U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Airport Design	Date: August 16, 2024	AC No: 150/5300-13B
	Initiated By: AAS-100	Change: 1

1 **Purpose.**

This Advisory Circular (AC) contains the Federal Aviation Administration's (FAA) standards and recommendations for airport design.

2 **Applicability.**

No change to paragraph 3, Applicability, dated 3/31/2022.

3 **Principal Changes.**

This AC change incorporates the following principal changes:

1. Added the touchdown zone definition to paragraph 1.5 as item 99, and the V_1 definition as item 100.
2. Simplified Figure 1-1, Taxiway Design Groups, and added Table 1-4 to clarify.
3. Updated paragraph 1.12, Related Documents and Federal Regulations.
4. Clarified paragraph 2.4, Addressing Non-standard Airport Conditions.
5. Clarified paragraph 2.6.1, Critical Aircraft.
6. Expanded paragraph 2.7.2, Wrong Surface Events.
7. Updated paragraph 2.10.6.5. The main point of contact for reviews of operations within the non-paved area of the RSA is now the Flight Procedures and Airspace Group.
8. Replaced and cancelled Engineering Brief (EB) reference in paragraphs 3.6.1.2 and 3.6.2.3.
9. Added a note to Table 3-2 to clarify guidance for circling-only approaches.
10. Clarified footnotes for Figure 3-17, Table 4-2, Figure 4-10, Figure 4-12, Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-22, Figure 4-23, and Figure 4-24.
11. Expanded paragraph 3.9.3, Simultaneous Instrument Flight Rules (IFR) Arrival Operations.
12. Clarified paragraph 3.11.4.2.

13. Adjusted precision obstacle free zone on Figure 3-25.
14. Added exception to paragraph 3.12.1, items 4.c and 4.e.
15. Clarified paragraph 4.2.
16. Added design considerations to paragraph 4.4.
17. Clarified paragraph 4.7.1, item 1.
18. Expanded paragraph 4.7.2.
19. Clarified paragraph 4.7.3, item 3.
20. Clarified paragraph 4.8.2.1, item 1.
21. Deleted Table 4-3, Dimensions for Runway Entrance/Exit Taxiways with TDG 1A, 1B, 2A, or 2B (Where the Two 90-Degree Turns are Non-standard).
22. Deleted Table 4-4, Dimensions for Runway Entrance/Exit Taxiways with TDG 3, 4, 5, or 6 (Where the Two 90-Degree Turns are Non-standard).
23. Revised paragraph 4.8.5, High-Speed Exit Taxiways.
24. Clarified the two design scenarios for paragraph 4.8.6, Crossover Taxiways.
25. Deleted Table 4-6, Crossover Taxiways with Direction Reversal Between Taxiways Based on TDG.
26. Deleted Table 4-7, Crossover Taxiways with Direction Reversal Between Taxiways Based on ADG.
27. Clarified standards for End-Around Taxiways (EATs) in paragraph 4.12.1.1 and paragraph D.1.4.
28. Clarified standards for apron taxilanes in paragraph 5.4.1.1.
29. Clarified standards for air operations area vehicle service roads in paragraph 6.5.2.
30. Clarified standards for perimeter security roads in paragraph 6.5.4.
31. Clarified standards for navigational aid access roads in paragraph 6.5.5.1.
32. Expanded Table 6-1 and related notes.
33. Revised paragraph D.1.3, Visual Screen Vertical Dimension Calculation, and paragraph D.1.4, Visual Screen and Vertical Elevation Difference.
34. Revised runway, shoulder, and blast pad widths for ADG-VI in Table G-12 and added footnote 14. Appended footnote 12.
35. Deleted items 1, 3, and 4 from paragraph H.4.1, and Figures H-2 and H-3.
36. Updated tables in paragraph J.3 and clarified notes.
37. Clarified paragraph J.4.2.
38. Added paragraph J.4.3, Example: Critical Aircraft TOFA Calculation.
39. Clarified Figure J-14 and Figure J-15.

40. Updated Figure J-30 and paragraph J.5.15 to include additional common mitigation.
41. Made minor editorial changes and layout adjustments throughout.

4 **Implementation.**

Implement changes addressed by this change upon effective date of this AC.

5 **Feedback on this AC.**

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback form at the end of this AC.

John R. Dermody
Director of Airport Safety and Standards

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Consolidated AC includes Change 1

Subject: Airport Design	Date: 3/31/2022	AC No: 150/5300-13B
	Initiated By: AAS-100	Change:

1 **Purpose.**

This Advisory Circular (AC) contains the Federal Aviation Administration's (FAA) standards and recommendations for airport design.

2 **Cancellation.**

This AC cancels AC 150/5300-13A, *Airport Design*, dated September 28, 2012.

3 **Applicability.**

The FAA recommends using the standards and guidelines in this AC for application at civil airports. This AC does not constitute a regulation, is not mandatory, and is not legally binding in its own right. It will not be relied upon as a separate basis by the FAA for affirmative enforcement action or other administrative penalty. Conformity with this AC is voluntary, except for the projects described in subparagraphs 3 and 4 below:

1. Use of these standards and guidelines are practices the FAA recommends for establishing an acceptable level of safety, efficiency, and capacity when designing and implementing airport development projects at civil airports.
2. This AC provides one, but not the only, acceptable means of meeting the requirements of 14 Code of Federal Regulations (CFR) Part 139, *Certification of Airports*.
3. Use of these standards is mandatory for projects funded under certain Federal grant assistance programs including, but not limited to, the Airport Improvement Program (AIP). See Grant Assurance #34. Airport sponsors should familiarize themselves with the obligations and assurances that apply to each grant program from which they obtained grant funds.
4. This AC is mandatory, as required by regulation, for projects funded by the Passenger Facility Charge (PFC) program. See PFC Assurance #9.

4 **Related Documents.**

Refer to paragraph 1.12 for documents referenced by this AC. ACs and FAA Orders referenced in the text of this AC do not include a revision letter, as they refer to the latest version.

5 **Principal Changes.**

This AC incorporates the following principal changes:

1. Restructured the entire document, locating design standards in the chapters with supporting information in the Appendices. Chapters and Appendices are organized and updated as follows:
    a. Chapter 1, Introduction:
        i. Added new paragraphs explaining the meaning of terms for:
            1. Standard, paragraph 1.2.1.1.
            2. Recommended Practice, paragraph 1.2.1.2.
            3. Requirement, paragraph 1.2.1.3.
        ii. Added or revised definitions in paragraph 1.5:
            1. Commercial Service Airport, item 27.
            2. Critical Aircraft, item 29.
            3. Parallel Taxiway, item 72.
            4. Runway Visual Range, item 84.
            5. Taxiway Centerline, item 92.
        iii. Separated Taxiway Design Group (TDG) 2 into TDG 2A and TDG 2B in Figure 1-1 and related discussions and tables throughout this document.
        iv. Removed TDG 7 and revised Main Gear Width (MGW) dimensions for TDG 5 and TDG 6 in Figure 1-1 and related discussions and tables throughout this document.
        v. Moved Instrument Flight Procedures to new Appendix K.
    b. Chapter 2, Design Principles (formerly Design Process):
        i. Expanded discussion for design process in paragraph 2.6, and visibility minimums in paragraph 2.6.2.
        ii. Added paragraph 2.7.2 on Wrong Surface Event.
        iii. Expanded latter portion of chapter to include discussions on Modification of Standards in paragraph 2.8, Safety Management System (SMS) in paragraph 2.9, and Diverse Aeronautical Uses of Airports (operations in the Runway Safety Area (RSA)) in paragraph 2.10.
        iv. Expanded guidance and information related to diverse aeronautical uses on airports in paragraph 2.10.

v. Moved Table 2-1, Changes in Airport Design Standards Associated with an Upgrade in the First Two Components (Aircraft Approach Category (AAC) and Airplane Design Group (ADG)) of the Runway Design Code (RDC); Table 2-2, Changes in Airport Design Standards Associated with Lowering the Third Component (Approach Visibility Minimums) of the Runway Design Code (RDC); and Table 2-3, Aircraft Characteristics and Design Components to new Appendix M.

c. Chapter 3, Runway Design:

i. Moved Crosswind Component table to Appendix B.

ii. Moved runway historical and background information to Appendix I.

iii. Moved Declared Distance information to Appendix H.

iv. Moved Approach and Departure Reference Code information to Appendix L.

v. Revised approach and departure tables in paragraph 3.6.

vi. Updated approach surface discussion in paragraph 3.6.1 and added new approach and departure surfaces Figure 3-5, Figure 3-6, and Figure 3-7.

vii. Updated departure surface to reflect forthcoming Terminal Instrument Procedures (TERPS) criteria in paragraph 3.6.2 and revised approach and departure surface values in Table 3-2, Table 3-3, Table 3-4, and Table 3-5.

viii. Expanded departure surface guidance in paragraph 3.6.2 and added new departure area surface Figure 3-9, Figure 3-10, and Figure 3-11.

ix. Added new paragraph 3.7.5 on overlapping RSAs.

x. Expanded Line of Sight (LOS) discussion in paragraph 3.8.

xi. Added new paragraph 3.9 on Parallel Runway Separation.

xii. Added new Figure 3-33 and expanded discussion on transverse slopes in paragraph 3.16.2.

xiii. Expanded and split Table 3-3, Transverse Grades, into Table 3-6, Transverse Grades Based on AAC, and Table 3-7, Transverse Grades Based on ADG.

xiv. Expanded turf runway discussion in paragraph 3.16.6.

xv. Removed Interactive Table 3-5, Runway Design Standards Matrix. This is available online as a design tool at https://www.faa.gov/airports/engineering/airport_design/.

xvi. Added new Table 3-1 to facilitate locating runway design standards in Appendix G based on AAC and ADG.

d. Chapter 4, Taxiway and Taxilane Design:

i. Reduced dimensions for taxilane object free area (TOFA) and taxiway separation (taxiway separation, taxiway centerline to fixed or moveable

object, and wingtip clearance) as described in paragraph 4.5 and shown in revised Table 4-1. Revised these same standards for taxilanes.

ii. Updated Table 4-2; Taxiway Edge Safety Margin (TESM) for TDG 5 and TDG 6 is now 14 ft (4.3 m).

iii. Updated taxiway turn and intersection criteria in paragraph 4.7.3.

iv. Updated Taxiway Fillet Design Tool with new criteria. This is available online as a design tool at https://www.faa.gov/airports/engineering/airport_design/.

e. Chapter 5, Aprons:

i. Expanded discussion on types of aprons in paragraph 5.2.

ii. Moved information on bridges to Chapter 6.

f. Chapter 6, Airfield Systems and Facilities (formerly Chapter 6, Navigation Aids (NAVAIDs) and On-airport Air Traffic Control Facilities (ATC-F)):

i. Consolidated information on NAVAIDs (Communications, Navigation, Surveillance and Weather (CSWN)) from other chapters.

ii. Contains information on systems and facilities only as it relates to airport design.

g. Removed former Chapter 7, Airfield Bridges and Tunnels.

h. Appendix A (formerly Appendix 1), Aircraft Characteristics:

i. Added new Figure A-3 on folding wingtip aircraft.

i. Appendix B (formerly Appendix 2), Wind Analysis:

i. Relocated Table B-1 on crosswind component from former Chapter 3.

j. Appendix D (formerly Appendix 4), End-Around-Taxiway (EAT) Screens:

i. Added evaluation by licensed engineer to establish structural integrity of the EAT Screen.

k. Appendix E (formerly Appendix 5, General Aviation Aprons and Hangars), General Aviation Facilities:

i. Relocated information from various areas of document on general aviation (GA) facilities to this appendix.

l. Appendix F (formerly Appendix 6, Compass Calibration Pad), Compass Calibration Pad Survey:

i. Consolidated information into this appendix.

ii. Moved runway historical and background information from former Chapter 3.

iii. Added Runway Object Clearing information.

m. New Appendix J (formerly Appendix 8, Taxiway Fillet Design), Taxiway Additional Information:

i. Describes examples of taxiway designs with elevated safety risks.

ii. Removed TDG 7. Separated TDG 2 into TDG 2A (Table J-3) and TDG 2B (Table J-4) and included these additional fillet design dimensions.

iii. Added paragraph J.4 containing a description of the methodology and calculations used for reductions in taxiway standards.

iv. Added reference to the Taxiway Fillet Design Tool available online at https://www.faa.gov/airports/engineering/airport_design/.

n. New Appendix L, Approach and Departure Reference Codes, containing former paragraph 323, Approach and Departure Reference Codes, and updated as follows:

i. Developed new Figure L-1 for ADG V-VI Departures.

ii. Updated Table L-1 on approach reference code.

iii. Relocated information from former Chapter 3.

2. Revised and updated figures throughout.

3. Updated the format of the document in this version and made minor editorial changes throughout.

6 Using this Document.

Hyperlinks (allowing the reader to access documents located on the internet and to maneuver within this document) are provided throughout this document identified by underlined text. When navigating within this document, return to the previously viewed page by pressing the "ALT" and " ←" keys simultaneously.

To aid in document navigation, users may add custom bookmarks to the bookmark panel list. Navigate to the location you want to bookmark. Highlight and select the text to appear on the bookmark, then click the "add bookmark" button at the top of the bookmark panel and edit the bookmark text as needed. New bookmarks appear at the end of the bookmark list, but you may drag and drop them to a preferred position.

Figures in this document are schematic representations and are not to scale.

7 Use of Metrics.

Throughout this AC, U.S. customary units are used followed with "soft" (rounded) conversion to metric units. The U.S. customary units govern.

8 Where to Find this AC.

You can view a list of all ACs at https://www.faa.gov/regulations_policies/advisory_circulars/. You can view the FAA Regulations at https://www.faa.gov/regulations_policies/faa_regulations/.

9 **Feedback on this AC.**

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback form at the end of this AC.

/signed/

John R. Dermody
Director of Airport Safety and Standards

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CHAPTER 1. Introduction

1.1 Policy.

The Federal Aviation Administration (FAA) has statutory authority to serve the public interest by developing a national aviation system for air commerce. Congress established it is within the public interest to assign, maintain, and enhance safety and security as the highest priorities in air commerce. See Title 49 United States Code (U.S.C.) § 40101(d)(1).

1.1.1 Airport Development.

It is the policy of the United States that the safe operation of the airport and airway system is the highest aviation priority. See 49 U.S.C. § 47101(a)(1). Among other responsibilities, the FAA's mission includes the development of airports to serve passengers and cargo in an efficient and effective manner that protects and enhances the natural resources and the quality of the environment of the United States. See 49 U.S.C. § 47101(a)(6).

1.2 Standards, Recommended Practices, and Requirements.

The promulgation of the standards and recommendations contained in this Advisory Circular (AC) advance the goals and objectives of the FAA's statutory authorities and the national policies established by Congress.

1.2.1 Meaning of Terms.

1.2.1.1 Standard.

A physical characteristic, quality, configuration, function, operation, or procedure established by the FAA as a benchmark for uniformity, safety, capacity, performance, economy, and environmental quality. The FAA's standards serve a prominent role in fulfilling the statutory objectives summarized in paragraph 1.1.1.

1.2.1.2 Recommended Practice.

Supplemental measures and guidelines the FAA recognizes as promoting safety, capacity, or efficiency. An airport has the discretion to implement a recommended practice to address a site-specific condition.

1.2.1.3 Requirement.

Mandatory language such as "must," "shall," "required," or "requirements," used in this AC describes obligations that originate in either Federal statutes or regulations. This AC does not establish or modify any statutory or regulatory requirements; it provides information regarding existing requirements under the law or agency policies.

1.2.1.4 **Design Consideration.**

Additional factors to take into account during airport design that may influence application of a standard or recommended practice.

1.2.2 Application of Airport Design Standards.

The standards and recommendations in this AC cover a wide range of size and performance characteristics of aircraft planned to operate at an airport. Airport development conforming to the standards of this AC establish an acceptable level of safety that ensures optimum operation of the critical aircraft (see paragraph 2.6.1) independent of individual operational controls that may affect the utility and efficiency of airport operations.

1.2.3 Operations Exceeding Airport Standards.

This AC does not prevent, regulate, or control the operation of aircraft at airports where the physical characteristics of the runways, taxiways, and aprons do not meet the standards provided herein for operation of a more demanding aircraft. While an aircraft operation exceeding airport standards is not inherently unsafe, such operations have the potential to introduce hazards and risks to the pilot or aircraft operator as well as to other aircraft, vehicles, individuals, and facilities on the airport.

1.2.3.1 Specific operational controls may be necessary in order to establish an acceptable level of safety for the operation of aircraft that exceed the standards at the airport. Consult with the appropriate FAA office (e.g., Airports, Flight Standards, Air Traffic Organization (ATO)) to identify potential adjustments to operational procedures that can accommodate these operations. Refer to AC 150/5000-17, *Critical Aircraft and Regular Use Determination*, for guidance related to critical aircraft.

1.3 Federal Regulations.

The following Federal regulations govern airport development. This list is not exhaustive.

1.3.1 14 CFR Part 77, *Safe, Efficient Use and Preservation of the Navigable Airspace*.

1.3.1.1 14 CFR Part 77 requires proponents of construction or alteration on or near an airport to give the FAA timely notification. This notification serves as the FAA's basis for evaluating the effect of the proposed construction or alteration on safety, air navigation, and airport traffic capacity at public use airports. The evaluation determines the level of obstruction marking and lighting and if additional measures are necessary for continued safety of air navigation.

1.3.1.2 The FAA Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) website https://oeaaa.faa.gov/oeaaa is available for electronic submission of this notice. FAA Order JO 7400.2, *Procedures for Handling Airspace Matters*, establishes the FAA's policy for processing airspace matters.

1.3.2 14 CFR Part 139, *Certification of Airports*.

Part 139 regulates airports, including joint-use airports, having scheduled air carrier operations with more than nine passenger seats or unscheduled air carrier operations with more than 30 passenger seats. This AC, along with other applicable ACs, contains methods and procedures that certificate holders may use to comply with Part 139 requirements.

1.3.3 14 CFR Part 157, *Notice of Construction, Alteration, Activation and Deactivation of Airports*.

Part 157 establishes standards and notification requirements for persons proposing to construct, alter, or deactivate a civil or joint-use (civil/military) airport. This regulation also addresses proposals that alter the status or use of an airport. This notification serves as the FAA's basis for evaluating the effects of the proposed action on the safe and efficient use of airspace by aircraft and the safety of persons and property on the ground. Notification allows the FAA to identify potential aeronautical hazards in advance, thus preventing or minimizing adverse impacts to the safe and efficient use of navigable airspace.

1.3.4 49 CFR Part 1542, *Airport Security*.

Part 1542 is a Transportation Security Administration regulation governing the security of airports that serve air carriers operating under security programs, per 49 CFR Part 1544, *Aircraft Operator Security: Air Carriers and Commercial Operators*, or 49 CFR Part 1546, *Foreign Air Carrier Security*. Compliance with Part 1542 satisfies the public protection requirements of § 139.335, *Public Protection*, from Part 139.

1.4 Environmental Protection.

The National Environmental Policy Act (NEPA) requires Federal agencies to consider the environmental effects of major Federal actions and their reasonable alternatives. Federal assistance for airport development projects and airport layout plan (ALP) approvals, where required by statute, are Federal actions that require the FAA to follow the procedures of NEPA. FAA compliance with NEPA is a legal requirement and aligns with the national policy of protecting and enhancing natural resources and the quality of the environment of the United States. For additional guidance and information, refer to the following FAA documents:

1. FAA Order 1050.1, *Environmental Impacts: Policies and Procedures*.
2. FAA Order 5050.4, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions.*

The circumstances in which the FAA must approve ALPs are addressed in 49 U.S.C. § 47101(a)(16).

1.5 Definitions.

1. *Accelerate-Stop Distance Available (ASDA).* See Declared Distances.

2. *Aeronautical Study.* Process by which the FAA determines the impact of an object on the safe and efficient use of airspace (see 14 CFR Part 77), or the impact of an airport proposal (see 14 CFR Part 157).

3. *Air Operations Area (AOA).*

   a. For 14 CFR Part 139 certificated airports, the air operations area is that portion of an airport in which security measures of 49 CFR Part 1540, *Civil Aviation Security: General Rules*, apply. This area includes aircraft movement areas, aircraft parking areas, loading ramps, and safety areas, for use by aircraft regulated under 49 CFR Part 1544, or 49 CFR Part 1546, and any adjacent areas (such as general aviation (GA) areas) that are not separated by adequate security systems, measures, or procedures (see 49 CFR § 1540.5).

   b. For non-Part 139 airports (e.g., GA airports), the air operations area is the paved and unpaved areas of an airport intended to facilitate aeronautical operations where local security measures apply. Typically, the air operations area encompasses that part of the airport within the perimeter fence.

4. *Air Traffic Control Facilities (ATC-F).* Electronic equipment and buildings aiding air traffic control (ATC) for communications and surveillance of aircraft including weather detection and advisory systems.

5. *Aircraft.* For this AC, the terms “aircraft” and “airplane” are synonymous, referring to all types of fixed-wing airplanes, including gliders. Unless specifically noted, these two terms exclude powered lift (tiltrotors) and single and dual rotor helicopters.

6. *Aircraft Approach Category (AAC).* As specified in 14 CFR § 97.3, *Symbols and Terms Used in Procedures*, a grouping of aircraft based on a reference landing speed (V_{REF}), if specified, or if V_{REF} is not specified, 1.3 times stall speed (V_{SO}) at the maximum certificated landing weight. V_{REF}, V_{SO}, and the maximum certificated landing weight are those values established for the aircraft by the certification authority of the country of registry. See Table 1-1.

7. *Airplane*. A fixed-wing aircraft that is heavier than air and supported by the dynamic reaction of the air against its wings (see Aircraft).

8. *Airplane Design Group (ADG).* A classification of aircraft based on wingspan and tail height. When the aircraft wingspan and tail height fall in different groups, the larger group applies. See Table 1-2.

9. *Airport Elevation.* The highest point on an airport’s usable runways expressed in feet above mean sea level (MSL).

10. *Airport Layout Plan (ALP).* A scaled drawing or set of drawings, in either hardcopy or electronic form, of existing and future airport facilities that provides a graphic representation of the existing and long-term development plan for the airport and demonstrates the preservation and continuity of safety, utility, and efficiency of the airport to the FAA’s satisfaction.

11. *Airport Reference Point (ARP).* The approximate geometric center of all usable runways at the airport.

12. *Airport.* An airport means an area used or intended to be used for the takeoff or landing of aircraft (14 CFR § 1.1).
13. *Aligned Taxiway.* A non-standard taxiway configuration with the centerline aligned with a runway centerline. Sometimes referred to as an "inline taxiway." Aligned taxiways represent a runway/taxiway configuration that increases the risk of a runway incursion.
14. *Approach Procedures with Vertical Guidance (APV).* An instrument approach based on a navigation system that provides course and glidepath deviation information but does not meet the precision approach standards of International Civil Aviation Organization (ICAO) Annex 10.
15. *Approach Reference Code (APRC).* A code signifying the current operational capabilities, within current standards, of a runway and associated parallel taxiway with regards to landing operations. See Appendix L.
16. *Approach Surface Baseline.* A horizontal line tangent to the surface of the earth at the runway threshold aligned with the final approach course.
17. *Blast Fence.* A barrier used to divert or dissipate jet blast or propeller wash.
18. *Blast Pad.* A surface adjacent to the ends of runways provided to reduce the erosive effect of jet blast and propeller wash.
19. *Building Restriction Line (BRL).* For planning considerations, a line identifying suitable and unsuitable locations for buildings on the airport.
20. *Bypass Taxiway.* An entrance taxiway used to manage aircraft queuing demand by providing multiple runway access points at or near a runway end or threshold.
21. *Category-I (CAT-I).* An instrument approach, or approach and landing, with a height above touchdown (HAT) or minimum descent altitude not lower than 200 ft (61 m) and with either a visibility not less than ½ statute mile (0.8 km), or a runway visual range not less than 1800 ft (549 m).
22. *Category-II (CAT-II).* An instrument approach, or approach and landing, with a HAT lower than 200 ft (61 m) but not lower than 100 ft (30.5 m) and a runway visual range not less than 1200 ft (366 m).
23. *Category-III (CAT-III).* An instrument approach, or approach and landing, with a HAT lower than 100 ft (30.5 m), or no HAT, or a runway visual range less than 1200 ft (366 m).
24. *Circling Approach.* A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or desirable.
25. *Clearway.* A defined rectangular area beyond the end of a runway cleared or suitable for use in lieu of a runway to satisfy takeoff distance requirements (see also Takeoff Distance Available (TODA)).
26. *Cockpit to Main Gear Distance (CMG).* The distance from the pilot's eye to the main gear turn center.

27. *Commercial Service Airport.* A public use airport receiving scheduled passenger aircraft service and at least 2,500 annual passenger boardings. Refer to the definition of Title 49 U.S.C. § 47102, *Definitions*.

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

29. *Critical Aircraft.* The critical aircraft is the most demanding aircraft type, or grouping of aircraft with similar physical and operational characteristics, that makes regular use of an airport. Regular use is 500 annual operations, excluding touch-and-go operations. See AC 150/5000-17. The critical aircraft determines the applicable design standards for facilities on the airport including individual runways, taxiways, etc. Previously referred to as "design aircraft."

30. *Crossover Taxiway.* A taxiway connecting two parallel taxiways (also referred to as a "transverse taxiway").

31. *Decision Altitude (DA).* A specified altitude on a vertically-guided approach at which a pilot initiates a missed approach if the pilot cannot establish the required visual reference to continue the approach. Values for DA reference MSL as the datum.

32. *Declared Distances.* The distances declared available for an aircraft's takeoff run, takeoff distance, accelerate-stop distance, and landing distance requirements. The distances are:

    a. *Takeoff Run Available (TORA)* – the runway length declared available and suitable for the ground run of an aircraft taking off;

    b. *Takeoff Distance Available (TODA)* – the TORA plus the length of any remaining runway or clearway beyond the far end of the TORA; the full length of TODA may need to be reduced because of obstacles in the departure area;

    c. *Accelerate-Stop Distance Available (ASDA)* – the runway plus stopway length declared available and suitable for the acceleration and deceleration of an aircraft aborting a takeoff; and

    d. *Landing Distance Available (LDA)* – the runway length declared available and suitable for landing an aircraft.

33. *Departure End of Runway (DER).* The end of the runway that is opposite the landing threshold.

34. *Departure Reference Code (DPRC).* A code signifying the current operational capabilities, within current standards, of a runway with regard to takeoff operations. See Appendix K.

35. *Displaced Threshold.* A threshold that is located at a point on the runway beyond the beginning of the runway. See Threshold.

36. *End-Around Taxiway (EAT).* A taxiway crossing the extended centerline of a runway and designed for free flow without specific clearance from ATC.

37. *Entrance Taxiway*. A taxiway designed for use by an aircraft for direct entry to a runway. An entrance taxiway may also serve as an exit from the runway.

38. *Exit Taxiway*. A taxiway designed for aircraft exit-only from a runway:

    a. *Acute-Angled Exit Taxiway* – A taxiway forming an angle less than 90 degrees from the runway centerline.

    b. *High Speed Exit Taxiway* – Also known as rapid exit taxiway, an acute-angled exit taxiway forming a 30-degree angle with the runway centerline, designed to allow aircraft to exit a runway quickly without having to decelerate to typical taxi speed.

39. *Fixed-By-Function Navigational Aid (NAVAID)*. An air navigational aid positioned in a specific location in order to provide an essential benefit for aviation is fixed-by-function. Table 6-1 gives fixed-by-function designations for various NAVAIDs as they relate to the Runway Safety Area (RSA) and Runway Object Free Area (ROFA).

40. *Frangible*. A physical characteristic whereby an object retains its structural integrity and stiffness up to a designated maximum load, but upon impact from a greater load, breaks, distorts, or yields in such a manner as to present the minimum hazard to aircraft. See AC 150/5220-23, *Frangible Connections*.

41. *General Aviation (GA)*. Per the Pilot/Controller Glossary, that portion of civil aviation that does not include scheduled or unscheduled air carriers or commercial space operations.

42. *General Aviation (GA) Airport*. A public-use airport that: 1) does not have scheduled service, or 2) has scheduled service with less than 2,500 annual passenger boardings. See 49 U.S.C. § 47102. FAA Report, *General Aviation Airports: A National Asset – May 2012*, establishes the following classifications of general aviation airports: national, regional, local, and basic.

43. *Glidepath Angle (GPA)*. The GPA is the angle of the final approach descent path relative to the approach surface baseline.

44. *Glide Slope (GS)*. Equipment in an Instrument Landing System (ILS) that provides electronic vertical guidance to landing aircraft.

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

46. *Height Above Airport (HAA)*. The height of the circling approach minimum descent altitude (MDA) above the airport elevation.

47. *Height Above Touchdown (HAT)*. The height of the Decision Height or MDA above the highest runway elevation in the touchdown zone (first 3,000 feet (914 m) of the runway). Instrument approach charts publish the HAT in conjunction with all straight-in minimums.

48. *High-energy area/intersection.* An area or intersection within the middle third of a runway.

49. *Hot Spot.* A location on an airport movement area with a history of potential risk of a collision or runway incursion. Heightened attention by pilots/drivers/controllers is necessary when maneuvering through a hot spot.

50. *International Civil Aviation Organization (ICAO).* ICAO is a United Nations specialized agency that manages the administration and governance of the Convention on International Civil Aviation. ICAO works with its Member States and industry groups to reach consensus on international civil aviation standards, recommended practices, and policies in support of a safe, efficient, secure, economically sustainable, and environmentally responsible civil aviation sector.

51. *Instrument Departure Runway.* A runway identified by the airport operator, through the appropriate FAA Airports Office, to the FAA Regional Airspace Procedures Team intended primarily for instrument departures.

52. *Instrument Flight Procedure (IFP).* An instrument flight procedure is a series of predetermined maneuvers for aircraft operating under instrument flight rules, e.g., instrument flight rules (IFR) conditions, when visual flight is not possible due to weather or other visually restrictive conditions. These maneuvers allow for the orderly transition of the aircraft through a particular airspace. The term "instrument flight procedure" refers to instrument approaches, instrument departures, and instrument en route operations.

53. *Island.* A non-serviceable paved or grassy area bounded by a taxiway, taxilane, or apron pavement.

54. *Joint-Use Airport*. An airport owned by the Department of Defense (DoD) at which both military and civilian aircraft make shared use of the airfield. Refer to 14 CFR Part 139.

55. *Landing Distance Available (LDA).* See Declared Distances.

56. *Large Aircraft.* An aircraft with a maximum certificated takeoff weight of more than 12,500 lbs (5,669 kg).

57. *Low Impact Resistant (LIR) Support.* A support designed to resist operational and environmental static loads and fail when subjected to a shock load such as that from a colliding aircraft.

58. *Main Gear Width (MGW).* The distance from outer edge to outer edge of the widest set of main gear tires.

59. *Minimum Descent Altitude (MDA).* The lowest altitude, expressed in feet above MSL, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard IFP where no electronic glide slope is provided.

60. *Modification of Standards.* Any approved deviation from published FAA standards applicable to an airport design, construction, or equipment project that is necessary to accommodate an unusual local condition for a specific project while maintaining

an acceptable level of safety and performance. FAA Order 5300.1 establishes FAA policy for administering requests for modification of standards.

61. *Movement Area.* An area at a towered airport designated by the Airport Traffic Control Tower (ATCT) for positive control of aircraft, vehicles, and personnel. The movement area consists of runways, taxiways, and other select areas of an airport (e.g., taxilanes) used for taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and aircraft parking areas. A movement area can include area for the operation of helicopters and tiltrotors. See 14 CFR Part 139.

62. *Navigational Aid (NAVAID)*. Electronic and visual air navigational aids, lights, signs, and associated supporting equipment.

63. *Non-movement area*. The areas of an airport that are used for taxiing, hover taxiing, or air taxiing aircraft including helicopters and tiltrotors, but are not part of the movement area (e.g., the loading aprons and aircraft parking areas).

64. *Non-Precision Approach (NPA).* An instrument approach based on a navigation system that provides course deviation information, but no glidepath deviation information.

65. *Non-Precision Runway.* A runway other than a precision runway with at least one end having a non-precision approach procedure.

66. *Object.* Includes, but is not limited to, above-ground structures, NAVAIDs, equipment, vehicles, natural growth, terrain, and parked or taxiing aircraft.

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

68. *Obstacle.* An existing object at a fixed geographical location or a planned object at a fixed location within a prescribed area with reference to which vertical clearance is necessary during flight operation.

69. *Obstacle Free Zone (OFZ).* The OFZ is the three-dimensional airspace along the runway and extended runway centerline that is clear of obstacles for the protection of aircraft landing or taking off from the runway and for missed approaches. The OFZ consists of four distinct surfaces: Runway OFZ, Precision OFZ, Inner-Transitional OFZ, and the Inner-Approach OFZ.

70. *Obstruction to Air Navigation.* An object of greater height than any of the heights or surfaces presented in Subpart C of Title 14 CFR Part 77, *Standards for Determining Obstructions to Air Navigation or Navigational Aids or Facilities*.

71. *Offset approach*. An approach conducted at an angle offset from the runway centerline. A typical offset approach is 3 degrees to the right or left of the straight in runway heading.

72. *Parallel Taxiway.* A continuous taxiway path located laterally to the runway it serves, providing access to one or both runway ends without entering the runway

safety area (RSA) or runway OFZ; it is not necessary for all points along the centerline of a parallel taxiway to be equidistant from the runway centerline.

a. *Dual Parallel Taxiways* – Two side-by-side taxiways, parallel to each other and the runway (usually called inner parallel and outer parallel taxiway relative to the runway being served).

b. *Full Parallel Taxiway* – A parallel taxiway extending the full length of the runway to provide access to both runway ends.

c. *Partial Parallel Taxiway* – A parallel taxiway extending less than the full length of the runway to provide access to only one runway end.

