U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: AIRPORT DESIGN

Date: 1/3/2008
Initiated by: AAS-100

AC No: 150/5300-13
Change: 12

1. PURPOSE. This Change reschedules the One Engine Inoperative (OEI) implementation date from January 1, 2008, to January 1, 2009.

This Change also does the following—

a. Corrects the definitions for Aircraft Approach Category and Displaced Threshold and removes the definition for Relocated Threshold in Chapter 1.

b. Adds Advisory Circulars 150/5190-6 and 150/5190-7 to the list of Reading Material in Chapter 1.

c. Makes an editorial correction to the titles of Tables 3-1 through 3-3 and note 1 of Figure 2-3.

d. Adds wording to paragraph 415 requiring end-around taxiway projects to be pre-approved by the Office of Airport Safety and Standards, Airport Engineering Division.

e. Changes the applicability of the Appendix 2, paragraph 3b, to allow the use of these standards to object to objects affecting navigable airspace relative to 14 Code of Federal Regulations (CFR) Part 77.

f. Changes Figures A2-3 and A2-4 to properly identify the starting elevation of the 40:1 and 62.5:1 surfaces when a clearway is present.

g. Adds paragraph 5 to Appendix 16 identifying what Airport Airspace Analysis Survey criteria to use based on current or planned instrument approaches serving the runway ends.

h. Changes the required survey required in Tables A16-1A, A16-1B, and A16-1C to be in line with AC 150/5300-18 requirements.

i. Removes the reference to an APV OFZ in Table A16-1B and changes the requirements to match those in Table A16-1C.

j. Removes Table A16-2.

2. CHANGED TEXT. Changed text is indicated by vertical bars in the margins.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
1–4	9/29/06	1	1/3/08
		2	9/29/06
		3–4	1/3/08
19	11/10/94	19	11/10/94
20	9/29/06	20	1/3/08
25–26	9/29/06	25–26-1	1/3/08
26-1	3/28/07		
26-2	9/29/06	26-2	9/29/06
35–38	9/29/06	35	1/3/08
		36–38*	1/3/08

* Pages renumbered.

PAGE CONTROL CHART (CONT.)

Remove Pages	Dated	Insert Pages	Dated
99	9/29/89	99	9/29/89
100–104	9/29/06	100	1/3/08
		101*	1/3/08
		102–103	1/3/08
		104	9/29/06
107	9/29/06	107–108	1/3/08
108	9/26/05		
291–296	9/29/06	291–294	1/3/08
		295–296*	1/3/08

* Pages renumbered.

David L. Bennett
Director of Airport Safety and Standards

Chapter 1. REGULATORY REQUIREMENTS AND DEFINITION OF TERMS

1. GENERAL. Section 103 of the Federal Aviation Act of 1958 states in part, "In the exercise and performance of his power and duties under this Act, the Secretary of Transportation shall consider the following, among other things, as being in the public interest: (a) The regulation of air commerce in such manner as to best promote its development and safety and fulfill the requirements of defense; (b) The promotion, encouragement, and development of civil aeronautics . . . ."

This public charge, in effect, requires the development and maintenance of a national system of safe, delay-free, and cost-effective airports. The use of the standards and recommendations contained in this publication in the design of airports supports this public charge. These standards and recommendations, however, do not limit or regulate the operations of aircraft.

2. DEFINITIONS. As used in this publication, the following terms mean:

Aircraft Approach Category. A grouping of aircraft based on 1.3 times their stall speed in their landing configuration at the certificated maximum flap setting and maximum landing weight at standard atmospheric conditions. The categories are as follows:

Category A: Speed less than 91 knots.

Category B: Speed 91 knots or more but less than 121 knots.

Category C: Speed 121 knots or more but less than 141 knots.

Category D: Speed 141 knots or more but less than 166 knots.

Category E: Speed 166 knots or more.

Airplane Design Group (ADG). A grouping of airplanes based on wingspan or tail height. Where an airplane is in two categories, the most demanding category should be used. The groups are as follows:

Group I: Up to but not including 49 feet (15 m) wingspan or tail height up to but not including 20 feet.

Group II: 49 feet (15 m) up to but not including 79 feet (24 m) wingspan or tail height from 20 up to but not including 30 feet.

Group III: 79 feet (24 m) up to but not including 118 feet (36 m) wingspan or tail height from 30 up to but not including 45 feet.

Group IV: 118 feet (36 m) up to but not including 171 feet (52 m) wingspan or tail height from 45 up to but not including 60 feet.

Group V: 171 feet (52 m) up to but not including 214 feet (65 m) wingspan or tail height from 60 up to but not including 66 feet.

Group VI: 214 feet (65 m) up to but not including 262 feet (80 m) wingspan or tail height from 66 up to but not including 80 feet.

Table 1-1. Airplane Design Groups (ADG)

Group #	Tail Height (ft)	Wingspan (ft)
I	<20	<49
II	20 - <30	49 - <79
III	30 - <45	79 - <118
IV	45 - <60	118 - <171
V	60 - <66	171 - <214
VI	66 - <80	214 - <262

Airport Elevation. The highest point on an airport's usable runway expressed in feet above mean sea level (MSL).

Airport Layout Plan (ALP). The plan of an airport showing the layout of existing and proposed airport facilities.

Airport Reference Point (ARP). The latitude and longitude of the approximate center of the airport.

Blast Fence. A barrier used to divert or dissipate jet blast or propeller wash.

Building Restriction Line (BRL). A line which identifies suitable building area locations on airports.

Clear Zone. See Runway Protection Zone.

Clearway (CWY). A defined rectangular area beyond the end of a runway cleared or suitable for use in lieu of runway to satisfy takeoff distance requirements.

Compass Calibration Pad. An airport facility used for calibrating an aircraft compass.

Declared Distances. The distances the airport owner declares available for the airplane's takeoff run, takeoff distance, accelerate-stop distance, and landing distance requirements. The distances are:

Takeoff run available (TORA). The runway length declared available and suitable for the ground run of an airplane taking off;

Takeoff distance available (TODA). The TORA plus the length of any remaining runway or clearway (CWY) beyond the far end of the TORA;

NOTE: The full length of TODA may not be usable for all takeoffs because of obstacles in the departure area. The usable TODA length is aircraft performance dependent and, as such, must be determined by the aircraft operator before each takeoff and requires knowledge of the location of each controlling obstacle in the departure area.

Accelerate-stop distance available (ASDA). The runway plus stopway (SWY) length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff; and

Landing distance available (LDA). The runway length declared available and suitable for a landing airplane.

Fixed By Function NAVAID. An air navigation aid (NAVAID) that must be positioned in a particular location in order to provide an essential benefit for civil aviation is fixed by function. Exceptions are:

a. Equipment shelters, junction boxes, transformers, and other appurtenances that support a fixed by function NAVAID *are not* fixed by function unless operational requirements require them to be located in close proximity to the NAVAID.

b. Some NAVAIDs, such as localizers, can provide beneficial performance even when they are not located at their optimal location. These NAVAIDS are not fixed by function.

Frangible NAVAID. A navigational aid (NAVAID) which retains its structural integrity and stiffness up to a designated maximum load, but on impact from a greater load, breaks, distorts, or yields in such a manner as to present the minimum hazard to aircraft. The term NAVAID includes electrical and visual air navigational aids, lights, signs, and associated supporting equipment.

Hazard to Air Navigation. An object which, as a result of an aeronautical study, the FAA determines will have a substantial adverse effect upon the safe and efficient use of navigable airspace by aircraft, operation of air navigation facilities, or existing or potential airport capacity.

Large Airplane. An airplane of more than 12,500 pounds (5 700 kg) maximum certificated takeoff weight.

Low Impact Resistant Supports (LIRS). Supports designed to resist operational and environmental static loads and fail when subjected to a shock load such as that from a colliding aircraft.

Object. Includes, but is not limited to above ground structures, NAVAIDs, people, equipment, vehicles, natural growth, terrain, and parked aircraft.

Object Free Area (OFA). An area on the ground centered on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.

Obstacle Clearance Surface (OCS). An inclined obstacle evaluation surface associated with a glidepath. The separation between this surface and the glidepath angle at any given distance from GPI defines the MINIMUM required obstruction clearance at that point.

Obstacle Free Zone (OFZ). The OFZ is the airspace below 150 feet (45 m) above the established airport elevation and along the runway and extended runway centerline that is required to be clear of all objects, except for frangible visual NAVAIDs that need to be located in the OFZ because of their function, in order to provide clearance protection for aircraft landing or taking off from the runway, and for missed approaches. The OFZ is sub-divided as follows:

Runway OFZ. The airspace above a surface centered on the runway centerline.

Inner-approach OFZ. The airspace above a surface centered on the extended runway centerline. It applies to runways with an approach lighting system.

Inner-transitional OFZ. The airspace above the surfaces located on the outer edges of the runway OFZ and the inner-approach OFZ. It applies to runways with approach visibility minimums lower than 3/4-statute mile (1 200 m).

Obstruction to Air Navigation. An object of greater height than any of the heights or surfaces presented in Subpart C of Code of Federal Regulation (14 CFR), Part 77. (Obstructions to air navigation are presumed to be hazards to air navigation until an FAA study has determined otherwise.)

Precision Approach Category I (CAT I) Runway. A runway with an instrument approach procedure which provides for approaches to a decision height (DH) of not less than 200 feet (60 m) and visibility of not less than 1/2 mile (800 m) or Runway Visual Range (RVR) 2400 (RVR 1800 with operative touchdown zone and runway centerline lights).

Precision Approach Category II (CAT II) Runway. A runway with an instrument approach procedure which provides for approaches to a minima less than CAT I to as low as a decision height (DH) of not less than 100 feet (30 m) and RVR of not less than RVR 1200.

Precision Approach Category III (CAT III) Runway. A runway with an instrument approach procedure which provides for approaches to minima less than CAT II.

Runway (RW). A defined rectangular surface on an airport prepared or suitable for the landing or takeoff of airplanes.

Runway Blast Pad. A surface adjacent to the ends of runways provided to reduce the erosive effect of jet blast and propeller wash.

Runway Protection Zone (RPZ). An area off the runway end to enhance the protection of people and property on the ground.

Runway Safety Area (RSA). A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway.

Shoulder. An area adjacent to the edge of paved runways, taxiways, or aprons providing a transition between the pavement and the adjacent surface; support for aircraft running off the pavement; enhanced drainage; and blast protection.

Small Airplane. An airplane of 12,500 pounds (5 700 kg) or less maximum certificated takeoff weight.

