AC 150/5360-9

DATE 4/4/80

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

Subject: PLANNING AND DESIGN OF AIRPORT TERMINAL BUILDING FACILITIES AT NONHUB LOCATIONS

1. PURPOSE. This advisory circular provides guidance material for t planning and design of airport terminal buildings at nonhub locations.

2. RELATED READING MATERIAL. Appendix 1 contains a listing of documents containing supplemental material relating to terminal building planning and design. Ordering information is also contained therein.

3. BACKGROUND. Advisory Circular (AC) 150/5360-7, Planning and Design Considerations for Airport Terminal Building Development, provides guidance for the planning and design of airport terminals. The material contained within it is applicable to all airports serving air carriers, regardless of size. Because of this wide range of coverage, the material is necessarily very general in nature and of limited usefulness in providing detailed planning guidance, particularly for less sophisticated, low activity airports. To remedy this, a contract was awarded to the airport facility consulting firm of Arnold Thompson Associates, Inc., to provide assistance in the development of guidance material for the planning of terminal building facilities at nonhub locations. The nonhub category of airports was chosen as it represents a range of airports with relatively unsophisticated and uniform characteristics. The results of this contractual effort are presented in this circular.

William V. Vitale

WILLIAM V. VITALE
Director, Office of Airport Standards

Initiated by: AAS-200

CONTENTS

Chapter 1. INTRODUCTION

Chapter 2. FINANCIAL CONSIDERATIONS

Chapter 3. TERMINAL LOCATION FACTORS

Chapter 4. PLANNING CONSIDERATIONS

Chapter 5. PEAKING AND DEMAND FORECASTS

Chapter 6. FACILITY REQUIREMENTS

Chapter 7. SPECIAL CONSIDERATIONS

APPENDIXES

Figure

CHAPTER 1. INTRODUCTION

1. DESCRIPTION OF A NONHUB AIRPORT. The Civil Aeronautics Board (CAB) classifies geographic areas of domestic air traffic in the United States by each area's percentage of the total enplaned revenue passengers in all services and all operations of the U.S. certificated route air carriers. Geographic areas served by scheduled airlines which produce less than 0.05% of the annual U.S. total enplaned passengers are termed "nonhub." Airports within these geographic areas are referred to as "nonhub airports As an example, in Calendar Year 1978, geographic areas generating less than approximately 132,000 domestic enplaned passengers were in the nonhub category. Generally at nonhub airports, enplaned passengers and deplaned passengers are equal in number. Therefore, total annual passengers can be assumed to be twice the enplaned figure.

2. FUNCTIONS OF A NONHUB AIRPORT PASSENGER TERMINAL. The passenger terminal at an airport is the interface between ground and air transportation. As such, its primary purpose is to provide for the safe, efficient, and comfortable transfer of passengers and their baggage to and from aircraft and various modes of ground transportation. To accomplish this, essential elements such as ticketing, passenger processing, baggage handling, and security inspection are required. These are supported by food service, car rental, shops, rest rooms, airport management, and other ancillary functions. An airport passenger terminal is similar in many ways to other transportation terminals but has some distinctly different characteristics. The ground time of aircraft is kept to a minimum; and therefore, facilities must be able to accommodate compressed peak passenger and baggage conditions. Airports are generally remotely located from urban centers, requiring the use of private automobiles. This creates the need for adequate roadway access and parking facilities to a greater extent than at other urban transportation terminals. The terminals at nonhub airports not only serve scheduled airlines but, in most cases, also accommodate charter flights, commuter airlines, air taxis, and general aviation activities. In addition, some airports may handle international operations and be designated an international airport of entry or landing rights airport and thus require Federal Inspection Services and facilities in the terminal.

3. USE OF THIS GUIDANCE MATERIAL. This advisory circular is designed to be used as a general reference by planners. The planning and design of a small terminal building can be complicated since so many factors are involved. The information presented is intended to make the planner aware of the most important considerations, to avoid major errors, and to aid in providing a basis for the development of preliminary studies. The guidelines set forth in this circular cannot take in all factors and may require modification as individual project circumstances dictate.

