Portions of this AC are under review for update. Please contact the National Planning and Environmental Division for assistance.

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

/REPRINT INCLUDES CHANGE 1/

Subject: PLANNING AND DESIGN GUIDELINES FOR AIRPORT TERMINAL FACILITIES

Date: 4/22/88
Initiated by: AAS- 100

AC No: 150/5360-13
change:

1. **PURPOSE.** This advisory circular (AC) provides guidelines for the planning and design of airport terminal buildings and related access facilities.

2. **CANCELLATION.** The following advisory circulars are canceled:

a. AC 150/5360-6, Airport Terminal Building Development with Federal Participation, dated October 5, 1976.

b. AC **150/5360-7,** Planning and Design Considerations for Airport Terminal Building Development, dated October 5, 1976.

3. **RELATED READING MATERIAL.** Appendix 1 contains a listing of documents with supplemental material relating to the planning and design of airport terminal facilities and how they may be obtained.

Leonard E. Mudd

Leonard E. Mudd
Director, Office of Airport Standards

CONTENTS

CHAPTER 1. INITIAL PLANNING CONSIDERATIONS

CHAPTER 2. DESIGN METHODOLOGIES

CHAPTER 3. FUNCTIONAL RELATIONSHIPS AND TERMINAL CONCEPTS

CHAPTER 4. TERMINAL APRON AREAS

CHAPTER 5. TERMINAL BUILDING SPACE AND FACILITY GUIDELINES

CHAPTER 6. FEDERAL INSPECTION SERVICES (FIS) FACILITIES

CHAPTER 7. ACCESSIBILITY TO INDIVIDUALS WITH DISABILITIES AND SPECIAL NEEDS USERS

CHAPTER 8. MISCELLANEOUS DESIGN CONSIDERATIONS

CHAPTER 9. AIRPORT ACCESS SYSTEMS

CHAPTER 10. FEDERAL PARTICIPATION IN THE COSTS OF TERMINAL DEVELOPMENT

APPENDICES

FIGURES

TABLES

CHAPTER 1. INITIAL PLANNING CONSIDERATIONS

1. INTRODUCTION.

a. This advisory circular (AC) presents guidance material for the planning and design of airport terminal buildings and related access facilities.

b. The material and nomographs included herein provide general guidelines and approximations for determiningspace and terminalfacilityrequirementsfor planningpurposes. It is not intendedthat theybc used to replace the detailed engineecring analyses necessary for the specific design of individuhl airport terminal facilities.

c. Much of the material contained in this AC appears in various documents listed in Appendix 1. Architectural, engineering, and planning consultants are advised to review the referenced documents, as they contain supplemental information and provide more in-depth treatment of much of this material. The Transportation Research Board's (TRB) Special Report 215, Measuring Airport Landside Capacity, is particularly recommended.

d. AC 150/5360-9, Planning and Design of Airport Terminal Building Facilities at Nonhub Locations, containsguidance material for use in planningterminal facilities at low activity airports. It may be used in lieu of or in conjunctionwith this document, as appropriate.

2. AIRPORT MASTER PLANS.

a. Prior to initiatingan airport terminal building design project, the master planning report for the airport under study should be reviewed. Most airports will have such a report on file.

b. Airport master plans (see AC 150/5070-6, Airport Master Plans) contain considerable information useful to the terminal planner/designer. Typically, these plans will contain the following data and analyses: an inventoryof relevant data pertainingto the service area and existing airport facilities; activity forecasts; capacity analyses; estimates of facility requirements; environmental studies; various plans on airport layout, land use, terminal area, and intermodal surface access; etc. Planning horizons for master planning studies usually cover 5, 10, and 20 years into the future.

c. The terminal plan contained in an airport master plan is normally limited to layouts and drawings delineatinggeneral location, overall area, and basic configuration of the terminal area. For new airports or terminals, this plan may be limited to conceptual studies, layouts, and schematic drawings depicting the basic flow of passengers, cargo, and the various modes of airport surface access.

d. In most cases, the planner/architect should design the terminal facility to conform to the broad framework and guidelines established in the master plan. However, the master plan should be reviewed periodically, reevaluated, and, if necessary, appropriately revised to account for subsequent developments or definitive planning.

3. FACTORS INFLUENCING TERMINAL CONFIGURATION AND SIZE. In addition to historical traffic volumes, each airport has its own combination of individual characteristics to be considered in configuring and sizing terminal facilities. Similarly, each airline serving an airport has internal procedures, policies, and staffing criteria which influence facility planning. Some of the basic considerations which may significantly impact the planning and design of an airport terminal are discussed in following paragraphs.

a. **Service Area.** A form of reference often used to describe an airport's service area is the air traffic hub structure developed by the Federal Aviation Administration (FAA) to measure the concentrationof civil air traffic. Air traffic hubs are not airports; they are the cities and Standard Metropolitan Statistical Areas (SMSAs) requiring aviation service. Individual communities fall into four hub classifications (see Table l-l) as determined by each community's percentage of the total U.S. enplaned domestic revenue passengers carried.

Table l-l. Hub Classifications

Hub size	Percent of total enplaned passengers	1991 enplanements
Large (L)	1.0 percent or more	4,886,665
Medium (M)	0.25 to 0.9999 percent	1,221,663 to 4,886,665
Small (S)	0.05 to 0.249 percent	244,333 to 1,221,663
Nonhub (N)	Less than 0.05 percent	Less than 244,333

The location and number of air traffic hubs can be obtained from the latest issue of the Department of Transportation Airport Activity Statistics. Apart from obvious influences, such as physical size and topography, some of the more significant characteristics of the airport service area which may influence the airport terminal design include: population and per capita income and their growth potential; geographic location and distance from other airports with similar or larger service areas; concentration of commercial activity that involves a relatively high propensity for air transportation; and proximity of major vacation/recreation areas.

b. Passenger Characteristics. Two basic categories of passengers are those who travel for business purposes and those traveling as tourists or for personal reasons. Business passengers are usually more travel experienced; arrive just prior to flight time; and are more apt to use the full range of public terminal services and concessions. On the other hand, vacation travelers are more likely to arrive much earlier, relative to flight departure time, compared to business travelers; depart from the destination airport later; and, generate a larger number-of visitors/greeters. Consequently, significant variations in the characteristics and ratio of these two passenger types can influence space requirements and staffing. A small airport serving a vacation/ resort area with a relatively short season will involve different requirements than an airport handling comparable peak-month volumes of predominantly business travelers. Similarly, an airport close to a military installation, or serving a college town, may generate a significant volume of standby traffic, thus warranting additional facilities and services.

c. Airline Station Characteristics. The route structures of the scheduled airlines serving an airport influence its character and, consequently, its facility requirements. Airports can generally be categorized into three types 'on the basis of the route structures of the using airlines. These categories and their related characteristics are discussed in succeeding paragraphs. The peak hour movements per gate specified (*gate utilization factor*) are typical for airports averaging six or more daily departures per gate.

(1) Origination/Termination Airport. This category of airport usually involves a high percentage (over 70 percent of total enplanements) of originating passengers and a preponderance of turnaround flights. Ground times range from 45 to 90 minutes, or more. The high flow of passengers between aircraft and ground transportation vehicles generates a relatively high requirement for ticket counter area, curb length, and parking spaces per enplaned passenger. Passengers will usually require maximum baggage-handling services for checking and claiming baggage. Typical domestic peaks will average about 0.9 to 1.1 hourly aircraft movements per gate. Boarding load factors at this category of airport often range between 65 and 80 percent.

(2) Through Airport. This category has a relatively high percentage of originating passengers combined with a low percentage of originating flights, resulting in the shortest aircraft ground times. Boarding load factors may be lower than origination/termination airports (ranging from 40 to 60 percent), thereby reducing departure lounge space requirements. Typical domestic peaks will average 1.5 to 2.0 hourly aircraft movements per gate.

(3) Transfer Airport. This Category of airport has a significant proportion of passengers, at least 30 percent of total enplanements, transferring between on-line and off-line flights. Aircraft ground servicing times average30 to 60 minutes, dcpendingupon connectingpatternsand airlineoperatingpolicics. Typicaldomestic peaks average 1.2 to 1.4 hourly aircraft movements per gate. Compared to the same volume of enplanements at the other two categorics of airports, thc transfer airport has lcss ground transportation activity and a lower requirement for curb frontage; less need for airline counter positions serving normal ticketing and baggage check-in (although more positions may be required for flight information and ticket changes); less requirement for baggage claim area; more space for baggage transfer (on-line and/or interline taggage); increased requirements for concessions and public services; and increased need for centralized security locations.

d. Aircraft Mix. Thc forecast mix of aircraft expected to use an airport can significantly impact terminal design. For instance, airports serving a large variety of aircraft types and sizes require terminal facilitiesmore flexible and complex than those serving predominantly one class of aircraft. The latter are more conducive to standardizing the area and facilities at each gate position. Tcrminals at airports serving wide-body-aircraft require the ability to accommodate the large passenger surgcs which normally occur when these aircraft load or unload.

e. Nonscheduled Service. In addition to schedulcd opcrations, most airports scrve a variety of non-scheduled operations such as charter flights, group tour flights, and air-taxi operations. At some airports, a relatively high volume of airline charter or other nonscheduled operations may warrant consideration of separate, modest, terminal facilities for supplemental carricrs. Occasionally, scheduled carriers may desire separate apron hardstands and buildings to serve charter operations which exceed the capabilitiesof facilities required for normal scheduled operations. Any such proposal should be evaluated thoroughly, since a separate facility can often create inefficiencies in such aspects as logistics, staffing, and ground equipment utilization.

f. International Service. Airports with intcrnational flights may have other characteristics which influence terminal planning and design. One characteristic is a tendency toward higher aircraft activity peaks because of the heavy dependence on schedules for city pairs related to time zone crossing. Another characteristic is the relatively long ground service times (2 to 3 hours for turnarounds, 1 hour for through flights) required for long range aircraft servicing. The additional space requirements for Federal Inspection Services (FIS) facilities will also affect terminal planning and design. (See Chapter 6.)

4. TERMINAL SITING CONSIDERATIONS. Since most terminal development involves the expansion or modernization of an existing facility or terminal complcx, its location will more or less bc fixed. However, in the case of a new airport or major airport redevelopment, a new terminal site may be necessary or desirable. There are a number of basic considerations which will affect the ultimate terminal site selection. Some of the more important of thcse considcrations includc:

a. Runway Configuration. The runway configuration at an airport has a significant impact on the location of the apron-terminal complex. The terminal sitc should be locatcd to minimize aircraft taxiing distances and times and the numbcr of active runway crossings rcquired bctwcen parking aprons and runways. At airports with a single runway or very simple runway configuration (for instance, airports with a primary plus crosswind runway or single set of parallel runways), this may dictate locating the passenger terminal centrally with respect to the primary runway(s). At airports with morc complex runway configurations, siting may require detailed analyses to determine runway use, predominant landing and takeoff directions, location and configuration of existing taxiways, and the most efficient taxiway routings. The runway configuration may also restrict ground access to certain areas of the airport and thus limit alternative terminal sites. Figure l-l depicts the relationship between runway configurations, tcrminal locations, and ground access facilities.

b. Access to Transportation Network. While the motor vehicle will remain the major mode of ground transportation to and from thc airport, other public transit modcs are cxpcctcd to assume an increasing role. The passenger terminal should bc located, when possible, to provide thc most dircct/shortest routing to the access transportation systcm serving the population ccntcr gcncrating the major sourcc of passengers and freight. Adequate arca and distance should be providcd bctwccn the transportation acccss network and the primary terminal building (and within the terminal building) to accommodate the ultimate terminal development and necessary future ground access systems and improvements.

c. Expansion Potential. To assure the long-term success of an airport terminal facility, potential expansion beyond forecast requirementsshould always be taken into consideration. In the planning stage, the terminal should be conceived in its ultimate form with reasonable allowance for growth and changes in operation beyond forecasted needs. Use of this principal in selecting a terminal site or expansion scheme will promote the provision of adequate space around the terminal (both on the airside and landside) for orderly construction of succeeding stages.

d. FAA Geometric Design Standards. Terminal facilities require a location which will assure adequate distances from present and future aircraft operational areas in order to satisfy FAA airport geometric design standards. These standards include such minimum separation distances as those between a runway centerline and aircraft parking aprons, buildings, and airport property lines; and those between a taxiway centerline and fixed/movable objects and other taxiways. Refer to AC 150/5300-13, Airport Design, for information on FAA airport geometric design standards.

e. Existing and Planned Facilities. Existing and planned structures and utilities should be carefully inventoriedand taken into account when planning new or expanded terminal facilities. In some cases, existing facilities or utilities, which are not related to and are restrictive to terminal development, can be demolished, abandoned, or relocated to a more suitable area. In other instances, existing conditions may limit the number of possible alternative terminal sites. In all cases, existing or planned locations of a FAA control tower, navigational aids, weather equipment, etc., should be analyzed to assure that terminal development will not interfere with line-of-sight or other operational restrictions associated with these facilities.

f. Terrain. Topographical conditions should be considered in the selection of a terminal building site. For instance, potential drainage problems can be reduced if the terrain lends itself to naturally carrying water away from the building. Developing the terminal site on relatively flat land can prove economically advantageous by reducing grading or quantities of fill. However, an existing terrain feature, such as a grade differential between the landsidc of the terminal and an aircraft parking apron, can be incorporated into a multi-level terminal concept.

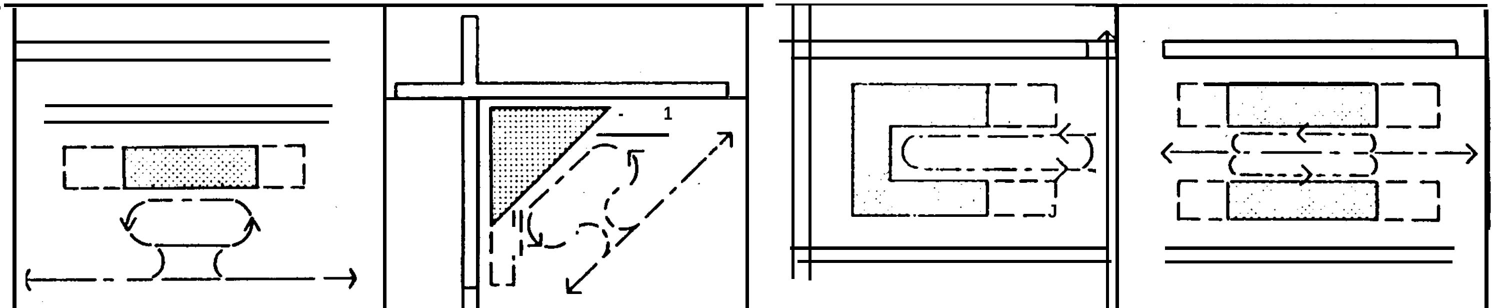
g. Environmental Impacts. The location of a terminal facility or major expansionof an existingone may result in significant environmental impacts which must be analyzed and weighed, if capacity is increased by 25 percent or more, in considering alternative terminal sites. The FAA airport layout plan (ALP) approval process associated with terminal facility planning includes necessary environmental assessment.

h. General. Figure 1-2 illustrates the terminal facility's role as the transfer mode from airport landside to airport airside.

