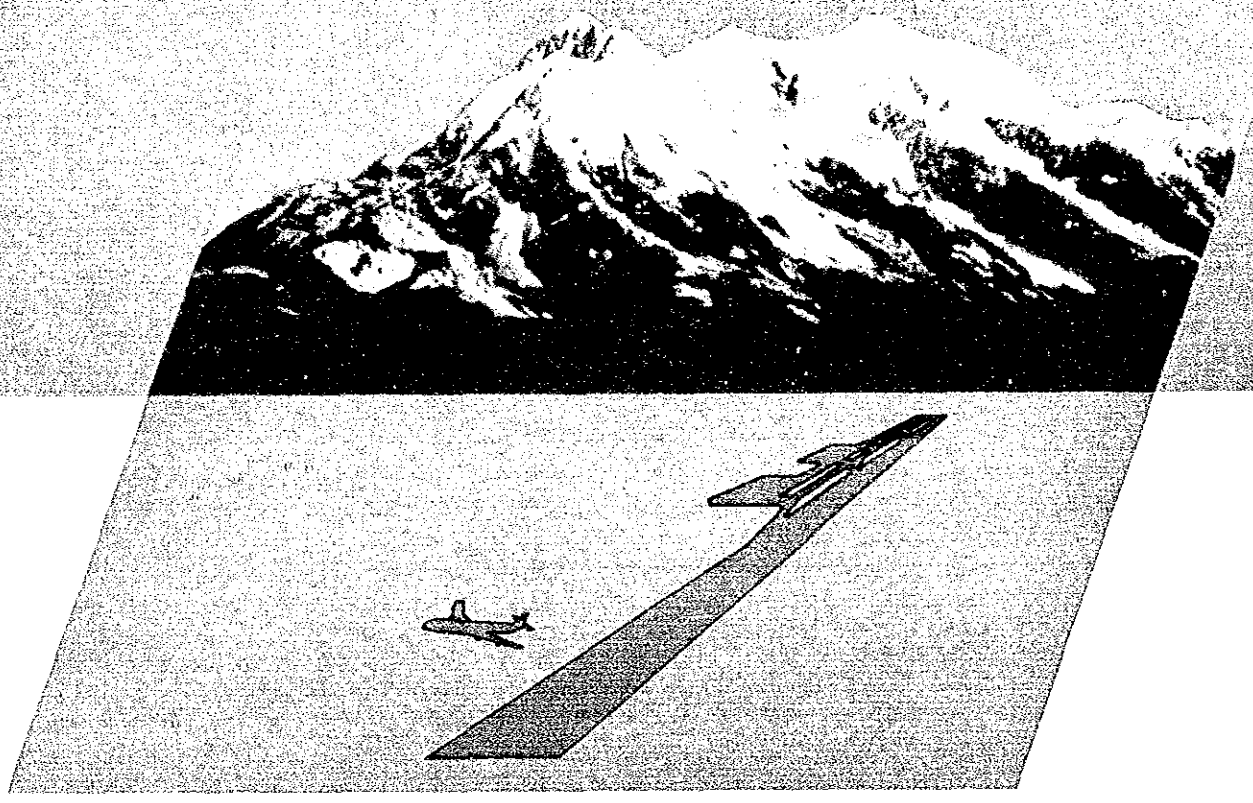
社会開発協力部報告書

No. 7

REPUBLIC OF BOLIVIA

FEASIBILITY STUDY ON EL ALTO AIRPORT MODERNIZATION PROJECT

EXECUTIVE SUMMARY



FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF BOLIVIA

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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.

