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THE STUDY ON THE DEVELOPMENT PLAN  
OF  
THE INTERNATIONAL AIRPORT OF CARRASCO  
IN  
THE ORIENTAL REPUBLIC OF URUGUAY  
FINAL REPORT

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

THE STUDY ON THE DEVELOPMENT PLAN OF  
THE INTERNATIONAL AIRPORT OF CARRASCO  
IN THE ORIENTAL REPUBLIC OF URUGUAY

FINAL REPORT

MARCH 1990

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国際協力事業団

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## PREFACE

In response to a request from the Government of the Oriental Republic of Uruguay, the Japanese Government decided to conduct a study on the Development Plan of the International Airport of Carrasco and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Oriental Republic of Uruguay a survey team headed by Mr. Shigeru Shibata of Japan Airport Consultants, Inc., three times from April 1989 to March 1990.

The team held discussions with concerned officials of the Government of the Oriental Republic of Uruguay, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Oriental Republic of Uruguay for their close cooperation extended to the team.

March 1990



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Kensuke Yanagiya  
President  
Japan International Cooperation Agency

March 1990

Mr. Kensuke Yanagiya  
President  
Japan International Cooperation Agency  
Tokyo, Japan

Dear Sir,

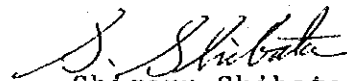
LETTER OF TRANSMITTAL

We have pleasure in submitting to you herewith the final report of The Study on The Development Plan of The International Airport of Carrasco in The Oriental Republic of Uruguay. The Study was made during the period from April 1989 to March 1990 to examine the technical, economic and financial feasibility of the Project as well as to pursue technology transfer to Uruguayan Government experts during the Study period.

The final report was prepared based on the draft final report, duly reflecting the official comments of the Uruguayan Government thereon.

We wish to take this opportunity of expressing our sincere gratitude to the officials concerned of your Agency, Advisory Committee, as well as the Embassy of Japan in Uruguay and last but not least to those of the Government of the Oriental Republic of Uruguay for the kind assistance and cooperation extended to us throughout the period of the Study.

Yours faithfully,



Shigeru Shibata  
Team Leader

Japan Airport Consultants, Inc.

THE STUDY ON THE DEVELOPMENT PLAN  
OF  
THE INTERNATIONAL AIRPORT OF CARRASCO  
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THE ORIENTAL REPUBLIC OF URUGUAY  
- FINAL REPORT -

TABLE OF CONTENTS

CONCLUSION AND SUMMARY

CHAPTER	1	BACKGROUND OF PROJECT	
	1-1	Introduction	1-01
	1-2	Socio-economic Situation	1-03
	1-3	Transport System	1-05
	1-4	Air Transport System in Uruguay	1-07
	1-5	Carrasco International Airport	1-09
CHAPTER	2	FORECAST OF FUTURE AIR TRAFFIC DEMAND	
	2-1	The Present Air Traffic Demand At Carrasco	2-01
	2-2	Forecasting Approaches for Air Traffic Demand	2-06
	2-3	Forecasting Model Building	2-11
	2-4	Forecasting Assumptions	2-18
	2-5	Forecast of Future Air Traffic Demand at Carrasco	2-19
CHAPTER	3	EXISTING FACILITY CONDITIONS	
	3-1	Airfield Facilities	3-02
	3-2	Terminal Area Facilities	3-26
	3-3	Air Navigation Facilities	3-41
CHAPTER	4	FACILITY REQUIREMENTS	
	4-1	Basic Conditions	4-02
	4-2	Airfield Facilities	4-17
	4-3	Terminal Area Facilities	4-23
CHAPTER	5	AIRPORT MASTER PLAN	
	5-1	Alternative Airport Layout Plan	5-01
	5-2	Airport Master Plan, Finalized Facility Requirements and Airport Development Plan for Feasibility Study	5-08
	5-3	Air Space Use Plan	5-26

CHAPTER	6	PRELIMINARY DESIGN	
	6-1	General	6-01
	6-2	Airfield Facilities	6-01
	6-3	Terminal Area Facilities	6-09
	6-4	Air Navigation Facilities	6-13
CHAPTER	7	AIRPORT MANAGEMENT AND OPERATION	
CHAPTER	8	CONSTRUCTION SCHEDULE AND COST ESTIMATE	
	8-1	Construction Conditions	8-01
	8-2	Construction Schedule	8-03
	8-3	Cost Estimate	8-22
CHAPTER	9	ECONOMIC ANALYSIS	
	9-1	Basic Concept	9-01
	9-2	Estimate of Economic Costs	9-04
	9-3	Estimate of Economic Benefits	9-06
	9-4	Economic Evaluation	9-09
CHAPTER	10	FINANCIAL ANALYSIS	
	10-1	General	10-01
	10-2	Estimate of Financial Costs	10-01
	10-3	Estimate of Financial Benefits	10-03
	10-4	Financial Evaluation	10-06
CHAPTER	11	PROJECT IMPLEMENTATION PROGRAMME	
	11-1	Airport Administration Organization	11-01
	11-2	Project Implementation Organization	11-01
	11-3	Financing Plan for the Project	11-04
CHAPTER	12	STAFF TRAINING PROGRAMME	



LIST OF TABLES

		(Page)
A	Summary of Forecasted Air Traffic Demand at Carrasco International Airport	0-3
B	Summary of Facility Requirements	0-5
C	Summary of Improvement Measures for Short-term Development (1995 & 2000)	0-6 0-7
D	Summary of Construction Cost Estimate	0-11
2-1	AIR TRAFFIC DATA AT CARRASCO AIRPORT	2-3
2-2	INDEX OF AIR TRAFFIC DATA AT CARRASCO AIRPORT	2-3
2-3	THE FORECASTING ASSUMPTIONS FOR AIR TRANSPORT DEMAND	2-18
2-4	FORECAST OF FUTURE AIR TRAFFIC DEMAND AT CARRASCO	2-19
2-5	PUENTE AEREO PASSENGER BY CASE	2-20
2-6	OTHER INTERNATIONAL PASSENGER BY CASE	2-21
2-7	TOTAL INTERNATIONAL PASSENGER IN THREE CASES	2-22
2-8	INTERNATIONAL AIR PASSENGER DEMAND AT CARRASCO AIRPORT BY ROUTE	2-23
2-9	DOMESTIC PASSENGER BY CASE	2-24
2-10	DOMESTIC AIR PASSENGER DEMAND OF CARRASCO AIRPORT BY ROUTE	2-25
2-11	EXPORT CARGO BY CASE	2-26
2-12	IMPORT CARGO BY CASE	2-27
2-13	TOTAL INTERNATIONAL CARGO BY CASE	2-28
2-14	INTERNATIONAL AIR CARGO DEMAND BY ROUTE	2-29

LIST OF TABLES

		(Page)
3-1	SCOPE OF SUPPLEMENTARY FIELD SURVEYS	3-9
3-2	STRUCTURE OF PAVEMENT AND EXISTING SURFACE CONDITIONS	3-14
3-3	EQUIVALENCY FACTOR FOR ASPHALT AND CEMENT CONCRETE LAYER	3-16
3-4	GENERAL CHARACTERISTICS AND EVALUATION OF BASE AND SUB-BASE	3-17
3-5	INITIAL ALLOWABLE LOAD OF EXISTING PAVEMENT	3-20
3-6	PROBLEMS OF SLOPES ON EXISTING RUNWAYS AND TAXIWAYS	3-21
3-7	SUMMARY OF BUILDING FLOOR SPACE AND ACTUAL CAPACITY OF MAJOR TERMINAL FACILITIES	3-28
3-8	SUMMARY OF EXISTING SITUATION ON THE CARGO FACILITIES	3-33
3-9	ACTUAL PARKING SPACES AND CAPACITIES	3-34
4-1	DEVELOPMENT SCHEDULE	4-2
4-2	ACTUAL AIRCRAFT MIXTURE	4-3
4-3	AIRCRAFT MIXTURE AND AVERAGE NUMBER OF SEATS PER FLIGHT BY DESIGN YEAR(Other International flight)	4-5
4-4	PEAK-DAY AIRCRAFT MOVEMENT (Peak-day flight)	4-7
4-5	PEAK-DAY PASSENGER MOVEMENT	4-11
4-6	PEAK-HOUR PASSENGER MOVEMENT	4-14
4-7	PEAK-DAY CARGO VOLUME	4-15
4-8	ESTIMATED DISTRIBUTION OF INTERNATIONAL AIR CARGO BETWEEN PASSENGER AIRCRAFT AND CARGO FREIGHTER	4-16
4-9	REQUIRED RUNWAY LENGTH	4-19
4-10	WIND COVERAGE AT CARRASCO	4-20
4-11	THE PROBABILITY WITH THE WX MINIMA	4-21

LIST OF TABLES

		(Page)
4-12	REQUIRED NUMBER OF AIRCRAFT PARKING APRONS	4-23
4-13	ESTIMATED TOTAL FACILITY REQUIREMENTS FOR PASSENGER TERMINAL BUILDING	4-24
4-14	ESTIMATED TOTAL FACILITY REQUIREMENTS FOR CARGO TERMINAL BUILDING	4-25
4-15	RECOMMENDED FACILITY REQUIREMENTS OF AIRFIELD FACILITIES	4-33
4-16	RECOMMENDED FACILITY REQUIREMENTS OF TERMINAL AREA FACILITIES	4-35
4-17	RECOMMENDED FACILITY REQUIREMENTS OF AIR NAVIGATION FACILITIES	4-38
5-1	CONCEPTUAL AIRPORT LAYOUT PLANS	5-2
5-2	SUMMARY OF EVALUATION ON THE ALTERNATIVE AIRPORT LAYOUT PLANS IN THE YEAR 2010	5-7
5-3	FINALIZED FACILITY REQUIREMENTS FOR AIRFIELD FACILITIES	5-12
5-4	FINALIZED FACILITY REQUIREMENTS FOR TERMINAL AREA FACILITIES	5-15
5-5	FINALIZED FACILITY REQUIREMENTS FOR AIR NAVIGATION FACILITIES	5-20
6-1	REQUIRED OVERLAY THICKNESS (RWY06/24 and related taxiways)	6-3
6-2	REQUIRED OVERLAY THICKNESS (RWY01/19)	6-5
6-3	TYPICAL CROSS SECTION OF APRON PAVEMENT	6-8
6-4	PRELIMINARY DESIGN CONDITIONS AND CRITERIA FOR TERMINAL AREA FACILITIES	6-10
6-5	PRELIMINARY DESIGN CONDITIONS AND CRITERIA FOR AIR NAVIGATION FACILITIES	6-14
7-1	RECOMMENDED MANNING PROGRAMME OF DGIA	7-5

LIST OF TABLES

		(Page)
8-1	SUMMARY OF CONSTRUCTION COST (Grade-I)	8-23
8-2	SUMMARY OF CONSTRUCTION COST (Grade-II)	8-24
8-3	SUMMARY OF CONSTRUCTION COST (Grade-III)	8-25
9-1	ANNUAL ECONOMIC COSTS OF INVESTMENT	9-4
9-2	MAINTENANCE AND OPERATION COST OF EXISTING FACILITIES AT CARRASCO INTERNATIONAL AIRPORT	9-5
9-3	ANNUAL ECONOMIC COSTS OF MAINTENANCE AND OPERATION	9-5
9-4	INCREMENTAL NET TOURISM INCOME	9-7
9-5	INCREMENTAL AIRPORT OPERATING REVENUES	9-8
9-6	CASH FLOW OF ECONOMIC COST AND BENEFITS	9-10
10-1	ANNUAL FINANCIAL COSTS OF INVESTMENT	10-1
10-2	ANNUAL FINANCIAL COSTS OF MAINTENANCE AND OPERATION	10-2
10-3	INCREMENTAL AIRPORT TARIFF REVENUE	10-5
10-4	COMPARISON OF REPRESENTATIVE CHARGES	10-7
10-5	CASH FLOW OF FINANCIAL COST AND BENEFITS	10-8
11-1	CONDITIONS OF FUNDS AVAILABLE	11-4
11-2	CASE OF CASH-FLOW FORECAST	11-5
11-3	FORECAST OF CASH FLOW	11-6
11-4-(1)	CASH FLOW STATEMENT (Case 1)	11-7

LIST OF TABLES

		(Page)
11-4-(2)	CASH FLOW STATEMENT (Case 1)	11-8
11-4-(3)	CASH FLOW STATEMENT (Case 1)	11-9
11-5-(1)	CASH FLOW STATEMENT (Case 2)	11-10
11-5-(2)	CASH FLOW STATEMENT (Case 2)	11-11
11-5-(3)	CASH FLOW STATEMENT (Case 2)	11-12
11-6-(1)	CASH FLOW STATEMENT (Case 3)	11-13
11-6-(2)	CASH FLOW STATEMENT (Case 3)	11-14
11-6-(3)	CASH FLOW STATEMENT (Case 3)	11-15
11-7-(1)	CASH FLOW STATEMENT (Case 4)	11-16
11-7-(2)	CASH FLOW STATEMENT (Case 4)	11-17
11-7-(3)	CASH FLOW STATEMENT (Case 4)	11-18
11-8-(1)	CASH FLOW STATEMENT (Case 5)	11-19
11-8-(2)	CASH FLOW STATEMENT (Case 5)	11-20
11-8-(3)	CASH FLOW STATEMENT (Case 5)	11-21
11-9-(1)	CASH FLOW STATEMENT (Case 6)	11-22
11-9-(2)	CASH FLOW STATEMENT (Case 6)	11-23
11-9-(3)	CASH FLOW STATEMENT (Case 6)	11-24

LIST OF FIGURES

		(Page)
a	Finalized Airport Master Plan	0-13
b	Short-term Development Plan Grade 1	0-14
c	Short-term Development Plan Grade 2	0-15
d	Short-term Development Plan Grade 3	0-16
1-1	THE ORIENTAL REPUBLIC OF URUGUAY	1-3
1-2	TRANSPORT SYSTEM IN URUGUAY	1-6
1-3	LOCATION OF AIRPORTS AND DOMESTIC AIR ROUTE	1-8
1-4	EXISTING AIRPORT LAYOUT	1-10
2-1	PUENTE AEREO PAX, GDP & FARE	2-4
2-2	OTHER INT PAX, GDP & FARE	2-4
2-3	DOMESTIC PAX, GDP & FARE	2-4
2-4	EXPORT CARGO & GDP	2-5
2-5	IMPORT CARGO & GDP	2-5
2-6	FORECASTING PROCEDURE OF AIR TRAFFIC DEMAND AT CARRASCO AIRPORT	2-7
2-7	TYPICAL TREND CURVES	2-8
2-8	INT. PAX (PUENTE AEREO)	2-12
2-9	INT. PAX (OTHER INT'L PAX)	2-14
2-10	DOM. PAX	2-15
2-11	EX. CGO	2-16

LIST OF FIGURES

		(Page)
2-12	IM. CGO	2-17
2-13	PUENTE AEREO PASSENGER	2-20
2-14	OTHER INT'L PASSENGER	2-21
2-15	DOMESTIC PASSENGER	2-24
2-16	EXPORT CARGO	2-26
2-17	IMPORT CARGO	2-27
3-1	EXISTING SURFACE LAYER	3-4
3-2	ORIGINAL CONSTRUCTION HISTORY	3-5
3-3	HISTORY OF OVERLAY WORKS	3-6
3-4	LOCATIONS OF TOPOGRAPHIC FIELD SURVEYS	3-10
3-5	LOCATIONS OF GEOLOGICAL AND PAVEMENT SURVEYS	3-11
3-6	SURFACE CONDITIONS OF PAVEMENT	3-15
3-7	PROCEDURES FOR ESTABLISHING LOAD-CARRYING CAPACITY OF EXISTING PAVEMENT	3-19
3-8	EXISTING PASSENGER TERMINAL BUILDING	3-27
3-9	EXISTING CARGO TERMINAL BUILDING	3-30
3-10	SCHEMATIC ACTUAL CARGO FLOW	3-31
3-11	ACTUAL STORED PERIOD OF IMPORT CARGO	3-32
3-12	EXISTING CAR FLOW AND LAYOUT OF CAR PARKS	3-35
3-13	EXISTING FUEL SUPPLY FACILITIES (located at military area)	3-38
3-14	EXISTING LOCATIONS OF RADIO NAVIGATION AIDS INSIDE THE AIRPORT	3-44

LIST OF FIGURES

		(Page)
3-15	EXISTING LOCATIONS OF RADIO NAVIGATION AIDS OUTSIDE THE AIRPORT	3-45
3-16	EXISTING AFTN SYSTEM CONFIGURATION	3-46
3-17	EXISTING DIRECT SPEECH SYSTEM CONFIGURATION	3-47
3-18	EXISTING LAYOUT OF VISUAL AIDS	3-50
3-19	DIAGRAM OF EXISTING MAIN SUBSTATIONS	3-52
3-20	THE RELATION BETWEEN RWY 24 ILS COURSE AND STANDARD TRAFFIC PATTERN OF ARTIGAS AERODROME	3-54
4-1	SIMULATED FLIGHT SCHEDULE (Year 1995)	4-8
4-2	SIMULATED FLIGHT SCHEDULE (Year 2000)	4-9
4-3	SIMULATED FLIGHT SCHEDULE (Year 2010)	4-10
4-4	CUMULATIVE CURVE OF PASSENGERS PER FLIGHT ENTERING THE CARRASCO AIRPORT PRIOR TO DEPARTURE FLIGHT (PUENTE AEREO)	4-12
4-5	CUMULATIVE CURVE OF PASSENGERS PER FLIGHT ENTERING THE CARRASCO AIRPORT PRIOR TO DEPARTURE FLIGHT (INTERNATIONAL FLIGHT)	4-13
4-6	HOURLY CAPACITY OF RUNWAY USE DIAGRAM NOS. 1,54 FOR IFR CONDITIONS	4-18
4-7	COMPARISON BETWEEN ACTUAL AND REQUIRED CAPACITIES (APRON)	4-27
4-8	COMPARISON BETWEEN ACTUAL AND REQUIRED CAPACITIES (PASSENGER TERMINAL)	4-29
5-1	AIRPORT LAYOUT PLAN (Year 2010) ALTERNATIVE A	5-5
5-2	AIRPORT LAYOUT PLAN (Year 2010) ALTERNATIVE B	5-6
5-3	FINALIZED AIRPORT MASTER PLAN	5-10
5-4	FINALIZED AIRPORT DEVELOPMENT PLAN PHASE 1 TARGET YEAR 1995	5-24



LIST OF FIGURES

		(Page)
5-5	FINALIZED AIRPORT DEVELOPMENT PLAN PHASE 2 TARGET YEAR 2000	5-25
5-6	PRELIMINARY CONCEPT OF INSTRUMENT APPROACH AND DEPARTURE PROCEDURES (RWY 06 OPERATION)	5-27
5-7	PRELIMINARY CONCEPT OF INSTRUMENT APPROACH AND DEPARTURE PROCEDURES (RWY 24 OPERATION)	5-28
5-8	PRELIMINARY CONCEPT OF INSTRUMENT APPROACH AND DEPARTURE PROCEDURES (RWY 01 OPERATION)	5-29
5-9	PRELIMINARY CONCEPT OF INSTRUMENT APPROACH AND DEPARTURE PROCEDURES (RWY 19 OPERATION)	5-30
6-1	DIMENSION OF NEW APRON (S-7)	6-7
7-1	ORGANIZATION CHART OF DINACIA	7-2
7-2	ORGANIZATION CHART OF DGIA	7-3
8-1	PROJECT DEVELOPMENT SCHEDULE	8-3
8-2	CONSTRUCTION SCHEDULE OF AIRFIELD FACILITIES	8-10
8-3	CONSTRUCTION STAGE 1 (Early of 1991)	8-11
8-4	CONSTRUCTION STAGE 2 (Last Half of 1991)	8-12
8-5	CONSTRUCTION STAGE 3 (Early of 1992)	8-13
8-6	CONSTRUCTION STAGE 4 (1992)	8-14
8-7	CONSTRUCTION STAGE 5 (Early of 1993)	8-15
8-8	CONSTRUCTION STAGE 6 (Middle of 1993)	8-16
8-9	CONSTRUCTION STAGE 7 (End of 1993 and 1994)	8-17
8-10	CONSTRUCTION SCHEDULE OF TERMINAL AREA FACILITIES	8-19



CONCLUSION

AND

SUMMARY

## CONCLUSIONS AND SUMMARY

### 1. CONCLUSIONS

- 1-1. The results of the Study reveal that many of the Airport's airfield and air navigation facilities suffer deterioration due to age, possibly bringing about enforced closure of the airport to international traffic, and posing serious operational safety problems in the near future, unless corrective measures are taken urgently. Since it is the only international airport in Uruguay, its improvement to international operational standards should be the utmost concern of the country. It is, therefore, strongly recommended that the Project, at least in Grade 3, be implemented as early as possible, making every effort to find some means of financing
- 1-2. No significant technical difficulty is anticipated in the implementation of the Project, and no problem should arise for nighttime construction,
- 1-3. The Project is economically feasible, in either Grade 1\*, Grade 2\*\* or Grade 3\*\*\*, since the economic internal rates of return (EIRR) are 16.1%, 17.5%, and 19.9% respectively, while the "Opportunity Cost of Capital" in Uruguay is understood to be 12%.
- 1-4. The financial internal rate of return (FIRR) shows a negative value for the Project, in all cases of Grade 1, Grade 2, and Grade 3.

