AC NO: AC 150/5360-7
DATE: October 5, 1976

ADVISORY CIRCULAR

PLANNING AND DESIGN CONSIDERATIONS FOR AIRPORT TERMINAL BUILDING DEVELOPMENT

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAP-580

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SUBJECT: PLANNING AND DESIGN CONSIDERATIONS FOR AIRPORT TERMINAL BUILDING DEVELOPMENT

1. PURPOSE. This advisory circular presents planning and design procedures to be considered in airport terminal building development funded under the terms of the Airport and Airway Development Act, as amended.

2. REFERENCES.

   a. Advisory Circular (AC) 00-2, Advisory Circular Checklist and Status of Federal Aviation Regulations, updated triannually, contains the listing of all current issuances of advisory circulars and changes thereto. It explains the circular numbering system and gives instructions for ordering advisory circulars that are for sale as well as those distributed free of charge. AC 00-2 also gives instructions for ordering Federal Aviation Regulations.

      (1) The following free advisory circulars may be obtained from the Department of Transportation, Publications Section, TAD-443.1, Washington, D.C. 20590.

         (a) AC 00-2, Federal Register, Advisory Circular Checklist and Status of Federal Aviation Regulations.

         (b) AC 150/5200-11, Airport Terminals and the Physically Handicapped.

         (c) AC 150/5360-6, Airport Terminal Building Development with Federal Participation.

      (2) The following advisory circular and Federal Aviation Regulation may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402:

Initiated by: AAP-580

(a) AC 150/5070-6, Airport Master Plans

(b) FAR Part 107, Airport Security

b. The following FAA reports are for sale and may be obtained from the National Technical Information Service, Springfield, Virginia 22151:

(1) Report No. FAA-RD-73-82, The Apron-Terminal Complex.

(2) Report No. FAA-RD-75-191, The Apron and Terminal Building Planning Report.

3. <u>BACKGROUND</u>. This advisory circular should be used in conjunction with Advisory Circular 150/5360-6, referenced above. Federal participation in airport terminal development does not mean that any particular style of architecture will be imposed on airport sponsors and their designers. Each community is free to select the architectural style and treatment that expresses local wishes and needs. Construction details should be in accord with appropriate local, state, or national building codes. These codes have wide acceptance within the building industry and reflect safe and prudent procedures that are applicable to all types of construction. Therefore, the material which is presented in this advisory circular should be considered only as general guidance to the aviation community on airport terminal buildings. The final review and approval of Federal assistance to projects must depend on the rationale presented by the airport sponsor and his designer after careful coordination with the various parties involved.

4. <u>HOW TO GET THIS PUBLICATION</u>. Obtain additional copies of this circular, AC 150/5360-7, Planning and Design Considerations for Airport Terminal Building Development, from the Department of Transportation, Publications Section, TAD-443.1, Washington, D.C. 20590.

William V. Vitale

WILLIAM V. VITALE
Acting Assistant Administrator
Office of Airports Programs

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CHAPTER 1. FORECASTS

1. GENERAL. Airport terminal developments should be planned on the basis of forecasts. From forecasts, the relationships between demand and the capacity of the various components of a terminal complex can be established and requirements for gate positions and terminal area space can be determined. Short, intermediate, and long-range forecasts (usually 5, 10, and 20 years) should cover enplaned passengers, aircraft mix, aircraft operations, and airport access data to arrive at the timing and extent of terminal construction. Forecast information is available from FAA Terminal Area Forecasts, the Air Transport Association, and master planning studies made under the FAA's Planning Grant Program. This information should be adapted to provide forecast data which are essential to the design of terminal area development and should be submitted as part of the design rationale.

2. ANNUAL PASSENGER ENPLANEMENTS. Forecasts for individual airports are developed initially in terms of annual passenger enplanements. The airlines should be consulted for assumptions on trend changes in the ratio of originations to enplanements in scheduled service. Annual passenger volumes should be converted to daily and hourly volumes. Airport planners and terminal designers should identify daily and hourly volume of future terminal occupants and aircraft that the facilities are planned to accommodate.

3. AVERAGE DAY OF PEAK MONTH. This represents the most common method of projecting other planning statistics including aircraft movements as well as passengers. There may be other rational approaches to selecting an activity level suitable for planning and design. Forecasting for future years involves identifying peak month enplanements as a percent of annual enplanements based on historical data and consideration of local circumstances that might change that percentage up or down. Average day enplanements are derived simply by dividing peak month enplanements by the number of days in that month. Airline aircraft departures should also be identified for the average day/peak month by type and/or seating capacity.

4. PEAK HOUR OF AVERAGE DAY OF PEAK MONTH.

   a. Many aspects of terminal development planning require hourly volumes or statistics consistent with the average day baseline. Usually, the peak hour aircraft departures or movements are developed first as a basis for projecting enplanements. Arriving at peak hour passengers by multiplying the average daily passengers by a peaking factor requires the utmost caution. Historical factors should be investigated but may not represent future peaking conditions created by the introduction of larger aircraft in prime time. For this reason every attempt should be made to develop a design day activity table. (See paragraph 5.)

b. In addition to computing the total peak hour passengers, it may be necessary to distinguish between enplaning and deplaning passengers. In the absence of other data, peak hour enplanements may be assumed to represent about 60% to 70% of total peak hour inbound and outbound passengers. Similarly, deplaning passengers may be assumed as 60% to 70% of the total in and out, indicating another characteristic of airports--that enplaning and deplaning peaks do not always occur simultaneously.

c. Planning for certain facilities often requires activity statistics for time increments less than 1 hour, especially for counters and baggage systems. Such statistics are usually developed by factors applied to peak hour statistics or special surveys. In some cases activity plots may be developed projecting arrivals and departures for the specific period of concern, indicating approximate times in and out, aircraft type, and passengers, for internal analysis.

5. DESIGN DAY ACTIVITY TABLE. Project planning, especially for public areas of joint-use airline facilities, requires detail beyond that provided by the usual average day/peak month statistics. The use of a design day activity table is recommended for obtaining the basic data needed. This table uses information obtained from carriers to develop consolidated listings of clock time arrivals and departures by aircraft type with estimated passenger loads for the average day/peak month of an appropriate year or traffic level. Normally, the year or years selected should be within 3 to 10 years of the current period. Design day activity tables list arrival and departure times for the various flights involved, passenger enplanements and deplanements, and aircraft types. These tables provide the basic data needed for:

a. More accurate sizing of baggage claim facilities, public lobby areas, and curb frontage. Many joint-use bag claim facilities have been undersized in the absence of these data.

b. Developing industry terminal gate activity charts which show the magnitude and timing of composite peaks in schedules. This helps identify the relative utilization of facilities and any opportunities for sharing aircraft gate positions and holdrooms.

c. Preliminary analyses of aircraft operations on aprons and taxi lanes.

6. EQUIVALENT AIRCRAFT (EQA). Space requirements for certain terminal components can be conveniently determined by using EQA conversion factors as indicated in chapter 4. EQA is computed by applying the factor to the design day and peak hour data. EQA is a single number reflecting the seating capacities and number of passengers which directly influence the sizing of a particular component of the apron-terminal complex. Typical conversion factors for developing EQA are shown in Table 1-1, Equivalent Aircraft.

TABLE 1-1. EQUIVALENT AIRCRAFT

AIRCRAFT SEATING CAPACITY	EQUIVALENT AIRCRAFT (EQA) CONVERSION FACTOR	REPRESENTATIVE AIRCRAFT @
Up to 80	0.6	BAC-111;CU-580;DC-9-10;FH-227;YS-11
81 to 110	1.0	B-737;B-727-100;DC-9-30;CU-880;L-188
111 to 160	1.4	B-707;B-720;B-727-200;DC-8-50;DC-9-50
161 to 210	1.9	B-707-320;DC-8-62
211 to 280	2.4	DC-8-61-63;DC-10;L-1011
281 to 420	3.5	B-747
421 to 500	4.6	Future

@ Aircraft typically falling within the stipulated seating range considering usual airline load factors.

7. FORECAST REASONABILITY CHECKS. Activity forecasts and variables that influence sizing should be examined as to their reasonability and credibility. The following are key examples:

a. Passenger Traffic Growth (scheduled operations). Check local airport growth against that forecast for the U.S. domestic market.

b. Ratio of Originating Passengers to Total Enplanements. Explain assumptions if the present ratio is forecast to change. This is particularly important for planning auto parking facilities, curb lengths, airline counters, and baggage claim areas.

c. Boarding Load Factor. Compare boarding passengers versus available seats, reviewing with airlines any average day/peak month load factors outside the range of 55% to 60%. Peak hour average load factors may run 15 to 25 percentage points higher.

d. Aircraft Growth Trends. Check increase in aircraft seating capacities in conjunction with boarding load factors.

e. Gate Utilization. Identify existing and forecast annual enplanements per gate and daily arrivals per gate. Check reasonableness of any projected change.

f. Aircraft Movements. Check peak hourly operations as percent of daily operations for average day/peak month. Explain forecast changes up or down from the existing ratio, 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 Operations. Explain the forecast ratio of passengers carried in nonscheduled operations versus those for scheduled service. Separate statistics should be kept if existing volumes or forecast growth represent any significant percentage of total operations. Identify assumptions if separate facilities are proposed for nonscheduled traffic growth or if such operations are assumed to have a significant impact on the terminal.

h. Number of Scheduled Carriers. Explain assumptions for any anticipated increase or decrease in the number of carriers. The facilities required by four airlines per 100,000 domestic enplanements will usually be more than those for two or three carriers serving the same volume.

CHAPTER 2. APPROXIMATIONS OF TERMINAL SPACE NEEDS

8. GENERAL. Effective planning of the terminal area involves the active participation of the owner/operator, the airlines and other tenants, and the consultants engaged by the parties. The planning process normally includes surveys, questionnaires, and forecasting activity, usually for short and intermediate periods; developing design day and peak hour activity tables; establishing passenger, aircraft, and vehicular traffic relationships through surveys and historic patterns; taking inventory and evaluating existing facilities; evaluating space requirements using alternate layouts; and estimating costs and developing financial plans. From these data the designer can analyze alternative concepts and select the most economically feasible and practical terminal area facilities. Typical forms for collecting design data may be found in Report No. FAA-RD-75-191, The Apron and Terminal Building Planning Report. Forecasts should be developed according to the general guidance contained in Chapter 1, Forecasts. From the forecasts the relationship between demand and capacity should be analyzed to obtain approximations of gate and terminal space requirements. These approximations will also be helpful in selecting the type of terminal to be developed at a particular airport. Factors to be considered in selecting a terminal concept are described in Chapter 3, Terminal Functions and Concepts. Guidance for determining approximations of requirements for gates and terminal space is contained in the following paragraphs.

9. GRAPHS AND RULES OF THUMB. Graphs and rules of thumb are provided for the purpose of making order-of-magnitude estimates of passenger terminal activity and space requirements. These estimates are intended to be used in connection with indepth studies of needs. They are not satisfactory for design, detailed analysis, or evaluation of a particular airport. The graphs and rules of thumb are intended to be used for determining gross approximations of activity, gates, and terminal space. Each has been developed largely from examining data on existing facilities and are representative of "averages." They, however, DO NOT represent an average condition for individual airports and should not be used as such. Each airport has its own characteristics, and many can readily be identified as airports which are likely to deviate from the average conditions. OBSERVATIONS AT INDIVIDUAL AIRPORTS OFTEN INDICATE WIDE VARIATIONS FROM THE AVERAGES PRESENTED IN THESE GRAPHS. VARIATIONS ON THE ORDER OF 50 PERCENT CAN BE CITED.

10. PEAKING FACTORS - AIRCRAFT OPERATIONS. The graph shown in figure 2-1 provides a rough estimate of the percentage of peak day aircraft operations which can be expected in the busiest hour of the day. The graph was developed from airline schedules. Airports which have substantial international, tourist, and long-haul traffic, as well as island locations, often exhibit unusually high peak hour activity. Airports with unusually high amounts of short-haul business traffic and those operating with runway or gate capacity restrictions can be expected to have less sharply defined peaks.