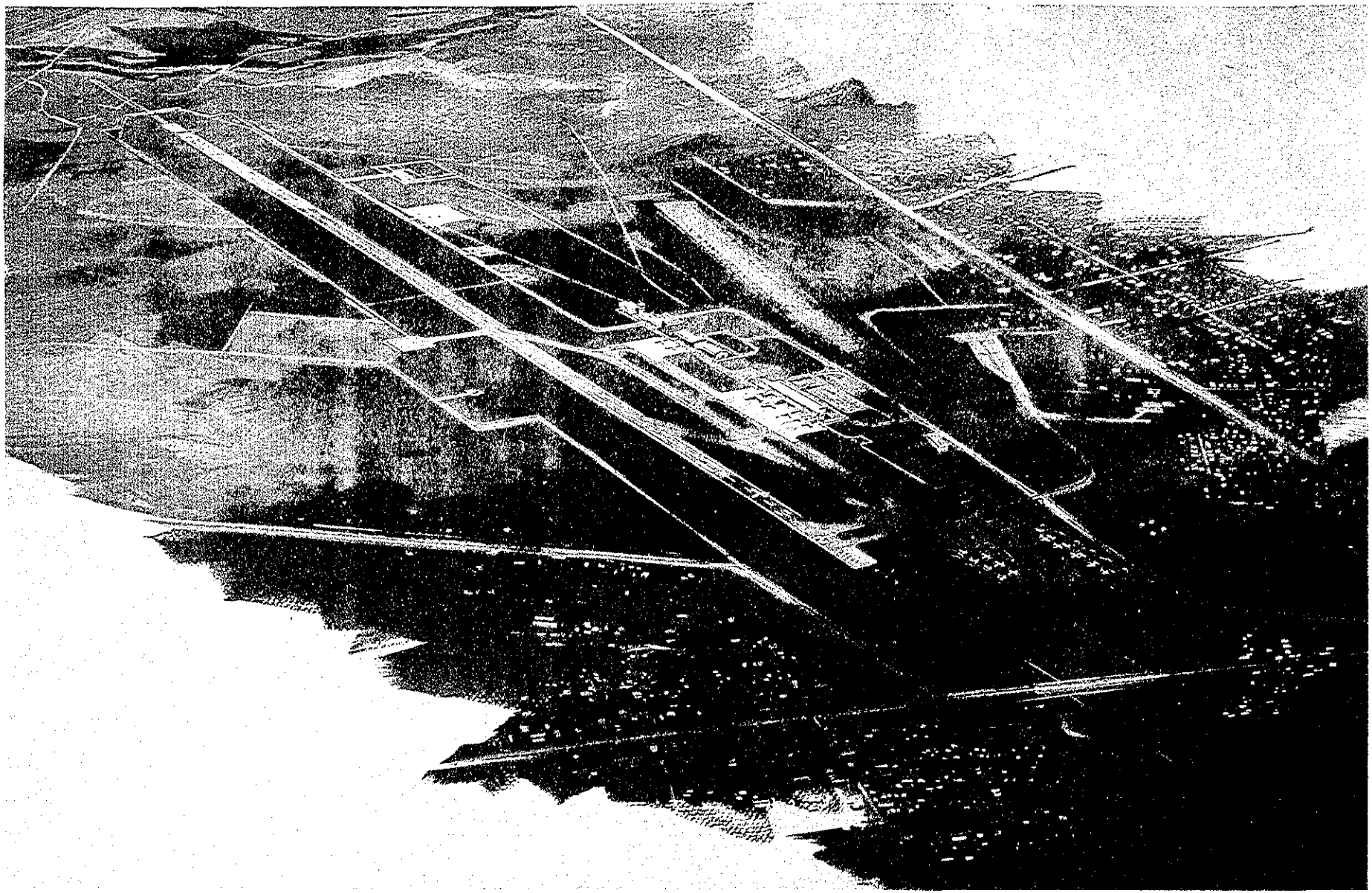
February, 1988

Kensuke Yanagiya

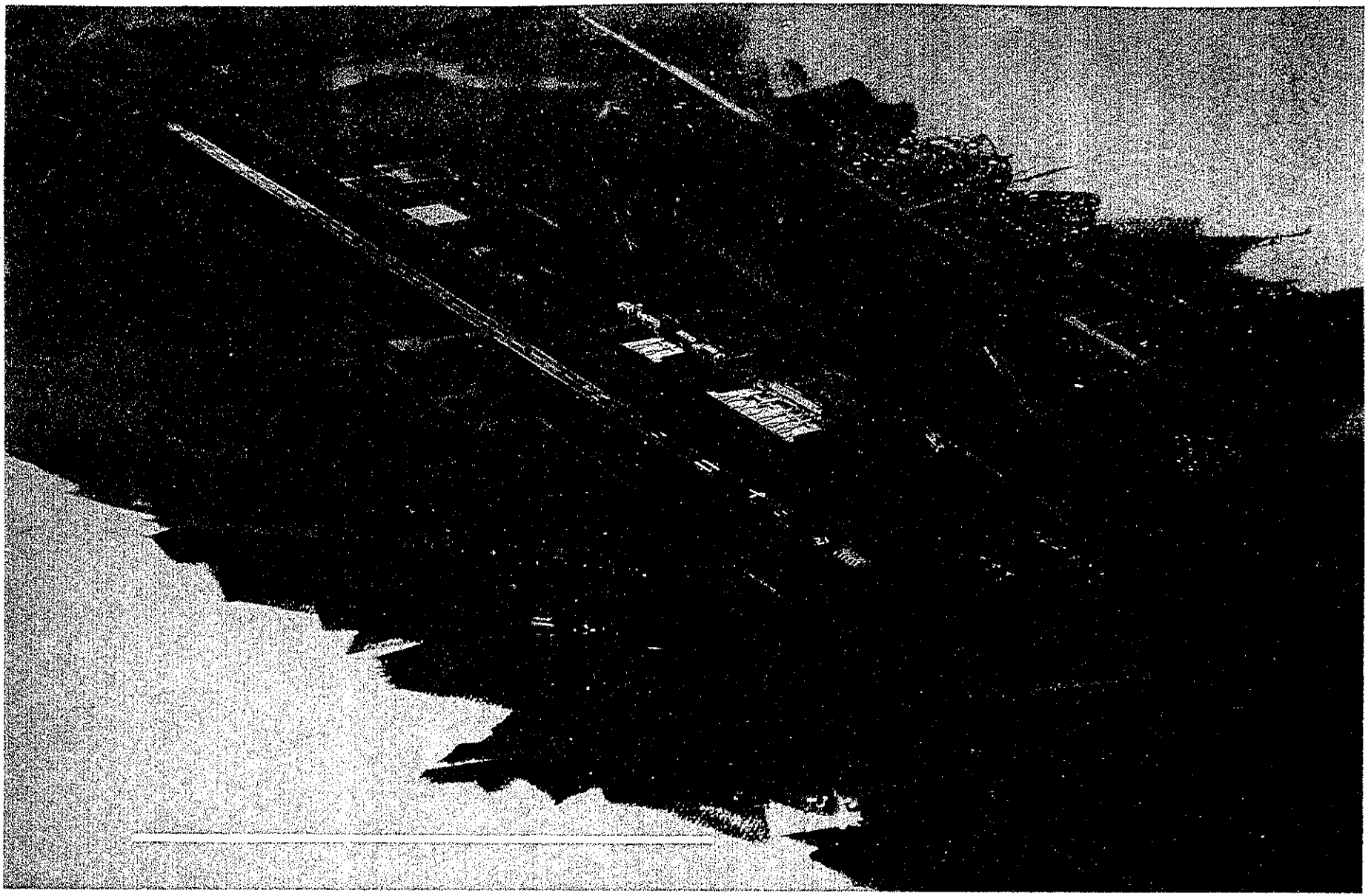
Kensuke Yanagiya

President

Japan International Cooperation Agency

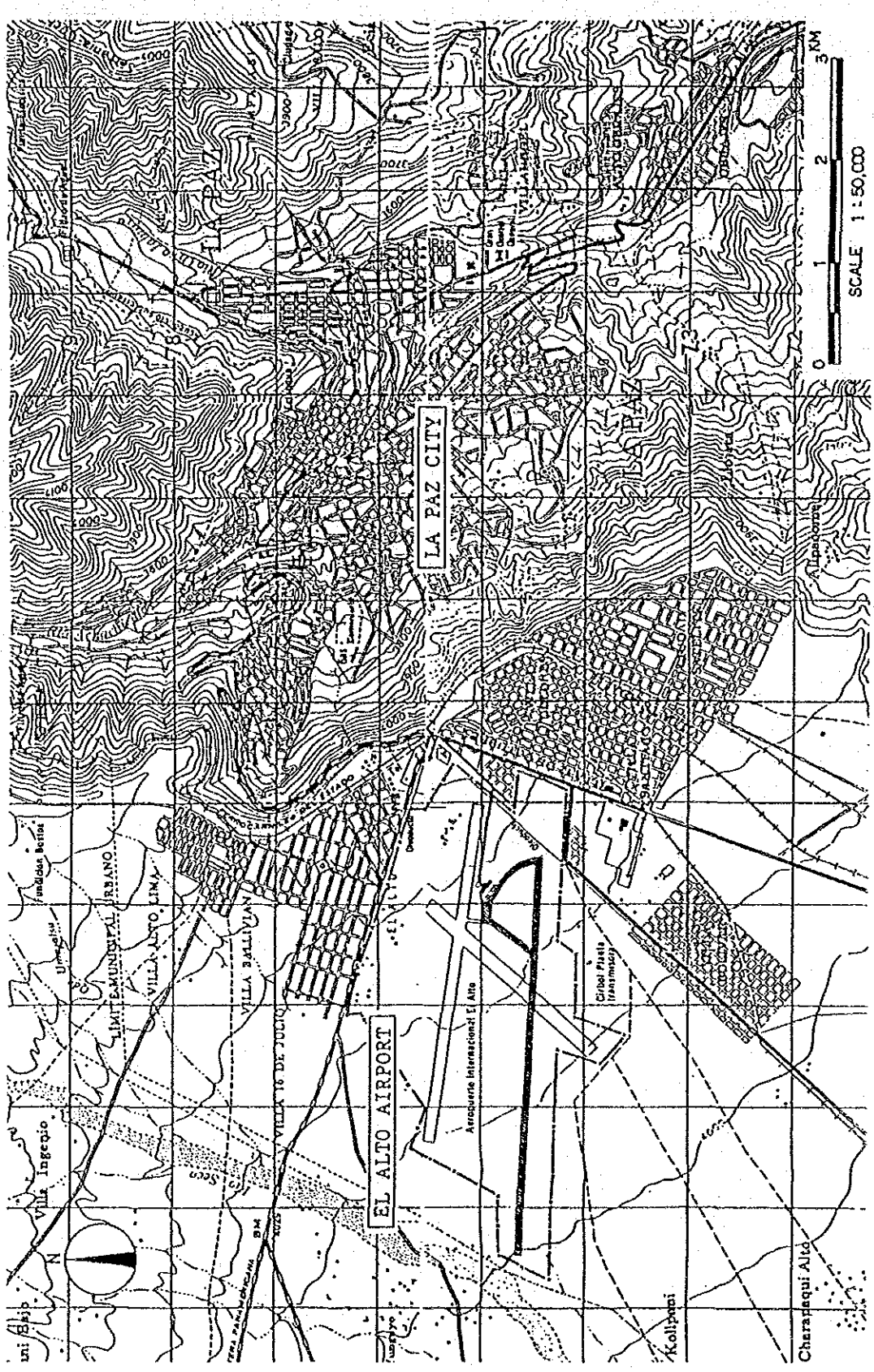


EL ALTO INTERNATIONAL AIRPORT PHASE I DEVELOPMENT PLAN



EL ALTO INTERNATIONAL AIRPORT PHASE I DEVELOPMENT PLAN

PROJECT LOCATION MAP - 1



PROJECT LOCATION MAP - 2

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CHAPTER I INTRODUCTION

Bolivia is a landlocked country in South America surrounded by five countries : Brazil, Argentine, Chile, Peru and Paraguay. It has a population of 6.4 million and a total area of 11,000 sq. km.

Land transportation in Bolivia is far from adequately developed due to the existence of the Andes Mountains running northwest to southeast in the western part of the country, a vast uncivilized Amazon area spreading north and east of the country called Llanos, and a number of large rivers tributaries of the Amazon.

Air transportation in Bolivia, therefore, plays an essential role for cargo transport as well as both international and domestic passengers because of the landlocked geography and underdeveloped land transport in the country. Thus, the development of a good air transportation system is recognized to be indispensable for the socio-economic development of Bolivia.

An international air transport network from/to Bolivia is established centered in La Paz which is essentially the capital of the country, and a domestic network is mainly formed from/to hub airports located in the capital city of each department, i.e., La Paz, Trinidad, Cochabamba, Santa Cruz, Sucre and Tarija.

Considering the importance of air transportation, the Government of Bolivia decided to replace the Santa Cruz airport, the second most important airport in Bolivia, because it was located within the city area and the facilities were very old. The new airport, constructed in Viru Viru, inaugurated its services in 1985 and it has been playing a role as the single most modern airport in Bolivia. The Government of Bolivia plans to start the development and modernization of Cochabamba airport which handles the third largest traffic demand in Bolivia.

El Alto airport however functioning as the country's "international gateway" and the hub of domestic network has continued without any of the required facility development to cope with the increase in traffic demand since the inauguration of major facilities in 1970, even though passenger demand increased to 5 times that level since then. The obsolete airport has many problems at present including the function of its air navigation systems, the capacity of the terminal building, the service level for passengers, etc.

Based on these circumstances, the Government of Bolivia recognized the modernization of El Alto airport to be an urgent project and requested the Government of Japan to provide technical assistance. The Japan International Cooperation Agency, an official government agency responsible for the implementation of technical cooperation between Japan and other countries carried out the study.

The feasibility study established a long-term master plan for El Alto airport up to the year 2005 and suggested further utilization of El Alto airport beyond the year 2005 with required expansion of the terminal facilities. The study concluded based on a consideration of the technical aspects and the national economy that **the Phase I Development Project assuming a design target year of 1997 in the framework of the long-term master plan should be implemented as soon as possible.**

CHAPTER 2 NEED FOR THE PROJECT

2.1 Problems at the Existing El Alto Airport

The existing airport layout and facilities are outlined in Figure 1 and Table 1.

The runway, taxiway and apron were completed in 1966 and the passenger terminal building was opened in 1970. Since then, this airport has had no positive investment for improvement, and many problems, with regard to safe aircraft operations, maintenance of airport functions, capacity of the facilities, service level for passengers, etc., have developed and still exist at the present time.

The major problems at the existing El Alto airport are summarized below :

(1) Problems in Safe Aircraft Operation

1) Slopes of the existing runway, taxiway and apron are 1.55% for runway profile (ICAO recommendation is a maximum 1.0%), 2.2% for NO.2 exit taxiway profile (ICAO maximum 1.5%) and 1.5% for apron (ICAO maximum 1.0%). They all exceed the maximum slope recommended by ICAO. The problem of the longitudinal slope of the runway which has the greatest influence on aircraft operations among those stated above, is avoided by the "preferential use" of the runway at the present time.

2) Due to the elevation difference of approx. 60m between both runway thresholds, the western end of the runway is not visible from the existing control tower (eye level 23.5m height). To meet the height requirement, the control tower should be 17m higher than the existing height.

3) Many of the existing air navigation systems, meteorological observation facilities and aeronautical ground lights were installed 15 to 20 years ago. These obsolete facilities should be replaced immediately in order to ensure safe aircraft operations and to maintain reliability.