4. PROJECT COORDINATION. Building a new or expanding an existing airport terminal facility requires considerable coordination and input involving a number of airport users and other interested parties. Consequently, it is both important and necessary that the architect/engineer develop and maintain a line of communication with all these groups from the earliest stages of the project to its ultimate conclusion. The requirements and input of each group will differ somewhat and, in some cases, may conflict with each other or with the design concept. These differences require resolution and/or compromise prior to the design stage. To avoid overlooking important user requirements resulting in costly and time-consuming design changes, it is often prudent to establish a facilities development advisory committee for the terminal project. This advisory committee should be composed of airport management representatives, airline facilities planning representatives, selected building tenants and concessionaires, and other airport users and parties having particular interest in the facility. The airport manager or a representative of the airport owner should normally chair this committee. Regardless of whether or not such a committee is established however, the architect/engineer, as the designer of the facility, has a responsibility to insure that coordination is achieved with those persons and/or organizations having necessary input from the initial studies through final design. Examples of interested groups include:

a. Airport Management. The airport manager and the staff are usually the primary contacts for the architect/engineer in planning and designing a terminal facility. Usually the manager of the appointed representative will serve as the focal point for project coordination. As the chief administrator of the airport, the airport manager has detailed knowledge of airport activities and operational requirements as well as other factors that will influence the final design. In all likelihood, he/she is a source of financial data on airport revenues and outlays; is aware of budgetary limitations as well as local governmental considerations; and can provide insight into local community values and cultural characteristics that might influence the building design and architecture. The airport manager may also have a wealth of experience in prior airport design and construction projects of a similar nature and thus can be extremely helpful and contribute a great deal as an active member of the design team.

b. Airlines. As the primary airport terminal building occupants, the airlines have very specialized requirements for space and facilities within the terminal area. It is therefore extremely important that their input, cooperation, and participation in the review process be sought and maintained throughout the design period. The airline facilities planner, in addition, can provide valuable information on passenger and aircraft-type forecasts and is a source of technical expertise on many aspects of airport designs. For this information and assistance, the headquarters of each airline operating into a particular airport should be contacted directly.

c. Federal Aviation Administration (FAA). Federal funds are available for the planning, design, and construction of airport facilities at public airports (see paragraph 10). Whenever such funds are utilized, there is a requirement that Federal standards and environmental requirements be met. If is therefore suggested, particularly when the architect/engineer is unfamiliar with FAA grant procedues, that the appropriate FAA Airports District or Regional Office having jurisdiction over the airport be consulted during the early stages of the project. Also, where FAA air navigation facilities are located on the airport, appropriate FAA field offices should be contacted and consulted to insure that the terminal design does not interfere with the operation of existing or planned FAA facilities and that FAA facility requirements to be furnished by the airport operator are incorporated in the design. The airport manager will be cognizant of the appropriate FAA field offices to contact. (See AC 150/5000-3, Address List for Regional Airports Divisions and Airports District/Field Offices, current edition.)

d. Local and Regional Public Agencies. In a case of a new terminal facility, local and regional planning and public agencies should be contacted to insure that the facility location does not conflict with local plans and building code restrictions. Since airport access is a major concern in locating a terminal facility, it is particularly important that coordination with local and state highway departments be maintained.

e. Terminal Building Occupants. In addition to airlines, a number of tenants rent space in the terminal building or adjacent to it. They include concessionaires, food service operators, air taxi and fixed base operators, and rental car and parking lot operators. These tenants have specialized needs and should be consulted as to their facility requirements.

f. Others. Each airport's operating body, such as commissions or authorities, will have particular characteristics that may impose additional coordination requirements with individual or specialized groups. In addition, the airport may employ terminal planning and/or financial consultants to serve as part of the project team. Close cooperation between team members is essential to the success of the project.

5. REFERENCE DOCUMENTS. Before the planner/engineer commences the preparation of an airport terminal development program, familiarization with the following reference documents is essential.

a. Airport Master Plan. Most airports will have a current master plan on file. Such a plan depicts the ultimate development of a specific airport and serves as the basis for the detailed design and engineering of all public airport improvements. It presents the research and logic from which the plan evolved in a graphic form and includes a written report. Master plans are applied to the expansion of existing airports and to the site selection and planning of new airports. They provide much useful information to the terminal planner with respect to the airfield and associated facilities.

