4.3 Annual International Passenger Forecast

Annual demand for international passengers at Juan Santamaria and Liberia Airports are forecast based on the flowchart in Figure 4.3.1. Details of the calculation are *given in the following sections.*

4.3.1 Total Future International Passengers in Costa Rica

The demand forecast concerning total future international passengers in Costa Rica was made by using the following logistic curve:

$$y = \frac{k}{1+\alpha \cdot e^{\beta \cdot x}} \quad \cdots\cdots (4.3.1)$$

where, y: Traffic demand

x: GDP

α, β and k: Parameters

The parameters shown in Table 4.3.1 were obtained by regression analysis of actual records of traffic in Table 2.5.3 and past GDP in Table 4.2.1. As actual examples, *the results of the regression analyses for North America and Europe are given in* Appendix-4.3.1.

Table 4.3.1 Parameters from Regression Analysis

Zone	α	β	k
- North America	150.503	-8.35356E - 04	2,100
- Central America	629.045	-0.152106	12,000
- South America	60.8681	-0.137585	200
- Caribbeans	3420.27	-1.36894	280
- Europe	195.081	-5.82123E - 03	110

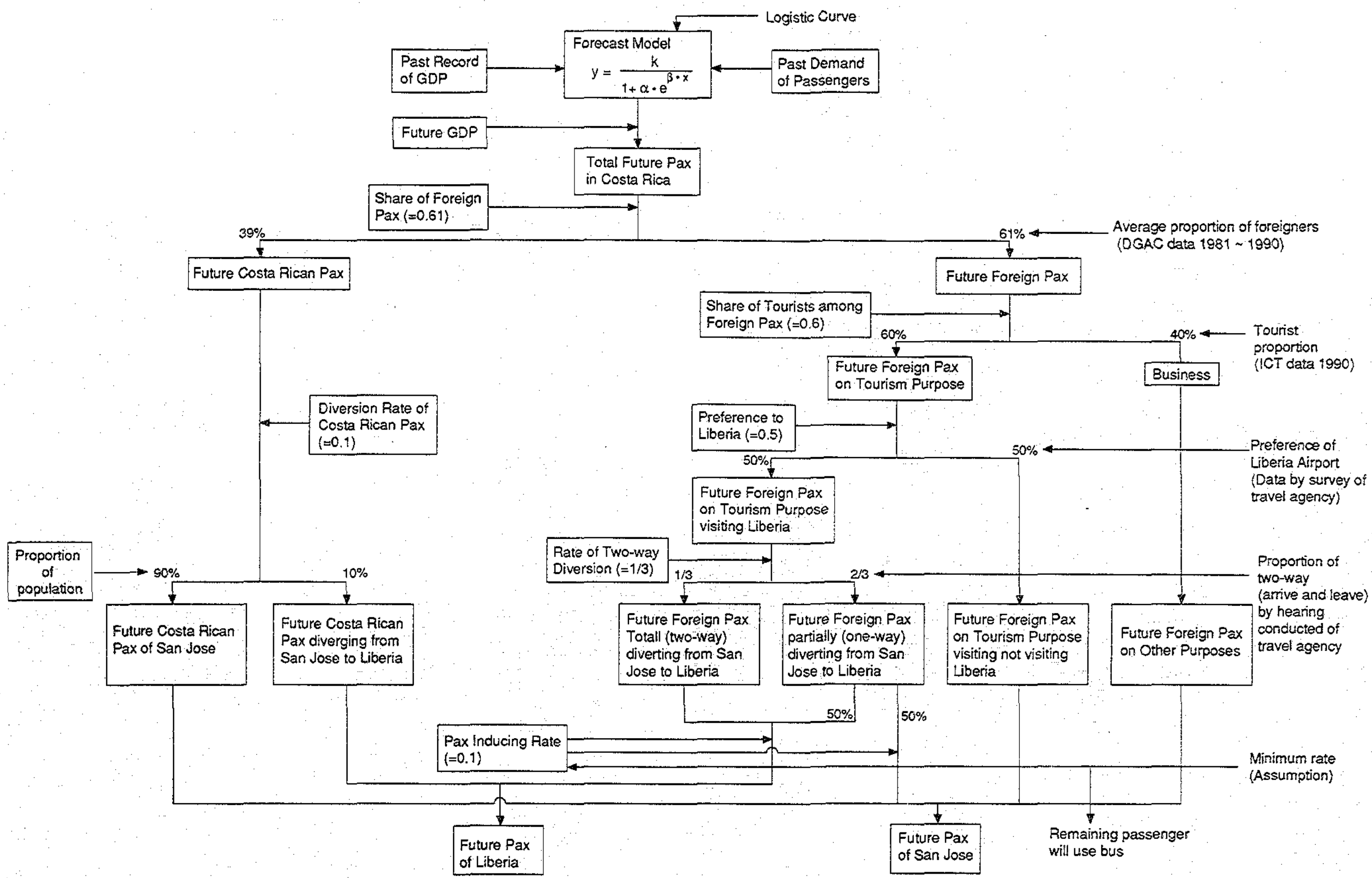


Figure 4.3.1 Flowchart for Forecast of International Passenger Demand

Future total international passengers estimated by equation (4.3.1) are given in Table 4.3.2). It is noted that induced traffic by the introduction of direct flights to Liberia Airport have not been taken into consideration in Table 4.3.2.

Table 4.3.2 Future Total International Passengers in Costa Rica

(Unit: 1,000 Pax)

Year	North America	Central America	South America	Caribbeans	Europe	Total
1991	593	293	55	64	31	1,036
1992	649	303	59	71	33	1,115
1993	710	314	62	77	35	1,199
1994	776	326	65	85	38	1,290
1995	846	338	69	93	40	1,386
1996	921	351	73	101	43	1,488
1997	999	364	77	110	46	1,596
1998	1,080	378	81	120	49	1,708
1999	1,164	393	85	129	52	1,823
2000	1,248	409	90	139	55	1,941
2001	1,333	425	94	150	58	2,060
2002	1,416	442	99	160	61	2,179
2003	1,497	460	104	170	65	2,295
2004	1,574	478	109	180	68	2,409
2005	1,646	497	114	190	71	2,519
2006	1,713	517	119	199	74	2,623
2007	1,782	538	124	208	77	2,729
2008	1,853	559	129	217	80	2,839
2009	1,927	582	135	226	84	2,952
2010	2,004	605	140	235	87	3,070
1990 -2000 (*)	8.9%	4.7%	7.4%	8.8%	5.9%	7.7%
2000 -2010 (*)	4.8%	4.0%	4.5%	5.4%	4.7%	4.7%

Note : (*) Average Annual Growth Rate

4.3.2 Distribution of Foreign International Passengers

Foreign international passengers are distributed to Juan Santamaria and Liberia Airports by estimating the following categories of passengers along with considering the induced traffic by the introduction of direct international flights to Liberia

a) Juan Santamaria Airport

- Passengers on Other Purposes (than Tourism) : NTQ
- Passengers on Tourism Purpose not Visiting Liberia : NDQ
- Passengers on Tourism Purpose Partially Diverting (one-way) from San Jose to Liberia (using both San Jose and Liberia for ports of entry/exit) : HDQ•0.5

b) Liberia Airport

- Passengers on Tourism Purpose Totally Diverting (two-way) from San Jose to Liberia (using only Liberia for port of entry/exit) : TDQ
- Passengers on Tourism Purpose Partially Diverting (one-way) from San Jose to Liberia (using both San Jose and Liberia for ports of entry/exit) : HDQ•0.5

The above categories of passengers are estimated by the following equations:

$$NTQ = Q \cdot RF \cdot (1 - RT) \quad (4.3.1)$$

$$NDQ = Q \cdot RF \cdot RT \cdot (1 - RL) \quad (4.3.2)$$

$$TDQ = Q \cdot RF \cdot RT \cdot RL \cdot RTD \quad (4.3.3)$$

$$HDQ = Q \cdot RF \cdot RT \cdot RL \cdot (1 - RTD) \quad (4.3.4)$$

where,
- Q : The Total international passenger in Costa Rica in Table 4.3.2.
- RF : Proportion of foreign Passengers among the entire number of passengers (RF = 0.61, the average between 1981 through 1990 obtained from the DGAC data)
- RT : Proportion of tourists among the foreign passengers (RT = 0.6, from 1990 data of Encuesta Area de Extranjeros, Instituo Costarrisense de Tourismo)
- RL : Preference of Liberia Airport indicated by the foreign tourists (RL = 0.5, obtained by surveying travel agencies)
- RTD : Proportion of both arrival and departure (not one way) being diverted to Liberia Airport (RTD = 1/3 obtained from hearings conducted of travel agencies)

The results of the estimate are included in Appendix-4.3.2.

By the introduction of direct international flights to Liberia, induced traffic will be anticipated by improving passengers' convenience. Considering the above effect, the annual demand of foreign international passengers for Juan Santamaria and Liberia Airports are estimated by the following equations:

$$FSQ = NTQ + NDQ + HDQ \cdot (1 + INDR) \cdot 0.5 \quad (4.3.5)$$

$$FLQ = TDQ + HDQ \cdot (1 + INDR) \cdot 0.5 \quad (4.3.6)$$

where,
FSA : Foreign international passengers at Juan Santamaria Airport
FLA : Foreign international passengers at Liberia Airport
INDR : Traffic inducing rate (INDR = 0.1, As there was no accumulated data available for the rate of induced traffic, the minimum was estimated.)

The results of the estimation are indicated in Table 4.3.3.

Table 4.3.3 Annual Demand of Foreign International Passengers

(Unit: 1,000 Pax)

Year	Juan Santamaria Airport	Liberia Airport	Total
1991	632	-	632
1992	680	-	680
1993	592	154	746
1994	637	165	803
1995	685	178	862
1996	735	191	926
1997	789	204	993
1998	844	219	1,063
1999	901	234	1,134
2000	959	249	1,208
2001	1,018	264	1,282
2002	1,077	279	1,356
2003	1,134	294	1,428
2004	1,012	262	1,275
2005	1,245	323	1,567
2006	1,296	336	1,632
2007	1,348	350	1,698
2008	1,403	364	1,766
2009	1,459	378	1,837
2010	1,517	393	1,910

4.3.3 Distribution of Costa Rican International Passengers

Distribution of Costa Rican international passengers between Juan Santamaria and Liberia Airports are determined by the following equations:

$$CSQ = Q \cdot (1 - RF) \cdot (1 - RCL) \quad (4.3.7)$$

$$CSQ = Q \cdot (1 - RF) \cdot RCL \quad (4.3.8)$$

where,
CSQ : Costa Rican international passengers at Juan Santamaria Airport
CLQ : Costa Rican international passengers at Liberia Airport
RCL : Rate of Costa Rican passengers diverting from Juan Santamaria Airport to Liberia Airport (RCL = 0.1 and is the proportion of the population in the Liberia area to the nationwide population).

The results of the estimate are indicated in Table 4.3.4.

Table 4.3.4 Annual Demand of Costa Rican Passengers

Year	Juan Santamaria Airport	Liberia Airport	Total
1991	404	-	404
1992	435	-	435
1993	421	47	468
1994	453	50	503
1995	486	54	541
1996	522	58	580
1997	560	62	622
1998	600	67	666
1999	640	71	711
2000	681	76	757
2001	723	80	803
2002	765	85	850
2003	806	90	895
2004	719	80	799
2005	884	98	982
2006	921	102	1,023
2007	958	106	1,064
2008	996	111	1,107
2009	1,036	115	1,151
2010	1,078	120	1,197

4.3.4 Annual International Passengers at Juan Santamaria and Liberia Airports

Annual demand of international passengers at Juan Santamaria and Liberia Airports are calculated in Table 4.3.5 and as a total of demand for foreign passengers and Costa Rican passengers estimated in Tables 4.3.3 and 4.3.4.

Table 4.3.5 Annual International Passengers at Juan Santamaria and Liberia Airports

(Unit: 1,000 Pax)

Year	Juan Santamaria Airport						Liberia Airport
	North America	Central America	South America	Caribbeans	Europe	Total	
1991	593	293	55	64	31	1,036	-
1992	639	315	59	69	33	1,115	-
1993	600	266	52	65	30	1,013	200
1994	656	275	55	72	32	1,090	216
1995	715	286	58	78	34	1,171	232
1996	778	296	61	86	36	1,258	249
1997	844	308	65	93	39	1,349	267
1998	913	320	68	101	41	1,443	285
1999	984	332	72	109	44	1,541	305
2000	1,055	345	76	118	46	1,640	324
2001	1,127	359	80	126	49	1,741	344
2002	1,197	374	84	135	52	1,841	364
2003	1,265	389	88	144	55	1,940	383
2004	1,330	404	92	152	57	2,036	342
2005	1,391	420	96	161	60	2,128	421
2006	1,448	437	101	169	63	2,217	438
2007	1,506	455	105	176	65	2,307	456
2008	1,566	473	109	183	68	2,399	474
2009	1,628	492	114	191	71	2,495	493
2010	1,694	511	118	198	73	2,595	513
1990 -2000 (*)	7.1%	2.9%	5.6%	7.0%	4.0%	5.9%	-
2000 -2010 (*)	4.8%	4.0%	4.5%	5.3%	4.7%	4.7%	4.7%

Note : (*) Average Annual Growth Rate

4.4 Annual Domestic Passenger Forecast

Annual demand of domestic cargo at Juan Santamaria and Liberia Airports are forecast based on the flowchart in Figure 4.4.1.

4.4.1 Trend Projection

Due to erratic growth of the domestic passenger demand in Costa Rica which has been influenced by the development of a highway system and closure of airports for improvement, no significant relationship was found between the past demand and any economic indices. However, as a general trend since the recovery of the national economy of the country in 1983, the growth of the domestic passenger demand indicated an elasticity of 0.8 with respect of GDP growth. (3.4% per annum traffic growth divided by 4.5% per annum GDP growth).

Since the utilization of domestic air transport is expected to increase in accordance with the rise of passenger income levels, the future domestic passenger demand is estimated based on an assumption that this elasticity will be maintained for the future. Then, an annual growth rate of 2.4% (0.8 multiplied by future estimate of Costa Rican GDP of 3.0% per annum) is applied for the estimate of future domestic passenger demand in Costa Rica. Although this method enables only rough estimation, it is sufficient for the succeeding airport planning because the influence of the domestic demand on airport planning is considered minimal due to the small amount of demand. The results of the estimate for future domestic passenger demand at Juan Santamaria Airport for other than the Liberia route and Liberia route are shown in Table 4.4.1.

Table 4.4.1 Trend Projection of Annual Domestic Passengers at Juan Santamaria Airport

(Unit: 1,000 Pax)

Year	Passengers on Other Than Liberia Route	Passengers on Liberia Route	Total
1991	66.4	-	66.4
1992	67.9	-	67.9
1993	69.6	2.5	72.1
1994	71.2	2.6	73.8
1995	73.0	2.7	75.6
1996	74.7	2.7	77.4
1997	76.5	2.8	79.3
1998	78.3	2.8	81.2
1999	80.2	2.9	83.1
2000	82.1	3.0	85.1
2001	84.1	3.1	87.2
2002	86.1	3.1	89.3
2003	88.2	3.2	91.4
2004	90.3	3.3	93.6
2005	92.5	3.4	95.8
2006	94.7	3.4	98.1
2007	97.0	3.5	100.5
2008	99.3	3.6	102.9
2009	101.7	3.7	105.4
2010	104.1	3.8	107.9

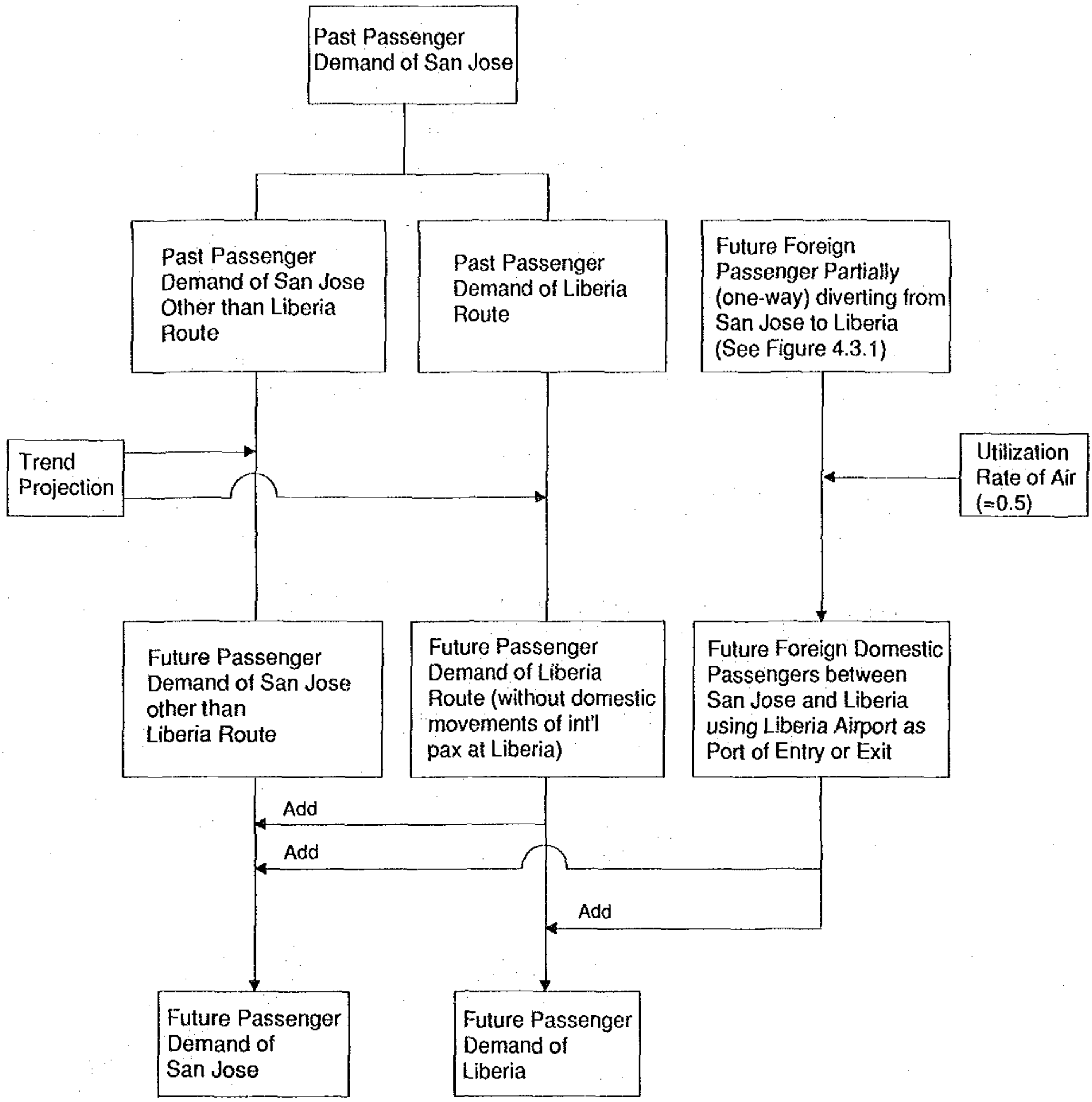


Figure 4.4.1 Flowchart for Forecast of Domestic Passenger Demand

4.4.2 Effect of Direct International Flights at Liberia Airport

The trend projection in the previous section does not include the effect of introduction of direct international flights at Liberia Airport. As explained in Section 4.3, there will be a certain amount of foreign tourists who will utilize both Juan Santamari and Liberia Airport for the ports of entry and exit, and some portion of those passengers is expected to use domestic air transport between Juan Santamaria and Liberia Airports. They are estimated by the following equation:

$$DDQ = HDQ \bullet (1 + INDR) \bullet 0.5 \bullet URA \quad (4.4.1)$$

where, DDQ : Future foreign domestic passengers between San Jose and Liberia utilizing Liberia Airport as the port of entry or exit.

URA : Utilization rate of air (= 0.5, assuming 50% by air and 50% by bus)

4.4.3 Annual Domestic Passengers at Juan Santamaria and Liberia Airport

Annual domestic passengers at Juan Santamaria and Liberia Airports are estimated as a sum of values in Table 4.4.1 and the calculation result of equation (4.4.1). They are shown in Table 4.4.2.

Table 4.4.2 Annual Domestic Passengers at Juan Santamaria and Liberia Airport

(Unit: 1,000 Pax)

Year	Juan Santamaria Airport	Liberia Airport
1991	66.4	-
1992	101.3	-
1993	105.4	35.8
1994	109.6	38.4
1995	114.0	41.1
1996	118.7	44.0
1997	123.5	47.0
1998	128.5	50.2
1999	133.7	53.5
2000	138.9	56.8
2001	144.3	60.2
2002	149.7	63.5
2003	155.0	66.8
2004	150.4	60.1
2005	165.7	73.2
2006	170.9	76.2
2007	176.2	79.2
2008	181.6	82.3
2009	187.2	85.5
2010	193.0	88.9
1990 -2000 (*)	7.9%	-
2000 -2010 (*)	3.3%	4.6%

Note : (*) Average Annual Growth Rate

4.5 Annual International Cargo Forecast

Annual demands of international cargo at Juan Santamaria and Liberia Airports are forecast based on the flowchart in Figure 4.5.1. Future values of exported and imported cargo demands in Costa Rica are respectively estimated and are distributed to Juan Santamaria and Liberia Airports.

4.5.1 Total Future Exported Cargo in Costa Rica

The logistic curve expressed as the equation (4.3.1) was used in the demand forecast for exported cargo. The values of the parameters are shown in Table 4.5.1. These parameters were obtained by regression analysis of the past exported cargo demand at Juan Santamaria Airport in Table 2.5.5 and the past figures of GDP in Costa Rica in Table 4.2.1. As actual examples, the results of the regression analyses for North America and Europe are given in Appendix-4.5.1. The future estimated exported cargo volume is shown in Table 4.5.2.

