U.S. Department of Transportation

**Federal Aviation Administration**

# Advisory Circular

**Subject:** Airport Design | **Date:** DRAFT | **AC No:** 150/5300-13
**Initiated by:** AAS-100 | **Change:** 17

1. **PURPOSE.** This change includes the following principle revisions:

   a. Chapter 2, paragraph 206 and Tables 2-1 and 2-2. Added note stating that the use of the Obstacle Free Zone (OFZ) criteria as the basis to justify a reduction in Runway to Taxiway separation standards is not allowed.

   b. Chapter 2, Table 2-2, Footnote 7. Reverted to the wording prior to Change 15. The elevation adjustment increasing distances applies only to the holdline location for airplane design groups under approach category D.

   c. Chapter 2, Table 2-3, Taxiway and taxilane separation standards, below footnotes. Revised format of equations on taxiway/taxilane separation used to show that a modification to standards will provide an acceptable level of safety. Three new equations added covering dual parallel taxiway/taxilane separation, as well as an example.

   d. Chapter 4. Numerous changes to address runway incursion prevention. Introduced 3-node principle for taxiway intersections. New figures on taxiway and runway geometry to avoid. Deleted judgmental oversteering as a design element from taxiways.

   e. Table 4-1 Taxiway Dimensional Standards. For Airplane Design Group VI:

   - Taxiway width is reduced from 100 feet to 82 feet
   - Taxiway edge safety margin is reduced from 20 feet to 15 feet

   The basis for these revisions is the taxiway wander studies for Boeing 747s at three airports as discussed in AAS-100 Memo dated July 1, 2010 and Engineering Brief No. 80.

   f. Appendix 1, paragraph 8. Noted a wind analysis tool is added to the Airports GIS website.

   g. Appendix 2, paragraph 5.c and Figure A2-2. Paragraph revised and figure redrawn clarifying how to determine the approach area for an offset approach.

   h. Appendix 2, Table A2-1. Approach/Departure Requirements Table. Deleted Item #4 (Approach end of runway expected to support instrument night circling); renumbered remaining rows moving GQS to new position as Item #9. Revised footnotes.

   i. Appendix 11, Computer Program. Appendix deleted, as well as all references to the program throughout the advisory circular. The program was outdated and not current with the criteria in the AC. The software has been removed from the Airports website.

   j. Appendix 15, Transfer of Electronic Data. Appendix deleted. Guidance has been superseded by Airports GIS.

   k. Appendix 16, Tables A16-1A, A16-1B, and A16-1C. Changed sections in the body of the tables and footnotes for clarification of requirements and to reflect changes made to Appendix 2, Table A2-1.

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

**PAGE CONTROL CHART**

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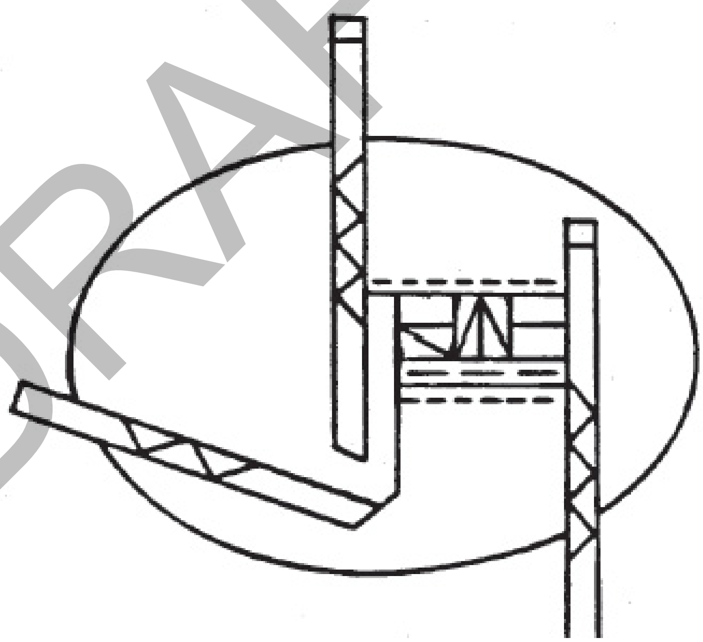
Federal Aviation Administration

# AIRPORT DESIGN

/ INCORPORATES CHANGES 1 THRU 17 /

AC: 150/5300-13
Date: 9/29/89

# Advisory Circular



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Appendix cancelled (pp. 125-130)

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## Appendix 15. TRANSFER OF ELECTRONIC DATA

Appendix cancelled (pp. 283-290)

## Appendix 16. NEW INSTRUMENT APPROACH PROCEDURES



## Appendix 17. MINIMUM DISTANCES BETWEEN CERTAIN AIRPORT FEATURES AND ANY ON-AIRPORT AGRICULTURE CROPS (1 page).

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*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, Safe, Efficient Use, and Preservation of the Navigable Airspace.

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

nn. 14 CFR Part 135, Operating Requirements: Commuter and On Dem and 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, National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions.

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).

**4. AIRPORT REFERENCE CODE (ARC).** The ARC is a coding system used to relate airport design criteria to the operational and physical characteristics of the airplanes intended to operate at the airport.

a. **Coding System**. The airport reference code has two components relating to the airport design aircraft. The first component, depicted by a letter, is the aircraft approach category and relates to aircraft approach speed (operational characteristic). The second component, depicted by a Roman numeral, is the *airplane design group* and relates to airplane wingspan or tailheight (physical characteristics), whichever is the most restrictive. Generally, runways standards are related to aircraft approach speed, airplane wingspan, and designated or planned approach visibility minimums. Taxiway and taxilane standards are related to airplane design group.

b. **Airport Design**. Airport design first requires selecting the ARC(s), then the lowest designated or planned approach visibility minimums for each runway, and then applying the airport design criteria associated with the airport reference code and the designated or planned approach visibility minimums.

(1) An upgrade in the first component of the ARC may result in an increase in airport design standards. Table 1-1 depicts these increases.

(2) An upgrade in the second component of the ARC generally will result in a major increase in airport design standards.

(3) An airport upgrade to provide for lower approach visibility minimums may result in an increase in airport design standards. Table 1-2 depicts these increases.

(4) Operational minimums are based on current criteria, runways, airspace, and instrumentation. Unless this is taken into consideration in the development of the airport, the operational minimums may be other than proposed.

(5) For airports with two or more runways, it may be desirable to design all airport elements to meet the requirements of the most demanding ARC. However, it may be more practical to design some airport elements, e.g., a secondary runway and its associated taxiway, to standards associated with a lesser demanding ARC.

5. **AIRPORT LAYOUT PLAN**. An Airport Layout Plan (ALP) is a scaled drawing of existing and proposed land and facilities necessary for the operation and development of the airport. Any airport will benefit from a carefully developed plan that reflects current FAA design standards and planning criteria. For guidance on developing Airport Master Plans, refer to AC 150/5070-6, *Airport Master Plans*.

a. **FAA-Approved ALP**. All airport development carried out at Federally obligated airports must be done in accordance with an FAA-approved ALP. The FAA-approved ALP, to the extent practicable, should conform to the FAA airport design standards existing at the time of its approval. Due to unique site, environmental, or other constraints, the FAA may approve an ALP not fully complying with design standards. Such approval requires an FAA study and finding that the proposed modification is safe for the specific site and conditions. When the FAA upgrades a standard, airport owners should, to the extent practicable, include the upgrade in the ALP before starting future development.

b. **Guidance**. AC 150/5070-6, Airport Master Plans, contains background information on the development of ALPs, as well as a detailed listing of the various components that constitute a well-appointed ALP.

c. **Electronic Plans**. The FAA recommends the development of electronic ALPs where practical.

6. **MODIFICATION OF AIRPORT DESIGN STANDARDS TO MEET LOCAL CONDITIONS**. "Modification to standards" means any change to FAA design standards other than dimensional standards for runway safety areas. Unique local conditions may require modification to airport design standards for a specific airport. A modification to an airport design standard related to new construction, reconstruction, expansion, or upgrade on an airport which received Federal aid requires FAA approval. The request for modification should show that the modification will provide an acceptable level of safety, economy, durability, and workmanship. Appendixes 8 and 9 discuss the relationship between airplane physical characteristics and the design of airport elements. This rationale may be used to show that the modification will provide an acceptable level of safety for the specified conditions, including the type of aircraft.

7. **NOTICE TO THE FAA OF AIRPORT DEVELOPMENT**. 14 CFR Part 157, Notice of Construction, Activation, and Deactivation of Airports, requires persons proposing to construct, activate, or deactivate an airport to give notice of their intent to the FAA. The notice applies to proposed alterations to the takeoff and landing areas, traffic patterns, and airport use, e.g., a change from private-use to public-use.

a. **Notice Procedure**. 14 CFR Part 157 requires airport proponents to notify the appropriate FAA Airports Regional or District Office at least 30 days before construction, alteration, deactivation, or the date of the proposed change in use. In an emergency involving essential public service, health, or safety, or when delay would result in a hardship, a proponent may notify the FAA by telephone and submit Form 7480-1, Notice of Landing Area Proposal, within 5 days.

b. **The Notice**. The notice consists of a completed FAA Form 7480-1, a layout sketch, and a location map. The layout sketch should show the airport takeoff and landing area configuration in relation to buildings, trees, fences, power lines, and other similar significant features. The preferred type of location map is the 7.5 minute U.S. Geological Survey

Quadrangle Map showing the location of the airport site. Form 7480-1 lists FAA Airports Office addresses.

c. **FAA Action**. The FAA evaluates the airport proposal for its impact upon the: safe and efficient use of navigable airspace; operation of air navigation facilities; existing or potential airport capacity; and safety of persons and property on the ground. The FAA notifies proponents of the results of the FAA evaluation.

d. **Penalty for Failure to Provide Notice**. Persons who fail to give notice are subject to civil penalty.

8. **NOTICE TO THE FAA OF PROPOSED CONSTRUCTION**. 14 CFR Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace, requires persons proposing any construction or alteration described in 14 CFR Section 77.5 to give 45-day notice to the FAA of their intent. This includes any construction or alteration of structures more than 200 feet (61 m) in height above the ground level or at a height that penetrates defined imaginary surfaces located in the vicinity of a public-use airport.

a. **Airport Data Requirements**. Future airport development plans and feasibility studies on file with the FAA may influence the determinations resulting from 14 CFR Part 77 studies. To assure full consideration of future airport development in 14 CFR Part 77 studies, airport owners must have their plans on file with the FAA. The necessary plan data includes, as a minimum, planned runway end coordinates, elevation, and type of approach for any new runway or runway extension.

b. **Penalty for Failure to Provide Notice**. Persons who knowingly and willingly fail to give such notice are subject to criminal prosecution.

9. **FAA STUDIES**. The FAA studies existing and proposed objects and activities, on and in the vicinity of public-use airports. These objects and activities are not limited to obstructions to air navigation, as defined in 14 CFR Part 77. These studies focus on the efficient use of the airport and the safety of persons and property on the ground. As the result of these studies, the FAA may resist, oppose, or recommend against the presence of objects or activities in the vicinity of a public-use airport that conflict with an airport planning or design standard/recommendation. This policy is stated as a notice on page 32152 of Volume 54, No. 149, of the Federal Register, dated Friday, August 4, 1989. FAA studies conclude:

a. Whether an obstruction to air navigation is a hazard to air navigation;

b. Whether an object or activity on or in the vicinity of an airport is objectionable;

c. Whether the need to alter, remove, mark, or light an object exists;

d. Whether to approve an Airport Layout Plan;

e. Whether proposed construction, enlargement, or modification to an airport would have an adverse effect on the safe and efficient use of navigable airspace; or

f. Whether a change in an operational procedure is feasible.

10. **FEDERAL ASSISTANCE**. The FAA administers a grant program (per Order 5100.38, Airport Improvement Program (AIP) Handbook) which provides financial assistance for developing public-use airports. Persons interested in this program can obtain information from FAA Airports Regional or District Offices. Technical assistance in airport development is also available from these offices.

11. **ENVIRONMENTAL ASSESSMENTS**. Federal grant assistance in, or ALP approval of, new airport construction or major expansion normally requires an assessment of potential environmental impacts in accordance with FAA Order 5050.4, National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions.

12. **STATE ROLE**. Many State aeronautics commissions or similar departments require prior approval and, in some instances, a license for the establishment and operation of an airport. Some States administer a financial assistance program similar to the Federal program and technical advice. Proponents should contact their respective State aeronautics commissions or departments for information on licensing and assistance programs.

13. **LOCAL ROLE**. Most communities have zoning ordinances, building codes, and fire regulations which may affect airport development. Some have or are in the process of developing codes or ordinances regulating environmental issues such as noise and air quality. Others may have specific procedures for establishing an airport.

**14. to 199. RESERVED**

# Chapter 2. AIRPORT GEOMETRY

**200. INTRODUCTION**. This chapter presents the airport geometric design standards and recommendations to ensure the safety, economy, efficiency, and longevity of an airport.

**201. PRINCIPLES OF APPLICATION**.

**a. Need to Plan.** The significance of the interrelationship of the various airport features cannot be overemphasized. It is important that airport owners look to both the present and potential functions of the airport.

**(1)** Existing and planned airspace required for safe and efficient aircraft operations should be protected by acquisition of a combination of zoning, easements, property interests, and other means. AC 150/5190-4, A Model Zoning Ordinance to Limit Height of Objects Around Airports, presents guidance for controlling the height of objects around airports.

**(2)** All other existing and planned airport elements, including the following, should be on airport property:

**(a)** Object free areas;

**(b)** Runway protection zones;

**(c)** Areas under the 14 CFR Part 77 Subpart C airport imaginary surfaces out to where the surfaces obtain a height of at least 35 feet (10 m) above the primary surface; and

**(d)** Areas, other then those which can be adequately controlled by zoning, easements, or other means to mitigate potential incompatible land uses.

**b. Airport Functions.** Coordination with the FAA and users of the airport should assist in determining the airport's immediate and long range functions which will best satisfy the needs of the community and traveling public. This involves determining the following:

**(1)** The operating characteristics, sizes, and weights of the airplanes expected at the airport;

**(2)** The airport reference code (ARC) resulting from (1);

**(3)** The most demanding meteorological conditions in which airplanes will operate;

**(4)** The volume and mix of operations;

**(5)** The possible constraints on navigable airspace; and

**(6)** The environmental and compatible landuse considerations associated with topography, residential development, schools, churches, hospitals, sites of public assembly, and the like.

**c. Airport Layout Plan**. When developing the airport layout plan, application of the standards and recommendations in this publication to the long range functions of the airport will establish the future airport geometry.

**202. RUNWAY LOCATION AND ORIENTATION**. Runway location and orientation are paramount to airport safety, efficiency, economics, and environmental impact. The weight and degree of concern given to each of the following factors depend, in part, on: the airport reference code; the meteorological conditions; the surrounding environment; topography; and the volume of air traffic expected at the airport.

**a. Wind.** Appendix 1 provides information on wind data analysis for airport planning and design. Such an analysis considers the wind velocity and direction as related to the existing and forecasted operations during visual and instrument meteorological conditions. It may also consider wind by time of day.

**b. Airspace Availability**. Existing and planned instrument approach procedures, missed approach procedures, departure procedures, control zones, special use airspace, restricted airspace, and traffic patterns influence airport layouts and locations. Contact the FAA for assistance on airspace matters.

**c. Environmental Factors**. In developing runways to be compatible with the airport environs, conduct environmental studies which consider the impact of existing and proposed land use and noise on nearby residents, air and water quality, wildlife, and historical/archeological features.