5. PROJECT COORDINATION. Planning and designing an airport terminal complex requires considerable coordination and input involving a number of airport users and other interested parties. Participants in such a process include: airport management; the consultants engaged to perform the planning and/or design; tenant airlines; the FAA; Federal Inspection Services (FIS) representatives (if international service is involved); local governmental planning agencies; building concessionaires; and, other airport tenants. The requirementsof each of these parties may differ somewhat and in some cases conflict with each other or with the design concept. These differences require resolution and/or compromise as early in the planning/design stage as possible. For this reason, it is advisable to establish a terminal facility advisory committee composed of representatives of airport management, planning consultants, airlines, and other principal airport tenants. This committee can meet periodically to review the terminal design and provide input as a project progresses.

6. - 19. RESERVED.

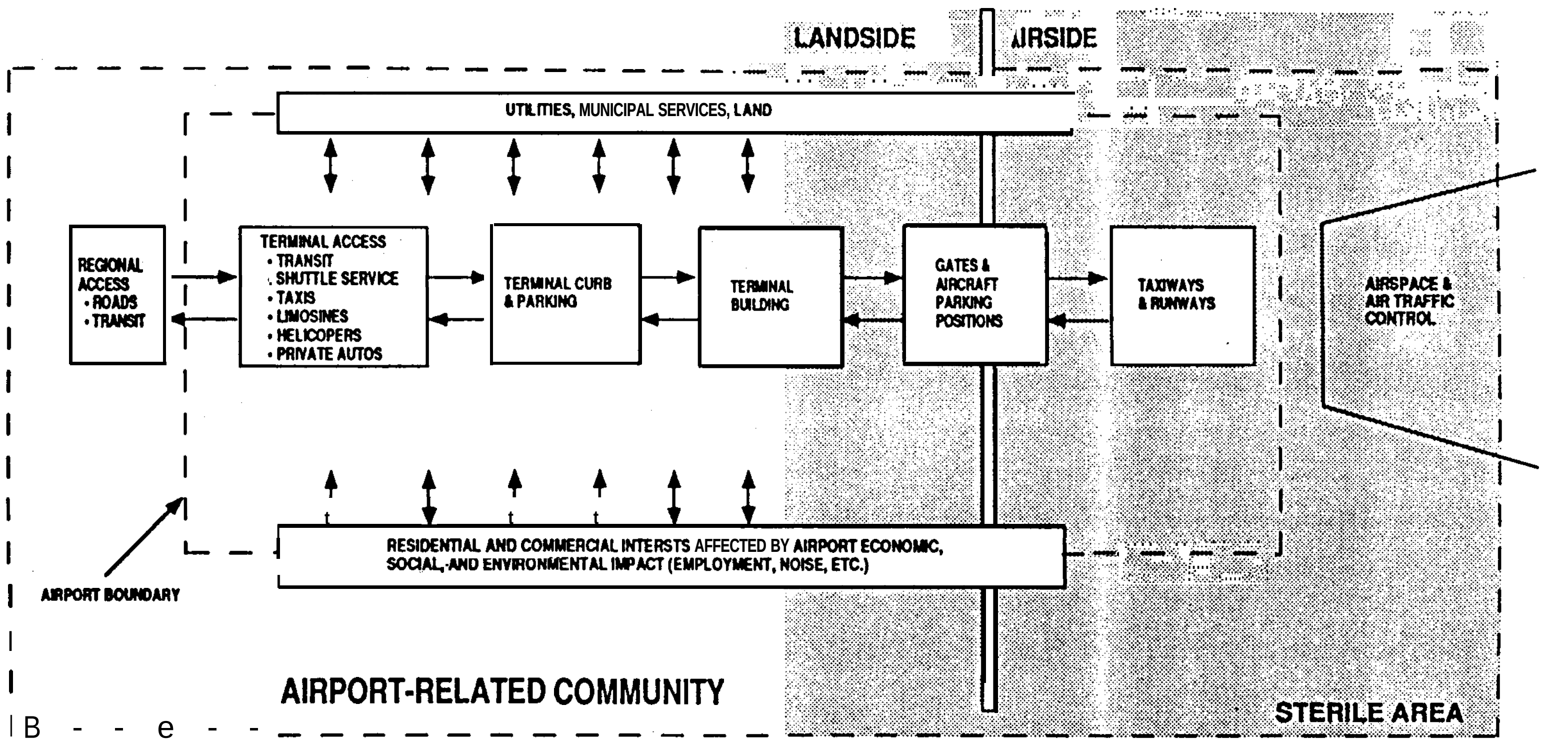
LAYOUT



APRON-TERMINAL RELATIONSHIPS	SINGLE OR CLOSELY PLACEO PARALLEL RUNWAYS: LIMITING APRON TERMINAL ON ONE SIDE	RUNWAYS WITH INTERSECTING AXES; LIMITING APRON TERMINAL ON TWO SIDES	WIDELY SPACED PARALLEL RUNWAYS WITH INTERSECTING CROSSWIND RUNWAY OR TAXIWAY; LIMITING APRON TERMINAL ON THREE SIDES	WIDELY SPACELI PARALLEL RUNWAYS WITH NO INTERSECTING CROSSWIND RUNWAY, LIMITING APRON TERMINAL ON TWO SIDES, EXCEPT AS LIMITED BY TAXIWAYS
GROUND-ACCESS CHARACTERISTICS	ACCESS FROM SINGLE POINT USING ONE-WAY LOOP ROAD	ACCESS FROM SINGLE POINT USING ONE-WAY LOOP ROAD	ACCESS FROM SINGLE POINT USING ONE-WAY LOOP ROAD	POSSIBLE ACCESS FROM TWO POINTS USING TWO-WAY AXIAL ROAO WITH ONE-WAY LOOP ROAOS SERVING EACH APRON-TERMINAL AREA
APRON-TERMINAL EXPANSION	RUNWAY ANO ROAOWAY LIMIT EXPANSION TO TWO DIRECTIONS	RUNWAY ANO ROADWAY LIMIT EXPANSION TO TWO DIRECTIONS	RUNWAY ANO ROAOWAY LIMIT EXPANSION TO TWO DIRECTIONS	RUNWAYS LIMIT EXPANSION TO TWO DIRECTIONS
AIRCRAFT CAPACITY	USUALLY (BUT NOT LIMITED TO) SMALL OR MEDIUM VOLUMES	SMALL, MEDIUM, OR LARGE VOLUMES	MEDIUM OR LARGE VOLUMES	MEDIUM OR LARGE VOLUMES

APRON TERMINAL RUNWAYS GROUND ACCESS

Figure 1-1. Terminal Siting/Runway Configuration Relationships



SOURCE: ADAPTED FROM TRANSPORTATION RESEARCH BOARD SPECIAL REPORT 215

Figure 1-2. Functional View of an Airport

CHAPTER 2. DESIGN METHODOLIGIES

20. GENERAL. Effective planning and design of the terminal area involve the active participation of airport management, the airlines, concessionaires, and the consultants engaged by the parties. The process normally includes: compiling surveys, questionnaires, and forecasts, usually for short and intermediate periods; developing design day and peak hour activity tables; establishing passenger, aircraft, and vehicular traffic relationships; taking inventory and evaluating existing facilities; analyzing space requirements for alternative layouts; and estimating costs and developing financial plans. Sample forms for collecting design data 'are provided in Appendix 2. From this data collection, the designer can analyze alternative concepts and select the most economically feasible and practical terminal facilities.

21. FORECASTS. Airport terminal facilities are planned on the basis of activity forecasts. Depending on the various types of facilities being planned, the principal annual forecasts include passenger enplanements, passenger originations, and aircraft movements (by aircraft size). The most useful sources for this information include: the current airport master plan; the FAA published terminal area forecasts; forecasts developed by the Air Transport Association (ATA); and those forecasts developed by the individual airlines serving the airport. The airlines should be consulted for assumptions on trend changes in the ratio of originators to enplanements in scheduled service. Normally, nonscheduled operations are not considered the primary basis for terminal planning and should be evaluated separately.

22. TRANSLATING FORECASTS TO PEAK DEMANDS. Airport terminal facilities are planned, sized, and designed to accommodate peak passenger demands for a selected forecast period. Generally, the initial stage of construction is designed for a selected year (or years) within 5 to 10 years of the current period. Master plans look 20 years into the future. Planning for absolute peak demands, i.e., the greatest demands anticipated, will result in facilities impractically oversized and underutilized. Accordingly, the planner should be cautious in the use of data on absolute peak traffic volumes. Methodologies for converting annual forecast data to daily and hourly demand are discussed in paragraphs 23 and 24.

23. PEAK DAILY ACTIVITY. The Average Day/Peak Month (ADPM) represents the most common method of converting planning statistics to a daily and ultimately to an hourly demand baseline. A determination of the ADPM demand for the design year involves first identifying peak month enplanements as a percent of annual enplanements based on historical data. This percentage may be adjusted up or down as local circumstances and/or other factors dictate (seldom necessary). Applying this percentage to the annual enplanement forecast for the design year results in a peak month demand forecast for that year. Demand for the average day of the peak month of the design year is determined simply by dividing the peak month demand by the number of days in that month. The same ratio of annual originating passengers (or transfers) to annual enplanements can be assumed for ADPM passengers unless indicated otherwise by seasonal data or surveys. This ratio may vary during the peak hour at some airports.

24. PEAK HOURLY ACTIVITY. Many aspects of terminal facility planning require hourly volumes or statistics consistent with the average day baseline. An airport may have peak hour operations as high as 12 to 20 percent of daily total operations. As schedules increase, peaks tend to spread out over the day. A theoretical absolute low is 6.25 percent which assumes uniform distribution of domestic operations over 16 hours. Such a theoretical low normally never happens. In actual practice, some peaking will always occur, both in aircraft movements and, even more so, in passenger activity. The latter occurs even with a relatively uniform distribution of aircraft movements, since larger aircraft are normally scheduled in the prime hours of the day so as to best meet public demand. Several procedures for arriving at peak hour activities are discussed in the following paragraphs.

a. Hypothetical Design Day Activity Method. The recommended procedure for determining design peak hour activity statistics involves the use of aircraft movement data and load factors (historic and projections) obtained from the airline to develop a hypothetical design day activity table. This table is comprised of data columns depicting hypothetical arrival and departure clocktimes for the various airline flights, aircraft types, and passenger enplanements and deplanements for the average day/peak month of the selected design year. From these tables, passenger/visitor population plots can be developed for enplaning, deplaning and total passengers. An example of an Enplaning Passenger/Visitor Population Plot is shown in Figure 2-1.

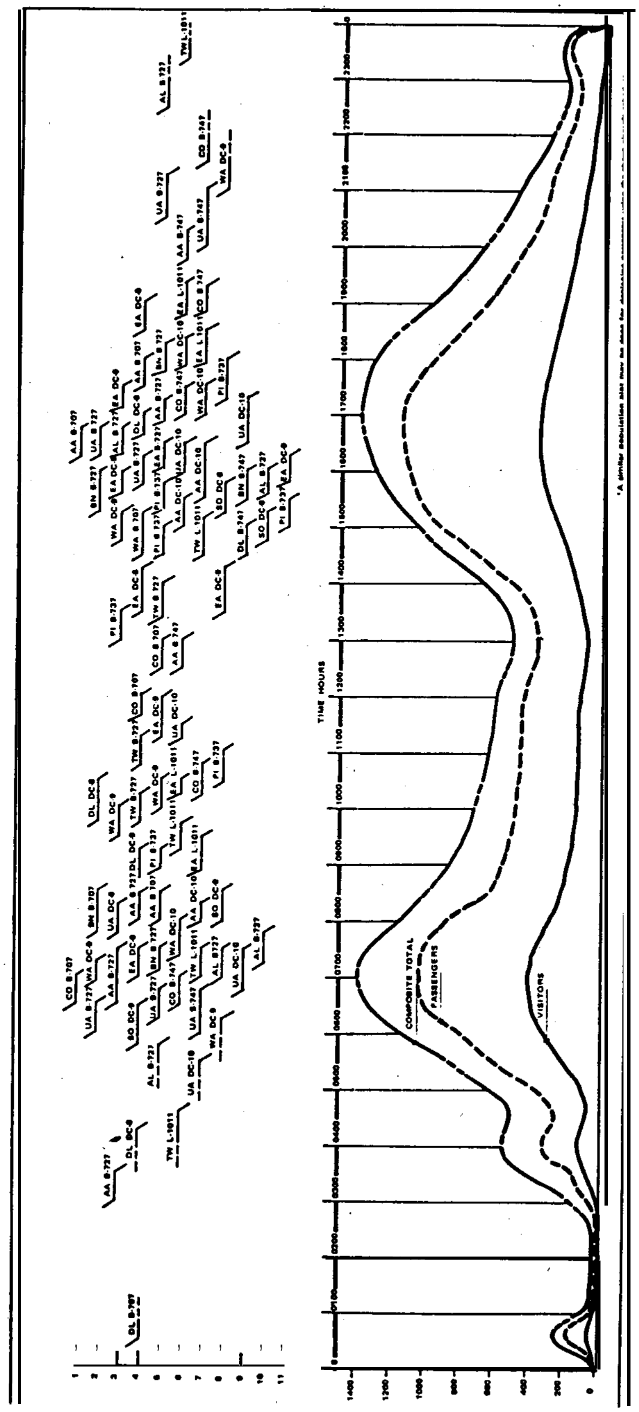


Figure 2-l. Hypothetical Aircraft Schedule and Arriving Passenger/Visitor Population Plot

b. Historical Peaking Factors.

(1) In lieu of developing a detailed design day activity analysis as discussed in the preceding paragraph, a simple method of estimating peak hour demand involves the use of the most recent data on peak hour demands at the airport under study. This information can be obtained from airline records of hourly enplanements and deplanements (total passengers) during the most recent peak month. If such information is not available, current data can be collected for a minimum 2-week period and then adjusted upward proportionately to correspond with the most recent peak month activity. From an analysis of the hourly counts obtained, a typical peak hour level of activity can be selected. This peak hour/peak month count can then be converted to a percentage (peaking factor) of the current ADPM enplanements. The peaking factor is then multiplied by the design year ADPM to arrive at a total passenger peak hour forecast for the design year.

