One of the important new features in this concourse is the construction of a new underground passage at one point (Refer to Drawing 5-4 and Figure 5-1) to allow ground support equipment (GSE) to cross through at ground level without interference with the passenger flow. Escalators would be provided for wheelchairers.

Finally, the exclusive use of this concourse by smaller airplanes with less passengers will alleviate the congestion in the Departure (Holding) Rooms, as attested by Table 5.2.

Transit Lounges: At the present time, the transit passengers must wander in the corridor, which constitute a violation of security rules. The addition of new transit lounges will insure a separation of all arrivals and departures.

- New International Concourse: The requirements for new aircraft positions and gates for 1995 will dictate the construction of a new international concourse for that year. The location, shown in Drawing 5-4, will be designed to fit within existing airport property lines. The new concourse will accommodate 3 gates, all for wide-body jets. To facilitate future expansion, the concourse will be built with the required width to accommodate the traffic flow from all the future additional gates (a total of 8 additional gates envisaged in the long-term master plan).

- New Domestic Concourse: A logical concept of international and domestic activities will be established throughout the building. Based on this concept, a domestic concourse will be built south of the terminal to accommodate one boarding bridge (for B-737) and one access to a ramp parking position. Unlike the international concourse, it is not required to separate the departure and arrival traffic in the concourse. Therefore the ground floor level can be left open, or modified for other uses.

5.3.4 Airport Security in Terminal Area

Airport security has gained increasing importance in the field of airport planning in recent years. Drug trafficking and terrorism are major concerns. Both of these concerns have been addressed during the course of this Study, and solutions have been incorporated in the design whenever possible. In the passenger terminal, special attention was given to the prevention of acts of terrorism, specifically the loading of firearms and explosives on board any flight. More specifically, the following measures deserve to be mentioned:

a) Separation of Arrival and Departure Traffic: When aircraft mix on the same apron, passengers can exchange weapons and/or drugs in an uncontrolled environment. The separation of traffic avoids the possibility of such exchange. More specifically, unloading passengers should not be allowed to mix with passengers waiting to board. The complete separation of arrival and departure traffic from every gate and the addition of new transit lounges will resolve that dangerous possibility.

b) Baggage Sorting: Another security concern is the fact that baggage handlers manipulate the suitcases from the aircraft to the belt . Therefore, a pre-determined arrangement can allow somebody to retrieve any article from such luggage. The location of the belt loading area facing the open apron is intended to expose that process to the public eye and avoid any suspect manipulation.

c) Baggage Make-up: Similarly, baggage make-up, or the grouping of luggage after check-in and before loading on the aircraft, is a sensitive period during which the baggage can be tampered with for trafficking or to endanger the aircraft. The solution lies again, in addition to the use of security guards, in the treatment of the space itself. At La Aurora, both domestic and international make-up areas will still be located on the north and south sides of the terminal, but the spaces will be exposed, and architecturally treated to be more pleasant (Refer to Figure 5-2).

d) Enclosing of Second Floor Mezzanine: The existence of second floor open mezzanine overlooking passengers at the baggage claim area, before they clear customs, is a dangerous feature. In fact, any ingenious violator can pass an item to an accomplice above before going through searching. That is why it is recommended as a first step to install glass panels at the mezzanine to prevent physical contact, without impairing visual contact.

e) Modern Screening Devices: The airport security field is a very prolific one and many devices are available to improve the quality of the screening process. These range from pressure-sensitive and plastic sensitive screening for explosives to the simple process of dog-sniffing for drugs. Although some of the more modern devices are relatively expensive and are just now being used in the busier airports, others require little investment. Modern screening devices are proposed to be installed to satisfy the requirements resolved by ICAO.

CCTV security systems, X-ray inspection equipment and pan/tilt cameras will be appropriately installed as proposed further in Chapter 5.4.5.

5.3.5 Cargo Terminal Improvement

The existing cargo terminal building of 8,100 m^2 in area appeared to be adequate for the present cargo volume of 18,300 tons, judging from a simple application of the accepted "quick reference" standard for gross area requirement of 5 tons per m^2. Furthermore, projections of 23,000 tons for 1995 (Refer to Chapter 3.2.2) would tend to indicate that the building is large enough for that target year also. As noted in Chapter 4.2.2, however, the systems applied for cargo handling and management in the cargo terminal building leave much to be improved. Before discussing the cargo terminal improvement concept in the subsequent Chapter 5.3.6, the types of cargo handled in La Aurora are analysed in more detail.

1) Cargo Size

Actual figures are unavailable with respect to the make-up of the cargo, which is usually classified as "heavy" and "light", referring to both weight and volume. (International standards usually classifies as "heavy" cargo which weighs more than 150 kg per m^2 and with any of its dimensions larger the 1.50 m.) Observation, and conversations with airlines, indicated that the breakdown for imports is 80% light (pharmaceuticals, glass windows and furniture, computers and luxury and beauty items) and 20% heavy (refrigerators and appliances in general). For exports, observations have revealed 100% light cargo. For design purposes, however, 10% can be assumed to be heavy. The cargo projections can now be presented as follows:

Cargo Projections By Types

(tons)

	Year	Heavy	Light	Total
Outbound:	1995	1,300	11,700	13,000
	2005	2,300	20,700	23,000
Inbound:	1995	2,000	8,000	10,000
	2005	3,600	14,400	18,000
Total:	1995	2,650	20,350	23,000
	2005	4,750	36,250	41,000

It must be noted that the distinction between heavy and light cargo is marginal, since there does not seem to be any truly heavy cargo shipped by air in Guatemala. This will result in a rather uniform type of storage space.

2) Perishable Cargo

- Outbound: Statistics were not available either as to what percentage of perishable items makes up the light cargo category. However, it is not unreasonable to assume that percentage to be 80%. But, since the cargo companies have proposed to install and operate the cold storage facilities, a separate figure for the volume of cold storage will not be computed. Instead,the general storage area will be architecturally designed with enough flexibility to allow the insertion of such specialized spaces at a later date.

- Inbound: The volume of perishable inbound cargo is much smaller than that of the outbound. However, there remains a small percentage of items, such as pharmaceuticals, seafood etc., which need refrigeration. As in the case of outbound cargo, a flexible storage space system will be used.

3) Belly Cargo

At La Aurora it is presently left to the discretion of the customs officer to decide what portion of the belly cargo (cargo carried by passenger aircraft, versus exclusive cargo flights) is handled by the airlines in their own facilities (now in the passenger terminal basement), and which is sent to the cargo terminal for processing. The resulting confusion is that many airlines sometimes do not know the whereabouts of their own inbound cargo.

Under the short-term improvement plan, it is recommended that all cargo, including belly cargo, both outbound and inbound, be handled through the cargo facility. This will avoid inefficient spreading of the already scarce manpower of the customs department. This does not signify that all belly cargo must necessarily be stored inside the cargo terminal. There are cases when after being palletized, the cargo is taken directly to the apron to be loaded on the passenger flights. A centralized palletization area is proposed to be provided at a space next to the existing cargo building.

4) Originating vs Transfer Cargo

Although it has been shown that there is a small percentage of trans-shipment of cargo arriving from or going to Central America (such as birds from Honduras and pharmaceuticals from Panama), the majority of this cargo is transferred directly on the apron, without going through the cargo terminal because of its perishable nature. For this reason, a 100% terminating and originating cargo will be assumed in the planning criteria.

5.3.6 Cargo Terminal Improvement Concept

For the short-term plan for the target year 1995, there are not many alternatives as to the type or extent of the improvements to be made to the cargo facilities, considering the severe limitation in availability of land under current situations. The solution, therefore, lies in improving the operation of the existing system, which would consist of the following:

a) Handling of Export Cargo: The existing facility only handles import cargo stored on the floor. It is proposed that one of the two identical 4,050 m^2 modules will be converted in export cargo storage area, and the other will remain for import storage. The area requirements for the year 1995, established in Table 5.4, can be fulfilled more than adequately. However, in order to accommodate more easily the projected volume, a rack storage system must be installed, that is a two-tier storage of heavy cargo and up-to 4 level shelves for some light cargo.

b) Refrigerated Cargo Space: It will be left up to the cargo companies to install their own refrigerated space in the general area, under the supervision of the customs office. However, the loading of the existing building through the short ends, instead of the customary long sides, makes all interior rearrangement difficult. Therefore, a new area will be reserved outdoor, behind the existing Maintenance Department, for the installation of refrigerated containers and prefabricated buildings.

c) Palletizing and Cargo Consolidating Area: The process of palletizing and consolidating the export cargo, which took place before in an area directly north of the passenger terminal, will be moved to a new 1,500 m^2 covered area, south of the existing cargo terminal. The decision to accommodate that area outside was motivated by the same difficulty to alter the interior layout of the existing building.

d) Storage Time (Dwell Time) Limit: At present the importer is allowed a twelve (12) day grace period before he is charged a storage fee. Thereafter, the merchandize can remain as long as three (3) months before it is sent to the central storage in the city as long as the storage fee is paid. In developed countries, the dwell time is usually kept at three (3) days. (It is actually possible to compute a "penalty factor", in terms of square meters, caused by each additional "dwell day" that the cargo is allowed to remain in the terminal.) At La Aurora, a more realistic figure could be two weeks. After that, the merchandise would be sent to central storage. A steep charge would be assessed to the owner after just (7) days of arrival of the cargo.

No elaborate analysis of standards and procedures were developed in this Chapter because of the nature of the work proposed, namely that of remodeling. These standards will be included in Chapter 7.3 where a new cargo terminal will be proposed for the long-term improvement for the target year 2005.

5.3.7 Access Road and Parking Lot

1) Access Road

At present, access to the airport from the city is mainly via 11th Avenue which runs between the airport complex and the nearby horse race-track. The 7th Avenue which runs from the Tecun Uman monument and the airport along a group of museums, can also serve as access to the airport. To the south, the 11th Avenue extends to serve as access for the general aviation hangars and other residential districts. Since, in the short-term improvement plan stage, all the modifications, expansions and new constructions will be executed inside the current airport boundaries and there will not likely be such a great increase in traffic volume, there will be no need to change or expand the existing airport accesses, except minor modifications around the expanded parking lot in front of the passenger terminal building.

2) Parking Lot

The existing capacity of the parking lots is 567 cars for passengers and 94 cars exclusively for airport personnel (Refer to Appendix-G). For the peak hour passenger of 1,092 anticipated for 1995, the required number of parking spaces is estimated to be about 550 cars (Refer to Appendix-G). Consequently, no expansion will be envisaged for parking spaces for passengers.

On the other hand, the number of airport personnel is envisaged to increase in the short-term improvement plan. Additional requirements of spaces are estimated to be for 19 cars or 665 m^2 (19 x 35 m^2). There exist a number of open spaces in front of the terminal building, including i) a grass field on north front (7,000 m^2), ii) a grass field beside INSIVUMEH compound (3,500 m^2) and iii) an unused space around toll parking lots (4,900 m^2). It is recommended that the grass field in front of the terminal (symmetrical to the existing parking area) be converted to a parking area, mostly for aesthetic reasons. It is now being used as a football field and is unsightly (Refer to Drawing 5-4).

5.4 Airport Support Facility Improvements

5.4.1 Control Tower

The existing control tower at La Aurora has operational deficiencies, as noted in Chapter 4.3.1. It is proposed to construct a new and properly designed control tower in the short-term improvements.

In the light of siting requirements as enumerated in Appendix-H, three alternative sites for the control tower have been selected and evaluated; (a) the western front of DGAC building at the north-eastern corner of the existing apron, (b) nearby the access road to the apron from the security gate, and (c) the north-eastern corner of the green near DGAC building. Through comparative analysis, including analysis on radar wave obstruction, it is recommended that the site (c) located nearest to DGAC building be selected.

On the basis of the analysis of the tower cab eye level, as well as to avoid creating an obstacle in the transitional surface, the tower height is proposed to be 34 m, with the floor elevation at about 30 m and the eye level at 31.5 m above the ground.

The proposed new tower will have 10 floors with a VFR Control Cab atop the shaft. The Control Cab will be octagonal in floor shape and 7 m x 7 m clear of control console. The tower is so designed that ATC functions are consolidated in the 10th to 8th floors, telecommunications in the 7th to 5th floors and other facilities in the 4th to 1st floors. A proposed floor plan is presented below.

Floor	Facility	Floor	Facility
(10)	VFR Control Cab	(5)	Communications Room
(9)	RAPCON	(4)	MOO & Training Room
(8)	Break/Briefing, & Radar Simulator Training	(3)	Extra Floor
(7)	Computer Room	(2)	ATS Office
(6)	Radar Equip. room	(1)	Power Supply Room

The tower layout is also illustrated in Drawing 5-9.

The training room is proposed to be used for training of operational personnel for aeronautical traffic services. By utilizing this training room, it will be possible for DGAC to set up an Aeronautical Training Center or ATC Training Course at minimum cost.

The control tower is proposed to be properly equipped with equipment for the aerodrome control, radar approach control, telecommunication center, meteorological center, etc. Outline of the equipment is further explained in Appendix-H and Appendix-I, as well as in Chapter 5.5.

In relation to the relocation of the control tower, it is noted that a group of trees near the existing cargo terminal, which are as tall as 22 m, will have to be cut short or relocated to other areas because they block a controller's view of the aircraft movements on the taxiway towards the Runway 01 end where the runway elevation is about 11 m higher than the tower base elevation.

5.4.2 CFR Facilities

It had been stated in Chapter 4.3.1 that the major problem in the existing CFR facility is the equipment, which is old and inadequate, both in capacity and in condition. On the other hand, according to the short-term plan layout, by the year 1995 the CFR building could stay in the same location. However, it will be necessary to modify the building to fit the new situation. Various parameters to be used in the design of such a facility are analyzed below.

1) Facility Improvements

By counting the aircraft movements in the busiest consecutive three months of the year, the current airport category can be determined to be Category-8 (Refer to Appendix-G, Section G.4). With regard to the future aircraft movements, large wide-body aircraft (e.g.B-747) are not expected to be introduced to such an extent that might alter the airport category in the short-term plan period. The airport Category-8, therefore, would remain through the short-term plan period.

For the Category-8 airport, the minimum amount of equipment and the minimum amount of extinguishing agents are estimated as follows:

Minimum Requirement of CFR Facilities
(Airport Category-8)

	1988	1995
Vehicles:		
Rapid intervention vehicle	1	1
Major vehicle	2	2 or 3
Total	3	3 or 4
Extinguishing Agents:		
Water (kl)	20.45	18.2
Discharge rate foam solution/min. (kl)	-	7.2
Dry chemical powder (kg)	227	450

As noted in Chapter 4.3.1, the existing vehicles are all very old, with an average age of 15 years, and in poor working conditions. The existing equipment should be replaced at the earliest possible date. The equipment is proposed to have the following specifications:

CFR Equipment Characteristics

Vehicle	Q'ty	Specifications	
Rapid intervention vehicle	1	Water tank cap.	: 1,200 l
		Foam tank cap.	: 100 l
		Dry chemical cap.	: 135 kg
		Foam monitor	: 1,000 l/min
Major vehicle	2	Water tank cap.	: 10,000 l
		Foam tank cap.	: 1,200 l
		Dry chemical cap.	: 180 kg
		Foam monitor	: 4,500 l/min

2) CFR Building Improvements

The existing CFR building is a 2-story, concrete block wall, steel structure roof, and corrugated asbsestos cement board covered building. The building has a total floor area of 480 m^2 and two covered garage areas (Refer to Appendix-G, Section G.4).

The existing building has two separate covered parking areas: one measuring 15.8 m by 8.2 m and the other only 6.8 m wide by the same depth. These dimensions are inadequate. A 3.0 m extension will indeed be needed in one module to accommodate the two major vehicles, while the rapid intervention vehicle can fit inside the existing second modules.

The CFR station is manned currently with 14 personnel in total, and operated in two shifts of 7 in each. They undergo a regular basic training once a month and perform operational tactics training every six months. For the operation and maintenance of vehicles in the airport Category-8, it is estimated that the required number of personnel will be 14 (plus 2 stand-by) for the day shift and 12 for the night shift (Refer to Appendix-G, Section G.4). It is recommended that the short-term improvement plan envisage such manpower requirements for efficient operation of the CFR facilities.

5.4.3 Maintenance Shop Improvements

The existing DGAC maintenance shop has deficiencies particularly in repair equipment, as pointed out in Chapter 4.3.1. In the short-term improvement plan, it is proposed to improve the maintenance shop as follows:

1) Maintenance Shop Building

The building is a one-story steel structure, with brick walls and a rectangular layout. The roof is made of corrugated metal sheets. The layout has a column span of 24 m and 7 bays of 8 intervals resulting in a total floor area of 1,344 m^2. The layout consists of a central maintenance area and a number of service compartments around that area, such as body shop, parts shop, tire shop, electric shop, paint shop, carpentry shop, etc.

The existing building is large enough for its intended purpose and still structurally sound, and it can be kept in use for a considerably long period of time. However, the following repairs or modifications are proposed to be carried out in the short term improvements:

- Repair of metal roof
- Installation of four rolling doors

2) Maintenance Equipment

Work load at the maintenance shop is expected to grow with time. The list of the repair equipment required will be determined by the degree and amount of repair works. In the short-term plan period, the shop is expected to perform a complete overhaul of vehicles, as well as construction and maintenance equipment. Judging from the current backlog and future prospects, the equipment listed up in Table 5.5 would be proposed for installation in the DGAC maintenance shop.

5.4.4 Fuel Farm

The existing fuel firm of ESSO and TEXACO has a total tankage capacity of 908 kl (240,000 gallons), as noted in Chapter 4.3.1. The existing fuel firm is supplying 1,230 kl (325,000 gallons) per week, which is estimated to be equivalent to about 74% of the weekly requirements.

The fuel supply facilities will, as they are now, be erected and operated by private oil companies in all future development stages. Therefore, in this report, no investment plan to this end will be assumed. However, for the purpose of planning a fuel farm, its location and approximate dimension, the required capacity of the fuel supply facilities has been estimated as follows:

1) Design Fuel Farm Capacity

The required fuel storage capacity should be determined on the basis of the types of operating aircraft, frequency of operations, fuel uplift per aircraft and different types of fuel required, for a period of time determined by the reserve policy of an airport. It is, however, a common practice at many international airports to provide a storage capacity for one week demand.

The required fuel storage capacity for the short-term improvements can be computed on the assumption that the current supply ratio would be proportionately maintained for the 1995 commercial aicraft operations. The design fuel farm capacity is thus estimated as follows:

$$\text{Design Capacity} = 1{,}230 \text{ kl} \times \frac{\text{Aircraft Movement in 1995}}{\text{Aircraft Movement in 1988}}$$

$$= 1{,}230 \text{ kl} \times \frac{27{,}000}{18{,}962}$$

$$= 1{,}751 \text{ kl (say, 1,750 kl)}$$

2) Fuel Tank Yard

Because of the new parallel taxiway to be constructed, the existing fuel farm must be relocated. The new location will be at the north end of the new concourse of the passenger terminal building, still inside the airport boundary as indicated in the airport layout plan in Drawing 5-4.