**d. Obstructions to Air Navigation**. An obstruction survey should identify those objects which may affect airplane operations. Approaches free of obstructions are desirable and encouraged, but as a minimum, locate and orient runways to ensure that the approach areas associated with the ultimate development of the airport are clear of hazards to air navigation.

e. **Topography**. Topography affects the amount of grading and drainage work required to construct a runway. In determining runway orientation, consider the costs of both the initial work and ultimate airport development. See chapter 5 and AC 150/5320-5 for further guidance.

f. **Airport Traffic Control Tower Visibility**. The location and orientation of runways and taxiways must be such that the existing (or future) airport traffic control tower (ATCT) has a clear line of sight to: all traffic patterns; the final approaches to all runways; all runway structural pavement; and, other operational surfaces controlled by ATC. A clear line of sight to taxilane centerlines is desirable. Operational surfaces not having a clear unobstructed line of sight from the ATCT are designated by ATC as uncontrolled or nonmovement areas through a local agreement with the airport owner. See chapter 6 for guidance on airport traffic control tower siting.

g. **Wildlife Hazards**. In orienting runways, consider the relative locations of bird sanctuaries, sanitary landfills, or other areas that may attract large numbers of birds or wildlife. Where bird hazards exist, develop and implement bird control procedures to minimize such hazards. See *FAA/USDA manual Wildlife Hazard Management at Airports*. This manual may be used to determine, on a case-by-case basis, what uses may be compatible with a particular airport environment with respect to wildlife management. Guidance is also available through local FAA Airports Offices.

203. **ADDITIONAL RUNWAYS**. An additional runway may be necessary to accommodate operational demands, minimize adverse wind conditions, or overcome environmental impacts.

a. **Operational Demands**. An additional runway, or runways, is necessary when traffic volume exceeds the existing runway's operational capability. With rare exception, capacity justified runways are parallel to the primary runway. Refer to AC 150/5060-5 for additional discussion.

b. **Wind Conditions**. When a runway orientation provides less than 95 percent wind coverage for any aircraft forecasted to use the airport on a regular basis, a crosswind runway is recommended. The 95 percent wind coverage is computed on the basis of the crosswind not exceeding 10.5 knots for Airport Reference Codes A-I and B-I, 13 knots for Airport Reference Codes A-II and B-II, 16 knots for Airport Reference Codes A-III, B-III, and C-I through D-III, and 20 knots for Airport Reference Codes A-IV through D-VI. See Appendix 1 for the methodology on computing wind coverage.

c. **Environmental Impact**. An additional runway may be needed to divert traffic from overflying an environmentally sensitive area.

204. **TAXIWAY SYSTEM**. As runway traffic increases, the capacity of the taxiway system may become the limiting operational factor. Taxiways link the independent airport elements and require careful planning for optimum airport utility. The taxiway system should provide for free movement to and from the runways, terminal/cargo, and parking areas. It is desirable to maintain a smooth flow with a minimum number of points requiring a change in the airplane's taxiing speed.

a. **System Composition**. Through-taxiways and intersections comprise the taxiway system. It includes entrance and exit taxiways; bypass, crossover or transverse taxiways; apron taxiways and taxilanes; and parallel and dual parallel taxiways. Chapter 4 discusses taxiway design.

b. **Design Principles**:

(1) Provide each runway with a parallel taxiway or the capability therefore;

(2) Build taxiways as direct as possible;

(3) Provide bypass capability or multiple access to runway ends;

(4) Minimize crossing runways;

(5) Provide ample curve and fillet radii;

(6) Provide airport traffic control tower line of sight; and

(7) Avoid traffic bottlenecks.

205. **AIRPORT APRONS**. Chapter 5 contains gradient standards for airport aprons. The tables cited in paragraph 206 present separation criteria applicable to aprons. For other apron criteria, refer to AC 150/5360-13 and Appendix 5 herein.

206. **SEPARATION STANDARDS**. Tables 2-1, 2-2, and 2-3 and Figure 2-1 describe the separation standards applicable to all new airport projects. The separation distances may need to be increased with airport elevation to meet the runway obstacle free zone (OFZ) standards. Existing airport geometry will be acceptable to support existing runway service level (i.e. Cat I, II, III) until such time as the airport environment is modified due to runway and/or taxiway extensions, modifications, or rehabilitation of the runway and/or taxiway environment.

NOTE: Use of the Obstacle Free Zone (OFZ) to justify a modification to standards for the purpose of reducing runway to taxiway separation standards is not allowed.

207. **PARALLEL RUNWAY SEPARATION -- SIMULTANEOUS VFR OPERATIONS**.

a. **Standard**. For simultaneous landings and takeoffs using visual flight rules (VFR), the minimum separation between centerlines of parallel runways is 700 feet (214 m).

b. **Recommendations**. The minimum runway centerline separation distance recommended for Airplane Design Group V and VI runways is 1,200 feet (366 m). Air traffic control practices, such as holding airplanes between the runways, frequently justify greater separation distances. Runways with centerline spacings under 2,500 feet (762 m) are treated as a single runway by ATC when wake turbulence is a factor.

208. **PARALLEL RUNWAY SEPARATION--SIMULTANEOUS IFR OPERATIONS**. To attain instrument flight rule (IFR) capability for simultaneous (independent) landings and takeoff on parallel runways, the longitudinal (in-trail) separation required for single runway operations is replaced, in whole or in part, by providing lateral separation between aircraft operating to parallel runways. Subparagraphs a and b identify the minimum centerline separations for parallel runways with operations under instrument flight rules (IFR). Where practical, parallel runway centerline separation of at least 5,000 feet (1 525 m) is recommended. Placing the terminal area between the parallel runways minimizes taxi operations across active runways and increases operational efficiency of the airport. Terminal area space needs may dictate greater separations than required for simultaneous IFR operations.

a. **Simultaneous Approaches.** Precision instrument operations require electronic navigational aids and monitoring equipment, air traffic control, and approach procedures.

(1) **Dual simultaneous precision instrument approaches** are normally approved on parallel runway centerline separation of 4,300 feet (1 310 m). Further on a case-by-case basis, the FAA will consider proposals utilizing separations down to a minimum of 3,000 feet (915 m) where a 4,300 foot (1 310 m) separation is impractical. This reduction of separation requires special high update radar, monitoring equipment, etc..

(2) **Triple simultaneous precision instrument approaches** for airports below 1,000 feet (305 m) elevation normally require parallel runway centerline separation of 5,000 feet (1 525 m) between adjacent runways. Triple simultaneous precision instrument approaches for airport elevations at and above 1,000 feet (305 m) and reduction in separation are currently under study by the FAA. In the interim, the FAA, on a case-by-case basis, will consider proposals utilizing separations down to a minimum of 4,300 feet (1 310 m) where a 5,000-foot (1 525 m) separation is impractical or the airport elevation is at or above 1,000 feet (305 m). Reduction of separation may require special radar, monitoring equipment, etc..

(3) **Quadruple simultaneous precision instrument approaches** are currently under study by the FAA. In the interim, the FAA, on a case-by-case basis, will consider proposals utilizing separations down to a minimum of 5,000 feet (1 525 m). Quadruples may require special radar, monitoring equipment, etc..

b. **Simultaneous Departures or Approaches and Departures**. Simultaneous departures do not always require radar air traffic control facilities. The following parallel runway centerline separations apply:

(1) **Simultaneous Departures**.

(a) Simultaneous nonradar departures require a parallel runway centerline separation of at least 3,500 feet (1 067 m).

(b) Simultaneous radar departures require a parallel runway centerline separation of at least 2,500 feet (762 in).

(2) **Simultaneous Approach and Departure**. Simultaneous radar-controlled approaches and departures require the following parallel runway centerline separations:

(a) When the thresholds are not staggered, at least 2,500 feet (762 m).

(b) When the thresholds are staggered and the approach is to the near threshold, the 2,500-foot (762 m) separation can be reduced by 100 feet (30 m) for each 500 feet (150 m) of threshold stagger to a minimum separation of 1,000 feet (305 m). For Airplane Design Groups V and VI runways, a separation of at least 1,200 feet (366 m) is recommended. See figure 2-2 for a description of "near" and "far" thresholds.

(c) When the thresholds are staggered and the approach is to the far threshold, the minimum 2,500-foot (762 m) separation requires an increase of 100 feet (30 m) for every 500 feet (152 m) of threshold stagger.

209. **RUNWAY TO PARALLEL TAXIWAY AND TAXILANE SEPARATION**.

a. **Standards**. Tables 2-1 and 2-2 present the runway centerline to parallel taxiway/taxilane centerline separation standard. This distance is such to satisfy the requirement that no part of an aircraft (tail tip, wing tip) on taxiway/taxilane centerline is within the runway safety area or penetrates the obstacle free zone (OFZ).

b. **Recommendations**. To have room for the acute-angled exit taxiway, provide a runway centerline to parallel taxiway centerline of at least 400 feet (120 m) for Airplane Design Groups I and II, 500 feet (150 m) for Airplane Design Group III, and 600 feet (180 m) for Airplane Design Groups IV, V, and VI.

210. **BUILDING RESTRICTION LINE (BRL)**. A BRL should be placed on an airport layout plan for identifying suitable building area locations on airports. The BRL should encompass the runway protection zones, the runway object free area, the runway visibility zone (see paragraph 503), NAVAID critical areas, areas required for terminal instrument procedures, and airport traffic control tower clear line of sight.

211. **OBJECT CLEARING CRITERIA**. Safe and efficient operations at an airport require that certain areas on and near the airport be clear of objects or restricted to objects with a certain function, composition, and/or height. The object clearing criteria subdivides the 14 CFR Part 77, Subpart C, airspace and the object free area (OFA) ground area by type of objects tolerated within each subdivision. Aircraft are controlled by the aircraft operating rules and not by this criteria.

a. **Standards**. Object clearance requirements are as follows:

(1) **Object Free Area (OFA)**. Object free areas require clearing of objects as specified in paragraph 307, Runway Object Free Area, and paragraph 404, Taxiway and Taxilane Object Free Area (OFA).

(2) **Runway and Taxiway Safety Areas**. Runway and taxiway safety areas require clearing of objects, except for objects that need to be located in the runway or taxiway safety area because of their function. Objects higher than 3 inches (7.6 cm) above grade should be constructed on low impact resistant supports (frangible mounted structures) of the lowest practical height with the frangible point no higher than 3 inches (7.6 cm) above grade. Other objects, such as manholes, should be constructed at grade. In no case should their height exceed 3 inches (7.6 cm) above grade. Underground fuel storage facilities should not be located within runway and taxiway safety areas (see AC 150/5230-4), Aircraft Fuel Storage, Handling, and Dispensing on Airports). Tables 3-1, 3-2, 3-3, and 4-1 specify runway and taxiway safety area standard dimensions.

(3) **Obstacle Free Zone (OFZ)**. Obstacle Free Zones require clearing of object penetrations, except for frangible visual NAVAIDs that need to be located in the OFZ because of their function. Paragraph 306 specifies OFZ standard dimensions.

(4) **Threshold**. The threshold obstacle clearance surfaces, defined in Appendix 2, paragraph 5, require clearing of object penetrations.

(5) **NAVAIDs**. Certain areas require clearing for the establishment and operation of NAVAIDs. These NAVAID critical areas are depicted in chapter 6.

(6) **14 CFR Part 77 Safe, Efficient Use and Preservation of the Navigable Airspace**. Obstructions to air navigation must be removed unless an FAA aeronautical study, based on proposed operations, determined otherwise. To determine otherwise, the FAA must find no substantial adverse effect as defined in Order 7400.2, Procedures for Handling Airspace Matters, Chapter 7, Evaluating Aeronautical Effect, Section 1, General. The FAA, normally, limits aeronautical studies of existing objects to obstructions to air navigation which are not included in the criteria cited in paragraphs 211a(1) through (5).

(7) **Runway Protection Zone (RPZ)**. The RPZ requires clearing of incompatible objects and activities as specified in paragraphs 212a(1)(a) and 212a(2).

(8) **General**. Other objects which require clearing are those which generally can have an adverse effect on the airport. These include objects in the inner part of the approach area (coinciding with the RPZ) such as fuel handling and storage facilities, smoke and dust generating activities, misleading lights, and those which may create glare or attract wildlife.

**b. Recommendations.** Other objects that are desirable to clear, if practicable, are objects that do not have a substantial adverse effect on the airport but, if removed, will enhance operations. These include objects in the controlled activity area and obstructions to air navigation that are not covered in paragraph 211.a, especially those penetrating an approach surface. On a paved runway, the approach surface starts 200 feet (61 m) beyond the area usable for takeoff or landing, whichever is more demanding. On an unpaved runway, the approach surface starts at the end of the area usable for takeoff or landing.

**212. RUNWAY PROTECTION ZONE (RPZ)**. The RPZ's function is to enhance the protection of people and property on the ground. This is achieved through airport owner control over RPZs. Such control includes clearing RPZ areas (and maintaining them clear) of incompatible objects and activities. Control is preferably exercised through the acquisition of sufficient property interest in the RPZ.

**a. Standards.**

**(1) RPZ Configuration/Location**. The RPZ is trapezoidal in shape and centered about the extended runway centerline. The central portion and controlled activity area are the two components of the RPZ (see Figure 2-3). The RPZ dimension for a particular runway end is a function of the type of aircraft and approach visibility minimum associated with that runway end. Table 2-4 provides standard dimensions for RPZs. Other than with a special application of declared distances, the RPZ begins 200 feet (60 m) beyond the end of the area usable for takeoff or landing. With a special application of declared distances, see Appendix 14, separate approach and departure RPZs are required for each runway end.

**(a) The Central Portion of the RPZ**. The central portion of the RPZ extends from the beginning to the end of the RPZ, centered on the runway centerline. Its width is equal to the width of the runway OFA (see Figure 2-3). Paragraph 307 contains the dimensional standards for the OFA.

**(b) The Controlled Activity Area**. The controlled activity area is the portion of the RPZ to the sides of the central portion of the RPZ.

**(2) Land Use**. In addition to the criteria specified in paragraph 211, the following land use criteria apply within the RPZ:

**(a)** While it is desirable to clear all objects from the RPZ, some uses are permitted, provided they do not attract wildlife (see paragraph 202.g., Wildlife Hazards, and Appendix 17 for dimensional standards), are outside of the Runway OFA, and do not interfere with navigational aids. Automobile parking facilities, although discouraged, may be permitted, provided the parking facilities and any associated appurtenances, in addition to meeting all of the preceding conditions, are located outside of the central portion of the RPZ. Fuel storage facilities may not be located in the RPZ.

**(b)** Land uses prohibited from the RPZ are residences and places of public assembly. (Churches, schools, hospitals, office buildings, shopping centers, and other uses with similar concentrations of persons typify places of public assembly.) Fuel storage facilities may not be located in the RPZ.

**b. Recommendations**. Where it is determined to be impracticable for the airport owner to acquire and plan the land uses within the entire RPZ, the RPZ land use standards have recommendation status for that portion of the RPZ not controlled by the airport owner.

**c. FAA Studies of Objects and Activities in the Vicinity of Airports**. The FAA policy is to protect the public investment in the national airport system. To implement this policy, the FAA studies existing and proposed objects and activities, both off and on public-use airports, with respect to their effect upon the safe and efficient use of the airports and safety of persons and property on the ground. These objects need not be obstructions to air navigation, as defined in 14 CFR Part 77. As the result of a study, the FAA may issue an advisory recommendation in opposition to the presence of any off-airport object or activity in the vicinity of a public-use airport that conflicts with an airport planning or design standard or recommendation.

**213. RUNWAY HOLDING POSITION (HOLDLINE)**. At airports with operating airport traffic control towers, runway holding positions (holdlines) identify the location on a taxiway where a pilot is to stop when he/she does not have clearance to proceed onto the runway. At airports without operating control towers, these holdlines identify the location where a pilot should assure there is adequate separation with other aircraft before proceeding onto the runway. The holdline standards, which assume a perpendicular distance from a runway centerline to an intersecting taxiway centerline, are in Tables 2-1 and 2-2. However, these distance standards may need to be longer and placed in such a way to take into account the largest aircraft (tail, body, or wing tip) expected to use the runway from penetrating the Obstacle Free Zone.