73. *Plans-on-File*. Plans-on-file represent the airport's future airfield development including, but not limited to, runway extensions or construction of taxiways. Obligated airports submit their plans-on-file to the FAA by way of their ALP or submit through FAA Form 7460-1, *Notice of Proposed Construction or Alteration*; whereas non-obligated airports submit through FAA Form 7480-1, *Notice for Construction, Alteration and Deactivation of Airports*, in accordance with 14 CFR Part 157.

74. *Precision Approach (PA).* An instrument approach based on a navigation system that provides course and glidepath deviation information meeting the precision standards of ICAO Annex 10.

75. *Precision Runway*. A runway with at least one end having a precision approach procedure.

76. *Primary Airport (large hub, medium hub, small hub, non-hub)*. A commercial service airport with 10,000 annual passenger boardings. See 49 U.S.C. § 47102.

77. *Public Use Airport.* An airport used for public purposes that is 1) under control of or owned by a public agency, or 2) under private ownership that is a reliever airport or has scheduled passenger service with at least 2,500 annual passenger boardings. See 49 U.S.C. § 47102.

78. *Regular Use*. As defined in AC 150/5000-17, regular use is 500 annual operations, including both itinerant and local operations, but excluding touch-and-go operations. An operation is either a takeoff or landing.

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

80. *Runway Design Code (RDC).* A code signifying the design standards that apply to an existing or planned runway.

81. *Runway Incursion.* Any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft.

82. *Runway Protection Zone (RPZ).* An area at ground level prior to the threshold or beyond the runway end to enhance the safety and protection of people and property on the ground.

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

84. *Runway Visual Range (RVR).* An instrumentally derived value that represents the horizontal visual range a pilot sees down the runway from the approach end. It is based on the sighting of either HIRL or on the visual contrast of other targets, whichever yields the greater visual range. RVR, in contrast to prevailing or runway visibility, is based on what a pilot in a moving aircraft should see looking down the runway.

85. *Shoulder.* An area adjacent to the defined edge of paved runways, taxiways, or aprons designed to:

    a. transition between the pavement and the adjacent surface,

    b. support aircraft and emergency vehicles deviating from the full-strength pavement,

    c. facilitate drainage, and

    d. provide blast protection.

86. *Small Aircraft.* For the purpose of this AC, an aircraft with a maximum certificated takeoff weight of 12,500 lbs (5669 kg) or less (14 CFR § 1.1).

87. *Stopway.* An area beyond the takeoff runway, no less wide than the runway and centered upon the extended centerline of the runway, able to support the airplane during an aborted takeoff, without causing structural damage to the airplane, and designated by the airport for use in decelerating the airplane during an aborted takeoff.

88. *Takeoff Distance Available (TODA).* See Declared Distances.

89. *Takeoff Run Available (TORA).* See Declared Distances.

90. *Taxilane (TL).* A defined taxi path designed for low speed and precise maneuvering of aircraft. Taxilanes provide access from a taxiway to aircraft parking positions and other terminal areas. Taxi speeds on taxilanes are generally not more than 15 mph (13 kts).

91. *Taxiway (TW).* A defined path established for the taxiing of aircraft from one part of an airport to another. Taxi speeds on taxiways will typically range from 15 mph (13 kts) to 35 mph (30 kts).

92. *Taxiway Centerline.* A surface painted marking on the taxiway that provides continuous visual reference for pilot steering of aircraft during taxi operations. On straight taxiway sections, the taxiway centerline represents the physical center of the taxiway width. On curved taxiway sections, the taxiway centerline represents the optimum steering path even though the marking itself may not be located at the physical center of the pavement section.

93. *Taxiway Design Group (TDG).* A classification of airplanes based on outer-to-outer MGW and CMG distance.

94. *Taxiway Edge Safety Margin (TESM).* The distance between the outer edge of the landing gear of an airplane with its nose gear on the taxiway centerline and the edge of the taxiway pavement.

95. *Taxiway Object Free Area (TOFA).* See paragraph 67.

96. *Taxiway/Taxilane Safety Area (TSA).* A defined surface on both sides of the taxiway prepared and suitable for reducing the risk of damage to aircraft deviating from the pavement and for supporting passage of aircraft rescue and fire fighting (ARFF) equipment.

97. *Threshold (TH).* The beginning of that portion of the runway available for landing. A displaced threshold is located along the runway apart from the physical end of the runway. "Threshold" always refers to landing, not the start of takeoff.

98. *Threshold Crossing Height (TCH).* The height of the glidepath above the threshold of the runway, measured in feet.

99. *Touchdown Zone (TDZ).* The first 3,000 feet (914 m) of the runway beginning at the threshold. The area is used for determination of the Touchdown Zone Elevation in the development of straight-in landing minimums for instrument approaches.

100. V_1. The maximum speed during takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. V_1 also means the minimum speed during takeoff, following a failure of the critical engine at Velocity Engine Failure (V_{EF}), at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance. See 14 CFR Part 1, *Definitions and Abbreviations*.

101. *Visibility Minimums.* The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night. Visibility reports are in units of statute miles or hundreds of feet.

102. *Visual Runway.* A runway without an instrument approach or departure procedure. For the purpose of this AC, consider runways with circling-only approaches as visual runways.

103. *Wingspan*. The maximum horizontal distance from one wingtip to the other wingtip, including the horizontal component of any extensions such as winglets or raked wingtips. See Appendix A.

1.6 Categories and Codes.

1.6.1 Aircraft Approach Categories (AAC).

A grouping of aircraft related to aircraft approach speed (operational characteristic), per Table 1-1. Operational Specifications and/or Flight Standardization Board Reports applicable to specific operators and aircraft types may specify the AAC per 14 CFR §

97.3, which applies for airport design purposes in this AC. Such operators and aircraft types fall under:

- 14 CFR Part 121, *Operating Requirements: Domestic, Flag, and Supplemental Operations*,
- 14 CFR Part 129, *Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage*, or
- 14 CFR Part 135, *Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft*

Table 1-1. Aircraft Approach Category (AAC)

AAC	V_{REF}/Approach Speed
A	Approach speed less than 91 knots
B	Approach speed 91 knots or more but less than 121 knots
C	Approach speed 121 knots or more but less than 141 knots
D	Approach speed 141 knots or more but less than 166 knots
E	Approach speed 166 knots or more

1.6.2 Airplane Design Group (ADG).

A grouping of aircraft related to aircraft wingspan or tail height (physical characteristics), whichever is most restrictive. Refer to Table 1-2.

Table 1-2. Airplane Design Group (ADG)

Group #	Tail Height	Wingspan
I	< 20 ft (< 6.1 m)	< 49 ft (< 14.9 m)
II	20 ft to < 30 ft (6.1 m to < 9.1 m)	49 ft to < 79 ft (14.9 m to < 24.1 m)
III	30 ft to < 45 ft (9.1 m to < 13.7 m)	79 ft to < 118 ft (24.1 m to < 36.0 m)
IV	45 ft to < 60 ft (13.7 m to < 18.3 m)	118 ft to < 171 ft (36.0 m to < 52.1 m)
V	60 ft to < 66 ft (18.3 m to < 20.1 m)	171 ft to < 214 ft (52.1 m to < 65.2 m)
VI	66 ft to < 80 ft (20.1 m to < 24.4 m)	214 ft to < 262 ft (65.2 m to < 79.9 m)

1.6.3 Visibility Minimums.

The runway's lowest visibility published on an instrument approach chart expressed by RVR values of 1,200 ft (366 m), 1,600 ft (488 m), 2,400 ft (732 m), 4,000 ft (1,219 m),

and 5,000 ft (1,524 m), per Table 1-3. For a visual approach only runway, use "VIS" in lieu of an RVR value.

Table 1-3. Visibility Minimums

RVR *	Instrument Flight Visibility Category (statute mile)
5,000 ft (1,524 m)	Not lower than 1 mile (1.6 km)
4,000 ft (1,219 m)	Lower than 1 mile (1.6 km) but not lower than ¾ mile (1.2 km)
2,400 ft (732 m)	Lower than ¾ mile (1.2 km) but not lower than ½ mile (0.8 km)
1,600 ft (488 m)	Lower than ½ mile (0.8 km) but not lower than ¼ mile (0.4 km)
1,200 ft (366 m)	Lower than ¼ mile (0.4 km)

Note: * RVR values are not exact equivalents.

1.6.4 Runway Design Code (RDC).

The RDC is a three-component code relating AAC, ADG, and approach visibility minimums establishing the design characteristics for a particular runway. The critical aircraft with regular use defines the AAC and ADG components of the RDC, whereas the runway's lowest visibility published on an instrument approach chart determines the visibility component. The RDC convention is as follows:

RDC: AAC-ADG-RVR

Example: D-IV-1200

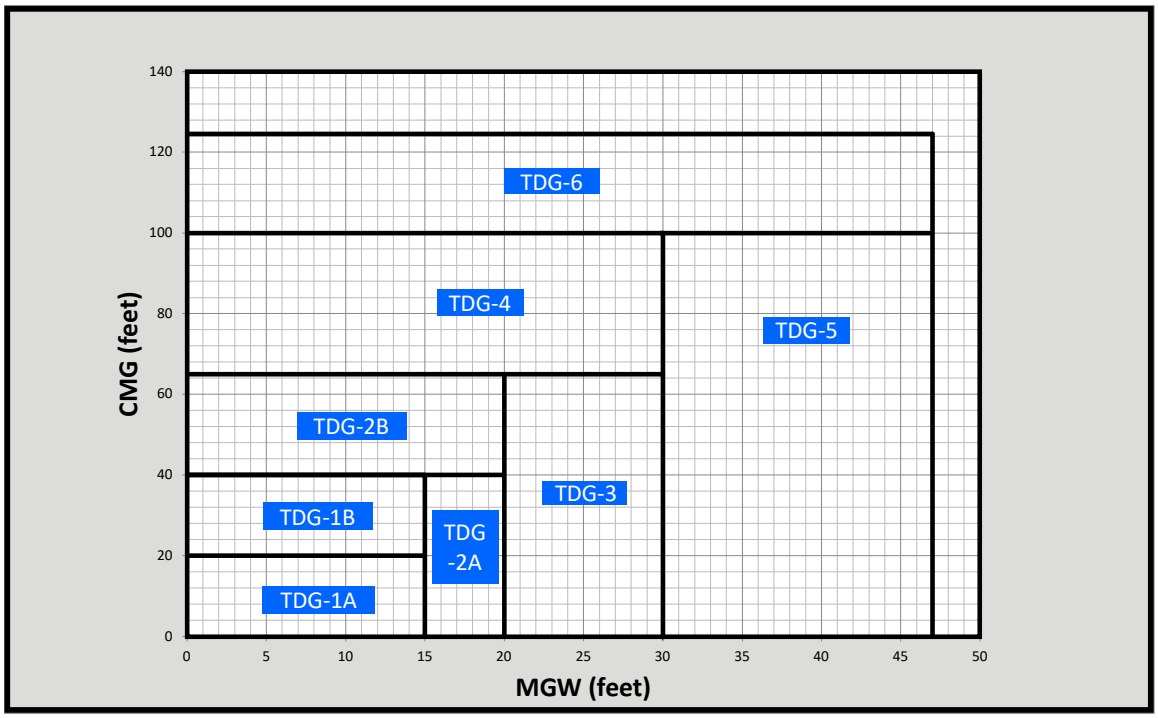
1.6.4.1 **Application.**

The RDC establishes the standards that apply to a specific runway, existing or future. This can vary per runway. For example, an airport's air carrier runway may have an RDC of C-IV-1200. The same airport's GA runway may have an RDC of B-II-2400. The airport's ALP may show both an existing RDC and future RDC.

1.6.5 Taxiway Design Group (TDG).

A TDG is the grouping of aircraft based on undercarriage dimensions. TDG relates the cockpit to main gear dimension and the width of the main gear. The TDG is a primary design factor for taxiway/taxilane width and fillet standards. Separate areas of an airport may have different TDG classifications due to segregation of aircraft types, sizes, and operations. See Figure 1-1 and Table 1-4 for general reference. Tail wheel aircraft maneuver differently than aircraft with tradition tricycle landing gear. This AC does not cover designs based on tail wheel aircraft.

Figure 1-1. Taxiway Design Groups (TDGs)



Note: Values for CMG and MGW in the graph are rounded to the nearest foot. 1 foot = 0.305 meters.

Table 1-4. TDG Table

	TDG (feet)							
	1A	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**
CMG	0 to ≤ 20	> 20 to ≤ 40	0 to ≤ 40	> 40 to ≤ 65	0 to ≤ 65	> 65 to ≤ 100	0 to ≤ 100	> 100 to ≤ 125
MGW	0 to ≤ 15	0 to ≤ 15	> 15 to ≤ 20	0 to ≤ 20	> 20 to ≤ 30	0 to ≤ 30	> 30 to ≤ 47	0 to ≤ 47

Note: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.

1.7 Airport Layout Plan (ALP).

An ALP is a graphic representation of existing facilities and proposed development plans for an airport. Airports that receive certain types of Federal assistance accept a grant assurance that obligates them to maintain a current ALP. See paragraph 1.9.1 for additional information on Federal obligations. Refer to the FAA's Office of Airport Planning and Environmental (APP-400) guidance for additional information on developing ALPs.

1.8 Airport Data.

Airport planning, design, and evaluation activities involve collection of information that accurately describes the location, characteristics, and condition of airport facilities, infrastructure, and off-airport structures. This information also consists of geospatial data collected during the planning, design, and construction phase of airport development. It is paramount for airport operators to accurately collect and report safety-critical data to the FAA in a timely manner. Refer to AC 150/5300-18, *General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards,* for calculation requirements and further guidance.

1.8.1 Airport Reference Point (ARP).

The approximate geometric center of all usable runways. The ARP is not typically monumented on the airport.

1.8.2 Aeronautical Studies.

The FAA conducts aeronautical studies of proposed development on and adjacent to airports under 14 CFR Part 77, as described in paragraph 1.1. These studies assess the potential impact proposed development has on air navigation based on the best available data and plans on file. Physical changes to airport elements can adversely affect the accuracy of such studies. The FAA encourages airport operators to submit airfield changes to the FAA as soon as an airport plans changes. This includes timely submittal of ALP updates ensuring the FAA has the latest data on actual and planned facilities for the following elements:

1. Runway ends
2. Displaced thresholds
3. High and low points on the runway surfaces
4. Helipads

1.8.3 Airport Master Record.

The Airport Master Record, also known as FAA Form 5010 (see https://adip.faa.gov), describes the basic operational and services data of an airport. The primary purpose of the Airport Master Record is to identify the minimum data and information about the existing physical infrastructure, characteristics, services, operations, and status of all airports composing the National Airspace System (NAS). Title 49 U.S.C. § 47130, *Airport Safety Data Collection*, authorizes the FAA to collect and manage this data.

1.8.3.1 The FAA uses this data for flight information publications, navigation databases, and various analyses. Airport operators, FAA inspectors, and state-sponsored inspectors may collect and submit data for the Master Record.

1.8.3.2 Timely collection and submittal of data reflecting changed conditions enhances the accuracy of aeronautical information. Refer to AC 150/5300-19, *Airport Data and Information Program*, for additional guidance and information.

1.8.4 Aeronautical Surveys.

The FAA uses aeronautical survey data for designing and evaluating an IFP. The FAA reviews all IFPs periodically – approximately every two years. The FAA uses this data, in part, to:

1. Protect existing runway approaches from proposed development and discover obstacles that could create a hazard to air navigation by:
   a. Raising approach minima,
   b. Restricting night operations, or
   c. Cancelling approach procedures.
2. Provide for the design and development of new IFPs to the lowest visibility minimums possible,
3. Provide accurate information for planning studies that assess the impact of airport noise, and
4. Ensure that review and coordination of on-airport development proposals maintain critical clearance standards for the completed project.

1.8.4.1 **Applicable ACs.**

1. AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey.*
2. AC 150/5300-17, *Standards for Using Remote Sensing Technologies in Airport Surveys.*
3. AC 150/5300-18, *General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards.*

1.8.5 Plans-on-File.

The information on file with the FAA influences the determination resulting from aeronautical studies. Having an up-to-date plan-on-file with the FAA ensures proposed airport development receives full consideration during FAA studies. An update to the ALP is the conventional method to transmit development information. Filing notification of proposed development represents another method of establishing a plan-on-file. Keeping plan-on-file data and information current, complete, and accurate greatly improves the effectiveness of FAA evaluations. For any new runway, runway extension, or planned runway upgrade, at a minimum the plan data includes:

1. Planned runway end and threshold coordinates and elevation

2. Proposed type of instrument approach
3. Desired visibility minimum(s)
4. Indication of whether the airport will have a designated instrument departure runway.

1.9 Airport Improvement Program (AIP).

Title 49 U.S.C. § 47104, *Project Grant Authority*, authorizes the FAA to administer a grant program that provides financial assistance to public use airports for airport planning and development. Refer to paragraph 3 for applicability of the standards of this AC to projects funded by the Airport Improvement Program or other applicable grant programs. Refer to FAA Order 5100.38, *Airport Improvement Program Handbook*, or contact the local FAA Airports District Office (ADO) for information on matters concerning project eligibility. This AC does not establish, modify, or address project eligibility under any FAA grant program.

1.9.1 Obligations.

Airport sponsors agree to certain obligations as a condition for the grant of Federal funds or the conveyance of Federal property for airport purposes. Conformance to the FAA standards in this AC are a factor in determining an airport's compliance with select obligations. The FAA enforces these obligations through its Airport Compliance Program. Refer to FAA Order 5190.6, *FAA Airport Compliance Manual*, for additional information on the Airport Compliance Program. For a complete list of assurance obligations, visit the FAA Grant Assurances webpage.

1.10 State Role.

Each state has an aeronautical office, or similar department, that oversees civil aviation activities in that state. The degree of involvement varies among states. Typical state activities include:

1. Maintaining state aviation system plans
2. Conducting airport inspections
3. Updating Airport Master Records (FAA Form 5010)
4. Working with local agencies on airport zoning and environmental matters
5. Providing supplemental financial assistance
6. Protecting environmental resources
7. Promoting aviation education
8. Licensing of airports

1.10.1 State Block Grant Program.

States participating in the State Block Grant Program (SBGP), under 49 U.S.C. § 47128, *State Block Grant Program*, assume responsibility for administering AIP

grants at nonprimary airports. The FAA and each participating state enter into a memorandum of agreement identifying the scope of the agreement and the relative responsibilities of the program. See AC 150/5100-21, *State Block Grant Program*, for further guidance.

1.10.2 State Standards.

In limited circumstances, the FAA approves standards developed by a State for development of non-primary airports.

1.10.2.1 Title 49 U.S.C. § 47105(c), *State Standards for Airport Development*, allows the FAA to approve standards a State prescribes for airport development at non-primary airports. This provision excludes the FAA standards for safety of approaches. Once approved by the FAA, the State's standards apply instead of comparable FAA standards.

1.10.2.2 Title 49 U.S.C. § 47114(d)(5), *Use of State Highway Specifications*, prescribes the use of State highway specifications for airfield pavement construction at nonprimary airports serving aircraft not exceeding 60,000 pounds gross weight, provided the FAA determines safety is not adversely affected and the expected service life of pavement is not less than what FAA standards provide. Refer to AC 150/5100-13, *Development of State Aviation Standards for Airport Pavement Construction*, for additional details.

1.11 Local Government Role.

A local government is responsible for the maintenance and operation of the airport it owns or operates. Local government units may have regulations and ordinances affecting airport development and operation. Many local governmental units establish zoning ordinances that benefit the protection of airspace surrounding an airport and persons residing close to an airport. Additionally, local rules may exist for storm water management, building codes, and fire code.

1.12 Related Documents and Federal Regulations.

The following are links to comprehensive lists of documents referenced in this AC and additional related information. Unless otherwise stated, non-FAA documents do not supersede FAA regulations, policies or standards. All references to ACs, FAA Orders, and other relevant FAA guidance within this document are to the most recent versions.

1. Advisory Circulars (ACs) are available at https://www.faa.gov/regulations_policies/advisory_circulars/.
2. FAA Orders are available at https://www.faa.gov/regulations_policies/orders_notices/.
3. Federal Regulations are available at https://www.ecfr.gov/.
4. United States Code (U.S.C.) is available at https://www.govinfo.gov/.

5. FAA Forms are available at https://www.faa.gov/forms/.

6. Other FAA Documents.

   a. *Aeronautical Information Manual (AIM)*, https://www.faa.gov/air_traffic/publications/.

   b. *Aeronautical Information Publication*, https://www.faa.gov/air_traffic/publications/atpubs/aip_html/index.html.

   c. *U.S. Chart Supplement (formerly known as Airport/Facility Directory)*, https://www.faa.gov/air_traffic/flight_info/aeronav/productcatalog/supplementalcharts/AirportDirectory/.

   d. FAA Airport Diagrams, https://adip.faa.gov.

   e. FAA-H-8083, *Glider Flying Handbook.*

   f. FAA/USDA manual, *Wildlife Hazard Management at Airports*, https://www.faa.gov/airports/airport_safety/wildlife/resources.

   g. Grant Assurances – Airport Sponsors, https://www.faa.gov/airports/aip/grant_assurances.

7. Non-FAA Documents.

   a. Aircraft Owners and Pilots Association (AOPA), *Hangar Development Guide*, https://www.aopa.org/-/media/Files/AOPA/Home/Supporting-General-Aviation/Get-Involved/Airport-Support-Network/Airport-Support-Network-Aircraft-Hangar-Development-Guide/hangar-planning.pdf.

   b. Airport Cooperative Research Program (ACRP) Reports, http://onlinepubs.trb.org/onlinepubs/acrp/.

   c. American Association of State Highway and Transportation Officials (AASHTO), https://www.transportation.org/, M268, *Standard Specification for Retroreflective Sheeting for Flat and Vertical Traffic Control Applications*.

   d. ASTM International D4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, https://www.astm.org/Standards/D4956.htm.

   e. ASTM International E810, *Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry*, https://www.astm.org/Standards/E810.htm.

   f. Federal Specification FP-14, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects*, https://highways.dot.gov/federal-lands/specs/archives.

   g. International Air Transport Association (IATA), *Airport Development Reference Manual (ADRM)*, https://www.iata.org/.

   h. NASA/Aviation Safety Reporting System (ASRS) Directline Issue No. 6, August 1993, *Ground Jet Blast Hazard*, https://asrs.arc.nasa.gov/publications/directline/dl6_blast.htm.

i. National Fire Protection Association (NFPA) 407, *Standard for Aircraft Fuel Servicing*, NFPA Catalog Home.

j. NFPA 409, *Standard on Aircraft Hangars*, NFPA Catalog Home.

k. NFPA 415, *Standard on Airport Terminal Building, Fueling Ramp Drainage, and Loading Walkways*, NFPA Catalog Home.

l. Transportation Security Administration document, *Recommended Security Guidelines for Airport Planning and Construction*, https://www.sskies.org/images/uploads/subpage/PARAS_0004.Recommended_Security_Guidelines_.FinalReport_.v2_.pdf.

m. Transportation Security Administration Information Publication A-001, *Security Guidelines for General Aviation Airports*, https://www.tsa.gov/sites/default/files/2017_ga_security_guidelines.pdf.

n. United States Parachute Association (USPA), *Basic Safety Requirements (BSR)*, https://uspa.org/.

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CHAPTER 2. Design Principles

2.1 General.

Airport design involves identifying aviation demand at an airport and applying FAA standards to the various airport elements. Effective airport design ensures airport development meets aviation needs and environmental considerations while maintaining acceptable levels of safety, efficiency, and capacity.

2.2 Airport Planning Relationship to Airport Design.

2.2.1 Airport design and airport planning are complementary processes. Airport planning provides a framework to guide future airport development. Airport design incorporates FAA design standards in a manner that addresses existing and future airport needs and demands.

2.2.2 The ALP graphically depicts existing airport facilities and infrastructure, as well as proposed development.

2.2.3 Related planning guidance:

1. AC 150/5000-17, *Critical Aircraft and Regular Use Determination.*
2. AC 150/5020-1, *Noise Control and Compatibility Planning for Airports.*
3. AC 150/5060-5, *Airport Capacity and Delay.*
4. AC 150/5070-6, *Airport Master Plans.*

2.3 Present Needs Versus Future Demand.

2.3.1 The application of airport planning and design criteria has future implications. Airport designs based only on aircraft currently using the airport can severely limit the airport's ability to accommodate future operations of more demanding aircraft. Conversely, it is not practical or economical to base airport design on aircraft that will not realistically use the airport. Refer to AC 150/5000-17 for guidance related to critical aircraft.

2.3.2 A key factor to consider during airport design is the spatial relationship between a runway and other airport elements such as taxiways, aprons, and airfield structures. This relationship can affect future growth at the airport. Once constructed, it is very costly to relocate airfield infrastructure that conflicts with the operation of more demanding aircraft. Established infrastructure may preclude the airport from benefitting from improved approach procedures.

2.3.3 To limit constraints to future airport development, consider the separation standards for the next most demanding ADG, AAC, TDG, and approach visibility minimums during current airport design activities. Also consider the OFZ needed for aircraft that exceed

the RDC (that will use the runway with less than regular use) in order to avoid possible operational controls. See Appendix M.

2.4 Addressing Non-standard Airport Conditions.

The FAA expects airport owners to address non-standard conditions through the airport planning process. The FAA acknowledges that conformance to current standards is not always practical. However, the FAA expects airports to continue to investigate mitigation measures, whether in one or multiple phases, and correct the non-standard conditions over time.

1. The FAA expects implementation of new or revised standards to occur through the planning process.
2. If there is an explicit or immediate safety deficiency for a non-standard condition, the FAA expects airport owners to prioritize the mitigation of the safety deficiency using the current standard.
3. Inconvenience does not represent an acceptable justification for non-conformance to standards.
4. Justifications based on impractical conditions do not represent a permanent justification for non-conformance to standards.

2.5 New Construction, Reconstruction, and Rehabilitation.

2.5.1 For airport projects involving new construction or reconstruction, the FAA expects airport owners to meet the FAA standards described in this AC. For the purpose of this AC, reconstruction represents a complete restoration of the original functionality of the facility, resulting in development with a minimum useful life equal to new construction. FAA Order 5100.38 establishes FAA policy on minimum useful life of development funded under the AIP.

2.5.2 For rehabilitation projects, the FAA expects airport owners to meet the FAA standards to the extent practicable. If it is not practical to meet current standards, the FAA expects the airport to develop a plan to meet the standards in the future, per paragraph 2.4. For the purpose of this AC, rehabilitation is a restoration of an original functionality of the facility, resulting in a useful life at least equal to half the minimum useful life of new construction. FAA Order 5100.38 establishes FAA policy on minimum useful life of development funded under the AIP.

2.6 Design Process.

The airport design process involves a series of steps that align current airport needs with appropriate development satisfying these needs, taking into consideration safety, capacity, economics, and the environment. The steps generally include the following:

1. Identify critical aircraft (size and AAC, ADG, and TDG).

2. Identify reasonably attainable visibility minimums.
3. Establish applicable RDC.
4. Apply appropriate design standards contained in this AC.

2.6.1 Critical Aircraft.

As defined in AC 150/5000-17, the critical aircraft is the most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of the airport. Regular use is 500 annual operations including both itinerant and local operations but excluding touch-and-go operations. The critical aircraft enables airport planners and engineers to design the airport to meet the operational needs of the aircraft while applying the applicable standards. The critical aircraft is a single aircraft or a composite of several different aircraft with similar characteristics per logical groupings of AAC, ADG, and TDG, as defined in AC 150/5000-17. Unless otherwise stated in AC 150/5000-17, apply the critical aircraft criteria for the appropriate design standard. Table M-3 in Appendix M relates characteristics to various design components. Refer to AC 150/5000-17 for FAA guidance. Regular-use criteria apply to the determination of the critical aircraft.

2.6.2 Design Precedence.

The FAA acknowledges that during planning and design processes, space constraints may limit the ability to meet safety standards while providing the desired flexibility of airport operations. These safety standards include:

1. Safety areas
2. OFAs
3. Runway OFZ surfaces
4. Terminal Instrument Procedures (TERPS) surfaces
5. Separation standards
6. 14 CFR Part 139 requirements

These standards have precedence over lower-priority airport operational areas such as Remain-Over-Night (RON) parking locations, vehicle service roads, ground service equipment storage, and vehicle parking.

2.6.3 Considerations for Visibility Minimums.

Although desirable, lower visibility minimums will result in more restrictive design factors such as obstacle limitations and increased separation criteria. Factors determining approach visibility minimums for a runway include the demand for lower minimums, the resulting benefits, and the associated costs.

2.6.4 Visibility Categories.

For the purpose of airport design, there are four categories of visibility. Note these categories and definitions do not match with 14 CFR Part 77.

2.6.4.1 **Visual (V).**

Runways classified as visual are either not suitable for IFR operations or have not been evaluated for IFR operations. Visual runways do not permit a straight-in approach. For the purpose of airport design, runways with circling-only approaches fall under the visual visibility category. Visual runways:

1. Support Visual Flight Rules (VFR) operations only, as well as IFPs with only circling minima;
2. Are unlighted or lighted with Low Intensity Runway Lights (LIRL) or Medium Intensity Runway Lights (MIRL); and
3. Have visual (basic) runway markings, as defined in AC 150/5340-1, *Standards for Airport Markings*.

2.6.4.2 **Non-Precision Approach (NPA).**

An NPA is an instrument approach based on a navigation system that provides course deviation information, but no glidepath deviation information. NPA runways:

1. Support IFR approach operations to visibilities of ½ statute mile (0.8 km) or greater and have a HAT no lower than 250 feet (76 m).
2. Rely on NAVAIDs providing lateral only guidance for instrument approaches such as Very High Frequency Omnidirectional Range (VOR), non-directional beacon (NDB), Area Navigation (RNAV) Lateral Navigation (LNAV), localizer performance (LP), and localizer (LOC).
3. Generally, have lengths at least 3,200 feet (975 m) long, with a minimum width based on RDC.
4. Have runway edge lights using LIRL or MIRL.
5. Have non-precision runway markings, as defined in AC 150/5340-1.

2.6.4.3 **Approach Procedure with Vertical Guidance (APV).**

APV is an instrument approach based on a navigation system that is not required to meet the PA standards of the ICAO Annex 10, but that provides course and glidepath deviation information. Runways classified as APV handle instrument approach operations where the navigation system provides vertical guidance down to 200 feet (61 m) HAT and visibilities to as low as ½ statute mile (0.8 km). APV runways:

1. May apply to the following approach types: Vertical Navigation (VNAV), Localizer Performance with Vertical Guidance (LPV), or RNAV/Required Navigation Performance (RNP).
2. Typically have a length of at least 3,200 feet (975 m) in length and a typical width of at least 60 feet (18.3 m).

3. Typically have a runway with at least a MIRL and non-precision runway markings, as defined in AC 150/5340-1.

2.6.4.4 **Precision Approach (PA).**

A PA is an instrument approach based on a navigation system that provides course and glidepath deviation information. Runways classified as precision, handle instrument approach operations supporting an instrument approach with a HAT lower than 250 feet (76 m) and visibility lower than ¾ statute mile (1.2 km), down to and including Category (CAT) III. Precision Instrument Runways (PIRs):

1. Support IFR operations with visibilities down to and including CAT-III with the appropriate infrastructure.
2. Have navigational systems capable of supporting precision operations that include instrument landing system (ILS) and Ground Based Augmentation System (GBAS) Landing System (GLS). (FAA Order JO 6850.2, *Visual Guidance Lighting Systems*, contains descriptions of various approach lighting systems.)
3. Have runway lengths of at least 4,200 feet (1280 m).
4. Have minimum runway width of at least 75 feet (22.9 m) with the typical width being 100 feet (30.5 m).
5. Have High Intensity Runway Lights (HIRL).
6. Have precision runway markings, as defined in AC 150/5340-1.

2.6.5 Establish Applicable RDC.

Establishing the critical aircraft and justified visibility minimums establishes the RDC. Determine an RDC for each runway at the airport, per paragraph 1.6.4.

2.6.6 Apply Applicable Design Standards.

The RDC determines the applicable standards for runway design. Each runway will have a specific RDC establishing design criteria such as runway to taxiway separations, safety areas, OFAs, and OFZs.

2.6.6.1 **Example.**

Consider that an airport may have a runway for air carrier operations and a runway for GA operations. The runway serving air carrier operations may have an RDC of D-IV-2400 while the runway serving GA operations may have an RDC of B-II-5000.

2.7 Key Safety Considerations for Airport Design.

2.7.1 Runway Incursions.

A runway incursion is any occurrence involving the incorrect presence of an aircraft, vehicle, or person in a protected area designated for the landing or takeoff of aircraft.

Airfield geometry is a factor affecting the risk associated with runway incursions. Appropriate consideration of this aspect during runway and taxiway design can mitigate the factors that lead to increased risk of runway incursions.

1. Refer to Chapter 3 and Appendix J for taxiway design practices that reduce the risk of runway incursions.
2. Certain runway configurations can increase the risk of runway incursions. Such configurations include, but are not limited to:
   - Close proximity of thresholds
   - Closely spaced parallel runways
   - Wide expanses of pavement between intersecting runways.

2.7.2 Wrong Surface Events.

A wrong surface event is an occurrence when an aircraft lands or departs, or tries to land or depart, on the wrong runway or on a taxiway. The causal factors for such events are broad. As it relates to airport design, airfield pavement geometries may contribute to wrong surface events. See paragraphs 4.6 and 4.8. Some considerations that can increase the risk of wrong surface events include:

1. The width of a parallel taxiway plus its shoulders may visually appear as a runway to a pilot on final approach to the associated runway.
2. The presence of pavement wider than standards:
   a. Can obscure the location of the landing threshold due to inadequate contrast, and
   b. Can draw a pilot's attention to an incorrect runway for landing.
3. The presence of a wide expanse of pavement fillet causing the pilot to mistake a parallel taxiway as the runway.
4. Parallel runways without standard separation distance.
5. Close proximity of thresholds of non-parallel runways.
6. The low visual contrast of runway pavement as compared to surrounding pavements and landscape.