Included in the master plan are aviation activity forecasts, dimensional layouts of existing and future runways, taxiways, aprons, terminal areas, approach zones, air navigation aids, and financial and environmental considerations. No major airport expansion or terminal development should be undertaken without having a current, comprehensive master plan. Details on the contents of airport master plans are contained in AC 150/5070-6, Airport Master Plans, current edition.

b. Advisory Circulars. FAA issues advisory circulars as a means of providing guidance materials and promulgating standards on aviation and airport matters. These circulars provide essential information on the design and construction of airport facilities, particularly when Federal funds are involved in the development of the airport. The advisory circulars which are considered most relevant to the terminal planner and which provide necessary supplemental guidance material are referenced in appropriate paragraphs of this circular and in the Bibliography listed in Appendix 1.

c. Federal Aviation Regulations (FAR). In some instances, FAA advisory circulars may not adequately cover a subject sufficiently in depth. Consequently, it sometimes is necessary to refer directly to the pertinent FAR's. FAR's of interest to the terminal planner are listed in Appendix 1.

d. FAA Reports. There are several Department of Transportation (DOT) and FAA reports available which provide useful information relating to terminal complex projects. These reports, together with ordering information, are also listed in Appendix 1.

6. METRIC UNITS. To promote an orderly transition to metric units, the text and drawings include both English and metric units. The conversion to metric units herein does not always result in exact equivalents.

CHAPTER 2. FINANCIAL CONSIDERATIONS

7. IMPORTANCE OF FINANCIAL PLANNING. The financial aspects of new, expanded, or modified passenger terminals should be given careful consideration beginning in the early stages of planning. The revenue-producing capability of passenger terminals designed for passenger volumes at nonhub communities is often limited, and only modest amounts of Federal aid for such projects are currently available. Prudent financial planning requires a hard look at an airport's capability to produce revenues and careful consideration of sources of capital funds at the local, state, and Federal levels. Revenues and capital will be limited; and such limitations must be considered in selecting terminal size and design criteria, materials to be used in construction, and planning of the project.

8. THE ECONOMIC IMPORTANCE OF THE AIRPORT TO THE LOCAL COMMUNITY. The value of the airport to the community is often a factor in the ability to raise local capital funds, especially if tax monies are required. A thoughtfully designed survey of the business community to define the airport's economic contribution often produces enlightening results and can become an important element in any campaign to raise local funds. Local citizens do not always realize how valuable a financial asset their airport is. In all cases, it is better to be prepared with facts and figures about the cost of construction for various alternatives, combinations of capital available, potential revenues from the facility, and general economic benefits which will accrue to the local community as a result of airport development.

9. FINANCIAL FEASIBILITY. A financial feasibility study should be made in the early stages of planning to indicate whether the project can be self-supporting from its own revenues or, if not, the extent to which annual financial support will be required from the airport operator. Some financial aspects of an airport terminal building project are discussed below.

10. FUNDING SOURCES. There are a number of possible funding sources and financial mechanisms that are utilized for funding the project costs of terminal development. The most common of these are discussed below.

a. Federal Grants-in-Aid. There are three common types of Federal grants-in-aid that are utilized for airport terminal area projects. These include:

(1) Airport Planning Grants. Terminal area planning can be undertaken as part of a complete airport master plan under the Planning Grant Program (PGP). This program provides Federal funds to airport operators to undertake airport master planning studies.

(2) Airport Development Aid Program (ADAP) Grants. Grants for detailed planning, design, and construction of terminal buildings are available under the ADAP program. These grants normally cover 50% of the cost for the design and construction of nonrevenue-producing public-use areas in terminal buildings serving air carriers. Other eligible terminal facilities, including access and circulation roads and security facilities, may be eligible at a higher rate of Federal participation. Details on the program can be found in FAR Part 152 and AC 150/5360-6, Airport Terminal Building Development with Federal Participation, current edition.

(3) Economic Development Administration (EDA) Grants. EDA grants are available for detailed planning, design, and construction of passenger terminals when communities meet certain economic criteria, such as high rates of unemployment. Details on the EDA programs are available from FAA Airports District Offices and Regional Offices of EDA.

b. State Grant Programs. Many states have grant programs that assist local communities and airport operators in funding eligible support and airport access projects. Funds obtained from these state grants usually can be used by an airport operator and counted as part of the required participation in the project cost when applying for PGP or ADAP grants. State Departments of Transportation (DOT), State Highway Departments, or aviation agencies can provide information concerning the availability of these grants.

c. Financing Methods. Financing the capital costs of airport terminal facilities includes such methods as revenue bonds, general obligation bonds, bank loans, and contributions from the airport sponsor or prospective tenants. Competent legal counsel and financial advice are essential in determining the financing method or combinations most advantageous to the airport. It should be noted that no part of the Federal share of projects is to be included in user charges.