Stopway (SWY). A defined rectangular surface beyond the end of a runway prepared or suitable for use in lieu of runway to support an airplane, without causing structural damage to the airplane, during an aborted takeoff.

Taxilane (TL). The portion of the aircraft parking area used for access between taxiways and aircraft parking positions.

Taxiway (TW). A defined path established for the taxiing of aircraft from one part of an airport to another.

Taxiway Safety Area (TSA). A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an airplane unintentionally departing the taxiway.

Threshold (TH). The beginning of that portion of the runway available for landing. In some instances, the landing threshold may be displaced.

Displaced Threshold. A threshold that is located at a point on the runway other than the designated beginning of the runway.

Visual Runway. A runway without an existing or planned straight-in instrument approach procedure.

3. <u>RELATED/REFERENCED READING MATERIAL</u>. The following is a listing of documents referenced in other parts of this advisory circular. Advisory Circulars 00-2 and 00-44 may be obtained by writing to: The U.S. Department of Transportation; Utilization and Storage Section, M-443.2; Washington, D.C. 20590. The most current versions of the ACs listed below are available online at www.faa.gov.

NOTE: Some of the ACs in this paragraph have been cancelled but are still referenced in the main document. They will continue to be listed here and shown as cancelled until the next complete revision of the document.

a. AC 00-2, Advisory Circular Checklist.

b. AC 00-44, Status of Federal Aviation Regulations.

c. AC 20-35, Tiedown Sense.

d. AC 70/7460-1, Obstruction Marking and Lighting.

e. AC 70/7460-2, Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace. (Cancelled)

f. AC 107-1, Aviation Security-Airports.

g. AC 120-29, Criteria for Approving Category I and Category II Landing Minima for FAR Part 121 Operators.

h. AC 150/5000-3, Address List for Regional Airports Divisions and Airports District/Field Offices. (Cancelled)

i. AC 150/5060-5, Airport Capacity and Delay.

j. AC 150/5070-3, Planning the Airport Industrial Park. (Cancelled)

k. AC 150/5070-6, Airport Master Plans.

l. AC 150/5190-1, Minimum Standards for Commercial Aeronautical Activities on Public Airports. (Cancelled by AC 150/5190-5)

m. AC 150/5190-4, A Model Zoning Ordinance to Limit Height of Objects Around Airports.

n. AC 150/5190-5, Exclusive Rights and Minimum Standards for Commercial Aeronautical Activities. (Cancelled by AC 150/5190-6 and AC 150/5190-7)

o. AC 150/5190-6, Exclusive Rights at Federally-Obligated Airports

p. AC 150/5190-7, Minimum Standards for Commercial Aeronautical Activities

q. AC 150/5200-33, Hazardous Wildlife Attractants On or Near Airports.

r. AC 150/5220-16, Automated Weather Observing Systems (AWOS) for Non-Federal Applications.

s. AC 150/5230-4, Aircraft Fuel Storage, Handling, and Dispensing on Airports.

t. AC 150/5320-5, Airport Drainage.

u. AC 150/5320-6, Airport Pavement Design and Evaluation.

v. AC 150/5320-14, Airport Landscaping for Noise Control Purposes.

w. AC 150/5325-4, Runway Length Requirements for Airport Design.

x. AC 150/5340-1, Standards for Airport Marking.

y. AC 150/5340-5, Segmented Circle Marker Systems.

z. AC 150/5340-14, Economy Approach Lighting Aids. (Cancelled by AC 150/5340-30)

aa. AC 150/5340-18, Standards for Airport Sign Systems.

bb. AC 150/5340-21, Airport Miscellaneous Lighting Visual Aids. (Cancelled by AC 150/5340-30)

cc. AC 150/5340-24, Runway and Taxiway Edge Lighting System. (Cancelled by AC 150/5340-30)

dd. AC 150/5340-28, Precision Approach Path Indicator (PAPI) Systems. (Cancelled by AC 150/5340-30)

ee. AC 150/5340-30, Design and Installation Details for Airport Visual Aids

ff. AC 150/5345-52, Generic Visual Slope Indicators (GVGI).

gg. AC 150/5360-13, Planning and Design Guidelines for Airport Terminal Facilities.

hh. AC 150/5370-10, Standards for Specifying Construction of Airports.

ii. AC 150/5390-2, Heliport Design.

jj. 14 CFR Part 23, Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes.

kk. 14 CFR Part 25, Airworthiness Standards: Transport Category Airplanes.

ll. 14 CFR Part 77, Objects Affecting Navigable Airspace.

mm. 14 CFR Part 97, Standard Instrument Approach Procedures.

nn. 14 CFR Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.

oo. 14 CFR Part 139, Certification of Airports.

pp. 14 CFR Part 151, Federal Aid to Airports.

qq. 14 CFR Part 152, Airport Aid Program.

rr. 14 CFR Part 153, Acquisition of U.S. Land for Public Airports. (Removed from Title 14)

ss. 14 CFR Part 154, Acquisition of Land for Public Airports Under the Airport and Airway Development Act of 1970. (Removed from Title 14)

tt. 14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports.

uu. Order 1050.1, Policies and Procedures for Considering Environmental Impacts.

vv. Order 5050.4, Airport Environmental Handbook.

ww. Order 5100.38, Airport Improvement Program (AIP) Handbook.

xx. Order 7400.2, Procedures for Handling Airspace Matters.

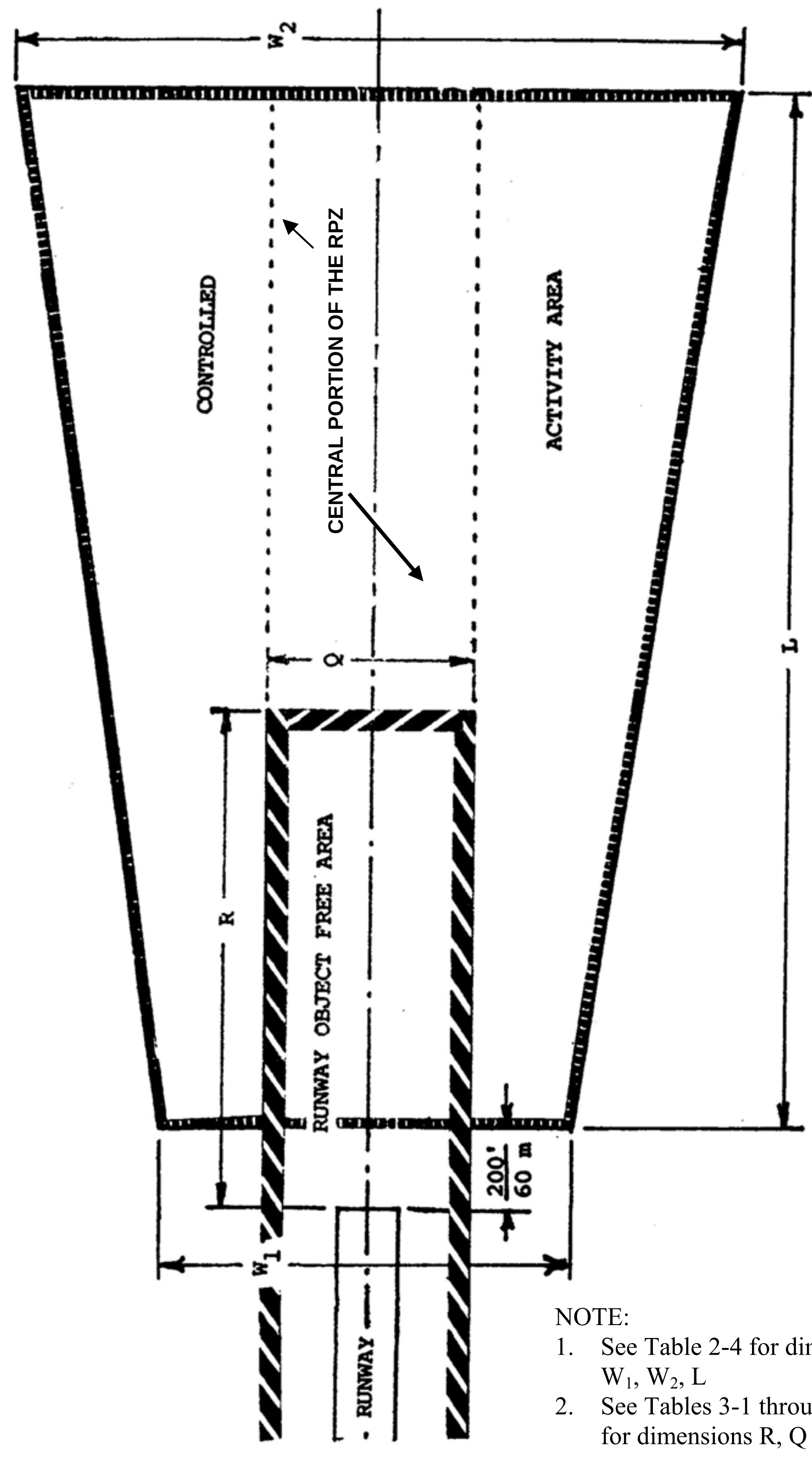
yy. Order 8200.1, United States Standard Flight Inspection Manual.

zz. Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS).

Table 2-4. Runway protection zone (RPZ) dimensions

Approach Visibility Minimums 1/	Facilities Expected To Serve	Dimensions			
		Length L Feet (meters)	Inner Width W_1 feet (meters)	Outer Width W_2 feet (meters)	RPZ acres
Visual And Not lower than 1-Mile (1 600 m)	Small Aircraft Exclusively	1,000 (300)	250 (75)	450 (135)	8.035
	Aircraft Approach Categories A & B	1,000 (300)	500 (150)	700 (210)	13.770
	Aircraft Approach Categories C & D	1,700 (510)	500 (150)	1,010 (303)	29.465
Not lower than ¾-Mile (1 200 m)	All Aircraft	1,700 (510)	1,000 (300)	1,510 (453)	48.978
Lower than ¾-Mile (1 200 m)	All Aircraft	2,500 (750)	1,000 (300)	1,750 (525)	78.914

1/ The RPZ dimensional standards are for the runway end with the specified approach visibility minimums. The departure RPZ dimensional standards are equal to or less than the approach RPZ dimensional standards. When a RPZ begins other than 200 feet (60 m) beyond the runway end, separate approach and departure RPZs should be provided. Refer to Appendix 14 for approach and departure RPZs.



