope at RWY 02 threshold is 1.25 % and exceeds the ICAO requirement ("recommendation") of 0.8 %.

(2) It is desirable for the slope to be corrected. However this work will not be easy to do while the airport in operation. Therefore it is recommended to perform this work simultaneously with the large amount of earth works, such as runway strip widening and parallel taxiway shifting.

6.2.5 Shoulder

The existing runway shoulder width of two (2) meters does not meet the ICAO recommendation of 7.5 meters for the aerodrome reference code letter D and E. However it is planned to be rehabilitated to meet the requirement by the on-going project.

6.3 Runway Strip

6.3.1 Width

(1) In Annex 14 of ICAO, the width of the runway strip is prescribed from the view point of reducing the probability of aircraft accidents around runways. For a non-precision approach runway which is the condition of TIA at present and in the future, 300 meters width of runway strip is recommended.

ICAO Annex 14 also prescribes other conditions of slope and grading mainly at the inner 150 meter-width portion of runway strips. For the outer portion of runway strips, Annex 14 recommends free airspace above the strip to secure safe aircraft operations, and does not expect for the runway strip to be constructed perfectly flat.

As the category of the runway will remain as a non-precision approach runway even after the installation of radar due to the existing high mountains on the approach to TIA, the condition of the runway of TIA at present is not and will not be against requirements of the ICAO requirement.

(2) However it is naturally desirable to install a wider strip to reduce the probability of aircraft accidents and to ease the mental burden of pilots in compliance with the ICAO requirement as much as practicable. Due to the specific topographic conditions of TIA, there will be earth works and relocation of some existing structures in order to construct a strip. Therefore, this project is not identified as urgent.

The 300 meter-wide strip will be rationalized at the stage of shifting the parallel taxiway to meet the ICAO requirement, and/or constructing a completely new parallel taxiway.

6.3.2 Length

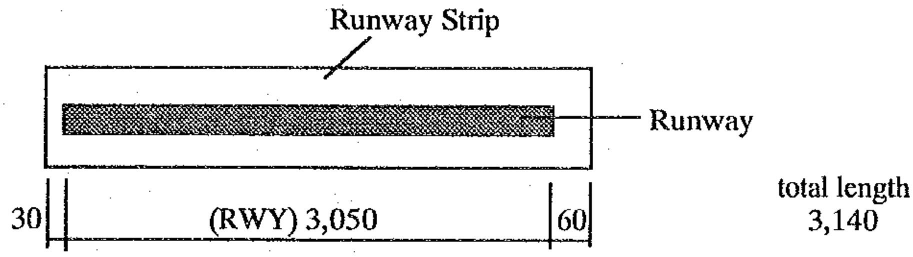
(1) At the end of RWY 02, there is a distance of 90 meters before the threshold. However, at the end of RWY 20, there is no distance between the end of the runway and the runway strip. According to the ICAO, it is recommended to provide at least 60 m for a runway strip length.

(2) There is no Runway End Safety Area at each end of the runway strips. The ICAO recommendation requires that a runway end safety area at each end of the runway strip should be provided with a dimension of 90 meters in length and twice the width of the associated runway width at least.

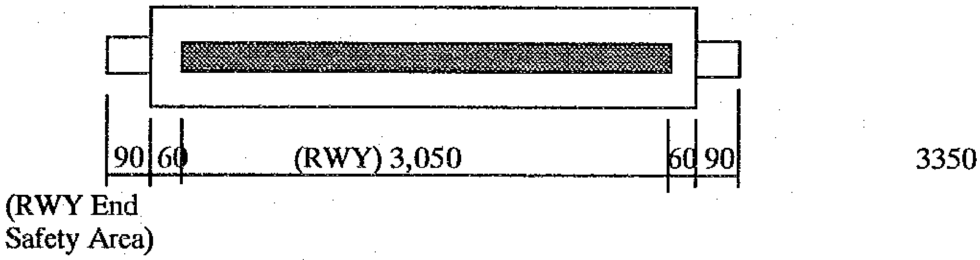
(3) In order to realize the recommendations above, it will be necessary to shorten the length of the existing runway or to extend the area next to the runway ends.

These relations mentioned above are visualized below.

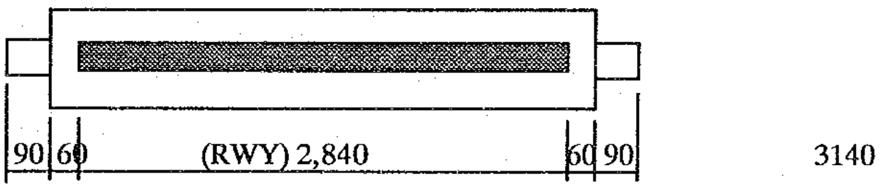
a. present condition



b. extended case



c. shortened case



(in meters)

The present runway length has already cast a weight restriction for aircraft operation, so it is not desirable to shorten the runway. On the other hand, an extension will cause the same problem as described in 6.2.2.
Also the installation of these safety areas requires relocation of the existing ALS.

Therefore, these recommended improvements will be expected to be considered after completion of the other projects.

6.4 Taxiway and Apron

6.4.1 Taxiway

(1) Parallel taxiway

a) A parallel taxiway is effective to improve aircraft operations and ground movements and to raise the runway capacity because one-way traffic of aircraft will enhance the smooth and quick flow of aircraft's ground movements. TIA has already a partial parallel taxiway (almost 2/3 of the runway length) except for connections to both of the runway ends.

b) The existing partial parallel taxiway of TIA has two problems for the improvement. One of them is its completion to the same length as the runway length and connection to runway ends. The other is shifting the taxiway to secure the separation distance of 176 m and 182.5 m between the runway centerlines from 109 meters at present, which is recommended by ICAO for the code letter D and E aerodromes accommodating larger aircrafts.

c) Medium and small-size aircraft already use the parallel taxiway according to their operational requirements. The completion of the taxiway is expected to contribute only to large-size aircraft operations by reducing their runway occupancy time. It will be planned to be used at the stage of more than 8 operations at the peak-hour under IFR conditions.