Table 4.5.1 Parameters from Regression Analysis

Zone	α	β	k
- North America	4429.34	-1.35719E - 03	265,000
- Central America	19.6831	-0.210337	2,800
- South America	119.795	0.0030461	20,000
- Caribbeans	178.189	-0.0552265	210,000
- Europe	12692.8	-0.0107872	16,000

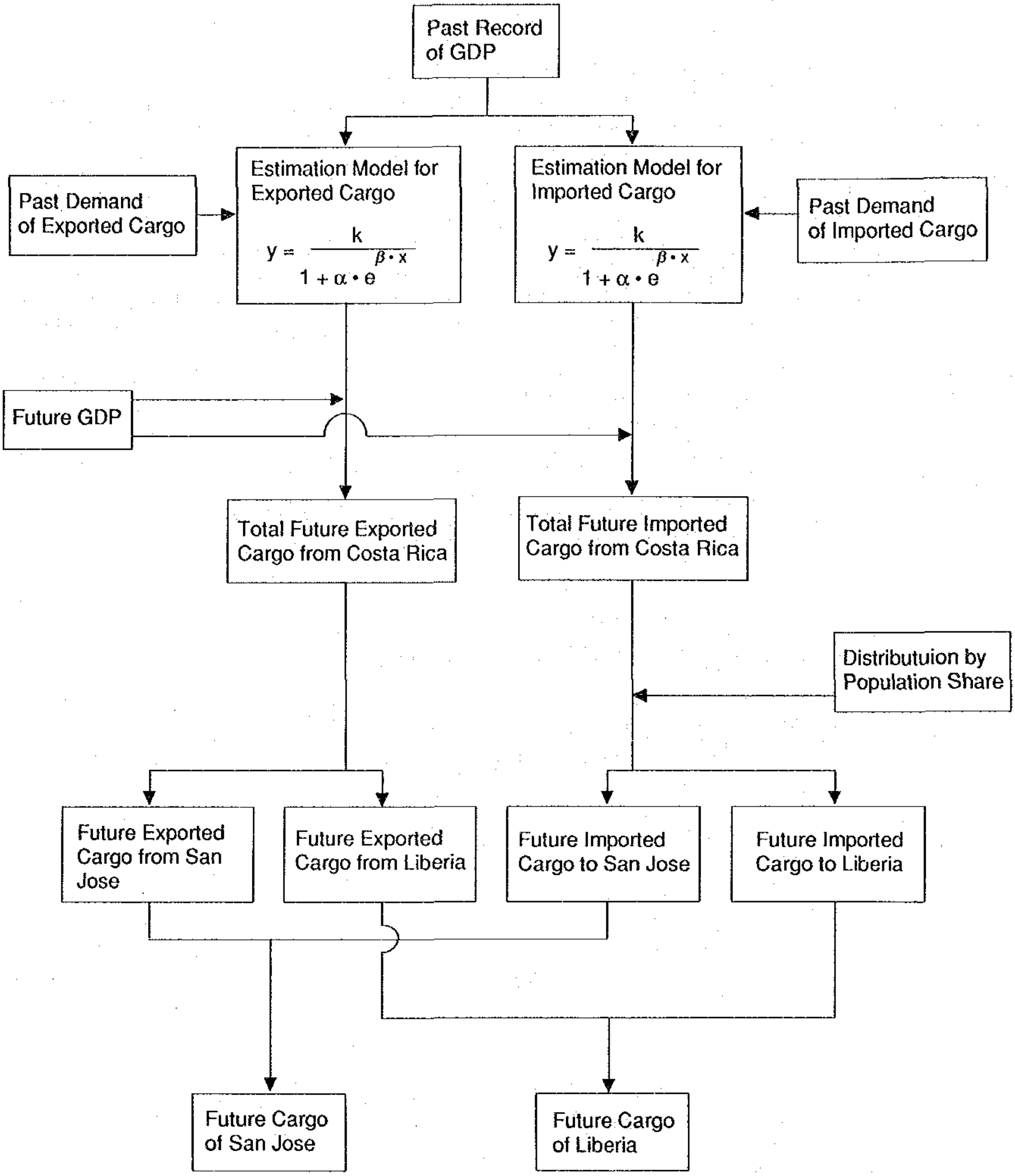


Figure 4.5.1 Flowchart for Forecast of International Cargo Demand

Table 4.5.2 Future Total Exported Cargo in Costa Rica

(Unit: Ton)

Year	North America	Central America	South America	Caribbeans	Europe	Total
1991	38,711	1,959	158	1,570	3,113	45,531
1992	46,146	1,998	161	1,602	3,600	53,506
1993	54,949	2,038	164	1,634	4,127	62,912
1994	65,268	2,079	168	1,666	4,714	73,895
1995	77,199	2,120	171	1,700	5,362	86,552
1996	90,757	2,163	174	1,734	6,066	100,893
1997	105,833	2,206	178	1,768	6,820	116,806
1998	122,172	2,250	181	1,804	7,613	134,021
1999	139,359	2,295	185	1,840	8,432	152,111
2000	156,842	2,341	189	1,877	9,259	170,507
2001	173,995	2,388	192	1,914	10,077	188,566
2002	190,202	2,436	196	1,952	10,867	205,653
2003	204,945	2,484	200	1,991	11,612	211,233
2004	217,868	2,534	204	2,031	12,301	234,938
2005	228,806	2,585	208	2,072	12,922	246,593
2006	237,767	2,637	212	2,113	13,472	256,201
2007	244,900	2,689	217	2,156	13,948	263,910
2008	252,247	2,743	221	2,199	14,367	271,776
2009	259,814	2,798	225	2,243	14,798	279,878
2010	267,609	2,854	230	2,287	15,242	288,222
1990 -2000 (*)	15.8%	2.4%	3.7%	3.9%	14.8%	15.1%
2000 -2010 (*)	5.5%	2.0%	1.9%	2.0%	5.1%	5.4%

Note : (*) Average Annual Growth Rate

4.5.2 Total Future Imported Cargo in Costa Rica

The logistic curve was also used forecast demand of imported cargo. The values of the parameters are shown in Table 4.5.3. These parameters were obtained by regression analyses of the past imported cargo demand in Juan Santamaria Airport in Table 2.5.6 and the past figures of GDP in Costa Rica in Table 4.2.1. As actual examples, the results of regression analysis for North America and the Caribbean countries are given in Appendix-4.5.2. The estimated future imported cargo volume is shown in Table 4.5.4.

Table 4.5.3 Parameters from Regression Analysis

Zone	α	β	k
- North America	1013.41	-1.15718	89,000
- Central America	2137.68	-0.0705542	3.5E + 0.6
- South America	28737.5	-0.178045	3.5E + 0.6
- Caribbeans	1796.47	-1.21581	4,100
- Europe	4.51876	-0.395835	1,100

Table 4.5.4 Future Total Imported Cargo in Costa Rica

(Unit: Ton)

Year	North America	Central America	South America	Caribbeans	Europe	Total
1991	22,952	2,339	300	856	684	27,132
1992	26,074	2,365	303	988	700	30,429
1993	29,535	2,391	306	1,138	715	34,085
1994	33,326	2,418	309	1,306	731	38,090
1995	37,419	2,447	312	1,491	747	42,417
1996	41,768	2,476	316	1,694	763	47,017
1997	46,301	2,507	319	1,910	779	51,816
1998	50,931	2,540	322	2,136	795	56,723
1999	55,554	2,573	325	2,367	811	61,630
2000	60,063	2,609	328	2,596	827	66,423
2001	64,355	2,645	332	2,817	843	70,991
2002	68,339	2,684	335	3,025	859	75,242
2003	71,949	2,724	338	3,216	874	79,101
2004	75,143	2,766	342	3,385	889	82,524
2005	77,904	2,810	345	3,531	904	85,494
2006	80,242	2,856	349	3,655	918	88,018
2007	82,180	2,904	352	3,757	932	90,125
2008	83,824	2,954	356	3,839	946	91,919
2009	85,501	3,007	359	3,916	960	93,742
2010	87,211	3,062	363	3,994	974	95,604
1990 -2000 (*)	11.0%	2.1%	-1.1%	11.7%	1.6%	10.2%
2000 -2010 (*)	3.8%	1.6%	1.0%	4.4%	1.6%	3.7%

Note : (*) Average Annual Growth Rate

4.5.3 Annual International Cargo at Juan Santamaria and Liberia Airports

Total exported and imported cargo demands estimated in the previous two sections were distributed to Juan Santamaria and Liberia Airports. All exported cargo is at present loaded at Juan Santamaria Airport since major export items of Costa Rica, i.e., flowers and light industrial products, are all produced around the San Jose area. Although this export loading from Juan Santamaria Airport will be continued for several years, Liberia Airport may share a small percentage of export loading by inauguration of direct international flights, growth of flight numbers and establishment of export facilities, such as a delivery center and cold storage for perishable cargo. Imported cargo covering a wide range of commodities, such as general machinery, electrical equipment, spare parts, food and medicine may be distributed to Liberia Airport after the inauguration of direct international flights. The share of imported cargo of Liberia Airport will be in proportion to the population. The results of the estimate based on the above considerations are summarized in Table 4.5.5.

Table 4.5.5 Annual International Cargo at Juan Santamaria and Liberia Airport

(Unit: Ton)

Year	Juan Santamaria Airport	Liberia Airport
1991	72,663	-
1992	83,985	-
1993	91,701	5,296
1994	105,959	6,026
1995	122,131	6,838
1996	140,182	7,728
1997	159,936	8,686
1998	181,051	9,693
1999	203,015	10,726
2000	225,172	11,758
2001	246,801	12,756
2002	267,201	13,694
2003	276,087	14,247
2004	302,161	15,301
2005	316,140	15,947
2006	327,731	16,488
2007	337,105	16,930
2008	346,350	17,345
2009	355,849	17,771
2010	365,619	18,207
1990 -2000 (*)	12.9 %	-
2000 -2010 (*)	5.0 %	4.5 %

Note : (*) Average Annual Growth Rate

4.6 Annual Domestic Cargo Forecast

The previous data for domestic cargo demand was determined to be very poor with annual records being available up to 1988 at Juan Santamaria Airport only. Since the cargo demand at the airport is small and has the least impact on airport planning, a simple method using an unit volume of cargo per passenger is employed. The cargo space available for presently operating Aviocar (C-212) is very limited in weight and size. Therefore, the actual value in 1988 of 5.1 kg/passenger can be assumed to be maintained for the future. The future domestic cargo demand at Juan Santamaria and Liberia Airports are estimated as shown in Table 4.6.1.

Table 4.6.1 Annual Domestic Cargo at Juan Santamaria and Liberia Airport

(Unit: Ton)

Year	Juan Santamaria Airport	Liberia Airport
1991	338	-
1992	517	-
1993	537	182
1994	559	196
1995	582	210
1996	605	224
1997	630	240
1998	656	256
1999	682	273
2000	709	290
2001	736	307
2002	763	324
2003	791	341
2004	767	306
2005	845	373
2006	871	388
2007	898	404
2008	926	420
2009	955	436
2010	984	453
1990 -2000 (*)	7.3%	-
2000 -2010 (*)	3.4%	4.6%

Note : (*) Average Annual Growth Rate

4.7 Annual Aircraft Movement Forecast

4.7.1 International Passenger Aircraft Movements

1) Juan Santamaria International Airport

The types of aircraft presently operating at Juan Santamaria Airport are DC-10, A-300, B-767, B-707, B-757, B-727, A-320, B-737 and DC-9. Wide-body jets are operated for Miami route (A-300) and long-range European routes of Madrid and Amsterdam (DC-10). All other routes are operated by narrow-body jets.

The Miami route, with 351,000 annual passengers in 1990, accounted for approximately 40% of the total international passengers, and is one of the highest traffic routes in Costa Rica. The annual route passengers will reach about 650,000 and 1,000,000 in 2000 and 2010 respectively. For this route, it is expected that the share of wide-body jets will increase in accordance with the increase of route demand. The demands for other routes from/to Juan Santamaria Airport were much lower than the Miami route with less than 70,000 annual passengers in 1990. Since the total annual passenger demand in 2010 will be about 2.8 times the 1990 traffic, the passenger demands for these other routes will be less than 200,000 even in 2010. For this level of traffic, it is expected that the increase of traffic will be met with an increase of flight frequency. Based on the above estimate and an increasing trend in the average number of passengers per aircraft movement for the past several years at Juan Santamaria Airport, the annual number of international passenger aircraft movements is forecast as shown in Table 4.7.1.

Table 4.7.1 Annual International Passenger Aircraft Movements at Juan Santamaria Airport

Item	1990 (Actual)	1995	2000	2005	2010
1. Passengers	923,000	1,171,000	1,640,000	2,128,000	2,595,000
2. Pax/Aircraft Mvt.	64	69	74	80	86
3. Total Aircraft Movements	14,532	17,000	22,100	26,600	30,100
4. Aircraft Mix					
a) Jumbo Jet (JJ)	-	-	-	2%	5%
b) Wide-body Jet (WB)	4%	10%	16%	18%	20%
c) Narrow-body Jet (NB)	96%	90%	84%	80%	75%
5. Aircraft Movements by Aircraft Types					
a) Jumbo Jet (JJ)	-	-	-	530	1,500
b) Wide-body Jet (WB)	580	1,700	3,540	4,790	6,020
c) Narrow-body Jet (NB)	13,910	15,300	18,560	21,280	22,580
6. Passenger Share by Aircraft-Types *2					
a) Jumbo Jet (JJ)	-	-	-	6%	15%
b) Wide-body Jet (WB)	10%	22%	32%	34%	35%
c) Narrow-body Jet (NB)	90%	78%	68%	60%	50%

Note 1: Average annual growth rate of 1.5% based on the past trend from 1985 to 1990 at Juan Santamaria Airport.

2: Seat capacity, JJ:400, WB:250 and NB:100

The seat capacity of the narrow body jet is reduced by 30% from the actual average capacity of 140 taking into account the share of transit passengers.

3: Annual average load factor is set at 60% based on the actual records.

2) Liberia International Airport

Upon reopening of Liberia Airport with the extended runway in 1992, some airlines have placed interest in operating international flights. These are the LACSA to Miami, Air Canada from Montreal and LTU from Dusselfolf. The LACSA plans scheduled flights by their narrow-body jet, and others by DC-10. The international passenger aircraft movements at Liberia Airport are estimated based on an assumed share of 5% for charter flights by wide-body jets. The results of the estimate are shown in Table 4.7.2.

Table 4.7.2 Annual International Passenger Aircraft Movements at Liberia Airport

Item	1995	2000	2005	2010
1. Passengers	232,000	324,000	421,000	513,000
2. Aircraft Mix				
a) Wide-body Jet (WB)	5%	5%	5%	5%
b) Narrow-body Jet (NB)	95%	95%	95%	95%
3. Aircraft Movements				
a) Wide-body Jet (WB)	100	150	200	250
b) Narrow-body Jet (NB)	2,100	2,850	3,700	4,550
c) Total	2,200	3,000	3,900	4,800

Note: Seat capacity, WB: 250 and NB: 140

4.7.2 Domestic Passenger Aircraft Movements

Types of aircraft currently used by the domestic airline, SANSA, are C-212 (22 seats) and DC-3 (32 seats). The weighted average of seat capacity by scheduled aircraft movement is 25.

The current aircraft mix is expected to cope with the future traffic increase by the increase of flight frequency up to 2010. Therefore, the annual number of the domestic scheduled aircraft movements at Juan Santamaria and Liberia Airports are estimated by using this present average seat capacity and by an actual average load factor of 80% as show in Table 4.7.3.

Table 4.7.3 Annual Domestic Aircraft Movements at Juan Santamaria and Liberia Airports

Year	1990 (Actual)	1995	2000	2005	2010
- Juan Santamaria Airport	3,190	5,700	6,900	8,300	9,700
- Liberia Airport	-	2,100	2,800	3,700	4,400

Note: All movements by Small Prop (SJ) with average seat capacity of 25.

4.7.3 International Freighter Aircraft Movements

Due to limited cargo capacity of the narrow-body passenger aircraft which accounted for most of the international passenger aircraft movements, a considerable volume of the international cargo was carried by freighter aircraft at Juan Santamaria Airport. Approximately 50% of the total cargo demand at the airport was transported by freighter airlines such as Challange Air Cargo, Florida West, Wrangler and Trans Cargo. This trend is expected to continue in the future.

The annual number of freighter aircraft is estimated by the following method:

- Estimation of cargo volume to be transported by passenger aircraft
- Estimation of cargo volume to be transported by freighter aircraft as total cargo forecast volume minus cargo volume to be transported by passenger aircraft
- Estimation of annual freighter aircraft movements with a projection of average cargo volume per freighter movement in the future

The above calculation is presented in Table 4.7.4.

Table 4.7.4 International Freighter Aircraft Movements at Juan Santamaria Airport

Item	1990 (Actual)	1995	2000	2005	2010
1. Cargo (ton)					
a) Passenger Aircraft	34,444	57,800	86,190	117,040	150,500
b) Freighters	32,459	64,331	138,982	199,100	215,119
c) Total	66,903	122,131	225,172	316,140	365,619
2. Cargo/AC Mvts. (ton)					
a) Passenger Aircraft *1	2.4	3.4	3.9	4.4	5.0
b) Freighters	14.8	16.0	17.2	18.5	20.0
3. Aircraft Movements					
a) Passenger Aircraft	14,532	17,000	22,100	26,600	30,100
b) Freighters	2,198	4,000	8,100	10,800	10,800

Note 1: Cargo load factor of 80% miltiplied by average cargo capacity of future aircraft mix (1995: 4.2 ton, 2000: 4.9 ton, 2005: 5.5 ton, 2010: 6.3 ton). Cargo capacities for NB, WB and JJ are 3 ton, 15 ton and 20 ton respectively. Aircraft mix is from table 4.7.1.

2: Cargo volume per freighter movements will increase by 1.5% per annum assuming that the present old freighters will be replaced by B-757 class freighters (cargo capacity: 39 ton, cargo load factor: 50%, cargo volume per movement: 20 ton).

4.7.4 General Aviation

Aircraft movements other than that of passenger and freighter aircraft include the movement of services for special (charter and fun flights), flying school, government, registered foreigners and agriculture (fumigation). The total general aviation movements at Juan Santamaria, Liberia, Limon and Tobias Bolaños Airports increased at an average growth rate of 4.0% from 1986 to 1989, while the GDP increased at an average growth rate of 4.6% for the same period. This indicates that the elasticity of the growth of general aviation movements with respect to GDP growth was 0.9 (4.0% divided by 4.6%).

The general aviation movements are estimated based on an assumption that this elasticity will be maintained for the foreseeable future. Therefore, an average annual growth rate of 2.7% (0.9 multiplied by future estimate of Costa Rican GDP growth of 3.0% per annum) is applied for the estimate of general aviation movements for the respective airports.

As for Limon Airport, no scheduled international or domestic flights will be expected due to proximity of this airport to Juan Santamaria Airport which is only a two-hour ride by bus. Small population size and a limited tourism industry are also the reasons for not justifying the regular flights. Major agricultural products from the region will continue to be exported by ships. However, some amount of passengers will continue to utilize this airport as charter flight passengers, in particular, during the special occasions such as Limon Carnival. These charter flights are expected to occupy approximately 15% of the total aircraft movements at Limon Airport based on the 1989 record.

The general aviation movements for Juan Santamaria, Liberia Limon and Tobias Bolaños Airports are estimated as shown in Table 4.7.5.

Table 4.7.5 General Aviation Movements at Juan Santamaría, Liberia, Limon and Tobias Bolaños Airport

Airport	1990 (Actual)	1995	2000	2005	2010
1. Juan Santamaria	15,649	17,900	20,400	23,300	26,700
2. Liberia	3,450 (*)	3,900	4,500	5,100	5,900
3. Limon					
a) Charter	203 (*)	230	260	300	350
b) Others	1,123 (*)	1,270	1,440	1,700	1,950
c) Total	1,326 (*)	1,500	1,700	2,000	2,300
4. Tobias Bolaños	28,258 (*)	32,300	36,900	42,100	48,100

Note : (*) 1989 figure

4.8 Peak Hour Forecast

4.8.1 Design Basis

Airport facilities should be planned on the design traffic which is determined so that the facilities may not unnecessarily cater to peak traffic. Peak hour traffic of an average day of the peak month, which is the most common design basis for airport facilities, is utilized in this Study. A flowchart describing the breakdown of the annual traffic volume to the peak hour demands is shown in Figure 4.8.1.

4.8.2 Peak Coefficients

The design day ratio, peak hour factor and heavy direction factor are used for the breakdown of annual aircraft movements as shown in Figure 4.8.1. These peak coefficients are obtained from the analysis of the actual traffic records.

1) Design Day Ratio

A design day ratio is a value indicating the degree of traffic concentration on an average day of the peak month against the annual traffic. The following values were obtained for the respective categories of aircraft movements from the monthly traffic records at Juan Santamaria Airport in 1990.

Table 4.8.1 Design Day Ratio

Category of Aircraft Movements	Design Day Ratio
- International Passenger Aircraft Movements	1/330
- Domestic Passenger Aircraft Movements	1/280
- International Freighter Aircraft Movements	1/290
- General Aviation Movements	1/300
- Total Aircraft Movements	1/330

Design day aircraft movements are obtained by multiplying the above design day ratio by annual aircraft.