It is concluded that the Project is not financially feasible under the current airport tariff structure if the Airport is to continue to run on a self-supporting accounting principle.

- 1-5. However, with 100% revenue increase in Grade 2 and Grade 3, the FIRR is raised to a positive value of 5.7% and 7.7% for the Project.
- 1-6. It can therefore be anticipated that Short-term Development may be implemented either in Grade 2 or Grade 3, depending on the financial arrangement obtainable.

- 1-7. In case of Grade 2, Short-term Development may be implemented under the new airport tariff by obtaining a foreign soft loan for the foreign portion, and the Government's own financing for the local portion without any repayment.
- 1-8. In case of Grade 3, Short-term Development may be implemented under the new airport tariff by obtaining a foreign hard loan for the foreign portion, and the Government's own financing for the local portion without any repayment.

\*, \*\*, \*\*\*;

Grade 1: This plan corresponds to the projected size and volume of facilities in full as required by D.G.I.A. (See Finalized facility requirements in Chapter 5.)

Grade 2: This plan excludes RWY 01/19 extension and upgrading to ILS CAT-I runway.

Grade 3: This plan represents the minimum projected size and volume of facilities to enable Carrasco airport to operate as the only international airport in Uruguay.

2. SUMMARY

2-1. Forecast of Future Air Traffic Demand

Forecast is made for the period of 15 years from 1995 to 2010 at the interval of every 5 years based on the elasticity values method obtained by analyzing relationship with GDP and air fare.

The result is shown in Table A.

Table A Summary of Forecasted Air Traffic Demand at Carrasco International Airport

Item of Forecast		Year					
		1988	1995	2000	2005	2010	
Passenger (1000 persons)	Int'l	Puente Aereo	337	498	572	656	752
		Other Int'l	301	448	604	814	1,098
		Domestic	43	48	50	53	55
		Total	681	994	1,226	1,523	1,905
Freight (cargo) ton	Int'l	Export	7,042	10,843	14,310	18,886	24,925
		Import	5,263	10,522	16,127	24,719	37,887
		Total	12,305	21,365	30,437	43,605	62,812
Aircraft Movement	Int'l	Puente Aereo	4,320	6,385	7,330	-	8,000
		Other Int'l	4,700	6,400	8,390	-	11,437
		Domestic	2,870	3,200	3,335	-	3,240
		Total	11,890	15,985	19,055	-	22,677

## 2-2. Facility Requirements

Facility requirements are analyzed taking into consideration the latest applicable standards for this Project, and recommended practices of ICAO, IATA, FAA and CAB of Japan, in accordance with the basic data, such as design year, longest route, peak factors, aircraft mixture, and simulated flight schedule that have been derived from the forecast of air traffic demand for 1995, 2000, and 2010. The result is shown in Table B.

Table B-1 Summary of Facility Requirements for Grade 1

Facility		Short-term Development 1995 urgent		Long-term Development 2010	
Airfield Facilities	Runway Length (m)				
	1. 06/24	2,700	2,700	3,100	
	2. 01/19	1,750	2,050	2,050	
	3. 10/28	(1,700)	(1,700)	(1,700)	
	pavement				
	1. 06/24	should be reinforced	-		depend on
	2. 01/19	should be reinforced	-		the conditions
	3. 10/28	(as is)	(as is)		of TWY A parallel
	Taxiway System	should be reinforced (except TYW-C1)	-		
	Apron	12	16	18	
	parking positions	4			
	parking system	as is	mixed: taxi-in, push-out and taxi-in, taxi-out	taxi-in, push-out	
Terminal Area Facilities	Passenger Terminal	as is	as is	should be modified and expanded to 22,000 m <sup>2</sup>	
	Cargo Terminal	as is	as is	should be expanded to 6,415 m <sup>2</sup>	
	container and pallet work station	4,620 m <sup>2</sup>	4,620 m <sup>2</sup>	-	
	G.S.E. Building	should be reconstructed open shed only should be reconstructed	360 m <sup>2</sup>		
Air Nav. Facilities	Radio Nav.	3,000 m <sup>2</sup>	3,000 m <sup>2</sup>		
		CAT-I ILS	CAT-I ILS	CAT-I ILS	
		---	CAT-I ILS	CAT-I ILS	
	Visual aids	ALS SALS	ALS SALS	ALS SALS	
	SALS	ALS SALS	ALS SALS		
	---	---	---		
	10/28	PAPI	PAPI		
	Each	To be renewed		ASR/SSR should be AFTN renewed	



Table B-2 Summary of Facility Requirements for Grade 2

Facility		Short-term Development 1995 urgent	Short-term Development 2000	Long-term Development 2010
Airfield Facilities	Runway Length (m)			
	1. 06/24	2,700	2,700	3,100
	2. 01/19	1,750	1,750	1,750
	3. 10/28 pavement	(1,700)	(1,700)	(1,700)
	1. 06/24	should be reinforced	-	depend on
	2. 01/19	should be reinforced	-	the conditions
	3. 10/28	(as is)	(as is)	TWY A parallel
	Taxiway System	should be reinforced (except TWY-C1)	-	
	Apron	12	16	18
	parking positions	4		
	parking system	as is	mixed: taxi-in, push-out and taxi-in, taxi-out	taxi-in, push-out
Terminal Area Facilities	Passenger Terminal	as is	as is	should be modified and expanded to 22,000 m <sup>2</sup>
	Cargo Terminal	16,000 m <sup>2</sup>	16,600 m <sup>2</sup>	should be expanded to 6,415 m <sup>2</sup>
	container and pallet work station	as is	as is	-
	G.S.E. Building	should be constructed open shed only should be reconstructed	should be constructed 360 m <sup>2</sup>	
		3,000 m <sup>2</sup>	3,000 m <sup>2</sup>	
Air Nav. Facilities	Radio Nav.	CAT-I ILS	CAT-I ILS	CAT-I ILS
		---	---	---
	Visual aids	ALS SALS SALS	ALS SALS SALS	ALS SALS SALS
		---	---	---
	Radar & Communication	PAPI	PAPI	PAPI
		To be renewed		ASR/SSR should be AFTN renewed

Table B-3 Summary of Facility Requirements for Grade 3

Facility		Short-term Development		Long-term Development
		1995 urgent	2000	2010
Airfield Facilities	Runway Length (m)			
	1. 06/24	2,700	2,700	3,100
	2. 01/19	1,750	1,750	1,750
	3. 10/28	(1,700)	(1,700)	(1,700)
	pavement			
	1. 06/24	should be reinforced	-	depend on
	2. 01/19	(as is)	-	the conditions
	3. 10/28	(as is)	(as is)	TYW A parallel
	Taxiway System	should be reinforced	-	
	(except TYW-C1)			
Apron parking positions	existing	12	16	18
	new	4		
	parking system	as is	mixed: taxi-in, push-out and taxi-in, taxi-out	taxi-in, push-out
	new	taxi-in, push-out		
Terminal Area Facilities	Passenger Terminal	as is	as is	should be modified and expanded to 22,000 m <sup>2</sup>
	Cargo Terminal	16,000 m <sup>2</sup>	16,600 m <sup>2</sup>	should be expanded to 6,415 m <sup>2</sup>
	container and pallet work station	as is	as is	-
	G.S.E. Building	4,620 m <sup>2</sup>	4,620 m <sup>2</sup>	
		should be constructed open shed only should be reconstructed	should be constructed 360 m <sup>2</sup>	
Air Nav. Facilities	Radio Nav.	3,000 m <sup>2</sup>	3,000 m <sup>2</sup>	
	Visual aids	CAT-I ILS	CAT-I ILS	CAT-I ILS
	06/24	----	----	----
	01/19	----	----	----
	10/28	----	----	----
Radar & Communication	Each	ALS SALS	ALS SALS	ALS SALS
	06/24	----	----	----
	01/19	----	----	----
	10/28	----	----	----
	To be renewed	PAPI	PAPI	ASR/SSR should be AFTN renewed

2-3. Short-term Development Plan (1995 & 2000)

Table C presents the summary of the improvement measures for Short-term Development of the Project.

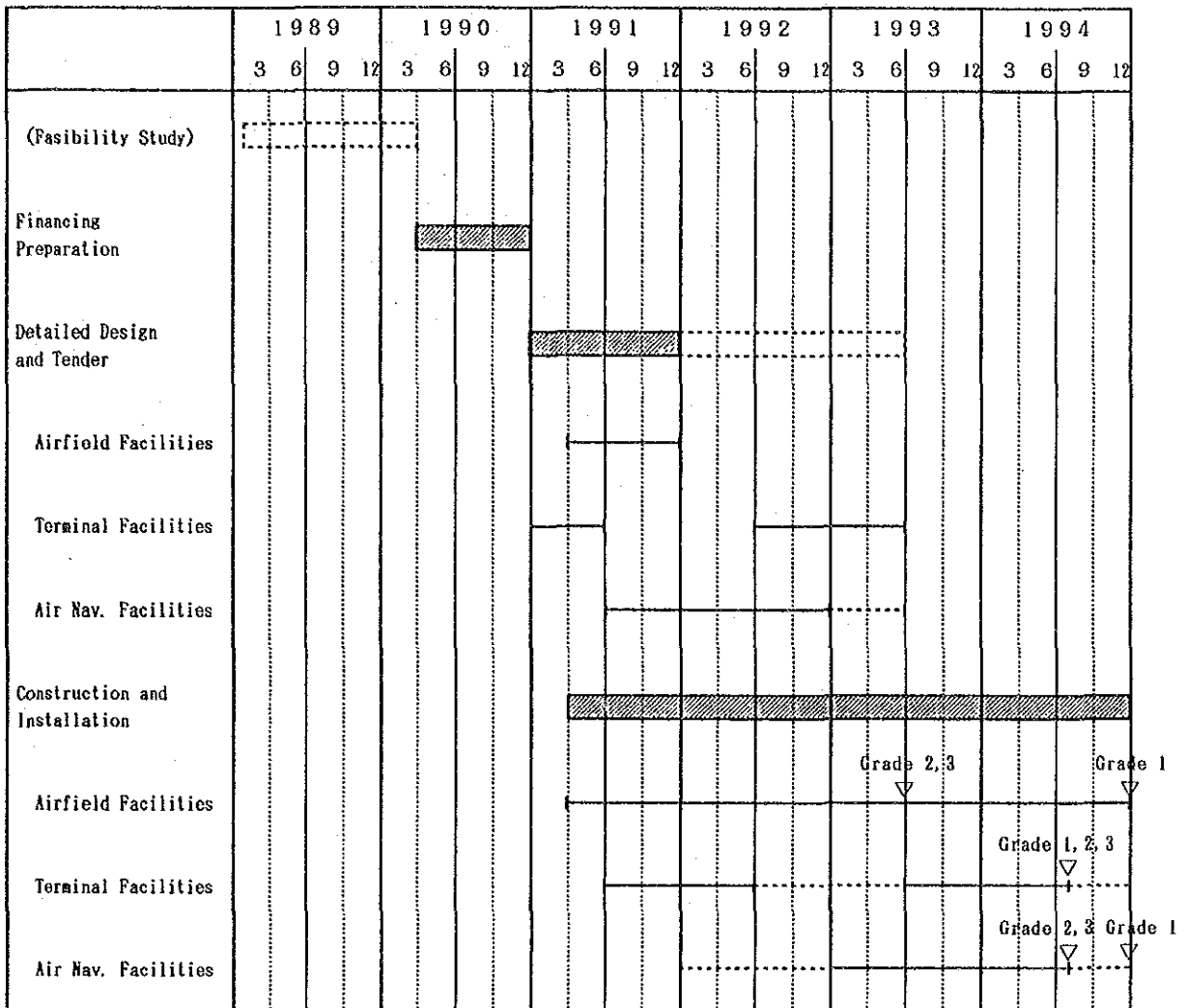
Table C Summary of Improvement Measures for Short-term Development (1995 & 2000)

Facility	1995 (urgent phase)	2000
Runway 06/24 (Primary)	<ul style="list-style-type: none"> <li>- Reinforcement to accommodate B747-400 and extension of R/W strip (to 300 m).</li> <li>- Reconstruction of shoulders</li> </ul>	--
01/19	<ul style="list-style-type: none"> <li>- Reinforcement to accommodate B737 in case of Grade 1 and 2.</li> </ul>	<ul style="list-style-type: none"> <li>- Extension (1750 -- 2050) in case of Grade 1.</li> </ul>
Taxiway A, B, C2, D.	<ul style="list-style-type: none"> <li>- Reinforcement to accommodate B747-400</li> </ul>	
Apron	<ul style="list-style-type: none"> <li>- Reconstruction: S-4, S-5, S-6</li> <li>- Repairs: S-1, S-2, S-3</li> <li>- Construction of new apron two for B747-400 two for B707 or B767</li> </ul>	<ul style="list-style-type: none"> <li>- Reinforcement: S-3</li> </ul>
Passenger Terminal	<ul style="list-style-type: none"> <li>- Install X-ray and metal detector</li> </ul>	<ul style="list-style-type: none"> <li>- Modification of central building</li> <li>- Install one baggage claim</li> </ul>
Cargo Terminal	<ul style="list-style-type: none"> <li>- Construction of open shed</li> </ul>	<ul style="list-style-type: none"> <li>- Install "work station"</li> <li>- Modification of existing building</li> <li>- Provide cold storage</li> </ul>

Facility	1995 (urgent phase)	2000
Other Buildings	- Reconstruction of G.S.E. building	
Radio Nav.	- Renew ILS equipment for RWY 24 and terminal VOR/DME	- Install two (2) VOR/DME and one (1) NDB.
ATC	- Renew VFR and VHF air-to-ground equipment	- Install ILS equipment for RWY 19 in case of Grade 1.
Communications	- Renew HF stations	
Meteorological	- Renew equipment - Install RVR system	
Electrical Power Supply	- Install new equipment with station	
Visual Aids	- Install ALS for RWY 24 and SLAS for RWY 06  - Renew and install lights for RWY 06/24, TWYs A, B, C2, D.  - Renew aerodrome beacon and apron flood-lights  - Install PAPI, SALS and other lights for RWY 01/19 in case of Grade 1 and 2.	- Install ALS for RWY 19 in case of Grade 1.

2-4 Project Schedule and Construction Cost Estimate

Project schedule for Short-term Development is established as shown in the following chart:



Construction cost for Short-term Development is estimated as tabulated in Table D.

\*, \*\*, \*\*\*;

Grade 1: This plan corresponds to the projected size and volume of facilities in full as required by D.G.I.A. (See Finalized facility requirements in Chapter 5)

Grade 2: This plan excludes RWY 01/19 extension and upgrading to ILS CAT-I runway.

Grade 3: This plan represents the minimum projected size and volume of facilities to enable Carrasco airport to operate as the only international airport in Uruguay.

Table D Summary of Construction Cost Estimate

(US\$ Thousand)

Item	Grade 1			Grade 2			Grade 3		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
1. Airfield Facilities	5,570	28,110	33,680	5,330	23,820	29,150	4,390	20,990	25,380
2. Terminal Area Facilities	1,887	2,182	4,069	1,887	2,182	4,069	1,887	2,182	4,069
3. Air Navigation Facilities	17,433	2,596	20,029	15,349	2,252	17,601	11,872	1,864	13,736
Sub-total	24,890	32,888	57,778	22,566	28,254	50,820	18,149	25,036	43,185
4. Engineering Services	1,245	1,645	2,890	1,128	1,412	2,540	908	1,252	2,160
5. Physical Contingency	2,614	3,453	6,067	2,370	2,967	5,337	1,907	2,629	4,536
Grand Total	28,749	37,986	66,735	26,064	32,633	58,697	20,964	28,917	49,881

Based on exchange rates as of April 1989: US\$ 1.00 = Peso 500

## 2-5. Economic and Financial Evaluation

### 2-5-1 Economic Evaluation

The economic cost-benefit analysis based on the cash flow of the economic costs and the direct tangibles of the economic benefits identified from the viewpoint of national economy indicates an economic internal rate of return (EIRR) of 16.1% for the Grade 1, 17.5% for the Grade 2, and 19.9 for the Grade 3. These values, therefore, indicates that the Carrasco International Airport Development Project is economically feasible from the viewpoint of the national economy of Uruguay, since the opportunity cost of capital of the country is understood to be 12.0%.

