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Guidelines for Evaluating Characteristics of Airport Landside Vehicle and Pedestrian Traffic

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Results of a study of the characteristics of landside vehicle and pedestrian traffic at Miami International, Stapleton International, and LaGuardia Airports and one terminal at John F. Kennedy International Airport are presented. Vehicle and pedestrian flow rates at all terminal buildings, curbside areas, parking facilities, and airport entrance and exit roadways were measured simultaneously and related to levels of air-passenger activity by using enplanements and deplanements as indices. Processing time and service rates were also sampled at several locations at three of the four airports. These data were obtained at ticket counters, automobile-rental areas, passenger security checkpoints, parking cashier operations, and other locations within the terminals. Representative per-passenger flow rates and processing times for pedestrians and vehicles are presented as rules of thumb to assist other airport planners.

Many agencies and organizations are attempting to analyze and derive solutions for the congestion problems encountered on the ground at airports, specifically on access roads and at terminal buildings. This paper results from several studies prepared for two organizations—the Transportation Systems Center of the U.S. Department of Transportation (1) and American Airlines (2, 3)—both of which are interested in airport congestion problems but from different viewpoints. Since the studies were designed to meet the distinctive needs of each organization, there were variations between them in the methods of data collection and the analyses performed.

Data were collected at four airports that represent, in total passenger enplanements, a cross section of the 20 largest airports in the United States. In 1978, John F. Kennedy International and LaGuardia Airports in New York, Stapleton International Airport in Denver, and Miami International Airport ranked fourth, seventh, eighth, and ninth, respectively, among U.S. airports in terms of total annual enplanements served. Data collected at John F. Kennedy International focused on the curbside area and access roads that serve the American Airlines terminal. At the other three airports, data were collected at each area of the airport where a passenger might encounter delays before boarding or after disembarking from an aircraft. This included all public areas in the terminal building, road curbside areas, and parking facilities. The data collected in those four studies form the basis for the guidelines and characteristics presented in this paper.

PURPOSE AND SCOPE

The purpose of this paper is to provide the airport planner and other interested groups with basic general guidelines for evaluating the reasonableness of vehicle and pedestrian forecasts for various sectors of the airport landside system and to present observed distributions of process times that can be used to plan passenger service facilities for airport terminal buildings. The findings presented relate to groundside vehicle characteristics, such as modal choice, traffic generation rates on airport roads and at parking facilities, and use of curb-frontage roadways; pedestrian trip-generation rates for airline passengers and visitors; and processing or service times for ticketing, security, and parking-cashiering operations at the subject airports.

AIRPORT CHARACTERISTICS

During 1979, Miami International Airport (MIA) handled about 8 248 000 enplaning passengers. MIA, which serves Dade County, Florida, is a major entry point for passengers arriving from South and Central America. During the study period (March 17 and 18, 1978), tourist traffic made up the largest portion of passenger demand. The proximity of Miami Beach and the cruise ships that berth at Miami generates a large portion of the tourist traffic. More than 25 percent of all enplaning air passengers are transfer passengers who do not have an impact on the terminal roadway system.

MIA provides more than 6000 public parking spaces, including 4700 spaces in the central terminal area in three garages and a surface lot. The terminal complex is on two levels and has approximately 1060 m (3500 ft) of arrival curb space and 1135 m (3750 ft) of departure curb space. A central island that has a dual curb separates the six-lane curbside roadways.

Stapleton International Airport (DEN) serves the Denver region and the largest volume of passengers of any airport between Chicago and the Pacific Coast. In 1978, DEN, which is classified as a major hub airport by the

Federal Aviation Administration, handled a total of about 9 481 000 enplaning passengers, of whom more than 35 percent were transferring passengers.

DEN provides more than 6200 parking spaces in a garage and surface lot in the central terminal area and adjacent peripheral lots. DEN has a two-level terminal complex that has approximately 275 linear m (900 linear ft) of departure curb frontage and 320 linear m (1050 linear ft) of arrival curb frontage. The departure-level road is three lanes in width, and the arrival-level road is four lanes in width.

Of the three airports studied, LaGuardia Airport (LGA) has the least percentage of interline transfers (during the survey, approximately 8 percent). In 1978, a total of about 8 547 000 enplaning passengers were accommodated at LGA, which makes this the second most active of the four airports under study. Because it is so close to midtown Manhattan, in comparison with JFK and Newark airports, LGA serves a higher percentage of business travelers than most airports. During the survey, more than 50 percent of all air-passenger enplanements were on business-related trips.