2) Peak Hour Factor

A peak hour factor indicates a percentage of 2-way aircraft movements during the peak hour for the aircraft movements of the design day. This factor is usually given as a decreasing function of the number of design day aircraft movements because the peak of the traffic will gradually be flattened when the airport becomes congested. The following equation is found to express the peak hour factors of the international and domestic aircraft movements, and used for the peak hour forecast.

$$\alpha = \frac{1.5}{A} + 0.12 \qquad (4.8.1)$$

where, α: Peak hour factor

A: Design day aircraft movements

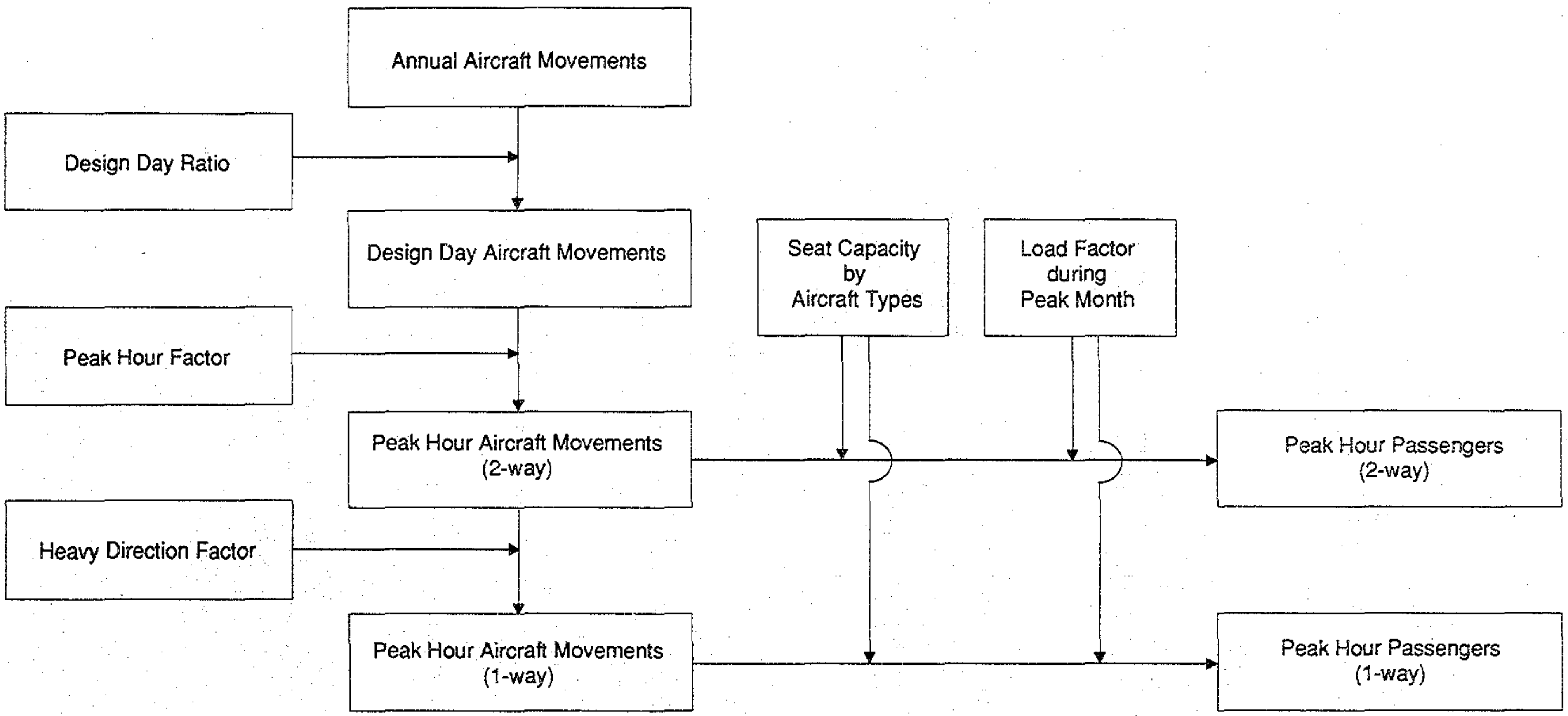


Figure 4.8.1 Flowchart for the Traffic Break-down

As for general aviation aircraft, peak hour movements are estimated by equally distributing the design day movements to eight hours of a day. Thus, the peak hour factor of 0.125 (1/8) is utilized.

Two-way peak hour aircraft movements are calculated by multiplying the above peak hour factor by design day aircraft movements for each category of aircraft.

3) Heavy Direction Factor

Heavy direction peak hour traffic, which is the traffic volume of 1-way traffic (arrival or departure) during the peak hour is also necessary for airport planning. A heavy direction factor which indicates the percentage of 1-way traffic to 2-way traffic is usually used to estimate this traffic. The value of 0.7 is used for the forecast based on the actual heavy direction factor at Juan Santamaria Airport.

4.8.3 Peak Hour Aircraft Movements

Airport movements during the peak hour of the design day of the peak month are estimated for five year intervals up to 2010 as show in Tables 4.8.2 and 4.8.3 for Juan Santamaria and Liberia Airports respectively.

Table 4.8.2 Peak Hour Aircraft Movements of Juan Santamaria Airport

Item		Int'l Passenger Aircraft				Domestic Passenger Aircraft	Int'l Freighter	General Aviation	Total
		JJ	WB	NB	Total				
Annual Aircraft Movements	1990 (Actual)	-	582	13,950	14,532	3,190	2,198	15,649	35,569
	1995	-	1,700	15,300	17,000	5,700	4,200	17,900	44,800
	2000	-	3,540	18,560	22,100	6,900	8,400	20,400	57,800
	2005	530	4,790	21,280	26,600	8,300	11,200	23,300	69,400
	2010	1,500	6,020	22,580	30,100	9,700	11,200	26,700	77,700
Design Day Aircraft Movements	1990 (Actual)	-	2	42	44	12	8	52	108
	1995	-	6	46	52	20	14	60	136
	2000	-	10	56	66	24	28	68	176
	2005	2	14	64	80	30	38	78	210
	2010	4	18	70	92	34	38	90	236
Peak Hour Aircraft Movements (2-way)	1990 (Actual)	-	-	7	7	3	2	7	17
	1995	-	1	7	8	4	3	8	20
	2000	-	1	8	9	4	5	9	22
	2005	-	2	9	11	5	6	10	26
	2010	1	2	10	13	5	6	11	29
Peak Hour Aircraft Movements (1-way)	1990 (Actual)	-	-	5	5	2	1	5	12
	1995	-	-	6	6	3	2	5	14
	2000	-	1	5	6	3	3	6	15
	2005	-	1	7	8	3	4	7	18
	2010	1	1	7	9	3	4	8	20

Table 4.8.3 Peak Hour Aircraft Movements at Liberia Airport

Item		Int'l Passenger Aircraft			Domestic Passenger Aircraft	General Aviation	Total
		WB	NB	Total			
Annual Aircraft Movements	1995	100	2,100	2,200	2,100	3,900	8,200
	2000	150	2,850	3,000	2,800	4,500	10,300
	2005	200	3,700	3,900	3,700	5,100	12,700
	2010	250	4,450	4,700	4,400	5,900	15,000
Design Day Aircraft Movements	1995	2	6	8	8	14	24
	2000	2	8	10	10	16	32
	2005	2	10	12	14	18	38
	2010	2	12	14	16	20	46
Peak Hour Aircraft Movements (2-way)	1995	1	1	2	2	2	6
	2000	1	1	2	3	2	7
	2005	1	2	3	3	2	8
	2010	1	2	3	3	3	9
Peak Hour Aircraft Movements (1-way)	1995	1	-	1	1	2	4
	2000	1	-	1	2	2	5
	2005	1	1	2	2	2	6
	2010	1	1	2	2	2	6

4.8.4 Peak Hour Passengers

The future number of peak hour passengers at Juan Santamaria and Liberia Airports should correspond to the peak hour aircraft movements in Tables 4.8.2 and 4.8.3 respectively. Peak hour passengers are calculated by multiplying the peak hour aircraft movements, seat capacity by aircraft types and passenger load factor during the peak month. The load factor of 80% is used for both international and domestic traffic. The results of the estimate are shown in Table 4.8.4.

Table 4.8.4 Peak Hour Passengers at Juan Santamaria Airport

Item		International	Domestic	Total
Peak Hour Passengers (2-way)	1990 (Estimate)	560	60	620
	1995	760	80	840
	2000	840	80	920
	2005	1,120	100	1,220
	2010	1,520	100	1,620
Peak Hour Passengers (1-way)	1990 (Estimate)	400	40	440
	1995	480	60	540
	2000	600	60	660
	2005	760	60	820
	2010	1,080	60	1,140

Table 4.8.5 Peak Hour Passengers at Liberia Airport

Item		International	Domestic	Total
Peak Hour Passengers (2-way)	1995	310	40	350
	2000	310	40	350
	2005	420	60	480
	2010	420	60	480
Peak Hour Passengers (1-way)	1995	200	20	220
	2000	200	20	220
	2005	310	40	350
	2010	310	40	350

CHAPTER 5 AIRPORT FACILITY REQUIREMENTS

CHAPTER 5 AIRPORT FACILITY REQUIREMENTS

5.1 General

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

As for Limon Airport, the traffic demand forecasts do not justify the operations of regular commercial air transport. Limon Airport will maintain its present role as a general aviation airport up to 2010. Therefore, the estimate of airport facility requirements is omitted from this chapter and included in the evaluation of existing airport facilities in Chapter 6 as necessary.

5.2 Runway and Runway Strip

5.2.1 Runway

(1) Aerodrome Reference Code and Operational Category

The aerodrome reference code, i.e., code number and code letter will be as shown in Table 5.2.1 in accordance with the largest aircraft anticipated to serve the airport. The operational category of the main approach runway at Juan Santamaria Airport should be a precision instrument runway as is already practiced. As for Liberia Airport, although the operations of jet aircraft are limited in number, it is preferable to conduct precision instrument procedures.

Table 5.1.1 Summary of Facility Requirements

Item		Unit	Juan Santamaria Airport 1991 (Present)	1995	2000	2005	2010	Liberia Airport 1991 (Planned)	1995	2000	2005	2010
1. ICAO Aerodrome Reference Code			4D	4D	4D	4E	4E	4D	4D	4D	4D	4D
2. Runway	- Length	m	3,012	3,000	3,000	3,000	3,000	2,750	2,750	2,750	2,750	2,750
	- Width	m	45	45	45	45	45	45	45	45	45	45
3. Runway Strip	- Length	m	3,120	3,120	3,120	3,120	3,120	2,870	2,870	2,870	2,870	2,870
	- Width	m	150	300	300	300	300	300	300	300	300	300
4. Taxiway	- System		Partial Parallel Taxiway	Partial Parallel Taxiway	Partial Parallel Taxiway	Complete Parallel Taxiway	Complete Parallel Taxiway	One Right Angle Exit	One Right Angle Exit	One Right Angle Exit	One Right Angle Exit	One Right Angle Exit
	- Width	m	18	23	23	23	23	23	23	23	23	23
5. Apron	- Aircraft Stands	no.	WB/NB:13 Cargo: 2 SP: 2 Total:17	JJ/WB: 2 NB:13 Cargo: 3 SP: 3 Total:21	JJ/WB: 2 NB:14 Cargo: 5 SP: 3 Total:24	JJ/WB: 3 NB:15 Cargo: 6 SP: 3 Total:27	JJ/WB: 4 NB:16 Cargo: 6 SP: 3 Total:29	DC-10:2 Total:2	JJ/WB:2 NB:1 SP:2 Total:5	JJ/WB:2 NB:1 SP:2 Total:5	JJ/WB:2 NB:2 SP:2 Total:6	JJ/WB:2 NB:2 SP:2 Total:6
6. Passenger Terminal Building	- International	m²	9,060	8,900	11,200	14,100	20,100	-	3,700	3,700	5,800	5,800
	- Domestic	m²	324	600	600	600	600	-	200	200	400	400
	- Total	m²	9,384	9,500	11,800	14,700	20,700	1,600	3,900	3,900	6,200	6,200
7. Cargo Terminal Building	- International	m²	3,740	8,700	16,100	22,600	26,100	-	700	1,200	1,600	1,800
	- Domestic	m²	-	60	70	80	100	-	20	30	40	50
	- Total	m²	3,740	8,260	16,170	22,680	26,200	-	720	1,230	1,640	1,850
8. Administration/Operations Building		m²	1,300	1,800	1,800	1,800	1,800	-	300	300	300	300
9. Carpark	- Parking Slots	no.	324	500	550	730	970	100	210	210	290	290
	- Area	m²	8,000	17,500	19,300	25,600	34,000	5,000	7,400	7,400	10,200	10,200
10. Passenger Building Curb	- Curb Length	m	120	240	260	350	460	36	105	105	140	140
11. Air Navigation Systems	- Operational Category		Precision (ILS, VOR/DME, NDB)	Precision (ILS, VOR/DME, NDB)	Precision (ILS, VOR/DME, NDB)	Precision (MLS, VOR/DME, NDB)	Precision (MLS, VOR/DME, NDB)	Non-precision (VOR/DME)	Precision (ILS,VOR/DME)	Precision (ILS,VOR/DME)	Precision (MLS,VOR/DME)	Precision (MLS,VOR/DME)
12. Rescue and Fire Fighting	- Level of Protection		Category-8	Category-8	Category-8	Category-8	Category-8	-	Category-7	Category-7	Category-7	Category-7
	- Fire Station	m²	600	450	450	450	450	-	400	400	400	400
13. Airport Utilities	- Power Supply	KVA	750	900	1,200	1,500	1,900	-	300	300	400	400
	- Water Supply	ton/day	170	280	360	450	610	-	100	100	150	150
	- Sewage Disposal	ton/day	-	280	360	450	610	-	100	100	150	150
	- Solid Waste Disposal	kg/day	-	1,300	2,200	2,900	3,500	-	250	250	350	350
14. Fuel Supply Facility	- Tank Capacity (JETAI)	KL	600	850	1,300	1,700	2,000	-	90	120	150	190
	- Fuel Depot Area	m²	1,400	6,000	9,000	12,000	14,000	-	1,500	2,000	2,500	3,000
15. Aircraft Maintenance Hangar	- Hangar Space	no.	B-727:2	NB:3	NB:3	NB:3	NB:3	-	-	-	-	-

Table 5.2.1 Aerodrome Reference Code and Operational Category

Airport		1995	2000	2005	2010
Juan Santamaria	Reference Code	4D	4D	4E	4E
	Operational Category	Precision Instrument			
Liberia	Reference Code	4D	4D	4D	4D
	Operational Category	Precision Instrument			

Note: Aerodrome reference code 4D for DC-10 and 4E for B-747

(2) Number of Runways

A single runway with proper exit taxiways under IFR conditions can handle 50 to 59 hourly aircraft operations according to the FAA. The above runway capacity changes depending on traffic control procedures, aircraft mix, percent arrivals and layout of exit taxiways.

Applying the local conditions at Juan Santamaria Airport, the maximum runway capacity is calculated to be 34 operations per hour if proper taxiway-improvements are provided (See Section 6.2.1 for details). This hourly operations corresponds to 110,000 annual operations based on the peak characteristic at Juan Santamaria Airport. Since the number of annual aircraft movements expected in 2010 at the airport is about 78,000, a single runway can cope with the traffic demand up to 2010 with appropriate measures.

For Liberia Airport, as the aircraft movements are far fewer than that of Juan Santamaria Airport, a single runway is sufficient for a considerable period of time beyond 2010.

(3) Runway Length and Width

The required runway lengths are calculated for DC-10 and B-747 as representing the most demanding types of aircraft expected at Juan Santamaria Airport. Typical destinations require the following runway length.

Table 5.2.2 Required Runway Length

Destination		DC-10-40		B-747-200B	
		Max Payload	Full Pax & Bag.	Max Payload	Full Pax and Bag.
Europe					
- Madrid	(8,500 km)	not feasible	3,450 m	not feasible	3,250 m
North America					
- Los Angeles	(4,400 km)	2,800 m	2,400 m (*)	2,800 m (*)	2,800 m (*)
- New York	(3,600 km)	2,500 m	2,400 m (*)	2,800 m (*)	2,800 m (*)
- Miami	(1,800 km)	2,400 m (*)	2,400 m (*)	2,800 m (*)	2,800 m (*)

Note (*): Landing runway length requirements for maximum landing weight
Conditions: International reserve, 3000ft altitude, 30°C, no wind, no runway gradient and wet runway

As seen in the above table, non-stop operation to Europe requires a runway longer than 3,000m. However, the number of flights between Costa Rica and Europe are few and these routes are presently operated with transits at Caribbean cities. Therefore, the necessity for a runway longer than 3,000m is low. The most demanding route in term of runway length among North American destinations is Los Angeles with a 2,800m long runway (the Montreal route is slightly shorter than Los Angeles.) Taking into consideration the 5% to 10% allowance for 1% runway gradient for uphill take-off operations, the runway length requirement of 3,000m is adequate for the foreseeable future

Liberia Airport, situated at sea level, requires a shorter runway for the same condition as Juan Santamaria Airport. A 3,000m long runway at the altitude of 3,000ft is equivalent to approximately 2,600m for DC-10. Therefore, the 2,750m long runway presently under construction at Liberia Airport is adequate as the future runway requirement.

The required width of the runway is 45m with a 7.5m wide shoulder on each side for an aerodrome with reference code of 4D or 4E.

(4) Runway Strip

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

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

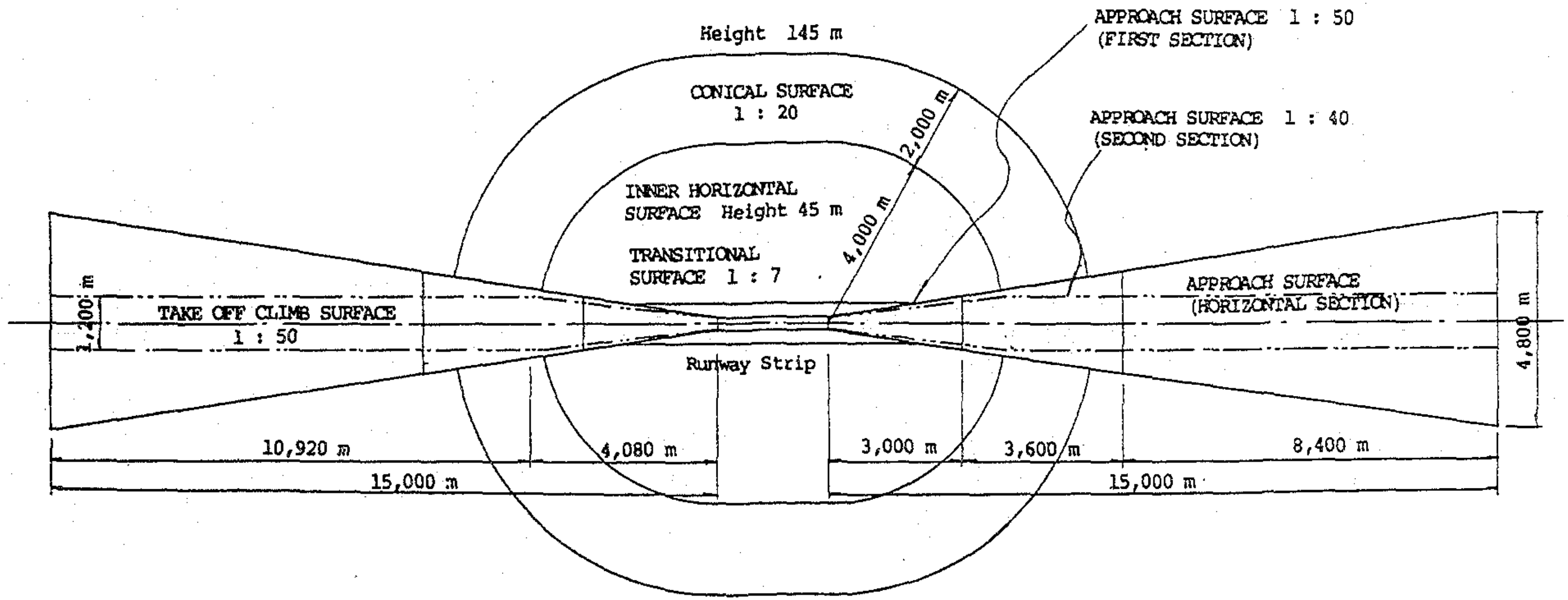
The FAA has a similar concept to the runway strip termed as the "primary surface". The width of the primary surface is 300m for a precision instrument runway, which is the same as the ICAO requirement. For non-precision instrument approach runways, the FAA stipulates two different widths, which are 150m and 300m for runways having visibility minimas greater than 1.2km and as low as 1.2km respectively. However, width of the strip should be 300m whenever the opposite approach runway is precision.

5.3 Obstacle Limitation Surfaces

The requirements of ICAO obstacle limitation surfaces for non-precision and precision approach runways with the code number of 4 are illustrated in Figure 5.3.1.

The FAA stipulates "imaginary surfaces" instead of obstacle limitation surfaces, but major components are common to the two standards for precision approach runways. For non-precision instrument approach runways the FAA allows a 2.9% slope approach surface.

The slope of the ICAO's take-off climb surface is 2.0%, while planning based on the FAA standard is satisfied with 2.9% slope which is established as a slope requirement for non-precision instrument runways.



Note 1: Height above aerodrome elevation.

Note 2: The FAA stipulates 2.9% slope approach surface for non-precision instrument runways.

Note 3: Radii of the inner-horizontal and conical surfaces are 10,000ft and 4,000ft respectively in the FAA.

Figure 5.3.1 Obstacle Limitation Surfaces

5.4 Taxiway and Apron

5.4.1 Taxiway

1) Taxiway System

A complete parallel taxiway with right angle exits is economically justified where the number of instrument approaches exceeds four during the normal peak hour. Based on this criterion, Juan Santamaria Airport should be provided with a complete parallel taxiway or equivalent taxiway system. The partial parallel taxiway sometimes provides satisfactory efficiency to aircraft operations. Whether or not the existing partial taxiway will cope with future increases of peak hour aircraft movements in terms of capacity will be examined in the evaluation of existing facilities in Chapter 6. In the case of Liberia Airport, no need for the parallel taxiway is foreseen until 2010, and one right angle existing taxiway and turnarounds at each runway end are sufficient.

2) Taxiway Width and Separation Distance

The width of the taxiway is 23m where it is intended to be used by aircraft such as DC-10 and B-747. The width of the shoulders for DC-10 and B-747 is 7.5m and 10.5m respectively according to the ICAO and the FAA. Seven point five meter wide shoulders are practiced at Japanese airports by the JCAB.

The separation distance between centerlines of the runway and parallel taxiway for an instrument runway is stipulated to be 176m for DC-10 and 182.5m for B-747 by the ICAO. The FAA provides smaller separation distances of 120m and 135m for DC-10 and B-747 respectively.

The distance from the taxiway (other than aircraft stand taxiline) centerline to objects such as parked aircraft for DC-10 is 40.5m and 39.5m by the ICAO and FAA respectively. That for B-747 is 47.5m and 48.5m by the ICAO and FAA respectively.

5.4.2 Apron

1) Loading Stands

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

$$S = \sum_{i}^{n} \frac{Ti}{60} \times \frac{Ni}{2} \times \alpha + \beta \quad \text{.......} \quad (5.4.1)$$

where,
- S : Number of loading stands
- T : Apron occupancy time of aircraft category (i) in minutes (International: 90, Domestic: 60)
- Ni : Number of movements of aircraft category (i) during peak hour
- α : Allowance for special occasions (= 1.2)
- β : Extra stands for special occasions

2) Overnight Stay Stands

Juan Santamaria Airport accommodates the overnight stay requirements of the LACSA and various foreign airlines. At present up to 13 aircraft are parked overnight at the airport. The number of overnight stay stands is calculated using the following formula:

$$N = A \times \alpha \quad (5.4.2)$$

where,
N : Number of overnight stay stands
A : Number of international passenger aircraft movements of the design day
α : Overnight stay ratio

The present overnight stay ratio (no. of overnight stay aircraft/no. of daily aircraft movements) is 0.3. It is assumed that this ratio will gradually decline to 0.2 in 2010 in accordance with the increase of daily aircraft movements.

3) Freighter Stands

The number of freighter stands is calculated using the same formula as the loading stand.

4) Total Number of Aircraft Stands

The total number of aircraft stands by aircraft type is estimated as shown in Table 5.4.1. In this estimate, all the loading stands are assumed to be co-used for overnight stay as practiced at Juan Santamaria Airport at present.

