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Airport Design Standards
General Aviation Airports
Basic and General Transport

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

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
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Subject: AIRPORT DESIGN STANDARDS--GENERAL AVIATION AIRPORTS--BASIC AND GENERAL TRANSPORT

1. PURPOSE. This advisory circular provides recommended design criteria for the development of airports serving general aviation business jets and other large aircraft used in general aviation.

2. CANCELLATION. This publication cancels Advisory Circular (AC) 150/5300-6, AIRPORT DESIGN STANDARDS--GENERAL AVIATION AIRPORTS--BASIC AND GENERAL TRANSPORT, dated July 14, 1969.

3. PRINCIPAL CHANGES. In addition to editorial changes made to update material, to provide metric dimensional equivalents, and to recognize changes in titles and references, the following technical changes have been made:

a. The upper weight limit of transport category airplanes accommodated by a general transport (GT) airport has been reduced to 150,000 lb (68 000 kg) gross weight (paragraph 2b).

b. The criteria required for infrequent business jet use of a utility airport runway have been deleted and are now contained in AC 150/5300-4, UTILITY AIRPORTS--AIR ACCESS TO NATIONAL TRANSPORTATION, current edition, (paragraph 3c).

c. In figure 1, dimensional criteria for taxiway safety areas have been included. Also, changes have been made to the following items:

(1) The taxiway width at GT airports;

(2) The distance from the runway centerline at basic transport (BT) airports to:

(i) The taxiway centerline,

(ii) The airplane parking area,

(iii) The property/building restriction line;

(3) The separation between taxiway centerline and airplane parking area at BT and GT airports;

(4) The distance from the runway centerline at GT airports to:

(i) The airplane parking area,

(ii) The property/building restriction line;

(5) For all precision instrument runways:

(i) The runway width,

(ii) The separation between runway centerline and airplane parking area,

(iii) The separation between the taxiway centerline and:

(A) Other parallel taxiways,

(B) Fixed or movable obstacles.

d. The BT performance curves for runway length are now presented for 75 percent and 100 percent of the fleet (figures 4a and 4b).

e. Information on clearways and stopways is now provided (paragraphs 5a and 5b).

f. Detailed information on the sizing of runway safety areas to encompass the concept of the extended safety area has been included.

g. Discussion on the taxiway safety area and the impact of the imaginary surfaces in Federal Aviation Regulations (FAR) Part 77, Objects Affecting Navigable Airspace, on airport design has been provided (paragraphs 7b and 7c).

h. The recommended longitudinal runway grade for GT airports has been revised (figure 9).

4. AIRPORT DEVELOPMENT. The contents of this circular have been assembled to encourage and guide those persons interested in the development of general aviation facilities expected to accommodate aircraft of more than 12,500 lb (5 700 kg) maximum certificated takeoff weight. This advisory circular provides information concerning the FAR criteria, standards, and specifications which must be met and maintained as a condition of participation in Federal assistance programs.

Leonard E. Mudd
LEONARD E. MUDD
Acting Associate Administrator for Airports

CONTENTS

1. INTRODUCTION. This publication is directed primarily to providing the geometric design standards for the group of general aviation airports serving transport category airplanes, including the increasingly popular business jets.

a. This advisory circular should be used in conjunction with AC 150/5300-4, UTILITY AIRPORTS--AIR ACCESS TO NATIONAL TRANSPORTATION, current edition, which presents information and criteria for the planning and development of general aviation airports intended for use by small airplanes. The general information in AC 150/5300-4 pertaining to capacity, wind analysis, runway clear zone configurations, runway orientation, land considerations, preliminary site engineering, airport hazard removal, buildings, hangars, operations, maintenance, administration, and construction plans is applicable to all general aviation airports, including those described in this circular.

b. To promote an orderly transition to metric units, the text and drawings include both customary and metric dimensions. Where possible, the metric dimension is the value recommended by the International Civil Aviation Organization for the equivalent design feature. This value may not be an exact conversion of the customary unit. Airport facilities may be designed in the metric system of units or in the customary system of units. In general, where additions or expansions are planned to an existing facility, such as a runway, a taxiway, or an apron, the units in the original design may be used to extend the work. Where a new facility is to be built, the use of metric units is encouraged.

c. Technical assistance in the planning, design, and construction of airports may be obtained from state aviation officials, Federal Aviation Administration (FAA) airport engineers, and experienced engineering firms. AC 150/5000-3, ADDRESS LIST FOR REGIONAL AIRPORTS DIVISIONS AND AIRPORTS DISTRICT/FIELD OFFICES, current edition, contains the addresses for all FAA regional Airports Divisions and Airports District/Field Offices.

2. AIRPORT CLASSIFICATION. Design standards for basic and general transport airports are set forth in this advisory circular.

a. Basic Transport Airport. The basic transport airport accommodates turbojet powered airplanes up to 60,000 lb (27 200 kg) gross weight. This type of airport is planned for use by business jets.

b. General Transport Airport. A general transport airport accommodates transport category airplanes up to 150,000 lb (68 000 kg) gross weight used in general aviation. For recommended airport design standards to accommodate general aviation airplanes greater than 150,000 lb (68 000 kg) gross weight, AC 150/5335-4, AIRPORT DESIGN STANDARDS--AIRPORTS SERVED BY AIR CARRIERS--RUNWAY GEOMETRICS, current edition, and references therein, should be used.

3. <u>APPLICATION OF DESIGN CRITERIA</u>. Figure 1 contains the recommended widths, minimum separations, and other dimensional criteria for basic transport and general transport airports. Figure 2 shows a typical airport layout with dimensional letters keyed to figure 1. AC 150/5325-5, AIRCRAFT DATA, current edition, should be consulted for aircraft dimensional data.

a. <u>Future Considerations</u>. In order to select the proper design standards, the future role of the airport should be determined as accurately as possible. Where the airport will receive substantial use by general aviation airplanes over 12,500 lb (5 700 kg) in addition to business jets, the design criteria shown in figure 1 for general transport airports should be used. These standards are also applicable to general aviation runways and taxiways provided especially for business jets or large general aviation aircraft at airports served by air carriers. Separation of these facilities at airports served by air carriers should conform to the appropriate criteria for air carrier operational facilities specified in AC 150/5335-4.

b. <u>Parallel Runway Configurations</u>. Parallel runways at basic and general transport airports should be separated according to criteria in AC 150/5335-4. These minimum separations should be considered in the preparation of the airport layout plan, and, when possible, the land required for future construction of a parallel runway configuration should be acquired.

c. <u>Utility Airport Expansion</u>. The dimensions shown in the precision instrument runway column of figure 7-1, AC 150/5300-4, are the minimum required in conjunction with the extension of a runway at an existing utility airport to accommodate business jet airplanes on an infrequent basis. At new airports serving business jets, the basic transport standards of figure 1 should be used. The lateral basic transport dimensions are also sufficient to accommodate infrequent use by large aircraft other than jet aircraft over 60,000 lb (27 200 kg).

d. <u>Precision Instrument Runway Clearances</u>. If an operational demand sufficient to justify a precision instrument runway designation is anticipated, the precision instrument runway clearances should be provided at the outset.

e. <u>Alternatives</u>. Alternate methods, which may be used in the conversion of an airport from a utility type to a basic transport or general transport airport, are shown in figure 3.

(1) In Concept A the original utility airport runway is utilized as a taxiway with a new runway built at the proper separation from the taxiway.

(2) In Concept B an extension is added to the utility airport runway as the initial development. In the ultimate development, the original runway becomes the taxiway with a new runway constructed at the proper separation from the taxiway.

ITEM	1/ DIM	NONPRECISION INSTRUMENT RUNWAY		PRECISION INSTRUMENT RUNWAY FOR BASIC OR GENERAL TRANSPORT
		BASIC TRANSPORT 2/	GENERAL TRANSPORT 2/	
Runway Length	A	See figures 4a, 4b, and 5	As required by the critical airplane	
Width-Runway	B	100' (30 m)	100' (30 m)	100' (30 m)
-Runway Safety Area	C	300' (90 m)	300' (90 m)	500' (150 m)
-Taxiway 3/	D	40' (12 m)	50' (15 m)	50' (15 m) 4/
-Taxiway Safety Area	E	90' (27 m)	110' (34 m)	110' (34 m) 5/
Runway Centerline to				
-Taxiway Centerline	F	300' (90 m)	300' (90 m)	400' (120 m)
-Airplane Parking Area	G	375' (115 m)	425' (130 m)	675' (205 m)
-Parallel Runway Centerline	H	- Refer to Advisory Circular 150/5335-4 -		
-Property/Building Restriction Line	I	400' (120 m)	500' (150 m)	750' (230 m)
Taxiway Centerline to				
-Parallel Taxiway Centerline	J	150' (45 m)	200' (60 m)	200' (60 m)
-Fixed or Movable Obstacle	K	75' (23 m)	100' (30 m)	100' (30 m)

1/ Letters are keyed to those shown as dimensions on figure 2.

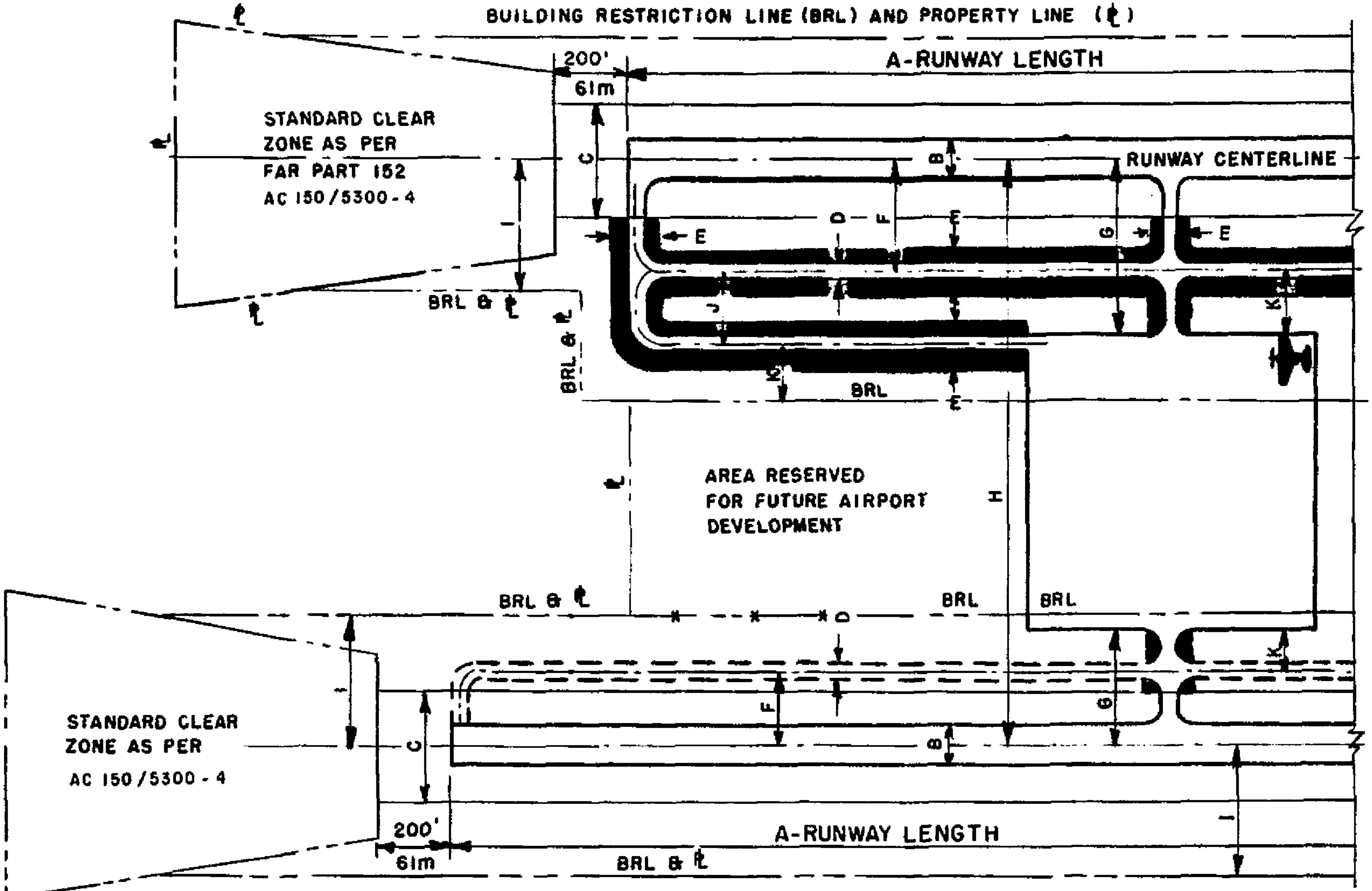
2/ For visibility minimums greater than 3/4 mile. For visibility minimums as low as 3/4 mile, the separation criteria for precision instrument runways should be used.

3/ Refer to figure 7 for criteria on widening taxiway curves and intersections.