(1) Revenue Bonds. Revenue bonds can be considered if it is reasonably estimated that the terminal facility can produce revenues in amounts equal to the annual costs of operations and maintenance plus 125% of the amount of annual principal and interest due on the bonds. Revenue bonds, because they are backed only by the revenue-earning capability of the terminal facility, or in some instances the whole airport, will carry a higher annual interest rate than general obligation bonds. However, revenue bonds will usually carry a lower rate than available through a bank loan.

(2) General Obligation Bonds. General obligation bonds are usually authorized to be issued for financing airport facilities. As these bonds are backed by the full faith and credit of the local community, they carry a lower annual interest rate than revenue bonds. Since each community

will have a statutory limit on the principal amount of general obligation bonds outstanding at any one time, financing of airport facilities with these bonds must compete with the financing needs of other capital projects in a community.

(3) Bank Loans. Bank loans are sometimes available in limited amounts for short periods (normally about 5 years' maximum) at prevailing interest rates. These rates will usually be higher than required either for general obligation or for revenue bonds. Banks loans are most often used for interim financing of airport capital projects and are usually retired with the proceeds of long-term borrowings on completion of the project.

(4) Advances from the Airport Sponsor of Prospective Tenants. A number of smaller airports have been able to arrange for contributions from the airport sponsor or prospective tenants to reduce the amount of long-term borrowings required to construct a project. It should be recognized that contributions from prospective tenants amount to prepaid rentals for space to be occupied, and appropriate reduction in rental revenues should be expected.

11. REVENUE-ESTIMATING TECHNIQUES. Airport management has various sources available for estimating the future annual revenues that activities in the terminal building will produce to be used to pay for the annual costs of operation, maintenance, and cost of borrowing. Preliminary discussions and eventual final negotiations with airline tenants will fix the rental rate per square foot, which they will pay annually. As concession revenues vary with traffic levels and their location with respect to traffic flow in the building and depend more on the vagaries of passenger preferences and habits, these revenues are more difficult but not impossible to estimate. It is especially important for airport management to weigh carefully revenue/passenger volume data and trends at other airports against its own good judgment about the pecularities of its own airport, the nature and terms of its own concession contracts, and the habits of local citizens. (Some small airports have rather substantial restaurants frequented mostly by local citizens and/or airport employees.) Each airport situation has at least some factors which are unique and which, therefore, must be carefully considered by airport management. In communities where an air carrier airport does not exist and the terminal is therefore part of an initial construction project of the air carrier facility, estimation of terminal revenues is more difficult. A reasonable approach in such a circumstance is to gather and examine terminal revenue histories from other airports which have a terminal size, an activity level, and passenger characteristics similar to that being constructed. As a further check when resorting to data from other airports, contacting organizations such as the Airport Operators Council International and the American Association of Airport Executives, which maintain data files on airport financial characteristics and trends available to members, would be helpful.

12. ANNUAL TERMINAL BUILDING COSTS. The architect/engineer retained to plan the terminal facility is a good source of estimations for annual costs of operating and maintaining the terminal. Operation cost records are good guides for estimating future costs. Assistance by the financial officers of the airport sponsor or of the sponsor's financial advisor to estimate the annual costs of principal, interest, and coverage, if required, would normally be required and is recommended.

13. SAMPLE ESTIMATION OF ECONOMIC FEASIBILITY. Figure 2-1 illustrates a sample worksheet display comparing annual terminal costs and revenues to determine estimated financial results. Dollar amounts are not used as each situation has significantly different cost and revenue characteristics. This does not affect the worksheet's usefulness as a guide, but it should be understood that other display formats may be used. If, on an annual basis, the worksheet results show an excess of costs over revenues (deficit), there are four principal avenues for overcoming this situation: seeking greater contributions in aid for the terminal's initial cost, thus reducing the net amount financed; relying on annual contributions in amounts equal to indicated deficits; increasing revenues from tenants and concessionaires; or finally, in combination with any or all of the above, scaling down the program. Completion of this worksheet or facsimile should provide an indication whether the project can reasonably be estimated to be self-supporting or operate at a deficit and, if so, provide a basis for working out agreements for annual contributions to support operating costs.