(2) The peaking factor methodology requires judgment in application. Studies have shown that, with an increasing total passenger volume, the peak hour percentage decreases, since the peaks tend to spread out more over a day. Accordingly, a downward adjustment to the design peak hour count may be appropriate. This methodology is less accurate than the hypothetical design day activity (HDDA) method; The HDDA procedure is highly sensitive to passenger surges occurring in time increments of less than one hour (e.g., ticket counters, baggage systems, etc.). It also may be insensitive to the peaking conditions created by the future introduction of larger aircraft service which, in all likelihood, will be scheduled during peak hours.

c. Peaking Graphs. Peaking graphs have been developed for the purpose of making order-of-magnitude estimates of passenger and aircraft activity. ***They are not satisfactory for design and/or detailed analyses of a particular airport.*** Each has been developed largely by examining data from a number of airports and are representative of "averages." They ***do not*** represent an average condition for an individual airport and should not be used as such.

(1) Figure 2-2 provides a rough estimate of the percentage of peak day aircraft operations to be expected in the busiest hour of the day. The curve was developed from airline schedules. Airports with substantial international, tourist, and long-haul traffic often exhibit unusually high peak hour activity. Conversely, those with a large proportion of short-haul traffic and those with runway or gate capacity restrictions have less sharply defined peaks.

(2) The information shown in Figure 2-3 relates passenger peaking factors to annual enplaned passengers. Passenger peaking more or less parallels aircraft activity. However, passenger peaks may be more sharply defined than aircraft peaks because larger-than-average aircraft are introduced in prime times. The values shown were developed largely from reported passenger volumes, supplemented with' values derived from aircraft operations at smaller airports.

(3) Figure 2-4 presents peak hour operations related to annual enplaned passengers. Shown are an average relationship based on 1975 schedules and one based on IO-year projected increases in average fleet seating and load factors. Since terminal development is generally sized for a forecasted passenger volume, it is important that changes in the average fleet size be considered.

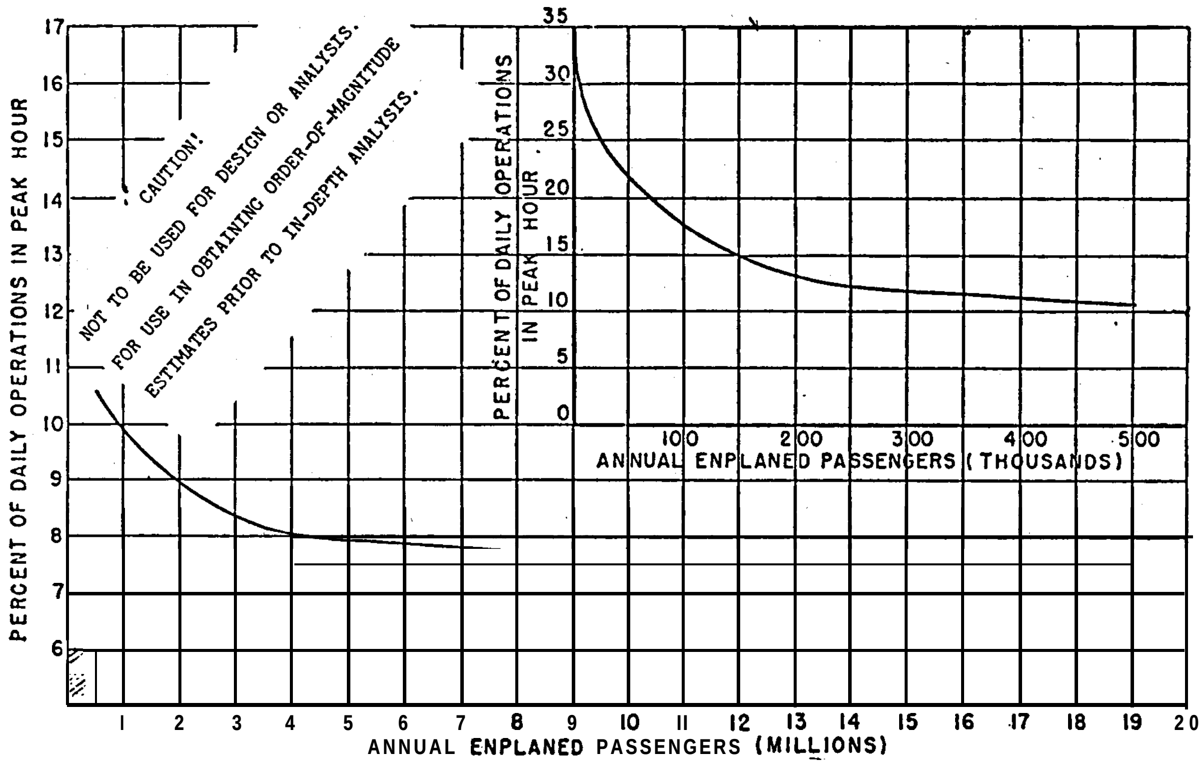


Figure 2-2. Percent of Daily Operations in Peak Hour vs. Annual **Enplaned** Passengers

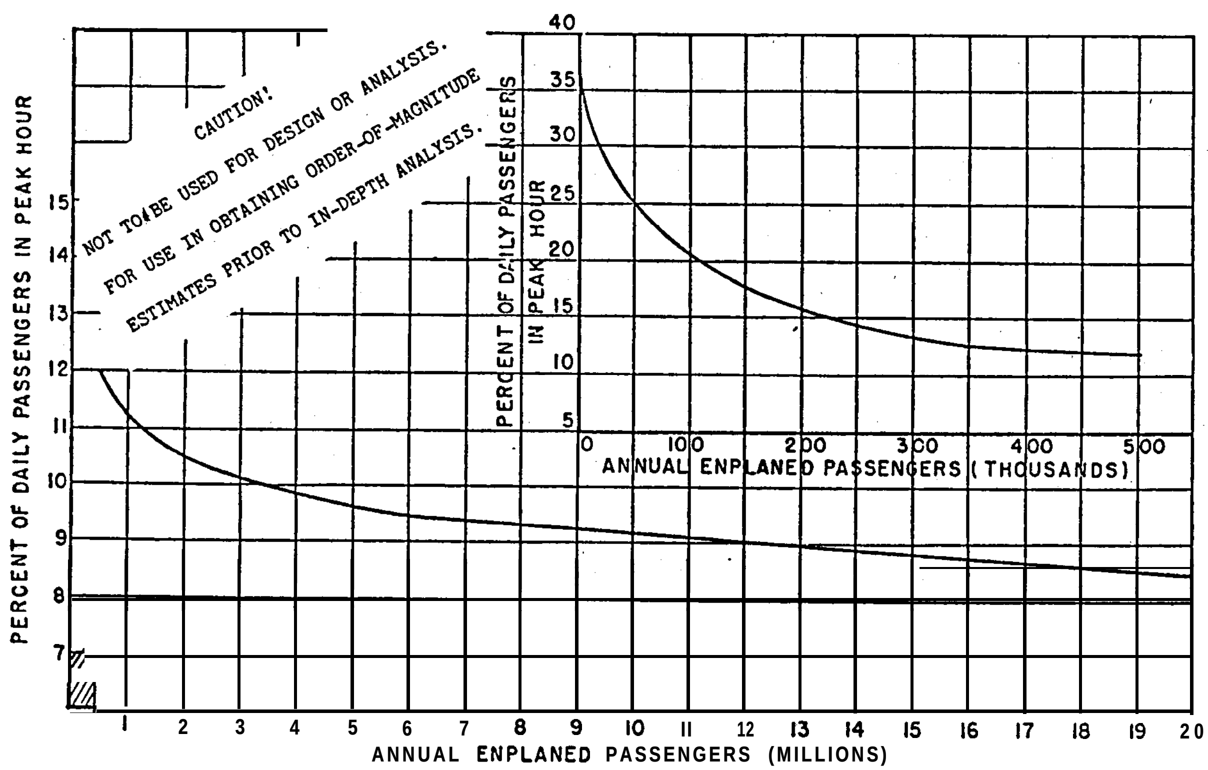


Figure 2-3. Percent of Daily Passengers in Peak Hour vs. Annual **Enplaned** Passengers

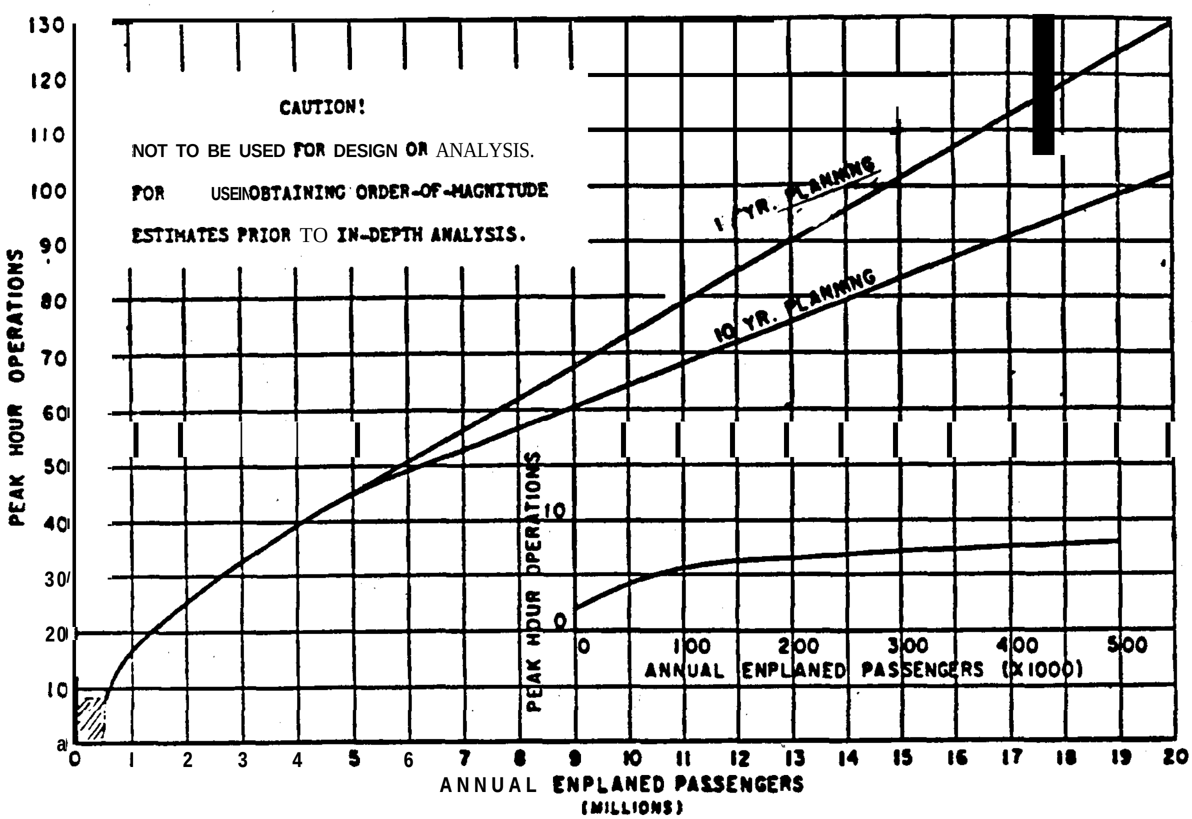


Figure 2-J. **Estimated Peak Hour Operations** vs. **Annual Enplaned Passengers**

d. Rules-of-Thumb. In the absence of historical data, the rules-of-thumb discussed in the following paragraphs may be used for roughly estimating activity levels. Their use should be similar to the "peaking" graphs, that is, they are ***not intended*** for a detailed design analysis of an individual report.

(1) Either peak hour enplaned or deplaned passengers may be assumed to represent approximately 60 to 70 percent of the total peak hour passengers.

(2) Peak month passengers may be approximated as 10 percent of the annual passengers.

(3) Average day-peak month aircraft operations may be estimated as 1.05 times the average daily activity for the year.

25. EQUIVALENT AIRCRAFT (EQA) FACTORS.

a. The sizing of most terminal elements is based on passenger volumes for a selected design hour or some part thereof--enplanements, deplanements, peak 20 minutes, etc. However, forecasts of these activities are not always readily available. When they are not, approximations can be developed by considering aircraft seating capacities, as estimated for the peak hour of the average day-peak month. Applying EQA factors, which represent the aircraft's passenger capacity (seats divided by 100) is useful in estimating the impact of future growth on various terminal components.

b. The EQA methodology is based on aircraft movements as the primary generators of passenger flows. The magnitude of each flow is related to aircraft seating capacities and load factors. However, average seats per aircraft movement increase in future years, often with larger aircraft being introduced first during peaks for prime time flights. Accordingly, it is reasonable to assume that boarding load factors and gate utilization will also increase in the future.

c. The EQA technique provides a common denominator for numbers of gates and aircraft seats useful for sizing terminal components and evaluating capacities in airport master planning. Specific sizing applicationsof EQA in this document include airline ticket office, ticket counter frontage areas, baggage areas, lobbies, departure lounges, etc., and are discussed in Chapter 5.

d. Tables and charts provided in this documentation for use in obtaining terminal facility sizing approximations require a knowledge of the following EQA factors: Base Year,Total Gate EQA, Future Total Gate EQA; and, EQA Arrivals. The methods for calculating these factors are discussed in following paragraphs.

26. BASE YEAR TOTAL GATE EQA. To obtain this value, identify the appropriate category of aircraft seating capacity for each active gate position. Note that the number of base year active gate positions may be greater or less than the number of actual gates. Consistent double parking of aircraft at one gate should count as two active gate positions. Conversely, a new terminal facility may not have all its gates "active." Multiply the total number in each category by the appropriate EQA Conversion Factor, and sum the results. Table 2-l illustrates this computation.

Table 2-1. Bsse Year Total Gate EQA Computation

Aircraft Seating Capacity	No. of Active Positions	EQA Conversion Factor [1]	GATE EQA	Aircraft Type
421 to 500	__	4.8	= __	B747 (high dens./stretch)
341 to 420	__	3.9	= __	B747
281 to 340	__	3.4	= __	DC-10/L1011 (high dens./stretch)
221 to 280	__	2.7	= __	B747-SP/DC-10/L1011
161 to 220	__	2.0	= __	DC-8-61/A300/B767/B757
111 to 160	__	1.4	= __	DC-8/B707/B727-200/DC-9-50
81 to 110	__	1.0	= __	B737/DC-9-30/BAE-146-100&200
61 to 80	__	0.7	= __	DC-9-10/BAC-111
1 to 60	__	0.5	= __	CV-580/DHC-7/SD3-30&60/F-227/F-28
Base Year Total = GATE EQA				

[1] When actual seating is known, divide the number by 100 to determine the EQA Factor.

27. FUTURE TOTAL GATE EQA. To compute a future design year Total Gate EQA, it is first necessary to know the forecasted peak hour ADPM movements for each aircraft type (based on seating capacities). This information can either be obtained from ATA Airline Airport Demand Forecast Reports or from master planning studies, as appropriate. Additionally, the total number of forecast aircraft gates for the future design year must be known or calculated (see paragraph 43). To determine Future Total Gate EQA, first allocate future gates at one per peak hour movement for all seating capacity aircraft categories above 160. Then, proportionately allocate the remaining gates among the remaining categories. (Note that in the case where peak hour utilization is less than 1.0, the additional number of gates in excess of the peak hour movements are to be added to the aircraft groups with seating capacity > 160.) Then, multiply the number of gates by the EQA Conversion Factor for each aircraft seating group and add the products. Table 2-2 depicts a sample calculation.