2.8 Modification of Standards.

Site-specific conditions may make it impractical to meet all FAA design standards at an airport. The FAA considers, on a case-by-case basis, modifications to design standards that result in an acceptable level of safety and efficiency. Specific operational controls may be necessary to establish an acceptable level of safety for operation of aircraft at the airport. FAA Order 5300.1 establishes FAA policy for administering airport requests for modification of standards. See paragraphs 2.4 and 2.5.

2.8.1 The FAA views an approved modification of standards as an interim measure intended to mitigate unique site-specific conditions. Unless the FAA explicitly states otherwise in the approval action, the FAA expects airports with approved modifications to pursue

ways to meet design standards. This may occur incrementally over time or at such time it becomes practical to correct the non-standard condition.

2.8.2 The FAA will not consider any request to modify design standards associated with the following:

1. RSA dimensions
2. OFZ dimensions
3. Approach or departure surface dimensions
4. Standards established within a regulation (e.g., stopway, clearway).

2.8.3 An airport seeking FAA approval of modification to a design standard submits a request using the Modification of Standards application tool within the Airport Data and Information Portal (ADIP) at https://adip.faa.gov. The FAA relies on the following information, in part, to determine the acceptability of a modification to FAA design standards:

1. Information on the standard proposed for modification.
2. Description of proposed modification and why the airport cannot meet standards.
3. Statement addressing how modification will provide an acceptable level of safety, economy, durability, and workmanship.
4. Listing of any special operational measures necessary to accommodate the modification.

2.9 Safety Management Systems (SMS).

FAA Order 5200.11, *FAA Airports (ARP) Safety Management System (SMS)*, establishes FAA policy for the implementation of SMS within the FAA's Office of Airports (ARP). Among other things, this Order describes when Safety Risk Management practices apply to ARP-produced airport standards and project-specific approvals and provides procedures thereto.

2.10 Diverse Aeronautical Activities on Airports.

Airports can support a diverse range of aeronautical activities. In addition to aircraft operations, aeronautical activities may include powered-parachutes, helicopters, parachute drop zones, balloons, gliders, weight-shift-control aircraft, airships, banner towing, and others. Some of these aeronautical activities use airport operational surfaces in a non-typical manner. FAA Order 5190.6, *FAA Airport Compliance Manual*, provides guidance on reasonably accommodating these activities while addressing safety concerns and related considerations including coordination with other FAA offices such as Flight Standards and the ATO.

2.10.1 Heliports/Helipads.

Refer to AC 150/5390-2, *Heliport Design*, for guidance on helicopter facilities on airports. This AC provides helipad dimensions, as well as recommended distances between the helicopter final approach and takeoff area to the runway centerline.

2.10.2 Light Sport Aircraft (LSA).

LSA generally have greater aeronautical capabilities than ultralights, while being lighter than GA aircraft certified under 14 CFR Part 23, *Airworthiness Standards: Normal Category Airplanes*, and 14 CFR Part 27, *Airworthiness Standards: Normal Category Rotorcraft*. FAA Order 8130.2, *Airworthiness Certification of Aircraft*, establishes policies and procedures for LSA. The FAA bases certification of LSAs on accepted industry consensus standards. For aircraft operating under LSA rules, use the standards in this AC for small aircraft with approach speeds of more than 50 knots.

2.10.3 Ultralights.

Title 14 CFR Part 103, *Ultralight Vehicles*, regulates ultralight aircraft. Maximum takeoff weight is less than 254 lbs (115 kg) and maximum stall speed is not more than 24 knots. Use the standards in this AC for small aircraft with approach speeds of less than 50 knots. Refer to AC 103-6, *Ultralight Vehicle Operations-Airports, ATC, and Weather*, for operational guidance.

2.10.4 Seaplanes.

Refer to AC 150/5395-1, *Seaplane Bases*.

2.10.5 Parachute Operations.

Parachute operations are a permissible aeronautical activity at Federally obligated airports subject to compliance with reasonable terms and regulatory requirements. Per 14 CFR Part 105, *Parachute Operations*, parachute operations on an airport require prior approval from the airport operator. Refer to FAA Order 5190.6 for FAA policy addressing reasonable accommodation of parachute operations at an airport, safety considerations, and coordination with other appropriate FAA offices. Additional resources for information on parachute operations as it relates to airport design include:

- FAA Order JO 7110.65, *Air Traffic Control.*
- FAA Order JO 7210.3, *Facility Operation and Administration.*
- AC 150/5190-7, *Minimum Standards for Commercial Aeronautical Activities.*
- AC 105-2, *Sport Parachuting.*
- AC 90-66, *Non-Towered Airport Flight Operations.*
- United States Parachute Association (USPA), *Basic Safety Requirements (BSR)*, https://uspa.org/

2.10.6 Aircraft Operations in the Unpaved Runway Safety Area (RSA).

The primary function of a standard RSA is to enhance the safety of aircraft that undershoot, overrun, or veer off the runway. Pilots of certain aircraft (such as ultralights, powered-parachutes, helicopters, gliders, agricultural aircraft, tailwheels, aircraft with large balloon type "tundra" tires, etc.) occasionally use the unpaved portion of the RSA adjacent to a runway for takeoffs, landings, or other operations (e.g., banner towing). While aircraft operations from the unpaved portion of an RSA are not inherently unsafe, such operations have the potential to introduce various hazards and risks to the pilot, as well as other aircraft, vehicles, individuals, and facilities on the airport.

2.10.6.1 Key risk factors to consider include:

1. The separation standards of Tables G-1 through G-12 in Appendix G do not consider landing and takeoff operations from the RSA adjacent to the paved runway surface.
2. Aeronautical studies do not cover operations to and from the RSA adjacent to the paved runway.

2.10.6.2 From an airport design perspective, the optimum approach for an airport with a demonstrated need for operations from a turf surface is the development of a standard turf runway, per paragraph 3.20. Runway justification conditions and regular-use criteria apply if the airport desires Federal assistance with development of a turf runway.

2.10.6.3 AIP Airport Sponsor Grant Assurance 19 requires the owner of an airport developed with Federal grant assistance to operate its airport at all times in a safe and serviceable condition. Refer to AC 150/5000-17. An airport with operations in the RSA adjacent to the runway pavement may need to assess the operational safety implications, with assistance from the FAA, to ensure an acceptable level of safety.

2.10.6.4 FAA Order 5190.6 establishes FAA policy for reasonably accommodating these activities while addressing safety considerations and coordination with other FAA offices. Flight Standards, working in conjunction with the Office of Airports and/or ATO, will analyze supporting data and documentation to determine whether conducting a particular activity at an airport results in an acceptable level of safety.

2.10.6.5 The Flight Procedures and Airspace Group (FPAG) specialist serves as the initial point of contact for a safety assessment. The FPAG engages other Flight Standards offices, as appropriate, to assess and determine if an acceptable level of safety for aircraft operations within the unpaved portion of an RSA exists. In many cases, current FAA regulations, guidance, and operational procedures are sufficient to establish an acceptable level of safety. In other cases, operational mitigations are necessary based on Flight Standards safety assessment and guidance.

Contact the applicable FPAG specialist for questions related to the safety of aircraft operations within the unpaved portion of an RSA. See https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afx/afs/afs400/afs420 for FPAG contact information.

2.10.6.6 Airport design standards do not account for these types of operations. Consider the following factors when assessing aircraft operations in the RSA:

1. Education of the pilot community to reflect an operation in the RSA adjacent to the paved runway surface represents an operation on the paved runway.
2. The separation values and hold line locations on the runway side, where RSA operations occur, may be inadequate to mitigate identified risk.
3. Provision for enhanced inspection and maintenance of the RSA to ensure a serviceable condition.
4. Provision of airport informational notes in the Chart Supplement and Automatic Weather Observation Systems (AWOS) broadcasts.
5. Provisions based on State laws on landing and takeoff areas.
6. Consultation with the Part 139 inspector at certificated airports.

2.10.7 Emerging Entrants into the National Airspace System

The effect emerging entrant systems have on airport design will evolve over time. Stay current with technology advancements to understand impacts to airport design.

2.10.7.1 **Unmanned Aircraft Systems (UAS).**

See https://www.faa.gov/uas/ or contact the appropriate FAA Regional or Airports District Office for guidance.

2.10.7.2 **Advanced Air Mobility (AAM).**

See https://www.faa.gov/air-taxis or contact the appropriate Regional or Airports District Office for guidance.

2.10.8 Gliders.

The airport design standards that apply to powered aircraft apply to gliders as well, including self-launching gliders. The long wing lengths and low wingtip clearance common with gliders may present conflicts with airport infrastructure (e.g., lights, signs, etc.) whenever the glider is not the critical aircraft meeting regular use criteria.

2.10.8.1 Similar to an aircraft at a runway holding position, a glider and its associated tow vehicle may stage in a ROFA. However, support equipment such as vehicles, trailers, stands, dollies, etc., represent objects that need to be clear of active safety areas, OFAs, and OFZs.

2.10.8.2 Refer to FAA document FAA-H-8083, *Glider Flying Handbook*, for additional considerations related to operations on the airport.

2.10.8.3 Contact the appropriate FAA Regional Office or ADO for additional guidance regarding site-specific safety assessments. Safety assessments typically involve engagement of the FAA Flight Standards Service.

2.10.9 Military Operations at Civil Airports.

The standards in this AC apply to civilian aeronautical activities. For airports with military operations, consult the appropriate DoD Agency for guidance related to military design criteria. Refer to AC 150/5000-17 for FAA guidance addressing how to handle military operations for critical aircraft determination.

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CHAPTER 3. Runway Design

3.1 General.

The runway design standards, recommendations, design considerations, and requirements in this chapter describe features essential for safe and efficient takeoff and landing operations.

3.2 Runway Design Code (RDC).

The RDC determines the standards that apply to a specific runway and parallel taxiway allowing optimal safe operations by the critical aircraft under desired meteorological conditions. The RDC is based on existing and planned development and does not have any operational application.

3.3 Runway Design Standards.

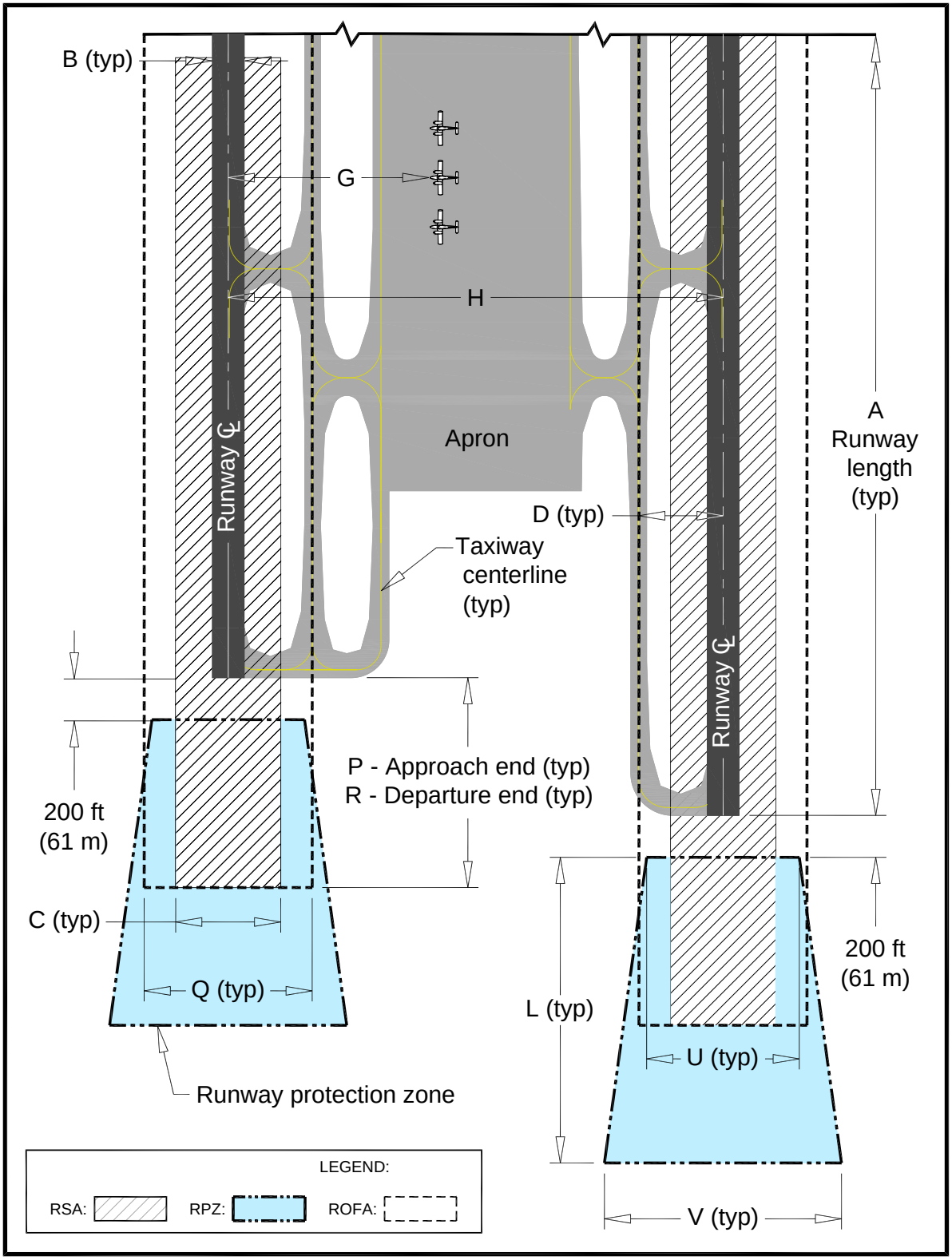
Refer to Appendix G or the online Runway Design Standards Matrix Tool for specific dimensional design standards. Refer to Figure 3-1 for an illustration of design standard dimensions using an airport layout example. Unless otherwise noted, dimensional standards are independent of the surface type of the runway. The links in Table 3-1 navigate the user to the corresponding design code table in Appendix G.

Table 3-1. Runway Design Standards

ADG-I	ADG-II	ADG-III	ADG-IV	ADG-V	ADG-VI
A-I Small	A-II Small	-	-	-	-
A-I	A-II	A-III	-	-	-
B-I Small	B-II Small	-	-	-	-
B-I	B-II	B-III	B-IV	-	-
C-I	C-II	C-III	C-IV	C-V	C-VI
D-I	D-II	D-III	D-IV	D-V	D-VI
E-I	E-II	E-III	E-IV	E-V	E-VI

Note: Alternatively, see the online Runway Design Standards Matrix Tool.

Figure 3-1. Airport Layout Example



Note: See Appendix G or online Runway Design Standards Matrix Tool for dimensions.

3.4 Runway Design Concepts and Considerations.

3.4.1 Runway Length.

Use AC 150/5325-4, *Runway Length Requirements for Airport Design*, to determine the runway length for the critical aircraft. Key design factors include:

1. Critical aircraft takeoff and landing distances.
2. Obstacle clearance for all aircraft intended to use the runway.
3. Airport elevation.
4. Airport climate condition.
5. Surface gradient.

3.4.2 Runway Threshold.

Runway length, obstructions, and visibility requirements are key factors when locating a runway threshold.

1. The appropriate approach and departure surfaces are clear of obstacles.
2. Operational mitigations may be necessary to address obstacle penetrations of standard approach surfaces.
3. Refer to paragraph 3.6 and Table 3-2, Table 3-3, Table 3-4, and Table 3-5 for runway approach and departure standards.

3.4.3 Number of Runways.

Runway location and orientation are paramount to airport safety, efficiency, economics, and environmental impact. Capacity and/or wind coverage determine the number of runways needed.

3.4.3.1 Capacity

Use AC 150/5060-5 for planning guidance on runway capacity.

3.4.3.2 Orientation and Wind.

The primary runway orientation is normally in the direction of the prevailing wind. A wind data analysis considers wind speed and direction for existing and forecasted operations for local meteorological conditions.

1. Refer to Appendix B for wind analysis for airport planning and design.
2. Design for a crosswind runway when the primary runway orientation:
   a. provides less than 95.0 percent wind coverage during all weather conditions, and
   b. regular use for the critical aircraft needing crosswind coverage exists, per AC 150/5000-17.

3. Wind coverage is based on the allowable crosswind component not exceeding the values in Table B-1.

3.4.4 Airspace Analysis and Obstruction to Air Navigation.

The runway orientation determines the approach and departure path for the design level of service. An obstruction survey identifies objects that may affect aircraft operations in this path. Contact the local FAA Regional Office or ADO for assistance and information regarding the following matters:

- Existing and planned IFPs
- Missed approach procedures
- Departure procedures
- Traffic patterns influencing airport layouts and locations
- Obstructions to air navigation

3.4.5 Environmental Factors.

An evaluation under the NEPA considers the impact of runway development on existing and proposed land use, noise on nearby residents, air and water quality, wildlife, and historical/archeological features. FAA Order 1050.1 and FAA Order 5050.4 establish FAA policies and procedures for complying with the NEPA.

3.4.6 Topography.

Topography affects:

1. The amount of grading and drainage work necessary to develop a runway, both existing and long term. See AC 150/5320-5, *Airport Drainage Design*, for further guidance.
2. IFPs when it is necessary to increase minima to keep flight paths clear of terrain in the approach surfaces.
   a. The presence of precipitous terrain may also result in increased minima to provide additional clearance.
   b. For takeoff, establishing an obstacle departure procedure may be needed when operating under IFR to ensure safe clearance from rising terrain.

3.4.7 Wildlife Hazards.

Consider the location of bird and wildlife attractants (e.g., ponds, wetlands, storm water detention, trees, etc.) when establishing runway orientation.

1. See AC 150/5200-33, *Hazardous Wildlife Attractants on or near Airports*, AC 150/5200-34, *Construction or Establishment of Landfills near Public Airports*, and FAA/United States Department of Agriculture (USDA) manual, Wildlife Hazard Management at Airports.
2. Information is also available through local FAA Airports offices.

3.4.8 Geospatial Survey.

Perform surveys in accordance with AC 150/5300-16, AC 150/5300-17, and AC 150/5300-18.

3.4.9 Runway Markings and Airport Sign Systems.

1. AC 150/5340-1, *Standards for Airport Markings*, addresses runway markings.
2. AC 150/5340-18, *Standards for Airport Sign Systems*, addresses airport sign systems.
3. AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*, addresses airport lighting.

3.4.10 Navigational Aids (NAVAIDs).

NAVAIDs provide desired visual and electronic signals that support visual and instrument approach access. Chapter 6 provides relevant NAVAID information that supports runways.

3.4.11 Runway Design.

As a minimum, the design of runways and runway extensions involves an evaluation of the following standards:

- Runway Safety Area (RSA), paragraph 3.10
- Obstacle Free Zone (OFZ), paragraph 3.11
- Runway Object Free Area (ROFA), paragraph 3.12
- Runway Protection Zone (RPZ), paragraph 3.13
- Approach and Departure Surfaces, paragraphs 3.6.1 and 3.6.2
- Runway to taxiway separation standards using the online Runway Design Standards Matrix Tool or Appendix G
- Runway Line of Sight (LOS), paragraph 3.8
- Runway Approach and Departure Surfaces, Table 3-2, Table 3-3, Table 3-4, and Table 3-5

3.4.12 Approach and Departure Imaginary Surfaces.

The FAA utilizes three sets of imaginary surfaces to evaluate and protect the approach and departure areas of a runway.

3.4.12.1 **14 CFR Part 77.**

1. Provides the standards for identifying obstructions to air navigation.
2. Consists of the primary, approach, transitional, horizontal, and conical surfaces.

The FAA presumes obstructions are hazards to air navigation unless further aeronautical study concludes that the object is not a hazard.

3.4.12.2 **United States Standard for Terminal Instrument Procedures (TERPS).**

1. Prescribes the criteria for designing and evaluating IFPs.
2. Specifies the minimum measure of obstacle clearance that provides a satisfactory level of vertical protection from obstructions for IFR procedures.
3. Establishes the standard takeoff and landing minimums for instrument runways.

3.4.12.3 **Runway Approach and Departure Surfaces.**

See paragraph 3.6 and the dimensional values in Table 3-2, Table 3-3, Table 3-4, and Table 3-5:

1. Prescribes the criteria for evaluating runways serving only visual operations, and
2. Provides basic planning surfaces, as it relates to instrument runways, intended to protect select TERPS surfaces.

3.5 Runway End Siting Criteria.

For runways with instrument procedures, base the final design on a detailed analysis applying the criteria of FAA Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS)*. This analysis is typically performed by the FAA Flight Procedures Office. Runway ends and runway thresholds are two distinct design elements.

3.5.1 Runway Ends.

The runway ends are the physical ends of a rectangular prepared surface that constitutes a runway. (See Figure 3-2).

3.5.2 Runway Threshold.

A properly located threshold provides obstacle clearance for landing aircraft. The optimum location of a threshold is the beginning of the runway.

3.5.2.1 **Standards.**

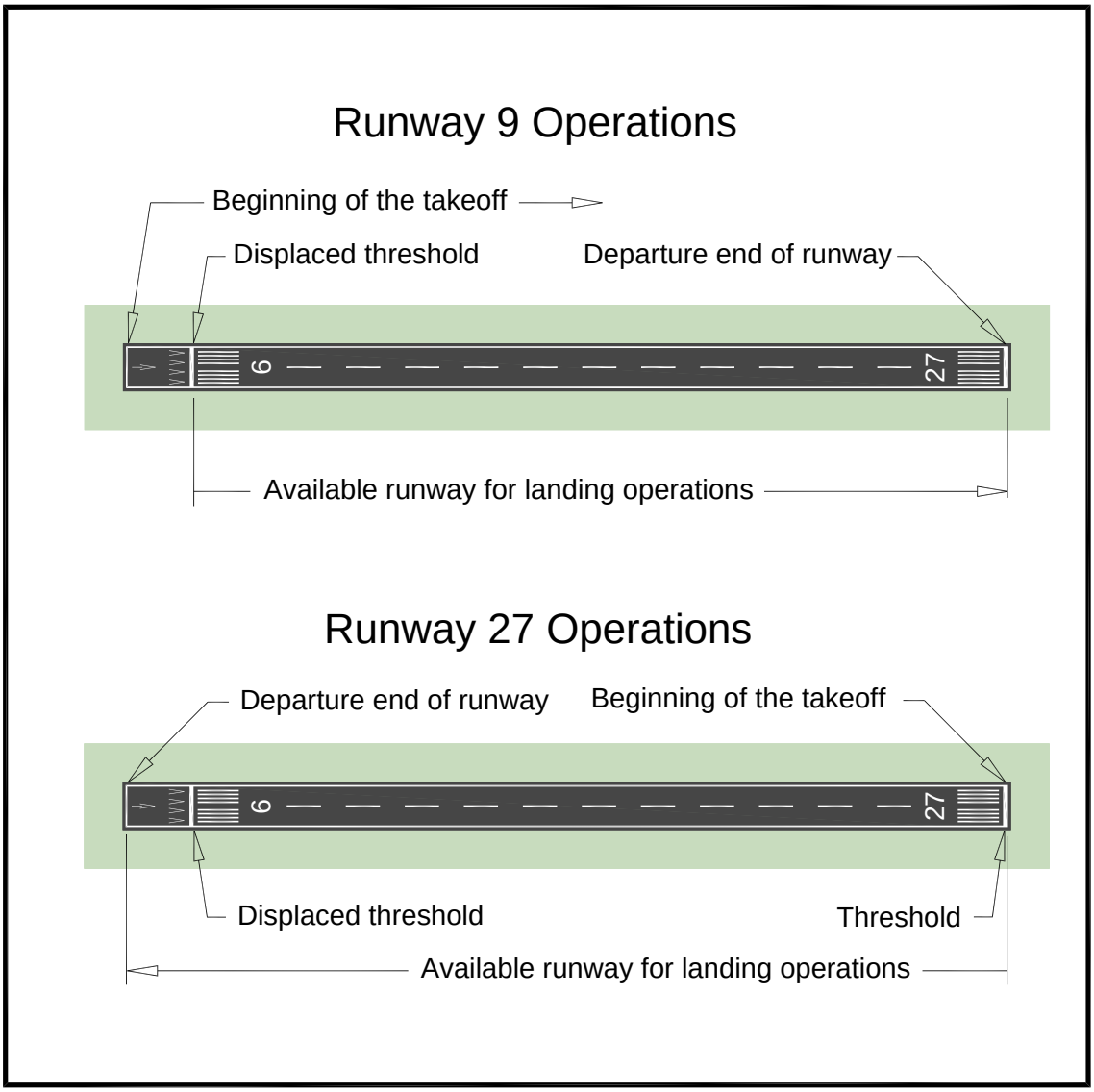
Locate the threshold to meet the following criteria:

1. No obstacle penetration of the approach surface, per Table 3-2, Table 3-3, and Table 3-4.
2. Location allows for standard RSA, ROFA, and OFZ.

3.5.2.2 **Design Considerations.**

Consider the ultimate approach visibility minimums planned for the runway.

Figure 3-2. Runway Ends



Note 1: For runway marking standards, see AC 150/5340-1.
Note 2: For runway lighting standards, see AC 150/5340-30.

3.5.3 Displaced Threshold.

When it is impractical to locate a threshold at the beginning of the runway, it may be necessary to apply a displaced threshold. A displaced threshold reduces runway length available for landings in one direction. The portion of the runway prior to the displaced threshold typically remains available for takeoffs. Depending on the circumstances surrounding the displacement, operations from the opposite runway end may or may not be affected. Refer to Appendix H for related information on declared distances. Generally, a runway threshold displacement provides:

1. A means for obtaining additional RSA prior to the threshold.
2. A means for obtaining additional ROFA prior to the threshold.

3. A means for locating the RPZ to mitigate incompatible land uses.
4. A means for obstacle clearance prior to the threshold.
5. Increased arrival capacity with certain parallel runway approach procedures. See FAA Order 7110.308, *Simultaneous Dependent Approaches to Closely Spaced Parallel Runways*.

3.5.3.1 **Standards.**

The runway threshold standards in paragraph 3.5.2.1 apply to a displaced threshold.

3.5.3.2 **Design Considerations.**

Consider a displaced threshold only after a full evaluation establishes that displacement is the best available alternative. While threshold displacement is often a convenient solution for constrained airports, the evaluation needs to weigh the trade-offs and consequences of a displaced threshold. These include factors such as:

1. Relocation of approach light systems and NAVAIDs.
2. Threshold displacement may result in existing taxiways, holding bays, and aprons now being located prior to the runway threshold, thus creating potential situations where taxiing aircraft may penetrate a protected surface such as an approach surface or a Precision Obstacle Free Zone (POFZ).
3. Additional holding positions may be necessary to keep aircraft clear of approach surfaces.
4. Threshold displacement may result in holding positions on the parallel taxiways where pilots may not expect to encounter a holding position.

3.5.4 Departure End of Runway (DER).

When a clearway (Figure 3-10) is not present, the DER indicates the end of the prepared runway surface (e.g., full-strength pavement) available and suitable for departure. Refer to Appendix H for the effect declared distances may have on the DER.

3.5.4.1 **Standards.**

When establishing runway ends, ensure:

1. All applicable approach surfaces of Table 3-2, Table 3-3, and Table 3-4 associated with the threshold are clear of obstacles.
2. The 40:1 departure surface associated with the ends of designated instrument departure runways are clear of obstacles, per paragraph 3.6.2.
3. Standard dimensions for the RSA and ROFA are available.

a. **Exception:** The presence of a standard Engineered Materials Arresting System (EMAS) is equivalent to the standard length for a departure RSA and OFA prior to a runway end.

4. Incompatible objects and activities remain clear of the RPZ, per paragraph 3.13.

5. Controls in the form of land-use restriction, zoning, easements, or acquisition are in place, to the extent practical, to protect approach and departure surfaces from adverse conditions such as:

   a. proposed development, or

   b. natural vegetation growth.

6. Critical areas, light signal clearance surfaces, and approach surfaces associated with electronic and visual NAVAIDs such as a visual glide slope indicator (VGSI), approach lighting system (ALS), or ILS remain clear of interfering sources.

3.6 Approach and Departure Surfaces.

Table 3-2, Table 3-3, Table 3-4, and Table 3-5 present the dimensional standards applicable to varying runway types based on normal conditions (e.g., standard 3-degree glidepath angle). Meeting the criteria of these tables protects the runway use and establishes maximum runway utility during meteorological weather conditions. The FAA determines final published visibility minimums by applying the criteria prescribed in TERPS.

3.6.1 Approach Protection Surfaces.

The approach protection surfaces defined in this paragraph are distinct from the approach surfaces defined in 14 CFR Part 77. The specific size, slope, and starting point of the surface depend upon the visibility minimums and each type of procedure associated with the runway end. Evaluate any obstacle penetrating the approach surfaces in Table 3-2, Table 3-3, and Table 3-4 through the OE/AAA process.

3.6.1.1 Standards.

Approach surfaces protect runway use for visual and instrument aircraft operations. The FAA will not issue a modification of standard for standards prescribed in Table 3-2, Table 3-3, and Table 3-4.

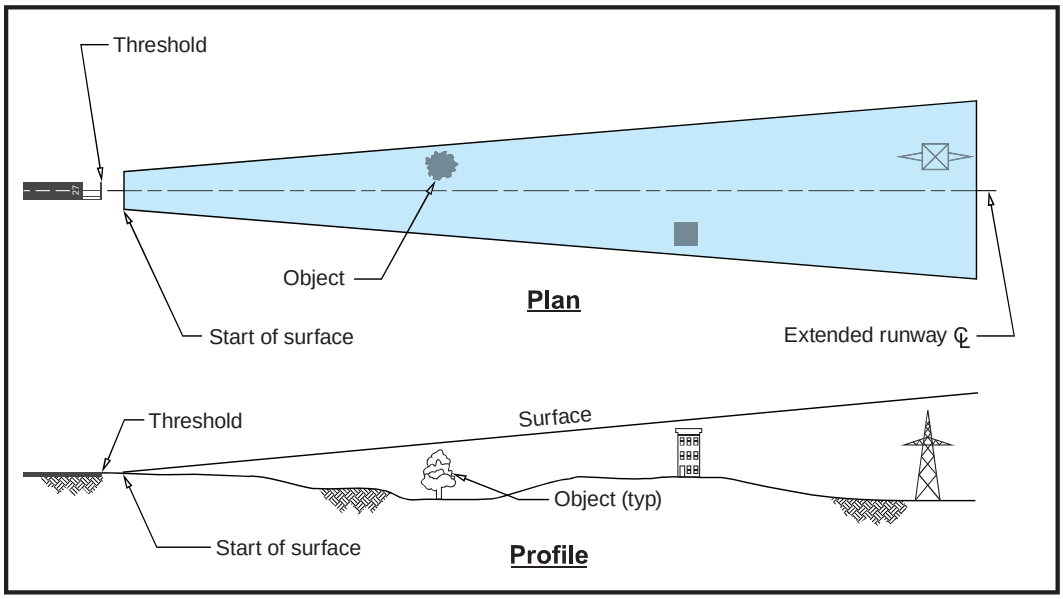
1. Visual runway (Table 3-2) approach surfaces are clear of obstacles.

2. Instrument runway (Table 3-3 and Table 3-4) approach surfaces are clear of obstacles.

3. The approach surface has a trapezoidal shape, per Figure 3-3, Table 3-2, Table 3-3, and Table 3-4.

4. If necessary to avoid obstacles, the instrument approach surface may be offset, as shown in Figure 3-8. Contact the Flight Procedures Team for more information on offset instrument approaches.

Figure 3-3. Standard Approach Surface



Note 1: The starting elevation of the approach slope is the elevation of the runway threshold.
Note 2: Refer to Figure 3-4 for a displaced threshold.

3.6.1.2 **Design Considerations.**

1. The instrument approach surfaces in Table 3-3 and Table 3-4 only reflect the visual segment of an instrument approach, as defined in TERPS.
   a. Other TERPS criteria may apply.
   b. Coordination with the FAA Flight Procedures Team is necessary for a complete assessment of instrument runways.
2. Ensure protection of runway ends from proposed development or natural vegetation growth that could penetrate the approach surfaces:
   a. Protection measures include land use restrictions and zoning, easements, and property acquisitions (see AC 150/5020-1).
   b. For additional guidance on Approach and Departure Protection, see https://www.faa.gov/airports/engineering.
   c. Refer to the Runway Airspace Management (RAM) Tool on the FAA's ADIP website https://adip.faa.gov for management of data regarding vegetation on and around airports.

d. Consider operational surfaces associated with electronic and visual NAVAIDs such as a VGSI, ALS, or ILS (see AC 150/5340-30).

3. For instrument runways, the FAA adjusts minimums as applicable, whenever an airport cannot mitigate obstacles penetrating an instrument approach and departure surface.

