3.3.3 Nepalgunj Airport

Nepalgunj Airport, which was inaugurated in 1983, is expected to be developed as a hub airport in western Nepal. DCA made a master plan of Nepalgunj Airport in 1988 and has started the maintenance base project as a part of it. The outline of the existing facilities is listed in Table 3.3.3.

The major problems of the existing facilities are as follows:

(1) The existing runway length is 1,505 m long. HS-748 as the design aircraft, however, requires 1,600 m under wet surface condition without any operational restrictions.

(2) The existing loading apron has already reached its capacity during the peak hour period.

(3) Pavement surface conditions and structure are poor as follows:

- Inadequate pavement thickness
- Low CBR of base course material
- Poor drainage on the runway, taxiway, and apron

(4) No fire fighting vehicles are provided.

Table 3.3.3 Outline of Existing Nepalgunj Airport

Country	Name of Airport	INTL/DOM / ICAO CODE	Commencement of Services	Total Area of Airport	Aerodrome Reference Point	Airport Elevation	Runway Bearing	Aerodrome Reference Temperature	Operation Hour	Seasonal Availability	Note
NEPAL	NEPALGUNJ	DOM / 3c	JULY 1983	—	28°06'N 81°40'E	(540ft)	08-26	38°C	Sunrise to sunset	All Seasons	Note: Old airport used 15 Mar. '61 til Jun. '81. Administrative Authority: DCA

City/Town Name	Population	Distance to Airport	Transportation: Railway	Taxi	Bus	Wind Coverage	Aerodrome Operating Minima: Runway	Approach Distance	Approach Procedure	Jet MDA	Jet Visibility	Turbo Prop MDA	Turbo Prop Visibility	Note
NEPALGUNJ	BANKE DISTRICT 205,000 as of 1981	7.5km	—	—	—	—	08		VFR					Note: IFR procedures are under consideration.
							26		VFR					

Navigation Aids – Radio

	NDB	VOR	DME	TACAN	ILS	ASR	PAR	SSR	ARTS	ASDE	HF	VHF	UHF	ITS	VDF	ITV	TTY	AFTN
Existing	Yes	Yes	Yes	—	—	—	—	—	—	—	Yes	Yes	—	—	(Yes)	—	Yes	—

Note: ( ) not in operation
VOR 0.5nm fm RWY 08 THR

Navigation Aids – Lightings

	ALS	SFL	SALS	ALB	AGL	CGL	PAPI	RWYL	RTL	REIL
Existing	—	—	Yes (RWY26)	—	—	—	Yes	Yes	Yes	—
	RCLL	TDZL	OL	DML	TWYL	TWCL	TGL	ABN	WDIL	AFL
Existing	—	—	—	—	Yes	—	—	Yes	Yes	Yes

Meteorological Facilities

Runway Surface Sensors	—
Weather Facsimile	—
ART Receiver	—
Radiosonde	—
Weather Radar	—
VOLMET Broadcast	—

Note:

Basic Facilities

	Size	Pavement	Note
Runway Strip	1,625m x 150m		
Runway	1,505m x 35m	Asphalt	
Taxiway	145m x 27m	Asphalt	

Apron: Design Aircraft	Number of Stand	Pavement	Area (m²)	Parking Configuration
HS-748	HS748:1 DHC-6:3	Asphalt	110m x 66m	Self Manoeuvering

Flight Services

Int'l/DOM	Major Air Route	Name of Airline	Type of Aircraft	No. of Flight/Week	Note
DOM	NEPALGUNJ→KATHMANDU	RNAC	HS-748	7	Monsoon schedule 1987
			DHC-6	1	
	→SANFEBAGAR	〃	DHC-6	3	
	→JUMLA	〃	〃	2	
	→CHAURAJHARI	〃	〃	5	
	→SURKHET	〃	〃	13	
	→SILGADI DOTI	〃	〃	2	
	→Others	〃	〃	5	
	Total			38 Flts/Week	

General Note
DCA: Department of Civil Aviation
RNAC: Royal Nepal Airline Corporation

Other Facilities

	Size	Structure	Note
Access Road	2km, 5.5m		
Vehicle Parking			
Pax.T.Building	955 m2	R.C.	GF of T/B
Cargo.T.Building	159 m2	R.C.	Not Used
Office Building	440 m2	R.C.	1F of T/B
Control Tower	25 m2	R.C.	VFR Room
Fire Station	116 m2 (For-Vehicles)	R.C.	No Fire Vehicle
Electrical & Mechanical Workshop	679 m2	R.C.	
Power House	208 m2	R.C.	
Staff Quarter	10 house		
POL	ATF 70 kl x 4		NOC

Statistics of Air Traffic

Note: Indicating RNAC scheduled traffic only

No. of Landing & Take-off	4,102	4,592	4,301	4,195	4,576
Annual Freight Volume (ton)	121	154	256	211	177
No. of Annual Passengers	33,985	42,331	45,263	46,361	51,335
Year (Fiscal)	1982/83	1983/84	1984/85	1985/86	1986/87

DATE	◇	BY
REVISION		
Drawn by	JICA Study Team	
DATE	September 1989	

In 1988, "Airport Master Plan Report for Nepalgunj Airport Construction Project" was prepared for the airport development, which was divided into two phases, i.e., Phase I planned for year 2000 and Phase II planned for year 2010.

Traffic demand and facility requirements for master plan are as shown in Table 3.3.4. The outline of the master plan is as follows:

(1) The runway will be extended to 1600 m and the runway strip will be widened to 300 m from 150 m for non-precision approach operations of HS-748 in Phase I. In the ultimate stage after 2010, the runway will be extended to 2,000 m for a small jet aircraft operation.

(2) The loading apron will be expanded in order to accommodate seven aircraft in Phase II. A new maintenance apron will be constructed in Phase I.

(3) A partial parallel taxiway and exit taxiways will be constructed in Phase I.

(4) Passenger terminal building will be expanded to 1,300 sq.m to accommodate annual passengers of 180,000 in Phase II.

(5) Operational category in Phase I and II is a non-precision approach. Existing CVOR, NDB, SALS, and other navigation aids will be utilized in Phase I and II. Runway end identification lights (REIL) will be newly installed in Phase I. In the ultimate stage, MLS/DME will be introduced.

Table 3.3.4 Air Traffic Demand and Airport Facility Requirements

	Phase I (1999/2000)	Phase II (2009/10)	Ultimate (2010 +)
Annual Passengers	112,500	179,500	350,000
Annual Cargo (ton)	2,770	3,050	3,770
Operational Category	Non-Precision	do	CAT-1
Runway (m x m)	1,600 x 30	do	2,000 x 45
Runway Strip (m x m)	1,720 x 300	do	2,120 x 300
Taxiway	Parallel taxiway justifiable (w=15 m)		
Loading Apron (Stands)	HS-748: 1 DHC-6: 5 Total: 6	HS-748: 3 DHC-6: 4 Total: 7	B-737: 1 HS-748: 3 DHC-6: 5 Total: 9
Air Navigation Systems	NDB, CVOR, SALS, PAPI, etc.	do	MLS (ILS)/ DME, NDB, CVOR, ALS, SALS, PAPI, etc.

3.3.4 STOL Airports

STOL airports in category D have more shortcomings. Specifically, the pressing problems are with short runways, poor surface conditions and a steep runway gradient, all of which make aircraft performance critical. If these shortcomings are corrected, the function of the airports will be greatly enhanced.

This chapter evaluates in Table 3.3.5 to 3.3.12 the following selected airports:

- Dolpa Airport
- Jomsom Airport
- Jumla Airport
- Lukula Airport
- Phaplu Airport
- Sanfebagar Airport
- Simikot (Humla) Airport
- Syangboche Airport

The scheduled hour shown in these tables indicate the last departure time on the RNAC time schedule by season.

(1) Dolpa Airport

Table 3.3.5 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	457 m	75 m (1) 130 m (2)	Grass but almost bald and stony	soft	8200 ft 2500 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 10:30	0		2900 5700	30 cm (3) Few Days(4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway - Runway gradient is steep.

b) Operation - Rocks obstruct the approach.

- A pilot cannot see the end of the runway on taking off due to the runway profile.

- Comments from pilot
"Difficult operation due to unstable winds and a steep slope."
"A high speed turn off should be installed."

(2) Jomsom Airport

Table 3.3.6 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	610 m	110 (1) 170 (2)	Silty sand with rock	soft and slippery	8800 ft 2682 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 10:00 or 12:00	0	0	7900 13500	25 cm (3) Few Days (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway and runway strip – The north end of the strip is being eroded away by a river.

b) Operation – "Difficult operation" by pilot.

c) Weather – An annual snowfall of 25 cm takes four days to clear. But seven years ago, 90 cm snow fell and 22 flights were cancelled.