4/ A 40' (12 m) width may be used at airports designed to accommodate turbojet aircraft up to 60,000 lb (27 200 kg) maximum gross takeoff weight.

5/ A 90' (27 m) width may be used at airports designed to accommodate turbojet aircraft up to 60,000 lb (27 200 kg) maximum gross takeoff weight.

Figure 1. Dimensional standards for basic and general transport airports.



NOTES:
1. DIMENSION LETTERS ARE KEYED TO FIGURE 1.
2. SHADED AREA SURROUNDING TAXIWAYS DELINEATES THE LIMITS OF THE TAXIWAY SAFETY AREA.
3. PREFERRED LOCATION FOR BUILDING AND AIRPLANE PARKING AREA IS NEAR MIDPOINT OF RUNWAY. THE SIZE AND SHAPE ARE VARIABLE AS REQUIRED.
4. SEE FIGURE 14 FOR AN ALTERNATE TURNAROUND DESIGN
5. SEE FIGURE 12 FOR A SUGGESTED AIRPLANE PARKING AREA FOR BUSINESS JETS.

Figure 2. Typical airport layout.

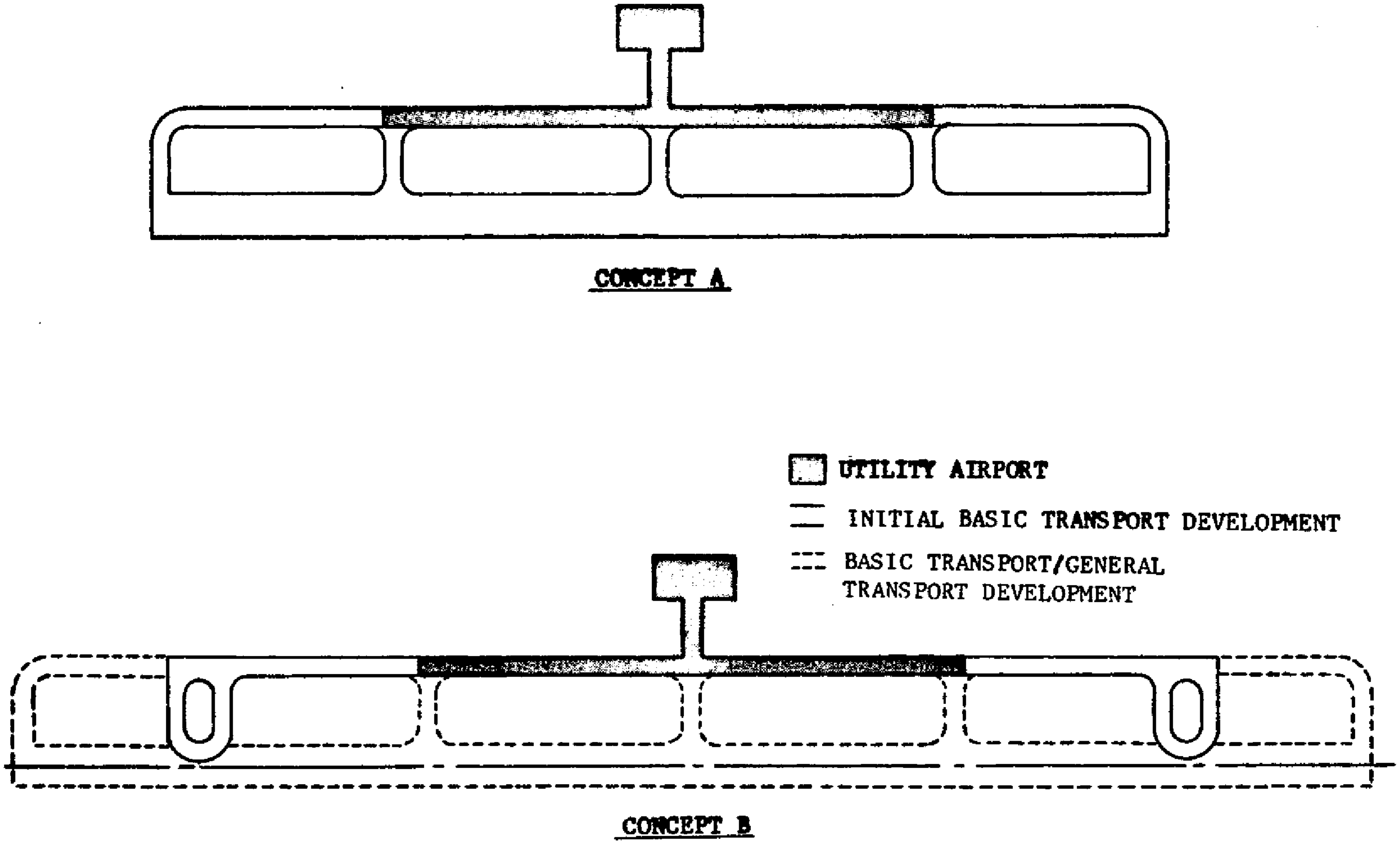


Figure 3. Alternate scheme for expansion of existing general utility airport.

f. New Airports Serving Air Carriers. For large metropolitan areas, forecasts for airline activity may indicate the need for new airports serving air carriers to supplement or possibly even replace existing ones. A practical planning concept is to preserve future land areas for this purpose. While there may be a choice of interim uses for this land, the immediate development of a basic transport or a general transport airport, which can eventually become an air carrier airport, may prove to be the best approach. In these cases, additional land for expansion to an air carrier-size airport should be dedicated and measures should be taken to assure future environmental and airspace compatibility with aircraft operations of this type. If use of the general aviation airport as an air freight terminal can be anticipated, expansion requirements to accommodate future use of large jet freighters should be considered.

g. Airport Layout Plans. Once the role of the airport has been determined and a category has been selected, the governing body of the airport should prepare an airport layout plan. Approval of the plan should be obtained from the FAA, particularly if Federal funds are anticipated in support of the construction. (See AC 150/5070-6, AIRPORT MASTER PLANS, current edition, for further guidance.)

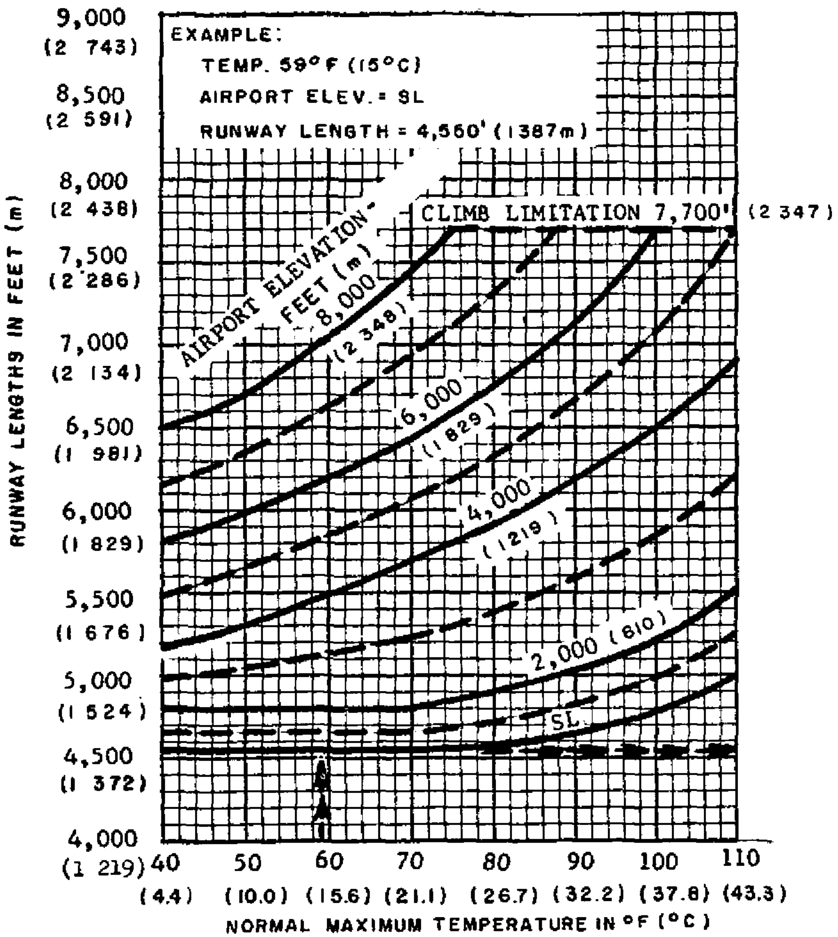
h. Notice of Construction. Proponents of airport projects are required under FAR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports, to give the FAA notice before establishing or substantially altering any runway layout. Such notice allows the FAA to advise the proponent of the effects of the project on the safe and efficient use of airspace by airplanes. (Refer to AC 70-2, AIRSPACE UTILIZATION CONSIDERATIONS IN THE PROPOSED CONSTRUCTION, ALTERATION, ACTIVATION AND DEACTIVATION OF AIRPORTS, current edition.)

4. RUNWAY LENGTH. Recommended runway lengths for basic transport and general transport airports are based on performance curves developed from FAA-approved airplane flight manuals in accordance with the provisions of FAR Part 25, Airworthiness Standards: Transport Category Airplanes, and FAR Part 91, General Operating and Flight Rules. It should be noted that the critical airplane for runway length determination may not be the one which is critical for other design considerations.

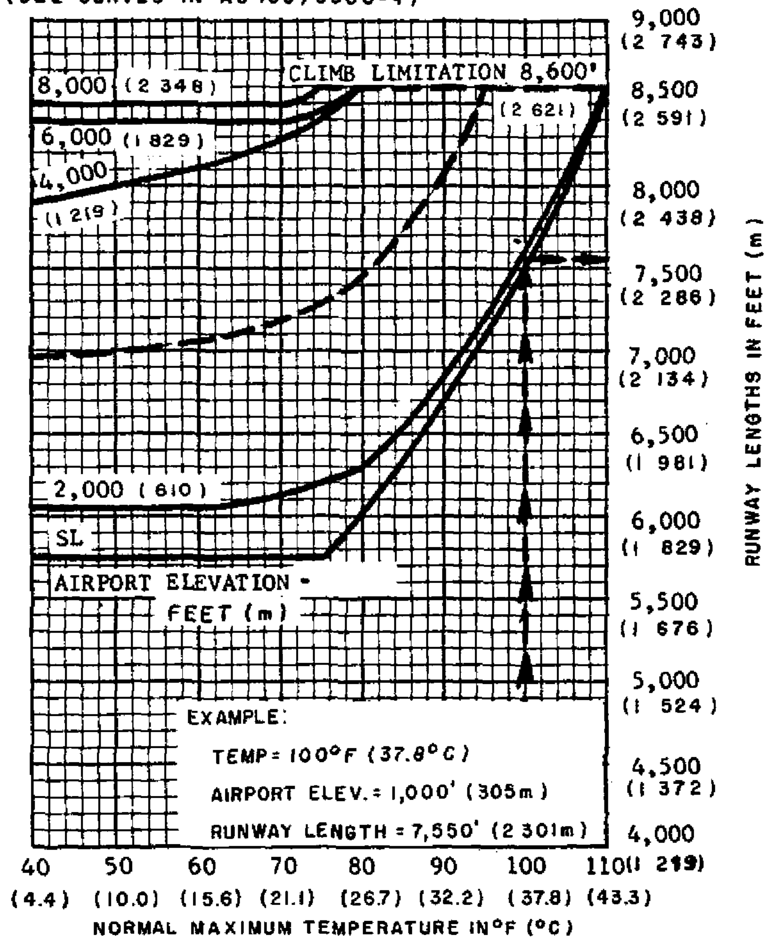
a. Basic Transport.

(1) If the airport is planned for operations that will include only turbojet airplanes under 60,000 lb (27 200 kg) gross weight and other general aviation airplanes of 12,500 lb (5 700 kg) or less, the runway length should be determined by using the applicable curves shown in figures 4a and 4b. At elevations over 5,000 feet (1 500 m) MSL, the runway lengths obtained from the utility airport standards (AC 150/5300-4) may be greater than those obtained by the use of figures 4a and 4b of this advisory circular and, if so, should be provided.