### 2-5-2 Financial Evaluation

The financial cost-benefit analysis based on the cash flow of the financial cost and financial benefits indicates a financial internal rate of return (FIRR) in negative value in all cases of Grade 1, Grade 2, and Grade 3 under the current airport tariff structure.

To obtain a higher FIRR value it is necessary either to reduce the financial costs, especially the initial construction cost, or to increase the airport revenues. It would be impractical to expect any reduction in the construction cost. On the other hand, in order to increase the revenue, airport tariffs should be raised above the current level.

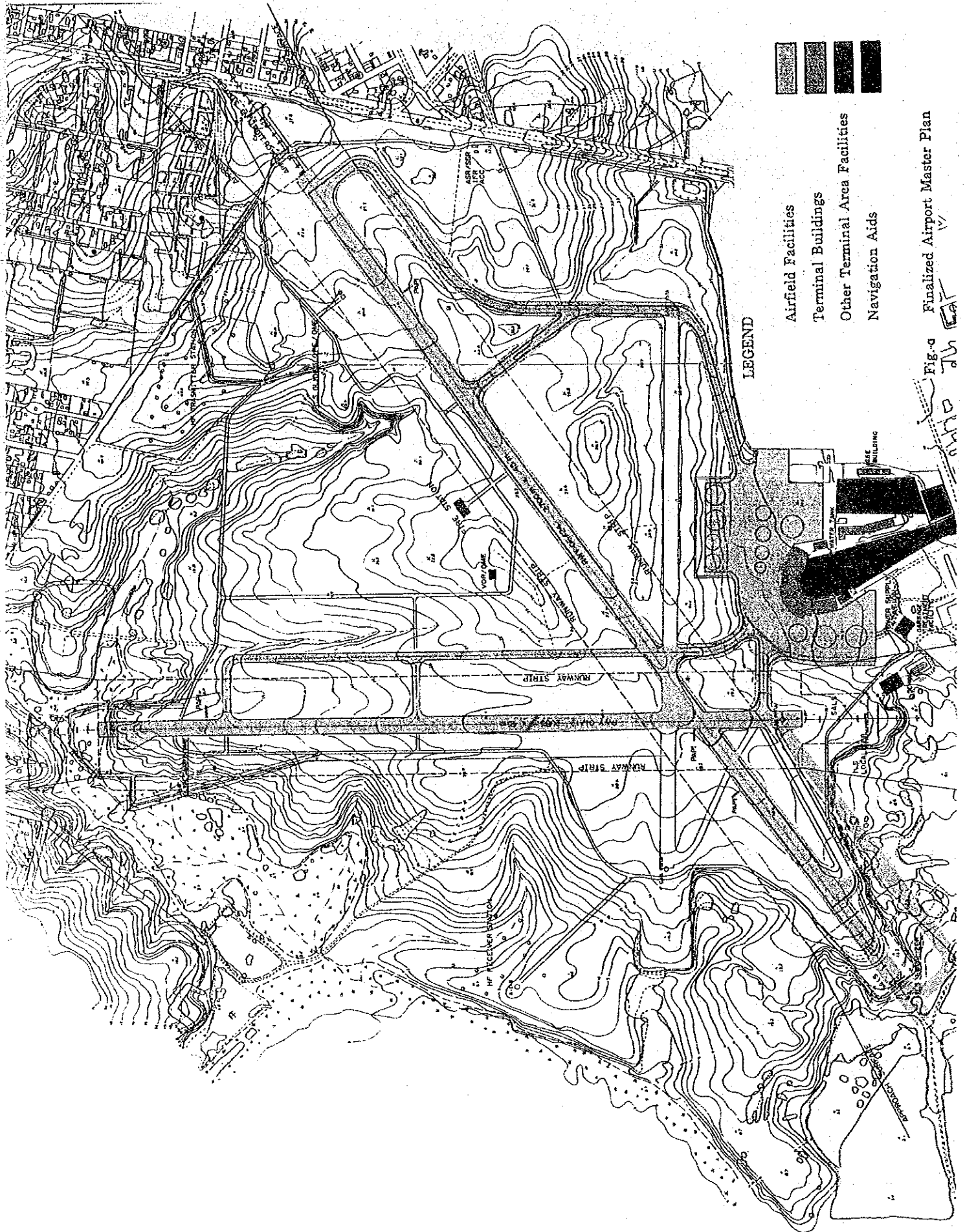
The level of the current airport tariff of Carrasco Airport is very low compared with those of the neighbouring countries.

If the tariff were raised to 100% of the current level, the FIRR either in Grade 2 or Grade 3 would yield 5.7% or 7.7%.

The Short-term Development may therefore be implemented either in Grade 2 or Grade 3, depending on the financial arrangement obtainable.

In case of Grade 2, Short-term Development may be implemented under the new airport tariff by obtaining a foreign soft loan for the foreign portion, and the Government's own financing for the local portion without any repayment.

In case of Grade 3, Short-term Development may be implemented under the new airport tariff by obtaining a foreign hard loan for the foreign portion, and the Government's own financing for the local portion without any repayment.



LEGEND





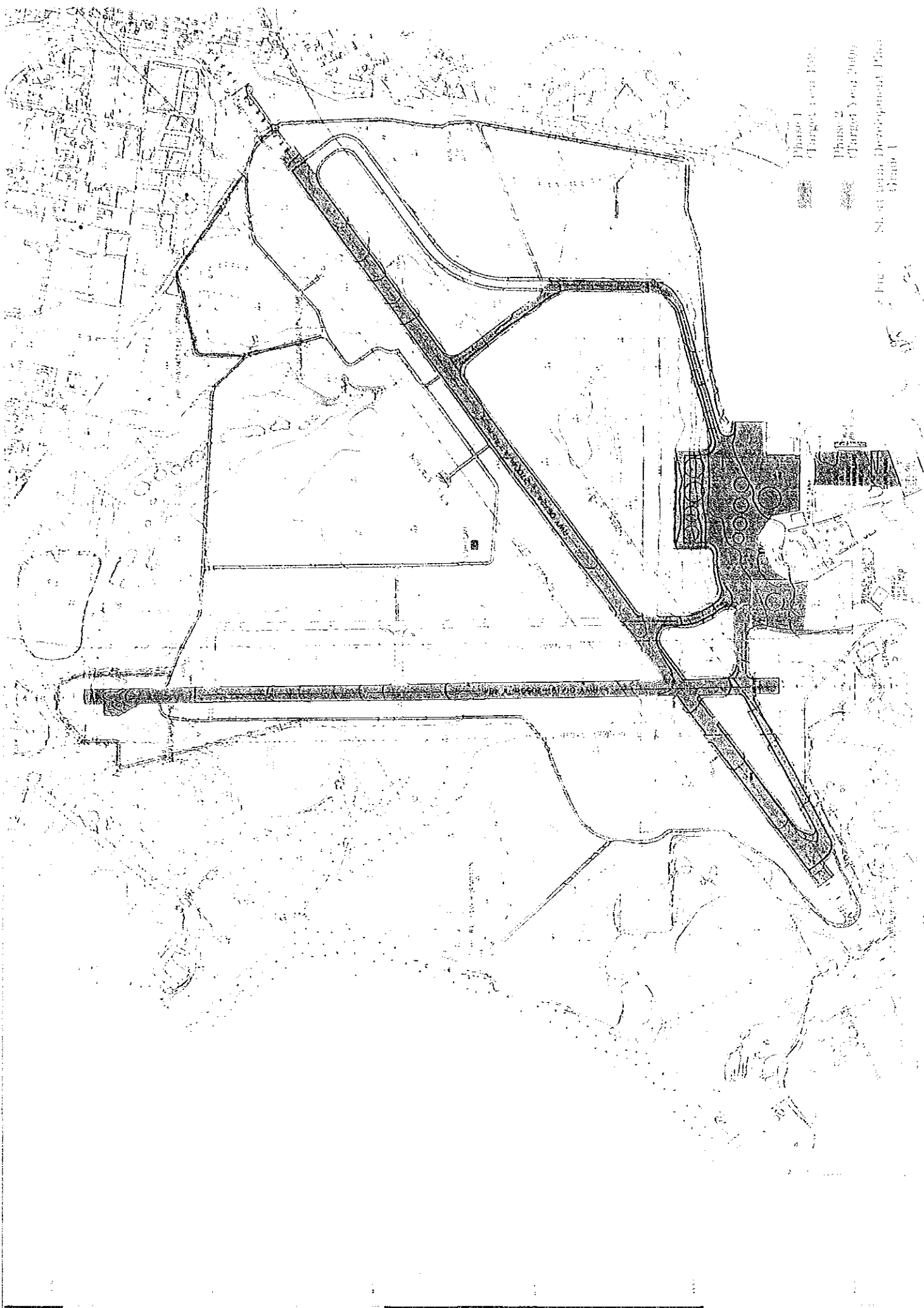
-  Airfield Facilities
-  Terminal Buildings
-  Other Terminal Area Facilities
-  Navigation Aids

Fig. 9 Finalized Airport Master Plan









Phase 1  
Target Year 1990

Phase 2  
Target Year 2000

Phase 3  
Target Year 2010

Phase 4  
Target Year 2020

Phase 5  
Target Year 2030

Phase 6  
Target Year 2040

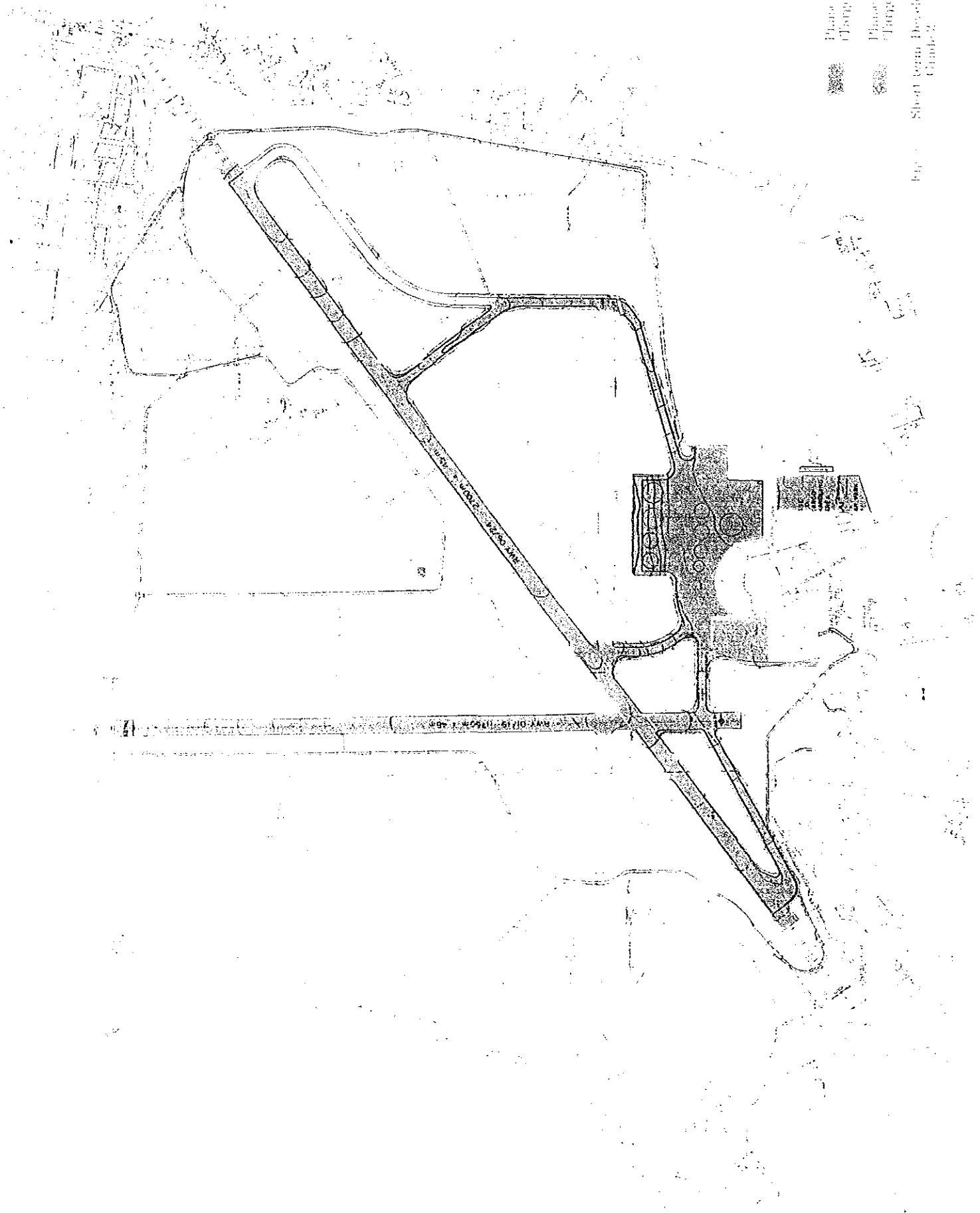
Phase 7  
Target Year 2050

Phase 8  
Target Year 2060

Phase 9  
Target Year 2070

Phase 10  
Target Year 2080





Phase 1  
 Target Year 2016  
 Phase 2  
 Target Year 2020  
 Fig. 1 Short term Development Plan  
 Clunder



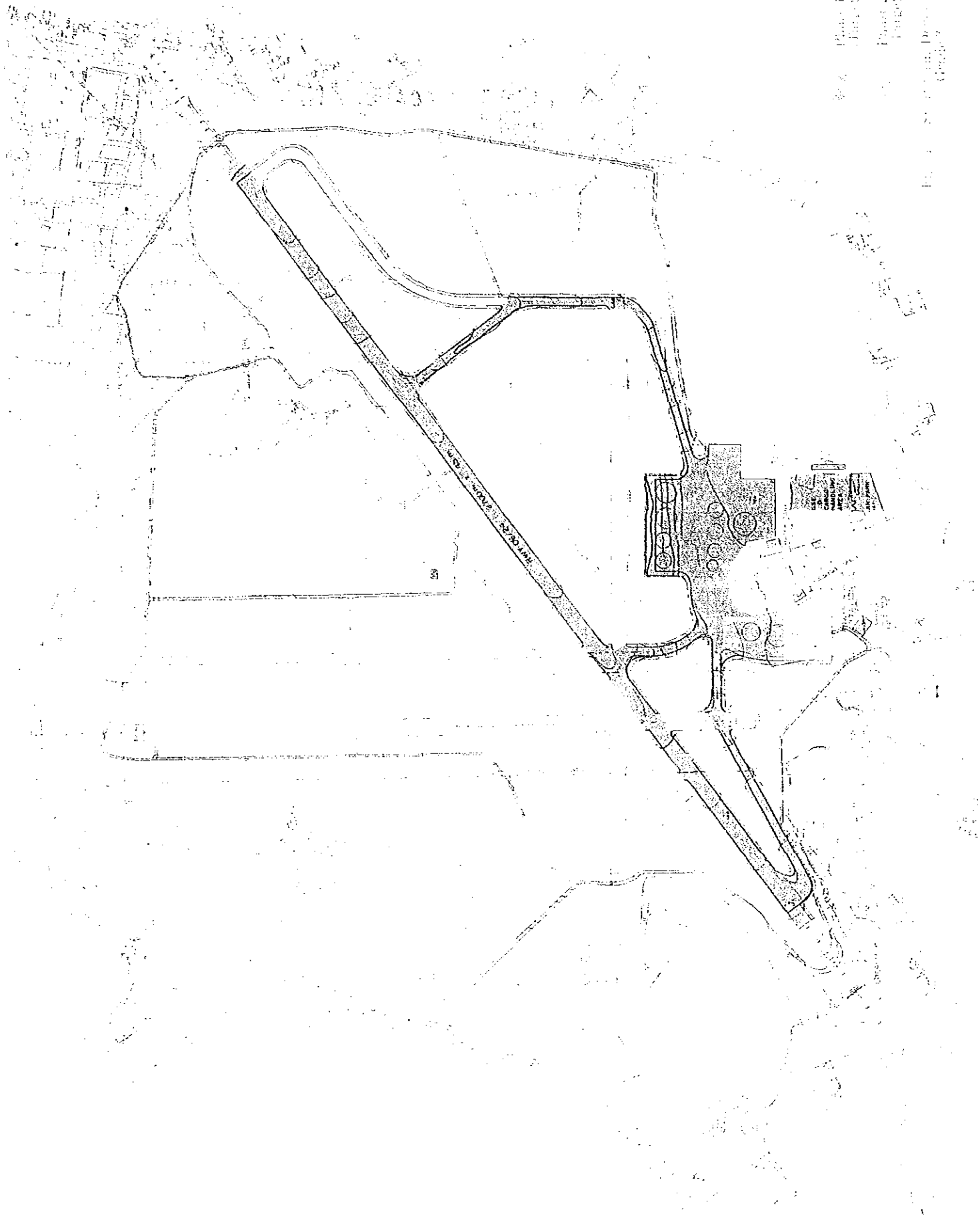


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U.S. PATENT OFFICE  
WASHINGTON, D.C. 20540

## **CHAPTER 1**

### **BACKGROUND OF PROJECT**



## 1-1. Introduction

### 1-1-1 Background

Oriental Republic of Uruguay is an agricultural country in south-eastern part of the South American Continent. It is bounded on the east by the Atlantic Ocean, and on the north by Brazil and on the west by Argentina.

Carrasco International Airport handles most of the country's air passengers and air cargo as the main gateway of the country, and serves 21 international air routes with 11 countries.

The airport was opened in 1947, but its facilities are physically getting old and outdated today, especially in respect of its runway and taxiway pavements, and navigational aids and telecommunication facilities except passenger terminal building which were recently expanded and modified. Furthermore, due to the recent increase in air traffic caused by the introduction of wide-body aircraft, functional relation between passenger terminal building and passenger loading apron in particular is beginning to show inadequacy.

Under these circumstances, the Government has given a high priority to the Carrasco International Airport Development Project, so as to enable safe and efficient operation for wide-bodied aircraft. In response to the request of the Government of Uruguay to conduct a feasibility study for the Project, the Japan International Cooperation Agency (hereinafter referred to as JICA) sent a preliminary survey mission to Uruguay in November 1988 to define the Project; and the Scope of Work for the feasibility study was agreed upon between the Oficina de Planeamiento y Presupuesto and the JICA Mission.