**214. to 299. RESERVED**

**Table 2-1. Runway Separation Standards for aircraft approach categories A & B**

| ITEM | DIM 1/ | AIRPLANE DESIGN GROUP | | | | |
|---|---|---|---|---|---|---|
| | | I 2/ | I | II | III | IV |
| Visual runways and runways with not lower than ¾-statue mile (1200m) approach visibility minimums<br><br>Runway Centerline to: | | | | | | |
| Parallel Runway Centerline | H | Refer to paragraphs 207 and 208 | | | | |
| Holdline | | 125ft 7/<br>38m | 200ft<br>60m | 200ft<br>60m | 200ft 5/<br>60m | 250ft<br>75m |
| Taxiway/Taxilane/ Centerline 3/ | D | 150ft<br>45m | 225ft<br>67.5m | 240ft<br>72m | 300ft<br>90m | 400ft<br>120m |
| Aircraft Parking Area | G | 125ft<br>37.5m | 200ft<br>60m | 250ft<br>75m | 400ft<br>120m | 500ft<br>150m |
| Helicopter Touchdown Pad | | Refer to Advisory Circular 150/5390-2 | | | | |
| Runways with lower than ¾ -statue mile (1200m) approach visibility minimums 4/<br><br>Runway Centerline to: | | | | | | |
| Parallel Runway Centerline | H | Refer to paragraphs 207 and 208 | | | | |
| Holdline | | 175ft 7/<br>53m | 250ft<br>75m | 250ft<br>75m | 250ft 5/<br>75m | 250ft 6/<br>75m |
| Taxiway/Taxilane/ Centerline 3/ | D | 200ft<br>60m | 250ft<br>75m | 300ft<br>90m | 350ft<br>105m | 400ft<br>120m |
| Aircraft Parking Area | G | 400ft<br>120m | 400ft<br>120m | 400ft<br>120m | 400ft<br>120m | 500ft<br>150m |
| Helicopter Touchdown Pad | | Refer to Advisory Circular 150/5390-2 | | | | |

1/ Letters correspond to the dimensions on Figure 2-1.

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

3/ The taxiway/taxilane centerline separation standards are for sea level. At higher elevations, an increase to these separation distances may be required to keep taxiing and holding airplanes clear of the OFZ (refer to paragraph 206).

4/ For approaches with visibility less than ½-statue miles, runway centerline to taxiway/taxilane centerline separation increases to 400 feet (120m).

5/ This distance is increased 1 foot for each 100 feet above 5,100 feet above sea level.

6/ This distance is increased 1 foot for each 100 feet above sea level.

7/ The holdline dimension standards pertains to facilities for small airplanes exclusively, including airplane design groups I & II

NOTE: Use of the Obstacle Free Zone (OFZ) to justify a modification to standards for the purpose of reducing runway to taxiway separation standards is not allowed.

**Table 2-2. Runway Separation Standards for aircraft approach categories C & D**

| ITEM | DIM 1/ | AIRPLANE DESIGN GROUP | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| Visual runways and runways with not lower than ¾-statue mile (1200m) approach visibility minimums<br>Runway Centerline to: | | | | | | | |
| Parallel Runway Centerline | H | Refer to paragraphs 207 and 208 | | | | | |
| Holdline 7/ | | 250ft<br>75m | 250ft<br>75m | 250ft<br>75m | 250ft<br>75m | 250ft 6/<br>75m | 280ft 6/<br>85m |
| Taxiway/Taxilane/ Centerline 2/ | D | 300ft<br>90m | 300ft<br>90m | 400ft<br>120m | 400ft<br>120m | 3/<br>3/ | 500ft<br>150m |
| Aircraft Parking Area | G | 400ft<br>120m | 400ft<br>120m | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m |
| Helicopter Touchdown Pad | | Refer to Advisory Circular 150/5390-2 | | | | | |
| Runways with lower than ¾-statue mile (1200m) approach visibility minimums<br>Runway Centerline to: | | | | | | | |
| Parallel Runway Centerline | H | Refer to paragraphs 207 and 208 | | | | | |
| Holdline 7/ | | 250ft<br>75m | 250ft<br>75m | 250ft<br>75m | 250ft 6/<br>75m | 280ft 6/<br>85m | 280ft 6/<br>85m |
| Taxiway/Taxilane/ Centerline 2/ | D | 400ft<br>120m | 400ft<br>120m | 400ft<br>120m | 400ft<br>120m | 3/ 4/<br>3/ 4/ | 5/<br>5/ |
| Aircraft Parking Area | G | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m | 500ft<br>150m |
| Helicopter Touchdown Pad | | Refer to Advisory Circular 150/5390-2 | | | | | |

1/ Letters correspond to the dimensions on Figure 2-1.

2/ The taxiway/taxilane centerline separation standards are for sea level. At higher elevations, an increase to these separation distances may be required to keep taxiing and holding airplanes clear of the OFZ (refer to paragraph 206).

3/ For Airplane Design Group V, the standard runway centerline to parallel taxiway centerline separation distance is 400ft (120m) for airports at or below an elevation of 1,345feet (410m); 450feet (135m) for airports between elevations for 1,345 feet (410m) and 6,560 feet (2,000m); and 500 feet (150m) for airports above an elevation of 6,560 feet (2,000m).

4/ For approaches with visibility less than ½-statue mile, the separation distance increases to 500 feet (150m) plus required OFZ elevation adjustment.

5/ For approaches with visibility down to ½-statue mile, the separation distance increases to 500 feet (150m) plus elevation adjustment. For approaches with visibility less than ½-statue mile, the separation distance increases to 550 feet (168m) plus required OFZ elevation adjustment.

6/ For aircraft approach category C, the distance is increased 1 foot for each 100 feet above sea level.

7/ For all airplane design groups under aircraft approach category D, this distance is increased 1 foot for each 100 feet above sea level.

NOTE: Use of the Obstacle Free Zone (OFZ) to justify a modification to standards for the purpose of reducing runway to taxiway separation standards is not allowed.

**Table 2--3. Taxiway and taxilane separation standards**

| ITEM | DIM 1/ | AIRPLANE DESIGN GROUP | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| *Taxiway Centerline to:* Parallel Taxiway/ Taxilane Centerline | J | 69 ft 21 m | 105 ft 32 m | 152 ft 46.5 m | 215 ft 65.5 m | 267 ft 81 m | 324ft 99 m |
| Fixed or Movable Object 2/ and 3/ | K | 44.5 ft 13.5 m | 65.5 ft 20 m | 93 ft 28.5 m | 129.5 ft 39.5 m | 160 ft 485 m | 193 ft 59 m |
| *Taxilane Centerline to:* Parallel Taxilane Centerline | | 64 ft 19.5 m | 97 ft 29.5 m | 140 ft 42.5 m | 198 ft 60 m | 245 ft 74.5 m | 298 ft 91 m |
| Fixed or Movable Object 2/ and 3/ | | 39.5 ft 12 m | 57.5 ft 17.5 m | 81 ft 24.5 m | 112.5 ft 34 m | 138 ft 42 m | 167 ft 51 m |

1/ Letters correspond to the dimensions on Figure 2-1.

2/ This value also applies to the edge of service and maintenance roads.

3/ Consideration of the engine exhaust wake impacted from turning aircraft should be given to objects located near runway/taxiway/taxilane intersections.

**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 and FAA Order 5300.1 for guidance on modification of standard requirements.**

Taxiway centerline to parallel taxiway/taxilane centerline: (1.2 x WS) + 10 feet (3m)

Taxiway centerline to fixed or movable object: (0.7 x WS) + 10 feet (3m)

Taxilane centerline to parallel taxilane centerline: (1.1 x WS) + 10 feet (3m)

Taxilane centerline to fixed or movable object: (0.6 x WS) + 10 feet (3m)

**The values obtained from the following equations may be used to show that a modification of standards will provide an acceptable level of safety for centerline to centerline separation of dual parallel taxiways/taxilanes that use two different wingspans from the same or different ADGs. Refer to paragraph 6 and FAA Order 5300.1 for guidance on modification of standard requirements.**

Dual parallel taxiway applications: $1.2 \times [(WS_1 + WS_2)/2] + 10$ feet (3m)

Dual parallel taxilane application: $1.1 \times [(WS_1 + WS_2)/2] + 10$ feet (3m)

Mixed parallel taxiway and taxilane application: $[(1.2 \times WS_1 + 1.1 \times WS_2)/2] + 10$ feet (3m)

Example:

Can an existing standard ADG III parallel taxiway centerline separation of 152 feet accept an ADG IV airplane if it is speed restricted (taxilane)? Given: $WS_1$ = 118 feet (full ADG III WS) and $WS_2$ = 124.8 feet (Boeing 757, ADG IV).

Apply $[(1.2 \times WS_1 + 1.1 \times WS_2)/2] + 10$ feet = $[(1.2\,(118) + 1.1\,(124.8))/2] + 10$ feet = 149.4 feet.

**ANSWER: Yes. Result (149.4') is less than existing 152' CL to CL separation.**

WS = wingspan of the taxiway/taxilane design aircraft

# Chapter 3. RUNWAY DESIGN

300. **INTRODUCTION**. This chapter presents standards for runways and runway associated elements such as shoulders, blast pads, runway safety areas, obstacle free zones (OFZ), object free areas (OFA), clearways, and stopways. Tables 3-1, 3-2, and 3-3 present the standard widths and lengths for runway and runway-associated elements. Also included are design standards and recommendations for rescue and firefighting access roads. At new airports, the RSA and ROFA lengths and the RPZ location standards are tied to runway ends. At existing constrained airports, these criteria may, on a case-by-case basis, be applied with respect to declared distances ends. See appendix 14.

301. **RUNWAY LENGTH**. AC 150/5325-4 and airplane flight manuals provide guidance on runway lengths for airport design, including declared distance lengths.

302. **RUNWAY WIDTH**. Tables 3-1, 3-2, and 3-3 present runway width standards that consider operations conducted during reduced visibility.

303. **RUNWAY SHOULDERS**. Runway shoulders provide resistance to blast erosion and accommodate the passage of maintenance and emergency equipment and the occasional passage of an airplane veering from the runway. Tables 3-1, 3-2, and 3-3 present runway shoulder width standards. A natural surface, e.g., turf, normally reduces the possibility of soil erosion and engine ingestion of foreign objects. Soil with turf not suitable for this purpose requires a stabilized or low cost paved surface. Refer to chapter 8 for further discussion. Figure 3-1 depicts runway shoulders.

304. **RUNWAY BLAST PAD**. Runway blast pads provide blast erosion protection beyond runway ends. Tables 3-1, 3-2, and 3-3 contain the standard length and width for blast pads for takeoff operations requiring blast erosion control. Refer to chapter 8 for further discussion. Figure 3-1 depicts runway blast pads.

305. **RUNWAY SAFETY AREA (RSA)**. The runway safety area is centered on the runway centerline. Tables 3-1, 3-2, and 3-3 present runway safety area dimensional standards. Figure 3-1 depicts the runway safety area. Appendix 8 discusses the runway safety area's evolution.

a. **Design Standards**. The runway safety area shall be:

(1) cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations;

(2) drained by grading or storm sewers to prevent water accumulation;

(3) capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and firefighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft; and

(4) free of objects, except for objects that need to be located in the runway safety area because of their function. Objects higher than 3 inches (7.6 cm) above grade should be constructed, to the extent practicable, on low impact resistant supports (frangible mounted structures) of the lowest practical height with the frangible point no higher than 3 inches (7.6 cm) above grade. Other objects, such as manholes, should be constructed at grade. In no case should their height exceed 3 inches (7.6 cm) above grade.

b. **Construction Standards**. Compaction of runway safety areas shall be to FAA specification P-152 found in AC 150/5370-10.

c. **Sub-standard RSAs**. RSA standards cannot be modified or waived like other airport design standards. The dimensional standards remain in effect regardless of the presence of natural or man-made objects or surface conditions that might create a hazard to aircraft that leave the runway surface. Facilities, including NAVAIDs, that would not normally be permitted in an RSA should not be installed inside the standard RSA dimensions even when the RSA does not meet standards in other respects. A continuous evaluation of all practicable alternatives for improving each sub-standard RSA is required until it meets all standards for grade, compaction, and object frangibility. FAA Order 5200.8, Runway Safety Area Program, explains the process for conducting this evaluation. Each FAA regional Airports division manager has a written determination of the best practicable alternative(s) for improving each RSA. Therefore, runway and RSA improvement projects must comply with the determination of the FAA regional Airports division manager.

d. Threshold Displacement. Incremental improvements that involve the displacement of a landing threshold need to be carefully planned so that they do not incur unnecessary costs or create situations that could compromise operational safety.

(1) Runway thresholds that are displaced temporarily pending the planned relocation of objects (such as Localizer antennas) should consider the extra costs associated with re-arranging the runway lights, approach lights and navigational aids.

(2) The displacement of a threshold that does not also include relocation of the lead-in taxiway can create an undesirable and confusing operating environment for the pilot. (See paragraph 204.)

e. Allowance for Navigational Aids. The RSA is intended to enhance the margin of safety for landing or departing aircraft. Accordingly, the design of an RSA must account for navigational aids that might impact the effectiveness of the RSA:

(1) RSA grades sometimes require approach lights to be mounted on massive towers that could create a hazard for aircraft. Therefore, consider any practicable RSA construction to a less demanding grade than the standard grade to avoid the need for massive structures.

(2) Instrument landing system (ILS) facilities (glide slopes and localizers) are not usually required to be located inside the RSA. However, they do require a graded area around the antenna. (See chapter 6 for more information on the siting of ILS facilities.) RSA construction that ends abruptly in a precipitous drop-off can result in design proposals where the facility is located inside the RSA. Therefore, consider any practicable RSA construction beyond the standard dimensions that could accommodate ILS facilities if and when they are installed.

**306. OBSTACLE FREE ZONE (OFZ).** The OFZ clearing standard precludes taxiing and parked airplanes and object penetrations, except for frangible visual NAVAIDs that need to be located in the OFZ because of their function. The runway OFZ and, when applicable, the precision OFZ, the inner-approach OFZ, and the inner-transitional OFZ comprise the obstacle free zone (OFZ). Figures 3-2, 3-3, 3-4, 3-5,and 3-6 show the OFZ.

a. Runway OFZ (ROFZ). The runway OFZ is a defined volume of airspace centered above the runway centerline. The runway OFZ is the airspace above a surface whose elevation at any point is the same as the elevation of the nearest point on the runway centerline. The runway OFZ extends 200 feet (60 m) beyond each end of the runway. Its width is as follows:

(1) For runways serving small airplanes exclusively:

(a) 300 feet (90 m) for runways with lower than 3/4-statute mile (1 200 m) approach visibility minimums.

(b) 250 feet (75 m) for other runways serving small airplanes with approach speeds of 50 knots or more.

(c) 120 feet (36 m) for other runways serving small airplanes with approach speeds of less than 50 knots.

(2) For runways serving large airplanes, 400 feet (120 m).

b. Inner-approach OFZ. The inner-approach OFZ is a defined volume of airspace centered on the approach area. It applies only to runways with an approach lighting system. The inner-approach OFZ begins 200 feet (60 m) from the runway threshold at the same elevation as the runway threshold and extends 200 feet (60 m) beyond the last light unit in the approach lighting system. Its width is the same as the runway OFZ and rises at a slope of 50 (horizontal) to 1 (vertical) from its beginning.

c. Inner-transitional OFZ. The inner-transitional OFZ is a defined volume of airspace along the sides of the runway OFZ and inner-approach OFZ. It applies only to runways with lower than 3/4-statute mile (1 200 m) approach visibility minimums.

(1) For runways serving small airplanes exclusively, the inner-transitional OFZ slopes 3 (horizontal) to 1 (vertical) out from the edges of the runway OFZ and inner-approach OFZ to a height of 150 feet (45 m) above the established airport elevation.

(2) For runways serving large airplanes, separate inner-transitional OFZ criteria apply for Category (CAT) I and CAT II/III runways.

(a) For CAT I runways, the inner-transitional OFZ begins at the edges of the runway OFZ and inner-approach OFZ, then rises vertically for a height "H", and then slopes 6 (horizontal) to 1 (vertical) out to a height of 150 feet (45 m) above the established airport elevation.

1) In U.S. customary units,

$H_{feet} = 61 - 0.094(S_{feet}) - 0.003(E_{feet})$.

2) In SI units,

$H_{meters} = 18.4 - 0.094(S_{meters}) - 0.003(E_{meters})$.

3) S is equal to the most demanding wingspan of the airplanes using the runway and E is equal to the runway threshold elevation above sea level.

