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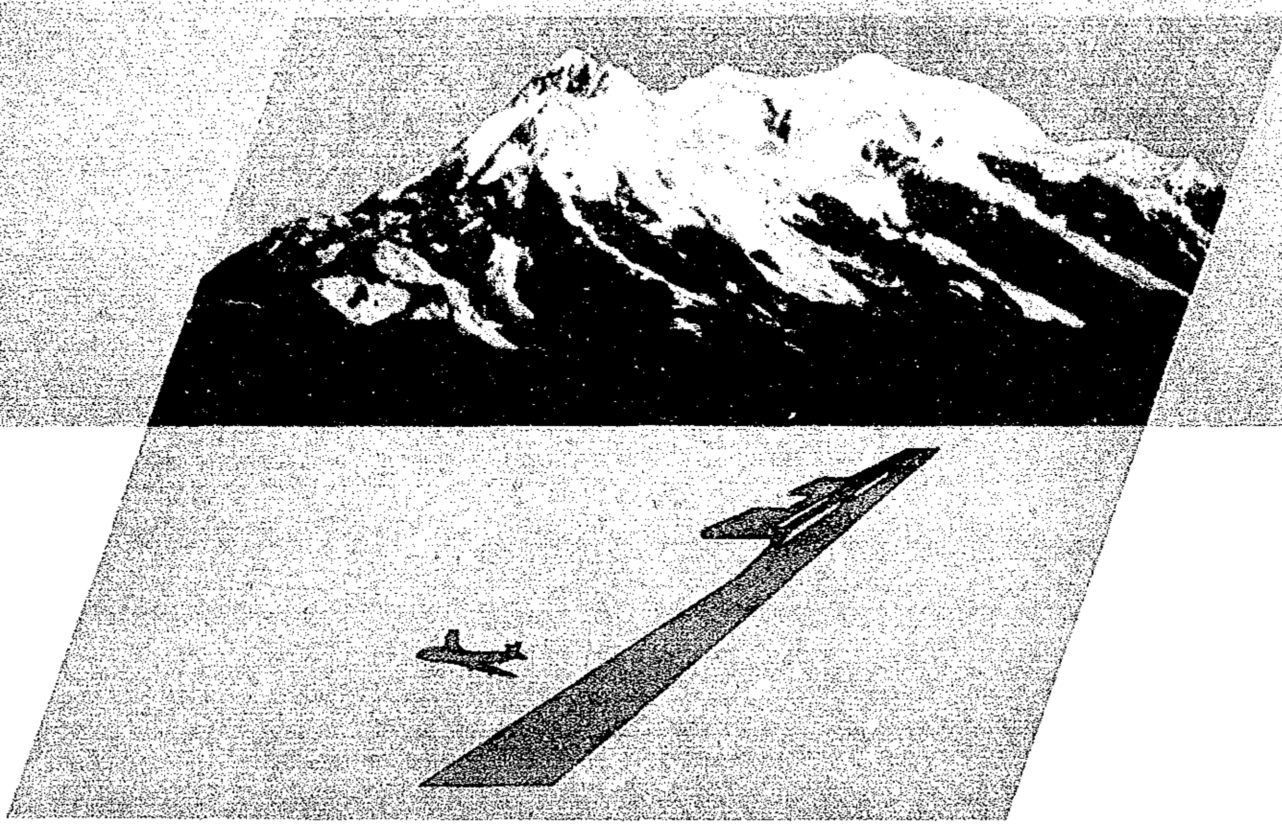
No. 7

REPUBLIC OF BOLIVIA

FEASIBILITY STUDY ON EL ALTO AIRPORT MODERNIZATION PROJECT

REPUBLIC OF BOLIVIA FEASIBILITY STUDY ON EL ALTO AIRPORT MODERNIZATION PROJECT FEBRUARY 1988



FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF BOLIVIA

FEASIBILITY STUDY
ON
EL ALTO AIRPORT
MODERNIZATION PROJECT

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PREFACE

In response to the request of the Government of the Republic of Bolivia, the Japanese Government has decided to conduct a study on the El Alto Airport Modernization Project and entrusted the study to the Japan International Cooperation Agency (J.I.C.A.). The J.I.C.A. sent to Bolivia a study team headed by Mr. Makoto TANAKA, Pacific Consultants International from January to December, 1987.

The team had discussions on the project with the officials concerned of the Government of Bolivia and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relationship between our two countries.

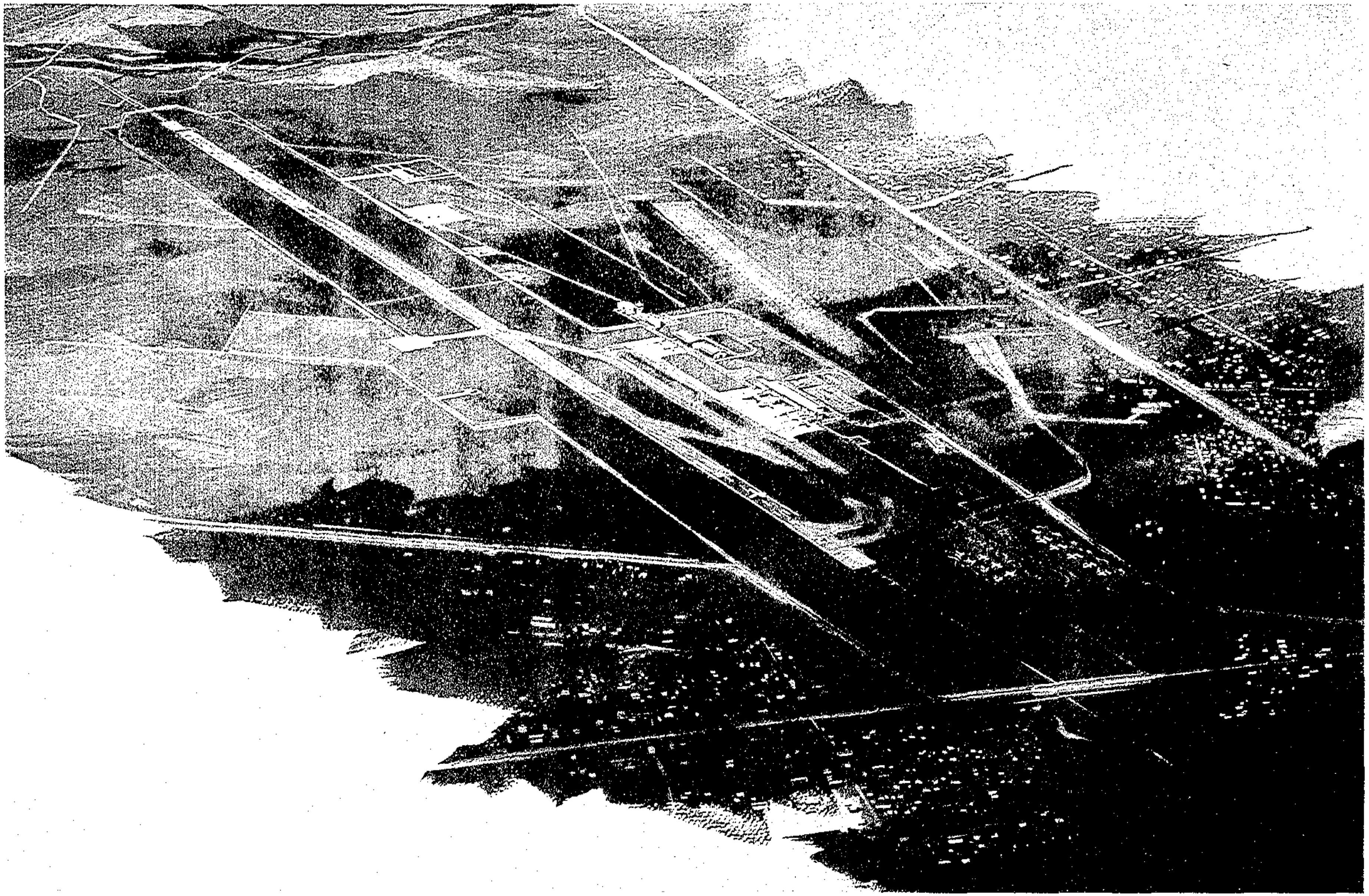
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Bolivia for their close cooperation extended to the team.

February, 1988

Kensuke Yanagiya

President

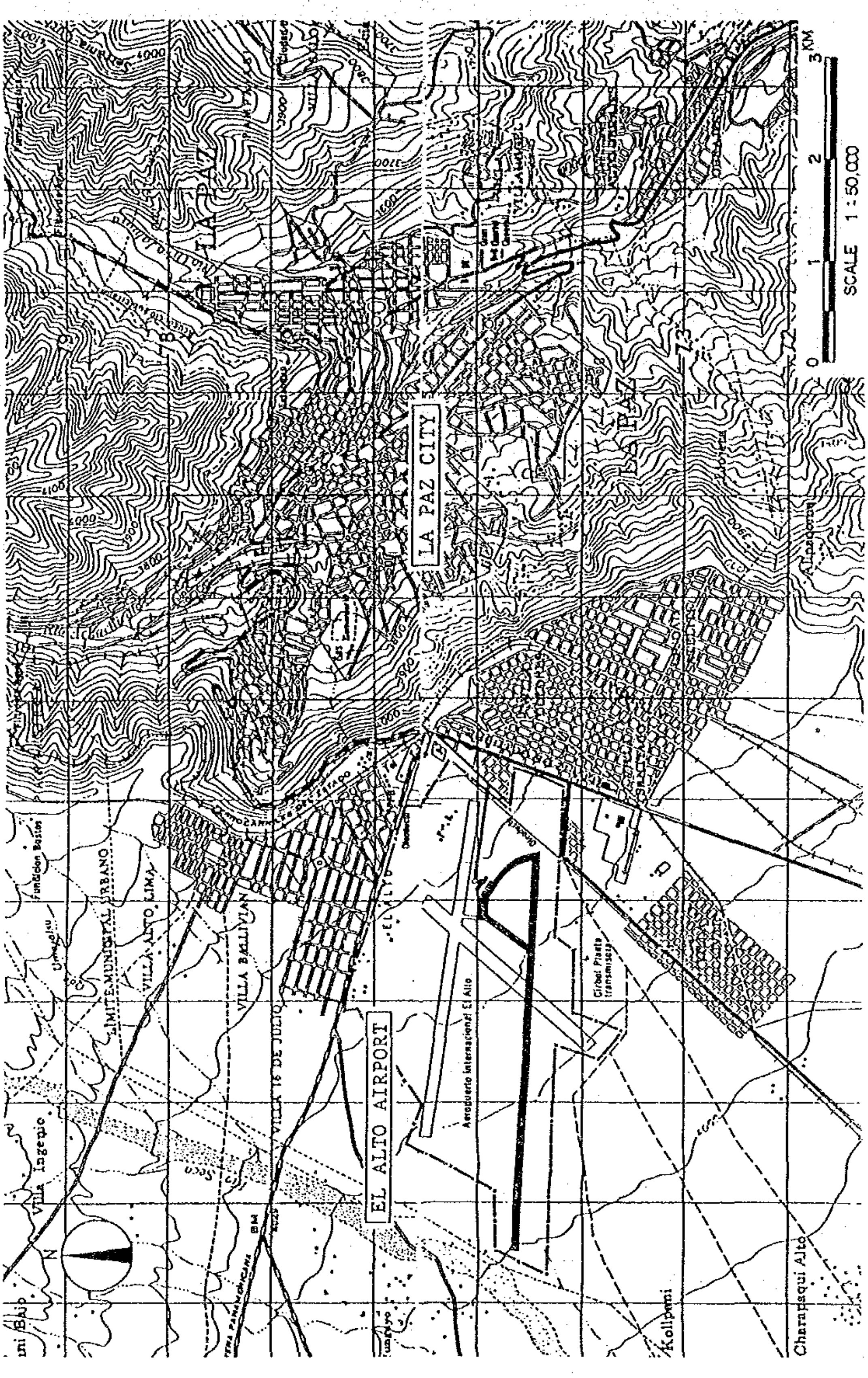
Japan International Cooperation Agency



EL ALTO INTERNATIONAL AIRPORT PHASE I DEVELOPMENT PLAN

EL ALTO INTERNATIONAL AIRPORT PHASE I DEVELOPMENT PLAN

PROJECT LOCATION MAP - 1



PROJECT LOCATION MAP - 2

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PART I INTRODUCTION

INTRODUCTION

1. General

Bolivia is a landlocked country situated in the center of South America. It has a total area of 1,099,000 sq.km and a population of 6.4 million. El Alto airport is located approximately 15 km west of La Paz city, which is the political and economic center of Bolivia and substantially the capital of the nation against Sucre as the constitutional capital.

Air transport in Bolivia plays important and essential roles for both international and domestic communications. International air transport, passenger as well as cargo transport, is indispensable for Bolivia's socio-economic activities due to its landlocked geographical features. Domestic air transport is essential for the efficient and effective communications within the nation due to its sparsely scattered population and its underdeveloped surface transportation system because of the difficult geographical conditions.

Under these circumstances, Viru Viru airport was constructed in 1984 in Santa Cruz, the second largest city and the strategic area from the viewpoints of the industrial development of Bolivia in order to ensure an unrestricted international civil air transport and to promote the international economic activites. El Alto airport as the nation's main gateway, however, has remained without any positive improvement to cope with the demands since its inauguration in 1966 due to the difficult budgetary condition in spite of the keen necessity of the development. Therefore, the Government of Bolivia recognized the urgent need for a long-term master plan on which the future development of El Alto airport should be predicated.

The Government of Bolivia has decided to request the Government of Japan to provide a technical assistance necessary for the modernization of El Alto airport.

Based on an agreement between the governments, Japan International Cooperation Agency (hereinafter referred to as "JICA"), an official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, was entrusted to carry out the Feasibility Study on El Alto Airport Modernization Project (hereinafter referred to as "the Study"). JICA organized the Study Team and commenced the Study in January, 1987.

This Final Report explains results of the above study finalized in accordance with the mutual understanding between JICA and the Government on Bolivia.

2. Objectives and Scope of Work

The objectives of the Study are to prepare the long term master plan for the modernization of El Alto airport, and finally to establish the most economic viable implementation program from the national economic viewpoint.

The Study comprises the following 17 major working items which are performed in accordance with the work flow chart indicated in Figure 1.