NOTE:
1. See Table 2-4 for dimension W_1, W_2, L
2. See Tables 3-1 through 3-3 for dimensions R, Q

Figure 2-3. Runway protection zone

Table 3-1. Runway design standards for aircraft approach category A & B visual runways and runways with not lower than 3/4-statute mile (1,200 m) approach visibility minimums

(Refer also to Appendix 16 for the establishment of new approaches)

ITEM	DIM 1/	AIRPLANE DESIGN GROUP				
		I 2/	I	II	III	IV
Runway Length	A	- Refer to paragraph 301 -				
Runway Width	B	60 ft	60 ft	75 ft	100 ft	150 ft
		18 m	18 m	23 m	30 m	45 m
Runway Shoulder Width		10 ft	10 ft	10 ft	20 ft	25 ft
		3 m	3 m	3 m	6 m	7.5 m
Runway Blast Pad Width		80 ft	80 ft	95 ft	140 ft	200 ft
		24 m	24 m	29 m	42 m	60 m
Runway Blast Pad Length		60 ft	100 ft	150 ft	200 ft	200 ft
		18 m	30 m	45 m	60 m	60 m
Runway Safety Area Width	C	120 ft	120 ft	150 ft	300 ft	500 ft
		36 m	36 m	45 m	90 m	150 m
Runway Safety Area Length Prior to Landing Threshold 3/, 4/		240 ft	240 ft	300 ft	600 ft	600 ft
		72 m	72 m	90 m	180 m	180 m
Runway Safety Area Length Beyond RW End 3/, 4/	P	240 ft	240 ft	300 ft	600 ft	1,000 ft
		72 m	72 m	90 m	180 m	300 m
Obstacle Free Zone Width and Length		- Refer to paragraph 306 -				
Runway Object Free Area Width	Q	250 ft	400 ft	500 ft	800 ft	800 ft
		75 m	120 m	150 m	240 m	240 m
Runway Object Free Area Length Beyond RW End 5/	R	240 ft	240 ft	300 ft	600 ft	1,000 ft
		72 m	72 m	90 m	180 m	300 m

1/ Letters correspond to the dimensions on figures 2-1 and 2-3. Use this table only when both ends of the runway provide not lower than ¾-statute mile approach visibility minimums.

2/ These dimensional standards pertain to facilities for small airplanes exclusively.

3/ The runway safety area (RSA) length begins at each runway end when a stopway is not provided. When a stopway is provided, the length begins at the stopway end.

4/ The standard RSA length beyond the runway end may be reduced to the standard RSA length prior to landing threshold if a standard Engineered Materials Arresting System (EMAS) is provided. To qualify for this reduction, the EMAS installation must provide the ability to stop the critical aircraft exiting the end of the runway at 70 knots, and the runway must provide either instrument or visual vertical guidance for approaches in the opposite direction. See AC 150/5220-22.

5/ The runway object free area length beyond the end of the runway never exceeds the standard RSA length beyond the runway end as provided by note 4 above.

Table 3-2. Runway design standards for aircraft approach category A & B runways with lower than 3/4-statute mile (1,200 m) approach visibility minimums

(Refer also to Appendix 16 for the establishment of new approaches)

ITEM	DIM 1/	AIRPLANE DESIGN GROUP				
		I 2/	I	II	III	IV
Runway Length	A	- Refer to paragraph 301 -				
Runway Width	B	75 ft 23 m	100 ft 30 m	100 ft 30 m	100 ft 30 m	150 ft 45 m
Runway Shoulder Width		10 ft 3 m	10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m
Runway Blast Pad Width		95 ft 29 m	120 ft 36 m	120 ft 36 m	140 ft 42 m	200 ft 60 m
Runway Blast Pad Length		60 ft 18 m	100 ft 30 m	150 ft 45 m	200 ft 60 m	200 ft 60 m
Runway Safety Area Width	C	300 ft 90 m	300 ft 90 m	300 ft 90 m	400 ft 120 m	500 ft 150 m
Runway Safety Area Length Prior to Landing Threshold 3/, 4/		600 ft 180 m	600 ft 180 m	600 ft 180 m	600 ft 180 m	600 ft 180 m
Runway Safety Area Length Beyond RW End 3/	P	600 ft 180 m	600 ft 180 m	600 ft 180 m	800 ft 240 m	1,000 ft 300 m
Obstacle Free Zone Width and Length		- Refer to paragraph 306 -				
Runway Object Free Area Width	Q	800 ft 240 m	800 ft 240 m	800 ft 240 m	800 ft 240 m	800 ft 240 m
Runway Object Free Area Length Beyond RW End 5/	R	600 ft 180 m	600 ft 180 m	600 ft 180 m	800 ft 240 m	1,000 ft 300 m

1/ Letters correspond to the dimensions on figures 2-1 and 2-3. Use this table for both ends of the runway even when one end does not have lower than ¾-statute mile visibility minimums.

2/ These dimensional standards pertain to facilities for small airplanes exclusively.

3/ The runway safety area (RSA) length begins at each runway end when a stopway is not provided. When a stopway is provided, the length begins at the stopway end.

4/ The standard RSA length beyond the runway end may be reduced to the standard RSA length prior to landing threshold if a standard Engineered Materials Arresting System (EMAS) is provided. To qualify for this reduction, the EMAS installation must provide the ability to stop the critical aircraft exiting the end of the runway at 70 knots, and the runway must provide either instrument or visual vertical guidance for approaches in the opposite direction. See AC 150/5220-22.

5/ The runway object free area length beyond the end of the runway never exceeds the standard RSA length beyond the runway end as provided by note 4 above.

Table 3-3. Runway design standards for aircraft approach categories C & D

(Refer also to Appendix 16 for the establishment of new approaches)

ITEM	DIM 1/	AIRPLANE DESIGN GROUP					
		I	II	III	IV	V	VI
Runway Length	A	- Refer to paragraph 301 -					
Runway Width	B	100 ft	100 ft	100 ft 2/	150 ft	150 ft	200 ft
		30 m	30 m	30 m 2/	45 m	45 m	60 m
Runway Shoulder Width 3/		10 ft	10 ft	20 ft 2/	25 ft	35 ft	40 ft
		3 m	3 m	6 m 2/	7.5 m	10.5 m	12 m
Runway Blast Pad Width		120 ft	120 ft	140 ft 2/	200 ft	220 ft	280 ft
		36 m	36 m	42 m 2/	60 m	66 m	84 m
Runway Blast Pad Length		100 ft	150 ft	200 ft	200 ft	400 ft	400 ft
		30 m	45 m	60 m	60 m	120 m	120 m
Runway Safety Area Width 4/	C	500 ft	500 ft	500 ft	500 ft	500 ft	500 ft
		150 m	150 m	150 m	150 m	150 m	150 m
Runway Safety Area Length Prior to Landing Threshold 5/, 6/		600 ft	600 ft	600 ft	600 ft	600 ft	600 ft
		180 m	180 m	180 m	180 m	180 m	180 m
Runway Safety Area Length Beyond RW End 5/, 6/	P	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft
		300 m	300 m	300 m	300 m	300 m	300 m
Obstacle Free Zone Width and Length		- Refer to paragraph 306 -					
Runway Object Free Area Width	Q	800 ft	800 ft	800 ft	800 ft	800 ft	800 ft
		240 m	240 m	240 m	240 m	240 m	240 m
Runway Object Free Area Length Beyond RW End 7/	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft
		300 m	300 m	300 m	300 m	300 m	300 m

1/ Letters correspond to the dimensions on figures 2-1 and 2-3.

2/ For Airplane Design Group III serving airplanes with maximum certificated takeoff weight greater than 150,000 pounds (68,100 kg), the standard runway width is 150 feet (45 m), the shoulder width is 25 feet (7.5 m), and the runway blast pad width is 200 feet (60 m).

3/ Design Groups V and VI normally require stabilized or paved shoulder surfaces.

4/ For Airport Reference Code C-I and C-II, a runway safety area width of 400 feet (120 m) is permissible.

5/ The runway safety area (RSA) length begins at each runway end when a stopway is not provided. When a stopway is provided, the length begins at the stopway end.

6/ The standard RSA length beyond the runway end may be reduced to the standard RSA length prior to landing threshold if a standard Engineered Materials Arresting System (EMAS) is provided. To qualify for this reduction, the EMAS installation must provide the ability to stop the critical aircraft exiting the end of the runway at 70 knots, and the runway must provide either instrument or visual vertical guidance for approaches in the opposite direction. See AC 150/5220-22.

7/ The runway object free area length beyond the end of the runway never exceeds the standard RSA length beyond the runway end as provided by note 6 above.

This page intentionally left blank.

412. TAXIWAY BETWEEN PARALLEL RUNWAYS. A taxiway located between two parallel runways requires a centerline separation from each runway to meet the standard separation distance specified in table 2-1.

413. EXIT TAXIWAYS. Design and locate exit taxiways to meet the operational requirements of the airport.

a. Efficiency. Appendix 9 provides guidance on exit taxiway location utilization. AC 150/5060-5 provides guidance on the effect of exit taxiway location on runway capacity. Exit taxiways should permit free flow to the parallel taxiway or at least to a point where air traffic control considers the airplane clear of the runway.

b. Type. A decision to provide a right-angled exit taxiway or a standard acute-angled exit taxiway rests upon an analysis of the existing and contemplated traffic. The purpose of an acute-angled exit taxiway, commonly referred to as a "high speed exit," is to enhance airport capacity. However, when the design peak hour traffic is less than 30 operations (landings and takeoffs), a properly located right-angled exit taxiway will achieve an efficient flow of traffic.

c. Separation. The type of exit taxiway influences runway and taxiway separation. The standard runway-taxiway separations specified in tables 2-1 and 2-2 are satisfactory for right-angled exit taxiways. A separation distance of at least 600 feet (180 m) is necessary for an efficient acute-angled exit taxiway, which includes a reverse curve for "double-back" operations. The runway-taxiway separations specified in tables 2-1 and 2-2 are adequate for acute-angled exits where the taxiway traffic flow is in the direction of landing.

d. Configuration. Figure 4-1 illustrates the configuration for a right-angled exit taxiway. An entrance spiral of at least 30 degrees and 300 feet (90 m) in length should be provided. Figure 4-12 illustrates the standard acute-angled exit taxiway with a 30-degree angle of intersection and a 1,400-foot (420 m) entrance spiral. When runway capacity needs justify the additional cost, high-visibility taxiway centerline lights can be added and the exit taxiway widened by doubling the taxiway edge safety margin. These design enhancements will increase pilot acceptance of an exit. Figures 4-13 and 4-14 present a computer printout of layout data for a 1,400-foot (420 m) spiral exit using a program operable on IBM compatible equipment. Appendix 11 gives details on the availability of this program.