Table 2-2. Sample — Future Design Year Total Gate EQA Computation

[Design Year — 1995; Forecast Gates — 21 [1]

A/C Seating Capacity	1995 Per Hr ADPM Movements [2]	No. Gates [3]		EQA Conv. Factor [4]	Gate EQA
421 to 500	—	—		—	—
341 to 420	—	—		—	—
281 to 340	1	[illegible]	x	3.4	3.4
221 to 280	4	[illegible]	x	2.7	10.8
161 to 220	3	[illegible]	x	2.0	6.0
111 to 160	9	[illegible]	x	1.4	9.8
81 to 110	6	[illegible]	x	1.0	4.0
61 to 80	3	2	x	0.7	1.4
1 to 60	—	—		—	—
Total............................	26	21			[5] 35.4

[1] See paragraph 43.
[2] Source: ATA Airline Airport Demand Forecast.
[3] Allocate one gate per movement for seating capacity categories > 160 and then allocate remaining gates proportionally to equal total of 21 gates.
[4] Use actual conversion factors when available (seating capacity divided by 100).
[5] Total Gate EQA for 1995.

28. EQA Arrivals. The term "EQA Arrivals" is synonymous with "EQA Inbound" and is used primarily for sizing baggage claim facilities. Passenger aircraft arrivals in periods of peak 20 minutes are the basis for these calculations. This can be approximated by assuming that 50 percent of the total gates are used in those periods for arriving aircraft. To determine EQA Inbound, allocate projected design year gates beginning with the largest aircraft until 50 percent of the gates are used. (This will ensure adequate facilities for the highest potential peak 20 minute passenger load.) The number of gates occupied by each aircraft type is then. multiplied by the appropriate EQA Conversion Factor and the sum of these products is the EQA Inbound.

29. FORECAST REASONABILITY CHECKS. Activity forecasts and variables which influence sizing should be examined for reasonability. The following are key examples:

a. Passenger Traffic Growth (Scheduled Operations). Local airport growth should be compared against that forecast for the U.S. domestic market.

b. Ratio of Originating Passengers to Total Enplanements. Assumptions used in forecasting a change to the current ration should be explained. This information is particularly important for planning auto parking facilities, curb lengths, airline counters, and baggage claim areas.

c. Boarding Load Factor. The number of boarding passengers versus available seats should be compared. Any ADPM load factors outside the range of 55 percent to 60 percent should be reviewed with the airlines. Peak hour average load factors may be 15 to 25 percentage points higher.

d. Aircraft Growth Trends. Projected growth in aircraft seating capacities should be compared with boarding load factors.

e. Gate Utilization. Existing and forecast annual enplanements per gate and daily arrivals per gate should be identified and checked for reasonableness of any projected change.

f. Aircraft Movements. Peak hourly operations as a percent of daily operations for ADPM should be verified. Forecast changes up or down from the existing ratio, should be explained, recognizing that the ratio of peak hourly to daily operations tends to decline as traffic increases. The relationship between peak hourly passengers and daily passengers may not follow an identical trend, since larger aircraft are usually introduced into prime time or peak periods.

g. Nonscheduled Operation& The forecast ratio of passengers carried in nonscheduled operations versus those for scheduled service should be reviewed. Separate statistics should be kept when existing volumes or forecast growth represent a significant percentage of total operations. Assumptions used in forecast-. ing a significant impact of nonscheduled traffic growth in terminal operations or in proposing separate facilities to accommodate this growth should be explained.

h. Number of Scheduled Carriers. Assumptions for any anticipated increase or decrease in the number of carriers require an explanation. The facilities needed by four airlines to serve 100,000 domestic enplanements will usually be more than those for two or three carriers handling the same volume.

30. RESERVED.

CHAPTER 3. FUNCTIONAL RELATIONSHIPS AND TERMINAL CONCEPTS

31. **MAJOR TERMINAL COMPONENTS.** The terminal complex functions as an area of interchange between ground and air transportation modes. To accomplish this interchange, the following major components are required:

a. Apron. The apron comprises the area and facilities used for aircraft gate parking and aircraft support and servicing operations. It includes the following sub-components:

(1) Aircraft Gate Parking Positions--used for parking aircraft to enplane and deplane passengers. The passenger boarding device is part of the gate position.

(2) Aircraft Service Areas--on or adjacent to an aircraft parking position. They are used by airline personnel/equipment for servicing aircraft and the staging of baggage, freight, and mail for loading and unloading of aircraft.

(3) Taxilanes--reserved to provide taxiing aircraft with access to and from parking positions.

(4) Service/Fire Lanes--identified rights-of-way on the apron designated for aircraft ground service vehicles and tire equipment.

b. Connector. The connector consists of the structure(s) and/or facilities normally located between the aircraft gate position and the main terminal building. At low activity airports, i.e., less than approximately 200,000 annual enplaned passengers, this component is often combined with'the terminal building component. It normally contains the following elements:

(1) Concourse--a passageway for circulation between aircraft gate parking positions and the main terminal building.

(2) Departure Lounge--an area for assembling and holding passengers prior to a flight departure. In some instances, it may be a mobile'lounge also used to transport passengers to a parked aircraft.

(3) Security Inspection Station--a control point for passenger and baggage inspection and controlling public access to parked aircraft.

(4) Airline Operational Areas--areas set aside for airline personnel, equipment, and servicing activities related to aircraft arrivals and departures.

(5) Passenger Amenities--areas normally provided in both the connector as well as the terminal components, particularly at the busier airports with relatively long connectors. These amenities include rest rooms, snack bars, beverage lounges, and other concessions and passenger services.

(6) Building Maintenance and Utilities--areas often included in the connector component to provide terminal building maintenance and utilities.

c. Main Terminal Building. The following elements comprise this component:

(1) Lobbies--public areas for passenger circulation, services, and passenger/visitor waiting.

(2) Airline Ticket Counters/Office Areas--areas required for ticket transactions, baggage check-in, flight information, and administrative backup.

(3) Public Circulation Areas--areas for general circulation which include stairways, escalators, elevators, and corridors.

(4) Terminal Services--facilities, both public and nonpublic, which provide services incidental to aircraft flight operations. These facilities include rest rooms, restaurants and concessions, food preparation and storage areas, truck service docks, and miscellaneous storage.

(5) Outbound Baggage Facility--a nonpublic area for sorting and processing baggage for departing flights.

(6) Intraline and Interline Baggage Facility--a nonpublic area for processing baggage transferred from one flight to another.

(7) Inbound Baggage Facility-La nonpublic area for receiving baggage from an arriving flight and public areas for baggage pickup by arriving passengers.

(8) Federal Inspection Services--a control point for processing passengers arriving on international flights.

(9) Airport Administration and Services--areas set aside for airport management, operations, and maintenance functions.

d. Airport Access System. This component is composed of the functional elements which enable ground ingress and egress to and from the airport terminal facility. They include the following:

(1) Curb--platforms and curb areas (including median strips) which provide passengers and visitors with vehicle loading and unloading areas adjacent to the terminal.

(2) Pedestrian Walkways--designated lanes and walkways for crossing airport roads, including tunnels and bridges which provide access between auto parking areas and the terminal.

(3) Auto Parking--areas providing short-term and long-term parking for passengers, visitors, employees, and car rental.

(4) Access Roads--vehicular roadways providing access to the terminal curb, public and employee parking, and to the community roadway/highway system.

(5) Service Roads--public and nonpublic roadways and fire lanes providing access to various sub-elements of the terminal and other airport facilities, such as air freight, fuel tank stands, postal facility, and the like.

32. FUNCTIONAL RELATIONSHIPS OF TERMINAL COMPONENTS.

a. Activities within the terminal building can be categorized primarily into three functional areas: processing and servicing passengers; handling and processing of belly cargo (including passenger baggage); and, aircraft servicing. Consequently, a good terminal design necessitates a layout in which the various components are located in a sequence or pattern which coincides with the natural movement and services each requires, and those activities and operations which are functionally dependent on each other. Such a design will minimize passenger walking distances, airline servicing and processing times, and congestion caused by the intermingling of nonrelated activities.

b. Figure 3-l presents the usual functional components of a typical terminal from curb to aircraft parking apron in terms of sequence of flow. For simplicity, only two relationships are used in the figure; that in which functional adjacency is essential for good design; and that in which it is merely recommended. The relationships, although graphically depicted in a single plane, apply equally to multilevel terminals. It should not be implied that every terminal should provide for all of the functions shown or that each function must have has an individually defined area. For example, at low activity airports, one general space may suffice for multiple functions, such as a combined lobby, ticket counter area, and waiting lounge. Figure 3-2 shows these same functional adjacency relationships in a matrix format.

33. OBJECTIVES IN SELECTING TERMINAL CONCEPTS.

a. The objective of the terminal area plan should be to achieve an acceptable balance between passenger convenience, operating efficiency, facility investment, and aesthetics. The physical and psychological comfort characteristics of the terminal area should afford the passenger an orderly and convenient progress from an automobile or public transportation through the terminal to the aircraft and vice versa. Some of the objectives to be considered in the development of a terminal area plan are minimum walking distance, convenient auto parking, and convenient movement of passengers through the terminal complex. Conveyances such as moving walks and automated baggage handling systems should be considered for high volume airports.

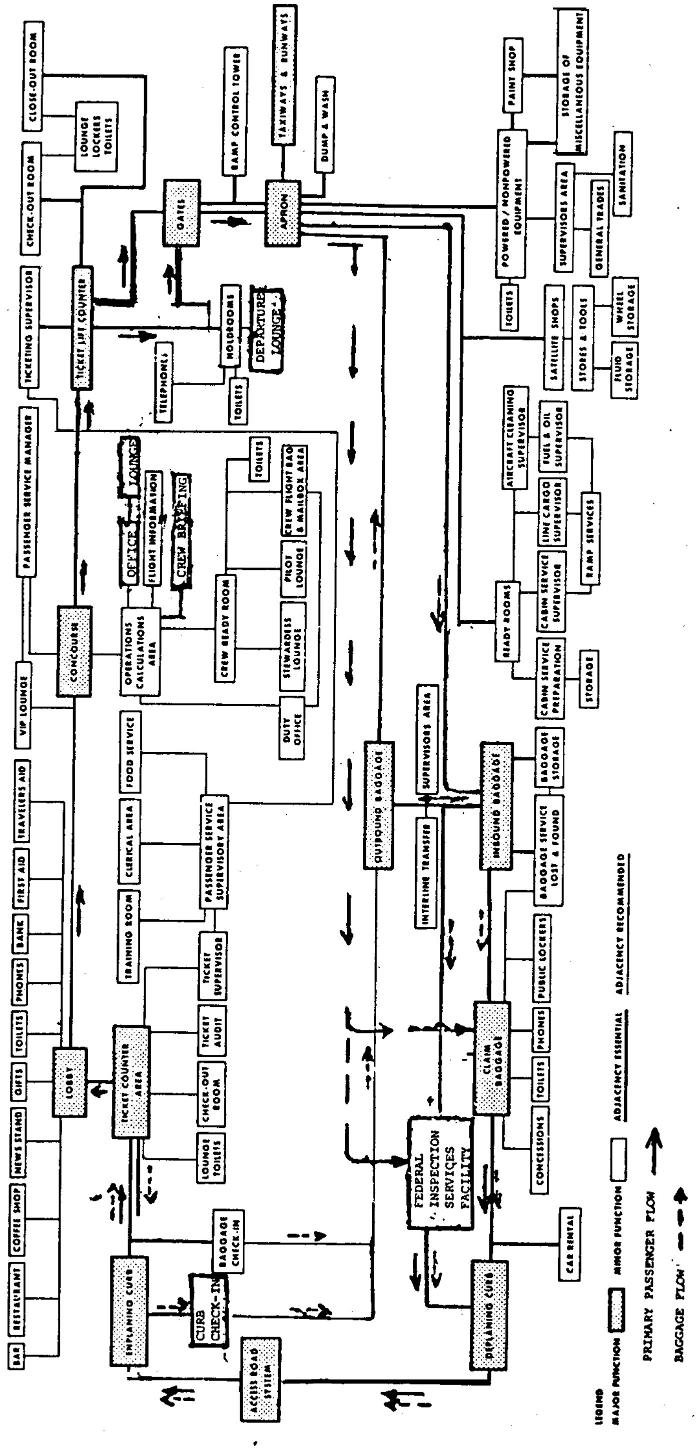


Figure 3-1. Functional Adjacency Diagram

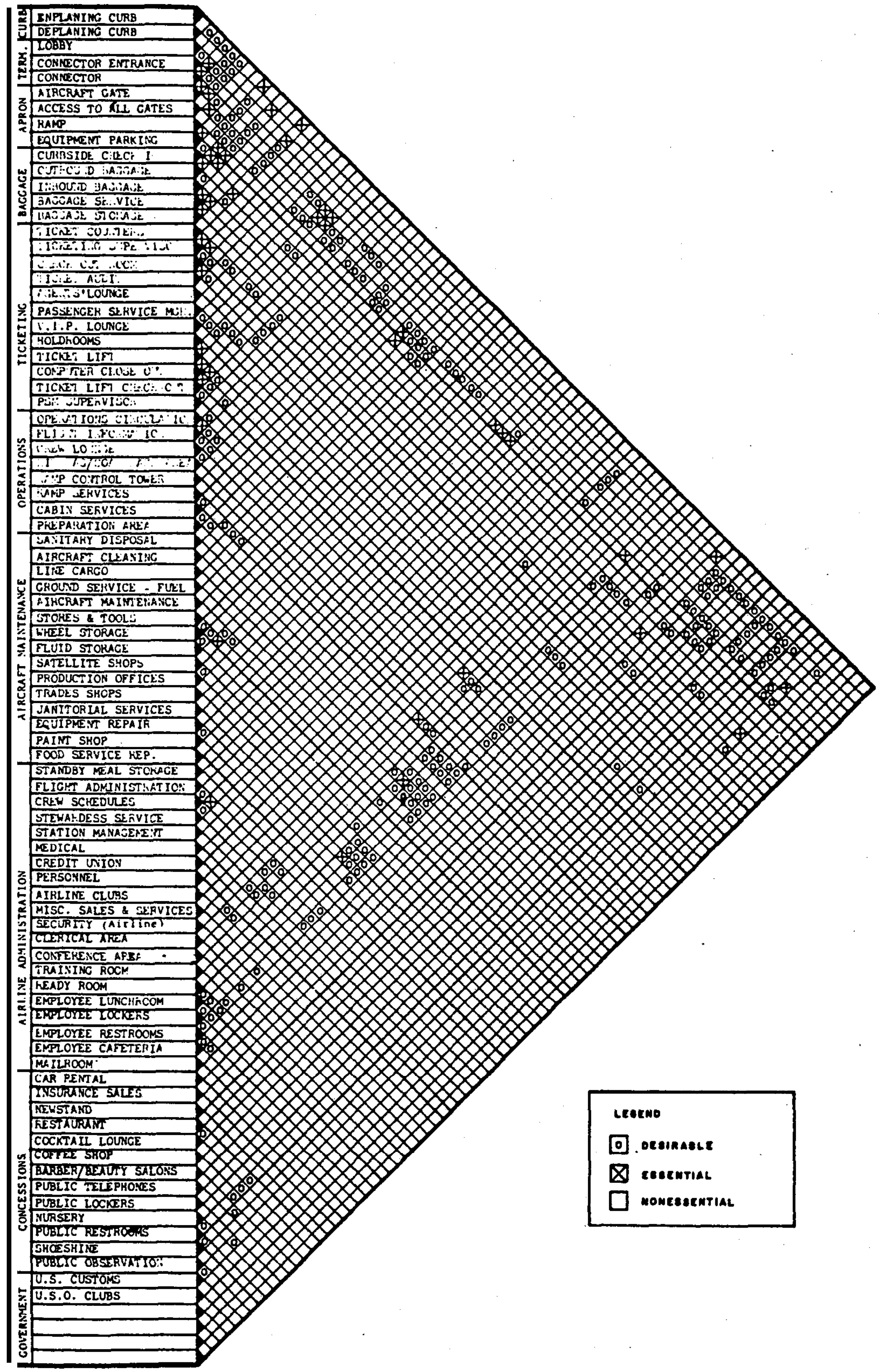


Figure 3-2. Functional Adjacency Matrix

b. The terminal complex's functional arrangement should be flexible enough for expeditiously handling passengers and ground-servicing aircraft to achieve minimum gate occupancy time and maximum airline operating economy. The ultimate plan should strive to meet these objectives within acceptable funding levels while considering not only capital investment but also maintenance and operating costs. Regardless of the scheme selected, the importance of complete planning flexibility to permit expansion both horizontally and vertically at minimum cost and with as little interference as possible to existing facilities cannot be overemphasized.