(1) Collection of the relevant data and information
(2) Site investigation of the existing airport
(3) Topographic survey, soil investigation, pavement investigation and traffic survey
(4) Air traffic analysis and demand forecast
(5) Airport facility requirements analysis
(6) Evaluation of the existing airport facilities
(7) Preparation of alternative airport master plans
(8) Preliminary cost estimates for alternative airport master plans
(9) Evaluation comparison for alternative airport master plans
(10) Study of the staged construction and determination of the scope of the Phase I development
(11) Preliminary design for Phase I development
(12) Airspace utilization planning
(13) Aircraft noise forecast, land use planning and other study
(14) Preliminary design for immediate improvement
(15) Project implementation schedule and cost estimates
(16) Economic and financial analyses
(17) Conclusion

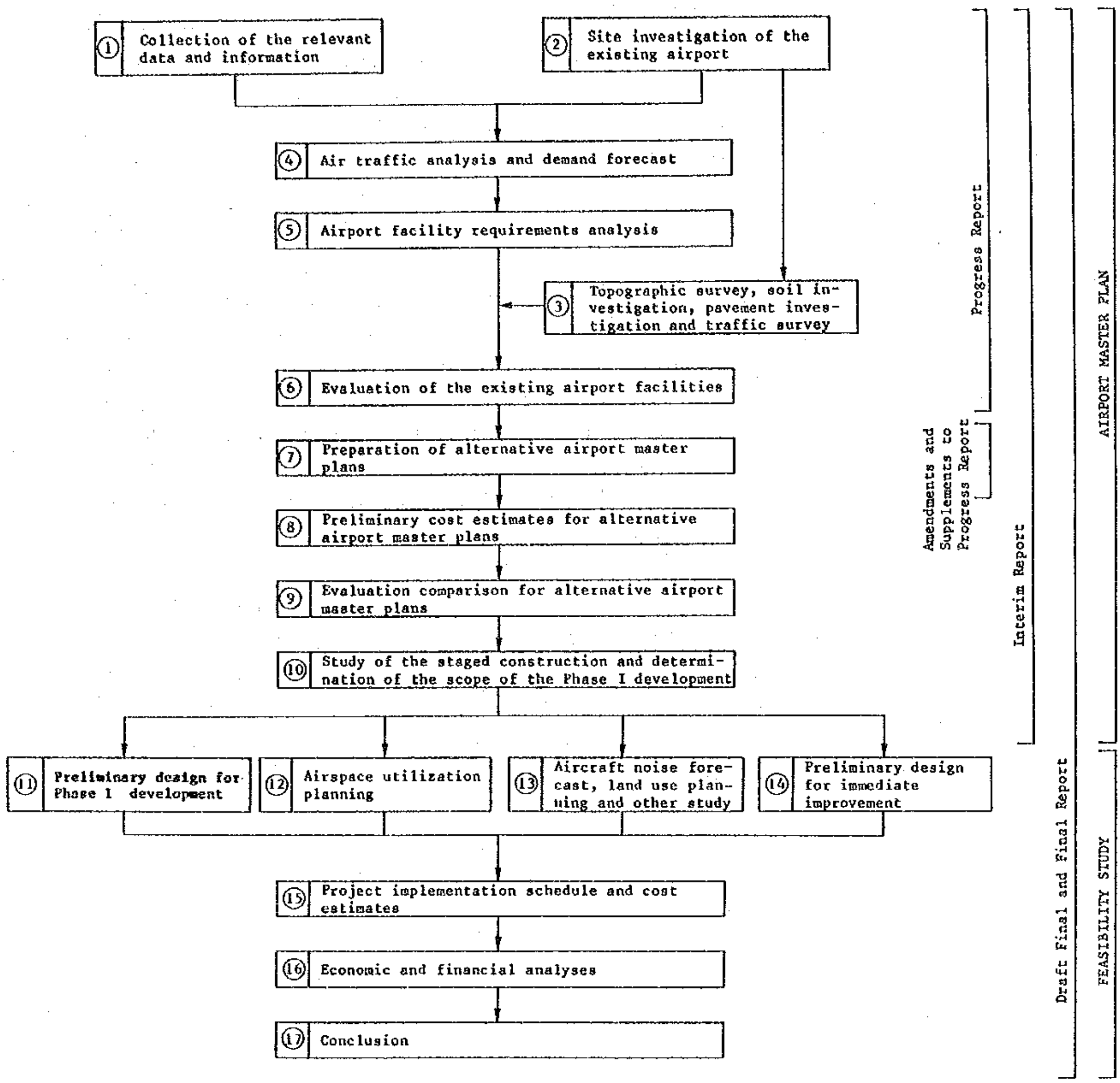


Figure 1 Main Work Flow Chart

3. Execution Method and Reporting System

The Study Team conducted the Study in accordance with the procedures in the Inception Report accepted by the Ministerio de Aeronautica (hereinafter referred to as "MDA") and Administracion de Aeropuertos y Servicios Auxiliares a la Navegacion Aerea (hereinafter referred to as "AASANA") in January, 1987.

The Study Team immediately started with data collection and site investigation of the existing airport. The Study Team, in the meanwhile, carried out the topographic survey, soil investigation, pavement investigation, traffic survey and the studies covering the air traffic analysis and demand forecast, airport facility requirements analysis and evaluation of the existing airport facilities. Progress Report containing the results of these studies were submitted to MDA/AASANA in March, 1987, and was accepted. The contents of the Progress Report are included as Chapters 1 through 4 of this Report.

The Study Team after returning to Japan carried out further study on the air traffic demand forecast and the preparation of the alternative airport master plans. Amendments and Supplements to Progress Report containing the results of these studies were submitted in July, 1987. The contents of the preparation of the alternative airport master plans are included as Chapter 5 of this Report.

In order to select the most viable airport masters plan, the Study Team carried out the evaluation comparison for alternative airport master plans including preliminary cost estimates of these plans. The Study Team also determined the construction work items of the Phase I development. Interim Report containing the result of these studies was submitted in September, 1987, and was accepted. The contents of these studies are included as Chapters 6 and 7 of this Report.

The preliminary design for Phase I development based on the selected airport master plan, ALT-TC3, was drawn up along the line of the results of the Interim Report, incorporating MDA/AASANA's comments. The Draft Final Report which was made by adding Chapters 8 through 13 to the Interim Report contains the comprehensive results of the feasibility study on El Alto airport modernization project. The Draft Final Report was submitted in December, 1987, and was accepted.

This Final Report is finalized incorporating MDA/AASANA's comments on the Draft Final Report and consists of "Main Report" and "Supporting Information Report".

4. Study Organization

The Study was carried out by the Study Team organized by JICA under the supervision of the JICA Advisory Committee and with the close cooperation of their counterparts officials of MDA/AASANA. The organization chart is shown in Figure 2.

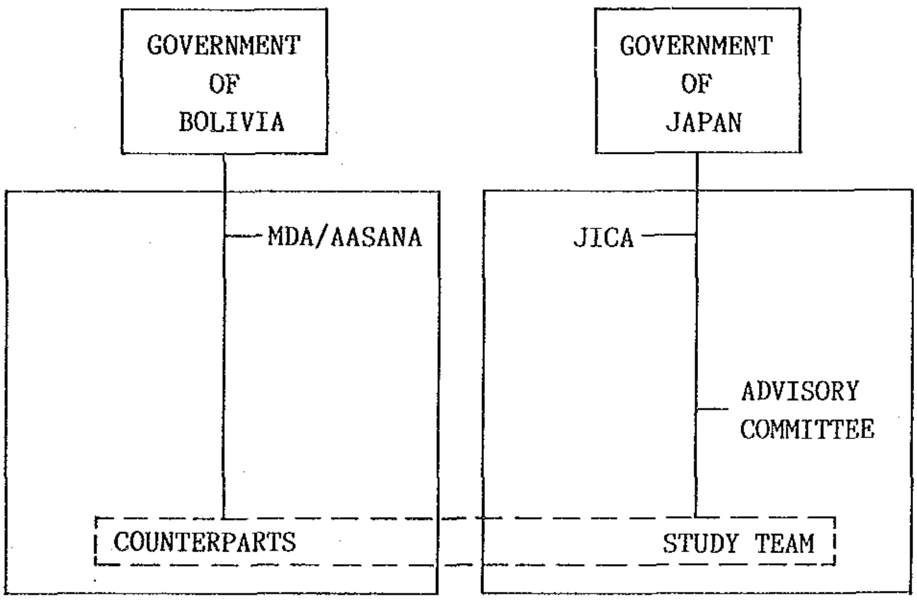


Figure 2 The Overall Organization Frame

The members of JICA Advisory Committee, Study Team, and MDA/AASANA's counterpart are presented in the following list.

JICA ADVISORY COMMITTEE

Mr. Norio SANAKA (Chairman)	Deputy Director Construction Division Aerodrome Department Civil Aviation Bureau Ministry of Transport
Mr. Nobumasa FUNAKI	Special Assistant Planning Division Aerodrome Department Civil Aviation Bureau Ministry of Transport
Mr. Takao TAKAHASHI	Port and Harbour Research Institute Ministry of Transport
Mr. Yoshiyuki HOSHIYAMA	1st Port and Harbour Construction Bureau Ministry of Transport
Mr. Koji TAKAHASHI	International Cooperation Division International Transport and Tourism Bureau Ministry of Transport

JICA STAFF

Mr. Masaru SUZUKI	1st Development Survey Division Social Development Cooperation Department Japan International Cooperation Agency (JICA)

JICA STUDY TEAM

Mr. Makoto TANAKA	Team Leader
Mr. Ryuji TAGUCHI	Airport Planner
Mr. Keiichi TAKEDA	Airport Planner/Navaids Planner
Mr. Kazuo HAYASHI	Airport Civil Engineer
Mr. Tadamitsu ITOH	Aircraft Operations Planner
Mr. Kazuhiko DENDA	Traffic Forecast and Economic/ Financial Analyst
Mr. Tokio ODA	Airport Architect
Mr. Shota MORITA	Airport Construction Planner

MDA/AASANA EXECUTIVE COMMITTEE

Ing. Fernando Guillen Monje (Chairman)	Executive Director
Arq. Walter Hoz de Vila Luna	Under Executive Director

MDA/AASANA - STUDY TEAM

Ing. Eduardo Viscarra	Representative of MDA
Ing. Fernando Saavedra	Team Leader
Ing. Maximo Jaen	Team Leader
Ing. Luis Ramos	Under Team Leader
Ing. Juán José Peralta	Under Team Leader
Ing. Jaime Quiroga	Airport Planner
Arq. Antonio Blanco	Airport Planner
Mr. Vito Rodriguez	Facilitation/Civil Aviation Security
Mr. Mario Arze Vergas	Facilitation/Civil Aviation Security
Ing. Antonio Treviño	Civil Works
Ing. Luis Pantoja	Civil Works
Mr. Humberto Obleas	Civil Works
Lic. Julio Almaraz T.	Economic/Financial Analyst
Lic. Marcelo Aguirre	Economic/Financial Analyst
Lic. Edgar Monje	Economic/Financial Analyst
Lic. Jose Pardo	Economic/Financial Analyst
Mr. Andres Kucharsky	Operation Planner
Mr. Fernando Acosta	Operation Planner
Ing. Vicente Aguilar	Maintenance Airport Leader
Mr. Ramiro Molina C	Assistant to Study Team

PART II BACKGROUND

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Socio - Economic Conditions in Bolivia

Bolivia is located in the central area of South America. It is a land locked country with an area of 1,099,000 sq.km and a population of 6.4 million.

The country is divided into three regions, i.e. Altiplano, Valles and Tropico, based on their geographical conditions.

Altiplano is located in the highlands, 4,000 m in elevation surrounded by the eastern and western Andes mountain ranges. More than half of the population is concentrated in this region.

The Valles region is a gently sloping area extending from the eastern Andes to the Amazon plain, with an elevation of 1,500 m to 3,000 m. Approximately 30 % of the population inhabits this region. This region supplies cereals and fruit to Altiplano.

Tropico is a vast tropical plain area extending from east of Valles to the boundary of Brazil and Paraguay. This region is less developed than other regions. Around 20% of the population inhabits this region.

The gross domestic product (GDP) of Bolivia maintained favorable growth rate prior to 1973. It sharply decreased after 1973, however, due to two oil crises and depressed export prices for the primary mining products.

1.2 Socio-Economic Conditions in La Paz Department

La Paz city is located near the center of Altiplano (Highlands) and its elevation is 3,600m above sea level. This city is the largest and substantially the capital of Bolivia with a population of 993 thousand (1985, estimated).

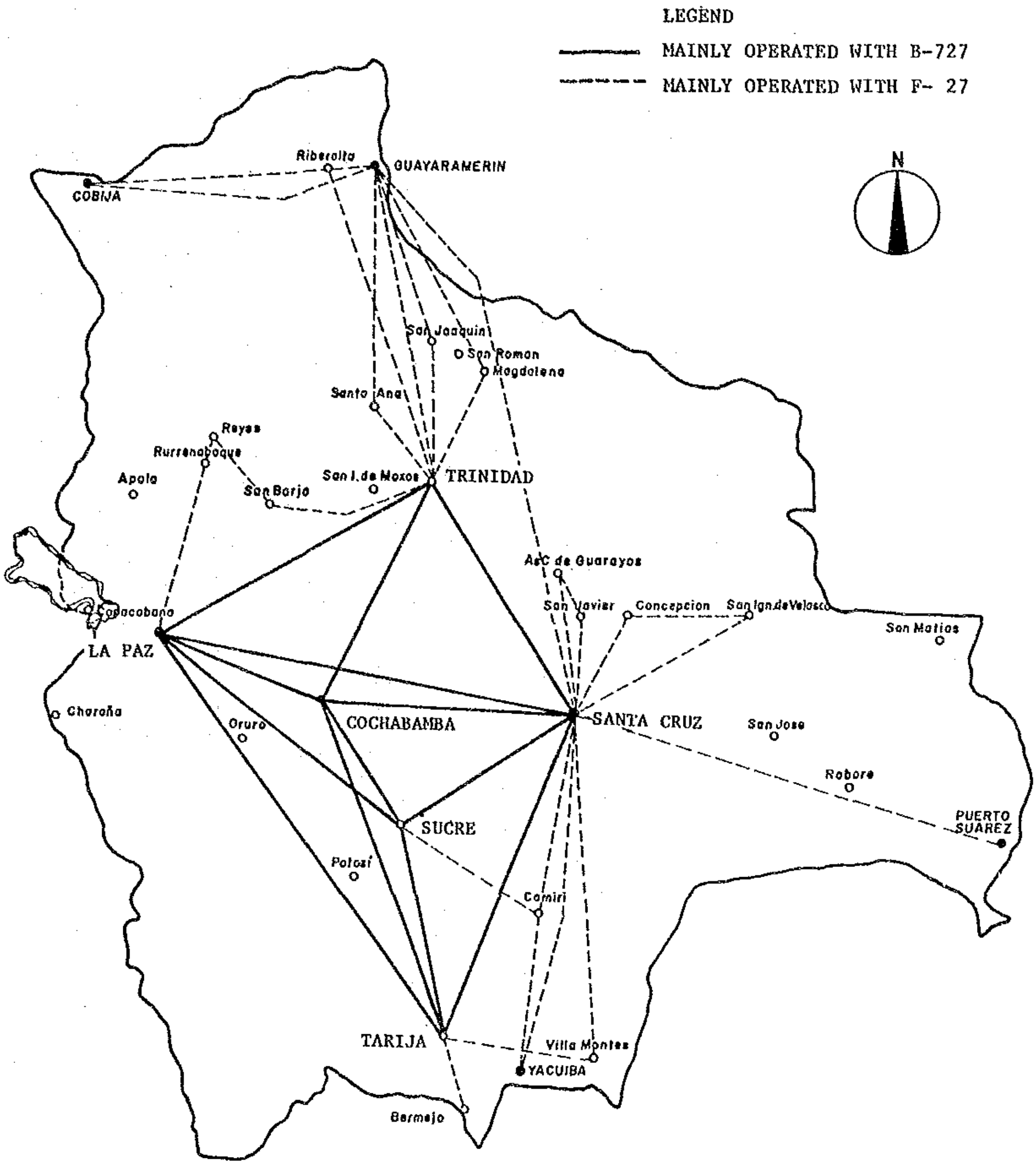
1.3 Air Transportation in Bolivia

There are a total of 33 airports under the control of the AASANA which are being used for civil aviation in Bolivia.

Domestic air routes being used in Bolivia are shown in Figure 1.3.1. In this figure, the routes shown by the solid lines are operated mainly for B-727 aircraft. The routes shown by the broken lines are operated for F-27 planes.