– Situated in the bottom of a deep gorge, weather is changeable; clouds and turbulence occur frequently.

– Very strong winds of 15 knots from the south are frequently experienced.

(3) Jumla Airport

Table 3.3.7 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	670 m	0 (1) 30 m (2)	Grass	-	7700 ft 2347 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 12:00 or 13:30	0 Zonal Headquarters	0	9200 14900	30 cm (3) Few Days (4)

(3) depth
(4) duration to melt awey
* BHN :Basic Human Needs

a) Operation - A maximum of 19 non-scheduled flights were recorded per day. (38 Movements)

- Average flights are normally three to four per day.

- Enough air space for missed approach cannot be ensured because of the narrow valley.

b) Weather - Minimum temperature: -15°C.

- The monthly average temperature from Dec. to Feb. drops to 0°C.

- Snow fall is about 30 cm and it usually takes a few days to melt. Sometimes snow closes the runway for 15 to 20 days.

- It has frost in Jan. to Mar.

c) Other - The terminal buidling is too old. It should be newly built.

(4) Lukla Airport

Table 3.3.8 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	488 m	0 (1) 0 (2)	Gravel and very rough	-	9100 ft 2774 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 8:00 or 11:30	0	0	14300 24200	15 cm (3) 3 Days (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway and Apron
- As the airport has an exceptionally steep slope of 11.5%, the runway strip is easily eroded by rapidly flowing water.
- Small drains crisscross the runway.
- Additional apron space should be constructed.

b) Weather
- Minimum temperature: -4^{o} to -5^{o}C. Below-zero minimum monthly average temperature continue from December to February.
- Frost has not been found.

c) Operation
- Lukla is the busiest STOL airport in the area with five scheduled flights per day.
- Pilot comments; "Difficult operation due to wind and steep slope of 11.5%."

(5) Phaplu Airport

Table 3.3.9 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
PC-6	670	0 (1) 0 (2)	Grass	-	9000 ft 2743 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Monsoon closed	Morning to 9:30	0	0	800 1400	30 cm (3) Few Days (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway - The runway was extended to accommodate the DHC-6. However, operation of DHC-6 is difficult on it because of the reasons described below c).

b) Weather - Snowfall is about 30 cm and it takes three to four days to melt away.

- Airport is closed in the monsoon season.

c) Operation - Landing from the north is difficult because a very tight turn and alignment with the runway center line is required in a narrow valley. Take off is also difficult because the aircraft has to roll and gain speed against a steep gradient of runway of 6%.

- Pilot comments; "Difficult operation due to very soft and slippery condition of the runway."

d) Other - There is no control tower and terminal building.

(6) Sanfebagar Airport

Table 3.3.10 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	427	20 (1) 60 (2)	Grass	Soft spot in the middle of RWY	2280 ft 695 m

(1) as paved
(2) as firm dry sod.

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 14:00 or 16:00	0		14800 27200	(3) (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway – The runway is situated near the junction of two rivers, the Budhi Ganga and the Chhipe Khola. The Budhi Ganga river flows nearly parallel to the runway, whereas the Chhipe Khola river flows nearly across to the runway. It is possible that the southern threshold could be damaged by erosion from the river Chhipe Khola. The Chhipe Khola river has much less discharge in the winter, but it flows with high velocity and discharge during the monsoon.

(7) Simikot (Humla) Airport

Table 3.3.11 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
DHC-6	549 m	105 m (1) 160 m (2)	Grass but bold	Soft and Slippery	9246 ft 2818 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Yearly	Morning to 8:00 or 9:00	0		2900 5100	100 cm (3) 3 Months (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway and Apron
- The first quarter of the eastern end of the runway has a steep slope of 6.5% and is eroded, leaving the surface scarred and without grass.
- No apron has yet been constructed.

b) Operation
- Pilot comments; "Difficult operation due to unstable wind."
- Extension to the western side is desirable in consideration of topographical features.

(8) Syangboche Airport

Table 3.3.12 Existing Conditions

Runway					
Operating Aircraft	Existing Length	Required Extension Length	Surface	Condition When wet	Elevation
PC-6	405 m	bellow (1) bellow (2)	Grass	-	12297 ft 3748 m

(1) as paved
(2) as firm dry sod

Operation		Role of Airport		Traffic Volume	Snowfall
Season	Scheduled Hour	BHN *	Tourism	1986/87 2000	
Charter	During morning	0	0	- 8300	15 cm (3) Few Days (4)

(3) depth
(4) duration to melt away
* BHN : Basic Human Needs

a) Runway - This high altitude airport is at 3,748 m (12,300 ft) and can be served by PC-6. Upgrading the runway by a realignment has been planned by DCA. The introduction of the DHC-6 which is not certified above 10,000 ft has to be investigated.

b) Other - The level of the control tower is as same as the runway level. It should be constructed at another site.

3.3.5 Air Traffic Control and Air Navigation Systems

(1) Existing Conditions

Table 3.3.13 summarizes the existing air navigation systems in Nepal including radio navigation aids, air traffic control, aeronautical telecommunications, aeronautical ground lights, and meteorological and power supply systems.

Table 3.3.14 summarizes the frequencies used for VHF air-ground and ground-ground telecommunications and navigation aids in Nepal.

The following are supplementary explanations for the above tables:

a) Kathmandu area control center (ACC), the only one ACC in Nepal, provides air traffic control services for international air routes i.e., B345, G335, G336, and R344. Kathmandu flight information center (FIC) provides flight information services within the area of Kathmandu flight information region (FIR) except the above controlled areas.

   The domestic air routes are provided with flight information services by Kathmandu FIC.

b) Eight airports including Tribhuvan International Airport are provided with aerodrome control services.

c) Twenty two airports have aerodrome flight information services (AFIS). However, the remaining 13 airports have no aerodrome control services nor AFIS.

d) Neither radar air traffic control nor precision approach is carried out in Nepal.

Table 3.3.13 Summary of Existing Air Navigation Systems in Nepal

NO.	CATEGORY		AIRPORT	CODE	AIR TRAFFIC SERVICES				NAVAIDS			ATC/COM						LIGHTS				MET	POWER		
	DCA	JICA			ACC	TWR	SMC	AFIS	VOR/ DME	NDB	LOC	VHF A/G	HF G/G	VDF	CON SOLE	TAPE REC.	P.A. SIREN	ALS	RWYL RWTL	PAPI VASIS	TWYL	MET	CITY POWER	SOLAR POWER	EMGY GEN
(1)	(2)		(3)	(4)	(5)				(6)			(7)						(8)				(9)	(10)		
1	A	A	KATHMANDU (TRIBHUVAN)	KTM	O	O	O		O	O	O	O	O	O	O	O	O	O	O	O *1		O	O	O VDF	O
2	B	B	BHAIRAHAWA	BWA		O				O	O	O	O		O	O		O	O	O	O	O	O		O
3	B	B	BIRATNAGAR	BIR		O				O	O	O	O	O	O	O			O	O		O	O		O
4	B	B	NEPALGUNJ	KEP		O			O	O		O	O	O	O	O		O	O	O	O	O	O		O
5	B	B	POKHARA	PKR		O				O		O	O		O							O	O		O
6	C	C	BHARATPUR	BHR		O				O		O	O		O	O						O	O		O
7	C	C	DHANGADHI	DHI				O		O		O	O		O		O					O	O	O	O
8	C	C	JANAKPUR	JKR		O				O		O	O		O							O	O		O
9	C	C	RAJBIRAJ	RJB				O		O		O	O		O	O									O
10	C	C	SIMRA	SIF		O				O		O	O		O	O						O	O		O
11	C	C	SURKHET	SKH				O		O		O	O		O	O	O					O	O	O	O
12	C	C	TUMLINGTAR	TMI				O		O		O	O		O	O	O			O		O	*4	O	O
13	D	D	BAITADI (PATAN)	BIT				O				O	O		O	O	O					O		O	
14	D	D	BAGLUNG (BALEWA)	BGL				O				O	O		O	O	O					O		O	
15	D	D	BAJHANG	BJH				O				O	O		O	O	O			O		O		O	O
16	D	D	BAJURA	BJU				O				O	O		O	O	O					O		O	
17	D	D	BHOJPUR	BHP				O				O	O		O		O			O		O		O	
18	D	C	CHANDRAGADI	BDP				O		O		O	O		O	O	O					O	O	O	
19	D	C	DANG (TULSIPUR)	DNP				O		O		O	O		O	O	O					O	*2	O	O
20	D	D	DARCHULA	DAP				O				O	O		O	O	O					O		O	
21	D	D	DHORPATAN																						
22	D	D	DOLPA	DOP				O				O	O		O	O	O					O		O	
23	D	D	DOTI (DIPAYAL)	SIH				O				O	O		O	O	O			O		O		O	O
24	D	D	GORKHA (PALUNGTAR)	GKH																					
25	D	D	JIRI	JIR																					
26	D	D	JOMSOM	JMO				O				O	O		O	O	O			O		O		O	
27	D	D	JUMLA	JUM				O		O		O	O		O	O	O			O		O	O	O	O
28	D	D	LAMIDADA	LDN				O		O		O	O		O	O	O			O		O		O	
29	D	D	LANGTANG																						
30	D	D	LUKLA	LUA				O				O	O		O	O	O					O		O	
31	D	C	MAHENDRANAGAR	XMG																					
32	D	D	MANANG	MGX																					
33	D	B	MEGHAULI	MEY																					
34	D	D	PHAPLU	PPL																			*3		
35	D	D	RAMECHHAP	RHP				O				O	O		O	O	O					O		O	
36	D	D	ROLPA	RPA																					
37	D	D	RUKUMKOT (CHAURAJHARI)	HRJ				O		O		O	O		O	O	O			O		O		O	
38	D	D	RUMJATAR	RUM																					
39	D	D	SANFEBAGAR	FEB				O				O	O		O	O	O					O		O	O
40	D	D	SIMIKOT (HUMLA)	IMK				O				O	O		O	O	O					O		O	
41	D	D	SYANGBOCHE																						
42	D	D	TAPLEJUNG	TPJ																					
43	D	C	TIKAPUR	TKP																					