COST OF CONSTRUCTION: $ DATE OF INITIAL OPERATION:

LESS CONTRIBUTIONS
IN AID _____ USEFUL LIFE:_____YEARS

NET AMOUNT FINANCED

ANNUAL REVENUE	YEAR 1	YEAR 2	YEAR 3	ETC.	ETC.
Airline Rents Concession Fees & Rents Rental Car Food/Beverages Parking Lot ETC.					
TOTAL REVENUE					
ANNUAL COSTS Interest, Principal and Coverage Operations Maintenance Other					
TOTAL COSTS					
Excess Revenues					
Excess Costs (deficit)					
(Annual Support Required)					

FIGURE 2-1. SAMPLE FINANCIAL FEASIBILITY WORKSHEET

CHAPTER 3. TERMINAL LOCATION FACTORS

14. AIRFIELD VERSUS LANDSIDE. In many cases the site selection for a new passenger terminal is accomplished in the airport master plan. In some instances, however, the terminal area may be only generally located, while in others a number of alternative sites might be shown. The actual terminal location is usually resolved in the design phase where all planning problems must be solved and where the architect/engineer influence is the greatest. It is not always possible to locate the terminal so that ideal relationships are achieved between present and future airfield and landside facilities. In making a trade-off between building a terminal close to the runways thereby limiting future aircraft parking or not leaving adequate space for automobile parking and roadway expansion on the landside, a decision must be made as to which compromise creates the least impact to the airport with respect to safety, efficient operation, and future expansion.

15. RELATIONSHIP OF TERMINAL TO AIRFIELD. The following considerations affect the relative location of the terminal building with respect to the airfield.

a. Aircraft Considerations. The taxiing and parking of air carrier aircraft and the size and type of airplanes have an effect on the location of the passenger terminal on the airport. Such considerations include:

(1) Aircraft Circulation. Aircraft taxiing routes for takeoff should be as direct as possible from the passenger terminal to the ends of the primary runway. Landing aircraft should exit from the runways onto taxiways as quickly as possible in order to minimize taxiing distances to the terminal and to clear the runway for use by other aircraft. It is therefore desirable to locate the passenger terminal centrally with respect to the primary runways and in such a manner as to avoid, if possible, the necessity of landing or departing aircraft crossing active runways when taxiing to and from the parking apron. This will minimize costly and time-consuming taxiing of aircraft and conserve fuel.

(2) Aircraft Parking. An aircraft parking apron is located adjacent to the passenger terminal. The loading and unloading of passengers, baggage, cargo, and mail as well as the fueling, servicing, and light maintenance of aircraft take place at the aircraft parking apron. The distance between the passenger terminal and adjacent runways and taxiways is determined in part by the depth of apron required for the maneuvering and parking of aircraft. Adequate depth for the apron should be preserved for maneuvering and parking of both current and future aircraft and for apron activities. Paragraph 21 contains guidance material on aprons and aircraft parking.

(3) Aircraft Types. A variety of types of aircraft are presently used by domestic air carriers. These aircraft vary considerably in size, weight, and passenger capacity. The type of aircraft in use and expected in the future governs runway and taxiway separations and establishes building and obstacle clearances and setback requirements. The size of the aircraft determines the area of ramp required for aircraft parking and maneuvering, and the aircraft capacity influences the sizing of passenger handling and services within the terminal building. Generally, nonhub air carrier airports are served by a mix of small- and medium-sized aircraft. This could include, for example, the Nord 262, FH 227, BAC 111, YS 11A, DC9-10, 30, 40, 50, 80, B737-100, 200 and B727-100, 200 type aircraft in addition to smaller commuter aircraft. Larger aircraft such as the B720, B707, and DC8, which are frequently used for charter service may be anticipated as well if the airport has a recreational or other special character. The planning of the terminal facility location should take into account the largest type aircraft using or anticipated to use the airport on a scheduled basis. Data on aircraft size and weight can be found in AC 150/5325-5, Aircraft Data, current edition.

b. FAA Design Standards. FAA has established geometric design standards for airport runways and taxiways. Among other things, these standards include minimum clearance distances between runway centerlines and buildings (building restriction line) and between taxiway centerlines and aircraft parking aprons and obstacles. These standards will influence the terminal building location. The terminal planner must be cognizant of building clearance limitations as they apply to existing airport facilities and must consider future airport and aircraft developments. Such considerations will insure that the terminal building and support facilities do not limit the future development and expansion of the airport. For air carrier airports, these design standards are described in AC 150/5335-4, Airport Design Standards--Airports Served by Air Carriers--Runway Geometrics, current edition; and AC 150/5335-1, Airport Design Standards--Airports Served by Air Carriers--Taxiways, current edition. For general aviation airports, similar geometric design standards have been established and are discussed in AC 150/5300-4, Utility Airports--Air Access to National Transportation, current edition, and AC 150/5300-6, Airport Design Standards, General Aviation Airports, Basic and General Transport, current edition.