Therefore at TIA, the taxiway will be realized beyond the year 2010 according to the demand forecast.

d) It is planned to shift the parallel taxiway to conform with the ICAO recommendation. This will require a large amount of earth fill at first, due to the specific topographic conditions. Therefore this modification is better to be arranged at the time of the taxiway completion as mentioned above.

(2) Shoulder

a) The present width of taxiway shoulders is 2 meters. ICAO recommends the over-all width of the taxiway and its shoulders on straight portions to be not less than 38 meters and 44 meters for the code letters D and E respectively. This implies a pair of 7.5 m and 10.5 m wide shoulders required for the code letters D and E respectively.

b) The paved taxiway overall width is important to prevent aircraft engines from suction of foreign materials. As the difference of the width between 7.5 meters and 10.5 meters for codes D and E is quite small, it is desirable to construct a 10.5 meter-wide shoulder from the beginning for the improvement in order to reduce the operations restrictions which will be caused by the construction work.

6.4.2 Apron

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

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

3) Beside the above mentioned circumstances, the demand forecast implies provision of an adequate number of aprons, which will prevent the shortage of parking spots at present too.

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

6.5 Airfield Pavement

(1) The AIP of Nepal describes the pavement classification number (PCN) for airfield pavement of TIA as shown in the following table.

Pavement Portion	PCN
RWY(0-20)	61/F/B/W/T
RWY(20-30)	54/F/A/W/T
TWY(0-09)	61/F/B/W/T
TWY(09-19)	54/F/A/W/T
APR(INT)	53/R/B/W/T 52/R/A/W/T*
APR(DOM)	61/F/B/W/T

* This figure will be achieved after the apron expansion work.

F : Flexible pavement
R : Rigid pavement
W : (Maximum allowable tire pressure category) High: no pressure limit
T : Technical evaluation (Evaluation method)

(2) The aircraft classification number (ACN) of the anticipated aircraft in the planning stage is shown in the table below.

Aircraft		ACN			
Type	Total Weight (ton)	Rigid pavement		Flexible pavement	
		A	B	A	B
B747	373.3	49	58	52	58
DC10-30	253.1	44	53	53	59
A300	142.0	37	44	40	45
B767	137.6	34	41	37	40

A : High strength category of subgrade
$120\ MN/M3 \leq K$ or
$13 \leq CBR$
B : Medium strength category of subgrade
$60\ MN/M3 \leq K < 120$, or
$8 \leq CBR < 13$

(3) For B747 aircraft which is the critical aircraft for the pavement, the ratios of ACN / PCN are as follows;

subgrade strength \ pavement type	Rigid Pavement	Flexible Pavement
A	0.94	0.96
B	1.09 0.95*	0.95

*New Int'l Apron

If the ratio of ACN/PCN is less than 1, there are, and will be, no restrictions on aircraft operations, except for the existing international apron. Concerning the international apron pavement, as the ratio is between 1.0 and 1.1, there are no restrictions if only a few regular operations per day.

6.6 Passenger Terminal Buildings

(1) International Passenger Building

a) This is one of the most modern facilities in TIA. It was built in 1989 with a modern design and can handle almost 430~530 passengers per peak hour. Also it was designed to be expanded by 7 bays for the future demand of 2000.

There is presently some congestion concerning the passenger handling and the flow of passengers, particularly at the check-in counters, the baggage inspection and the baggage claim areas.

b) As the existing passenger terminal building will be saturated in the near future according to the forecast, it will be necessary to arrange for an increase in the floor area and to improve the service.

c) The layout plan of the existing international passenger terminal building is shown in "Appendix to Chapter 6."

(2) Domestic Passenger Building

a) The existing domestic passenger building is definitely deficient and inadequate in capacity and functions required for a hub airport. It is always so congested and crowded both inside and outside that it cannot provide moderate levels of service to airport users, particularly when it rains and in the cold season.

b) At the same time, the existing domestic apron will become narrower due to the necessity to secure the separation between aircraft parking on the apron and aircraft taxing on the parallel taxiway. In order to cope with this condition, the existing terminal will have to be relocated. The new domestic terminal building is expected to be constructed next to the international area so as to improve the convenience of airport operations and user comforts.

c) The layout plan and temporary expansion plan of the existing domestic passenger terminal building are shown in "Appendix to Chapter 6."

6.7 Cargo Terminal Building

(1) The present international cargo complex consists of three scattered blocks; one export building south of the NOC fuel farm, one import building north of the fuel farm and another one next to the domestic passenger terminal. All buildings are located away from the site of the loading and unloading apron, and also it takes a long time to come and go, particularly for the export building where it is required to approach aircraft on the apron from outside of the airport. Thus the present condition causes unnecessary congested flow of freight, not only inside but also outside of the airport.

The import building in the domestic terminal becomes an obstacle which penetrates the obstacle limitation boundary (transitional surface).

All the buildings are congested because of the narrowness and non-systematic handling of cargo. Also the building is are old and there is a lack of parking spaces.

(2) The domestic cargo building being used for cargo handling and storage is very old and not functional.

(3) In order to cope with the present condition and future demands, the new cargo building will be expected to be constructed adjacent to the loading aprons.