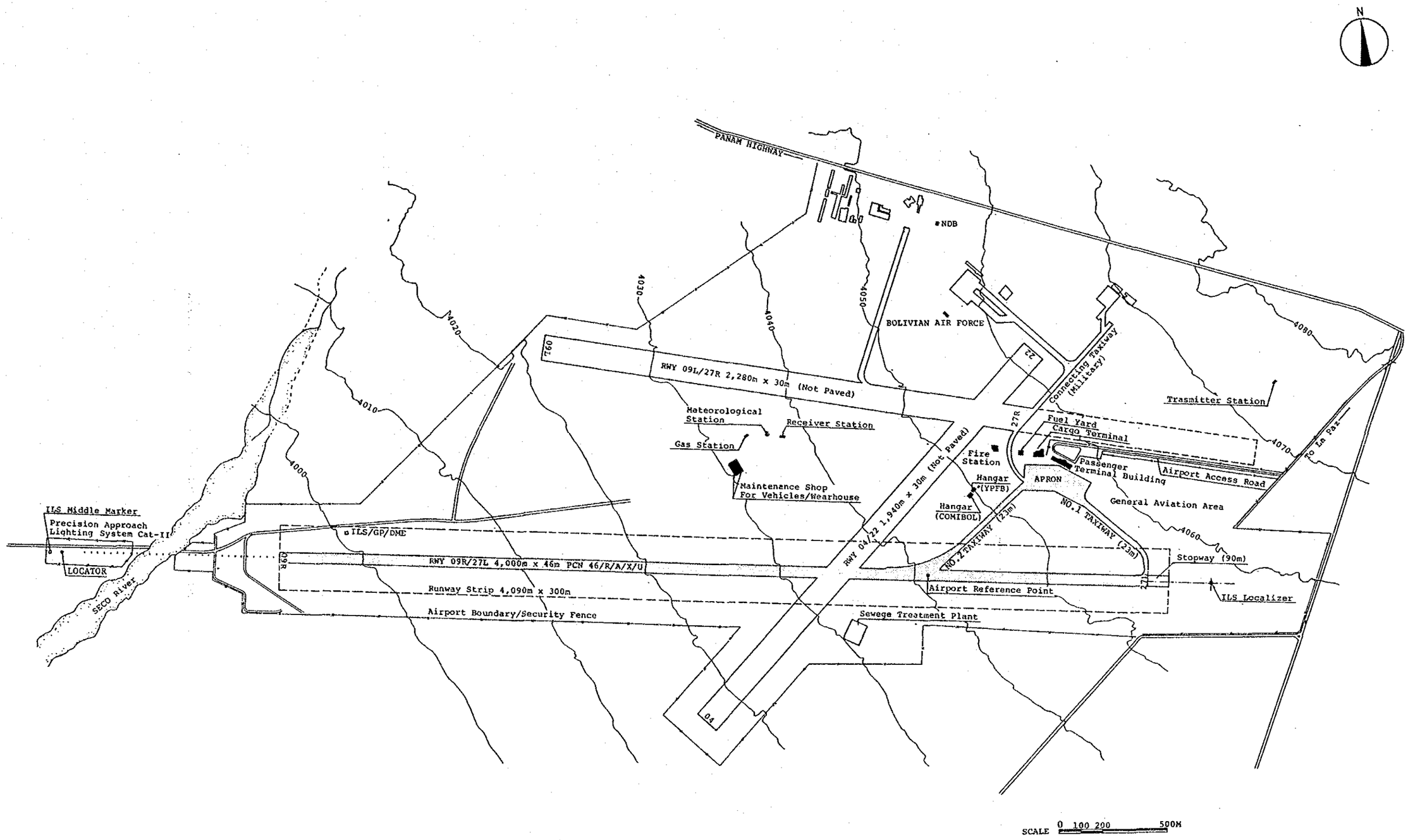


FIGURE I LAYOUT OF EXISTING EL ALTO AIRPORT

Table 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			Transportation			Wind Coverage	Minimum Meteoro-logical Conditions
Name	Population	Distance to Airport	Railway	Taxi	Bus		
La Paz	Approximately 993,000 (1985)	14.5 km	NO	YES	NO	RWY09R/27L 99.4%(13kt) 100%(20kt)	

Runway	Approach Procedure		Straight - in				Circling			
	Category of Aircraft		CAT-A	CAT-B	CAT-C	CAT-D	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
Existing	YES	YES	YES	YES	NO	YES	NO	NO		NO	NO	YES	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										

	ATIS	DF	ITV	TTY	AFTN
Existing	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
Apron	Design Aircraft	Number of Stand	Pave-ment	Area / Parking Configuration
	B-747	1	PCC	33,600 m² / 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
LPB - CBB	B 727	32
LPB - SRZ	B 727	12
LPB - TJA	B 727	2
LPB - SRE	B 727	6
LPB - TDD	B 727	8
LPB - RBQ	F 27	4

International Flights by LAB

Flight Route	Type of Aircraft	Weekly Aircraft Movement
LPB - MIA	B 727	14
LPB - RIO	B 727	8
LPB - BUE	B 727	2
LPB - SCL	B 727	4
SRZ - LPB - ARI	B 727	8
SRZ - LPB - LIM	B 727	8

International Flights by Foreign Airlines

Flight Route	Airline	Type of Aircraft	Weekly Aircraft Movement
LPB - FRA	LH	B 747M	4
ASU - LPB - MIA	EA	B 727	12
LPB - RIO	SC	B 727	6
LPB - LIM	PL	B 727	4
LPB - BUE	AR	B 727	2
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 m²	RC	Built in 1952
Cargo T. Building	1,300 m²	Steel	3 buildings
Adm. Building	2,820 m²	RC	Part of Pax Bldg.
Control Tower	Cab: 30 m²	RC	Part of Pax Bldg.
Fire Station (Level of Protection)	430 m²	RC	Height 24.5 m
	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

(2) Problems in Airport Functions

1) The pavement thickness of the existing runway, taxiway and apron is not considered adequate for the operation of B-747 aircraft, which have already been introduced at El Alto airport. A part of the runway pavement is seriously damaged due to overload conditions.

2) There is neither exit taxiway nor turning pad for landing aircraft on runway 27L. Therefore, large aircraft such as the B-747 require a long time to make a U-turn on the runway, and this lengthens the runway occupancy time.

3) NO.1 exit taxiway should be upgraded to dual taxiways in order to ensure safe and efficient aircraft ground operations under "preferential runway use".

(3) Problems in Capacity of the Facilities

1) The existing apron for three aircraft stands is fully utilized during the peak hour at the present time, and should therefore be expanded to cope with the increase in air traffic demand.

2) The existing passenger terminal building occupies in width 70% of the total floor area requirement. The floor area is particularly inadequate as an international facility, and expansion of this area is urgently required.

3) The administration office of AASANA including ACC has an inadequate floor area in spite of repeated small expansions in the past. The total building system is not functional.

(4) Problems in Service Level for Passengers

1) The existing passenger building which was planned about 20 years ago does not meet the requirements for mass and rapid air transport with respect to size, concept, internal layout, etc.

2) The following problems in the existing passenger terminal building have been clarified :

- Passenger flow in the building is complicated.

- A boarding bridge has not been installed even though El Alto is a high altitude airport.

- There is no information service for the passengers.

- Electrical and mechanical facilities in the building are deteriorated and do not function adequately.

- Curb length of the building is quite inadequate.

- It is very difficult to solve these problems by improving the existing building based on the technical and economic considerations.

2.2 Air Traffic Demand Forecast

The air traffic demand has been forecast from 1990 to 2010 at five year intervals. The forecast has been made for both international and domestic passengers and cargo based on the following principal steps.

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

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

- Projection of the population and GDP of Bolivia.

- Forecast of air traffic demand in Bolivia using regression analysis between air traffic demand and GDP.

- Distribution of the air traffic demand for El Alto airport.

The projected air passenger and cargo traffic demand are shown in Figures 2 and 3, respectively.

The design years for Phases I and II have been established to be year 1997 and 2005 respectively, and the corresponding air traffic demand is summarized in Table 2.