Assuming that each tank has a storage capacity of 330 kl (7.8 m dia x 7.7 m high) and 6 units of tanks are to be constructed, the required minimum tank yard area is estimated to be 6,000 m^2 in total.

5.4.5 Electrical Facility Improvements

The existing power supply systems consist of two independent systems; one for the terminal area and the other for the navaids equipment. The terminal area system has 1,000 kVA switchgears (13.2 kV - 480/277 V) and 250 kVA (480/277 V - 208/120 V) in the basement of the passenger terminal building, together with two emergency diesel generators of 250 kVA each. The navaids system has 500 kVA switchgears in the DGAC generator house, together with 385 kVA emergency diesel engine. The navaids system includes the DGAC headquarters, COCESNA, control tower, receiving station, radar site, radionavaids and visual navaids. In line with the improvements proposed for the terminal building in Chapter 5.3 and the navaids, telecommunication and lighting improvements proposed in Chapter 5.5, the electrical facilities are proposed to be improved as outlined hereunder.

1) Power Supply Systems Improvement

In line with the expansion of the airport facilities, the power demand is estimated to increase as follows:

[Terminal Area System]

Passenger terminal building	:	2,500 kVA
Apron flood lighting	:	120
FRC building	:	100
Cargo terminal	:	100
Parking lot and others	:	300
Miscellaneous	:	130
Total	:	3,250 kVA

[Navaids System]

DGAC headquarters	:	130 kVA
COCESNA	:	15
Control tower	:	350
Radar house	:	78
Radio NAVAID	:	15
Visual NAVAID	:	142
Miscellaneous	:	20
Total	:	750 kVA

These power requirements cannot be fed by the existing low tension panels, and additional panels with distribution transformers must be provided. Further, in order to centrally control the power supply systems, it is proposed to combine the two systems into one by furnishing a main switchgear. It is also recommended to make the trunk line as dual-circuit system in order to minimize the chance of total black-out of the airport. The total capacity of the new power supply station will be about 3,000 kVA, as computed below.

$$\frac{\text{Total demand (kVA) x load factor}}{\text{Diversity}} = \frac{(3{,}250 + 750 \text{ kVA}) \times 0.8}{1.05} = 3{,}047 \text{ kVA}$$

A block diagram of the proposed power supply system is shown in Figure 5-3. A layout of the navaids power supply room to be located on the first floor of the control tower is also shown in Figure 5-4.

2) Emergency Power Supply System

The emergency power supply capacity will also have to be improved as the airport facilities are expanded. Additional diesel generators will be provided to meet the estimated demand as shown below:

[Terminal Area System]		
PAX terminal bldg.	:	220 kVA
Apron flood lighting	:	30
CFR building	:	50
Parking lot and others	:	40
Total	:	340 kVA

[Navaids Area System]		
DGAC headquarters	:	50 kVA
COCESNA	:	15
Control tower	:	150
Radar house	:	57
Radio NAVAID	:	15
Visual NAVAID	:	142
Miscellaneous	:	21
Total	:	450 kVA

The diesel generator for emergency use of the navaids system is proposed to be provided to replace the existing 385 kVA generator which was installed in 1972. In addition to the diesel generator, batteries and charger sets will be programed for installation for the most critical equipments.

3) Terminal Building Electrical Facilities

The passenger terminal building will be provided with such electrical facilities as i) flight information display system, ii) clock systems, iii) CCTV (closed circuit) security surveillance systems, iv) telephone and intercom systems, v) public address systems and vi) fire alarm systems. Each system is outlined below.

a) Flight Information Display System (F.I.D.S.)

The Flight Information Display System which used to be installed in the passenger terminal (the old location of the boards are still visible) is no longer operative. Flights are announced solely by means of a paging system. Starting in 1995, it is proposed that a new simple F.I.D.S. will be installed to supplement the paging system. The system would consist of the following components:

i) Control:

- A central control/equipment room: Away from ordinary traffic, preferably on the 4th Floor. It would be equipped in addition to the regular equipment, with an area for an operator who is monitoring and who can intercept the automatic system to incorporate changes or feed information regularly to the system.

ii) Boards:

- A single combination departure/arrival board for international and domestic flights: Located on the 3rd Floor, this board will indicate all basic information about flight departures and arrivals, with a "Remarks" column. It is recommended that electro-magnetic (not flaps) systems be used, because of their flexibility.
- Departure (only) Boards: Located on the 2nd Floor, one board is for the international area and the other for the domestic side.
- Arrival (only) Board: Located on the 1st Floor, before customs area.
- Gate Boards (9): Located at each gate, showing the airline and flight number, with the departure time and destination.
- Baggage Belt Boards (2): Located at each belt, showing airline and flight number.

iii) Monitors:

In addition to the boards, video monitors will be placed mainly in the concourses and arrival/greeting areas to supplement the information. The exact location of the monitors and boards will be determined during the design stage of the Project. It is envisaged that the system will be a "low-end automatic system", with a simple processor with built-in memory and clock system, designed to upgrade a pre-determined number of flights from the memory at pre-set time intervals. All daily activities (updated) are stored in a permanent memory for record purposes.

b) Clock System

It is possible to couple the F.I.D.S. built-in clock with a master-clock system designed to provide information on time throughout the building. These clocks (estimated at 10 in total) will be distributed where needed, including one extension in the control tower.

c) CCTV Security Systems

CCTV security system will be provided to insure safety in the airport. X-ray inspection equipment will also be furnished for inspection of hand-baggage and personal effects. Pan/tilt cameras will be installed at suitable locations, indoor and outdoor of the buildings.

d) Telephone and Intercom Systems

Telephone and intercom systems are essential for exchange of information and data for the airport personnel and airline companies. One set of private automatic branch exchange (PABX) will be provided for the telephone system which is interconnected with the public telephone system. PABX will be equipped with a billing function for the airline companies and private users.

e) Public Address (Paging) System

An existing public address system is actually in use in the passenger terminal, and it is the only means to convey information on flights. In view of an absence of adequate zoning and generally unsatisfactory acoustics, a new system is proposed. The proposed system will be organized in the following zones which, in turn, dictate the area where they are broadcast:

- Departures: at departure/check-in areas (both floors); second floor concourse corridors (not waiting lounges); and transit lounges
- Arrivals: at first floor arrival/greeting area; and baggage claim area
- Boarding and other special announcements: at each gate; transit lounges; V.I.P. lounges; and baggage claim area
- Emergency messages and general paging: to be broadcast throughout all zones. These messages will generate from an information booth to be centrally located on the third floor.

f) Fire Alarm Systems

Fire alarm systems will be provided for quick detection of fire, in accordance with the International Fire Protection Regulation. This system is interconnected with the alarm system in the CFR building.

5.5 Navaids, Telecommunications and Lighting

Radionavaids, visual navaids and telecommunication facilities at La Aurora need to be improved because they are old and do not satisfy the ICAO standards, as noted in chapter 4.3.2. Improvements of these aviation support facilities are particularly important for safe operations at La Aurora where the extension of runway is not feasible and a series of natural and artificial obstructions exist in the obstacle limitation surfaces.

Improvements of radionavaids, visual navaids and telecommunication facilities are planned so as to be consistent with the forecast air traffic increase, proposed improvement of the airside infrastructures and terminal buildings, as well as with the proposed control tower facilities. For the operations of aircraft using instrument approach procedures, the application of the standards of "Precision Approach Runway, Category-I" to La Aurora runway is desirable. Every effort is therefore made to improve each associated facility to meet such requirements.

Outline of the proposed facilities is illustrated in Figure 5-5 and explained hereunder. A list of equipment proposed for each facility is tabulated in a summarized form in Appendix-I.

1) VHF Equipment

As noted in Chapter 5.4.1, a new control tower is proposed to be constructed in the short-term improvement plan. As a result, the existing obsolete equipment, such as VHF transmitters, tape-recorders and operator's consoles, should be replaced accordingly. VHF receiving station with aerodrome beacon is presently located at appropriate site and there seems to be no noise source causing radio interferences. Additional installation of VHF AM receivers, together with the floating power supply systems, is now proposed. VHF multi-channel TX/RX for emergency use is also planned to be installed in the new control tower, shutting on the existing receiving station circuit.

2) Radar

The existing radar equipment is not functioning properly, due to cathode ray deterioration, inaccurate identification, inability to display aircraft identification and altitude by SSR and inability to monitor in the control tower, as noted in Chapter 4.3.2. Discontinuation and lack of supply in spare parts have aggravated the situation. At present, the controller can not give instructions for aircraft separation to the pilot and the aircraft in general aviation can not be identified, because the radar is unable to identify small aircraft of less than 15 m^2. Further, aircraft guidance is not practicable in and around the Runway 01 threshold.

It is recommended to relocate the radar site to the area as indicated in Drawing 5-10. Two alternative sites have been studied; one at the western end of the green extending from the NDB antenna site (Alternative No. 1 site) and the other at the car parking area to the east of the runway (Alternative No. 2 site). Through comparative analysis in the light of the sites of NDB antenna tower, microwave tower and the proposed control tower, it is recommended that the alternative No. 1 site be selected. The alternative No. 2 site is located too close to the mountains to the east of the aerodrome. Though the said three towers might likely be obstructions to radar wave at the selected No. 1 radar site, it would coincide with the blind area extended to the direction of 065°, as shown in ASR/SSR coverage chart in Figure 5-7.

It is proposed to renew the radar at the earliest possible time. The minimum requirements of radar equipment are as follows:

ASR : With coverage capacity of more than 50 nautical miles and detectability of aircraft of larger than 2 m^2.

SSR : With coverage capacity of more than 250 nautical miles and altitude coverage up to 100,000 ft.

A layout of the proposed ASR/SSR system is shown in Drawing 5-10. The radar system diagram and ASR/SSR coverage chart are also illustrated in Figures 5-6 and 5-7.

For safe operations of La Aurora airport, the renewal of radar equipment is urgently required. It is recommended to be renewed as an Emergency Improvement Program without any delay.

3) Installation of Off-Aerodrome Radio Facilities

Analysis of meteorological data indicates that the north wind is predominant, representing approximately 68%. The south wind represents 18%, and the remaining 14% are classified as calm. Under such circumstances, controller's discretion is used for determining an active runway. Thus, Runway 01 becomes the preferential runway, with its probability of use estimated at 79% (68% + 14% x 68%/86%).

There are, however, obstructions near the extended centerline of Runway 19, or the southern area from the Runway 01 end, as shown hereunder:

Mountains (obstruction)	Elevation (MSL)	Elevation above Runway 01 Elev. (1,487 m)	Distance from Runway 01 End	Variation from Extended Centerline
Volcán de Pacaya	2,500 m	1,013 m	22.25 km (12.01 NM)	2 deg. west
Cerro Grande	2,580 m	1,073 m	20.80 km (11.23 NM)	2 deg. east

These obstructions hamper not only arrival and intermediate segments to land on Runway 01, but departure from Runway 19 to make a straight-out climbing.

The instrument part of the final approach segment begins at the final approach fix (FAF) and ends at the missed approach point (MAPt). In an ILS approach, the final approach is deemed to commence at the final approach point (FAP). An outer marker fix (OM) is necessary so as to permit comparison between the indicated glide path and the aircraft altimeter information, though it can be specified by the terminal DME.

However, installation of approach lighting system, which is one of elements to constitute ILS requirements, is almost impossible because of the topographical constraints (nearly 150 towers with the heights up to 160 m will be required to install approach lighting, due to steeply sloped depression to the south of Runway 01), and OM will not be provided in the final approach segment.

As an alternative measure, radionavaids are proposed to be provided at an appropriate site on the extended centerline of the runway, to the south of Runway 01. A recommendable site is:

a) Site is called PETEPA, located 7,960 m from Runway 01 threshold, on the extended runway centerline.
b) Site has an elevation of approximately 1,360 m (about 130 m below the elevation of Runway 01).
c) Site is privately owned as pineapple field.
d) Required area is 50 m x 45 m, with an access road of 50 m in length.

The VOR coverage at the proposed site is shown in Figures 5-8 and 5-9. A layout of the proposed off-aerodrome radio facilities is also shown in Figure 5-10. Major specifications of the proposed facilities are:

a)	Doppler VOR	50 watts
b)	DME (collocated with VOR)	100 watts
c)	NDB (independent)	50 watts
d)	VHF link with a monitor panel in the control tower	
e)	Electric power supply	1 set
f)	Secondary power supply	15 kVA

The provision of these off-aerodrome radio facilities would give advantages for aircraft operations as follows:

a) In conjunction with STARs, these radio facilities can be utilized to let an aircraft line on final approach leg with less deviation from final course. Thus, a straight-in approach can be conducted more precisely.
b) DME collocated with VOR gives the distance informations related to the runway threshold.
c) Missed approach procedures for Runway 19 landing aircraft can be improved.
d) A likely conflict with the obstacle limitation surfaces along the arrival and departure courses will be reduced.

It is proposed to provide MLS in the long-term improvements, as discussed in Chapter 7.5. It is predicted, however, that aircraft for domestic services cannot early provide a MLS indicator in their cockpits to response to the ground MLS system and many general aviation planes will still use ADF for their navigations. Hence, the proposed off-aerodrome NDB will still be useful for their operations, even after the introduction of MLS in the long term improvements.

4) Airfield Lighting

Since La Aurora continues to serve as an IFR landing airport, lighting facilities as visual navaids should be up-graded. The current lighting facilities as visual navaids are inadequate and insufficient. Distribution cables are old and wiring methods are inappropriate. It is proposed that the following airfield lighting will be renewed in the course of the short-term improvement plan:

- Precision approach path indicator system (PAPI)
- High intensity runway edge light (HIRL)
- Runway threshold light (RWTL)
- Runway end light (RWEL)
- Overrun end light (OREL)
- Runway centerline light (RWCL)
- Simple approach lighting system (SALS)
- Taxiway edge light (TWL)
- Taxiway centerline light (TWCL)
- Taxiway guidance sign (TGS)
- Distance marker light (DML)
- Runway threshold identification light (RTIL)
- Wind direction indication light (WDIL)
- Apron flood lighting (AFL)

A layout plan of the airfield lighting is shown in Drawing 5-11. A typical apron flood lighting pole is also shown in Figure 5-11.

5) Meteorological Equipment:

The existing meteorological equipments installed in the airfield, such as wind direction, wind speed, temperature, humidity, rainfall and atmospheric pressure, are proposed to be removed. Some of the equipment should be renewed at the time of relocation, and installation of some new equipment is to be contemplated. Further, the meteorological office is proposed to be installed in the new control tower, as noted in Chapter 5.4.1. (DGAC has an alternative plan to renew some of the meteorological equipment, separately.) A schematic diagram of meteorological circuit is illustrated in Figure 5-12.

Further details of equipment to be provided for the short-term improvements is listed in Appendix-I.

5.6 Airspace Operations

5.6.1 Obstacle Limitation Surfaces

The airspace around the aerodrome should be maintained free from obstacles to keep the aircraft operations safe in the airspace. To define the limitations, a series of obstacle limitation surfaces should be established properly.

La Aurora airport cannot be provided with the precision approach instruments due to limitation of the terrain configurations, and the obstacle limitation surfaces are established for the case of non-precision approach runways under the short-term improvements. These limitation surfaces will include i) conical surface, ii) inner horizontal surface, iii) approach surface, and iv) transitional surface. For La Aurora airport, the obstacle limitation surfaces are defined as shown in Figures 5-13 and 5-14 and as summarized below.

Surface and dimensions			Code Number
[Approach]			
Conical	:	slope	5%
		Height	100 m
Inner horizontal	:	Height	45 m
		Radius	4,000 m
Approach	:	Inner edge	300 m
		Distance from threshold	60 m
		Divergence	15%
First Section (length/slope)			3,000 m (2.0%)
Second Section			3,600 m (2.5%)
Horizontal section			8,400 m
Transitional	:		14.3%
[Take-off Climb]			
Length of inner edge			180 m
Distance from runway end			60 m
Divergence			12.5%
Final width			1,200 m
Length			15,000 m
Slope			2%

Within these limitation surfaces, there exist several obstructions under the current situation. It is recommended that a strong control regulation be put into force to restrict any intrusion into this obstacle limitation surfaces. This is quite important to maintain safe airspace operations at La Aurora.

5.6.2 SIDs and STARs

Standard Instrument Departure Procedures (SIDs) and Standard Terminal Arrival Routes (STARs) have originally been envisaged to be established in the long-term improvement plan when the VOR/DME site is relocated. Since DGAC has an alternative schedule to replace VOR at an earlier date, SIDs and STARs have been studied for their establishment at this short-term stage. Besides, it has been observed that the present holding patterns of VOR and NDB are inadequate for the Runway 19 operations, which are the landing procedures of VOR RWY 19 and NDB RWY 19. The holding pattern altitudes of both VOR and NDB are 8,000 ft at present. Since these holding pattern airspaces extend to the south and embrace the obstructions such as Volcan de Pacaya of 8,200 ft and Cerro Grande of 8,397 ft, the holding altitudes should be revised to be 9,400 ft.

Consequently, it is recommended that VOR 19 and NDB 19 let-down procedures be immediately corrected in the following manners:

1) Before VOR Replacement

a) VOR 19 Procedure

Holding Altitude	:	9,400 ft, Right Hand Pattern, 1 minute
Intermediate Approach Segment	:	3 minutes or 12 NM, Outbound Track: 027°
Base Turn Altitude	:	8,000 ft (descent gradient: approx. 140 ft/NM)
Final Approach Segment	:	Descent Gradient 307 ft/NM to 5,860 ft MDA (Minimum Descent Altitude) and maintain to MAPt (Missed Approach Point) Inbound Track: 192°

b) NDB 19 Procedure

Holding Altitude	:	9,400 ft, Right Hand Pattern, 1 minute
Intermediate Approach Segment	:	3 minutes or 12 NM, Outbound Track: 035°
Base Turn Altitude	:	8,000 ft (descent gradient: approx. 140 ft/NM)
Final Approach Segment	:	Descent Gradient: 310 ft/NM to 6,120 ft MDA, and maintain to MAPt, Inbound Track: 200°

2) After VOR Replacement:

a) VOR 19 Procedure

Holding Altitude	:	9,400 ft, Right Hand Pattern, 1 minute
Intermediate Approach Segment	:	3 minutes or 12 NM, Outbound Track: 035°
Base Turn Altitude	:	8,000 ft (descent gradient: approx. 140 ft/NM)
Final Approach Segment	:	Descent Gradient: 307 ft/NM to 5,860 ft MDA, and maintain to MAPt, Inbound Track: 199°

b) VOR DME Procedure : Inbound Track: 199°

c) NDB 19 Procedure

Holding Altitude	:	9,400 ft, Right Hand Pattern, 1 minute
Intermediate Approach Segment	:	3 minutes or 12 NM, Outbound Track: 035°
Base Turn Altitude	:	8,000 ft (descent gradient: approx. 140 ft/NM)
Final Approach Segment	:	Descent Gradient: 310 ft/NM to 6,120 ft MDA, and maintain to MAPt, Inbound Track: 200°

d) VOR 01 Procedure : Inbound Track: 012°

e) VOR DME 01 Procedure : Inbound Track: 012°

5.6.3 Lost Communication Procedures

The present RAC (Rules of the Air and Air Traffic Services) does not specify the lost-communication procedures. The procedures should especially be shown in MAP (Aeronautical Maps and Charts) in the columns of Missed Approach Procedures. This can be promulgated by publishing the Aeronautical Information Publication (AIP) as early as possible.