(Source: DCA)

Abbreviations in this table :

ACC : Area control center
TWR : Aerodrome control tower
SMC : Surface movement control
AFIS : Aerodrome flight information services
ATC : Air traffic control
COM : Communications
VOR : VHF omni-directional radio range
DME : Distance measuring equipment
NDB : Non-directional beacon
LOC : Locator
VHF A/G : Very high frequency air to ground radio (mobil)
HF G/G : High frequency ground to ground radio (fixed)

VDF : VHF direction finder
CONSOLE : Air traffic control console
TAPE REC : Tape recorder for ATC use
P.A. : Public address system
ALS : Approach lighting system
RWYL : Runway edge lights
RWTL : Runway threshold lights including end lights
PAPI : Precision approach path indicator
VASIS : Visual approach slope indicator system
TWYL : Taxiway edge lights
MET : Meteorological observation
CITY POWER: Commercial power supply
EMGY GEN : Emergency generator

Note

*1 : T-VASIS
*2 : Service expected
*3 : Possible
*4 : Services expected in 1989

O : Facility provided

Table 3.3.14 Frequency List of Navigation Facilities

NO.	CATEGORY		AIRPORT	AIR TRAFFIC SERVICES					COM	NAVAIDS				
	DCA	JICA		ACC	FIC	TWR	SMC	AFIS	DOM*2 RTF/SSB	VOR/DME	NDB	LOCATOR	LOCATOR-2	LOCATOR-3
1	A	A	KATHMANDU (TRIBHUVAN)	126.5	124.7 *1	118.1	121.9		O	112.3/70X	318KHz	LS 230KHz	LE 252KHz	LW358KHz*4
2	B	B	BHAIRAHAWA			122.5			O		345	369		
3	B	B	BIRATNAGAR			122.7			O		358	371		
4	B	B	NEPALGUNJ			118.3			O	*3	330			
5	B	B	POKHARA			122.5			O		336			
6	C	C	BHARATPUR			118.3			O		295			
7	C	C	DHANGADHI					122.5	F (1)		253			
8	C	C	JANAKPUR			122.5			O		287			
9	C	C	RAJBIRAJ					118.3	O		306			
10	C	C	SIMRA			118.3			O		246			
11	C	C	SURKHET					122.5/118.1	F (1)		387			
12	C	C	TUMLINGTAR					122.5/118.1	F (1)		227			
13	D	D	BAITADI (PATAN)					122.5/122.3	F (2)					
14	D	D	BAGLUNG (BALEWA)					122.3/118.1	F (1)					
15	D	D	BAJHANG					122.5	F (1)					
16	D	D	BAJURA					122.3	F (2)					
17	D	D	BHOJPUR					122.3	F (1)					
18	D	C	CHANDRAGADI					118.3/118.1	F (1)		397			
19	D	C	DANG (TULSIPUR)					118.1	F (1)		363			
20	D	D	DARCHULA					122.5/122.3	F (2)					
21	D	D	DHORPATAN											
22	D	D	DOLPA					122.3/122.5	F (1)					
23	D	D	DOTI (DIPAYAL)					122.5	F (1)					
24	D	D	GORKHA (PALUNGTAR)											
25	D	D	JIRI											
26	D	D	JOMSOM					122.5	F (1)					
27	D	D	JUMLA					122.5	F (1)		242			
28	D	D	LAMIDADA					122.5/118.1	F (1)		236			
29	D	D	LANGTANG											
30	D	D	LUKLA					122.3/122.5	F (1)					
31	D	C	MAHENDRANAGAR											
32	D	D	MANANG											
33	D	B	MEGHAULI											
34	D	D	PHAPLU											
35	D	D	RAMECHHAP					122.3/122.5	F (2)					
36	D	D	ROLPA											
37	D	D	RUKUMKOT (CHAURAJHARI)					122.5	F (1)		234			
38	D	D	RUMJATAR											
39	D	D	SANFEBAGAR					122.5	F (1)					
40	D	D	SIMIKOT (HUMLA)					122.5/122.3	F (2)					
41	D	D	SYANGBOCHE											
42	D	D	TAPLEJUNG											
43	D	C	TIKAPUR											

(Source: DCA)

Abbreviation :

ACC :Area control center
FIC :Flight Information Services
TWR :Aerodrome Control Tower
SMC :Surface Movement Control
AFIS :Aerodrome Flight Information Services
DOM RTF/SSB:Domestic Radio Telephone by HF Single Sideband

Note :

O :Facility provided
F (1) :Facility provided by French grant aid (Phase I)
F (2) :Ditto (Phase II)
*1 :HF Frequencies
International : 10,066, 6,556, 10,018, 5,658 KHz
Domestic : 5,512, 2,910 KHz
*2 :Frequencies : 5,805.5, 5,858, 3,280.25, 3,380.5 KHz
*3 :Flight inspected and observed satisfactory
*4 :Under test operation

e) Two VOR/DMEs are installed at Tribhuvan International and Nepalgunj Airports. Seventeen NDBs and five locators are operated in and in the vicinity of airports. The airport navaids are used to compose the international air-routes and domestic advisory routes.

f) Most of the airports except Tribhuvan International Airport and three major domestic airports in the Terai area are not provided with visual landing aids for night operations. Eight airports in the mountain area are provided with only precision approach path indicators (PAPI).

g) No commercial power supply to most airports in mountain area is available, and solar panel and batteries are the only means of power supply. Twenty-one airports are provided with only solar power supply facilities for equipment.

(2) Evaluation of Air Navigation Systems

The following is the major evaluation of the air navigation systems in Nepal and for the detailed evaluation of those in Tribhuvan International Airport, please refer to Chapter 9.

a) Kathmandu FIC mainly operates VHF air-ground radio (124.7 MHz; the transmitter and receiver station is located on the top of mountain Phulchauki and linked to Tribhuvan International by UHF radio link). However, this VHF radio does not cover the western area of Kathmandu FIR and the following HF radios are supplementary used for domestic advisory services:

HF SSB 5,512 KHz (for daytime operations)
HF SSB 2,910 KHz (for nighttime operations)

The above frequencies will be replaced by the frequencies of 5,580 KHz and 2,923 KHz respectively in accordance with the recommendation of ICAO when Kathmandu FIC is moved to the new administration building.

The communications by those HF radios are very difficult due to radio interferences. It will be justifiable to establish VHF remote controlled sub-repeater station and ensure the VHF radio coverage within the whole area in Kathmandu FIR.

b) The airports in the western area operate VHF air-ground 122.5 MHz and 122.3 MHz for airport flight information services. However, these frequencies are the same that are used for the training area in India and severe interference has been experienced. The adjustment of radio frequency with Indian Authority or change of radio frequency is urgently needed.

c) The following HF radio frequencies are operated for domestic point-point communications instead of domestic AFTN and ATS direct speech circuits.

HF SSB 5,805.5 KHz
HF SSB 5,858 KHz
HF SSB 3,280.25 KHz
HF SSB 3,380.5 KHz

Since all the flight data transmission and ATS coordination are made to Kathmandu, severe inteferences occur. Such countermeasures as follows will be required:

- Subdivide Kathmandu FIR into west and east sectors and assign different frequencies.