AT AIRPORTS OVER 5,000' (1500m) ELEVATION, THE UTILITY RUNWAY LENGTHS MAY CONTROL (SEE CURVES IN AC 150/5300-4)

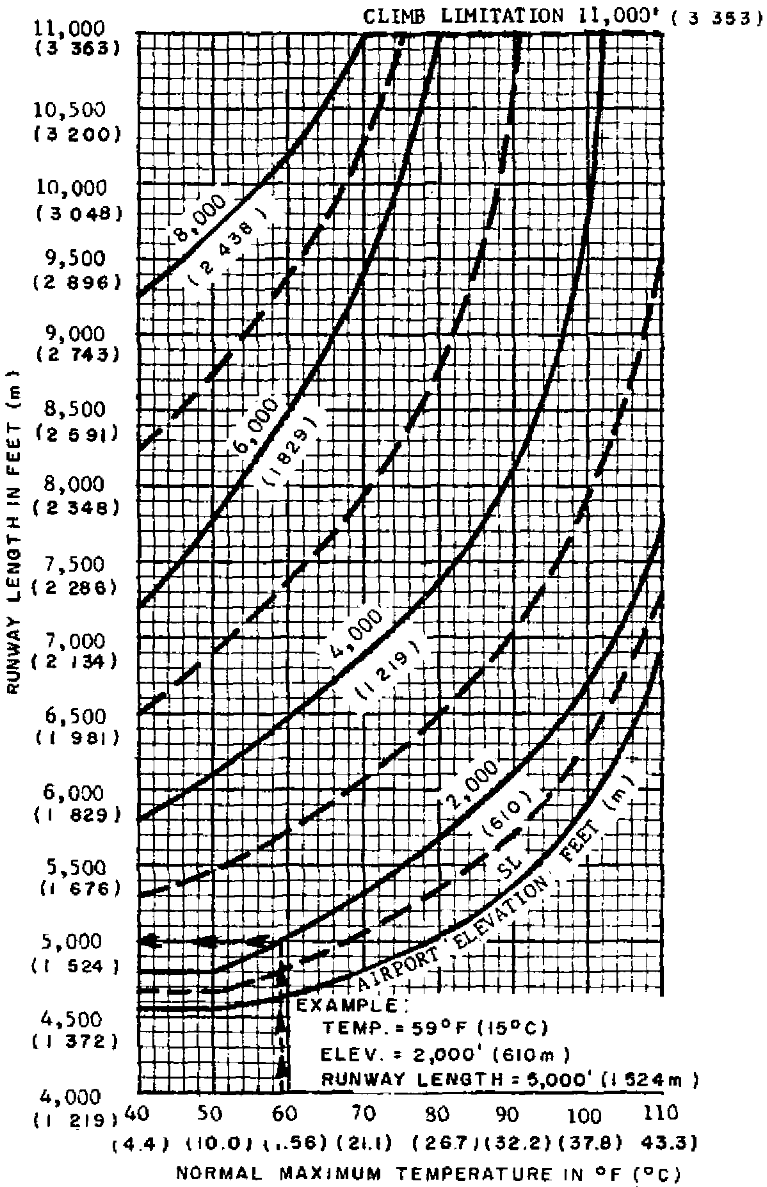


75% FLEET @ 60% USEFUL LOAD

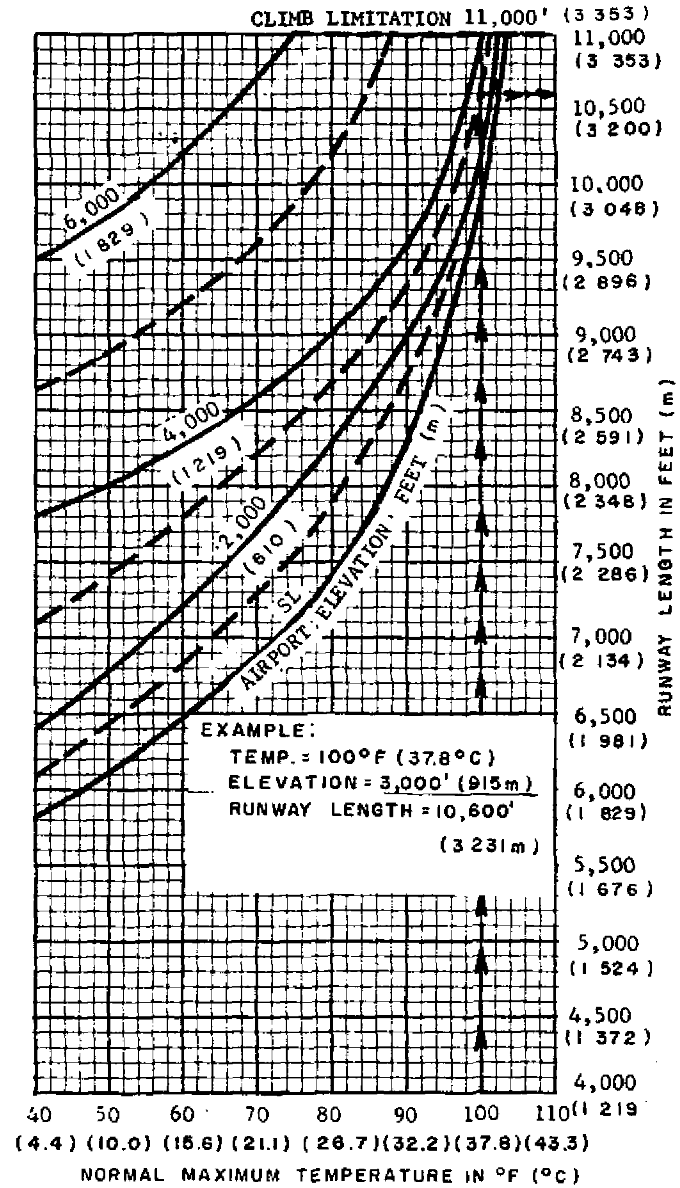


75% FLEET @ 90% USEFUL LOAD

Figure 4a. Basic transport performance curves for 75% of fleet.



100% FLEET @ 60% USEFUL LOAD



100% FLEET @ 90% USEFUL LOAD

Figure 4b. Basic transport performance curves for 100% of fleet.

(2) The sets of curves in figures 4a and 4b are based on a grouping of the business jet fleet according to performance capability. They are derived from data in airplane flight manuals approved by the FAA with an assumed loading condition. The title of each curve set indicates the percentage of the fleet and the percentage of useful load accommodated by a runway length obtained from the curve set. For example, the "75% fleet at 60% useful load" curve set provides a runway length sufficient to satisfy the operational requirements of approximately 75 percent of the basic transport fleet at 60 percent useful load. Interpolation between sets of curves is not valid.

(3) The useful load of an airplane is considered to be the difference between the maximum allowable structural gross weight and the operating weight empty. A typical operating weight empty includes the airplane's empty weight, crew, crew's baggage and supplies, removable passenger service equipment, removable emergency equipment, engine oil, and unusable fuel. The useful load then consists of passengers and baggage, cargo, and usable fuel.

(4) Curves have not been developed for business jet airplanes operating at 100 percent useful load, because most of these aircraft are limited in the second segment of climb. This means that the allowable takeoff weight is often limited by ambient conditions of temperature and elevation to less than the maximum structural takeoff weight shown in AC 150/5325-5. These limitations are shown in the approved airplane flight manuals and have been considered in the development of the runway length curves. Because of the climb limitation, the length of runway resulting from the 90 percent load factor is considered to approximate the limit of beneficial return, considering the airport's mission within the system.

(5) Those airplanes which, for purposes of this circular, comprise 75 percent of the basic transport fleet and which can be accommodated by runway lengths resulting from the curves in figure 4a are listed below:

Manufacturer	Model
Gates Learjet Corporation	Learjet (20, 30, 50 series)
Rockwell International	Sabreliner (40, 60, 75 series)
Cessna Aircraft	Citation (I, II, III)
Dassault - Breguet	Fan Jet Falcon (10, 20, 50 series)
British Aerospace Aircraft Group	HS-125 (400, 600 series)
Israel Aircraft Industries	1124 Westwind

(6) The sets of curves in figures 4a and 4b are based on no wind, zero gradient, and a dry runway. The runway lengths may need to be increased to account for the effect of either runway gradient or wet runway conditions. These effects are not cumulative and, when both conditions apply, the larger of the increases should be used.

(7) The runway length obtained from the curves shown in figures 4a and 4b should be increased to account for an effective runway gradient other than zero. To determine the required runway length when the effective runway gradient is other than zero, enter figure 5 on the left with the length obtained from figure 4a or 4b and proceed horizontally to the right to the effective runway gradient of the runway being considered. The required length will be directly below this point on the bottom scale.

(8) The runway length required for landing is the controlling length at lower elevations and temperatures. Therefore, an increase of up to 15 percent in runway length may be required for wet landing conditions in accordance with Federal Aviation Regulations. The following paragraphs provide guidance on the appropriate increase for that portion of the runway length curves where landing length governs:

(i) At 60 percent of useful load, an increase of 15 percent for runway lengths up to 4,800 feet (1 460 m) is recommended. For runway lengths between 4,800 feet (1 460 m) and 5,500 feet (1 680 m), it is recommended that the runway length be increased to 5,500 feet (1 680 m). Over 5,500 feet (1 680 m), no increase is required.

(ii) At 90 percent of useful load, an increase of 15 percent for runway lengths up to 6,100 feet (1 860 m) is recommended. For runway lengths between 6,100 feet (1 860 m) and 7,000 feet (2 130 m), it is recommended that the runway length be increased to 7,000 feet (2 130 m). Over 7,000 feet (2 130 m), no increase is required.

(9) The curves in the figures 4a and 4b present runway lengths for elevations up to 8,000 feet (2 438 m). At higher elevations, aircraft takeoff performance is restricted by climb characteristics. The runway length limits imposed in the performance curves recognize this phenomenon.

b. General Transport. The runway length provided at a general transport category airport should be based on the critical airplane to be using the airport. The runway length resulting from application of the procedures of AC 150/5325-4, RUNWAY LENGTH REQUIREMENTS FOR AIRPORT DESIGN, current edition, may be more or less than the lengths required to accommodate turbojet powered airplanes under 60,000 lb (27 200 kg) gross weight. Therefore, when mixed operations are to occur, the longer length requirement should be provided.

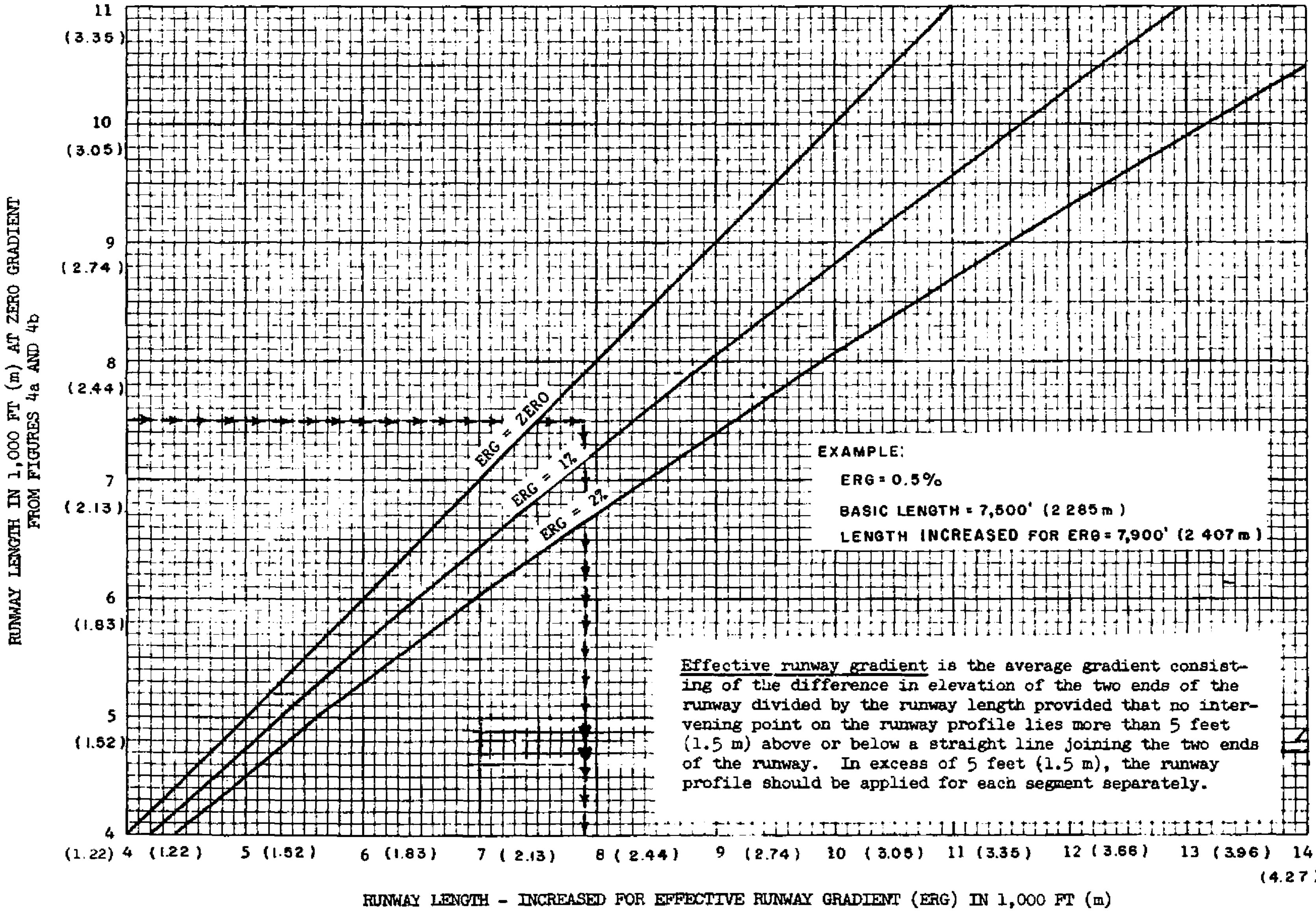


Figure 5. Basic transport runway length increased for gradient.