(b) For CAT II/III runways, the inner-transitional OFZ begins at the edges of the runway OFZ and inner-approach OFZ, then rises vertically for a height "H", then slopes 5 (horizontal) to 1 (vertical) out to a

# Chapter 4. TAXIWAY AND TAXILANE DESIGN

**400. INTRODUCTION.** This chapter presents the principles and design standards for taxiways, taxilanes, and associated airport elements. The airfield design process focuses on safety first, then efficiency and capacity. A taxiway's geometry and operational use play a crucial role in enhancing airfield safety and efficiency. The "3-Node" design principle and the Taxiway/Runway Interface principle is being introduced in this chapter under paragraph 406 and 409 respectively. Entrance Taxiways – paragraph 407, Bypass Taxiways – paragraph 408 and the two design principles discussed in this chapter will provide the designer with strategies that focus on mitigating airfield confusion, runway incursion and wrong runway takeoffs and landings. The airport planner and designer must ensure that the taxiway layout considers operational requirements are taken into consideration, such as to avoid the use of a runway as a taxiway. Additional information may be found under publication - Engineering Brief (EB) number 75, "Introduction of Runway Incursion Prevention into Taxiway and Apron Design." This EB can be downloaded at the FAA Airports web site: www.faa.gov/airports.

**401. DIMENSIONAL STANDARDS.** Tables 4-1 and 4-2 present the dimensional standards for taxiway, taxilanes, and associated elements. Appendix 9 discusses the relationship between airplane physical characteristics and the design of taxiway and taxilane elements. The rationale presented there is useable, on a case-by-case basis, to adapt separation standards to meet unusual local conditions or to accommodate a specific airplane within an airplane design group.

**402. TAXIWAY SHOULDERS**. All taxiways shall provide stabilized or paved shoulders to reduce the possibility of blast erosion and engine ingestion problems associated with jet engines that overhang the edge of the taxiway pavement. Taxiway shoulder width standards are presented in table 4-1. Soil with turf not suitable for this purpose requires a stabilized or low-cost paved surface. Chapter 8 contains additional information on this subject.

**403. TAXIWAY SAFETY AREA (TSA).** All taxiways and taxilanes must have a taxiway safety area that is centered on the taxiway centerline. Table 4-1 presents taxiway safety area dimensional standards based on the airplane design group (ADG). The same dimensional standards shall be applied to taxilanes.

a. **Design Standards.** The taxiway safety area shall be:

(1) cleared and graded and have no potentially hazardous ruts, bumps, depressions, or other surface variations;

(2) drained by grading or storm sewers to prevent water accumulation;

(3) capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and firefighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft, and

(4) free of objects, except for objects that need to be located in the taxiway safety area because of their function. Objects higher than 3 inches (7.6 cm) above grade should be constructed on low impact resistant supports (frangible mounted structures) of the lowest practical height with the frangible point no higher than 3 inches (7.6 cm) above grade. Other objects, such as manholes, should be constructed at grade. In no case should their height exceed 3 inches (7.6 cm) above grade.

b. **Construction Standards.** Compaction of taxiway safety areas shall be to FAA specification P-152 found in AC 150/5370-10.

**404. TAXIWAY AND TAXILANE OBJECT FREE AREA (OFA).** The taxiway and taxilane OFAs are centered on the taxiway and taxilane centerlines as shown in figures A9-2, A9-3, and A9-4. Table 4-1 presents the dimensional standards for the taxiway and taxilane OFAs. Note that the widths of the taxiway and taxilane OFA differ within each individual airplane design group.

a. The taxiway and taxilane OFA clearing standards prohibit service vehicle roads, parked airplanes, and above ground objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes. Vehicles may operate within the OFA provided they give right of way to oncoming aircraft by either maintaining a safe distance ahead or behind the aircraft or by exiting the OFA to let the aircraft pass. Provide vehicular exiting areas along the outside of the OFA where required..

b. OFA clearance shall be provided at intersections and turns where curved taxiway or taxilane centerline pavement markings, reflectors, or lighting are provided. The OFA clearance shall be configured to provide the standard wingtip clearance for the using aircraft. Appendix 9 provides guidance for finding the wingtip trace and Table 4-3 specifies the standard wingtip clearances.

c. Offset taxilane pavement markings may be used at existing facilities where it is impracticable to upgrade the facility to existing standards or as a temporary measure to assure adequate wingtip clearance until upgraded facilities meeting design standards are completed. The offset taxilane pavement markings should be located on an arc offset and parallel to the curved centerline. The radius of the offset arc should be approximately (R2 + d2)0.5. R being the radius of the taxilane turn and d being a representative distance from the center of the cockpit to the center of the main undercarriage of the larger wingspan aircraft. Increasing the offset radius increases the clearance inside of the curve while decreasing the clearance outside of the curve. Both clearances for each of the larger wingspan aircraft need to be examined. Where offset taxilane pavement markings are provided, centerline lighting or reflectors are required.

**405. FULL-LENGTH PARALLEL TAXIWAY.** A basic airport consists of a runway with a full-length parallel taxiway, an apron, and connecting transverse taxiways between the runway, the parallel taxiway and the apron.

a. **Separation Distance.** Tables 2-1 and 2-2 show the standard separation distances between parallel taxiways and runways.

b. **Centerline Profile.** The centerline profile of a parallel taxiway should prevent excessive longitudinal grades on crossover or transverse taxiways. Chapter 5 provides the standards for taxiway longitudinal grades.

**406. TAXIWAY INTERSECTIONS.** All taxiway intersections are to be constructed in accordance with the "3-Node" design principle. The "3-Node" design principle is defined as a taxiway intersection with (at most) three directions to proceed beyond the intersection. Adopting this design principle will allow pilots to continue through the intersection, turn left or turn right. The 3-Node design precludes pilots from making multiple right and left turns as shown in Figure 4-1 (a). This design reduces confusion, minimizes runway incursions, and results in greater compliance with standard signage (AC 150/5340-18), markings (AC 150/5340-1), and airfield lighting criteria.

A direct safety benefit of the 3-Node principle is the elimination of airfield "Hot Spots" (HS). Hot Spots are problematic geometries on the airfield designated by the airport operator as taxiway intersections that are confusing to pilots. Some of these HS are associated with runway incursion incidents. Many HS are taxiway intersections that do not comply with the 3–Node principle. Figure 4-3 shows examples of geometry that should be avoided.

a. **Cockpit over Centerline.** The taxiway centerline(s) at taxiway intersections shall be designed to cockpit-over-centerline**.** Taxiway intersections designed to accommodate cockpit over centerline steering, as compared to judgmental oversteering, enable more rapid movement of traffic with minimal risk of aircraft excursions from pavement surface.

b. **Judgmental Oversteering.** Taxiway intersections shall not be designed to accommodate judgmental oversteering. Judgmental oversteering is not a design parameter. It is an operational maneuver which requires complex maneuvering, increases the risk of aircraft excursions from the pavement surface, and slows the flow of traffic.

c. **Taxiway Intersections.** Taxiways utilizing the 3-Node principle should only intersect at multiples of 30, 45, or 90 degrees from the travelling taxiway. See figure 4-1(a). Right-angle taxiways are preferable because they provide a pilot approaching an intersection the best visual perspective to observe aircraft in both the left and right directions. They also provide the optimum orientation for viewing taxiway signage associated with other intersecting taxiways. It is recommended to avoid geometry which require excessive pavement fillets and taxiway width since they force airfield signage farther from the taxiway centerline; thereby potentially contributing to pilot disorientation.

d. **Design.** Figure 4-1 shows the most common designs of taxiway-taxiway intersections and tables 4-1 and 4-2 present the associated dimensional standards. The designs also apply to taxiway-apron intersections. Do not construct a wide throat taxiway leading directly from an apron to a taxiway parallel to a runway. Wide entrances contribute to lack of situational awareness by pilots and have contributed to runway incursion incidents. Pilots have the tendency to confuse wide expanse of pavement as part of an apron. Figure 4-3(b) illustrates the wide-throat taxiway from an apron.

e. **Applicable Limitations.** The criteria depicted in figure 4-1 apply only to taxiway-taxiway intersections and taxiway-apron intersections and not to runway-taxiway intersections. Discussion and details on runway-taxiway intersections and accompanying figures are in subsequent paragraphs.

**407. ENTRANCE TAXIWAYS.**

a. **Dual Use.** An entrance taxiway shall be located at both runway ends thereby also serving as the final exit taxiway on a bidirectional runway. See figures 4-5 and 4-6.

b. **Radius.** The centerline radius of curvature should be as large as possible to accommodate higher speeds. The radius is dependent on the separation distance between the runway and parallel taxiway.

c. **Design.** An entrance taxiway shall conform to the standard width for each ADG as specified in Table 4-1. The taxiway width includes the taxiway edge safety margin which is the minimum acceptable distance between the outside of the airplane's main gear wheels and the pavement edge. The entrance taxiway shall be perpendicular to the runway centerline. Entrance taxiways should not be constructed beyond the runway end. The design length of a perpendicular taxiway entrance leading to a runway should permit the longest fuselage in the ADG to fully line-up perpendicular to the runway. The entrance design shown in figure 4-5, with a centerline radius of 200 feet (60 m), will allow entrance speeds of 20 mph (30 km per hour), the minimum design speed for the taxiway system. Larger radii will permit higher entrance speeds.

d. **Mitigation of runway incursions.** Avoid the construction of wide expanses of pavement at entrance taxiways. Airports with existing wide expanses of pavement should paint the excess pavement green or use aviation grade artificial turf to make the entrance taxiway more distinctive (figure 4-6). Each distinct entrance taxiway shall have its own taxiway designator, marking and signage. To minimize the landing on a parallel taxiway, the outer edge of the taxiway (outer common curve) should be curved as shown in figure 4-5 and 4-6. This curvature provides a visual cue to help pilots avoid landing on a taxiway parallel to a runway. Refer to AC 150/5340-1, Standards for Airport Markings and AC 150/5370-15, Airside Application for Artificial Turf for additional guidance.

**408. BYPASS TAXIWAYS.** Air traffic personnel at busy airports encounter occasional bottlenecks when moving airplanes ready for departure to the desired takeoff runway. Bottlenecks result when a preceding airplane is not ready for takeoff and blocks the access entrance taxiway. Bypass taxiways provide flexibility in runway use by permitting ground maneuvering of steady streams of departing airplanes. An analysis of existing and projected traffic will indicate if a bypass taxiway will enhance traffic flow. A bypass taxiway should be provided when runway operations reach 30 takeoff operations per hour.

a. **Location.** Bypass taxiway locations are normally at or near the runway end. They must be parallel to the main entrance taxiway serving the runway end, as shown in figure 4-6, or used in combination with the dual parallel taxiways, as depicted in figure 4-7.

b. **Design.** Bypass taxiways shall conform to the standard width in table 4-1 for each specific ADG. The bypass taxiway width includes the standard taxiway edge safety margin. The separation and clearance standards for bypass taxiways are the same as for parallel taxiways as specified in table 2-3. The standard design is to not pave the areas(s) between the entrance taxiway and bypass taxiway(s).

c. **Mitigation of runway incursions.** The bypass taxiway centerline shall be perpendicular to the runway centerline. Airports with existing paved areas between bypass taxiways and entrance taxiway shall have islands between them as shown in figure 4-6. Existing pavement between bypass and entrance taxiways shall be painted green or covered with artificial green turf. Each bypass taxiway shall have its own taxiway designator, markings, and signage.

**409. TAXIWAY AND RUNWAY INTERFACE.** Taxiways should intersect at a right-angle with the runway to the extent possible. Intersecting angles less than 45 degrees are not recommended except for a standard 30 degree high-speed exit from a runway. Figure 4-3(d), (e), (f) and (g) illustrate several examples of problematic runway/taxiway interfaces. Configurations such as: Y-shaped taxiway crossings, taxiways crisscrossing a high-speed exit, aligned taxiways between two closely spaced runway ends, and a taxiway serving a V-shaped runway shall not be designed. Airport operators should remove such confusing geometry. The use of taxiway strategies to reduce the number of active runway crossings should be considered, e.g. crossings in the first and the last third of the runway are recommended.

**410. HOLDING BAYS.** Providing holding bays instead of bypass taxiways also enhances capacity. Holding bays provide a standing space for airplanes awaiting final air traffic control (ATC) clearance and to permit those airplanes already cleared by ATCT to move to their runway takeoff position. By virtue of their size, they enhance maneuverability for holding airplanes while also permitting bypass operations. A holding bay may be considered when runway operations reach a level of 30 takeoffs per hour.

a. **Location.** Although the most advantageous position for a holding bay is adjacent to the parallel taxiway serving the runway end, it may be satisfactory in other locations. Precaution: Place holding bays to keep airplanes out of the OFZ (runway, inner-transitional and inner-approach OFZ), POFZ (figure 3-6) and the runway safety area, as well as avoiding interference with instrument landing system operations.

b. **Design.** Figure 4-8 shows some typical holding bay configurations.

**411. TURNAROUNDS.** At low activity airports, a turnaround can serve as a combination holding bay and bypass taxiway when it is not economically feasible to provide a parallel taxiway. The turnaround needs to extend far enough away from the runway centerline so airplanes will be able to remain behind the hold line. Figure 4-9 shows a taxiway turnaround.

**412. DUAL PARALLEL TAXIWAYS.** To accommodate high-density traffic or eliminate the use of an operationally closed runway as a temporary taxiway, airport operators and planners should design multiple accesses to runways by constructing dual parallel taxiways. For example, to facilitate ATCT handling when using directional flow releases, e.g., south departure, west departure, etc., airplanes may be selectively queued on dual (or even triple) parallel taxiways. The outer most dual parallel taxiway need not extend the full length of runway.

Crossover taxiways between dual parallel taxiways increase flexibility. See figure 4-10.

**413. 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 Tables 2-1, 2-2 and 2-3.

**414. 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 30-degree acute-angled exit taxiway rests upon an analysis of the existing and contemplated traffic. The purpose of a 30-degree 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) per hour, 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 30-degree 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 4-11 illustrates the configuration for a right-angled exit taxiway. 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.

**415. 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 recommended.

**416. 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 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 VI 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 table 2-1 and 2-2) 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 VI 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 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 tile 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 he 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 he 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 Retroreflective 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 he 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) **Frangibilitity.** 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 he 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 affect 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.

**417. to 499. RESERVED**.

**Table 4-1. Taxiway dimensional standards**

| ITEM | DIM [1/] | AIRPLANE DESIGN GROUP (ADG) | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| Taxiway Width | W | 25 ft<br>7.5 m | 35 ft<br>10.5 m | 50 ft [2/]<br>15 m [2/] | 75 ft<br>23 m | 75 ft<br>23 m | 82 ft<br>25 m |
| Taxiway Edge Safety Margin [3/] | | 5 ft<br>1.5 m | 7.5 ft<br>2.25 m | 10 ft [4/]<br>3 m [4/] | 15 ft<br>4.5 m | 15 ft<br>4.5 m | 15 ft<br>4.5 m |
| Taxiway Pavement Fillet Configuration | | - Refer to Table 4-2 - | | | | | |
| Taxiway Shoulder Width | | 10 ft<br>3 m | 10 ft<br>3 m | 20 ft<br>6 m | 25 ft<br>7.5 m | 35 ft [5/]<br>10.5 m [5/] | 40 ft [5/]<br>12 m [5/] |
| Taxiway Safety Area Width | E | 49 ft<br>15 m | 79 ft<br>24 m | 118 ft<br>36 m | 171 ft<br>52 m | 214 ft<br>65 m | 262 ft<br>80 m |
| Taxiway Object Free Area Width | | 89 ft<br>27 m | 131 ft<br>40 m | 186 ft<br>57 m | 259 ft<br>79 m | 320 ft<br>97 m | 386 ft<br>118 m |
| Taxilane Object Free Area Width | | 79 ft<br>24 m | 115 ft<br>35 m | 162 ft<br>49 m | 225 ft<br>68 m | 276 ft<br>84 m | 334 ft<br>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).