414. APRON TAXIWAYS AND TAXILANES. Requirements often exist to provide through-taxi routes across an apron and to provide access to gate positions or other terminal areas.

a. Apron Taxiways. Apron taxiways may be located either inside or outside the movement area. Apron taxiways require the same separations as other taxiways. When the apron taxiway is along the edge of the apron, locate its centerline inward from the apron edge at a distance equal to one-half of the width of the taxiway structural pavement. A shoulder is necessary along the outer edge in addition to the taxiway safety area and the separations specified in tables 2-1, 2-2, 2-3, and 4-1.

b. Taxilanes. Taxilanes are located outside the movement area. Taxilanes provide access from taxiways (usually an apron taxiway) to airplane parking positions and other terminal areas. When the taxilane is along the edge of the apron, locate its centerline inward from the apron edge at a distance equal to one-half of the width of the taxiway structural pavement and satisfy other apron edge taxiway criteria, i.e., a shoulder, safety area, and the separations specified in tables 2-1, 2-2, 2-3, and 4-1.

c. Visibility. Airport traffic control tower personnel require a clear line of sight to all apron taxiways under air traffic control (ATC). Although ATC is not responsible for controlling taxilane traffic, a clear line of sight to taxilanes is desirable.

415. END-AROUND TAXIWAYS. In an effort to increase operational capacity, airports have added dual and sometimes triple parallel runways, which can cause delays when outboard runway traffic has to cross active inboard runways to make its way to the terminal. To improve efficiency and provide a safe means of movement around the departure end of a runway, it might be feasible to construct a taxiway that allows aircraft to transition around the ends of the runway. This type of taxiway is called an End-Around Taxiway (EAT). Due to the safety critical nature of these operations, it is necessary for planners to work closely with the FAA prior to considering the use of an EAT. EATs should be done only to enhance safety and capacity. Before EAT projects are proposed and feasibility studies and/or design started, they must be pre-approved by the FAA Office of Airport Safety and Standards, Airport Engineering Division (AAS-100). Submission for project approval is through the local Airports District Office for coordination with the approval authority (AAS-100). See figure 4-15.

a. Design Considerations. End-around taxiways must remain outside of the standard runway safety area (RSA), which extends 1,000 feet along the centerline extended of the departure end of the runway (DER). In addition, the EAT must be entirely outside of the ILS critical area. An airspace study for each site should be performed to verify if the tail height of the critical design group aircraft operating on the EAT does not penetrate any FAA Order 8260.3 TERPS surface and meets the requirements of 14 CFR 121.189 for the net takeoff flight path to clear all obstacles either by a height of at least 35 feet vertically, or by at least 200 feet horizontally within the airport boundaries.

b. Visual Screen. The placement and configuration of EATs must take into account additional restrictions to prevent interfering with navigational aids, approaches and departures from the runway(s) with which they are associated. In order to avoid potential issues where pilots departing from a runway with an EAT might mistake an aircraft taxiing on the EAT for one actually crossing near the departure end of the runway, a visual screen type device may be required, depending on the elevation changes at a specific location. Through a partial or complete masking effect, the visual screen will enable pilots to better discern when an aircraft is crossing the active runway versus operating on the EAT. The intent is to eliminate any false perceptions of runway incursions, which could lead to unnecessary aborted takeoffs, and alert pilots to actual incursion situations. A visual screen is required for any new EAT unless the elevation of the EAT centerline, at a point in line with the extended runway centerline, is at least 29 feet below the elevation at the DER, so the terrain creates a natural masking of the aircraft on the EAT. Research has shown that "masking" is accomplished at a height where a critical design group aircraft's wing-mounted engine nacelle would be blocked from view, as discerned from the V-1 point during take-off. DO not locate the visual screen structure within any runway safety area, taxiway obstacle free zone, critical ILS area, or should it penetrate the inner approach OFZ, the approach light plane or other TERPS surfaces.

(1) Screen Sizing. The size of the EAT visual screen is dependent on the runway geometry, the size of the critical design group aircraft operating at that particular airport (on both the departing and EAT), and the elevation relationship between the EAT and the departing runway.

(a) Horizontal Geometry. The width of the screen should be designed to be perceived to originate and end at the taxiway/runway hold line(s) at the DER from a position on the runway equivalent to V1 (take-off decision speed under maximum conditions) for the critical design group aircraft. In order to calculate the screen width, the distance to where the screen will be located beyond the runway end must first be determined. From the runway centerline location of V1 for the design aircraft, lines are drawn through the runway hold line position closest to the DER (normally derived from the Aircraft Holding Position Location in Advisory Circular 150/5340-18) and extended until they intersect with a line perpendicular to the runway at the screen location. See figure 4-16. Use the formula in Figure 4-17 to calculate the width of the visual screen.

(b) Vertical Geometry. The vertical height of the screen must be designed so the top of the screen will mask that portion of an aircraft that extends up to where the top of a wing-mounted engine nacelle would be of a critical design group aircraft taxiing on the EAT, as viewed from the cockpit of the same design group aircraft at the typical V1 point on the departure runway. In a situation where the EAT and the DER elevation are the same, the lower edge of the visual panels should be at the same vertical height as the centerline of the DER. The visual panels of the screen should extend from that point, up to the heights shown in table 4-4, depending on the design group aircraft. For the higher design groups, it is permissible to have the lower limit of the visual screen up to two (2) feet above the DER elevation, as shown in table 4-4. Variations in terrain at the site where the screen is to be constructed will need to be considered, and they may result in the screen being a sizeable distance off the ground. In the event the EAT and DER are at different elevations, either higher or lower, the overall screen height will have to be adjusted to ensure the same masking capability. Tables 4-5, 4-6, and 4-7 provide guidance on determining the height of the visual screen for the respective design groups if the elevation of the EAT is below the elevation of the DER. If the EAT is lower than 29 feet in elevation as compared to the centerline of the DER, a screen is not required. Table 4-8 provides guidance on determining the height of the visual screen for design groups 3 through 6 if the elevation of the EAT is above the elevation of the DER. It may be feasible to grade the site of the visual screen to allow for an additional 2-foot separation between the visual screen panels and the ground for mowing access.

(2) Screen Construction. The visual screen must be constructed to perform as designed and be durable, resistant to weather, frangible, and resistant to excessive wind speeds. The visual screen comprises foundations, frame, connection hardware, and front panels.

(a) Foundations. The foundation of the screen structure should be sufficient to hold the visual screen in position. The base of the foundation should have a sufficient mow strip around it to provide a safety buffer between mowing equipment and the screen structure.

(b) Frame. The frame structure of the screen should be constructed so it is durable, able to withstand wind loading, and frangible in construction. Figure 4-18 illustrates three methods for constructing the frame structure, depending on the overall height of the structure. The visual screen structure should be constructed to allow the front panels of the screen to be angled upward 12 (±1°) degrees from the vertical plane. All connections within the frame structure, the panels, and the foundations should be designed to break away from the structure in the event an aircraft impacts them.

(c) Front Panel. The front panel of the visual screen should be designed so it is conspicuous from the runway side of the screen. The front panel should be constructed of aluminum honeycomb material, as described in the next paragraph. The replaceable front panels should be 12 feet long and 4 feet high and attached to the frame structure so as to allow easy replacement if necessary. See figure 4-19.

(i) Aluminum Honeycomb Performance Criteria. The screen panels should be constructed of aluminum honeycomb material, as described in this section. The front panel of the screen should be constructed of 4-foot-tall panels, with the remaining difference added as required. For example, three 4-foot-high panels plus one 1-foot-tall panel would be used to create a 13-foot-tall screen. These panels should be undersized by 0.50 inches to allow for thermal and deflection movements. The front and back panel faces should be specified to meet the required deflection allowance and should be a minimum 0.04 inches thick. The honeycomb material should be of sufficient thickness to meet the required deflection allowance, but should not be more than 3 inches thick. The internal aluminum honeycomb diameter should be of sufficient strength to meet the required deflection allowance, but should not be more than 0.75 inches in diameter. The panel edge closures should be of aluminum tube that is 1 inch times the thickness of the honeycomb and sealed. The deflection allowance for the screen is 0.50 inches maximum at the center of the panel when supported by four points at the corner of the panel. The panel faces should have a clear anodized finish on both front and back. The wind-loading deflection should be as specified in table 4-9.

(ii) Pattern. The front panel of the screen should visually depict a continuous, alternating red and white, diagonal striping of 12-foot-wide stripes set at a 45-degree angle ± five (5) degrees, sloped either all to the left or all to the right. To provide maximum contrast, the slope of the diagonal striping on the screen should be opposite the slope of aircraft tails operating in the predominant flow on the EAT, as shown in Figure 4-20.

(iii) Color. The front panel of the screen should be reflective red and white. The colors of the retroreflective sheeting used to create the visual screen must conform to Chromaticity Coordinate Limits shown in table 4-10, when measured in accordance with Federal Specification FP-85, Section 718.01(a), or ASTM D 4956.

(iv) Reflectivity. The surface of the front panel should be reflective on the runway side of the screen. Measurements should be made in accordance with ASTM E810, *Standard Test Method for Coefficient of Retro-reflection of Retro-reflective Sheeting.* The sheeting must maintain at least 90 percent of its values, as shown in table 4-11, with water falling on the surface, when measured in accordance with the standard rainfall test of FP-85, Section 718.02(a), and Section 7.10.0 of AASHTO M 268.

(v) Adhesion. The screen surface material must have a pressure-sensitive adhesive, which conforms to adhesive requirements of FP-85 (Class 1) and ASTM D 4956 (Class 1). The pressure-sensitive adhesive is recommended for application by hand or with a mechanical squeeze roller applicator. This type adhesive lends itself to large-scale rapid production of signs. Applications should be made with sheeting and substrate at temperatures above 65˚ F (18˚C).

(3) Environmental Performance. The front panel of the screen surface material and all its required components must be designed for continuous outdoor use under the following conditions:

(a) Temperature. Screen surface material must withstand the following ambient temperature ranges: -4 degrees to +131 degrees F (-20 degrees to +55 degrees C).

(b) Wind Loading. The screen must be able to sustain exposure to wind velocities of at least 90 mph or the appropriate velocity rating anticipated for the specific airport location, whichever is greater.

(c) Rain. The screen surface material must withstand exposure to wind-driven rain.

(d) Sunlight. The screen surface material must withstand exposure to direct sunlight.

(e) Lighting. If required, the top edge of the visual screen should be illuminated with steady burning, L-810 FAA-approved obstruction lighting, as provided in the current version of AC 150/5345-43, and positioned as specified in paragraph 58(b) of the current version of AC 70/7460-1.