- To establish sub-centeres, i.e., Nepalgunj in the western area and Biratnagar in the eastern area and de-centralize the function of Kathmandu. In this case, domestic AFTN and ATS direct speech circuits among Kathmandu, Nepalgunj and Biratnagar as explained below will be mandatory.

d) No domestic AFTN (RTT) circuits are operated in Nepal. Although there is an HF selcall system installed, the system has never been used. Domestic AFTN (RTT) circuits and ATS direct speech circuits should be supplied by a leased common carrier such as a microwave link by Nepal Telecom. Cooperation will be very necessary among Kathmandu, Nepalgunj, and Biratnagar Airports.

e) Most air navigation equipment in Nepal except those recently installed in mountain airports, and under installation in Tribhuvan International Airport are old and staged replacement is desirable.

f) The VHF air-ground radio and HF point-point radio facilities in the mountain airports are single unit configuration and provision of stand-by equipment will be mandatory.

CHAPTER 4 BASIC POLICY FOR DEVELOPMENT OF AIRPORTS AND RELATED FACILITIES

CHAPTER 4 BASIC POLICY FOR DEVELOPMENT OF AIRPORTS AND RELATED FACILITIES

4.1 Basic Policy

The formulation of the master plan for the Air Transport System in Nepal shall be carried out in order to contribute to the public welfare in remote districts, the promotion of tourism and the growth of international and domestic trade. Keeping in mind the above three objectives, basic policies for the development of the airports and air transport are established as mentioned below for a safe and efficient transport system.

a) Development in Mountainous Region

Airports in Nepal are located in varied places from the plains of Terai to the High Himalayan region. Under such circumstances it is not appropriate to develop all airports on a uniform standard. For example, at some airports in the High Himalayas, approach and takeoff are limited to only one direction and the slope of the runway exceeds the ICAO recommendation because the terrain is so severe. In such circumstances lower standards have to be applied to the planning and design of airport facilities as long as flight safety is ensured. It is also important to consider the difficulties in constructing and maintaining projects in a mountainous region.

b) Financial Circumstances

Developing airports takes a great deal of time and money. Under financial constraints it is important to allocate money to priority projects which need to be implemented immediately in order to secure safe operations and to meet increasing demand.

c) Maintenance and Operation

In planning the facilities, it is important to reduce the difficulties of maintenance because maintenance costs, especially for airports in mountainous regions, are high due to the severe conditions and the remoteness from cities. Therefore it is desirable to plan low-maintenance facilities for the High Himalayas. Equipment should also be standardized for easy maintenance.

d) Operating Aircraft and Categorization of Airport

In general, facility requirements are calculated from the traffic demand at each airpport. But at most airports in Nepal, aircraft movements are small, so the required capacity of each facility will be decided by the type of aircraft to be operated, not by aircraft movements. Therefore all airports will be categorized according to the aircraft they accommodate and required facilities will be decided in accordance with the category of each airport.

In this study, aircraft to be accommodated in the future have been considered as follows:

The primary factors used in planning airport facilities and air space use are aircraft performance and the dimensions of the aircraft.

As the introduction of large jet aircraft in the domestic routes require extensive development of airport facilities, it is not considered economical for its use in the near future because of low demand but small jet aircraft could be used as shown in the fore-cast.

RNAC considers the replacement of the aged HS-748's to be urgent and is now comparing the ATR-42 (46 seats), the ATP (64 seats), the DHC-8 (50 seats) and the F-50 (50 seats), but in the planning aircraft fleet, existing facilities should be considered and should be coordinated with DCA.

Since aircraft serving STOL airports require excellent STOL perfor-mance, 20-seat class aircraft will be selected from a limited selection.

Due to the above-mentioned reasons, the design aircraft for future use are 50-seat aircraft for the trunk routes and 20-seat aircraft for STOL routes. The PC-6 will be retired in the future.

Replacement of Aircraft

Aircraft in Use	Future Aircraft	Serving Route
HS-748	50-seaters	Trunk route
DHC-6	20-seaters	STOL route
PC-6	To be retired	

4.2 Working Policy

Based on the above-mentioned basic circumstances, working policies will be set forth as follows:

a) Basic Airport Facilities

Regarding the basic facilities, runway length, which is most important for safe operation, shall not be shorter than the length required by the aircraft using it. If the existing runway cannot be extended to the required length due to topographic conditions, runway surfacing should be executed with priority.

The facilities of TIA which are insufficient in function and capacity should be developed before all others.

Air navigation systems of international standard should be installed at Tribhuvan International Airport. They should also be installed at the major airports along the trunk routes as soon as possible.

b) Development of the Airway Network

The air transport network will be strategically improved with the construction of new airports, the closure of some existing airports and introduction of hub and spoke system. Reorganization of the airway network shall be done on the premise of IFR implementation for safe and efficient aircraft operation. Therefore VOR/DME will be installed along the trunk route in the Terai area and new facilities including NDB should be installed based strictly on viable operational requirements. A nationwide air telecommunications network should be developed as soon as possible.

c) Future of Helicopter and General Aviation

A helicopter has the disadvantages of higher operation and maintenance costs than those of a fixed wing aircraft. This tendency is greater in high altitude operations. Nevertheless, the helicopter has the advantage of not being influenced by the tail wind, transportation of bulky load and the capability of taking-off and landing in a very small area. Therefore, the effectiveness and the demand of the helicopter should be studied for economy and confirmed prior to introducing it into the scheduled flight services. After the network of fixed wing aircraft is sufficiently developed and the demand of the helicopter increases, the helicopter may be introduced into the scheduled flight services in limited conditions.

With regard to a general aviation, the development particular for it is not necessary at the present time because the demand is not expected to increase rapidly considering the national economy development. The tendency of the demand should, however, be watched since the demand will gradually increase.

CHAPTER 5 AIR TRANSPORTATION NETWORK TO BE DEVELOPED

CHAPTER 5 AIR TRANSPORTATION NETWORK TO BE DEVELOPED

5.1 General

RNAC currently operates a fleet of 3 HS-748's, 10 DHC-6's, and one PC-6 to 38 domestic airports as a scheduled flight. The routes are shown in Figs. 1.2.4 to 1.2.6.

As can be seen from these figures, the domestic route network varies by season due to weather conditions, and serves all areas of the country with both direct flights to and from TIA and local flights to and from regional centers, Nepalgunj, and Biratnagar Airports.

The HS-748 aircraft is used on the routes from TIA to Nepalgunj, Biratnagar, Pokhara, Bhairahawa, and Meghauli Airports.

The DHC-6 serves all other routes and the PC-6 is operated to Manang which is high altitude airport and Jiri Airport.

All-season airports, seasonally-operated airports and unmanned airports account for 29, 10, and 11, respectively. These networks will change and grow in accordance with the influence of the following factors:

a) DCA's development plan includes Mugu New Airport, which is now being designed, new Pokhara Airport which will replace the existing Pokhara Airport, and Syangboche Airport which will be upgraded to accommodate DHC-6.

b) Although closing or constructing new airports is generally decided by air traffic demand, such a criterion does not exclusively determine those questions in Nepal where public welfare has to be duly considered.

c) The "Hub and Spoke System" will progress from the "Linear System" as air transportation demand changes route by route.

d) Instrument flight rules (IFR) should be established for safety sake and to improve the reliability of scheduled flights. In order to secure the system, some navigation facilities should be placed at appropriate locations.

With these points in mind, restructuring the air transportation network is hereinafter described along with basic policy, contribution to basic human needs, promotion of tourism, and growth of trade.

5.2 Aeronautical Weather Conditions

In constructing the future airway network, aeronautical weather conditions are considered as an influential primary factor. Aeronautical weather condition is very changeable by place, by season, and by hour in Nepal. Not only aircraft operation but also the scheduling of aircraft movement is severely limited in paticular by Kathmandu's fog, the turbulence and low clouds of the High Himalayas and the monsoons that affect the whole country.

5.2.1 Fog of Kathmandu

Kathmandu is covered with morning fog until 10:00 am between mid November and mid January. Besides this period there are about two weeks out of the year when fog is not limited to the mornings and continues into the afternoon. Oftentimes the back-up from this daytime paralysis of airport functions continues into the evening. This affects the "Mountain Flight" which is said to be one of Nepal's sightseeing highlights.

VFR operational minima is 5000 m (minima of special VFR: 2500 m) but because of the fog, visibility is less than 100 m on 15 days out of a month in the morning (50% of the time). The fog conditions for January 1984 and January 1985 are shown in Fig. 5.2.1.

Consequently the flight schedule faces significant shortcomings in punctuality and regularity. Table 5.2.1 and Fig. 5.2.2 show the regularity and punctuality records for a recent year of the TIA. As the table demonstrates, punctuality was especially poor in the winter in which case it was 16.4% lower (66.4-50.0%) for international flights and 14.9% lower (61.0-46.1%) for domestic flights when compared to the year-round average. Though the low number includes weather condition other than fog as problems of aircraft maintenance, that of winter is quite low.