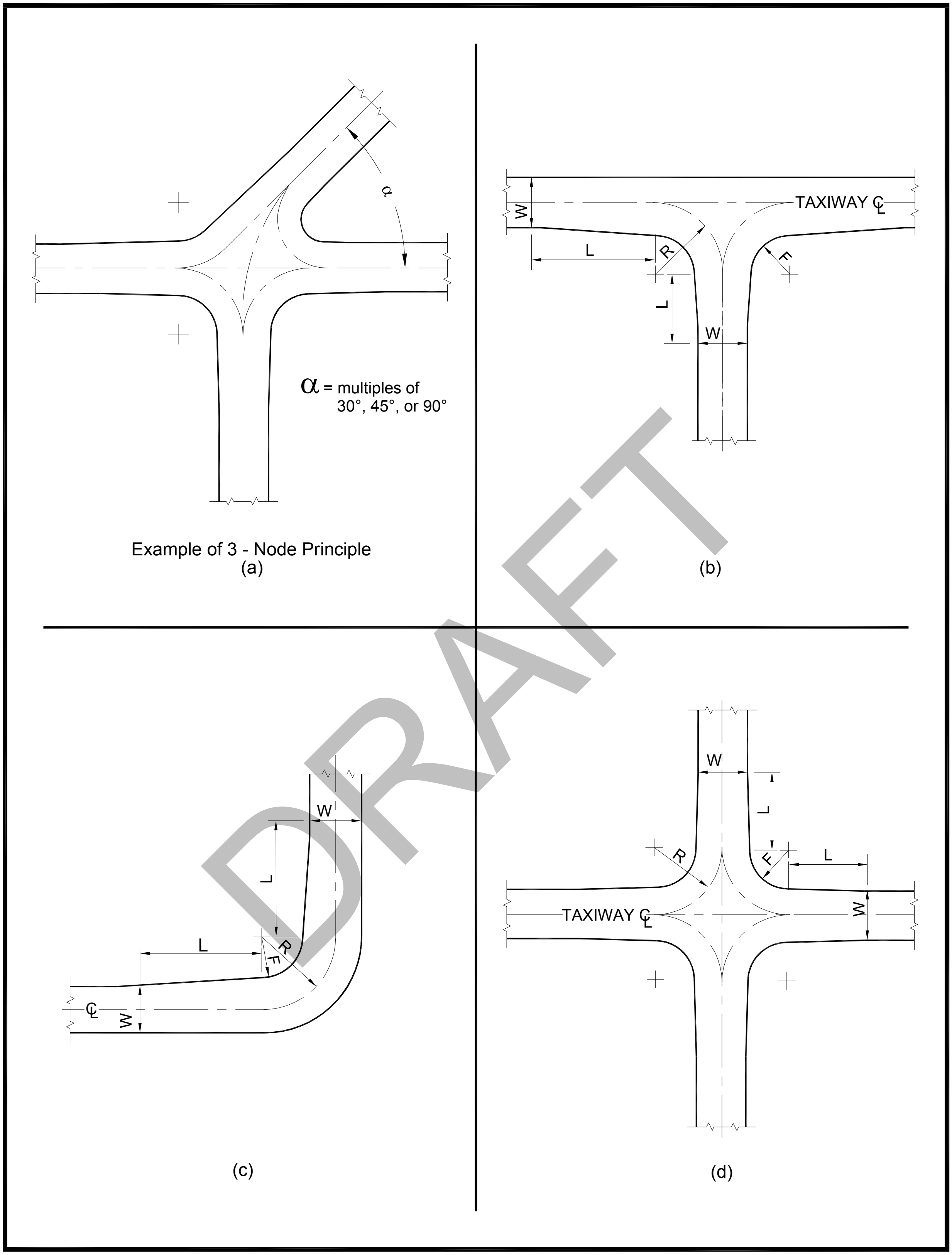



**Figure 4-1. Taxiway to taxiway intersection details**

**Table 4-2. Taxiway fillet dimensions**

| ITEM | DIM 1/ | AIRPLANE DESIGN GROUP (ADG) | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III 2/ | IV | V | VI |
| Radius of Taxiway Turn 3/ | R | 75 ft<br>22.5 m | 75 ft<br>22.5 m | 100 ft<br>30 m | 150 ft<br>30 m | 150 ft<br>45 m | 170 ft<br>52 m |
| Length of Lead-in to Fillet | L | 50 ft<br>15 m | 50 ft<br>15 m | 150 ft<br>45 m | 250 ft<br>75 m | 250 ft<br>75 m | 250 ft<br>75 m |
| Fillet Radius for Tracking Centerline 4/ 5/ | F | 60 ft<br>18 m | 55 ft<br>16.5 m | 55 ft<br>16.5 m | 85 ft<br>25.5 m | 85 ft<br>25.5 m | 85 ft<br>25.5 m |

1/ Letters correspond to the dimensions on figure 4-1.

2/ Airplanes in Airplane Design Group III with a wheelbase equal to or greater than 60 feet (18 m) should use a fillet radius of 50 feet (15 m).

3/ Dimensions for taxiway fillet designs relate to the radius of taxiway turn specified. Figure 4-2 shows a range of wheelbase and undercarriage width combinations that provide the standard taxiway edge safety margin for each ADG. Custom-designed pavement fillet are necessary when the specified "R" or the undercarriage (also undercarriage to cockpit) dimensions fall outside of the standard taxiway edge safety margin of figure 4-2. The equations in appendix 10 offer this ability.

4/ Figure 4-1 (c) displays a pavement fillet with taxiway widening on one side.

5/ Figure 4-1(d) displays pavement fillets with symmetrical taxiway widening.

**Table 4-3. Wingtip clearance standards**

| ITEM | DIM | AIRPLANE DESIGN GROUP (ADG) | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| Taxiway Wingtip Clearance | | 20 ft<br>6 m | 26 ft<br>8 m | 34 ft<br>10.5 m | 44 ft<br>13.5 m | 53 ft<br>16 m | 62 ft<br>19 m |
| Taxilane Wingtip Clearance | | 15 ft<br>4.5 m | 18 ft<br>5.5 m | 22 ft<br>6.5m | 27 ft<br>8 m | 31 ft<br>9.5 m | 36 ft<br>11 m |

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 wingtip clearance equals 0.2 times airplane wingspan plus 10 feet (3 m) and

Taxilane wingtip clearance equals 0.1 times airplane wingspan plus 10 feet (3 m).

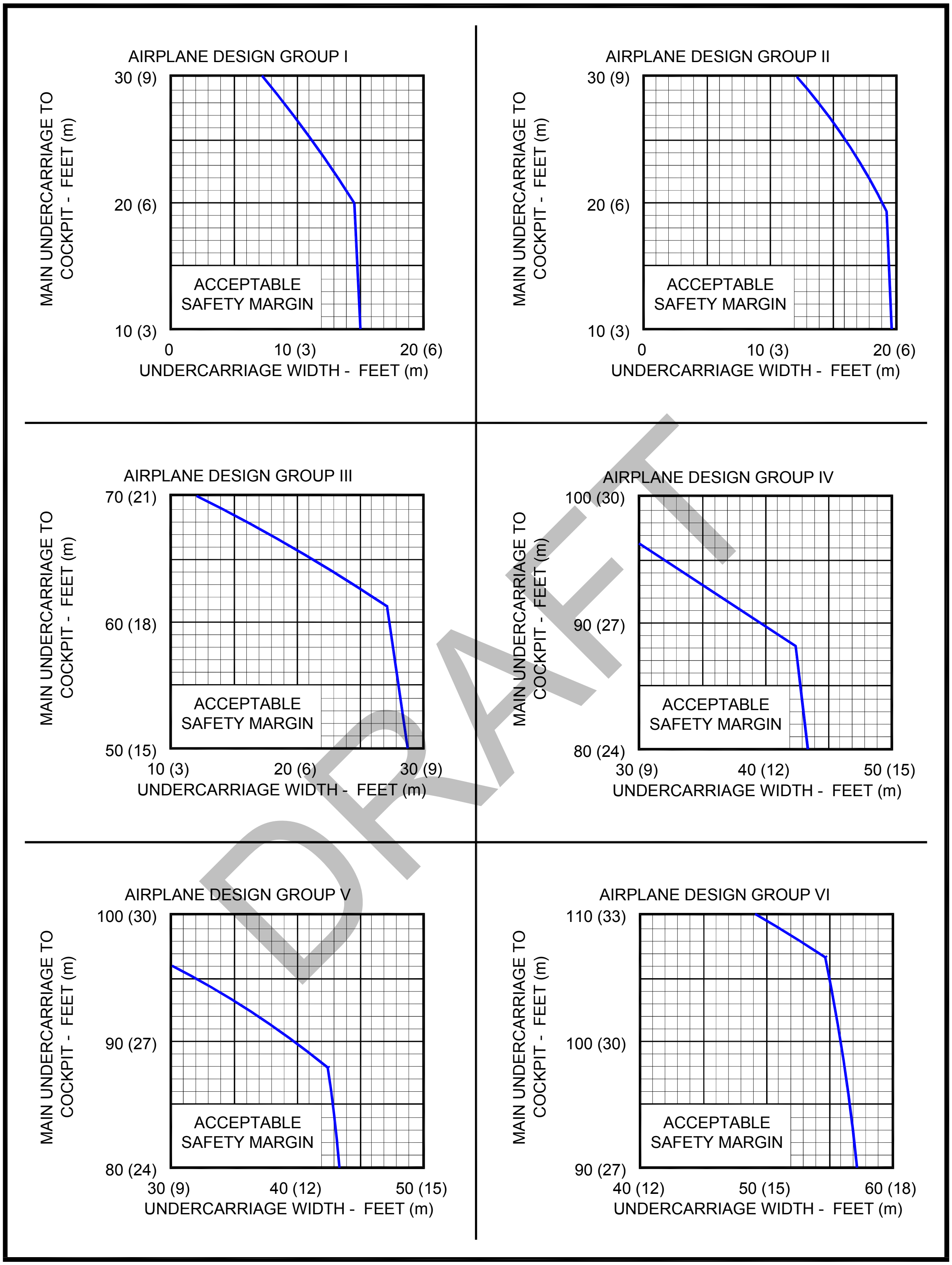
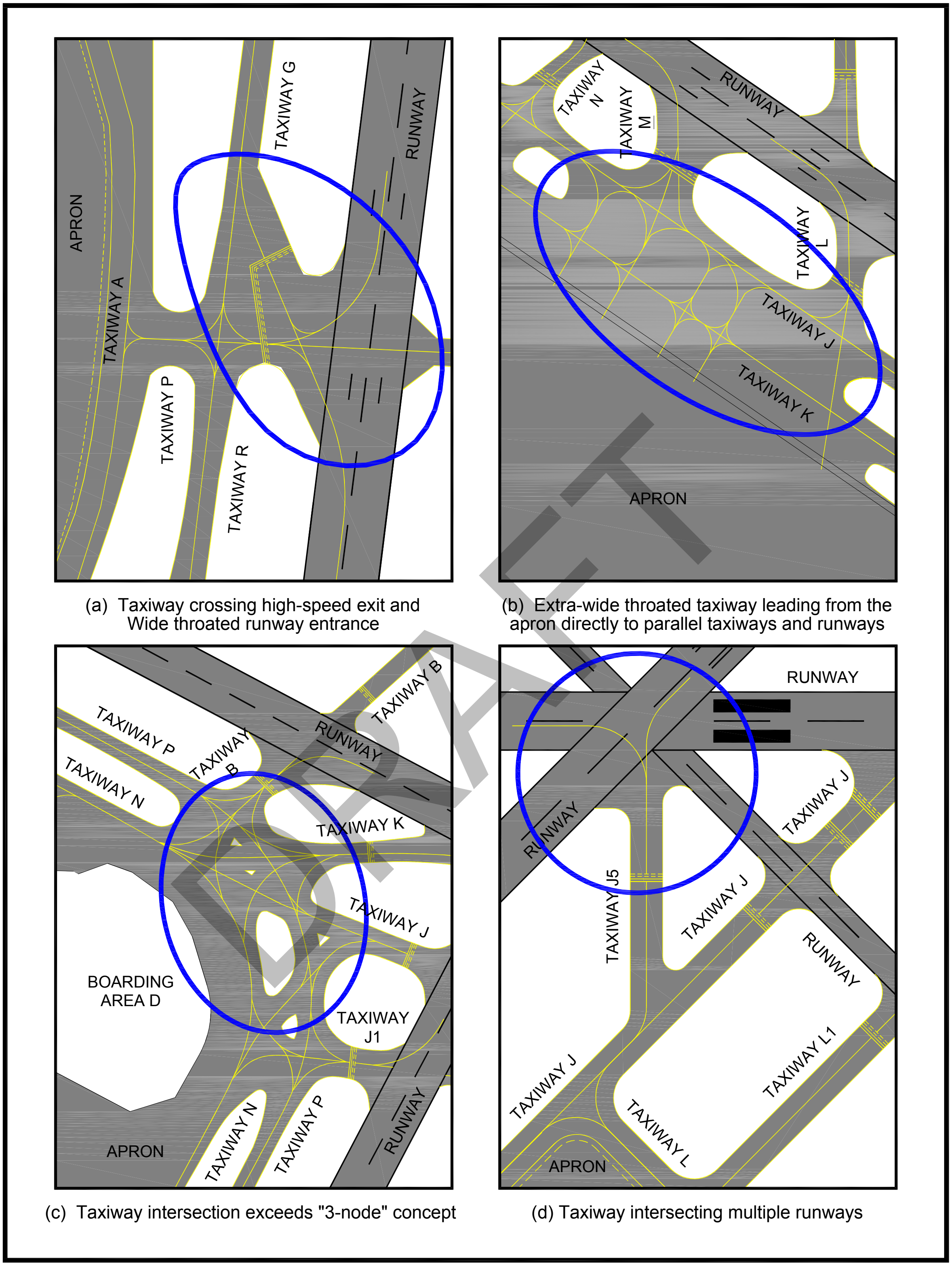





**Figure 4-2. Maintaining cockpit over centerline**




(a) Taxiway crossing high-speed exit and Wide throated runway entrance

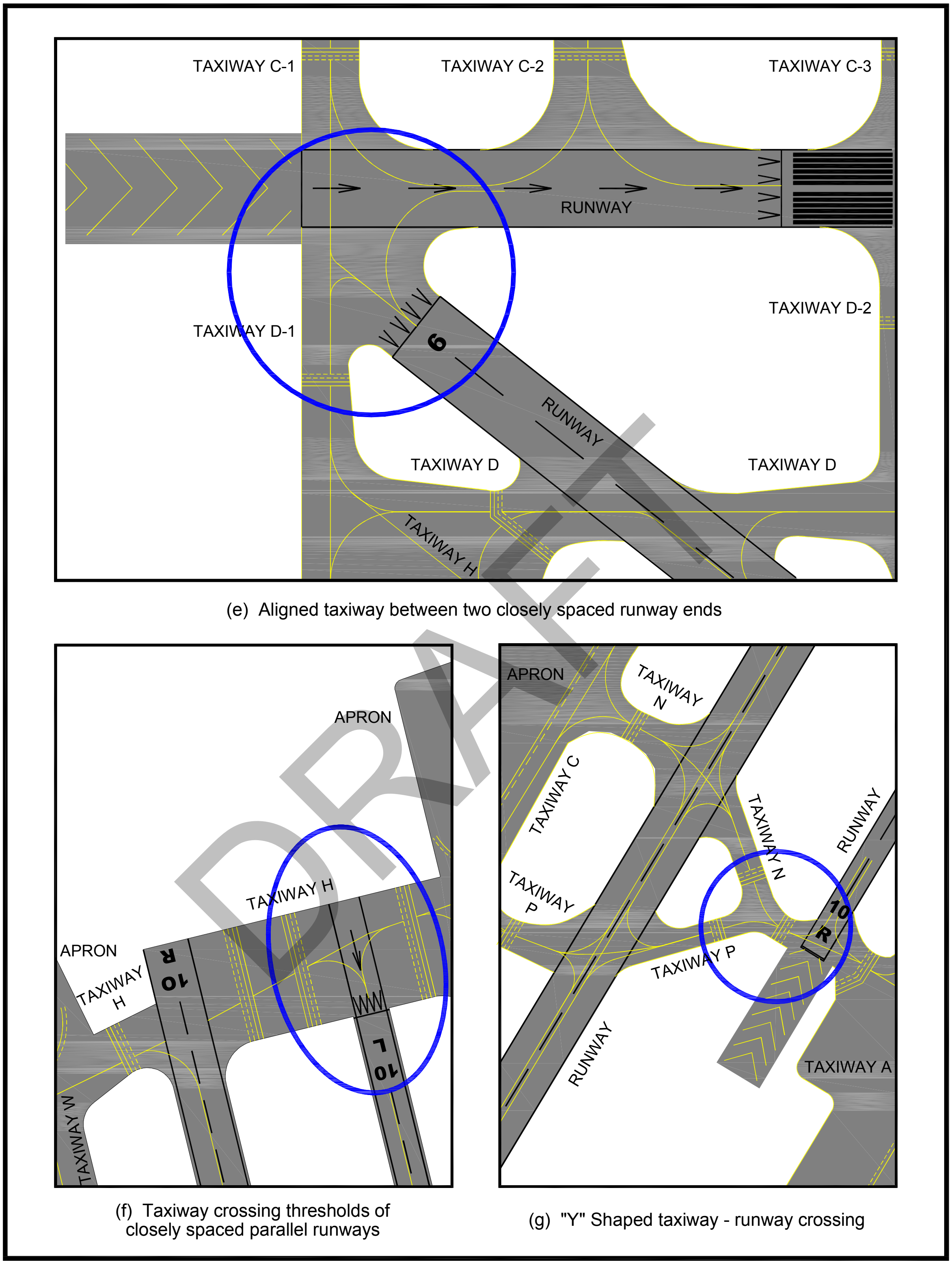
(b) Extra-wide throated taxiway leading from the apron directly to parallel taxiways and runways