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5. CLEARWAY AND STOPWAY.

a. Clearway. Federal Aviation Regulations permit the use of a clearway to provide part of the distance required for the takeoff of turbine powered airplanes certificated after September 30, 1958.

(1) The clearway concept is illustrated in figure 6a and is defined from FAR Part 1, Definitions and Abbreviations, as follows:

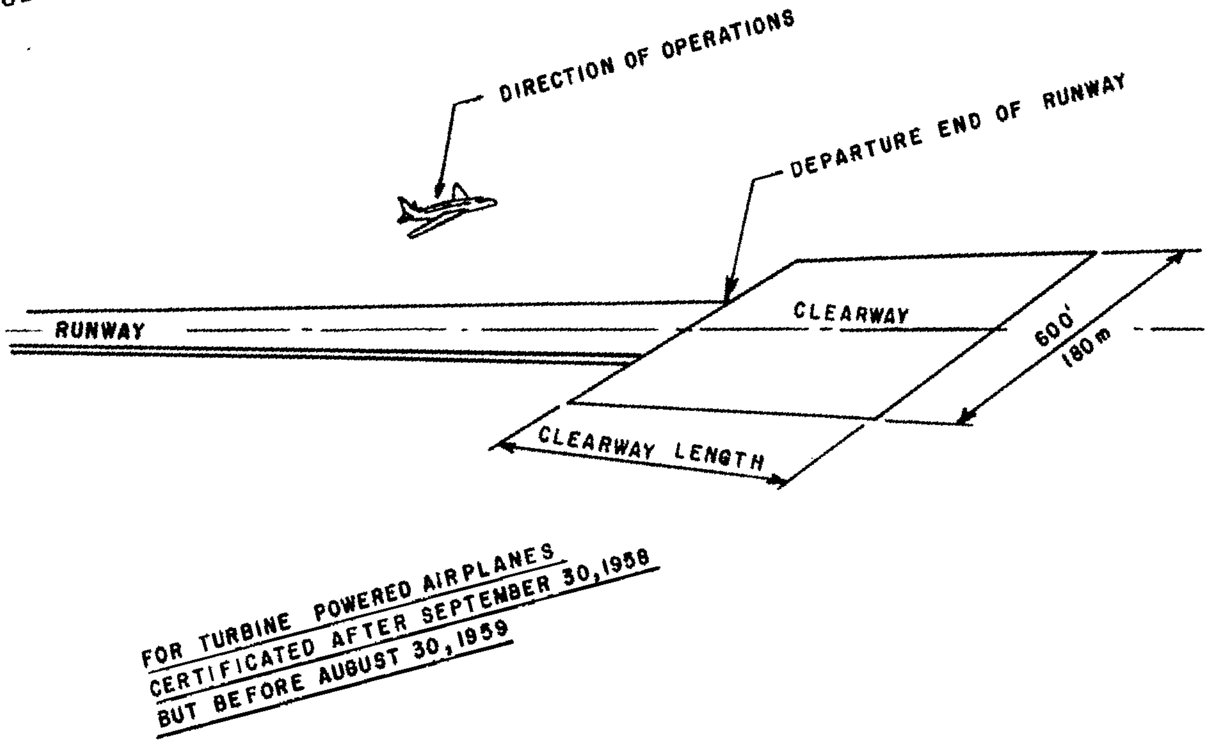
(i) For turbine engine powered airplanes certificated after September 30, 1958, but before August 30, 1959, an area beyond the takeoff runway extending no less than 300 feet (90 m) on either side of the extended centerline of the runway, at an elevation no higher than the elevation of the end of the runway, clear of all fixed obstacles, and under the control of the airport authorities.

(ii) For turbine engine powered airplanes certificated after August 29, 1959, an area beyond the runway, not less than 500 feet (150 m) wide, centrally located about the extended centerline of the runway, and under the control of the airport authorities. The clearway is expressed in terms of a clearway plane, extending from the end of the runway with an upward slope not exceeding 1.25 percent, above which no object nor any terrain protrudes. However, threshold lights may protrude above the plane if their height above the end of the runway is 26 inches (.66 m) or less and if they are located to each side of the runway.

(2) A clearway is a plane available for continuation of the takeoff operation which is above a clearly defined area connected to and extended beyond the end of the runway. The area over which the clearway lies need not be suitable for stopping aircraft in the event of an aborted takeoff. A clearway is not intended to be a substitute for a runway, but it does supplement the runway by providing a clear path for climb-out during the takeoff operation. Clearways are applicable for use only in takeoff operations of turbine engine powered airplanes certificated after September 30, 1958, when their flight manuals provide for such use in the takeoff performance data. Presently, the flight manuals for airplanes certificated before August 30, 1959, do not provide this takeoff performance data, nor is it expected to be provided. It should be noted that instructions related to clearways for turbine powered aircraft, certificated after August 29, 1959, should be used for airport design.

(3) A clearway may be used to increase allowable operating weights without increasing runway length. A clearway length of 1,000 feet (300 m) is the practical limit for benefit to takeoff operations.

(4) The consideration of the airplane performance limitations specified in FAR 25.113 and FAR 91.37 applies.



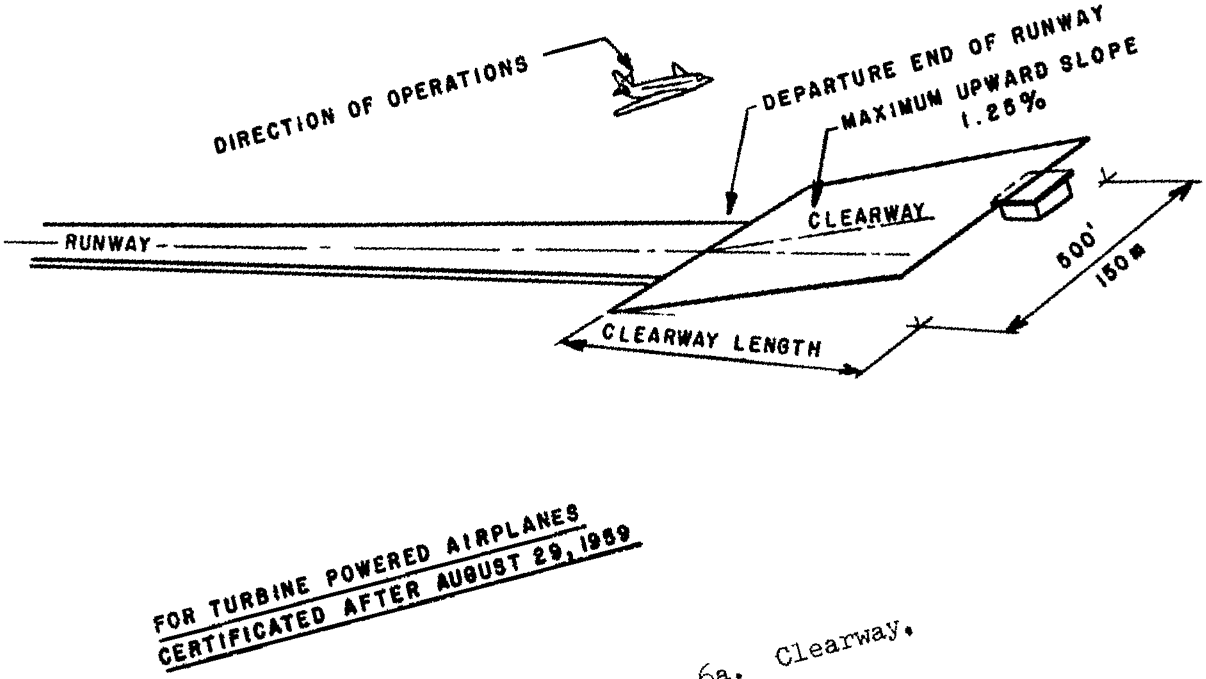


Figure 6a. Clearway.

(5) An owner who is interested in providing a clearway should be aware of the requirement for the control of the area involved. The clearway must be under the control of the airport authority, although not necessarily by direct ownership. The objective of the control is to insure that no flight is initiated using a clearway unless it has been determined with certainty that no fixed or movable object, except threshold lights 26 inches (.66 m) or less in height and located to each side of the runway, will penetrate the clearway plane when the airplane flies over.

(6) Although the use of a clearway is a technique which permits higher allowable operating weights without an increase in runway length, the runway length recommended without use of a clearway (or stopway--see paragraph 5b) for the critical aircraft should be provided. The clearway should only serve as a means of accommodating the takeoff distance requirements for that occasional operation requiring a greater takeoff distance than the critical aircraft for which the runway length is designed. When the frequency of this occasional operation increases to the point where a new critical aircraft is dictated, the additional runway length should be provided.

b. Stopway.

(1) According to FAR Part 1, and as illustrated in figure 6b, a stopway is an area beyond the takeoff runway, no less wide than the runway, centered upon the extended centerline of the runway, able to support the airplane during an aborted takeoff without causing structural damage to the airplane, and designated by the airport authorities for use in decelerating the airplane during an aborted takeoff.

(2) Stopways are applicable for use only in takeoff operations of turbine powered airplanes certificated after August 29, 1959. Due to the cost of providing stopways versus the advantages derived from their use, the construction of stopways is not recommended.

(3) The provisions of FAR 25.109 and FAR 91.37 apply with the use of a stopway.

6. RUNWAY AND TAXIWAY WIDTHS.

a. Runway Width. Runway widths for transport airplanes on both instrument and visual runways are based on the physical requirements of the aircraft, statistical data on deviations from runway centerline, and experience. At those locations which will have substantial large jet airplane activity under 150,000 lb (68 000 kg), shoulders should be treated for a distance of 25 feet (8 m) beyond the pavement edge with bituminous material or dense turf to prevent erosion and the blowing of loose material. (See AC 150/5325-6,

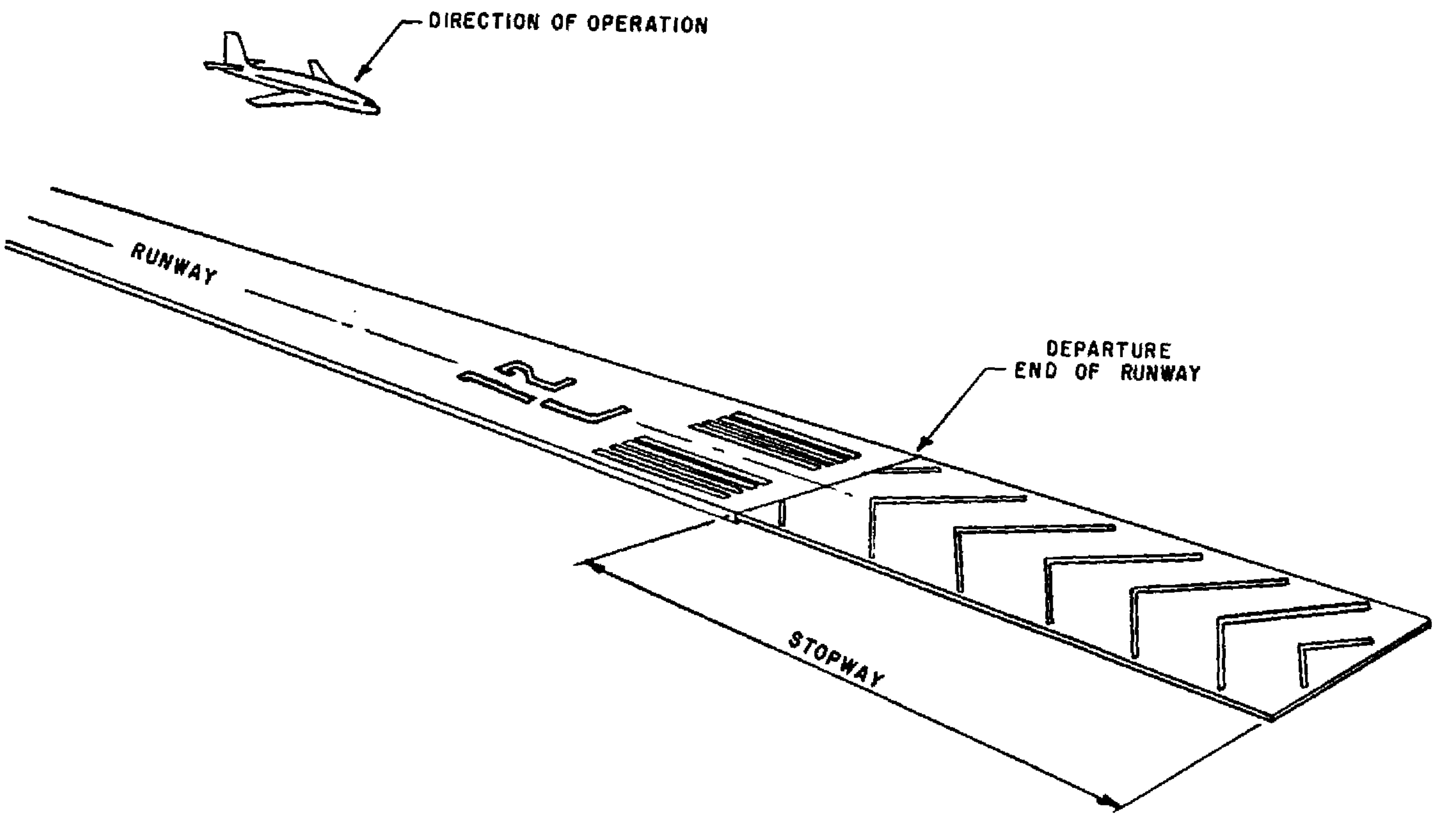


Figure 6b. Stopway.