Table 5.4.1 Number of Aircraft Stands

Airport	Type of Stand	Aircraft Type	1995	2000	2005	2010
Juan Santamaria	Int'l Loading	JJ/WB	2 (*)	2 (*)	3 (*)	4 (*)
		NB	7	8	9	10
	Overnight Stay	NB	6	6	6	6
	Freighter	WB/NB	3	5	6	6
	Domestic	SP	3	3	3	3
	Total	-	21	24	27	29
Liberia	International	JJ/WB	2 (*)	2 (*)	2 (*)	2 (*)
		NB	1	1	2	2
	Domestic	SP	2	2	2	2
	Total	-	5	5	6	6

Note (*): Including one extra stand.

5) Size of Aircraft Stands

The sizes of the aircraft stands for each category of aircraft are shown in Table 5.4.2. The size of stands for jumbo jet (JJ) and wide-body jet (WB) are planned to be the same for flexible use of aircraft stands.

Table 5.4.2 Size of Aircraft Stands

Category	Width of Stand*	Parking Configuration
JJ/WB	70 m	Nose-in
NB	45 m	Nose-in
SP	35 m	Self-maneuvering

Note: Including wing tip clearance*

5.5 Passenger Terminal Building and Other Buildings

5.5.1 Passenger Terminal Building

The floor area required for the passenger terminal building is calculated by use of the following formula:

RTA = UA x PAX

where, RTA : Required floor area in m^2

UA : Unit floor area required per peak hour passenger

PAX : Number of peak hour passengers (1-way passenger x 2)

The IATA defines UA = 9.3 sq. m per peak hour international passenger. UA = 5.0 sq. m is applied for the domestic terminal based on practices of small domestic airports. The floor area requirement up to 2010 is shown in Table 5.5.1.

Table 5.5.1 Required Floor Area of Passenger Terminal Building

(Unit: m^2)

Item	1995	2000	2005	2010
Juan Santamaria Airport				
a) International	8,900	11,200	14,100	20,100
b) Domestic	600	600	600	600
c) Total	9,500	11,800	14,700	20,700
Liberia Airport				
a) International	3,700	3,700	5,800	5,800
b) Domestic	200	200	400	400
c) Total	3,900	3,900	6,200	6,200

5.5.2 Cargo Terminal Building

The floor area required for the cargo terminal building is estimated based on the annual cargo volume and unit cargo handling capacity. Based on the actual cargo handling capacity of international airports in Japan, one square meter of cargo terminal floor can handle 10 to 14 tons of cargo on an average. The unit capacity of 14 ton/m² is used for the calculation of the floor area of the international cargo terminal building at Juan Santamaria Airport. Other terminals are calculated with 10 ton/m².

Table 5.5.2 Required Floor Area of Cargo Terminal Building

(Unit: m²)

Item	1995	2000	2005	2010
Juan Santamaria Airport				
a) International	8,700	16,100	22,600	26,100
b) Domestic	60	70	80	100
c) Total	8,760	16,170	22,680	26,200
Liberia Airport				
a) International	700	1,200	1,600	1,800
b) Domestic	20	30	40	50
c) Total	720	1,230	1,640	1,850

5.5.3 Administration/Operations Office

The required floor area for the administrative and operational function of the DGAC is estimated to be 1,800m² for Juan Santamaria Airport in the light of the current practice of Japanese airports with comparable facilities. A 300m² office area is sufficient for Liberia Airport.

A control tower, VFR room on the top, should be provided for air traffic control. Its location and height should be planned so that it may be free from transitional surfaces and secure an unobstructed view of the airfield with a minimum sight angle of 35 minutes to runway thresholds from its VFR room.

5.6 Carpark and Passenger Building Curb

5.6.1 Carpark

The following formula is used to calculate the required number of parking slots:

$$LOT = PAX \times PR \quad (5.6.1)$$

where,
- LOT : Required number of parking slots
- PAX : Number of peak hour passengers (2-way)
- RP : Parking ratio (= 0.6 from the traffic survey at Juan Santamaria Airport)

The required total carpark area is estimated as shown in Table 5.6.1 by applying a unit space of 35m² for a parking slot which includes internal roads and a green zone in addition to net parking slots.

Table 5.6.1 Required Number of Parking Slots and Carpark Area

Item	1995	2000	2005	2010
Juan Santamaria Airport				
a) Number of Slots	500	550	730	970
b) Carpark Area (m2)	17,500	19,300	25,600	34,000
Liberia Airport				
a) Number of Slots	210	210	290	290
b) Carpark Area (m2)	7,400	7,400	10,200	10,200

5.6.2 Passenger Building Curb

The required curb length of the passenger building is calculated by the following formula as shown in Table 5.6.2.

$$PBC = PAX \times (1 + a)/Q \times T/60 \times L$$

where,
- PBC : Required curb length of the building in meters
- PAX : Number of peak hour passengers (2-way)
- a : Number of greeters per passenger (0.7)
- Q : Number of occupants per vehicle (2.0)
- T : Average dwell time at curb (3.0 min)
- L : Length of parking slot per vehicle (6.7 m)

Table 5.6.2 Required Length of Passenger Building Curb

(Unit : m²)

Item	1995	2000	2005	2010
Juan Santamaria Airport				
a) International	220	240	320	430
b) Domestic	20	20	30	30
c) Total	240	260	350	460
Liberia Airport				
a) International	90	90	120	120
b) Domestic	15	15	20	20
c) Total	105	105	140	140

5.7 Air Navigation Systems

Air navigation systems consisting of the following should be planned to satisfy the requirements of aircraft operations and air traffic control.

a) Radio Navigation System
b) Aeronautical Telecommunication System
c) Aeronautical Ground Lights
d) Meteorological Observation System

5.7.1 Air Navigation Systems

Radio navigation aids required for non-precision instrument approach runway are;

a) VOR
b) DME
c) NDB (can be omitted)

A precision approach runway requires an Instrument Landing System (ILS) or Microwave Landing System (MLS) in addition to the above.

At the time this report is prepared, the ICAO states that ILS cease to be an ICAO standard system for precision approach runways on January 1, 1998, but can remain in service for international airports until January 1, 2000 on the basis of Regional Agreement. MLS is a sole ICAO standard system from the year 2000 although there are some matters to be solved for MLS installation.

In this study, the ILS is assumed to be effective up to 2000 and replaced by MLS after that at Juan Santamaria Airport. The runway at Liberia Airport is also preferable to be precision with the ILS.

5.7.2 Aeronautical Telecommunications

Air to ground VHF/HF communications and aeronautical fixed services should be provided to satisfy required services of air traffic control.

5.7.3 Aeronautical Ground Lights

Aeronautical ground lights required for the non-precision and precision approach runways are shown in Table 5.7.1.

Table 5.7.1 Required Aeronautical Ground lights for Non-precision and Precision Runways

Aeronautical Ground Lights		Non-precision	Precision
- Standard Approach Lighting System	(ALS)	-	x
- Simple Approach Lighting System	(SALS)	x	-
- Precision Approach Path Indicator	(PAPI)	x	x
- Runway Edge Lights	(RWYL)	x	x
- Runway Threshold/Evd Lights	(RWTL)	x	x
- Wing Bar Lights	(WBAR)	-	x

Note: "x" indicates required items.

In addition to the above, aerodrome beacon (ABN), taxiway edge lights (TWYL), apron floodlights (AFL), wind direction indicator light (WDIL), obstruction lights (OBL), and AGL control system are required.

The maximum switch-over time of aeronautical ground lights related to runways and obstruction lights should be within 15 seconds for both non-precision and precision runways.

5.7.4 Meteorological Observation System

Wind speed, wind direction, atmospheric pressure, temperature, humidity, rainfall, visibility, cloud amount and cloud base should be observed at the airport. Runway visual range should be added for precision approach operations.

Forecast services covering en-route, terminal and area are also a basic requirement of the meteorological system at the airport.

5.8 Rescue and Fire Fighting Services

The facility requirements for the rescue and fire fighting services are estimated in compliance with the ICAO recommendations. For the planning of rescue and fire fighting services, the levels of protection will be determined first. Those for DC-10 and B747 class aircraft are Category-8 and Category-9 respectively. However, these can be reduced to lower levels by taking infrequent aircraft operations into account. The levels of protection required for Juan Santamaria and Liberia Airports are estimated to be Category-8 and Category-7 respectively. The requirements of fire fighting services for corresponding levels of protection are shown in Table 5.8.1.

Table 5.8.1 Requirements of Rescue and Fire Fighting Services

Item	Juan Santamaria (Category-8)	Liberia (Category-7)
Principal Extinguishing Agent	Performance level B	Performance Level B
- Water (L)	18,200	12,100
- Discharge Rate (L/min) (*)	7,200	5,300
Complementary Agent	Dry Chemical Powder, Halons or CO_2	Dry Chemical Powder, Halons or CO_2
- Amount (kg)	450	225
Rescue and Fire Fighting Vehicles		
- Minimum Number of Vehicles	3	2
Fire Station		
- Floor Area	450 m2	400 m2

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

The location of the fire station should be planned to achieve a response time not exceeding three minutes to the ends of each runway as well as any other part of the movement area. The ICAO's new recommendation effective November, 1990 states that the response time is considered to be the time when the first responding vehicle is in position to apply foam at a rate of at least 50% of the discharge rate specified in the above table.

5.9 Airport Utilities

The airport utility requirements are calculated based on the unit demand shown in Table 5.9.1.

Table 5.9.1 Unit Utility Demand

Utilities	Unit Demand		
Electricity	Passenger Terminal Building	:	40 VA/ m²
	Cargo Terminal Building	:	20 VA/m²
	Administration Building and others	:	40 VA/m²
	Equipment	:	Calculated by Equipment
Water and Sewage	Passenger Terminal Building	:	23 L/m²/day
	Cargo Terminal Building	:	3 L/m²/day
	Administration Building and others	:	10 L/m²/day
Waste	Passenger Terminal Building	:	0.035 kg/m²/day
	Cargo Terminal Building	:	0.070 kg/m²/day
	Administration Building and others	:	0.070 kg/m²/day

The demands of airport utilities anticipated at Juan Santamaria and Liberia Airports are estimated as shown in Table 5.9.2 by multiplying the above unit demand by the required floor area of each building.

Table 5.9.2 Airport Utility Demands

Item		1995	2000	2005	2010
Juan Santamaria Airport					
a) Electricity Demand	(KVA)	900	1,200	1,500	1,900
b) Water Demand	(ton/day)	280	360	450	610
c) Sewage	(ton/day)	280	360	450	610
d) Waste Disposal	(kg/day)	1,300	2,200	2,900	3,500
Liberia Airport					
a) Electricity Demand	(KVA)	300	300	400	400
b) Water Demand	(ton/day)	100	100	150	150
c) Sewage	(ton/day)	100	100	150	150
d) Waste Disposal	(kg/day)	250	250	350	350

5.10 Other Facilities and Services

5.10.1 Aviation Fuel Supply

The fuel supply requirements are calculated by multiplying the trip fuel by the number of departing flights for each route and aircraft type. The required fuel storage capacity is estimated based on the calculated fuel requirements and three day reserve policy presently practiced at Juan Santamaria Airport. The aviation fuel storage requirements as well as required area for a fuel depot up to 2010 are as shown in Table 5.10.1.

Table 5.10.1 Requirements for Aviation Fuel Storage and Fuel Depot Area

Item	1995	2000	2005	2010
Juan Santamaria Airport				
a) Tank Capacity JET-A1 (KL)	850	1,300	1,700	2,000
b) Fuel Depot Area (m2)	6,000	9,000	12,000	14,000
Liberia Airport				
a) Tank Capacity JET-A1 (KL)	90	120	150	190
b) Fuel Depot Area (m^2)	1,500	2,000	2,500	3,000

5.10.2 Aircraft Maintenance Facilities

The COOPESA plans to expand its aircraft maintenance business which provides service for several international airlines including the LACSA, SAM, SHASA, VARIG etc. There is a strong intent by the COOPESA to expand its hangar capacity which can accommodate up to two narrow-body jet aircraft at present. The LACSA is considering constructing their own maintenance hanger to undertake heavy maintenance which is presently entrusted to the COOPESA. Although no concrete plan or study for the new hangar exists, additional maintenance hangar space for one narrow-body jet aircraft should be adequate to reserve in the future plan of Juan Santamaria Airport up to 2010.

CHAPTER 6 EVALUATION OF EXISTING AIRPORTS

CHAPTER 6 EVALUATION OF EXISTING AIRPORTS

6.1 General

The development of the existing airports, in general, requires large-scale construction with substantial capital investment. To achieve optimum capital utilization, the development should have an adequate useful life. The development should also ensure safe and efficient aircraft operations, minimum adverse environmental impact on the airport surroundings and provide for future expansion capability.

The way to accomplish the above objectives is to evaluate the existing airport facilities against current and future traffic demands. This chapter discusses the present condition of airport facilities and evaluates capacities against future facility requirements estimated in Chapter 5. A summary of the evaluation for existing airport facilities at the three airports is illustrated in Figures 6.1.1 through 6.1.3.

6.2 Juan Santamaria International Airport

6.2.1 Runway

1) Runway Capacity

The existing single runway handled 35,569 annual aircraft movements and 17 peak hour aircraft movements in 1990. The aircraft movements are expected to reach 78,000 annual and 29 peak hour movements in 2010. To investigate the degree of capacity saturation of the runway, it is necessary to evaluate the runway capacity for three different runway usage patterns practiced at present. They are the following:

- Pattern - 1	:	Take-off	:	Runway 07
(67%)		Landing	:	Runway 07
- Pattern - 2	:	Take-off	:	Runway 25
(5%)		Landing	:	Runway 25
- Pattern - 3	:	Take-off	:	Runway 25
(28%)		Landing	:	Runway 07

Since the runway capacity is considerably influenced by the efficiency of the taxiway system, it is also necessary to investigate the changes of runway capacity by taxiway systems. The following four different cases are considered for capacity calcualtion:

Figure 6.1.1 *Summary of Evaluation of Existing Facilities at Juan Santamaria Airport*

No.	Facilities		Year (1990 1995 2000 2005 2010)	Remarks
1.	Runway	- Capacity		- The runway will reach its maximum capacity during its preferential use (landing and take-off from/to the west) before 2005. An obstacle-free 3,000m long runway will be required to fundamentally solve the capacity problem and to handle traffic increase beyond 2010.
		- Length		- Non-stop operations of DC-10 and B-747 to Los Angles are possible with the existing runway length.
		- Width		- A 45m wide runway is adequate for aircrafts up to B-747.
2.	Runway Strip		x	- A 300m wide strip is required for precision instrument operations.
3.	Obstacle Limitation Surfaces	- Approach	x	- The landing to runway 25 is obstructed due to existence of obstacles.
		- Transitional	x	- There are many obstacles protruding upon the transitional surface from the 150m wide strip.
4.	Taxiway	- System		- The existing taxiway system will become inadequate in terms of runway capacity before 2005.
		- Separation Distance	x	- The separation between the centerlines of runway and parallel taxiway is not sufficient. - The separation from the centerline of parallel taxiway to parked aircraft is sufficient except for B-747 aircraft.
5.	Apron	- Int'l Loading	x	- The existing seven aircraft stands in front of the terminal building (six with boarding bridge) are fully occupied during peak hours.
		- Int'l Overnight Stay	x	- Overnight stay aircraft floods out of the passenger loading apron, and are parked in front of maintenance hangar.
		- Cargo	x	- Aircraft stands for freighter aircraft are completely saturated.
		- Domestic		- An additional aircraft stand is required around 1995.
6.	*Aircraft Pavement*	- *Strength*		- *The existing pavement is adequate for aircrafts up to B-727.* Overload operations of DC-10 is acceptable, but should be limited within 5% of the total operations of jet aircraft
7.	Passenger Terminal Building	- International	x	- Check-in counters, check-in lobby, departure immigration counters, security inspection counters, baggage claim area, customs counters, and the queuing space are insufficient even for the present traffic.
		- Domestic	x	- The terminal building is too small for the present traffic. It is of substandard quality in many aspects.
8.	Cargo Terminal Building		x	- The shortage of capacity of the customs building is very serious. Most imported cargo is handled in the customs branches in San Jose. LACSA constructed their own building for temporary storage to wait for customs clearance.
9.	Administration/Operations Office		x	- The office space is too small for standard requirement of 24-hour operations airport.
10.	Carpark	- Passenger		- The carparks are adequate for the present traffic, but will become insufficient before 1995.
		- Cargo	x	- Truck yard of the cargo area is too small to enable smooth flows of vehicle traffic.
11.	Passenger Building Curb		x	- The length of the terminal building curb is too short. Parked cars are always in double rows in front of the terminal buildig during peak hours.
12.	Air Navigation Systems	- Radio Navaids		- Most radio navigation aids will need to be replaced around 2000 due to the expiration of operational life.
		- Radar		- The new radar is planned to be installed by the COCESNA to replace the existing old one.
		- Communications		- Most aeronautical telecommunication equipment will need to be replaced around 2000 due to expiration of operational life.
		- Ground Lights		- The lighting system can be used until around 2010 by the renewal plan under consideration of the DGAC
		- Meteorological		- The existing meteorological system covers the requirements for the airport operations. However, the replacement of equipment may be considered before 2000. RVR and ceilometer are desired to be added.
13.	Rescue and Fire Fighting service			- The existing fire vehicles are old, and will need to be replaced after 2000.
14.	Airport Utilities	- Power Supply		- Capacity of the power supply system should be increased to cope with increase of demand.
		- Water Supply		- Water is supplied by a water main from the city. No problem is observed for the capacity.
		- Sewage Disposal	x	- The existing septic tank faces over-capacity problem, and most sewage is disposed directly to a nearby river.
		- Telephone		- Quality of signals and reliability of services are very low.
15.	Aviation Fuel Supply System			- Storage capacity of fuel tanks will be reduced to two day consumption level in 2000 from the present three day consumption level.

Note: "x" indicates facility reached its capacity or is not adequate.

Table 6.1.2 Summary of Evaluation of Planned Facilities at Liberia Airport

No.	Facilities		Year (1990 1995 2000 2005 2010)	Remarks
1.	Runway	- Capacity		- The runway has sufficient capacity up to 2010.
		- Length		- Non-stop operations of DC-10 to Los Angeles are possible with the planned runway length.
		- Width		- A 45m wide runway is adequate for aircraft up to B-747.
2.	Runway Strip			- A 300m wide strip is adequate for the instrument runway.
3.	Obstacle Limitation Surfaces	- Approach		- There are no obstacles to the approach surfaces.
		- Transitional		- The new terminal area is planned to be free from transitional surface. - It is necessary to demolish the old terminal building.
4.	Taxiway			- One right angle exit taxiway for the new terminal area is sufficient for aircraft movements up to 2010.
5.	Apron			- The increase of air traffic will require extension of the apron
6.	Aircraft Pavement			- Existing pavement strengthening and new pavement for the runway extension are adequate to accommodate DC-10 aircraft.
7.	Passenger Terminal Building			- The size of the planned passenger terminal building is insufficient to handle peak hour passengers from a single movement of DC-10.
8.	Cargo Terminal Building		x	- It is necessary to construct a cargo terminal building to meet with air cargo demand.
9.	Administration/Operations Office			- Administration office in the terminal building and control tower are planned in the development work.
10.	Carpark			- The expansion of the carpark will be required along with the expansion of the terminal building.
11.	Air Navigation Systems	- Radio Navaids	x	- It is desirable to introduce an ILS to the Runway 07 to ensure safe aircraft operations.
		- Communications		- The upgrading plan of the system is adequate up to 2010.
		- Ground Lights	x	- The planned lighting system is insufficient. It is desirable to install an ALS for runway 07 and a SALS for Runway 25.
		- Meteorological		- The planned meteorological system covers minimum requirement for the airport operations.
12.	Rescue and Fire Fighting Service		x	- It is necessary to provide the facilities in compliance with the ICAO category -7 for the introduction of DC-10.
13.	Aviation Fuel Supply System		x	- Appropriate provision should be considered as soon as possible.

Note: "x" indicates facility reached its capacity or is not adequate.

Table 6.1.3 Summary of Evaluation of Existing Facilities at Limon Airport

No.	Facilities		Year (1990 / 1995 / 2000 / 2005 / 2010)	Remarks
1.	Runway	- Capacity		- The runway has sufficient capacity up to 2010.
		- Length		- A 1,800m long runway is far sufficient for general aviation activities.
		- Width		- A 30m wide runway is adequate for general aviation activity.
2.	Runway Strip		x	- Apron, terminal building, etc. are located inside the runway strip.
3.	Obstacle Limitation Surfaces	- Approach	x	- Principal Route No.36 is an obstacle to Runway 32 approach surface.
		- Transitional	x	- No transitional surface exists because of the fact that all the terminal facilities are located inside the runway strip.
4.	Taxiway		x	- No taxiway is provided.
5.	Apron	- Size		- The size of the apron is sufficient for the present traffic.
		- Location	x	- The existing apron is located directly adjacent to the runway without taxiway.
6.	Aircraft Pavement			- The pavement has sufficient strength to accommodate general aviation aircraft after the emergency rehabilitation work in September 1992.
7.	Passenger Terminal Building	- Size		- No expansion of the terminal size is foreseen to be required due to low traffic level.
		- Location	x	- The location of the terminal building should be changed to secure safe aircraft operations.
8.	Carpark			- The present capacity is sufficient for future traffic.
9.	Air Navigation Systems	- Radio Navaids		- The existing VOR/DME will need to be replaced around 1995 due to the expiration of operational life.
		- Communications		- The existing equipment for AFIS will need to be replaced around 2000 due to the expiration of operational life.
		- Ground Lights		- The existing aeronautical ground lights will need to be replaced around 1995 due to the expiration of operational life.
		- Meteorological		- The existing meteorological system covers minimum requirements for the airport operations. However, the replacement of equipment may be considered before 2000.
10.	Rescue and Fire Fighting Service		x	- No service is available at the airport.
11.	Aviation Fuel Supply System			- Supply by drums can be continued due to low traffic level.

Note: "x" indicates facility reached its capacity or is not adequate.

- Existing Taxiway System : Partial parallel taxiway
  - No taxiway for the runway 25 threshold
  - No taxiing of wide-body jet on the existing parallel taxiway

- Improvement Measure 1 : Partial parallel taxiway
  - Addition of taxiway for Runway 25 threshold

- Improvement Measure 2 : Partial parallel taxiway
  - Improvement of existing partial parallel taxiway for use of wide-body jet aircraft

- Improvement Measures 1 plus 2 : Complete parallel taxiway
  - Addition of taxiway for Runway 25 threshold
  - Improvement of existing partial parallel taxiway for use of wide-body jet aircraft

The runway capacity was calculated for the above as combinations as shown in Table 6.2.1. Retailed calculations are explained in Appendix 6.2.1.