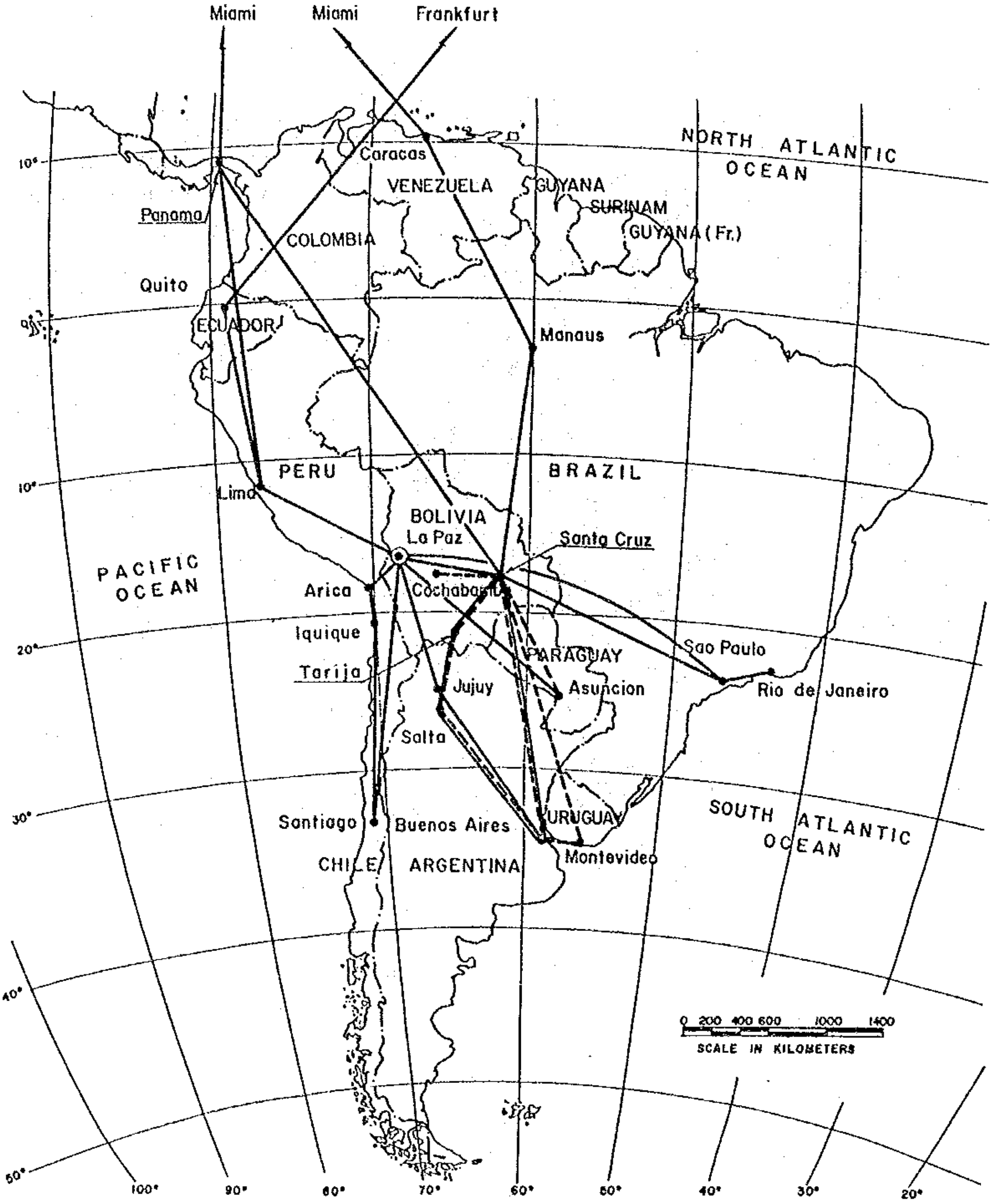
International routes to and from El Alto airport are shown in Figure 1.3.2. The United States of America, Europe and neighbouring nations are linked by an air transport network.

The scheduled flight services in Bolivia are mainly operated by LLOYD AEREO BOLIVIANO (LAB).



Note: As of July, 1987

Figure 1.3.1 Domestic Air Routes in Bolivia



LEGEND

——— INTERNATIONAL AIR ROUTES TO/FROM LA PAZ

----- INTERNATIONAL AIR ROUTES TO/FROM COCHABAMBA

Note: As of July, 1987

Figure 1.3.2 International Air Routes in Bolivia

The present annual air traffic volume in Bolivia and at the El Alto airport is summarized in Table 1.3.1.

Table 1.3.1 Present Annual Air Traffic Volume as of 1985

Item	Bolivia	El Alto Airport	
			Share of Total (%)
Domestic Passengers *1	1,908,000	413,000	22
International Passengers *1	263,000	133,000	51
Domestic Cargo *2	15,492 ton	6,135 ton	40
Meat Cargo *2	-	17,357 ton	-
International Cargo	10,978 ton	5,790 ton	53

Note *1 : Embarked and disembarked passengers excluding transit passengers

*2 : As of 1984

The annual aircraft movements at El Alto airport as of 1985 are shown in Table 1.3.2.

Table 1.3.2 Annual Aircraft Movements at La Paz as of 1985

Classification	Annual Aircraft Movements	Percent of Total (%)
Commercial Aviation		
Domestic		
Scheduled	4,376	21.2
Non-scheduled		
General Aviation	1,912	9.3
Small Carriers for Meat Cargo	3,508	17.0
International		
Scheduled	2,566	12.4
Non-scheduled	74	0.4
Military and Training	8,176	39.7
Total	20,612	100

Source : Boletin Estadistico, AASANA, 1976 - 1985

1.4 Other Transportation Systems

Road density is too low for Bolivia to make full use of its vast land and natural resources. In particular, the road density is surprisingly low in Tropico, where many cities have no permanent roads connecting them with major cities such as La Paz, Santa Cruz and Cochabamba. The absolute lack of an existing road network will make air transportation a necessity for a rather long time in the future.

Railroads account for only several percent of the total transportation system. They do play some role in inland transportation but are not competitive with air transportation particularly if the existing marketing policy is maintained.

In addition to the road and rail transportation, Bolivia has inland waterways and pipelines. The inland waterways are used for cargo transportation, but only in a very limited way. The pipelines are used particularly for the transportation of petroleum-products.

Taking into account travel time and the existing transportation network, air transportation is considered to play an important role for a rather long time in Bolivia.

1.5 Existing Conditions at El Alto Airport

El Alto airport (officially called John F. Kennedy international airport) is located about 14.5 Km west of the city of La Paz.

The existing airport layout and outline of the facilities are illustrated and summarized in Figures 1.5.1 and 2, and Table 1.5.1, respectively.

The runway, taxiway and apron was completed in 1966. The passenger terminal building was opened in 1970.

Since then, this airport has had no positive investment for improvement and preventive maintenance in spite of the steadily increasing air traffic, obvious saturation in capacity and obsolescence of many existing facilities.

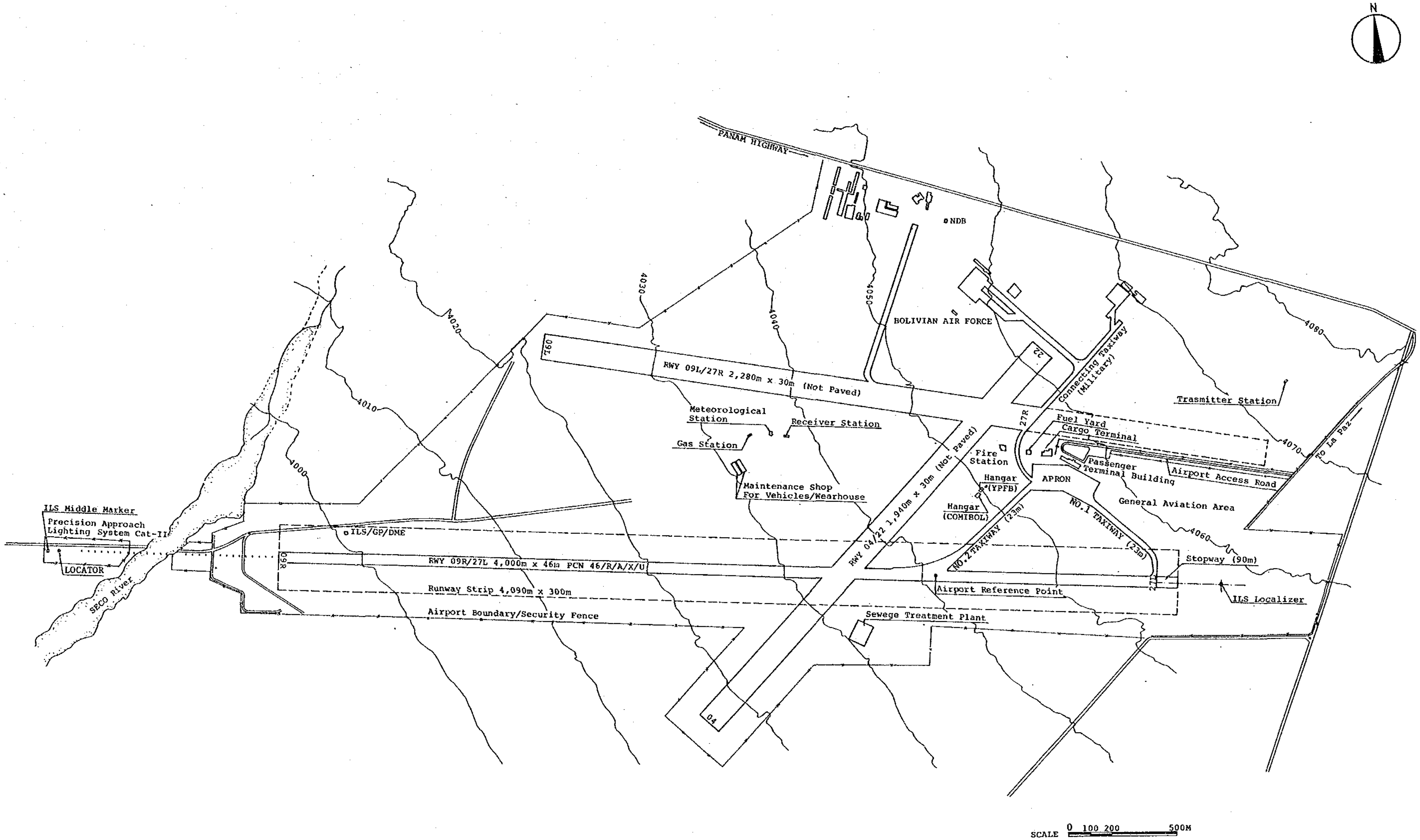


FIGURE 1.5.1 LAYOUT OF EXISTING EL ALTO AIRPORT

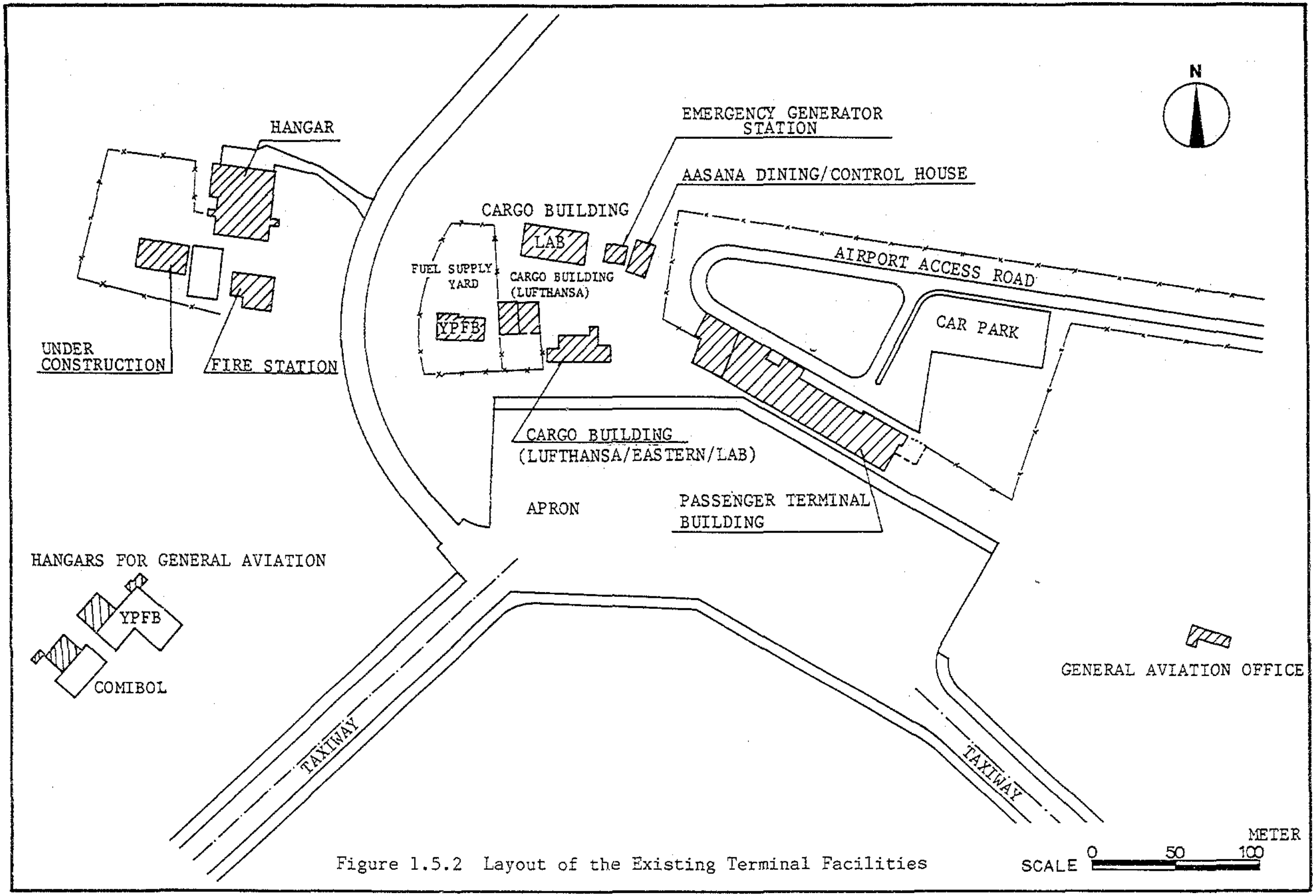


Figure 1.5.2 Layout of the Existing Terminal Facilities

Table 1.5.1 Outline of Existing El Alto Airport

"YES" indicates "Provided or available"

"NO" indicates "Not provided or not available"

Country	Name of Airport	INTL/DOM / ICAO CODE	Commencement of Services	Total Area of Airport	Aerodrome Reference Point	Airport Elevation	Runway Orientation	Aerodrom Reference Temperature	Operation Hour	Seasonal Availability	Administrative Agency
Republic of Bolivia	John F. Kennedy	INTL/DOM / 4E	1966	850 ha	S 16°30'36" / W 68°10'52"	4,058 m (13,313 ft)	RWY09R/27L N92°E(Mag.)	16 °C	24 hours	All Seasons	AASANA

City/Town: Name	Population	Distance to Airport	Transportation: Railway	Taxi	Bus	Wind Coverage
La Paz	Approximately 993,000 (1985)	14.5 km	NO	YES	NO	RWY09R/27L 99.4%(13kt) 100%(20kt)

Minimum Meteorological Conditions

Runway	Approach Procedure		Straight - in CAT-A	CAT-B	CAT-C	CAT-D	Circling CAT-A	CAT-B	CAT-C	CAT-D
09R	ILS/DME	OCA/H	13341/185	13355/199	13365/209	13378/222	14081/768	14081/768	14180/867	14180/867
		Visibility	-	-	-	-	1.6 Km	2.0 km	4.0 km	4.4 km
	VOR/DME	OCA/H	13900/744	13900/744	13900/744	13900/744	14081/768	14081/768	14180/867	14180/867
		Visibility	1.6 km	1.6 km	3.2 km	3.6 km	1.6 km	2.0 km	4.0 km	4.4 km
	NDB/LM	OCA/H	13900/744	13900/744	13900/744	13900/744	14081/768	14081/768	14180/867	14180/867
		Visibility	1.6 km	1.6 km	3.2 km	3.6 km	1.6 km	2.0 km	4.0 km	4.4 km