LGA provides public parking spaces for about 8300 vehicles; a garage located in the central terminal area has a capacity of about 2800 spaces. Five separate curb-frontage roadways serve the terminal—three on the upper level and two on the lower level. Approximately 515 linear m (1700 linear ft) of enplaning curb frontage is provided, 300 m (1000 ft) of which is located on the roadway adjacent to the terminal and an additional 210 m (700 ft) of which is within the parking garage. About 425 linear m (1400 linear ft) is provided on the arrival level. The inner roadway, which accommodates all commercial vehicles, has approximately 275 m (900 ft) of curb frontage; the outer roadway, which serves private automobiles, has a curb frontage approximately 150 m (500 ft) in length. In addition, a remote shuttle terminal complex is also provided at LGA for the shuttle operations of Eastern Airlines. Activities at this terminal, however, have been excluded from the study.

The American Airlines terminal at JFK (AA/JFK) is one of nine terminal facilities within the airport complex. The terminal is a two-level facility that, at the time of the survey, had 115 linear m (380 linear ft) of available departure curb frontage and 135 m (450 ft) of available arrival curb frontage. The American Airlines terminal is served by both parking in the central terminal area and remote long-term parking.

In 1978, JFK accommodated about 12.4 million enplaning passengers.

FIELD INVESTIGATIONS

Extensive data were collected at all four airports. Field studies were conducted over six consecutive hours on two specified days at each of the three grouped airports and for one day at AA/JFK. The 1978 surveys were timed jointly with the airport operating agencies and carriers for peak activity periods during the day and, if possible, during months of above-average patronage. Surveys at MIA were conducted between 11:00 a.m. and 5:00 p.m. on Friday and Saturday, March 17 and 18. The survey period preceded Easter week, which historically has proved to be a peak activity period at MIA. Surveys at DEN were conducted on Thursday, April 20, and Friday, April 21, near the end of the ski season, between the hours of 2:00 and 8:00 p.m. The LGA surveys were conducted between 2:00 and 8:00 p.m. on Wednesday and Thursday, May 24 and 25, the week before the Memorial Day weekend. Surveys were conducted at AA/JFK between the hours of 4:00 and 10:00 p.m. on Friday, January 27.

To determine the appropriate number of samples that would be required to ensure a 95 percent confidence level for the survey data at MIA, DEN, and LGA, pilot studies were conducted to determine data variability and thus enable the researchers to ascertain required sample sizes. Where required sample sizes were found to be greater than the flow rate (or sample universe), the maximum practical sample size was obtained. Because of the number of samples and the number of observation locations required, more than 125 field observers were used simultaneously at each airport over the two-day period to ensure complete coverage and accurate data collection. The table below summarizes the number of usable samples obtained for various types of data collected by sampling methods:

Type of Data	MIA	DEN	LGA
Passenger interview	950	1620	1560
Processing time			
Ticket counters	970	830	770
Security areas	680	1530	1460
Parking-lot exits	665	860	310
Vehicle dwell time	1725	1225	2220

(These data represent totals for the two-day survey period at each airport. A one-day survey conducted at the American Airlines terminal at JFK resulted in a total of 900 for vehicle dwell times.)

As noted, 950 passenger interviews were obtained at MIA, 1620 at DEN, and 1560 at LGA, for both enplaning and deplaning passengers. Processing times at ticket counters were obtained for 970 samples at MIA, 830 at DEN, and 770 at LGA. Other sample sizes obtained for processing times at security areas as well as at parking lot exits are also noted.

Continuous flow rates (number of entities) were collected simultaneously at all of the following locations by using 5-min increments: airport entrance roadways and exit roadways, parking lot entrances and exits, enplaning roadways, deplaning roadways, recirculation roadways, and terminal entrance and exit doors.

In addition, various characteristics of vehicle activity on the airport landside sector were measured. These included the processing times required to exit parking facilities (cashiering), vehicle dwell times on the enplaning and deplaning curb-frontage sections, and vehicle unloading and loading times on the enplaning and deplaning curb-frontage roadway sections.

Processing times were measured at several locations within the terminal buildings, including express and full-service airline ticket counters, customs and immigration, automobile-rental counters, and security locations. This information was collected at several processing points at each airport. In addition, passenger modes of arrival, bags per passenger, and group size were determined in passenger interviews. To obtain and ensure overall control, volumes of enplaning, deplaning, and transferring passengers were provided by the individual air carriers at each airport for each of the 6-h study periods. When passenger volumes were unavailable, the numbers of passengers that passed security stations were used to indicate activity levels. These values have been related to vehicle and pedestrian volumes measured during the same time intervals.

Table 1. Average patterns of modal choice for trips to and from the airport.