1) RWY 19

a) SDF DME: If a communication is lost for any one minute, make left turn at 9,000 ft to intercept 17 DME Arc AUR VOR and proceed to MOTAGUA Holding Pattern and hold at 9,000 ft.

b) VOR DME: If a communication is lost for any one minute, make left turn at 9,000 ft to intercept 17 DME Arc AUR VOR and proceed to MOTAGUA Holding Pattern and hold at 9,000 ft.

c) VOR: If a communication is lost for any one minute, make right turn at 9,400 ft and proceed direct to AUR VOR and hold at 9,400 ft.

d) NDB: If a communication is lost for any one minute, make right turn at 9,400 ft and proceed direct to TGE NDB and hold at 9,400 ft.

2) RWY 01

a) LOC DME ARC: If a communication is lost for any one minute, continue climb until reaching D7/AUR VOR, and make right turn 7 DME Arc/AUR VOR to proceed to D7 AUR VOR Holding Pattern and hold at 10,000 ft.

b) VOR ARC: If a communication is lost for any one minute, continue climb until reaching D7/AUR VOR, and make right turn 7 DME Arc/AUR VOR to proceed to D7 AUR VOR Holding Pattern and hold at 10,000 ft.

c) VOR DME: If a communication is lost for any one minute, make left turn at 9,400 ft and proceed direct to AUR VOR, and descend in Holding Pattern and hold at 8,000 ft.

5.6.4 Radar Control

As noted in Chapter 4.3.2 and 4.4.5, safe operation of La Aurora is critically hampered due to the deteriorated ASR/SSR radar system. Until the new radar system is introduced as proposed in Chapter 5.5, it is recommended that the following control measures be taken in order to prevent a likely near-miss or collision:

a) Refrain from positive radar control and execute only advisory service of monitoring on flight movements, depending on the traffic situatoin at any peak hour period.

b) Bear it mind that primary target is the essential for controlling aircraft at any moment when a controller uses the radar system.

c) When a controller observed that the radar becomes unserviceable, he should not hesitate to immediately switch to the conventional manual control using flight strips by applying ATC separation as specified in PANSOPS, ICAO.

5.7 Environmental Impacts

Noise is the major environmental consideration associated with the airport operations. The noise level anticipated in the operations in the stage of the short-term improvements, as well as the level of the present situations, has been studied to evaluate the major environmental impacts.

5.7.1 Noise Level Measurement

Various measures have been developed to evaluate the aircraft noise effect by noise level and frequency. Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method is currently used in Japan. WECPNL is a modified version of the Effective Perceived Noise Level (EPNL) defined by ICAO. It reflects the perceived severeness of flight noise, giving larger weight on night flights than daytime flights. WECPNL is given by the following formula:

$$WECPNL\ (i) = 10 \log 10 \left[\sum^{j} \text{anti} \log (EPNL\ ij)/j\right] + 10 \log 10N - 39.4$$

where,

- j : Type of aircraft and type of flight patterns
- N : Total weighted number of flights at "I" point (= N1 + 3N2 + 10N3)
  - N1: Number of flights from 7 am to 7 pm
  - N2: Number of flights rom 7 pm to 10 pm
  - N3: Number of flights from 10 pm to 7 pm
- i : Any selected point

The take-off profile is determined to be a function of distance to destination and type of aircraft. Hence, the distance to aircraft from any point, or the so called "Slant Distance" is calculated. Since EPNL (Effective Perceived Noise Level) for every aircraft has been obtained as a function of the slant distance, EPNLij at "j" point can be calculated based on each aircraft type and traffic pattern (Refer to Figures 5-15 and 5-16).

The traffic pattern and other basic conditions at La Aurora are assumed as follows:

Traffic Pattern	:	As shown in Figure 5-17.		
Daily Flight	:	As shown in Table 5-6.		
Runway Length	:	2,987 m		
Ratio of Runway Use	:	RWY 19	:	79%
		RWY 01	:	21%
Descent Gradient	:	RWY 19	:	2.75°
		RWY 01	:	2.50°
Climb Gradient	:	152ft/NM (both RWY 19 and RWY 01)		
Background Sound Pressure Level	:	40 dB		

The scale of WECPNL applied in the evaluation will be 70 WECPNP up to 95 WECPNL in 5 WECPNL increments. It is also noted that the traffic patterns, shown in Figure 5-17, represent a straight-out climb for departure and a straight-in approach for landing, both on Runway 01 and Runway 19.

5.7.2 Present Noise Level

By applying the WECPNL method, the present noise level at La Aurora has been examined. The number of daily flights by aircraft types has been determined on the basis of ATC logs (December 24, 1988), as shown in Table 5-6. In brief, 44 flights were operated from 7 am to 7 pm (N1), 9 flights from 7 pm to 10 pm (N2) and 7 flights from 10 pm to 7 am (N3).

A high speed computer was utilized to calculate and plot the noise contours, by using an XY plotter. The noise contours in 1988 have been plotted as shown in Figure 5-18.

5.7.3 Measures to Reduce Noise Level

Three types of measures are primarily considered to either reduce noise or to limit its impact on the environment. They are:

a) Suppression of noise at its sources--primarily with the quieter engines. Significant attention has been paid by aircraft manufacturers to reduce aircraft engine noise as a way of reducing aviation noise levels at their sources.

b) Modification of airport and aircraft procedures--such as engine power settings. Modification of aircraft operating procedures would also be effective to reduce the perceived noise levels or to reduce the noise impacts on the airport vicinity.

c) Development of land uses more compatible with the noise levels associated with the airport operations. The control of land use development in areas of high noise intensity will be applied to bring about less impacts.

Technologies to suppress aircraft engine noise (measure a) above) have been remarkably developed in recent years, and quieter engines have been introduced in the recent aircraft types, such as B-737, B-767, A-310, A-320, MD-80 series, etc. From a viewpoint of noise abatement, it is desirable to introduce such types of aircraft for the service in future. In this context, it appears to be encouraging that Aviateca has a plan to substitute B-737 type aircraft for on-going B-727 type aircraft in the near future.

The measure b) above could be usually put into practice by combinations of various methods. For instance, reduced engine power settings on take-offs or landings would reduce the noise intensity being emitted from the aircraft engines. On the other hand, steeper approaches on landing and steeper take-offs would result in smaller area noise exposure with higher noise emissions, while low engine power settings require aircraft to fly over a longer distance at lower altitudes with much larger areas for noise exposure.

Applicability of the noise abatement operating procedures for La aurora has been examined. These procedures include i) preferential runway, ii) preferential route, iii) steepest climb and iv) thrust cutback climb for take-off, and i) reduced flap setting and ii) delayed flap approach for landing. Table 5-7 shows the result of examination. In brief, the preferential route, steepest climb and delayed approach system are applicable to La Aurora. Due to the short length of the runway and the unavoidable constraints of terrain around the airport, other noise abatement operating procedures are found unapplicable to La Aurora.

5.7.4 Noise Level of 1995 Operations

The traffic pattern, as well as descent and climb gradients, will not be modified in evaluating the noise level of operations in 1995 for reasons explained above. On the other hand, the number of daily flights in specific hours has been estimated as shown in Table 5-6. It is anticipated that about 125 flights are operated from 7 am to 7 pm (N1), about 14 flights from 7 pm to 10 pm (N2) and about 17 flights from 10 pm to 7 am (N3). Although it is desirable to introduce aircraft of quieter engines as noted above, the noise contours have been prepared by applying the aircraft types similar to those currently operated at La Aurora.

Figure 5-19 indicates the WECPNL noise contours anticipated for operations in 1995. By reviewing the 1995 noise contours, it will be possible to observe the following:

a) The noise level would not be aggravated substantially even though the daily traffic in 1995 will be 2.6 times the traffic in 1988. It is primarily attributable to the fact that the flight schedule will continue to concentrate in the time range of 07:00 - 10:00 and 16:00 - 20:00 when less effect is expected on the weight noise level.

b) It is noted that in 1995 the width of WECPNL 70 through 95 becomes a little wider than that of 1988. This is attributable to the increased number of aircraft in 1995. On the other hand, the length of WECPNL 80 - 95 will be a little shorter, but the length of WECPNL 70 and 75 becomes remarkably shorter. This reflects that relatively high take-off climb of 152 ft/NM affects to the points farther from the runway.

There are noise sensitive installations within the 1995 noise contour area. The number of these installations have been estimated in accordance with the scale of WECPNL, as summarized below:

Noise Sensitive Installations: 1995

	WECPNL Scale					
	70	75	80	85	90	95
Hospital	5	2	0	0	0	
School	40	10	6	1	1	
Church	16	6	0	0	0	
Library, Theater	1	3	0	0	0	
Hotel	19	8	3	1	0	

To reduce the noise level at La Aurora, it is recommended that the following countermeasures be taken further:

a) To prohibit the midnight flights, as applied by many international airports in the world.

b) To introduce and request the airlines to introduce newer types of aircraft with less engine noise levels, such as B-737, B-757, B-767, A-310, A-320, MD-80 series, etc.

c) To plan noise sensitive installations to be built outside the noise affected area or in the lower WECPNL level areas in the future.

5.8 Institutional Improvements

DGAC has been in charge of administration and management of the airports in Guatemala, without having regional aeronautical headquarters. La Aurora airport itself has at present the minimum organization and man-power for operations, as briefly noted in Chapter 4.3.3

To operate and maintain the facilities and services proposed for the short-term improvements and to maintain a level of such services consistent with the traffic increase, the organization and man-power should be amplified substantially. It is estimated that the total number of staff required for management of civil aviation and La Aurora airport would be about 820 in the short-term improvement stage (about 1,000 in the long term) if the institutional improvements were not realized. Such an amplification, if it is made to the DGAC organization, would bring about a larger governmental institution and make the management less efficient. It is therefore envisaged, as an alternative method, to set up a Civil Aviation Authority (CAA) or Guatemala International Airport Authority (GIAA) for the management of La Aurora airport.

Under this concept for institutional improvements, the operating policies for each facility and service of the airport are first reviewed and the organization of DGAC and GIAA are proposed for consideration.

5.8.1 Operating Policies

General policies for operating the airport have been studied, and they have been presumed for estimating purposes, as follows:

a) ATC services: Will be performed by the detachment operating the control tower and other control centers. The detachment will be independent with respect to operational and administrative requirements, but it will depend on DGAC for general services and utilities.

b) Aprons: Assignment and overall control will be managed by the Operations Department of GIAA, and pavement and lighting maintenance by the Maintenance Department of GIAA.

c) Passenger Terminal Complex: Terminal building will be operated and maintained by GIAA. Customs inspection will be operated and maintained by Ministry of Finance; public health inspection by Ministry of Health and quarantine check by Ministry of Agriculture. These services will be provided at no cost to GIAA except for utilities and building maintenance.

d) Cargo Terminal: Basic cargo facilities will be installed and maintained by Ministry of Finance, or alternatively by concessionaire for operations.

e) Access Road and Parking Lot: Access road is maintained by the Municipality, and parking facilities will be provided by GIAA and operated as a concession.

f) CFR Facilities: GIAA will provide equipment. In an emergency, such equipment might be required to assist fire fighting services in neighboring communities.

g) Maintenance shop: GIAA will be responsible for operation of the maintenance shop.

h) Fuel Farm: Will be maintained as a concession and at no cost to GIAA.

i) Electricity and Water: Will be supplied by the public sources, except the installation of the secondary power. GIAA will install treatment facilities for sewage from terminal building in the airport compound, and treated water will be drained to the public drainage system.

j) Radionavaids and Lighting: Radionavaids including NDB, VOR/DME will be maintained by COCESNA. Lighting will be operated and maintained by GIAA at cost to the users.

k) Meteorological Facilities: Will be installed by GIAA. INSIVUMEH can continue to maintain them. Alternatively, GIAA may take over the responsibility for their maintenance.

5.8.2 Organization of DGAC

DGAC remains as the central government agency responsible for making policies and overall supervision of La Aurora and other airports. Director General is the executive officer, and he will be assisted by a deputy and five principal Departments. Principal functions of these Departments will be as follows:

a) Administration Department: Will be responsible for personal affairs, training and associated activities, purchase, storing and supply, public relations and legal advices.

b) Planning and Statistics Department: Will be responsible for keeping traffic and other statistics, ICAO documents and regulations, and planning to maintain the master plan up to date. (Through the execution of this Study, it has been observed that the stream of information from a number of sources does not flow regularly and consistently to the section in charge within DGAC. Improvements in the scope and quality of the statistical data are of primary importance.)

c) Operations Department: Will be responsible for operations of all airfields and terminal areas, including supervision of GIAA operations. The Department will be assisted by a police detachment for public security and safety, a military detachment for airport security, and a detachment for air traffic control.

d) Engineering and Maintenance Department: Will be in charge of designing new facilities and supervision of consultants, supervision of contracts for major maintenance, repair and expansion, supervision of maintenance of facilities including maintenance works by GIAA.

e) Finance Department: Will handle financial data, analysis of operations to identify trends that indicate a need for change in policies or facilities and monitoring of departmental operations with the maximum financial efficiency.

It is envisaged that DGAC would be responsible for overall administration, management and engineering, and its organization and staffing would be simplified and minimized as far as possible. The actual operation and maintenance of La Aurora airport would be turned over to GIAA, as proposed in the subsequent Chapter.

5.8.3 Establishment of GIAA

As noted above, it is proposed to establish Guatemala International Airport Authority (GIAA) as a semi-autonomous and, to the utmost, self-financing authority for operation and management of La Aurora airport. The existing organizational functions of La Aurora terminal will be absorbed into GIAA.

Charges for the use of La Aurora airport would be counted as revenues to GIAA, including landing fees, international departure fees, handling charges, parking and various concessions. On the other hand, GIAA will be responsible for expenditures for operation and maintenance, as well as for repayment of investments made to the improvements proposed herein. To be financially sound, GIAA has to keep the conditions of the airport complex neat and tight. Otherwise, airport users will not pay tariff willingly.

The establishment of GIAA has another advantage for sustainability of efficient airport operations. A cross personnel interchange could be activated and retired aeronautical staff could move to GIAA, thus maintaining a solid core of aeronautical knowledge in Guatemala.

Major organizational functions of GIAA are contemplated as briefly introduced below.

a) GIAA Administration: The Administrator or Chairman will be nominated by the Board of Directors composed of DGAC Director General, representative of the Ministry of Communications, Transport and Public Works, representative of the Ministry of Finance, representative of INGUAT, and representative of private enterprises. The Administrator will be responsible for all the operations of GIAA. He will be assisted by Sub-

Administrator and necessary secretarial and legal supports. Auditor will also be appointed.

b) Operations and Safety Department: Will be sub-organized into Telecommunications Division, Navaids Division, Security Division, CFR Division, Fuel Control Division, Ramp and Marshal Division and Airport Service division.

c) Maintenance Department: Will be sub-organized into Civil Engineering Division, Architecture Division and Electric-Mechanic Division. They are responsible for maintenance of all the airport facilities and installations.

d) Planning and Statistics Department: Will consist of Planning Division and Statistics Division, and will be responsible for technical and economic monitoring for operation and maintenance, as well as analysis of financial and statistic records to keep improving the airport operations and to plan for future improvements.

e) Accounting Department: Will be sub-organized into Budget and Revenue division, concessionaire Division and Purchase and Supply Division. They are responsible for all the financial management of GIAA.

f) General Affairs Department: Will consist of Legal Division, Personnel Division, Environmental Division, Welfare division, Public Relations Division and Auxiliary Services Division.

Detachments for protocol, migration, customs and quarantine would also be incorporated for GIAA operations.

A profile of the proposed organization is illustrated in Figure 5-20. Number of personnel to be assigned to each function or Department is calculated to be nearly 500 in total for estimate purposes as listed in Table 5.8.

The financial viability of the GIAA operations will be evaluated further in Chapter 6.4.

VI. EVALUATION OF SHORT-TERM IMPROVEMENTS OF LA AURORA AIRPORT

6.1 Implementation Schedule

Prior to the economic and financial evaluation of the short-term improvements proposed in Chapter V, a schedule for the implementation of the proposed improvement works is discussed herein. A subsequent evaluation will be made on the basis of such an implementation schedule.

6.1.1 Target Schedule

The proposed short-term improvements set forth in the foregoing Chapters have been made with reference to the traffic anticipated in the target year, 1995. However, the passenger traffic forecast in Chapter 3.3 and the capacity verification in Chapter 4.4, indicate that the traffic demand would outrun the runway-taxiway capacity, apron berth and gate capacity, and terminal capacity by 1994 or even before. It is, therefore, desirable that the schedule for implementation of the short-term improvements be programed so that they will be completed in 1993-1994.

Even with this target schedule for comprehensive short-term improvements, it is emphasized that some of the improvement programs should be executed at the earliest possible time, as "Emergency Programs". Such programs include:

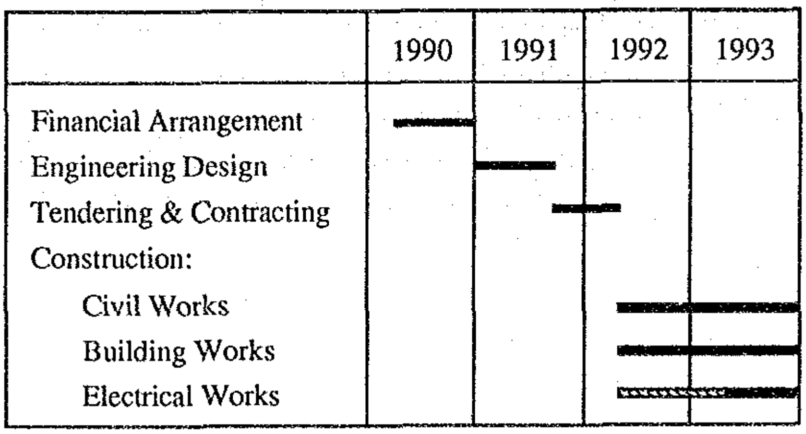
a) Renovation of ASR/SSR radar equipment
b) Renovation of CFR facilities

The renovation of this equipment is critically needed for safe operations at La Aurora airport, and it should be implemented immediately. Although the economic and financial evaluation in the subsequent Chapter is made on the recommended short-term improvements, including such Emergency Programs, it is prudent for the Emergency Programs to be separately scheduled for immediate realization.