AIRPORT DESIGN STANDARDS--EFFECTS AND TREATMENT OF JET BLAST, current edition.) The following considerations have been included in determining the width requirements listed in figure 1:

(1) The controllability of the airplane during landing and takeoff crosswind;

(2) The positioning of the engines on the airplane and the protection of those engines from ingestion of loose material;

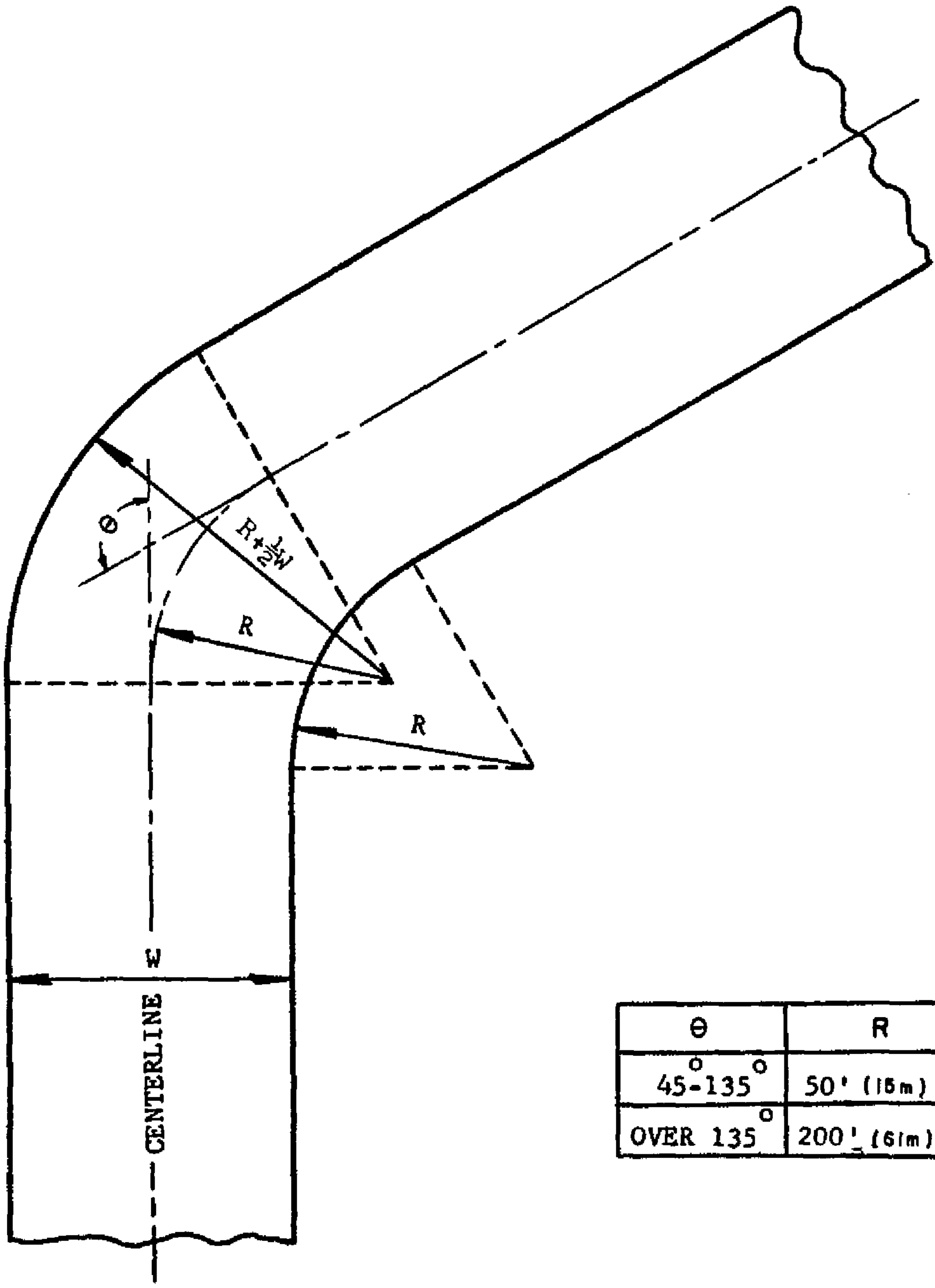
(3) The blast effects of the engines on the runway shoulders;

(4) The wheel track of the airplane landing gear.

b. Taxiway Width. Since the speed of airplanes on taxiways is less than that on runways, the width of the taxiway may be less than that of the runway. However, the possibility of ingestion of foreign material into the engines still remains and should be considered. Also, the blast effects of engines on taxiway shoulders (refer to AC 150/5325-6), the tread width of the airplane, and the ability to maneuver the airplane in turns should be considered. Taxiway widths of 40 feet (12 m) and 50 feet (15 m), respectively, are recommended for basic transport and general transport airports. Figure 7 shows criteria on widening of curved taxiway sections for aircraft with a wheelbase up to 44 feet (13 m) in length. For wheelbase lengths greater than 44 feet (13 m), the criteria for taxiway widening in AC 150/5335-1, AIRPORT DESIGN STANDARDS--AIRPORTS SERVED BY AIR CARRIERS--TAXIWAYS, current edition, should be used.

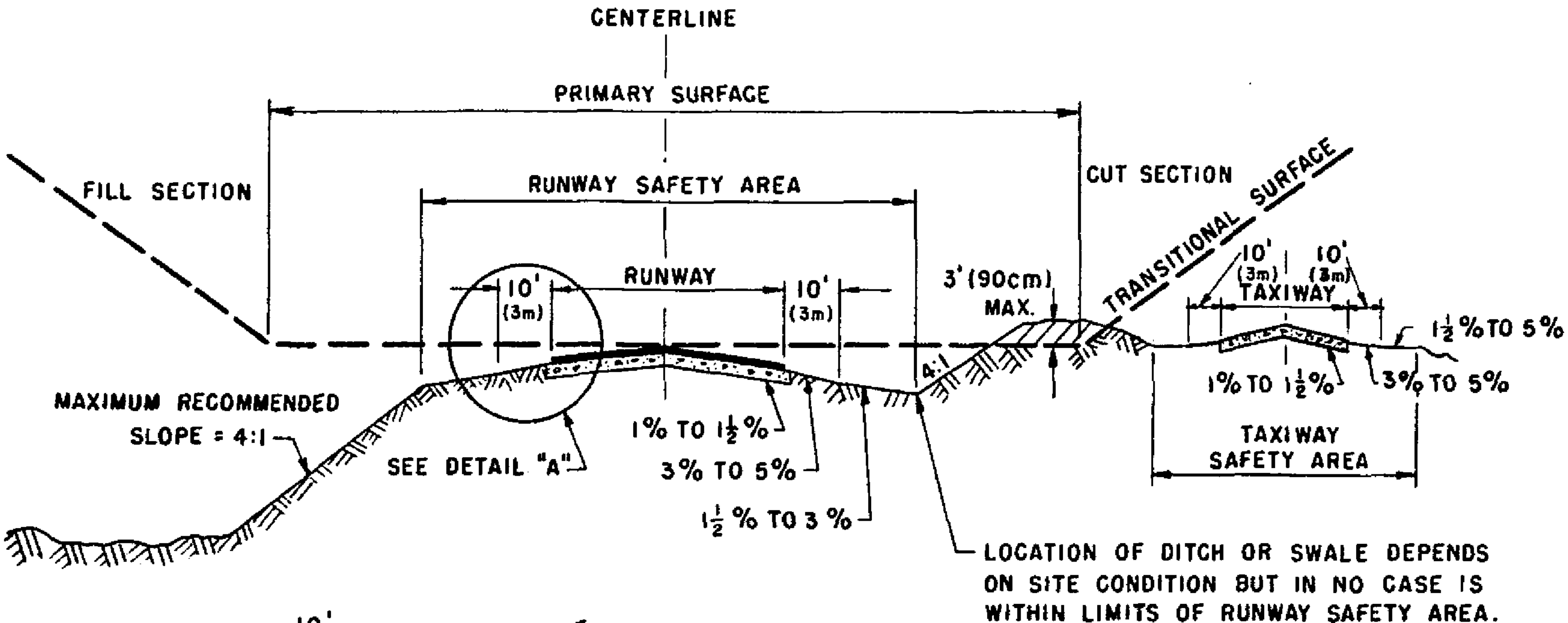
7. SAFETY AREAS AND IMAGINARY SURFACES.

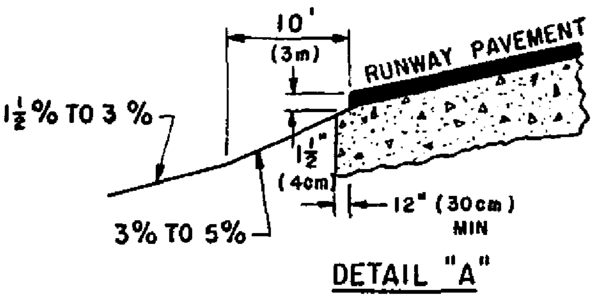
a. Runway Safety Area. The runway safety area, which should be provided, is a cleared, drained, graded, and preferably turfed area symmetrically located about the runway. Under normal conditions, the runway safety area is capable of supporting snow removal, firefighting, and rescue equipment and of accommodating the occasional passage of aircraft without causing major damage to the aircraft. The width is as shown in figure 1, and the length extends for a distance of twice its width beyond each runway end. For a runway with a stopway length over twice the runway safety area width, the runway safety area should extend to the end of the stopway. The runway safety area performs the same function as the landing strip formerly did; i.e., it provides an area capable of accommodating the occasional passage of aircraft without causing major damage to the aircraft.



θ	R
45°-135°	50' (15m)
OVER 135°	200' (61m)

Figure 7. Taxiway widening detail for use on curves.





ORIGINAL GROUND ABOVE PRIMARY SURFACE ACCEPTABLE FOR STAGE CONSTRUCTION.

NOTES:

1. TRANSVERSE SLOPES SHOULD BE ADEQUATE TO PREVENT THE ACCUMULATION OF WATER ON THE SURFACE BUT SHOULD FALL WITHIN THE RANGES SHOWN ABOVE.
2. THE RECOMMENDED 1½" (4 cm) PAVEMENT EDGE IS INTENDED TO BE USED BETWEEN PAVED AND UNPAVED SURFACES.
3. FOR THE FIRST 10' (3m) OF UNPAVED SURFACE IMMEDIATELY ADJACENT TO THE PAVED SURFACE IT IS DESIRABLE TO MAINTAIN A 5% SLOPE. THE MINIMUM REQUIRED SLOPE IS 3%.

Figure 8. Transverse grade limitations.

considered for treatment to prevent erosion and the blowing of debris or loose material into a following airplane. This treatment normally consists of a shoulder stabilized with bituminous surface treatment or dense turf up to a width of 20 feet (6 m).

c. Imaginary Surfaces. Imaginary surfaces, as defined in Subpart C of FAR Part 77, are used to define obstructions to air navigation. An obstruction to air navigation is presumed to be a hazard to air navigation unless an FAA aeronautical study determines otherwise. Provision of the separation distances recommended in this advisory circular should avoid the establishment of hazards to air navigation. The primary and transitional surfaces are two of these imaginary surfaces which are factors in the planning and siting of facilities on the airport with respect to the runway centerline. They are illustrated in figure 8.

(1) Primary Surface. The primary surface is longitudinally centered about a runway. It extends 200 feet (60 m) beyond each end of a runway that has a specially prepared hard surface, but ends at the end of the runway when the runway has no specially prepared hard surface, or planned hard surface. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline. The width of the primary surface varies with the type of airport and type of operations at the airport and is given in FAR Part 77, Subpart C.

(2) Transitional Surface. The transitional surface extends outward and upward at right angles to the runway centerline at a slope of 7 to 1 from the sides of the primary surface to a height of 150 feet (45 m).