	Passengers (%)							
	MIA		DEN		LGA		AA/JFK	
Mode	Enplaning	Deplaning	Enplaning	Deplaning	Enplaning	Deplaning	Enplaning	Deplaning
Private automobile	42	47	56	70	25	31	46	47
Automobile-rental bus	11	20	14	8	9	4	3	2
Taxi	22	18	13	10	46	35	35	37
Airport limousine	10	10	5	5	13	20	7	5
Bus	15	5	3	5	5	5	9	9
Other	-	-	9	2	2	5	-	-
Total	100	100	100	100	100	100	100	100

Note: Transfer passengers excluded.

Table 2. Average air-passenger volumes.

	Number of Passengers[a]			
Type of Passenger	MIA[b]	DEN[b]	LGA[b,c]	AA/JFK
All				
Enplaning	14 900	10 400	14 400	3950
Deplaning	15 150	9 250	12 200	3350
Total	30 050	19 650	26 600	7300
Excluding transfer passengers				
Originating	11 200	5 950	12 300	3200
Deplaning	11 750	5 600	10 300	2750
Total	22 950	11 550	22 600	5950

[a]Data represent more than 95 percent of total passengers.
[b]Average of two-day survey.
[c]Excluding Eastern Airlines shuttle passengers.

Table 3. Average airport traffic generation relations: pedestrians.

Planning Ratio	MIA[a]	DEN[a]	LGA[a]	AA/JFK[b]
Ratio of total persons entering terminal to originating passengers	2.00	2.03	1.45	2.00
Ratio of total persons exiting terminal to deplaning passengers	2.01	2.18	1.51	1.91
Ratio of total persons entering and exiting terminal to				
Originating passengers	4.10	4.08	2.71	4.03
Deplaning passengers	3.91	4.34	3.23	3.75
Combined total	2.00	2.10	1.47	1.95

[a]Based on air-passenger volumes excluding transfer passengers.
[b]Excluding intraline passengers and including interline passengers (transfer passengers between terminals).

Table 4. Average airport traffic generation relations: vehicles.

Planning Ratio	MIA[a]	DEN[a]	LGA[a]
Ratio of total vehicles entering airport to			
Originating passengers	0.87	1.34	1.02
Total passengers	0.43	0.69	0.56
Ratio of total vehicles exiting airport to			
Deplaning passengers	0.93	1.26	0.99
Total passengers	0.48	0.61	0.45
Ratio of total vehicles entering and exiting airport to			
Originating passengers	1.84	2.54	1.83
Deplaning passengers	1.75	2.70	2.18
Combined total	0.90	1.30	1.00

[a]Excluding transfer passengers.

Table 5. Airport traffic generation relations: use of curb-frontage roadway.

Planning Ratio	MIA[a]	DEN[a]	LGA[a]	AA/JFK[a]
Ratio of total vehicles using curb frontage roadways to originating passengers	0.49	0.53	0.54[b]	0.68
Ratio of total vehicles using curb frontage roadways to deplaning passengers	0.54	0.53	0.51[c]	0.75

[a]Excluding transfer passengers.
[b]Including curb in garage.
[c]Excluding vehicles forced to traverse the deplaning roadway in exiting from the metered parking lot and the garage.

STUDY FINDINGS

Modal Choice

An important consideration in planning airport landside facilities is the landside modal choice of air passengers traveling to and from the airport. Passenger interviews were conducted to determine the modes of arrival and departure of enplaning and deplaning passengers, respectively. The results of these studies are summarized in Table 1.

Patterns of modal choice were found to vary according to time of day. At LGA, for example, use of automobiles in the morning by enplaning passengers is greater than the daily average. Possibly, this results from arriving business travelers parking their vehicles at the airport for the duration of the trip. Arriving passengers in the evening hours use more taxis. It is suggested that this is a result of business travelers who spent the day in New York returning to the airport for the reverse leg of their journey.

At all airports except LGA, the primary modal choice for both enplanements and deplanements is the automobile. During the survey, about 42, 56, and 25 percent of enplaning passengers used automobiles at MIA, DEN, and LGA, respectively. The pattern of modal choice observed at these airports compares favorably with earlier data, which indicate that 45, 68, and 38 percent of enplaning air passengers at MIA, DEN, and LGA, respectively, use private automobiles (4).

Passenger Volumes

The passenger activity level for the 6-h period at each facility is summarized in Table 2. The daily average volume of the two 6-h study periods at each of the four airports is given. For purposes of clarity, the information is presented for total enplaning, originating, and deplaning passengers. These values were used to arrive at planning factors and ratios.

The numbers of passengers served during the survey periods were 30 050, 26 600, 19 650, and 7300 at MIA, LGA, DEN, and AA/JFK, respectively. Transfer passengers were observed to represent about 24 percent at MIA, 41 percent at DEN, 8 percent at LGA, and 18 percent at AA/JFK during the survey periods.