## 1-1-2 Objective and Scope of the Study

### (1) Objectives

The objectives of the study are:

- 1) to formulate the Master Plan for long-term development of Carrasco International Airport; and
- 2) to evaluate technical, economical and financial feasibility for the short-term development of Carrasco International Airport, so as to facilitate the optimum planning of the project to ensure safe and efficient operation of wide-bodied aircraft; and
- 3) to pursue technology transfer to Uruguayan Government personnel in the course of the Study.

### (2) Scope of the Study

For the purpose of achieving the objectives mentioned above, the Study will include the following tasks:

- 1) Evaluation of Existing Situation
  - Review of available data and information relevant to the Study;
  - Supplementary field surveys; and
  - Evaluation of Existing facilities and their use.
- 2) Development to the Airport Master Plan  
Appropriate Master Plan will be prepared for the target year 2010; it will consist of:
  - Forecast of future air transport demand;
  - Demand and capacity analysis;
  - Analysis of facility requirements;
  - Airport layout planning;
  - Preparation of airport development plans in various grades and
  - Preparation of preliminary cost estimates.
- 3) Feasibility Study  
Feasibility Study will be conducted for Short-term Development Plan for the target year 1995, as a urgent development, and 2000 within the framework of Master Plan. It will include:
  - Finalized facility requirement;
  - Preliminary design;
  - Cost estimate;
  - Construction schedule;
  - Economic analysis;
  - Financial analysis;
  - Preparation of project implementation programme;
  - Airport management and operation plan; and
  - Staff training programme.

1-2. Socio-economic Situation

1-2-1 Geographical Situation

The Oriental Republic of Uruguay is bordered by Argentina in the west and Brazil in the east. It lies between 30° - 35° degrees south latitude, and between 53° - 58° degrees west longitude as shown in Fig. 1-1.

The total area of the country is approximately 176,000 sq.km, almost all of large wide plains.

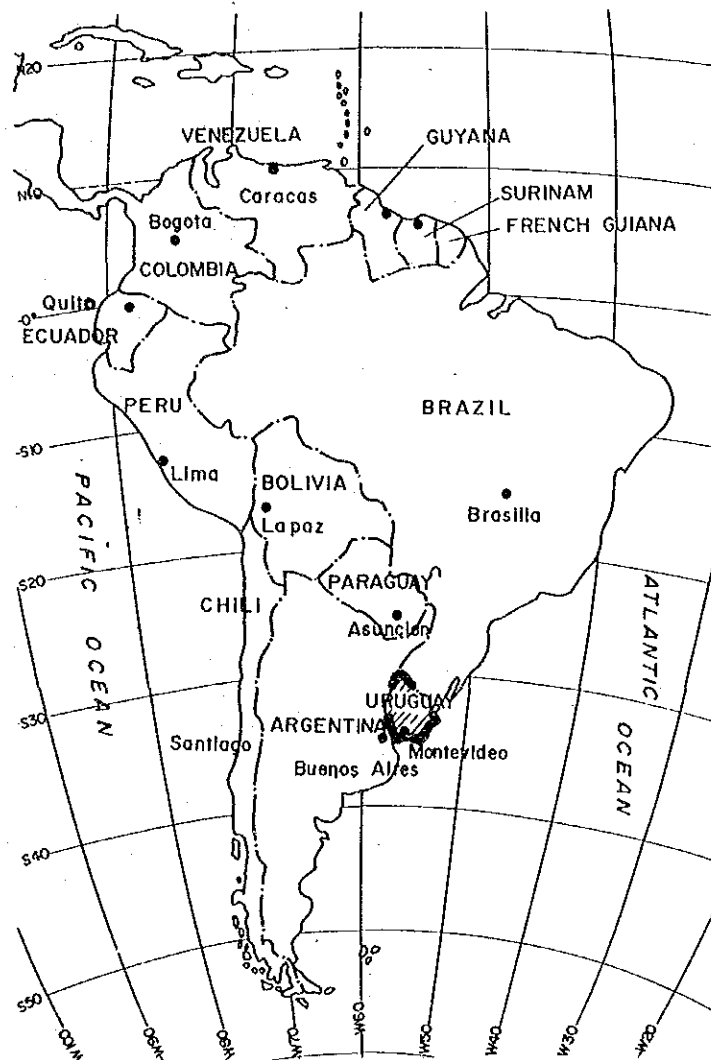


Fig. 1-1 THE ORIENTAL REPUBLIC OF URUGUAY

### 1-2-2 Social Situation

Uruguay has become independent in 1828 from Brazil. Uruguay has become the first social welfare country in 1903 among the Latin American countries.

The population of the country is now approximately 3,035,000 (1986), and live on export of wine and agricultural products such as meat, wheat, rice, wool, and fish.

It boasts of high literacy based on enhanced educational and cultural standards, supported by well-established social security system.

### 1-2-3 Economic Development of the Country

The Gross National Product is estimated to have increased by 0.6 percent annually in constant prices during 1976-1986 and the current GNP per capita was estimated at US\$1860 in 1986.

Agriculture is the dominant industry in the country, accounting for 11 percent in GNP, and occupies together with agriculture-related industry nearly all of its total exports.

For the economic development of the nation, the Government has adopted the following objectives in the Economic Reactivation Plan of 1986:

- to increase export of domestic products;
- to decrease financial deficit; and
- to alleviate the structural inflation.

### 1-3. Transport System

The transport system of the country consists of road, air, rail and water transports. However, among those modes of transport, air transport plays a very significant role in the carriage of passengers: 320 million pax-km in 1984, while the railway transport achieved only 3.4 million pax-km in 1981. Fig. 1-2 shows transport system in Uruguay.

The Government has placed considerable emphasis on the development of aviation industry in recent years. Air services are expected to take an increasing share as they can offer fast point-to-point services to such neighbouring countries as Brazil, Argentina and the United States of America.

Air services have also played an important role in the development of tourism. Although foreign tourists numbered 620,000 in 1983, with tourism revenue of US\$150 million, the future demand is obviously promising with beautiful beaches along the coast and old European-style towns with ethnic atmosphere attracting a greater number of tourists not only from the South American countries but also from North America and Europe.

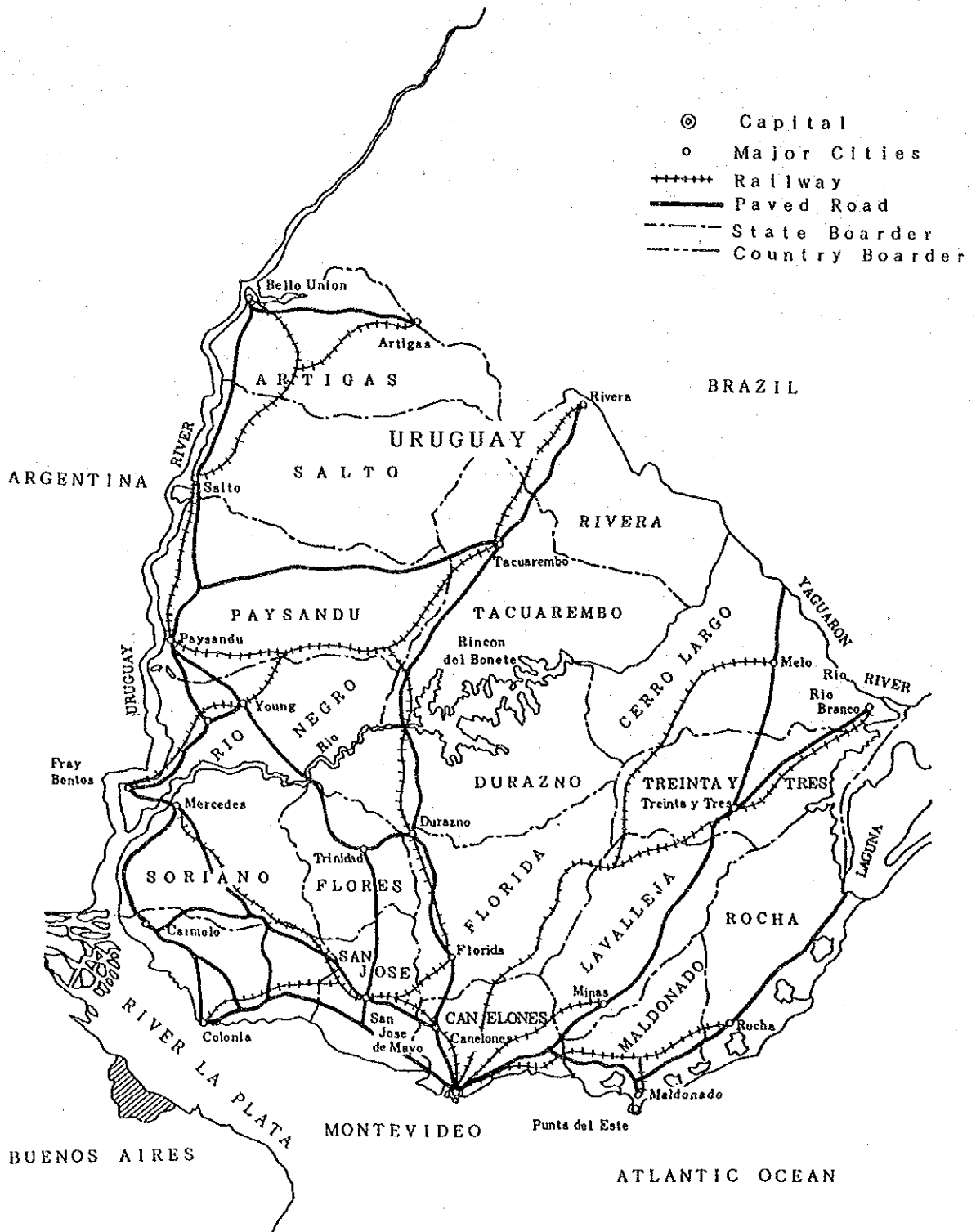


Fig. 1-2 TRANSPORT SYSTEM IN URUGUAY

#### 1-4. Air Transport System in Uruguay

International commercial scheduled air operation are being carried out by PLUNA (Primeras Lineas Uruguayas de Navegacion Aerea), a state owned company, and domestic air transport is provided by TAMU (Transportes Aereos Militares Uruguayos).

There are 23 airports; 12 are classified as international, 3 as national, and the rest as small airstrips. Four airports in the tourism corridor (Carrasco, C.A. Curbelo, Colonia and Laguna del Sauce) handle over 90 percent of the country's passenger traffic.

The most important airport is Carrasco located near Montevideo. It was designed in 1947 to meet the traffic conditions and using the equipment available at that time. It is a main international gateway airport of Uruguay.

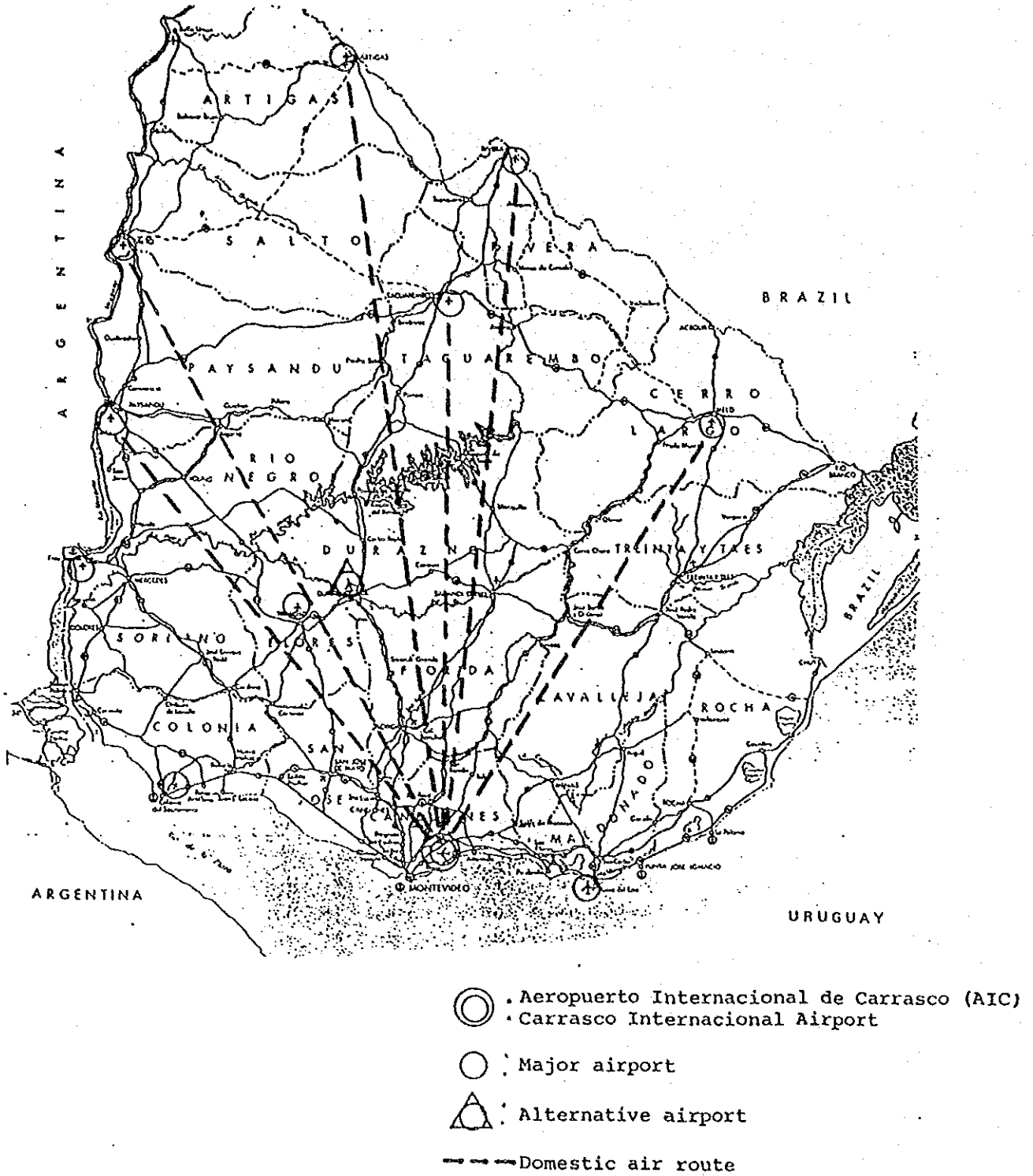
Carrasco Airport has only six domestic air routes (Paysandu, Salto, Artigas, Rivera, Melo and Tacuarembó). Apart from this hub-and-spoke services, there are no services between the local airports.

Air transport has developed slowly in Uruguay, principally because of the concentration of population in the Montevideo area, the country's favourable topography resulting in abundance of surface transportation and short distance involved. International traffic totalled about 638,000 passengers at Carrasco in 1988.

More than half of the international passengers were travellers in the River "Rio de La Plata".

Fig. 1-3 shows the location of international and major domestic airports in Uruguay, and 6 domestic air routes.

Fig. 1-3 LOCATION OF AIRPORTS AND DOMESTIC AIR ROUTE





1-5. Carrasco International Airport

Carrasco International Airport is located 25 km southeast of the center of Montevideo city in line with the Rio de la Plata.

The airport was opened in 1947. Existing layout of the airport is as shown in Fig. 1-4.

The airport facilities, however, are physically getting old and outdated today, especially in respect of its runways and taxiways pavements, and navigational and telecommunication facilities. Furthermore, due to the recent increase and qualitative evolution of air traffic caused by the introduction of wide-body jet aircraft such as DC-10, Conventional B747 and B747-400, functional relation between terminal building and loading apron in particular is beginning to show inadequacy.

The airport handled 338 thousand puente aereo (air shuttle) passengers, 300 thousand other international passengers, totaling 638 thousand international passengers, and 43 thousand domestic passengers in 1988, and is now served by, besides the national flag carrier of PLUNA, and the other foreign carriers.

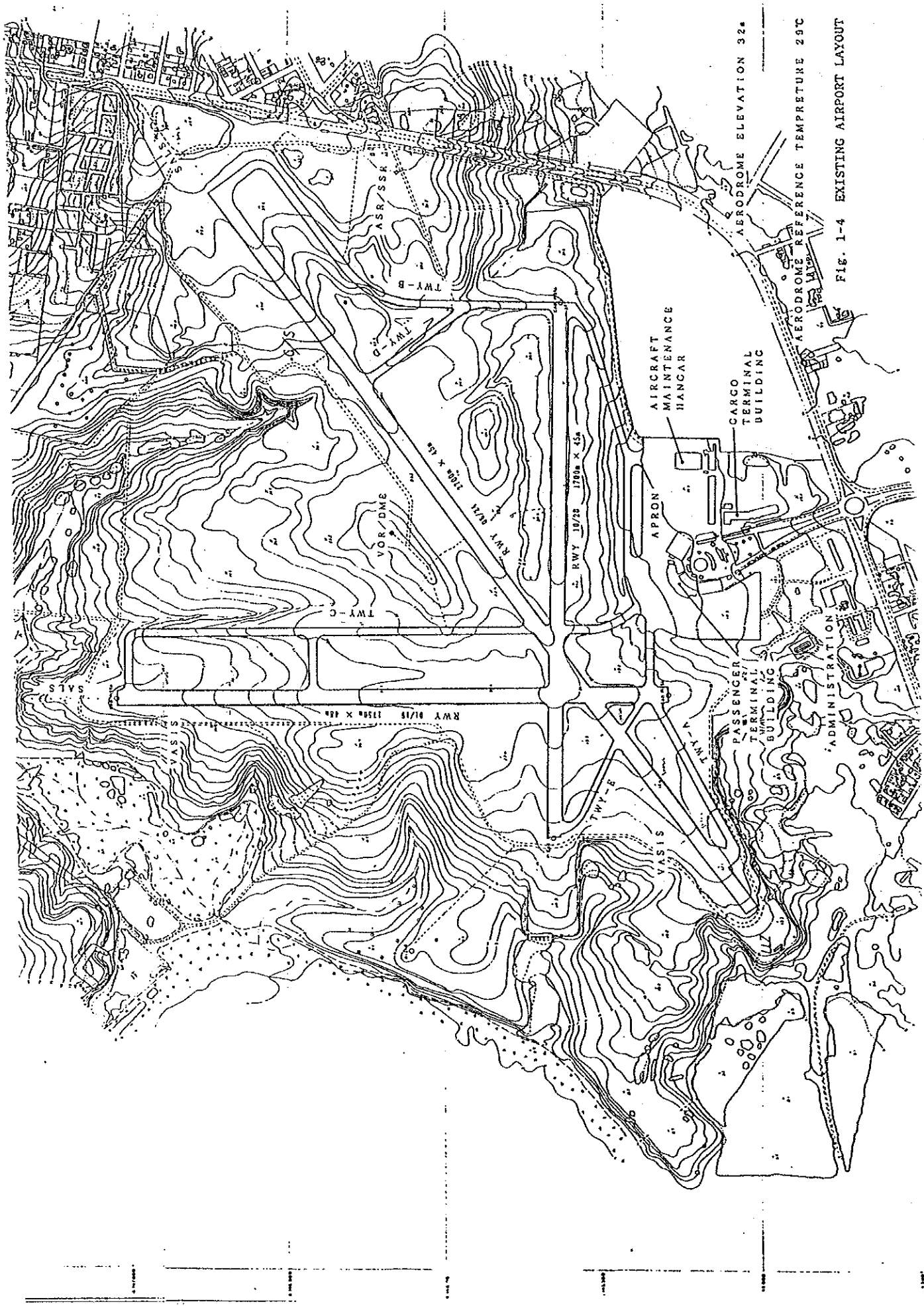


FIG. 1-4 EXISTING AIRPORT LAYOUT

CHAPTER 2

FORECAST OF FUTURE AIR

TRAFFIC DEMAND

## 2-1 The Present Air Traffic Demand at Carrasco

### 2-1-1 International Passenger

International passenger traffic increased steadily during the three years after 1985. The number of international passengers was 638,000 in 1988 while it was 458,000 in 1985. Between 1985 and 1988, international passenger increased at an average annual growth rate of 11.7%. The passengers consisted of 53% (337,674) on Puente Aereo and 47% (300,667) on other international flights. (Table 2-1)

#### (1) Puente Aereo Passenger

In 1985, 278,556 passengers were handled. Between 1985 and 1988, number of passengers increased at an average annual growth rate of 6.6%. (Fig. 2-1)

#### (2) Other International Passenger

In 1985, 179,827 passengers were handled. Between 1985 and 1988, number of passengers increased at an average annual growth rate of 18.7%. (Fig. 2-2)

### 2-1-2 Domestic Passenger

Domestic passenger traffic has decreased during the last four years. The number of passengers handled in 1984 was 56,700, while it was 43,200 in 1988, an average decline of 7.0 percent a year. Carrasco has six domestic air routes. Among them, Rivera and Salto are important routes, representing 30% and 28% respectively of total domestic passenger traffic in 1988 (Artigas 15%, Paysandu 12%, Melo 12% and Tacuarembó 3%). (Fig. 2-3)

### 2-1-3 International Cargo.

After 1984, international air cargo traffic has increased. About 8,500 tons of air cargo were handled in 1984, while 12,300 tons were handled in 1988, showing a yearly average increase of 9.7 percent.