Air Navigation Systems

Radio

	NDB	LO	VOR	DME	TACAN	ILS	ASR	PAR	SSR	ARTS	ASDE	HF	VHF	UHF	ATIS	DF	ITV	TTY	AFTN
Existing	YES	YES	YES	YES	NO	YES	NO	NO		NO	NO	YES	YES	YES	NO	NO	NO	YES	YES
Plan									YES										

Lightings

	ALS	SFL	SALS	ALB	AGL	CGL	REIL	VASIS	PAPI	RWL	RWTL
Existing	YES	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Plan											

	RWCL	TDZL	OL	DML	TWL	TWCL	TGS	ABN	WDIL	AFL
Existing	NO	NO	YES	NO	YES	NO	NO	NO	YES	YES
Plan										

Meteorological Facilities

Runway Surface Sensors	YES
Weather Facsimile	YES
APT Receiver	NO
Radiosonde	NO
Weather Radar	NO
VOLMET Broadcast	NO

Basic Facilities

	Size	Pavement	Note
Runway 09R/27L	4,000m x 46m	Concrete	PCN46/R.A.X.U.
Runway 09L/27R	2,280m x 30m	Not Paved	
Runway 04 /22	1,940m x 30m	Not Paved	
Taxiway	23m Wide		2 connecting taxiways

	Design Aircraft	Number of Stand	Pavement	Area	Parking Configuration
Apron	B-747	1	PCC	33,600 m^2	Angle-out
	B-727	2	PCC		Angle-out
GA Apron	C-54 Class	16	Not Paved		

Flight Services

Domestic Flights by LAB: Flight Route	Type of Aircraft	Weekly Aircraft Movement	International Flights by LAB: Flight Route	Type of Aircraft	Weekly Aircraft Movement	International Flights by Foreign Airlines: Flight Route	Airline	Type of Aircraft	Weekly Aircraft Movement
LPB - CBB	B 727	32	LPB - MIA	B 727	14	LPB - FRA	LH	B 747M	4
LPB - SRZ	B 727	12	LPB - RIO	B 727	8	ASU - LPB - MIA	EA	B 727	12
LPB - TJA	B 727	2	LPB - BUE	B 727	2	LPB - RIO	SC	B 727	6
LPB - SRE	B 727	6	LPB - SCL	B 727	4	LPB - LIM	PL	B 727	4
LPB - TDD	B 727	8	SRZ - LPB - ARI	B 727	8	LPB - BUE	AR	B 727	2
LPB - RBQ	F 27	4	SRZ - LPB - LIM	B 727	8	LPB - SCL	LA	B 737	2

Other Facilities

	Size	Structure	Note
Car Parking	100 lots	Under expansion	150 lots after expansion
Pax. T. Building	4,800 m^2	RC	Built in 1952
Cargo T. Building	1,300 m^2	Steel	3 buildings
Adm. Building	2,820 m^2	RC	Part of Pax Bldg.
Control Tower	Cab: 30 m^2	RC	Part of Pax Bldg.
Fire Station	430 m^2	RC	Height 24.5 m
(Level of Protection)	Category 7 Available		3 cars
Fuel Supply	Hydrant Supply Available		
	Jet A-1 : 2,056 kl		
	Avigas : 1,662 kl		

Statistics of Air Traffic

Year	1981	1982	1983	1984	1985
INTL PASSENGERS (x 1,000)	161	113	135	133	133
DOM PASSENGERS (x 1,000)	445	412	444	441	413
INTL CARGO (ton)	6,833	3,722	3,295	4,938	5,790
DOM CARGO (ton)	26,515	18,396	23,931	23,492	N.A.
INTL AIRCRAFT MOVEMENTS	3,046	2,452	2,726	2,678	2,640
SCHEDULED DOM. AIRCRAFT MOVEMENT	5,442	5,066	4,876	4,644	4,376
NON-SCHEDULED DOM. AIRCRAFT MOVEMENT	9,676	7,472	8,076	7,208	5,420
MILITARY & TRAINING	11,436	11,248	8,498	9,196	8,176

1.6 Problems at Existing El Alto Airport

The major problems at the existing El Alto airport are summarized hereinafter. The detailed description and quantitative evaluations are discussed in Chapter 4.

1) Runway

- The runway was constructed 20 years ago. Many cracks existing in the concrete slab, especially where the main landing gears of the aircraft pass, have been identified.

- The longitudinal slope of the runway is 1.55% which exceeds ICAO recommendations.

- No runway shoulders are provided thereby, threatening safe aircraft operations and causing engine trouble resulting from a cloud of dust raised on the runway.

- There is no turning pad for runway 09R taking-off and runway 27L landing.

2) Taxiway

- The taxiway pavement is obsolescent and cracks were found.

- Large jet aircraft utilize No. 1 exit taxiway at the east end for both landings and take-offs in preferential runway operations. There is no separation of taxiway manoeuvering for departing and landing aircraft.

- The longitudinal slope of No. 2 exit taxiway is 2.2% which exceeds the recommended slope by ICAO of less than 1.5%.

3) Apron

- The apron has areas equivalent to 4 gate positions for B-727 aircraft. Only 3 central positions are utilized however, which are provided with hydrant pits.

- The slope of the apron from the terminal building to the runway is 1.5% down-slope which exceeds the ICAO recommendation of 1.0%.

- No GSE (Ground Service Equipment) road has been established.

4) Passenger Terminal Building

The existing passenger terminal building was constructed in 1952 (35 years ago) and the partial expansions have been made as required. Since an old concept was used from beginning and no drastic expansion to fully meet the traffic demand was made, the building has the following basic deficiencies in capacity and function at the present time:

- The floor area of the passenger terminal building is insufficient to accommodate the present needs.

- The depth of the building is only 20-30 meter which is inadequate for the establishment of functional zoning.

- The passenger flows intersect at many points, which is one of the reasons for congestion.

- There is no waiting lounge, baggage claim area, or security check system for domestic passengers.

- The arrival immigration area is extremely limited in size which sometimes forces passengers to wait outside the building. The baggage claim conveyor (linear type) for international use is not long enough. Extreme congestion is observed in this area.

- The arrival areas are very small compared with the departure areas and the utilization ratio of the floor areas for arrival and departure is quite unbalanced.

- There is a 1.5 meter difference in levels between the apron surface and the ground floor level of the building. This is the principal deficiency in baggage handling.

- The building curb length is not sufficient.

- The zoning of the building utilization is neither functional nor effective since the partial expansions have been made without a master plan. Since the electrical and mechanical facilities, etc., have not been systematically expanded and improved there are problems in function, operation and maintenance.

- No adequate information systems for passengers are provided.

- No building security and fire-fighting facilities are provided.

5) Others

- Water drainage facilities along the front road curb and car park are not complete, and these areas have been submerged a few times a year, in the past.

- The general aviation area is not paved at all. Raised cloud of dust tend to damage propellers and engines.

- The air navigation system equipment and public utilities are superannuated and the system configurations are also obsolescent.

PART III BASIC ASSUMPTIONS

CHAPTER 2 AIR TRAFFIC ANALYSIS AND DEMAND FORECAST

CHAPTER 2 AIR TRAFFIC ANALYSIS AND DEMAND FORECAST

2.1 General

Air traffic demand is forecast from 1990 to 2010 at five-year intervals including the following categories:

- Domestic passengers
- International passengers
- Domestic cargo
- International cargo

The forecasts are made in the following steps in principle:

- Analysis of the past trend of air traffic volume and economic factors in Bolivia and other countries.

- Study of the methodology for the air traffic demand forecast.

- Projection of the population and GDP of Bolivia.

- Forecast of air traffic demand in Bolivia based on the past trend of the correlation between air traffic demand and GDP.

- Distribution of air traffic demand for El Alto airport.

The demand forecasts prepared in accordance with these steps are described in Section 2.2. and subsequent sections.

2.2 Demand Forecast for Annual Air Passenger Traffic

2.2.1 Methodology

In the case of forecasting medium and long term air traffic demand, GDP or per capita GDP has been generally utilized as an explanatory variable.

Considering the past trend of air passenger traffic and GDP in Bolivia, the most appropriate method of forecasting the future traffic demand will be based on the past trend of the correlation between air traffic demand and GDP.

2.2.2 Projection of Economic Factors

(1) Projection of Population

Considering the drastically decreased death rate compared with birth rate, the population of Bolivia will increase at a rather high rate in the near future. Based on this situation, the projection by Instituto Nacional de Estadistica, Bolivia (INE) is adopted for this study. The population forecast up to 2010 is shown in Table 2.2.1.

Table 2.2.1 Projected Population in Bolivia

Year	Population (x 1,000)	Annual Growth Rate (%)
1985	6,429	-
1990	7,314	2.6
1995	8,422	2.9
2000	9,724	2.9
2005	11,195	2.9
2010	12,820	2.7
1985 - 2010		2.8

Source: Estimaciones y Proyecciones de Poblacion, 1985 Instituto Nacional de Estadistica.

(2) <u>Projection of GDP</u>

According to "Evaluacion Economica 1986" published by Muller and Machicado Asociados, the Government is anticipating 3% economic growth in 1987.

Taking into account these conditions, the future GDP in Bolivia is projected as follows for the purpose of air traffic demand forecast:

1985 - 1990	:	To attain 3% of GDP growth per annum, the Government expects as a survival period for the Bolivian economy.
1990 - 1995	:	To attain 4% of GDP growth per annum is the lower estimate by the World Bank for the middle-income oil importing countries (At present, Bolivia is classified in this category).
After 1995	:	To attain 3.5% of GDP growth per annum as a stable economic growth period.

Traffic forecast, however, is very sensitive to the projection of the future GDP. For the sensitivity analysis, the following two cases were also studied:

- Low economic growth

1985-90	:	Annual growth rate of 1.5% similar to that of oil importing countries in the 1980's when the world economy was depressed.
1990-95	:	3.5% growth rate similar to that of Bolivia before entering the serious depression in the 1980's.
After 1995	:	3.0% growth rate as a stable growth period.

- High economic growth

1985-90	:	Annual growth rate of 4.0% projected by the World Bank.
1990-95	:	5.5% growth rate, a higher one projected by the World Bank under such preferable economic circumstances as low interest rate, stabilized protectionism and improved trading conditions.
After 1995	:	5.0% growth rate in 1995-2000 and 4.5% in 2000-2010 as a stable growth period.

The projected GDP for three cases is summarized in Table 2.2.2.

Table 2.2.2 Projection of GDP

(Unit: Million US$ in 1980 constant prices)

Year	Low Economic Growth	Medium Economic Growth	High Economic Growth	Remarks
1985	4,452	4,452	4,452	Actual
1990	4,796	5,161	5,417	
1995	5,696	6,279	7,080	
2000	6,603	7,457	9,036	
2005	7,655	8,857	11,260	
2010	8,874	10,519	14,032	

2.2.3 Annual Domestic Passengers

(1) Domestic Passengers in Bolivia

The Annual number of domestic passengers is forecast based on the following equation in accordance with the projected economic conditions.

$$Y_n = -2,727 + 0.851\ X_{n-1} \quad (r=0.9681)$$

Where, Y: Embarked/disembarked domestic passengers in Bolivia
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.
n: Year (1972-1982)

The estimated number of domestic passengers in Bolivia will be 10 million in 2010, with an estimate range of 8 million low and a 15 million high, as presented in Table 2.2.3.

Table 2.2.3 Projected Domestic Passengers in Bolivia (Embarked/Disembarked)*1

(Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1985	1,908	1,908	1,908	Actual
1990	2,180	2,600	2,880	
1995	3,300	4,070	5,040	
2000	4,610	5,750	7,770	
2005	6,080	7,700	10,880	
2010	7,780	10,000	14,700	

*1: "Embarked/Disembarked" means "not including transit passengers".

(2) Domestic Passengers at El Alto Airport

The number of domestic passengers at El Alto airport in the future is estimated by assuming that the present share of 22% will continue in the future. The estimated domestic passengers at El Alto airport will therefore be 2.2 million in 2010, with an estimate range of 1.7 million low and 3.2 million high, as presented in Table 2.2.4.

Table 2.2.4 Projected Domestic Passengers at El Alto Airport (Embarked/Disembarked)

(Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1985	413	413	413	Actual
1990	480	570	630	
1995	730	900	1,110	
2000	1,010	1,270	1,710	
2005	1,340	1,700	2,390	
2010	1,710	2,200	3,200	

2.2.4 Annual International Passengers

(1) International Passengers in Bolivia

The annual number of international passengers is forecast based on the following equation in accordance with the projected economic conditions.

$$Y_n = -310.3 + 0.119\ X_{n-1} \quad (r=0.9915)$$

Where, Y: International passengers
X: GDP in Bolivia expressed in U.S. dollars at 1980 constant prices.

The estimated number of international passengers in Bolivia is as shown in Table 2.2.5.

Table 2.2.5 Projected International Passengers in Bolivia (Embarked/Disembarked)

(Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1985	263	263	263	Actual
1990	290	330	360	
1995	400	470	560	
2000	520	630	820	
2005	660	810	1,120	
2010	820	1,030	1,480	

(2) International Passengers at El Alto Airport

The number of international passengers at El Alto airport is projected by using a present share of 54%.

In addition, the international transit passenger volume is estimated based on the assumption that transit passengers will be 14% of the embarked and disembarked passengers.

Table 2.2.6 summarizes the projected international passenger demand at El Alto airport.

Table 2.2.6 Projected International Passengers at El Alto Airport (Embarked/Disembarked)

(Unit : 1,000 passengers)

Year	Low Estimate		Medium Estimate		High Estimate		Remarks
	Pax	Transit	Pax	Transit	Pax	Transit	
1985	133	19	133	19	133	19	Actual
1990	160	22	180	25	190	27	
1995	220	31	250	35	300	42	
2000	280	39	340	48	440	62	
2005	360	50	440	62	600	84	
2010	440	62	560	78	800	112	

2.2.5 Summary of Projected Air Passenger Traffic Demand

Figure 2.2.1 summarizes the projected air passenger traffic demand.