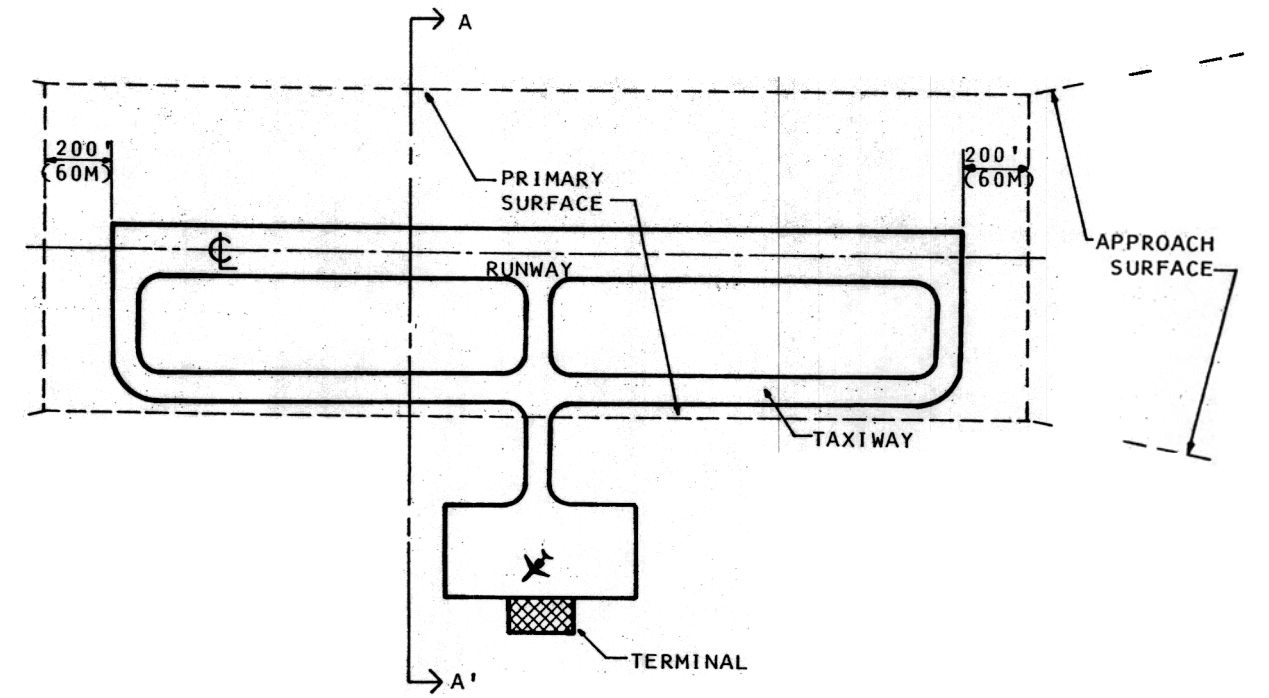
c. FAR Part 77 Obstruction Standards. Obstruction standard requirements are contained in FAR Part 77. A number of imaginary surfaces relating to each runway have been established in order to provide a basis of judging whether an object or building presents an obstruction to air navigation. The size of the surface is determined by the category of each runway and by the approach system to be used. Terminal buildings are usually located along the side of a runway and are, therefore, most likely to be affected by the primary and transitional surfaces. The primary surface extends

outward at zero slope on both sides of the runway centerline and 200 feet (60 m) beyond each end. The width of this surface can vary from 500 feet (150 m) for a noninstrument runway to 1000 feet (300 m) for a precision instrument runway. The transitional surfaces extend upward from the edge of the sides of the primary surface at a ratio of 7:1. No portion of the terminal structure or tail surfaces of parked aircraft should penetrate this imaginary surface. Depending on how aircraft are parked, the 750-foot (225 m) building restriction line, recommended by the FAA, may not be adequate. A diagram of this imaginary surface is shown in Figure 3-1. A terminal building located near the end of a runway can also be affected by the approach surface which extends outward and upward from each end of the primary surface at slopes varying from 50:1 for precision instrument approach runways to 20:1 for noninstrument runways. In determining allowable clearances for siting terminal facilities, consideration of future runway instrumentation is important. The airport master plan can be helpful in this respect.