#### (1) Export Cargo

Export cargo handled in 1984 was 5,078 tons, while 7,042 tons were handled in 1988. Between 1984 and 1988, export cargo increased at an average annual rate of 8.5%. (Fig. 2-4)

#### (2) Import Cargo

Import cargo handled in 1984 was 3,409 tons, while 5,263 tons were handled in 1988. Between 1984 and 1988, export cargo increased at an average annual rate of 11.5%. (Fig. 2-5)

### 2-1-4 Domestic Cargo

There is no domestic air cargo transport in Uruguay.

### 2-1-5 General Aviation

Almost all of general aviation are operated at Adami Airport near Montevideo.

Table 2-1 AIR TRAFFIC DATA AT CARRASCO AIRPORT

YEAR	INT. PAX			DOM. PAX	CARGO			GDP (P=1988)		FARE		
	PUENTE	OTHER	TOTAL	DOM. PAX	EXPORT	IMPORT	TOTAL	URUGUAY	ARGENTINA	PUENTE	OTHER	DOMESTIC
								(Million) (N. Peso)	(Thousand) (Austria,)			
1975	448,273	93,178	533443	44809	4295	1040	8135	83879	21244			
76	400,532	228,213	828745	88240	7358	2337	9695	88237	21884			
77	426,738	94,553	821291	59991	5825	3438	9263	87059	22459			
78	445,888	135,458	588458	37787	8754	4483	13217	78887	21661			
79	583,554	182,333	765887	37842	5826	6839	11665	75888	23354	88	88	
1980	558,254	277,936	837198	44625	7746	5528	13272	79539	23936	88	88	
81	454,858	244,243	699102	38838	4944	4548	9493	89846	22183	88	91	
82	385,488	318,983	784391	34465	5385	3846	9151	73181	21882	88	91	19.77
83	388,389	189,738	498125	43334	5815	2984	8799	88755	21885	88	91	11.35
84	388,887	184,114	498911	58885	5878	3488	8487	87988	22183	88	91	11.8
1985	278,558	179,827	458385	61815	4928	3888	8824	87877	21139	88	91	11.8
86	288,225	252,882	541107	49188	8242	4291	18533	72819	22484	88	91	13
87	333,528	273,889	687225	39533	8922	5428	12342	78288	22788	88	100	12.91
88	337,874	388,887	838341	43228	7842	5283	12385	78849	23239	88	100	13.52

Table 2-2 INDEX OF AIR TRAFFIC DATA AT CARRASCO AIRPORT (1989 = 100)

YEAR	INT. PAX			DOM. PAX	CARGO			GDP		FARE		
	PUENTE	OTHER	TOTAL	DOM. PAX	EXPORT	IMPORT	TOTAL	URUGUAY	ARGENTINA	PUENTE	OTHER	DOMESTIC
1975	78	34	84	99	55	33	48	79	89			
76	72	92	75	153	95	42	79	82	88			
77	78	34	62	124	75	82	78	83	94			
78	88	48	88	84	113	81	188	89	91			
79	184	88	91	85	75	188	88	94	98	188	88	
1980	188	188	188	188	188	188	188	188	188	188	188	
81	81	88	83	81	84	82	72	102	93	188	181	
82	89	115	84	77	88	78	89	92	88	188	181	188
83	55	88	88	97	72	54	85	87	91	188	181	57
84	55	88	59	127	88	62	84	88	93	188	181	88
1985	58	85	55	118	84	87	65	88	89	188	181	59
86	52	91	65	118	81	78	79	92	94	188	181	88
87	88	98	73	39	89	88	93	98	85	188	111	65
88	88	188	76	97	91	95	93	99	97	188	111	88

Fig. 2-1 PUENTE AEREO PAX, GDP & FARE (1980 = 100)

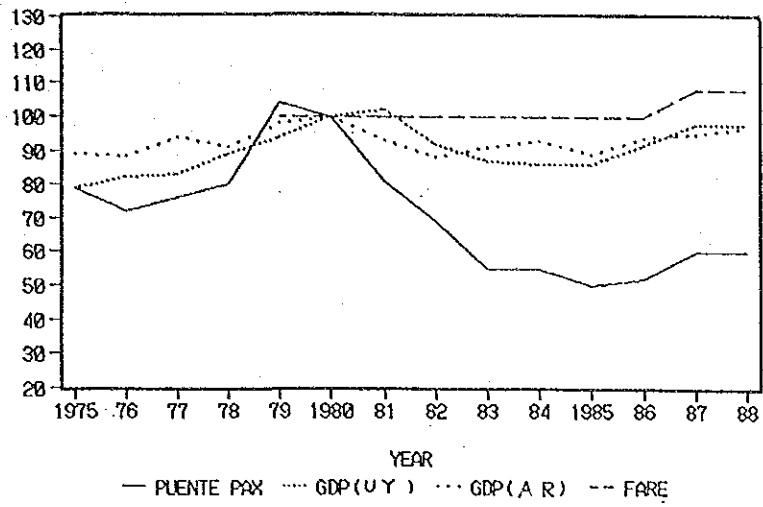


Fig. 2-2 OTHER INT PAX, GDP & FARE (1980 = 100)

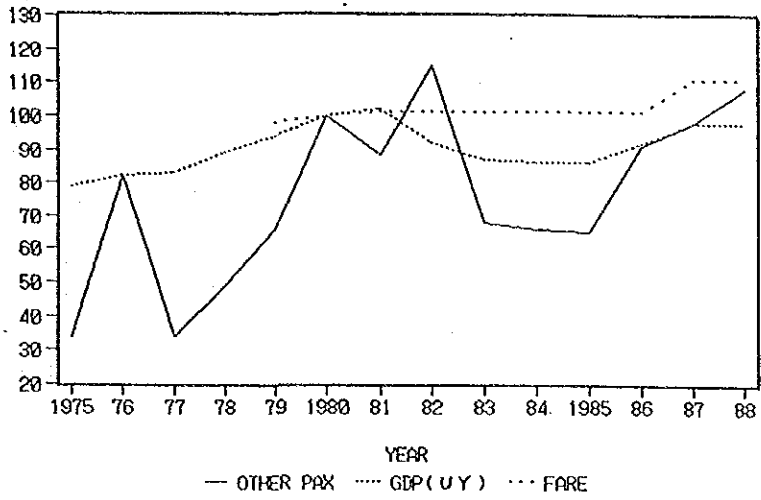


Fig. 2-3 DOMESTIC PAX, GDP & FARE (1980 = 100)

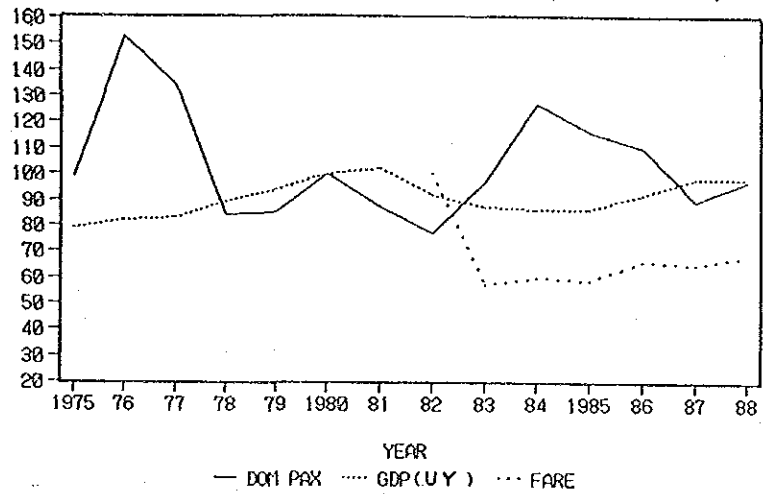


Fig. 2-4 EXPORT CARGO & GDP (1980 = 100)

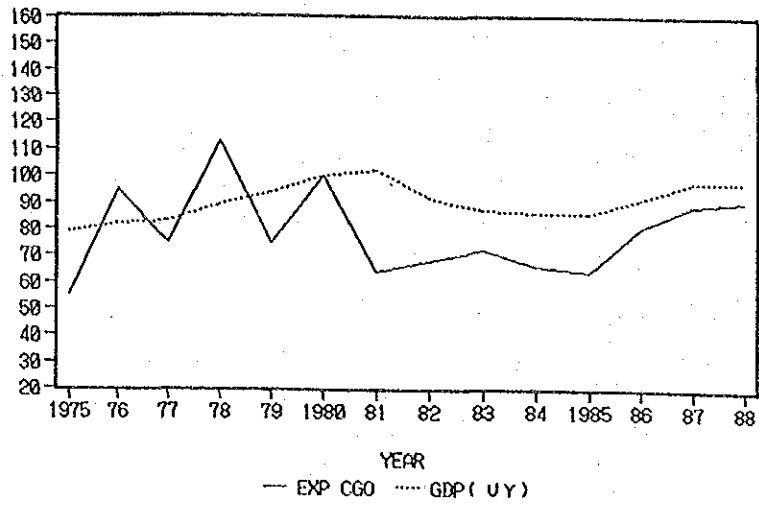
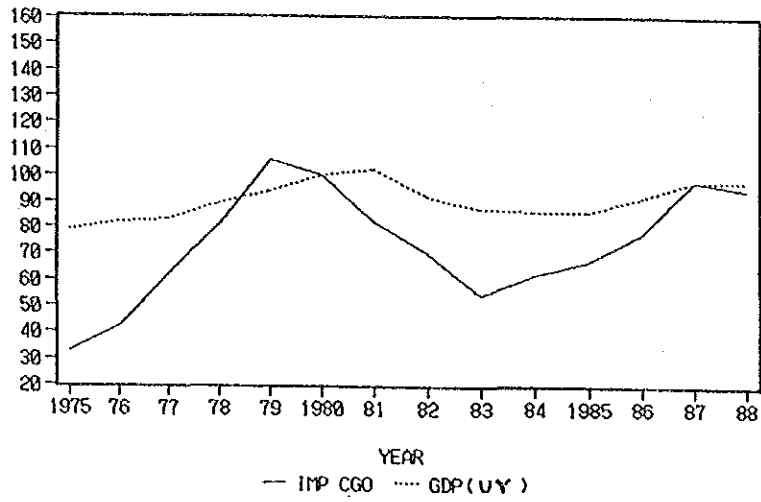


Fig. 2-5 IMPORT CARGO & GDP (1980 = 100)





## 2-2. Forecasting Approaches for Air Traffic Demand

The air traffic demand at Carrasco International Airport is measured in terms of annual levels of passengers and cargo. The air traffic demand is forecast using mainly two approaches: direct and indirect forecasting methods. In this study, the direct forecasting methods are chosen, depending on the quality and extent of the data available and the particular characteristics of each traffic category.

The methods disregard the possibility of the transfer of demand to or from other transportation modes.

### 2-2-1 Forecasting Procedure

The procedure of air traffic demand forecasting at Carrasco is shown in Fig. 2-6. The forecasting procedure is made up of four steps as follows:

- (1) Analysis of air traffic, and factors evaluation of affecting demand.
- (2) Selection of the type of functional relationship, and statistical estimation of coefficients.
- (3) Specification of forecasting model, and establishment of assumptions for forecast.
- (4) Forecast of air traffic demand by region.

### 2-2-2 Forecasting Methods

The two main forecasting methods of air traffic demand are trend projection and econometric method.

#### (1) Trend Projection

Trend projection is a useful tool whenever the past development of traffic has taken place in a gradual evolutionary environment and no great changes are expected in that environment during the forecast period.

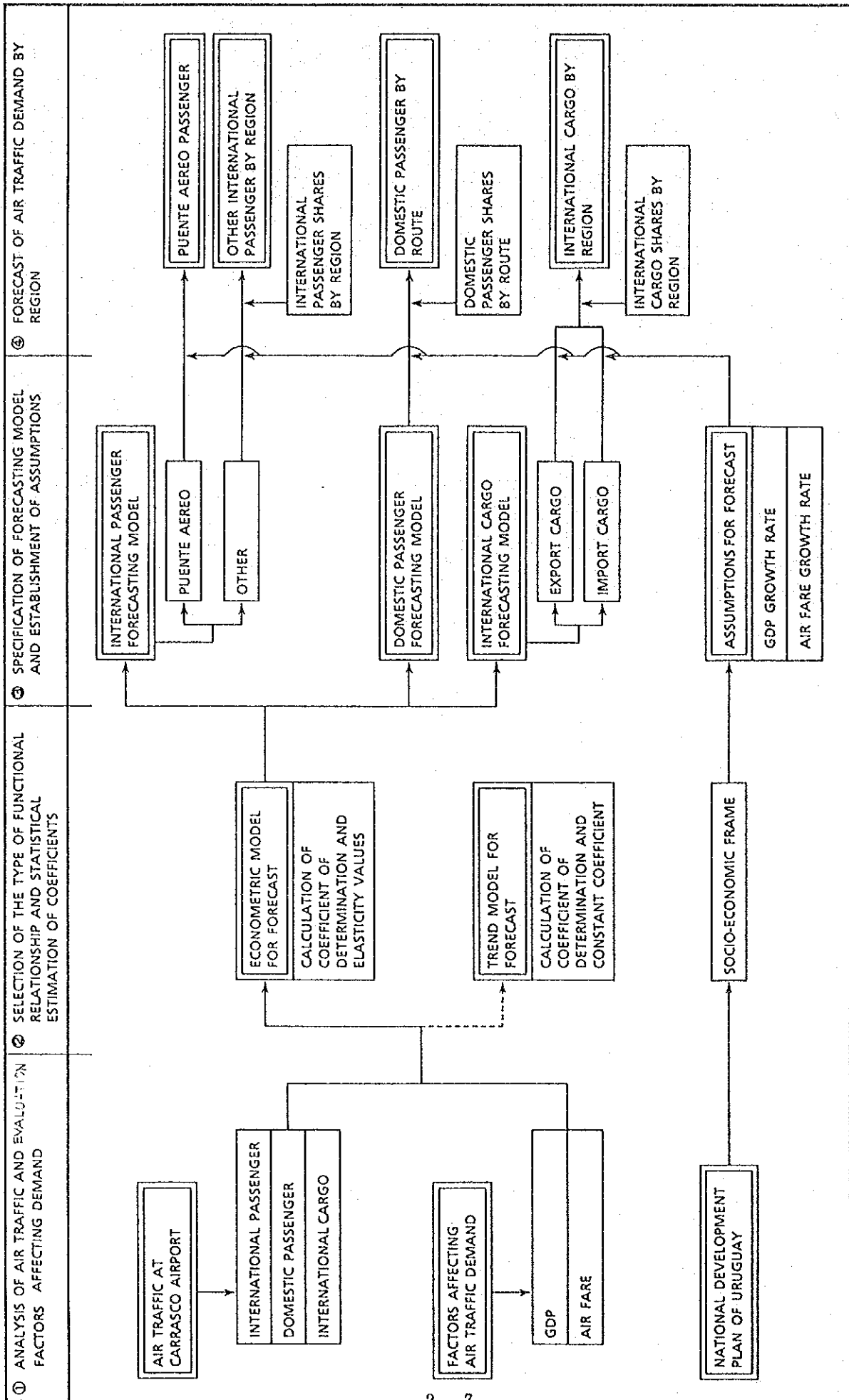


Fig. 2-6 Forecasting Procedure of Air Traffic Demand at Carrasco Airport

The mathematical formulations which express to the trend curves of Fig. 2-7 are given below. In each case, the dependent variable Y is traffic, the independent variable T is time, and a, b and c are all constants (sometimes called coefficients) whose values can be estimated from the data.