(4) **Provision for Alternate Spacing of Visual Screen.** If access is needed through the area where the visual screen is constructed, various sections of the screen may be staggered up to 50 feet from each other, as measured from the runway end, so an emergency vehicle can safely navigate between the staggered sections of screen. The sections of screen must be overlapped so the screen appears to be unbroken when viewed from the runway, at the V1 takeoff position.

(5) Frangibility. The screen structure, including all of its components, should be of the lowest mass possible to meet the design requirements so as to minimize damage should the structure be impacted. The foundations at ground level should be designed so they will shear on impact, the vertical supports should be designed so they will give way, and the front panels should be designed so they will release from the screen structure if impacted. The vertical support posts should be tethered at the base so they will not tumble when struck. Figure 4-21 provides information on how this level of frangibility can be achieved.

(6) Navigational Aid Consideration. The following considerations should be given when determining the siting and orientation of the visual screen. The visual screen may have adverse affects on navigational aids if it is not sited properly. The uniqueness and complexity of the airport siting environment requires that all installations be addressed on a case-by-case basis, so mitigations can be developed to ensure the installation of the visual screen does not significantly navigational aid performance.

(a) Approach Light Plane. No part of the visual screen may penetrate the approach light plane.

(b) Radar Interference. Research has shown that a visual screen erected on an airport equipped with Airport Surface Detection Equipment (ASDE) may reflect signals that are adverse to the ASDE operation. To avoid this, the visual screen should be tilted back/away (on the side facing the ASDE) 12 degrees (±1°). This will minimize or eliminate false radar targets generated by reflections off the screen surface. Examples of this tilting are shown in figure 4-18.

(c) Instrument Landing System (ILS) Interference. Research has shown that the presence of visual screens on a runway instrumented with an ILS system (localizer and glide slope) will generally not affect or interfere with the operation of the system. An analysis must be performed for glide slopes, especially null reference glide slopes, prior to the installation of the screens. The uniqueness and complexity of the airport siting environment requires that all installations be addressed on a case-by-case basis, so mitigations can be developed to ensure the installation of the visual screen does not significantly impact the performance of the ILS.

416. to 499. RESERVED.

Table 4-1. Taxiway dimensional standards

ITEM	DIM 1/	AIRPLANE DESIGN GROUP					
		I	II	III	IV	V	VI
Taxiway Width	W	25 ft 7.5 m	35 ft 10.5 m	50 ft 2/ 15 m 2/	75 ft 23 m	75 ft 23 m	100 ft 30 m
Taxiway Edge Safety Margin 3/		5 ft 1.5 m	7.5 ft 2.25 m	10 ft 4/ 3 m 4/	15 ft 4.5 m	15 ft 4.5 m	20 ft 6 m
Taxiway Pavement Fillet Configuration		- Refer to Table 4-2 -					
Taxiway Shoulder Width		10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m	35 ft 5/ 10.5 m 5/	40 ft 5/ 12 m 5/
Taxiway Safety Area Width	E	49 ft 15 m	79 ft 24 m	118 ft 36 m	171 ft 52 m	214 ft 65 m	262 ft 80 m
Taxiway Object Free Area Width		89 ft 27 m	131 ft 40 m	186 ft 57 m	259 ft 79 m	320 ft 97 m	386 ft 118 m
Taxilane Object Free Area Width		79 ft 24 m	115 ft 35 m	162 ft 49 m	225 ft 68 m	276 ft 84 m	334 ft 102 m

1/ Letters correspond to the dimensions on figures 2-1 and 4-1.

2/ For airplanes in Airplane Design Group III with a wheelbase equal to or greater than 60 feet (18 m), the standard taxiway width is 60 feet (18 m).

3/ The taxiway edge safety margin is the minimum acceptable distance between the outside of the airplane wheels and the pavement edge.

4/ For airplanes in Airplane Design Group III with a wheelbase equal to or greater than 60 feet (18 m), the taxiway edge safety margin is 15 feet (4.5 m).

5/ Airplanes in Airplane Design Groups V and VI normally require stabilized or paved taxiway shoulder surfaces.

Consideration should be given to objects near runway/taxiway/taxilane intersections, which can be impacted by exhaust wake from a turning aircraft.

The values obtained from the following equations may be used to show that a modification of standards will provide an acceptable level of safety. Refer to paragraph 6 for guidance on modification of standards requirements.

Taxiway safety area width equals the airplane wingspan;

Taxiway OFA width equals 1.4 times airplane wingspan plus 20 feet (6 m); and

Taxilane OFA width equals 1.2 times airplane wingspan plus 20 feet (6 m).

```
E51: 'AREA NOT INCLUDED
A52: +A2
COPY CELL A52 TO RANGE(A52..A54)
D52: +D2
COPY CELL D52 TO RANGE(D53..E54)
A57: +A7
E57: +E7
B58: (A9+B8)/2
COPY CELL B58 TO RANGE(B58..J58)
B59: (B9+C8)/2
COPY CELL B59 TO RANGE(B59..J59)
A61: +A11
COPY CELL A61 TO RANGE(A61..A96)
B61: @IF($K61<=B$58,1,@IF($L61>B$59,$A$9,(B$59^2-$K61*$L61+
     @IF($K61<B$59,0,$L61*($K61-B$59)^2/($K61-$L61))-
     @IF($L61>B$58,0,$K61*(B$58-$L61)^2/($K61-$L61)))/(B$59^2-B$58^2)))
COPY CELL B61 TO RANGE(B61..J96)
K61: @MAX($D$4/(@MAX(@ABS(@SIN(($D$3-A61*10+5)*@PI/180)),1.0000000E-50)),
     $D$4/(@MAX(@ABS(@SIN(($D$3-A61*10-5)*@PI/180)),1.0000000E-50)))
COPY CELL K61 TO RANGE(K61..K96)
L61: @MIN($D$4/(@MAX(@ABS(@SIN(($D$3-A61*10+5)*@PI/180)),1.0000000E-50)),
     $D$4/(@MAX(@ABS(@SIN(($D$3-A61*10-5)*@PI/180)),1.0000000E-50)))
COPY CELL L61 TO RANGE(L61..L96)
A100: |::
E101: '% WIND NOT COVERED
A102: +A2
COPY CELL A102 TO RANGE(A102..A104)
D102: +D2
COPY CELL D102 TO RANGE(D103..E104)
A107: +A7
E107: +E7
L107: 'TOTAL:
B108: +B58
COPY CELL B108 TO RANGE(B108..J109)
A111: +A61
COPY CELL A111 TO RANGE(A111..A146)
B111: @IF(B61=0,$A$9,100*(B61*B11)/$K$48)
COPY CELL B111 TO RANGE(B111..J146)
L111: @SUM(B111..J111)
COPY CELL L111 TO RANGE(L111..L146)
A148: 'TOTAL:
B148: @SUM(B111..B146)
COPY CELL B148 TO RANGE(B148..J148)
L148: @SUM(L111..L146)
A150: |::
```

Figure A1-11. Lotus cell-formulas page 2

Appendix 2. RUNWAY END SITING REQUIREMENTS

1. PURPOSE. This appendix contains guidance on siting thresholds to meet approach obstacle clearance requirements and departure obstacle clearance requirements.

2. APPLICATION.

a. The threshold should be located at the beginning of the full-strength runway pavement or runway surface. However, displacement of the threshold may be required when an object that obstructs the airspace required for landing and/or departing airplanes is beyond the airport owner's power to remove, relocate, or lower. Thresholds may also be displaced for environmental considerations, such as noise abatement, or to provide the standard RSA and ROFA lengths.

b. When a hazard to air navigation exists, the amount of displacement of the threshold or reduction of the TODA should be based on the operational requirements of the most demanding airplanes. The standards in this appendix minimize the loss of operational use of the established runway and reflect the FAA policy of maximum utilization and retention of existing paved areas on airports.

c. Displacement of a threshold reduces the length of runway available for landings. Depending on the reason for displacement of the threshold, the portion of the runway behind a displaced threshold may be available for takeoffs in either direction and landings from the opposite direction. Refer to Appendix 14, Declared Distances, for additional information.

d. Where specifically noted, the Glidepath Angle (GPA) and Threshold Crossing Height (TCH) of a vertically guided approach may be altered (usually increased) rather than displacing the threshold. Examples of approaches with positive vertical guidance include Instrument Landing System (ILS), Microwave Landing System (MLS), Localizer Performance with Vertical Guidance (LPV), Lateral Navigation/Vertical Navigation (LNAV/VNAV), and required navigation performance (RNP). Alternatively, a combination of threshold displacement and altering of the Glidepath Angle/ Threshold Crossing Height (GPA/TCH) may also be accomplished. Guidelines for maximum and minimum values of TCH and GPA are contained in FAA Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS).* The tradeoff between threshold displacement, TCH, and GPA is complex, but can be analyzed by applying formula contained in the order. Contact the appropriate FAA Airports Regional or District Office for assistance on the specific requirements and effects of GPA and TCH changes.

3. LIMITATIONS.

a. These standards should not be interpreted as an FAA blanket endorsement of the alternative to displace or relocate a runway threshold. Threshold displacement or relocation should be undertaken only after a full evaluation reveals that displacement or relocation is the only practical alternative.

b. The standards in this appendix are applicable for identifying objects affecting navigable airspace. See Title 14 Code of Federal Regulations Part 77, Objects Affecting Navigable Airspace.

4. EVALUATION CONSIDERATIONS.

a. Possible Actions. When a penetration to a threshold siting surface defined in paragraph 5 exists, one or more of the following actions are required:

(1) Approach Surfaces.

(a) The object is removed or lowered to preclude penetration of applicable threshold siting surfaces;

(b) The threshold is displaced to preclude object penetration of applicable threshold siting surfaces, with a resulting shorter landing distance; or

(c) The GPA and/or TCH is/are modified, or a combination of threshold displacement and GPA/TCH increase is accomplished.

(d) Visibility minimums are raised.

(e) Night operations are prohibited unless the obstruction is lighted or an approved Visual Glide Slope Indicator (VGSI) is used.

(2) Departure Surfaces for Designated Runways. The applicability of the surface defined in Table A2-1 is dependant on the designation of primary runway(s) for departure. The Airport Sponsor, through the Airports District Office to the Regional Airspace Procedures Team (RAPT), will identify runway end(s) intended primarily for instrument departures. The determination of primary runway(s) for departure does not prohibit or negate the use of other runways. It only identifies the applicability of the surface in Table A2-1 to the runway end(s).