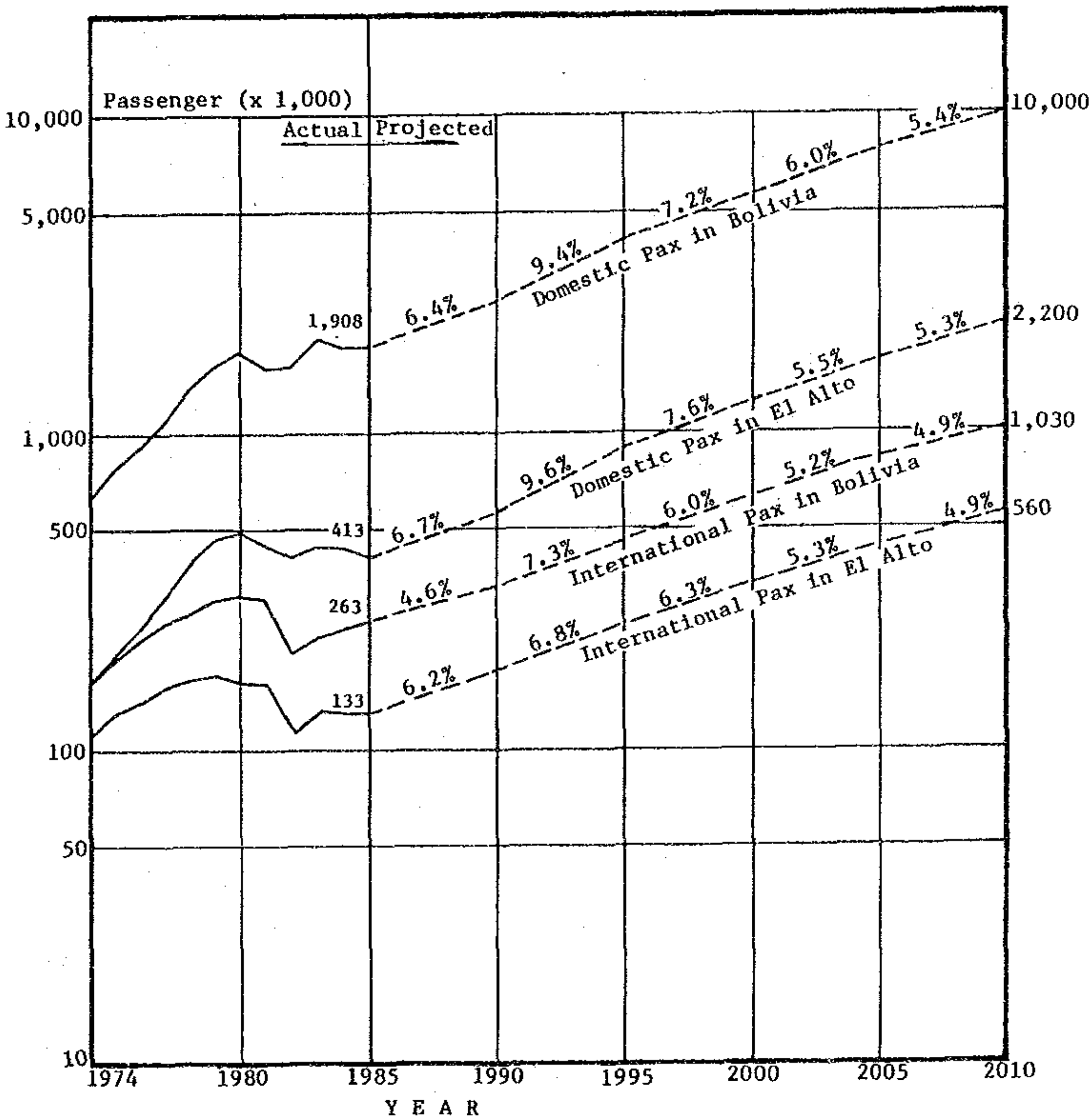


Figure 2.2.1 Projected Air Passenger Traffic Demand

2.3 Demand Forecast for Air Cargo

2.3.1 Methodology

Several analyses were made to explain the fluctuations in air cargo demand. Judging from these analyses as well as analysis of the world trend, it is considered the most appropriate to forecast the future traffic demand based on the past correlation between air cargo demand and GDP.

2.3.2 Annual Domestic Cargo

(1) Domestic Cargo in Bolivia

Annual domestic cargo in Bolivia is forecast based on the following equation between air cargo demand and GDP:

$$Yn = -19,997 + 5.873\ X_{n-1} \qquad (r=0.9656)$$

Where, Y: Domestic cargo carried (ton)
X: GDP in Bolivia expressed in US$ at 1980 constant prices.
n: Year (1975-82)

The projected domestic cargo in Bolivia is summarized in Table 2.3.1.

Table 2.3.1 Projected Domestic Cargo in Bolivia (Loaded/Unloaded)

(Unit : Ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1984	15,500	15,500	15,500	Excluding meat cargo
1990	17,500	21,300	24,000	
1995	27,900	35,000	43,900	
2000	39,900	50,500	69,100	
2005	53,500	70,700	97,900	
2010	69,200	89,800	133,100	

(2) Domestic Cargo at El Alto Airport

The future share of El Alto airport in domestic cargo is projected by using an average share of 38% during 1983 and 84 based on a consideration of the influence of Viru Viru airport. The projected domestic cargo at El Alto airport is summarized in Table 2.3.2.

Table 2.3.2 Projected Domestic Cargo at El Alto Airport (Loaded/Unloaded)

(Unit : Ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1984	6,100	6,100	6,100	Excluding meat cargo
1990	6,700	8,100	9,100	
1995	10,600	13,300	16,700	
2000	15,200	19,200	26,300	
2005	20,300	26,900	37,200	
2010	26,300	34,100	50,600	

2.3.3 Annual International Cargo

(1) International Cargo in Bolivia

The annual international cargo is forecast based on the following equation between air cargo demand and GDP:

$$Y_n = -19,973 + 6.242\ X_{n-1} \qquad (r=0.8844)$$

Where, Y: International cargo carried (ton)
X: GDP in Bolivia expressed in US$ at 1980 constant prices.
n: Year (1972-81)

The projected international cargo in Bolivia is presented in Table 2.3.3.

Table 2.3.3 Projected International Cargo in Bolivia (Loaded/Unloaded)

(Unit : Ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1985	11,000	11,000	11,000	Actual
1990	12,600	15,000	16,600	
1995	19,000	23,500	29,000	
2000	26,500	33,100	44,700	
2005	35,000	44,300	62,600	
2010	44,800	57,500	84,500	

(2) International Cargo at El Alto Airport

The future share of El Alto airport in international cargo is forecast by using an average share of 58% during 1983 to 85 considering the influence of Viru Viru airport. The projected international cargo at El Alto airport is summarized in Table 2.3.4.

Table 2.3.4 Projected International Cargo at El Alto Airport (Loaded/Unloaded)

(Unit : Ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1985	5,800	5,800	5,800	Actual
1990	7,300	8,700	9,600	
1995	11,000	13,600	16,800	
2000	15,400	19,200	26,000	
2005	20,300	25,700	36,000	
2010	26,000	33,400	49,000	

2.3.4 Summary of Projected Air Cargo Traffic Demand

Figure 2.3.1 illustrates the projected air cargo traffic demand.

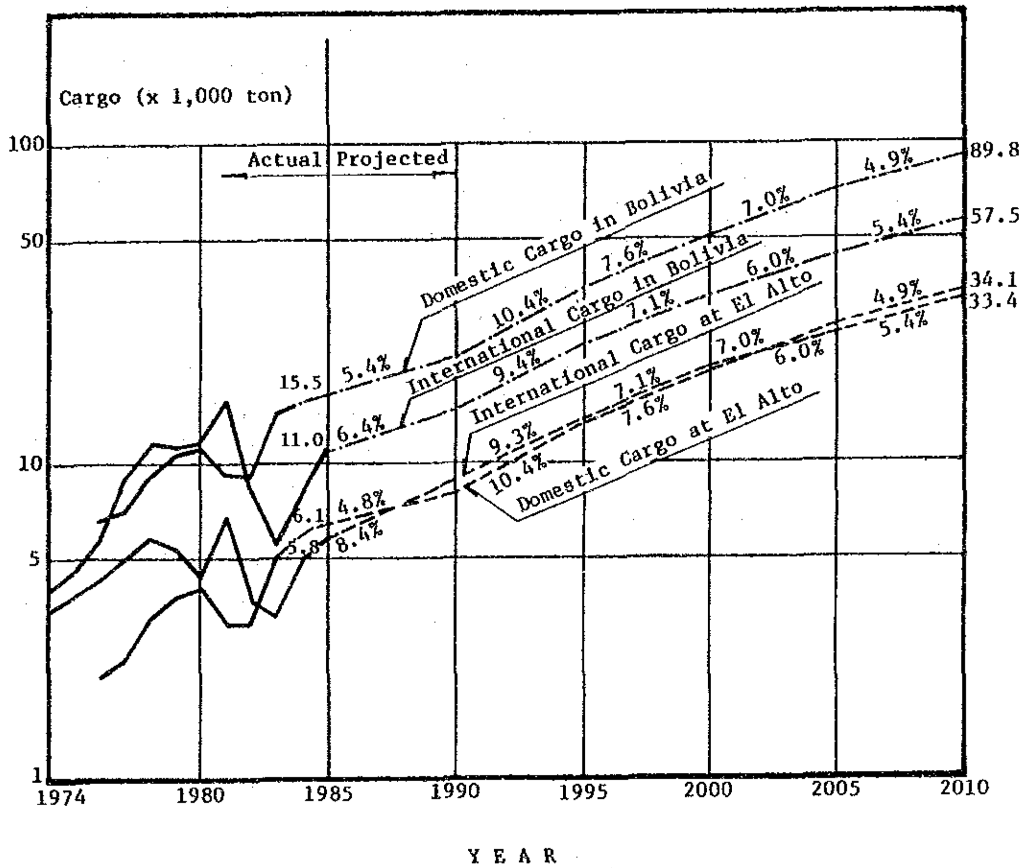


Figure 2.3.1 Projected Air Cargo Traffic Demand

2.4 Meat Cargo

Meat is hauled mainly from Beni where the road density is surprisingly low and there is no permanent road connecting with La Paz.

Meat hauling in the future will largely depend upon the progress of road construction as well as the demand for meat in La Paz. The exact information, however, is not available at the present time.

The volume of meat hauled in the future is therefore projected by the following regression equation calculated using time series analysis based on past statistics.

$$Y = 28,638 - 5,195 \times \log_e t \qquad (r=0.9553)$$

Where, Y: Volume of meat cargo (ton)
t: Year, 1978 = 1

The projected volume of meat cargo is summarized in Table 2.4.1.

Table 2.4.1 Projected Meat Cargo

Year	Meat Cargo (ton)	Annual Growth Rate (%)
1984	17,357 (Actual)	
1990	15,300	-2.1
1995	13,600	-2.3
2000	12,400	-1.8
2005	11,300	-1.8
2010	10,500	-1.5

2.5 Air Traffic Volume

2.5.1 Aircraft Classification and Movement

(1) Aircraft Classification and Seat Capacity

Seat capacity based on aircraft category has been established as shown in Table 2.5.1, considering the present aircraft types operating in El Alto airport and taking into account the future fleet plan of LAB.

Table 2.5.1 Aircraft Seat Capacity

Category	Type of Aircraft	Seat Capacity				Remarks
		Present 1987	Up to 1990	Up to 2000	Up to 2010	
JJP	B-747 Passenger Class	-	-	500	500	
JJM	B-747 Mixed Passenger/Freighter Class	236	240	240	240	
LJ	DC-10, L-1011, A-300 Class	-	260	290	320	
MJ	B-767, A-310 Class	-	220	260	280	
NJ	B-707 B-727-200 B-757, A-320, MD 80 Class	164 - 178	170	200	220	Present B-707 and B-727-200 are assumed to be replaced by new aircraft.
SJ	B-727-100 B-737, DC-9-40 Class	122	125	140	160	Present B-727-100 is assumed to be replaced by larger aircraft including B-737-300.
P	F 27, ATR-42, DASH 8, SF-340 Class	40	40	40	40	Seat capacity will remain the same for turbo prop.

(2) Annual Aircraft Movement in La Paz

a) Scheduled Flight

The annual number of aircraft movements anticipated at El Alto airport is projected based on the future passenger demand by routes, the present utilization of fleet, anticipated aircraft seat capacity and expected load factor, etc.

i) Scheduled and Non-scheduled Domestic Passengers at El Alto Airport

The future proportion of domestic passengers using non-scheduled flights is assumed to be about 1.4 percent, based on an average proportion between 1983 and 1985.

Based on this assumed proportion, the scheduled and non-scheduled number of domestic passengers at El Alto airport are projected as shown in Table 2.5.2.

Table 2.5.2 Scheduled and Non-scheduled Domestic Passengers at El Alto Airport

Year	Scheduled Domestic Passengers (x 1,000)	Non-scheduled Domestic Passengers (x 1,000)
1985	410	3
1990	562	8
1995	887	13
2000	1,250	20
2005	1,680	20
2010	2,170	30

About the international passengers, all of the figures shown in Table 2.2.6 are regarded as scheduled because the number of non-scheduled passengers is very limited.

ii) Route Structures

Future route structures from/to La Paz for domestic and international flights are assumed to be basically the same as the present route structures shown in Figures 1.3.1 and 2. Mixed flight services, utilized for both international and domestic passengers on the same aircraft, are assumed to be continued on the routes from La Paz to Cochabamba and La Paz to Santa Cruz the same as at present used by LAB.

iii) Scheduled Passengers by Routes

The annual number of domestic and international passengers by routes are projected as shown in Tables 2.5.3 and 4, based on the assumption that the future shares of scheduled passengers by routes is the same as at present.

Table 2.5.3 Annual Scheduled Domestic Passengers Embarked/Disembarked at El Alto Airport by Origin/Destination

Origin/ Destination	Passengers (x 1,000)					
	1985	1990	1995	2000	2005	2010
SANTA CRUZ	178	242	381	537	723	933
COCHABAMBA	136	185	293	412	554	716
TRINIDAD	24	34	53	75	101	130
SUCRE	30	42	67	94	126	163
TARIJA	37	50	80	113	151	195
PUERTO SUAREZ	3	6	9	13	17	22
OTHERS	2	3	4	6	8	11
TOTAL	410	562	887	1,250	1,680	2,170

Table 2.5.4 Annual Scheduled International Passengers Embarked/Disembarked at El Alto Airport by Route

Route	Passengers (x 1,000)					
	1985	1990	1995	2000	2005	2010
(LB) LPB-MIA via SRZ, PTY or via SRZ, MAO, CCS	17	22	31	42	55	70
(LB) LPB-RIO via SRZ, SAO	4	5	8	10	13	17
(LB) LPB-BUE via SRZ, SLA	7	9	13	17	22	28
(LB) LPB-SCL	6	9	13	17	22	28
(LB) SRZ-ARI via CBB, LPB	9	13	17	24	31	39
(LB) SRZ-LIM via CBB, LPB	20	27	37	51	66	84
(LH) LPB-FRA via LIM, UIO, SJU	15	21	29	39	51	64
(EA) ASU-MIA via LPB, LIM, PTY	18	25	35	48	61	79
(SC) LPB-RIO via SAO	9	13	17	24	31	39
(PL) LPB-LIM	10	13	19	26	33	42
(AR) LPB-BUE via JUJ	8	11	15	20	26	34
(LA) LPB-SCL via ARI, IQQ	9	12	16	22	29	36
Total	132	180	250	340	440	560

Note: Refer to supporting information report for abbreviations

iv) Aircraft Movements by Routes

Aircraft movements by routes expected in the future are projected based on the following assumptions:

- The annual average load factors to be projected are assumed to be basically as follows based on those adopted to prepare the fleet plans of LAB.

  Domestic services: 70%

  International services: 60%

  On some of the sectors however from/to La Paz, the actual load factors are lower than these projected load factors. Fleet plans are established based on the other critical sectors.

- Proportion of domestic and international passengers boarding mixed flights of LAB is assumed as shown in Table 2.5.5, based on the present proportion which was obtained from hearings with LAB.

Table 2.5.5 Projected Proportion of Domestic and International Passengers on Mixed Flight of LAB

Route	Sector of Mixed Flight	Proportion (%)	
		Domestic Passengers	International Passengers
LPB - MIA	LPB - SRZ	50	50
LPB - RIO	LPB - SRZ	50	50
LPB - BUE	LPB - SRZ	50	50
SRZ - CBB - LPB - ARI	SRZ - LPB CBB - LPB	30 20	50
SRZ - CBB - LPB - LIM	CBB - LPB CBB - LPB	30 20	50

Weekly aircraft movements are projected as shown in Tables 2.5.6 through 8.