34. CENTRALIZED AND UNIT **TERMINALS.** There are two basic concepts for the arrangement of the terminal area. In a centralized terminal, all passengers and baggage are processed in one building. Most airports utilize this arrangement. At some high activity airports, however, each airline (or several airlines combined) may be located in a separate terminal building. This is referred to as a unit terminal concept. These two design concepts are often combined in varying degrees. Examples of airports having a unit terminal concept include John F. Kennedy International, Kansas City International, and Dallas-Ft.Worth Regional airports. A single centralized terminal building has many advantages and for most situations is preferable. It represents a reasonably compact operation without the significant problem of transferring passengers and baggage between buildings. Building maintenance and operating costs for the centralized terminal will generally be significantly lower than the total costs for operating all unit terminals. A unit terminal concept can be justified only at the very high activity airports, particularly where the percentage of airline transfer passengers is relatively low. An efficient transportation system for passenger and baggage transfer between buildings is a must and should be incorporated in the design at an early stage.

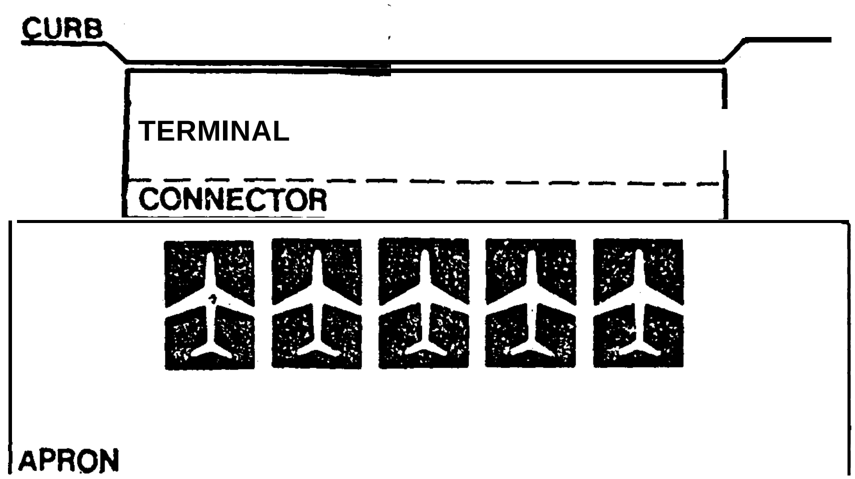
35. ALTERNATIVE TERMINAL BUILDING CONCEPTS. A terminal building design can be categorized as one of five basic concepts or a variation or combination of them. The connector is the single element that distinguishes between the various concepts, since it is different in each case. Terminal building concepts are categorized in the following manner:

a. Simple Terminal Concept. The simple terminal consists of a single common waiting and ticketing area with exits leading to the aircraft parking apron. It is suitable at airports with low airline activity with an apron providing close-in parking for three to six commercial transport aircraft. A simple terminal normally consists of a single level structure with two to four gates with access to aircraft by walking across the aircraft parking apron. The layout of the simple terminal should take into account the possibility of pier or linear extensions for terminal expansion.

b. Linear Concept. In the linear concept (Figure 3-3), aircraft are parked along the face of the terminal building. Concourses connect the various terminal functions with the aircraft gate positions. This concept offers ease of access and relatively short walking distances if passengers are delivered to a point near gate departure by vehicular circulation systems. Expansion may be accomplished by linear extension of an existing structure or by developing two or more linear-terminal units with connectors.

c. Pier Concept. The pier concept (Figure 3-4) provides interface with aircraft along piers extending from the main terminal area. In the pier concept, aircraft are usually arranged around the axis of the pier in a parallel or perpendicular parked relationship. Each pier has a row of aircraft gate positions on both sides, with the passenger right-of-way or concourse running along the axis of the pier and serving as the circulation space for enplaning and deplaning passengers. Access to the terminal area is at the base of the connector (pier). If two or more piers are used, spacing for aircraft maneuvering between the piers by means of an apron taxilane(as discussed in paragraph 46, is required.

d. Satellite Concept. The satellite concept (Figure 3-5) consists of a building, surrounded by aircraft, which is separated from the terminal and usually reached by a surface, underground, or above-grade connector. Aircraft are normally parked in radial or parallel positions around the satellite. The satellite can have common or separate departure lounges. Since enplaning and deplaning of aircraft are accomplished from a common area, mechanical systems may be employed to transport passengers and baggage between the terminal and satellite.



THE LINEAR CONNECTOR MAY CONSIST OF ONE OR BOTH OF THE FOLLOWING:

— A CONCOURSE, ENCLOSED AT THE FIRST OR SECOND LEVEL, CONNECTING TO THE TERMINAL ALONG A LINE OF PARKED AIRCRAFT WITH ACCESS TO THESE AIRCRAFT AT THE AIRCRAFT GATE POSITIONS

— A CONCOURSE CONNECTING TICKET POSITIONS, BAGGAGE CLAIM AREAS, ETC.

NOTE: DEPARTURE LOUNGES, CONCOURSE RELATED TO FUNCTIONAL AREAS.

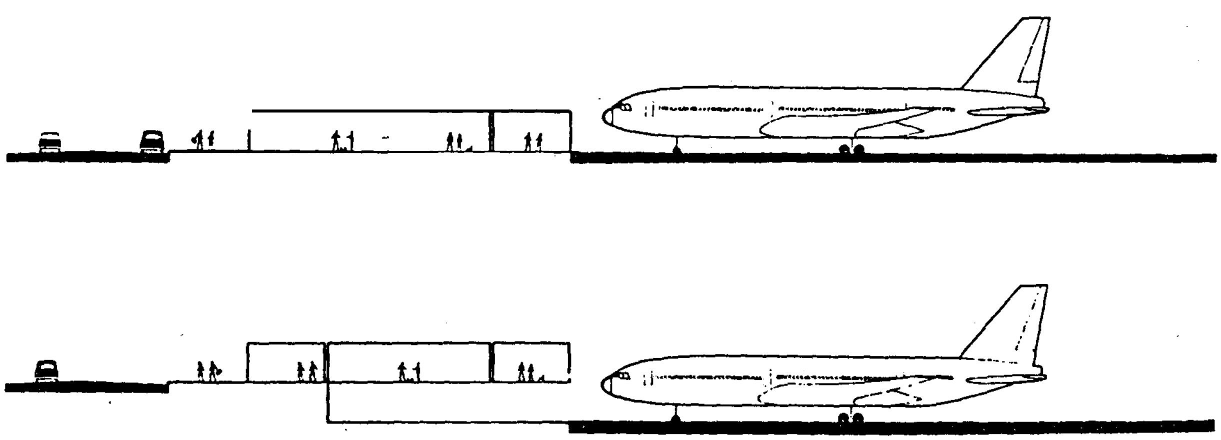


Figure 3-3. Tbe Linear Concept

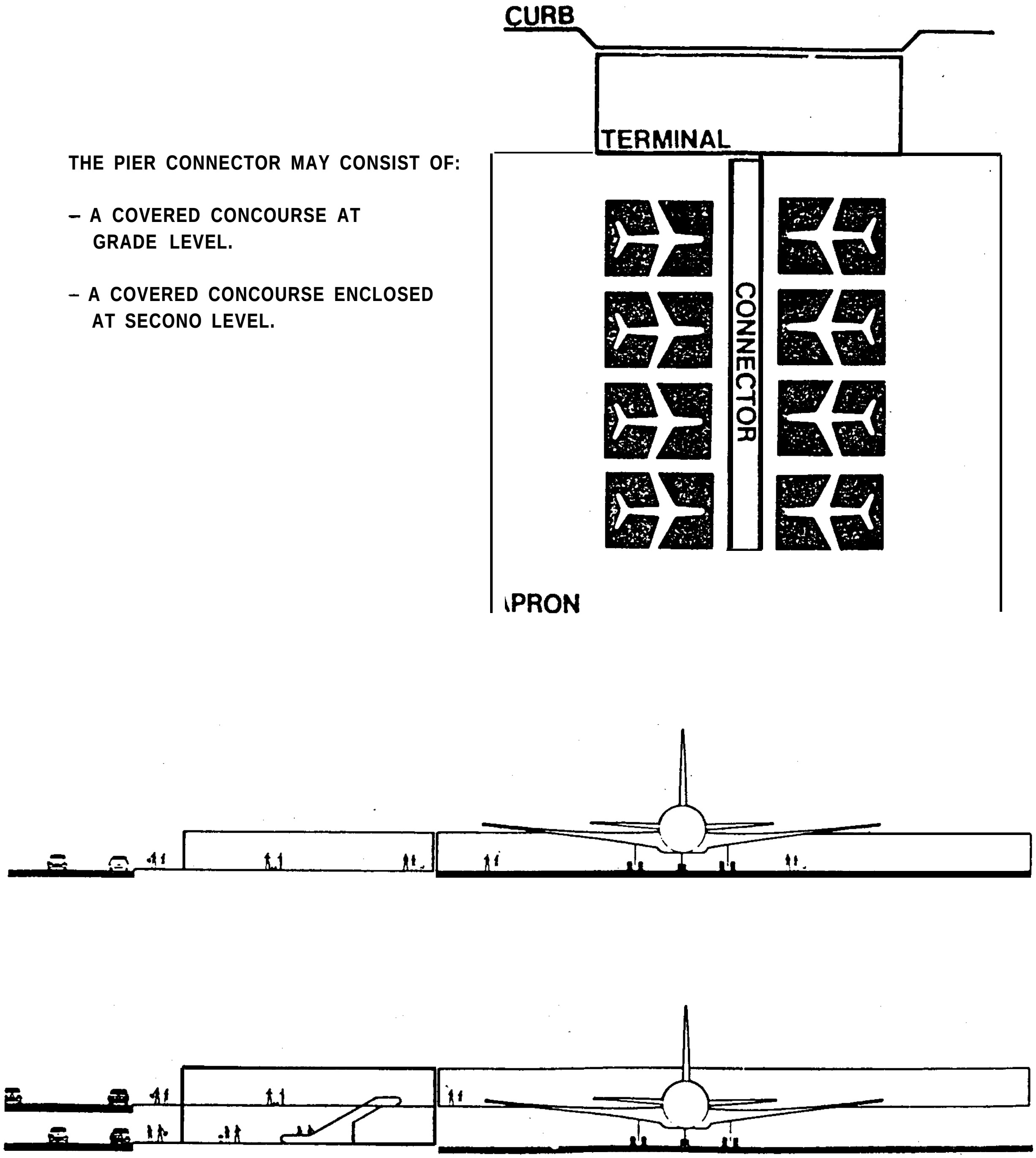
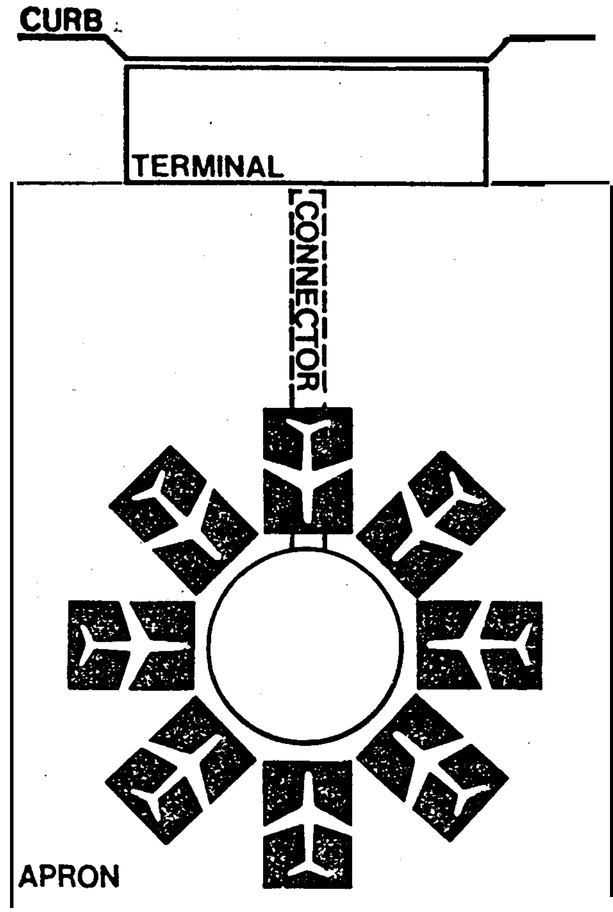


Figure 3-4. The Pier Concept

THE SATELLITE CONNECTOR MAY CONSIST OF:

- A CONCOURSE BELOW, AT OR ABOVE GRAOE CONNECTING THE SATELLITE **BUILDING** WITH THE TERMINAL.