4. For roads, railroads, waterways, or other traverse ways for mobile objects within the limits of the approach surface:

   a. Consider the height of the highest mobile object that normally traverses the area under the approach surface.

   b. If unknown, apply the following typical values above the traverse way surface:

      i. interstate highways: 17 feet (5.2 m)

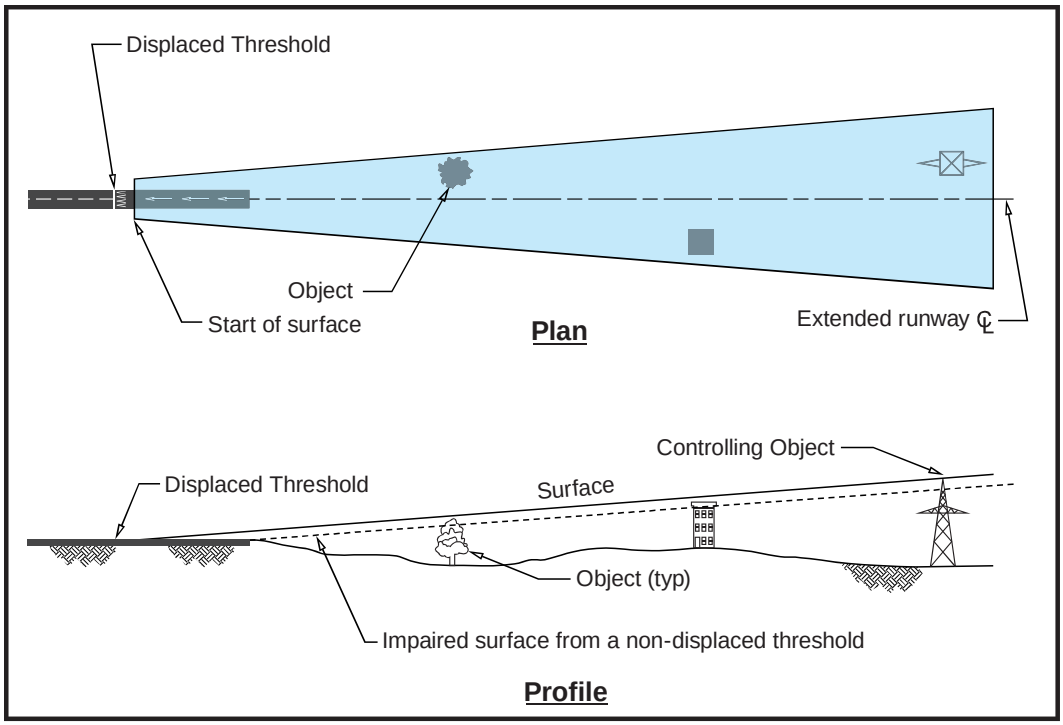
      ii. railroads: 23 feet (7 m)

      iii. access controlled roads: 10 feet (3 m)

      iv. all other public roads, highways, and vehicle parking areas: 15 feet (4.6 m).

5. Displacing the threshold may mitigate obstacle(s) penetrating the approach surface. See Figure 3-4.

Figure 3-4. Displaced Threshold



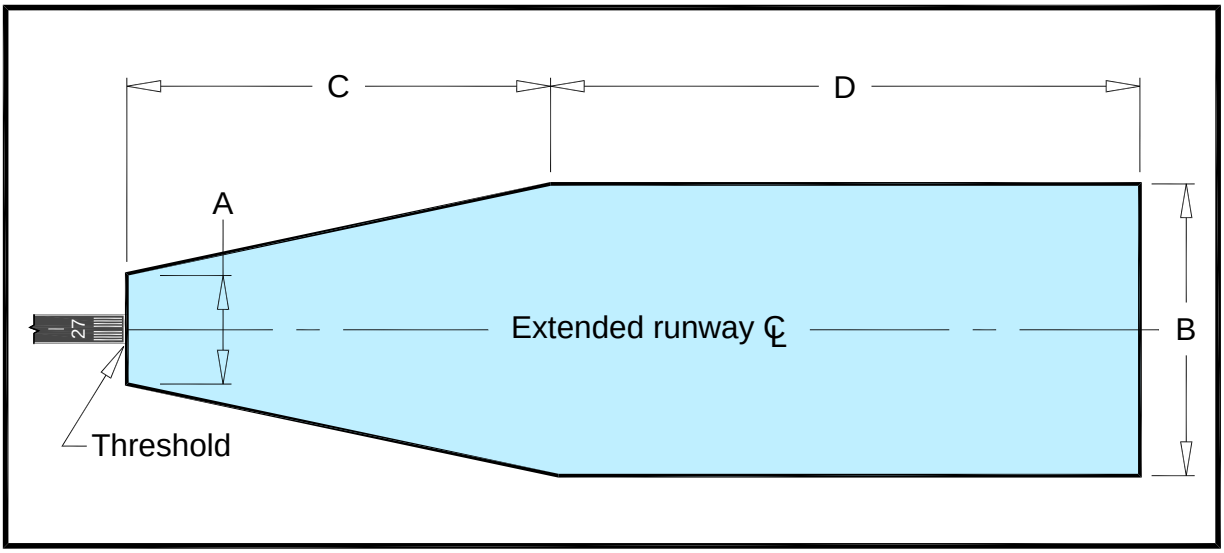
Note 1: The starting elevation of the approach slope is the elevation of the runway displaced threshold.

Table 3-2. Visual Approach Surfaces

Surface	Runway Type	A ft (m)	B ft (m)	C ft (m)	D ft (m)	Slope
Surface 1	Approach end of runways serving small airplanes with approach speeds less than 50 knots.	120 (37)	300 (91)	500 (152)	2,500 (762)	15:1
Surface 2	Approach end of runways serving small airplanes with approach speeds of 50 knots or more.	250 (76)	700 (213)	2,250 (686)	2,750 (838)	20:1
Surface 3	Approach end of runway serving large airplanes (>12,500 lbs (5,669 kg))	400 (122)	1,000 (305)	1,500 (457)	8,500 (2,591)	20:1

Note 1: Approach surface begins at the runway threshold.
Note 2: Use Table 3-3 for runways with a circling-only approach.

Figure 3-5. Visual Approach Surfaces



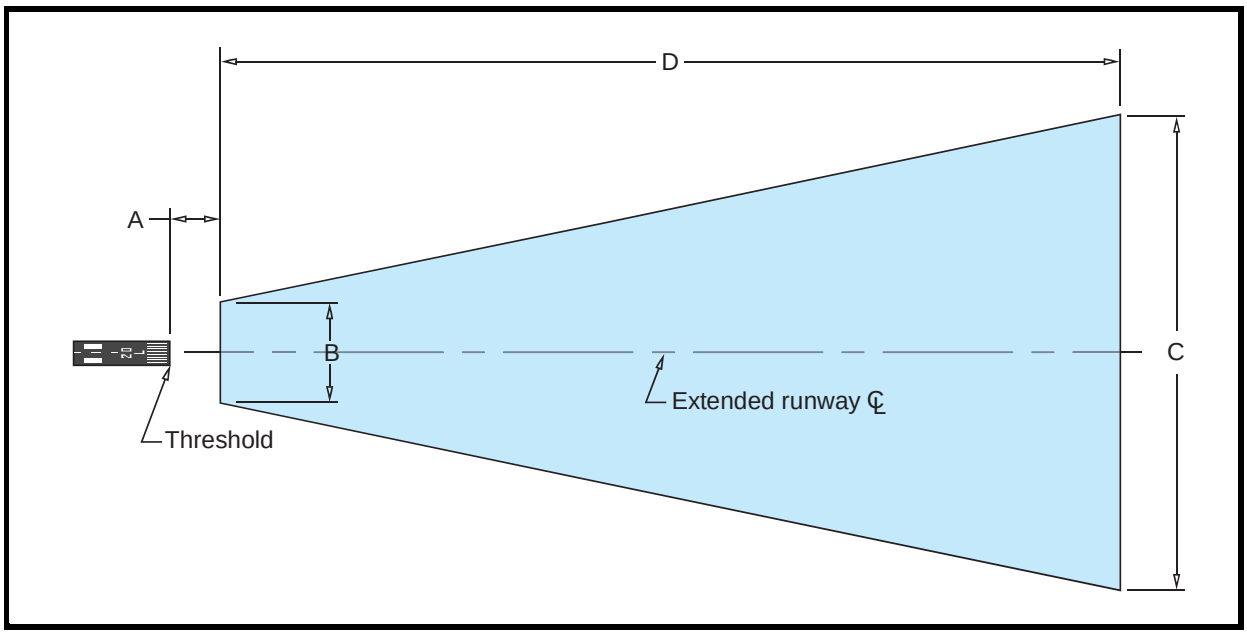
Note 1: Refer to Table 3-2 for dimensional values.
Note 2: Surface slopes upward and away from starting point.

Table 3-3. Non-Precision and IFR Circling Approach Surfaces

Surface	Runway Type	Visibility minimums	A ft (m)	B ft (m)	C ft (m)	D ft (m)	Slope
Surface 4	Approach end of runways that support IFR circling procedures and procedures only providing lateral guidance (VOR, NDB, LNAV, LP, TACAN, VORTAC, ASR, and LOC).	≥ ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	20:1
		< ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	34:1

Note 1: Dimension A is relative to the runway threshold.
Note 2: Refer to the U.S Terminal Procedures Publication (TPP) to determine if circling minimums are available.
Note 3: Marking and lighting of obstacle penetrations to this surface or the use of a Visual Guidance Lighting System (VGLS) may mitigate displacement of the threshold. Contact the Flight Procedures Team if existing obstacles penetrate this surface.
Note 4: 10,000 feet (3,048 m) represents a nominal value for planning purposes. The length is dependent on the Visual Descent Point (VDP) location.

Figure 3-6. Non-Precision and IFR Circling Approach Surfaces



Note: Refer to Table 3-3 for dimensional values.

Table 3-4. APV and PA Instrument Runway Approach Surfaces

Surface	Runway Type	Visibility minimums	A ft (m)	B ft (m)	C [4] ft (m)	D [4] ft (m)	Slope
Surface 5	Approach end of runways providing ILS, MMLS, PAR, and localizer type directional aid with glidepath, LPV, LNAV/VNAV, RNP, or GLS.	≥ ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	20:1
		< ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	34:1
Surface 6	Approach end of runways providing ILS, MMLS, PAR, and localizer type directional aid with glidepath, LPV, LNAV/VNAV, RNP, or GLS.	All	0	Runway Width + 200 (61)	1,520 (463)	10,200 (3,109)	30:1

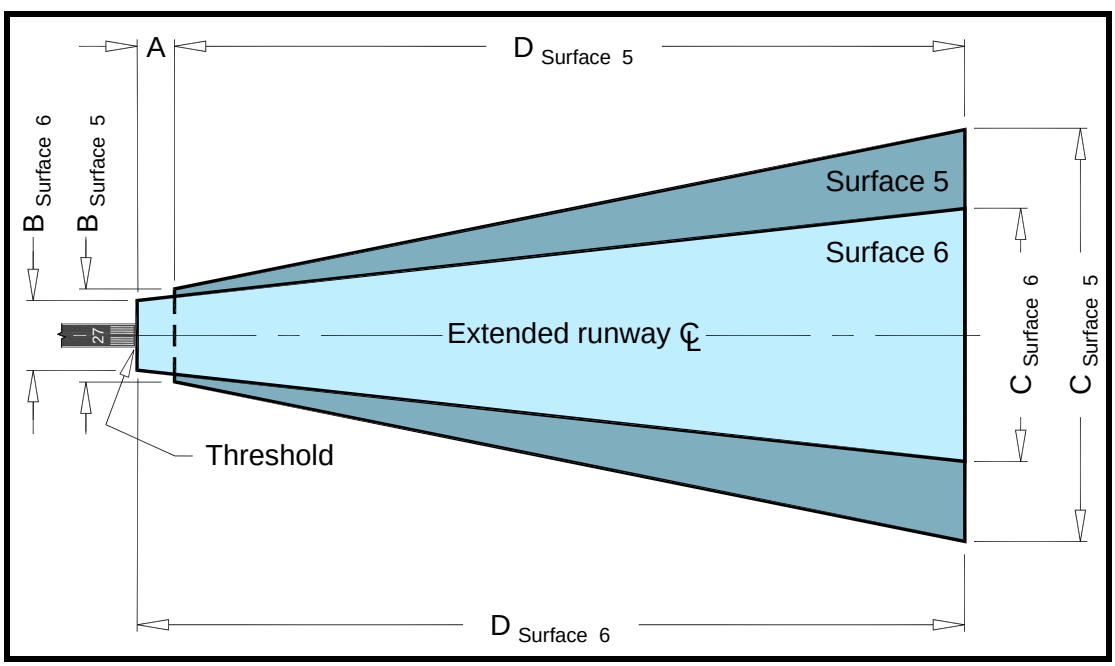
Note 1: Dimension A is relative to the runway threshold.

Note 2: Surface 5 represents the TERPS visual portion of the final approach segment. Surface 6 represents the TERPS Vertical Guidance Surface (VGS). Both surfaces apply for APV and PA procedures. Contact the Flight Procedures Team if existing obstacles penetrate this surface.

Note 3: The FAA assesses TERPS final approach segment criteria (e.g., W, X, Y surfaces) for all runway ends authorized for ILS, mobile microwave landing system (MMLS), precision approach radar (PAR), and localizer type directional aid with glidepath, LPV, and GLS procedures. Refer to FAA Order 8260.3 for additional information on TERPS surfaces.

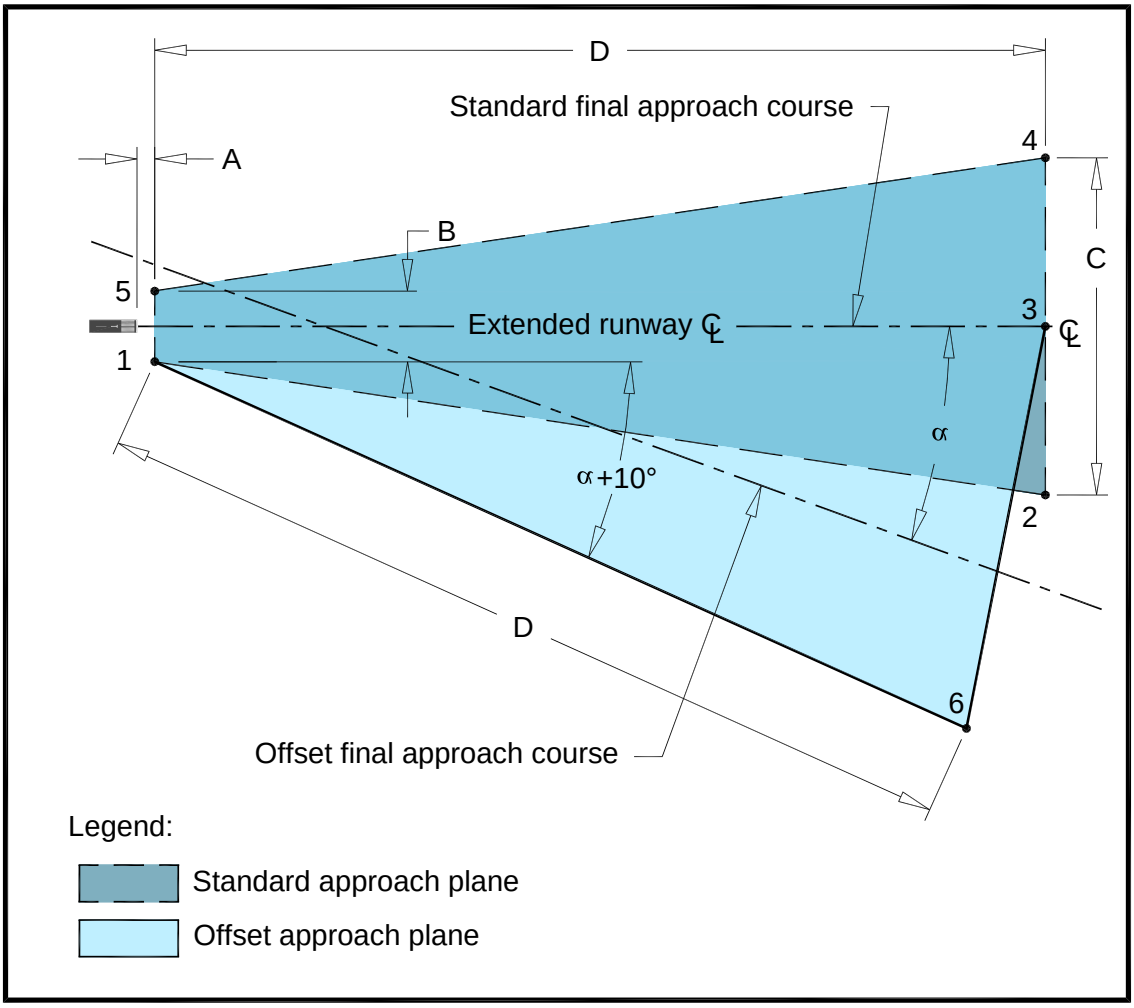
Note 4: Represents a nominal value for planning purposes. The actual dimension depends on the precision final approach fix.

Figure 3-7. APV and PA Instrument Runway Approach Surfaces



Note: Refer to Table 3-4 for dimensional values.

Figure 3-8. Offset Approach Plane



Note 1: Refer to Table 3-3 and Table 3-4 for all applicable dimensional standards and slopes.
Note 2: The offset area is defined by the perimeter 1-6-3-4-5-1.
Note 3: α = angle of the offset final approach (angle formed by the intersection of the offset final approach course with the extended runway centerline).

3.6.2 Departure Surfaces.

Clear departure surfaces allow pilots to follow standard instrument departure procedures, which assist pilots in avoiding obstacles during the initial climb from the terminal area. These procedures are published in the TPP. The departure surface applies to all runways, unless otherwise specified in the TPP. The airport operator, in coordination with the FAA, identifies runway ends without an instrument departure surface as not authorized (for IFR departures). Refer to Appendix H for the effect declared distances may have on departure surfaces.

3.6.2.1 **Standards.**

1. The departure surface begins at the departure end of runway (DER) elevation and extends laterally the width of the usable runway.

a. From the edge of the usable runway, Section 2 rises laterally to 150 feet (46 m) to a point 500 feet (152 m) on either side of the runway centerline.

b. The surface rises along the extended runway centerline until reaching 303.8 feet (93 m) above the DER (rounded to 304 feet for simplicity).

c. The Section 2 surface levels out upon reaching approximately 304 feet (93 m) above the threshold elevation.

2. See Figure 3-9 for standard size, shape, and orientation of the departure surface.

3. Maintain the 40:1 instrument departure surface associated with the ends of runways with published instrument departure procedures to be clear of obstacles, or with applicable mitigation, as identified in paragraph 3.6.2.2.

3.6.2.2 **Recommended Practices.**

For runway ends that are visual and/or without a published instrument departure procedure, the application of the 40:1 instrument departure surface is desirable where practicable. There can be valid reasons for an airport operator not to protect the visual runway for the instrument departure surface, in the interest of other needed development on or near the airport.

3.6.2.3 **Design Considerations.**

1. Evaluate any obstacle that penetrates the 40:1 departure surface through the OE/AAA process.

2. Ensure protection of runway ends from proposed development or natural vegetation growth that could penetrate the departure surfaces:

a. Protection measures include land use restrictions and zoning, easements, and property acquisitions (see AC 150/5020-1).

b. For additional guidance on Approach and Departure Protection, see https://www.faa.gov/airports/engineering.

c. Refer to the RAM Tool on the FAA's ADIP website https://adip.faa.gov for management of data regarding vegetation on and around airports.

3. Penetrations to the departure surface may result in a/an:

a. Non-standard climb gradient, and/or

b. Increase in the standard takeoff minimums, departure minimums, and/or

c. Reduction in takeoff length.

4. For roads, railroads, waterways, or other traverse ways for mobile objects within the limits of the departure surface:
   a. Consider the height of the highest mobile object that normally traverses the area under the approach surface.
   b. If unknown, apply the following typical values above the traverse way surface:
      i. interstate highways: 17 feet (5.2 m)
      ii. railroads: 23 feet (7 m)
      iii. access controlled roads: 10 feet (3 m)
      iv. all other public roads, highways, and vehicle parking areas: 15 feet (4.6 m).

Table 3-5. Instrument Departure Surface

Surface	Runway Type	A ft (m)	B ft (m)	C ft (m)	D [4] ft (m)	E ft (m)	Section 2 Angle θ [2]	Section 2 Transverse Slope m[2]
Surface 7	Runways providing instrument departure operations	60 (18.3)	470 (143.3)	7,512 (2,290)	12,152 (3,704)	6,152 (1,875)	17:7	3.13:1
		75 (22.9)	462.5 (141.0)				18.0	3.08:1
		100 (30.5)	450 (137.2)				18.4	3.00:1
		150 (45.7)	425 (129.5)				19.4	2.83:1
		200 (61.0)	400 (121.9)				20.6	2.67:1

Note 1: Section 1 of the departure surface starts at the DER elevation for the width of the runway and rises along the extended runway centerline at 40:1. Section 2 starts at an equal elevation to the adjoining Section 1. Section 2 continues until reaching 304 ft (92.7 m) and then levels off until reaching the line where Section 1 and Section 2 reach 304 ft (92.7 m) above DER elevation, then that part of Section 2 that leveled off continues at a 40:1 slope.

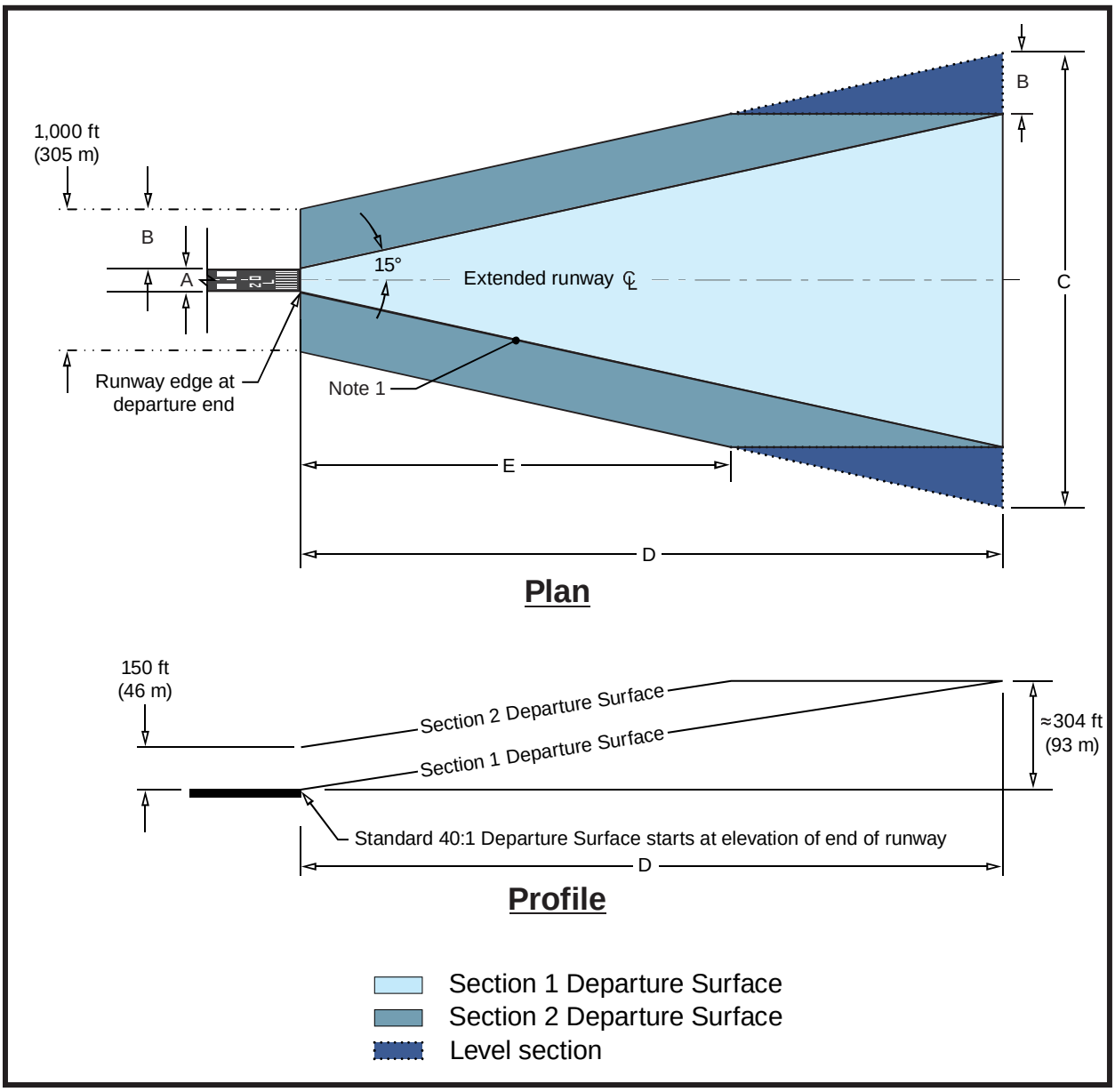
Note 2: See Figure 3-11 for a graphical depiction of these values.

Note 3: The start of the surface is relative to the DER. For runways with published declared distances, the TODA indicates the beginning of the departure surface. See Figure 3-10.

Note 4: 12,152 feet (3,704 m) represents a 2 nm nominal value for planning purposes.

Note 5: For other runway width values, interpolation is required to determine the value of "B", the Section 2 angle, and the Section transverse slope.

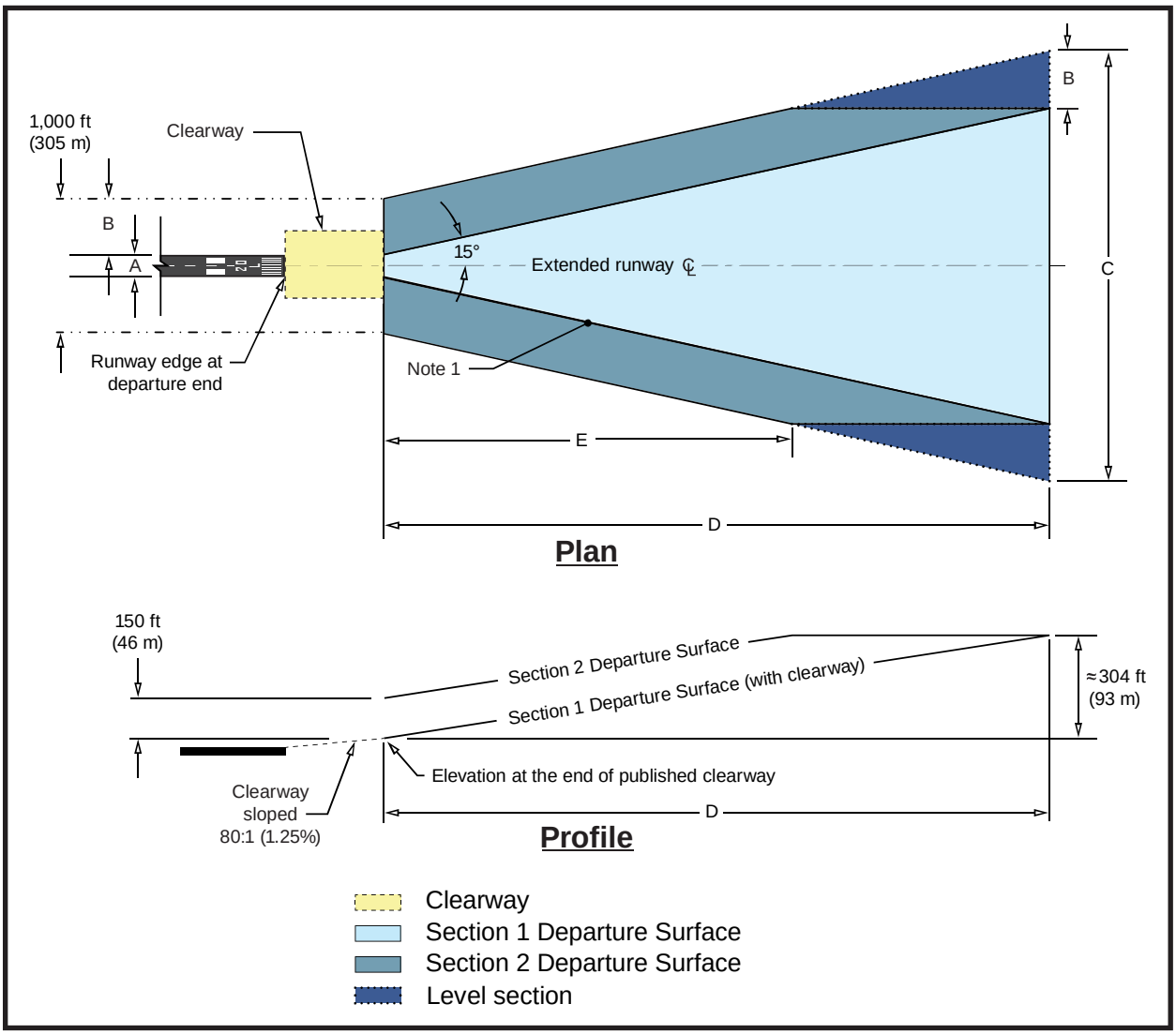
Figure 3-9. Instrument Departure Surface



Note 1: The half-width of Section 1 is calculated by the formula:
Section $1_{\text{Half Width}}$ = (1/2 RWY Width) + (Tan 15° × X), where X = distance from the DER.

Note 2: See Table 3-5 for dimensional values.

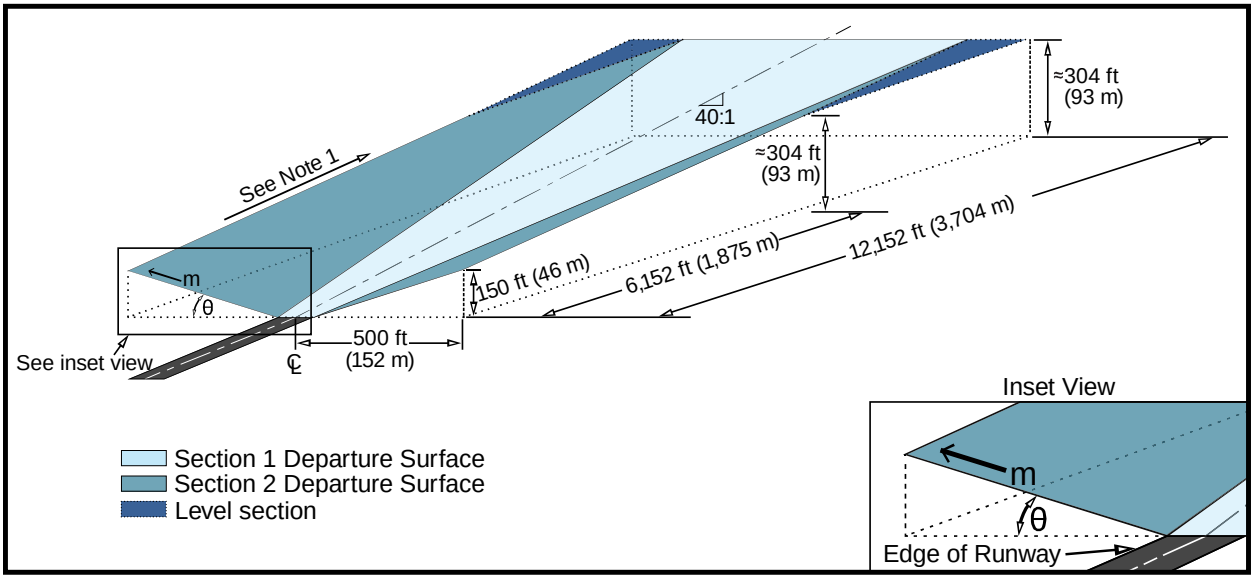
Figure 3-10. Departure Surface with Clearway



Note 1: The half-width of Section 1 is calculated by the formula:
Section $1_{\text{Half Width}}$ = (1/2 RWY Width) + (Tan 15° × X), where X = distance from the end of the published clearway.

Note 2: See Table 3-5 for dimensional values.

Figure 3-11. Departure Surface – Perspective View (Without Clearway)



Note 1: The outer edge of the Section 2 Departure Surface has a slope of 40:1.
Note 2: The 304-foot (93 m) value represents the height above the DER.
Note 3: Refer to paragraph 3.6.2.1 for additional information.

3.7 Runway Geometry.

3.7.1 Runway Length.

Runway length accommodates the landing and departure length needed by the critical aircraft. AC 150/5325-4 describes applicable methodologies for determining runway length.

3.7.2 Runway Width.

Runway standard widths accommodate airplane performance needs during landing and takeoff operations taking into account various weather and surface conditions. Appendix G and the online Runway Design Standards Matrix Tool present runway width standards based on RDC.

3.7.3 Runway Shoulders.

Runway shoulders provide resistance to jet blast erosion. Refer to Figure 3-33 for a graphic depiction of runway shoulders. See Appendix C for additional information on jet blast.

3.7.3.1 Standards.

1. See Appendix G for runway shoulder width standards.
2. Provide paved shoulders for runways accommodating ADG-IV and larger aircraft.

a. When installed, provide paved shoulders for the full length of the runway.

b. Design shoulder pavement to support:

i. the occasional passage of the most demanding aircraft, and

ii. the most demanding emergency or maintenance vehicle for the design life of the full-strength pavement.

iii. See AC 150/5320-6, *Airport Pavement Design and Evaluation*.

c. Design the paved shoulder to be flush with the runway pavement.

3. Provide stabilized shoulders for runways serving a critical aircraft of ADG-I, ADG-II, and ADG-III consisting of one of the following:

a. Turf, per standards in AC 150/5370-10, *Standard Specifications for Construction of Airports*.

b. Stabilizing soil treatments, per standards in AC 150/5370-10.

4. Design shoulders to provide surface drainage away from the edge of the runway pavement.

a. Design a 1.5-inch (38 mm) drop-off with a ±1/2-inch (13 mm) tolerance from the edge of the pavement to the adjacent unpaved areas to enhance drainage off the pavement.

3.7.3.2 **Recommended Practices.**

Provide paved shoulders for:

1. Runways with ADG-III as the critical aircraft,

2. Runways experiencing erosion of soil adjacent to the runway, and

3. Runways with soil not suitable for turf establishment (see AC 150/5320-6).

3.7.4 Runway Blast Pads.

Runway blast pads provide resistance to jet blast erosion beyond runway ends. Blast pads are not stopways, though a paved stopway can serve as a blast pad. Refer to Figure 3-19, Chapter 6, and Appendix C.

3.7.4.1 **Standards.**

1. Appendix G and the online Runway Design Standards Matrix Tool provide blast pad length and width standards.

2. Provide paved blast pads for runways where the critical aircraft is ADG-IV or larger.

3. Design blast pad pavement similar to shoulder pavement to support the occasional passage of the:

a. most demanding aircraft

b. most demanding emergency and maintenance vehicles.

4. Design to the same longitudinal and transverse grades as the safety area.

5. Provide a stabilized blast pad for runways serving a critical aircraft of ADG-I, ADG-II, and ADG-III consisting of one of the following:

   a. Turf, per standards in AC 150/5370-10.

   b. Stabilizing soil treatments, per standards in AC 150/5370-10.