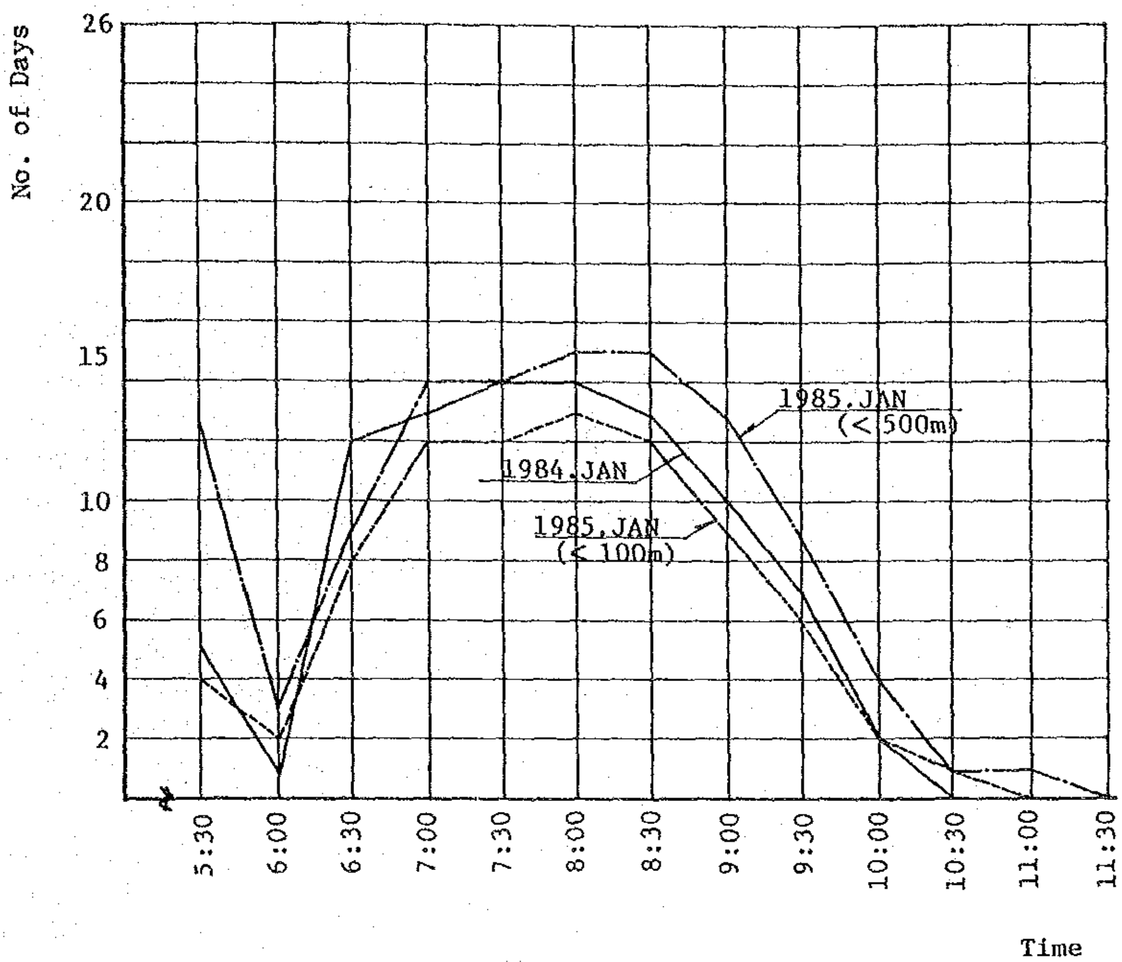


Fig. 5.2.1 Fog Appearance Time in TIA

Source : Planning and Statistics TIA

Table. 5.2.1 Regularity and Punctuality

87.7.15 ~ 88.7.15

	Int'l		Dom		
	1/15 ~ 2/15	Annual	1/15 ~ 2/15	7/15 ~ 8/15	Annual
Regularity	96.5	97.7	91.6	66.0	86.4
Punctuality	50.0	66.4	46.1	49.4	61.0

Source : Planning and Statistics TIA

5.2.2 Aeronautical Weather Conditions in the High Himalayas

Almost all the airports in the High Himalayan area exist under such harsh geographical and weather conditions that few provide sufficient runway length and the slope of most runways is too steep. In addition to this, approach and take-off are usually limited to one direction and soft or slippery ground surfaces and approach obstructions make landing difficult at most airports.

Because of such circumstances, operations are often cancelled due to weather conditions so that safety can be guaranteed.

As shown in Fig. 5.2.3, operating hours at each airport in the High Himalayas are restricted to between 7:00 am and midday. This is due to tail winds, turbulence and built-up clouds.

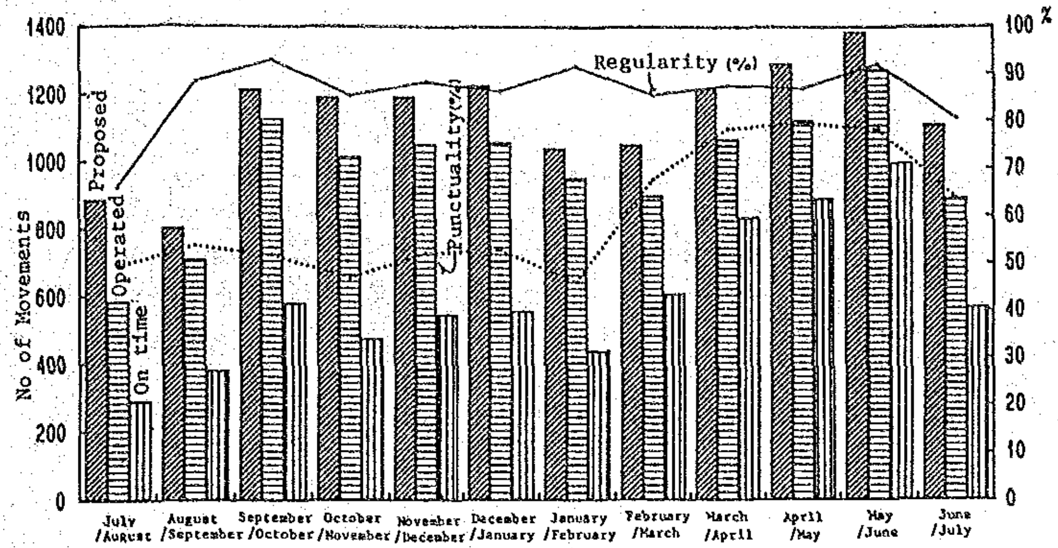
Because of these weather-related restrictions, it is difficult for RNAC to effectively schedule aircraft without sacrificing safety. As is shown in Table 5.2.1, RNAC's performance as far as regularity and punctuality are concerned is generally quite low compared to the other countries.

5.2.3 Monsoon in the Western Region

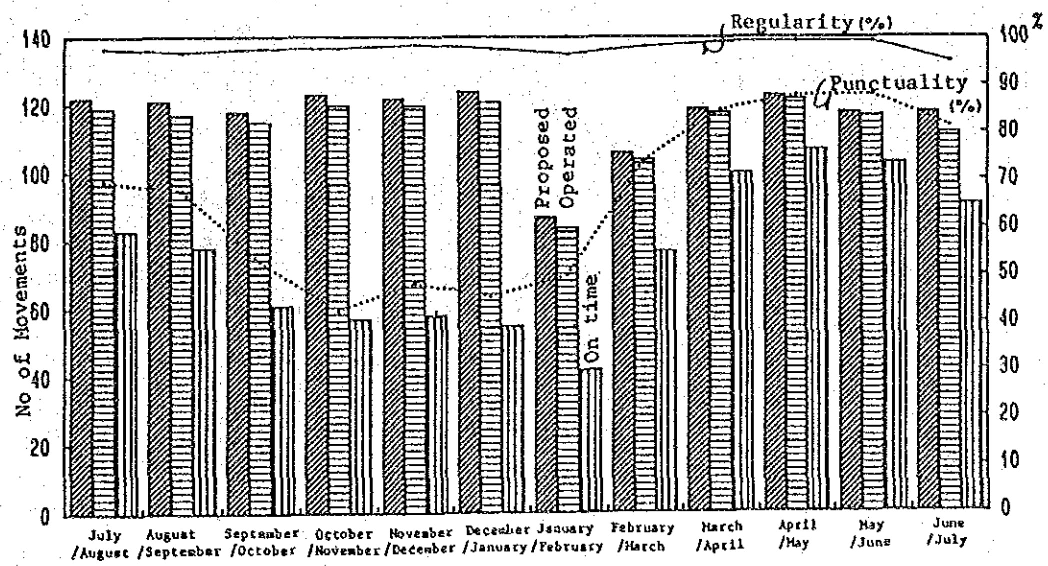
The monsoon season between mid July and mid September has a major impact on all of Nepal. Among others, Pokhara Airport in the Western Region can get as much as 4,000 mm of rainfall in one year. As is shown on the Table 5.2.1 and Fig. 5.2.2 demonstrating the effect of the monsoon season on Tribhuvan International Airport, the number of proposed flights drop while the number of cancelled flights increase so that the rate of regularity drops to 66%. It is necessary to complete a navigation system at this site.