Table 2.5.6 Weekly Aircraft Movements for Domestic Flight by LAB

Flight Route	Present 1987*1	1990	1995	2000	2005	2010
LA PAZ - COCHABAMBA	SJ: 32	SJ: 36	SJ: 52	NJ: 52	LJ: 22 NJ: 32	LJ: 28 NJ: 42
LA PAZ - SANTA CRUZ	SJ: 12	SJ: 28	SJ: 46	SJ: 68	NJ: 60	LJ: 54
LA PAZ - TARIJA	SJ: 2 (SJ: 6) *2	SJ: 10	SJ: 16	SJ: 22	SJ: 26	SJ: 32
LA PAZ - SUCRE	SJ: 6	SJ: 8	SJ: 12	SJ: 18	SJ: 22	SJ: 28
LA PAZ - TRINIDAD	SJ: 8	SJ: 8	SJ: 10	SJ: 14	SJ: 18	SJ: 22
LA PAZ - RURRENABAQUE	P: 4	P: 4	P: 4	P: 4	P: 6	P: 8
TOTAL	SJ: 60 P: 4 TTL: 64	SJ: 90 P: 4 TTL: 94	SJ:136 P: 4 TTL:140	NJ: 52 SJ:122 P: 4 TTL:178	LJ: 22 NJ: 92 SJ: 66 P: 6 TTL:186	LJ: 82 NJ: 42 SJ: 82 P: 8 TTL:214

Note, *1: As of July 1, 1987 and based on ABC World Airways Guide.
*2: Including weekly aircraft movements of flight via Sucre.

Table 2.5.7 Weekly Aircraft Movements for International Flights by LAB

Flight Route	Present 1987*1	1990	1995	2000	2005	2010
LPB-MIA via SRZ, MTY or via SRZ, MAU CCS	NJ: 14	NJ: 16	NJ: 20	NJ: 28	LJ: 22	LJ: 28
LPB-RIO via SRZ, SAO	NJ: 8	NJ: 8	NJ: 8	NJ: 10	NJ: 12	NJ: 14
LPB-BUE via SRZ, SLA	NJ: 2	NJ: 4	NJ: 4	NJ: 6	NJ: 6	NJ: 8
LPB-SCL	NJ: 4	NJ: 4	NJ: 4	NJ: 4	NJ: 6	NJ: 6
SRZ-ARI via CBB, LPB	NJ: 8	NJ: 8	NJ: 8	NJ: 8	NJ: 8	NJ: 10
SRZ-LIM via CBB, LPB	NJ: 8	NJ: 8	NJ: 8	NJ: 10	NJ: 12	NJ: 14
TOTAL	NJ: 44 TTL: 44	NJ: 48 TTL: 48	NJ: 52 TTL: 52	NJ: 66 TTL: 66	LJ: 22 NJ: 44 TTL: 66	LJ: 28 NJ: 52 TTL: 80

Note, *1: As of July 1, 1987 and based on ABC World Airways Guide

Table 2.5.8 Weekly Aircraft Movements for International Flights by Foreign Airlines

Flight Route	Present 1987*1	1990	1995	2000	2005	2010
(LH) LPB-FRA via LIM, UIO, SJU	JJM: 4	JJM: 6	JJM: 8	JJM: 10	JJM: 12	JJM: 14
(EA) ASU-MIA, via LPB, LIM, PTY	LJ: 2 NJ: 10	LJ: 12	LJ: 12	LJ: 16	LJ: 20	LJ: 24
(SC) LPB-RIO via SAO	SJ: 6	SJ: 6	SJ: 6	SJ: 6	SJ: 6	SJ: 8
(PL) LPB-LIM	NJ: 4	NJ: 4	NJ: 4	NJ: 4	NJ: 6	NJ: 6
(AR) LPB-BUE via JUJ	SJ: 2	SJ: 4	SJ: 4	SJ: 4	SJ: 6	SJ: 6
(LA) LPB-SCL via ARI, IQQ	SJ: 2	SJ: 4	SJ: 4	SJ: 6	SJ: 6	SJ: 8
TOTAL	JJM: 4 LJ: 2 NJ: 14 SJ: 10 TTL: 30	JJM: 6 LJ: 12 NJ: 4 SJ: 14 TTL: 36	JJM: 8 LJ: 12 NJ: 4 SJ: 14 TTL: 38	JJM: 10 LJ: 16 NJ: 4 SJ: 16 TTL: 46	JJM: 12 LJ: 20 NJ: 6 SJ: 18 TTL: 56	JJM: 14 LJ: 24 NJ: 6 SJ: 22 TTL: 66

Note; *1: As of July 1, 1987 and based on ABC World Airways Guide

b) Non scheduled Aircraft Movement

Future domestic non-scheduled aircraft movements are projected as shown in Table 2.5.9, based on the following assumptions:

- Future aircraft movement of general aviation are assumed to increase at the same growth rate as domestic scheduled aircraft movements.

- Aircraft movements of small carriers for meat cargo are assumed to gradually decrease with the decrease of the meat volume to be transported as mentioned in Section 2.4.

- Future movements of military and training aircraft are assumed to be approximately 8,200 the same as the present number of aircraft movements.

Table 2.5.9 Domestic Non-scheduled Aircraft Movements

Year	Scheduled Aircraft Movements	Non-scheduled Aircraft Movements			
		General Aviation	Small Carriers for Meat Cargo	Military and Training	Total
1985	4,376	1,912	3,508	8,176	13,596
1990	4,900	2,140	3,160	8,200	13,500
1995	7,300	3,190	2,810	8,200	14,200
2000	9,280	4,050	2,560	8,200	14,810
2005	9,700	4,240	2,330	8,200	14,770
2010	11,160	4,880	2,170	8,200	15,250

Future international non-scheduled aircraft movements are assumed to be 3 percent of international scheduled aircraft movement, taking the present proportion into account.

Projected international non-scheduled aircraft movements are shown in Table 2.5.10.

Table 2.5.10 International Non-scheduled Aircraft Movements

Year	Aircraft Movements	
	Scheduled	Non-scheduled
1985	2,566	74
1990	4,380	130
1995	4,690	140
2000	5,840	180
2005	6,360	190
2010	7,610	230

2.5.2 Peak Air Passengers and Aircraft Movements

Peak air passengers and aircraft movements are projected as shown in Tables 2.6.1 through 3, based on the assumption that the peak characteristics at El Alto airport remain unchanged in the future.

2.6 Summary of Air Traffic Demand

Air traffic demand at El Alto airport is summarized as shown in Tables 2.6.1 through 3.

Table 2.6.1 Summary of Air Traffic Demand
(Domestic)

Year	Item / Period	Passengers Embarked/ Disembarked	Passengers Transit	Cargo (Ton)	JJP	JJM	LJ	MJ	NJ	SJ	P	Sub Total	Others	Total
					Number of Aircraft Movements									
1990	Annual	570,000	-	8,100	-	-	-	-	-	4,690	210	4,900	13,500	18,400
	Peak Month	59,400	-	-	-	-	-	-	-	440	20	460	-	-
	Design Day	1,980	-	-	-	-	-	-	-	14	1	15	-	-
	Peak Hour	490		-	-	-	-	-	-	2.9	0.1	3	-	-
	Heavy Direction Peak Hour	290										2		
1995	Annual	900,000	-	13,300	-	-	-	-	-	7,090	210	7,300	14,200	21,500
	Peak Month	93,800		-	-	-	-	-	-	660	20	680	-	-
	Design Day	3,140		-	-	-	-	-	-	22	1	23	-	-
	Peak Hour	680		-	-	-	-	-	-	3.9	0.1	4	-	-
	Heavy Direction Peak Hour	410										3		
2000	Annual	1,270,000	-	19,200	-	-	-	-	2,710	6,360	210	9,280	14,810	24,090
	Peak Month	132,000		-	-	-	-	-	250	600	20	870	-	-
	Design Day	4,350		-	-	-	-	-	8	20	1	29	-	-
	Peak Hour	830		-	-	-	-	-	1.5	3.4	0.1	5	-	-
	Heavy Direction Peak Hour	500										3		
2005	Annual	1,700,000	-	26,900	-	-	1,150	-	4,800	3,440	310	9,700	14,770	24,470
	Peak Month	177,000		-	-	-	110	-	450	320	30	910	-	-
	Design Day	5,890		-	-	-	3	-	15	11	1	30	-	-
	Peak Hour	1,120		-	-	-	0.6	-	2.5	1.8	0.1	5	-	-
	Heavy Direction Peak Hour	670										3		
2010	Annual	2,200,000	-	34,100	-	-	4,280	-	2,190	4,270	420	11,160	15,250	26,410
	Peak Month	229,000		-	-	-	400	-	200	400	40	1,040	-	-
	Design Day	7,640		-	-	-	14	-	7	13	1	35	-	-
	Peak Hour	1,450		-	-	-	2.3	-	1.2	2.3	0.2	6	-	-
	Heavy Direction Peak Hour	870										4	-	-

Table 2.6.2 Summary of Air Traffic Demand
(International)

Year \ Item Period		Passengers		Cargo (Ton)	Number of Aircraft Movements									
		Embarked/ Disembarked	Transit		JJP	JJM	LJ	MJ	NJ	SJ	P	Sub Total	Others	Total
1990	Annual	180,000	25,000	8,700	-	310	630	-	2,710	730	-	4,380	130	4,510
	Peak Month	17,000		-	-	30	50	-	240	60	-	380	-	-
	Design Day	950		-	-	1	3	-	11	3	-	18	-	-
	Peak Hour	180		-	-	0.2	0.4	-	1.9	0.5	-	3	-	-
	Heavy Direction Peak Hour	130										3		
1995	Annual	250,000	35,000	13,600	-	410	630	-	2,920	730	-	4,690	140	4,830
	Peak Month	23,600		-	-	40	50	-	250	60	-	400	-	-
	Design Day	1,230		-	-	2	2	-	11	3	-	18	-	-
	Peak Hour	240		-	-	0.2	0.4	-	1.9	0.5	-	3	-	-
	Heavy Direction Peak Hour	170										3		
2000	Annual	340,000	48,000	19,200	-	520	840	-	3,650	830	-	5,840	180	6,020
	Peak Month	32,100		-	-	50	70	-	310	70	-	500	-	-
	Design Day	1,370		-	-	2	3	-	11	2	-	18		
	Peak Hour	250		-	-	0.2	0.4	-	1.9	0.5	-	3		
	Heavy Direction Peak Hour	180										3		
2005	Annual	440,000	62,000	25,700	-	620	2,190	-	2,610	940	-	6,360	190	6,550
	Peak Month	41,500		-	-	50	190	-	230	80	-	550	-	-
	Design Day	1,610		-	-	2	6	-	7	3	-	18		
	Peak Hour	310		-	-	0.3	1.0	-	1.2	0.5	-	3		
	Heavy Direction Peak Hour	220										3		
2010	Annual	560,000	78,000	33,400	-	730	2,710	-	3,020	1,150	-	7,610	230	7,840
	Peak Month	52,800		-	-	60	240	-	260	100	-	660	-	-
	Design Day	2,090		-	-	2	8	-	9	3	-	22	-	-
	Peak Hour	400		-	-	0.4	1.4	-	1.6	0.6	-	4		
	Heavy Direction Peak Hour	280										3		

Table 2.6.3 Summary of Air Traffic Demand
(Domestic + International)

Year	Item / Period	Passengers: Embarked/ Disembarked	Passengers: Transit	Cargo (Ton)	Number of Aircraft Movements: JJP	JJM	LJ	MJ	NJ	SJ	P	Sub Total	Others	Total
1990	Annual	750,000	25,000	16,800	-	310	630	-	2,710	5,420	210	9,280	13,630	22,910
	Peak Month	74,300		-	-	30	60	-	240	490	20	840		2,250
	Design Day	2,600			-	1	2	-	8	16	1	28		74
	Peak Hour	580				0.2	0.3	-	1.5	2.9	0.1	5		12
	Heavy Direction Peak Hour	350										3		
1995	Annual	1,150,000	35,000	26,900	-	410	630	-	2,920	7,820	210	11,990	14,340	26,330
	Peak Month	114,000			-	40	60	-	260	700	20	1,080		2,580
	Design Day	3,990				1	2	-	9	25	1	36		85
	Peak Hour	800				0.2	0.3	-	1.5	3.9	0.1	6		12
	Heavy Direction Peak Hour	480										4		
2000	Annual	1,610,000	48,000	38,400	-	520	840	-	6,360	7,190	210	15,120	14,990	30,110
	Peak Month	159,000			-	50	80	-	570	650	20	1,370		2,950
	Design Day	5,600			-	2	2	-	19	22	1	46		97
	Peak Hour	1,020			-	0.2	0.4	-	3.0	3.3	0.1	7		13
	Heavy Direction Peak Hour	610										5		
2005	Annual	2,140,000	62,000	52,600	-	620	3,340	-	7,410	4,380	310	16,060	14,960	31,020
	Peak Month	212,000		-	-	60	300	-	670	400	30	1,460		3,040
	Design Day	7,500		-	-	2	10	-	22	13	1	48		100
	Peak Hour	1,370			-	0.3	1.5	-	3.2	1.9	0.1	7		13
	Heavy Direction Peak Hour	820										5		
2010	Annual	2,760,000	78,000	67,500	-	730	6,990	-	5,210	5,420	420	18,770	15,480	34,250
	Peak Month	274,000			-	70	630	-	470	490	40	1,700		3,360
	Design Day	9,730			-	2	21	-	16	17	1	57		110
	Peak Hour	1,610			-	0.3	3.0	-	2.2	2.3	0.2	8		14
	Heavy Direction Peak Hour	970										5		

CHAPTER 3 AIRPORT FACILITY REQUIREMENTS ANALYSIS

CHAPTER 3 AIRPORT FACILITY REQUIREMENTS ANALYSIS

3.1 General

This chapter explains the airport facility requirements which are established or estimated based on the air traffic demand forecast (reported in Chapter 2), and also in compliance with the relevant standards, recommended practices, regulations and guidance materials of ICAO (International Civil Aviation Organization), FAA (Federal Aviation Administration) of the United States and JCAB (Japan Civil Aviation Bureau).

The airport facility requirements have been established for the period from 1990 to 2010 at five-year intervals in accordance with the air traffic demand forecast.

3.2 Summary of Airport Facility Requirements Analysis

Table 3.2.1 shows the airport facility requirements which should be used as the bases for the subsequent planning and design.

The operational category of the runway has been established as "Precision approach category-I" and the aerodrome reference code is "4E" in accordance with the maximum aircraft anticipated.

The dimensions and slopes of the obstacle limitation surfaces required for El Alto airport are shown in Figures 3.2.1 and 2.