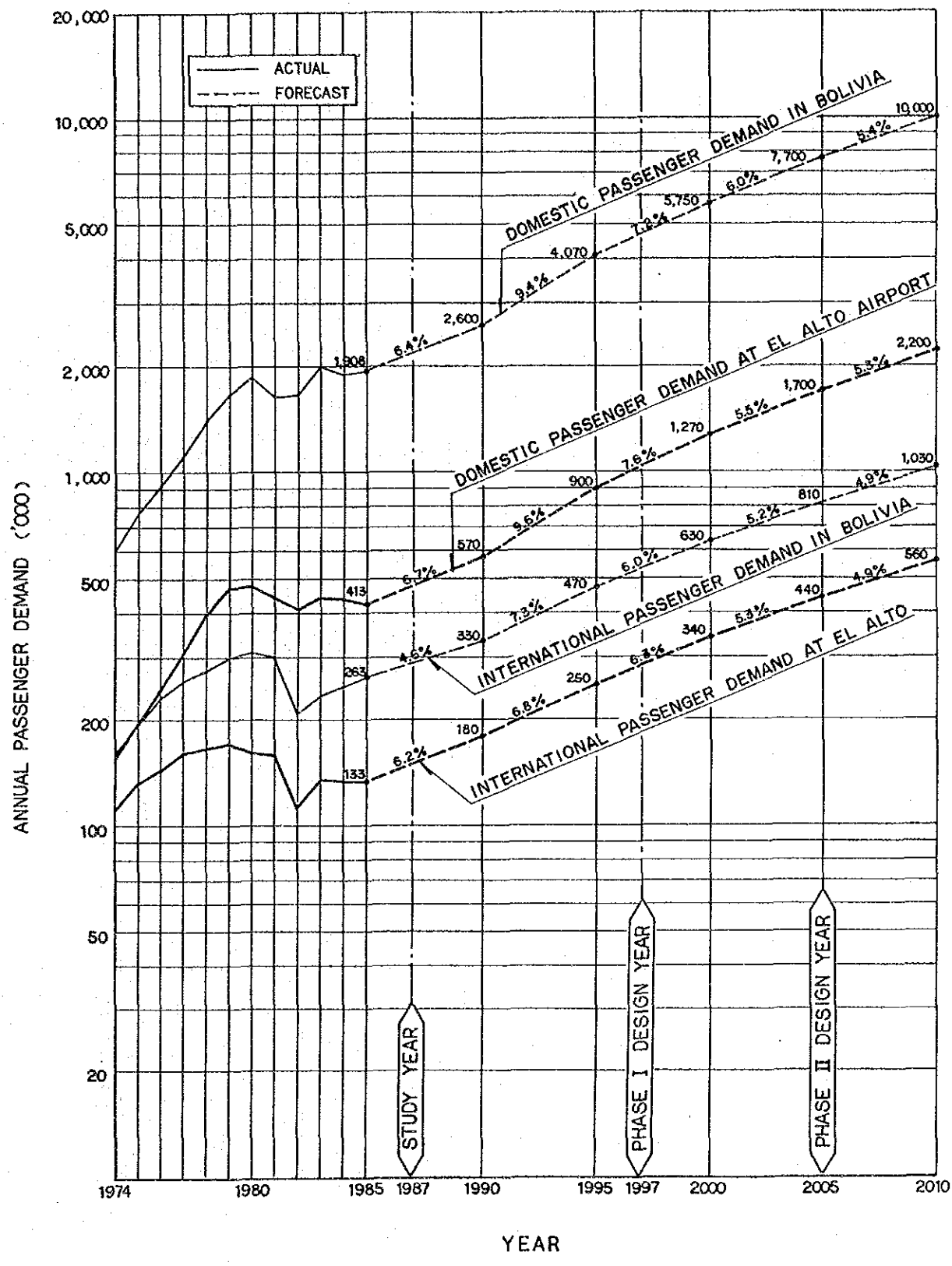


Figure 2 Projected Air Passenger Traffic Demand

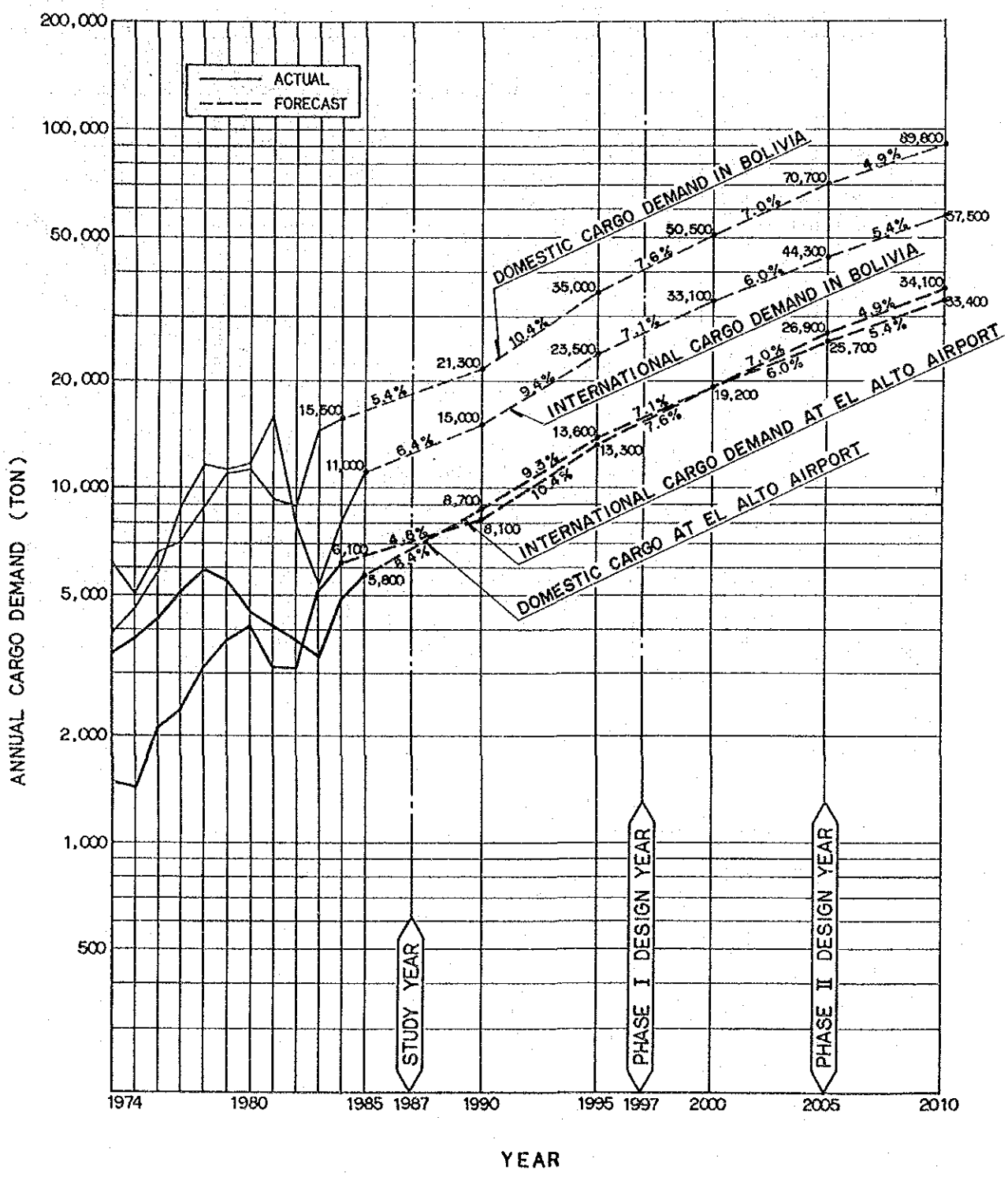


Figure 3 Projected Air Cargo Traffic Demand

Table 2 Traffic Demand for the Phase I and II Developments

Item		Present Conditions (as of 1987)	Phase I 1997	Phase II 2005
1. Annual Number of Passengers*a	Domestic	413,000(1985)	1,030,000	1,700,000
	International	133,000(1985)	280,000	440,000
	Total	546,000(1985)	1,310,000	2,140,000
2. Annual Cargo (ton)*b	Domestic	6,700(1985)	15,400	26,900
	International	5,800(1985)	15,600	25,700
	Total	12,500(1985)	31,000	52,600
3. Annual Aircraft Movements*a	Domestic	17,970(1985)	22,530	24,470
	International	2,640(1985)	5,310	6,550
	Total	20,610(1985)	27,840	31,020
4. Peak Hour Passengers*c	Domestic	290*f(1987)	680	1,120
	International*d	110*f(1987)	240	310
	Total*e	290*f(1987)	800	1,370
5. Peak Hour Aircraft Movements	Domestic*c	3(1987)	4	5
	International*c	3(1987)	3	3
	Domestic and International*c*e	4(1987)	6	7
	Total Airport*a	11(1986)	13	13

Note *a: Including non-scheduled *b: Excluding meat cargo
*c: Excluding non-scheduled *d: Excluding transit
*e: Not a mathematical summation of domestic and international, but an overall figure for the total airport
*f: Estimated figure

2.3 Airport Facility Requirements

The Airport facility requirements have been estimated based on the results of the air traffic demand forecasts and in compliance with the standards, recommendations and/or regulations of ICAO (International Civil Aviation Organizaiton), FAA (Federal Aviation Administration) and JCAB (Japan Civil Aviation Bureau), as shown in Table 3.

Table 3 Airport Facility Requirements for the Phases I and II

No.	Facility	Phase / Design Year / Unit	Present Conditions (as of 1987)	Phase I 1997	Phase II 2005
1	Runway	meter	RWY 09R/27L 4,000 x 46 RWY 09L/27R 2,280 x 30 RWY 04/22 1,940 x 30	RWY 09R/27L 4,000 x 46	RWY 09R/27L 4,000 x 46
2	Runway Strip	meter	RWY 09R/27L 4,090 x 300 RWY 09L/27R 2,280 x 100 RWY 04/22 2,060 x 300	RWY 09R/27L 4,120 x 300	RWY 09R/27L 4,120 x 300
3	Taxiway	meter	Exit Taxiway 1,250 x 22.9	Partial Parallel Taxiway	
4	Passenger Terminal Apron	gate position	B-747 Class:1 B-727 Class:2 Total 3	International B-747 Class:2, B-757 Class:1 Domestic B-757 Class:3 Total 6	International B-747 Class:2, B-757 Class:2 Domestic B-747 Class:1, B-757 Class:2 Total 7
5	Cargo Terminal Apron	gate position	Nil	B-707 Class:2	B-747 Class:2
6	Cargo Apron for Small Carriers	gate position	C-54 Class:16	13	11
7	General Aviation Apron	gate position	COMMANDER-690 Class:9	13	19
8	Passenger Terminal Building — Domestic	sq. meter		10,200	16,800
	Passenger Terminal Building — International	sq. meter		7,200	9,300
	Passenger Terminal Building — Total *a	sq. meter	4,800 (Combined)	16,500	24,800
9	Cargo Terminal Building	sq. meter	1,300	5,160	8,670
10	Administration Building	sq. meter	2,819	4,000	4,000
11	Air Navigation Systems		Precision Approach Category-I	Precision Approach Category-I (ILS/MLS)	(MLS)
12	Car Park	cars	100	560	960
		sq. meter	4,600	20,000	34,000
13	Access Road		1 lane for each direction	1 lane for each direction	2 lanes for each direction
14	Fuel Supply (Jet. A-1)	Kl *b	2,056	2,500	4,000
		sq. meter	2,500	8,500	8,500
15	Rescue and Fire-Fighting	Category	7	7	8
		cars	3	4	4 or 5
		sq. meter	450	450	550
16	Utilities				
	Power Supply System	KVA	320 (270kw)	2,000	3,200
	Water Supply System	ton/month	6,900	12,000	20,400
	Sewerage System	ton/month	6,900	12,000	20,400
	Solid Waste Disposal System	ton/month	30	60	110

Note, *a: Not a mathematical summation of domestic and international, but an overall figure for the total airport

*b: Tank capacity

2.4 Necessity for the Project

As previously described, air transportation plays an important role in the overall transport system of Bolivia, since it is a landlocked country and also related to the country's geographic and topographic conditions. This situation for the transport system is expected to remain unchanged in the future considering the fact that a significant breakthrough of the current underdeveloped land transportation system can not be anticipated for the present.