8. SEPARATIONS. The dimensions shown in figure 1 are minimums. Prudent planning may dictate that they be greater. It should be noted that the critical airplane for runway length determination may be different from that one which is critical for other design factors.

a. Runway Centerline to Taxiway Centerline. This dimension is based on current instrument landing system standards for instrument runways.

b. Runway Centerline to Airplane Parking Area. The airplane parking area(s) (all aprons except holding) should be located so that the airplanes will not be within the primary surface nor penetrate above the other airport imaginary surfaces as defined in Subpart C of FAR Part 77. If this is found to be impossible or economically not feasible, these areas may in some cases be expanded to include the area where only the tails of the parked airplanes penetrate the transitional surfaces. To utilize this additional area for airplane parking, a case-by-case study is required to to air navigation for the types of operations expected to be conducted at the airport, this additional area or part of this additional area may not be used for parking airplanes. (Note: A parked airplane penetration considered acceptable for nonprecision approaches may not be acceptable for certain precision instrument approaches.) The dimensions shown are with respect to an airplane positioned on the apron as shown in figure 2. Other positioning may cause tail penetration of imaginary surfaces.

c. Separation Between Parallel Runways. Where instrument operations are anticipated, parallel runways should be separated for full Instrument Flight Rules (IFR) simultaneous arrival capability. Where this is not possible, a design for simultaneous IFR arrival and departure capability is recommended. If neither can be achieved, simultaneous Visual Flight Rules (VFR) capability should be provided. In any event, the desirability of placing the terminal and other operational areas between the parallel runways in order to minimize taxi operations across active runways should be considered. (See AC 150/5335-4 for detailed separation criteria.)

d. Taxiway Centerline to Fixed or Movable Obstacle. This separation provides a comfortable clearance for the critical airplane in each category with the wheels on the edge of the taxiway.

e. Separation Between Parallel Taxiways. This dimension is selected to provide adequate clearance between wingtips when two critical airplanes pass, each with their undercarriage on the near edge of the pavement. (Refer to AC 150/5335-1 for background information.)

f. Separation Between Building Restriction Line and Runway Centerline. The building restriction line helps to assure that structures will not project above the imaginary surfaces as defined in Subpart C of FAR Part 77; it helps provide wingtip clearances for airplanes on operational areas of the airport; and it reduces the likelihood that structures will cause electromagnetic interference with navigational aids. (See AC 150/5300-2, AIRPORT DESIGN STANDARDS--SITE REQUIREMENTS FOR TERMINAL NAVIGATIONAL FACILITIES, current edition.) The building restriction line associated with the runway should be extended until it either intersects or reaches a point adjacent to the end of the standard runway clear zone.

9. SURFACE GRADIENT.

a. Transverse Grades. The maximum and minimum transverse grades for runways, taxiways, and their associated safety areas are shown in figure 8. The transverse grade for the portion of the runway safety area beyond the runway ends should be between plus or minus 5 percent.

b. Longitudinal Grades. These grade limitations are necessary for the safe and efficient operation of aircraft and electronic navigational facilities. Line-of-sight standards should also be considered in the determination of the runway longitudinal grade. (See paragraph 10.)

(1) Runway. The maximum and minimum longitudinal grades for runways (and stopways) are shown in figure 9, except that AC 150/5325-2, AIRPORT DESIGN STANDARDS--AIRPORTS SERVED BY AIR CARRIERS--SURFACE GRADIENT AND LINE-OF-SIGHT, current edition, should be consulted for vertical curve criteria pertaining to general transport airports.

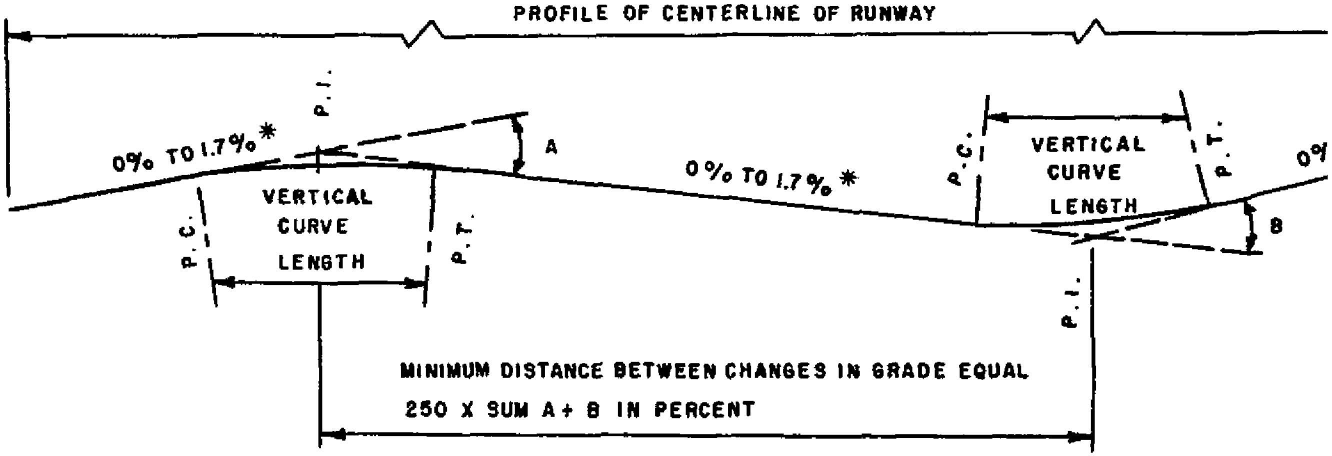
(2) Runway Safety Area. The runway safety area adjacent to the runway has the same longitudinal grade as the runway, except where deviations are required by the presence of taxiways or other runways within the area. In such cases, the longitudinal grade of the runway safety area should be modified by the use of smooth curves. For the first 200 feet (60 m) of the runway safety area beyond the runway ends, the longitudinal grade should be between 0 percent and negative 3 percent. For the remainder of the runway safety area, the maximum longitudinal grade should be such that no part of the runway safety area penetrates the approach surface. The maximum allowable negative grade is 5 percent. The maximum grade change is limited to plus or minus 2 percent per 100 feet (30 m). The use of parabolic curves, where practical, is recommended.

(3) Taxiway and Taxiway Safety Areas. The recommended maximum longitudinal grade is 2 percent. Longitudinal grade changes should be avoided but, when necessary, should not exceed 3 percent. Vertical parabolic curves with a minimum length of 100 feet (30 m) for each 1 percent change should be used to accomplish the change. The distance between points of intersection of vertical curves should be a minimum of 100 feet (30 m) multiplied by the sum of the grade changes (in percent) associated with the two vertical curves.

10. LINE-OF-SIGHT. Line-of-sight standards impose an additional restraint on the determination of surface gradients. It is desirable to provide an unobstructed line-of-sight along the entire length of an individual runway or taxiway, as well as along the entire length of an intersecting runway. The following paragraphs provide line-of-sight standards which should be met as a minimum:

a. Along Individual Runways.

(1) Airports Not Having a 24-Hour Control Tower. Runway grade changes should be such that any two points 5 feet (1.5 m) above the runway centerline will be mutually visible for the entire runway length. However, if the runway has a parallel taxiway for its full length, runway grade changes may be such that an unobstructed line-of-sight exists from any point 5 feet (1.5 m) above the runway centerline to all other points 5 feet (1.5 m) above the runway centerline within a distance of half the length of the runway.



VERTICAL CURVES

LENGTH OF VERTICAL CURVES AT BASIC TRANSPORT AIRPORTS SHOULD NOT BE LESS THAN 300'(91m) FOR EACH 1% EXCEPT THAT NO VERTICAL CURVE WILL BE REQUIRED WHEN GRADE CHANGE IS LESS THAN 0.4%. REFER TO AC 15(AIRPORT DESIGN STANDARDS-AIRPORTS SERVED BY AIR CARRIERS-SURFACE GRADIENT AND LINE-OF-SIGHT, FOR C PERTAINING TO GENERAL TRANSPORT AIRPORTS.

SIGHT DISTANCE

RUNWAY GRADE CHANGES SHOULD CONFORM TO LINE-OF-SIGHT CRITERIA GIVEN IN PARAGRAPH 10.

GRADE CHANGE

MAXIMUM GRADE CHANGE, SUCH AS (A) OR (B), SHOULD NOT EXCEED 1.7%.*

* A MAXIMUM GRADE OF 2% IS ACCEPTABLE AT AIRPORTS WHOSE ULTIMATE DEVELOPMENT IS EXPECTED TO BE IN TRANSPORT CATEGORY.

Figure 9. Longitudinal grade limitations.

(2) Airports Having a 24-Hour Control Tower. Although it is desirable to provide an unobstructed line-of-sight for the entire runway length, adherence to longitudinal gradient standards will provide an adequate line-of-sight at these airports. However, before applying these criteria, a careful analysis should be made of the forecast airport activity to assure that the tower will remain in 24-hour operation. Visibility requirements from the air traffic control tower to the airport surface areas utilized in aircraft ground movement should also be considered.

b. Between Intersecting Runways.

(1) Airports Not Having a 24-Hour Control Tower. Runway grades, terrain, structures, and permanent objects must be such that there will be unobstructed line-of-sight from any point 5 feet (1.5 m) above one runway centerline to any point 5 feet (1.5 m) above an intersecting runway centerline, both points being within the area of the runway visibility zone. The runway visibility zone is an area formed by imaginary lines connecting the two runways' visibility points as shown in figure 10. The location of each runway's visibility points is determined in the following manner:

(i) When the distance from the intersection of two runway centerlines to a runway end is 750 feet (250 m) or less, the visibility point is located on the centerline at the runway end.

(ii) When the distance from the intersection of two runway centerlines to a runway end is greater than 750 feet (250 m) but less than 1,500 feet (500 m), the visibility point is located on the centerline 750 feet (250 m) from the intersection of the runway centerlines.

(iii) When the distance from the intersection of two runway centerlines to a runway end is equal to or greater than 1,500 feet (500 m), the visibility point is located on the centerline equidistantly from the runway end and the intersection of the centerlines.

(2) Airports Having a 24-Hour Control Tower. Although it is desirable to provide an unobstructed line-of-sight along the entire length of an intersecting runway, there are no mandatory line-of-sight requirements between intersecting runways at these airports. However, an analysis should be made of the forecast airport activity to assure that the tower will remain in 24-hour operation.

c. Taxiways. There are no specific line-of-sight requirements for taxiways. The sight distance along a runway from an intersecting taxiway, however, should be sufficient to allow a taxiing aircraft to safely enter or cross the runway.

11. OTHER DESIGN COMPONENTS.

a. Figure 2 illustrates the application of the dimensional standards and is keyed to the items in figure 1.

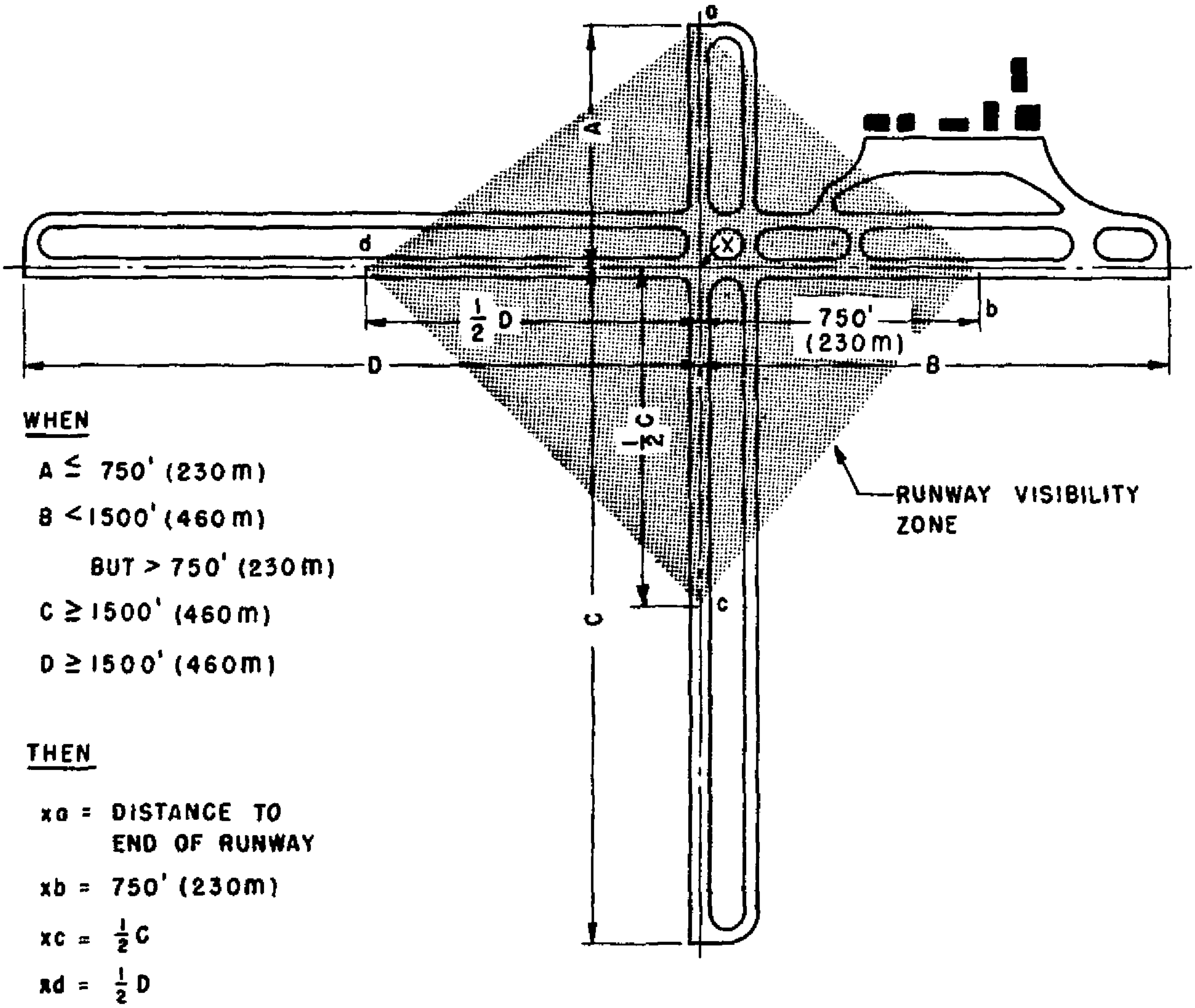


Figure 10. Runway visibility zone.