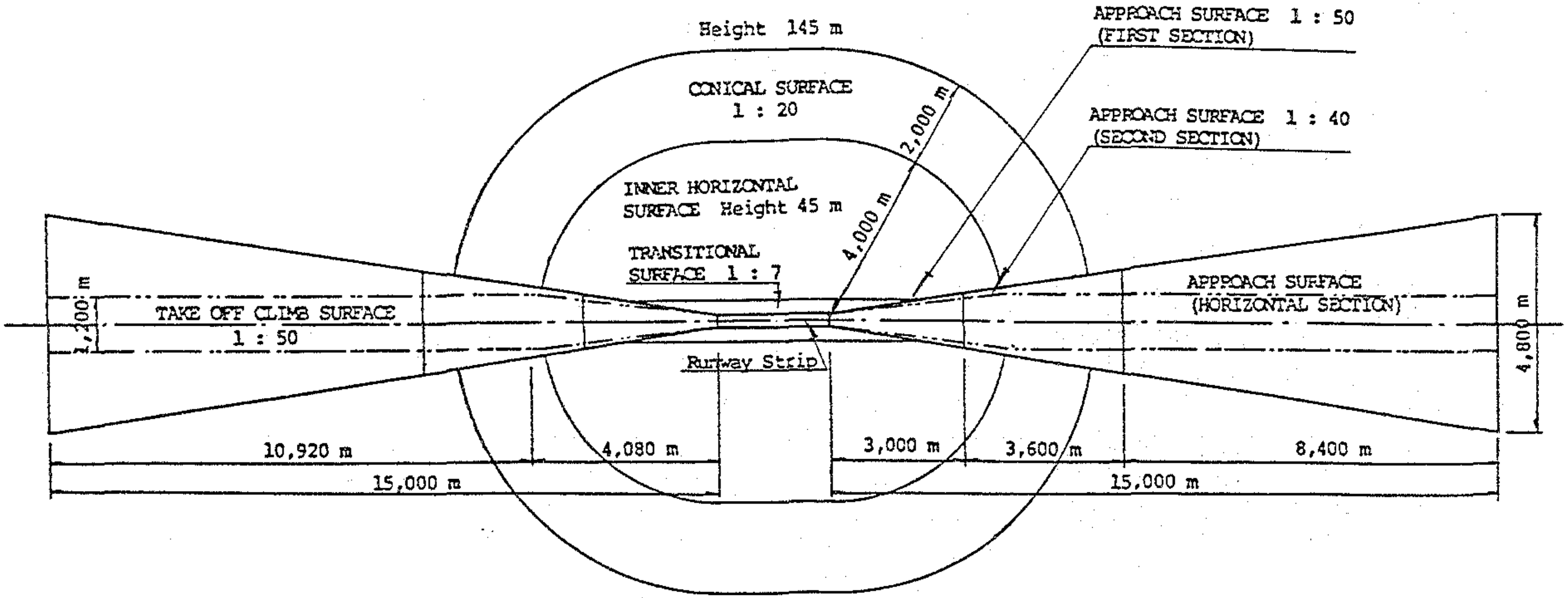
Table 3.2.1 Traffic Demand vs. Airport Facility Requirements

	Item \ Year		Present Conditions (as of 1987)	1990	1995	2000	2005	2010
AIR TRAFFIC DEMAND	1. Annual Passenger	Dom. Intl Total	413,000(1985) 133,000(1985) 546,000(1985)	570,000 180,000 750,000	900,000 25,000 1,150,000	1,270,000 340,000 1,610,000	1,700,000 440,000 2,140,000	2,200,000 560,000 2,760,000
	2. Annual Cargo (ton)	Dom. Intl Total	6,700(1985) 5,800(1985) 12,500(1985)	8,100 8,700 16,800	13,300 13,600 26,900	19,200 19,200 38,400	26,900 25,700 52,600	34,100 33,400 67,500
	3. Annual Aircraft Movement (operation)	Dom. Intl Total	17,970(1985) 2,640(1985) 20,610(1985)	18,400 4,510 22,910	21,500 4,830 26,330	24,090 6,020 30,110	24,470 6,550 31,020	26,410 7,840 34,250
	4. Peak Hour *c Passenger	Dom. Intl Total *b	*a 290(1987) *a 110(1987) *a 290(1987)	490 180 580	680 240 800	830 250 1,020	1,120 310 1,370	1,450 400 1,610
	5. Peak Hour *d Aircraft Movement (operation)	Dom. Intl Total *b	3(1987) 3(1987) 4(1987)	3 3 5	4 3 6	5 3 7	5 3 7	6 4 8
	6. Largest Aircraft		B - 747	B - 747 Class	B - 747 Class	B - 747 Class	B - 747 Class	B - 747 Class
	7. Longest Route		CALI Colombia	CALI Colombia	CALI Colombia	CALI Colombia	CALI Colombia	CALI Colombia
AIRPORT FACILITY REQUIREMENT	8. Runway (m x m)		RWY 09R/27L 4,000m x 46m RWY 09L/27R 2,280m x 30m RWY 04/22 1,940m x 30m	RWY 09R/27L 4,000m x 46m	RWY 09R/27L 4,000m x 46m	RWY 09R/27L 4,000m x 46m	RWY 09R/27L 4,000m x 46m	RWY 09R/27L 4,000m x 46m
	9. Runway Strip (m x m)		RWY 09R/27L 4,090m x 300m RWY 09L/27R 2,280m x 100m RWY 04/22 2,060m x 300m	RWY 09R/27L 4,120m x 300m	RWY 09R/27L 4,120m x 300m	RWY 09R/27L 4,120m x 300m	RWY 09R/27L 4,120m x 300m	RWY 09R/27L 4,120m x 300m
	10. Taxiway (m x m)		Exit Taxiways 1,250 x 22.9	Only Exit Taxiways Required	Partial Parallel Taxiway			
	11. Passenger Terminal Apron (gate position)		B-747 Class:1 B-727 Class:2 Total 3	Intl B-747 Class:2 B-757 Class:1 Dom. B-757 Class:2 Total 5	Intl B-747 Class:2 B-757 Class:1 Dom. B-757 Class:3 Total 6	Intl B-747 Class:2 B-757 Class:2 Dom. B-757 Class:3 Total 7	Intl B-747 Class:2 B-757 Class:2 Dom. B-747 Class:1 B-757 Class:1 Total 7	Intl B-747 Class:3 B-757 Class:1 Dom. B-747 Class:2 B-757 Class:2 Total 8
	12 Cargo Terminal Apron (gate position)		Nil	B - 707 Class: 2			B - 747 Class: 2	
	13. Cargo Apron for Small Carriers (gate position)		C-54 Class:16	14	13	12	11	10

Table 3.2.1. (Cont.)

	Item / Year	Present Conditions (as of 1987)	1990	1995	2000	2005	2010
AIRPORT FACILITY REQUIREMENT	14. General Aviation Apron (gate position)	COMMANDER -690 Class:9	9	11	16	19	22
	15. Passenger Terminal Building (sq.meter) Dom.		7,400	10,200	12,500	16,800	21,800
	Intl		5,400	7,200	7,500	9,300	12,000
	Total *b	4,800 (Combined)	12,100	16,500	18,900	24,800	32,000
	16. Cargo Terminal Building (sq. meter)	1,300	2,830	4,480	6,380	8,670	11,180
	17. Administration Building (sq. meter)	2,819	4,000	4,000	4,000	4,000	4,000
	18. Air Navigation Systems	Precision Approach Category-I	Precision Approach Category - I				
			(ILS)	(ILS/MLS)	(MLS)	(MLS)	(MLS)
	19. Car Park (cars)	100	410	560	710	960	1,100
	(sq. meter)	4,600	14,000	20,000	25,000	34,000	39,000
	20. Access Road (lane)	1 lane for each direction	1 lane for each direction		2 lanes for each direction		
	21. Fuel Supply (kl) *e (Jet. A-1)	2,056	2,000	2,500	3,000	4,000	4,500
	(sq. meter)	2,500	7,000	8,500	8,500	8,500	10,500
	22. Rescue and Fire-Fighting (category)	7	7	7	8	8	9
	(cars)	3	4	4	4 or 5	4 or 5	4 or 5
	(sq. meter)	450	450	450	550	550	600
	23. Utilities: Electricity (KVA)	320 (270kw)	1,600	2,000	2,300	3,200	3,600
	Water (ton/month)	6,900	9,200	12,000	16,000	20,400	23,000
	Sewage (ton/month)	5,200	9,200	12,000	16,000	20,400	23,000
	Solid Waste (ton/month)	30	45	60	80	110	130

Note" *a. Estimated figure
*b. Not Mathematical sum of domestic and international, but overall figure of the total airport
*c. Excluding transit
*d. Excluding non-scheduled flight
*e. Tank capacity



Note : Height above aerodrome elevation

Figure 3.2.1 Obstacle Limitation Surfaces (1)

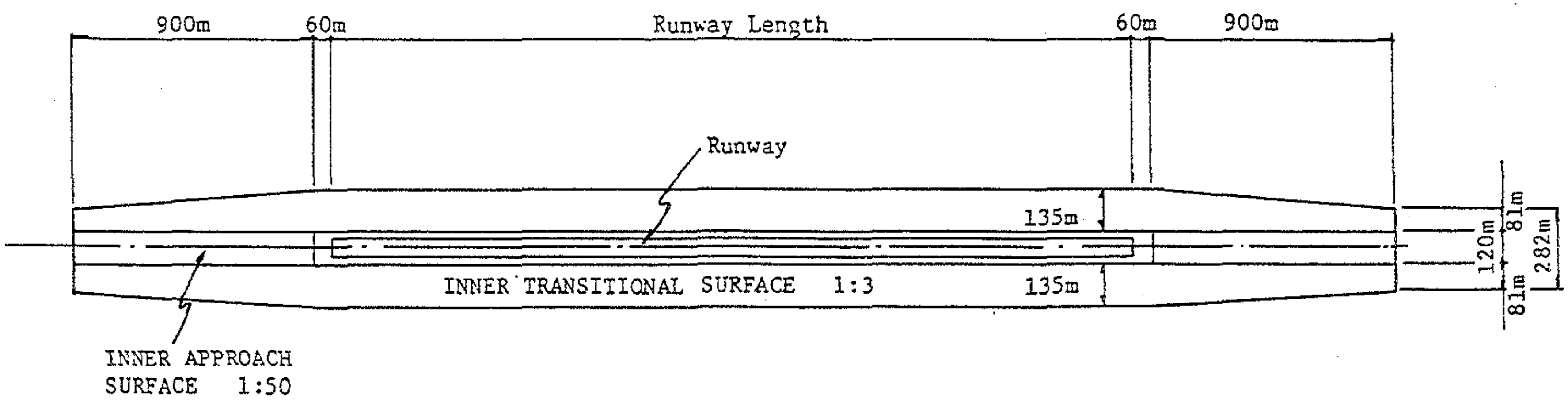


Figure 3.2.2 Obstacle Limitation Surfaces (2)

PART IV SELECTION OF ALTERNATIVE AIRPORT MASTER PLANS

CHAPTER 4 EVALUATION OF EXISTING AIRPORT FACILITIES

CHAPTER 4 EVALUATION OF EXISTING AIRPORT FACILITIES

4.1 General

Table 4.1.1 summarizes the results of the evaluation of the major existing facilities and the anticipated time of saturation when the existing facilities reach their respective capacities, based on the description presented in later sections.

Although the saturation time varies for the facilities, the following points can be noted in Table 4.1.1.

(1) Aircraft Movement Area

All the pavements for runway, taxiway and apron are insufficient for the loads of aircraft presently being operated. The area of the apron is already saturated for the present number of aircraft movements.

The total capacity of the existing aircraft movement area is therefore considered to be insufficient for the present air traffic demand.

(2) Terminal Area

The passenger terminal building including the administration, operations areas and the control tower is insufficient for present needs in terms of floor areas and functions. The area allocated for car parking is insufficient for the present demand.

The total capacity of the existing terminal area is therefore also considered to be insufficient to accommodate the present air traffic demand.

(3) Other Airport Facilities

Most of the aeronautical equipment is antiquated and requires replacement.

(4) Whole of the airport

The capacity of the existing airport facilities are concluded to already be insufficient to accommodate the present air traffic demand.

On the recognition of the saturation time for both capacity and functional requirements, the airport master plans will be prepared for the year 2005 in order to overcome the above deficiencies in capacity and performance requirements for a modern airport.

Table 4.1.1 Anticipated Time of Saturation of the Existing Facilities

X = Already out of capacity
/// Existing capacity

Facilities \ Year		87	88	89	90	91	92	93	94	95	96	97	98	Descriptions
Main Runway 09R/27L	Length	///	///	///	///	///	///	///	///	///	///	///	/// a	a. Runway extension is needed if it is intended to increase the allowable payload for B-727-200
	Pavement	x												
Runway Strip for Main Runway		///	///	///	///	///	///	///	///	///	///	///	///	
Exit Taxiway	Number	///	///	///	///	///	///	///	///	///	///	///	///	
	Pavement	x												
Apron	Gate Positions	x												
	Pavement	x												
Passenger Terminal Building	International	x	b											b. The passenger terminal building is insufficient for the present needs.
	Domestic	x	b											
Cargo Terminal Building		x	c											c. No government facilities are provided.
Administration Building		x	d											d. Floor areas necessary for operations of ATC, COM, MET, power, etc., are very limited and the building does not meet the functional requirements.
Control Tower		x	e											e. Control tower does not meet the height requirements.
Car Parking		x												
Access Road		///	///	///	///	///	///	///	///	///	f			f. Saturation time is anticipated to be around the year 1995. Saturation time of the Autopista depends on future traffic volume other than airport users.
Air Navigation System	Navaids (ILS/VOR)	///	///	///	///	///	///	///	///	///	g			g. DME, NDB, Locator are already obsolescent.
	ATC and Telecommunications System	x	h											h. Almost all equipment exceed the usable life time.
	Meteorological Systems	x	i											i. Equipment necessary for Category-I operations are not provided. All equipment are obsolescent.
	Aeronautical Ground Lights (ALS, PAPI)	///	///	///	///	///	///	///	///	///				
	Other Lights	x												
Fuel Supply System (Jet fuel)		///	///	///	///									
Rescue an Fire Fighting Facilities		///	///	///	///	///	///	///	///	///				(Note: in terms of water and extinguishing agents)
Utilities	(1) Power Supply System	///	///	j										j. The system configuration is already obsolescent.
	(2) Water Supply System	///	///	///	///	///	///	///	///	///	///	///	/// k	k. Saturation time is anticipated to be around the year 2000.
	(3) Sewage System	///	///	///	///	///	///	///	///	///	///	///	///	
	(4) Solid Waste Disposal System	x	l											l. There is no incinerator. Incinerator should be provided.

4.2 Airside Facilities

4.2.1 Runways

(1) The longitudinal slope of the runway is 1.55% (viz., runway 09R threshold is about 60 meter lower than 27L threshold), which does not meet ICAO recommendations.

(2) There is no runway shoulder, which causes engine trouble for the aircraft followed by a large jet aircraft such as B-747. Approximately 45% of the engine trouble of LAB is caused by the suction of small stones and/or dust into the engines. The provision of runway shoulders is definitely needed.

(3) Rubber from aircraft tires is accumulated in the runway 09R touch down zone. This reduces runway friction and the cleaning is urgently required in order to ensure safe aircraft operations.

(4) There is no exit taxiway for runway 27L landing and aircraft are forced to turn on a 46 meter wide runway. Although the runway 27L landing and runway 09R take-off are made during May through October and the percentage is less than that of 09R landing and 27L take-off, a turning pad designed especially for B-747 aircraft landing at the runway 27L is required.

(5) A runway end safety area is not provided at the runway 09R end (runway 27L threshold side). The existing terrain for the runway 09R end safety area does not meet the longitudinal slope requirement recommended by ICAO.

(6) The runway 09R/27L has an excellent cross-wind coverage of 99.44%. It is noted however, that the improvement in percent of cross-wind coverage is only 0.45% of the provision of the cross-wind runway 04/22.

(7) The runway capacity is 23 operations (take-off or landing) per peak hour considering preferential operations, which occur more than 90% of the time. Even for RWY 09 or RWY 27 landings and take-offs, more than 15 operations per peak hour can be expected.

The forecast aircraft movements per peak hour are 14.0 movements by the year 2010 including non-scheduled aircraft. Accordingly, the runway can be operated beyond the year 2010 in terms of its capacity.

It is noted that this determination is based on the existing layout of runway and taxiway. Additional increase of capacity can be expected by providing of adequate exit taxiways.