6.1.2 Construction Schedule

The major improvement works proposed in the short-term plan should be carried out by qualified contractors. The construction and erection works should be executed without endangering and impeding the on-going airport operations.

Judging from the volume and complexity of improvement works, as well as the limitations on construction and erection of works due to the continuing operations of the airport, it is estimated that the construction will take a period of about 20 months. It is also scheduled that the engineering design, tendering and contracting procedures will take about 16 months. Consequently, the proposed improvements of La Aurora airport will take a total execution period of 36 months. If the execution of improvements start at the beginning of 1991, it will be possible to complete it by the end of 1993, as illustrated hereunder.



A detailed implementation schedule is shown in Figure 6-1.

This construction schedule will coincide with the target schedule noted hereinabove, and will meet the requirements to cope with the traffic increase and existing capacity limitations. (As a matter of course, procurement and installation of the ASR/SSR radar equipment and CFR facilities should be scheduled to be completed much earlier.) The tentative implementation schedule proposed hereinabove will be followed in the economic and financial evaluation in the subsequent Chapter.

6.2 Estimated Costs

6.2.1 Basis of Estimate

The financial cost of the proposed improvement works is estimated on the basis of the following criteria:

a) Estimates are made in terms of the price level prevailing in the middle of 1989.

b) Contractors for the improvement works will be selected through international competitive biddings.

c) Direct construction cost is estimated on the basis of unit prices, covering the cost of equipment, materials, work forces and other costs required for construction and erection. (Basic prices of construction materials and labor wages applied in the estimate are shown for reference in Appendix-L)

d) Estimates are made in terms of a foreign currency component and a local currency component. The local currency portion will cover the cost of locally available construction materials, including cement and aggregates, labor forces, etc. The foreign currency portion is estimated for imported materials and services at international market prices.

e) Physical contingencies are estimated at the rates of direct construction costs, i.e. 10% for civil works, 5% for building works and 3% for electrical works.

f) Financial contingencies are estimated to cover the price escalation at the rates of 3% per annum for the foreign currency portion and 10% for the local currency portion. Judging from the price index in recent years, shown in Table A-20 in Appendix-A, price escalation in local currency at 10% per annum is considered reasonable.

g) Interest during construction period is estimated by assuming a foreign loan on concessional terms at the rate of 2.9% per annum to cover 85% of the total cost and a local borrowing at 8% per annum to cover the remaining 15% of the total cost.

h) Estimates are made on the basis of international and local market prices. When conversion is necessary, the exchange rates of one US Dollar equivalent to 2.78 Quetzales and 140 Yen are applied.

6.2.2 Estimated Financial Costs

The financial cost of the proposed improvement works is estimated as shown in Table 6.1. Details of the estimate are explained in Appendix-L. The estimated financial cost is summarized as follows:

Summary of Financial Cost, La Aurora

		Foreign Currency (US$ 10^3)	Local Currency (US$ 10^3 equiv.)	Total (US$ 10^3 equiv.)
1)	Civil Works, including runway, taxiway, apron, drainage, access road and parking	569	5,128	5,697
2)	Building Works, including terminals, service equipment, sewage disposal	7,074	5,684	12,758
3)	Electrical Works, including Navaids, telecommunications, lighting, power supply, meteorological and special equipment	24,682	1,651	26,333
4)	Engineering and Administration	3,225	358	3,583
	Sub-Total	(35,550)	(12,821)	(48,371)
5)	Physical Contingencies	1,423	513	1,936
	Sub-total	(36,973)	(13,334)	(50,307)
6)	Price Contingencies	3,831	5,058	8,889
7)	Interest during Construction	1,372	1,639	3,011
	TOTAL	42,176	20,031	62,207

In the event that the emergency programs for renovation of ASR/SSR radar equipment and CFR facilities are executed separately, the financial cost of the improvement works will be as follows:

Financial Cost, excluding Emergency Program

		Foreign Currency (US$ 10^3)	Local Currency (US$ 10^3 equiv.)	Total (US$ 10^3 equiv.)
1)	Civil Works	569	5,128	5,697
2)	Building Works	7,074	5,684	12,758
3)	Electrical works	17,034	1,212	18,246
4)	Engineering and Adm.	2,642	294	2,936
5)	Physical Contingencies	1,093	493	1,586
6)	Price Contingencies	2,941	4,862	7,803
7)	Interest during Const.	1,057	1,573	2,630
	TOTAL	32,410	19,246	51,656

It is further noted that if the programs alternatively contemplated by DGAC with a French proposal for the installation of some electrical works are realized, the financial cost of electrical improvement works and CFR vehicles would be reduced by US$5,289,000 equivalent, thus making the total financial cost of US$56,918,000 equivalent.

6.2.3 Disbursement Schedule

In line with the implementation schedule programed in Chapter 6.1, the financial cost estimates in Chapter 6.2.2 will be disbursed as summarized hereunder.

Disbursement Schedule

(US$ 10^3 equiv.)

	1991		1992		1993		Total		
	F	L	F	L	F	L	F	L	Total
1) Direct Const. Cost	1,342	149	22,018	8,213	13,613	4,972	36,973	13,334	50,307
2) Price Contingency	82	31	7,041	2,719	1,708	2,308	3,831	5,058	8,889
3) Interest during Const.	21	7	380	452	961	1,180	1,372	1,639	3,011
Total	1,445	187	24,449	11,384	16,282	8,460	42,176	20,031	62,207
	(1,632)		(35,833)		(24,742)				

F: Foreign Currency Portion
L: Local Currency Portion

6.3 Economic Evaluation

6.3.1 Estimate of Economic Costs

The financial costs estimated in Chapter 6.2.2 are converted into economic costs for the economic evaluation. In addition, the operation and maintenance cost, as well as the replacement costs are estimated to determine the stream of economic costs.

1) Conversion into Economic Costs

The financial cost of US$50,307,000 equivalent, estimated as the direct construction cost of implementing the recommended short-term improvement plan for La Aurora requires some modifications before it can be incorporated into the economic analysis. The adjustments are performed as follows:

a) About $5,226,000 equivalent, or 10.8% of direct construction cost, involves expenditures for local, unskilled labor. It has been evaluated that if these workers were not engaged on this Project, their likely alternative income would be no more than half of what they would receive on the La Aurora Project. Accordingly, a "shadow price" adjustment amounting to 50% has been made on this component of project costs.

b) The local currency component in the direct construction cost estimate includes a 7.5% sales tax on equipment and materials purchased in Guatemala. This tax merely represents a transfer within Government accounts and is not an economic or resource cost of the project. These transfer payments will be deducted from the financial cost.

2) Operation and Maintenance Costs

Operation and maintenance (O&M) costs are required to keep the newly improved airport in efficient operating condition. It appears appropriate to set required annual O&M costs at 3% of total costs of project construction. While this may appear relatively high, the terminal will incorporate some existing rather than totally new facilities. Such O&M expenditures would be incurred starting in 1994--the first year after the completion of construction. These annual O&M expenditures are estimated to be about $1,500,000 equivalent. Further, it appears that every 5 years the annual outlay for O&M should be doubled. This will permit periodic accelerated maintenance, as well as replenishment of the inventory of spare parts.

3) Replacement Costs

Replacement costs to be incurred during the period of economic evaluation are estimated in view of the service lives of equipment and other components in the short-term improvement plan.

4) Stream of Economic Costs

Based on the modifications and adjustments, discussed above, a stream of economic costs have been calculated for the implementation of the short-term improvement plan for La Aurora, as summarized in Table 6-2.

6.3.2 Estimate of Benefits

An airport is a complex of interdependent facilities. In simplified terms, the main elements in the complex are the land-side access to the terminal, the passenger processing capabilities of the terminal and the airfield infrastructures of the complex. The limiting factor in any airport is the component with the lowest capacity. However, once that limiting facility has been improved, another element in the complex may prove to have such a limited level of capacity that it prevents the entire complex from handling existing or foreseen demands. At La Aurora, the major restricting elements in the total complex are the terminal and the runway-taxiway-apron combination on the airfield side, as noted in Chapter 4.4.

The analysis of project benefits begins with a review of the terminal constraints, followed by discussion of the airfield components. The analysis takes due account of the interdependence of these various facilities.

1) Rejected Passengers

The current peak hour capacity of the existing terminal at La Aurora has been estimated to be 850, as noted in Chapter 4.4.4. This capacity is equivalent to around 1,140,000 passengers on an annual basis. The estimate of annual passenger flow reflects the concentrated nature of La Aurora operation. It also indicates that the terminal will reach full capacity sometime in 1994. Thereafter, the terminal will reject passenger increases over and above the 1994 level. The air travel plans of these rejected passengers are considered to be unrealized through La Aurora. The annual La Aurora passenger forecast along with yearly estimates of rejected passengers beginning in 1995 are shown in Table 6-3. The rejected passengers will gradually be increased and they will reach a plateau of 612,000 in the year 2001. That is the year in which the improved terminal will be operated at full capacity.

If the airport remains unimproved, the rejected passengers and cancelled trips would reduce the pressure on the runway-taxiway-apron combination. As noted in Chapter 4.4.2 and 4.4.3, the present apron capacity is placed at 7 commercial operations per hour and the runway-taxiway capacity is calculated to be about 10 - 11 operations per hour. To illustrate this, the number of rejected passengers anticipated in 1998 is 368,000. By assuming a load factor of 45, the number of cancelled flights in that year would be more than 8,000, and the average daily cancelled flights would be more than 22. If 20% of these flights were peak hour operations, it would mean a drop of almost 5 in peak hour operations. Since forecast peak hour flights in 1998 are about 15, the cancelled flights would bring this number down to 10. This would materially reduce demand on the airfield complex. Once the short-term improvement plan for the terminal is implemented, the forecast levels of peak hour operations will not be curtailed by terminal constraints.

2) Willingness to Pay

In order to calculate the benefit of serving these otherwise rejected passengers, it is helpful to use the "willingness to pay" concept. This concept states that the value of an unrealized trip is at least worth what the passenger was willing to pay for it. "Willingness to pay" derives value from market data rather than from subjective considerations.

It appears conservative to estimate that an average air fare for La Aurora passengers is about US$500--about 75% of a Miami-Guatemala round trip fare. (Later in this chapter, a sensitivity analysis indicates the impact on project feasibility if an average airfare of $400 were used. Conceivably, competitiveness in the airline industry could lead to lower fares, or Guatemalans might tend to take journeys of shorter length.) The year by year benefits that will accrue--between 1995 and 2010--as a result of the short-term improvements to La Aurora which will eliminate the necessity of a huge level of cancelled flights are estimated as shown in Table 6-3. As a conservative technique, benefits generated are shown for the "low forecast", as well as the "best estimate" projections.

Table 6-3--the "best estimate" passenger forecast--shows that the improvement of the terminal capacity at La Aurora will create a benefit stream that starts at $18.5 million in 1995 and rises to $153 million in 2001, when the capacity of the improved terminal will be reached. Thereafter, this $153 million remains constant throughout the analysis period. This benefit stream represents the value of trips that would otherwise have been cancelled but which can now be realized because of implementation of the terminal improvements in the proposed short-term plan. As expected, the benefits generated by the "low forecast" start later, at a lower level and take longer to reach the capacity of the improved terminal facility.

3) Alternative Approach to Benefit Estimation

In order to confirm the magnitude of the benefits shown above--and as an analytical exercise--the national income approach has been alternatively applied to benefit estimation. To make the alternative calculation manageable and workable, the national income approach was applied only to the year 1995.

The willingness to pay approach estimated 1995 benefits--based on an assumed average fare of $500--at $18.5 million. The national income approach begins by dividing the 74,000 rejected passengers in 1995 into an estimated 50,000 foreigners and 24,000 Guatemalans. This division is in line with historical trends as noted in Chapter 3.1. In terms of cancelled trips, then, some 25,000 trips were cancelled by foreigners and about 12,000 by Guatemalans.

Reliable data on trip purpose could not be obtained in Guatemala. However, certain judgments can be made. Foreign travellers are composed almost entirely of business visitors and tourists. It is not practical to measure the gain in Guatemalan income arising from, say, a businessman's decision to invest in Guatemala. But it is not too difficult to estimate an average length of stay and an average daily expenditure for all foreign travellers. Assuming an average 8 day visit with a total daily outlay of $80 puts *spending in Guatemala at $640 for each of the 25,000 trips by foreigners which were* cancelled because of the constraints of the existing terminal. This means unrealized spending by foreigners of some $16 million. This outlay represents revenue for Guatemalans, but not all the revenue reflects an increase in income. However, Guatemala has a high labor component in nearly all sectors of the economy. Therefore, the value added percentage--or the ratio of income created per dollar of sales--is high. If the value added percentage is considered to fall within the range of 65% - 70%, then the $16 million spent by foreigners would create almost $11 million in new Guatemalan income.

Turning to the 12,000 trips cancelled by the 24,000 rejected Guatemalan passengers. By assuming that 50% of the passengers are business travellers and that the average air fare of US$500 can be taken as a minimum estimate of the gain in income that would result from their trip, it is estimated that the Guatemalan business travellers would create benefit approaching US$3 million. Guatemalan travellers who are forced to cancel tourist trips can be excluded from these calculations since they would be spending funds abroad for recreational rather than income creating purposes.

Summarizing to this point, the alternative national income approach generates benefits of about US$14 million. Further, the revenue and income impact on Aviateca should be taken into account. Of the total unspent air fares of US$17.5 million, about 15% or US$2.7 million are assumed to accrue to Aviateca. These higher revenues for the Guatemalan airline may lead to an income gain on the order of US$1 - 1.5 million. Consequently, the national income approach would yield a total benefit of US$15 - 15.5 million. If compared with the willingness to pay estimated at US$18.5 million in 1995, the benefits calculated through the national income approach would be lower by no more than 20%. As noted above, a sensitivity check will be made later by taking into account such a lower estimate of benefits.

4) Improvement in Aircraft Delay

The practical capacity of the present runway-taxiway at La Aurora is 10 - 11 operations an hour, as noted in Chapter 4.4.2. After the short-term improvements are implemented, the capacity will be increased to 16 operations an hour. On the other hand, the present peak hour demand on the runway-taxiway is 10, and the projected figure for 1995 is 14 operations.

In order to estimate any possible delay imposed on aircraft as a result of these capacity considerations, the FAA Advisory Circular, AC: 150/5060-5, Date: 9-23-83, entitled Airport Capacity and Delay has been referred to. Admittedly, the FAA Circular draws on American experience and derives principles and analytical techniques from that evidence. It is advisable, therefore, to consider the estimates of delay which follow as approximations, or order of magnitude figures rather than as precise and exact data.

Essentially, the FAA technique involves using a monograph that the Agency has constructed which shows Ratio of Annual Demand to Annual Service volume (annual capacity) on the horizontal axis and Average Delay Per Aircraft (minutes) on the vertical axis (Refer to Figure 6-2). It is essential to note that these are average delays. Individual aircraft in congested time slots can suffer up to 5 - 10 times the average delay.

Applying this FAA technique suggests that average aircraft delay at La Aurora in 1988 was on the order of 1.75 minutes or about 500 hours per year. This level of delay may be considered acceptable. It should be recalled, however, that the safety limitations at La Aurora are unacceptable.

If only terminal improvements are implemented at La Aurora and the runway-taxiway remains unimproved, the average delay per aircraft by 1995 will be in excess of 8 minutes. Such a level is intolerable and assures that airline service to La Aurora will be sharply reduced. It is generally considered that an average delay of about 5 - 6 minutes per plane is about the maximum burden that can be imposed on airlines without causing loss of service. At a 5 minute average delay level, the total delay associated with the 27,000 flights forecast for 1995 would be about 2,250 hours. With the improvements of proposed airside infrastructures and aviation support facilities, aircraft delays will be kept below a burdensome level.

5) Other Benefit Categories

Other benefit categories that contribute to the justification for implementing the short-term improvement plan at La Aurora include passenger time saving and the gains in air cargo shipments made possible by the new facilities.

The most important benefit, though not quantified, is the enhancement of the ability of La Aurora to provide safe and reliable aeronautical services. At present, La Aurora has a dangerously high potential for a serious accident.

6.3.3 Indicators of Economic Feasibility

On the basis of the economic costs estimated in Chapter 6.3.1 and the quantifiable economic benefits calculated in Chapter 6.3.2, the economic feasibility of the short-term improvement plan has been evaluated in terms of the Economic Internal Rate of Return and the Net Present Value.

1) Economic Rate of Return

Through the costs and benefits summarized in Table 6-4, the Internal Rate of Return and the Net Present Value for a 20 year analysis period are calculated as follows:

	20 Year Analysis Period	
	Best Estimate Traffic Forecast	Low Traffic Forecast
Internal Rate of Return:	56%	37%
Net Present Value: (at 12% discount rate)	$473.8 million	$289.4 million

Further, the Internal Rate of Return for a 10 year period has been calculated, as follows:

	10 Year Analysis Period	
	Best Estimate Traffic Forecast	Low Traffic Forecast
Internal Rate of Return:	50%	17%
Net Present Value: (at 12% discount rate)	$166.2 million	$15.1 million

These data demonstrate forcefully that the short-term improvement plan for La Aurora is economically feasible and that it should be implemented as rapidly as possible. Another perspective on the merit of the project is indicated by the fact that only 3 years of operation of the improved facility will be required to justify project construction, based on the "best estimate" forecast. For the "low forecast" seven years of operation are required to justify implementation of the short-term improvement plan.

2) Sensitivity Analysis

As discussed earlier in this Chapter, a check on the impact of a lower value of willingness to pay (average airfare) has been undertaken. On the assumption that the benefits turn out to be 20% lower (average airfare lowered from US$500 to US$400 or adoption of the national income approach to benefit estimation which yields benefits some 20% below the willingness to pay levels), the project benefit will become as shown in Table 6-5, and the indicators of economic feasibility will become as shown below.

		Best Estimate Traffic Forecast
(20 Year Analysis Period)		
Internal Rate of Return	:	50%
Net Present Value	:	$347 million
(10 Year Analysis Period)		
Internal Rate of Return	:	43%
Net Present Value	:	$123.6 million

The result is unambiguous. Reducing benefits by 20% and shortening the analysis period used in the economic evaluation does not compromise indications of project feasibility.

3) Impact on Income Differentials in Guatemala

In the case of the La Aurora airport improvement project, the principal users of the facility--in terms of both passenger and airlines--will be foreign rather than Guatemalan. But the improved travel made possible by the short-term improvement plan will do much to create a favorable climate for foreign businessman who might be considering new or expanded investment activities in Guatemala. Such investment decisions create jobs and help those with lower income levels. Similarly, increased visits abroad by Guatemalan travellers may lead to expanded penetration of foreign markets. This, too, can lead to higher output and employment within Guatemala. Finally, the improved air cargo facilities will assist economic growth in the low income rural areas of the country.

On all counts, therefore, the proposed short-term improvement plan for La Aurora is in the nation's interest.