Pedestrian Generation Ratios

In planning airport terminals, an important considera-

Table 6. Mean unloading or loading and dwell times at airport curbs by type of vehicle.

			Time (min)					
Curb	Airport	Type of Time	Automobile	Taxi	Bus	Limousine	Other	Total Average
Departure	MIA	Unloading or loading	1.3	3.0	1.3	1.0	0.9	1.2
		Dwell	3.0	1.8	2.9	1.7	1.5	2.6
	DEN	Unloading or loading	1.0	0.7	0.8	0.6	0.6	0.9
		Dwell	2.3	1.2	1.8	1.3	0.7	1.9
	LGA	Unloading or loading	0.6	0.5	0.7	0.5	0.4	0.5
		Dwell	1.2	1.1	2.2	1.3	1.2	1.4
	AA/JFK	Unloading or loading	1.2	0.8	1.3	1.7	0.7	1.1
		Dwell	2.5	1.3	1.7	2.6	1.0	2.0
Arrival	MIA	Unloading or loading	2.8	0.9	2.8	-	0.5	2.0
		Dwell	4.3	NA	3.5	-	1.5	3.9
	DEN	Unloading or loading	2.9	1.0	2.6	-	-	2.7
		Dwell	4.2	NA	3.2	-	-	3.9
	LGA	Unloading or loading	1.2	0.3	1.2	3.8	-	1.9
		Dwell	2.4	NA	1.6	4.5	-	2.4
	AA/JFK	Unloading or loading	1.6	-	1.2	2.5	1.0	1.5
		Dwell	3.3	-	1.7	4.4	1.5	3.0

Note: NA = not applicable.

tion is the volume of pedestrians that are expected to use the terminal. This value is a function of many factors, including air-passenger activity, passenger-visitor ratios, points of passenger loading and unloading, group sizes, and non-passenger-related activities at the terminal building.

Determining the volume of passengers entering and exiting a major airport terminal building is an expensive and difficult task because of the number of entrances and exits. At MIA, for example, 35 observers were required to monitor all doors simultaneously during the survey.

Table 3 gives the ratios of total persons observed entering and exiting various terminal buildings to enplaning, deplaning, and total passengers excluding transfer passengers. LGA has the lowest ratio of persons entering and exiting per passenger—about 1.5 pedestrians/air passenger. At MIA, DEN, and AA/JFK, which are more oriented to tourist and international travel, the ratio is about 2 pedestrians/passenger. It is suggested that the lower ratio at LGA is a result of the many business-oriented trips, which typically have a lower visitor-passenger ratio than social and recreation trips. Because the business trip is frequent and routine, few visitors are likely to accompany the business traveler.

Traffic Generation Relations

Traffic entering and exiting the central terminal areas at the study airports was observed to be quite variable because of its dependence on many factors, such as passenger arrival rates, modal-choice patterns, characteristics of vehicle occupancy, passenger-visitor ratios, and characteristics of employee traffic. The amount of use and volume of courtesy-type vehicles, hotel vans, rented automobiles, and shuttle buses are believed to substantially affect these values. As the data given in Table 4 indicate, the ratio of total vehicles observed entering and exiting the airport to total originating and deplaning passengers varies from 0.90 at MIA to 1.30 at DEN.

Vehicles traveling the curb frontage were also compared with the number of air passengers (see Table 5). Vehicle activity on the enplaning roadway was observed to vary from 0.49 vehicles to 0.68 vehicles/originating passenger at MIA and AA/JFK, respectively. The ratio for JFK can be attributed to the number of public vehicles required to serve all the terminals at JFK—that is, intra-airport vehicle traffic such as buses, rental vehicles, hotel vans, and others, which are routed so that they generally use the curb-frontage roadways of each terminal.

Activity on the arrival level varies from 0.51 vehicles/passenger at LGA to 0.75 vehicles/passenger at AA/JFK, again reflecting the additional intra-airport vehicles that use the facilities. It should be noted that including those vehicles that use the deplaning-level roadway in exiting from the garage and the metered parking lot at LGA would produce a 0.76 ratio of vehicles to passengers. These vehicles have been excluded since, because of the roadway configurations, all traffic that exits the garage at LGA must traverse the deplaning roadway.

Vehicle Dwell Times

Dwell time is the difference between the time at which a vehicle stops at a curb and the time at which it departs from the curb. Table 6 gives data on average curbside loading, unloading, and dwell times obtained at each airport on both departure (enplaning) and arrival (deplaning) curbs by type of vehicle. At an efficiently used curb, the difference between average dwell time and average loading or unloading time should be no more than about 0.5 min, the time required to enter the vehicle and depart the curb. A large difference in these times suggests that drivers are leaving vehicles unattended, which results in less efficient use of the terminal curb areas.