5.3 Road Connection and Air Transportation Network

As stated in Chapter 2, "Air Traffic Demand Forecast," air traffic volume is directly linked to the number and quality of road connections so that as Nepal's roads improve, some airports will inevitably be closed.



Domestic Flight



International Flight

Fig. 5.2.2 Regularity and Punctuality at TIA
(Source: Planning and Statistics, TIA)

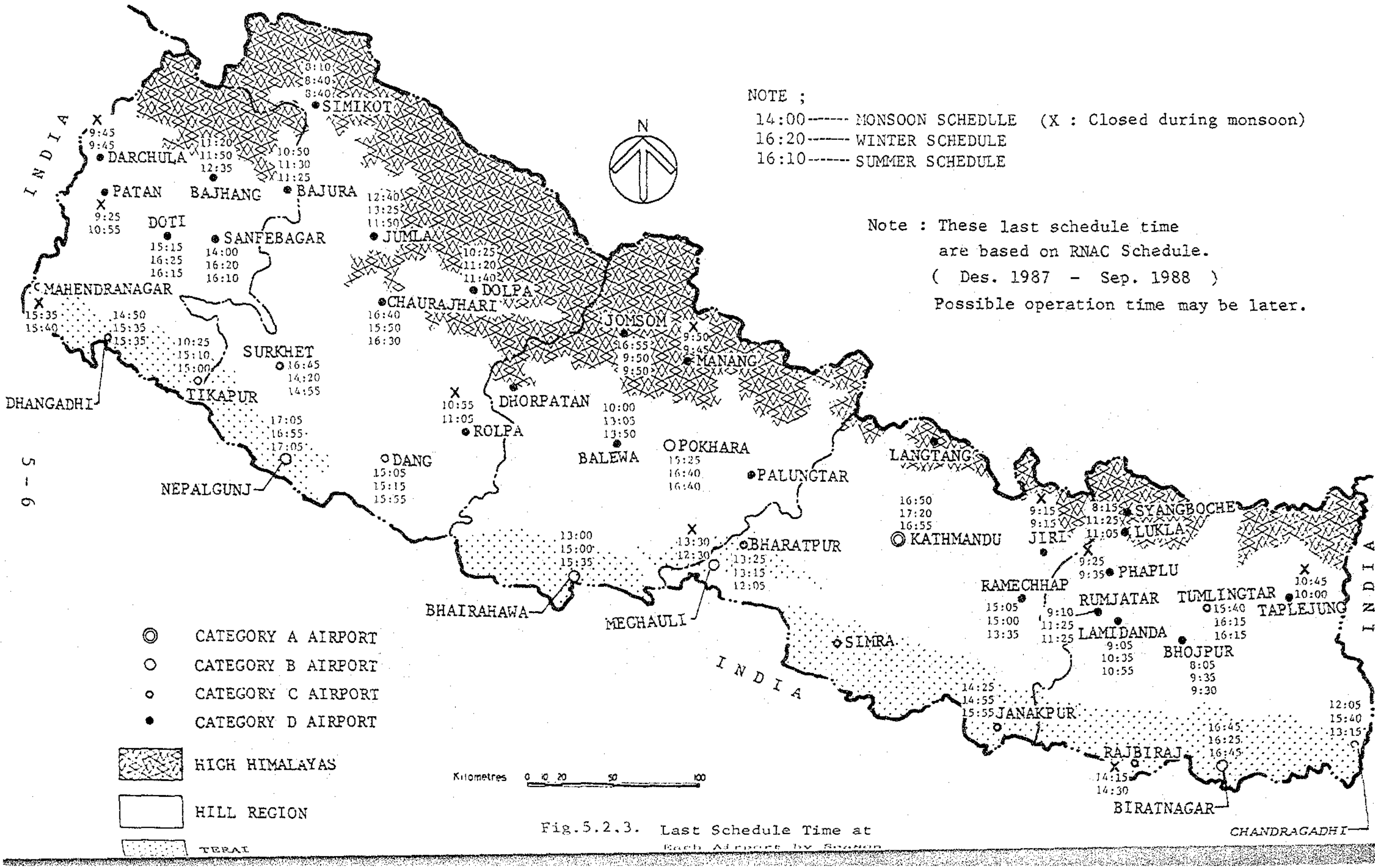


Fig.5.2.3. Last Schedule Time at Each Airport by Season

This conclusion is based on a judgement that a decreasing trend in air traffic demand at these airports is remarkable due to the completion of linked road network, there is little possibility of recovery for a while and present demand is too low for profitable operation. Assuming that a route should be abandoned if it does not operate at 1/2 of the average seat factor of 75% (in other words 37.5% of capacity), the minimum number of people a weekly round-trip route should carry is about 630 people per year.

$$19 \times 0.75 \times 1/2 \times 2 \times 365/7 \times 0.85 = 630 \text{ people/year}$$

19: seat capacity of DHC-6
0.75: average seat factor
0.85: regularity of scheduled flights

From this information, the standard for closure can be determined.

(1) Airports that face a continued decline in the number of passengers should be closed.

(2) Presently the demand of passengers per route should be at least 600 people per year.

In closing an airport the negative economic impact on the surrounding area must be considered. However, as there are several advantages such as those listed below, a bold decision should be made in dealing with matters.

- Improved management capabilities by RNAC due to an abandonment of unprofitable routes.

- Aircraft which are presently used inefficiently can be used more efficiently on different routes.

- Government subsidies can be redistributed to remote areas which need the subsidies most.

- Maintenance costs for airports will be cut.

- The limited number of trained DCA personnel can be efficiently redistributed to areas where they are needed.

However, after closure of it, it is recommended to retain the airport space to provide for emergencies when road connections are destroyed.

Future development of the road network will have a major impact on the demand for air transportaion services. As pointed out in Chapter 2, an especially big project is the Sindhli road which will lead to a nationwide about 15% drop in the demand for air transportation services. Other roads won't have as much impact as this but certainly their influence will be felt in local areas. Airports to be closed in the future are Bharatpur, Rajbiraj, Chandragadhi, Jiri, and Rolpa.

Although the road network is rather developed overall, the extreme western region and the High Himalaya region still lag far behind in road construction. At the same time, providing new roads to the area is very expensive, so air transportation system is more suitable for these region as cheap, easy and quick means.

The major factors determining demand for airports in the air network is the rapidly changing road network so estimates for the future are very difficult to make. This means that long-term precise plans for airports should not be made based on present circumstances. Instead, the progress of road construction should be assessed to make short-term estimates that can be reconsidered every five years.

5.4 Plans for New Airports

The New Pokhara Airport and the Mugu Airport are presently being brought into design stage according to the plan for new airports. Also, although it is not a new airport, the Syangboche Airport is being proposed to accommodate DHC-6 aircraft. This section seeks to review existing development plans as well as assess their adequacy and also examine the expansion they call for.

5.4.1 Pokhara

(1) Historical Background

In 1969 the ICAO selected a new site at Daduwakhola Village and produced a design that provided for a 1740 m runway. After that, a report called the "Airport Development Project" was prepared by Dr. Ing. Walter Ikg (DIWI) and it confirmed the adequacy of the plan. After a detailed plan was completed, land purchasing was begun.

In 1984 the "Feasibility Study on Pokhara Airport" was prepared by S. R. Shresta and Co. (P.) Ltd. The report made demand forecast for the airport and made the following recommendations after reviewing the plan of each facilities.

Landing Strip Dimension	1980 m x 150 m
Runway Dimension	1799 m x 30 m

and reconfirmed the feasibility of the new airport.

(2) The Necessity of a New Airport

In addition to ICAO and DIWI surveys, a study on airport operation was conducted this time. As stated in subsection 3.3.2, "Evaluation of Existing Airports and Related Facilities" on the present Pokhara Airport, the fact that aircraft operations are very hard due to surrounding mountains and many major faults plague the facility. There is no room for argument on the necessity for a new airport on this point.

(3) The Role and Size of the Airport

Pokhara is a major tourist resort (second only to Kathmandu) in Nepal because it is surrounded by abundant scenery and nature and plays an important role in trekking activities. The number of passengers utilizing the airport, especially tourists, is significantly increasing.

In year 2010, it is forecast that about one hundred thousand people will use the airport. As shown in Table 2.3.1, it will develop into a major domestic airport in the future.