(8) The existing operational category of the runway 09R/27L is precision approach category-I for runway 09R and non-precision approach for runway 27L. RVR meter, ceilometer and aerodrome beacon are required to be provided for complete operations of precision approach category-I.

(9) Upgrading of the operation category from Category-I to Category-II can not be justified economically.

(10) It is understood that weight restriction caused by runway length at El Alto airport is notable only for B-727-200 take-offs. International flights particularly suffer from the extreme payload reduction. If it is intended to improve the allowable payload for B-727-200 take-offs, then runway extension is required.

A runway extension to 4,300 m, for this purpose, is considered unnecessary however, based on economics.

(11) The thickness of the existing cement concrete pavement slab is 28 cm at the critical area and 23 cm at the non-critical area and is considered insufficient for the current load of aircraft operated at the present time.

4.2.2 Runway Strip

(1) The longitudinal slope of the strip is 1.55% which exceeds the ICAO recommendations of less than 1.0%.

(2) The runway strip is established based on the threshold of the runway 09R. ICAO recommends that a strip should extend before the threshold and beyond the end of the runway a distance of at least 60 meters.

(3) There are many rubbles in the strip. It is preferable to remove them outside the strip for safety reasons.

(4) An excavated open ditch should be provided along the perimeter road to the south of the main runway to handle storm water so it will not flow out from the airport to the residential area.

4.2.3 Taxiways

(1) A partial parallel taxiway will be sufficient for the anticipated movements under preferential runway operations.

(2) All aircraft taking-off, however, utilize No. 1 taxiway, thus, a dual configration of No. 1 taxiway will be required for the increasing movements of large jet aircraft, in the future.

(3) The longitudinal slope of the No. 2 exit taxiway is 2.2% and exceeds the recommended slope by ICAO of less than 1.5%.

The correction of this slope is difficult as far as the existing runway and apron are utilized at the present condition. No problems related to the taxiway operation resulting from this slope have been identified to date.

(4) The thickness of the existing cement concrete slab is 28 cm and is also considered inadequate as mentioned for the existing runway pavement.

4.2.4 Aprons

(1) Scheduled Aviation Apron

a) The actual capacity of the existing apron for scheduled aviation is only two positions for B-727 and one for B-747 respectively.

   At present, three aircraft parking positions are occupied at the same time. The existing apron for scheduled aviation is therefore already saturated and cannot cope with the increase of air traffic demand.

b) The thickness of the existing cement concrete slab is 28 cm and is also considered inadequate as mentioned for a runway pavement.

c) The slopes on the existing apron are approximately 1.5% and exceed the 1.0% of maximum slope recommended by ICAO.

(2) General Aviation Apron

The existing parking area for aircraft of COMIBOL (Corporacion Minera de Bolivia, Bolivian Mining Corporation) and YPFB (Yacimientos Petroliferos Fiscales Bolivianos, Bolivian National Petroleum Corporation) is not paved. The general aviation apron should be paved in order to avoid the ingestion of a cloud of dust into turbine engines.

(3) Cargo Apron for Small Carriers

The cargo apron for small carriers is not paved. This area should also be paved similarly to the general aviation apron.

4.3 Airspace Use

4.3.1 Airspace Configuration in Bolivia

There are no problems in particular related to airspace configuration in Bolivia as it is established in compliance with ICAO recommendations.

With regard to the existing airspace configuration, the Supporting Information Report should be refferred to.

4.3.2 Obstacle Limitation Surfaces

Obstacle limitation surfaces for three runways: 09R/27L, 09L/27R and 04/22 are established at El Alto airport.

(1) Runway 09R/27L

Some mountains and houses north of Runway 09R/27L infringe on the inner horizontal and conical surfaces. A TV antenna mast of 4,201.97 m above mean sea level (AMSL) infringes the inner horizontal surface.

(2) Runways 09L/27R and 04/22

The width of the landing strip for runway 04/22 is established to be 300 m. Some buildings remain in this area, however and many obstacles which are located near the runway 27R threshold infringe the approach and transitional surfaces for runway 09L/27R.

4.3.3 Aircraft Operations Procedures

With regard to the present aircraft operations procedures, refer to the Supporting Information Report.

There is a high mountain, Illimani, 21,010 feet AMSL, which locates about 27 NM SE of El Alto airport. However, there is no remarkable problem for standard instrument departure (SID) routes passed near Illimani such as AROMA DOS and ISAMO DOS which have the sufficient clearance to this mountain.

4.4 Passenger Terminal and Other Buildings

4.4.1 Passenger Terminal Building

(1) The passenger terminal building is already antiquated and the building depth is only 20-30 meters. It does not permit the introduction of a modern terminal concept for large jet aircraft.

(2) The existing floor areas are considered extremely inadequate for the present passenger volume.

(3) Although boarding bridges are essentially required for passengers taking the high altitude conditions into account, it is difficult to install them due to the original design of the building.

(4) The building and the service equipment/facilities are obsolescent and it is very difficult to provide standard services for passengers.

(5) There is about 1.5 meters difference in level between the apron surface and first floor level of the building. This is considered unsatisfactory for a modern baggage handling system.

4.4.2 Cargo Terminal Building

It is necessary to centralize the cargo buildings with government facilities in order to modernize them. The location should be compatible with the cargo apron.

4.4.3 Administration Building and Control Tower

(1) At present the height (eye level) of the control tower is 23.5 meters, while the required height is 40.9 meters in accordance with FAA criteria due to the location of the existing control tower.

(2) Tower and ACC are considered inadequate with respect to floor area.

(3) There is no fire alarm, fire hydrant or fire extinguishers.

(4) There is no fire extinguishing system for the aeronautical equipment.

(5) The communication wires and cables for the electronic equipment are not properly installed, and therefore it is difficult to provide good maintenance.

(6) Due to the repetitive expansion of the building, the electrical, telecommunications and mechanical systems are not well organized and therefore problems in function, operation and maintenance, occur.

(7) All the piping and wiring for the electrical, mechanical and plumbing facilities should be installed new related to utilization of this building for other than administration and operations purposes.

(8) Storm water (rain) leakage often occurs during the rainy season and repairs were required on these occasions.

4.5 Landside Facilities

4.5.1 Car Parking

(1) The present demand has already exceeded the capacity of the planned car parking expansion.

(2) An adequate storm water drainage system should be provided at the curb area and the car parking for convenience of the passengers. It is considered desirable to improve the existing system as soon as possible.

(3) A storm water drainage system should be provided completely separated from the sewage system.

4.5.2 Access Road

The existing access road in the airport property area is supposed to meet the demand until the year 1995.

4.6 Air Navigation Systems

4.6.1 Radio Navigational Aids

(1) The airport perimeter road passes through the critical area of the glide path and therefore the relocation of the perimeter road is required.

(2) A non-interrupted power supply to VOR/DME is required in order to meet the maximum change-over time of 15 seconds.

(3) Relocation of the locator or change of antenna type will be required.

(4) The NDB, locator and DME co-located with the VOR, are required to be replaced by new equipment.

4.6.2 Air Traffic Control System

(1) The control consoles i.e., aerodrome and approach control consoles, area control consoles and FIS consoles, are obsolete.

(2) The tape recorder for ATC use has been operated for more than 19 years and is obsolete. The number of recording channels is also inadequate.

4.6.3 Aeronautical Telecommunications System

(1) Communications by TWR frequency (118.3 MHz) are sometimes not possible between the control tower and parked aircraft on the apron or aircraft positioned near the runway 09 threshold. The relocation of VHF air-ground antennas (transmitters and receivers) to airside will solve this problem. Antenna structures and steps by which antennas and coaxial connector/cables can be easily maintained are mandatory.

(2) It is necessary to expand the service coverage of the VHF air-ground radio for La Paz Information (127.1 MHz) because the existing coverage is only 80 NM.

(3) Improvement to ensure the high reliability of VHF radio for La Paz Control and VHF link will be considered the first priority.

(4) Replacement of VHF link equipment by UHF link is required.

(5) All the VHF air-ground equipment should have dual equipment.

4.6.4 Meteorological Observation System

(1) There is no automated data collection and recording system for airport surface observation.

(2) All the meteorological observation equipment was installed between 1969 and 1973, and is considered extremely obsolescent.

(3) Neither ceilometer nor runway visual range meter are provided, which are considered basic equipment for category I operations.

(4) Two observation sites near both the runway touch-down zones are required for a 4,000 m runway.

(5) Upper air observation by radiosonde has been suspended because hydrogen for the balloon can not be produced.

4.6.5 Aeronautical Ground Lights

(1) Since no substation exclusively for aeronautical ground lights was available, constant current regulators were separately installed in the motor house in the passenger terminal building and in two shelters for VASIS and runway edge lights on the airside. The remote control panels for on-off and intensity control are installed at the control consoles on the tower, however the panels are separated in three positions.

This equipment installation causes inconvenience to both operations and maintenance.

(2) The approach lighting system for the runway 09R is designated for the precision approach category-II. The longitudinal slope of lights, however, are minus 1.52% in the first 300 m section from the threshold which does not meet the category-II requirements.

(3) The runway threshold lights (RWY09) does not meet the category-I requirements in terms of light layout.

(4) No aerodrome beacon is installed.

(5) 3KV high tension cables for runway edge lights, taxiway edge lights and VASIS are obsolescent and need re-wiring in order to maintain their reliability. Cables for other lights are 5KV cables.

(6) Seventeen light fittings for the runway edge lights have been broken by stones thrown by jet blast. Since no spare lights are available at this moment, lanterns (not electrical) are laid by fire-fighting men at night.

(7) When an overlay of the runway and/or provision of shoulders is made, the following old light fittings and cables should be replaced:

- Runway edge lights
- Runway end lights
- Runway threshold lights

(8) Logical control system of light intensity will be required when the aeronautical ground lights are improved.

(9) No spare CCR for back-up is provided.

4.6.6 Power Supply System

(1) The electric loads for visual aids and radio aids are not adequately classified at the low-tension distribution board. Requirements for switch-over time are different between the visual aids and radio aids.

(2) The power supply concept for the constant current regulators is not unified.

(3) It is preferable to supply direct current to navaids and VHF air-ground transmitters and receivers in order to eliminate the transitional interruption during the built-up time of the emergency generator.

4.7 General Services

4.7.1 Rescue and Fire Fighting Facilities

(1) The water supply capacity, extinguishing agents, complementary agents and discharge rate of the three vehicles meets the present requirements for airport category 7. The existing capacity itself will satisfy the requirements up to the year 1995.

(2) The location of the existing fire station is not adequate in terms of the response time, that is the time between the initial call to the rescue and fire fighting services and the first effective intervention at the accident by a rescue and fire fighting vehicles, and that should not exceed three minutes. Therefore, the existing fire station is required to be relocated to near the central section of main runway 09R/27L.

(3) The fire station was constructed in 1968 and is antiquated.

(4) There is no direct access to the runway and the existing indirect access road is not paved.

(5) The water supply for the vehicles is obtained from a water tap. An adequate supply system utilizing water hose is required.

(6) The chassis frame for the major vehicles was originally designed for a truck. Thus, they do not meet the ICAO vehicle performance requirements.

The ground sweep nozzles of those vehicles which protect the bottom of the vehicle and inner side of the wheels and tires are out of order, resulting in a very hazardous situation.

(7) The rescue equipment is 18 years old and obsolescent. New equipment together with the provision of oxygen masks is required.

4.7.2 Fuel Supply System

The existing tank capacity is sufficient for the present demand and also for the demand to the year 1990.

At this time, no other problem with respect to aviation fuel supply is noted.

4.8 Airport Utilities

4.8.1 Power Supply System

The emergency generator which was installed new in 1986, has a capacity of 470 KW. This capacity does not coincide with the transformer capacity (270 KW) existing at present.

All the power supply equipment except the above mentioned emergency generator are considered obsolescent. In addition, the system composition is not considered adequate because the electric loads are not classified in order of priority or importance due to the partial expansion which has taken place during the past 20 years.

All the power supply equipment except the 470 KW generator should be completely modernized together with the planning of a new system concept for load classification and system composition.

4.8.2 Water Supply System

According to the facility requirements shown in Table 3.1.1, the existing water supply system is considered to reach its maximum capacity in the year 2000.

4.8.3 Sewage System

Based only on the estimate for the existing sewage pipe capacity and future sewage demand shown in Table 3.2.1, the capacity is anticipated to be sufficient until the year 2010.

Some of the rainwater on the roof of the terminal building actually flows into existing sewer pipes.

Considering these observations, the saturation time (maximum capacity attainment) mentioned above is anticipated to be advanced.

Although the sewage is not treated at the present time, treatment before discharge or infiltration is required in order not to cause water pollution in the vicinity of the existing reservoir, and considering subterranean water development and use in this area in the future.

4.8.4 Solid Waste Disposal

Considering the increase of the volume of solid waste in future, the solid waste disposal by an incinerator is desirable to protect the environment in the vicinity of the airport.

4.9 Natural and Social Environment Surrounding the Airport

The aircraft noise influence on the area surrounding the airport is not considered a serious problem at the present time because of the limited aircraft movements and the preferential runway operations.

The aircraft noise influence is anticipated to increase, however, with the increase of the number of aircraft movements in the future. The legal control or the coordination with the related organizations necessary for the control of the housing should be taken as soon as possible.

There are at the present time no obstacles which protrude upon the approach surface and take-off climb surface for the main runway 09R/27L.

Height limitations for structures and trees in the vicinity of the airport, however, is required to be established as soon as possible in order to ensure safe aircraft operations, because it is anticipated that urbanization in the vicinity will increase in the future.

CHAPTER 5 ALTERNATIVE AIRPORT MASTER PLANS

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5.1 General

In this section, alternative airport master plans are presented in order to study the development policy of El Alto airport for the future through their comparison. Airport master plans are prepared for the design target year of 2005 based on the airport facility requirements analysis in Chapter 3 and the evaluation of the existing airport facilities in Chapter 4. Phased development plans are to be studied within the framework of the airport master plan which will be selected as discussed in subsequent chapters of this report.

For the preparation of alternative airport master plans, necessary discussion were made with the airport administrator, and due attention was paid for requests from airline companies which serve El Alto airport.

Six alternative airport master plans presented here are based on the concept that the existing main runway continues to be utilized. Therefore, these six alternatives differ from each other only in the layout plan for the terminal area development.

5.2 Basic Concepts for Alternative Airport Master Plans

(1) Runway

Although the longitudinal slope of the existing runway 09R/27L is 1.55% which exceeds the maximum slope of 1.0% stipulated in ICAO recommendation, this runway will be utilized without slope improvement. This improvement will require approximately US$110 million and is therefore judged not to be practical.

Non-paved runways 09L/27R and 04/22 will be closed since these runways conflict with the terminal area development and main runway 09R/27L will satisfy the capacity requirements beyond the year 2005.

(2) Taxiways

Double taxiways connecting with runway 27L threshold and partial parallel taxiway will be provided based on consideration of aircraft operational efficiency and safety.

Two rapid exit taxiways will be necessary in order to minimize the runway occupancy time and to enable rapid access to the terminal for landing aircraft.

(3) Location of Terminal Area

The existing runway will normally be operated as a preferential operation. It is preferred therefore that the terminal area be located at the eastern area of the airport in order to minimize the taxiing distance required by aircraft.

(4) Control Tower

A new control tower is planned to be built near the central section of the runway so that complete visibility from the tower is available for all airport surface areas utilized for movement of aircraft.

(5) Cargo Apron for Small Carriers

Small carriers for meat hauling currently utilize the area east of the existing passenger terminal building. Continuous utilization of this area by the small carriers is considered satisfactory for the reason that the location of this area is not suitable for the future development of the major terminal facilities.