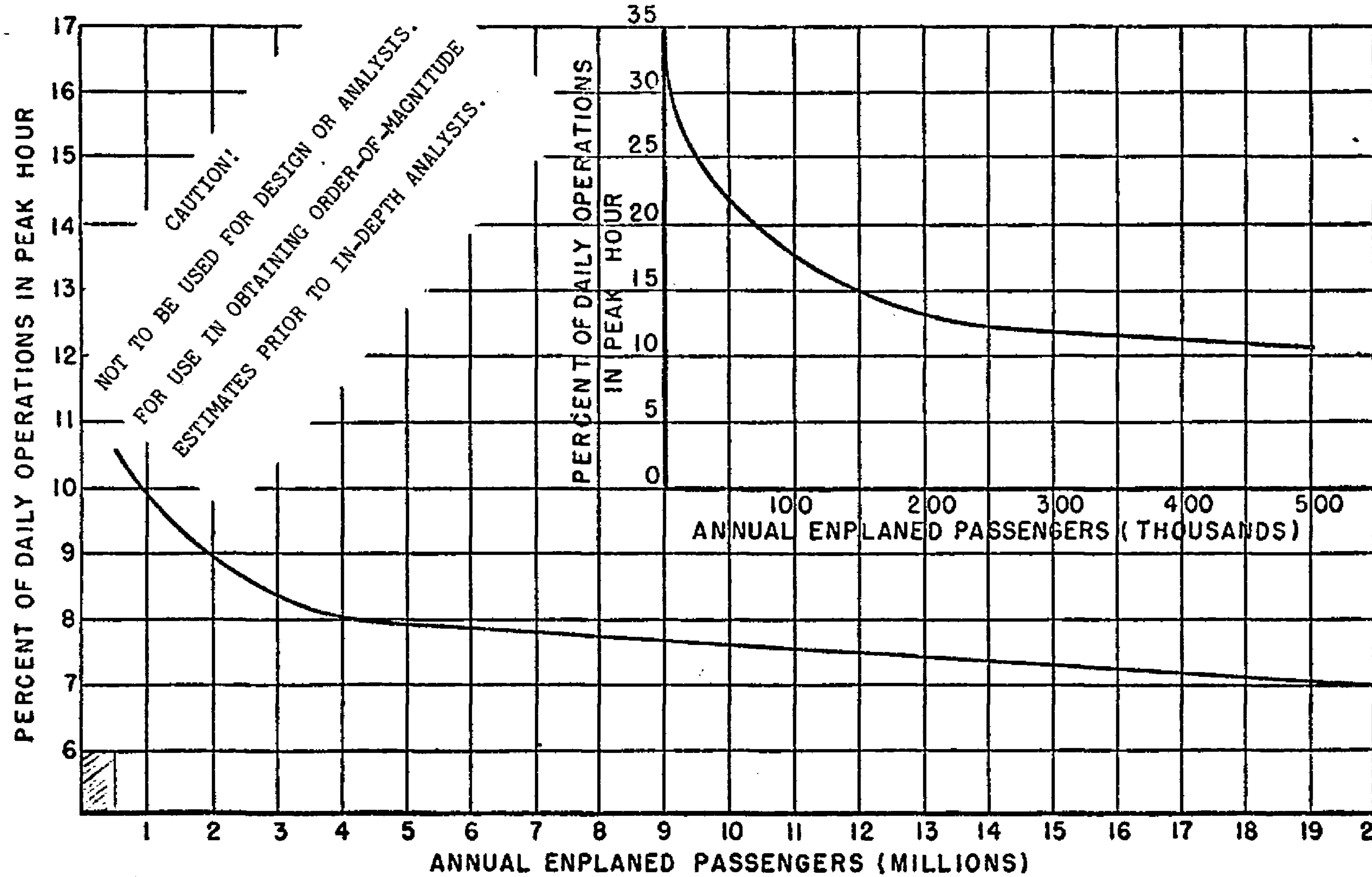


FIGURE 2-1. PERCENT OF DAILY OPERATIONS IN PEAK HOUR VS. ANNUAL ENPLANED PASSENGERS

11. PEAKING FACTORS - ANNUAL ENPLANED PASSENGERS. The graph shown in figure 2-2 relates passenger peaking factors to annual enplaned passengers. Passenger peaking more or less parallels aircraft activity but passenger peaks may be more sharply defined than aircraft peaks because larger-than-average aircraft are introduced in prime times. The graph was developed largely from reported passenger volumes, but supplemented with values derived from aircraft operations for the smaller airports.

12. PEAK HOUR OPERATIONS - ANNUAL ENPLANED PASSENGERS. Figure 2-3 presents peak hour operations related to annual enplaned passengers. The graph shows an average relationship based on current schedules as well as one based upon projected increases in the average seating and load factors of the fleet. Since terminal development is generally sized for a forecasted passenger volume, it is important that changes in the average fleet size be considered.

13. APPROXIMATING GATE REQUIREMENTS.

a. Figure 2-4 shows approximate gate requirements based upon annual enplaned passengers. Some of the factors influencing the number of gates (aside from the number of operations) are the gate occupancy time, the extent of international service, the number of airlines and gate sharing arrangements between airlines, and the terminal concept. The graph is intended for use in estimating domestic service requirements and includes provisions for exclusive-use gates, but doesn't provide for future needs. An examination of active gate positions at existing airports may indicate somewhat higher values (25%), but these values may include gates which are excess to immediate needs.

b. There is no simple way of relating gates required for commuter aircraft with total passenger enplanements or with gates required for transport-type aircraft. Where it is necessary to estimate these gates, the Official Airline Guide should be consulted and special peaking factors developed. Airports whose current activity levels approximate the forecasted levels for the airport being studied should be examined, and analogies made.

14. APPROXIMATING TERMINAL BUILDING SPACE.

a. Establishing Design Day and Design Hour Activity.

(1) In virtually all terminal development, it will be necessary to estimate hourly passenger and aircraft activity prior to computing space requirements. A number of approaches may be used, but the most common is to consider the peak hour of the average day of the peak month as a level of activity suitable for planning and design purposes.