(c) Taxiway intersection exceeds "3-node" concept

(d) Taxiway intersecting multiple runways



**Figure 4-3. Problematic taxiway geometry**




(e) Aligned taxiway between two closely spaced runway ends

(f) Taxiway crossing thresholds of closely spaced parallel runways

(g) "Y" Shaped taxiway - runway crossing



**Figure 4-3 (continued). Problematic taxiway geometry**

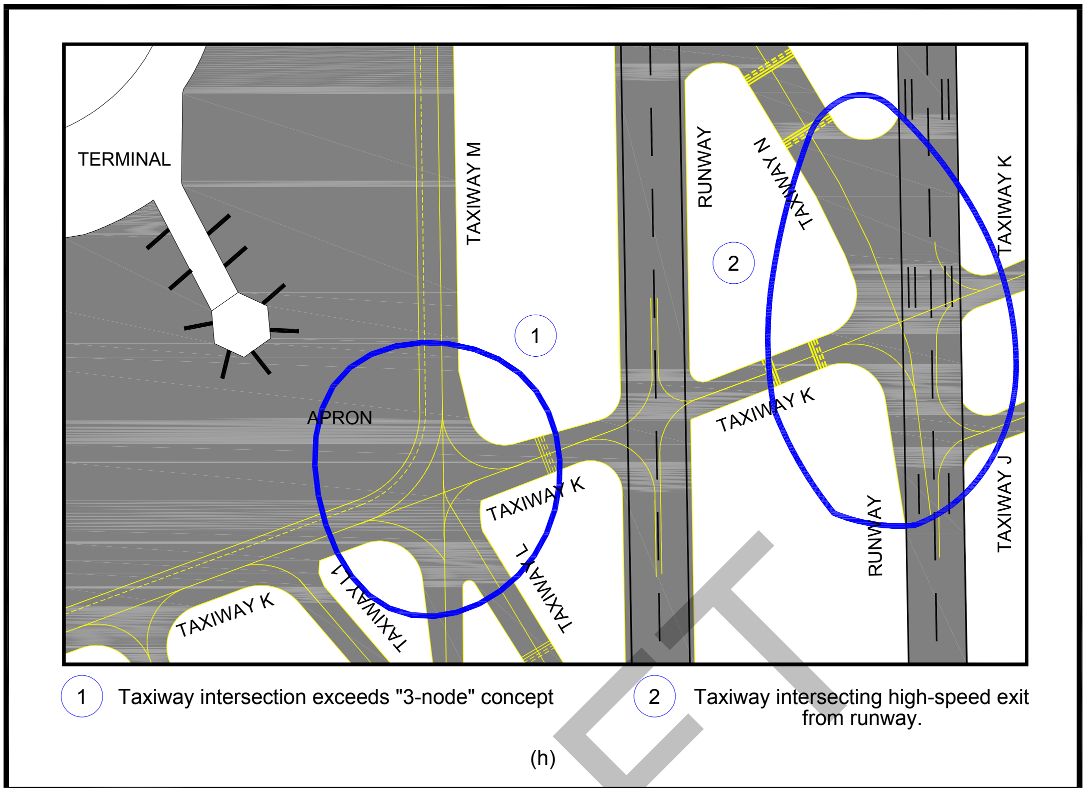



**Figure 4-3 (continued). Problematic taxiway geometry**

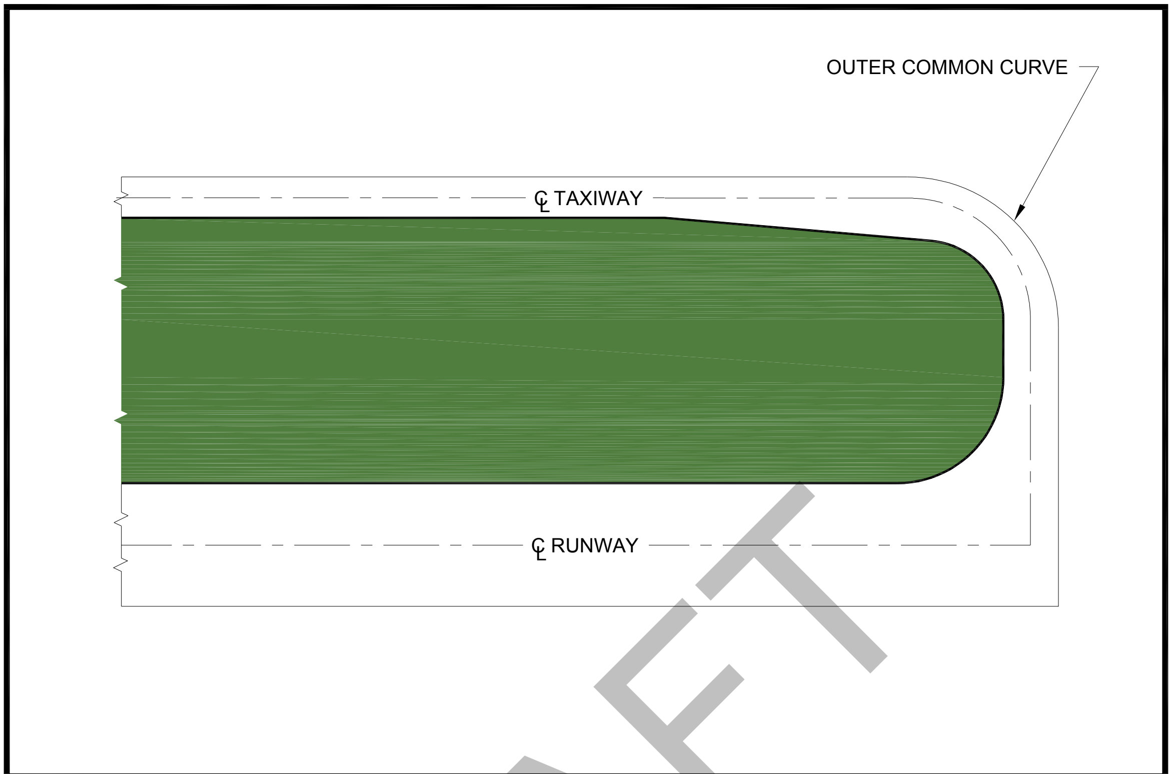



**Figure 4-5. Entrance taxiway**

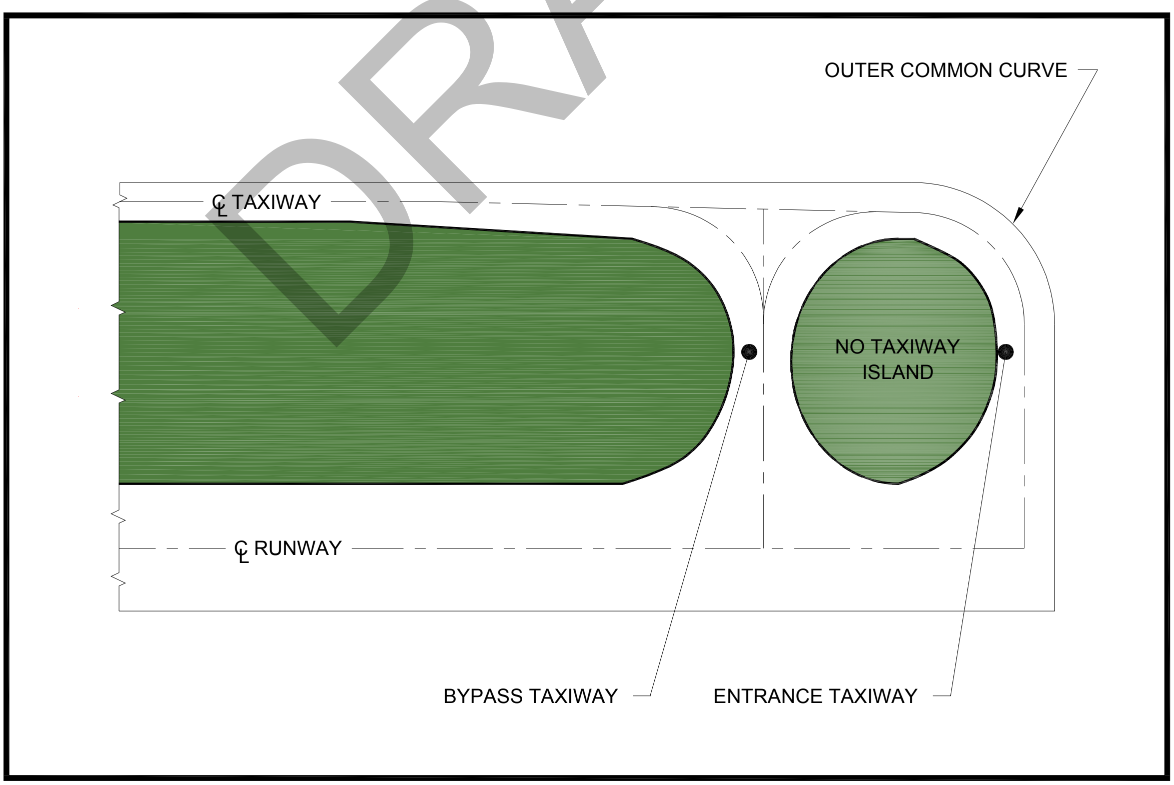



**Figure 4-6. Bypass taxiway & Entrance Taxiway**

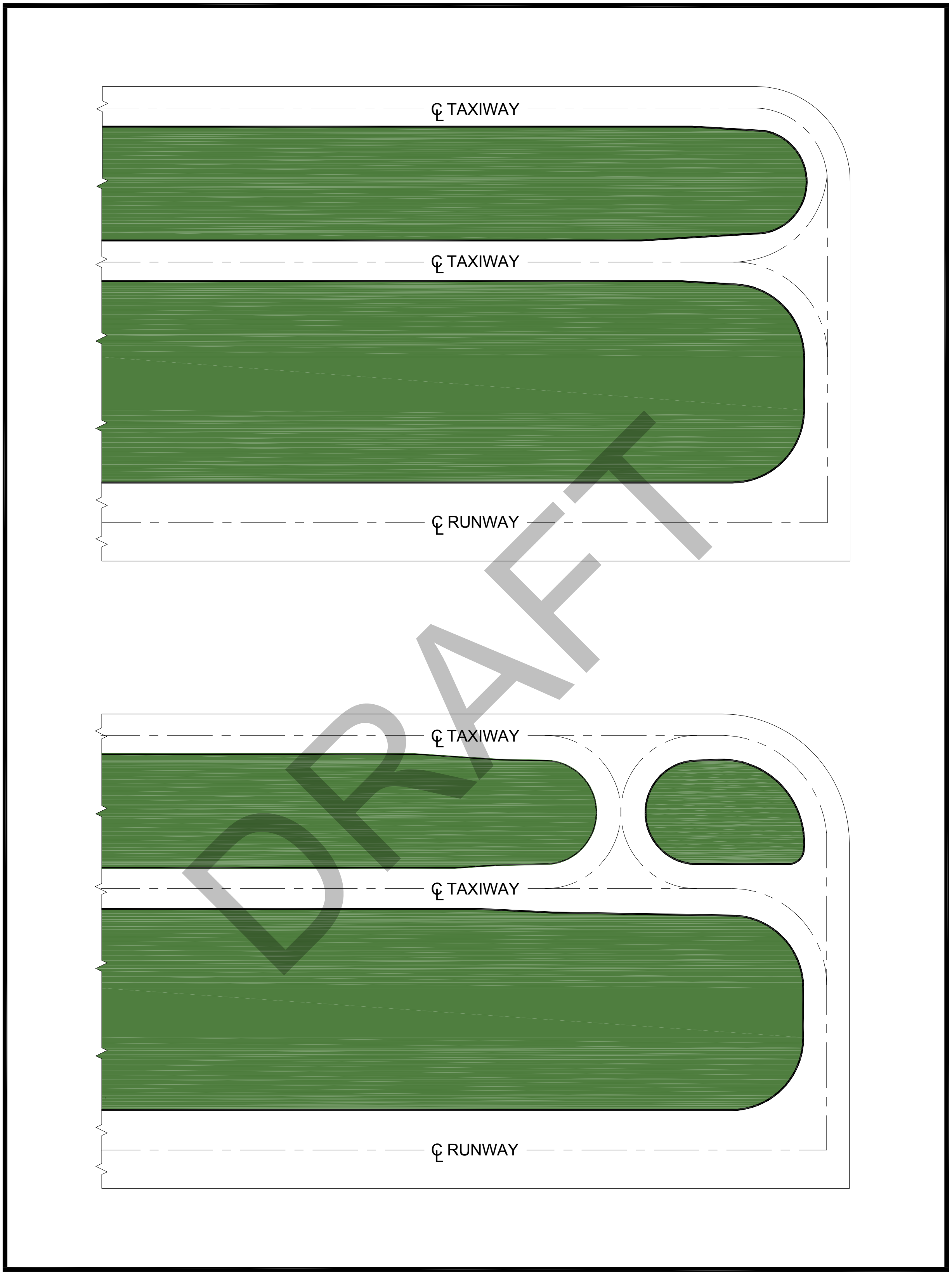



**Figure 4-7. Dual parallel taxiway entrance**

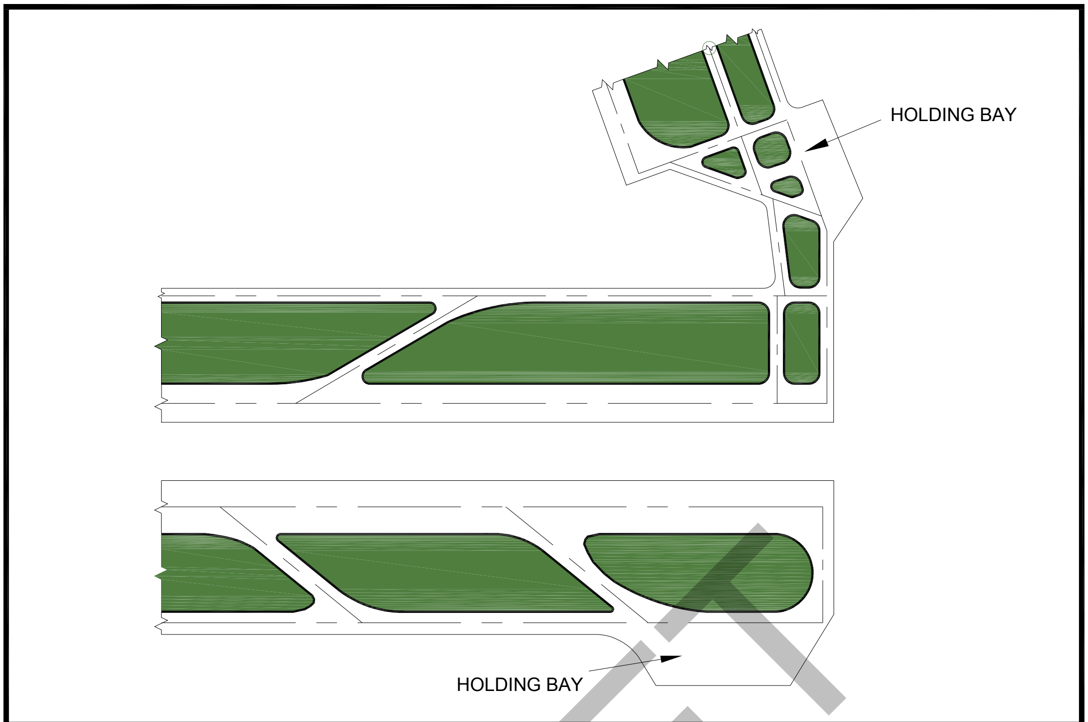



**Figure 4-8. Typical Holding Bay Configuration**

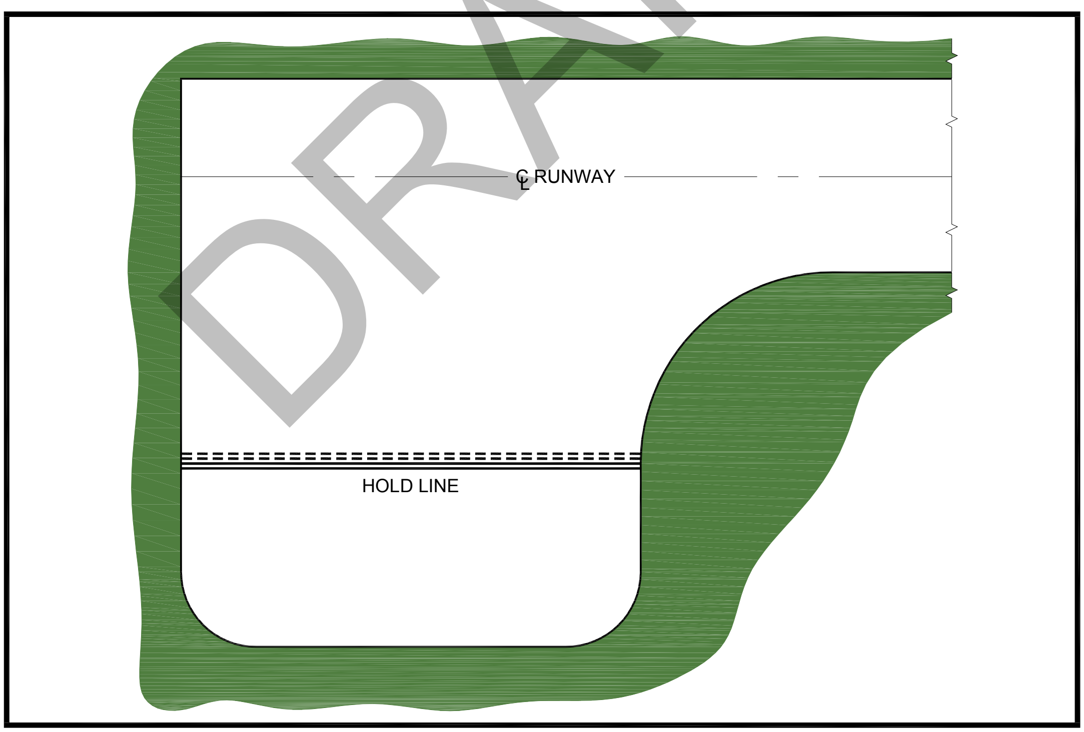



**Figure 4-9. Taxiway Turnaround**

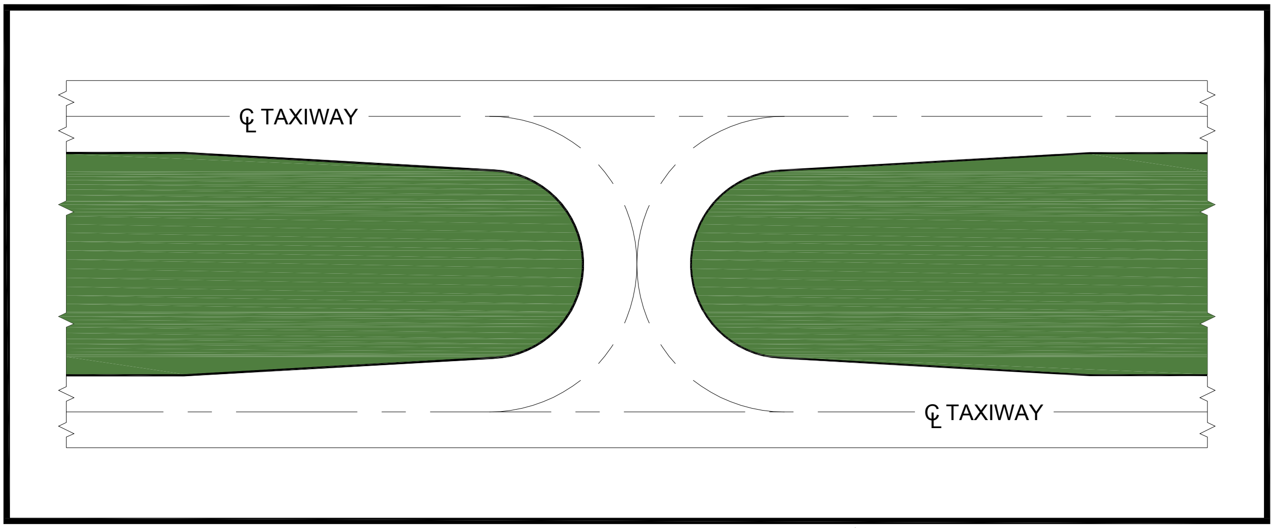



**Figure 4-10. Crossover Taxiway**

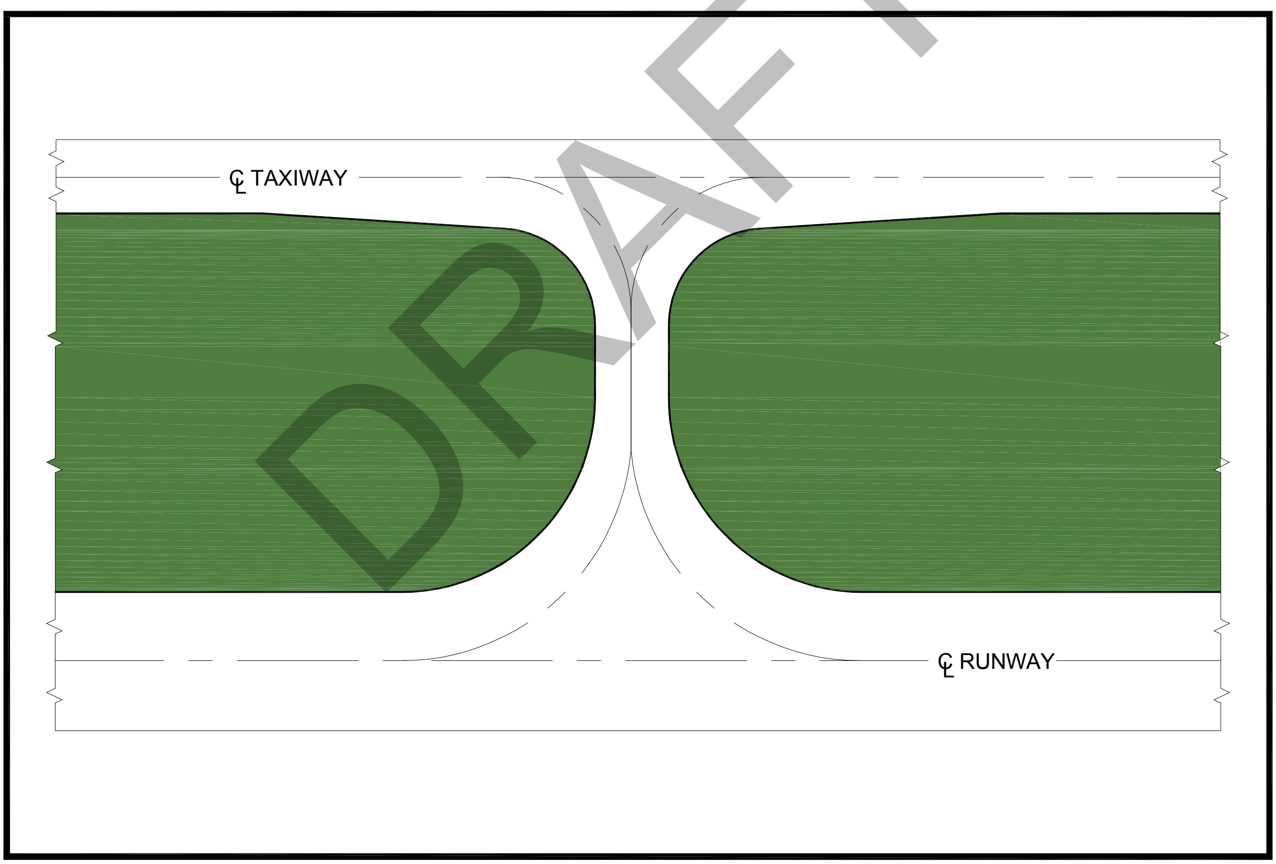



**Figure 4-11. Right-angled Exit Taxiway**

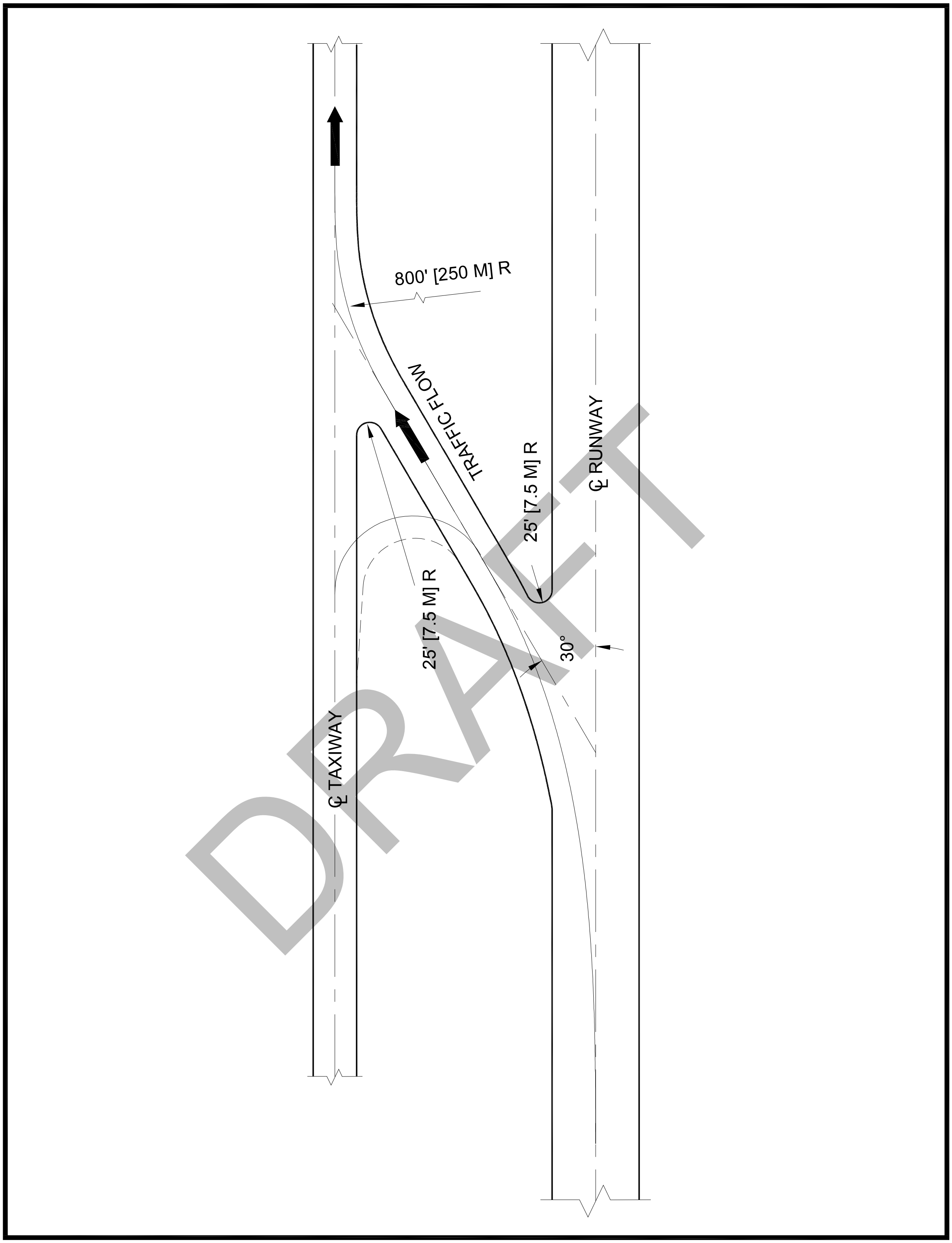



**Figure 4-12. Acute-angled Exit Taxiway**

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# Appendix 1. WIND ANALYSIS

**1. OBJECTIVE**. This appendix provides guidance on the assembly and analysis of wind data to determine runway orientation. It also provides guidance on analyzing the operational impact of winds on existing runways.

**a.** A factor influencing runway orientation and number of runways is wind. Ideally a runway should be aligned with the prevailing wind. Wind conditions affect all airplanes in varying degrees. Generally, the smaller the airplane, the more it is affected by wind, particularly crosswind components (see figure A1-1). Crosswinds are often a contributing factor in small airplane accidents.

**b.** Airport planners and designers should make an accurate analysis of wind to determine the orientation and number of runways. In some cases, construction of two runways may be necessary to give the desired wind coverage (95 percent coverage). The proper application of the results of this analysis will add substantially to the safety and usefulness of the airport.

**2. CROSSWINDS**. The crosswind component of wind direction and velocity is the resultant vector which acts at a right angle to the runway. It is equal to the wind velocity multiplied by the trigonometric sine of the angle between the wind direction and the runway direction. Normally, these wind vector triangles are solved graphically. An example is shown in figure A1-1. From this diagram, one can also ascertain the headwind and tailwind component for combinations of wind velocities and directions. Refer to paragraph 203 for allowable crosswind components.