6.4 Financial Evaluation

As estimated in Chapter 6.2, the total financial cost of implementing the proposed short-term improvement plan at La Aurora is estimated to be US$62,207,000. This total estimate may be reduced if the Emergency Programs for renovation of ASR/SSR radar and CFR facilities are separately executed. And, additionally, if the electrical improvements alternatively contemplated by DGAC with French cooperation are implemented, the financial costs may be further reduced. The financial evaluation in this Chapter, however, is made on the total financial costs to evaluate the overall financial viability of the project implementation.

6.4.1 Assumed Financial Plan

It is assumed that financing will be made available for the entire estimated total cost of $62.2 million. It is expected that a concessionary loan to cover 85% of total project cost, in the amount of $52,870,000 would be extended by an external source. The interest rate is assumed to be 2.9%. There would be a 10 year grace period--where only interest payments would be required--followed by a 20 year repayment period. During the construction period from 1991 - 1993, interest due would be related only to actual disbursements.

Because of the present uncertainties in Guatemala, there are no new long-term public financings being undertaken. At present a 14% annual rate is required for short-term commercial borrowings. These terms do not provide a realistic guide to appropriate financing conditions for a major capital improvement. It is, therefore, assumed in this initial calculations that the 15% of total project costs not covered by the external loan will be financed by a borrowing--guaranteed by the Guatemalan Ministry of Finance--at an 8% interest rate, with a ten year repayment span. The local borrowing would be in the amount of $9,330,000.

Under such conditions, the total of debt service obligations associated with the borrowing conditions described above, are calculated as shown in Table 6-6. The table above indicates that debt service requirements during years 3 - 10 are estimated at US$2,903,230 while for years 11 - 30 the obligations will rise to US$3,500,000. These figures have an element of uncertainty. The local borrowing terms used above assume reasonable and hopeful conditions in Guatemalan financial markets. As negotiations and discussions get underway, it may be possible to find valid guidelines to such local borrowing in the Guatemalan financial market.

6.4.2 Revenue Potential

In order to estimate the revenue potential of La Aurora, it is appropriate to "normalize" the existing accounts. "Normalization" strives to show what the revenue flow would be if all users were charged--and all users paid--reasonable, competitive, market-based tariffs. Achieving such a condition is often a sensitive matter. It is a policy decision for the Guatemalan authorities. This Study can only prepare pro forma statements, indicating such "normalized" revenue flows.

The revenue potential of La Aurora is estimated on the basis of a "normalized" tariff structure, as explained hereunder.

a) Landing Fee Revenue, Commercial Aircraft: The present landing fee tariff at La Aurora is 0.002 Quetzales per kg. Average aircraft weight is presumed to remain at 78,000 kgs over the entire span of the normalized statement. This is the gross take-off weight of a B-727 which has been selected as the average commercial aircraft. (Although the future aircraft mix has been projected in Chapter 3.4, the B-727 gross take-off weight is applied to simplify the estimate and to make it conservative.) Existing and forecast data on commercial aircraft operations were then divided by two to estimate the number of landing operations.

Landing fees might be raised--in these normalized accounts--to 0.006 Quetzales per kg as of 1994, the year when the short-term improvements at La Aurora become operative and better services are provided. It is expected that a trebling of the landing charge may well be overdue when physical and competitive conditions are considered. At present, Honduras, Nicaragua and Panama have landing fees three times as high as Guatemala, as shown in Table 6-7.

The landing revenues from commercial aircraft landings are forecast to move laterally after 1998, reflecting the fact that the capacity level of the improved La Aurora airfield will be reached by 1999. A flow of landing revenues is estimated as shown in Table 6-8.

b) Landing Fee Revenue, Other Aircraft: The same landing fee pattern that was discussed above for commercial aircraft has been applied to present and prospective operations by other aircraft. Present landings of these aircraft are some 12,700 per year and this total is expected to remain approximately constant over the period of the normalized financial statement. Average weight of the aircraft is placed at 40,000 kg. This estimate is forecast to remain unchanged in the years of the financial statement. The estimated landing revenues are incorporated in Table 6-8.

c) International Departure Tax: The present international departure tax of Q.20 per departing passenger is expected to double starting in 1994 when the short-term terminal improvements become operative. At present, the departure tax in Guatemala is just about the lowest in Central America, as indicated in Table 6-7. The improved passenger comfort in the new terminal--plus competitive rates in the area--clearly justify an increase to Q.40 per departing international passenger. The passenger forecast was divided by two to find the number of passengers subject to the departure tax. Departure tax revenues are held constant commencing with the year 2000, to reflect the fact that the improved terminal is expected to have reached its capacity by that date. The estimated international departure tax revenues are shown in Table 6-9.

d) Terminal Space Rental: The improved terminal will have the same amount of rental space as the existing facility--an estimated 7,904 m^2. However, the quality of the space will be substantially improved. Water, electricity and telephone connections will also be provided. Therefore, it is expected that average space rental rates will double from the present average of Q.4/m^2 to Q.8/m^2 as of 1994. Total annual revenues are estimated to be about Q.63,230 in 1994 - 2020.

e) Petroleum Revenues: The principal airport petroleum revenue is an override of 0.35 Q/gallon. Current gasoline sales exceed 1,250,000 gallons per year. There does not appear to be a justification for any increase in this gasoline tariff arrangement. Gasoline revenues are expected to increase over the years as a consequence of the increase in aircraft operations. When aircraft operations level off in 1999 because the capacity of the short-term runway improvements will have been reached, gasoline revenues will move sideways. The annual petroleum revenues are estimated as shown in Table 6-10.

f) Other Revenues: This category includes fees for airport illumination, for navigational guidance, for both aircraft and vehicle parking, revenues from general aviations, etc. It is estimated that this category will add 10% to airport estimated revenues.

g) Estimated Operation and Maintenance Costs: The estimates for 1988 and 1991 - 1993 are based on current experience at DGAC. For the period 1994 - 2020, the estimates are those made as an integral part of calculating the costs required to implement and maintain the recommended short-term improvements at La Aurora.

h) Net Revenues Available for Debt Service: This item is the total of revenues less O&M (including capital replacement) outlays.

i) Repayment Obligations: These are the debt service obligations calculated earlier in Chapter 6.4.1 (Table 6-6).

j) Surplus: This is the sum available for future airport improvements and expansion or contributions to the Guatemalan Treasury. Such routing to the Treasury means the airport can subsidise other public sector programs and activities. A logical use for these funds is to consolidate them with the financial data for Santa Elena so that the overall performance of the Guatemala air transport sector--and its ability to be finally self-sufficient--can be evaluated.

The annual revenues, as well as O&M cost and repayment obligations, are tabulated as shown in Table 6-11. Through this proforma financial statement, it is possible to conclude that the short-term improvements to La Aurora will generate a consistent revenue surplus of about US$14 million per year after all borrowing costs have been fully covered. Even in the period of construction, it will not be necessary to count on additional borrowing for repayment of interest on external loan and repayment of local loan.

It might be noted that at La Aurora about 65% of revenue comes from charges principally against passengers--departure tax, terminal space rental, car parking, etc. The remaining 35% of revenues are derived from charges against aircraft.

6.4.3 Financial Rate of Return

A financial rate of return for the recommended short-term improvement plan can be calculated by comparing financial outflows with financial inflows. Further, a sensitivity test of lower net financial inflows will be made for analytical purposes.

1) Financial Internal Rate

The financial outflows consist of the $62.2 million of financial costs needed to implement the short-term improvements plus the O&M (including capital replacement) costs needed to keep it operating at planned efficiency. The financial inflows represent the net increase in airport revenues or incremental revenues, that is, the increase in revenues over and above what the revenue flow would have been if La Aurora remained unimproved.

The financial outflows and inflows are tabulated in Table 6-12. Although the normalized financial calculations cover the entire 30 year loan repayment, the financial rate of return calculation will be limited to a 20 year analysis period. This is--deliberately--a conservative analytical technique. It is doubly conservative because a 20 year analysis period includes only 17 years of financial inflows.

On the basis of financial outflows for 20 years and inflows for 17 years, the financial internal rate of return for the short-term improvements to La Aurora is calculated as follows:

Financial Internal Rate of Return: 16%

This is an entirely satisfactory rate. The investments in the short-term improvements are, clearly, financially viable and profitable.

It should be noted that the economic rate of return is considerably higher than the financial rate of return. This is an encouraging indication for the future of the Guatemalan economy. The economic rate of return showed benefits--in the form of added income--"created" or "generated" as a result of project implementation. The financial rate of return reveals benefits "captured" by La Aurora, a Government institution.

To the extent that benefits "generated" exceed benefits "captured" by the Government, there is a substantial volume of benefits which remain in the private sector. These benefits will permit accelerated private business activity and investment. This is a most encouraging development as regards future trends in the economy of Guatemala.

2) Sensitivity Test

As a sensitivity check, the financial rate of return has been calculated for a net revenue flow some 20% below that shown in the normalized financial accounts. The logical basis for such an alternative is the possibility of disappointingly low economic activity which adversely affects airport operations and leads to lower than expected revenue flows. Table 6-13 shows the 20% reduction in net financial inflows.

The financial rate of return for this calculation is 12%. This rate will still be considered satisfactory in deciding the investments in the development of economic infrastructures.

VII. FURTHER LONG-TERM IMPROVEMENTS OF LA AURORA

7.1 General

The long-term improvement plan of La Aurora airport had been formulated, as noted in Chapter 1.2 and Chapter 5.1, prior to the preparation of the short-term improvements proposed in Chapter V, and it was basically agreed to by DGAC as a master plan for La Aurora improvements. The long-term plan has been worked out to satisfy the anticipated traffic demand in the year 2005. As noted in Chapter 3.2.1, the annual air passengers using La Aurora would reach nearly 2.5 million and cargo movements would reach about 41,000 tons in 2005. To meet the requirements in that target year, additional investments will be required for the expansion of airside infrastructures, terminal areas, airport support facilities, navaids and telecommunications. The outline of the proposed expansion program is presented in this Chapter.

With the uncertain nature of the economic situation in the future, as experienced in the past, it is considered desirable that the traffic forecast be renewed periodically or at least after the completion of the short-term improvements and well in advance to the expansion for further improvements. Such a traffic forecast would indicate the magnitude and timing for further development. Notwithstanding such uncertainties, it is believed that the proposed long-term improvements will remain as the principal plan to be studied in further detail.

The long-term improvements have been studied as a master plan or expansion program at La Aurora. An investigation of the desirability of relocating the existing airport to another site is beyond the scope of this Study, as noted in Chapter 1.2.

Since it is premature to define precisely the implementation schedule for the long-term improvements, the economic evaluation of the proposed plan will be indicative rather than a guide to present decision making.

7.2 Airfield Expansion

7.2.1 Runway and Taxiway

In the target year 2005, it is anticipated that the peak hour commercial operations at La Aurora would reach 22 flights, as noted in Chapter 3.3. The long-term improvements are programmed to ensure safe operations of aircraft in such a magnitude.

Basically, the target of meeting the requirements for a precision approach runway Category-1 to the utmost extent will be pursued consistently in the long-term improvement plan. As it will be discussed in Chapter 7.5, it is envisaged that the microwave landing system (MLS), instead of ILS, would be adopted to La Aurora in the long terms. Consequently, the runway and taxiway improvements are proposed to be further enhanced to satisfy such requirements.

For IFR operations by adopting the MLS, it will be necessary at first to secure the runway strip of 300 m in width in accordance with the ICAO standards. At present and with the short-term improvements, there exist a number of obstacles within such a runway strip. These obstacles, particularly in the southeastern part of the airfield presently used as general aviation hangar areas and in the northeastern part of the runway used for other aviation purposes, should be relocated or cleared off to secure a 300 m wide free runway strip, as shown in Drawing 7-1.

Extension of the runway length is not possible even in the long-term improvement plan. The runway length will remain at 2,987 m, and the penalty of the take-off weight limitation will continue to apply. It is noted, however, that such limitations would not seriously affect the operation of large jets, since La Aurora airport will continue serving in principle as a hopping airport rather than a major global hub.

In the long-term improvement stage, an overlay is proposed on the asphalt-paved runway. Such an overlay is designed to have a pavement strength of PCN 60 FBXT to meet the requirements of the ICAO standards.

Extension of the parallel taxiway to the southern part for the full 2,987 m runway length is indispensable in the long terms. With the expansion of the parallel taxiway, safety and efficiency in operations will be enhanced. As noted briefly in Chapter 4.4 and as analysed in detail in Appendix-E, the runway-taxiway capacity would be increased theoretically to 36 commercial flights per hour, and the practical capacity will be increased to 24 operations per hour. This capacity would satisfy the anticipated peak hour operations estimated for the year 2005. It is additionally noted that the ATC capacity will become a critical factor in order to cope with the continuous heavy traffic flow. It is an international practice for ATC to take account of traffic during three consecutive hours. Three consecutive hours of heavy traffic with excessive movements aggravates controllers mental stress, thereby causing possible misjudgements. Operations over consecutive 3 hours typically exceed sustainable ATC capacity.

A rapid-exit taxiway is proposed additionally in the southern part of the parallel taxiway. The location of the rapid-exit taxiway has been decided as a result of analysis made and explained in Appendix-D. A design similar to the rapid-exit taxiway to be constructed in the short terms will be applied. In addition, three exit taxiways are provided in this section. A layout of the exit taxiways, as well as the parallel taxiway, is illustrated in Drawing 7-1.

As a result of geotechnical investigations executed during this Study period, as explained in detail in Appendix-C, the pavement structure of the taxiways will be designed in the same manner as proposed for the short-term improvements.

7.2.2 Apron Expansion

Requirements for apron berths have been estimated on the basis of ATC records and by defining various parameters as explained in Appendix-F. It is anticipated that about 14 berths are required to satisfy the peak hour operations in 2005. Over 30% of the aircraft mix would be large or medium jets (wide-body) and the rest would be small jets. It is envisaged, therefore, that the new international finger to be constructed in the short-term plan would be expanded to accommodate 3 additional berths for large and medium jets (6 berths for wide-body in total for international passengers in the short and long term plan) and 2 additional berths for small jets (8 berths for small jets in total for international passengers). These additional berths are designed to be installed on the north-western side of the new international finger, as shown in Drawing 7-1 and Drawing 7-2.

The area of apron expansion in the long-term stage would be around 40,900 m^2 (totaling about 64,800 m^2 of passenger terminal apron expansion in the short and long stages). The pavement design would be the same as adopted in the short-term improvements. An expansion of the apron area for domestic passengers would not be required, though the domestic concourse would be extended to accommodate an additional gate in the long term stage.

The cargo apron and building will have to be relocated because of the extension of the parallel taxiway, as well as to satisfy the cargo traffic which is anticipated to exceed 41,000 tons by the year 2005. The requirements for the cargo aircraft parking positions have been estimated as follows:

Daily outbound cargo volume $= \dfrac{23{,}000 \text{ t}}{52 \text{ weeks} \times 5 \text{ days}} = 88.5 \text{ t}$

Average load (B-707, DC-8 Types) = 28 t/flight

Required positions for export $= \dfrac{88.5 \text{ t}}{28 \text{ t}} = 3.2$

Four (4) positions are provided to cover the possibility of duplicate arrivals of cargo flights.

Expansion of the cargo apron and terminal at the existing location, which is proposed for the short-term improvement phase, is not physically possible in the long term. Space for any expansion of the cargo facilities is only available in the area to the north of the passenger terminal apron (Refer to Drawing 7-1 and Drawing 7-2). It is expected that the new cargo apron will have a total area of about 26,900 m^2 (about 115 m x 234 m).

A new general aviation terminal, with adjoining parking, will be designed in the area where the existing cargo apron is now located. The general aviation hangars presently located along the parallel taxiway, as well as located within the 300 m wide runway strip, are proposed to be relocated to a new general aviation hangar area to the north of the new cargo terminal. The new general aviation hangar area will be about 140,000 m^2 (14 ha) and it would accommodate all the hangers to be relocated.

7.2.3 Aerodrome Compound

To expand the airfield infrastructures as proposed above and to meet the passenger and cargo traffic increases in the early 2000's, it is indispensable that La Aurora airport acquire a concession of the land extended to the north of the passenger terminal, which is presently used as a horse racetrack. Major part of this land is in the custody of the Ministry of Agriculture. The horse racetrack is seldom open, and the land is underutilized.

As noted in Chapter 6.3 and 6.4, the airport operations would be highly economic and would financially generate large incomes. The economic and financial profitability would continue even in the stage of the long term improvements at La Aurora. In due consideration of such economic and financial background, it is recommended that the concession for use of the horse racetrack be given to the Guatemala International Airport Authority (GIAA) by the time the expansion for the long term improvements is implemented in the early 2000's.

The acquisition of land for the aerodrome compound is necessary for the expansion of the parallel taxiway to be extended to the south of the apron area in the stage of long term improvements. A relatively narrow stretch of about 48 m from the present airport boundary, which encompasses a public road running along the boundary and a part of the residential quarters, has to be also acquired for the long term improvement plan. The cost of such a land acquisition will be incorporated in the estimate of the project cost.

7.3 Terminal Area Expansion

The main feature of the proposed long-term improvements for the terminal area is the annexation of the racetrack located to the north of the terminal building. The improvements of the terminal area in the short-term stage have been proposed by making maximum use of space currently available in the airport grounds to accommodate the three additional gates required. For further expansion, annexation of the land presently used as a racetrack is indispensable as noted in the foregoing Chapter 7.2.3. For the year 2005, it is thus assumed that such a land will be annexed and some important activities, such as cargo, general aviation, fuel farm, will be able to be relocated in a well planned environment. This new arrangement is indicated in Drawing 7-2.

7.3.1 Passenger Terminal Expansion

The long-term improvements for the passenger terminal for the year 2005 consist mainly in increasing the scope of the expansions already implemented in the building during the short-term phase. The traffic forecasts, design method and standards applied for the short-term improvements, as explained in Chapter 5.3, will be followed in the expansion of the passenger terminal building in the long-term stage. The space requirements for the long term improvements are also listed in Table 5.2 and explained in more detail in Appendix-G. All these data will constitute the basis for the proposed work. The new layouts are shown in Drawings 7-3 and 7-4, and contain the following special features:

1) Second Floor Passenger Drop-off

It has been explained before that the concept for the expansion of the terminal building contemplated to make the second floor the main departure floor, at the same level as the concourses. This concept will be maintained and the second floor amplified to accommodate the additional check-in counters. However, the proportion of check-in activity taking place on the second floor, compared to the third floor, is such that it is no longer logical to require all passengers to go thru the third floor entrance in order to reach the second floor. Therefore, a separate passenger drop-off is proposed to serve the departure level as indicated in the non-section in Drawing 7-5.

2) New International Departure Gates

Five more gates will be needed in 2005, totaling 14 gates (as opposed to 9 gates in the short-term). Out of this total, six gates will be for wide-body aircraft.

The new international concourse was built to accommodate these new gates, as shown in Drawing 7-2, once the apron is enlarged accordingly. The five new gates will be made up of three wide-body and two standard positions, with their adjacent departure lounges as shown in the Drawings.