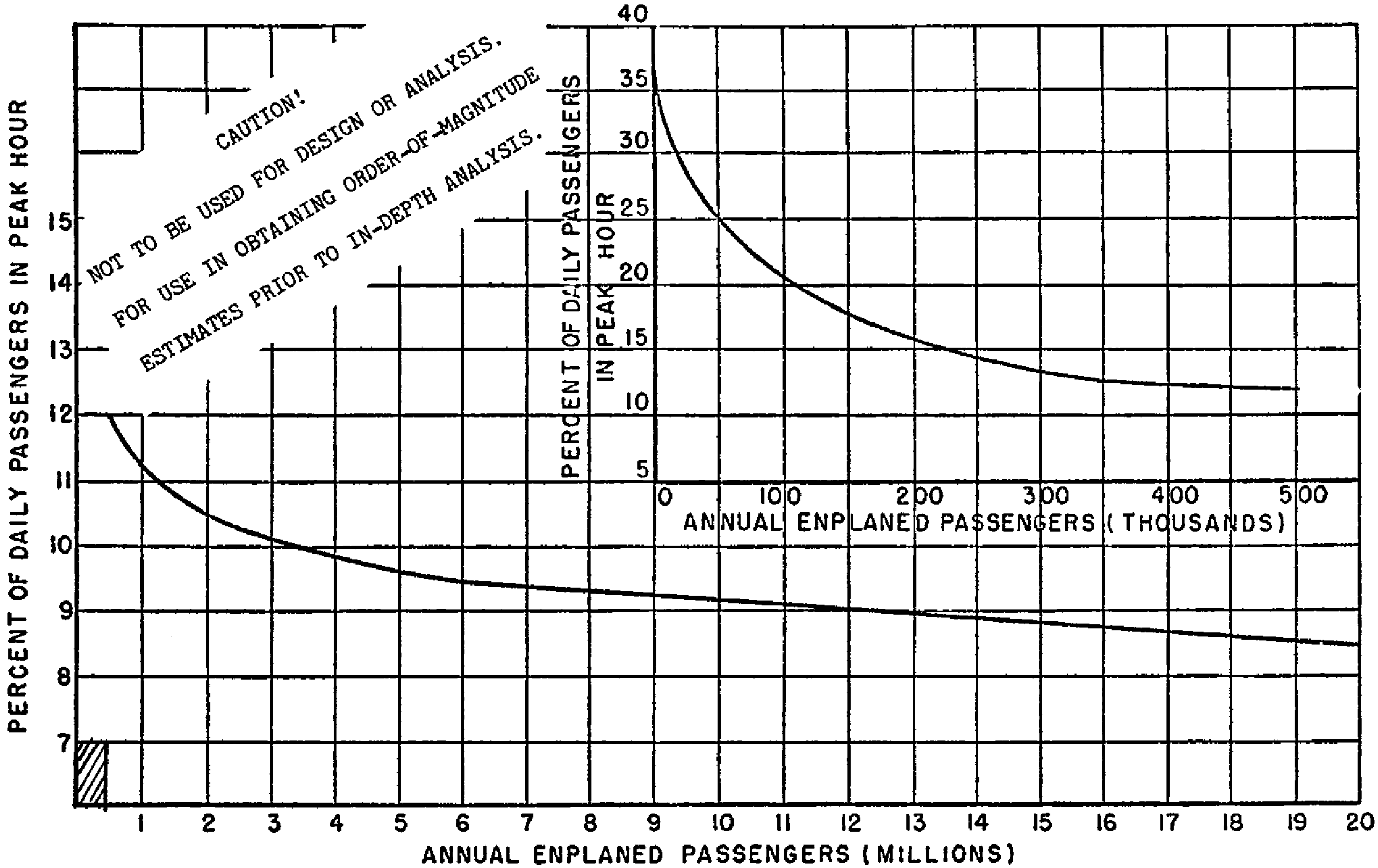


FIGURE 2-2. PERCENT OF DAILY PASSENGERS IN PEAK HOUR VS. ANNUAL ENPLANED PASSENGERS

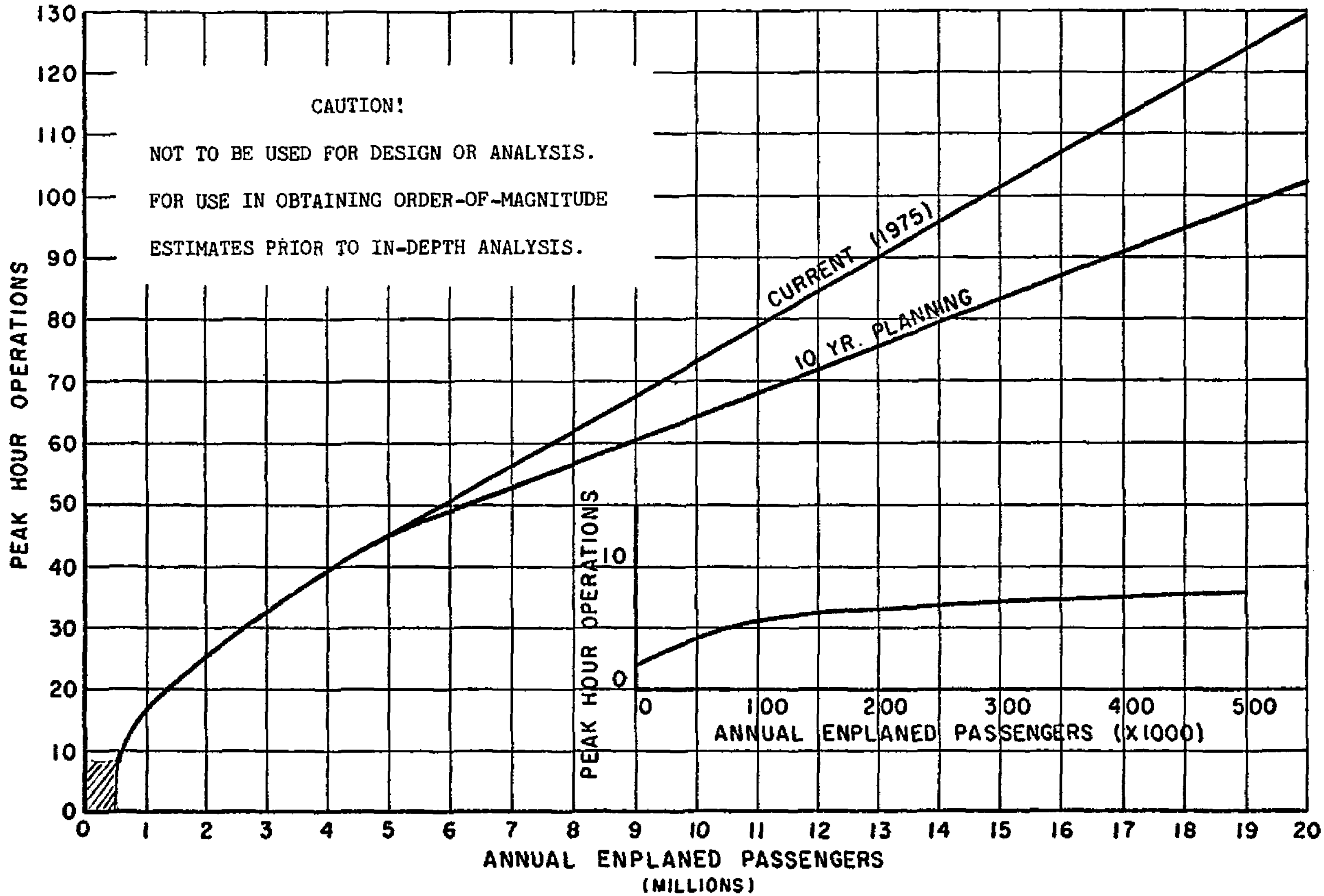


FIGURE 2-3. ESTIMATED PEAK HOUR OPERATIONS VS. ANNUAL ENPLANED PASSENGERS

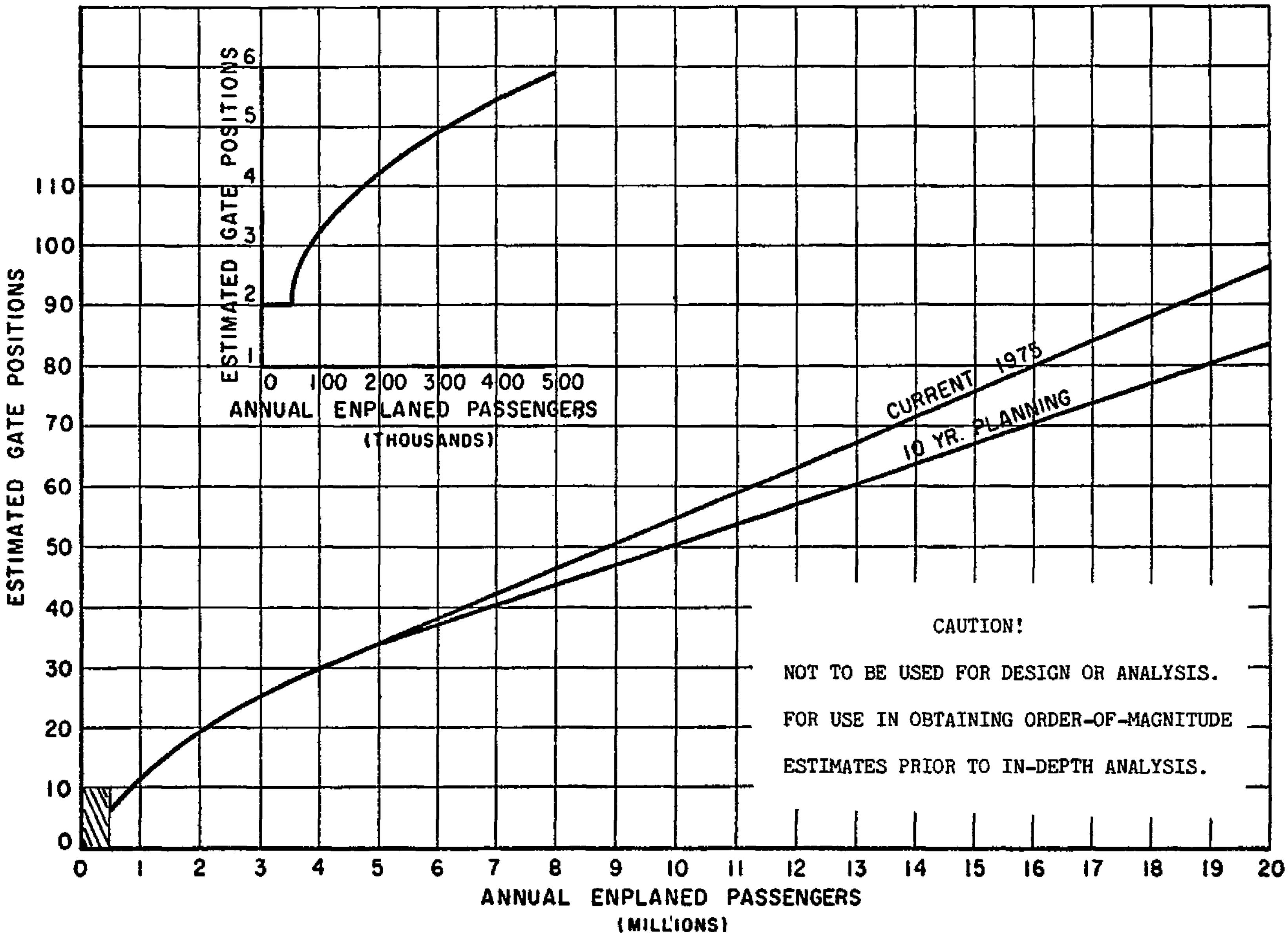


FIGURE 2-4. ESTIMATED GATE POSITIONS VS. ANNUAL ENPLANED PASSENGERS

(2) In the absence of historic data, and this will be rare, the peak month passengers may be approximated as 10% of the annual passengers. Average-day-peak-month passengers can be taken as the total monthly passengers divided by the days of the month. A peaking factor from figure 2-2 can then be applied to the daily volume to obtain the design-hour passengers for planning purposes. Further divisions into enplaning-deplaning, originating-transferring, domestic-international, etc., may also be required, depending upon the facility or portion of a facility being planned. Aircraft operations normally do not fluctuate on a monthly and daily basis as much as passenger volumes. Unless indicated otherwise, average-day-peak-month operations may be considered as 1.05 times average daily activity for the year. A peaking factor may be obtained from figure 2-1 and applied to daily operations to obtain peak hour operations. Figure 2-3 may be used to estimate peak hour operations directly from annual passengers when forecasts of operations are not available.

b. Estimating Gross Areas.

(1) Even rough estimates of terminal building space requirements are deserving of careful consideration, and the planner should be willing to devote time to the effort. A little extra time and effort will produce noticeably improved results and will provide the analyst with some degree of confidence in the preliminary estimates.

(2) Every effort should be made to obtain the current size of the existing terminal, as well as the number of peak hour passengers, operations, and gate requirements. If a building does not exist, an analogy with a terminal at a nearby airport with similar traffic characteristics should be attempted. Simple sketches will assist greatly.

(3) A rule of thumb of about 150 square feet (14 m^2) of gross terminal area per design-hour passenger may also be helpful. Less accurate estimates can be made on the basis of annual enplaned passengers, but these should be avoided as it is not difficult to estimate the design-hour passengers using figure 2-2. It would appear, however, that for ten-year planning purposes the passenger terminal building gross area is about 0.08-0.12 square feet (0.007-0.011 m^2) per annual enplanement at airports with over 250,000 annual enplanements. At smaller airports, estimates should be based on peak hour considerations and simple sketches. It will probably be desirable to compare the above approximations with more detailed estimates of space which can be obtained by methods described in Section 6 of FAA Report No. FAA-RD-75-191, previously cited.

CHAPTER 3. TERMINAL FUNCTIONS AND CONCEPTS

15. GENERAL. After approximations of gate and terminal space requirements have been developed as described in chapter 2, various terminal types or concepts should be analyzed to determine which type best fits the needs of a particular airport. In selecting a terminal type, the functions of the various components of the terminal should be examined first to determine how the components will fit into the overall terminal plan. Then, considering functions of terminal components, approximations of gate and space requirements, and airfield configuration, a terminal type should be selected based on concept evaluation and drawings. Design details for specific areas within the terminal complex will follow the selection of the terminal type and the preparation of conceptional drawings. Guidance for the development of design details is contained in chapter 4. Material pertaining to terminal functions and concepts is offered in the following paragraphs.

16. OBJECTIVES IN SELECTING A TERMINAL AREA CONCEPT. The objective of the terminal area concept 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 orderly and convenient progress from his automobile or public transportation through the terminal to the aircraft and back again. 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. The functional arrangement of the terminal area complex with its aircraft maneuvering areas should be flexible enough to meet the operating characteristics of the airline industry for handling passengers and for fast ground servicing of aircraft so that minimum gate occupancy time and maximum airline operating economy will be achieved. A final objective should be to develop a terminal area complex which provides all necessary services within an optimum expenditure of funds from the standpoints of capital investment and maintenance and operating costs. This should take into account flexibility and costs which will be required in future expansions of the terminal area.

17. FUNCTIONS OF TERMINAL COMPONENTS.

a. The Apron. This element is for aircraft gate parking and for all support activities, including the following subelements:

(1) Aircraft Gate Position: Area for parked aircraft, ground-service equipment, and passenger boarding devices.

(2) Aircraft Service Area: Area for aircraft ground-service equipment around the aircraft.

(3) Apron Baggage and Freight Service: Area for staging and loading aircraft baggage, freight, and mail.

(4) Taxi Lanes: Joint-use areas of apron that provide aircraft access to terminal gate positions.

(5) Service Roads: Rights-of-way designated for vehicular traffic, including fire lanes within the apron area, identified by stripes painted on apron surfaces.

b. The Connector. This element joins the terminal to parked aircraft, usually including the following subelements:

(1) Concourse: Area for circulation to and between departure lounges and other public terminal areas.

(2) Departure Lounge: Area used for assembling passengers for a flight departure.

(3) Passenger Boarding Device: The device used to enplane and deplane passengers from the aircraft door to the connector lounge or concourse.

(4) Airline Operations Space: Area for airline personnel and equipment activities related to aircraft arrivals and departures.

(5) Security Inspection Space: Area used for inspection of passengers and baggage and control of public access to passenger boarding devices.

(6) Terminal Services Space: Area providing amenities to the public, and nonpublic areas required for operations such as building maintenance and utilities.

c. The Terminal. This element is for passengers and baggage to be processed for aircraft arrivals and departures and their ground transportation mode, including the following subelements:

(1) Airline Ticket Counter/Office: Area for ticket transactions, baggage check-in, flight information, and administrative backup.

(2) Terminal Services Space: Public and nonpublic areas such as concessions, amenities for passengers and visitors, truck service docks, food preparation areas, food storage, and miscellaneous storage.

(3) Lobby: Public areas for circulation and passenger and visitor waiting.

(4) Public Circulation: General circulation areas, other than lobbies, such as stairways, escalators, elevators, and corridors.

(5) Outbound Baggage Space: Nonpublic area for sorting and processing baggage for departing flights.

(6) Intraline and Interline Baggage Space: Nonpublic area for processing baggage transferred from one flight to another.

(7) Inbound Baggage Space: Nonpublic area for receiving baggage from an arriving flight, and public areas for presenting baggage to be claimed by the arriving passenger.

(8) Airport Administration and Services: Area for airport management, operations, and maintenance functions.

(9) Federal Inspection Services (FIS): Area for processing passengers arriving on international flights (sometimes incorporated as part of the connector element).

d. Curb, Parking, and Roadways. This element provides terminal curb, vehicular parking facilities, and connecting roadways that enable enplaning and deplaning passengers, visitors, and baggage to enter and exit the terminal, including the following subelements:

(1) Curb: The platforms (including median strips) that provide the public with loading and unloading vehicular access to and from the terminal.

(2) Auto Parking: The areas providing short-term and long-term auto parking spaces for passengers and visitors.

(3) Public Roads: Vehicular roadways providing access to the terminal curb, auto parking spaces, and the public street and highway system.

(4) Pedestrian Walkways: The designated lanes for crossing roads including tunnels or bridges that provide access between auto parking facilities and the terminal element.

(5) Service Roads and Fire Lanes: Nonpublic roadways providing access to various subelements of the terminal and to other airport facilities, such as air freight, fuel truck stands, post office, etc.

18. TERMINAL AREA CONCEPTS. The following terminal concepts should be considered in the development of the terminal area plan. Sketches of the various concepts are shown in figures 3-1 through 3-4. Many airports have combined one or more terminal types.

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 adaptable to airports with low airline activity which will usually have an apron providing close-in parking for three to six commercial transport aircraft. A simple terminal will normally consist of a single level structure with 2 to 4 gates where access to aircraft is afforded by a walk 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. Pier Concept. The pier concept (figure 3-1) has an 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 which serves 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 employed, the spacing between the two piers must provide for maneuvering of aircraft on one or two apron taxilanes. When each pier serves a large number of gates, and the probability exists that two or more aircraft may frequently be taxiing between two piers and will be in conflict with one another, then two taxilanes are advisable. Also, access from this taxiway system by two or more aircraft may require two apron-edge taxiways to avoid delays.

c. Satellite Concept. The satellite concept (figure 3-2) consists of a building, surrounded by aircraft, which is separated from the terminal and is usually reached by means of a surface, underground, or above-grade connector. The aircraft are normally parked in radial or parallel positions around the satellite, which can have common or separate departure lounges. Since enplaning and deplaning of the aircraft are accomplished from a common area, mechanical systems may be employed to carry passengers and baggage between the terminal and satellite.