6. Design blast pads to provide surface drainage away from the edge of the runway pavement and off the blast pad pavement.

   a. Design the blast pad to be flush with the runway pavement.

   b. Design a 1.5-inch (38 mm) drop-off with a ±1/2-inch (13 mm) tolerance from the edge of the pavement to the adjacent unpaved areas to enhance drainage off the blast pad.

3.7.4.2 **Recommended Practices.**

Provide paved blast pads for:

1. Runways with ADG-III as the critical aircraft.

2. Runways experiencing erosion of soil adjacent to the runway.

3. Runways with soil not suitable for turf establishment (see AC 150/5320-6).

4. Locations experiencing wrong surface landings due to the presence of parallel runways or taxiways, the installation of a blast pad and associated chevron markings may improve pilot visual cues to runway ends.

3.7.5 Overlapping RSAs.

RSAs (see paragraph 3.10) represent a safety measure for aircraft during landing and takeoff operations. Overlapping RSAs introduce safety risks and potential operational limitations. When two or more runways converge but do not intersect, thus creating overlapping RSAs, apply the standards of 3.7.5.1, to establish an acceptable level of safety in this area. Refer to paragraph I.7 for information on the risk associated with overlapping RSAs.

3.7.5.1 **Standards.**

1. Configure runway ends, taxiways, and holding positions to allow taxiing and holding aircraft to remain clear of all RSAs.

2. Configure runway ends to facilitate holding positions that allow holding aircraft to be perpendicular to the runway centerline, per Scenarios #1 and #2 of Figure 3-12.

3. For existing configurations not meeting standards, prioritize mitigation measures, per paragraphs 2.4 and 2.5.

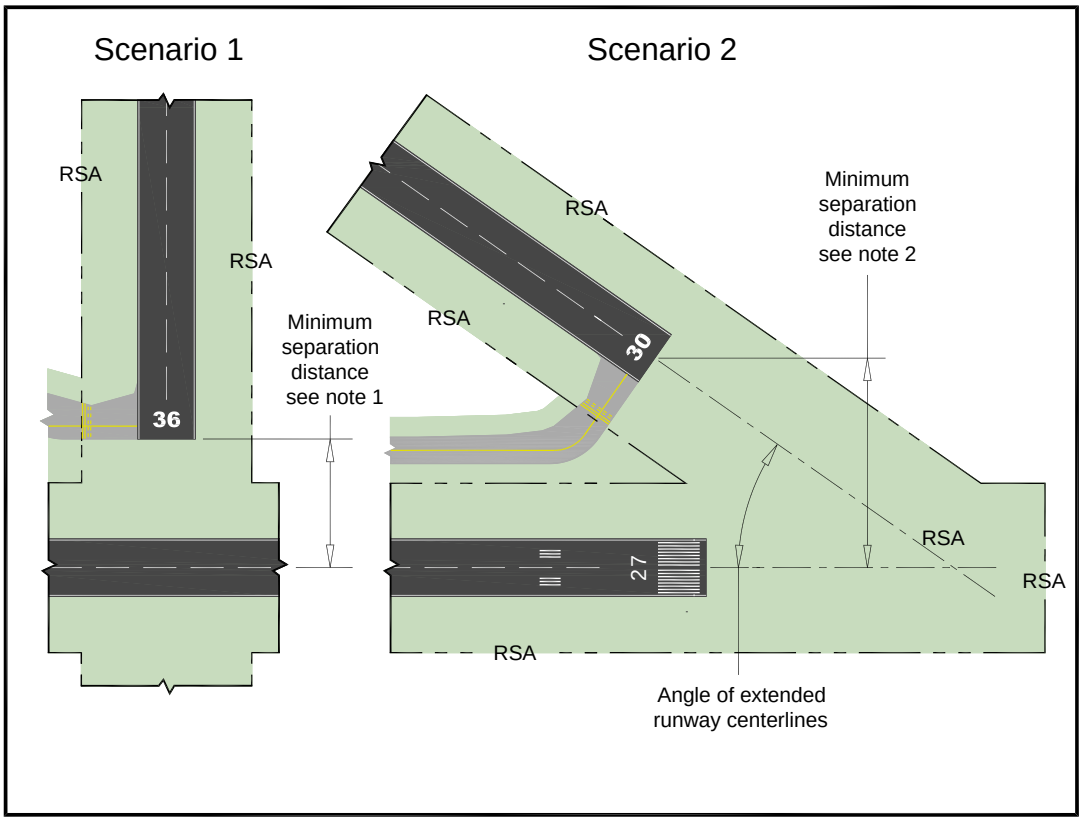
3.7.5.2 **Recommended Practices.**

1. For multiple runways that converge but do not intersect, configure runway ends for the optimum condition of independent RSAs.
2. When the most demanding aircraft using the airport is not the critical aircraft with regular use, configure the runway ends, taxiways, and holding positions to preclude the need for operational controls, if practical.

3.7.5.3 **Design Considerations.**

1. Overlapping RSAs may create conditions resulting in holding positions on taxiways not leading directly to a runway.
2. Overlapping RSAs can present an elevated risk for wrong runway departures when an aligned taxiway is present, per Figure I-3.

Figure 3-12. Converging Non-Intersecting Runways



Note 1: Minimum distance is the standard runway centerline to taxiway centerline separation (Appendix G) minus ½ taxiway width.

Note 2: The minimum separation distance allows an aircraft to hold without encroaching upon an RSA.

3.7.6 Intersecting Runways.

The intersection of two or more runways creates risks to airport safety and operational efficiency. The degree of risk varies depending on the intersection location for each runway. See paragraph I.7 for additional information on the associated risk.

3.7.6.1 **Standards.**

1. Configure runways ends, taxiways, and holding positions such that taxiing and holding aircraft remain clear of all RSAs.
2. Configure runway ends to facilitate holding positions that allow holding aircraft to be perpendicular to the runway centerline, per Figure 3-13.
3. For existing configurations not meeting standards, prioritize mitigation measures through the planning process to meet the standard in the future (see paragraphs 2.4 and 2.5).

3.7.6.2 **Recommended Practices.**

1. Configure runways that intersect to eliminate the need to adjust aiming point markings and/or remove touchdown zone markings.
2. When the most demanding aircraft using the airport is not the critical aircraft with regular use, configure the runway ends, taxiways, and holding positions, if practical, to preclude the need for operational controls.

3.7.6.3 **Design Considerations.**

1. Intersecting runways with runway ends in close proximity present an elevated risk for wrong runway departures. See Appendix I.
2. When two runways intersect, adjustment of pavement markings may be necessary for the lesser order runway, as specified in AC 150/5340-1.

3.8 Runway Line of Sight (LOS).

The runway LOS standards reduce conflicts among aircraft, and between aircraft and vehicles operating along active runways. A clear runway LOS allows pilots on the runway to visually verify the location and actions of other aircraft and vehicles on the ground.

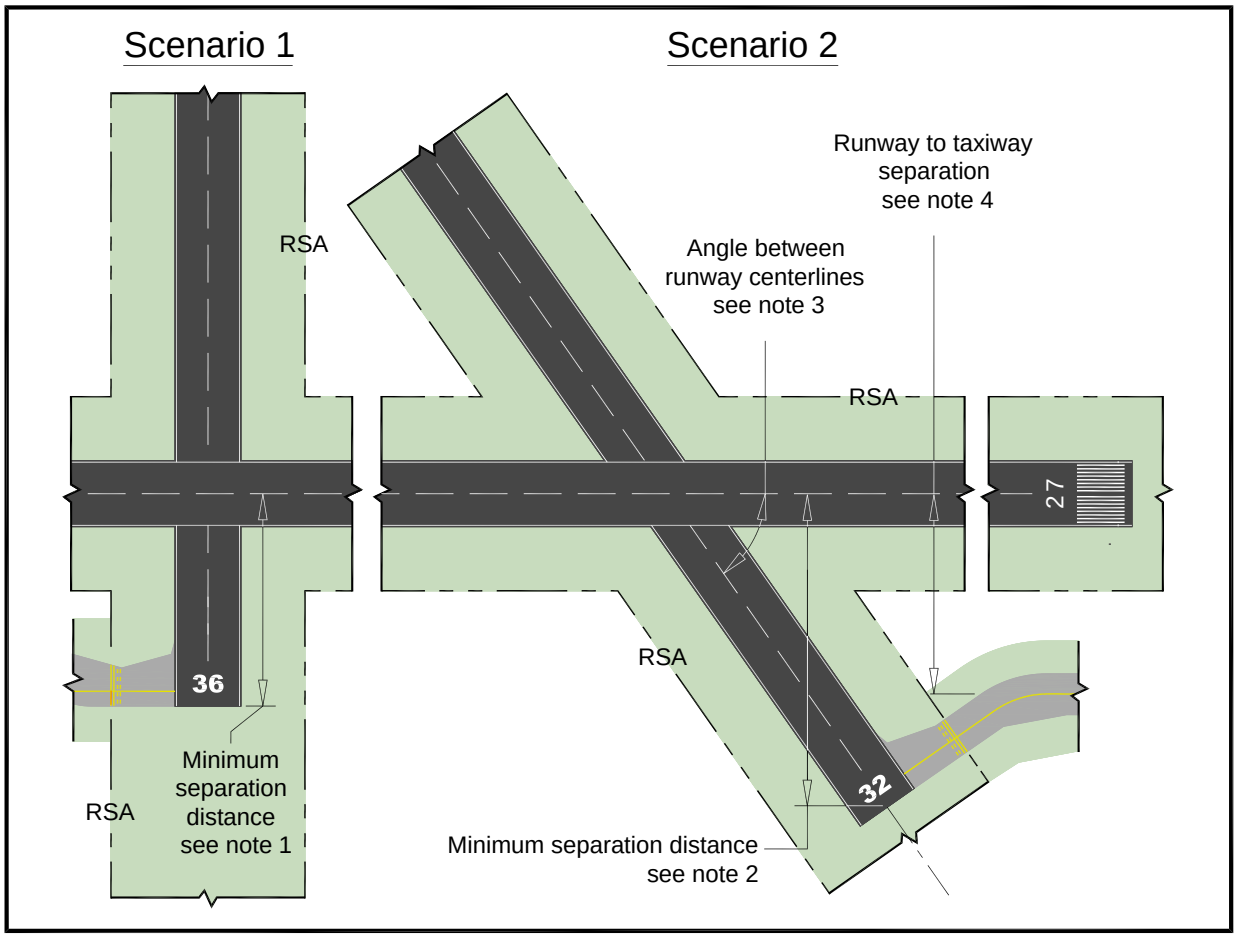
3.8.1 Individual Runways.

3.8.1.1 **Standards.**

1. For runways without full parallel taxiways, ensure any point 5 feet (1.5 m) above the runway centerline is mutually visible with any other point 5 feet (1.5 m) above the runway centerline.

2. For runways with a full parallel taxiway, ensure any point 5 feet (1.5 m) above the runway centerline is mutually visible with any other point 5 feet (1.5 m) above the runway centerline for a distance equal to half the length of the runway length.

Figure 3-13. Intersecting Runways



Note 1: Minimum distance: standard runway centerline to taxiway centerline separation plus ½ taxiway width.
Note 2: The minimum separation distance allows an aircraft to hold without encroaching upon an RSA.
Note 3: Refer to paragraph 3.7.6.3 for design considerations.
Note 4: See Appendix G for runway-taxiway separation value.

3.8.2 Intersecting Runways.

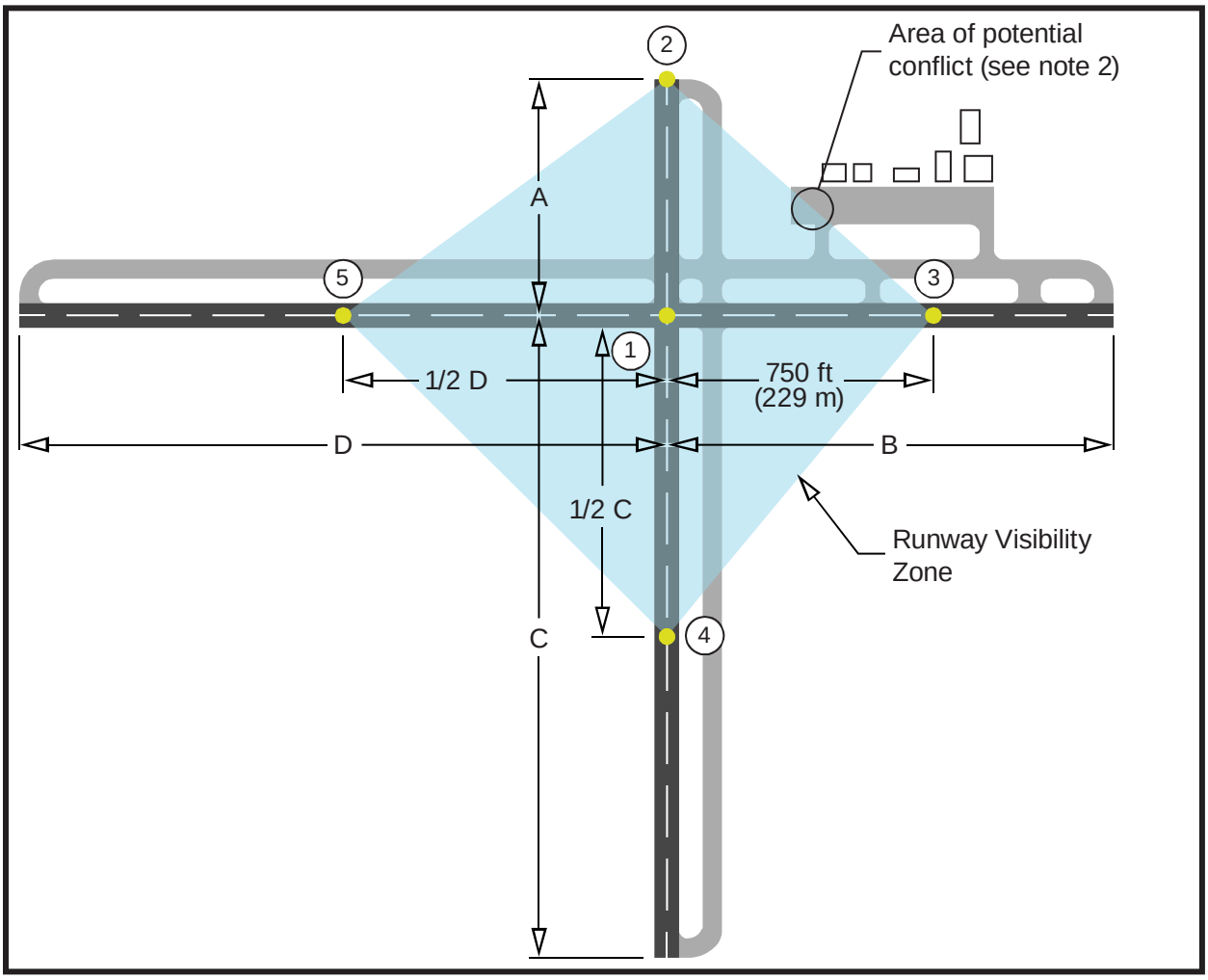
The Runway Visibility Zone (RVZ) is an area formed by imaginary lines connecting two physically intersecting runways' LOS points. A clear LOS precludes objects not fixed-by-function (e.g., buildings, structures, and parked aircraft) residing within the RVZ from blocking the pilot's view to the intersecting runway. The RVZ provides a visual field of view enhancing pilot situational awareness to avoid conflict with aircraft operating on an intersecting runway. Determine the LOS points using the orientation of the intersecting runways.

3.8.2.1 **Standards.**

The following standards apply to airports without an ATCT and airports with part-time ATCT operations.

1. Ensure any point 5 feet (1.5 m) above the runway centerline and in the RVZ (Figure 3-14) is mutually visible with any other point 5 feet (1.5 m) above the centerline of the crossing runway and inside the RVZ.

Figure 3-14. Runway Visibility Zone – Perpendicular Intersection Runways



Note 1: Dimensions:

a. When A ≤ 750 ft (229 m), then ① to ② = distance to the end of the runway.

b. When B < 1500 ft (457 m) but > 750 ft (229 m), then ① to ③ = 750 ft (229 m).

c. When C ≥ 1500 ft (457 m), then ① to ④ = ½ C.

d. When D ≥ 1500 ft (457 m), then ① to ⑤ = ½ D.

Note 2: RVZs that include apron areas create potential LOS conflicts whenever parked aircraft or hangar structure is present.

2. For perpendicular intersecting runways, locate the runway LOS points, per Figure 3-14 and as follows:
   a. The end of the runway if the runway end is located within 750 feet (229 m) of the intersecting runway centerlines.
   b. A point 750 feet (229 m) from the intersecting runway centerlines if the end of the runway is located less than 1,500 feet (457 m) from the intersecting runway centerlines.
   c. A point half the distance from the runway end and the intersecting runway centerlines, if the end of the runway is located 1,500 feet (457 m) or greater from the intersecting runway centerlines.
3. For non-perpendicular intersecting runways, locate the runway LOS points, per Figure 3-15 and Figure 3-16 as follows:
   a. The end of the runway if the centerline extended distance is less than 750 feet (229 m).
   b. A point 750 feet (229 m) from the intersecting runway centerlines if the intersecting runway centerlines extended distance X is equal to or greater than 750 feet (229 m).
   c. A point half the distance from the runway end and the intersecting runway centerlines, if the centerline extended distance X is greater than or equal to 1,500 feet (457 m).

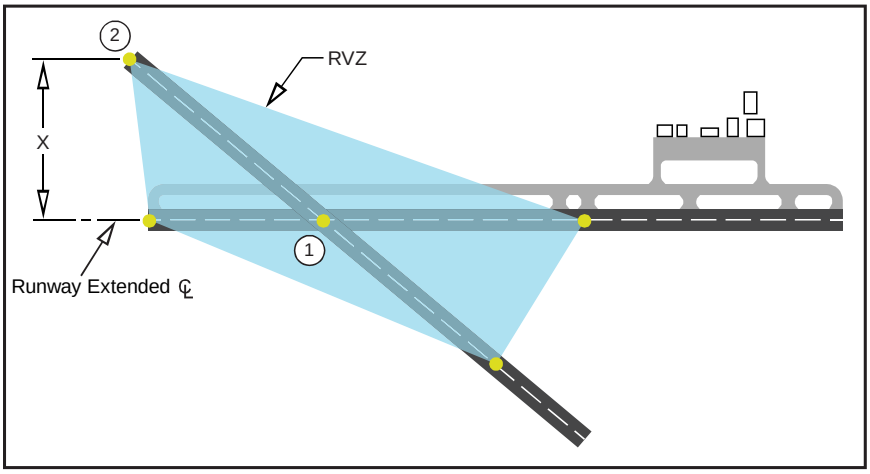
3.8.2.2 **Recommended Practices.**

For airports with a 24-hour ATCT, apply the RVZ criteria to intersecting runways as a supplemental safety measure.

3.8.2.3 **Design Considerations.**

Design the apron layout to preclude aircraft parking positions that reside within an RVZ. Refer to the area of potential conflict, shown on Figure 3-14.

Figure 3-15. Runway Visibility Zone – Non-Perpendicular Intersecting Runways – X Less Than 750 Feet (229 m)



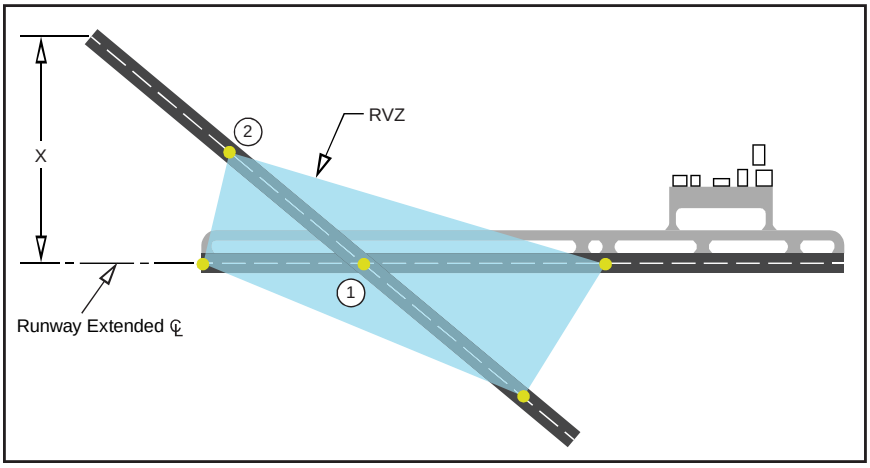
Dimensions:

a. When the separation distance X < 750 ft (229 m), then the ① to ② value equals the distance from the runway intersection to the end of the runway.

b. When the separation distance X ≥ 750 ft (229 m) but < 1500 ft (457 m), then the ① to ② value equals 750 ft (229 m).

c. When the separation distance X ≥ 1500 ft (457 m), then the ① to ② value equals ½ the distance from the runway intersection to the end of the runway.

Figure 3-16. Runway Visibility Zone – Non-Perpendicular Intersecting Runways – X Distance Equal to or Greater Than 750 Feet (229 m)



Dimensions:

a. When the separation distance X < 750 ft (229 m), then the ① to ② value equals distance from the runway intersection to the end of the runway.

b. When the separation distance X ≥ 750 ft (229 m) but < 1500 ft (457 m), then the ① to ② value equals 750 ft (229 m).

c. When the separation distance X ≥ 1500 ft (457 m), then the ① to ② value equals ½ the distance from the runway intersection to the end of the runway.

3.8.3 Converging Non-Intersecting Runways.

The "See and Avoid" concept of 14 CFR § 91.113 is the primary safeguard for collision avoidance for separate aircraft operating visually on runways with alignments that converge but do not physically intersect. As a supplemental safety enhancement for pilot situational awareness, airports may evaluate the LOS between runways that converge but do not intersect. FAA Order JO 7110.65 addresses FAA criteria for operational separation of IFR aircraft using converging non-intersecting runways.

3.8.3.1 **Recommended Practices.**

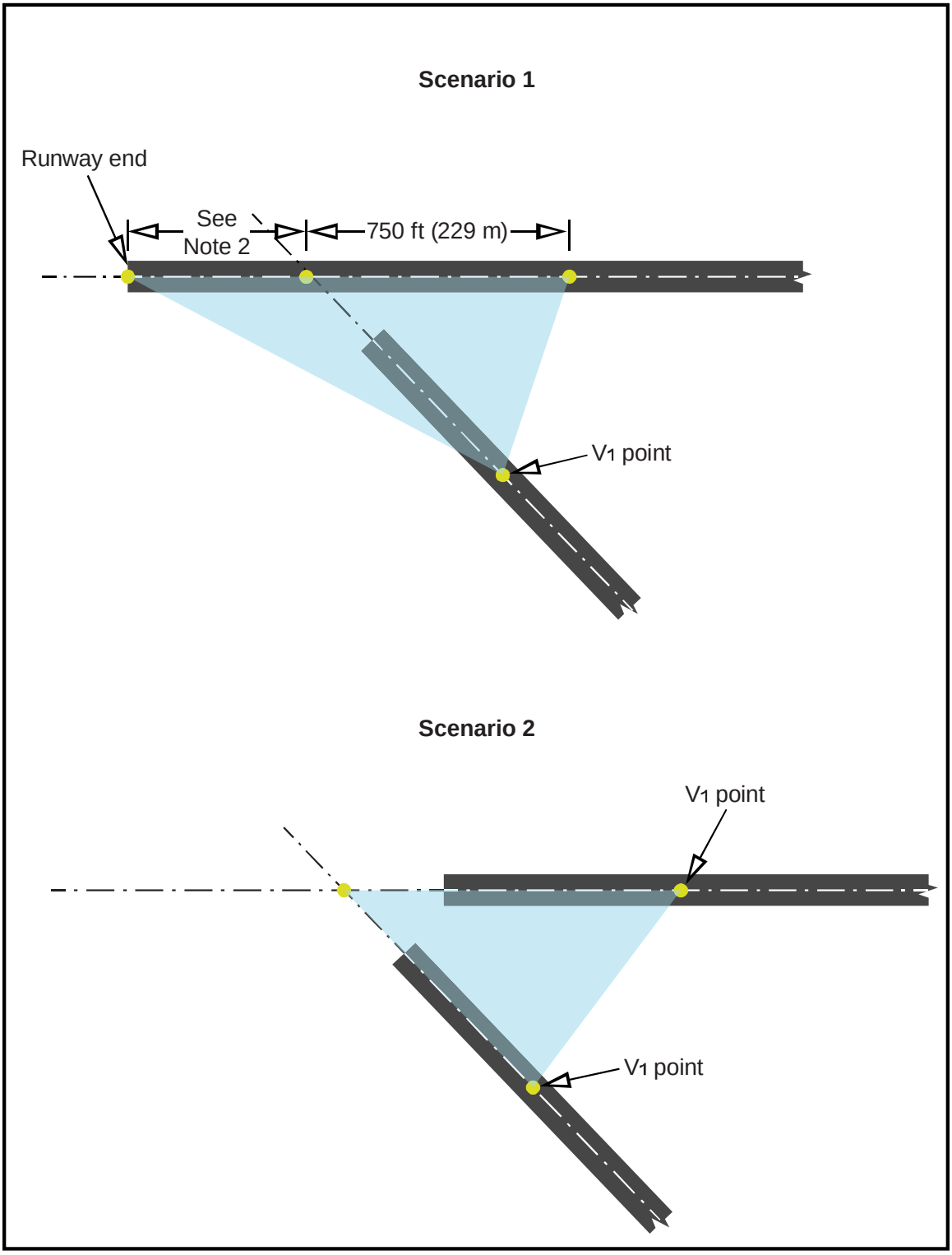
The following recommended practices apply to airports without an ATCT and airports with part-time ATCT operations. Individual ROFAs provide a measure of protection facilitating LOS between converging runways. To enhance this protection, evaluate the following for aircraft operations on a non-intersecting runway. Refer to Figure 3-17.

1. Scenario 1 – Converging runways where the extended centerline of a runway (Runway 1) intersects a crossing runway (Runway 2).
   a. Provide a clear LOS from the V_1 point of Runway 1 to points on Runway 2 located 750 ft (229 m) from the intersection with the extended centerline of Runway 1.
2. Scenario 2 – Converging runways where the extended centerline of both runways intersect.
   a. Provide a clear LOS from the V_1 point of both runways.
3. For both scenarios, evaluate if limiting development in this area to fixed-by-function facilities enhances pilot situational awareness.

3.9 **Parallel Runway Separation.**

This section provides an overview of the basic separation criteria between parallel runways. The FAA continues to refine parallel runway separation standards for various operational scenarios as part of modernization efforts for the NAS, including the Next Generation Air Transportation System (NextGen). FAA Order JO 7110.65 establishes FAA policy addressing operational procedures for parallel runways, including information on relevant dependencies with aircraft avionics and NAS automation equipment. While referencing FAA Order JO 7110.65 is normally sufficient for conceptual airport layout, additional coordination with Flight Standards, Flight Procedures and Technologies Division (AFS-410), is necessary for the development of detailed operational procedures and requirements for parallel runway procedures at a specific airport.

Figure 3-17. Runway Visibility Zone for Converging Non-Intersecting Runways



Note 1: Refer to paragraph 3.8.3.1 for further discussion.
Note 2: The lesser value of the distance from the runway end to the intersection and 750 ft (229 m).

3.9.1 Basic Principles.

To attain IFR capability for simultaneous independent landings and takeoffs on parallel runways, the lateral separation between aircraft operating to parallel runways replaces, in whole or in part, the aircraft-to-aircraft separation necessary for single runway operations. For parallel runways having sufficient centerline-to-centerline separation, the FAA can authorize simultaneous operations during visual or instrument weather conditions. Parallel runways with less than the necessary separation distance will have dependent operations, with reduced capacity, as compared to independent operations. Helipads have unique criteria for separation from runways and other helipads. Generally, departure operations follow criteria in paragraph 3.9.4. Arrival and mixed operations criteria vary. FAA Order JO 7110.65 establishes applicable operating criteria which is applied to locate the helipad.

3.9.2 Visual Flight Rules (VFR).

3.9.2.1 **Standards.**

1. For simultaneous independent landings and takeoffs using VFR, the minimum separation between centerlines of parallel runways is 700 feet (213 m) at a towered or non-towered airport (also when the tower is not operating).
2. With an operating control tower, the minimum separation between the centerlines of parallel runways for dependent landings and takeoffs using VFR is 300 feet (91 m).

3.9.2.2 **Design Considerations.**

With a narrow runway separation of 300 feet (91 m), preventing problematic taxiway geometry requires special attention. However, the 300-foot (91 m) separation configuration may be suitable for a paved runway paired with a turf runway. This avoids operating in the RSA of the paved runway for aircraft that prefer to use a grass surface. See paragraph 2.10.6 for discussion on operations within an RSA.

3.9.3 Simultaneous Instrument Flight Rules (IFR) Arrival Operations.

It is a condition of the separation criteria that the arriving aircraft establish itself on an IFP. Other criteria apply with ATC automation (in the Terminal Radar Approach Control Facilities (TRACON)), surveillance update rates, and ATC staffing for approach monitoring. Contact the applicable FAA Airports Regional Office or ADO to initiate applicable FAA coordination.

3.9.3.1 **Standards.**

1. For dual, simultaneous instrument approaches for airports with high update rate surveillance, typically Automatic Dependent Surveillance – Broadcast (ADS-B):

a. For straight-in approaches, the minimum parallel runway centerline separation between adjacent runways is 3,200 feet (975 m).

b. Separation of 2,500 feet (762 m) between adjacent parallel runways is allowable with an offset approach to one runway end.

2. For dual simultaneous instrument approaches for airports without high update rate surveillance, when using straight-in approaches, the minimum parallel runway centerline separation is 3,100 feet (945 m) between adjacent runways.

3. For triple simultaneous instrument approaches for airports with high update rate surveillance, when using straight-in approaches, the minimum parallel runway centerline separation is 3,100 feet (945 m) between adjacent runways.

a. A separation of 2,500 feet (762 m) between adjacent runways is allowable with an offset approach to an applicable outboard runway.

4. For quadruple simultaneous instrument approaches:

a. This capability does not currently exist in the NAS.

b. Development of quadruple approach capabilities involves a site-specific study by Flight Standards with procedure implementation by ATO

3.9.4 Simultaneous IFR Departures or Mixed Operations.

Simultaneous operations normally involve radar surveillance provided by ATC to monitor aircraft separation. ATC treats such operations on runways with centerline separation under 2,500 feet (762 m) as dependent runway operations when wake turbulence is a factor.

3.9.4.1 **Standards.**

1. Simultaneous departures:

a. With the parallel runway centerline separation of at least 2,500 feet (762 m) and the departure courses diverge by at least 10 degrees with RNAV or 15 degrees with non-RNAV courses.

b. With the parallel runway centerline separation of less than 2,500 feet (762 m) and the departure courses diverge by at least 15-degrees.

c. In non-radar airspace, with the parallel runway centerline separation of at least 3,500 feet (1,067 m) and the departure courses diverge by at least 45 degrees.

2. Simultaneous, radar-controlled, mixed operations (aircraft departing on a runway and an aircraft on final approach to another parallel

runway) require the following parallel runway centerline separations and a missed approach course divergent by at least 30 degrees from the departure course:

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

b. When the thresholds are staggered and the approach is to the near threshold, reducing the 2,500-foot (762 m) separation by 100 feet (30.5 m) for each 500 feet (152 m) of threshold stagger to a minimum separation of 1,000 feet (305 m) is allowable. See Figure 3-18.

c. When the thresholds are staggered and the approach is to the far threshold, increase the separation distance from the minimum 2,500-foot (762 m) by 100 feet (30.5 m) for every 500 feet (152 m) of threshold stagger. See Figure 3-18.

3.9.4.2 **Recommended Practices.**

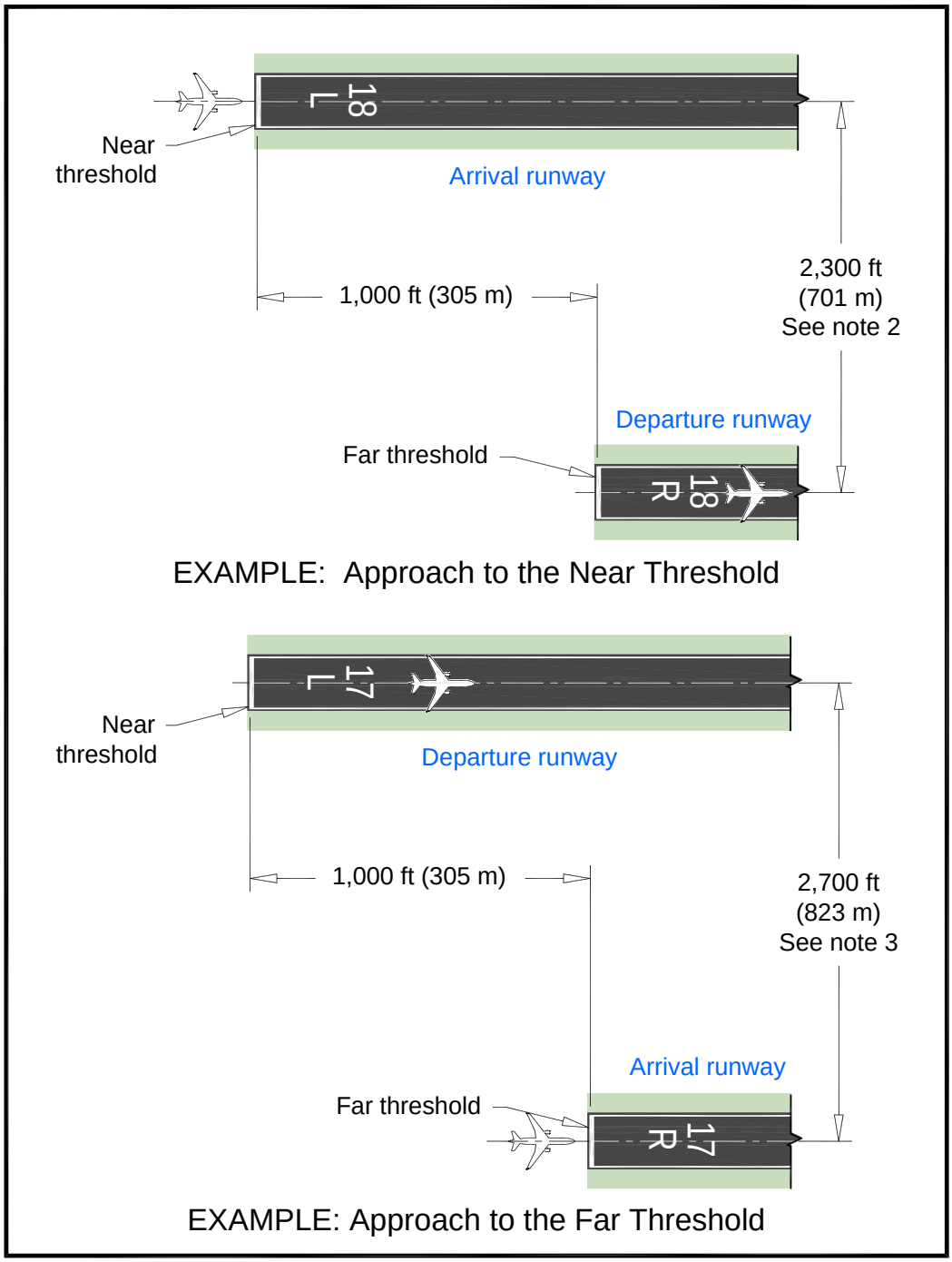
1. The recommended minimum runway centerline separation distance for ADG-V and ADG-VI runways is 1,200 feet (366 m).