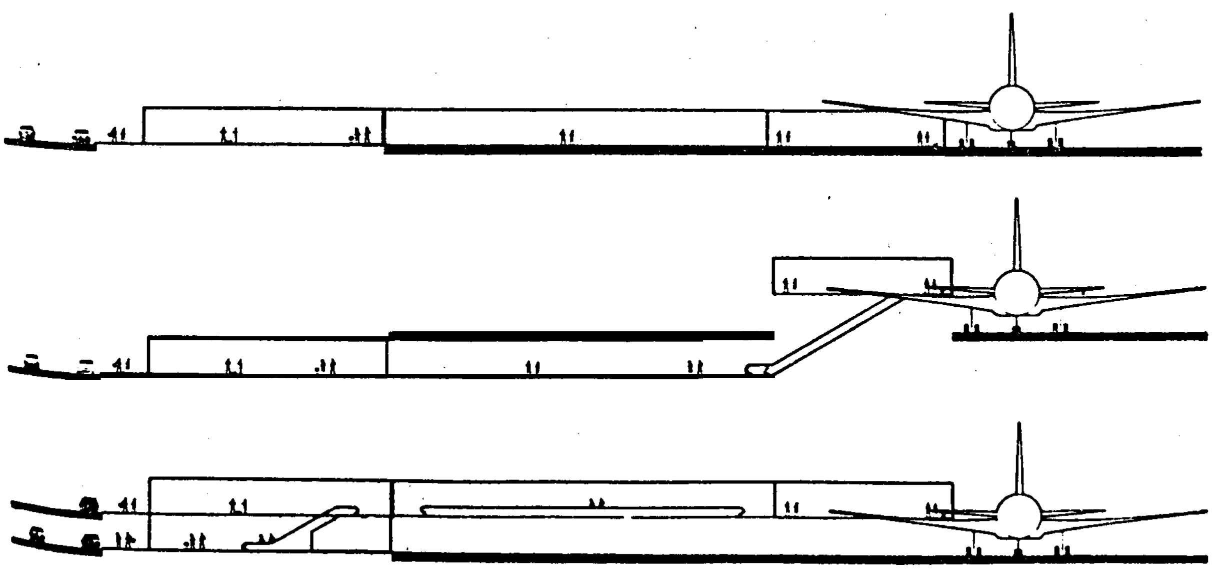


Figure 3-5. The Satellite Concept

e. Transporter Concept. Aircraft and aircraft-servicing functions in the transporter concept (Figure 3-6) are remotely located from the terminal. The connection to the terminal is provided by vehicular transport. The advantages of the transporter concept include flexibility in providing additional aircraft parking positions to accommodate increases in schedules; ease and speed in maneuvering aircraft in and out of parking positions under their own power; separation of aircraft servicing activities from the terminal; and reduced walking distances for passengers. Transporters may also be used in establishing remote gates for charter flights. The disadvantages mainly relate to the initial, operational, and maintenance costs associated with the transporter vehicles, although the increased transfer times required in changing airplanes can also be detrimental to airport efficiency.

36. SINGLE-LEVEL/MULTILEVEL TERMINALS. The decision on whether the terminal building design should incorporate single or multilevels for processing passengers and baggage is influenced primarily by the volume of traffic. Variations of these designs are shown in the bottom elevations depicted on Figures 3-3 through 3-6 and are discussed as follows:

a. Single-level Terminal. The single level terminal is the preferred design at the majority of small and nonhub airports. The processing of passengers and baggage takes place at the same level as the apron, and the entire layout is quite simple and economical.

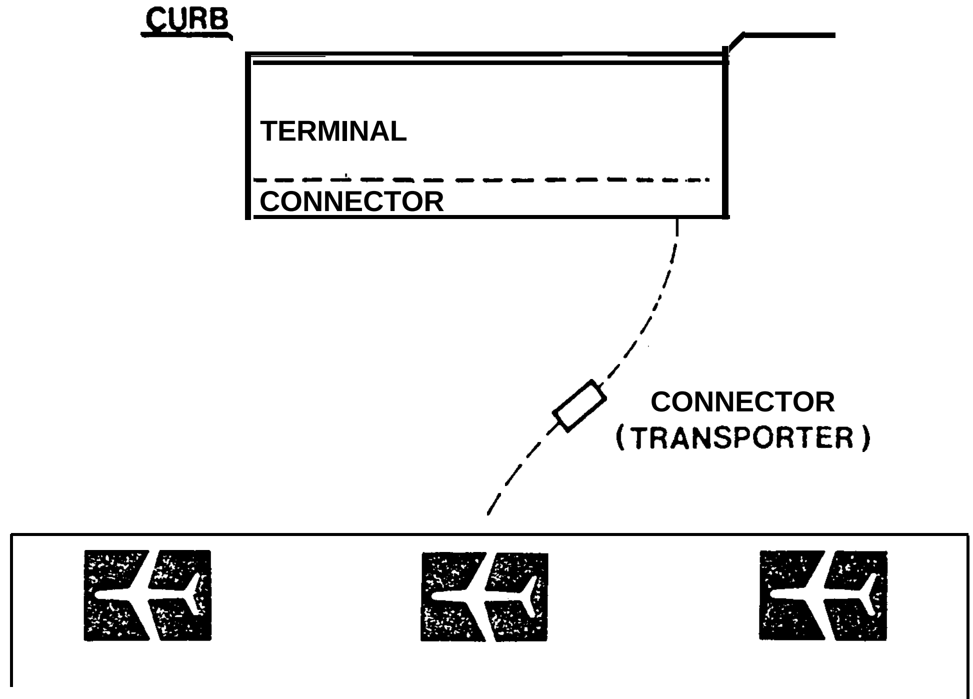
b. Multilevel Terminal. At a traffic level of over 500,000 annual enplaned passengers, structures of more than one story should be investigated. In this concept, arriving and departing passengers are vertically separated. Enplaning passengers are usually processed on the upper level and deplaning passengers on the lower level. The fingers or piers leading to the aircraft are usually two stories, whereas, the terminal enplaning and deplaning curbs may be on single or multilevels, as discussed in the following paragraph. The principal advantage of a multilevel terminal is the reduction of congestion by segregating opposing flows of passengers and baggage. The disadvantages are the higher initial investment and the continuing higher operation and maintenance costs. In evaluating the design of a multilevel terminal, the physical limitations of the site, terrain, and airline station characteristics are important considerations.

c. Multilevel Curbs. While single level curbs may be utilized with all concepts and traffic volumes, multilevel curbs are appropriate only at multilevel terminals. Construction of multilevel curbs should be considered when passenger volumes exceed one million enplanements or when physical limitations within the terminal area or building frontage make curb separation desirable. Multilevel curbs, with their corresponding structural roads and ramps, are costly to construct and should be considered only after investigation of single-level alternatives.

d. Second Level Aircraft Boarding. Boarding and deplaning aircraft from the second story is the usual procedure at multilevel terminals for reasons of simplicity and efficiency, unless limited by terrain features. Conversely, for the same reasons, apron-level boarding is the norm for single-level terminals. However, severe or extreme weather conditions, or other considerations, may justify second-level boarding at a single-level terminal. In such cases, two story connectors, raised pier structures, or inclined loading bridges can be utilized. Airports with over 500,000 annual enplanements are candidates for second-level boarding installations. In some situations, a combination of apron and second-level boarding gates may be a desirable alternative.

37. TERMINAL CONCEPT COMBINATIONS AND VARIATIONS.

a. Combinations and variations of terminal concepts often result from the changing conditions experienced at an airport during its lifespan. An -airport may have many types of passenger activity, varying from originating and terminating passengers using the full range of terminal services to passengers using limited services on commuter flights. The predominant type of activity usually affects the initial terminal concept selected. In time, the amount of traffic may increase, necessitating modification or expansion of the facilities. Growth of aircraft size, a new combination of aircraft types serving the airport, or a change in the type of service may affect the suitability of the initial concept. Similarly, physical limitations of the site may cause a pure conceptual form to be modified by additions or combinations of other concepts.



THE TRANSPORTER CONNECTOR MAY CONSIST OF:

- A NON-ELEVATING VEHICLE THAT PERMITS ENPLANING AND DEPLANING AT APRON LEVEL AT THE AIRCRAFT AND AT THE TERMINAL.

- AN ELEVATING VEHICLE THAT PERMITS DIRECT ENPLANING AND DEPLANING TO THE AIRCRAFT AND TERMINAL BY MOVING THE PASSENGER CAB VERTICALLY TO MATCH ENTRANCE LEVELS AT THE AIRCRAFT AND TERMINAL

- (DOTTED) A SECONOARY CONCOURSE CONNECTING TRANSPORTER POSITIONS.

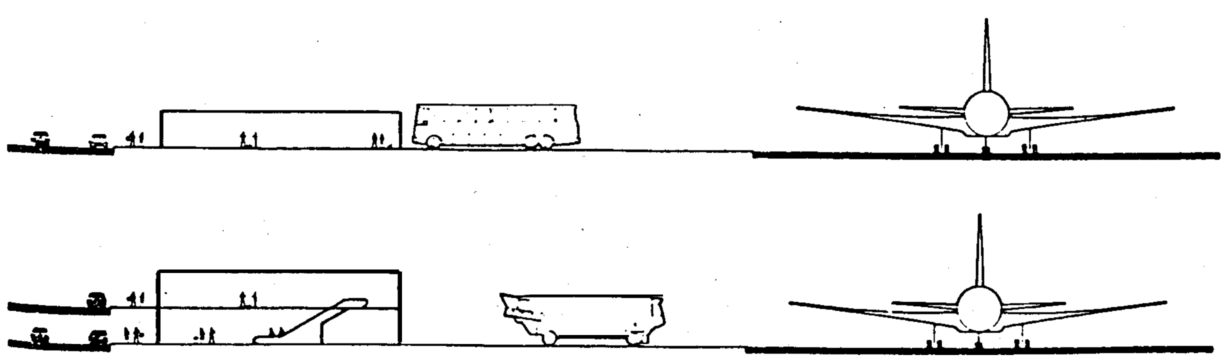


Figure 3-6. The Transporter Concept

b. Combined concepts acquire some of the advantages and disadvantages of each basic concept used. A combination of concept types can be advantageous where more costly modifications would be necessary to maintain the original concept. For example, while an airline may be suitably accommodated within an existing transporter concept terminal, a commuter operation with rapid turnovers is best served by a linear concept extension. In this case, concept combination is desirable. Thus, the appearance of concept variations and combinations in a total apron-terminal plan may reflect an evolving situation in which altering needs, growth, or physical limitations have determined the final terminal configuration. Figure 3-7 depicts concept combinations and variations typically utilized in airport terminal designs.

38. CONCEPT EVALUATION. Particularly at high activity'locations, a thorough analysis of the type of terminal concept to be utilized at an airport should be conducted before a final decision is made. Initial evaluation efforts should narrow the choices down to two or more alternative schemes before development of preliminary layouts and drawings. The final choice should be made only after indepth analyses are completed. Quantifiable aspects of each concept (walking distances, areas required, etc.) should be compared; efficiency studies of passenger and aircraft flows, ground vehicular movements, and operational/functional sequences conducted; and cost estimates made. At very high activity airports with complex inter-relationships, the application of simulation techniques may be warranted. Some of the principal factors which should be considered in the overall evaluation of alternatives are discussed in following paragraphs. A more thorough discussion on concept evaluation may be found in Report No. FAA-RD-73-82, The Apron-Terminal Complex - Analysis of Concepts for Evaluation of Terminal Buildings.

a. Airport Design Activity Levels. Figure 3-8 provides a matrix for identifying applicable terminal concepts related to design activity levels. The rationale behind the formulation of this matrix is as follows:

(1) For airports with projected design activity levels up to 200,000 annual enplaned passengers, simple or linear concepts with varying degrees of complexity at the higher enplanement levels appear to be the most appropriate. Low activity airports warrant a simple, compact structure incorporating all activities, including airfreight. As traffic increases, consideration should be given to providing covered walkways from the terminal element.

(2) For a design activity level between 200,000 and one million annual enplaned passengers, linear, pier, and satellite concepts are used. The linear concept, however, begins to exhibit an increasing degree of decentralization. The result is greater connecting distances for transfer passengers, while passengers who departed on one airline and returned on another are placed at greater distances from their parked automobiles. In addition, the linear concept, after reaching this activity level, requires a sophisticated signing and graphics system for identifying airlines, gate positions, and other activity centers.

(3) When the activity level exceeds one million annual enplaned passengers, pier, satellite, and transporter concepts are applicable. The first two concepts offer an additional alternative of utilizing multiple terminal units or a larger centralized terminal to accommodate the entire traffic load. At transfer airports, a multiple unit terminal or transporter concept may be inappropriate. This is due to inefficiencies resulting from transferring passengers and baggage between aircraft (e.g., transporter) or between airlines (e.g., multiple unit terminal).

b. Passenger Walking Distances. In evaluating alternate terminal concepts and building designs, major consideration should be directed toward keeping passenger walking distances to a minimum. This is particularly important at locations where there is considerable transfer between aircraft. Under these circumstances, walking distances become more time critical. Relationships between passenger walking distances and terminal concept selections are discussed in following paragraphs.

(1) A passenger activity level up to one million annual enplanements represents approximately a six to eight gate simple or linear terminal, normally, serving an aircraft mix up to B-727 size, and requires an average overall gate width of 110 to 130 feet (33 to 40 m). Aircraft park in front of the terminal, usually in a taxi-in/power-out operating mode. The terminal itself provides the common areas for the main functions, such as ticket counters, waiting space with concessions, and baggage-claim areas. The total overall length is approximately 700 to 1,000 feet (210 to 300 m). This means that the walking distance from the general areas in the terminal to the farthest gate is not more than 350 to 500 feet (105 to 150 m).