Table 6.2.1 Capacity of the Existing Runway

Runway Usage Pattern	Percentage Composition	Runway Capacity (operations/hour)			
		Existing Taxiway System	Taxiway Improvement Measure 1	Taxiway Improvement Measure 2	Improvement Measures 1 plus 2
Pattern-1 Take-off: Runway 07 Landing: Runway 07	67%	35	35	37	37
Pattern-2 Take-off: Runway 25 Landing: Runway 25	5%	28 (x)	34	30	37
Pattern-3 Take-off: Runway 25 Landing: Runway 07	28%	25 (xx)	29	25 (xx)	29
Average	100%	31	33	32	34

Note: (x) indicates capacity saturation before 2010.
(xx) indicates capacity saturation before 2005.

The maximum capacity is estimated to be 34 hourly operations (110,000 annual operations) which can be attained by the taxiway improvement measures 1 plus 2. In case of the runway capacity with the existing partial parallel taxiway, maximum capacity is 32 hourly operations or 100,000 annual operations. However, it should be noted that the limit of the runway capacity during the preferential use (Pattern-3) will be reached before 2005. In order to eliminate this bottleneck situation, the provision of a taxiway for Runway 25 threshold (taxiway improvement measure 1) is effective. The improvement of the existing partial parallel taxiway for use of wide-body jets (taxiway improvement measure 2) will not influence the runway capacity during the preferential use.

Although the existing runway can be used until 2010 with the above-mentioned improvement on the taxiway system, it is also clarified that the existing runway has a marginal capacity for traffic increase beyond 2010. A major constraint which will constitute the bottleneck situation of the runway other than the taxiway system is the preferential use of the runway. The runway capacity during the preferential use (Pattern-3) is approximately 20% lower than that of normal one-direction usage patterns (Patterns 1 and 2). The main reason why the preferential operations are conducted at Juan Santamaria Airport is because the landing length of the runway 25 is shortened to 2,400m due to existence of many obstacles. Therefore, it is necessary to construct an obstacle-free 3,000m long runway to fundamentally solve the capacity problem and to handle traffic increases beyond 2010.

2) Runway Length and Width

The existing runway of Juan Santamaria Airport is 3,012 m in length and 45 m in width. The runway is operated with 3,012 m length for take-off from the runways 07 and 25. The Runway 25 threshold is displaced 600 m inside and the landing length available to the Runway 25 is 2,412 m because of the existence of obstructive terrain at the east of the airport. Available landing length to the Runway 07 is 3,012 m.

The take-off runway length of 3,012 m is adequate for full-payload operations of DC-10 and B-747 to Los Angeles of which the flight distance is longest among probable non-stop flight destinations. The runway length of 2,412 m for Runway 25 landing is short for the landing requirement of B-747 with maximum landing weight. However, the number of operations of B-747 is few and opportunities of landing with maximum weight are much fewer. Moreover, the landings from Runway 25 accounts for only 5% of the total landings. Therefore, the landing runway length is also evaluated to be adequate.

3) Slopes on Runway

The longitudinal slopes on the existing runway declines from east to west and exceeds the slope recommended by the ICAO Annex 14 as shown in Table 6.2.2.

Table 6.2.2 Longitudinal Slopes on Existing Runway

Item	East Quarter 0-800m	Central Half 800-2,200m	West Quarter 2,200-3,012m	Total
Actual Slope	1.31%	1.12%	0.85%	1.10%
ICAO Recommendation (Code 4)	0.8%	1.25%	0.8%	1.0%

Take-off operations require longer runways of 5% - 10% per 1% uphill gradient. However, the existing runway accommodates extra distance required by the steep longitudinal slopes. The slope correction of east equator of the runway within the ICAO recommended value is not practical.

4) Runway Shoulders

Seven point five meter wide shoulders are provided on each side of the runway. Its surface is paved with asphalt concrete along the entire runway length. These provisions are adequate for the future.

5) Runway Usability

During the rainy season (May to November), Juan Santamaria Airport experiences frequent flight cancellation due to low visibility caused by heavy rain and fog. This low visibility weather arises from 14:00 to 22:00 local time which is when most of international arrival flights concentrate at this airport, inconveniently. In 1989, 67 flights were diverted to other airports due to bad weather and 50 of them were international scheduled flights as shown in Appendix-3.2.4.

The wind coverage of the runway is also low. The data from the Costa Rica Meteorological Bureau indicated the all weather wind coverage of 90.1% for less than 20kt cross-wind component. This figure, however, may be too low as compared with a diversion rate of 0.4% for scheduled international flights. There is a possibility of errors in the original data. Nevertheless it may be true that this airport requires an alternate airport in Costa Rica to accommodate frequent flight diversions.

6.2.2 Runway Strip

The dimensions of the runway strip at Juan Santamaria Airport are not declared in the AIP Costa Rica. The required width of the runway strip for the precision instrument runway is 300m according to the ICAO, FAA and JCAB. However, in applying this wide strip, most terminal facilities such as passenger and cargo terminal buildings, fire station, COOPESA hangar, and storage of the LACSA, American Embassy and DGAC infringe 1:7 transitional surface starting from the edge of the runway strip. Aircraft parked at almost all aircraft stands will be obstacles to transitional surface. Some parts of Pan-American Highway on the north side of the runway 25 displaced threshold is also an obstacle to aircraft operation.

Even if applying a 150 m wide strip which is adequate for a non-precision instrument approach runway in accordance with the FAA and JCAB (FAA for non-precision instrument approach runway having visibility minima greater than 1.2km only), aircraft parked on aircraft stands, passenger terminal building, COOPESA hangar and Pan-American Highway infringe 1:7 transitional surface. The degree of infringement of obstacles to the transitional surface from a 150m wide strip is summarized in Table 6.2.3. This is also illustrated in Figure 6.2.1.

Table 6.2.3 Infringement of Obstacles to Transitional Surface from 150 m Wide Runway Strip

Obstacles	Degree of Infringement (above transitional surface)
Aircraft in front of Passenger Terminal	
a) DC-10	10.0m
b) B-727	2.3m
c) A-320	2.2m
d) B-737	0.6m
COOPESA Hangar	12.8m
Passenger Terminal Building	7.1m

6.2.3 Obstacle Limitation Surfaces

1) Approach Surface

The minimum slope required for an approach runway of precision instrument operations is 2.0% according to the ICAO, FAA and JCAB. Runway 07 where precision approaches are conducted satisfies the above requirement.

For Runway 25 (non-precision approach runway) of which threshold is displaced by 600m to the west, the minimum approach slope requirement is 2.0% by the ICAO and 2.9% by the FAA. There are many houses, trees and terrain which protrude upon the ICAO's 2% approach surface as shown in Figure 3.2.5, however, all of them except a few trees are not obstacles to the FAA's 2.9% approach surface. Therefore, the existing Runway 25 with 600m displaced threshold is adequate in terms of the approach surface requirement by the FAA if a few obstructive trees are felled. Further threshold displacement to satisfy ICAO's requirement is not feasible because it will make the existing terminal area obstructive to the approach surface.

2) Take-off Climb Surface

The slope requirement of the take-off climb surface is 2.0% by the ICAO and 2.9% by the FAA. There is no problem for Runway 25, while many obstacles exist for Runway 07. To satisfy the ICAO requirements for Runway 07 with the displacement of the runway end is not possible for the same reason as the runway 25 approach surface. The westward displacement of the runway 07 end by 600m is required by the FAA.

3) Transitional Surface

Refer to runway strip (Section 6.2.2)

4) Other Obstacle Limitation Surfaces

There are some obstacles to inner horizontal and conical surfaces, but no substantial influence is expected for aircraft operations.

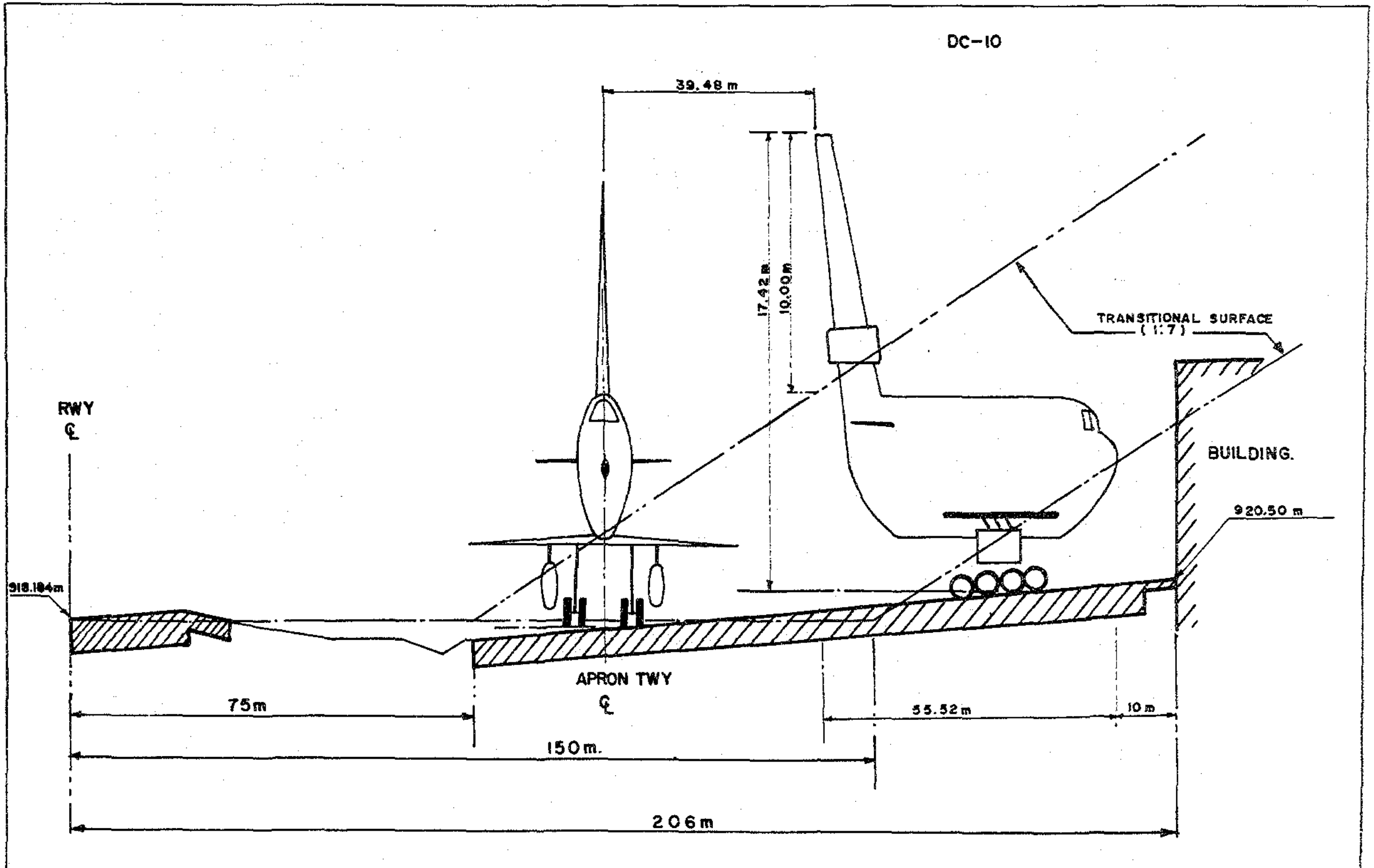


Figure 6.2.1 Infringement of Transitional Surface

6.2.4 Taxiway

1) Taxiway System

The existing taxiway system at the airport is a partial parallel taxiway with four right angle exits. The length of the parallel taxiway is 2,400m from Runway 07 threshold up to the front of the passenger terminal building. The remaining eastern part of the parallel taxiway cannot be constructed because of the close location of the Pan-American Highway. This results in a long runway occupancy time by take-off jet aircraft from Runway 25.

As analyzed in Section 6.2.1, the existing taxiway system will become inadequate in terms of runway capacity before 2005. It is necessary to provide a parallel taxiway connecting the terminal area with Runway 25 threshold.

2) Taxiway Width and Separation Distance

All the existing taxiways are planned for a design aircraft of B-727 which requires a 18m wide taxiway. This width is smaller than the required width (23m) for aircraft equal to or greater than DC-10 by five meters. It is preferable to provide 23m wide taxiways from the viewpoint of aircraft ground operations safety, but the existing width can barely cope with the operations of DC-10 and B-747.

The existing separation distance between the runway and parallel taxiway centerlines is 101m, which is only adequate for non-instrument operations of up to DC-10. More than 135m separation which is adequate for the operations of B-747 is preferable though this change will demand a complete new parallel taxiway or a new runway.

The separation distance from the centerline of the parallel taxiway to parked aircraft is also inadequate. When DC-10 is parked in front of the passenger terminal building, the above separation distance is 39.5m as shown in Figure 6.2.1. It is sufficient for up to DC-10, but 8m short for B-747.

6.2.5 Apron

The total number of aircraft stands available at the apron is 17, including 13 for A-320s (some of them adequate for DC-10), 2 for DC-8 freighters and 2 for C-212. Several aircraft for maintenance are parked beside the COOPESA hangar at random without designated parking positions. Of the 13 aircraft stands for A320, seven are loading stands located in front of the international passenger terminal building (six with a boarding bridge and one without a boarding bridge). Six other aircraft stands for A320 are for overnight stays.

The existing capacity of aircraft stands has already reached its limit. To alleviate this situation, the DGAC announced the construction of two aircraft stands for DC-10s on the south side of the existing COOPESA automobile workshop in October, 1991. It will be completed in 1993. However, the shortage of aircraft stands will become apparent again by 1995.

6.2.6 Aircraft Pavement

According to the analysis of the data provided by the DGAC and the results of the pavement survey carried out by the Study Team, the existing airfield pavement structures are clarified as summarized in Table 6.2.4.

Table 6.2.4 Existing Pavement Structures

(Unit: cm)

Facility	Asphalt Surface Course	Base Course	Sub-base Course	Total Thickness
Runway				
a) West (400m)	26	23	90	139
b) Central (2,012m)	42	22	32	96
c) East (600m)	25	31	63	119
Taxiway	12	24	72	108
Apron	10	59	-	69

Note: After the overlay work carried out by DGAC in 1991.

The strength of the subgrade represented by the CBR was estimated to be 5%, 3% and 3% for the runway, taxiway and apron respectively based on the results of soil investigations. Based on the above data, the pavement classification number (PCN) is estimated to be 62 for the runway pavement. (Refer to Appendix-6.2.2) On the other hand, the aircraft classification numbers (ACNs) for B-727 and DC-10 are 54 and 70 respectively.

Therefore, the pavement strength of the existing runway is evaluated to be adequate for unrestricted operations of B-727. In case of DC-10 whose ACN is approximately 10% higher than the PCN, occasional movements (less than 5% of the total operations) should not adversely affect the runway pavement according to the ICAO. Since the number of operations by wide body jets accounted for 4% of the total jet operations, it can be said that existing pavement strength has only a little room for future traffic increase. Section 10.2.8 explains the required overlay thickness to accommodate expected air traffic increases up to 2000.

6.2.7 International Passenger Terminal Building

1) General

The international passenger terminal building, located on the east side of the terminal area, was built in 1957. Since then, this terminal building has been extended and renovated several times as the number of passengers increased. The present floor plans of the terminal building are shown in Figures 6.2.2 through 6.2.7.

The concept of the terminal building is the centralized linear terminal with one and a half processing levels. The second to fifth floors are used for a restaurant, snack bar, airlines office, administration/operations office of DGAC and control tower. The land side access to the building and departure passenger processing are on the first floor, which is one story above the apron level (the basement level). The arrival passenger processing is mainly at the basement level.

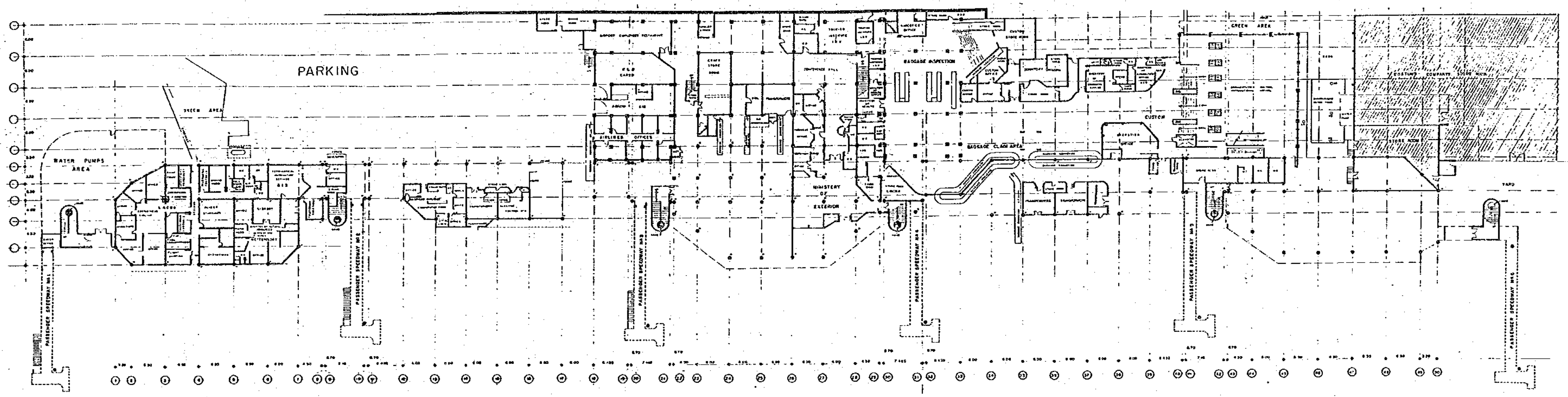


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Figure 6.2.2 Existing Floor Plan of International Passenger Terminal Building (Basement Floor)

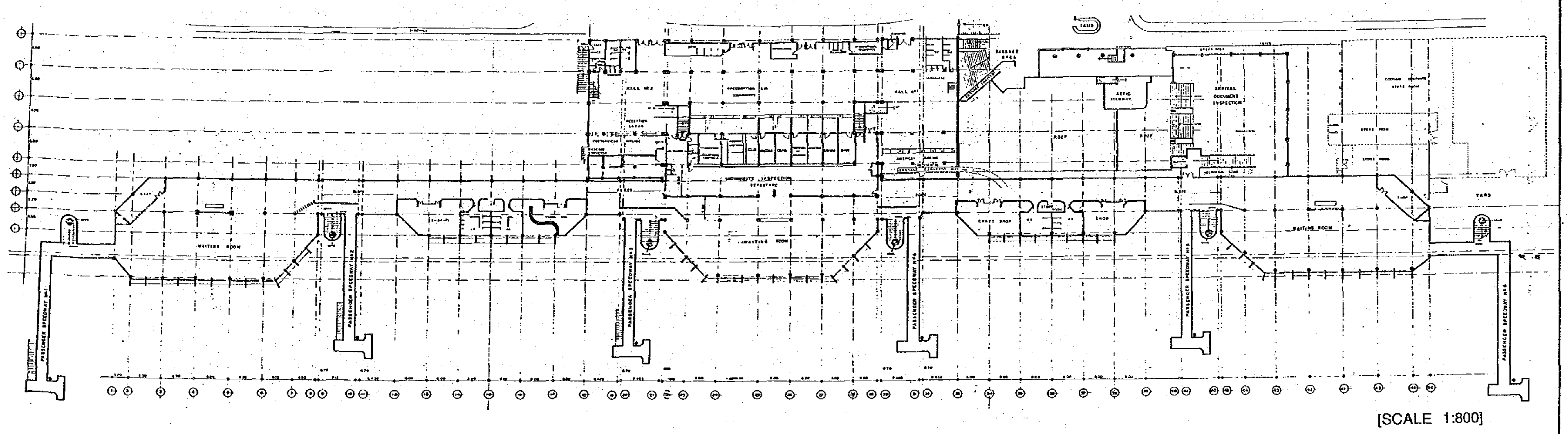

Figure 6.2.3 Existing Floor Plan of International Passenger Terminal Building (First Floor)

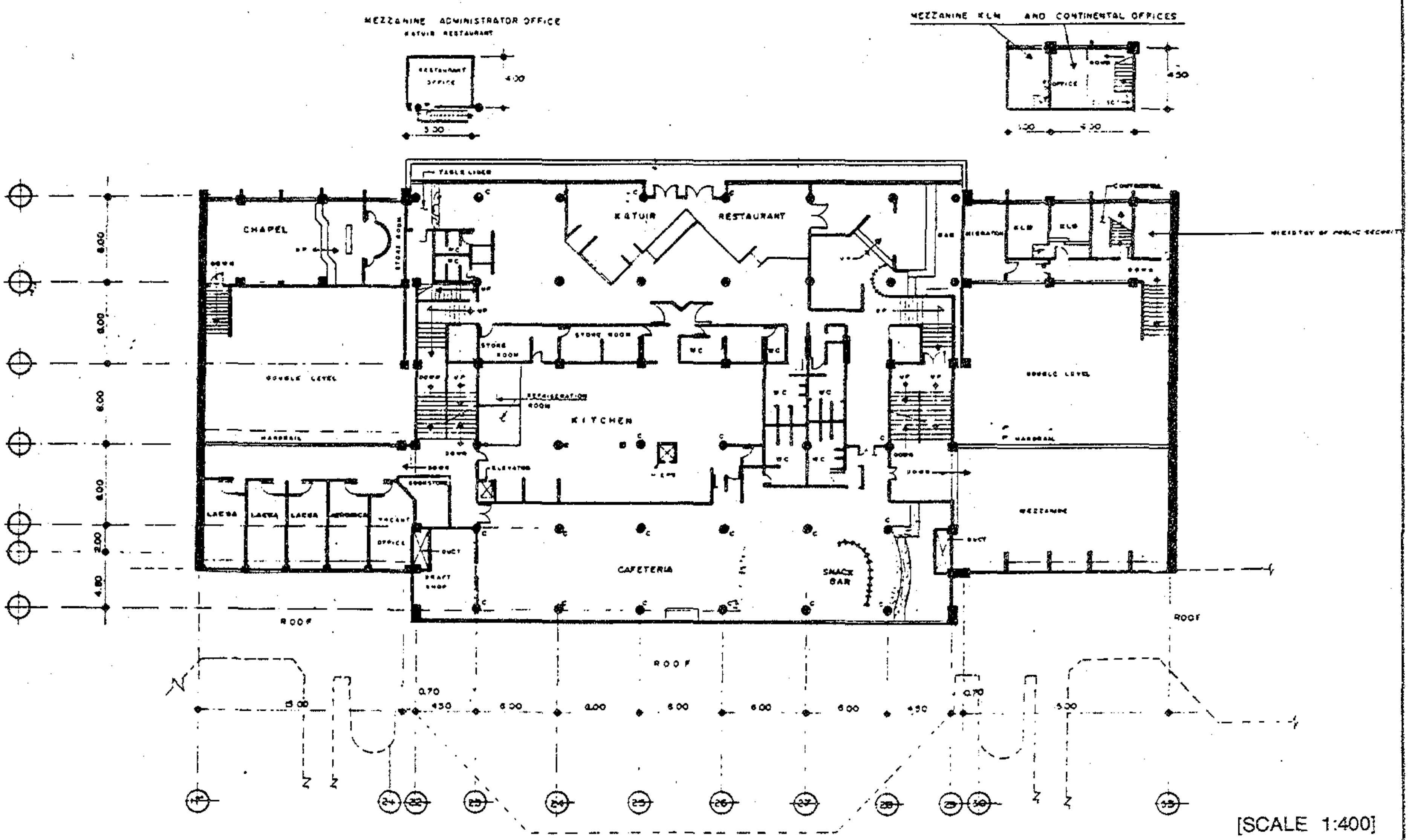

Figure 6.2.4 Existing Floor Plan of International Passenger Terminal Building (Second Floor)