2. The increased separation allows for holding aircraft between the runways in the interest of safety (preventing incursions) and efficiency.

3. Passenger terminal area space needs may dictate greater parallel runway separation than required for simultaneous IFR operations. Where practical, a parallel runway separation on the order of 5,000 feet (1,524 m) provides efficient surface operations to and from a terminal located between the runways.

4. Provide a separation distance that permits future development (e.g., parallel taxiway) without causing relocation of a runway.

Figure 3-18. Parallel Runway Separation – Simultaneous Radar-Controlled Mixed Operations with Staggered Thresholds



Note 1: Figure 3-18 illustrates parallel runway separation adjustments from the standard 2,500 ft (762 m) used with even thresholds for simultaneous radar-controlled mixed operations (arrival to one runway and departure on the other runway).

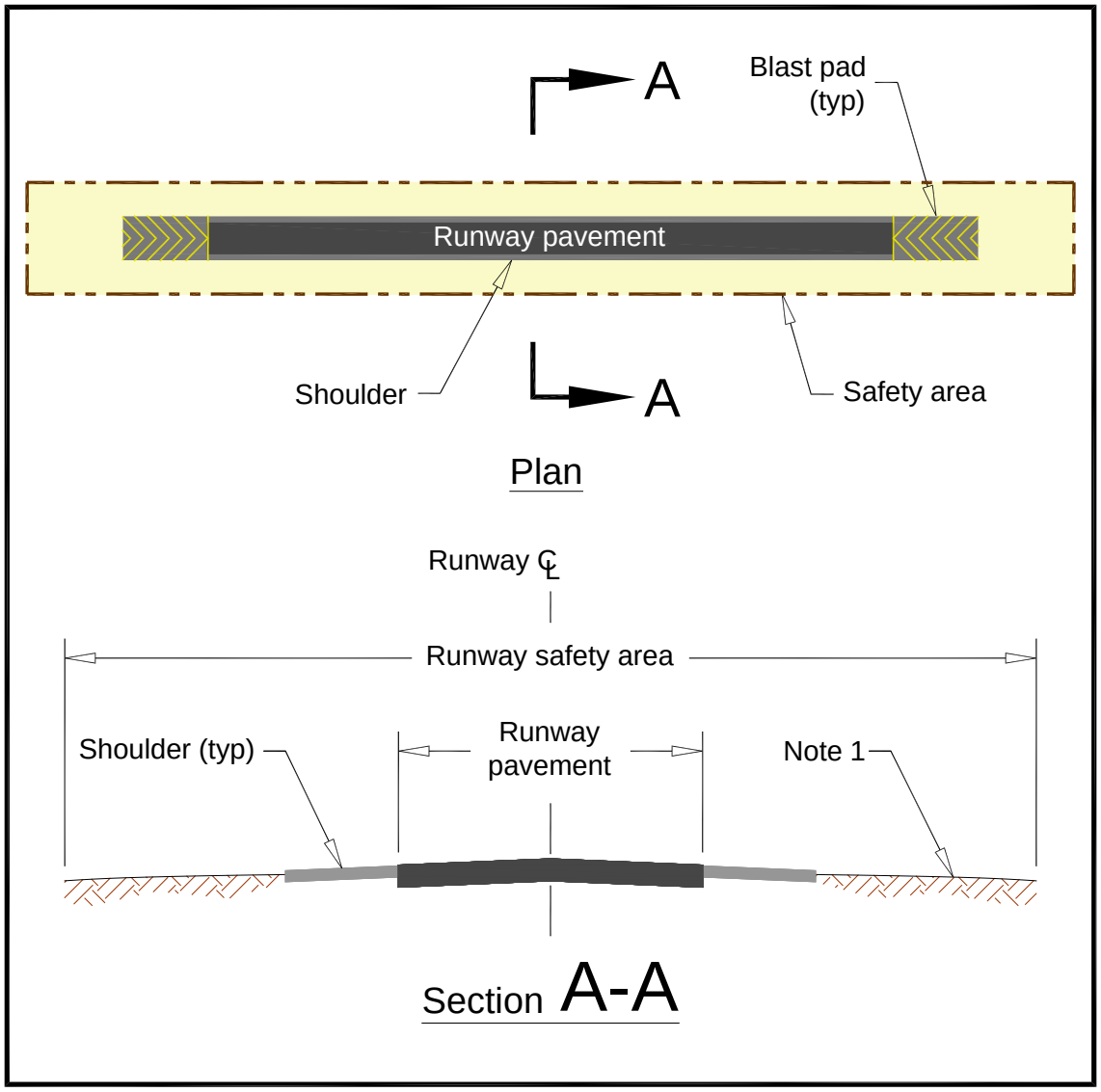
Note 2: Reduce the standard 2,500 ft (762 m) separation by 100 ft (30.5 m) for each 500 ft (152 m) of threshold stagger.

Note 3: Increase the standard 2,500 ft (762 m) separation by 100 ft (30.5 m) for each 500 ft (152 m) of threshold stagger.

3.10 Runway Safety Area (RSA).

The RSA enhances the safety of aircraft that undershoot, overrun, or veer off the runway, and provides greater accessibility for ARFF equipment during such incidents. Figure 3-19 depicts the RSA. Refer to Appendix H for the effect declared distances may have on runway safety areas. See Appendix I for historical and background information.

Figure 3-19. Runway Safety Area (RSA)



Note 1: The width and length beyond the runway end vary per the RDC. See Appendix G.

3.10.1 Standards.

3.10.1.1 **Location.**

The RSA is symmetrical to the runway centerline and runway extended centerline.

3.10.1.2 **Dimensions.**

Appendix G and the online Runway Design Standards Matrix Tool present RSA dimensional standards.

3.10.1.3 **Grading.**

Provide an RSA that is:

1. Cleared and graded with 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, ARFF equipment, and the occasional passage of aircraft without causing major damage to the aircraft; and
4. Graded to the longitudinal and transverse grades in paragraph 3.16.5.

3.10.1.4 **Object Clearing.**

Provide an RSA free of objects excluding those objects that need to reside in the RSA because of function (e.g., fixed-by-function).

1. Configure airfield geometries to keep the RSA clear during an aircraft operation of:
   a. All portions of a holding or taxiing aircraft.
   b. All portions of a holding or moving ground vehicle.
2. Design objects in the RSA with a height greater than 3 inches (76 mm) above the surrounding grade to have a frangible point no higher than 3 inches (76 mm) above the surrounding grade. See AC 150/5220-23.
3. Design foundations, concrete pads, and handholes that need to reside in the RSA:
   a. To be capable of supporting snow removal equipment (SRE) vehicles, ARFF vehicles, and occasional passage of the most demanding aircraft.
   b. Such that the top elevation is within a range between flush with grade and a height of 1-inch (25 mm) above immediate surrounding grade.
4. Locate objects outside the RSA if it is not essential for the object to reside within the RSA.

5. Do not locate objects, including NAVAIDs not fixed-by-function, inside the standard RSA dimensions even when the RSA does not meet the existing dimensional standards.

3.10.1.5 **Construction.**

Comply with compaction criteria in Specification P-152, Excavation, Subgrade and Embankment, found in AC 150/5370-10. Refer to AC 150/5320-6 for design guidance for foundations, inlets, and manholes located within the RSA to support occasional loads by the most demanding aircraft.

3.10.2 Design Considerations.

3.10.2.1 **Non-Standard RSAs.**

In accordance with FAA Order 5300.1, *Modifications to Agency Airport Design, Construction, and Equipment Standards*, the FAA will not consider a modification of standard to address non-standard RSA dimensions. RSA dimensional standards remain in effect regardless of the presence of natural objects, man-made objects, or surface conditions that preclude meeting full RSA standard dimensions.

1. Evaluate all practicable alternatives and opportunities to improve a non-standard RSA until it meets all standards for grade, construction, and object frangibility.
2. On the ALP, identify future development necessary to attain a standard RSA.
3. FAA Order 5200.8, *Runway Safety Area Program*, establishes FAA policy for the RSA determination process when assessing non-standard RSAs and identifies alternatives that may enhance safety.

3.10.2.2 **NAVAIDs.**

Consider the impact NAVAIDs have on the effectiveness of the RSA.

1. Evaluate practicable RSA construction at a grade that precludes the need for non-frangible towers for portions of approach lighting systems or the localizer antenna array.
   a. Non-frangible towers pose a hazard risk to aircraft and may represent a potential interference source to LOC performance.
   b. Construction to a lesser grade may allow installation on frangible or low impact resistant structures.
2. When practical, grade beyond the standard RSA dimensions to avoid abrupt drop-offs that can affect the location and performance of ILS components (GSs and LOCs).
   a. GS facilities need a graded area in front of the antenna to serve as an image-forming surface for the signal.

b. Extend the graded area past the RSA limits, if needed, to avoid placing the localizer within the RSA.

3.10.2.3 **Engineered Materials Arresting Systems (EMAS).**

Installing EMAS is an acceptable alternative where it is not practicable to obtain the standard RSA dimensions. A properly designed EMAS decelerates an aircraft during an excursion incident without damaging the landing gears, thus providing an equivalent level of safety to a standard RSA. The presence of an EMAS does not diminish the standard RSA width. Refer to AC 150/5220-22, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*, for guidance on planning, design, installation, and maintenance of EMAS. Refer to FAA Order 5200.9, *Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Material Arresting Systems*, to determine the best practical and financially feasible alternative. Key design considerations for EMAS performance include:

1. Aircraft weight, landing gear configuration, tire pressure, and entry speed.
2. Stopping the "EMAS critical aircraft" upon exiting the runway at 70 knots is a primary design condition.
3. Application of a standard EMAS may maximize the available runway length.

3.11 Obstacle Free Zone (OFZ).

The OFZ is a design surface kept clear during aircraft operations. This clearing standard does not allow aircraft and other object penetrations, except for locating frangible NAVAIDs in the OFZ because of their function. The FAA will not consider modification of the OFZ surface. The OFZ, when applicable, is composed of four components:

1. the Runway OFZ (ROFZ),
2. the Precision Obstacle Free Zone (POFZ),
3. the inner-approach OFZ (IA-OFZ), and
4. the inner-transitional OFZ (IT-OFZ).

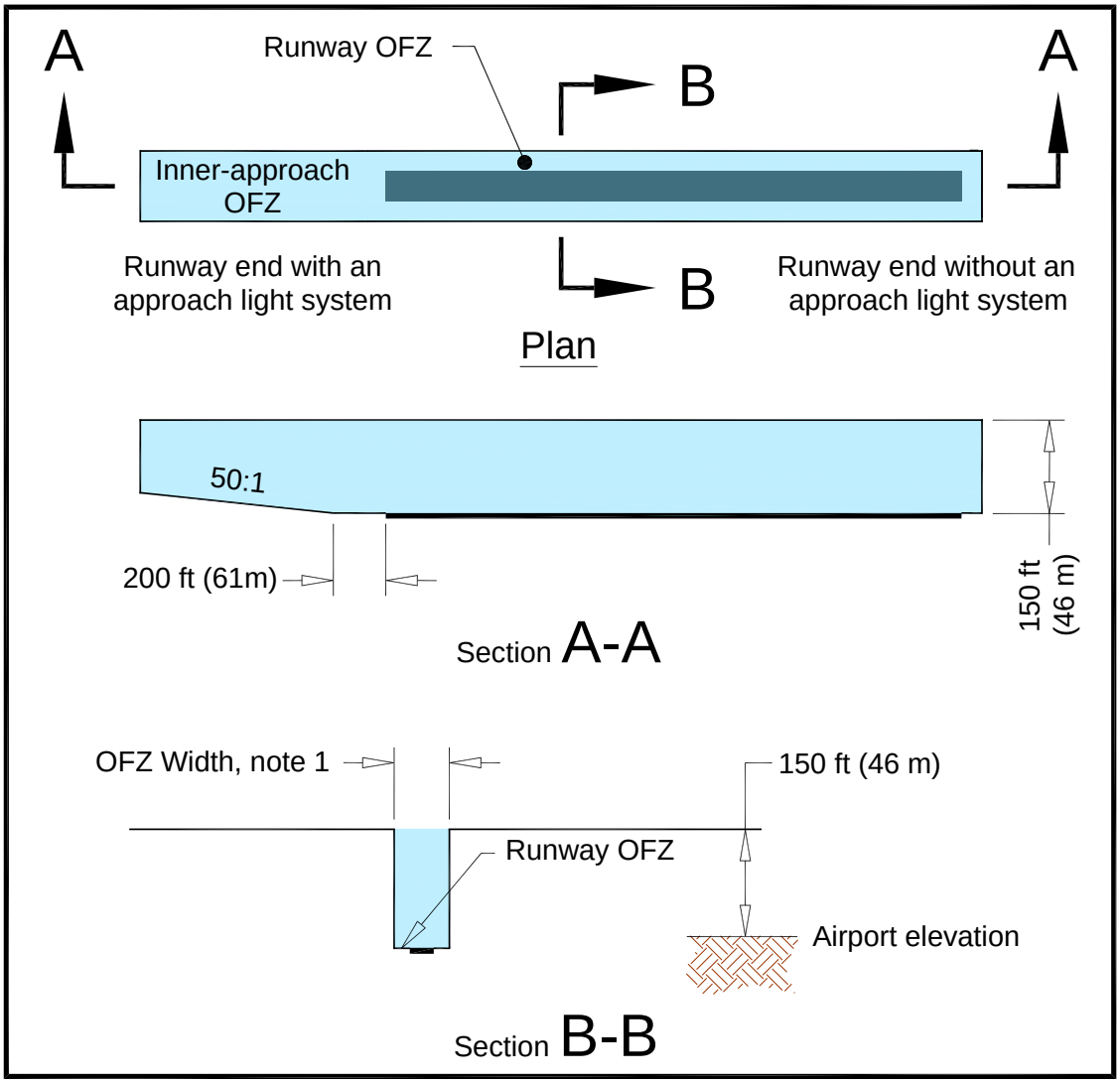
3.11.1 Design Considerations.

1. Use the critical aircraft when selecting the applicable OFZ for runway design.
2. The OFZ standard is dependent on the approach minimums for the runway end and the aircraft on approach, thus the OFZ for a specific aircraft operation may not be the same shape as that used for design purposes.
3. Procedures to protect the OFZ during operations by aircraft more demanding than used for the design of the runway are beyond the scope of this AC. Consultation

with the appropriate offices of the FAA Office of Airports, Flight Standards, and/or ATO will identify any applicable adjustments to operational procedures.

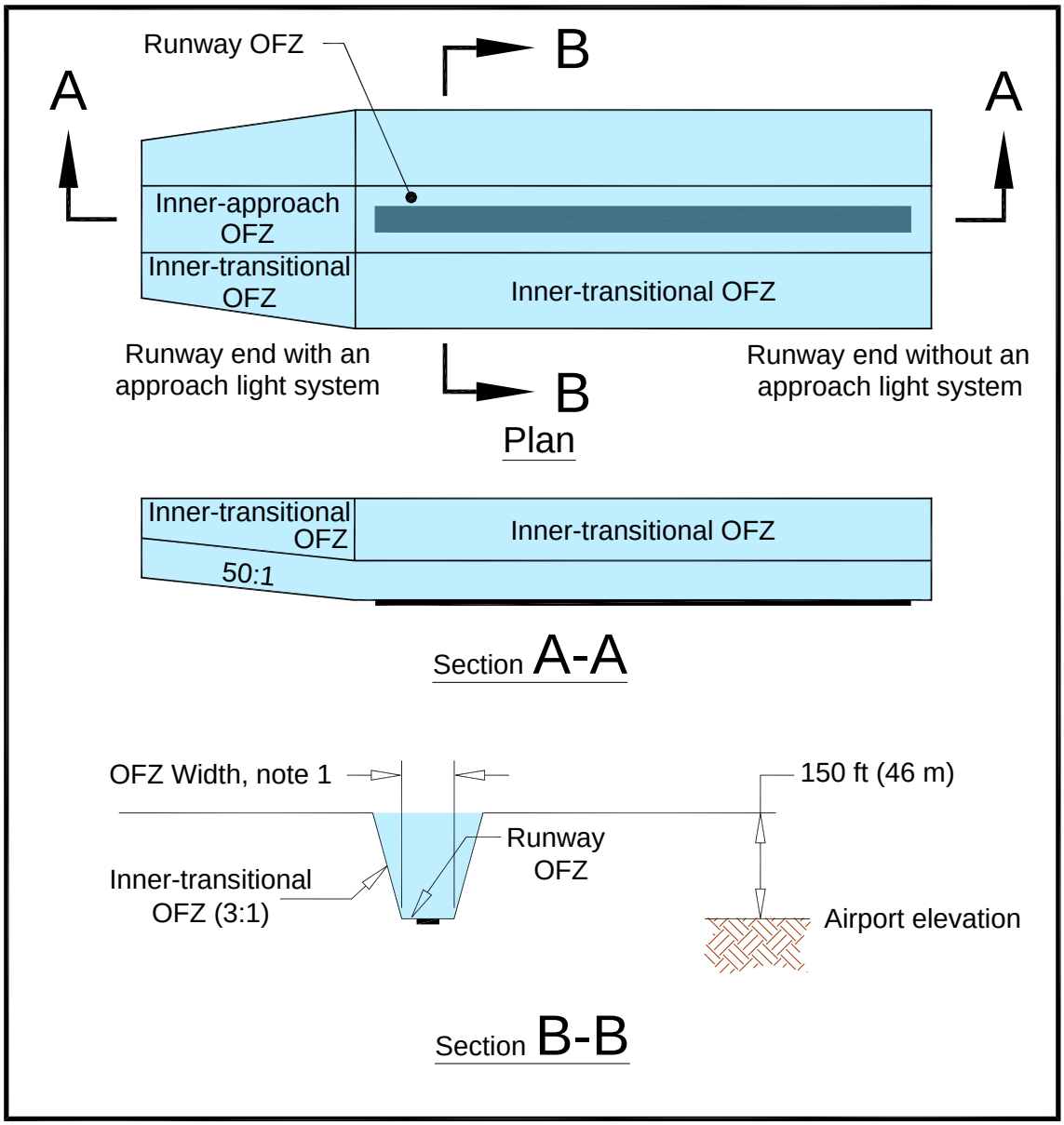
4. See Figure 3-20, Figure 3-21, Figure 3-22, and Figure 3-23 for various OFZ based on aircraft size and visibility minimums.

Figure 3-20. Obstacle Free Zone (OFZ) for Visual Runways and Runways with Not Lower Than ¾ Statute Mile (1.2 km) Approach Visibility Minimums



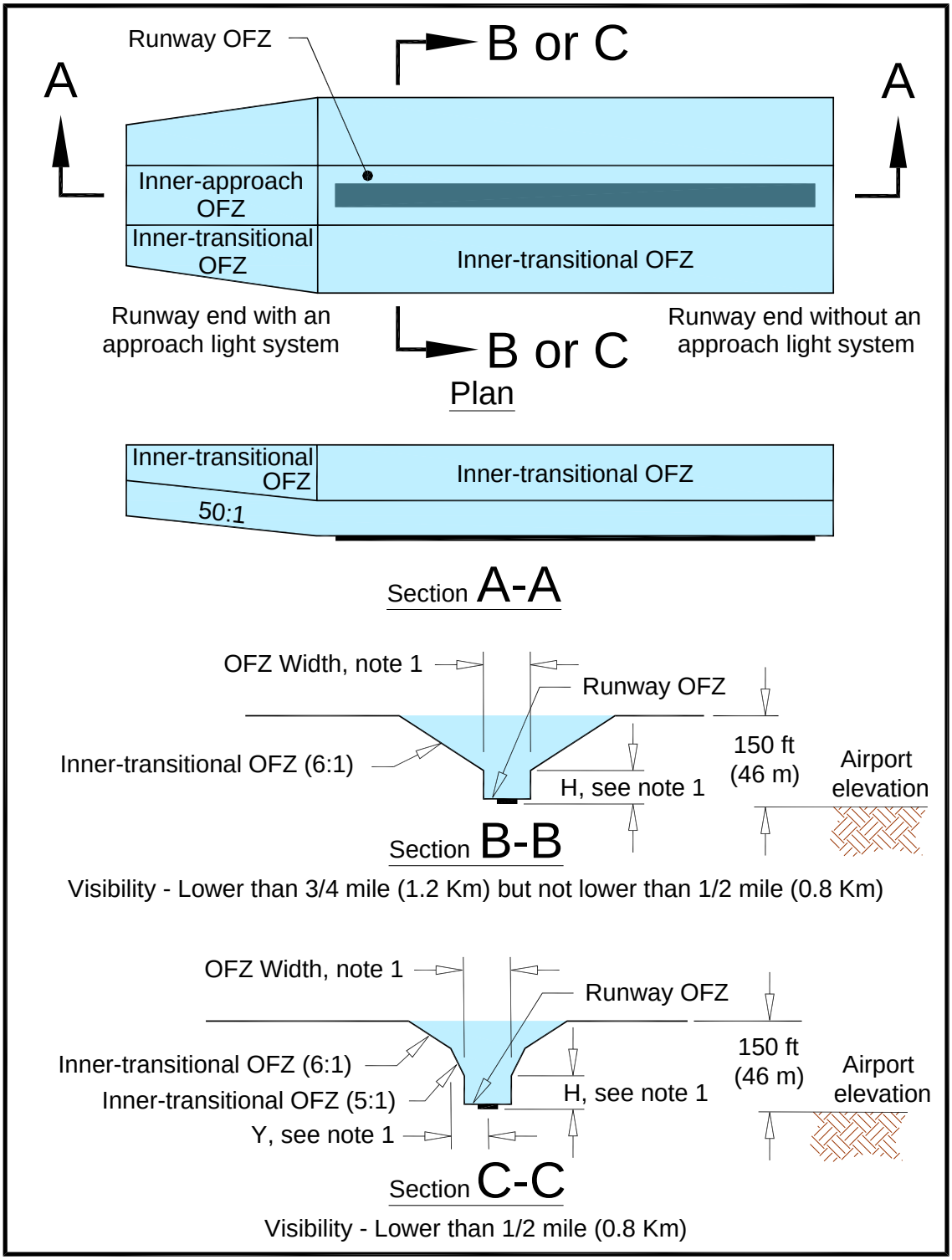
Note 1: Refer to paragraphs 3.11.2, 3.11.3, and 3.11.4 for dimensional values.

Figure 3-21. OFZ for Operations on Runways by Small Aircraft with Lower Than ¾ Statute Mile (1.2 km) Approach Visibility Minimums



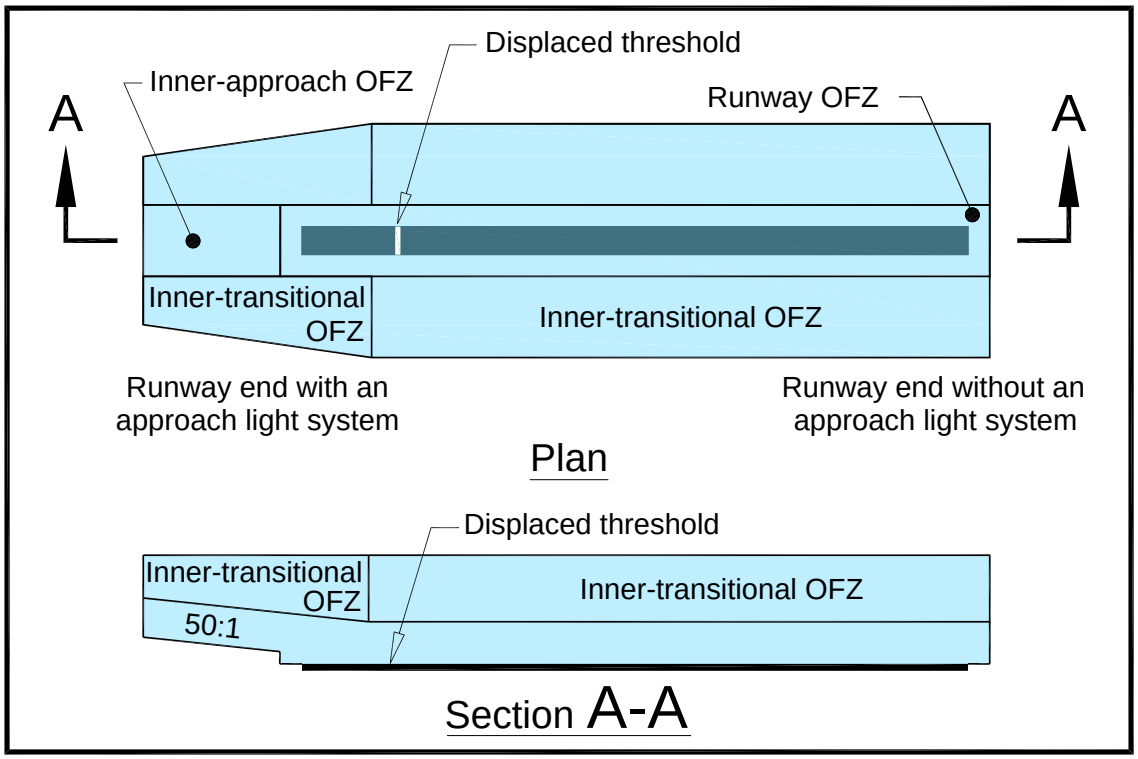
Note 1: Refer to paragraphs 3.11.2, 3.11.3, and 3.11.4 for dimensional values.

Figure 3-22. OFZ for Operations on Runways by Large Aircraft with Lower Than ¾ Statute Mile (1.2 km) Approach Visibility Minimums



Note 1: Refer to paragraphs 3.11.2, 3.11.3, and 3.11.4 for dimensional values.

Figure 3-23. OFZ for Operations on Runways by Large Aircraft with Lower Than ¾ Statute Mile (1.2 km) Approach Visibility Minimums and Displaced Threshold



Note 1: Refer to paragraphs 3.11.2, 3.11.3, and 3.11.4 for dimensional values.

3.11.2 Runway Obstacle Free Zone (ROFZ).

The ROFZ is a defined volume of airspace centered on the runway centerline, whose base elevation is that of the highest runway elevation at that particular location. The ROFZ extends 200 feet (61 m) beyond each end of the runway.

3.11.2.1 **Standards.**

1. For operations by small aircraft:
   a. 300 feet (91 m) wide for runways with lower than ¾ statute mile (1.2 km) approach visibility minimums.
   b. 250 feet (76 m) wide for operations on other runways by small aircraft with approach speeds of 50 knots or more.
   c. 120 feet (37 m) wide for operations on other runways by small aircraft with approach speeds of less than 50 knots.
2. For operations by large aircraft:
   a. 400 feet (122 m) wide for operations.

3.11.3 Inner-approach OFZ (IA-OFZ).

The IA-OFZ is a defined volume of airspace centered on the approach area. It only applies to runways with an ALS. The IA-OFZ begins 200 feet (61 m) from the runway threshold at the same elevation as the runway threshold and extends 200 feet (61 m) beyond the last light unit in the ALS. Its width is the same as the ROFZ and rises at a slope of 50 (horizontal) to 1 (vertical) from its beginning.

3.11.4 Inner-transitional OFZ (IT-OFZ).

The IT-OFZ is a defined volume of airspace along the sides of the ROFZ and IA-OFZ. It only applies to runways with lower than ¾ statute mile (1.2 km) approach visibility minimums. Aircraft tails may not violate the IT-OFZ. It is not acceptable to apply the OFZ criteria as support to decrease a runway to taxiway separation from the standard value.

3.11.4.1 For operations on runways by small aircraft, the IT-OFZ slopes 3 (horizontal) to 1 (vertical) out from the edges of the ROFZ and IA-OFZ to a height of 150 feet (46 m) above the established airport elevation.

3.11.4.2 For operations on runways by large aircraft, separate IT-OFZ criteria applies for runways with IFPs lower than ¾ mile (1.2 km) but not lower than ½ mile (0.8 km), and for lower than ½ mile (0.8 km).

1. For runways with IFPs lower than ¾ mile (1.2 km) but not lower than ½ mile (0.8 km), the IT-OFZ begins at the edges of the ROFZ and inner-approach OFZ, then rises vertically for height “H,” and then slopes 6 (horizontal) to 1 (vertical) out to a height of 150 feet (46 m) above the established airport elevation.

   a. In U.S. customary units,

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

   b. In the International System of Units (SI),

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

   c. S is equal to the most demanding wingspan of the RDC of the runway, and E is equal to the runway threshold elevation above sea level.

2. For runways with IFP lower than ½ mile (0.8 km) visibility, the IT-OFZ begins at the edges of the ROFZ and IA-OFZ, then rises vertically for height “H,” then slopes 5 (horizontal) to 1 (vertical) out to a distance “Y” from runway centerline, and then slopes 6 (horizontal) to 1 (vertical) out to a height of 150 feet (46 m) above the established airport elevation.

   a. In U.S. customary units,

   $H_{feet} = 53 – 0.13(S_{feet}) – 0.0022(E_{feet})$ and

$Y_{feet} = 440 + 1.08(S_{feet}) – 0.024(E_{feet})$.

b. In SI units,

$H_{meters} = 16 – 0.13(S_{meters}) – 0.0022(E_{meters})$ and

$Y_{meters} = 132 + 1.08(S_{meters}) – 0.024(E_{meters})$.

c. S is equal to the most demanding wingspan of the RDC of the runway and E is equal to the runway threshold elevation above sea level.

d. Beyond the distance "Y" from the runway centerline, the CAT-II/III IT-OFZ surface is identical to that for the CAT-I OFZ.

3.11.5 Precision Obstacle Free Zone (POFZ).

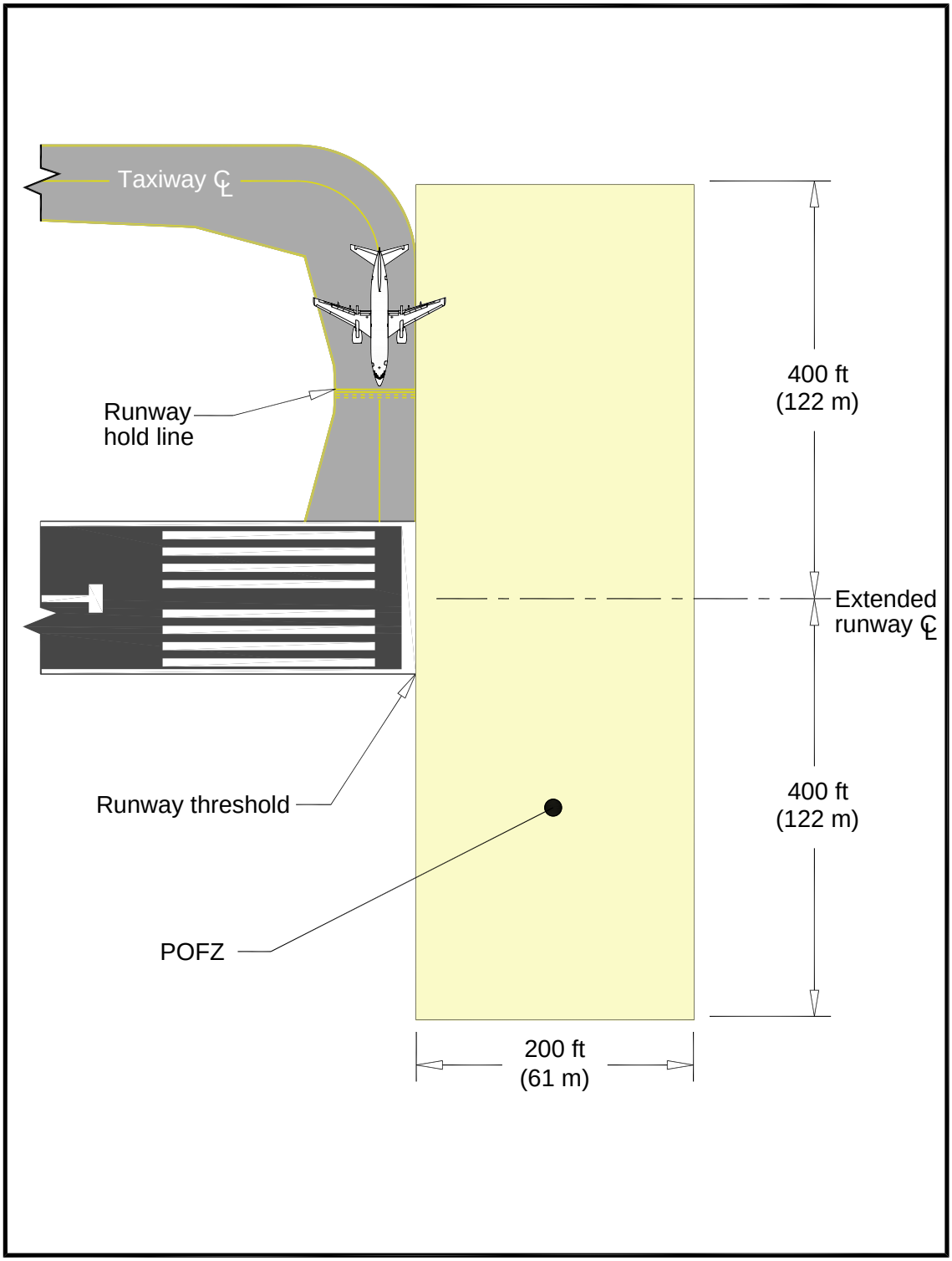
The POFZ is a volume of airspace above an area beginning at the threshold, at the threshold elevation. The POFZ extends along the extended runway centerline beyond the runway end for a distance of 200 feet (61 m) at a width of 800 feet (244 m). See Figure 3-24.