3) Additional Domestic Gates

The difficulty in computing meaningful requirements for the domestic traffic was discussed earlier. The small insignificant actual volume of that traffic made any mathematical computations unrealistic. It has been anticipated, however, that the peak hour operations would be 3 in 1995 and 4 in 2005, and a possible increase in activities which cannot be quantified at this time would also be anticipated. Drawing 7-2 shows two (2) domestic gates in the domestic concourse extended to the south; one apron position, with a possible additional extra, will also be provided. It will also be noted that a new mechanized baggage belt will be installed in the domestic arrival area, since the traffic will have increased enough to justify it.

4) Shortened Concourse

Because of the extension of the new parallel taxiway to the south, thereby crossing the apron, it will be necessary to cut 4.5 m from the extremity of the old international finger to abide by the 46.5 m distance requirement between a taxiing aircraft and a fixed object.

It is additionally noted that the baggage handling system is proposed to be improved as shown in Figure 7-1.

7.3.2 Cargo Terminal Facilities

The cargo volume is anticipated to exceed 41,000 tons by the year 2005, as noted in Chapter 3.2.2. Applying the same "quick-reference" standard as for the short-term improvements (5 t/m^2), the required total gross area is 8,000 m^2, or equivalent to the 8,100 m^2 of the existing building.

However, reference was made previously to a general consensus among airlines and exporters that the figures will be much higher, once the 1995 improvements are carried out. For this reason, and also for the fact that by the year 2005 there would be no room for expansion, the decision was made to plan for a new cargo facility for that year. Finally, the extension of the new parallel taxiway at 180 meters from the runway during that long-term stage makes the relocation of the cargo terminal building mandatory.

1) New Cargo Terminal Siting

Given the lack of available land in the vicinity of the airport, and for various other functional reasons discussed herein, the only logical location for the new cargo terminal is found to the north of the passenger terminal, as noted in the foregoing Chapter. This location is recommended for the following reasons:

a) Air-side Apron Expansion: The air-side component is an important element of any air cargo operation. The proximity of the new commercial apron extension will allow joint use by passenger aircraft and freighters and, above all, will facilitate the inter-action between these two facilities which is necessary in the case of belly-cargo traffic.

b) Land-side Vehicular Traffic: The maneuvering space required by the trucks delivering or picking-up the cargo is sometimes neglected but all the more important. The indicated location avoids the bottleneck which existed before and provides ample space for that traffic. In addition, it also allows the use of a secondary service road, separate from the main airport access and its traffic.

c) Future Expansion: The indicated location has enough available space to accommodate any reasonable future expansion, in case the actual volumes exceed the projections.

d) Cargo Agents: An area will also be reserved for independent agents who help customers with the paperwork associated with the cargo business. These offices would be removed from their present location in the passenger terminal.

e) Cold Storage: Provision will be made for the installation of cold storage facilities for both imports and exports, but particularly for exports. However, it is not recommended that these facilities be built by DGAC, or customs departments: individual companies should install and operate them at their own expense.

2) Design Criteria and Space Requirements

To estimate the cargo storage area, criteria have been set forth in such a manner that the outbound cargo would be 6.0 t/m^2/year for heavy cargo and 5.0 t/m^2/year for light cargo, and that the inbound cargo would be 7.0 t/m^2/year for heavy cargo and 5.5 t/m^2/year for light cargo, as noted in further detail in Appendix-G, Section G.2. The custom revision and cargo conditioning area has been estimated on the basis of 30 kg/m^2 for outbound and 40 kg/m^2 for inbound cargo. A flexible differentiation method (such as moving partitions) is proposed to separate an area for the inbound cargo which has already been verified by customs. Five (5) office modules of 60 m^2 each will be designed for rental to individual private cargo agents. Customs administration area is designed to accommodate necessary cargo facility personnel estimated to be 25 persons for day shift and 11 persons for night shift (Refer for further detail to Appendix-G, Section G.2).

The space requirements for the cargo terminal in the long-term improvements are estimated to be 13,100 m^2, as shown in Table 5.4. A preliminary design of the cargo terminal building is illustrated in Drawing 7-6.

7.3.3 General Aviation Facilities

1) General Aviation Terminal

With the redistribution of facilities made possible by the annexation of additional land by 2005, it will be possible to build a new general aviation terminal, as shown in Drawing 7-2. This facility will allow the centralization of all general aviation activities, both international and domestic. The international transit facility for general aviation, now operated at the tip of the south wing (domestic), will be moved to the new terminal. This new concept will greatly enhance security at the airport and facilitate the control of that aspect of flying. A layout of the new general aviation terminal is shown in Drawing 7-7.

2) General Aviation Hangars

The extension of the new parallel taxiway to the south by the year 2005 will require the demolition or relocation of almost all the existing hangars on the west side of the runway. The total area of the hangars in this area amounts to about 34,700 m^2; they are occupying a land as large as about 95,000 m^2.

A new general aviation hangar area is planned in the north-west corner of the expanded airport grounds by the year 2005, as shown in Drawing 7-2. General aviation pilots will be allocated spaces in that area to put up their hangars, much as it is done at present. However, in this case, an organized plan will be prepared, once an accurate survey of all the owners is taken, in order to insure an even and optimum distribution of hangars. The approximate 140,000 m^2 available in the new location should accommodate all tenants at that time. In addition, an effort will be made to also relocate some of the smaller charter companies now located on the east side of the runway.

7.3.4 Access Road and Parking Lot

1) Access Road

Under the proposed long-term plan for expansion of the passenger terminal, cargo terminal and general aviation, the 11th Avenue access will have to be abandoned. Consequently, it will be required to improve the 7th Avenue to serve as the main access road to the airport. Figure 7-2 illustrate a proposed plan for access to the airport. Such improvement works will include expansion of the Avenue to have two lanes on each direction. In addition, coordination must be insured with an ongoing road construction project. The beltway system locally referred to as "anillo periférico," is presently being completed. An exit is planned for the 7th Avenue southbound traffic from the beltway; but no access will be provided for the northbound traffic from the 7th Avenue to the beltway. It has been planned that such traffic will have to join the southbound 7th Avenue traffic, via the Liberación Avenue (now Avenue Tecún Uman). For that purpose, a separate connection is provided between 7th Avenue and Tecún Uman Avenue. This secondary access will also be used by the truck traffic serving the cargo terminal, in order to avoid congestion and a possible conflict with the pedestrian overpasses now existing on 7th Avenue.

The approach to the passenger terminal building would also be improved in accordance with the terminal improvement plan described in Chapter 7.3.1. A new passenger drop-off overpass is to be constructed to serve the new second floor departure area of the terminal building. The overpass will be designed with a width of 6 m. Additional access roads are planned for the new cargo terminal building and general aviation area to be constructed to the north of the passenger terminal building.

2) Expansion of Parking Lot

Requirement of spaces for the parking lot is estimated to be about 1,230 cars. Since the present parking capacity is about 660 cars, the expansion is required for about 570 cars in the stage of long-term improvements. The required area will be approximately 20,000 m^2. A new toll parking area will be opened in the area to the north of the existing toll parking lot-1, facing to the new airport access road on 7th Avenue, as shown in Drawing 7-2.

7.4 Airport Support Facility Expansion

7.4.1 Control Tower Equipment

The control tower to be constructed in the short-term improvement plan will continue to serve for the long-term plan period. In line with the further improvements of radionavaids and telecommunication facilities, as discussed in Chapter 7.5, the control tower will be additionally equipped with the following facilities:

a) A monitor of Microwave Landing System (MLS)
b) Monitors for VOR/DME (on airfield) and localizer/terminal DME
c) Meteorological equipment

7.4.2 CFR Building

In view of the aircraft mix and the large wide-body aircraft movements estimated for the busiest consecutive three months of the year, it is estimated that La Aurora airport will remain as a Category-8 airport for CFR requirements in the long-term improvement stage. No additional supply of vehicles will be required at this stage. The vehicles supplied in the short-term plan would still be serviceable. It is, however, proposed that a *new CFR building will be constructed in the long-term improvement stage.* The CFR building is designed in the following manner:

1) Space Requirement and Location

Space requirements for the CFR building are estimated to be about 600 m^2, as shown in Table 7.1 and as explained in Appendix-G, Section G.4.

The extension of the parallel taxiway south of the apron, will require the relocation of the CFR building. However, the central characteristic of the existing location, and its proximity to the apron (where most of the non-catastrophic periodic incidents occur) make it desirable for the facility to remain in the same general location as the actual one as indicated in the long-term plan layout in Drawing 7-2. Easy rapid access to the runway, sufficient for a three (3) minute response time to any part of the runway will be provided. Adequate parking for vehicles for the firemen and for visitors will also be provided.

2) Functional Considerations

The primary functional space in the building is the fire trucks parking area. Surrounding this space are various service areas arranged functionally in order to optimize the efficiency of the use of the equipment. The success of the design of a CFR building must be judged in terms of the adequacy of the interaction of those three components, namely man, machine and service areas.

The vehicle-related service rooms will be arranged surrounding the garage area with minimum circulation spaces. The firemen activity areas will be combined in one group. The break room area will be isolated from the equipment parking area, in a quiet place (preferably facing a garden) as this room must allow the firemen good rest and adequate comfort. Service rooms for the personnel such as toilets, shower room, locker room, etc. will be arranged adjacent to the break room for convenience. The observation room will be located at a place which commands a view over most of the runway, taxiway and apron.

3) Architectural Design Considerations

The following points will be taken into consideration in the design of the CFR building:

a) Referring to the functional relationships outlined in the previous paragraph, the building plan will be made as functional and as compact as possible, in plan and volume to optimize interaction and minimize the construction cost. The building configuration will be rectangular in floor and cubic in volume.

b) In the floor plan, although the availability of land is very restricted, consideration will be given to possible expansion of the buildings if needed.

c) The building will be divided into two principal activities; vehicle-related services and firemen-related activities.

d) The structure will be made of reinforced concrete frame with hollow clay block walls, which are the prevailing building materials in Guatemala for this type of building. The roof over the vehicle parking space will make use of a steel structure in view of the large span involved. Local construction methods and finishing materials will be used to a great extent.

A layout of the CFR building is illustrated in Drawing 7-8.

7.4.3 Maintenance Shop

As discussed previously in Chapter 5.4.3, the major problem in the maintenance shop is shortage of repair equipment, tools and spare parts, and this problem has been addressed in the short-term plan. The equipment as listed in Table 5.5 would still be usable at this stage, and no additional supply will be necessary in the long-term phase. As regards the building, it will have to be relocated anyway since it interferes with the new parallel taxiway. The new location is next to the new CFR building, as indicated in Drawing 7-2.

The building should be provided with the service spaces estimated to be about 880 m^2 as shown in Table 7.2. The building will be designed in accordance with the following concepts:

a) The maintenance bays are the primary service space in the building; other service bays and compartments will be laid out around it. The maintenance bay will face the exterior wall with individual entrances so that the vehicles are taken into the bay directly without passing through other spaces.

b) The maintenance bay area will have a sufficient height to enable lifting of vehicles and parts.

c) The building structure will be of steel to allow a spacious work space. Walls will be of hollow concrete blocks and the roof will be covered with light weight materials

d) To maintain a good working condition inside the building, natural illumination and ventilation will be provided as much as possible. Under the roofing, a good heat insulating material will be placed.

e) At the entrance doors in front of the maintenance bays, rolling doors will be provided in view of the large door size for easy operation.

A layout of the maintenance shop building is shown in Drawing 7-7.

7.4.4 Fuel Farm

Because of the anexation of the racetrack and the relocation of various facilities by 2005, the existing fuel farm relocated in the short-term plan must be relocated again. The new location proposed at the north-west corner of the expanded airport compound and indicated in Drawing 7-2, is a much safer and ideal location.

1) Fuel Storage Capacity

The required fuel storage capacity for the long-term improvements can be computed, as in the case of the short-term plan, in the following manner:

$$\text{Design Capacity} = 1{,}230 \text{ kl} \times \frac{\text{Aircraft Movement in 2005}}{\text{Aircraft Movement in 1988}}$$

$$= 1{,}230 \text{ kl} \times \frac{48{,}000}{18{,}962}$$

$$= 3{,}110 \text{ kl } (822{,}500 \text{ gallons})$$

2) Fuel Tank Yard

The existing tankage facilities could be re-used by careful dismantling and re-assembling. Then, the additional tanks to be built should have a total capacity of 1,350 kl (3,110 kl - 1,750 kl). Assuming that each new tank has a storage capacity of 500 kl and 3 units of tanks are to be constructed, the required minimum tank yard area including the re-used tanks is approximately 8,000 m^2.

7.4.5 Electrical Facilities

The expansion concept for the long term work will be the same for all the electrical facilities in the terminal, and will consist simply in enlarging the systems installed during the short-term phase to satisfy the requirements dictated by the project in the year 2005, or in general terms, a change in size and scope and not in function or system. For example, the creation of a second departure drop off area directly on the second floor will require a second Departure/Arrival general board on the second floor. All electrical facilities will thus be expanded according to their particular requirements.

7.5 Aviation Support Service Improvements

The objectives of attaining a near-Category I airport operation at La Aurora will be pursued in the long-term improvement phase, including the improvement of aviation support facilities. Radionavaids, visual-navaids and telecommunications will be further improved to meet the requirements for safe operation at La Aurora.

The major radionavaids, visual-navaids and telecommunication facilities proposed for improvements in the long-term stage are summarized as follows:

1) VOR/DME, NDB in Airport (Replacement)

As noted in Chapter 5.5, VOR/DME and NDB installed in the airport and operated by COCESNA will have to be replaced after exceeding 20 years of service under the proposed long-term improvement plan. It is noted that the location of VOR/DME should be reevaluated in view of the proposed improvement of the airside infrastructures. In order to increase signal receptionability, VOR will be proposed to be located at a site between the runway and the relocated parallel taxiway. (DGAC has an alternative plan to install these facilities at an earlier date.)

2) MLS (Microwave Landing System)

MLS is proposed to be installed under the proposed long-term improvement plan, because ILS installation is impracticable due principally to difficulty in the installation of a glide slope facility. It is widely known that MLS will be deployed and operated globally after 1998.

3) AIS (Aeronautical Information Service)

The teletypes installed in DGAC for aeronautical information services are substantially old, except a mini-computer installed in 1986. Under the long-term improvement it is proposed to install the automatic teletype message switching systems, which consist of front end processor, central processor, network subsystem and terminal control subsystem.

4) Airfield Lighting

The existing airfield lighting facilities should be replaced so as to meet the ICAO, Annex 14 provisions. It is recommended that this replacement would be performed in steps with the progress of construction of the new parallel taxiway.

A layout of the airfield lighting is shown in Drawing 7-9. A detailed list of equipment to be provided in the long-term improvement plan is also shown in Appendix-I.

7.6 Airspace Operations

The current approach configurations present such obstructions as the Volcan de Pacaya (8,200 ft) and Cerro Grande (8,397 ft) that hamper an arrival in the initial and intermediate approach segments to land on Runway 01 and a departure from Runway 19 to make a straight-out climbing. In the long-term improvements, it is envisaged that the off-aerodrome radio facilities (VOR and NDB) would be newly provided at the Petapa area located at about 7,960 m south of the Runway 01 threshold.

New approach procedures by VOR and NDB installed at Petapa have been elaborated as shown in Figures 7-3 thru 7-5. The major characteristics of these procedures are explained below.

7.6.1 VOR Approach Procedures

New approach procedures by a VOR relocated to Petaya will be proposed as follows:

1) A landing aircraft in the intermediate approach segment will not fly over the said obstructions, thus avoiding an acute descent gradient. The descent gradient of an approach in IFR is supposed to be approximately 646 ft/NM throughout the intermediate and the final approach segments.

2) Descent gradient in the intermediate approach segment should be flat, because this segment is used to prepare the aircraft speed and configuration for entry into the final approach segment. Cerro Grande still limits the descent altitude to 8,400 ft until an aircraft clear the point abeam of the obstruction (6 NM from Petapa VOR/DME), though the descent configuration will be much more improved than the existing one. The descent gradient from PET VOR/R-171 through IF (Intermediate Approach Fix) to level off at 8,400 ft for one mile before 6 NM DME/PET VOR is 290 ft/NM and 6 NM DME/PET VOR to the VOR site (FAF - Final Approach Fix), from which the final approach segment begins, is 350 ft/NM. If one mile leveling off at 6,300 ft prior to FAF (Petapa VOR) is to be provided, the descent gradient will be about 420 ft/NM. A descending under such high descent gradients is possible, since the segment length of 13 NM is

provided longer than the optimum length of 10 NM. It is inevitable to provide relatively high descent gradients because of the terrain configuration in this area.

3) The track to be flown in the intermediate approach segment should normally be the same as the final approach track. The planned procedure is forced to bend the track at 30 degrees at FAF in the interface from the intermediate to the final. This, however, conforms to the ICAO PANSOPS (Procedures for Air Navigation Services, Aircraft Operations), because FAF of this procedure is a navigational facility (Petapa VOR).

4) MDA (Minimum Descent Altitude) is supposed to be 5,560 ft, because the EDIFICIO VISTA AL LAGO with an elevation of 5,058 ft is located at the site 627 m inward from the Runway 01 threshold and 382 m east off the runway centerline. A group of buildings and mountains, in the missed approach segment in the northern area from the airport, do not penetrate the OCA (Obstruction Clearance Altitude) of a straight missed approach procedure. This MDA of 5,560 t is worse than the present one of 5,300 ft, because a VOR to be located at Petapa area is the Off-Aerodrome Facility. On-Aerodrome VOR will make MDA be 5,360 ft. The present MDA of 5,300 ft should then be corrected.

5) 15 DME Arc/PET VOR counter-clockwise (west quadrant) is provided as the initial approach segment to link with the intermediate approach segment. The altitude to be flown is 14,000 ft until clearing Volcan de Agua (12,333 ft), then descend and maintain 11,000 ft until the fix of PET VOR R-171. Another 15 DME Arc/PET VOR clockwise (east quadrant) is to be flown at 11,000 ft until AUR VOR R-126, then descend and maintain 9,000 ft until PET VOR R-155. From Rabinal VOR or NDB, a route RAB VOR R-200 (RBN NDB 200°) can be established to intersect 15 DME Arc/PET VOR at PET VOR R-240. The altitude to be flown until intersecting 15 DME Arc is 14,500 ft, because the route has to fly right over Volcan de Agua (12,333 ft). Another route from Rabinal is RAB VOR R-160 (RBN NDB 160°) to intersect 15 DME Arc/PET VOR at PET VOR R-106. The altitude to be flown until intersecting 15 DME Arc is 11,000 ft, because the minimum altitude of the route G-436 is 11,000 ft.

6) The intermediate approach segment can be directly linked with the route A-317 by establishing a new route. IAF (Initial Approach Fix) should be provided on A-317. The altitude on this route should be 11,000 ft.