El Alto airport which is the objective of this project is situated in La Paz which is the socio-economic center of Bolivia and has a population of 933,000. La Paz city is essentially the capital of Bolivia and therefore, El Alto airport which is the hub for both international and domestic air transport, must be developed and upgraded in view of the aforementioned condition of the overall transport system in Bolivia.

Although the passenger demand at El Alto airport numbered 133,000 international and 413,000 domestic passengers for a total of 546,000 in 1985; it is forecast that the demand will increase to as much as 4 to 5 times the present level based upon a long-term forecast for the year 2010, to 560,000 international and 2,200,000 domestic passengers annually for a total of 2,760,000. In order to cope with this future increase in traffic demand, it is necessary that El Alto airport be modernized by solving the present existing problems and permitting it to function as the base for international exchange as the "gateway of Bolivia". Furthermore, it is certain that the modernization of the El Alto airport will greatly contribute to the promotion of social and economic activity in Bolivia as the center of a domestic air transport network together with Santa Cruz (Viru Viru) airport which has already been developed and Cochabamba airport where modernization work has already been scheduled and will commence soon.

The modernization project of El Alto airport should therefore be implemented urgently as one of the first priority projects in Bolivia.

CHAPTER 3 OUTLINE OF THE MASTER PLAN AND THE PHASE I DEVELOPMENT PROJECT

3.1 Airport Master Plan

Six alternative long-term master plans for the design year 2005 which utilize the existing main runway with necessary improvement work have been studied with different concepts for the terminal area development. These alternatives were mainly divided into two groups, i.e., one to develop the airport utilizing the existing major terminal facilities as much as possible, and the other to construct all new major terminal facilities.

As a result of an evaluation comparison of all aspects including : convenience for airport users, efficiency of airport and airline operations, expansion potential, construction considerations, economy of project cost, etc., the best alternative master plan : to **construct all major airport facilities except for the runway** was selected.

The master plan selected will require more or less the same investment cost as the alternatives to utilize, as much as possible, the existing major terminal facilities. It ensures easier construction with less disruption of the existing airport operations and ample expansion potential of the terminal layout for future development.

With respect to expansion potential, El Alto airport could be utilized beyond the year 2005 if the terminal facilities were expanded in phases as required to meet the demand.

The long-term airport master plan consists of the following three development phases :

i) Immediate Improvement Work :
Immediate improvement work before the completion of the Phase I development construction, i.e., 1993.

ii) Phase I Development Project :
Development project for the design year **1997** and design number of annual passengers of **1.3 million.**

iii) Phase II Development Project :
Outline of the development project for the design year **2005** and design number of annual passengers of **2.1 million.**

3.2 Immediate Improvement Work to be Implemented by the Government of Bolivia

The following minimum improvement to the existing airport facilities will be required immediately in order to maintain the present standard of aviation services.

The immediate improvement work is not included in the scope of the Phase I Development Project and is to be carried out by the Government of Bolivia.

(1) Improvement of Runway Pavement

The existing cement concrete pavement which occupies an area 30 m long and 46 m wide located 1,740 m from the runway 09R threshold is seriously damaged and will, therefore, need to be replaced with a new pavement with adequate strength necessary to accommodate the largest aircraft operated at the present; i.e. B-747.

(2) Construction of Runway Shoulders and Blast Pads

7 m wide paved runway shoulders for the existing main runway 09R/27L and 60 m wide 120 m long blast pads should be constructed in order to ensure safe aircraft operation.

(3) Renovation of the Existing Passenger Terminal Building

Renovation of the existing passenger terminal building including expansion of the international arrival and departure areas by changing the existing partitions is required in order to eliminate serious congestion in the terminal.

The cost required for the immediate improvement is estimated on a preliminary basis to be 679,000 US dollars as shown in Table 4.

Table 4 Estimated Construction Cost for Immediate Improvement

Item	Cost
Improvement of runway pavement	US$ 83,000
Construction of runway shoulders and blast pads	US$ 526,000
Renovation of the existing passenger terminal building	US$ 70,000
Total	US$ 679,000

Note : Exchange Rate : US$1.00 = Bs1.95 = ¥150 (As of March, 1987)
Cost estimate based on 1987 prices

3.3 Scope of the Phase I Development Project

The Phase I development plan has been prepared based on the framework of the long-term master plan and is shown in Figure 4. The outline of the airport facilities after the Phase I construction has been completed is summarized in Table 5.

The scope of the Phase I Development Project (Design Year 1997) is listed below :

(1) Civil Works

1) Pavement overlay of the existing runways 09R/27L (4,000 m x 46 m) with asphalt concrete 14 cm thick.

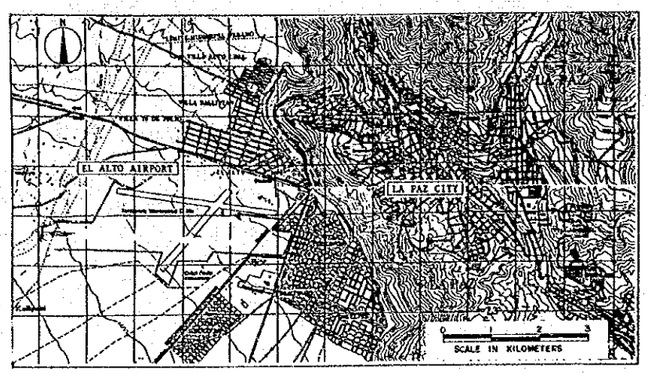
2) Construction of a turning pad for B-747 class aircraft at the runway 09 threshold.

3) Construction of dual/partial parallel taxiways and rapid exit taxiways for a total length of approx. 4,000 m (97,000 sq. m).

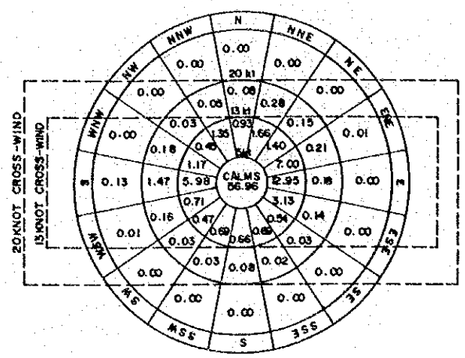
4) Construction of a passenger terminal apron to accommodate two B-747 class aircraft and four B-757 class aircraft (324.5 m wide and 131 m deep).

5) Construction of two lane internal roads (7 m width) and a car park with 560 parking spaces.

6) Construction of a security fence

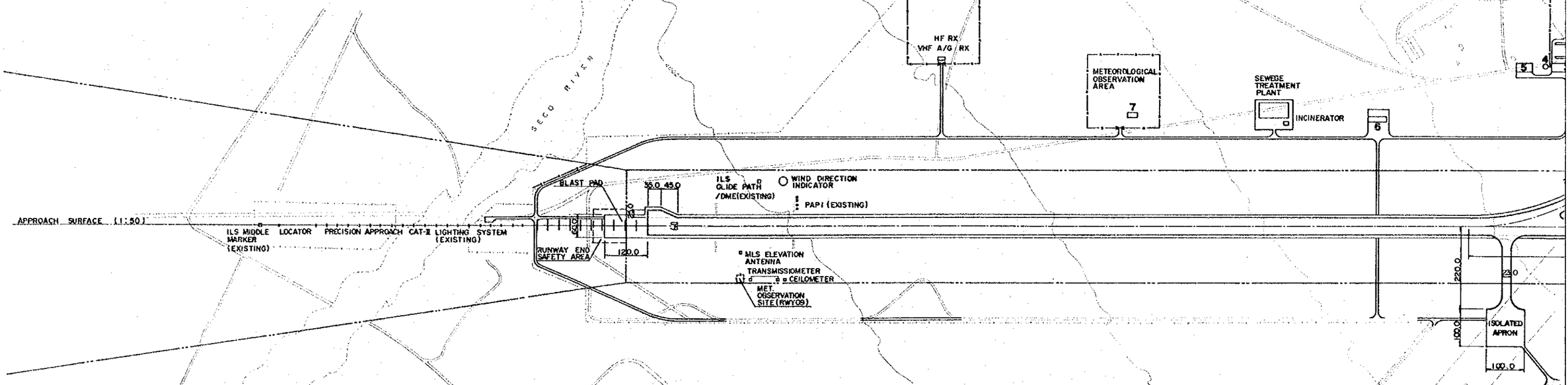


LOCATION MAP



WIND ROSE

LOCATION	:	EL ALTO AIRPORT
PERIOD	:	1984 – 1986
RUNWAY DIRECTION	:	N 92° E (MAG.)
13 KNOT CROSS-WIND COVERAGE	:	99.44 %
20 KNOT CROSS-WIND COVERAGE	:	100.00 %