3.11.5.1 The POFZ is applicable to any runway served by a vertically-guided approach with landing minimums less than 250 feet (76 m) or visibility less than ¾ statute mile (1.2 km) (or RVR is below 4,000 feet (1219 m)). The surface is in effect when an aircraft is on final approach within 2 miles (3.2 km) of the runway threshold.

3.11.5.2 When the POFZ is in effect, a wing or a fuselage-mounted horizontal stabilizer of an aircraft holding on a taxiway may penetrate the POFZ; however, neither the fuselage nor tail-mounted horizontal stabilizers may penetrate the POFZ.

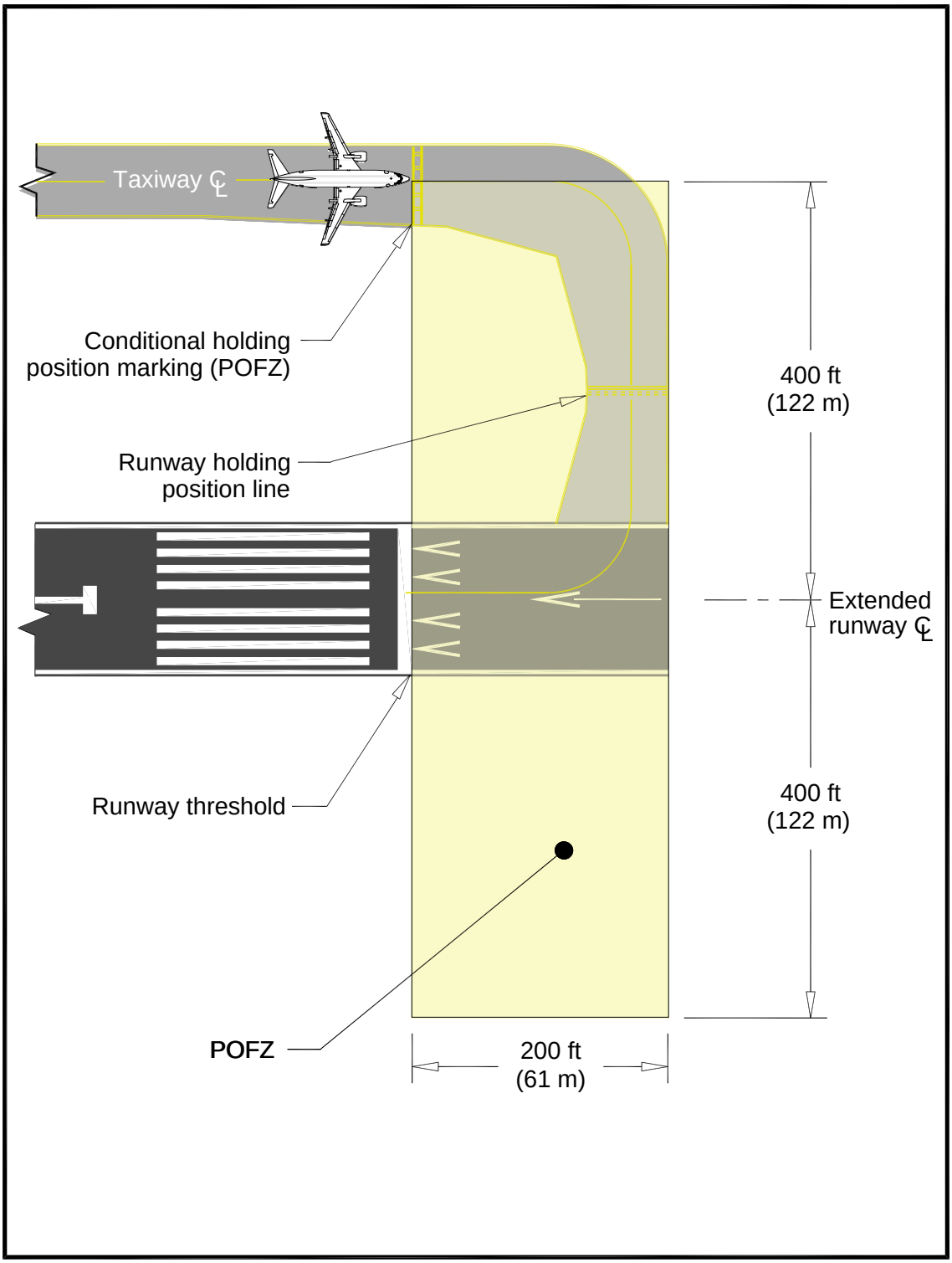
3.11.5.3 The POFZ still applies for runways with displaced thresholds while meeting the criteria in paragraph 3.11.5.1. Refer to Figure 3-25.

Figure 3-24. Precision Obstacle Free Zone (POFZ) – No Displaced Threshold



Note: See paragraph 3.11.5.

Figure 3-25. POFZ – Displaced Threshold



Note 1: Two holding position lines are necessary for this situation: 1) POFZ conditional hold for instrument meteorological conditions, and 2) mandatory hold for all conditions.

3.12 Runway Object Free Area (ROFA).

ROFA is a clear area limited to equipment necessary for air and ground navigation and provides wingtip protection in the event of an aircraft excursion from the runway.

3.12.1 Standards.

1. The ROFA is symmetrical about the runway centerline. See Figure 3-1.
2. See Appendix G or the online Runway Design Standards Matrix Tool for standard dimensions of the ROFA.
3. Provide area clear of above-ground objects protruding above the elevation of the nearest point of the RSA:
   a. Ensure terrain is no higher than the nearest point of the RSA within a distance from the edge of the RSA equal to half the most demanding wingspan of the RDC.
   b. Keep area clear of parked aircraft and vehicles, and any non-navigational objects not allowed in paragraph 3.12.1, item 4.
4. Exceptions:
   a. Taxiing and holding aircraft within the ROFA do not violate the standard.
   b. Precision approach path indicator (PAPI) power control units and supplemental wind cones may reside in the ROFA provided there is no wingtip conflict when locating the outer main gear of the RDC aircraft at the RSA boundary.
   c. Equipment that is necessary for air navigation or aircraft ground maneuvering and is fixed-by-function, per Table 6-1, may reside within the ROFA except as precluded by other clearing standards (e.g., NAVAID critical areas).
   d. For existing runways, it is permissible for the ROFA to have a positive grade lateral to the RSA, as shown in Figure 3-33, provided there is adequate drainage of the RSA.
   e. Above-grade drainage structures, such as a drainage headwall, not exceeding 3 inches (76 mm) above the elevation of the nearest point on the RSA may reside within the ROFA.

3.12.2 Recommended Practices.

1. To the extent practical, make objects in the ROFA that exceed the elevation of the nearest point on the RSA comply with the same frangibility criteria as the RSA.
2. Preclude locating objects in a ROFA that can function equally outside of the ROFA.

3.12.3 Design Consideration.

When locating ditches in a ROFA, consider the impact future vegetation growth in the ditch may have on the adjacent RSA.

3.13 Runway Protection Zone (RPZ).

The RPZ is a protection zone that serves to enhance the protection of people and property on the ground. Airport owner control and implementation of compatible land use principles for each runway RPZ is the optimum method of ensuring the public's safety in these areas. Acquisition of appropriate property interest (e.g., fee title, easement, etc.) offers a high degree of control. Zoning ordinances offer a lesser degree of control. The primary goals are to clear the RPZ areas of incompatible objects and activities, and to ensure this area remains clear of such objects and activities.

1. The approach RPZ dimensions for a runway end are a function of the aircraft approach category and approach visibility minimum associated with the approach runway end.
2. The departure RPZ is a function of the aircraft approach category and departure procedures associated with the runway.
3. For a particular runway end, the more stringent RPZ (usually the approach) will govern the property interests and clearing for the airport owner.

3.13.1 Standards.

The RPZ is trapezoidal in shape and centered about the extended runway centerline. Two different components comprise the RPZ; the approach and departure RPZ, which normally overlap. Discontinuity may occur when the approach or departure RPZ begins at a location other than 200 feet (61 m) beyond the end of the runway (refer to Figure 3-26 and Figure 3-28).

3.13.1.1 Approach RPZ.

The approach RPZ extends from a point 200 feet (61 m) from the runway threshold, as shown in Figure 3-26, for a distance as prescribed in Appendix G or the online Runway Design Standards Matrix Tool.

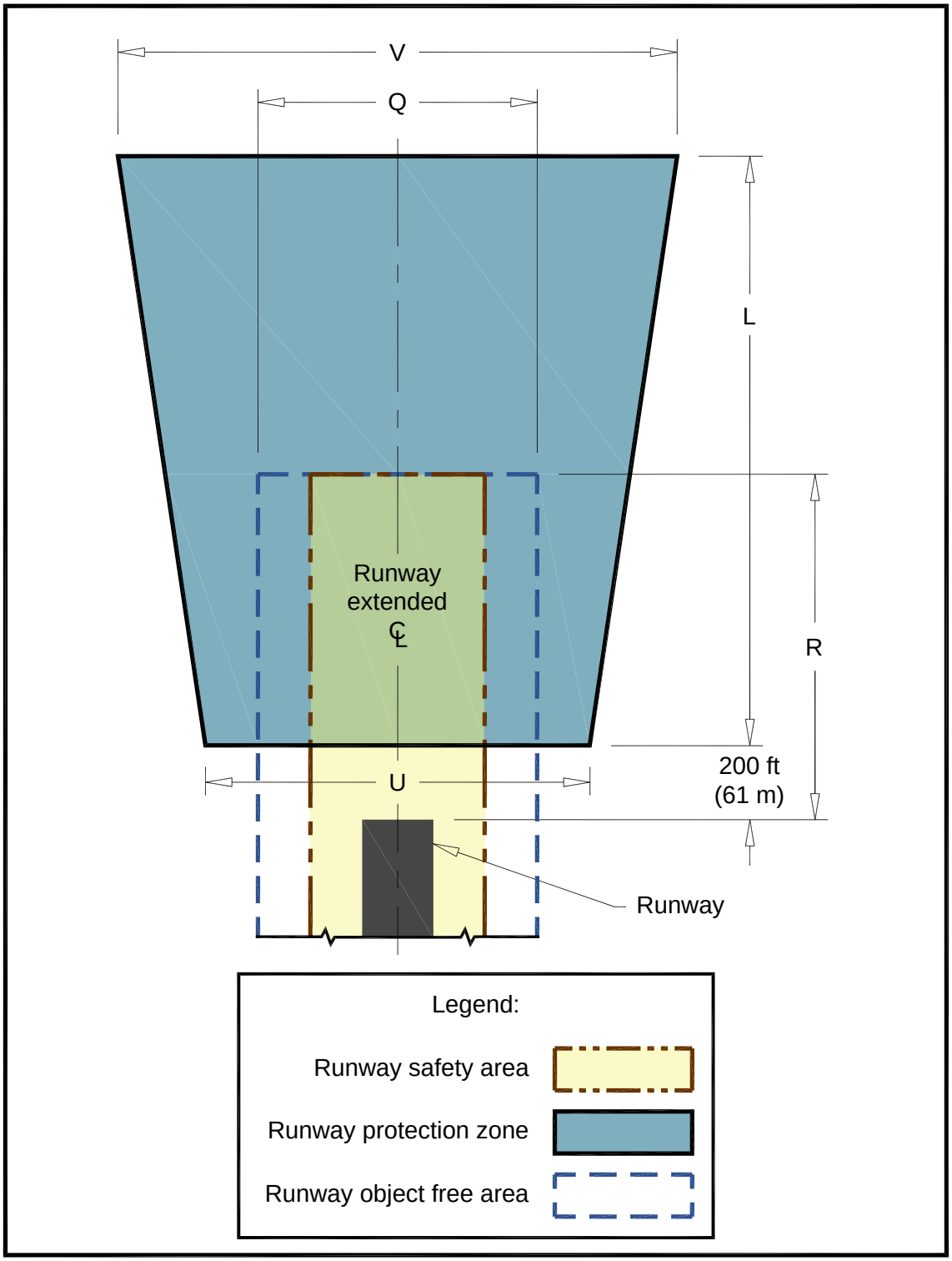
3.13.1.2 Departure RPZ.

The departure RPZ begins 200 feet (61 m) beyond the runway end. If the end of the TORA and the runway end are not the same, it is 200 feet (61 m) beyond the far end of the TORA. Refer to Appendix G or the online Runway Design Standards Matrix Tool for dimensional standards.

3.13.2 Design Considerations.

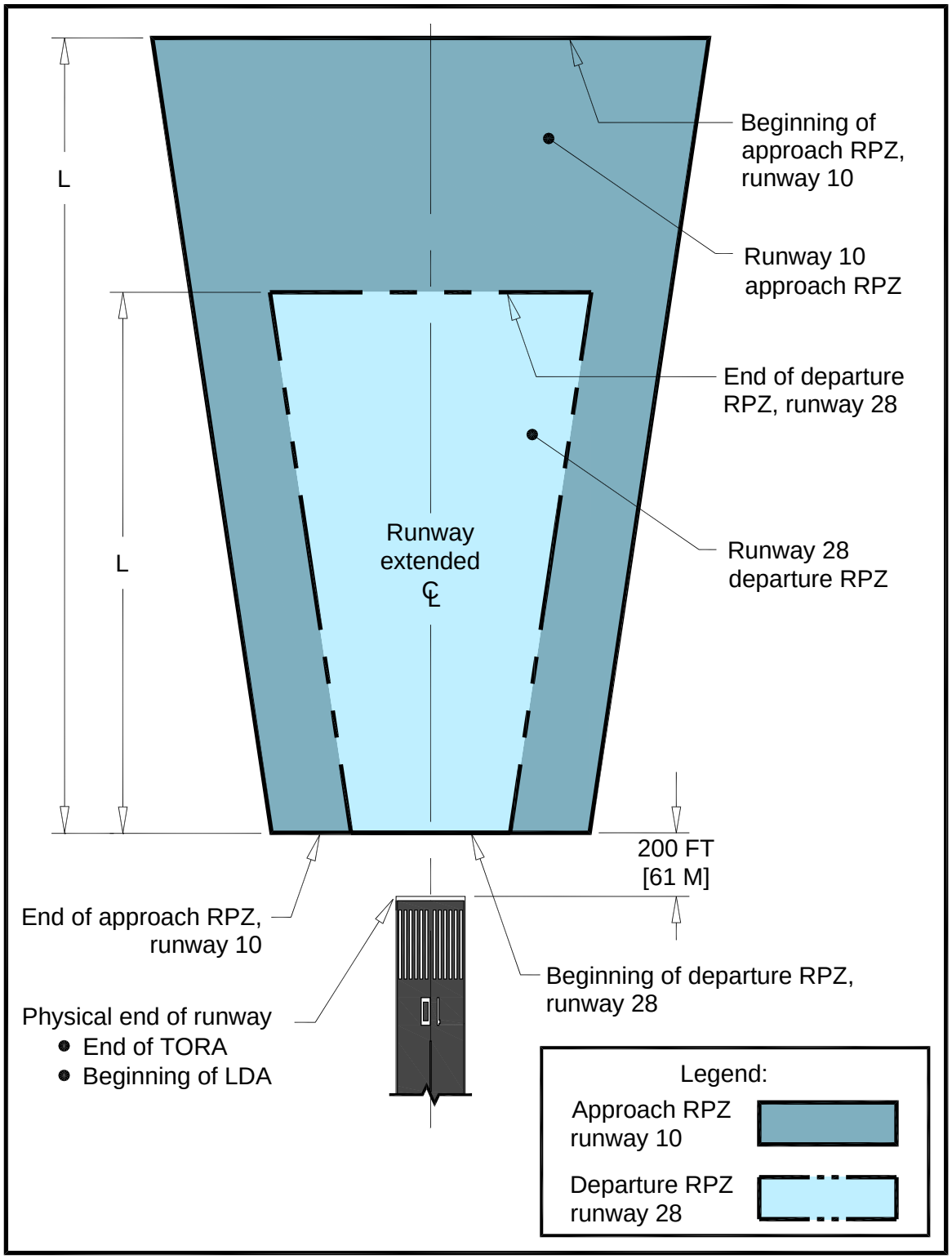
For land use discussion, see Appendix I.

Figure 3-26. Runway Protection Zone (RPZ), Runway Object Free Area (ROFA), and Runway Safety Area (RSA)



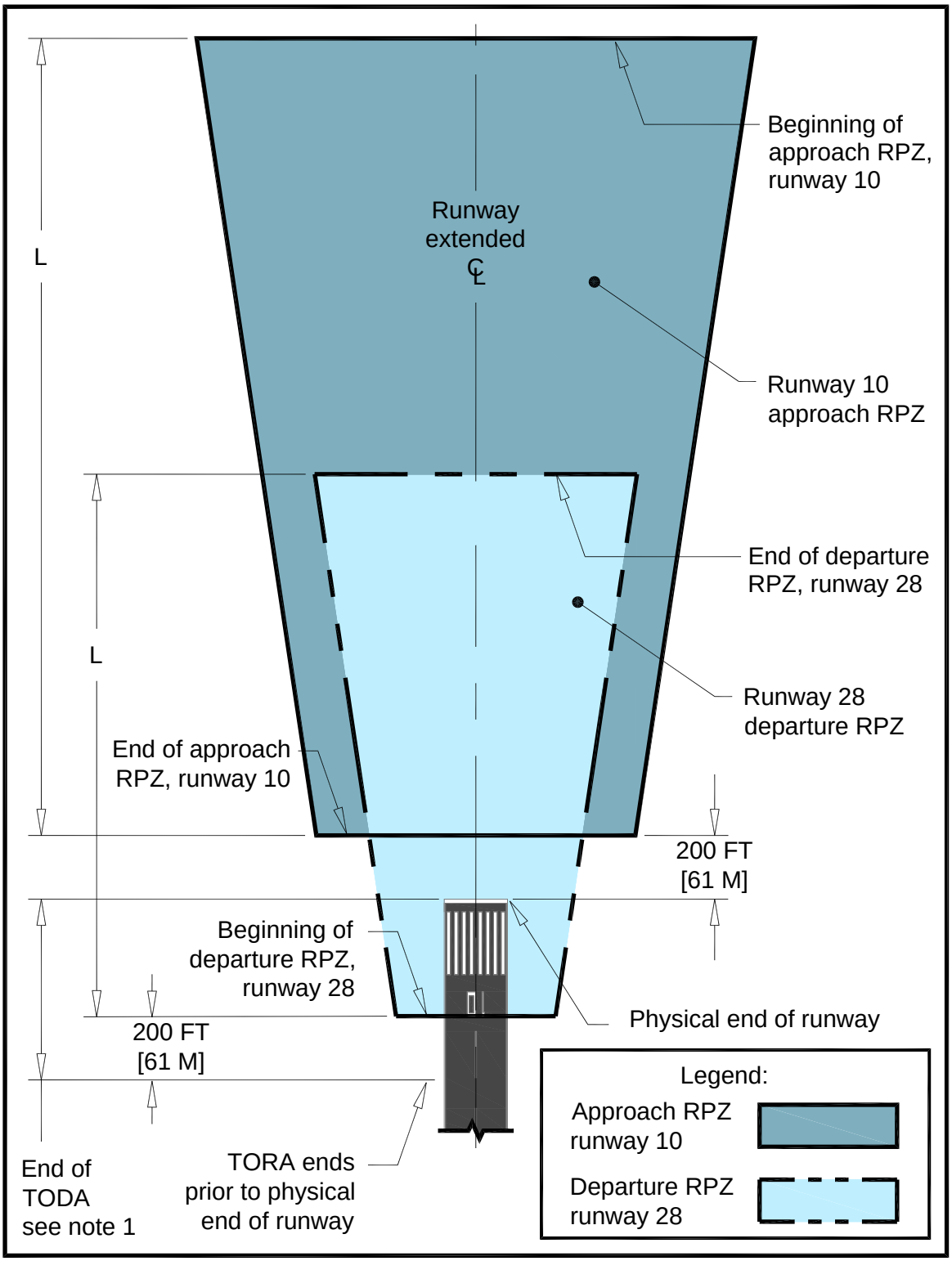
Note: See Appendix G or online Runway Design Standards Matrix Tool for dimensions.

Figure 3-27. Runway with all Declared Distances Equal to the Runway Length



Note: See Appendix G or online Runway Design Standards Matrix Tool for dimensions.

Figure 3-28. Approach and Departure RPZs Where the Takeoff Run Available (TORA) is Less Than the Takeoff Distance Available (TODA)



Note 1: See Appendix H for declared distances.
Note 2: See Appendix G or online Runway Design Standards Matrix Tool for dimensions.

3.14 Clearway.

The clearway (see Figure 3-29) is an area extending beyond the runway end available for completion of the takeoff operation of turbine-powered aircraft. A clearway increases the allowable aircraft operating takeoff weight without increasing runway length. The use of a clearway for takeoff computations requires compliance with the clearway definition of 14 CFR Part 1, *Definitions and Abbreviations*.

3.14.1 Standards.

The requirements in this paragraph originate from Part 1. These conditions must be met for a clearway to exist.

3.14.1.1 Dimensions.

The clearway must be at least 500 feet (152 m) wide symmetrically about the runway centerline. The length is no more than half the runway length.

3.14.1.2 Clearway Plane Slope.

The clearway plane slopes upward with a slope not greater than 1.25 percent (80:1).

3.14.1.3 Clearing.

No object or terrain may protrude through the clearway plane except for threshold lights no higher than 26 inches (660 mm) and located off the runway sides. The area over which the clearway lies need not be suitable for stopping aircraft in the event of an aborted takeoff.

3.14.1.4 Control.

A condition for standard clearways is that the airport owner have suitable control of the underlying property. While direct ownership is not necessary, ownership offers the highest degree of control. The purpose of such control is to ensure that no fixed or movable object penetrates the clearway plane during a takeoff operation.

3.14.1.5 Notification.

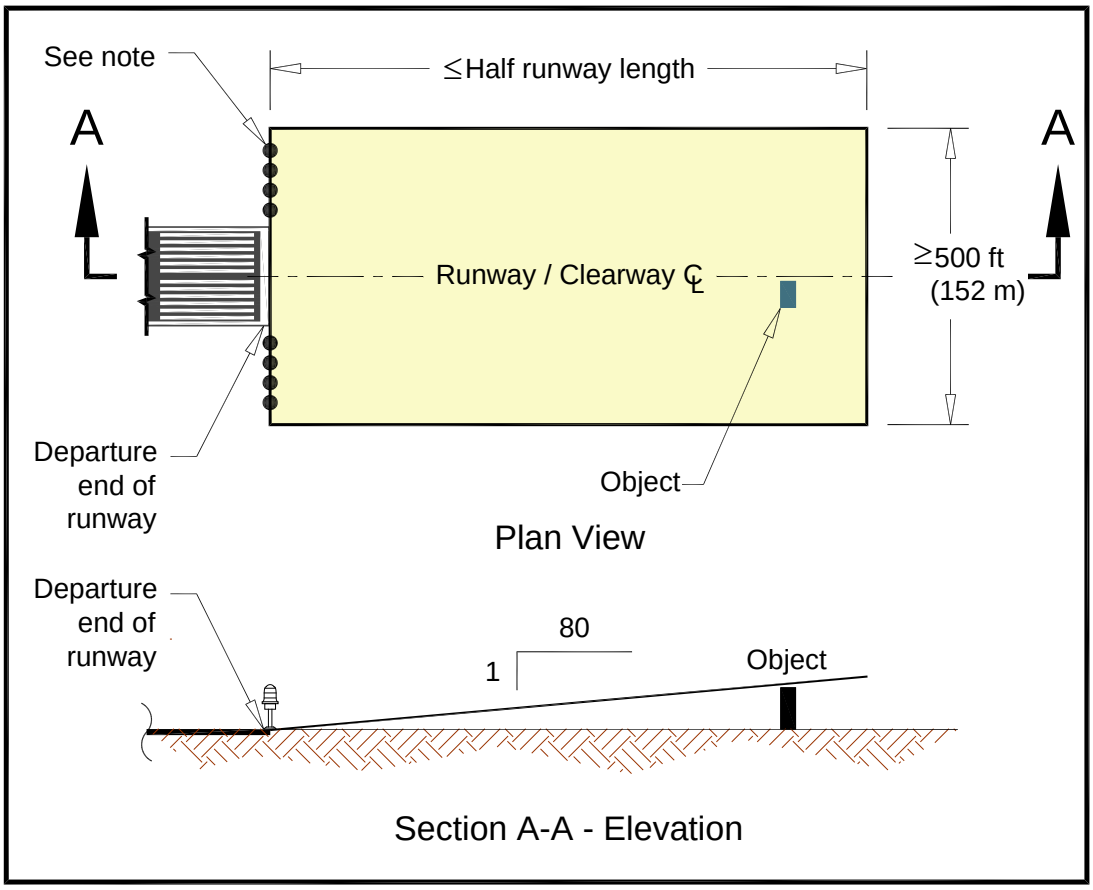
When providing a clearway:

1. Identify the clearway length and the declared distances, as specified in paragraph 3.14.1.1, and in the Chart Supplement (and in the Aeronautical Information Publication for international airports) for each operational direction.
2. Designate the clearway on the ALP at those airports with an FAA-approved ALP.

3.14.1.6 Clearway Location.

Locate the clearway at the far end of TORA. The portion of the runway extending into the clearway is unavailable for takeoff run computations.

Figure 3-29. Clearway



Note: Threshold lights located to each side of the runway.

3.15 **Stopway.**

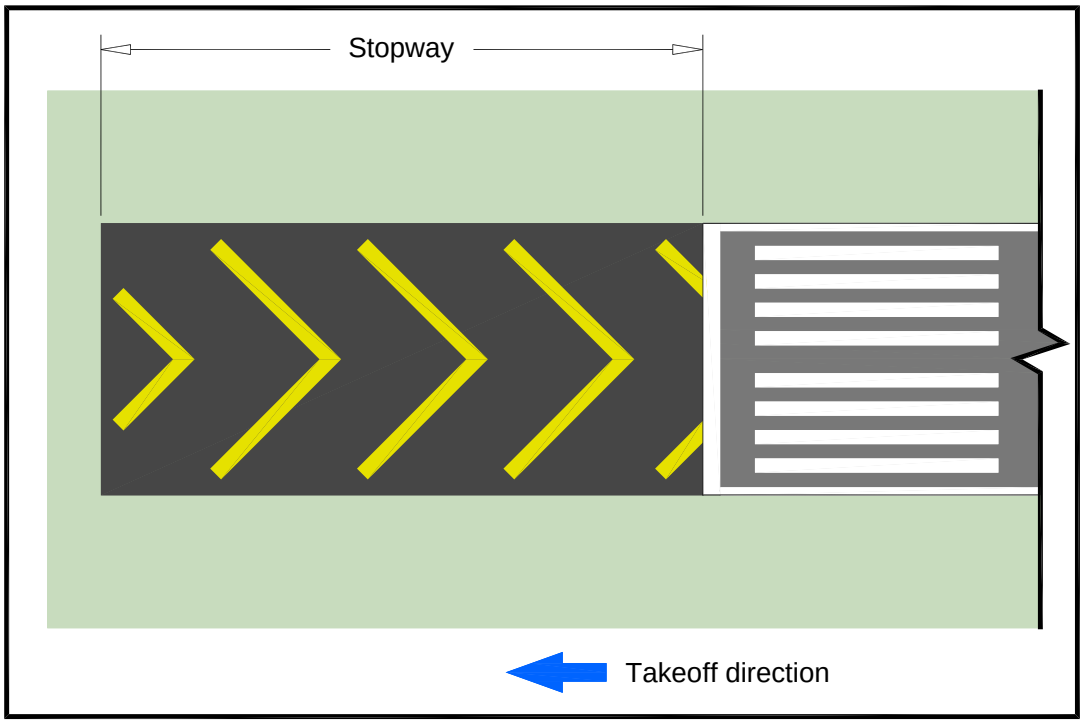
A stopway is an area beyond the takeoff runway located symmetrically about the extended runway centerline and designated by the airport owner for use in decelerating an aircraft during an aborted takeoff. (See Figure 3-30.) The presence of a blast pad does not mean a stopway exists. Refer to Part 1 for the criteria that establish a stopway.

3.15.1 Standards.

1. Width: At least as wide as the runway.
2. Surface strength:
   a. Able to support an aircraft during an aborted takeoff without causing structural damage to the aircraft.
   b. Refer to AC 150/5320-6 for pavement design standards for a stopway.
3. Publication: For each operational direction, provide the stopway length and declared distances in the Chart Supplement (and in the Aeronautical Information Publication for international airports).

4. ALP: For Federally obligated airports, depict the stopway on the FAA-approved ALP.

Figure 3-30. Stopway



Note 1: Width of stopway equals width of runway.
Note 2: See AC 150/5340-1 for stopway markings.

3.16 Surface Gradient.

Surface gradient is the rate of ascent or descent of an airport surface. The degree of surface gradient can have an effect on aircraft performance, pilot perception, and economy of development. An upsloping runway impedes acceleration resulting in longer ground runs during a takeoff operation. A down sloping runway affects deceleration, thus resulting in longer ground rollout during landing. The standards in this paragraph allow for economic design flexibility while establishing safe operation of aircraft during landing and takeoff operations. Some of the beneficial aspects provided by the gradient standards include:

1. Safe operation within aircraft structural limits.
2. Efficient drainage of surface water to reduce the risk of aircraft hydroplaning.
3. Visual LOS for pilot situational awareness.
4. Reduced risk of optical illusion effect due to runway and terrain slope.
5. Ride smoothness and comfort for aircraft passengers.

3.16.1 Standards for Longitudinal Gradient.

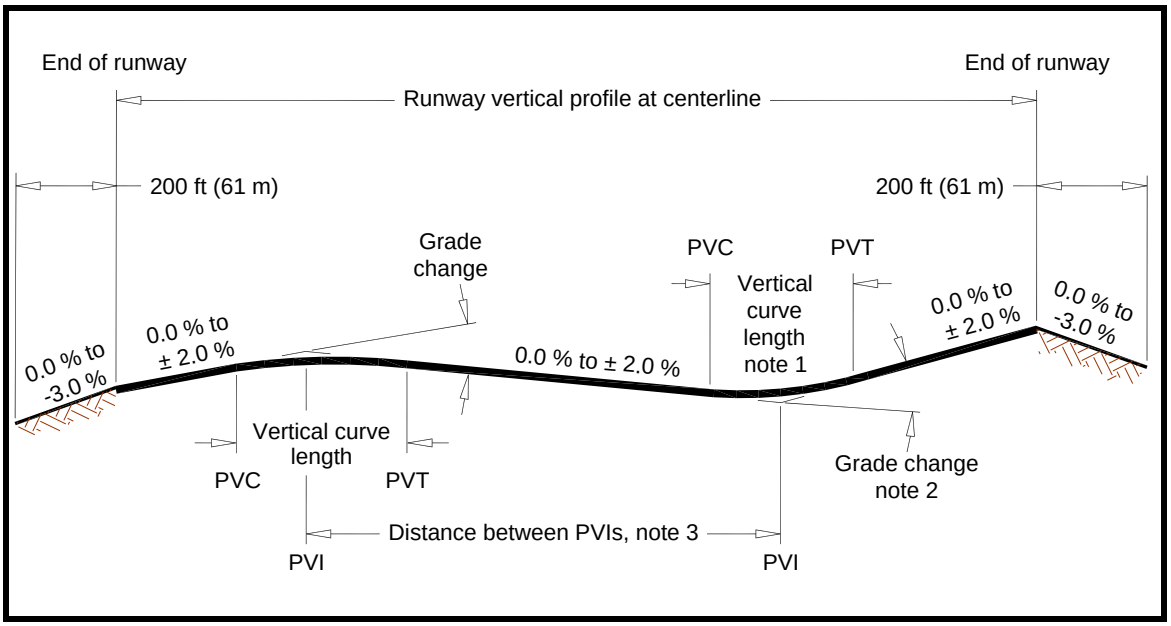
The longitudinal gradient standards for the centerline of runways and stopways vary per aircraft approach category.

3.16.1.1 **Aircraft Approach Categories A and B.**

Refer to Figure 3-31, and the following, for standards applicable to Aircraft Approach Categories A and B.

1. The maximum longitudinal grade is ±2.0 percent.
2. The maximum allowable grade change is ±2.0 percent.
3. Vertical curves for longitudinal grade changes are parabolic.
   a. The minimum length of the vertical curve is 300 feet (91 m) for each 1.0 percent of change.
   b. A vertical curve is not necessary when the grade change is less than 0.40 percent.
4. The minimum allowable distance between the points of intersection of vertical curves is 250 feet (76 m) multiplied by the sum of the grade changes (in percent) associated with the two vertical curves.