(a) Remove, relocate, or lower (or both relocate and lower) the object to preclude penetration of applicable siting surfaces unless it is fixed by function and/or designated impracticable. Within 6000' of the Table A2-1 surface origin, objects less than or equal to an elevation determined by application of the formula below are allowable.

$$E + (0.025 \times D)$$

Where:
E = DER elevation
D = Distance from OCS origin to object in feet

(b) Decrease the Takeoff Distance Available (TODA) to preclude object penetration of applicable siting surfaces, with a resulting shorter takeoff distance (the Departure End of the Runway (DER) is coincident with the end of the TODA where a clearway is not in effect); or

(c) Modify instrument departures. Contact the Flight Procedures Office (FPO) for guidance. Objects penetrating by ≤ 35 feet may not require actions (a) or (b); however, they will impact departure minimums/climb gradients or departure procedures.

b. Relevant Factors for Evaluation.

(1) Types of airplanes that will use the runway and their performance characteristics.

(2) Operational disadvantages associated with accepting higher landing/ takeoff minimums.

(3) Cost of removing, relocating, or lowering the object.

(4) Effect of the reduced available landing/takeoff length when the runway is wet or icy.

(5) Cost of extending the runway if insufficient runway length would remain as a result of displacing the threshold. The environmental aspects of a runway extension need to also be evaluated under this consideration.

(6) Cost and feasibility of relocating visual and electronic approach aids, such as threshold lights, visual glide slope indicator, runway end identification lights, localizer, glide slope (to provide a threshold crossing height of not more than 60 feet (18 m)), approach lighting system, and runway markings.

(7) Effect of the threshold change on noise abatement.

5. CLEARANCE REQUIREMENTS. The standard shape, dimensions, and slope of the surface used for locating a threshold are dependent upon the type of aircraft operations currently conducted or forecasted, the landing visibility minimums desired, and the types of instrumentation available or planned for that runway end.

a. Approaches with Positive Vertical Guidance. Table A2-1 and Figure A2-1 describe the clearance surfaces required for instrument approach procedures with vertical guidance.

The Glidepath Qualification Surface (GQS) limits the height of obstructions between Decision Altitude (DA) and runway threshold (RWT). When obstructions exceed the height of the GQS, an approach procedure with positive vertical guidance is not authorized. Further information can be found in the appropriate TERPS criterion.

b. Instrument Approach Procedures Aligned with the Runway Centerline. Table A2-1 and Figure A2-1 describe the minimum clearance surfaces required for instrument approach procedures aligned with the runway centerline.

c. Procedures Not Aligned with the Runway Centerline. To accommodate for offset procedures, increase the lateral width at threshold by multiplying the width specified in the appropriate paragraph by 2 (offset side only). The outside offset boundary splays from this point at an angle equal to the amount of angular divergence between the final approach course and runway centerline + 10 degrees. Extend the outside offset boundary out to the distance specified in the applicable paragraph and connect it to runway centerline with an arc of the same radius. On the side opposite the offset, construct the area aligned with runway centerline as indicated (non-offset side only). The surface slope is as specified in the applicable paragraph, according to Table A2-1. Figure A2-2 is an example of the offset procedure.

d. Locating or Determining the DER. The standard shape, dimensions, and slope of the departure surface used for determining the DER, as defined in TERPS, is only dependent upon whether or not instrument departures are being used or planned for that runway end. See Table A2-1 and Figures A2-1 and A2-2 for dimensions.

Subparagraph 5d(2) applies only to runways supporting Air Carrier departures and is not to be considered a clearance surface.

(1) For Departure Ends at Designated Runways.

(a) No object should penetrate a surface beginning at the elevation of the runway at the DER or end of clearway, and slopes at 40:1. Penetrations by existing obstacles of 35 feet or less would not require TODA reduction or other mitigations found in paragraph 4; however, they may affect new or existing departure procedures.

(2) Departure Runway Ends Supporting Air Carrier Operations.

(a) Objects should be identified that penetrate a one-engine inoperative (OEI) obstacle identification surface (OIS) starting at the DER and at the elevation of the runway at that point, and slopes upward at 62.5:1. See Figure A2-4. **Note:** This surface is provided for information only and does not take effect until January 1, 2009.

Table A2-1. Approach/Departure Requirements Table

	Runway Type	DIMENSIONAL STANDARDS* Feet					Slope/ OCS
		A	B	C	D	E	
1	Approach end of runways expected to serve small airplanes with approach speeds less than 50 knots. (Visual runways only, day/night)	0	60	150	500	2,500	15:1
2	Approach end of runways expected to serve small airplanes with approach speeds of 50 knots or more. (Visual runways only, day/night)	0	125	350	2,250	2,750	20:1
3	Approach end of runways expected to serve large airplanes (Visual day/night); or instrument minimums ≥ 1 statute mile (day only).	0	200	500	1,500	8,500	20:1
4	Approach end of runways expected to support instrument night circling. [1]	200	200	1,700	10,000	0	20:1
5	Approach end of runways expected to support instrument straight in night operations, serving approach category A and B aircraft only. [1]	200	200	1,900	10,000 [2]	0	20:1
6	Approach end of runways expected to support instrument straight in night operations serving greater than approach category B aircraft. [1]	200	400	1,900	10,000 [2]	0	20:1
7 [3, 6, 7, 8]	Approach end of runways expected to accommodate approaches with positive vertical guidance (GQS).	0	½ width runway + 100	760	10,000 [2]	0	30:1
8	Approach end of runways expected to accommodate instrument approaches having visibility minimums ≥ 3/4 but < 1 statute mile, day or night.	200	400	1,900	10,000 [2]	0	20:1
9	Approach end of runways expected to accommodate instrument approaches having visibility minimums < 3/4 statute mile or precision approach (ILS, GLS, or MLS), day or night.	200	400	1,900	10,000 [2]	0	34:1
10	Approach runway ends having Category II approach minimums or greater.	The criteria are set forth in TERPS, Order 8260.3.					
11	Departure runway ends for all instrument operations.	0 [4]	See Figure A2-3				40:1
12	Departure runway ends supporting Air Carrier operations. [5]	0 [4]	See Figure A2-4				62.5:1

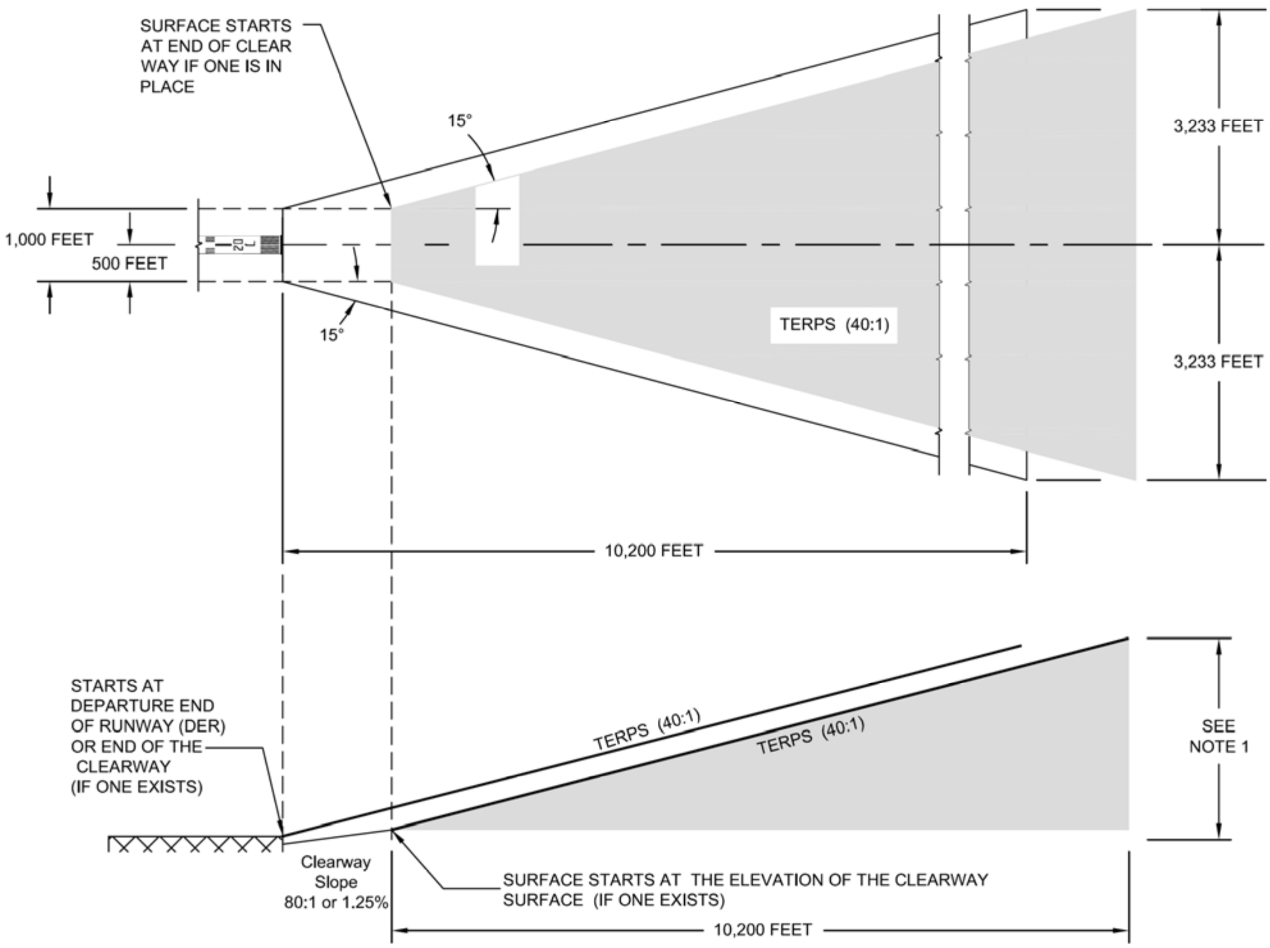
* The letters are keyed to those shown in Figure A2-1.

Notes:

1. Lighting of obstacle penetrations to this surface or the use of a VGSI, as defined by the TERPS order, may avoid displacing the threshold.
2. 10,000 feet is a nominal value for planning purposes. The actual length of these areas is dependent upon the visual descent point position for 20:1 and 34:1 and Decision Altitude point for the 30:1.
3. Any penetration to this surface will limit the runway end to nonprecision approaches. No vertical approaches will be authorized until the penetration(s) is/are removed except obstacles fixed by function and/or allowable grading.
4. Dimension A is measured relative to Departure End of Runway (DER) or TODA (to include clearway).
5. Data Collected regarding penetrations to this surface are provided for information and use by the air carriers operating from the airport. These requirements do not take effect until January 1, 2009.
6. Surface dimensions/Obstacle Clearance Surface (OCS) slope represent a nominal approach with 3 degree GPA, 50'

TCH, < 500' HAT. For specific cases refer to TERPS. The Obstacle Clearance Surface slope (30:1) represents a nominal approach of 3 degrees (also known as the Glide Path Angle). This assumes a threshold crossing height of 50 feet. Three degrees is commonly used for ILS systems and VGSI aiming angles. This approximates a 30:1 approach angle that is between the 34:1 and the 20:1 notice surfaces of Part 77. Surfaces cleared to 34:1 should accommodate a 30:1 approach without any obstacle clearance problems.