Departure Curb

As noted, LGA has the lowest average vehicle dwell time—1.4 min—compared with 1.9 min at DEN, 2.0 min at AA/JFK, and 2.6 min at MIA. It is believed that the smaller difference between dwell and unloading time at LGA reflects both the high level of curb parking enforcement and the nature of the air passengers (i.e., a low average number of bags per passenger). The higher value at MIA might be affected by the tourist orientation of the greeters.

Specific values by vehicle type are also given in Table 6. As noted, mean automobile unloading time varies between 0.6 min at LGA and 1.3 min at MIA. Similarly, observed mean dwell times for automobiles range between 1.2 and 3.0 min. Taxicabs were observed to have the lowest mean unloading and dwell times at each airport. Unloading and dwell times for buses, limousines, and other types of vehicles, including rented automobiles, are largely dependent on vehicle occupancy.

Arrival Curb

Activity at the deplaning curb also revealed that LGA has the lowest observed overall vehicle dwell time—2.4 min. MIA has the highest dwell time—3.9 min—and the greatest difference between parking and loading times—3.0 min. During the study period at MIA, many vehicles were observed to remain at the curb waiting for a passenger despite the resultant traffic congestion and queues.

Vehicle automobile loading time at the deplaning curb varied from a low of 1.2 min at LGA to more than 1.6 min at DEN, MIA, and AA/JFK.

Processing Times

Processing times at ticket counters, automobile-rental counters, and parking lot exits were recorded as the difference between the time at which a person or vehicle approached the service area and the time at which that person or vehicle left the area. Processing time at the security counter embraces the complete security procedure. This was measured from the time the passenger tendered an item to be X-rayed or checked until the passenger passed through the security area (the magnetometer), received the examined item, and was free to depart from the area to the gate.

Table 7 gives various processing times observed throughout the study airports. The observed aggregate data for all airports are also shown in a frequency-distribution format in Figures 1 and 2.

Full-Service Ticket Counters

As might be projected, the survey data revealed a wide range of process times at full-service ticket counters. Factors such as the type of trip (international versus domestic) or seat assignment, the equipment used in ticket verification, the operations of the individual air carriers, the volumes of passengers to be served, and human factors all influenced this activity. The 3.8-min difference between the mean high value (5.6 min) and the mean low value (1.8 min) reflects the diversity of this function.

Typically, air carriers are aware of the peak demand periods and the number of ticket-counter agents needed to serve this demand, given the factors cited above that affect processing times during the demand period.

Express Ticket Counters

As anticipated, the high and low mean values observed at express ticket counters are somewhat closer than those at full-service counters, ranging from 1.2 to 2.7 min/customer.

Security Areas

Processing times at security areas varied from a low of 9 s to a high of 46 s. The majority of the mean values recorded were in the 15- to 30-s range.

Automobile-Rental Counters

Mean processing times at the automobile-rental counters were the longest observed processing times, ranging from 2.6 to 7.7 min. In many instances, the duration of this processing time may depend on the availability of automobiles. Thus, longer processing times may result during periods of peak use of rented automobiles.

Parking Lot Exit Lanes

Cashier operations at exit lanes from parking facilities were also monitored. Results indicated a 30-s range between the lowest mean processing time—29 s at DEN (0.48 min)—and the highest—63 s at LGA (1.06 min). The majority of the values, however, were in the 30- to 50-s range.

SUGGESTED GUIDELINES AND PROCESSING TIMES

It is anticipated that the data produced by the surveys discussed in this paper will form the basis of many detailed studies that, it is hoped, will provide useful tools to assist planners in the evaluation of airport landside activities. As we stated initially, the analyses presented here are intended to form two initial steps to this end:

1. The development of guidelines that can be used to evaluate the reasonableness of vehicle and pedestrian forecasts and
2. The provision of observed distributions of process times that can be used to plan future and expanded passenger service facilities at terminal buildings.

Generation of Vehicle and Pedestrian Traffic

Table 8 gives suggested planning criteria for evaluating estimates of the impact of vehicle and pedestrian traffic at airports. These suggested criteria have been developed from the data obtained at the four airports studied. The range of values indicates the observed mean value; the recommended values are, in our opinion, the most useful values for planning.

As the table indicates, a ratio of 0.95 to 1.25 entering and exiting vehicles/total originating and deplaning passengers appears to be valid for forecasts of total traffic. The directional split (inbound versus outbound) is dependent on the anticipated distribution of enplanements and deplanements during a time period. The lower value—0.95—could be experienced at an airport that is business-trip oriented (about 50 percent business trips). The higher values of vehicles per passenger could occur at airports that serve many courtesy-type vehicles such as automobile-rental buses and hotel vans. The recommended planning range of vehicles per passenger is shown in Figure 3.