1. Linear
2. Exponential
3. Parabolic

$$Y = a + bT$$

$$Y = a \cdot b^T$$

$$Y = a + bT + cT^2$$

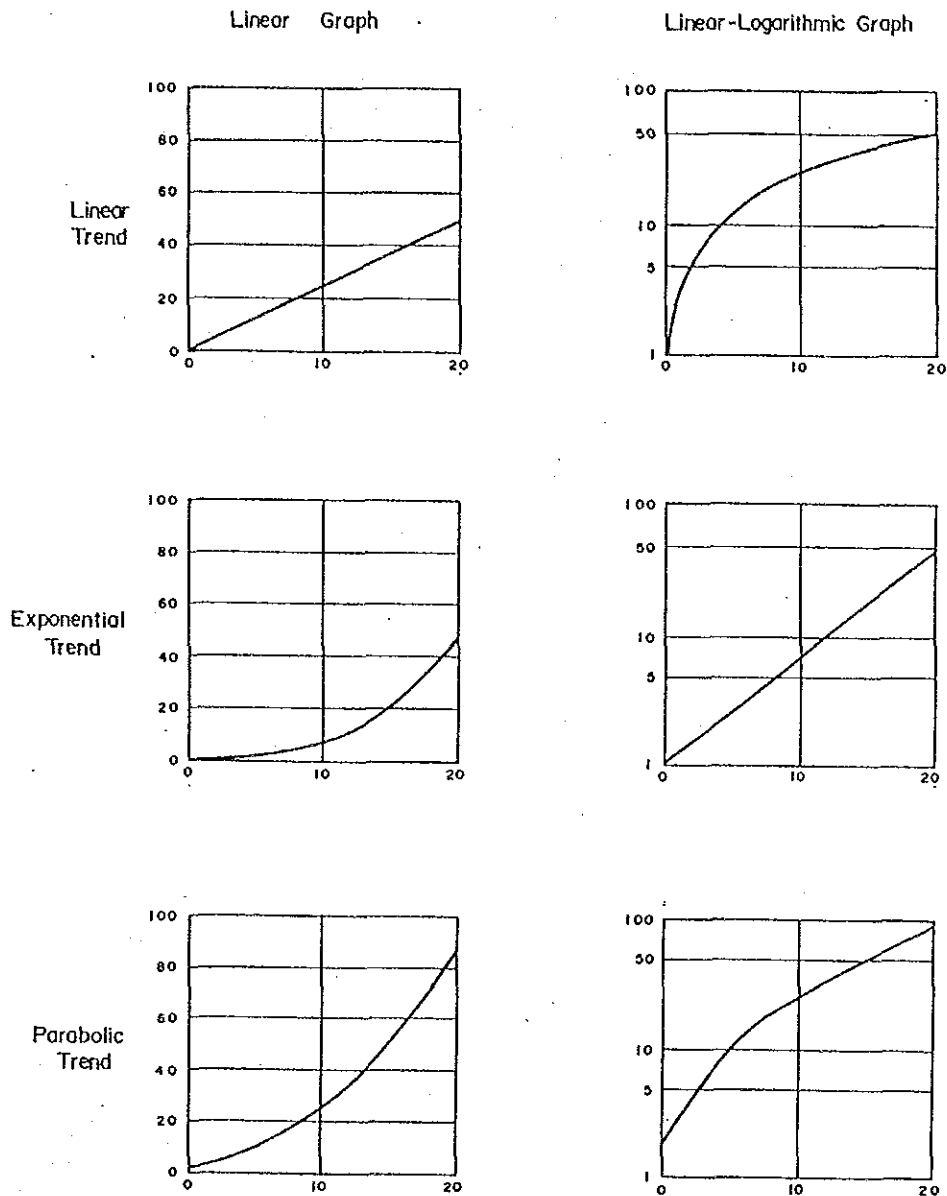


Fig. 2-7 TYPICAL TREND CURVES

(2) Econometric Method

Econometric forecasting involves determining, on the basis of historical data, a quantitative relationship between traffic on the one hand and the more important factors or variables which influence the level of traffic on the other, and then using this relationship and forecast of the underlying variables to derive the traffic forecast.

The type of functional relationship to be used for an econometric traffic forecast must be developed through judgment and experimentation, and the adequacy of the relationship can only be established empirically through tests against actual historical data.

Six alternative forms are suggested below. In each case, Y is traffic,  $X_1$ ,  $X_2$  and  $X_3$  are independent variables, and a, b, c and d are constant coefficients. The coefficients b, c and d of Multiplicative (A, B and C) are called the elasticity values, the values of the coefficients a, b, c and d which provide the best fit to the data are calculated on the basis of the least squares criterion.

- |                       |   |
|-----------------------|---|
| 1. Linear (A)         | $Y = a + bX_1$                              |
| 2. Linear (B)         | $Y = a + bX_1 + cX_2$                       |
| 3. Linear (C)         | $Y = a + bX_1 + cX_2 + dX_3$                |
| 4. Multiplicative (A) | $Y = a \cdot X_1^b$                         |
| 5. Multiplicative (B) | $Y = a \cdot X_1^b \cdot X_2^c$             |
| 6. Multiplicative (C) | $Y = a \cdot X_1^b \cdot X_2^c \cdot X_3^d$ |

(3) Forecast Items

Forecast items of air traffic at Carrasco Airport are suggested below.

- (1) International passenger
  - Puente Aereo passenger
  - Other International passenger
- (2) Domestic passenger
- (3) International cargo
  - Export cargo
  - Import cargo

(4) Forecast Years

The future air traffic demand are given for the years 1995, 2000, 2005 and 2010.

### 2-3. Forecasting Model Building

The following functions were examined and tested in terms of reliability based on the statistic data collected during the field survey.

- International passenger  
PUENTE.PAX = f(GDP, FARE, TIME)  
OTHER.PAX = f(GDP, FARE, TIME)
- Domestic passenger  
DOM.PAX = f(GDP, FARE, TIME)
- International cargo  
EX.CGO = f(GDP, TIME)  
IM.CGO = f(GDP, TIME)

Where:

PUENTE.PAX = Puente Aereo Passenger  
OTHER.PAX = Other International Passenger  
DOM.PAX = Domestic Passenger  
EX.CGO = Export Cargo (ton)  
IM.CGO = Import Cargo (ton)  
GDP = Gross Domestic Product of Uruguay  
(Millions of 1978 NUr\$)  
FARE = Air Fare (US\$)  
TIME = Year (1975 = 1, ..., 1988 = 14)

An air traffic forecast arrived at by projection of past trends does not explicitly take into account the way in which various economic and social conditions affect the traffic development. In long-term air traffic forecasting, no indicative trend projection can be made in case of Carrasco International Airport, since the past trends of air traffic at the Airport have been sporadic and inconsistent. The demands of air traffic at the airport tend to vary with national economy.

For this reason, the forecast of the air traffic demand is made on the basis of elasticity values obtained by analyzing relationship with economic indicator (GDP) and air fare. The periods of observation data used for analysis are for 11 years from the year 1979 through 1988.

The 1979 data were unstable by because of the second oil crisis. Therefore, the data of the year were excluded for the statistical estimation for forecasting model building.

The "goodness of fit" of the estimated relationship is measured by the coefficient of multiple determination,  $r^2$ . If the fit of the data is poor, the  $r^2$  will be close to 0. If the fit is good, the  $r^2$  will be close to 1.

The estimated coefficients of multiple determination ( $r^2$ ) using different types of functional relationship and analysis periods of data are presented in ANNEX I.

The forecasting models are selected by judging the estimated coefficient of multiple determination.

2-3-1 International Passenger

The International Passengers are divided into two categories: the Puente Aereo Passenger and the Other International Passenger.

(1) Puente Aereo Passenger

a. Statistical estimation using two independent variables

The two independent variables are GDP of Uruguay and International Air Fare in this model.

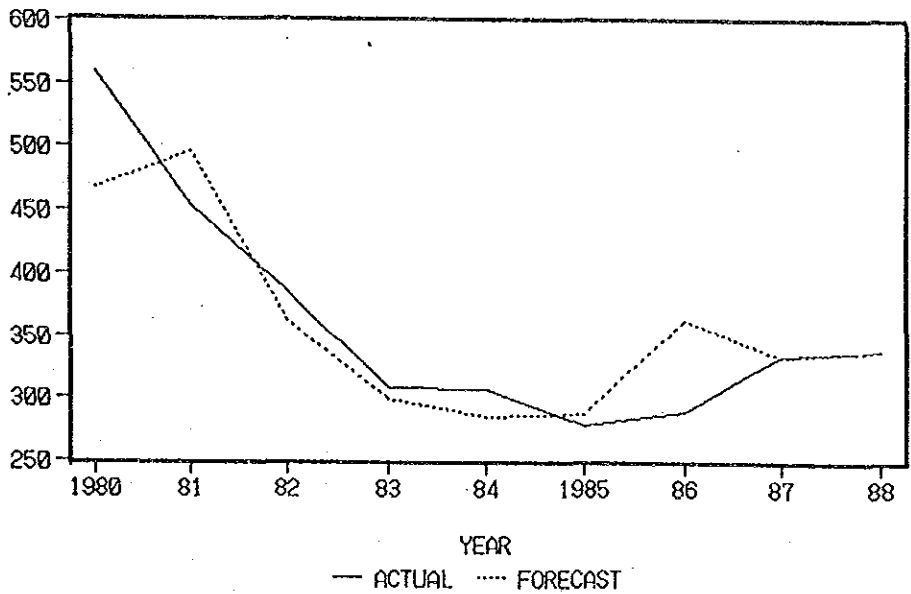
The forecasting model of the Puente Aereo Passenger was formulated using data for a nine year period (1980 - 1988). The GDP and FARE elasticities are equal to +3.2118098 and -3.731768 respectively.

Forecasting Model

$$PUE.PAX = 10^{-1.814775} \cdot GDP^{3.2118098} \cdot FARE^{-3.731768}$$

$$(R^2 = 0.7579248)$$

Fig. 2-8 INT.PAX (PUENTE AEREO) (Thousands)



b. Statistical estimation using three independent variables including Argentine GDP.

Air traffic passengers between Uruguay and Argentina will be affected by Uruguayan and Argentine economies. Therefore, Argentine GDP is taken into account as an additional independent variable .

The independent variables are thus Uruguayan GDP, Argentine GDP and International Air Fare in this model.

The independent variables were examined in terms of reliability based on the partial correlation coefficient in the forecasting model.

The partial correlation coefficient shows the relationship between two variables while holding all other variables constant.

The partial correlation coefficients of each independent variable were as follows:

Uruguayan GDP	0.8465
Argentine GDP	0.2936
Int'l Air Fare	-0.7209

The value of partial correlation coefficient of Argentine GDP was very low compared with other independent variables.

These values mean that Argentine GDP need not be taken into account as an important factor (independent variable) in this model.



(2) Other International Passenger

The forecasting model of the Other International Passenger was formulated using data for a nine-year period (1980 - 1988).

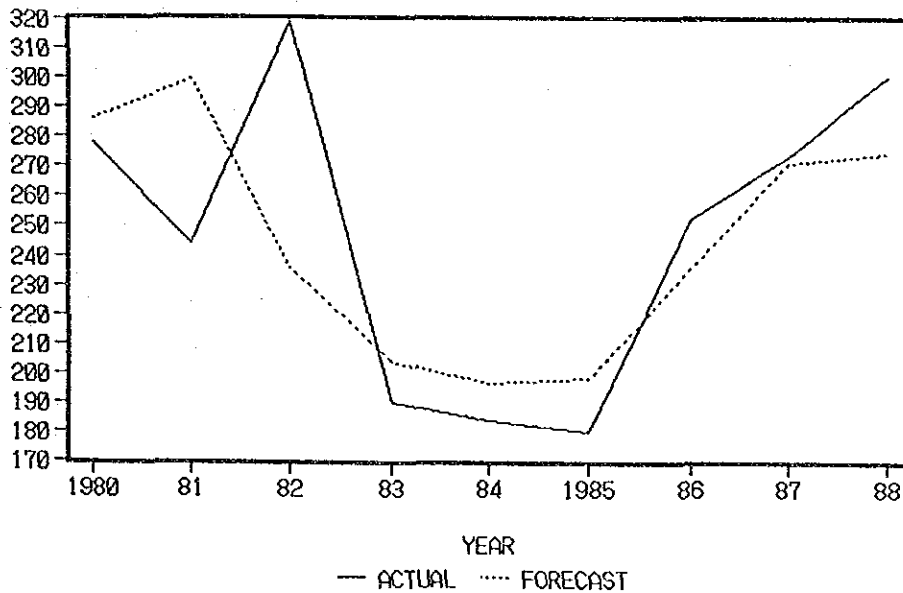
The GDP of Uruguay was used as the single independent variable in this model. The GDP elasticity was equal to +2.4225.

Forecasting Model

$$\text{OTHER.PAX} = 10^{-5.5455} \cdot \text{GDP}^{2.4225}$$

$$(R^2 = 0.5669)$$

Fig. 2-9 INT.PAX (OTHER INT'L PAX) (Thousands)



### 2-3-2 Domestic Passenger

The forecasting model of the Domestic passenger was formulated using data for a seven year period (1982 - 1988).

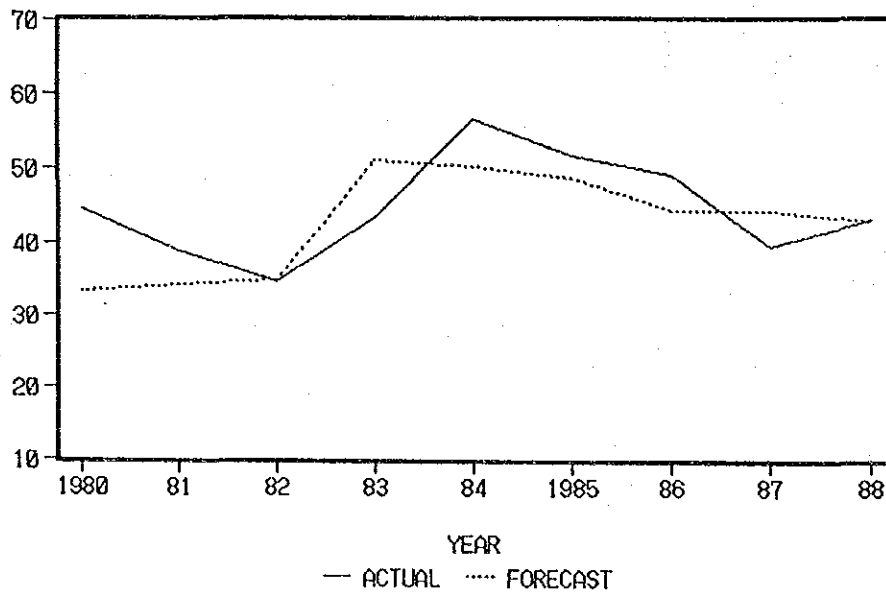
The two independent variables are GDP of Uruguay and Domestic Air Fare in this model. The GDP and FARE elasticities are equal to +0.4034526 and -0.64712 respectively.

#### Forecasting Model

$$\text{DOM.PAX} = 10^{3.5592359} \cdot \text{GDP}^{0.4034526} \cdot \text{FARE}^{-0.64712}$$

$$(R^2 = 0.5977912)$$

Fig. 2-10 DOM.PAX (Thousands)



### 2-3-3 International Cargo

The International Cargo are divided into two categories: the Export Cargo and the Import Cargo.

#### (1) Export Cargo

The forecasting model of the Export Cargo was formulated using data for a seven-year period (1982 - 1988).

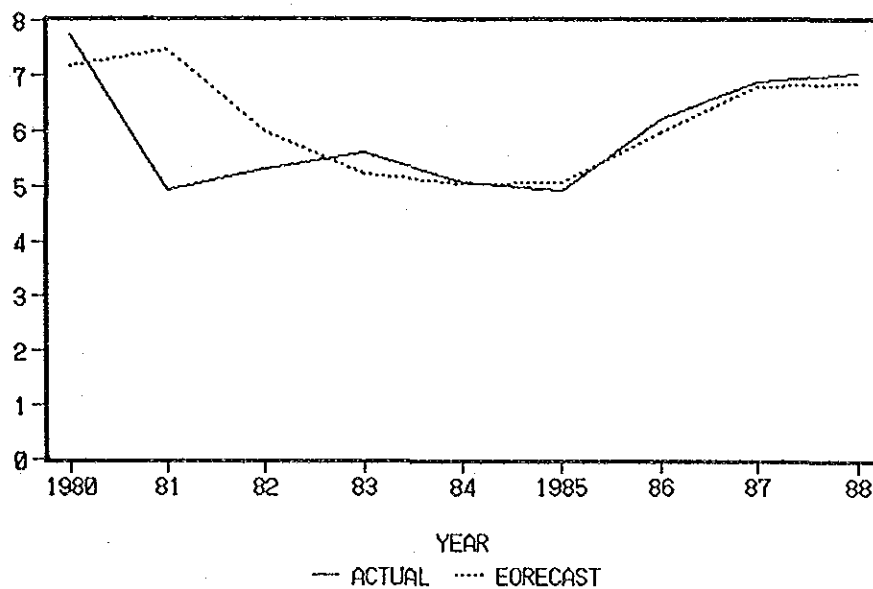
The GDP of Uruguay was used as the single independent variable in this model. The GDP elasticity was equal to +2.2472664.

#### Forecasting Model

$$EX.CGO = 10^{-6.35131} \cdot GDP^{2.2472664}$$

$$(R^2 = 0.8180346)$$

Fig. 2-11 EX.CGO (Thousand Tons)



(2) Import Cargo

The forecasting model of the Import Cargo was formulated using data for a seven year period (1982 - 1988).

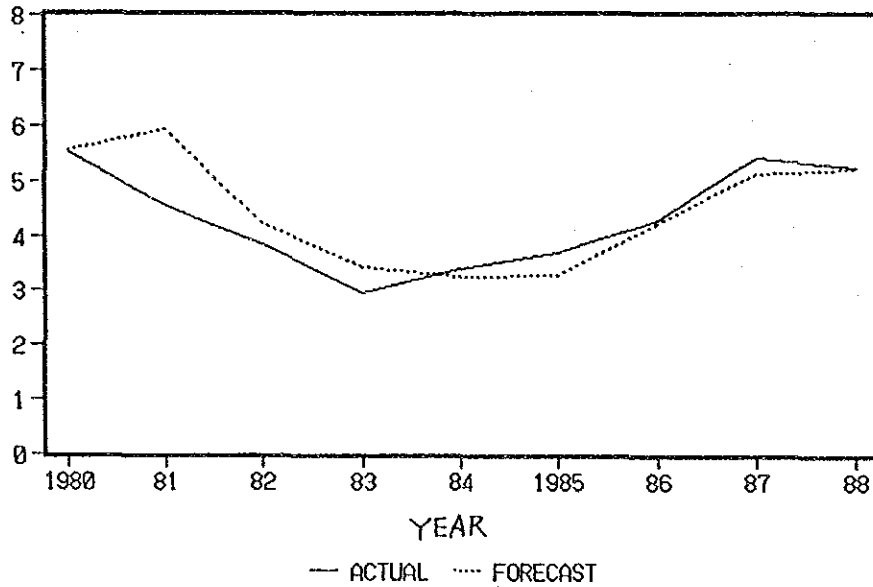
The GDP of Uruguay was used as the single independent variable in this model. The GDP elasticity was equal to +3.4588935.