7. For runways with vertically guided approaches the criteria in Row 7 is in addition to the basic criteria established within the table, to ensure the protection of the Glidepath Qualification Surface.
8. For planning purposes, sponsors and consultants determine a tentative Decision Altitude based on a 3° Glidepath angle and a 50-foot Threshold Crossing Height.



NOTES:

1. THIS IS AN INTERPRETATION OF THE APPLICATION OF THE TERPS SURFACE ASSOCIATED WITH A CLEARWAY.

Figure A2-3. Departure surface for Instrument Runways TERPS (40:1)

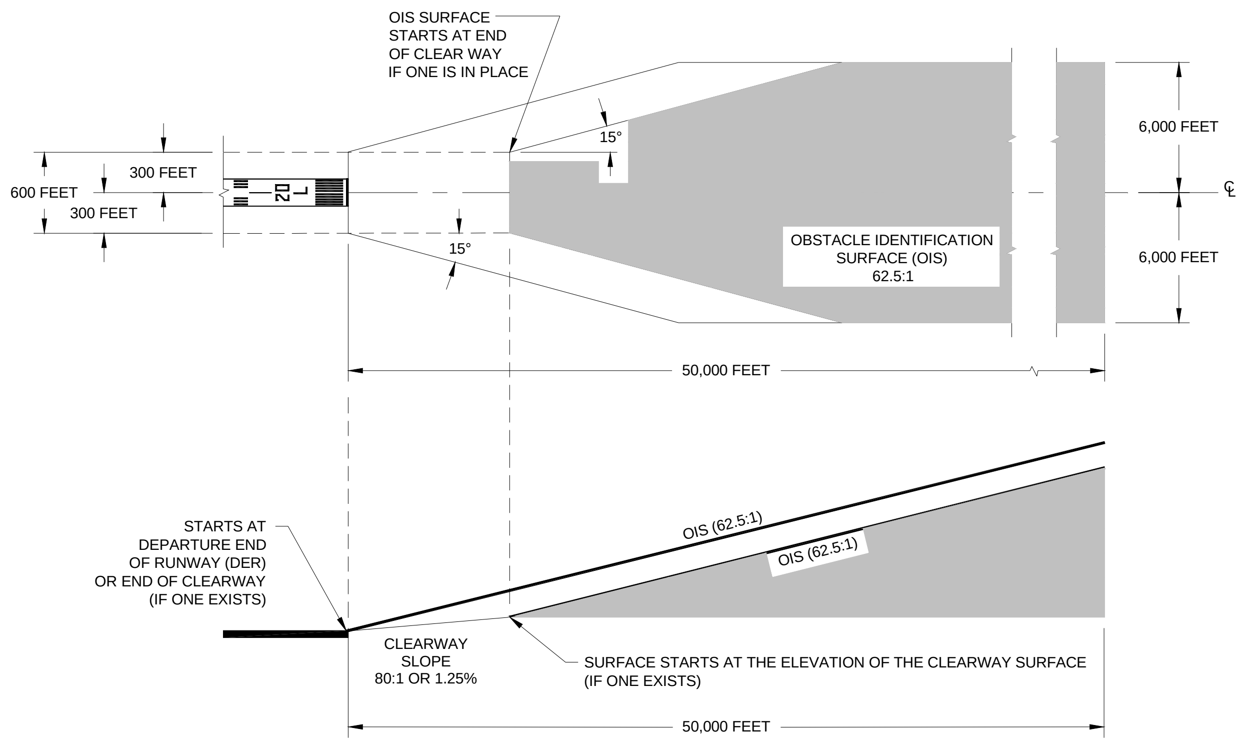


Figure A2-4. One-Engine Inoperative (OEI) Obstacle Identification Surface (62.5:1)

Appendix 16. NEW INSTRUMENT APPROACH PROCEDURES

1. BACKGROUND. This appendix applies to the establishment of new authorized instrument approach procedures. For purposes of this appendix, an Instrument Approach Procedure (IAP) amendment or the establishment of a Global Positioning System (GPS) instrument procedure "overlaying" an existing authorized instrument procedure does not constitute a new procedure. However, a significant reduction in minima (i.e. ¼ mile reduction in visibility and/or 50 foot reduction in decision altitude or minimum descent altitude) would constitute a new procedure.

a. This appendix identifies airport landing surface requirements to assist airport sponsors in their evaluation and preparation of the airport landing surface to support new instrument approach procedures. It also lists the airport data provided by the procedure sponsor that the FAA needs to conduct the airport airspace analysis specified in FAA Order 7400.2, *Procedures for Handling Airspace Matters*. The airport must be acceptable for IFR operations based on an Airport Airspace Analysis (AAA), under FAA Order 7400.2.

b. FAA Order 8260, *TERPS*, reflects the contents of this appendix as the minimum airport landing surface requirements that must be met prior to the establishment of instrument approach procedures at a public use airport. This order also references other FAA requirements, such as a safety analysis to determine the need for approach lighting and other visual enhancements to mitigate the effects of a difficult approach environment. This is a consideration regardless of whether or not a reduction in approach minimums is desired. Airport sponsors are always encouraged to consider an approach lighting system to enhance the safety of an instrument procedure. In the absence of any identified benefits or safety enhancement from an approach light system, sponsors should at least consider installing lower cost visual guidance aids such as REIL or PAPI.

c. The tables provided in this appendix are for planning purposes only and should be used in conjunction with the rest of the document. All pertinent requirements within this AC and other FAA documents, as well as local siting conditions, ultimately will determine the lowest minimums obtainable.

2. INTRODUCTION. To be authorized a new instrument approach procedure, the runway must have an instrument runway designation. Instrument runways are runway end specific. The runway end designation is based on the findings of an AAA study (Refer to Order 7400.2). In addition, the instrument runway designation for the desired minimums must be depicted on the FAA-approved ALP. If not depicted, a change to the ALP is required. As part of the ALP approval process, the FAA will conduct an AAA study to determine the runway's acceptability for the desired minimums.

3. ACTION. The airport landing surface must meet the standards specified in tables A16-1 A through C, for each specified runway, direction and have adequate airspace to support the instrument approach procedure. When requesting an instrument procedure, the sponsor must specify the runway direction, the desired approach minimums, whether circling approach procedures are desired, and the survey needed to support the procedure. For all obligated National Plan of Integrated Airport Systems (NPIAS) airports, the sponsor must also provide a copy of the FAA-approved ALP showing the instrument procedure(s) requested. An ALP is also recommended for all other airports.

4. DEFINITIONS.

a. Precision Approach. An instrument approach procedure providing course and vertical path guidance conforming to ILS, or MLS, precision system performance standards contained in ICAO annex 10. Table A16-1A defines the requirements for ILS, LAAS, WAAS, MLS, and other precision systems.

b. Approach Procedure with Vertical Guidance (APV). An instrument approach procedure providing course and vertical path guidance that does not conform to ILS or MLS system performance standards contained in ICAO annex 10, or a precision approach system that does not meet TERPS alignment criteria. Table A16-1B defines the requirements for WAAS and authorized barometric VNAV.

c. Nonprecision Approach. An instrument approach procedure providing course guidance without vertical path guidance. Table A16-1C defines the requirements for VOR, NDB, LDA, GPS (TS0-129) or other authorized RNAV system.

5. AIRPORT AIRSPACE ANALYSIS SURVEYS.

a. Use the standards identified in ACs 150/5300-16, 1505300-17, and 150/5300-18 to survey and compile the appropriate data to support the development of instrument procedures.

b. When the runway has or is planned to have an approach that has vertical guidance (ILS, MLS or PAR, APV, LPV, RNP, TLS, LNAV/VNAV, etc.), use the Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18.

c. When the runway has or is planned to have an approach without vertical guidance (VOR, VOR/DME, TACAN, NDB, LNAV, LP, etc.), use the Non-Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18.

Table A16-1A. Precision Instrument Approach Requirements.

Visibility Minimums[1]	<3/4 statute mile	< 1-statute mile
Height Above Touchdown (HAT)[2]	200	
TERPS Glidepath Qualification Surface (GQS)[3]	Table A2-1, Row 7, Criteria, and Appendix 2, par. 5a Clear	
TERPS precision "W" surfaces [4]	Clear	See Note 5
TERPS Paragraph 251	34:1 Clear	20:1 Clear
Precision Obstacle Free Zone (POFZ) 200 x 800[6]	Required	Not Required
Airport Layout Plan[7]	Required	
Minimum Runway Length	4,200 ft (1,280 m) (Paved)	
Runway Markings (See AC 150/5340-1)	Precision	Nonprecision
Holding Position Signs & Markings (See AC 150/5340-1 and AC 150/5340-18)	Precision	Nonprecision
Runway Edge Lights[8]	HIRL / MIRL	
Parallel Taxiway [9]	Required	
Approach Lights[10]	MALSR, SSALR, or ALSF	Recommended
Runway Design Standards; e.g., Obstacle Free Zone (OFZ) [11]	< 3/4-statute mile approach visibility minimums	≥ 3/4-statute mile approach visibility minimums
Threshold Siting Criteria To Be Met [12]	Table A2-1, Row 9, Criteria	Table A2-1, Row 8, Criteria
Survey Required for Lowest Minima	Vertically Guided Airport Airspace Analysis Survey	

1. Visibility minimums are subject to application of FAA Order 8260.3 (TERPS) and associated orders or this table, whichever are higher.
2. The HAT indicated is for planning purposes only. Actual obtainable HAT is determined by TERPS.
3. The GQS is applicable to approach procedures providing vertical path guidance. It limits the magnitude of penetration of the obstruction clearance surfaces overlying the final approach course. The intent is to provide a descent path from DA to landing free of obstructions that could destabilize the established glidepath angle. The GQS is centered on a course from the DA point to the runway threshold. Its width is equal to the precision “W” surface at DA, and tapers uniformly to a width 100 feet from the runway edges. If the GQS is penetrated, vertical guidance instrument approach procedures (ILS/MLS/WAAS/LAAS/Baro-VNAV) are not authorized
4. The “W” surface is applicable to precision approach procedures. It is a sloping obstruction clearance surface (OCS) overlying the final approach course centerline. The surface slope varies with glidepath angle. The “W” surface must be clear to achieve lowest precision minimums. Surface slope varies with glide path angle, 102/angle; e.g., for optimum 3º glide path 34:1 surface must be clear.
5. If the W surface is penetrated, HAT and visibility will be increased as required by TERPS.
6. This is a new airport surface (see paragraph 306).
7. An ALP is only required for airports in the NPIAS; it is recommended for all others**.**
8. Runway edge lighting is required for night minimums. High intensity lights are required for RVR-based minimums.
9. A parallel taxiway must lead to the threshold and, with airplanes on centerline, keep the airplanes outside the OFZ.
10. To achieve lower visibility minimums based on credit for lighting, a TERPS specified approach light system is required.
11. Indicates what chart should be followed in the related chapters of this document.
12. Circling procedures to a secondary runway from the primary approach will not be authorized when the secondary runway does not meet threshold siting (reference Appendix 2), OFZ (reference paragraph 306) criteria, and TERPS Order paragraph 251 criteria.