(4) The Possibilty for Future Internationalization

TIA is Nepal's only international airport. One more international airport has been expected for a long time and many wonder if Pokhara can become such an airport. There are many factors essential for an international airport, including the following:

- Facilities that meet international standards

  * A long runway which accommodates an international long range flight
  * Navigation aids more than Cat. I
  * Passenger and cargo handling system including CIQ
  * Air traffic services

- The organization and technology to manage the above-mentioned facilities

- An airspace with precision approach capability

- International level accommodation of Pokhara city

  * Hotels
  * Infrastructure
  * Transportation

To develop these essential facilities, large scale investment is necessary. TIA, the gateway to Nepal, will need to expand all of its facilites to meet future increases in air traffic volume. At the present when the expansion and upgrading of facilities is urgent and important, constructing one more international airport in Nepal can not be said to be a balanced distribution of investment from the viewpoint of the national economy.

Meantime, Pokhara Valley lacks some meteological and geographical advantages that are important for an international airport. The rainfall at Pokhara during monsoon season is greater than anywhere else in Nepal, as much as 4000 mm per year and 100 mm per hour.

Also, because of the surrounding mountains, there is not enough air space for a precision approach system to operate which is essential for an international airport. Moreover, because of the deep-valley Seti river it is impossible to properly install an approach lighting system. Since foreign pilots, especially charter flight pilots, are accustomed to a precision approach procedure, it is difficult to introduce international flights to Pokhara.

In consideration of the airport's functions and also the effective utilization of investment monies, the potential for internationalizing Pokhara Airport is scant, even if it were to be used as an alternate airport for TIA.

However, as long as it doesn't require excessive investment, it is possible (as far as the airport is concerned) for RNAC international flights to continue to Pokhara Airport by domestic service via TIA. In actuality this is not an introduction of international flights, but using jets on domestic routes to Pokhara would have a major impact on its tourism development.

Furthermore, considering the fact that TIA is the only airport with a long runway where large aircraft operate in Nepal, one more long runway, which can accommodate B-757 at least, should be prepared for transportation of relief goods and rescue party in case of an emergency.

5.4.2 Mugu Airport

(1) Location of the Airport

Mugu district is situated north of Jumla and Kalikot. It is one of the country's most remote districts and the most important place of interest for tourists in the Rara National Park.

The proposed Mugu Airport is located at an elevation of 2727 m above mean sea level and is near the lake Rara and the district headquarters, Gumgadhi.

(2) Historical Background

DCA had started the construction of a STOL airport to accommodate the PC-6 aircraft a few years ago. While the runway was being constructed, however, the National Planning Commission changed the plan so that the runway could accommodate the larger DHC-6.

Then the "Feasibility Study of Talcha (Mugu) Airport" was made by Building Design Associates in March, 1988. This study includes a soil survey and a topographical survey in addition to a feasibility study. Consequently the required runway length was set at 550 m and the runway direction was planned to shift slightly.

(3) Necessity of the Airport

Lake Rara, the biggest lake in the country, is of paramount scenic beauty and hence of high touristic importance. When this airport will be opened, it will be convenient for both tourists and the the people living in nearby remote areas.

Air traffic demand in the future is predicted to be 3300 and 4500 of passengers per year at year 2000 and 2010 respectively as shown in Chapter 2.

The conclusion of the above-mentioned report states that the project is economically feasible with a high EIRR. DCA is continuously making progress toward completing the detail design stage.

5.4.3 Syangboche Airport

(1) Location of the Airport

The Syangboche Airport is located at an altitude of 3749 m above mean seal level and is located in the Solvkhumbu District of the Sagarmatha Zone and is surrounded by Namche Bazar village, a well-known gateway to Mt. Everest and other peaks of Mahalangoor Himalaya.

(2) Historical Background

The Syangboche Airport opened in 1973. Although many tourists used this airport, it was occasionally used due to a shortage of aircraft to serve this route. At present, the existing Syangboche airport is one of the seven uncontrolled STOL airports by DCA in the Solukhumbu District. The available runway of only 400 m and the existence of a hill at the western end of the runway do not satisfy the safety requirements for DH-6's, thereby commercially limiting the airport to the smaller PC-6. The "Technical and Economical Feasibility Study of Syangboche Airport" was carried out by Building Design Associates in December, 1986 for the sake of introducing the DHC-6 with a view to future traffic demand.

(3) Necessity of the Airport

Since Mt. Everest and other High Himalayas are located in this Solukhumbu District, a large volume of tourists visit this district for Himalayan expeditions, trekking, and viewing the High Himalayas.

Air traffic volume is estimated at 8300 and 11600 of passengers in years 2000 and 2010 respectively, as shown in Chapter 2.

The study mentioned above reports the following:

"The project is economically feasible with a high EIRR. Therefore, the study highly recommends the project for implementation. Moreover, the project will fulfill the HMGN's objective of developing tourism in Nepal and thereby, earning foreign exchange for the overall economic development of the country."

(4) Issues for Future Consideration

The conclusion and recommendations of the above stody are as follows:

"The proposed Altiport meets all the technical requirements as specified in the Sale Engineering Report SER-6-228 issue: 3 of September 1973. However, it must be noted that the assumptions could be made valid only after the Civil Aviation Authority verifies high altitude performance ofe the Twin-Otter through a separate study."

In addition to this, the JICA study team recommends that mountain sickness among pilots and passengers be studied and medical care be provided.

5.5 Hub and Spoke System

To improve the economic efficiency of transportation in Nepal, the DCA and RNAC are continuing to cooperatively develop a hub and spoke system for the air network.

The old linear system centered on TIA as the single transfer point. The hub and spoke system, however, also uses Nepalgunji Airport (and in the future, Biratnagar Airport as well) as a major base airport with radial feeder lines of its own to other, smaller airports.

As the hub and spoke system is developed in the future, Nepalgunji Airport will be a key point. Recently a cooperative agreement with the Canadian Government was signed in September, 1988 and made aid available for the construction of a maintenance complex to be the next step for implementing hub and spoke system.

5.5.1 Advantages of the Hub and Spoke System

The advantages to implementing the hub and spoke system are as follows:

(1) RNAC can better manage the implementation of larger aircraft to meet greater demand. At the same time, the new aircraft will improve safety and offer better passenger service. Also, the system will provide advanced information about where to introduce new small jet aircraft in the future.

(2) DHC-6's can be used on short hauls rather than on long ones. It is more rational to construct a network in which aircraft that have the capability to land on STOL runways are used for remote STOL airports.

(3) As stated before, TIA is subject to closures in the mornings due to weather conditions, and STOL airports in the High Himalayas is same in the afternoon. A hub and spoke system would minimize the loss of utilization due to this problem.

(4) Regularity and punctuality of the scheduled flights will increase under the hub and spoke system. Presently the figures are a low 86.4% and 61.0% respectively.

(5) As the DHC-6's are more efficiently utilized a greater number of total flights will be possible with the same number of aircraft.

Beyond that, when the DHC-6's fly long hauls at high altitudes, the following problems occur:

- There is no pressurization equipment on-board so there is the potential for some medical problems.

- There are no toilets so there is a problem for passengers.

- Transportation efficiency is a problem since fuel for the return trip has to be carried.

Also, runway capacity of TIA could become a critical in near future, but the introduction of larger aircraft would counteract mounting difficulties.

As explained above, the hub and spoke system offers many significant benefits and should be aggressively adopted.

However, in contrast to these advantages, there are the following disadvantages to be considered:

(1) Since there will be fewer direct flights, the level of passenger service will drop.

(2) Because flights will go via a hub airport, the amount of time, fares, and lodging expenses will all increase and passenger service will drop.

(3) Decentralization of DCA and RNAC managment organizations and acquiring new facilities will initially increase expenses and the number of necessary staff.

As far as administrative policy is concerned, direct flights serving the tourist sector should be continued. Also, the pricing structure for flight via a hub airport should be reevaluated in consideration of subsidized fares. It is thought that the problems referred to (3) can be reconciled in a relativley short time.

5.5.2 The Current Hub and Spoke System and Its Future

The hub and spoke system is still in the process of being implemented but a few results can already be seen. As shown in Table 5.5.1, there has been a transition in the domestic passengers and the aircraft movements at TIA in the last few years. In spite of an increase of passenger, there is a trend for the number of movements to decrease. This is because the mix of aircraft using TIA as a base is changing and the average number of seats per aircraft is increasing. In other words, the number of flights for DHC-6 is decreasing and the number of HS-748's is rising, which is evidence that the aim of the hub and spoke system is being realized. Because this system is supported by an aggressive policy that calls for continued fleet utilization improvement, its implementation will assuredly continue into the future.

(1) Fleet reliability is expressed in terms of a aircraft-in-service ratio calculated from the number of days aircraft are in flyaway conditions. The aircraft-in-service ratio for the HS-748 has improved from 65.7% to 85.7% as shown in Table 5.5.2.

(2) Average daily utilization has largely remained unchanged. Even the HS-748's 2.51 hours/day is a low level of usage and represents a drop from the 5.39 hours/day recorded in 1977/78 as shown in Table 5.5.2.