d. Waivers. Many airports in existence today were constructed before current clearance standards were established. It is recognized that site limitations often make it impossible to meet all recommended clearance and spacing requirements. For example, under some circumstances, the tail structure of aircraft temporarily parked at gates may be allowed to penetrate the transitional surface. When a standard cannot be met and a possible obstruction to air navigation occurs, advice should be sought from the FAA. Subsequent studies may prove that the deviation does not jeopardize air safety and a waiver could be granted. If the deviation involves a building or other fixed structure, obstruction marking and/or lighting as outlined in AC 70/7460-1, Obstruction Marking and Lighting, may be required.

16. RELATIONSHIP OF TERMINAL TO OTHER AIRPORT FACILITIES. Those principal fixed elements of a passenger terminal complex, which are discussed in this chapter, should be located to allow for future expansion of each, with no encroachment on the passenger terminal or adjoining facilities. Figure 4-1 illustrates a desirable relationship of the basic facilities in the passenger terminal complex.

a. FAA Air Carrier Control and Terminal Navigation Facilities. The airport traffic control tower requires unobstructed visibility of all approach areas, runways, and taxiways. If the control tower is located remotely from the passenger terminal, the terminal building and its appurtenances must be located and limited in height so as not to interfere with sight lines from the tower to these critical portions of the airport. In addition, buildings and other new or planned structures may interfere with the operation of various FAA communication and navigation facilities located on the airport. Guidance concerning these facilities can be found in AC 150/5300-2, Airport Design Standards--Site Requirements for Terminal Navigation Facilities. If FAA facilities are located on the airport, the FAA field office(s) operating these facilities should be contacted for guidance and coordination.



PLAN

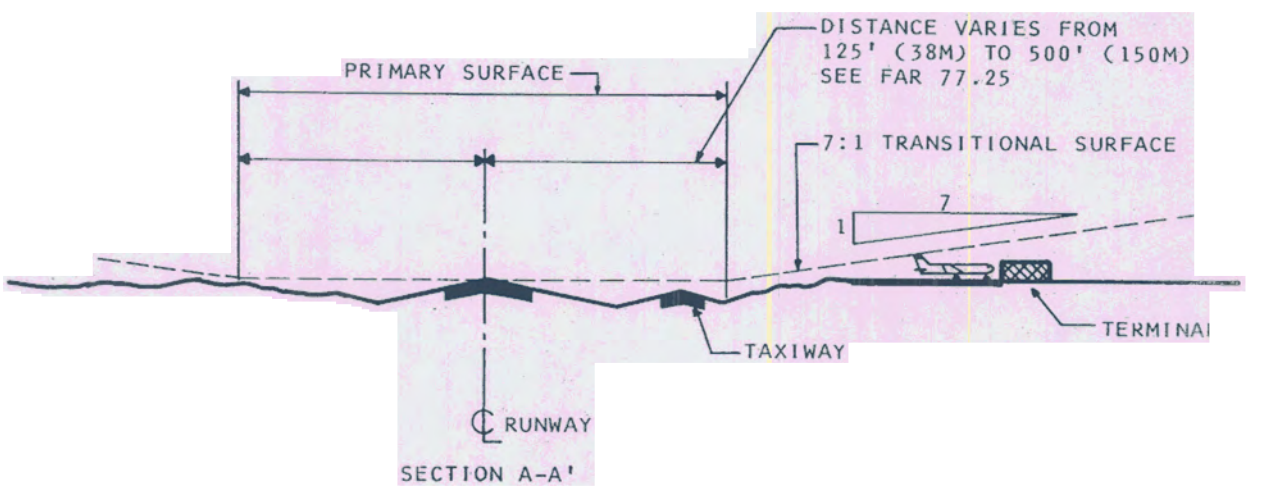


FIGURE 3-1. IMAGINARY SURFACES, FAR PART 77

b. Other Airport Activities. The terminal building site should be located in an area of the airport of adequate size for present and future roadway systems and parking facilities and to accommodate other related airport activities which would benefit from proximity to the passenger terminal. Other terminal-related functions include the following:

(1) Air Cargo Facilities. At most nonhub airports, cargo is carried in the lower compartments of passenger aircraft and processed through the passenger terminal. In some special situations at the larger nonhubs or those that have a sufficient volume of air cargo, a separate cargo building may be desirable. Such a building should be located in reasonable proximity to the passenger terminal to facilitate direct movement of cargo between the cargo building and the aircraft parked at the passenger terminal.