Table A16-1B. Approach Procedure With Vertical Guidance (APV-RNP) Approach Requirements

Visibility Minimums[1]	< 3/4-statute mile	< 1-statute mile	1-statute mile	>1-statute mile[14]
Height Above Touchdown (HAT)[2]	250	300	350	400
TERPS Glidepath Qualification Surface (GQS)[3]	Table A2-1, Row 7, Criteria, and Appendix 2, par. 5a Clear			
TERPS Paragraph 251	34:1 clear	20:1 clear	20:1 clear, or penetrations lighted for night minimums (See AC 70/7460-1)	
Precision Obstacle Free Zone (POFZ) 200 x 800[4]	Required	Recommended		
Airport Layout Plan[5]	Required			
Minimum Runway Length	4,200 ft (1,280 m) (Paved)	3,200 ft (975 m)[6] (Paved)	3,200 ft (975 m)[6,7]	
Runway Markings (See AC 150/5340-1)	Precision	Nonprecision *(precision recommended)*	Nonprecision[7]	
Holding Position Signs & Markings (See AC 150/5340-1 and AC 150/5340-18)	Precision	Nonprecision *(precision recommended)*	Nonprecision[7]	
Runway Edge Lights[8]	HIRL / MIRL		MIRL/LIRL	
Parallel Taxiway [9]	Required		Recommended	
Approach Lights[10]	*Required*[11]		Recommended	
Runway Design Standards; e.g., Obstacle Free Zone (OFZ) [12]	<3/4-statute mile approach visibility minimums	≥ 3/4-statute mile approach visibility minimums		
Threshold Siting Criteria To Be Met [13]	Table A2-1, Row 4 and 9, Criteria		Appendix 2, Table A2-1, Lines 4 and 8, Criteria	
Survey Required for Lowest Minima	Vertically Guided Airport Airspace Analysis Survey			

1. Visibility minimums are subject to the application of FAA Order 8260.3 (TERPS) and associated orders or this table, whichever is higher.
2. The HAT indicated is for planning purposes only. Actual obtainable HAT is determined by TERPS.
3. The GQS is applicable to approach procedures providing vertical path guidance. It limits the magnitude of penetration of the obstruction clearance surfaces overlying the final approach course. The intent is to provide a descent path from DA to landing free of obstructions that could destabilize the established glidepath angle. The GQS is centered on a course from the DA point to the runway threshold. Its width is equal to the precision “W” surface at DA, and tapers uniformly to a width 100 feet from the runway edges. If the GQS is penetrated, vertical guidance instrument approach procedures (ILS/MLS/WAAS/LAAS/Baro-VNAV) are not authorized
4. This is a new airport surface (see paragraph 306)
5. An ALP is only required for obligated airports in the NPIAS; it is recommended for all others**.**
6. Runways less than 3,200 feet are protected by 14 CFR Part 77 to a lesser extent (77.23(a)(2) is not applicable for runways less than 3,200 feet). However runways as short as 2400 feet could support an instrument approach provided the lowest HAT is based on clearing any 200-foot obstacle within the final approach segment.
7. Unpaved runways require case-by-case evaluation by regional Flight Standards personnel.
8. Runway edge lighting is required for night minimums. High intensity lights are required for RVR-based minimums.
9. A parallel taxiway must lead to the threshold and, with airplanes on centerline, keep the airplanes outside the OFZ.
10. To achieve lower visibility minimums based on credit for lighting, a TERPS specified approach light system is required.
11. ODALS, MALS, SSALS are acceptable. For LPV based minima approach lights are recommended not required.
12. Indicates what chart should be followed in the related chapters in this document.
13. Circling procedures to a secondary runway from the primary approach will not be authorized when the secondary runway does not meet threshold siting (reference Appendix 2), OFZ (reference paragraph 306) and TERPS paragraph 251 criteria.
14. For circling requirements, see Table 16-1C.

Table A16-1C. Nonprecision Approach Requirements

Visibility Minimums[1]	< 3/4-statute mile	< 1-statute mile	1-statute mile	>1-statute mile	Circling
Height Above Touchdown [2]	300	340	400	450	Varies
TERPS Paragraph 251	34:1 clear	20:1 clear	20:1 clear or penetrations lighted for night minimums (See AC 70/7460-1)		
Airport Layout Plan[3]	Required				Recommended
Minimum Runway Length	4,200 ft (1,280 m) (Paved)	3,200 ft (975 m)[4] (Paved)	3,200 ft (975 m)[4,5]		
Runway Markings (See AC 150/5340-1)	Precision	Nonprecision[5]			Visual (Basic)[5]
Holding Position Signs & Markings (See AC 150/5340-1 and AC 150/5340-18)	Precision	Nonprecision			Visual (Basic)[5]
Runway Edge Lights[6]	HIRL / MIRL		MIRL / LIRL		MIRL / LIRL (Required only for night minima)
Parallel Taxiway [7]	Required		Recommended		
Approach Lights[8]	MALSR, SSALR, or ALSF Required	Required [9]	Recommended[9]		Not Required
Runway Design Standards, e.g. Obstacle Free Zone (OFZ)[10]	<3/4-statute mile approach visibility minimums	≥ 3/4-statute mile approach visibility minimums			Not Required
Threshold Siting Criteria To Be Met [11]	Table A2-1, Row 9, Criteria	Table A2-1, Row 8, Criteria	Table A2-1, Row 1–5, Criteria		Table A2-1, Row 1–2, Criteria
Survey Required for Lowest Minima	Vertically Guided Airport Airspace Analysis Survey	Non-Vertically Guided Airport Airspace Analysis Survey	Non-Vertically Guided Airport Airspace Analysis Survey		Non-Vertically Guided Airport Airspace Analysis Survey

1. Visibility minimums are subject to the application of FAA Order 8260.3 (TERPS) and associated orders or this table, whichever is higher.
2. The Height Above Touchdown (HAT) indicated is for planning purposes only. Actual obtainable HAT is determined by TERPS.
3. An ALP is only required for obligated airports in the NPIAS; it is recommended for all others**.**
4. Runways less than 3,200 feet are protected by 14 CFR Part 77 to a lesser extent. However runways as short as 2400 feet could support an instrument approach provided the lowest HAT is based on clearing any 200-foot obstacle within the final approach segment.
5. Unpaved runways require case-by-case evaluation by regional Flight Standards personnel.
6. Runway edge lighting is required for night minimums. High intensity lights are required for RVR-based minimums.
7. A parallel taxiway must lead to the threshold and, with airplanes on centerline, keep the airplanes outside the OFZ.
8. To achieve lower visibility minimums based on credit for lighting, a TERPS specified approach lighting system is required.
9. ODALS, MALS, SSALS, SALS are acceptable.
10. Indicates what chart should be followed in the related chapters in this document.
11. Circling procedures to a secondary runway from the primary approach will not be authorized when the secondary runway does not meet threshold siting (reference Appendix 2), OFZ (reference paragraph 306), and TERPS Order, 8260.3 paragraph 251, criteria.

Appendix 17. MINIMUM DISTANCES BETWEEN CERTAIN AIRPORT FEATURES AND ANY ON-AIRPORT AGRICULTURE CROPS

Table A17-1. Minimum Distances Between Certain Airport Features and Any On-Airport Agriculture Crops

Aircraft Approach Category and Design Group [1]	Distance in Feet From Runway Centerline to Crop		Distance in Feet From Runway End to Crop		Distance in Feet from Centerline of Taxiway to Crop	Distance in Feet from Edge of Apron to Crop
	Visual & ≥ ¾ mile	< ¾ mile	Visual & ≥ ¾ mile	< ¾ mile		
Category A & B Aircraft						
Group I	200 [2]	400	300 [3]	600	45	40
Group II	250	400	400 [3]	600	66	58
Group III	400	400	600	800	93	81
Group IV	400	400	1,000	1,000	130	113
Category C, D, & E Aircraft						
Group I	530 [3]	575 [3]	1,000	1,000	45	40
Group II	530 [3]	575 [3]	1,000	1,000	66	58
Group III	530 [3]	575 [3]	1,000	1,000	93	81
Group IV	530 [3]	575 [3]	1,000	1,000	130	113
Group V	530 [3]	575 [3]	1,000	1,000	160	138
Group VI	530 [3]	575 [3]	1,000	1,000	193	167

1. Design Groups are based on wing span or tail height, and Category depends on approach speed of the aircraft as shown below:

Design Group	**Category**
Group I: Wing span up to 49 ft.	Category A: Speed less than 91 knots
Group II Wing span 49 ft. up to 73 ft.	Category B: Speed 91 knots up to 120 knots
Group III: Wing span 79 ft. up to 117 ft.	Category C: Speed 121 knots up to 140 knots
Group IV: Wing span 113 ft. up to 170 ft.	Category D: Speed 141 knots up to 165 knots
Group V: Wing span 171 ft. up to 213 ft.	Category E: Speed 166 knots or more
Group VI: Wing span 214 ft. up to 261 ft.	

2. If the runway will only serve small airplanes (12,500 lb. and under) in Design Group I, this dimension may be reduced to 125 feet; however, this dimension should be increased where necessary to accommodate visual navigational aids that may be installed. For example, farming operations should not be allowed within 25 feet of a Precision Approach Path Indicator (PAPI) light box.

3. These dimensions reflect the Threshold Siting Surface (TSS) as defined in AC 150/5300-13, Appendix 2. The TSS cannot be penetrated by any object. Under these conditions, the TSS is more restrictive than the OFA, and the dimensions shown here are to prevent penetration of the TSS by crops and farm machinery.

This page intentionally left blank.