BUILDINGS	
1	PASSENGER TERMINAL BUILDING
2	CARGO TERMINAL BUILDING
3	ADMINISTRATION BUILDING
4	CONTROL TOWER
5	AIRPORT MAINTENANCE SHOP AND STORAGE
6	FIRE STATION
7	METEOROLOGICAL OBSERVATION BUILDING
8	SWITCHING AND GENERATOR STATION
9	RESERVED AREA FOR STORAGE
10	RESERVED AREA FOR GSE MAINTENANCE SHOP
11	RESERVED AREA FOR CARGO AGENTS BUILDING
12	RESERVED AREA FOR CATERING BUILDING

RUNWAY DATA	
ITEMS	RUNWAY 09/27
EFFECTIVE GRADIENT %	1.55
PERCENTAGE WIND COVERAGE	20 KNOT 100.00 %
	13 KNOT 99.44 %
INSTRUMENT RUNWAY	✓
PAVEMENT STRENGTH	PCN52/F,A,X,T,
APPROACH SURFACES	1/50
RUNWAY LIGHTING	HIRL / RWCL
RUNWAY MARKING	PRECISION
LANDING AIDS	MLS/DME, PAPI, ILS/DME ALS(CAT-I), SALS

AIRPORT DATA	
ITEMS	
AIRPORT ELEVATION	4,058 M
AIRPORT REFERENCE POINT	LAT 16°30'36" S
(ARP) COORDINATES	LNG. 68°10'52" W
AIRPORT REFERENCE TEMPERATURE	16° C
AIRPORT AND TERMINAL NAVAIDS, AND TERMINAL RADAR	VOR/DME,NDB,LOC SSR
MAGNETIC VARIATIONS	02° W (1986)
CRASH PROTECTION PROVIDED	CAT-7

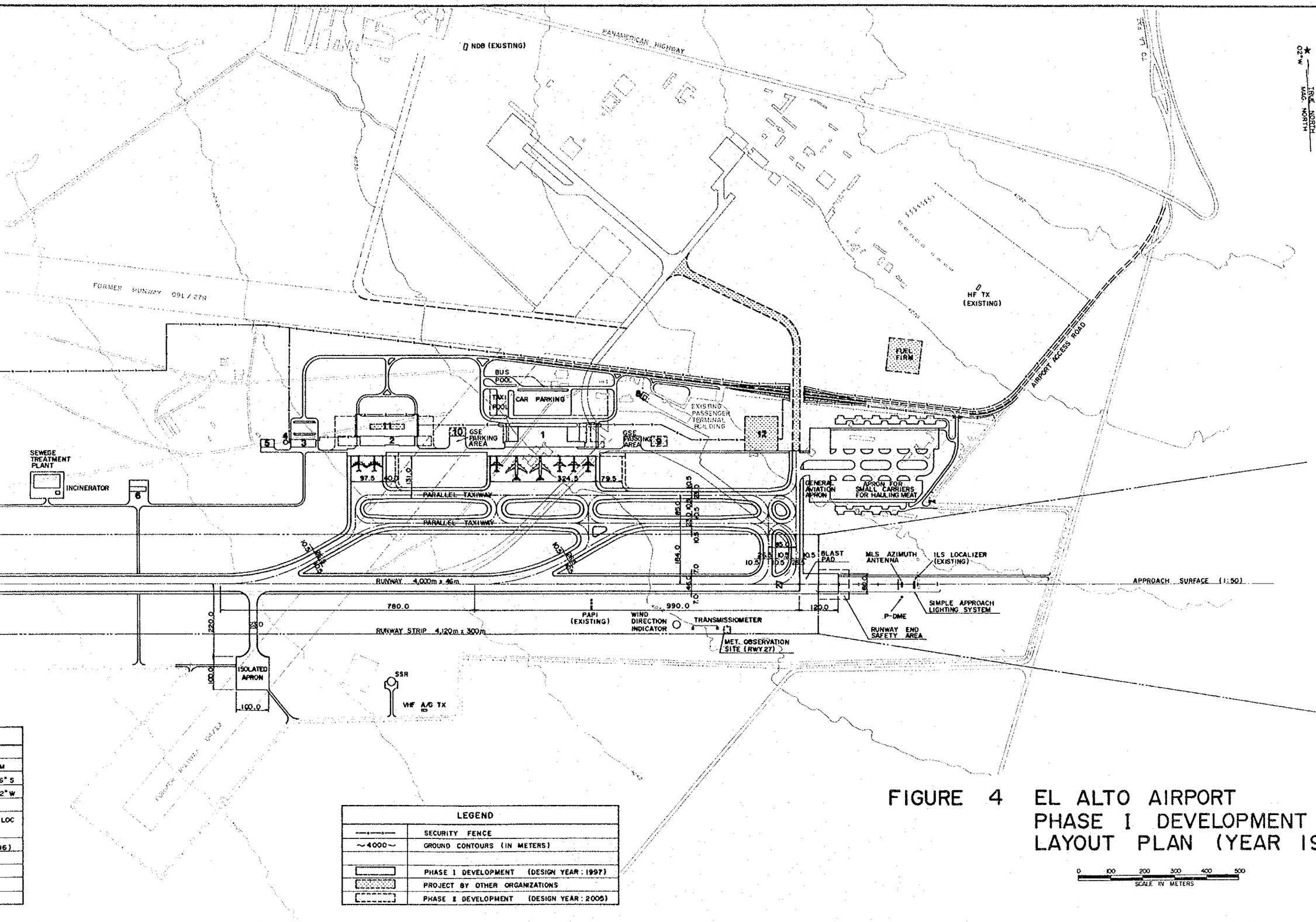


FIGURE 4 EL ALTO AIRPORT
PHASE I DEVELOPMENT
LAYOUT PLAN (YEAR 1997)

Table 5 Outline of El Alto Airport (Phase I) Development

"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 Ref. Point	Airport Elevation	Runway Orientation	Aerodrome Ref. 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)	RWY09/27 N92°E(Mag.)	16 °C	24 hours	All Seasons	AASANA

City/Town Name	Population	Distance to Airport	Transportation: Railway	Taxi	Bus	Wind Coverage	Minimum Meteoro-logical Conditions
La Paz	Approximately 993,000 (1985)	14.5 km	NO	YES	YES	RWY 09/27: 99.4%(13kt), 100%(20kt)	

Runway	Approach Procedure / Category of Aircraft		Straight - in CAT-A	CAT-B	CAT-C	CAT-D	Circling CAT-A	CAT-B	CAT-C	CAT-D
09	ILS/DME	OCA/H	13341/185	13355/199	13365/209	13378/223	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/MLS	ASR	PAR	SSR	ARTS	ASDE	HF	VHF	UHF	ATIS	DF	ITV	TTY	AFTN
Existing	YES	YES	YES	YES	NO	ILS	NO	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES
Plan	YES	YES	YES	YES	NO	ILS/MLS	NO	NO	YES	NO	NO	YES	YES	YES	YES	NO	NO	YES	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	YES	NO	YES	NO	NO	NO	NO	NO	YES	YES	YES
	RWCL	TDZL	STWL	DML	TWL	TWCL	TGS	ABN	WDIL	AFL	
Existing	NO	NO	NO	NO	YES	NO	NO	NO	YES	YES	
Plan	YES	NO	NO	NO	YES	NO	YES	YES	YES	YES	

Meteorological Facilities

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

Basic Facilities

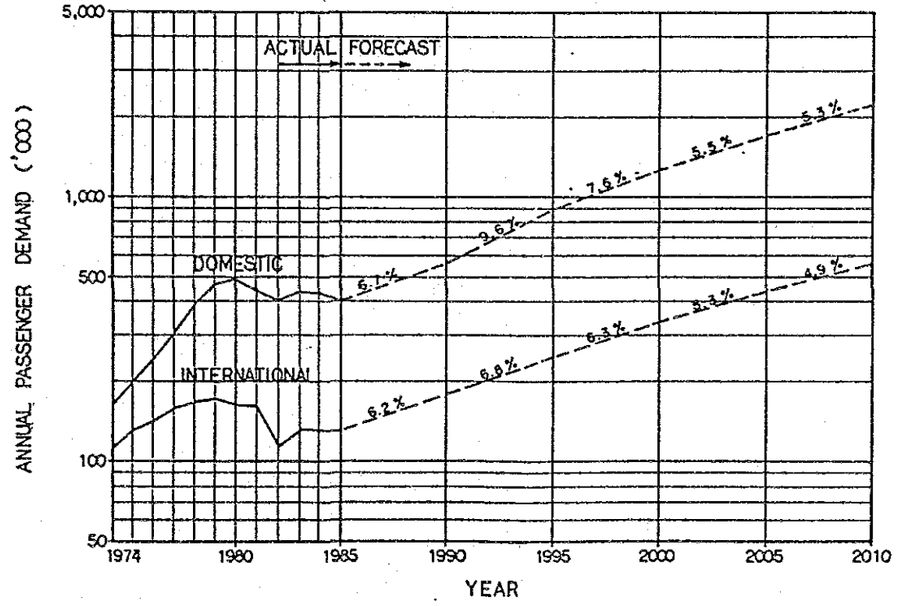
	Size	Pavement	Note
Runway	4,000m x 46m	Asphalt	PCN52/F.A.X.T.
Taxiway	Dual/Partial Parallel Taxiways with 2 Right Angle and 2 High Speed Exits W = 23m		