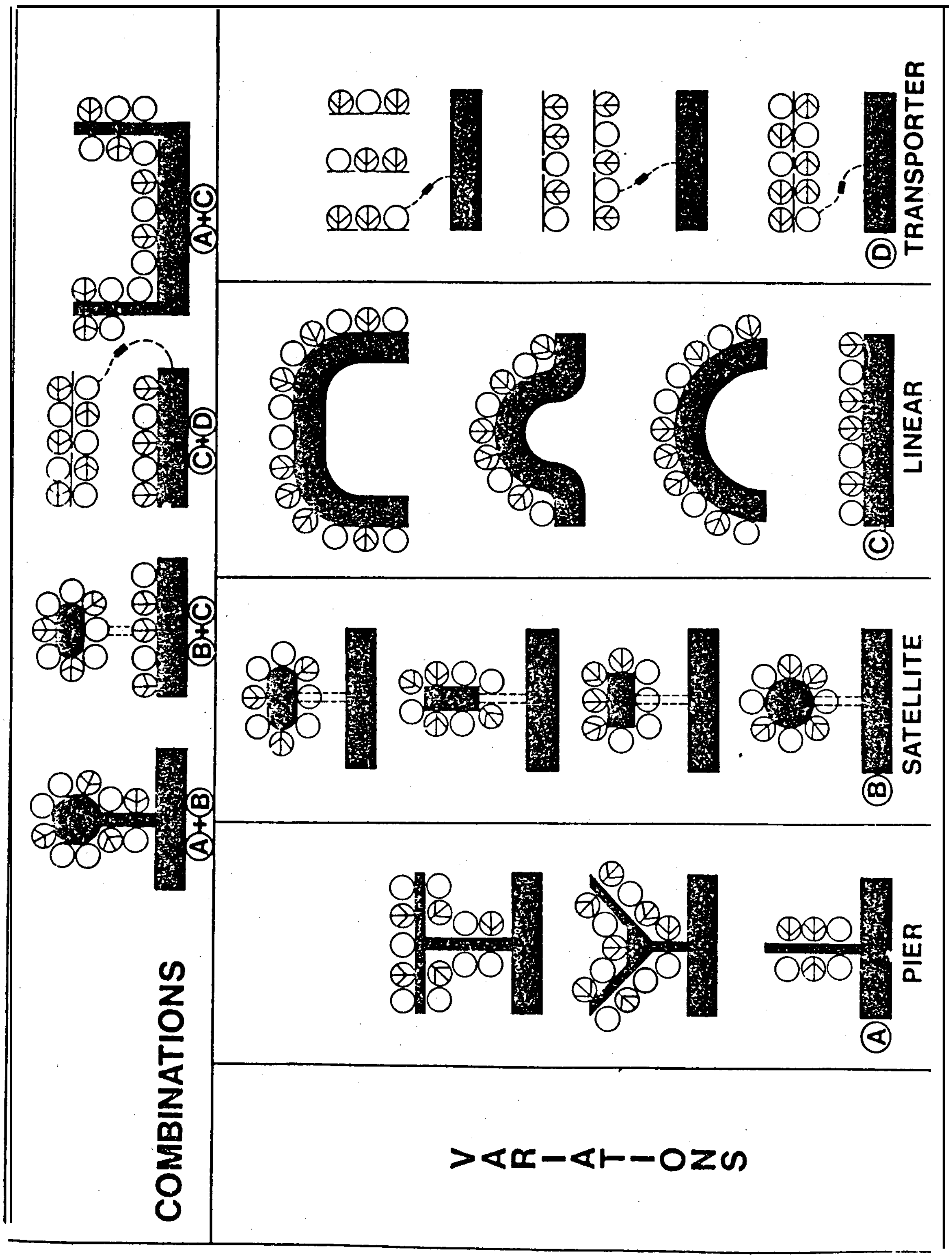


Figure 3-7. Concept Combinations and Variations

Airport Size by Annual Enplaned Passengers	CONCEPTS APPLICABLE	LINEAR	PIER	SATELLITE	TRANSPORTER	PHYSICAL ASPECTS OF CONCEPTS	SINGLE LEVEL CURB	MULTI LEVEL CURB	SINGLE LEVEL TERMINAL	MULTI LEVEL TERMINAL	SINGLE LEVEL CONNECTOR	MULTI LEVEL CONNECTOR	APRON LEVEL BOARDING	AIRCRAFT LEVEL BOARDING
FEEDER UNDER 25.000		X					X		X				X	
SECONDARY 25.000 TO 75.000		X					X		X				X	
75.000 TO 200.000		X					X		X		X		X	
200.000 TO 500.000		X	X				X		X		X		X	
PRIMARY OVER 75% PAX O/D 500.000 TO 1. 000.000		X	X	X			X		X		X	X	X	X
OVER 25% PAX TRANSFER 500.000 TO 1.000.000		X	X	X			X		X		X	X	X	X
OVER 75% PAX O/D 1.000.000 TO 3.000.000			X	X	X		X	X		X	X	X	X	X
OVER 25% PAX TRANSFER 1.000.000 TO 3.000.000			X	X			X	X		X	X	X	X	X
OVER 75% PAX O/D OVER 3.000.000			X	X	X		X	X		X	X	X	X	X
OVER 25% PAX TRANSFER OVER 3.000.000			X	X			X	X		X	X	X		X

Figure 3-8. Matrix of Concepts Related to Airport Size

(2) With au annual enplanement level between one million and three million, a mix of larger aircraft, including wide-body aircraft, will operate from the apron-terminal complex. Average gate widths will range from 150 to 180 feet (45 to 55 m). As a result, a unit of six to eight gates will reach an overall apron length of 1,000 to 1,500 feet (300 to 450 m). The overall walking distances will become even greater if aircraft are parked in a continuous single line, nose to tail. The common area will become individualized and walking distances and the distance between the terminal units will increase. Other concepts, such as the pier, satellite, and transporter, will become more appropriate for reducing walking distances.

(3) When the annual enplanement level reaches three million, with 25 percent or more transfer passengers, the transporter concept becomes less applicable since this concept increases the passenger transfer time between flights.

(4) When concept selection is limited, excessive walking distances can be made more tolerable by the installation of moving walkways, escalators, guideways, and other mechanized people moving systems.

c. Airline Station Characteristics. The characteristics of the route structure of the airlines serving the airport can be important factors influencing the selection of a terminal concept (e.g., transfer versus originating, domestic versus international, scheduled versus nonscheduled, etc.). Other factors include the size and type of aircraft used, aircraft ground and turnaround times, airline equipment and policies, and the like.

d. Physical Characteristics. The terminal concept selection is influenced by the physical characteristics of the terminal site such as the available area for expansion, existing facilities, terrain, airport layout, and access road systems.

e. Climatic Conditions. Extreme weather conditions of heat and cold, precipitation, wind, etc., can influence the selection of a terminal concept to provide optimum sheltering of passengers, baggage, and aircraft servicing areas.

f. Growth Potential. The potential for the growth of the airport requires considerable attention by the planner in choosing a terminal plan. Growth potential includes physical growth and airline growth. Airline growth takes into account future aircraft sizes, potential for increased flights, service equipment, and the introduction of new airlines.

39. - 40. RESERVED.

CHAPTER 4. TERMINAL APRON AREAS

41. **GENERAL.** Four primary considerations govern efficient apron area design: the movement and physical characteristics of the aircraft to be served; the maneuvering, staging, and location of ground service equipment and underground utilities; the dimensional relationships of parked aircraft to the terminal building; and, the safety, security, and operational practices related to apron control. The primary objective of these considerations is the ready accommodation of either a changingor static mix of aircraft. This involves maximizing the total area in terms of aircraft parking (interchangeability of types) with comparable relationships between these aircraft and the building. The optimum apron design for a specific airport will depend upon available space, aircraft mix, and terminal configuration.

42. **TERMINAL APRON GATE TYPES.** The terminal gate types used in this chapter relate to the wing spans and fuselage lengths of the aircraft which they accommodate. For dimensions of specific aircraft, refer to AC 150/5300-13, Airport Design. The aircraft included in these gate types make up the bulk of the U.S. commercial aviation fleet. These aircraft serve all types and lengths of domestic and international route structures. The four gate types are:

a. **Gate Type** A. The aircraft using this gate type arc those found in Airplane Design Group III, wing span between 79 feet (24 m) and 118 feet (36 m). (Refer to AC 150/5300-13, for information on Airplane Design Groups.) The route structures of these aircraft vary from short range/low density to medium range/ high density.

b. **Gate Type B.** Airplane Design Group IV aircraft, wing span bchvecn 118 feet (36 m) and 171 feet (52 m), with a fuselage length less *than* 160 feet (49 m), use this gate type. These aircraft serve longer range routes than those served by aircraft using Gate Type A, but have similar passenger demands.

c. Gate Type C. This gate type serves Airplane Design Group IV aircraft with a fuselage length *greater than* 160 feet (49 m). The typical route structure is similar to that for those aircraft using Gate Type B, although with a higher passenger volume.

d. Gate Type D. Aircraft in Airplane Design Group V, wing span between 171 feet (52 m) and 213 feet (65 m), use this gate type. Thcsc aircraft operate on a long-range route structure and carry a high volume of passengers.

43. **ESTIMATING AIRCRAFT GATE** POSITIONS. The required number of aircraft gate positions will influence the selection of both the terminal concept and the building design. Similarly, the size and type of aircraft serviced at the airport and the airline parking arrangement and procedures will affect the apron area requirements and, ultimately, the size and layout of the terminal building. Several methodologies for estimating the number of required aircraft gate positions arc discussed in succeeding paragraphs. These methodologies are applicable to domestic scheduled operations. Gates for international and commuter aircraft should be estimated separately. It is recommended that all of the first three methods bc utilized for comparative purposes and appropriate judgment exercised on estimating the final number.

a. Peak Hour Utilization. The current (base year) peak hour gate utilization factor is obtained by dividing the number of peak hour movcmeuts by the number'of active gates. (NOTE: See paragraph 26 concerning the counting of base year active gates.) Through discussions with the local airlines, a determination should be made on whether this base year utilization factor is applicable to the design year or whether an upward or downward adjustment is warranted. For rough estimates, the gate utilization factors specified in paragraph 3c can be used for the three basic airline stations. These factors are typical for airports with domestic operations averaging six or more daily departures per gate. Future total gates arc estimated by dividing the forecasted design year peak hourly aircraft movements by the selected gate utilization factor.

b. Daily Utilization. Future total gate rcquircmcnts can bc estimated by dividing the forecast design year ADPM aircraft departures (one-half the aircraft movcmcnts) by a projected daily utilization factor. The latter is determined by dividing current ADPM aircraft dcparturcsby total active gates and applying a reasonable additional factor to account forgrcatcr future gate utilization. Industry incrcascs normally considered appropriate range from 1.5 to 3.0 departures per gate for the 10 and 20 year master planning forecasts, rcspcctivcly. Thcsc increases are to be applied when the base year daily utilization is very low (four or less departures per gate). Generally, a daily utilization factor of 9 to 10 represents a ceiling for airport master planning purposes.

c. Annual Utilization. Future gates can be estimated from base year annual utilization and forecasted annual passenger enplanements by use of the nomographs in Figures 4-1 through 4-4. These figures provide intermediate (10 year) and long-range (20 year) forecasts of industry enplanements per active gate for high (Figures 4-2, 4-4) and low (Figures 4-1, 4-3) utilization airports. Low utilization averages less than six daily departures per gate and high utilization seven or more daily departures per gate for the average day of the peak month. After selecting the applicable nomograph, determine the current (base year) annual enplanements per active gate and enter this figure on the left side of the graph. On the right side, enter the ratio of forecast annual enplanements for the design year to the current year enplanements. A straight line connecting the two points will intersect the middle scale to estimate the design year annual enplanements per active gate. This number divided into the forecast design year annual enplancments will provide an estimate for total gate requirements.

d. Historical Data. Figure 4-5 provides a method for approximating gate requirements for initial planning and estimating purposes only. It is based on historic relationships between annual enplaned passengers and required gate positions.

44. GATE PARKING PROCEDURES. The parking procedures used by the airlines at an airport have considerable effect on the sizing and spacing requirements for gate positions.

a. Taxi-in, Push-out/Power-out Parking. This is the most common procedure used at high activity locations. It involves the taxiing of arriving aircraft directly into gate positions under their own power. Parking is generally nose-in and perpendicular to the building or pier finger. Departing aircraft either self power-out or are towed/pushed out by tractor/tug to a clear apron area where they can safely proceed under their own power. The procedure where an aircraft must be pushed or towed out is generally the most costly, from an operational standpoint. However, there are offsetting considerations which make its use both practical and advantageous at many locations. For one, it utilizes minimum gate area and therefore permits more gates for the same building or pier finger length. It also results in shorter loading bridges (hence, shorter passenger walking distances) and more efficient use of apron space and service equipment.

b. Taxi-in, Taxi-out Parking. This procedure is typically used at lower activity airports. Although it is less costly operationally, it requires more apron area and permits less gates per pier finger/building length. Aircraft taxi into and away from gate positions under their own power. Parking is either parallel to the building/pier finger or at 30, 45, or 60 degree angles. The choice is influenced by airline preference and physical or other constraints. Angle parking requires less ramp frontage than parallel parking.

45. AIRCRAFT GATE CLEARANCES. The sizing and clearances required for the design of aircraft gate positions can vary considerably. Airline policies and procedures, type of towing and service equipment used, type of aircraft, and terminal configuration all play a role. However, for planning purposes, the following guidelines are provided:

a. Nose to Building Clearances. In the push-out/power-out configuration, the distance between the nose of an aircraft and the building may vary anywhere between 15 to 30 feet (4.5 to 9 m), or more. This dimension is dependent on the method of push-out employed and whether the building is single or multi-level. A minimal 15 to 20 feet (4.5 to 6 m) clearance is practical either when a tug beneath the aircraft pulls the aircraft from the gate or when tug maneuvering space is available in front of the aircraft beneath the second level of a building. Larger nose-to-building dimensions are frequently required when a tug must operate in front of the aircraft (pushing out). The actual dimension involved in each case depends on the aircraft nose gear's position relative to its nose, the tug length, and associated maneuvering or parking requirements. For planning purposes, 30 feet (9 m) should be used for gate type A; 20 feet (6 m) for gate types B and C; and 15 feet (4.5 m) for gate type D.

b. Nose to Tail Clear&es. For taxi-in/out, in addition to separation for maneuvering, separation is required to accommodate the adverse effects of jet blast. Clearances on the order of up to 490 feet (149 m) for gate type D; 370 feet (113 m) for gate type C; and, 120 feet (37 m) for gate types A and B may need to bc established to account for a SO mph (80 km/b) jet blast. Use of jet blast fences and low break-away thrust operating procedures can considerably reduce these separations.

c. **Wingtip to Wingtip Clearance.** Clearances of 15 feet (4.5 m) for Gate Type A and 25 feet (7.5 m) for Gate Types B through D should be provided. At gates served by transporters, 45 feet (14 m) should be provided.