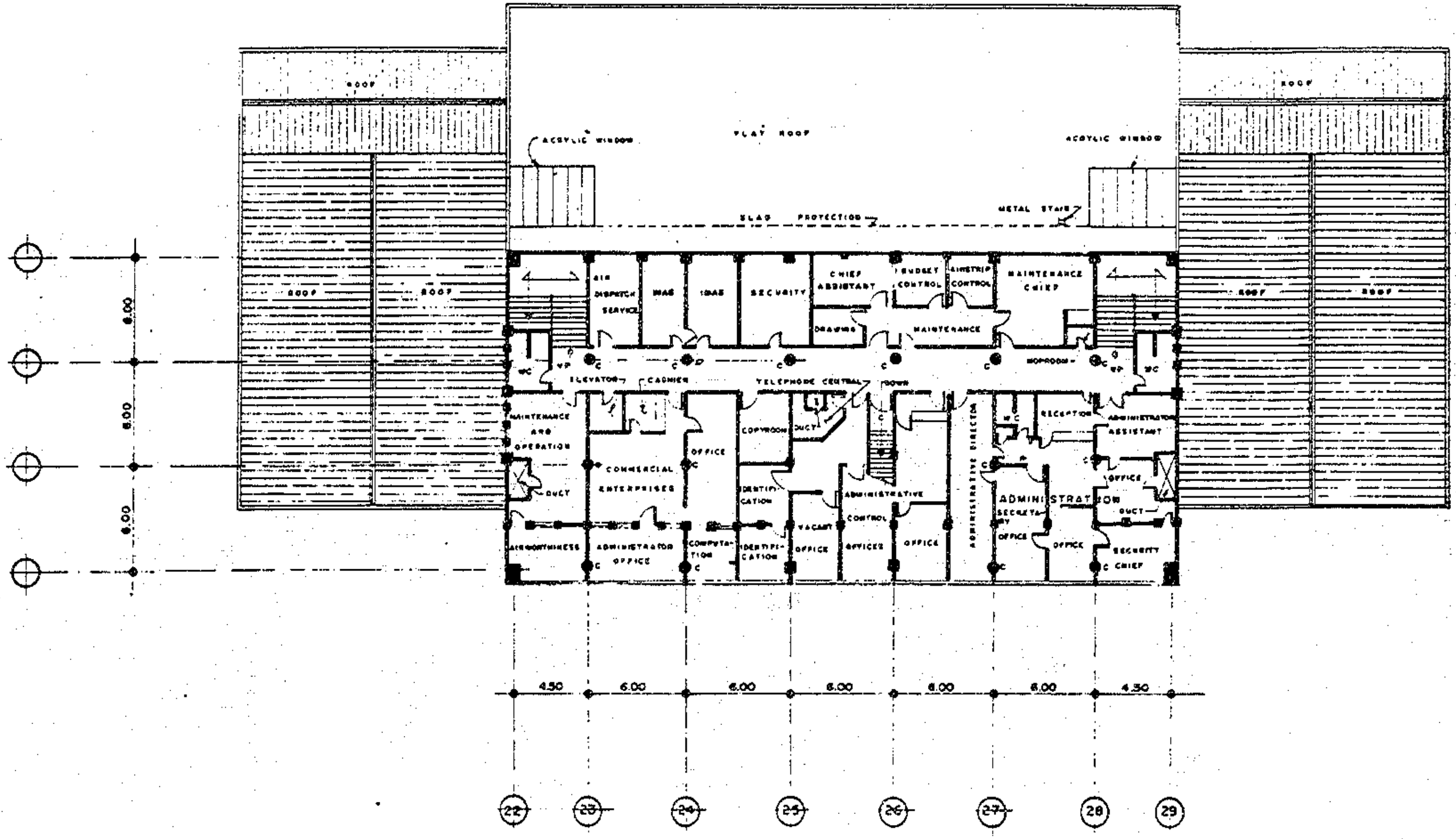

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Figure 6.2.5 Existing Floor Plan of International Passenger Terminal Building (Third Floor)

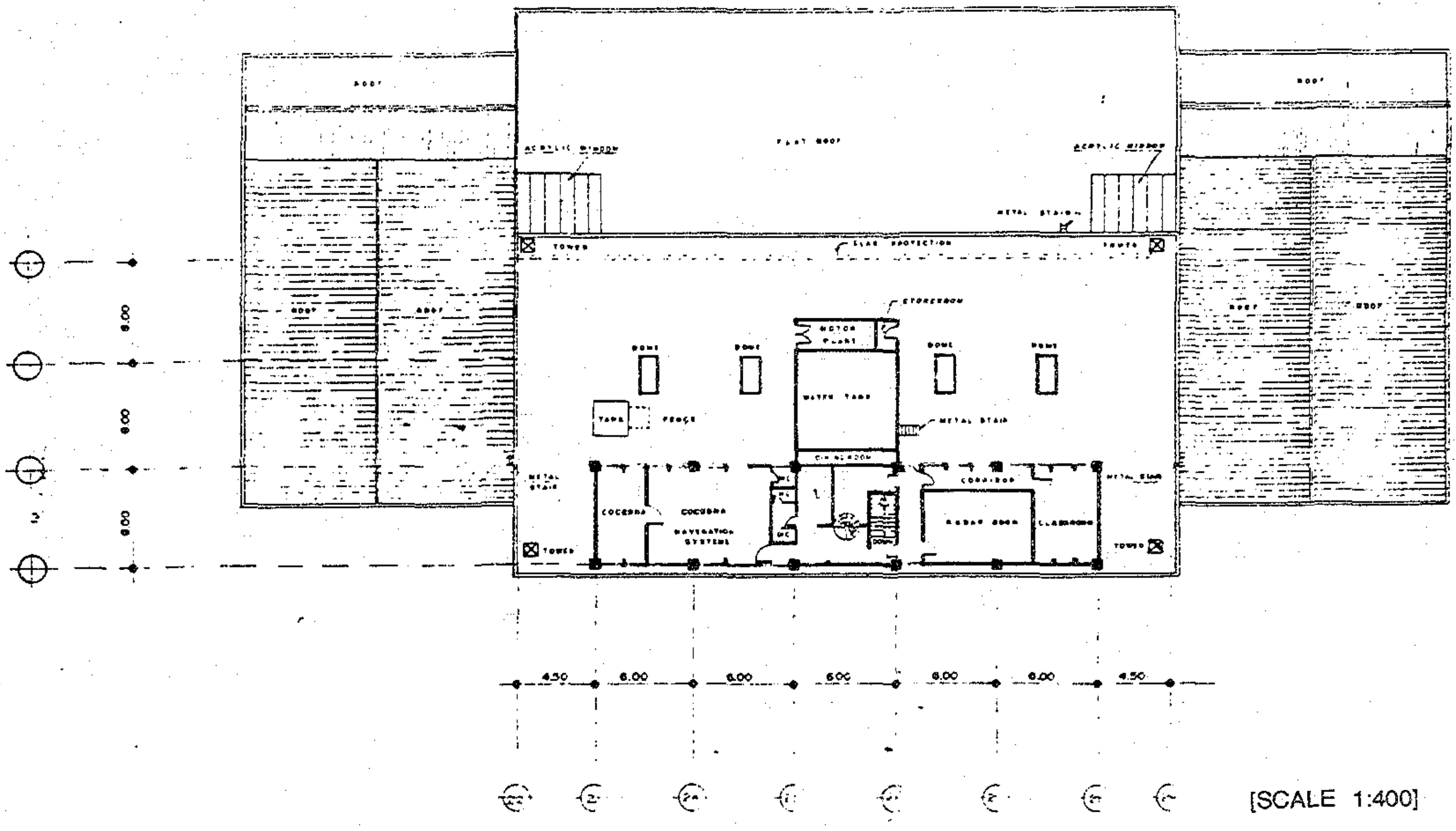

Figure 6.2.6 Existing Floor Plan of International Passenger Terminal Building
(Fource Floor)

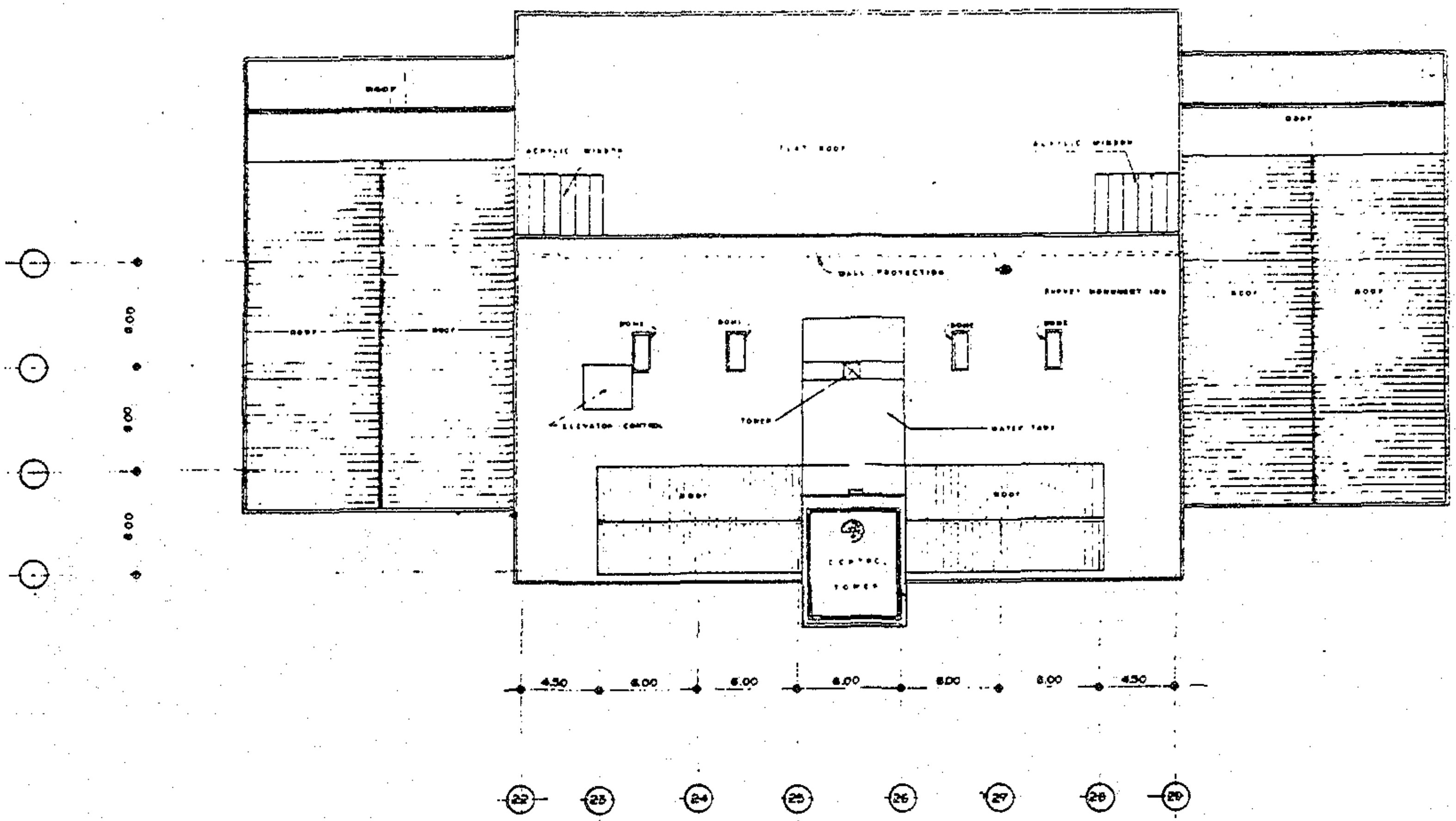

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Figure 6.2.6 Existing Floor Plan of International Passenger Terminal Building (Fifth Floor)

Six boarding bridges were installed in 1977 to directly connect the first level of the building with parked aircraft. Although the installation of boarding bridges enabled smooth flows of departing passengers, it created a new problem which is the mixture of arriving and departing passengers on the first level. This mixture is unfavorable from the viewpoints of security and congestion.

The maximum walking distance from the gate at the far end to the curb side is about 300m, which just equals the allowable limit by the IATA.

2) Floor Utilization

a) Basement (Apron Level)

On the basement floor, there are arrival facilities such as the areas for immigration inspection, baggage claim and customs inspection. Baggage make-up and break-down areas, VIP rooms, LACSA's flight operations office, airline cargo offices, FIS and MET offices, staff canteen, electric sub-stations, air-conditioning plant, storages for ground service equipment, etc. are also located there.

b) First Floor (Street Level)

This level is mainly used as the departure area, and divided into three functional areas, i.e., check-in lobby, departure government control area and departure lounges.

The departure curb side which is located in front of the central block of the terminal building is only 2.2m in width, and the projection of the canopy is not sufficient to cover passengers getting out of cars.

Departing international passengers enter through the doors at the center of the terminal into the check-in lobby, where facilities such as check-in counters, baggage control offices, tax counters, banking services, telephone and facsimile services, etc. are located.

After completing the check-in process, departing passengers proceed to the immigration check points, which consist of the following processes:

i) Rough checking of documentation
ii) Computer data-base registration
iii) Passport checking

There are, at both sides of the central check-in lobby, two separate routes. Each has a complete set of the immigration check points i), ii) and iii) stated above. It is often observed that a long queue is formed on one side, while the other side is vacant just waiting for the next passenger.

Then, passengers proceed to the security check gate, which contains an X-ray baggage check unit and a walk-through metal detector.

Along the air side, there are three departure lounges. Each of them has around 140 seats and serves two boarding gates. Along the corridors connecting these lounges, there are duty free shops, a bar, toilets and stairways.

Arriving passengers have to go through the departure lounge(s) after disembarking from the aircraft. It requires a long walking distance for arriving passengers in particular for those who disembarked at the western end boarding bridge.

c) Second Floor

On the second floor at the center of the building, a coffee shop, restaurant and kitchen are located. These facilities are located in the non-sterilized area. A Christian chapel, airline offices and an immigration office are also located on this floor.

d) Third Floor

This level contains a corridor running though the center of the floor, having stairways at each end that go down to the second floor and a staircase on its center that leads to the fourth floor. Along both sides of the corridor, there are administration and maintenance offices of the DGAC.

e) Forth Floor

The fourth floor is mainly used for the operations office of the DGAC, having rooms for radio-communications, radar control, a staff training and rest area, a small hall with a kitchenette, a toilet, a shower booth, portable water tank, and an emergency generator room

f) Fifth Floor

On the fifth floor, the control tower is located. A spiral staircase is provided as an access to the tower from the small hall below.

3) Total Floor Area

The floor areas of the terminal building are shown in Table 6.2.5.

Table 6.2.5 Floor Areas of International Passenger Terminal Building

(Unit: m^2)

Floor	Gross Floor Area	Passenger Terminal Related Area*	Major Function
- Basement	6,560	2,310	Arrival Passenger Processing
- First Floor	6,360	5,240	Departure Passenger Processing
- Second Floor	1,810	1,510	Restaurants/snack bar
- Third Floor	740	-	DGAC Administration Office
- Fourth Floor	230	-	DGAC Operation Office
- Fifth Floor	30	-	Control Tower
- Total	15,730	9,060	

Note: Including passenger processing area, airline offices, CIQS offices, restaurant, snack bars, shops, toilets, mechanical rooms, etc. (See Appendix-6.2.3 for details)*

The passenger terminal related floor area of 9,060m² in the above table corresponds to 11.3 m² per peak hour passenger at present. Since the floor area requirement by the IATA is 9.3 m², the size of the existing passenger terminal is, as a total, adequate for the present traffic. However, several functional areas in the terminal building are short of capacities even for the present traffic as mentioned in the following.

4) Capacities of Functional Areas

a) Number of Counters

The present number of counters is compared with the required number of counters for the present traffic in Table 6.2.6.

Table 6.2.6 Capacities Functional Areas - Counters

Counters	Existing No. of Counters	Requirements for Present Traffic*1	Average Processing Time*2
- Check-in	41	22*3	3.2 min/pax
- Departure Immigration	4	6	0.8 min/pax
- Security Inspection	1	2	0.3 min/pax
- Arrival Immigration	12	6	0.9 min/pax
- Customs	6	10	1.5 min/pax

Note 1: 400 passenger/hour
2: Based on the traffic survey by the Study Team
3: Common use check-in is assumed for calculation.

In the above table, the number of check-in counters provided at present is much more than the calculated requirement. However, heavy congestion occurs during peak season at present. This is because all the check-in counters are not available due to designated use of counters by airline companies. For example, the IBERIA and KLM occupy three and two check-in counters respectively, but the frequency of their flights is only four and two flights per week.

The counters at departure immigration, security inspection and customs are not sufficient for the present traffic, while the number of arrival immigration counters is far above the present requirement.

b) Floor Area

The present floor area of functional areas is compared with the required floor area for the present traffic in Table 6.2.7.

Table 6.2.7 Capacities of Functional Area - Floor Area

Functional Areas	Existing Floor Area	Requirements for Present Traffic*1	Remarks*2
- Check in Lobby (Including Public Area)	845 m^2	1,260 m^2	Calculated for 41 counters
- Departure lounge (Queuing Area)	280 m^2 per lounge	240 m^2	1.5 m^2/pax
- Arrival Immigration (Queuing Area)	240 m^2	140 m^2	0.36 m^2/pax
- Baggage Claim (Excluding Claim Device)	280 m^2	400 m^2	1.0 m^2/pax
- Customs (Queuing Area)	105 m^2	140 m^2	0.36 m^2/pax

Note 1: 400 passengers/hour (160 passengers for departure lounge)
2: Estimated from IATA Airport Terminal Reference Manual

The results show that floor areas are insufficient at check-in lobby, baggage claim area and customs inspection areas for the present traffic.

5) Structure

The main block at the center of the terminal building is a five story building with hybrid structure of concrete frames, steel beams and steel roof trusses. The central block and the adjacent two-story wings have flat roofs of concrete slabs, while the other areas, most of which are low rise extended blocks, have sloped roofs with corrugated iron sheets. The structural system of the building generally appears to be in fair condition except for minor damage observed at some of the expansion joints between each of the building blocks.

6) Finishings

The external finishings are generally well maintained, except for minor damage observed at some points of the corrugated steel roof sheets, expansion joints and waterproofing roof sheets.

The internal finishings are somewhere between good and barely acceptable. The restaurant and chapel, both of which are located on the second floor, are well furnished. The interior finishings in most of the other public areas may well be upgraded with a reasonable additional cost input.

7) Ancillary Facilities of Building

a) Air conditioning system

A central chilled water type air conditioning system with a capacity of 110 refrigeration ton is provided to departure waiting rooms, concession stores and check-in airline offices in the passenger terminal building. Split type air conditioning systems are provided for the restaurant and bar with a capacity of 30 refrigeration ton, and for the VIP lounge with a capacity of 15 refrigeration ton. Window type air conditioners are provided in each small office. The centralized air-conditioning system may be considered along with the development of the terminal building.

b) Fire hydrant system

No fire hydrants or automatic fire detection systems were provided at the existing terminal building. Only fire extinguishers are provided. The fire hydrant and protection system shall be considered in future plans in compliance with the regulations of the country to ensure safety and security of airport users.

c) Flight information system

No flight information system was provided. According to the DGAC, there is a plan to provide the system (flap type) in the near future.

d) Master Television and CCTV

One television monitor of commercial broadcasting quality is provided in the waiting hall. A master television system to distribute commercial broadcasting and other programs for the terminals in a wider area may be considered to provide better services for passengers.
At present, the CCTV (Closed Circuit Television) system is provided for security control and monitoring. Nine cameras are installed in the terminal building and are monitored at the supervisory room on the mezzanine of the passenger terminal building. These systems should be extended along with the development of the terminal building.

e) Public Address System

The current system has only one circuit for all of the terminal building. The system should be designed to provide information for departure, arrival, general and administrative purposes separately in accordance with the zoning of each function in the terminal building.

6.2.8 Domestic Passenger Terminal Building

The domestic passenger terminal building is located between the RECOPE fuel depot and the COOPESA hangar. Passenger handling is carried out in the first floor of this two story building. The second floor is used for storage space of the LACSA. The terminal building was inaugurated about five years ago when the existing international passenger terminal building was changed to be used exclusively for international use. The floor area available for domestic passenger handling is 216m², which is not sufficient even for the present traffic. Domestic cargo is also handled in this terminal building.

The following claims were raised by the SNSA and users of the terminal building.

- Located too close to RECOPE fuel depot, which endangers passengers in the event of accidents
- Very noisy due to proximity to COOPESA hangar
- Too far from international passenger terminal building, thus inconvenient for transfer passengers

The building has only minimum functions for handling of domestic passengers such as a small passenger waiting hall which is used both for arrivals and departures. Neither concessions nor any kind of air-conditioning are provided. Furthermore, finishing standards as well as spacing, and accordingly the appearances both inside and outside are far below average.

6.2.9 International Cargo Terminal Building

The cargo area is located at the east part of the terminal areas. There is a customs building just east of the international passenger terminal building. This building is a single story building of steel frame having a floor area of 3,740m². It is divided into three operational areas, i.e., cargo storage, customs administration and handling area. The main structural frame appears to be in sound condition, but rusted purlins will need replacement soon.

The LACSA has their own cargo warehouse for temporary storage at the east end of the terminal area because of a capacity shortage in the customs building. There are several small buildings for cargo agents behind the customs building and the LACSA warehouse. The LACSA warehouse is in good condition, while agent buildings are, though still operable, not well maintained.