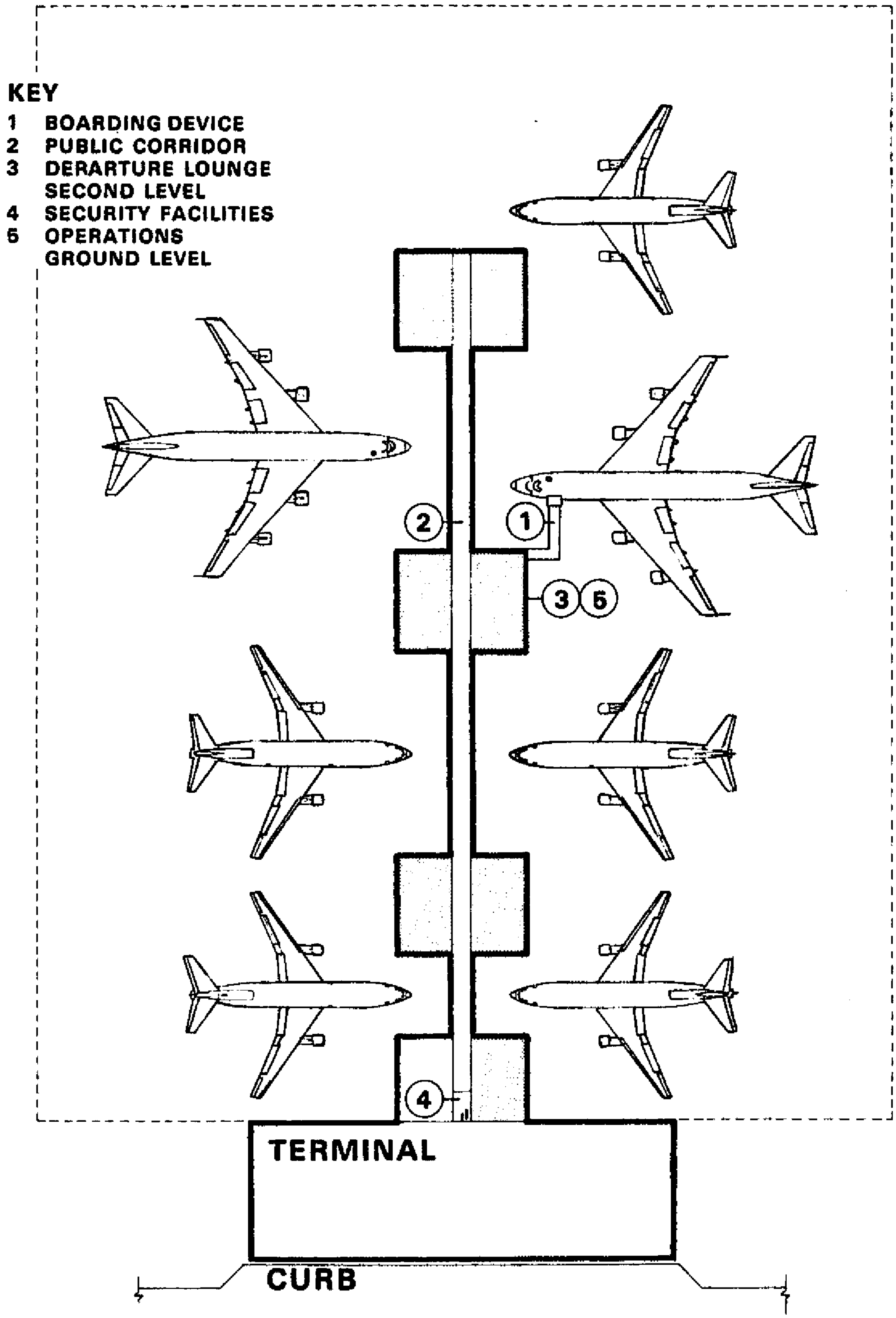


FIGURE 3-1. PIER CONCEPT

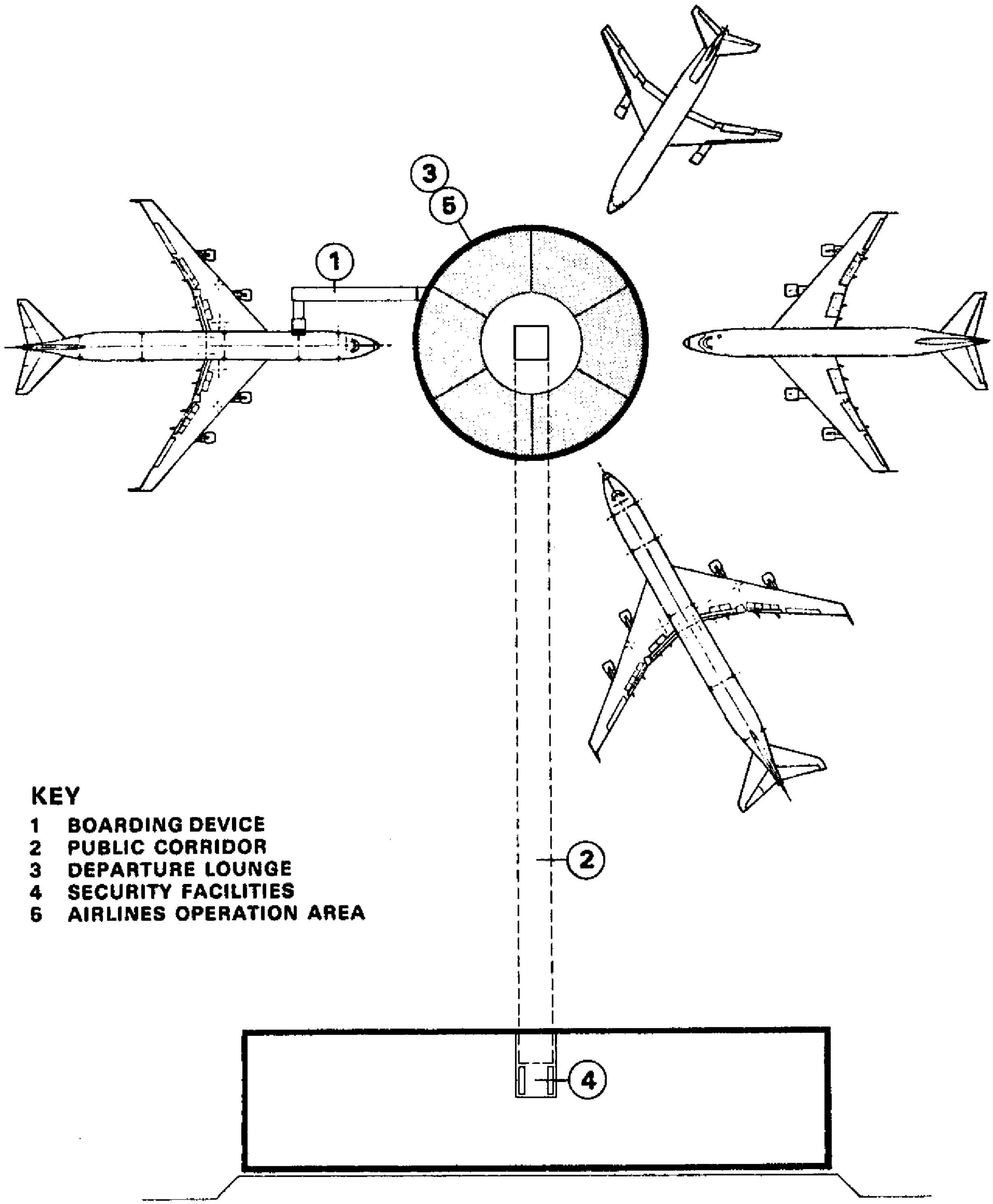


FIGURE 3-2. SATELLITE CONCEPT

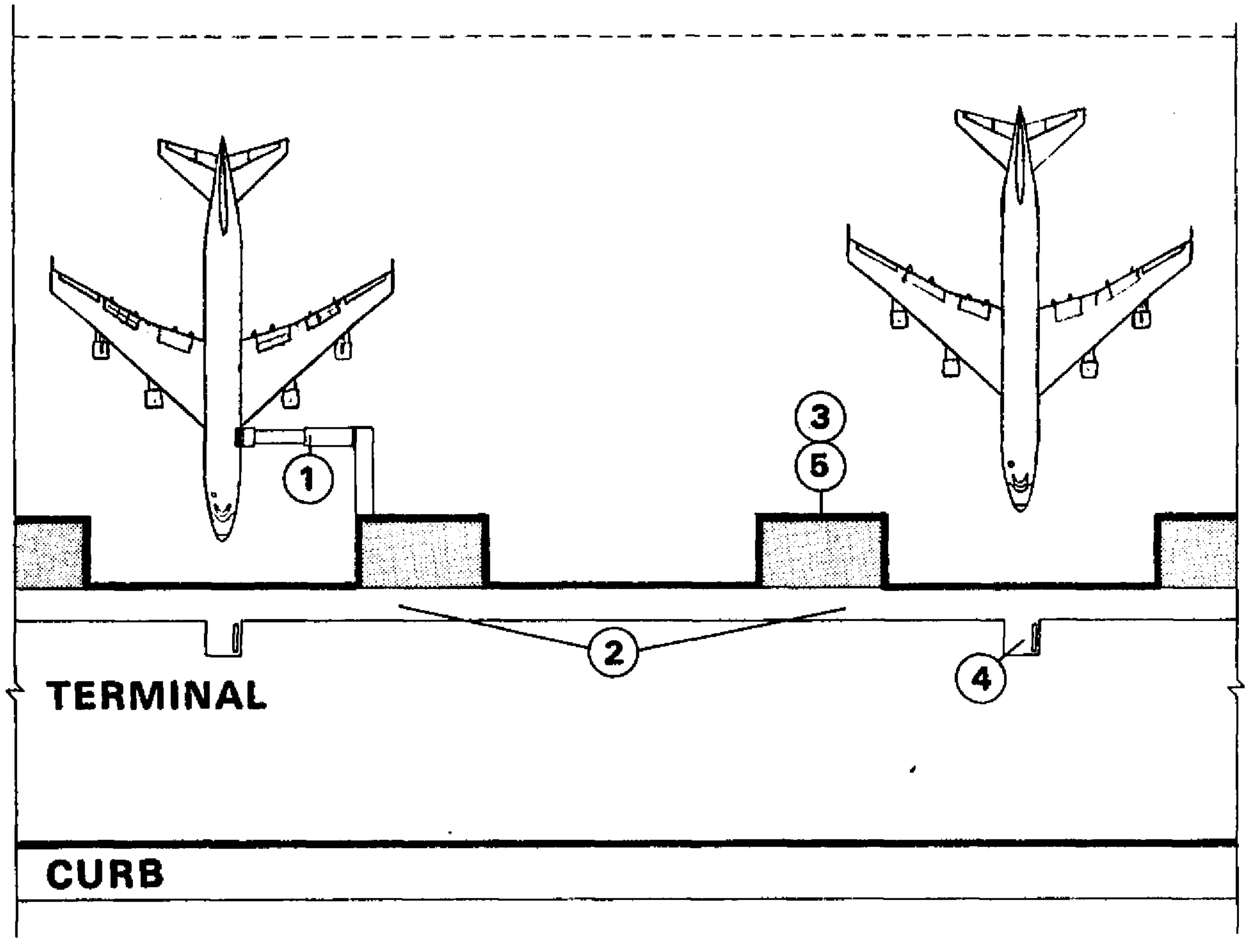
d. Linear Concept. In the linear concept (figure 3-3), aircraft are parked along the face of the terminal building. Concourses connect the various terminal functions with the aircraft gate positions. This concept offers ease of access and relatively short walking distances if passengers are delivered 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.

e. Transporter Concept. Aircraft and aircraft-servicing functions in the transporter concept (figure 3-4) are remotely located from the terminal. The connection to the terminal is provided by vehicular transport for enplaning and deplaning passengers. The characteristics of the transporter concept include flexibility in providing additional aircraft parking positions to accommodate increases in schedules for aircraft size, capability to maneuver an aircraft in and out of a parking position under its own power, separation of aircraft servicing activities from the terminal, and reduced walking distances for the passenger.

19. CONCEPT COMBINATIONS AND VARIATIONS.

a. Combinations of concepts and variations are a result of changing conditions experienced from the initial conception of the airport throughout 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. Each requires a concept that differs considerably from the other. In time, the proportion of traffic handled by these flights may change, necessitating modification or expansion of the facilities. Growth of aircraft size or a new combination of aircraft types serving the same airport will affect the type of concept. In the same way, physical limitations of the site may cause a pure conceptual form to be modified by additions or combinations of other concepts.

b. Combined concepts acquire certain of the advantages and disadvantages of each basic concept. A combination of concept types can be advantageous where more costly modifications would be necessary to maintain the original concept. For example, an airline might be suitably accommodated within an existing transporter concept terminal while an addition is needed for a commuter operation with rapid turnovers which would be best served by a linear concept extension. In this event, combined concepts would be desirable. In conclusion, the appearance of concept variations and combinations in a total apron-terminal plan may reflect an evolving situation in which altering needs or growth have dictated the use of different concepts.