Forecasting Model

$$\text{IM.CGO} = 10^{-11.96428} \cdot \text{GDP}^{3.4588935}$$

$$(R^2 = 0.8371423)$$

Fig. 2-12 IM.CGO (Thousand Tons)



## 2-4 Forecasting Assumptions

The assumptions used for forecasts are listed in Table 2-3.

Table 2-3 THE FORECASTING ASSUMPTIONS FOR AIR TRANSPORT DEMAND

Forecast items Assumptions	INT.PAX		DOM.PAX	INT.CGO	
	Puente Aereo	Other Int'l		Export	Import
1. Base year data(1988) (1,000), (ton) *1) 1990 - 2010	337	301	43	7,042	5,263
2. GDP Growth Rate (%) *2) 1990 - 2010	2.5	2.5	2.5	2.5	2.5
3. Change in Air Fares (%)	1.4	--	0.0	--	--
4. GDP Elasticity	3.2118	2.4225	0.4034	2.2472	3.4588
5. Price Elasticity	-3.7317	--	-0.6471	--	--

### \*1) GDP Growth Rate

It is considered adequate to assume the annual average growth rate at between 2 and 3% as projected by Oficina de Planeamiento y Presupuesto, Uruguay.

### \*2) Change in Air Fares

The change rate shown is the annual change rate of international air fares between Carrasco and main cities of the world for a ten year period. In case of the forecast of the domestic passenger, it was assumed that the change in domestic air fare would be maintained at zero under the national policy.

2-5 Forecast of Future Air Traffic Demand at Carrasco

The results of the air traffic forecasts are set out in Table 2-4 together with a summary of the annual growth rates.

Table 2-4 Forecast of Future Air Traffic Demand at Carrasco

Year	International Passenger (1,000)			D Domestic Passenger (1,000)	E = (C+D) Total Passenger (1,000)	F Export Cargo (ton)	G Import Cargo (ton)	H = (F+G) Total Cargo (ton)
	A Puente Aereo	B Other Int'l	C = (A+B) Total					
1988	337	301	638	43	681	7,042	5,263	12,305
1995	498	448	946	48	994	10,843	10,522	21,365
2000	572	604	1,176	50	1,226	14,310	16,127	30,437
2005	656	814	1,470	53	1,523	18,886	24,719	43,605
2010	752	1,098	1,850	55	1,905	24,925	37,887	62,812
Annual Growth Rates (%)								
1988 / 2000	4.5	6.0	5.2	1.3	5.0	6.1	9.8	7.8
2000 / 2010	2.8	6.1	4.6	1.0	4.5	5.7	8.9	7.5

2-5-1 International Passenger Demand

(1) Puente Aereo Passenger Demand

Number of Puente Aereo Passengers at Carrasco Airport will rise to 572,000 in 2000 and 752,000 in 2010.

Average annual growth rate of passengers is 4.5% between 1988 and 2000 and 2.8% for 2000 - 2010.

For the sensitivity analysis, three cases of the future passenger demand, based on three different assumptions of the GDP growth rate, are shown in Fig. 2-13, Table 2-5.

Fig. 2-13 PUENTE AEREO PASSENGER (Millions)

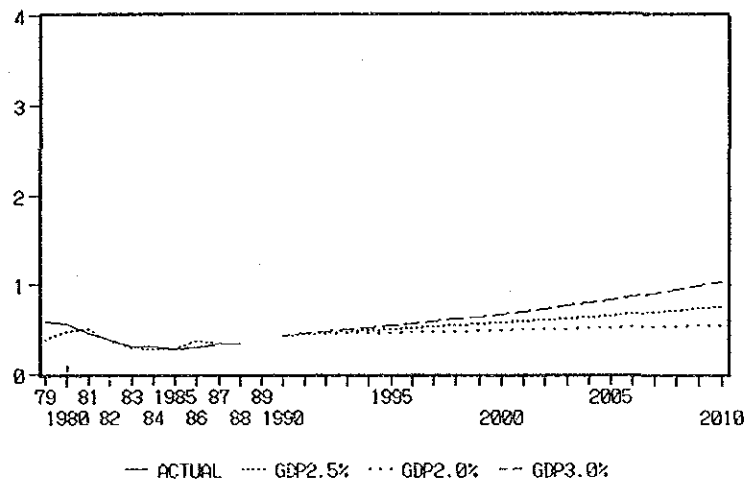


Table 2-5. PUENTE AEREO PASSENGER BY CASE (1,000)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	337	539	669	829	1,029
	2.5	337	498	572	656	752
	2.0	337	461	489	518	550

(2) Other International Passenger Demand

Number of Other International Passenger at Carrasco Airport will rise to 604,000 in 2000 and 1,098,000 in 2010.

Average annual growth rate of the passenger is 6.0% between 1988 and 2000 and 6.1% for 2000 - 2010.

For the sensitivity analysis, three cases of the future passenger demand, based on three different assumptions of the GDP growth rate, are shown in Fig. 2-14, Table 2-6.

Fig. 2-14 OTHER INT'L PASSENGER (Millions)

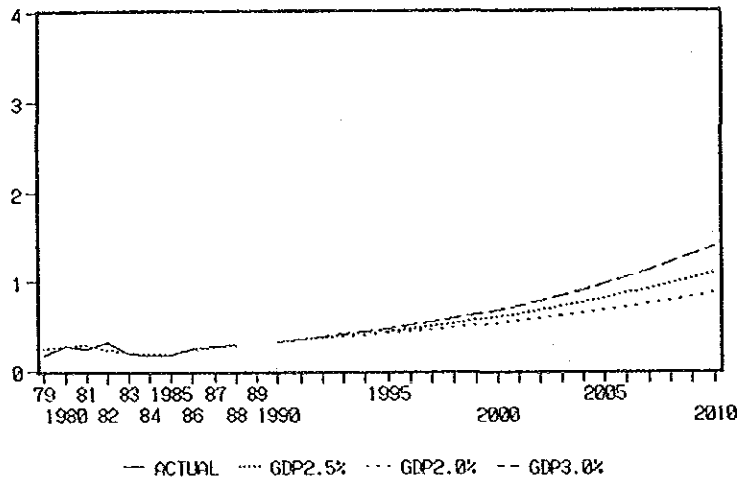


Table 2-6 OTHER INTERNATIONAL PASSENGER BY CASE (1,000)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	301	475	679	972	1,390
	2.5	301	448	604	814	1,098
	2.0	301	422	536	682	866



(3) Total International Passenger Demand

Total International Passenger Demand is the sum of Puente Aereo Passenger Demand and Other International Passenger Demand.

Number of Total International Passenger at Carrasco Airport will rise to 1,176,000 in 2000 and 1,850,000 in 2010.

Average annual growth rate of the passenger is 5.2% between 1988 and 2000 and 4.6% for 2000 - 2010.

Three cases of the future total international passenger demand, based on the different assumptions of the GDP growth rate, are shown in Table 2-7.

Table 2-7 TOTAL INTERNATIONAL PASSENGER IN THREE CASE (1,000)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	638	1,014	1,348	1,801	2,419
	2.5	638	946	1,176	1,470	1,850
	2.0	638	883	1,025	1,200	1,410

Note: Total International Passenger Forecast

The forecasting model of the Total International Passenger (Sum of Puente Aereo Passenger and Other International Passenger) was estimated using data for a nine-year period (1980 - 1988).

The GDP of Uruguay and the International Air Fare were used as the independent variables. The GDP and FARE elasticities are +2.7447 and -1.3305.

Forecasting Model:

$$\text{TOTAL.PAX} = 10^{-3.9897} \cdot \text{GDP}^{2.7447} \cdot \text{FARE}^{-1.3305}$$

$$(\text{R}^2 = 0.7661)$$

Forecast results of Total International Passenger using Forecasting Model (TOTAL.PAX) are as follows:

(1,000)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	638	1,056	1,444	1,975	2,710
	2.5	638	988	1,264	1,617	2,068
	2.0	638	924	1,105	1,322	1,581

(4) International Passenger by Route

International routes to and from Carrasco Airport are divided into six regions. The shares (average for a three-year period, 1986 - 1988) of passengers for these regions are as follows:

1. Puente Aereo	52.0%	
2. Other Routes	48.0%	(100%)
-1. Regional*	21.9%	(45.7%)
-2. Other South America	6.7%	(14.1%)
-3. North America	2.3%	(4.7%)
-4. Europe	4.6%	(9.5%)
-5. Others	12.5%	(26.0%)

(\*Buenos Aires, Asuncion, Rio de Janeiro, Santiago)

Other International passenger by route is obtained by multiplying the total international passenger by the shares of regional passenger.

Future international passenger demand by route at Carrasco Airport is shown in Table 2-8.

Table 2-8 INTERNATIONAL AIR PASSENGER DEMAND AT CARRASCO AIRPORT BY ROUTE

Route		1988	1995	2000	2005	2010
Puente Aereo (Aeroparque)		337	498	572	656	752
Other Inter- national	Regional	157	205	276	372	502
	Other South America	56	63	85	115	155
	North America	20	21	28	38	52
	Europe	34	43	57	77	104
	Others	63	116	158	212	285
	Sub Total	301	448	604	814	1,098
Grand Total		638	946	1,176	1,470	1,850

2-5-2 Domestic Passenger Demand

(1) Total Domestic Passenger Demand

Number of Domestic Passengers at Carrasco Airport will rise to 50,000 in 2000 and 55,000 in 2010.

Average annual growth rate of passengers is 1.3% between 1988 and 2000 and 1.0% for 2000 - 2010.

For the sensitivity analysis, three cases of the future passenger demand, based on three different assumptions of the GDP growth rate, are shown in Fig. 2-15, Table 2-9.

Fig. 2-15 DOMESTIC PASSENGER (Thousands)

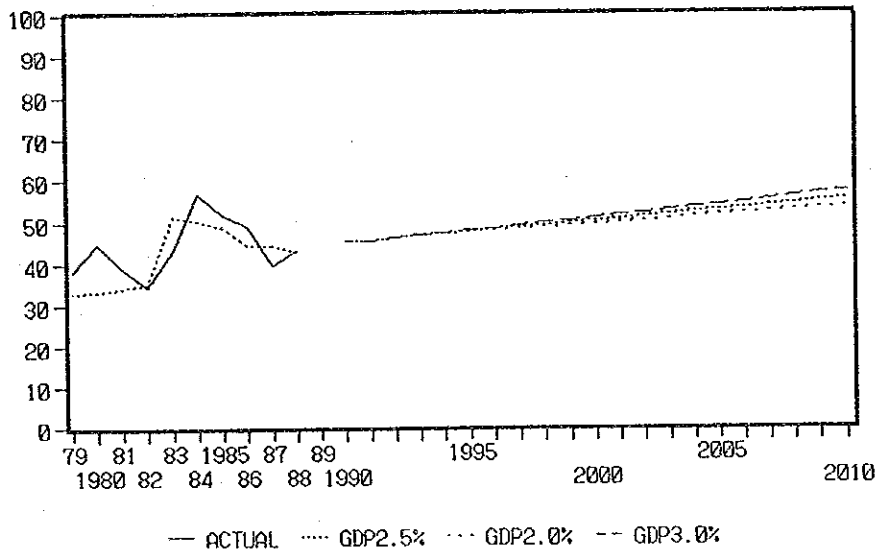


Table 2-9 DOMESTIC PASSENGER BY CASE (1,000)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	43	48	51	54	57
	2.5	43	48	50	53	55
	2.0	43	48	50	52	54

(2) Domestic passenger by route

Domestic routes to and from Carrasco Airport are six routes. The shares (average for a three year period, 1986 - 1988) of passengers for these routes are as follows:

1. Paysandu	13.5%
2. Salto	26.9%
3. Artigas	15.0%
4. Rivera	28.7%
5. Melo	13.3%
6. Tacuarembó	2.6%

Domestic passenger by route is obtained by multiplying the total domestic passenger by the shares of regional passenger.

Future domestic passenger demand by route at Carrasco Airport is shown in Table 2-10.

Table 2-10 DOMESTIC AIR PASSENGER DEMAND OF CARRASCO AIRPORT BY ROUTE

(1,000)

Route	1988	1995	2000	2005	2010
Paysandu	5	6	7	7	7
Salto	12	13	13	14	15
Artigas	6	7	7	8	8
Rivera	13	14	14	15	16
Melo	5	6	7	7	7
Tacuarembó	2	2	2	2	2
Total	43	48	50	53	55

2-5-3 International Cargo Demand

(1) Export Cargo Demand

Export cargo demand at Carrasco Airport will rise to 14,310 tons in 2000 and 24,925 tons in 2010.

Average annual growth rate of export cargo is 6.1% between 1988 and 2000 and 5.7% for 2000 - 2010. For the sensitivity analysis, three cases of the future cargo demand, based on three different assumptions of the GDP growth rate, are shown in Fig. 2-16, Table 2-11.

Fig. 2-16 EXPORT CARGO (Thousand Tons)

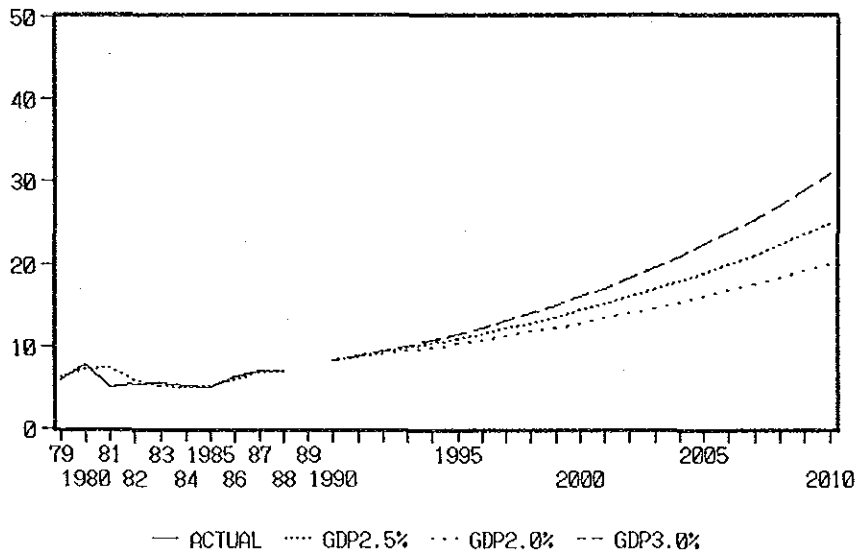


Table 2-11 EXPORT CARGO BY CASE

(ton)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	7,042	11,452	15,964	22,253	31,019
	2.5	7,042	10,843	14,310	18,886	24,925
	2.0	7,042	10,263	12,821	16,016	20,008

(2) Import Cargo Demand

Import cargo demand at Carrasco Airport will rise to 16,127 tons in 2000 and 37,887 tons in 2010.

Average annual growth rate of import cargo is 9.8% between 1988 and 2000 and 8.9% for 2000 - 2010.

For the sensitivity analysis, three cases of the future cargo demand, based on three different assumptions of the GDP growth rate, are shown in Fig. 2-17, Table 2-12.

Fig 2-17 IMPORT CARGO (Thousand Tons)

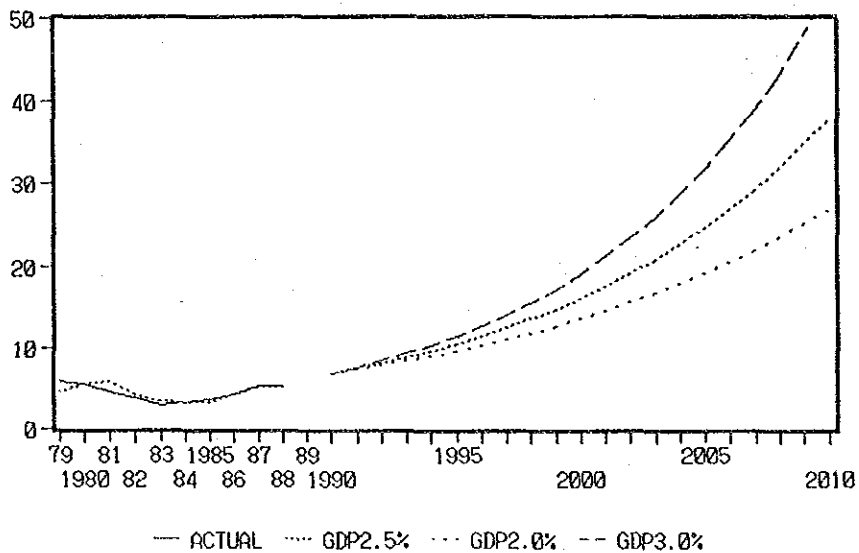


Table 2-12 IMPORT CARGO BY CASE

(ton)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	5,263	11,446	19,084	31,818	53,050
	2.5	5,263	10,522	16,127	24,719	37,887
	2.0	5,263	9,669	13,618	19,180	27,013

(3) Total International Cargo Demand

Total International Cargo Demand is the sum of Export Cargo Demand and Import Cargo Demand.

The total international cargo demand at Carrasco Airport will rise to 30,437 tons in 2000 and 62,812 tons in 2010.

Average annual growth rate of the international cargo demand is 7.8% between 1988 and 2000 and 7.5% for 2000 - 2010.

Three cases of the future total international cargo demand, based on three different assumptions of the GDP growth rate, are shown in Table 2-13.

Table 2-13 TOTAL INTERNATIONAL CARGO BY CASE (ton)

Year		1988	1995	2000	2005	2010
GDP Annual Growth Rate (%)	3.0	12,305	22,898	35,048	54,071	84,069
	2.5	12,305	21,365	30,437	43,605	62,812
	2.0	12,305	19,932	26,439	35,196	47,021

2-5-4 International cargo demand by route

International air freight routes to and from Carrasco Airport are divided into six regions. The shares (average for a three year period, 1986 - 1988) of air freights for these regions are as follows:

1. Buenos Aires	9.9%
2. Regional*	10.3%
3. Other South America	7.0%
4. North America	34.2%
5. Europe	18.6%
6. Others	20.0%

(\*Asuncion, Rio de Janeiro, Santiago)

International cargo demand by route is obtained by multiplying the total international cargo by the shares of regional air freight.

Future international cargo demand by route at Carrasco Airport is shown in Table 2-14.