Imported cargo is classified into two categories; Category - A: goods imported for consumption in Costa Rica, and Category - B: items to be used as materials for producing goods for export. Category - B cargo is exempt from import tax. According to the chief officer of the airport customs, the ratio of Category - A cargo to Category - B cargo is approximately 9:1. Due to very limited space of the customs building at the airport, these two categories are processed in different ways as described below:

Category - A cargo is inspected by customs officers for proper documentation in the airplane and transferred directly to trucks without being stocked in the customs building at the airport. Then, the cargo is carried to one of four customs branches in the city where final customs clearance procedures are carried out.

Category - B cargo is unloaded and transported to the customs building and stocked there. After being registered, the cargo is then transported to another customs branch in the city where it is cleared free of tax, and delivered to export goods manufacturers. End products are carried back through the same route to the customs building in the airport for export.

All the exporting cargo is handled through the customs building.

The existing customs building has completely been saturated in terms of capacity. At the air side, when cargo flights come, unloaded packages often accumulate outside the roof covering of the canopy waiting to be processed. In the warehouse, numerous packages are stored one on top of the other. At the truck yard, the limited area causes congestion in maneuvering of trucks. There is no space for expansion in the vicinity of the present building.

6.2.10 Administration/Operations Office

Most administrative and operational functions of the DGAC are accommodated on the third to fifth floor of the international passenger terminal building. The FIS office is located in the basement of the terminal building together with the meteorological office. The total floor area used for these functions is 1,300m². As claimed by the DGAC and as compared with Japanese airports of similar functions, this floor is small. Some 500m² of floor area be added to secure the preferable amount of space.

6.2.11 Roads and Carpark

The location of the terminal road and traffic flow are shown in Figure 6.2.8.

1) Access Road

The airport access road branches off from National Highway Route 1, viz., Pan-American Highway on the east side of the airport terminal area, and has two lanes in each direction. The intersection of Route 1 and Route 153 connecting Alajuela City is situated in the north side of the airport terminal area. The exit ways of Routes 1 and 153 are connected to the airport access road.

2) Terminal Road and Carpark in Passenger Terminal Area

The terminal circular road is connected with airport access road at the east and west sides of the terminal frontage. The terminal circular road is split into two roads. One is the terminal building frontage road with three lanes, and the other is a public bus service road with one lane.

The length of the terminal building curb is 120m, which is too short to provide adequate loading or unloading space for passengers, especially for arrival passengers.

The existing car parking area is separately located on both sides of the terminal building frontage. The capacity of public car parking is 190 and 134 slots for the west and east carparks, respectively. Taxi stands occupy the space in front of the arrival exits and have 31 standing spaces. The carpark and taxi stands are adequate for the present traffic, but will become insufficient before 1995.

These roads and carparks are paved with asphalt concrete.

3) Roads and Carparks in Cargo and Maintenance Area

The entrance to the cargo area is located on the east end of the terminal area. The parking area is approximately 4,800m² and is utilized as a trailer and truck yard. This area is too small to enable smooth flows of vehicle traffic.

The entrance to the maintenance area is located at the end of the airport access road. The public road connecting the airport access road detours around the airport maintenance area and reaches Route 124 on the west side of the airport maintenance area.

6.2.12 Air Navigation Systems

The layout plan and block diagram of the existing air navigation systems are shown in Figures 6.2.9 and 6.2.10. The details of the systems are included in Appendix-6.2.4.

1) Radio Navigation Aids

a) Operations and maintenance of the radio navigation aids are carried out by the COCESNA.

b) The ILS/LLZ-GP of category I for Runway 07 was installed in 1977. The antenna of the LLZ was replaced with a new one in 1988 due to a crash by an aircraft. There is no problem at the present.

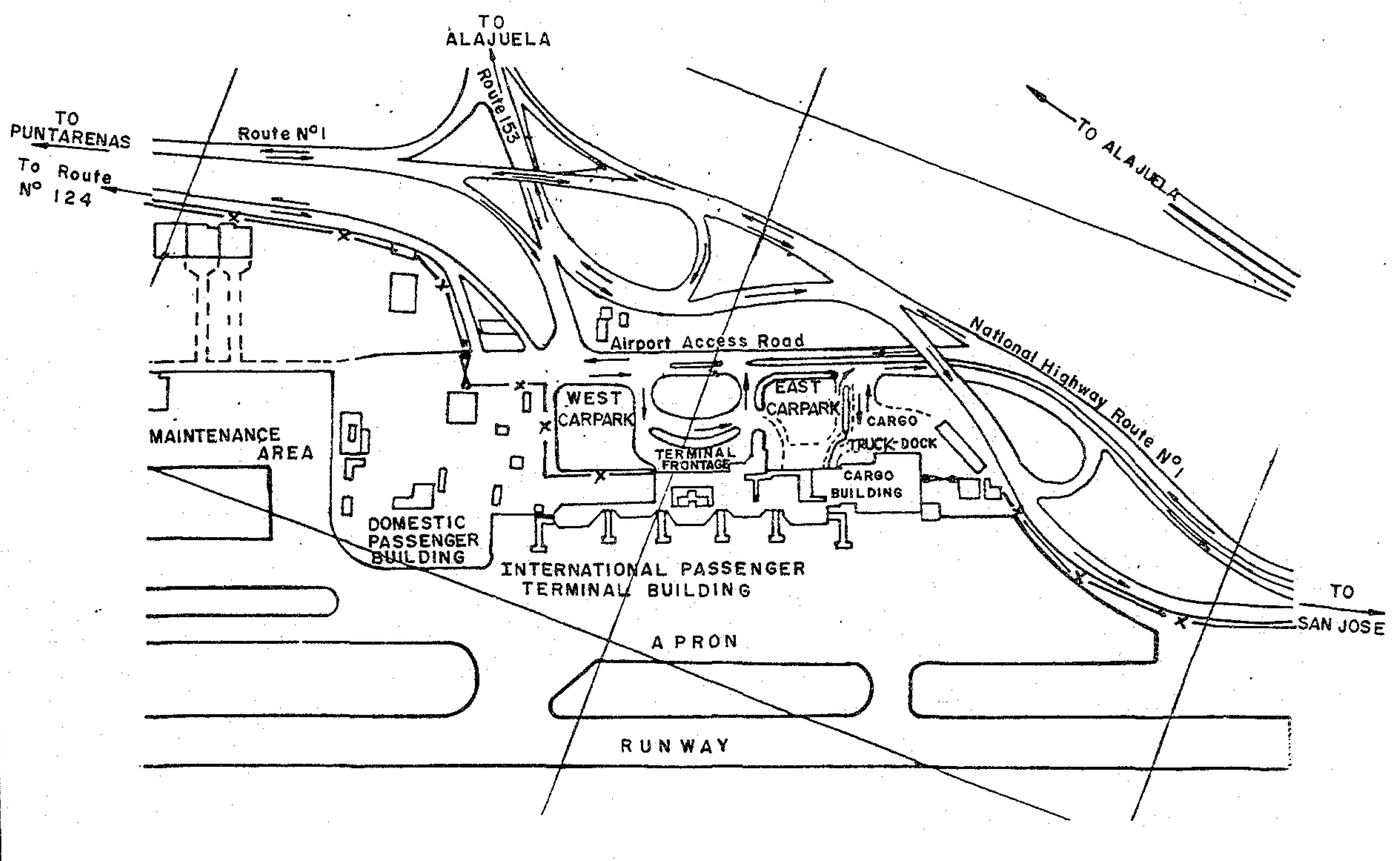

Figure 6.2.8 Vehicle Traffic Flows in Terminal Area

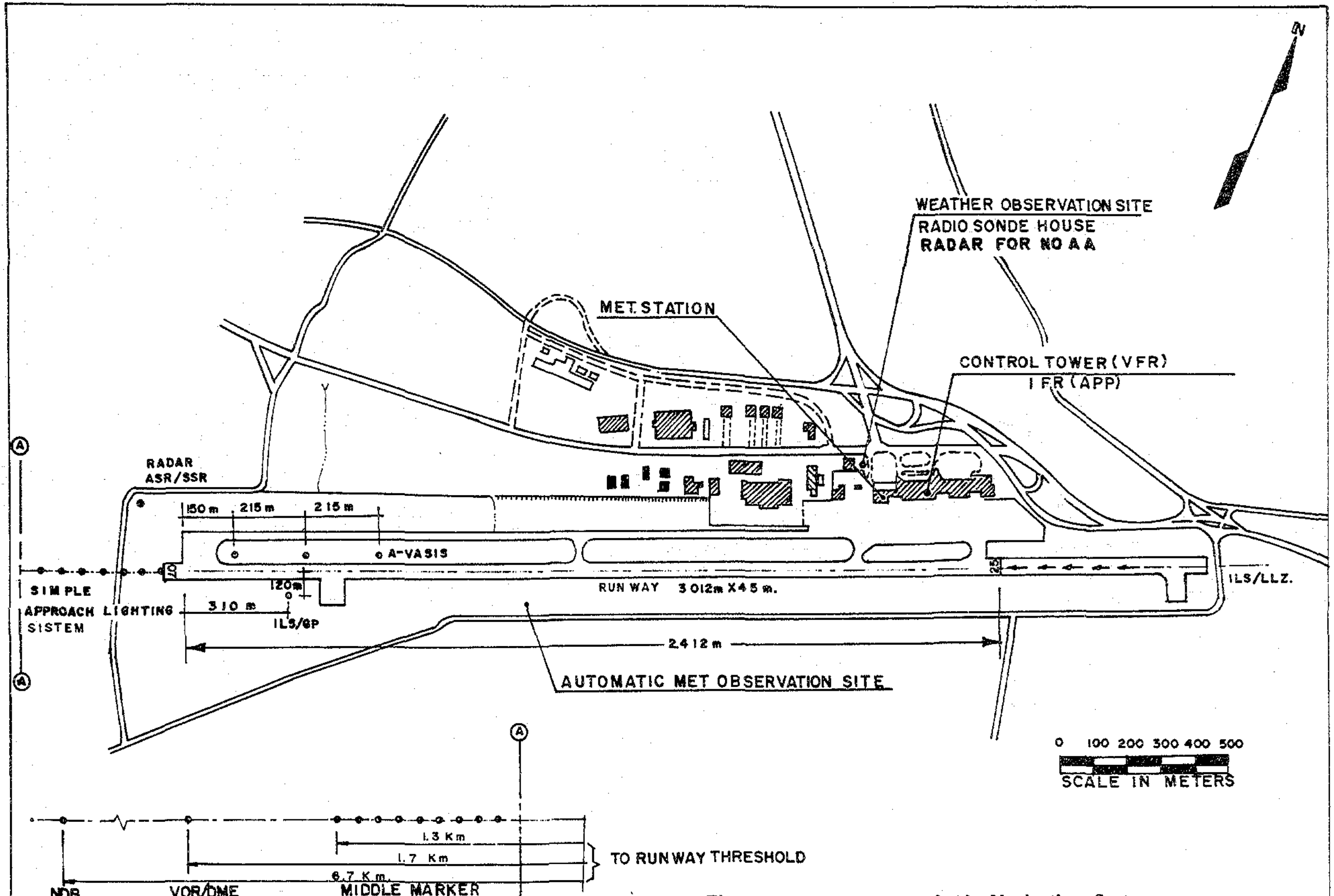

Figure 6.2.9 Layout of Air Navigation Systems

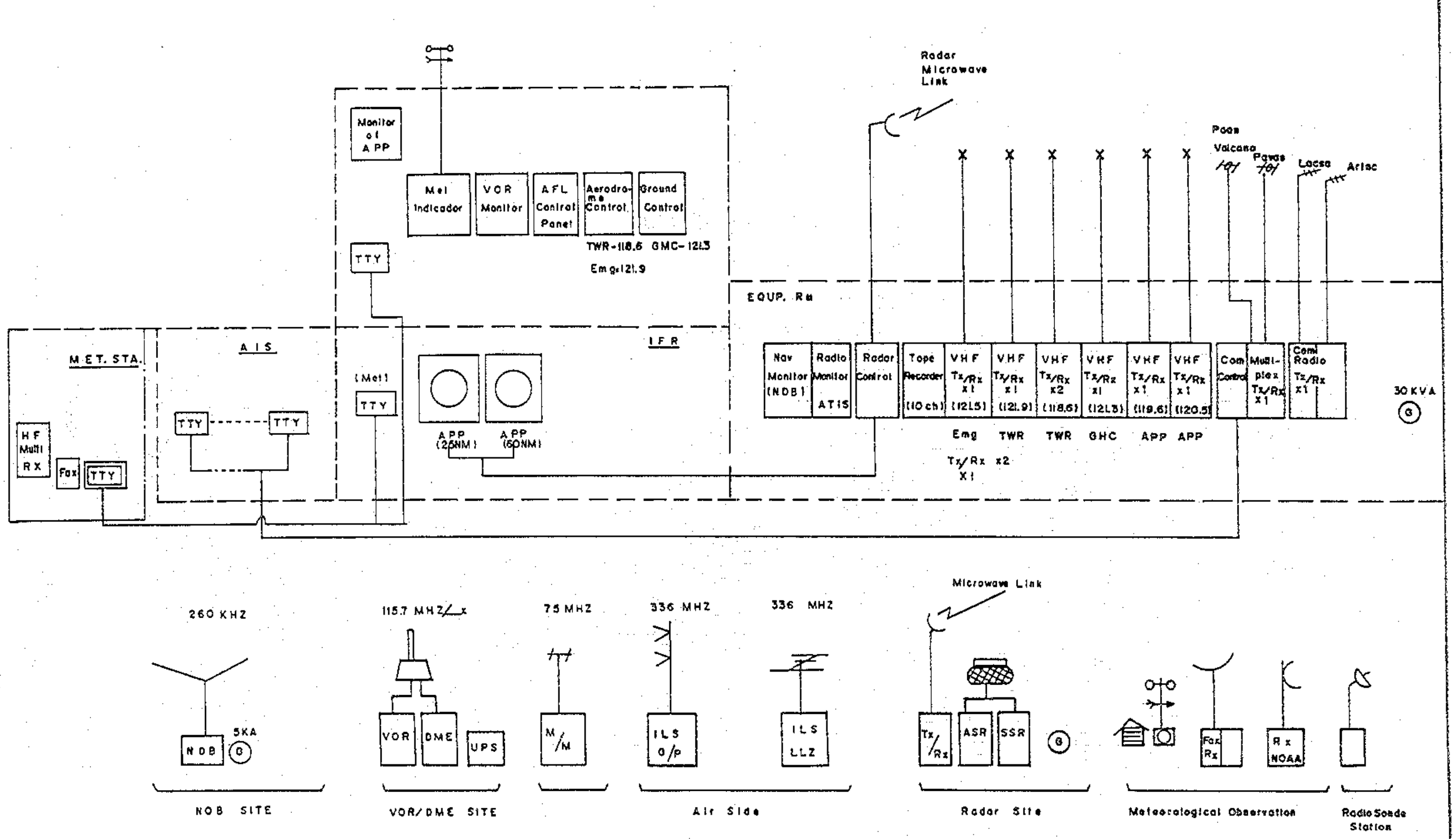

Figure 6.2.10 Block Diagram of Existing Air Navigation Systems

c) The VOR and co-located DME were installed on the extended centerline of the runway at a distance of about 2km from the Runway 07 threshold in 1980. The VOR/DME are operated by AC Power and backed up by the un-interrupted power supply system. No problem is observed at present.

d) The NDB was installed at a point about 8.4km away from the Runway 07 threshold on the extended centerline of the Runway 07 around 1975. A vertical antenna about 40 meters high was installed. The equipment is operated by commercial AC power with back up by the emergency generator of 5 KVA capacity and no problem has been noted.

e) Although radio navigation aids are operated in good condition at present, they will need to be replaced with new ones before 2000 taking into account the normal operational life of 15 to 20 years.

2) Air Traffic Control System

a) ASR/SSR radar control system was provided by the COCESNA in 1975. The radar site was established near the threshold of Runway 07 at a distance of 200m from the runway centerline. The type of radar is very old, because Airport Surveillance Radar System ASR-1.2.3. (Type FA5144) is of vacuum tube type.

The radar signal is transmitted from the radar site to the IFR room in the international passenger terminal building by a microwave link. The video signal is used for APP control and its monitor video is distributed also to the VFR room. The radar scope of the APP console consists of two scopes. One is the display of full scale range of 60NM, and the other is 25NM range as the detailed display around the airport. However, the radar scope of the APP console has become old and the display is not clear.

b) The control console panels for APP and at VFR room seem to have become old.

c) The COSESNA plans to replace the radar facility in 1992.

3) Aeronautical Telecommunications System

a) The aeronautical telecommunications system used by the DGAC is owned and maintenanced by the COCESNA.

b) The aeronautical communications for air to ground are in good condition.

c) The aeronautical telecommunication system between the airport and other stations and airports outside of Costa Rica is operated by the radio communication network of 900MHz. This system is relatively new, since it was completed in 1982.

d) ATIS services are now stopped due to equipment maintenance work.

e) Most aeronautical telecommunications systems will need to be replaced around 2000 due to the expiration of operational life.

4) Aeronautical Ground Lights

a) The simple approach lighting system with the capacitor discharge lights is only provided for Runway 07. It is a substandard system for the precision approach runway.

b) Visual approach slope indicators (VASIS) of three bar system are also provided for Runway 07.

c) There are runway threshold identification lights (RWYTIL) and VASIS for Runway 25. These are minimum provisions for the non-precision instrument runway.

d) As for other aeronautical ground lights, runway edge, taxiway edge, apron edge, runway threshold, runway end and obstruction lights, apron floodlights, and aerodrome beacon are provided. These lights are controlled from the control console in the VFR room.

e) The runway lights and cable were renewed in 1990. There is a plan to renew the taxiway lights.

f) The existing aeronautical ground lights maintain minimum requirements for the airport. They can be used until around 2010 by the renewal plan under consideration of the DGAC.

5) Meteorological Observation System

a) The observation of runway surface conditions is carried out at the observation fields located between the fire station and the public parking area, at the south side of runway and on the roof of the control tower. The flow of collected data is shown in Figure 6.2.11.

b) Upper air observation by radiosonde is carried out once a day at 5:30 a.m. The heights for the observations are between 10 to 15km.

c) Weather data are transmitted to Chacarita, Juan Santamaria, Limon, Palmar Sur, Liberia and Pavas Airports, Washington and other Central America cities.

d) The weather data by satellite from NOAA is received by the receiver installed in 1951. The maintenance of this equipment is performed by the NOAA.

e) The sensors of the runway visual range (RVR) and ceilometer are not provided.

f) The existing meteorological system covers the requirements for the airport operation. However, the replacement of equipment may be considered before 2000. The installation of RVR and ceilometer is desired to improve its services.

6.2.13 Rescue and Fire Fighting Services

The services of rescue and fire fighting at Juan Santamaria Airport are carried out by the National Institute of Insurance (INS). The services by the INS were started in February 1982 after the transfer of responsibility of services from the MOPT. The fire station is located at the northwest side of the international passenger terminal building.

1) Fire Vehicles

The following facilities are maintained at the fire station:

- One unit of fire vehicle with a capacity of 1,800 gallons of water and 240 gallons of foam at a discharge capacity of 1,000 GPM.
- One unit of water tank with a capacity of 3,000 gallons of water
- Two units of rapid intervention vehicle with a capacity of 1,500 gallons of water and 200 gallons of foam with a discharge capacity of 1,000 GPM with 1,500 pounds of dry chemical.
- One unit of vehicle with 500 pounds of dry chemical.

These vehicles were provided between 1968 and 1978.

There is no problem with maintenance of the equipment since the INS has a workshop at Desamparados for maintenance services.

2) Personnel

The total 12 skilled staff of the INS are engaged in the rescue and fire fighting services at the fire station with a rotation system of two shifts (6 persons per shift) for 24-hour service. Another 15 firemen are assigned as volunteers from among the members of the airport staff. In case of emergency, an assistance system by the nearest city's fire station at Alajuela, Heredia and Central Office is established.

3) Fire Station

The fire station was constructed in 1982. The building consists of a main block with two stories, which is approximately 24m by 25m in plan. A reinforced concrete frame structure is applied to the building with a roof of corrugated iron sheets. The building is in good condition except for minor damage on the internal wall caused by the recent earthquake.

4) Level of Protection

The abovementioned fire vehicles meet the ICAO's level of protection of category - 8. This level of protection is sufficient up to 2010, but existing old fire vehicles will need to be replaced before 2000.

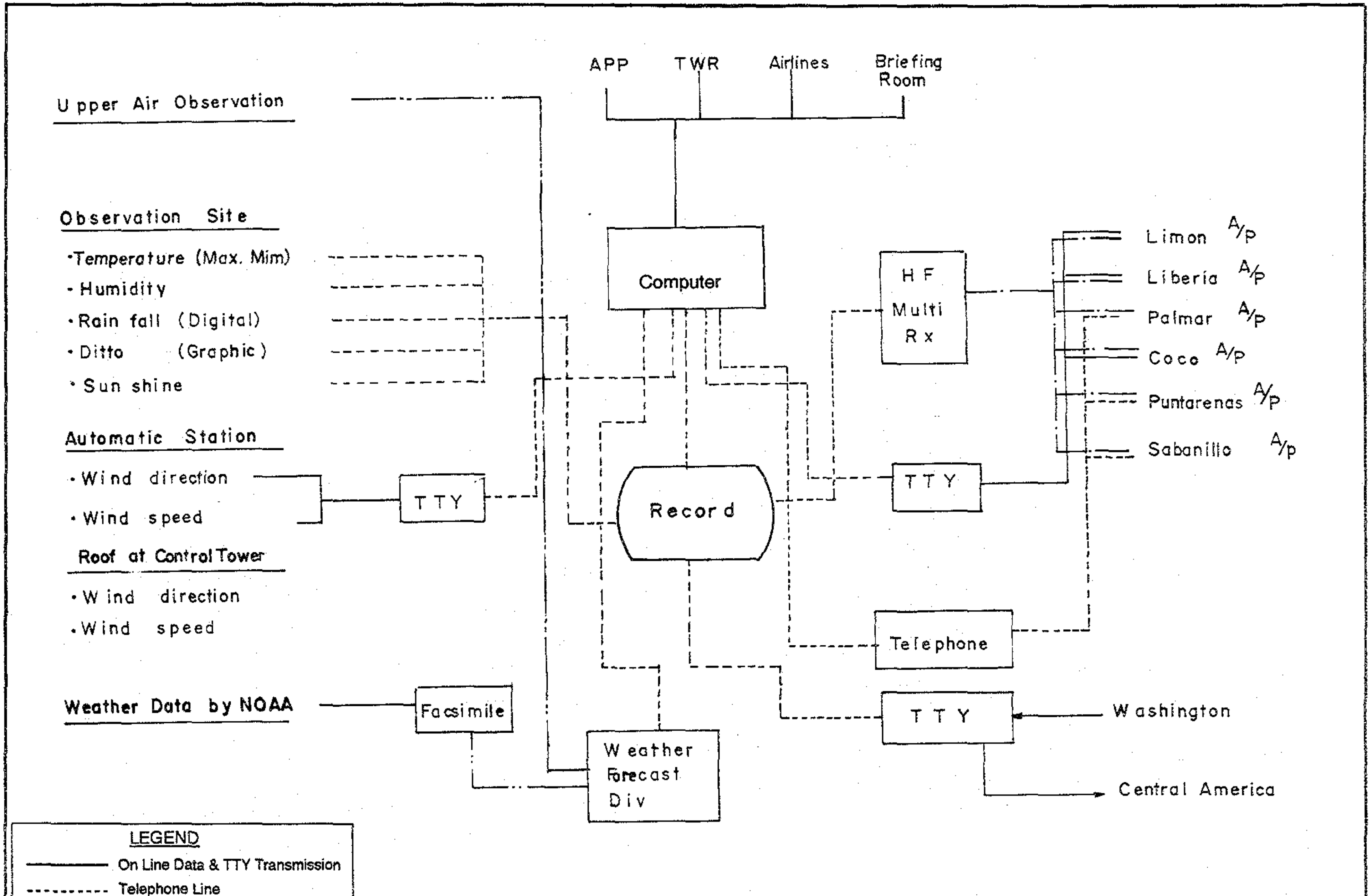

Figure 6.2.11 Conceptual Diagram of Existing Meteorological Observation System

6.2.14 Airport Utilities

1) Power Supply System

The system diagram of the power supply system for the terminal building and airport facilities is shown in Figure 6.2.12. The basic concept of power supply system for the airport facilities is as follows:

- The passenger terminal building and airport facilities are supplied by CNFL and ICE so as to keep the high reliability of power supply for the maintenance of basic airport operations.