**3. COVERAGE AND ORIENTATION OF RUNWAYS**. The most desirable runway orientation based on wind is the one which has the largest wind coverage and minimum crosswind components. Wind coverage is that percent of time crosswind components are below an acceptable velocity. The desirable wind coverage for an airport is 95 percent, based on the total numbers of weather observations. This value of 95 percent takes into account various factors influencing operations and the economics of providing the coverage. The data collection should be with an understanding of the objective; i.e., to attain 95-percent usability. At many airports, airplane operations are almost nil after dark, and it may be desirable to analyze the wind data on less than a 24 -hour observation period. At airports where operations are predominantly seasonal, regard should be given to the wind data for the predominant-use period. At locations where provision of a crosswind runway is impractical due to severe terrain constraints, consideration may be given to increasing operational tolerance to crosswinds by upgrading the airport layout to the next higher airport reference code.

**4. ASSEMBLING WIND DATA**. The latest and best wind information should always be used to carry out a wind analysis. A record which covers the last 10 consecutive years of wind observations is preferred. Records of lesser duration may be acceptable on a case-by-case basis. In some instances, it may be highly desirable to obtain and assemble wind information for periods of particular significance; e.g., seasonal variations, instrument weather conditions, daytime versus nighttime, and regularly occurring gusts.

**a. Data Source.** The best source of wind information is the National Oceanic and Atmospheric Administration, National Climatic Data Center (NCDC). The NCDC is located at:

Climate Services Branch
National Climatic Data Center
151 Patton Avenue
Asheville, North Carolina 28801-5001
Tel: 828-271-4800/ Fax: 828-271-4876
Public Web Address: http://www.ncdc.noaa.gov/

The Center should be contacted directly to determine the availability of data for a particular site.

**b. Data Costs.** The EDS provides wind information at cost. The cost will vary, depending upon the complexity of the information desired, how the data are being stored, and whether the data have been assembled (summarized) previously. The wind summary for the airport site should be formatted with the standard 36 wind quadrants (the EDS standard for noting wind directions since January 1, 1964) and usual speed groupings (see figure A1-3). An existing wind summary of recent vintage is acceptable for analysis purposes if these standard wind direction and speed groupings are used. Figure A1-2 is an example of a typical EDS wind summary.