b. Figure 7 is a detail of the procedure to be used for widening the taxiway on curves. Widening on curves is necessary to facilitate traffic flow by permitting airplanes to negotiate the turns without materially reducing speed. The concept provides for widening of the inside of the turn.

c. Figure 11 shows typical runway and taxiway fillets for basic and general transport airports. Fillets should have 25-foot (7.6 m), 50-foot (15 m), or 200-foot (61 m) radii, depending on the intersection angle of the pavement as shown in the figure.

d. Figure 12 shows an example of an airplane ramp and building area layout. It is essential that provisions be made for positioning of jet airplanes so that there will be no hazard to persons in the building area or damage to other airplanes and airplane service equipment from the high temperatures and blast velocity emitted by the jet engines. Blast velocities above 30 miles per hour (48 km/h) are undesirable for personal comfort and equipment operation in the terminal area. If jet engines are being tested or if runup is conducted with the exhaust pointed toward the taxiway or toward parked airplanes, the blast could divert taxiing airplanes from their intended path or damage parked airplanes. To diminish the velocity effects created by jet thrust up to that percentage of power required to start the airplane moving, the soil in the ramp area should be stabilized to prevent erosion around edges of the pavement. Also, blast pads and shoulder stabilization should be provided to protect the areas surrounding the runway ends from the velocity effects of takeoff thrust. Figure 13 shows the maximum velocities produced by various jet airplane engines. (See AC 150/5325-6 for further information.)

e. Figure 14 shows one type of turnaround. Other designs may be effective, provided sufficient space is available for the airplane beyond the holding line. Drainage, snow removal, and construction costs should be considered in the selection of a design configuration. For example, at a specific airport, a slight increase in cost may allow construction of a partial parallel taxiway rather than the circular turnaround. The hold line should be located outside of the runway safety area. This distance may need to be increased to keep aircraft clear of the obstacle free zone (see AC 150/5300-4) or the instrument landing system (ILS) localizer and glide slope critical areas. AC 150/5300-2 shows these ILS critical areas.

f. Figure 15 shows a typical layout of a holding apron. The purpose of a holding apron is to minimize delays by providing a place for airplanes to conduct engine checks, etc., without interfering with the normal flow of traffic. Figure 15 also shows the location of a possible bypass taxiway which may be desirable as an alternate or supplement to the holding apron. The bypass taxiway will allow an airplane unprepared for takeoff to circulate or permit following airplanes access to the runway for takeoff.

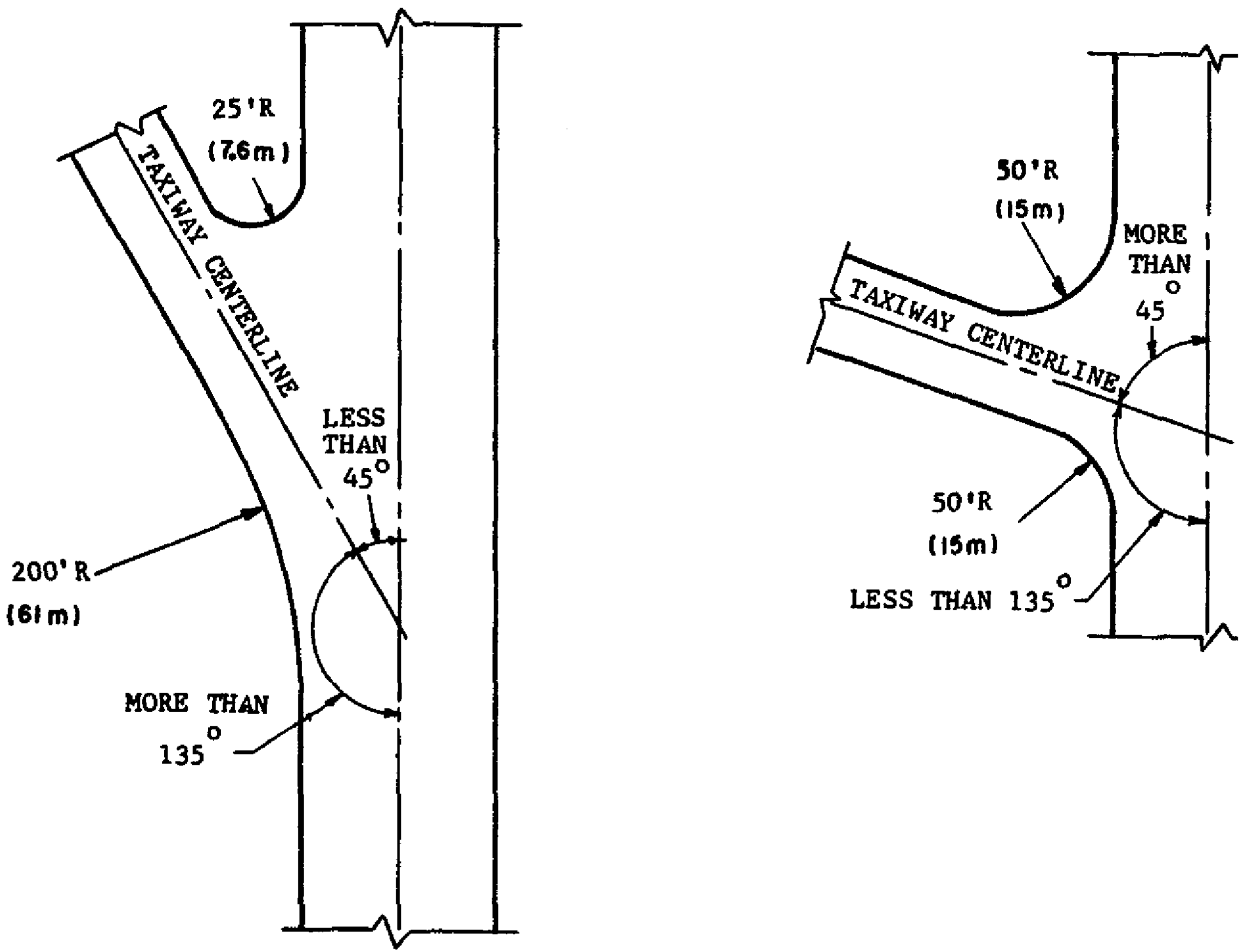


Figure 11. Typical runway and taxiway fillets.

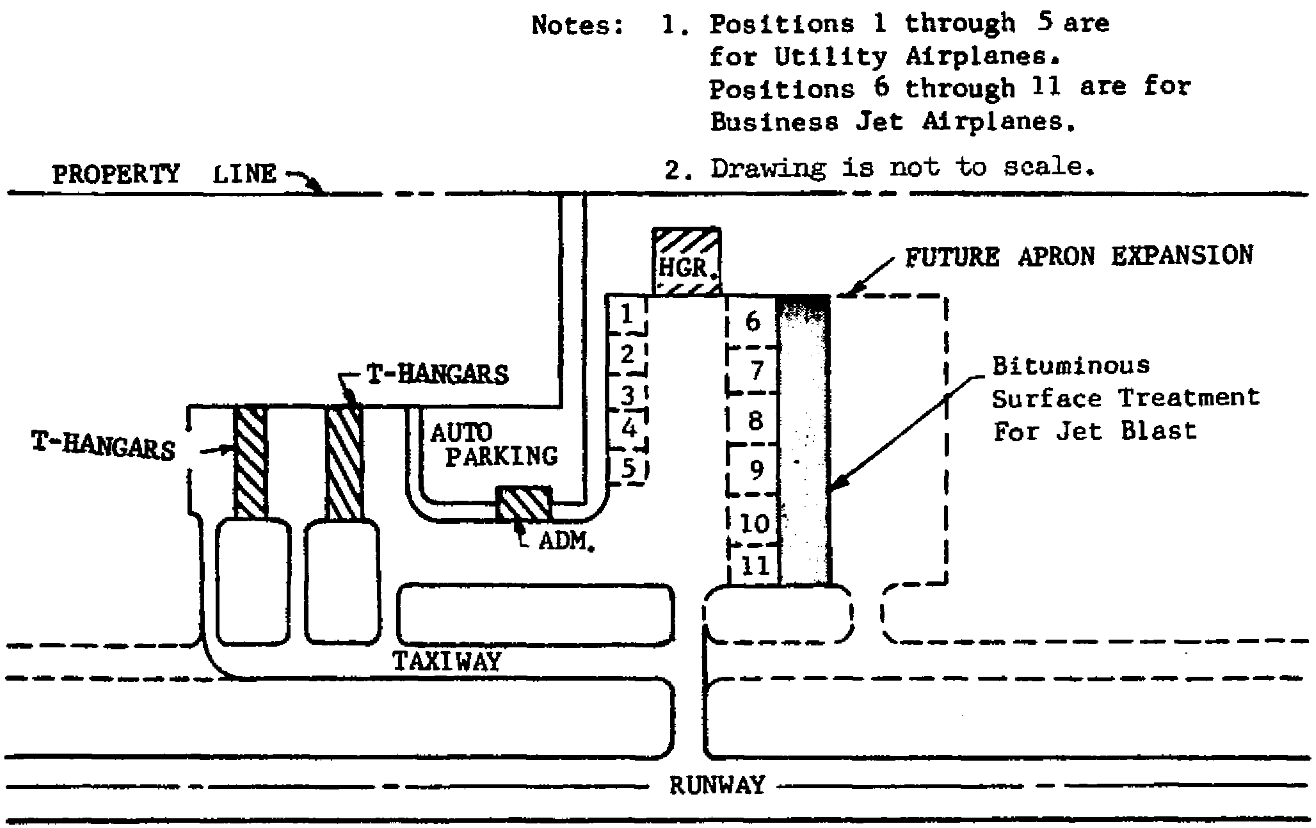


Figure 12. Example of airplane parking and building area.

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VELOCITY IN MILES/HOUR (KILOMETERS/HOUR)

Distance Behind Engine / Aircraft	20'(6 m)	40'(12 m)	60'(18 m)	80'(24 m)	100'(30 m)
Fan Jet Falcon					
Idle	82(132)	36(58)	25(40)	22(35)	18(29)
Breakaway 1/	150(241)	68(109)	46(74)	33(53)	27(43)
Takeoff	341(549)	155(249)	106(171)	75(121)	62(100)
Jet Commander, Lear Jet, & Hansa					
Idle	54(87)	24(39)	15(24)	11(18)	9(14)
Breakaway	114(183)	50(80)	31(50)	22(35)	18(29)
Takeoff	259(117)	114(183)	68(109)	52(84)	42(68)
Jet Star & Sabreliner					
Idle	92(148)	41(66)	25(40)	18(29)	15(24)
Breakaway	195(314)	85(137)	52(84)	39(63)	31(50)
Takeoff	443(713)	194(312)	119(192)	89(143)	72(116)
Gulfstream II					
Idle	153(246)	75(121)	48(77)	41(66)	34(55)
Breakaway	330(531)	150(241)	102(164)	72(116)	60(97)
Takeoff	750(1207)	341(549)	232(373)	164(264)	136(219)
The pressure of a jet blast on a surface perpendicular to it may be computed from the equation: $P = 0.00256\ V^2 (0.04733\ V^2)$, where V = the velocity in miles/hour(km /hr) and P = pounds/square foot(pascals).					

1/ "Breakaway"is that percentage of power required to start airplanes moving and is normally approximately 55% of maximum continuous thrust.

Figure 13. Blast effects of business jet airplane engines.