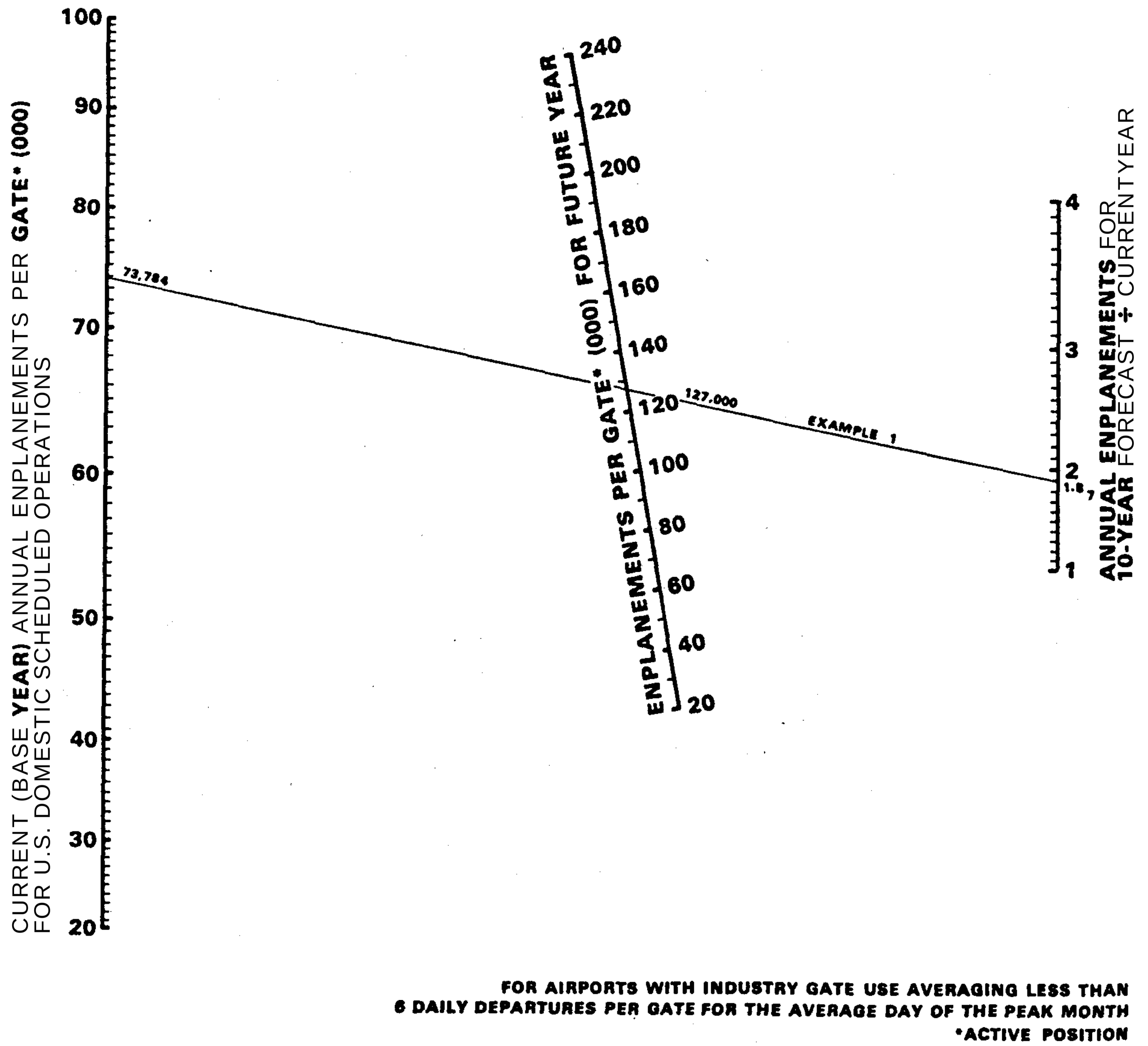
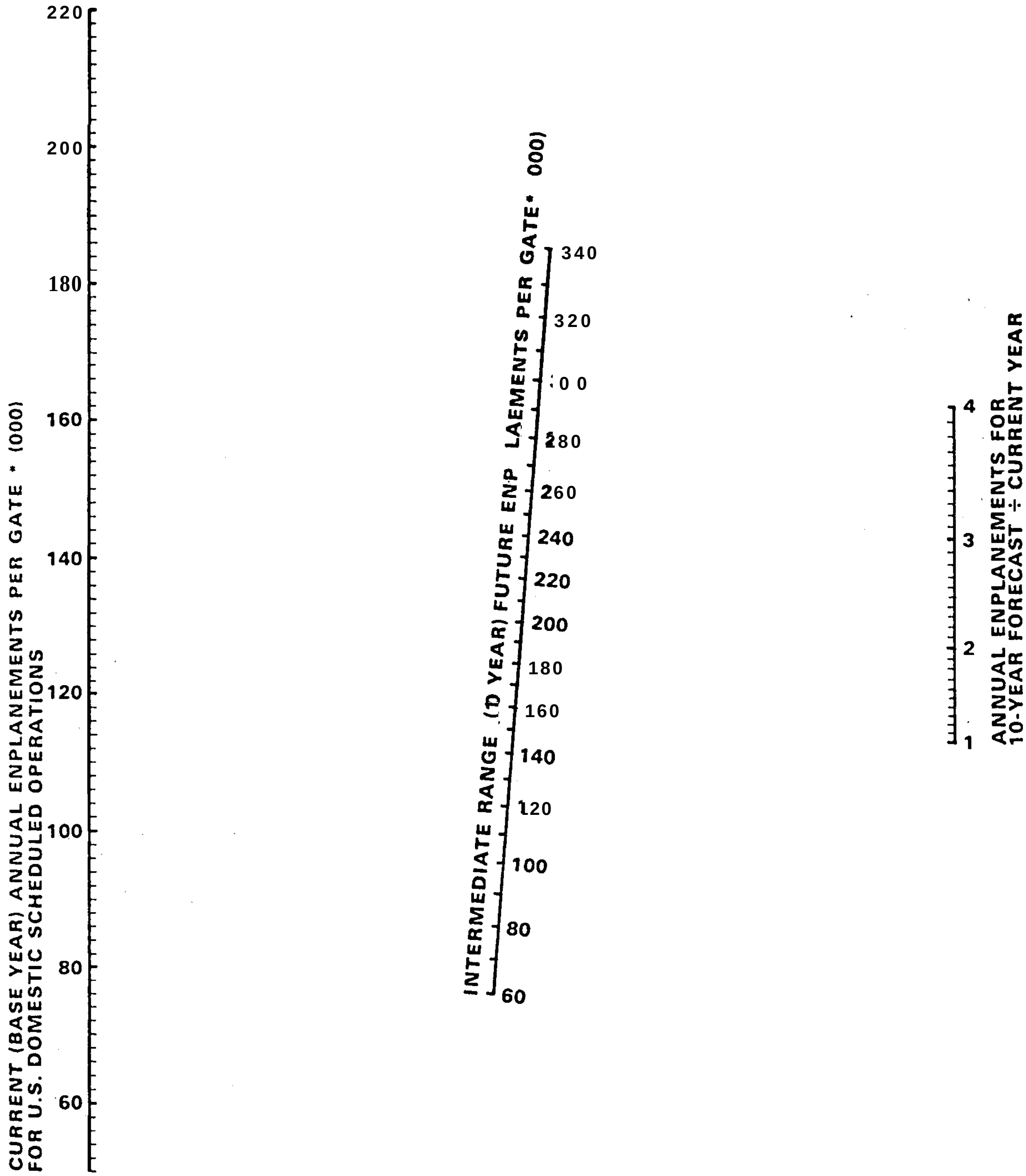


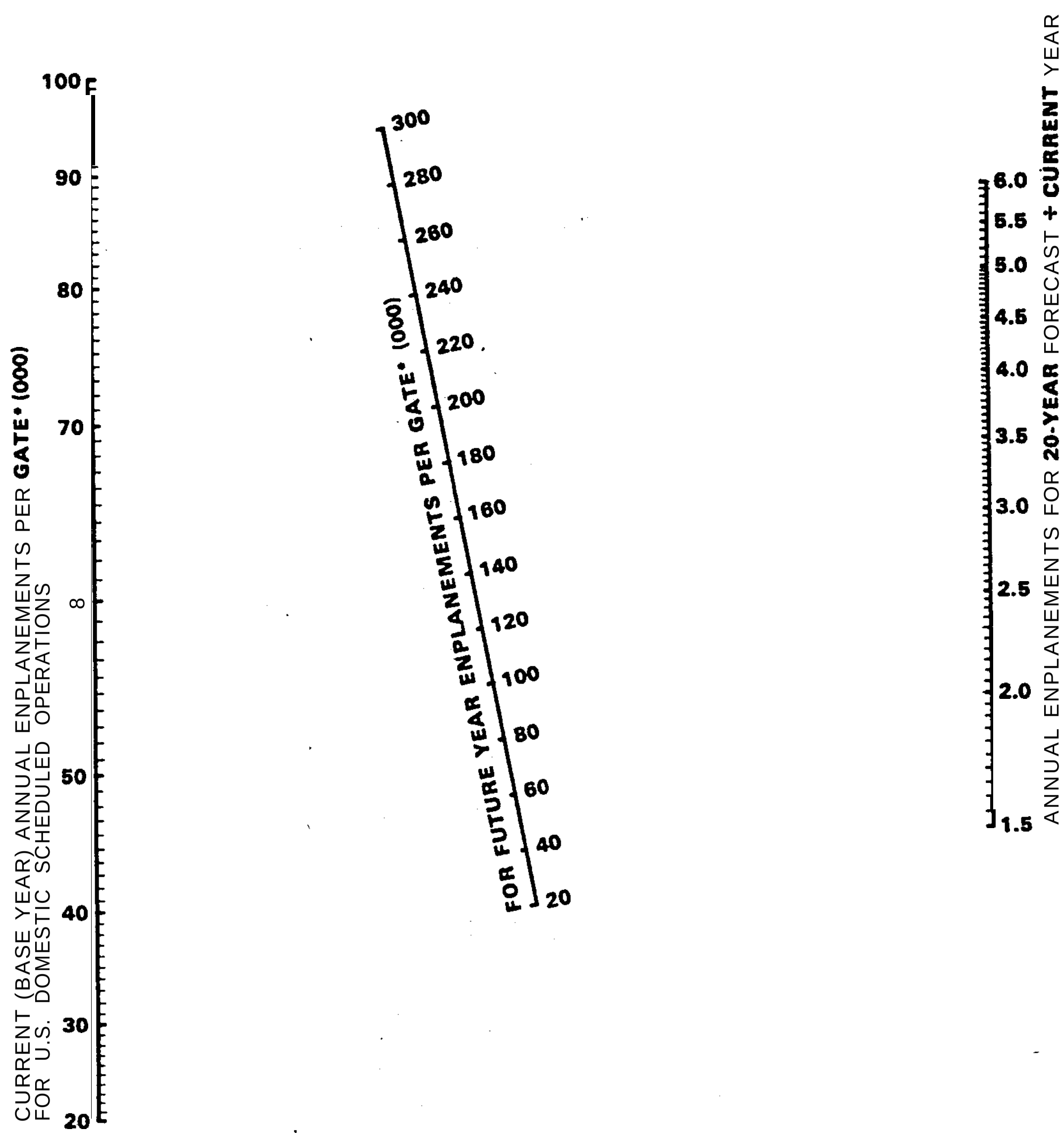
Figure 4-1. Enplanements Per Gate (10-Year Forecast - Low Utilization)



FOR AIRPORTS WITH INDUSTRY GATE USE AVERAGING 6 OR MORE DAILY DEPARTURES PER GATE FOR THE AVERAGE DAY OF THE PEAK MONTH.

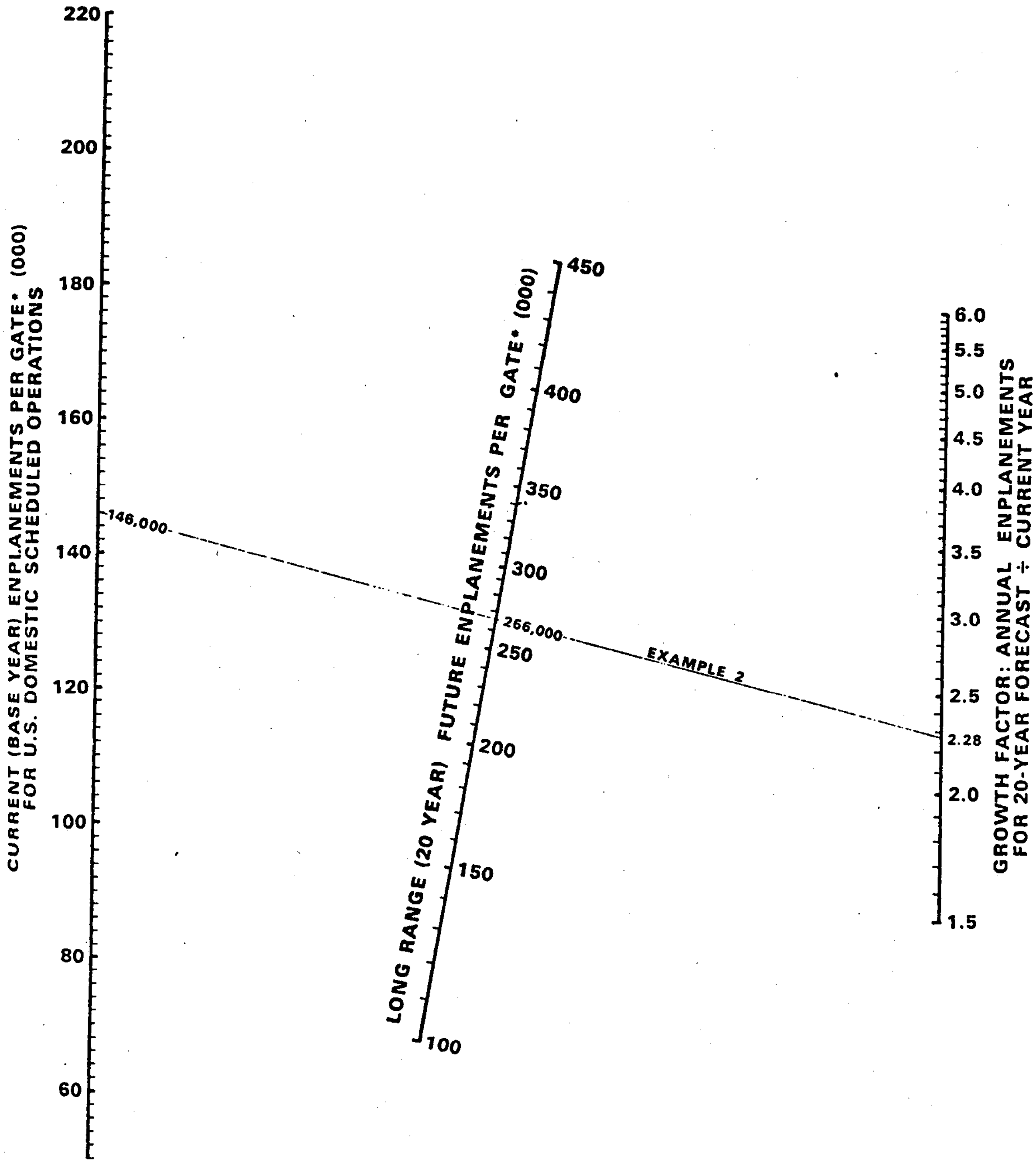
*ACTIVE POSITION

Figure 4-2. Enplanements Per Gate (IO-Year Forecast – High Utilization)



FOR AIRPORTS WITH INDUSTRY GATE USE AVERAGING LESS THAN 6 DAILY DEPARTURES
PER GATE FOR THE AVERAGE DAY OF THE PEAK MONTH
*ACTIVE POSITIONS

Figure 4-3. Enplanements Per Gate (20-Year Forecast – Low Utilization)



FOR AIRPORTS WITH INDUSTRY GATE USE AVERAGING 6 OR MORE DAILY OEPARTURES PER GATE FOR THE AVERAGE DAY OF PEAK MONTH

'ACTIVE POSITION

Figure 4-4. **Enplanements** Per Gate **(20-Year** Forecast – High Utilization)