Curb-Use Factor

A typical factor for use of curb frontage appears to be one vehicle for every two enplaning or deplaning passengers. Thus, about 50 percent of all vehicles entering the airport use the curb-frontage roadways. The curb-use factors are shown in Figure 4.

Pedestrian Volumes

Total persons entering and exiting the terminal typically account for between 1.50 and 2.10 pedestrians/passenger. At a business-oriented airport, about 1.5 persons/passenger appears to be an appropriate value for planning purposes. At an airport that has a large number of international flights or is tourist oriented, a higher volume of pedestrians may be generated—up to 2.10 persons/passenger—as shown in Figure 5.

Table 7. Mean processing time at various airport facilities.

	Time (min)					
	MIA		DEN		LGA	
Type of Facility	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Full-service ticket counter	2.7	1.9	3.1	3.7	5.5	4.4
	3.0	4.1	1.8	2.5	3.7	3.4
	4.0	3.6	3.9	2.6	2.8	3.3
	5.6	-	-	3.5	-	-
Express ticket counter	2.3	2.2	1.5	1.7	3.1	2.4
	-	-	2.7	2.5	1.2	1.3
Security area	0.47	0.50	0.31	0.22	0.59	0.32
	-	0.51	0.38	0.56	0.56	0.52
	-	-	0.18	0.19	0.15	0.77
	-	-	-	-	0.30	0.50
Automobile-rental counter (pickup)	5.2	6.0	4.3	7.7	4.2	5.1
	-	-	4.4	5.0	4.5	4.2
	-	-	-	-	4.0	2.6
Parking-lot exit (cashier lanes)	0.58	0.45	0.53	0.48	0.63	1.06

Figure 1. Distribution of ticket-counter processing time.

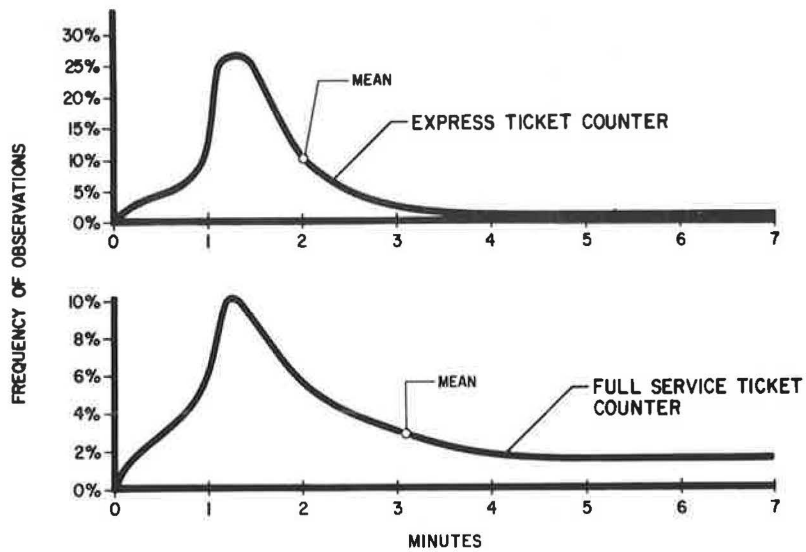
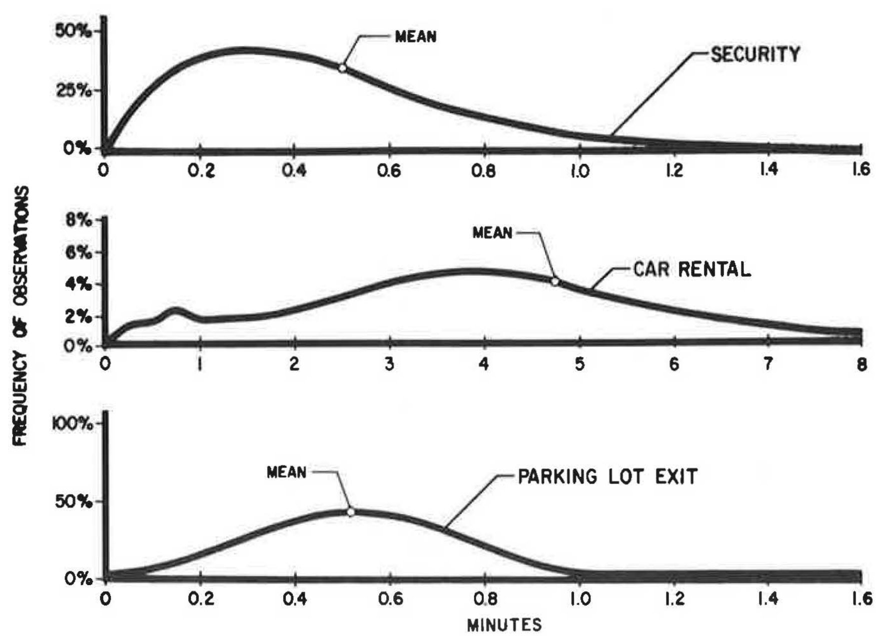


Figure 2. Distribution of landside processing time.