Apron: Design Aircraft	No. of Stands	Pave-ment	Area	Parking Configuration
B-747	2	PCC	Passenger	Nose-in
B-757	4			Nose-in
B-707	2	PCC	Cargo	Nose-in
C-54	13	Asphalt	Meat Cargo	Angle-out
COM690	13	Asphalt	General Aviation	Angle-out

Other Facilities

	Size	Structure	Note
Car Parking	560 lots	Asphalt	
Pax. T. Building	16,500 m^2	RC	
Cargo T. Building	5,160 m^2	Steel	
Adm. Building	4,000 m^2	RC	
Control Tower	Cab: 60 m^2	RC	Height 29m
Fire Station (Level of Protection)	450 m^2	RC	4 cars
	Category-7		
Fuel Supply	Hydrant Supply System		
	Jet A-1 : 2,500 kl		
	Avigas : 1,662 kl		

Air Traffic Demand Forecasts



Items	1985	1997 (Phase I)	2005 (Phase II)
Annual Domestic Passengers ('000)	413	1,030	1,700
Annual International Passengers ('000)	133	280	440
Annual Domestic Cargo (ton)	6,700	15,400	26,900
Annual International Cargo (ton)	5,800	15,600	25,700
Annual Domestic Aircraft Movements	17,970	22,530	24,470
Annual International Aircraft Movements	2,640	5,310	6,550

Note:
Completion of Phase I Development at the End of 1993

Prepared by JICA as of 1987

7) Construction of perimeter and maintenance roads

8) Construction of a storm water drainage system

9) Construction of a cargo terminal apron to accommodate two B-707 class aircraft (97.5 m wide and 131 m deep).

10) Construction of a general aviation apron with an area of 9,600 sq. m.

11) Construction of a cargo apron for small meat carriers with an area of 57,000 sq. m.

12) Construction of an isolated apron for one B-747 class aircraft with a connecting taxiway.

(2) Architectural Work

1) Construction of a new passenger terminal building consisting of a reinforced concrete structure with a total floor area of approx. 16,500 sq. m and the installation of flight information and airport security systems.

2) Construction of a new reinforced concrete administration building with a floor area of approx. 4,000 sq. m and a control tower 29 m high.

3) Construction of a new one storey reinforced concrete fire station with a total floor area of 450 sq. m.

4) Construction of a meteorological observation building with a total floor area of 300 sq. m.

5) Construction of a new cargo terminal building (single storey steel frame structure) with a total floor area of approx. 5,000 sq. m.

6) Construction of an airport maintenance shop and storage facility.

(3) Air Navigation Systems

1) Replacement of the runway edge lights, runway threshold and end lights, runway wingbar lights, and illuminated wind direction indicator lights.

2) Relocation of the secondary surveillance radar (SSR)

3) Installation of a simple approach lighting system, taxiway edge lights, taxiing guidance system, apron floodlights, aerodrome beacon, and power distribution and control system.

4) Replacement of radio navigation aids, viz., VOR/DME, locator, and installation of a microwave landing system including external telecommunications and a power supply cable.

5) Replacement of the VHF air-ground and HF air-ground radio equipment, VHF link, VHF multi-channel transceivers, control consoles, magnetic tape recorder, etc.

6) Installation of a VHF FM transceiver, and automatic terminal information service (ATIS) equipment.

7) Installation of a field weather data collection system including a runway visual range meter and ceilometer.

8) Replacement of the HF fascimile equipment, radiosonde receiver, and weather satellite receiver.

9) Provision of radiosonde, transmitters and a hydrogen generator

10) Provision of test equipment, spare parts, and consumables for the air navigation equipment.

(4) Airport Utilities

1) Expansion of the power supply and water supply systems, and a public telecommunications facility.

2) Construction of a new sewage system and installation of an incinerator.

(5) Fire Fighting Facilities

1) Provision of major fire fighting vehicles, an ambulance and rescue equipment

(6) Other Items

1) Installation of boarding bridges

2) Installation of a lighting system for the car park and access road

3.4 Project Cost, Implementation Schedule and Executing Agency

(1) Project Cost

The project cost of the Phase I Development Project has been estimated to be US$26 million for the Bolivian local currency portion, and US$112 million for the foreign currency portion, or a total of US$138 million based on 1987 prices.

The estimated project cost for the Phase I development is broken down in detail in Table 6.

(2) Project Implementation Schedule

The implementation schedule for the Phase I Development Project is shown in Table 7. This schedule is based on the assumption that arrangements and preparations required for the project implementation will be efficiently and smoothly executed.

The construction work is expected to start in the middle of 1991 and will be completed by the end of 1993. Airport operations will start in the beginning of 1994 after the completion of the Phase I Development Project.

The financial arrangements for the project must be completed by the end of 1988 in order to maintain the schedule outlined above.

Table 6 Estimated Project Cost for the Phase I Development

Exchange Rate: US$1.00 = Bs1.95 = ¥150 (As of March 1987)
Cost estimate based on 1987 price

Unit: US$1,000

	Item	Bolivian Portion	Foreign Portion	Total
Civil Works	Runway Overlay and Turning Pad	690	7,140	7,830
	Taxiways	1,550	6,260	7,810
	Passenger Terminal Apron	2,220	3,880	6,100
	Road and Car Parking Area	360	1,220	1,580
	Security Fence and Perimeter/Maintenance Road	120	310	430
	Cargo Terminal Apron	790	1,290	2,080
	General Aviation Apron, Cargo Apron for Small Carriers and Isolated Apron	380	1,940	2,320
	Sub Total	6,110	22,040	28,150
Architectural Works	Passenger Terminal Building including Flight Information System and Airport Security System	8,470	20,660	29,130
	Fire Station	200	460	660
	Administration Building and Control Tower	1,870	4,370	6,240
	Meteorological Observation Building	130	290	420
	Cargo Terminal Building	1,650	4,040	5,690
	Airport Maintenance Shop and Storage	340	790	1,130
	Sub Total	12,660	30,610	43,270
Air Navigation Systems	Aeronautical Ground Lights for Runway	170	3,320	3,490
	Relocation of Secondary Surveillance Radar	20	60	80
	Aeronautical Ground Lights for Taxiway and Apron	100	1,440	1,540
	Radio Navigational Aids	90	6,340	6,430
	Air Traffic Control and Aeronautical Telecommunications System	210	7,690	7,900
	Meteorological System	10	3,060	3,070
	Sub Total	600	21,910	22,510
Airport Utilities	Power Supply System	110	2,650	2,760
	Water Supply System	140	550	690
	Telecommunications	0	100	100
	Sewage Treatment System	490	1,950	2,440
	Incinerator	20	180	200
	Sub Total	760	5,430	6,190
Rescue and Fire Fighting Vehicles		0	1,890	1,890
Other Facilities	Boarding Bridges	0	3,300	3,300
	Lighting for Car Parking Area and Access Road	30	660	690
	Sub Total	30	3,960	3,990
Total of Construction Cost		20,160	85,840	106,000
Soil Investigation and Topographical Survey		400	0	400
Engineering Services		1,000	6,000	7,000
Construction Supervision		2,000	10,000	12,000
Sub Total		23,560	101,840	125,400
Contingency (approximately 10%)		2,440	10,160	12,600
Total of Project Cost		26,000	112,000	138,000

Table 7 Project Implementation Schedule for the Phase I Development

ITEMS \ YEAR	1987	88	89	90	91	92	93	94	95	96	97
Service Period								PHASE I			
● Feasibility Study											
■ Financial Arrangement and Selection of Consultant											
● Detailed Engineering Services											
■ Financial Arrangement and Tendering for Contractors											
● Assistance in Tendering and Construction Supervisory Services											
▲ Construction Works											
1. Access Road											
2. Runway Pavement Overlay											
3. Taxiways											
4. Aprons											
5. Roads, Car Parking, and Other Miscellaneous Civil Works											
6. Passenger Terminal Building											
7. Cargo Terminal Building											
8. Administration and Other Buildings											
9. Air Navigation Systems											
10. Airport Utilities											
■ Test Operations and Flight Checks, etc.											

Note, ■ : Employer's Activity
● : Consultant's Activity
▲ : Contractor's Activity

(3) Executing Agency

The executing agency for the project is MDA/AASANA.

MDA: Ministerio de Aeronáutica
AASANA: Administración de Aeropuertos y Servicios Auxiliares a la Navegación Aérea

3.5 Project Appraisal

The economic and financial feasibility of the project has been evaluated for the Phase I development.

(1) Economic Analysis

The economic feasibility was assessed in terms of EIRR (Economic Internal Rate of Return), B/C (Benefit Cost Ratio) and NPV (Net Present Value) with the results shown in Table 8.

Table 8 Result of Economic Analysis

EIRR (%)	B/C Ratio*	NPV* (Million US dollars, 1987)
18.2	1.7	78

Note, * : at discount rate of 12%

An EIRR of 18.2% indicates that this project is **feasible in terms of the state of the national economy** because it exceeds the 10 to 12% "opportunity cost" of capital which the World Bank generally adopts as a criterion for selecting economically viable projects.

A Sensitivity analysis was also made to provide probablistic judgement of the feasibility and the results are summarized in Table 9 and Figure 5.

Table 9 Results of Sensitivity Analysis for EIRR

Case	EIRR (%)
Base Case	**18.2**
Case 1 : Construction Cost Increased by 20%	16.0
Case 2 : Low Forecast Traffic Demand	13.5
Case 3 : Low Forecast Traffic Demand and Construction Cost Increased by 20%	11.7

Note: The low forecast traffic demand is approximately 80% of the medium forecast traffic demand (Base case). For further details, refer to the Main Report.