KEY
1 BOARDING DEVICE
2 PUBLIC CORRIDOR
3 DEPARTURE LOUNGE SECOND LEVEL
4 SECURITY FACILITIES
5 OPERATIONS GROUND LEVEL

FIGURE 3-3. LINEAR CONCEPT

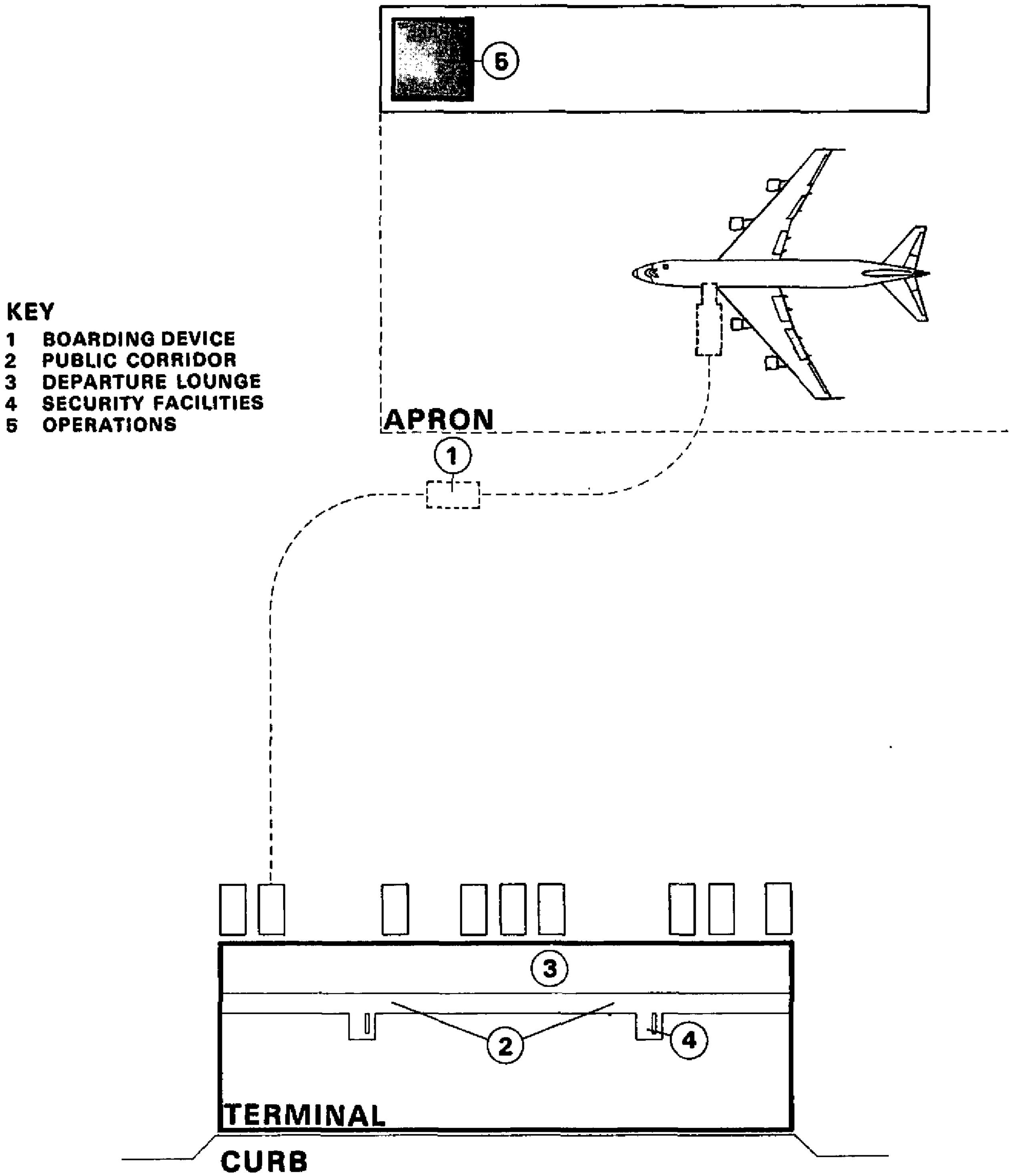


FIGURE 3-4. TRANSPORTER CONCEPT

CHAPTER 4. DESIGN CONSIDERATIONS OF PUBLIC-USE AREAS

20. GENERAL. This chapter provides guidance concerning spatial requirements to accommodate the several functions carried out within the public areas of the airport terminal. The guidance is indicative of the design range in use at U.S. airports to accommodate domestic scheduled passenger operations. Appropriate adjustments may be necessary to handle international, nonscheduled, third level, or charter operations. Airport terminals should be designed to be responsive to the projected needs of the community being served. The owner and the architect-engineer should modify and adjust the guidance herein after consultation with the airlines, FAA, other users, and tenants. The design should be in conformity with appropriate local, state, or national building codes, including the federally imposed requirement to design for the physically handicapped.

21. TERMINAL "LANDSIDE" ACCESS. The curb element is the interface between the terminal building and the ground transportation systems. A survey of the airport users will establish the number of passengers using each of the available ground transportation modes such as private automobile, taxi, limousine, courtesy car, public bus, rail, or rapid transit.

a. Terminal Curb. The length of curb required for loading and unloading of passengers and baggage is determined by the type and volume of ground vehicle traffic anticipated in the peak period of the design day. Airports with relatively low passenger levels may be able to accommodate both enplaning and deplaning passengers from one curb face. More active airports may find it desirable to physically separate the enplaning from the deplaning passengers; horizontally if space permits, vertically if space is limited.

b. Entryways and Foyers. Entryways and foyers are located along the curb element and serve as a weather buffer for passengers entering and exiting the terminal building. The size of an entryway or foyer depends upon its intended usage; as entrances and exits they may be relatively small, as sheltered public waiting areas they should be sized to meet local needs. Designs must accommodate the physically handicapped.

22. TERMINAL LOBBY AREAS. Three functions of significance to an air traveler performed in a terminal lobby are: (1) passenger ticketing, (2) passenger and visitor waiting, and (3) baggage check-in and claiming. Airports with less than 100,000 annual enplanements frequently carry out the three functions in a single lobby. More active airports usually have separate lobbies for each function.

a. Ticketing Lobby. As the initial objective of most passengers, the ticketing lobby should be arranged so that the enplaning passenger has ready access to and clear visibility of the individual airline locations. Airline ticketing with its related administrative and support space is carried out in exclusive-lease space. Therefore, each airline operating from the terminal must be contacted for these requirements.

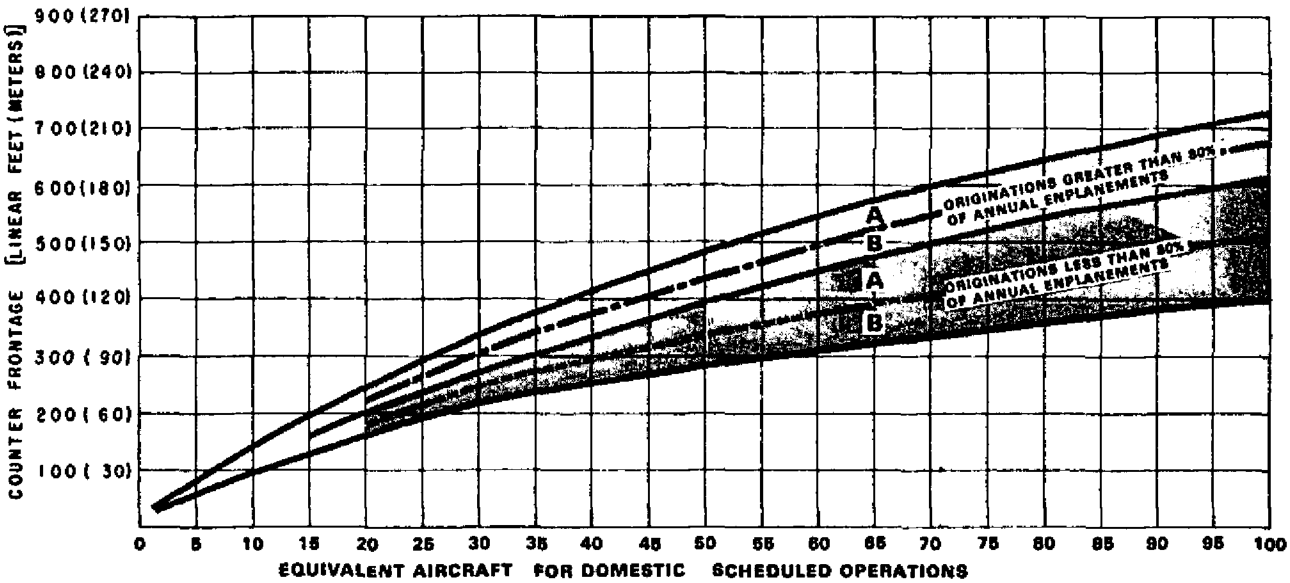
(1) Lobby Size. Ticketing lobby size is a function of the ticketing counter lengths and the width allowed for ticketing/check-in queues and lateral circulation.

(2) Area Approximations. Figure 4-1 may be used to estimate ticketing counter length. The counter length figure, validated by the airline tenants, is multiplied by the depth allowed for passenger queueing and lateral circulation. Queueing lengths of 12 to 15 feet (3 to 5 m) are considered reasonable with an additional 15 to 35 feet (5 to 11 m) allowed for circulation. Figure 4-2 may be used to approximate the ticketing lobby area.

b. Waiting Lobby. In addition to public seating space, the waiting lobby provides for passenger and visitor circulation to the principal amenities such as rest rooms, food services, and retail shops.

(1) Lobby Size. The size of a central waiting lobby is influenced by the extent and location of individual departure lounges at the aircraft boarding positions. If departure lounges are located at all aircraft boarding areas, the central waiting lobby may be reduced to seat 15% to 25% of the estimated peak hour passengers plus visitors. If no departure lounges are provided, it will still be reasonable to provide seating accommodations for 60% to 70% of the peak hour passengers plus visitors.

(2) Area Approximations. Figure 4-3 may be used to approximate the waiting lobby on the basis of projected seating requirements. Passenger requirements may be estimated from boarding load factors obtainable from the airlines. Boarding load factors of 40% to 60% are usual at airports having a preponderance of through flights and of 65% to 80% at airports having a preponderance of originating/terminating flights. Visitor-passenger ratios must be determined locally.



EQUIVALENT AIRCRAFT

SEATS	(A) TERMINAL GATES	(B) EQUIVALENT AIRCRAFT FACTOR	(C) EQUIVALENT AIRCRAFT
UP TO 80	______	.6	______
81 TO 110	______	1.0	______
111 TO 160	______	1.4	______
161 TO 210	______	1.9	______
211 TO 280	______	2.4	______
281 TO 420	______	3.5	______
421 TO 500	______	4.6	______

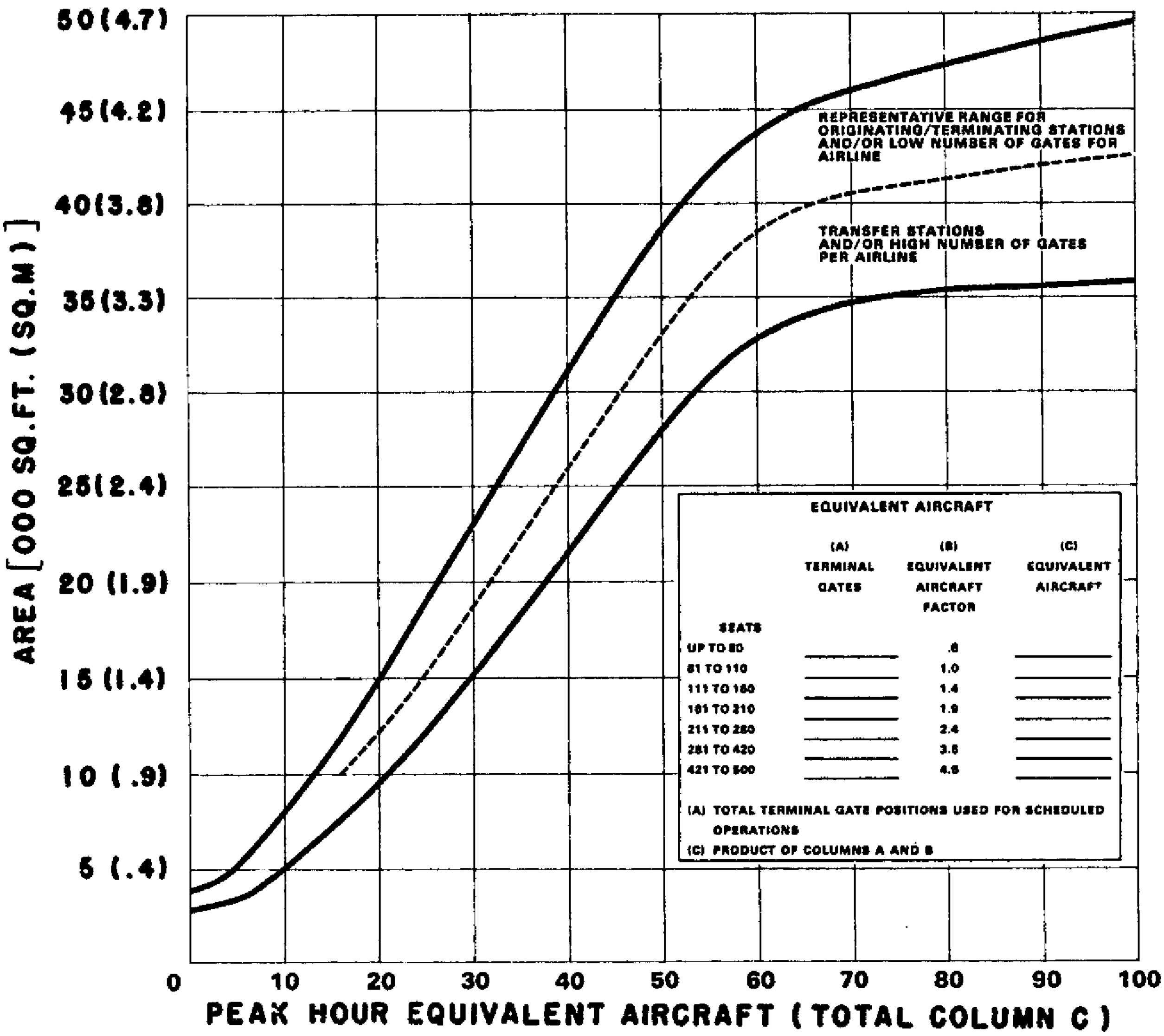
(A) TOTAL TERMINAL GATE POSITIONS USED FOR SCHEDULED OPERATIONS

(C) PRODUCT OF COLUMNS A AND B

(A) TYPICAL WHERE PEAK HOUR GATE UTILIZATION HAS HIGH PERCENTAGE OF DEPARTURES (EQUAL OR GREATER THAN 80% OF EQUIVALENT AIRCRAFT).