RNAC's goal is to raise that rate to a target level of 3.17 hours/day in 1987/88.

Presently the system does not utilize enough improved aircraft that offer better reliability. Clearly there is still room for improvement in better utilizing the HS-748's to deal with the serious shortage of DHC-6's in the future. Also, the system could be significantly improved if the old HS-748 were replaced with a more advanced model.

Table 5.5.1
Number of Domestic Flights and Passengers at Kathmandu

Year	Flight (b)	Pax (a)	Ave. Pax/Flt (a)/(b)
1984	15,119	173,156	11.5
1985	13,974	187,029	13.4
1986	10,847	208,459	19.2
1987	12,500	218,538	17.5
1988	13,684	264,427	19.3

Source: Planning and Statistics TIA

Table 5.5.2 Fleet Utilization

		77/78	84/85	85/86	86/87	87/88 (Target)	Reference
(1)	Fleet Aircraft Days	-	1,595	1,095	1,095	1,095	=No.of ACFT X 365
		-	3,270	3,276	3,650	3,650	
(2)	Aircraft in Service Days	-	720	819	901	939	
		-	2,990	2,963	3,158	3,130	
(3)	Aircraft in Service Ratio	-	65.7 %	74.8 %	82.2 %	85.7 %	=2)/1)
		-	91.4 %	90.4 %	86.5 %	85.6 %	
(4)	Revenue Block Hours	3936	2,909	2,750	2,744	3,475	
		6749	10,319	11,771	12,656	13,127	
(5)	Ave. Daily Utilization (hr)	5.39	2.66	2.51	2.51	3.17	=3)/1)
		4.24	3.15	3.59	3.47	3.60	

upper HS-748
lower DHC-6

Source:RNAC
- Operating Plan 1987/88
- Thirty Years of Progress

As stated above, the hub and spoke system offers many important advantages and should be actively promoted.

In the future hub and spoke system, Nepalgunj will be developed into a key hub airport while Dhangahi Airport will also eventually be developed into same type of role. Because of its location and closeness to Kathumandu, the development of the Biratnagar Airport into a part of the hub and spoke system in the far eastern region will not be expected to have a very significant effect. Therefore, heavy investment in Biratnager Airport should not be carried out until future trends are ascertained from developments at Nepalgunj Airport.

There are only three outdated HS-748's. As was observed during a site investigation (in September, 1988) two of the old aircraft had been overhauled. Since these old aircraft are too outdated for efficient service, they should be quickly replaced with new aircraft that can ensure safety and reliability. The introduction of such new aircraft will be the key to success for the hub and spoke system.

5.6 Airway Structure

The existing airway system in Nepal is shown in Fig. 1.2.3. In view of increased air traffic volume in the future, aircraft operations under IFR should be introduced in Nepal along with necessary facilities in order to ensure the punctuality of schedule flights and to improve the safety of flight operations.

Fig. 5.6.1 shows the result of a study of the airway network which researched the effects in the case that IFR operations are introduced on a national scale in Nepal.

Assumptions and conditions of the study are:

(1) VOR/DME which is not influenced by static (lightning) is planned as a basic facility

(2) Width of airway is based on the standard/recommendation described in ICAO Annex 11 and ANP (Air Navigation Plan), Middle East and Asian Region

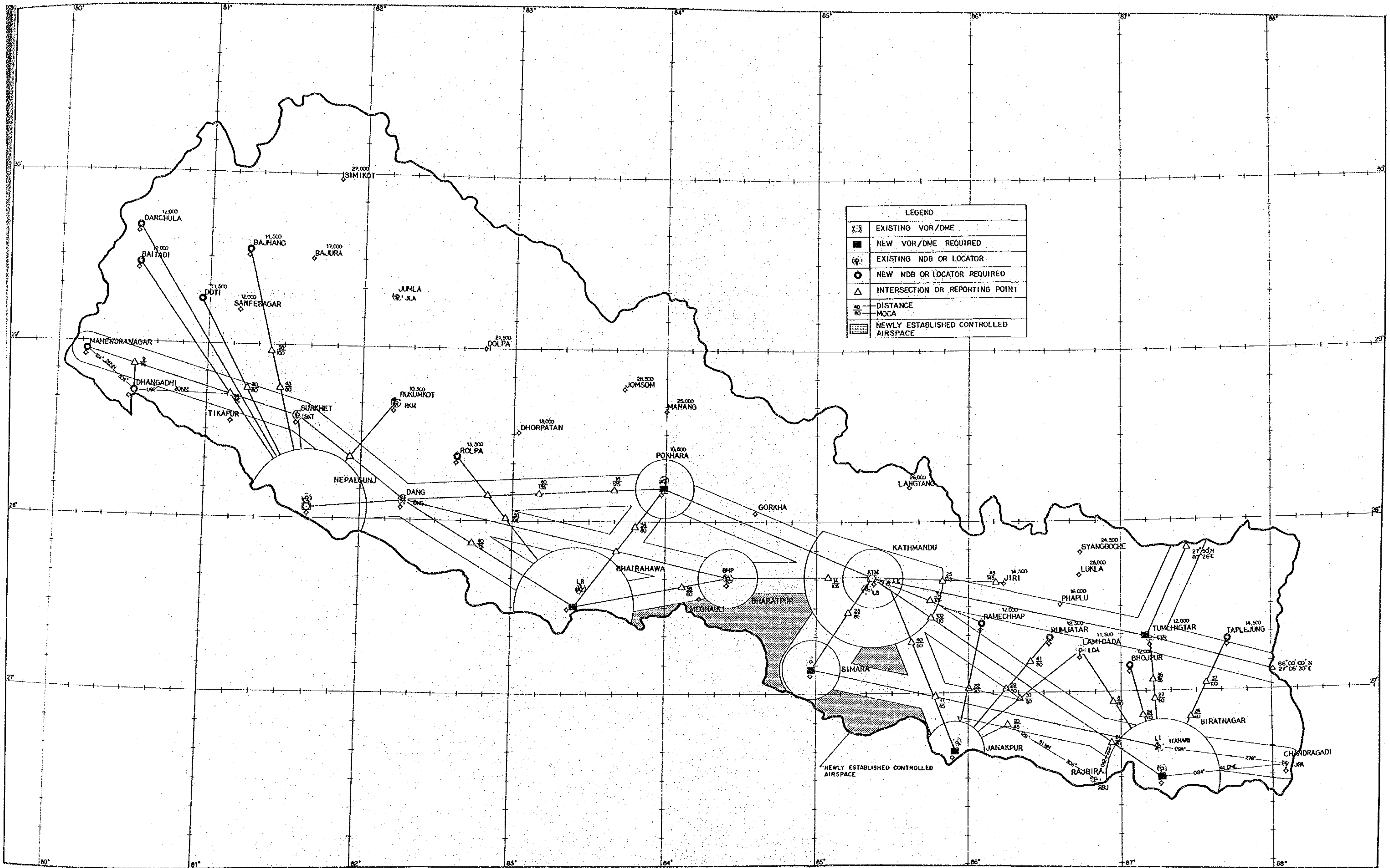


Fig. 5.6.1 Proposed VOR Airway in Nepal

(3) New VOR/DMEs installations are planned at the following airports:

Biratnagar, Janakpur, Simara, Bhairahawa, Pokhara, and Tumlingtar

(4) New NDB or locator are planned to be installed at the following airports for the reason stated below:

Taplejung, Bhojpur, Rumjatar, Ramechhap, Mahendranagar, Rolpa, Bajhang, Doti, Darchula and Baitadi.

The range of the VOR radials in terms of tolerance is effective only to 100 NM. Beyond that range, alignment error, bends, scalloping, and roughness make it impractical as a navigational aid. Accordingly, at the mountain airports, NDB or locators are planned to be installed to confirm the position of aircraft in relation to surrounding mountains.

(5) An airway ceiling of 15000 feet has been adopted in consideration of the performance of the DHC-6 aircraft which is used for domestic flights by RNAC.

- The DHC-6 aircraft used by RNAC have no airframe deicing equipment. Although IMC flights will have to be made during the monsoon and winter seasons, it is generally believed that the planes will not ice up in flight if the aircraft fly below an altitude of 15000 feet.

(6) In this study, MSA (Minimum Safe Altitude) which is derived from MOCA (Minimum Obstruction Clearance Altitude) is studied with the following formula:

$$D = 1.225 (\sqrt{Ht} + \sqrt{Hr})$$

where

D = Distance
Ht = Elevation of antenna of Navaid
Hr = Altitude of aircraft

- In general, the MEA (Minimum Enroute IFR Altitude) value for each route segment is the highest altitude among MOCA, MRA (Minimum Reception Altitude) and communication coverage. Also MRA and communication coverage can be found by flight check.