Processing Times

Processing times are relatively localized and reflect the individual passenger service areas. Some parameters to be used in evaluating some of these areas are given below:

Service Location	Suggested Processing Time (min)
Enplaning curb	
All vehicles	1.5-2.5
Automobile	1.2-3.0
Taxi	1.0-1.5
Deplaning curb	
All vehicles	2.5-4.0
Automobile	2.0-4.0
Parking lot exit lanes, cashier operation	0.50-0.60
Ticket counters	
Full service	2.0-5.0
Express	1.2-2.5
Security areas	0.15-0.50
Automobile-rental counters	2.5-5.0

The low values of time for enplaning and deplaning curbs reflect a high level of enforcement. The higher values for full-service ticket counters reflect operations oriented to international travel.

Vehicle dwell times on the departure roadway (enplaning curb) can vary an average of between 1.5 and 2.5 min for all vehicles. Dwell times for automobiles could vary between 1.2 and 3.0 min and, in some instances, higher values can be experienced when the curb is used for parking rather than unloading. Taxi dwell times vary from 1.0 to 1.5 min. Where strict enforcement and less baggage per person can be expected, the lower value should be used. At airports oriented to tourist and international travel, the higher values should be used to estimate curb-frontage needs. On the arrival roadway (deplaning curb), a range of 2.5-4.0 min is suggested. The practice of tolerating parking accounts for the higher values observed on the deplaning curb at MIA and DEN.

Processing times at parking lot cashier exits are also given in the table above. As noted, an average of 20-40 s/transaction is required. The longer times experienced reflect the paperwork involved in accepting checks, lost tickets, and the associated paperwork typical at an airport.

Other suggested ranges of process times, for ticket counters, automobile-rental counters, and security areas, are also given above. In most cases, processing times in these areas depend on the type of equip-

Table 8. Suggested airport planning criteria for vehicle and pedestrian traffic.

Item	Ratio per Passenger: Originating	Deplaning	Total
Airport vehicle traffic			
Entering	0.90-1.35	-	0.45-0.70
Exiting	-	0.95-1.25	0.45-0.65
Total	1.85-2.55	1.75-2.70	0.95-1.25[a]
Curb-frontage-roadways traffic			
Enplaning	0.50-0.55[b]	-	-
Deplaning	-	0.50-0.55[b]	-
Pedestrian traffic			
Entering terminal	1.50-2.00	-	-
Exiting terminal	-	1.50-2.20	-
Total	-	-	1.50-2.10[c]

Note: Recommended values are boxed. Transfer passengers are excluded.
[a]Maximum values reflect the predominance of courtesy-type vehicles.
[b]At individual terminals within a major airport, increase the value to 0.65-0.70.
[c]Commuter-type airports = 1.50; international-tourist airports = 2.10.

Figure 3. Vehicles entering and exiting the airport versus numbers of originating air passengers.

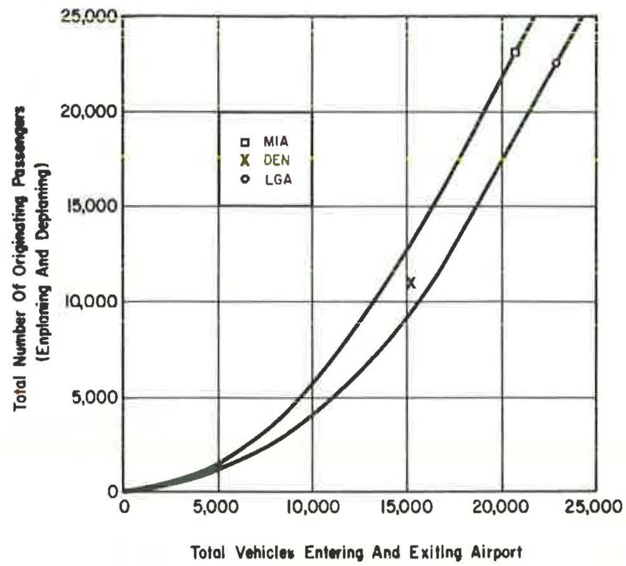


Figure 4. Curb-frontage utilization.