(B) TYPICAL WHERE PEAK HOUR GATE UTILIZATION COMBINES ARRIVALS AND DEPARTURES (DEPARTURES LESS THAN 80% OF EQUIVALENT AIRCRAFT).

FIGURE 4-1. TERMINAL COUNTER FRONTAGE



SEATS	(A) TERMINAL GATES	(B) EQUIVALENT AIRCRAFT FACTOR	(C) EQUIVALENT AIRCRAFT
UP TO 80	______	.6	______
81 TO 110	______	1.0	______
111 TO 160	______	1.4	______
161 TO 210	______	1.9	______
211 TO 280	______	2.4	______
281 TO 420	______	3.5	______
421 TO 500	______	4.6	______

(A) TOTAL TERMINAL GATE POSITIONS USED FOR SCHEDULED OPERATIONS
(C) PRODUCT OF COLUMNS A AND B

FIGURE 4-2. TICKET LOBBY AND COUNTER AREA

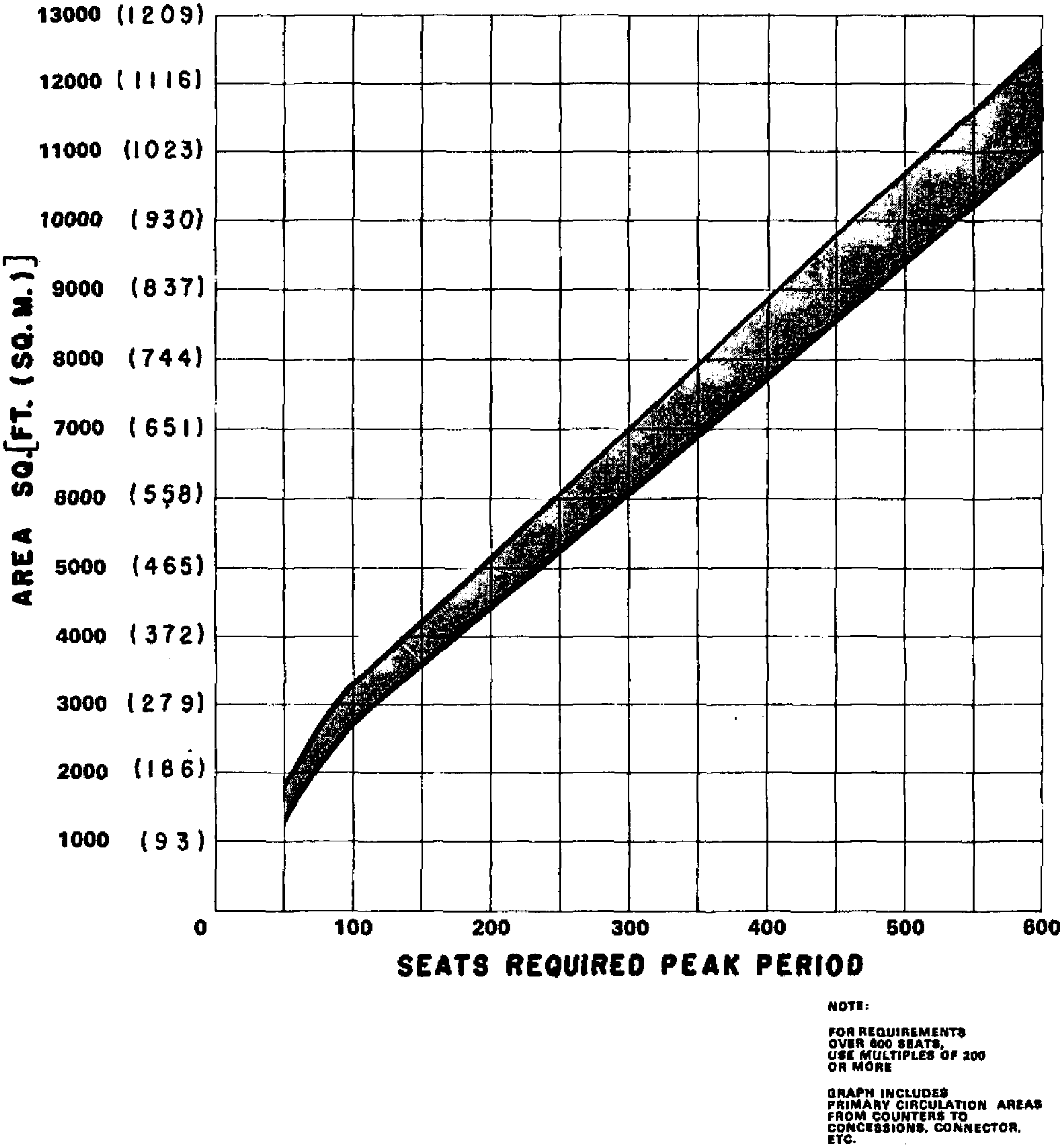


FIGURE 4-3. WAITING LOBBY AREA

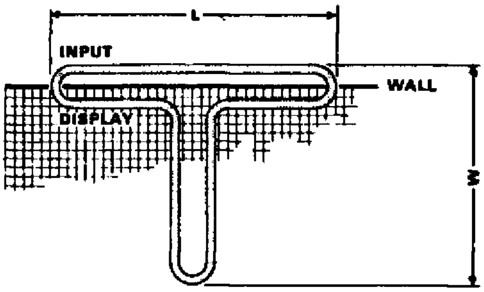
(3) Departure Lounges. The departure lounge serves as an assembly area for passengers waiting to board a particular flight and as the exit passageway for deplaning passengers. It is generally sized to accommodate (1) the number of passengers expected to be boarding the aircraft although all need not be seated, (2) space for airline processing plus passenger queues, and (3) a 5-to-6-foot (1 to 2 m) wide exiting passageway. Processing queues should not extend into the corridor to the extent that circulation is impaired. Lounge depths of 25 to 30 feet (7 to 9 m) are considered reasonable for holding boarding passengers.

c. Baggage Claim Lobby. The baggage claim lobby should be located so that checked articles may be returned to terminating passengers in reasonable proximity to a terminal curb. At low activity airports, checked baggage may be placed on a low counter for passenger claiming. More active airports have installed mechanical delivery-display equipment similar to that depicted in figure 4-4.

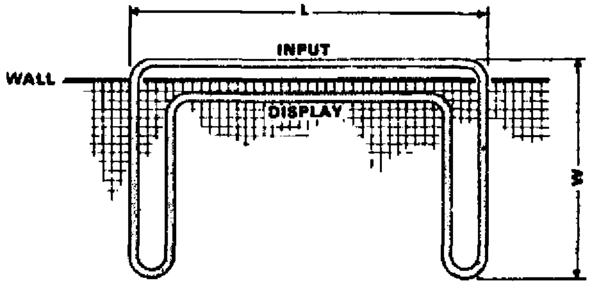
(1) Display Frontage. Figures 4-5 and 4-6 may be used to estimate the length of the display-claim counter or device for differing aircraft arrival rates and terminating passenger levels.

(2) Lobby Size. Figure 4-7 may be used to approximate the area required for baggage claim purposes. It incorporates space for the delivery-display equipment plus a reasonable area for passenger waiting and circulation. An additional 15 to 35 feet (4 to 11 m) of lobby width may be required to allow for public circulation to auto rental counters, telephones, limousine services, etc. Variables that affect baggage claim lobby size include the number of aircraft arriving in a given period, the number of checked bags per terminating passenger, and level of service offered by each airline.

23. CORRIDORS. In certain terminal configurations, corridors are used to provide for public circulation between departure lounges and between departure lounges and the central waiting lobby. Corridors should be designed to accommodate physically handicapped persons during peak surge periods of high density flow. Studies have shown that a typical corridor will have a capacity ranging from 16 to 25 persons per foot width per minute (48 to 75 persons per meter). The rate is predicated on an occupancy width of 2.5 feet (.7 m) per person and a depth separation of 4.0 to 6.0 feet (1.2 to 1.8 m). Table 4-1 lists corridor capacities for several spatial relationships at an average walk rate of 242 feet (74 m) per minute. The relatively abrupt surge of deplaning passengers impacts upon the walk rate but is compensated for by a decrease in observed separations. Corridor design must consider the adverse effect on flow rates of telephone installations, vending machines, drinking fountains, etc., as depicted in figure 4-8.

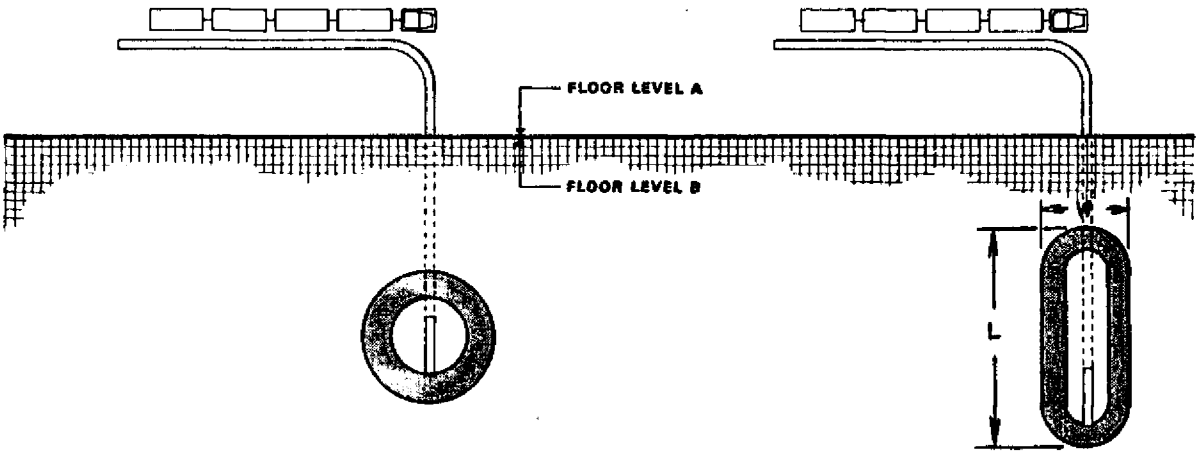


FLATBED — DIRECT FEED



FLATBED — DIRECT FEED

SHAPE	L FT(M)	W FT(M)	CLAIM FRONTAGE FT (M)	BAG STORAGE ①
	65(20)	5 (1.5)	65(20)	78
	85(26)	45 (13.7)	180(55)	216
	85(26)	65 (20)	220(67)	264
	50(15)	45(13.7)	190(58)	228



CIRCULAR
REMOTE FEED SLOPING BED

DIAMETER FT(M)	CLAIM FRONTAGE FT(M)	BAG STORAGE ①
20(6)	63 (19)	94
25(7.5)	78 (24)	132
30(9)	94 (29)	169

OVAL
REMOTE FEED SLOPING BED

L FT(M)	W FT(M)	CLAIM FRONTAGE FT(M)	BAG STORAGE ①
36(11)	20(6)	95(29)	170
52(16)	20(6)	128(39)	247
68(21)	18(5.5)	156(48)	318

① THEORETICAL BAG STORAGE — PRACTICAL BAG STORAGE CAPABILITY IS 1/3 LESS

FIGURE 4-4. MECHANIZED CLAIM DEVICES

EQUIVALENT AIRCRAFT

SEATS	(A) PEAK ARRIVALS 20 MINUTES	(B) EQUIVALENT AIRCRAFT FACTOR	(C) EQUIVALENT AIRCRAFT IN PEAK
UP TO 80	________	.6	________
81 TO 110	________	1.0	________
111 TO 160	________	1.4	________
161 TO 210	________	1.9	________
211 TO 280	________	2.4	________
281 TO 420	________	3.6	________
421 TO 500	________	4.6	________

A) IF "DESIGN DAY" ACTIVITY DATA IS NOT AVAILABLE, PEAK 20 MINUTE ARRIVALS CAN BE APPROXIMATED AS 50% OF AIRCRAFT DEPARTURES FORECASTED FOR PEAK HOUR-AVERAGE DAY OF PEAK MONTH (STARTING WITH LARGEST TYPE AND MOVING DOWN IN SIZE). FOR FIGURE 4-21 ASSUME ONE OF LARGEST AIRCRAFT PLUS 50% OF REMAINDER.