7) DME holding pattern toward the NAVAID is established at 15 DME/PET VOR with right hand pattern, 1.5 minute, Altitude 11,000 ft and a recommended airspeed of 220 kts.

Note: A restricted area, MGR 10 San Jose, exists from the southern portion of La Aurora TCA (Terminal Control Area) extending to the Pacific coast with the restricted altitude of 3,000 ft - 10,000 ft and 12,000 ft - 19,000 ft and the restricted area, MGR 5 Santa Clara, exists within La Aurora TCA at around Aral intersection along the route W-1 with the restricted altitude of Ground 3,000 ft. This is the reason why the altitude of the proposed routes, the holding pattern, as well as the existing W-1, infringing on MGR 10, have to be 11,000 ft.

7.6.2 NDB Approach Procedures

New approach procedures by Petapa NDB will be proposed as follows:

1) This procedure can be used when Petapa VOR is out of service, or an aircraft is not equipped with an airborne VOR instrument or unserviceable. In the same manner as VOR approach procedure, a landing aircraft will not fly over the obstructions of Volcan de Pacaya and Cerro Grande, thus avoiding an acute descent gradient.

2) The descent gradient in the intermediate approach segment is so mild that a descending to 7,900 ft can be easily achieved and maintained until 6 NM from Petapa DME in the nominal final approach segment, from where a further descent commences to Petapa NDB. The descent gradient in the later sector is about 270 ft/NM. If one mile leveling off at 6,300 ft prior to FAF is to be provided, the descent gradient will be about 320 ft/NM. This nominal final approach segment must really be considered as an intermediate approach segment, though the length of this segment is long. The initial approach segment can be shortened to 2 minutes pattern or 8 NM flight path. However, this idea should not be adopted, since the completion of the base turn from the nominal initial approach segment into the nominal final approach segment is done abeam of Cerro Grande.

3) The intersecting angle of the course from 6 NM DME with the nominal final approach segment is forced to be 30° at FAF. This conforms to the ICAO PANSOPS, as in the case of VOR.

4) The intermediate approach segment can straightly be linked with the route A-317 by establishing a new route. IAF should be provided on A-317. The altitude should be 11,000 ft because of the existing MGR 10.

5) A holding pattern should be established over the NAVAID (Petapa NDB) in the northern sector toward the airport, with Left Turn Pattern, 1 minute, Altitude 9,000 ft and a recommended airspeed of 180 kts.

These procedures can be used as the alternatives, when a weather condition is under IMC (Instrument Meteorological Condition) around Volcan de Pacaya and Cerro Grande, to avoid an sharp descent.

It is also important that a Letter of Agreement should be concluded for the use of airspace of MGR 10 San Jose on the proposed route of DME Arc 15 and route from A-317, though MGR 10 has the vacant altitude of 11,000 ft as noted before.

7.7 Environmental Impacts

7.7.1 Noise Level of 2005 Operations

The noise level of the anticipated airctraft operations in the year 2005 has been examined by preparing the noise contours. The same traffic patterns, descent - climb gradients and slant distance as noted in Chapter 5.7 have been applied in the preparationof the noise contours. The number of daily flights are assumed to be about 178 flights from 7 am to 7 pm (N1), about 20 flights from 7 pm to 10 pm (N2) and about 24 flights from 10 pm to 7 am (N3), as shown in Table 5.6. It might be probable that the aircraft of quieter engines would be introduced by that time, and the noise contours have been prepared by applying the newer types of aircraft, such as B-737-400 instead of B-727.

Figure 7-6 indicates the WECPNL noise contours anticipated for operations in 2005.

7.7.2 Noise Impacts

The review of the WECPNL noise contours in 2005 in Figure 7-6 would lead to the indicatons that the WECPNL noise level in 2005 would be substantially improved, even though the daily traffic would be increased by no less than 40% if compared with the 1995 traffic. This is due mainly to the effect that the newer types of aircraft with less engine noise levels would be introduced by 2005 and that the fligth schedule would continue to concentrate in the range of 07:00 - 10:00 and 16:00 - 20:00 when less affect is expected on the weight noise level.

There are noise sensitive installations within the 2005 noise contour area. The number of these installatins have been estimated in accordance with the scale of WECPNL as shown below.

Noise Sensitive Installations: 2005

	WECPNL Scale					
	70	75	80	85	90	95
Hospital	4	2	0	0	0	
School	26	11	2	0	2	
Church	13	3	0	0	0	
Library, Theater	1	3	0	0	0	
Hotel	17	7	3	1	1	

7.8 Estimated Costs and Economic Prospects

In order to evaluate--on a preliminary basis--the economic feasibility of the proposed long-term improvements for La Aurora, the direct construction costs of such improvements have been estimated. On the basis of these cost estimates, the economic feasibility prospects are discussed herein. Since it is premature to fix the plan and schedule for implementation of the long-term improvements, financial aspects of the long-term plan are not touched upon.

7.8.1 Estimated Construction Costs

The direct construction cost of the proposed long-term improvements is estimated at mid 1989 prices, as shown in Table 7.3 and summarized below.

Direct Construction Cost; La Aurora - Long Term

	Foreign Currency (US$ 103)	Local Currency (US$ 103 equiv.)	Total (US$ 103 equiv.)
1) Civil Works, including,runway, taxiway, apron, drainage, access road and parking	2,121	19,082	21,203
2) Building Works, including terminals, service equipment	4,898	6,793	11,691
3) Electrical Works, including Navaids, telecommunications, lighting, power supply	11,966	458	12,424
4) Engineering and Administration	3,262	363	3,625
(Sub-Total)	(22,247)	(26,696)	(48,943)
5) Land Acquisition	-	9,000	9,000
6) Physical Contingency	890	1,428	2,318
Total	23,137	37,124	60,261

With respect to the land acquisition cost, the estimate is for the acquisition along the expanded parallel taxiway to the south of the apron area, covering a public road and a part of the residential quarters. The racetrack is assumed to be rented in terms of a concession. In the event that the racetrack property is to be acquired on a commercial basis, the total land acquisition cost would be increased to about US$20 million.

Although it appears that the construction works would require a minimum period of 26 months and the pre-construction services would need 18 months, the implementation schedule for the long-term improvements cannot be firmly fixed at this moment. Hence, the price contingencies and interest during construction period are not estimated.

The disbursement of costs are provisionally scheduled as follows:

Disbursement Schedule, La Aurora - Long Term

	1st Year	2nd Year	3rd Year	4th Year	Total
Direct Construction Cost					
Foreign Currency	1,357	2,693	11,775	7,312	23,137
Local Currency	9,511	2,869	15,467	9,277	37,124
Total	10,868	5,562	27,242	16,589	60,261

7.8.2 Economic Prospects

In 2005, the target year for the long-term plan, the passenger flow is expected to be some 2,500,000. The terminal capacity after the implementation of the short-term improvements is estimated to be about 1,750,000. Table 7.4 gives an indication of the magnitude of the forecast passenger traffic and possible rejected passengers over the terminal capacity, as well as the estimated value of benefits calculated on the same basis as employed in the analysis of the short-term improvement plan, discussed in Chapter 6.3.2.

Table 7.4 indicates that capacity pressure will begin to be felt in the terminal--after the short-term improvement has been implemented--in the early years of the next century. Assuming that the long range improvement to the terminal is constructed during the span 2001 - 2004, the benefits in the first full year of the new facility, 2005, appear to be well over US$185 million.

These benefits can be compared with the costs estimated in the previous Chapter, i.e. US$60.3 million equivalent of total direct construction costs or US$71.3 million equivalent inclusive of land property acquisition costs totalling US$20 million equivalent (including the racetrack).

It now appears that, with the substantial traffic increase expected in the future and with the vast improvement in passenger comfort and convenience as well as in airfield efficiency, the long range plan will certainly prove to be financially feasible and economically justifiable.

If the short-term improvement plan is implemented in 1991 - 1993, as recommended, no decision need be made immediately with respect to the subsequent implementation of the recommended long term improvements at La Aurora. The long-term improvements were designed to meet the traffic requirements of 2005. After the short-term airport improvements are implemented and begin functioning, operational activities should be carefully reviewed. In the event that the initial improvement to La Aurora is followed by traffic increase at levels higher than anticipated in this Study, then plans and studies should be undertaken with a view to speeding up implementation of the subsequent improvements planned for La Aurora. If, on the other hand, traffic through the airport lags significantly behind the levels anticipated in this Study, then consideration should be given to delaying implementation of the subsequent improvement to La Aurora.

PART 3

SANTA ELENA AIRPORT IMPROVEMENTS

VIII. SANTA ELENA AIR TRAFFIC FORECASTS

8.1 Historical Data on Air Traffic

Santa Elena airport, alternatively called Flores airport, began operating in 1982. The only air passenger information made available on Santa Elena airport was for the years 1984 through 1988. The table below presents this historical data.

Historical Passenger Traffic at Santa Elena

Years	Total Passengers	Percent Over/Under Prior Year
1984	50,237	
1985	94,163	+87%
1986	72,681	-23%
1987	86,448	+19%
1988	99,359	+15%

The very short span of available data and the erratic nature of the year to year variations, along with the special situation at Santa Elena, make it virtually impossible to use past statistics as a guide to the future. First, with respect to the data. The very low figure for 1984 gives the impression of a strong rise in passenger traffic over the period 1984 through 1988, even though volumes are relatively small. Second, with respect to the special situation at Santa Elena. Whereas La Aurora has as a tributary area, the entire capital region with its large and varied population and its diverse recreational, political, industrial and cultural aspects, Santa Elena's tributary area is primarily the ruins at Tikal. It seems clear, based on a review of the available tourist facilities in the Tikal area-and on discussions with travel agents and transport officials-that the dominant pattern is for a one day visit to Tikal.

As noted in Chapter 2.2.4, Tikal is a most extraordinary attraction. But a one day visit is simply too short to explore the area in anything but a superficial manner. Further, a one day visit is very strenuous. A boom in travel to Tikal could occur in 1992, the

500th year anniversary of the Mayan civilization. Guatemala has many other archeological sites and hopes to explore and develop them over an extended period. Figure 8-1 indicates the principal Mayan ruins along the Maya Route planned by the US National Geographic Society.

At present, Tikal appeals primarily to those in full vigor, with minimum responsibilities. Families with young children, handicapped people and the elderly are probably reluctant to make the trip, even though they may have a strong interest in Mayan culture. It appears that the present level of traffic--about 100,000 passengers per year--is close to the maximum number of visitors prepared to make a one day round trip to the area.

8.2 Forecast Travel Volumes at Santa Elena

8.2.1 Air Passengers, Basis for Forecast

As pointed out above, it appears that a significant increase in the level of air passenger travel to Tikal depends on the development of varied recreational facilities that will permit visitors with diverse interests to enjoy a 2-3 day stay in the area. An improvement at Santa Elena--without the accompanying and supporting tourist facilities--will, by itself, have a limited impact as far as stimulating higher levels of travel is concerned.

The situation in Tikal requires what is often referred to as an Integrated Area Development Package. The forecast of anticipated air passenger traffic at Tikal, shown in Table below, assumes the timely availability of required tourist facilities.

Historical and Projected Passenger Traffic at Santa Elena

Years	Total Passengers
1984	50,237
1985	94,163
1986	72,681
1987	86,448
1988	99,359
1995	130,000
2005	200,000
2015	300,000
	Average Annual Rates of Increase
1988-1995	4%
1995-2005	4%
2005-2015	4%

The judgment underlying this forecast is that traffic to Santa Elena will only be able to make significant increases if required touristic facilities are available on a timely basis. In other words, if no supporting tourist facilities are created, it will be very difficult for passenger travel to Santa Elena to rise very much above the present 100,000 level. The increase in supporting tourist facilities is a costly and time consuming effort. For this reason, it will be advisable to anticipate only a relatively conservative average annual rate of increase in passenger movements at Santa Elena, in the order of 4%.

To illustrate in quantitative terms, one aspect of an Integrated Area Development Package is briefly discussed. It appears that the existing tourist facilities in the Tikal area are only adequate for the present traffic flow of about 100,000 passengers per year. The forecast increase of 30,000 passengers by 1995 means there will be an additional 15,000 visits to the area since each passenger is counted when entering as well as when departing the airport.

It is anticipated that 75% of the 15,000 visitor increase expected by 1995 will want to spend two nights in Tikal. That means 11,225 travellers at 2 bed-nights per person or 22,500 bed-nights per year. About 62 new beds could provide the necessary bed-nights (61.64 beds x 365 equals 22,500). If everyone were to stay in a twin-bedded room, that would mean more than 30 new hotel rooms would be required. It is noted, however, that single room occupancy is the preference of many. It could reasonably be assumed that some 33% of these 11,225 travellers--about 3,700--want to spend their 2 nights in single occupancy rooms. That involves 7,400 bed-nights on a single occupancy basis and the remaining 7,500 travellers spending their 15,000 bed-nights in double occupancy rooms. Assuming that all rooms are twin-bedded, that means double occupancy visitors will need more than 40 beds per year which means about 21 new hotel rooms. The 7,500 bed-night requirement of the single room occupants means more than 20 beds per year which translates into 20 new hotel rooms. Total new hotel room requirements will, therefore, exceed 40. Hotel officials in Guatemala indicated that an average price for constructing a new hotel room--including circulating area--may be as high as $50,000. That means an outlay of more than $2 million for hotels just to meet the sleeping needs of 1995 air travellers to Tikal.

When roads, telecommunications, athletic facilities, restaurants, etc. are included among the necessary supporting facilities, the cost outlays need to be substantially increased. Clearly, planning for and developing all the elements in a balanced Integrated Area Development package cannot be done rapidly. Therefore, anticipated passenger growth at Santa Elena is limited to an average annual rate of increase of 4% over the forecast period.

8.2.2 Air Cargo, Basis for Forecast

The available historical data on cargo movements through Santa Elena is limited to the period 1986-1988. This data is for such a short period and so lacking in any central tendency, that extensive interviewing was required before a cargo forecast could be prepared for Santa Elena.

The table below sets forth the available historical data on cargo movements through Santa Elena and the forecast prepared by the Study Team.

Historical and Forecast Cargo Movements at Santa Elena

(tons)

Year	Entering	Leaving	Total
1986	229.3	531.5	760.8
1987	157.8	646.6	840.4
1988	181.5	389.8	571.3
1995	265.0	640.0	905.0
2005	475.0	860.0	1,335.0
2015	935.0	1,150.0	2,085.0
	Average Annual Rates of Increase		
1988-1995	6%	7%	7%
1995-2005	6%	3%	4%
2005-2015	7%	3%	5%

The incoming traffic to Santa Elena consists of such edibles as ice cream, candy, biscuits as well as spare parts for trucks and other pieces of construction equipment and automotive batteries. As tourist facilities develop in the Petén and as the number of visitors expands, the level of entering traffic is expected to show a sturdy and sustained growth rate.

Outbound movements consist of decorative foliage, some artisanal products and a limited quantity of wood products. The long term outlook for outbound cargo movements is less favorable. Mexican producers are beginning to intensify their marketing of decorative foliage. And when an improved road between Santa Elena and the Capital is completed, it is expected that the wood products will move almost exclusively by road transport.

8.3 Forecast of Peak Hour Activity at Santa Elena

8.3.1 Passenger Movements

With the present pattern of traffic flows, Santa Elena has a morning inbound peak and an afternoon outbound peak. This conforms to the wishes of passengers who intend to make the most of their one day visit to Tikal. As passenger traffic at Santa Elena rises and more passengers stay overnight, there is expected to be some slight reduction in the relationship between peak passengers and total passengers.

The table below indicates projected peak hour passenger traffic at Santa Elena plus an estimate of peak hour passengers as a percent of total passengers.

Forecast Peak Hour Passenger Movements at Santa Elena

Years	Passengers	Pk Hr PAX/Total PAX (%)
1988	120	0.12
1995	140	0.11
2005	200	0.10
2015	300	0.10

8.3.2 Aircraft Operations

Data on aircraft operations at Santa Elena is only available on a fragmentary basis. Interviews, observations and review of scheduled flights were used to develop the estimates of peak hour operations, as shown in the table below.

Forecast Peak Hour Operations at Santa Elena

Year	Operations
1988	3
1995	3
2005	4
2015	5

Present service to Santa Elena are provided by a combination of scheduled service (Aerovias and Aeroquetzal) and charters. Planes in service by Aerovias include the Dart Herald and the Twin Otter--with an average seating capacity of somewhat less than 50 passengers. Aeroquetzal has recently introduced a DC-9 on the route, with an equivalent seating capacity.

At present, charter operations appear to be an element in peak hour operations. By 1995, it is believed that regular carriers will expand their service to the point where they satisfy the entire peak hour demand. Charter flights are expected to continue, but only in the off-peak periods.

Consequently, the aircraft mix in peak hour operation at Santa Elena in 1995 and 2005 is predicted as summarized hereunder.

Aircraft Mix in Peak Hour Operations

	Jets (B-737 type)	STOL (DH-6 dan)	Small Chartered Aircraft
1995	1	2	12
2005	2	2	12

IX. STATUS OF EXISTING SANTA ELENA AIRPORT

9.1 Airside Infrastructures

Santa Elena airport was constructed in 1981, on a site adjacent to the old airport which remained as an emergency strip for some while after the new airport was put into use. Improvement were made to Santa Elena in 1987 with the installation of basic navaids and telecommunications.

The aerodrome is located at the coordinates of 16.54.30 N and 89.51.15 W, and at an elevation of about 123 m above mean sea level. Climate is tropical, and the monthly average temperatures range from 22.1°C in January is 28.5°C in May. The monthly average maximum temperatures exceed 30°C except for the months from November to February. The relative humidity, on the other hand, ranges from 63% in April to 83% in September. (Refer to Table B-08 nd B-09 in Appendix-B.)

Annual mean rainfall at Santa Elena is about 1,530 mm. Approximately 75% of annual precipitation occurs during the rainy season from May to October. Visibility at the airport is fairly good throughout the year, except for May when the occurrence probability of low visibility of less than 5 km in distance is 8.4%. (Refer to Table B-10 and B-11 in Appendix-B.)

The status of the existing runway, taxiway and apron is explained hereunder in a summarized form.

9.1.1 Runway, Taxiway and Apron

The runway of Santa Elena airport extends in the direction of 100-280 Degrees (Runway 10 to Runway 28). East winds prevail throughout the year. Wind velocity is usually less than 10 knots. (Refer to Tables B-12 to B-14 in Appendix-B.) According to the wind records in 1982-86, the runway wind coverage is calculated to be 99%, as shown in Figure 9-1. The wind rose is also illustrated in the same Figure 9-1.

The concrete-paved runway of Santa Elena airport is 3,000 m in length with overruns at both ends. The runway width is 45 m, with 7.5 m wide shoulders on both sides. The maximum longitudinal slope is 0.9% and the effective slope is 0.36%, which conform to the ICAO standards. Future expansion of the runway, if and when needed, is possible towards the eastern area beyond Runway 28.