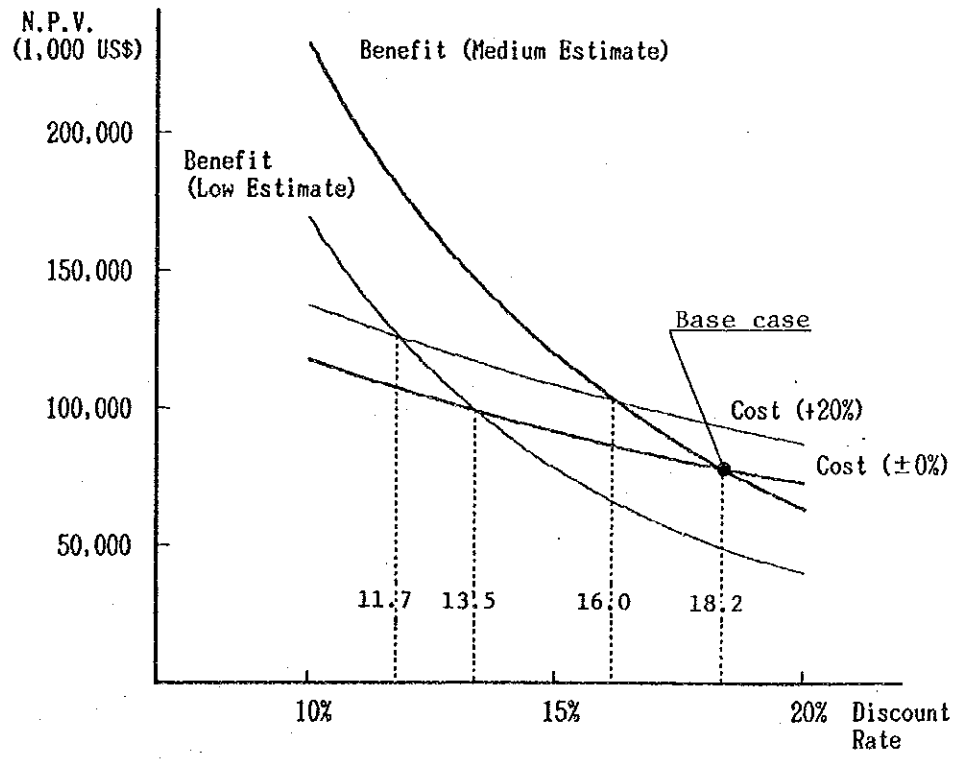


Figure 5 Sensitivity of EIRR

The results of the sensitivity analysis indicate that even for the worst projection, i.e. low forecast traffic demand and 20% increase in construction cost simultaneously, the EIRR is 11.7% and still satisfies the "opportunity cost" of capital criterion of the World Bank.

The economic and sensitivity analyses summarized above have been carried out based on the following costs and direct/tangible benefits:

Cost: - Investment Cost
- Operation and Maintenance Costs

Benefits: - Accommodation of overflowing domestic passengers
- Accommodation of overflowing international passengers
- Accommodation of overflowing foreign tourists
- Accommodation of overflowing airline aircraft
- Reduction of passenger processing time at the airport

In addition to these benefits, the following indirect and/or intangible benefits are expected to be brought about as a result of the implementation of this project.

- Air transport safety,
- Improvement of the national economy resulting from unrestricted and efficient air transport services,
- Increase in trade and business opportunities,
- An increase in employment opportunities, and
- Stimulation of international tourism.

(2) Financial Analysis

The financial feasibility has been assessed in terms of FIRR (Financial Internal Rate of Return) as shown below:

FIRR = 4.0%

This result of the financial analysis indicates the following :

1. Unless a loan with a low interest rate (less than 4.0%) is available, the airport revenues under the present fee system will not cover the investment cost required in addition to the operation/maintenance costs. It is generally known with regard to airport projects all over the world that the airport revenues

normally can not cover the investment cost.

2. For this project, airport revenues will adequately cover the operation/maintenance costs.

Sensitivity analysis for FIRR was made and is summarized in Table 10 and Figure 6.

Table 10 Estimated FIRR

Case	Traffic Forecast	Investment Cost	Landing Fee	Other Charges	FIRR
Base	Medium	±0 %	±0 %	±0 %	**4.0 %**
1		±0 %	-40 %	±0 %	0.4 %
2		±0 %	+10 %/10 year	+10 %/10 year	4.8 %
3		±0 %	+20 %/10 year	+20 %/10 year	7.5 %
4		±0 %	+20 %/ 5 year	+20 %/ 5 year	9.9 %
5		+10 %	±0 %	±0 %	3.2 %
6		+10 %	+20 %/10 year	+20 %/10 year	4.7 %
7		+20 %	+10 %/ 5 year	+10 %/ 5 year	4.4 %
8	Low	±0 %	±0 %	±0 %	2.5 %
9		±0 %	+10 %/ 5 year	+10 %/ 5 year	4.6 %
10		+10 %	+20 %/ 5 year	+20 %/ 5 year	5.7 %
11		+20 %	+20 %/ 5 year	+20 %/ 5 year	4.9 %
12	High	±0 %	±0 %	±0 %	5.3 %
13		+10 %	+10 %/10 year	+10 %/10 year	5.1 %
14		+20 %	+20 %/10 year	+20 %/10 year	5.0 %

Note: High forecast traffic demand is approximately 130% of the medium forecast traffic demand (Base case). For further details, refer to the Main Report.

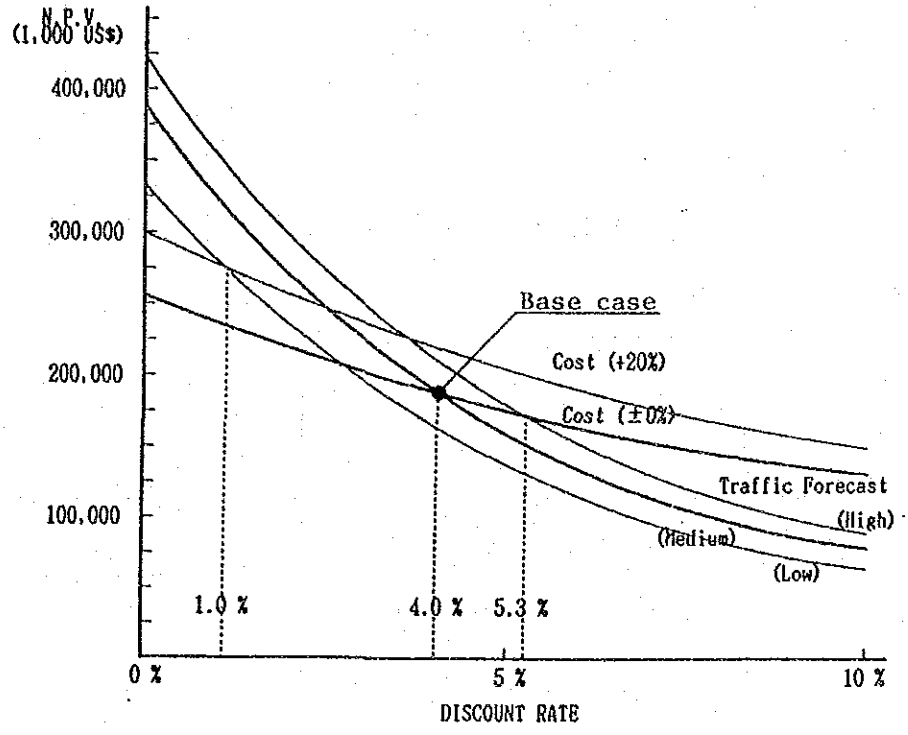


Figure 6 Sensitivity of FIRR

The results of the sensitivity analysis indicate the following :

If it is possible to increase the charge by 20% every five years, the FIRR will increase to 9.9%. The anticipated airport revenues are expected to be sufficient to cover the operation/maintenance costs and investment cost also, which can be obtained from a commercial bank loan at an interest rate of 8.75% (based on recent experience around the world).

The financial and sensitivity analyses summarized above were carried out based on the following expenditures and revenues:

Expenditures: - Investment cost
- Operation and maintenance costs

Revenues:
- Air passenger service charges
- Aircraft landing charges, navigation services and night/holiday surcharge
- Rent on concessions in the terminal building

Financial feasibility has also been assessed in terms of income and funds statements.

According to an analysis of the income and funds statements prepared for the project, the balance will be positive ("in the black") after the 13th year of operation based on the following conditions for raising funds:

Plan for Fund Raising	Type of Funds	Interest Rate
50 % of Bolivian Portion of Investment Cost	Capital or Subsidy	
50 % of Bolivian Portion of Investment Cost	Long-term Loan from Commercial Banks	8.75 %/year
Foreign Portion of Investment Cost	International Lending Agencies or Bilateral Aid Organizations	3.5 %/year
Working Capital	Bank Loan for Short-term Debt	6.5 %/year

This project can cover interest cost payable for long- and short-term loan as well as the operation/maintenance costs. Therefore, the project can be considered **relatively feasible based on financial evaluation** when compared with other similar projects.

CONCLUSIONS

The technical and economical feasibility study for the Phase I Development Project concluded that :

- There is an urgent necessity for the implementation of the project based on technical factors which are stated in the engineering study.

- The project cost is estimated to be US$138 million based on 1987 prices and the economic internal rate of return is evaluated to be 18.2 %.

- The project is considered economically feasible considering the overall national economy.

It is, therefore, considered mandatory to implement the project as soon as possible. The following actions will be required by the Government of Bolivia :

- To determine a consensus for the implementation of the project and to list it as a National Development Project with suitable priority.

- To prepare financial arrangements.

- To carry out the necessary topographic survey, soil investigations and pavement survey.

- To enact legally the height restriction required for safe aircraft operation and implement the land use plan considering future aircraft noise in the areas surrounding the airport.