C) PRODUCT OF COLUMNS A & B.

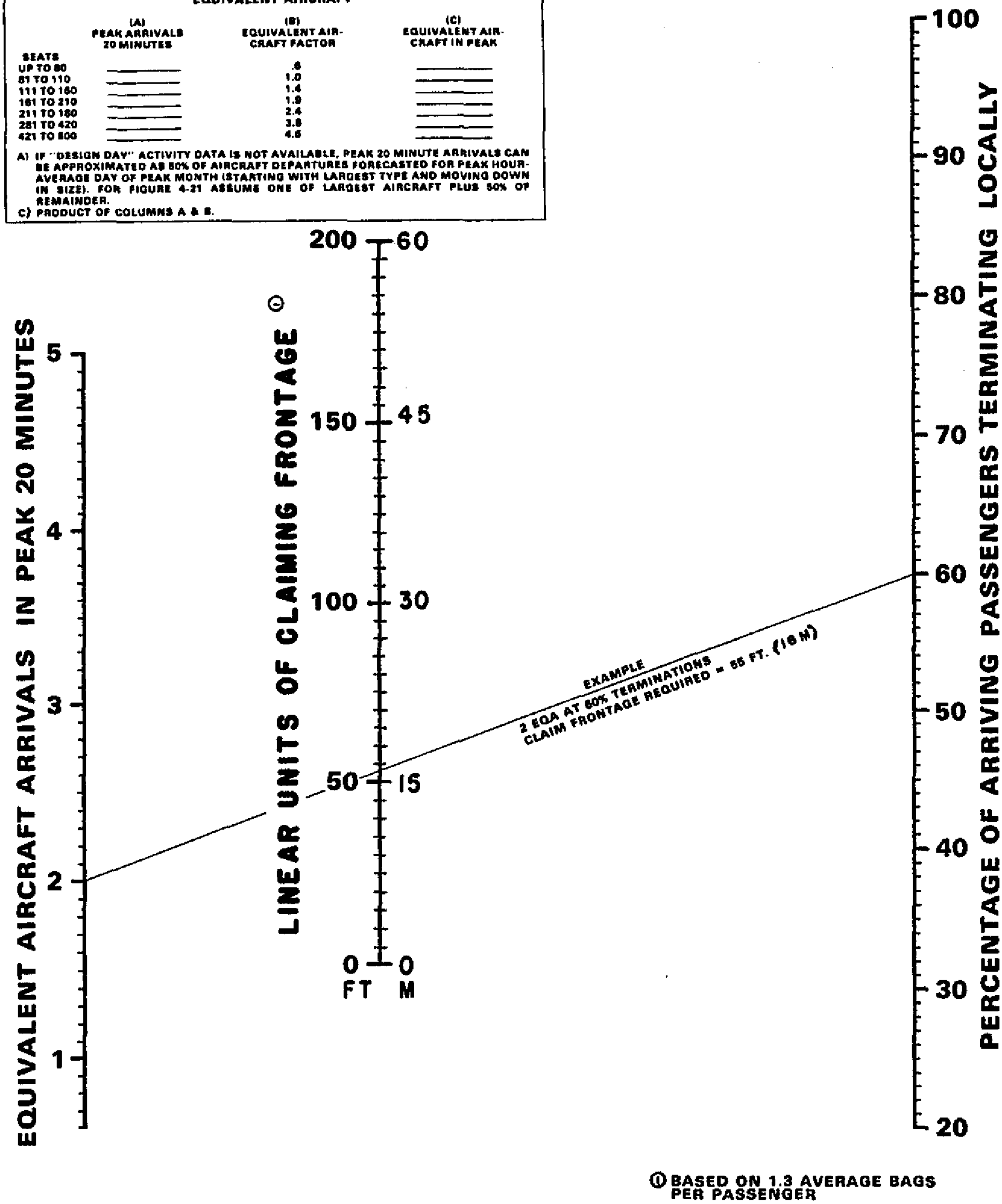


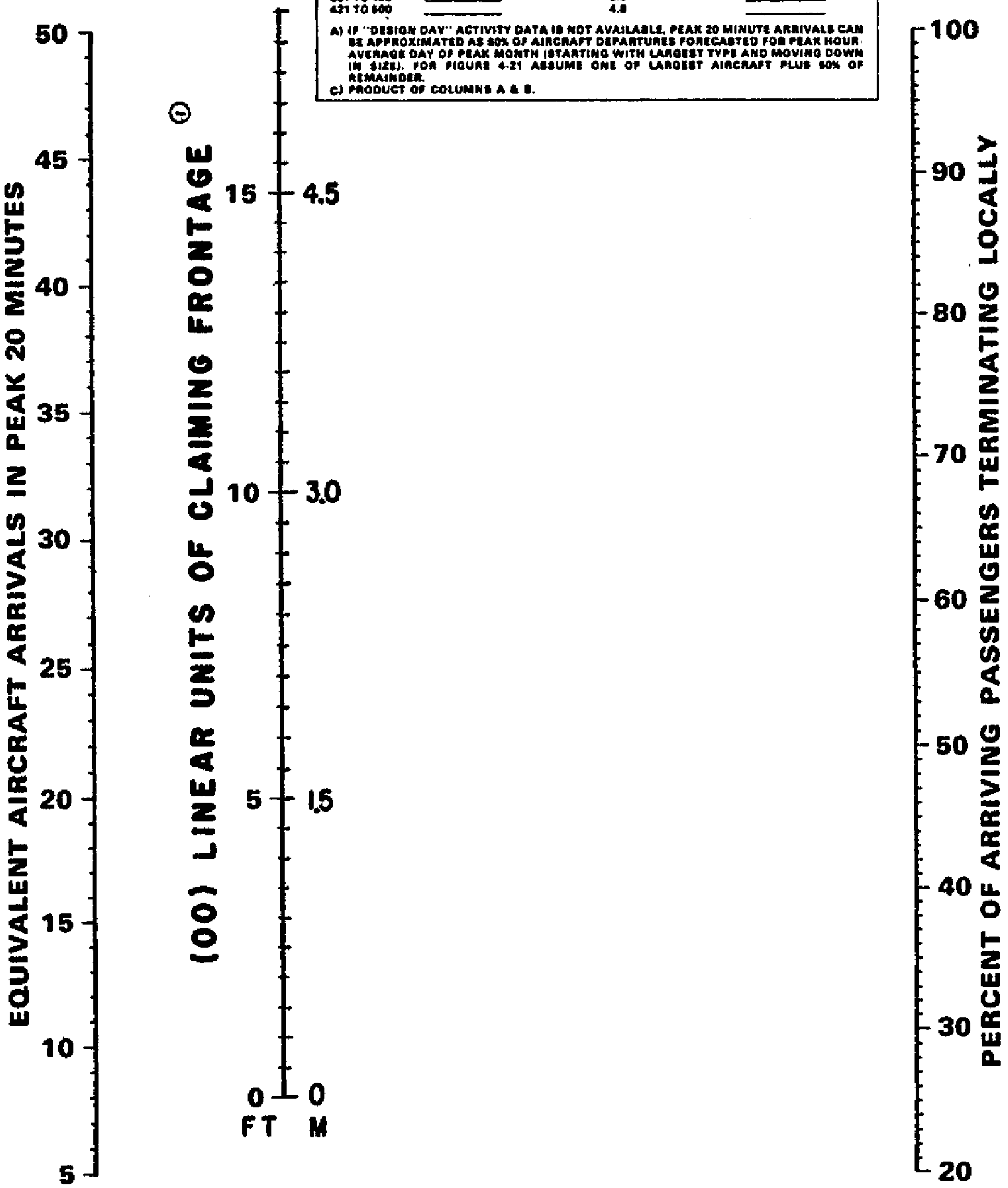
FIGURE 4-5. BAGGAGE CLAIM FRONTAGE
LESS THAN FIVE EQA ARRIVALS IN PEAK 20 MINUTES

EQUIVALENT AIRCRAFT

SEATS	(A) PEAK ARRIVALS 20 MINUTES	(B) EQUIVALENT AIRCRAFT FACTOR	(C) EQUIVALENT AIRCRAFT IN PEAK
UP TO 60	______	.6	______
61 TO 110	______	1.0	______
111 TO 160	______	1.4	______
161 TO 210	______	1.9	______
211 TO 280	______	2.4	______
281 TO 420	______	3.5	______
421 TO 500	______	4.6	______

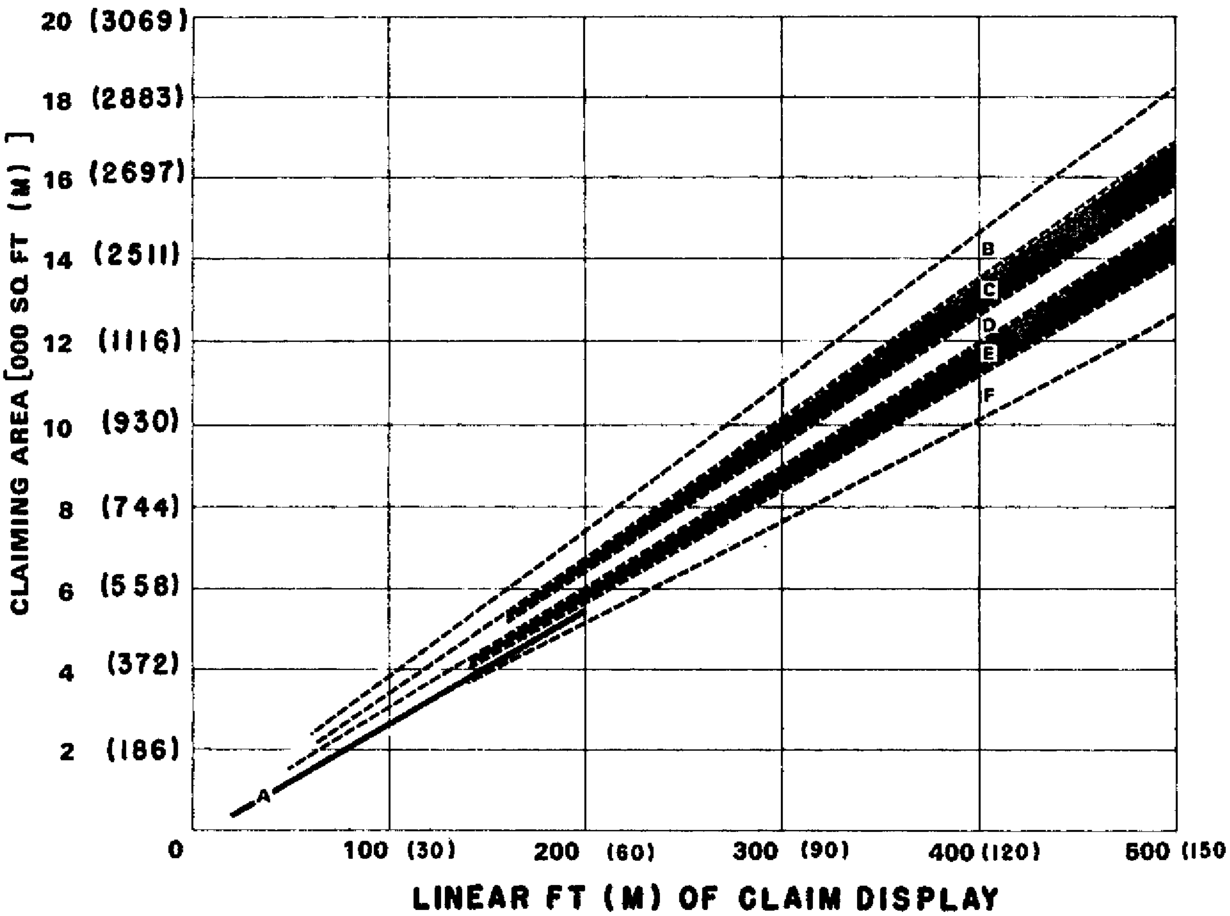
A) IF "DESIGN DAY" ACTIVITY DATA IS NOT AVAILABLE, PEAK 20 MINUTE ARRIVALS CAN BE APPROXIMATED AS 80% OF AIRCRAFT DEPARTURES FORECASTED FOR PEAK HOUR-AVERAGE DAY OF PEAK MONTH (STARTING WITH LARGEST TYPE AND MOVING DOWN IN SIZE). FOR FIGURE 4-21 ASSUME ONE OF LARGEST AIRCRAFT PLUS 50% OF REMAINDER.

C) PRODUCT OF COLUMNS A & B.