Table 2-14 INTERNATIONAL AIR CARGO DEMAND BY ROUTE (ton)

Route	1988	1995	2000	2005	2010
Buenos Aires	1,219	2,114	3,014	4,317	6,218
Regional	1,267	2,201	3,135	4,491	6,470
Other South America	870	1,496	2,131	3,052	4,397
North America	4,204	7,307	10,409	14,913	21,482
Europe	2,289	3,974	5,661	8,111	11,683
Others	2,456	4,273	6,087	8,721	12,562
Total	12,305	21,365	30,437	43,605	62,812



ANNEX I

ESTIMATED COEFFICIENTS OF  
MULTIPLE DETERMINATION

1. Puente Aereo Passenger		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.5340	0.3414	0.0564
	2. Exponential	0.5180	0.3116	0.0446
	3. Parabolic	0.9777	0.9433	0.8380
E	4. Linear (A)	0.5025	0.5286	0.2634
	5. Linear (B)	0.7485	0.7559	0.3373
	6. Multiplicative (A)	0.5365	0.5318	0.2885
	7. Multiplicative (B)	* 0.7579	0.7174	0.3414

2. Other Int'l Passenger		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.0011	0.0364	0.0578
	2. Exponential	0.0008	0.0385	0.0758
	3. Parabolic	0.4703	0.4993	0.7231
E	4. Linear (A)	0.4926	0.4684	0.7200
	5. Linear (B)			
	6. Multiplicative (A)	* 0.5669	0.5439	0.7668
	7. Multiplicative (B)			0.9123

3. Total Int'l Passenger		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.2620	0.0445	0.0037
	2. Exponential	0.2186	0.0319	0.0096
	3. Parabolic	0.8727	0.7469	0.7843
E	4. Linear (A)	0.6418	0.6532	0.5721
	5. Linear (B)	0.7335	0.6771	0.7059
	6. Multiplicative (A)	0.6962	0.6912	0.6247
	7. Multiplicative (B)	* 0.7661	0.7107	0.7416

4. Domestic Passenger		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.0512	0.0731	0.0128
	2. Exponential	0.0581	0.0929	0.0259
	3. Parabolic	0.2107	0.5295	0.6535
E	4. Linear (A)	0.1160	0.1419	0.1137
	5. Linear (B)			0.5665
	6. Multiplicative (A)	0.0821	0.1103	0.0849
	7. Multiplicative (B)			* 0.5978

5. Export Cargo		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.0352	0.6771	0.6388
	2. Exponential	0.0483	0.6614	0.6094
	3. Parabolic	0.6661	0.8022	0.8102
E	4. Linear (A)	0.3184	0.1997	0.8310
	5. Multiplicative (A)	0.3110	0.1964	* 0.8180

6. Import Cargo		R <sup>2</sup> ( '80~'88)	R <sup>2</sup> ( '81~'88)	R <sup>2</sup> ( '82~'88)
T	1. Linear	0.0245	0.3312	0.7036
	2. Exponential	0.0256	0.2986	0.6847
	3. Parabolic	0.8477	0.8126	0.8400
E	4. Linear (A)	0.7426	0.6984	0.8642
	5. Multiplicative (A)	0.7544	0.7120	* 0.8371

T: Trend Model  
E: Econometric Model  
\*: Adopted

#### Forecasting Model

Trend	1. Linear	$Y = a + bT$
	2. Exponential	$Y = a \cdot b^T$
	3. Parabolic	$Y = a + b \cdot T + c \cdot T^2$
Econometric	4. Linear (A)	$Y = a + b \cdot GDP$
	5. Linear (B)	$Y = a + b \cdot GDP + c \cdot FARE$
	6. Multiplicative (A)	$Y = a \cdot GDP^b$
	7. Multiplicative (B)	$Y = a \cdot GDP^b \cdot FARE^c$

Y : PAX or CARGO  
T : Time  
GDP : GDP of Uruguay

## **CHAPTER 3**

### **EXISTING FACILITY CONDITIONS**

In order to evaluate existing situation of airport facilities, field surveys were made in two main parts, namely, 1) a survey of physical conditions of the facilities, including topographic, geological and pavement surveys, and 2) a survey of how the facilities are being utilized, and the findings are shown hereinafter, with supplemental materials compiled in INVENTORY.

Airport facilities are classified into following three groups;

1. Airfield Facilities ----- runway, runway strip, taxiway, apron, and drainage.
  
2. Terminal Area Facilities ———— passenger terminal building,  
| rescue & fire-fighting, and  
| G.S.E. building.  
|  
| — aircraft fuel storage, potable  
| water, sewage, and waste disposal  
| and incinerator.  
|  
| — carparks and access road,  
| aircraft maintenance and general  
| aviation facilities
  
3. Air Navigation Facilities ———— Non-visual aids -- ILS, VOR/DME,  
| NDB, etc.  
|  
| — Visual aids -- ALS, PAPI,  
| runway lighting, etc.  
|  
| — Air traffic control facility  
|  
| — Aeronautical telecommunications  
| facility  
|  
| — Meteorological facility

### 3-1. Airfield Facilities

#### 3-1-1 Summary of airfield facilities

##### (1) Runways

Carrasco International Airport was constructed from 1942 to 1943, and has three runways.

The three runways, when built in 1943, had the following dimensions and pavement:

RWY01/19:	1,750 m x 48 m,	cement concrete
RWY06/24:	1,770 m x 45 m,	ditto
RWY10/28:	1,700 m x 45 m,	ditto

Of these, RWY06/24 is used as the primary runway, and this was lengthened and improved three times as follows:

From 1951 to 1954:	to 2,300 m
In 1970	: to 2,450 m
From 1980 to 1981:	Overlay of whole length to 2,700 m

RWY01/19 is normally used for operation of the aircraft smaller than B-737.

B-737 sometimes operates on RWY01/19 when strong wind comes from north or south.

RWY10/28 is used exclusively for general aviation aircraft.

No reinforcement has been made for RWY01/19, and RWY10/28, except some parts where intersection of runways.

##### (2) Taxiways and apron

There are following five taxiways.

###### 1) For RWY06/24

TWY-Alpha (between RWY06/24 and apron)  
TWY-Bravo (between RWY06/24 and apron)  
TWY-Delta (between RWY06/24 and TWY-B)

###### 2) For RWY01/19

TWY-Charlie (between RWY01/19 and TWY-A)

3) For RWY10/28

TWY-Echo (between RWY10/28 and TWY-A)

4) Apron

Apron was expanded in four stages; from 1942 to '43, from 1951 to '54, from 1975 to '76 and in 1981.

The part built after 1975 is used for DC-10 and B-747, and the other part for B-707, B-737 and other small aircrafts.

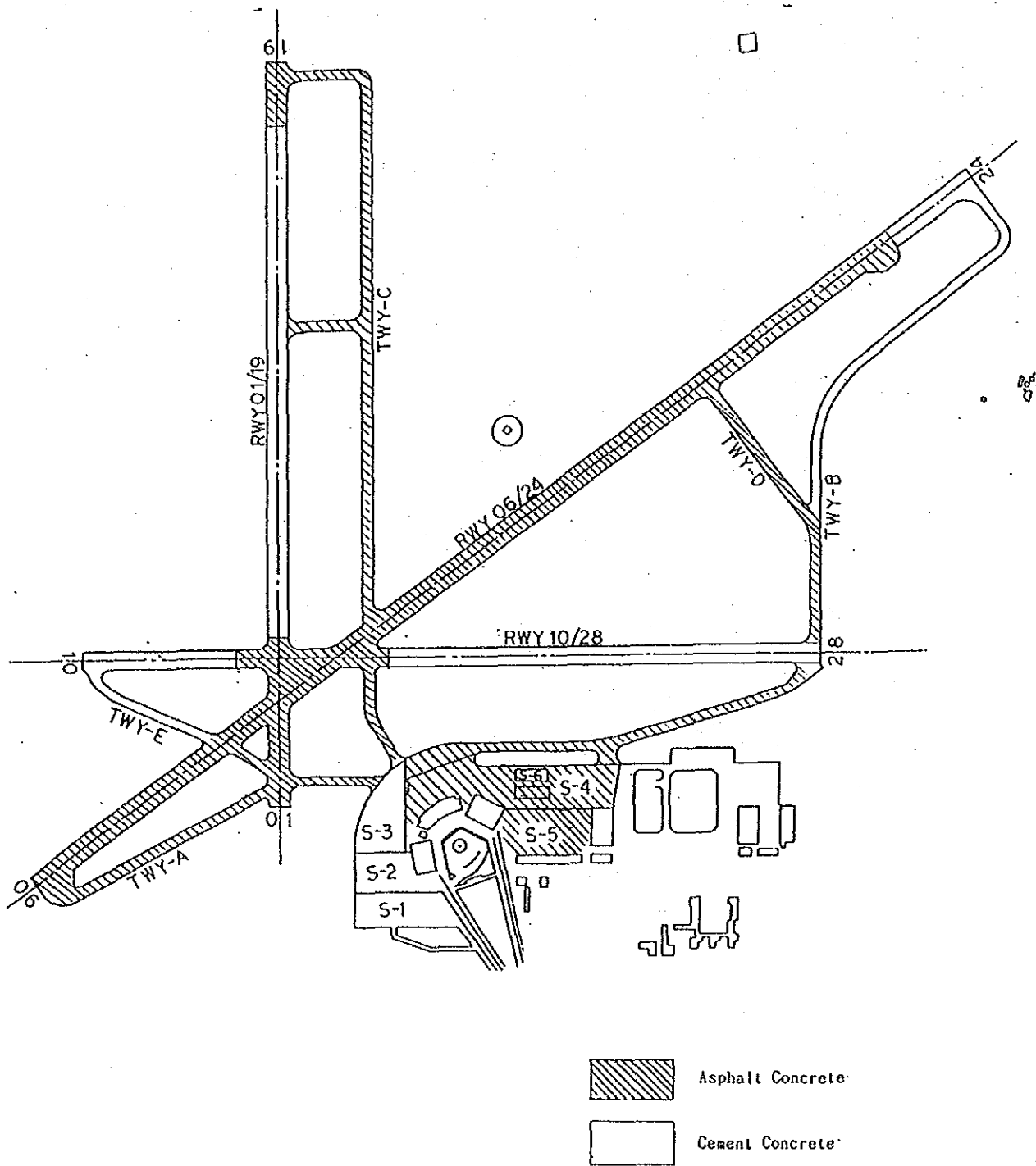


Fig. 3-1 EXISTING SURFACE LAYER



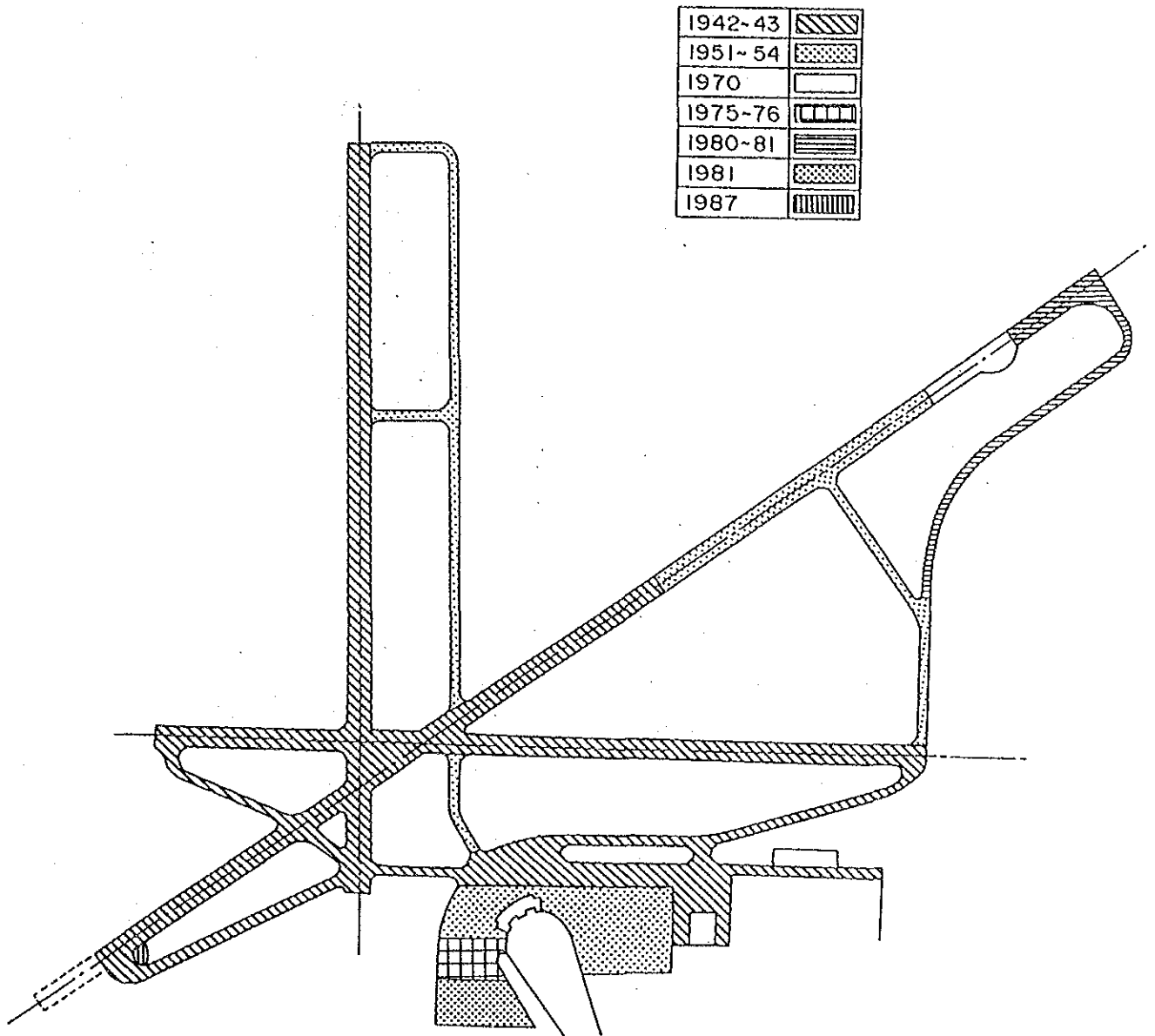






Fig. 3-2 ORIGINAL CONSTRUCTION HISTORY

1965 Asphalt overlay	
1980-81: Overlay (Asphalt concrete)	
1985: Overlay (Asphalt concrete)	
1986: Overlay (Asphalt concrete)	

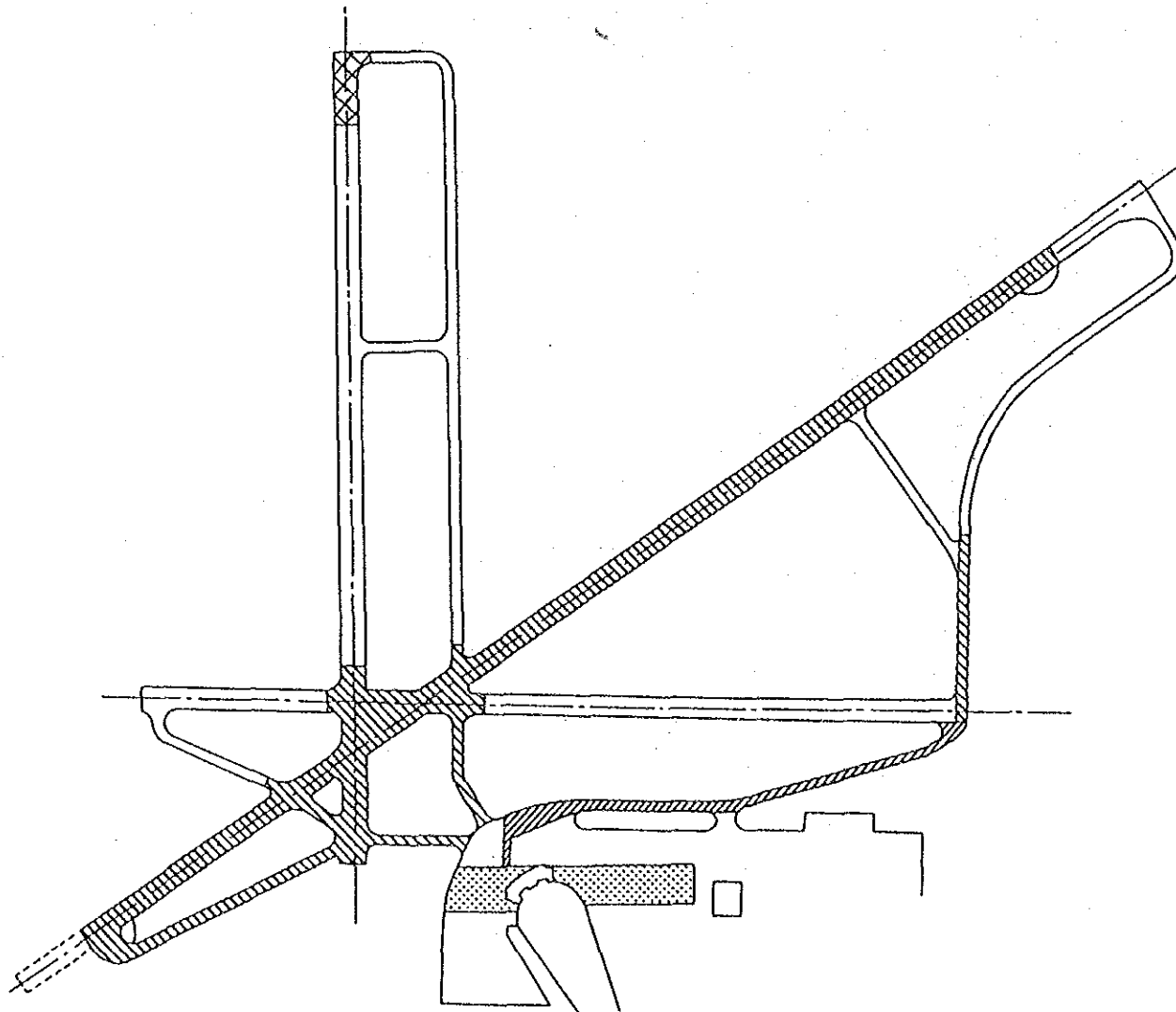


Fig. 3-3 HISTORY OF OVERLAY WORKS

(3) Summary of existing facilities

1) Primary runway and related taxiways

	<u>Length</u>	<u>Width</u>	<u>Strength</u>
RWY06/24:	2,700 m x	45 m,	60/F/C/W/U
Runway strip:	3,560 m x	150 m,	---
TWY - A:	---	23 m,	60/F/C/W/T
TWY - B:	---	23 m,	55/F/C/W/T
TWY - D:	---	23 m,	---

2) Secondary runways and related taxiways

	<u>Length</u>	<u>Width</u>	<u>Strength</u>
RWY01/19:	1,750 m x	48 m,	22/R/C/Y/T
Runway strip:	2,450 m x	150 m,	---
TWY - C:	---	23 m,	55/F/C/W/T
RWY10/28:	1,700 m x	45 m,	22/R/C/Y/T
TWY - E:	---	18 m,	---

3) Apron

For B-747 : 3 spots.  
DC-10 : 1 spot.  
B-707 : 3 spots.  
B-737 : 2 spots.

Remarks: Above information is based on AIP URUGUAY.