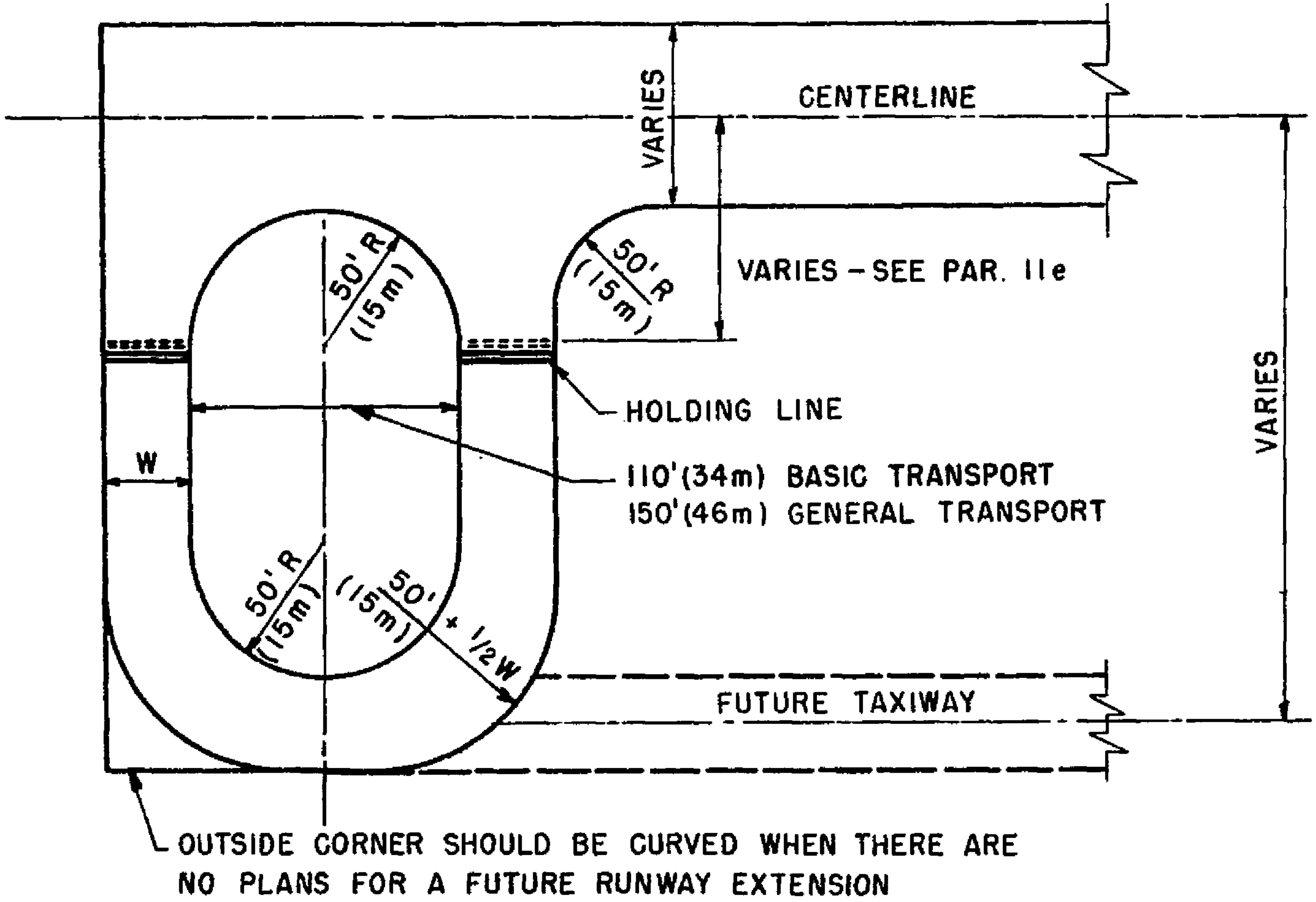

Figure 14. Turnaround.

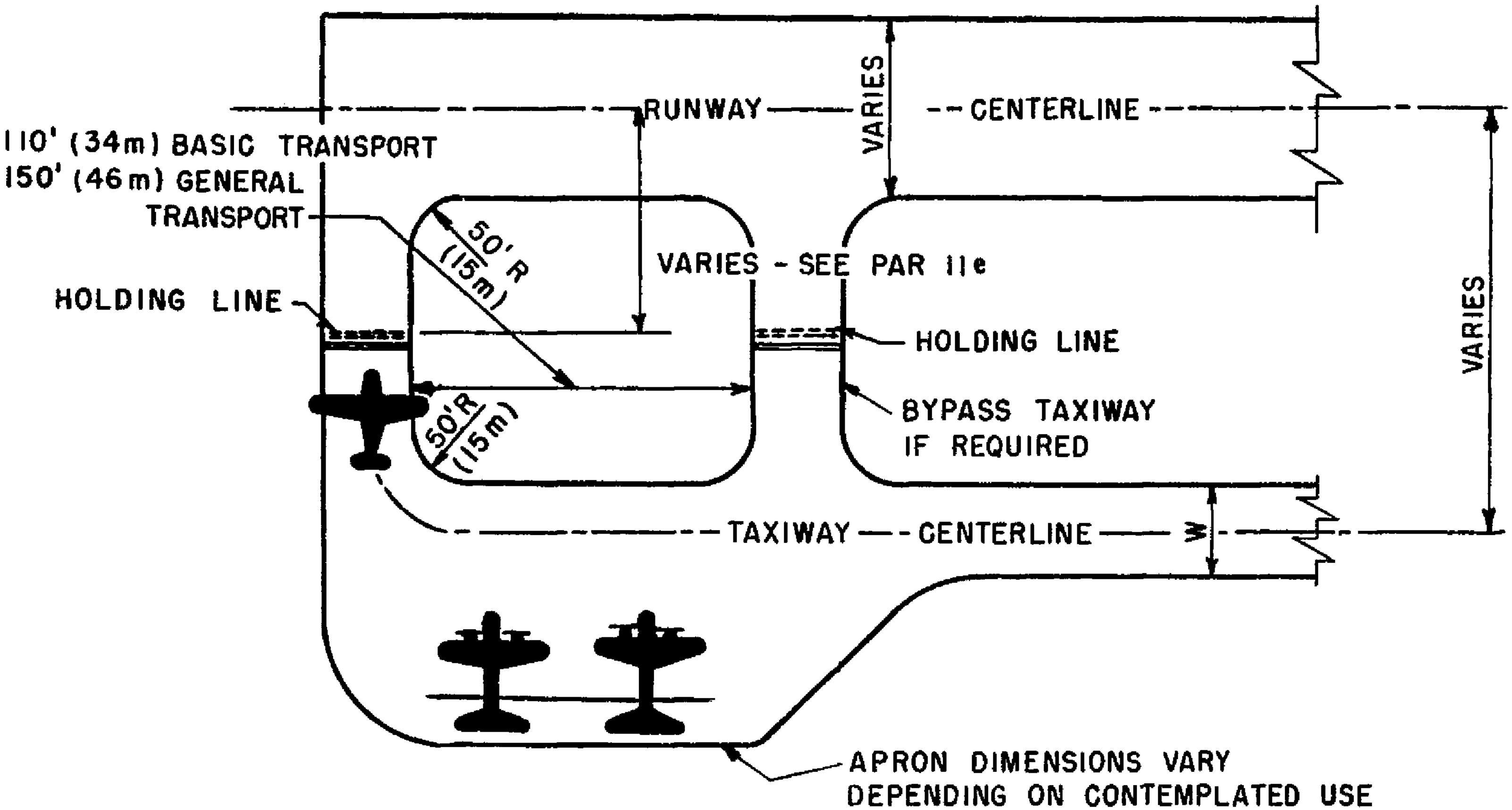

Figure 15. Holding apron.

12. CROSSWIND RUNWAYS.

a. Type certification procedures for airplanes over 12,500 lb (5 670 kg) maximum gross weight require that a maximum limiting crosswind value be determined for each airplane. However, only the maximum crosswind value under which the airplane has been tested is available in an airplane flight manual. These demonstrated crosswind values are usually accompanied with a statement that this crosswind value is not limiting. From a practical standpoint, it is limiting until the airplane is satisfactorily tested under greater crosswind conditions.

b. Most large turbine engine airplanes have demonstrated a capability to operate in a satisfactory manner with crosswind components (reported winds at the 50-foot (15 m) height) from 20 to 38 knots (37 to 70 km/h). Crosswind certification flight tests are normally conducted on wide, long, dry runways during VFR weather conditions. In actual operations, the climatological conditions (wind velocity/direction, visibility, ceiling) and the runway width, length, or surface condition (wet, dry) may materially reduce the allowable crosswind component.

c. In order to maximize airport utilization, crosswind runways with the same design applicable to the primary runway should be provided at BT and GT airports having a single runway subject to crosswind components of 13 knots (24 km/h) or higher more than 5 percent of the time. At those airports where the crosswind component is 10.5 knots (19.5 km/h) or higher more than 5 percent of the time and where the number of itinerant operations by small aircraft at the airport is at least the quantity required to develop a utility airport, a crosswind runway should be built to the lateral dimensional standards of a general utility airport (AC 150/5300-4) at BT airports and to BT airport standards at GT airports. The length provided for the primary runway should be provided for the crosswind runway.

13. PAVEMENT CONSIDERATIONS.

a. When a runway length obtained from figure 4b (100 percent of fleet) is used for a basic transport airport, a pavement designed to support a 60,000-lb (27 200 kg) airplane with a dual wheel landing gear is recommended. Refer to AC 150/5320-6, PAVEMENT DESIGN AND EVALUATION, current edition, for guidance on stage construction.

b. Basic transport airports designed with runway lengths in accordance with the curves of figure 4a should have a pavement design to support the group making up approximately 75 percent of the business jet fleet. Therefore, at these airports a pavement designed to support a 30,000-lb (13 600 kg) airplane with a single wheel landing gear is recommended.

c. Although the runway lengths of figures 4a and 4b are based on loadings less than the maximum gross weight, the preceding recommendations recognize that operations may be conducted at higher weights when temperatures are less than normal maximum.

d. There may be individual circumstances which will warrant the provision of a pavement for a specific use more restrictive than recommended in previous paragraphs. In those cases, it may be necessary to place load restrictions on maintenance, fire, and rescue equipment. For example, in the snow belt, the load imposed by snow removal equipment may exceed the bearing capacity of a runway pavement designed for light airplanes, and severe damage may result.

e. The pavement thickness and construction materials densities recommended in chapter 3 of AC 150/5320-6 should be provided for airplanes with gross weights over 30,000 lb (13 600 kg). The quality of the pavement material and the construction of the pavement subgrade should be in accordance with AC 150/5370-10, STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS, current edition.

f. When use by a mixture of large aircraft up to 150,000 lb (68 000 kg) maximum gross weight is anticipated, the pavement design should be based on the critical airplane at the anticipated weight.

14. AIRPORT PROTECTION AND PROPERTY CONTROL.

a. Protection for all of the imaginary surfaces defined in Subpart C of FAR Part 77 should be provided through the acquisition of property, avigation easements, or height restriction zoning. In addition, control for the preservation of the building restriction line and adequate space for a building and apron area should be provided. The needs of the airport should be studied and additional land should be purchased when needed. As a minimum, the property line should be established so that it encompasses the building restriction line and the runway clear zones as described in AC 150/5300-4 and permits a building area appropriate for existing and anticipated needs. For a typical layout, see figure 2 and AC 150/5070-6.

b. The purpose of zoning to limit the height of objects in the vicinity of airports is to prevent their interfering with the safe and efficient operation of the airport. AC 150/5190-4, A MODEL ZONING ORDINANCE TO LIMIT HEIGHT OF OBJECTS AROUND AIRPORTS, current edition, provides guidance for the preparation of a local ordinance.

15. LIGHTING, MARKING, AND VISUAL AIDS. A pilot landing at an unfamiliar airport must be able to easily determine the physical limits of the landing surface, the surface wind direction, and the nonstandard traffic patterns.

It is recommended that the current editions of the following advisory circulars be consulted to determine the requirements for lighting, marking, and visual aids at basic and general transport airports:

a. AC 150/5340-1, MARKING OF PAVED AREAS ON AIRPORTS.

b. AC 150/5340-4, INSTALLATION DETAILS FOR RUNWAY CENTERLINE AND TOUCHDOWN ZONE LIGHTING SYSTEMS.

c. AC 150/5340-5, SEGMENTED CIRCLE AIRPORT MARKER SYSTEM.

d. AC 150/5340-14, ECONOMY APPROACH LIGHTING AIDS.

e. AC 150/5340-18, TAXIWAY GUIDANCE SYSTEM.

f. AC 150/5340-19, TAXIWAY CENTERLINE LIGHTING SYSTEM.

g. AC 150/5340-21, AIRPORT MISCELLANEOUS LIGHTING VISUAL AIDS.

h. AC 150/5340-23, SUPPLEMENTAL WIND CONES.

i. AC 150/5340-24, RUNWAY AND TAXIWAY EDGE LIGHTING SYSTEM.

j. AC 150/5340-25, VISUAL APPROACH SLOPE INDICATOR (VASI) SYSTEMS.

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