(2) Aircraft Refueling Facility. When provided, it is important for an aircraft refueling facility to be located in reasonable proximity to the terminal area in order to minimize the distance that fuel must be transported by tanker trucks. Access to the facility separate from the public entrance road is desirable. Refueling services are often provided by a fixed base operator.

(3) Rental Car Storage and Maintenance. Rental cars returned to the passenger terminal are moved to a maintenance facility for cleaning and servicing. As cars are ready for rental, some are driven to the terminal area, but the majority will be stored at the maintenance facility until needed. For efficient rental car operations, this facility should be situated convenient to the terminal area.

(4) Crash/Fire/Rescue. Emergency equipment is often manned by employees who have additional responsibilities requiring work in and around the terminal area. In such cases, crash/fire/rescue equipment should be housed in proximity to the terminal consistent with required response times and access to the landing facilities.

17. PHYSICAL SITING CONSIDERATIONS. Site characteristics that may influence the location of the terminal area are as follows:

a. Terrain. Topographical conditions can be a major factor in the selection of the passenger terminal building site. Utilization of relatively level land with good drainage characteristics will usually prove economically advantageous; however, an existing terrain feature such as a grade differential between the landside of the terminal and the aircraft ramp can often be incorporated into the terminal concept. Economic advantages from the reduction of potential construction costs with respect to terminal site selection by utilizing existing topography will be an important factor in any comparison of site alternatives.

b. Existing Conditions. Existing structures and utilities must be carefully inventoried and considered in the planning of new or expanded passenger terminals. In some cases, existing facilities or utilities which are not related and are restrictive to passenger terminal development can be demolished, abandoned, or relocated to a more suitable area of the airport. In other instances, existing conditions will limit the number of possible alternative terminal solutions.

c. Expansion Potential. In order to insure the long-term success of a new passenger terminal or an addition to an existing terminal, potential expansion beyond forecast requirements should always be taken into consideration. In the planning stage, the terminal should be conceived of in its ultimate form with reasonable allowance for growth and changes in operation beyond forecasted needs. The utilization of this principle when selecting a terminal site or an expansion scheme will preserve adequate space around the terminal for orderly construction of succeeding stages. Minimum sizing of terminal areas is discussed in paragraph 36.

d. Environmental Impacts. The location of a terminal building facility or a major expansion of an existing one may result in significant environmental impacts. If this is the case, an environmental impact assessment report is required and building and siting alternatives must be evaluated and incorporated in the report. The requirements for environmental impact documentation are discussed in paragraph 43.

18. RELATIONSHIP OF TERMINAL TO ROADWAYS. The roadway system must be considered concurrently with the planning of the terminal building and auto and aircraft parking.

a. Connection to Highway Network. Access to the airport terminal area is required by air travelers, employees, greeters, visitors, truckers, and ground transportation companies. The private automobile continues to be the major mode of transportation to smaller airports and, as a result, air travelers and terminal area employees will be the main contributors to terminal area traffic. The passenger terminal should, therefore, when possible, be located on the side of the airport nearest to the population center generating the major source of traffic to the airport or the highway serving it. The location of the terminal with respect to the highway should allow sufficient distance to accommodate present and future vehicular traffic concepts such as diamond intersections and the ultimate terminal area development. Inadequate space for proper roadway alignment and possible interchanges is one of the most inhibiting factors of future terminal development.

b. Terminal Access. The terminal roadway system includes the roadway serving the terminal building and associated parking areas, and the service roads which provide access to terminal support facilities, to the airfield, and other nonpublic areas. Provision for adequate vehicular access, efficient circulation, and parking is essential to the success of a passenger terminal. Appropriate allotment of space in the terminal site for this purpose is a paramount planning consideration.