① BASED ON 1.3 AVERAGE BAGS PER PASSENGER

FIGURE 4-6. BAGGAGE CLAIM FRONTAGE
FIVE OR MORE EQA ARRIVALS IN PEAK 20 MINUTES



AREAS① FOR OPTIMUM CONFIGURATIONS OF:

A FIXED SHELF PER FIGURE 4-17
B ROUND — SLOPING BED/REMOTE FEED
TEE — FLAT BED/DIRECT FEED
C TEE AND U-SHAPE ALTERNATING @ 75' (22.5 M)
(FLAT BED/DIRECT FEED)
D OVAL — FLAT BED/DIRECT FEED
OVAL — SLOPING BED/REMOTE FEED
E TEE AND U-SHAPE ALTERNATING @ 60' (18 M)
(FLAT BED/DIRECT FEED)
F ⊥⊥ -SHAPE FLAT BED/DIRECT FEED

① INCLUDES INPUT SECTION OF FLAT BED DEVICES

NOTE: FIND DISPLAY LENGTH FROM FIGURES 5-5 OR 5-6. THEN SELECT DEVICE AND READ RANGE OF REQUIRED AREA.

FIGURE 4-7. BAGGAGE CLAIM AREA

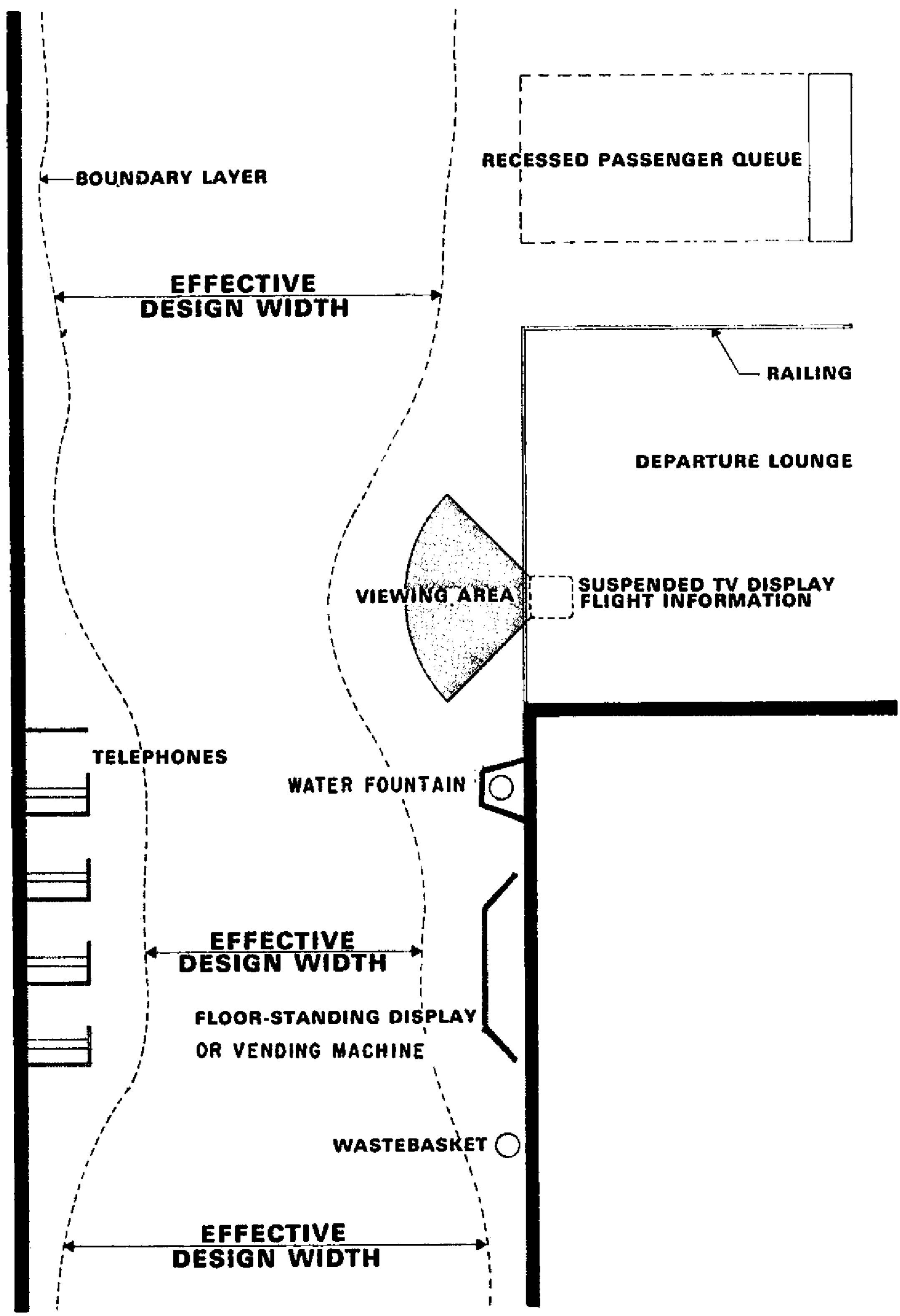


FIGURE 4-8. PUBLIC CORRIDOR EFFECTIVE DESIGN WIDTH

TABLE 4-1. CORRIDOR CAPACITY IN PASSENGERS PER AISLE WIDTH PER MINUTE

Aisle Width ft. (m)	Depth Separation (Front to Front)				
	4.0 (1.20)	4.5 (1.35	5.0 (1.50)	5.5 (1.65)	6.0 (1.80)
2.00 (.61)	30.9	27.5	24.7	22.5	20.6
2.25 (.69)	27.4	24.4	22.0	20.0	18.3
2.50 (.76)	24.7	22.0	19.8	18.0	16.5

24. SECURITY. Security screening of airline passengers is a relatively new but extremely important function to be carried out in an airport terminal. Security screening of passengers and hand-carried articles is required under FAR Part 107, Airport Security, prior to boarding an airline aircraft. Depending on the configuration, security screening may be conducted at various locations in a typical terminal with the area lying between the screening station and the aircraft boarding position considered a sterile area. Corridor and departure lounge congestion may be reduced if visitors are prohibited from sterile areas. Decisions to bar visitors from sterile areas must consider community reaction.

a. Location. Typically, security screening is performed between the ticketing and waiting lobbies, in corridors leading to boarding gates, or in some instances at the boarding gate. In most installations the passenger and the visitor must walk through a magnetometer with hand-carried articles subject to manual search or X-Ray screening.

b. Size. A typical manual search station with two tables to accept and two tables to return search articles plus the magnetometer requires approximately 144 square feet (13 m^2) of space. A typical X-Ray search unit requires approximately 120 square feet (11 m^2) of space.

c. Screening Rate. The rate of a typical screening installation will range from 500 to 600 persons per hour.

d. Baggage Lockers. The architect-engineer should locate baggage storage lockers and incorporate design features that will minimize the potential for bomb injury to the public. This may be accomplished through a design that effectively controls passenger movement in such areas.

25. INTERNATIONAL FACILITIES. Airports with international operations require space for Federal inspection of passengers, crew, baggage, aircraft, and cargo. The area required for Customs, Immigration, Agriculture, and Public Health Service, referred to as Federal Inspection Service (FIS), may be in a separate building or in the terminal proper.

a. Design Considerations. FIS facilities should be designed so that:

(1) Passenger flow between the aircraft and the initial processing station is unimpeded and as short as possible.

(2) There is no possibility of contact with domestic passengers, or with any non-FIS authorized personnel until FIS processing is completed.

(3) There is no possible way for an international arrival to bypass a processing station.

(4) There is no visual or physical contact between international passengers and waiting visitors prior to or during inspection.

(5) All emergency exits from the FIS area are equipped with alarm devices to ensure inspection area integrity.

(6) There is a segregated waiting area for intransit international passengers.

b. Size. The size of the FIS facility is based on the projection of hourly passengers to be processed. Figure 4-9 shows tentative FIS space requirements for different passenger processing rates. It is strongly recommended that the FIS agencies be contacted for advice and assistance prior to planning FIS facilities.

26. OTHER AREAS. Most terminals are developed to accommodate additional activities not cited in the preceding paragraphs. Other area activity and space requirements should be determined for each airport based on local needs and desires. The activities are generally considered revenue producing, nonpublic-use, or exclusive-use in nature.

Units	Number of passengers processed per hour		Reception area (includes pax toilets and queue)	Public health service	Immigration: Inspection booths	Immigration: Secondary inspection	Immigration: Office	Baggage claim	Customs ①: Inspection counters	Customs ①: Search rooms	Customs ①: Office	Agriculture	Staff space ②	Circulation and misc spaces	Total minimum area	Minimum area (per 100 pax)
CUSTOMARY UNITS	200	NO. OF ITEMS			4	1		150 LIN FT	4	2						
		SQ FT REQ			240	200	150		1024	160	500					
		TOTAL	1600	260	590			6000	1684			240	1300	2446	14,120	7060
	400	NO. OF ITEMS			8	1		300 LIN FT	8	2						
		SQ FT REQ			480	200	550		2048	160	950					
		TOTAL	3200	670	1230			12000	3158			380	1950	4964	27,552	6888
	600	NO. OF ITEMS			12	2		450 LIN FT	12	2						
		SQ FT REQ			720	400	750		3072	160	1050					
		TOTAL	4800	790	1870			18000	4282			510	2300	7396	39,828	6638
	800	NO. OF ITEMS			16	2		600 LIN FT	16	2						
		SQ FT REQ			960	400	800		4096	160	1150					
		TOTAL	6400	790	2160			24000	5406			610	2400	10,214	51,980	6498
	1000	NO. OF ITEMS			20	2		750 LIN FT	20	2						
		SQ FT REQ			1200	400	900		5120	160	1300					
		TOTAL	8000	790	2500			30000	6580			780	3100	12,730	64,480	6448
	1200	NO. OF ITEMS			24	2		900 LIN FT	24	2						
		SQ FT REQ			1440	400	1000		6144	160	1300					
		TOTAL	9600	790	2840			36000	7604			920	3100	15,296	76,150	6346
METRIC UNITS	200	NO. OF ITEMS			4	1		45 m	4	2						
		SQ M REQ			22	19	14		95	15	46					
		TOTAL	150	25	55			560	156			22	120	227	1315	658
	400	NO. OF ITEMS			8	1		90 m	8	2						
		SQ M REQ			44	19	51		190	15	88					
		TOTAL	300	60	114			1120	293			35	180	461	2563	641
	600	NO. OF ITEMS			12	2		135 m	12	2						
		SQ M REQ			66	38	70		285	15	98					
		TOTAL	450	75	74			1680	398			47	214	687	3725	621
	800	NO. OF ITEMS			16	2		180 m	16	2						
		SQ M REQ			88	38	74		380	15	107					
		TOTAL	600	75	200			2240	502			57	223	949	4846	606
	1000	NO. OF ITEMS			20	2		225 m	20	2						
		SQ M REQ			110	38	84		475	15	121					
		TOTAL	750	75	232			2800	611			73	288	1183	6012	601
	1200	NO. OF ITEMS			24	2		270 m	24	2						
		SQ M REQ			132	38	93		570	15	121					
		TOTAL	900	75	263			3360	706			86	288	1421	7099	592

NOTE — IMMIGRATION AND CUSTOMS CALCULATED AT A PROCESSING RATE OF 50 PASSENGERS PER HOUR PER BOOTH AND COUNTER. CUSTOMS PROCESSING RATE MUST BE VERIFIED WITH CUSTOMS, AS 50 PASSENGERS PER HOUR PER COUNTER IS THEIR MAXIMUM PROCESSING RATE, AND 35 PASSENGERS PER HOUR PER COUNTER IS A MINIMUM PROCESSING RATE

① BASED ON CUSTOMS ACCELERATED PASSENGERS INSPECTION SYSTEM. (CAPIS).

② STAFF SPACE SHOULD BE CONSIDERED A MAXIMUM REQUIREMENT.

FIGURE 4-9. FEDERAL INSPECTION SERVICE SPACE REQUIREMENTS

a. Airline Activities. These airline activities may exist at some but not necessarily all terminals. In some cases the function to be performed dictates location.

(1) Outbound baggage makeup.

(2) Inbound baggage transfer to delivery-display.

(3) Cabin services.

(4) Line maintenance.

(5) Flight operations.

(6) Crew grooming or ready area.

(7) Storage areas for valuable or outsized baggage.

(8) Airfreight and mail pickup and delivery.

(9) Passenger reservations.

(10) Administrative offices.

(11) VIP passenger waiting areas.

(12) Ramp vehicle and cart parking and maintenance.

b. Passenger Amenities. Factors that influence the extent of the listed passenger amenities include: passenger volumes, community size, location and extent of off-airport services, interests and abilities of potential concessionaires, and rental rates.

(1) Food and beverage services.

(2) News and tobacco stands.

(3) Gift, apparel, drug stores, and florist shop.

(4) Barber shop and shoe shine stand.

(5) Counters for auto rental firms or flight insurance companies.

(6) Public lockers.

(7) Public and courtesy telephones.

(8) Manned or automated post offices.

(9) Amusement arcades.

(10) First aid.

c. <u>Airport Operations and Building Services</u>. These facilities or services are normal to most public buildings.

(1) Public restrooms and nursery.

(2) Offices for the airport manager and the airport staffs including police, medical or first-aid, and building maintenance services.

(3) Government offices.

(4) Building mechanical systems such as heating, ventilation, and air conditioning.

(5) Circulation requirements, both vertical and horizontal, not covered as lobby or corridor space.

(6) Electrical vaults.

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