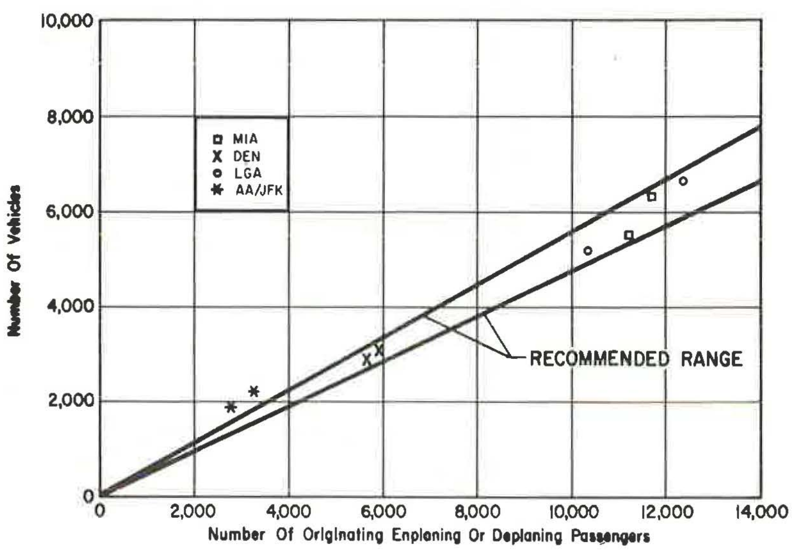
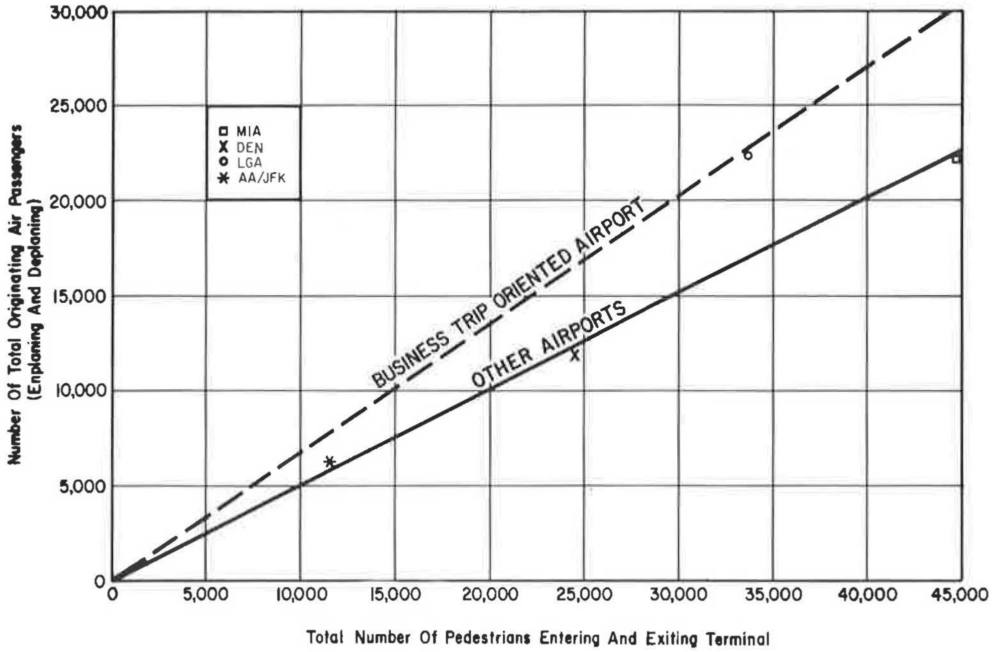


Figure 5. Pedestrians entering and exiting the air terminal versus numbers of originating air passengers.



ment used and the nature of the passenger. For functional planning purposes, however, these values have been presented to indicate the levels of activity that can be expected.

These values have been prepared as an aid to the user in forecasting levels of activity that may be expected at airports. Since each airport has its own peculiarities, only ranges and levels of activity for overall planning purposes are presented and not absolute factors.

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Two Programs to Ease Automobile Congestion at Los Angeles International Airport

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Two programs that have had a positive impact on alleviating automobile congestion at Los Angeles International Airport are discussed. One program consists of reduced-rate off-airport parking lots and free tram service to the terminal buildings. Two lots that provide a combined total of about 11 400 parking spaces are currently in operation. The other program, the FlyAway Bus, is an express bus service that transports people to and from Van Nuys, a large suburban community 32 km (20 miles) north of the airport. The service includes low-cost parking for up to 15 days at the suburban bus terminal. The success of both programs is significant not only because of their current impact on airport congestion but also because of their potential for expansion to broader uses in the future and because they prove that the public can be persuaded to trade the privacy and control of the automobile for the efficiency and convenience of public trams and buses.