Width of the present runway strip conforms to the ICAO standards of 150 m for VFR operations. When instrument landing is applied in future, there does not appear to be any problem in acquiring the necessary 300 m wide strip.

A short taxiway of 188 m in length is provided parallel to the runway between Runway 10 end and the apron. The distance between the centerlines of the runway and the parallel taxiway is about 190 m. One rapid exit taxiway and two conventional taxiways are also provided. The taxiway width is 23 m, with 7.5 m shoulders on both sides. Since an east wind prevails for nearly 70% and the apron is located to the west end of the runway, serviceability of the existing taxiway is substantially limited. It has been observed that small chartered aircraft landing continuously at Runway 10 in peak hour have to be lined up on the military taxiway in the central part of the runway, waiting for an approach to the apron. If and when large aircraft are operated, such a limited serviceability will hinder efficient operation of the airport.

The apron, located to the west in the sections of 300 - 450 m from the Runway 10 end, has an area of about 18,900 m^2. The apron parking capacity is limited to four B-727 type aircraft. At present, it is occupied for hours by commercial and private general aviation aircraft. With these small aircrafts occupying the apron, it appears to be inadequate to handle medium and large jets.

9.1.2 Pavement Strength

The strength of the existing concrete pavement at Santa Elena airport has been investigated, including portland cement concrete slabs of 30 cm in thickness, base course (20 cm), subbase and subgrade (30 cm). The results of a geotechnical analysis are presented in Appendix C, Section II. The PCN value was assessed to be PCN 40 RCXU. In general, Santa Elena airport pavement was constructed with the design strength for B-727 type aircraft, but it is serviceable for occasional use by large jet operations.

The concrete pavement, however, presents cracks primarily in the sections of 100 - 150 m and 450 - 700 m from Runway 10 end, as well as in the western corner of the taxiway and in the apron near the taxiway. The extent of the cracks has been surveyed, and it is reported in Appendix-J. Some cracks and joints will require immediate improvements and others require improvement at a later date. The causes for such cracks are considered to be inadequate earth works during construction which have been aggravated due to lack of maintenance repair work and infiltration of water into the subbase. An examination of the relation between the groundwater table and the Peten Lake water level in March - September 1989 revealed that there is little relation between the water levels. (Refer to Appendix-C.)

9.2 Passenger and Cargo Terminal

9.2.1 Passenger Terminal

The passenger terminal at Santa Elena was originally designed as a modern two-story building, with separate departure and arrival levels and a marble wall finish. However, a difference of opinion on the amount of investments to spend on the facility caused the plans to be scrapped, and two pre-fabricated industrial type metal structures with basic finishes were substituted instead.

The facility consists of a complex of two structures, one for arrival and the other for departures. These buildings also house the cargo facilities.

1) Arrival Building

The arrival building is 54 m in length by 18 m in width, and is the smallest of the two structures. The interior distribution is simple and consists mostly of a large open space, with some individual offices, created by low masonry walls.

2) Departure Building

The departure building is 72 m in length and 18 m in width. An equally simple building it contains the basic space required for a small airport operation, from passenger check-in to boarding (both domestic and international), in addition to supplementary space, such as airline offices, airport administration, and such service space as a cafeteria, shops and toilets.

Although traffic is usually light, it is possible to observe the departure building filling up very rapidly, even with only two commuter flights boarding. It is reasonable to assume that the lack of direct indoor connection between arrivals and departures is a potential problem area which must be improved eventually.

9.2.2 Cargo Facility

There are no separate cargo facility presently installed at Santa Elena; cargo is handled as part of general baggage through some large overhead doors located at the arrival building. No facility was observed for departing cargo, which must be stored on the apron.

9.2.3 Vehicle Access and Parking

There does not seem to exist any critical problems with the capacity of the land-side aspect of the terminal. Given the location of the two structures, the curb length appears to be adequate. The existing capacity of the parking lot is 118 cars, with an area of about 2,900 m^2. On the basis of peak hour passenger level of about 120, as noted in Chapter 8.3.1, and by assuming the ratio of vehicles-to-passengers and the rate of vehicles which use the parking lot to be 0.84 and 0.6 respectively, the requirement of parking space is computed to be 61 cars (120 passengers x 0.84 x 0.6). Evidently, the existing parking lot would suffice for both passengers and airport personnel.

9.3 Support Activities

9.3.1 Airport Support Facilities

1) Control Tower

In the control tower, a tape recorder, VHF transmitter, microwave transmitter/receiver and rectifier are installed and are in good condition.

There are 3 positions on the console in the VFR room, and the control of air-ground radio is performed at the console. There are also teletypes for AIS, a monitor for VOR and NDB, and a direct phone. However, a MET facility and clock are lacking. In the case of an electric power failure all equipment in the control tower stops functioning due to an insufficiency of secondary power supply systems and batteries. It is also noted that the controllers find it difficult to watch aircraft moving in the movement area, because the cabin wall is 10 cm higher than the top of the console and the distance between the cabin wall surface and the back panel of the console is more than 1.0 m. Further, there are four large poles in the cabin and they obstruct the controller's view. Another problem is that the tower forces the controllers to work with the sun in their eyes from morning to evening. This hampers their control of the aircraft. The controllers tried to correct the situation somewhat by using pieces of cardboard as a visor to keep direct sun rays from their eyes.

2) CFR Building

There are no CFR facilities presently available at Santa Elena airport.

3) Maintenance Facilities

There are no maintenance facilities at Santa Elena airport; there is also no DGAC equipment to be maintained.

4) Fuel Farm

Currently, there are no fuel storage and distribution systems for commercial flights at Santa Elena. The aircraft must taxi there. Inflatable plastic fuel containers are available for emergency use only. At present, the lack of fuel supply facilities does not cause serious problems to the airport operations because the majority of flights are quick round-trips originating from La Aurora, Belize, Cancun, etc. There are reports that a fuel company was planning to provide a fuel storage tank of 7.57 kl in capacity. With the eventual expansion of the traffic, there will be a need for a fuel supply system.

5) Electric Power

The airport receives electric power of 13.2 kV at 4 separate points. Secondary power facilities (188 kVA Diesel engine generator of more than 20 years old) are located near the control tower, but they have not been operated for the past several years. Spare parts are out of stock and the equipment cannot be properly adjusted.

Power failures occur several times a month, continuing for more than 30 minutes. In case of power failure,

- All equipment in the control tower fails, with the exception of power transceiver in VFR room which can be operated by battery for about 1 or 2 hours.
- The receiving station stops completely.
- VOR/DME are not affected because they have a secondary power system.
- Airfield lighting fails completely.
- All the lights in the terminal building fail and the communication in the building is out of service.

It is clear that a secondary power supply system to meet the ICAO standards is essential at Santa Elena.

9.3.2 Aviation Support Services

Airport telecommunication facilities, air-ground communication equipment, NDB and airport lightings were installed in 1982. VOR/DME were additionally installed in 1986 to 1987. Existing telecommunications equipment are briefly explained hereunder.

1) Receiving Station

The receiving station is located about 900 m from the control tower and on the opposite side of the runway. The receiver is operated at the same frequency as the control tower's transmitting frequency. The station also has problems with power supply.

Commercial power is received separately, and a secondary power system for emergencies is not installed. It is noted that a floating power supply system should be provided urgently.

2) Radionavaids

There are NDB, VOR and DME which are operated and maintained by COCESNA (the DME has not been transferred from DGAC to COCESNA as of February 1989). These facilities are in good conditions.

3) Visual Navaids

Visual navaids at Santa Elena consist of an aerodrome beacon, VASI, runway threshold lights, runway edge lights, and taxiway lights. Some edge lights are damaged due probably to traffic of vehicles passing the threshold and edge of the runway and taxiway, because adequate service roads are not provided in the aerodrome. Approach lighting is not provided.

It must be noted that an IFR route between La Aurora and Santa Elena has not been established yet. The flight procedures appear to be subject to pilot's discretion depending on weather condition en-route. If there are some aircrafts flying in such a manner without ATS establishment, it would be detrimental to the safety of aircraft operation. Further, Standard Instrument Departure Procedures (SIDs) and Standard Terminal Arrival Routes (STARs) have not been established for Santa Elena airport. This makes aircraft operations along the route between Santa Elena and La Aurora unreliable.

9.3.3 Airport Administration

The administration and management of the Santa Elena airport has a functional organization as shown in Figure 9-2.

The organization chart does not indicate C.I.Q. and the meteorological section which are under the jurisdiction of other authorities. Customs officers, at present, are not stationed permanently but are dispatched when needed.

9.4 Overall Evaluation

Santa Elena is a relatively new airport. Layout and design of the aerodrome, however, are not necessarily adequate for commercial aircraft operations and improvements are required in the short, medium and long term. The major necessary improvements are set forth hereunder in a summarized form.

9.4.1 Airside Infrastructures and Terminals

The concrete-paved runway of 3,000 m in length appears to be appropriate for operations of any anticipated aircraft mix in the foreseeable future. The concrete cracks and deterioration of slab joints of the runway, however, have developed due to a lack of proper maintenance which is said to have been caused by budgetary shortfalls. The repair of cracks and joints should be programed for execution at the earliest possible date.

The apron and terminals were forced to be located inadequately near the Runway 10 end, causing inefficiency in commercial aircraft operations. With the increase in commercial operations at peak hours, extension of the parallel taxiway would be required in the long term. The expansion of the apron area would also be necessary in line with an increase in operations of small and medium commercial jets.

Although a new terminal building will not be required, judging from the peak hour passengers at Santa Elena, estimated to be 140 in 1995 and 200 in year 2000, necessary development will consist of expanding the new facilities and, above all, improving the quality and function of space.

9.4.2 Airport Support Facilities

The existing control tower was inadequately designed and improperly equipped. Earliest improvement of the tower is desirable. More essential is a secondary power supply system. With a power failure, all control tower equipment fail and the receiving station stops completely, as well. Installation of a secondary power system is therefore urgently needed at Santa Elena.

The majority of the navaids and telecommunication equipment installed in the aerodrome will reach the limits of their economic life in the early years of the next century. Their renovation and modernization should be programed in the long term.

9.4.3 Serviceability as Alternate Airport

Santa Elena airport has the basic infrastructure to serve as an alternate aerodrome to La Aurora within the national territory. Development of other airport support facilities should be accelerated when the scheduled road improvement of CA Route 13 from Modesto Mendes to Santa Elena is completed.

One of the prerequisites for Santa Elena to function as an alternate airport, is the establishment of air route and ATS between Santa Elena and La Aurora, coupled with the establishment of SIDs and STARs at Santa Elena as noted previously. Under such circumstances, the scope of this Study may be voluntarily amplified to focus additionally on the development of ATS to and from Santa Elena airport.

X. PROPOSED SHORT-TERM IMPROVEMENTS OF SANTA ELENA

10.1 General

Santa Elena airport, as noted before, serves primarily for tourists visiting the Tikal area. The improvements of Santa Elena airport should be programmed in line with the development of the accompanying and supporting tourist facilities as an Integrated Area Development Package. The present evidence suggests that many elements in the required Integrated Area Development Program are already in advanced planning. Indeed, implementation of many elements in the overall program is already underway. Therefore, it is both appropriate and desirable to begin improvements at Santa Elena so that the airport will have the capability to serve the expected increase in the number of travellers projected for 1995.

Another role that Santa Elena airport could play in the future is to serve as an alternate airport to La Aurora. As noted in Chapter 2.2.4, landing of international commercial flights at La Aurora airport has been made unable forcibly due to foggy weather conditions about 20 times a year on an average and flights have been diverted to another country, El Salvador. In the event that Santa Elena airport is improved and the air route between La Aurora and Santa Elena is established, such diverted flights could land at Santa Elena within the national territory. Santa Elena is located en route to and from the US and it would be more convenient and economical for the flights to and from the US/Mexican destinations, which account for more than 63% of the estimated international commercial operations in 1995 (Refer to Chapter 3.4).

For the major reasons noted above, it is proposed to implement the minimum improvements at Santa Elena airport in the short term. The remainder of this Chapter sets for the proposed short-term improvement programs for Santa Elena airport.

10.2 Airfield Infrastructure Improvements

Constructed in 1981, the existing airfield infrastructures of Santa Elena are relatively new, and no substantial improvement will be required in the short term. The existing runway, taxiway and apron will continue to be serviceable in this period. Some repair works, however, are necessary in the short terms as explained hereunder.

10.2.1 Repair of Runway and Apron

The existing concrete-paved runway of 3,000 m in length will present little problem in serving large jet aircraft, as well as in serving as an alternate airport to La Aurora. It is also serviceable for A-300 and B-767 type aircraft to reach an air range of some 3,000 km, an equivalent distance to New York. The runway width of 45 m with 7.5 m shoulders on both sides, conforms to ICAO standards. Basic configurations of the runway, therefore, will not require any substantial improvement.

The runway, however, has a number of cracks in the concrete, some settlement of slabs and deterioration in joints. The extent of cracks and deterioration has been verified in the course of field investigation of this Study, as described in Appendix-J. The cracks and joints deterioration are being developed due to lack of maintenance repair work and infiltration of water further into the subbase.

It is proposed that cracks in two sections of the runway, 100 - 150 m and 450 - 700 m from Runway 10 end, will be repaired in the short-term improvement plan (Refer to Figure 10-1 and Drawing 10-1). Repair of runway cracks will be carried out by means of asphalt overlay of 10 cm in thickness in order to keep serviceability of the airport during repair works.

A part of the apron cracks, near the junction with the rapid-exit taxiway, is also proposed for repair in the short term. Repair of apron cracks will be executed by placing concrete slab of 30 cm in thickness after strengthening the subbase for the depth of 15 cm.

It is additionally noted that grooving on the runway will not be contemplated in Santa Elena, because the pavement strength of concrete slabs tend to decrease by grooving.

10.2.2 Improvement of Service Road

In the aerodrome of Santa Elena, there exist no service road appropriate to serve for operation and maintenance. This is particularly inadequate because the control tower and some other facilities are located on the opposite side of the terminal facilities. Vehicles and motor cycles are using the runway and taxiway shoulders as if they were access roads. Damages are thereby caused to runway lights and their wiring. Such vehicles have no communication contacts with the control tower and are impeding safe operation of the airport.

To prevent further damages and to secure safe operations, it is proposed to improve the service road and create a better and safer access to the control tower areas, by newly constructing a service road of about 980 m in length and 5.5 m in width, with bituminous surface pavement.

10.3 Terminal Area Improvements

10.3.1 Passenger Terminal Facilities

The existing terminal at Santa Elena is in need of some improvements as described in Chapter 9.2.1. On the other hand, the traffic projections for Santa Elena airport have also indicated a level of activity relatively low for the target year 1995 with peak hours of 3 jet and non-jet operations and about 12 small chartered aircraft operations.

It is possible to analyze the space requirements for the terminal which would satisfy the traffic projections for the year 1995, using the same criteria applied for La Aurora. A comparative space analysis would be more simple, and is summarized in Table below:

Comparative Space Analysis - Santa Elena Terminal

(m^2)

Function	Existing (1988)	1995	2005
Check-in Area	360	187	267
Departure Hall Area	108	231	330
Departure Lounge Area	378	301	439
Baggage Claim Area	360	246	352
Arrival Hall/Greeting	250	288	411
Partial Total	1,456	1,253	1,799

Notes:

1) Requirements for the years 1995 and 2005 have been both included for purpose of clarity, and to avoid repetition.

2) The greeting area/arrival hall, and the baggage claim area are practically combined into one large space in the arrival building.

Since Table above indicates that almost all the 1995 requirements are already met, the development concept will consist in reorganizing the new facility within where needed, and above all, in improving the quality of the spaces, both in function (distribution) and in quality (finishes, etc.). Drawing 10-2 shows the revised distribution, which includes the following revisions:

a) Buildings Link: Although the departure and arrival are distinct functions in an airport, it is often desirable that they be connected. This will be achieved with the use of a covered walkway in front of the existing patio which will remain as a visual focal point. This walkway will help eliminate the possibility of access of the public to the apron, which would be a violation of security rules.

b) Elimination of Dedicated International Areas: It is expected that the tourist traffic will most likely have already cleared formalities at La Aurora. Therefore, it was considered wasteful to have areas (such as the existing international departure lounge), which remain closed until they are needed. The new philosophy is to incorporate a measure of flexibility which allows some areas to be isolated only when needed. (For example, arriving passengers will walk every day by booths which will be manned by immigration agents only for international flights.)

c) Better Use of Baggage Claim Area: At present, private companies have been allowed to operate customs-like counters inside the baggage claim area. A more logical concession area will be created to be rented out and to free the baggage claim area.

d) New Baggage Delivery System: It is reasonable to assume that until the year 2005 it will not be necessary to install a new baggage belt for the passengers. The table system actually in use will be eliminated because it is uncomfortable; it will be replaced by a "pass-thru system" at ground level.

e) Better Finishes: At the present time, the interior finishes of the terminal are very rudimentary, with exposed steel structure and metal ceiling and concrete blocks etc. A more polished appearance will be achieved through the use of local materials.

f) Better Comfort: Considering the local weather conditions in Santa Elena during the summer seasons, it is recommended that most, if not all the building be air-conditioned for the convenience of the passengers.

g) Departure Hall: The departure hall is the only space which appears to be inadequate for 1995. The reason is only the smaller area in front of the holding rooms (or departure lounges) is indicated as departure hall, whereas the departure lobby also serves that function. The addition of the new concession area will help clear the hall and accommodate more people.

h) Cargo Area: With a slight relocation of the baggage claim area as shown on the plans, it will be possible to accommodate a space of 180 m^2 at the extreme of the building to be used by the cargo facilities during the short-term phase. This will be sufficient as will be shown in the subsequent Section.

Standards security systems will be installed inside the building. Arriving and departing traffic will also naturally be segregated horizontally, if not vertically, to maintain airport security.

10.3.2 Cargo Terminal Facilities

The projections for annual cargo volume for the year 1995 has been previously established at 905 tons, of which 640 tons are outbound and 265 tons are inbound, as noted in Chapter 8.2.2. At this stage, it is reasonable to assume that all the cargo goes through or comes from La Aurora airport before reaching Santa Elena. This means that it is still essentially domestic cargo which does not require customs inspection on a regular basis (except for sporadic verification checks for security purposes).

The cargo volume for 1995 is so small that it is possible to compute a storage space requirement based on the total volume, using the criteria previously used for La Aurora airport. In this case the low-end of 5.0 t/m^2 will be used, since the cargo make-up is small light packages. The resulting area is 181 m^2 which will be divided with a flexible partition to differentiate between inbound and outbound cargo.

The required size of the space obviously does not justify the construction of a separate facility, which will be built at later stage. An area in the far end (west end) of the arrival building has been designated for cargo storage, and is indicated as such in the building plans. It is assumed that a small office area will be incorporated within that space. Since it is estimated that 100% of the cargo will be belly cargo, no special dedicated apron will be needed.

10.3.3 Other Terminal Area Facilities

Requirements for improvement of other facilities in the terminal areas have been further examined as explained hereunder.