**c. Data Not Available.** In those instances when EDS data are not available for the site, it is permissible to develop composite wind data using wind information obtained from two or more nearby recording stations. Composite data are usually acceptable if the terrain between the stations and the site is level or only slightly rolling. If the terrain is hilly or mountainous, composite data may only have marginal validity. In extreme cases it may be necessary to obtain a minimum of 1 year of onsite wind observations. These meager records should be augmented with personal observations (wind-bent trees, interviews with the local populace, etc.) to ascertain if a discernible wind pattern can be established. Airport development should not proceed until adequate wind data are acquired.

5. **ANALYZING WIND DATA**. One wind analysis procedure uses a scaled graphical presentation of wind information known as a windrose.

a. **Drawing the Windrose**. The standard windrose (figure A1-3) is a series of concentric circles cut by radial lines. The perimeter of each concentric circle represents the division between successive wind speed groupings. Radial lines are drawn so that the area between each successive pair is centered on the direction of the reported wind.

b. **Plotting Wind Data**. Each segment of the windrose represents a wind direction and speed grouping corresponding to the wind direction and speed grouping on the EDS summary. The recorded directions and speeds of the wind summary are converted to a percentage of the total recorded observations. Computations are rounded to the nearest one-tenth of 1 percent and entered in the appropriate segment of the windrose. Figure A1-4 illustrates a completed windrose based on data from figure A1-2. Plus (+) symbols are used to indicate direction and speed combinations which occur less than one-tenth of 1 percent of the time.

c. **Crosswind Template**. A transparent crosswind template is a useful aid in carrying out the windrose analysis. The template is essentially a series of three parallel lines drawn to the same scale as the windrose circles. The allowable crosswind for the runway width establishes the physical distance between the outer parallel lines and the centerline. When analyzing the wind coverage for a runway orientation, the design crosswind limit lines can be drawn directly on the windrose. NOTE: EDS wind directions are recorded on the basis of true north.

d. **Analysis Procedure**. The purpose of the analysis is to determine the runway orientation which provides the greatest wind coverage within the allowable crosswind limits. This can be readily estimated by rotating the crosswind template about the windrose center point until the sum of the individual segment percentages appearing between the outer "crosswind limit" lines is maximized. It is accepted practice to total the percentages of the segments appearing outside the limit lines and to subtract this number from 100. For analyses purposes, winds are assumed to be uniformly distributed throughout each of the individual segments. Figures A1-5 and A1-6 illustrate the analysis procedure as it would be used in determining the wind coverage for a runway, oriented 105-285, intended to serve all types of airplanes. The wind information is from figure A1-2. Several trial orientations may be needed before the orientation which maximizes wind coverage is found.

6. **CONCLUSIONS**. The example wind analysis shows that the optimum wind coverage possible with a single runway and a 13 -knot crosswind is 97.28 percent. If the analysis had shown that it was not possible to obtain at least 95-percent wind coverage with a single runway, then consideration should be given to provide an additional (crosswind) runway oriented to bring the combined wind coverage of the two runways to at least 95 percent.

7. **ASSUMPTIONS**. The analysis procedures assume that winds are uniformly distributed over the area represented by each segment of the windrose. The larger the area, the less accurate is this presumption. Therefore, calculations made using nonstandard windrose directions or speeds result in a derivation of wind coverage (and its associated justification for a crosswind runway) which is questionable.

8. **WIND ANALYSIS TOOL**. A wind analysis tool is available on the Airports-GIS website:

airports-gis.faa.gov/public

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# 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, Safe, Efficient Use, and Preservation of the 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 x 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 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 obstacles exceed the height of the GQS, an approach procedure with vertical guidance (ILS, PAR, MLS, TLS, LPV, Baro¬VNAV, etc.) 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, follow the steps in Figure A2-2 to determine the offset boundary. The surface slope is as specified in the applicable paragraph, according to Table A2-1.

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, 2012.

## 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 operations, serving approach category A and B aircraft only. [1] | 200 | 200 | 1,900 | 10,000 [2] | 0 | 20:1 |
| 5 | Approach end of runways expected to support instrument night operations serving greater than approach category B aircraft. [1] | 200 | 400 | 1,900 | 10,000 [2] | 0 | 20:1 |
| 6 | 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 |
| 7 | 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 |
| 8 | Approach runway ends having Category II approach minimums or greater. | The criteria are set forth in TERPS, Order 8260.3. | | | | | |
| 9 | Approach end of runways expected to accommodate approaches with vertical guidance [Glideslope Qualification Surface (GQS).] | 0 | 1/2 width runway +100 | 760 | 10,000 [2] | 0 | 30:1 |
| 10 | Departure runway ends for all instrument operations. | 0[4] | See Figure A2-3 | | | | 40:1 |
| 11 | 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. Marking & 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. When obstacles exceed the height of the GQS, an approach procedure with vertical guidance (ILS, PAR MLS, TLS, LPV, LNAV/VNAV, etc.) is not authorized. No vertical approaches will be authorized until the penetration(s) is/are removed except obstacles fixed by function and/or allowable grading (paragraphs 305 and 308).
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, 2012.

6. Surface dimensions/Obstacle Clearance Surface (OCS) slope represent a nominal approach with 3 degree GPA, 50’TCH, <500’ HATh. For specific cases refer to TERPS. The Obstacle Clearance Surface slope (30:1) supports 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 9 is in addition to the basic criteria established within the table, to ensure the protection of the Glidepath Qualification Surface (GQS).
8. For planning purposes, sponsors and consultants determine a tentative Decision Altitude based on a 3° Glidepath angle and a 500-foot Threshold Crossing Height.

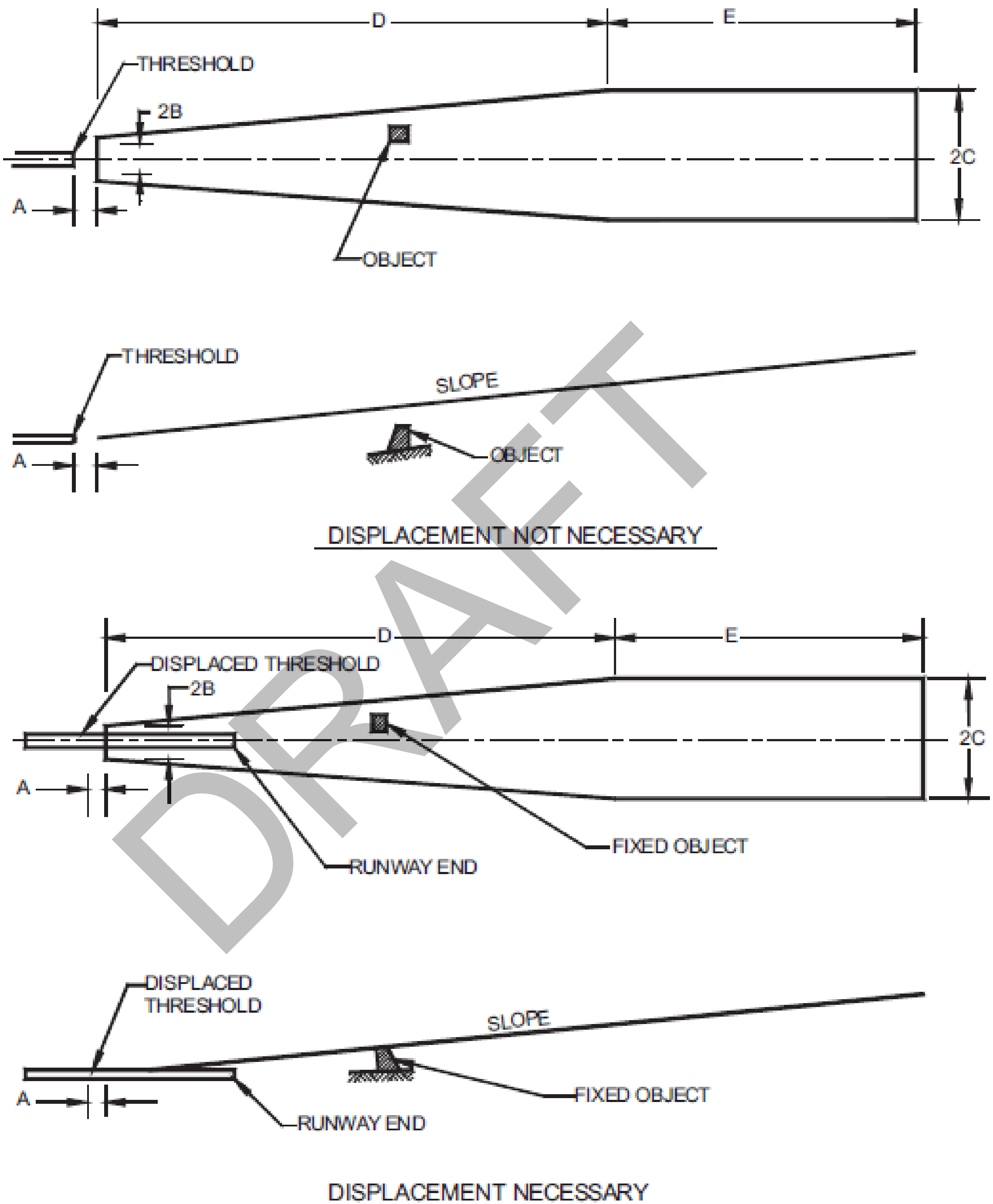




**Figure A2-1. Approach slopes**

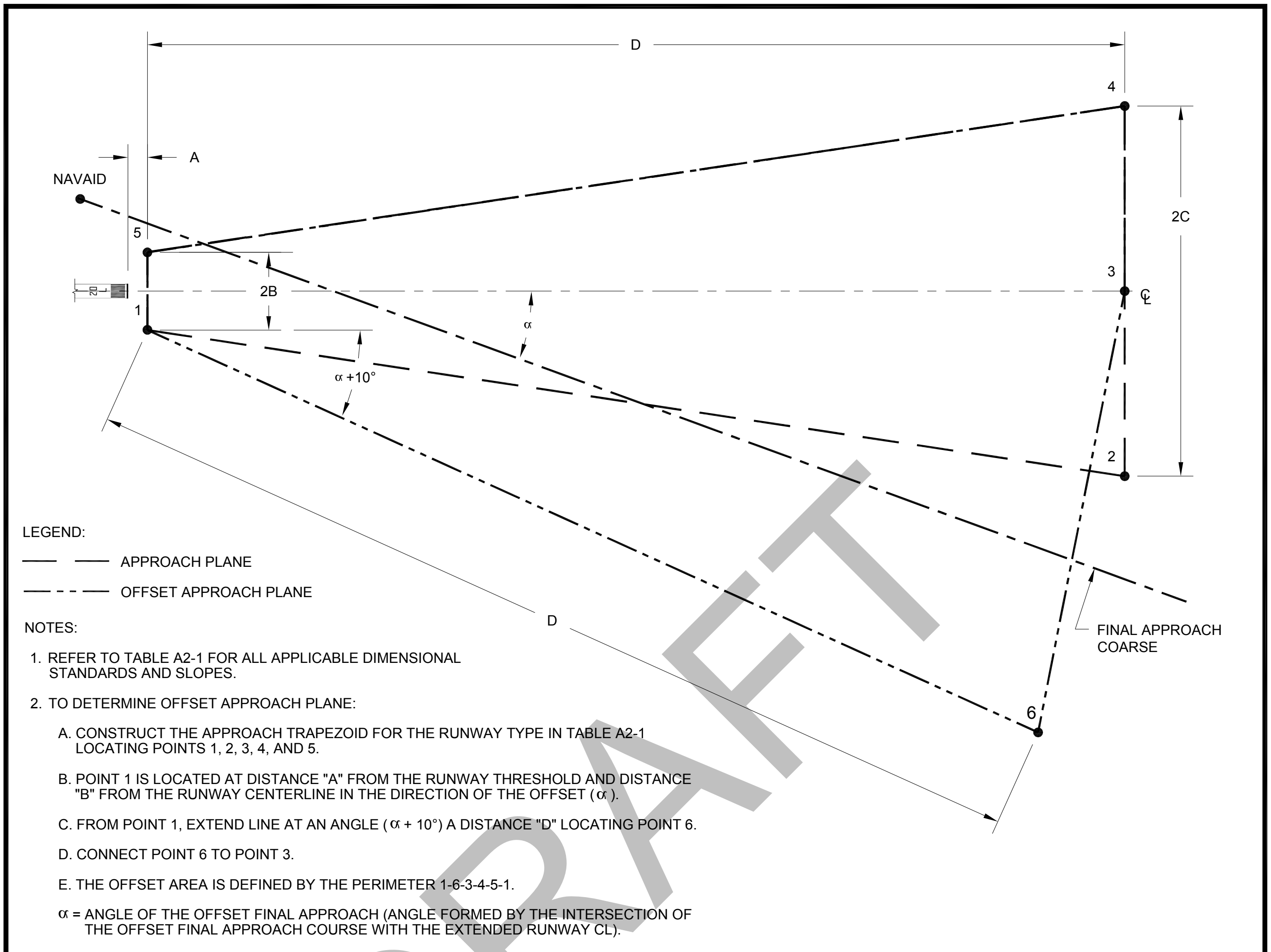


**Figure A2-2. Offset Approach Course**

# Appendix 11. COMPUTER PROGRAM

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# Appendix 15. TRANSFER OF ELECTRONIC DATA

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# Appendix 16. NEW INSTRUMENT APPROACH PROCEDURES

1. **BACKGROUND**. This appendix applies to the establishment of new or existing (under revision) instrument approach procedures (IAP).

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. ILS and LPV Approach Requirements.

| **Visibility Minimums** [1] | < 3/4 statute mile | < 1-statute mile |
|---|---|---|
| **Height Above Touchdown (HAT)** [2] | 200 | |
| **TERPS Glidepath Qualification Surface (GQS)** [3] | Appendix 2, Table A2-1, Row 9 Clear | |
| **TERPS precision "W" surfaces** [4] | Clear | See Note 5 |
| **TERPS Chapter 3, Section 3** | 34:1 Clear | 20:1 Clear |
| **Precision Obstacle Free Zone (POFZ) 200 x 800** | 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 7 & 9 | Table A2-1, Row 6 & 9 |
| **Survey Required for Lowest Minima** | Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18 | |

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 3 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.

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 full-length parallel taxiway meeting separation requirements - Tables 2-1 and 2-2.
10. To achieve lower visibility minimums based on credit for lighting, an approach light system is required.
11. Indicates which table in Chapter 3 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 Chapter 3, Section 3.

## Table A16-1B. Approach Procedure With Vertical Guidance

| **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 9, Criteria, and Appendix 2, par. 5a Clear | | | |
| **TERPS Chapter 3, Section 3** | 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** | 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 AC150/5340-1)** | Precision | Nonprecision *(precision* | 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] | MALSR, SSALR, ALSF | Recommended | 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 7 and 9 | Table A2-1 Row 6 and 9 | Appendix 2, Table A2-1, Row 5 and 9 | |
| **Survey Required for Lowest Minima** | Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18 | | Non-Vertically Guided Airport Airspace Analysis Survey AC 150/5300-18 | |

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

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. 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 the RAPT.
8. Runway edge lighting is required for night minimums. High intensity lights are required for RVR-based minimums.
9. A full-length parallel taxiway must lead to the threshold and meet standards in Tables 2-1 and 2-2.
10. To achieve lower visibility minimums based on credit for lighting, a TERPS specified approach light system is required.

12. Indicates what table 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 Chapter 3, Section 3.
14. For circling requirements, see Table A16-1C.

## Table A16-1C. Nonprecision Approach Requirements

Approach Procedures without Vertical Guidance

| 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 Chapter 3, Section 3** | 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 7 | Table A2-1, Row 6 | Table A2-1, Row 1-5 | | Table A2-1, Row 1-4 |
| **Survey Required for Lowest Minima** | Vertically Guided Airport Airspace Analysis Survey AC 150/5300-18 | Non-Vertically Guided Airport Airspace Analysis Survey AC 150/5300-18 | | | |

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 the RAPT.
6. Runway edge lighting is required for night minimums. High intensity lights are required for RVR-based minimums.
7. A full-length parallel taxiway must lead to the threshold.
8. To achieve lower visibility minimums based on credit for lighting, an approach lighting system is required.
9. ODALS, MALS, SSALS, SALS are acceptable.
10. Indicates what table 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 Chapter 3, Section 3.

# Appendix 19. INDEX