- The other facilities such as domestic and cargo terminal buildings, COOPESA hangar, general aviation hangars, fire station, etc. are supplied by independent lines of CNFL.

- The DGAC has full responsibility for maintaining the power supply system of the passenger terminal building. The emergency generator of 275KVA capacity is provided with stand-by equipment.

- Total load for the passenger terminal building is estimated at about 500KVA and the essential load by the generator is about 200KVA.

- The equipments and panels of the passenger terminal building were installed around 1975. The panels and equipment seemed to be obsolete.

- Some loads of the passenger terminal buildings are fed by the independent CNFL line so as to cope with the increasing demand. However, there is a plan to incorporate all of these loads into one system in order to unify and connect them with the emergency generators.

2) Telephone System

- The current telephone system at the airport is connected with the ICE lines.
- For the passenger terminal building, the receiving capacity is 400 lines at MDF, then it is distributed to each group with about 40 lines.
- About 200 lines are used for direct telephone lines, facsimile, telex, etc. Each airline has also received an exclusive line from the ICE. This system seems to be a primitive one. The service level of the system is very low because of the low quality of signals and reliability of services.

Maintaining good services and increasing capacity are required.

3) Sewerage System

- Sewage from the passenger terminal building at the airport is discharged to a septic tank located 250m west of the terminal building by a 200mm clay tile sewer main. The sewerage system of other facilities is connected to that of the terminal building.
- All sewage mains are old and deteriorated. The septic tank does not function properly due to being over capacity. Therefore almost all sewerages flow directly into the Ciruelas river nearby.
- The central treatment system will be adopted to modernize the airport sewerage system and to the protect the environment of the airport and surroundings.

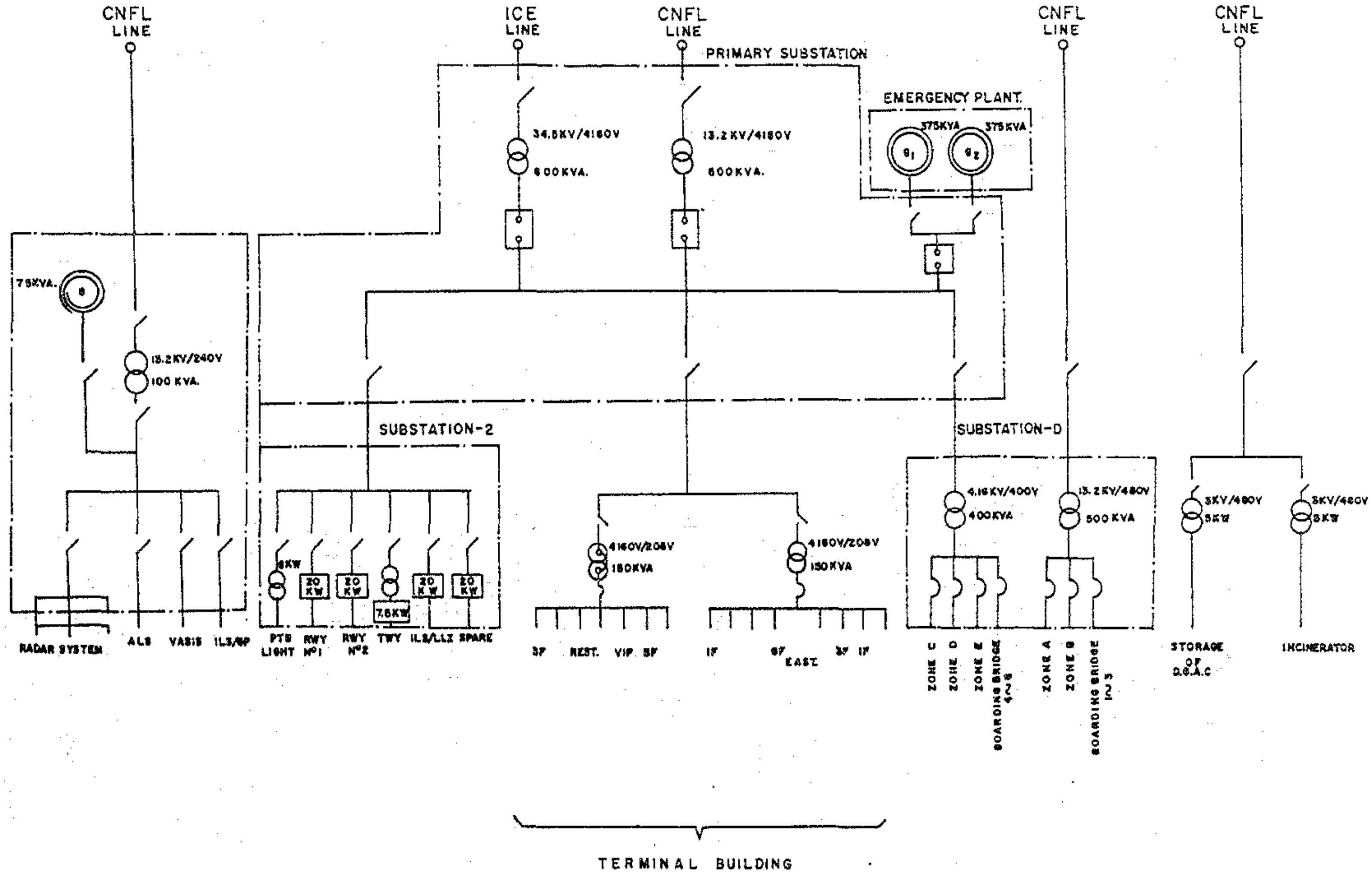

Figure 6.2.12 System Diagram for Power Supply System

6.2.15 Other Facilities and Services

1) Aviation Fuel Supply

The fuel supply system at the airport is operated by the RECOPE. The fuel depot is located on the west side of the international passenger terminal building in front of the fire station. The fuel supply was started on October 1, 1976 after the unification of services from TEXACO, EXON and ROHO DE DIO. The outline of the existing fuel supply system is summarized as follows:

Table 6.2.8 Outline of Fuel Supply System

Item	Description
- Supply Method of Fuel Depot	Transport by tank truck from the storage yard at La Garita, located 11km from the airport.
- Daily Consumption	Jet-1 : 47,000 gallons (214,000L) Avgas : 9,000 gallons (40,000L)
- Storage Capacity	Jet-1 : 155,000 gallons Avgas : 35,000 gallons
- Supply System to Aircraft	Apron hydrant system (24 spots) for passenger apron Fuel tankers for cargo apron
- Fuel Tanks	10 Jet A1 tanks (10,000 to 25,000 gallons) 3 Avgas tanks (10,000 to 15,000 gallons)
- Supply Vehicles	3 tankers (12,000 gallons each) 2 dispensers
- Power Supply Capacity	200 KVA
- Emergency Power Supply	200 KVA

No problems were found currently in terms of capacity, but there is some discrepancy on the capacities of the facility between filter and pump (800 gallons per minute) and dispenser (1,000 gallons per minute). This must be settled as soon as possible in order to maintain an adequate systems performance. An additional dispenser is required to cope with the services during peak hours.

2) Aircraft Maintenance Facilities

a) COOPESA Hangar

COOPESA hangar for providing maintenance to aircraft is located 350m west of the international passenger terminal building. The building is divided into three areas: the central hangar for aircraft (3,960 sq.m.), flanked by two wings, each measuring approximately 3,500m^2.

The central hangar is in good condition with well maintained structural frames and finishings. The two wings, though they are still operable, appear to be in need of repaint or replacement of external finishings.

The administration offices are located on the second floor of the east wing. Other spaces in the two wings are used for various maintenance shops. Toward the east, north and west of the hangar, there are some covered areas also used as a part of maintenance facilities. These were observed to be old and deteriorated.

b) General Aviation Hangars

At the north side of the access road running parallel to the runway, there are four hangars, all of them serving general aviation aircraft. They are generally in good condition. The administration offices and operations premises are built at the back part of the hangar. Each building measures very roughly 30m by 30m.

3) Airport Operation and Maintenance

The operation and maintenance of airport facilities under the control of the DGAC excluding the air navigation aid facilities (radio navigation aids, radar and aeronautical telecommunication system) is the responsibility of the maintenance division of the DGAC at the airport. The operation and maintenance of the air navigation system is performed by the COCESNA.

The maintenance division of the DGAC at the airport is responsible not for only Juan Santamaria International Airport but also for the airports of Limon, Liberia, Coto 47 and Pavas, and the DGAC Main Office. The maintenance division is organized by the sections of electrical, mechanical industry, building, metal structure, civil, mobile, topographic and air conditioning.
The following equipment and machines are owned by the maintenance division:

Table 6.2.9 Airport Operation and Maintenance Equipment of DGAC

Equipment	Set
- Towing tractor	2
- Sweeper	1
- Mowing tractor	6
- Grader	1
- Painting machine on pavement	1
- Asphalt cutter	1
- Road drill	1

6.3 Liberia International Airport

The evaluation for Liberia Airport will be carried out for the facilities after the completion of ongoing development work in April 1992.

6.3.1 Runway

(1) Runway Length and Width

The runway of Liberia Airport is being extended and widened by the development work. The original runway of 2,240m by 30m will be extended toward the west by 510m and widened by 7.5m on each side to 45m. This 2,750m long runway will allow non-stop operations of DC-10 to major North American destinations including Los Angeles, New York and Miami, and will be sufficient for air traffic anticipated up to 2010.

(2) Runway Shoulders

7.5m wide shoulders will be provided on each side of the runway. The surface is paved with asphalt concrete along the entire runway length. These provisions are adequate for the foreseeable future.

(3) Runway Usability and Acceptance of Diverting Flights from Juan Santamaria Airport

The weather conditions of Liberia Airport are much better than those of Juan Santamaria Airport. The wind coverage for cross-wind component less than 20kt of 95.8% exceeds the ICAO's requirement of 95%, and is expected to accommodate diverting aircraft from Juan Santamaria Airport of which wind coverage for the same condition is 90.1%.

In order to evaluate the acceptability of diverting flights from Juan Santamaria Airport, a supplemental relationship of meteorology between the two airports is checked. This is done by comparing the meteorological conditions of the two airports when the following bad weather conditions were observed at Juan Santamaria Airport.

- Visibility less than 800m
- Ceiling height less than 100m

The results of the comparison are shown in Table 6.3.1.

Table 6.3.1 Meteorological Conditions at Liberia Airport when Foul Weather was Observed at Juan Santamaria Airport

Year	Month	Day	TC	Juan Santamaria Airport		Liberia	
				Visibility (m)	Ceiling Height (m)	Visibility (m)	Ceiling Height (m)
1987	Aug.	3	23:00	800	100	10,000	3,000
	Sep.	9	19:00	500	100	10,000	3,000
	Sep.	4	21:00	200	100	10,000	12,000
	Oct.	4	23:00	500	100	10,000	24,000
1988	May	16	21:00	800	100	10,000	30,000
	Aug.	31	21:00	800	100	10,000	300
	Sep.	28	23:00	700	100	10,000	14,000
	Oct.	7	22:00	100	100	10,000	16,000
	Oct.	24	22:00	100	100	10,000	1,500
1989	Jun.	4	23:00	100	100	10,000	12,000
	Jul.	26	23:00	200	100	10,000	2,000
	Aug.	21	24:00	100	100	10,000	13,000
	Sep.	13	21:00	500	100	10,000	3,000
	Oct.	16	23:00	100	100	10,000	2,000
	Dec.	7	23:00	500	100	10,000	12,000
	Dec.	7	21:00	700	100	10,000	29,000

As clarified in the above table, excellent weather was observed for all the occasions of foul weather conditions at Juan Santamaria Airport. Therefore, Liberia Airport is expected to function as an alternate airport which can accommodate almost all the diverting fights from Juan Santamaria Airport.

Limon Airport will be another possible alternate airport of Juan Santamaria Airport. Flight distance from Juan Santamaria Airport to Limon Airport is approximately 130km which is shorter than 160km between Juan Santamaria Airport and Liberia Airport. In addition, the meteorological conditions of Limon Airport is superior to those of Liberia Airport. However, Liberia Airport is expected to have advantage over Limon Airport as an alternate airport from the viewpoints of adequate airport facilities to accommodate large jet aircraft and availability of accommodation facilities for passengers and crew.

6.3.2 Runway Strip

The development work of Liberia airport is planned based on a 300m wide runway strip, which is adequate for instrument approach operations. After the completion of the new terminal area, the existing apron will fall inside the runway strip. Thus, it should be used no longer.

6.3.3 Obstacle Limitation Surfaces

The existing terminal building should be demolished after the completion of the new terminal building because it will be an obstacle to 1:7 transitional surface starting from the edge of 300m wide runway strip. There will be no other obstacles which influence the aircraft operations from/to Liberia Airport.

6.3.4 Taxiway

The taxiway system planned in the development work at Liberia Airport consists of one right angle exit taxiway to connect the runway with the new apron and turnaround taxiways at both ends of the runway. These provisions are sufficient to cope with the anticipated aircraft movements up to 2010. Holding position on the turnaround taxiway will be located 180m away from the runway centerline, and adequate from the viewpoint of safe aircraft operations. The width of the taxiway of 23m is also adequate.

6.3.5 Apron

The size of the apron planned in the development work is 185m in width by 127m in depth. It was designed for parking of two DC-10s with self-maneuvering. This provision may be adequate for the initial development, however, the increase of air traffic will require the extension of the apron sooner or later.

The land side edge of the apron will be located 405m from the runway centerline. This location will allow the parking of B-747 in nose-in configuration without its tail empennage protruding upon the transitional surface.

6.3.6 Aircraft Pavement

The subgrade of the aircraft pavement is rock materials with the CBR value of 15% to 100%. The typical composition of the previous runway pavement consisted of 40cm thick sub-base, 25cm thick base and 5cm thick asphalt concrete surface courses. The sub-base and base course materials are granular aggregate with the CBR values of more than 35% and 80% respectively. The previous runway will be overlayed by 10cm thick asphalt concrete, thus the total thickness of the runway pavement will be 80cm.

The extended part of the runway will be composed of 15cm thick aggregate sub-base, 14cm thick asphalt concrete base and 14cm asphalt concretes surface courses. The equivalent thickness of this new pavement is evaluated to be 58cm.

Assuming a CBR value of 15% for the subgrade, the required thickness of the aircraft pavement to accommodate expected air traffic for the next 10 years is 50 cm. Therefore, the existing and planned pavement has a sufficient thickness (80cm, 58cm) and strength for the introduction of DC-10 to Liberia Airport.

6.3.7 Passenger Terminal Building

1) Old Passenger Terminal Building

The old passenger terminal building consists of a passenger waiting hall with a catering facility, customs office, immigration office, administration offices, generator room, etc. The total floor area of this building is 320m². The building is generally in good condition, however, when the new terminal building which is now under construction is inaugurated, the existing building is to be demolished because it protrudes upon the transitional surface.

2) New Passenger Terminal Building

A new passneger terminal building is under construction on the north side of the new apron. The new terminal building will be a two-story building with an initial total floor area of 1,580m². The DGAC plans to extend the ground floor of the building on both sides by 860 m², which will make the total floor area to be 2,440m². The floor plan of the planned terminal building is shown in Figure 6.3.1. The concept of the terminal building is one level passenger processing, i.e., processing of both departing and arriving passengers on the first floor. The second floor will be used for restaurant, airport administration office, etc.

The size of the planned terminal building is insufficient to handle a single movement of DC-10. The terminal building with a floor area of approximately 3,900m² will be required to cope with peak hour international passengers from a single movement of DC-10 plus some domestic passengers.

6.3.8 Cargo Terminal Building

There is no cargo terminal building planned at the airport. However, appropriate provision should be considered in the new terminal area because cargo demand is also expected to be generated along with the increase of passenger demand.

6.3.9 Administration/Operations Office

The operational function of the DGAC will be accommodated in the control tower building under construction. The administration office of the DGAC will occupy a part of the second floor of the new terminal building with a floor area of 60m². These provisions are considered adequate to carry out airport operations.

6.3.10 Roads and Carpark

1) Access Road

The new airport access road will branch off from Principal Route No.21 at the east side of the airport and connect the new terminal area. The width of the road will be 19.5m. It will have two lanes for each direction with a 1.5m wide median strip. The above provision is sufficient for anticipated vehicle traffic for the future.

2) Terminal Circular Road

The terminal circular road is planned to be a 12m wide one-way circulation road. The provision of three lanes in front of the terminal building, i.e., one standing lane, one weaving lane and one through lane, is adequate to enable smooth flows of vehicles.

3) Carpark

The carpark is under construction in the landside front of the terminal building encompassed by the terminal circular road. The capacity of the carpark is planned to be approximately 100 cars. Although this capacity is consistent with the size of the terminal building of the initial stage, it should also be expanded in accordance with the expansion of the terminal building.

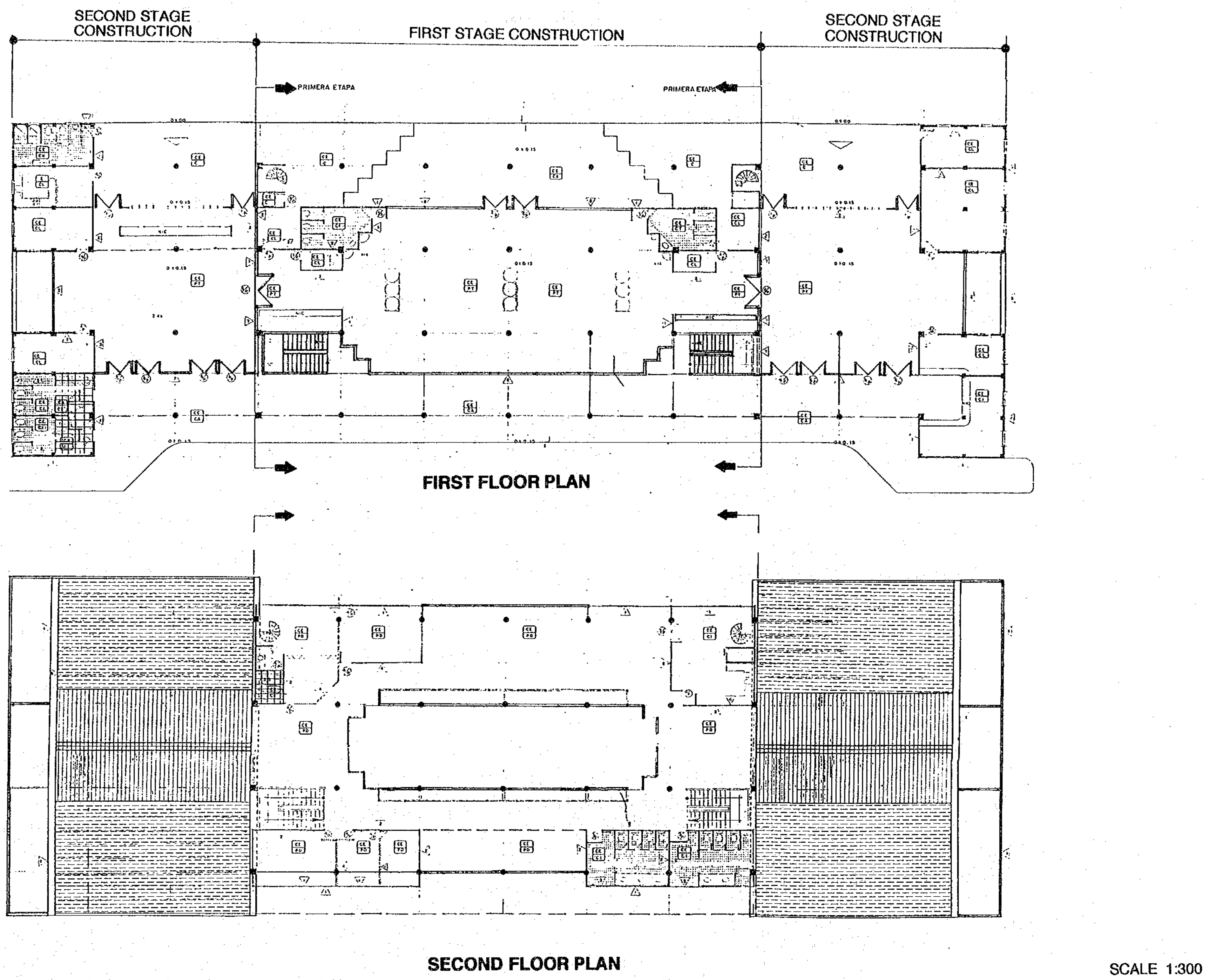

Figure 6.3.1 Floor Plans of Passenger Terminal Building