Figure 3-31. Longitudinal Grade Limitations for Aircraft Approach Categories A and B

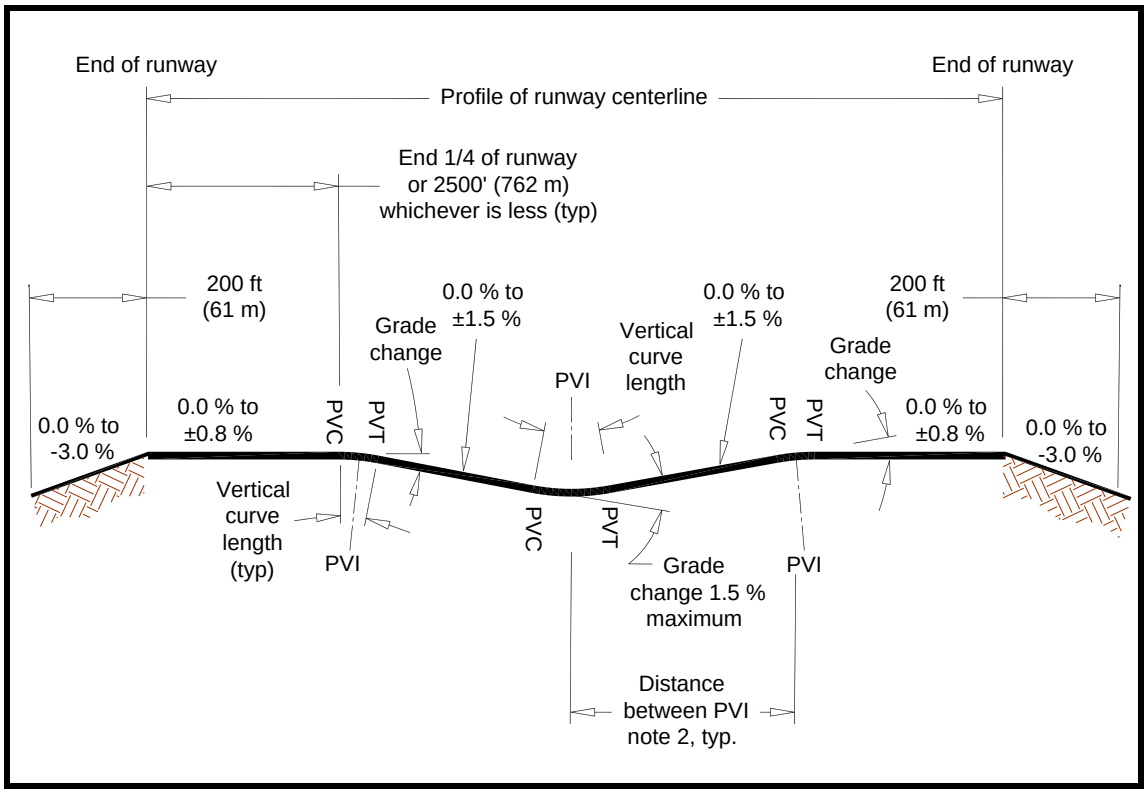


Note 1: Design the length of vertical curves to not be less than 300 ft (91 m) for each 1% grade change, except that no vertical curve is necessary when grade change is less than 0.4%.
Note 2: Do not design grade change at vertical curves greater than 2.0%.
Note 3: Minimum distance between points of vertical intersection is 250 ft (76 m) multiplied by the sum of absolute grade changes.

3.16.1.2 Aircraft Approach Categories C, D, and E.

Refer to Figure 3-32 and the following, for standards applicable to Aircraft Approach Categories C, D, and E.

Figure 3-32. Longitudinal Grade Limitations for Aircraft Approach Categories C, D, and E



Note 1: Minimum length of vertical curves equals 1,000 ft (305 m) multiplied by grade change percentage.
Note 2: The minimum vertical curve length is equal to 1,000 ft (305 m) multiplied by grade change.
Note 3: The standard minimum distance between points of vertical intersection is 1,000 ft (305 m) multiplied by the sum of the absolute grade changes.

1. The maximum allowable longitudinal grade is ±1.50 percent; however, longitudinal grades exceeding ±0.80 percent are not acceptable within the lesser of the following criteria:
   a. in the first and last quarter of the physical runway length, or
   b. the first and last 2,500 feet (762 m) of the physical runway length.
2. The maximum allowable grade change is ±1.50 percent; however, runway grade changes are not acceptable within the lesser of the following criteria:
   a. the first and last quarter of the physical runway length, or

b. the first and last 2,500 feet (762 m) of the physical runway length.

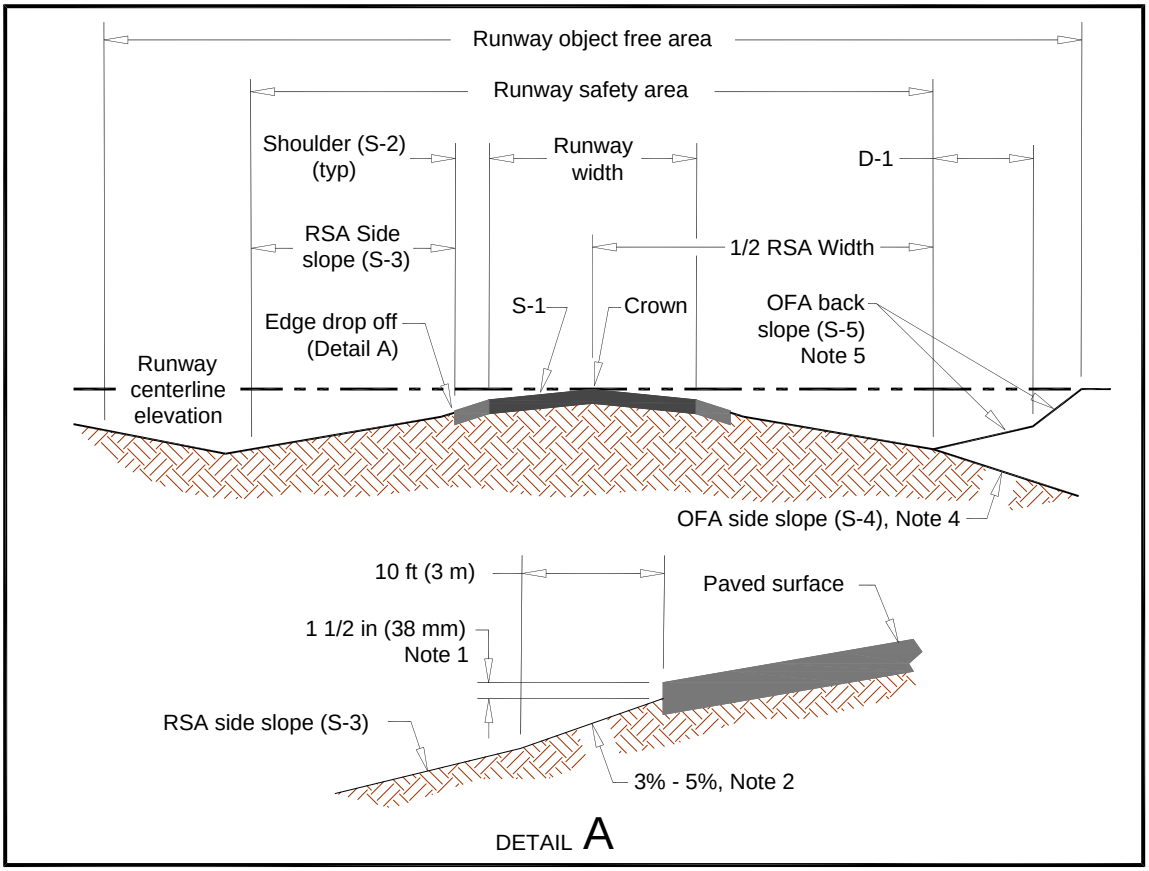
3. Vertical curves for longitudinal grade changes are parabolic. The length of the vertical curve is a minimum of 1,000 feet (305 m) for each 1.0 percent of change.

4. The minimum allowable distance between the points of intersection of vertical curves is 1,000 feet (305 m) multiplied by the sum of the grade changes (in percent) associated with the two vertical curves.

3.16.2 Standards for Transverse Gradients.

Transverse grades provide positive lateral drainage off runway pavement surfaces. Refer to Figure 3-33.

Figure 3-33. Transverse Grade Limitations



Note 1: Construct a 1.5 inch (38 mm) ±1/2 inch (13 mm) drop between paved and unpaved surfaces.
Note 2: Maintain between a 3% -5% negative grade for 10 ft (3 m) of unpaved surface adjacent to the paved surface.
Note 3: Slope S-2 applies when paved shoulders are present.
Note 4: S-4 is 0% or negative (unlimited) to drain water away from the RSA to the edge of the ROFA.
Note 5: **Exception:** A back slope (e.g., positive grade) is acceptable on the far side of the ROFA provided adequate wingtip clearance is available for ½ of the maximum wingspan of the critical aircraft.

3.16.2.1 **All Runways.**

The standard configuration is a center crown with equal, constant transverse grades on either side.

3.16.2.2 **Aircraft Approach Categories A and B.**

Design the transverse slope within a 1.0 to 2.0 percent range from the center crown.

3.16.2.3 **Aircraft Approach Categories C, D, and E.**

Design the transverse slope within a 1.0 to 1.5 percent range from the center crown.

3.16.2.4 **Cross-Slope Variations.**

The following configuration variances are acceptable methods to maintain positive drainage for site-specific runway conditions. Refer to Figure 3-34. Consider these variances when local site conditions are not suitable for application of the standard cross-slope. This includes localized site conditions that limit runway edge elevations in order to match existing grades. Variances are also suitable for runway/runway intersections in order to provide a cross-slope transition that creates positive surface drainage while allowing pilots to maintain directional control of the aircraft over a surface irregularity.

1. **Off-center crown:** A cross section with the crown off-set not more than 25 feet (7.6 m) from the centerline of the runway pavement.
2. **Varied cross-slope:** A cross section with different gradients on each side of the runway centerline.
3. **Non-uniform cross-slope:** A cross section with a transverse grade change of less than 0.5 percent located more than 25 feet (7.6 m) from the runway crown.

3.16.3 Runway/Taxiway Intersections.

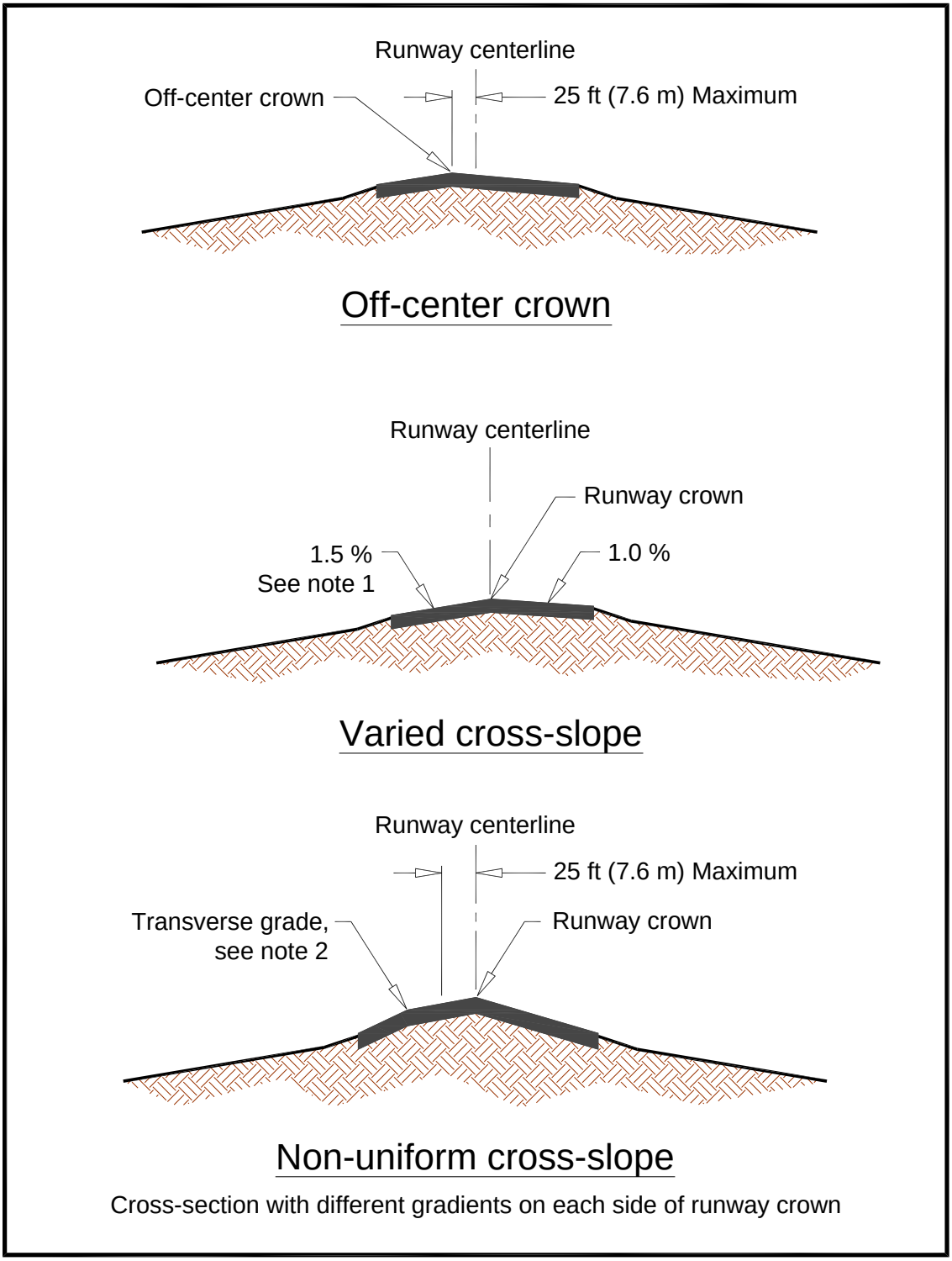
1. Maintain the surface gradient standards of the runway through intersections with taxiways.
2. Provide positive drainage off intersection pavement to prevent accumulation of surface water.

3.16.4 Runway/Runway Intersections.

Adjustments to runway transverse grades are necessary at runway/runway intersection in order to:

1. Maintain adequate surface drainage from the intersection pavement.
2. Provide a suitable longitudinal grade for both runways free of abrupt surface variations capable of impairing the pilot’s directional control of aircraft.

Figure 3-34. Alternate Runway Cross Sections



Note 1: Refer to Figure 3-33 and Table 3-6 for allowable transverse grades. The transverse grades shown here are for example illustrative purposes only.

Note 2: A transverse grade change of less than 0.5% located more than 25 feet (7.6 m) from the runway crown. The runway crown is not necessarily the runway centerline.

3.16.4.1 **Standards.**

1. The surface gradient criteria for a higher category runway (e.g., primary runway) have precedence over a lower category runway (e.g., crosswind).
2. Provide positive drainage off intersection pavement that prevents accumulation of standing water on the intersection pavement.
3. Within the runway/runway intersection:
   a. Adjust the transverse grade of the higher category runway from the standards in Table 3-6 and Table 3-7 to provide a maximum 3-inch (76 mm) elevation difference between the runway crown and the edge of the runway.
   b. Adjust the transverse grade of the lower category runway to establish a constant transverse slope matching the elevation of the edge of the pavement for the higher category runway.
   c. Prior to the runway/runway intersection, apply a transition from both runways to the standard transverse slope of Table 3-6 and Table 3-7 to the adjusted intersection transverse slope using a minimum intersection approach length of 150 ft (46 m).
4. To accommodate the longitudinal grade conditions of a lower category runway, it is acceptable to construct a constant-slope transverse grade on the higher category runway provided the intersection meets the following criteria:
   a. A minimum transverse slope of 0.5 percent is available to permit positive drainage across the higher category runway pavement.
   b. The higher category runway has grooving, per AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces*.
   c. The intersection does not create a bump capable of causing an aircraft to lose directional control.

Table 3-6. Transverse Grades Based on AAC

Category	**S-1 Runway** (percent)	**S-2 Shoulder** (percent)	**S-3 RSA Side Slope** (percent)
AAC-A	1.0% - 2.0%	1.5% - 5.0%	1.5% - 5.0%
AAC-B	1.0% - 2.0%	1.5% - 5.0%	1.5% - 5.0%
AAC-C	1.0% - 1.5%	1.5% - 5.0%	1.5% - 3.0%
AAC-D	1.0% - 1.5%	1.5% - 5.0%	1.5% - 3.0%
AAC-E	1.0% - 1.5%	1.5% - 5.0%	1.5% - 3.0%

Note 1: See Figure 3-33.

Table 3-7. Transverse Grades Based on ADG

Category	S-4 OFA Side Slope (Note 2)	S-5 OFA Back Slope (Ratio)	D-1 OFA Back Slope (feet/meter)
ADG-I	≤ 0%	8:1	25 (7.6)
ADG-II	≤ 0%	8:1	40 (12.2)
ADG-III	≤ 0%	10:1	59 (18.0)
ADG-IV	≤ 0%	10:1	86 (26.2)
ADG-V	≤ 0%	16:1	107 (32.6)
ADG-VI	≤ 0%	16:1	131 (39.9)

Note 1: See Figure 3-33.
Note 2: The S-4 slope relative to the RSA edge is negative to facilitate surface water drainage away from the RSA.
Note 3: S-5 and D-1 represent values for an acceptable back slope on the far side of the ROFA that provides adequate wingtip clearance.

3.16.4.2 **Design Considerations.**

The presence of surface variations at runway/runway intersections will have different effects depending on aircraft speed and the location of the surface variation on the runway. Consult with the appropriate FAA office to discuss options that pertain to a specific location. Consider the following:

1. When constructing a new runway that intersects another runway, include improvements to the existing runway to meet the criteria of this section.
2. When a change in aircraft type using the lower category runway occurs, consider the effect the operation of higher speed aircraft will have at the runway/runway intersection.
3. For existing conditions not meeting the standards of paragraph 3.16.4.1, assess the bump-roughness using Figure 2-3 of AC 150/5380-9, *Guidelines and Procedures for Measuring Airfield Pavement Roughness*, and determine if the existing condition falls within acceptable criteria for single bump events.
4. For existing conditions not falling within the acceptable range, refer to paragraph 2.4 for corrective planning actions.
5. Existing conditions falling outside the acceptable range may necessitate immediate corrective action such as runway closure or Notice to Air Missions (NOTAM) issuance.

3.16.5 RSA Grades.

The longitudinal and transverse gradient standards for RSAs are as follows and as illustrated in Figure 3-31, Figure 3-32, Figure 3-33, and Figure 3-35.

3.16.5.1 **Standards.**

1. Longitudinal grades, longitudinal grade changes, vertical curves, and distance between changes in grades for that part of the RSA between the runway ends are the same as the comparable standards for the runway and stopway.
2. For the first 200 feet (61 m) of the RSA beyond the runway ends, the longitudinal grade is between 0 and 3.0 percent, with any slope being downward from the ends.
3. Beyond the first 200 feet (61 m), the maximum allowable positive longitudinal grade is such that no part of the RSA penetrates any applicable approach surface or clearway plane.
4. The maximum allowable negative grade is 5.0 percent.
5. Limitations on longitudinal grade changes are ±2.0 percent per 100 feet (30.5 m).
6. Table 3-6 and Figure 3-33 show the maximum and minimum transverse grades for paved shoulders and for the RSA along the runway up to 200 feet (61 m) beyond the runway end.
7. For NAVAIDs located in the RSA, design the frangibility point of the equipment, including the foundation and supports, to be no higher than 3 inches (76 mm) above the surrounding finished grade.
8. Provide smooth grading transitions at runway/runway and runway/taxiway intersections.

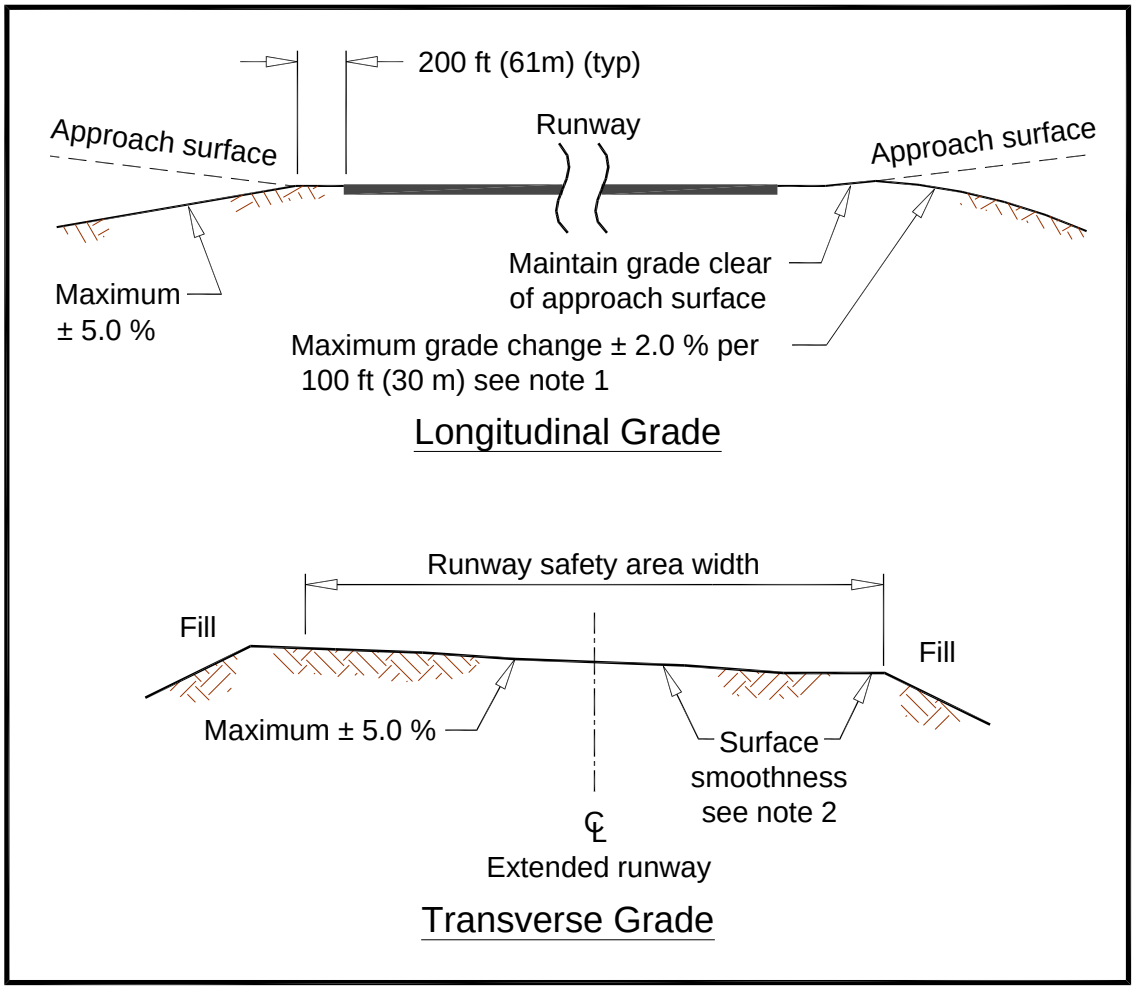
3.16.5.2 **Recommended Practices.**

1. Minimize the use of maximum grades.
2. Keep transverse grades to a minimum to facilitate local drainage conditions.
3. Use parabolic vertical curves to provide smooth transitions.

3.16.5.3 **Design Considerations.**

1. Consider drainage off the top of the foundation when establishing the height of the frangibility point relative to the surrounding finished grade.
2. Other grading requirements for NAVAIDs located in the RSA may be more stringent than the standard stated in Table 3-6.

Figure 3-35. RSA Grade Limitations Beyond 200 feet (61 m) from the Runway End



Note 1: Use a vertical curve to transition between longitudinal grade changes.
Note 2: Use a gradual transition between transverse grade changes to allow a pilot to maintain control of aircraft traversing the safety area.

3.16.6 Surface Gradient Design Considerations.

1. Keep longitudinal grades and grade changes to a minimum.
2. Keep transverse grades to a minimum that allow positive water drainage from pavement surfaces consistent with site-specific conditions.
3. Consider potential runway extensions and/or the future upgrade of the runway to a more stringent aircraft approach category when selecting the longitudinal and transverse grade of the runway.
4. If the approved ALP indicates extensions and/or upgrades, design grades to match to the ultimate plan.

3.17 Runway to Taxiway Separation.

3.17.1 Standards.

See Appendix G or the online Runway Design Standards Matrix Tool for the minimum runway to taxiway separation standards based on ADG and visibility minimums. These standards derive from landing and takeoff flight path profiles and the physical characteristics of aircraft.

3.17.2 Recommended Practices.

When space is available without causing relocation of existing facilities and structures, apply the separation values of the next larger ADG aircraft when constructing or re-constructing a parallel taxiway. This allows operation of more demanding aircraft without the need for:

1. Specific airport operational controls, or
2. Relocation of existing infrastructure when the larger ADG aircraft becomes the critical aircraft meeting regular use criteria.

3.17.3 Design Considerations.

3.17.3.1 Separation Based on ADG.

The dimensions in Appendix G or the online Runway Design Standards Matrix Tool assume that the same critical aircraft is using both the runway and taxiway. For example, if a taxiway serves larger aircraft (e.g., air carrier aircraft taxiing between the terminal and another runway), the basis for the runway to taxiway separation distance is the ADG of the larger aircraft.

3.17.3.2 Separation Based on TDG.

When an operational need exists for direction reversal between the runway and the parallel taxiway when using a high-speed exit, base the separation distance on the TDG of the critical aircraft, as shown in Table 4-3. This table provides the minimum and recommended separation distances between a runway and parallel taxiway for turns based on TDG. The greater value from Appendix G (or the online Runway Design Standards Matrix Tool) and Table 4-3 determines the applicable runway to taxiway separation distance. See paragraph 4.8.4 and paragraph 4.8.5 for additional information on the effect of exit taxiway design on runway/taxiway separation distance. See paragraph 3.11 for additional information on OFZ standards and design considerations related to runway to taxiway separation.

3.18 Runway to Hold Line Separation.

3.18.1 Standards.

The minimum runway to hold line separation in Appendix G or the online Runway Design Standards Matrix Tool derives from landing and takeoff profiles and physical performance characteristics of the critical aircraft. See paragraphs 4.8.1 and 4.8.2 for the standard for designing right-angle runway to taxiway intersections.

3.18.2 Recommended Practices.

For some aircraft and runway/taxiway geometries, the standard runway to hold line separation may be insufficient to hold aircraft perpendicular to the runway. Make adjustments to permit sufficient view of the runway environment including the extended centerline. See paragraphs 4.8.1 and 4.8.2 for recommended practices to attain a perpendicular holding position.

3.19 Runway to Aircraft Parking Area Separation.

3.19.1 Standards.

Locate aircraft parking areas to preclude any part of a parked aircraft (tail, wingtip, nose, etc.) from being within a ROFA or penetrating the OFZ.

3.19.2 Recommended Practices.

Locate aircraft parking positions in a manner to prevent exceeding the obstruction standards, as defined in Part 77.

3.20 Turf Runways.

Turf runways are used in many locations where traffic volume is low and aircraft wheel loading is light. Due to the nature of turf runways, landing, takeoff, and accelerate-stop distances are typically 20% longer than for paved runways. Refer to AC 150/5325-4 for additional information.

3.20.1 Standards.

3.20.1.1 Geometry.

Runway standards apply per Appendix G or the online Runway Design Standards Matrix Tool.

3.20.1.2 Grading.

1. Provide well-drained turf surface capable of supporting the critical aircraft under wet conditions.
2. Provide at least a 2.0 percent slope away from the center of the runway for a minimum distance of 40 feet (12.2 m) on either side of the centerline of the runway.

3. Provide a 5.0 percent slope from that point to the edge of the RSA to provide rapid drainage.
4. Construct drainage swales with a maximum of a 3.0 percent slope parallel to the runway and outside of the RSA.

3.20.1.3 **Compaction.**

The compaction standards for turf runways are the same as the compaction standards defined in paragraph 3.10.1.5.

3.20.1.4 **Vertical Curves.**

When longitudinal grade changes are necessary, do not exceed a 3.0 percent change. Provide vertical curves with curve length equaling at least 300 feet (91 m) for each 1.0 percent change.

3.20.1.5 **Thresholds.**

Ensure the location of the threshold provides obstacle clearance for landing aircraft. Refer to paragraph 3.6.1 for related information.

3.20.2 Recommended Practices.

3.20.2.1 **Landing Strip Boundary Markers.**

Install boundary markers to delineate the extent of the usable landing area.

1. The distance between markers is 200 – 400 feet (61 m – 122 m).
2. Locate boundary markers outside of the RSA limits.
3. Acceptable boundary marker equipment includes:
   a. Low mass cones.
   b. LIRL or reflectors, per AC 150/5340-30.
   c. Color panels contrasting with surrounding grade:
      i. In-pavement no higher than 1.5 inches (38 mm) above grade, or
      ii. Elevated and collapsible, or frangible, at 3 inches (76 mm) above grade.

3.20.2.2 **Holding Position Signs.**

Locate holding position signs at common entrance locations to provide adequate runway clearance for holding aircraft.

3.20.2.3 **Types of Turf.**

Soil and climate are key factors for selection of grass types suitable for turf runway use.

1. Use grasses for airport turf with a deep, matted root system producing a dense, smooth surface cover with a minimum of top growth.

2. Select long-lived grasses that are durable, capable of spreading (e.g., rhizomes), and recover quickly from dormancy or heavy-use conditions.
3. Refrain from using short-lived, shallow-rooted, weak sod species.
4. If seeding, time the planting to provide at least six weeks of favorable growing conditions to allow proper root development.
5. See AC 150/5370-10, Part 12 – Turfing, for specification information on turf establishment.

3.21 Markings/Lighting/Signs.

Refer to AC 150/5340-1, AC 150/5340-30 and AC 150/5340-18 for standards on airfield markings, lighting, and signs.

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CHAPTER 4. Taxiway and Taxilane Design

4.1 General.

This chapter presents the airport design standards, recommended practices, and design considerations for taxiways and taxilanes. It provides guidance to enhance safety and efficiency, including but not limited to:

1. Taxiway and taxilane dimensions, configuration, and separation standards.
2. Taxiway turns and intersection design.
3. Surface gradients.

See Appendix J for additional taxiway design information including calculations of taxiway standards and taxiway geometries with elevated risks to safety.

4.1.1 Design Criteria: Taxiways versus Taxilanes.

In general, the term "taxiway" as used in this chapter describes standards and recommended practices for both taxiways and taxilanes. Some of the design standards for taxiways and taxilanes vary given the different aircraft speeds and uses of taxiways versus taxilanes. The tables in this chapter define the differences between taxiway and taxilane design standards. Taxiways typically reside in movement areas, while taxilanes are more common in non-movement areas such as terminal apron areas.

4.1.1.1 Taxiway/Taxilane Differences.

The following standards are different between taxiways and taxilanes:

- OFA
- Centerline to centerline separation
- Centerline to fixed or movable object
- Wingtip clearance

4.1.1.2 Taxiway/Taxilane Similarities.

The following standards are equivalent between taxiways and taxilanes:

- TSA
- Taxiway/taxilane width
- TESM
- Taxiway/taxilane shoulder width

4.1.2 Coordination.

An efficient taxiway system design involves an understanding of operational requirements. Coordinate with the airport's applicable stakeholders during the planning and design of taxiways:

- ATCT personnel
- Airlines and fixed base operators (FBOs)
- Other airport users

4.2 Taxiway Design Group (TDG).

The combination of the MGW and the CMG determines the TDG classification, using the longest CMG and the widest TDG theoretical airplane for the TDG (Figure 1-1). Some airplanes have special steering characteristics (e.g., steerable main gear). In such cases, use the "effective CMG" provided by the manufacturer. The TDG establishes the standards used in Table 4-2 for:

- Taxiway/taxilane width
- TESM
- Taxiway shoulder width

See Figure 1-1, paragraph 1.6.5 and Figure 4-4. The TDG also influences fillet designs, see paragraph 4.7.

4.3 Taxiway and Taxilane Design Concepts and Considerations.

4.3.1 Taxiing Method.

Taxiways designed for cockpit over centerline steering enable rapid movement of traffic with minimal risk of aircraft excursions from the pavement surface. Judgmental oversteering, the technique where the pilot intentionally steers the cockpit outside the marked centerline on turns, introduces excursion risk to a turning maneuver. The TESM provides allowance for an aircraft's marginal wander from the centerline.

4.3.1.1 Standards.

Design taxiways for cockpit over centerline taxiing. Do not apply judgmental oversteering as a design technique to preclude provision of a standard fillet design.

4.3.1.2 Recommended Practice.

For new taxiway projects, upgrade other intersections along the associated route to eliminate the need for judgmental oversteering if it is practical to make such improvements at that time. The goal is to provide consistent cockpit over centerline taxiing throughout the airport.

4.3.2 Curve Design.

The dimensions in this AC are based on the assumption that the nose gear steering angle is directly under or forward of the cockpit. Where the nose gear is aft of the cockpit, the actual nose gear steering angle will be slightly less. This conservative design allows for the slight slippage by the nose gear in cornering.

4.3.2.1 **Standards.**

1. Design taxiway centerline radii for turns of less than 90 degrees such that the maximum nose gear steering angle allows the pilot to maintain an efficient speed (typically greater than 20 mph) in the turn.
2. Design the radius of the outer edge of the pavement to be equal to the centerline radius plus half the straight segment taxiway width.

4.3.2.2 **Recommended Practices.**

1. Design taxiway centerline radii for turns of 90 degrees or more such that the maximum nose gear steering angle is close to but no more than 50 degrees to prevent excessive tire scrubbing.
2. For existing conditions where centerline lights are present, it is acceptable to retain the existing taxiway centerline.
3. The FAA Office of Airports Taxiway Fillet Design Tool, which calculates centerline radii for simple turns, is available on the FAA website at: http://www.faa.gov/airports/engineering/airport_design/.

4.3.3 Three-Path Concept.

Complex intersections increase the possibility of pilot error and confusion which can lead to a runway incursion. Proper airport design practices keep taxiway intersections simple by reducing the number of taxiways intersecting at a single location, thus allowing for proper placement of airfield markings, signage, and lighting. The "three-path concept" (formerly known as the "three-node concept") means that a pilot has no more than three choices at an intersection – left, right, and forward. See Figure 4-1.

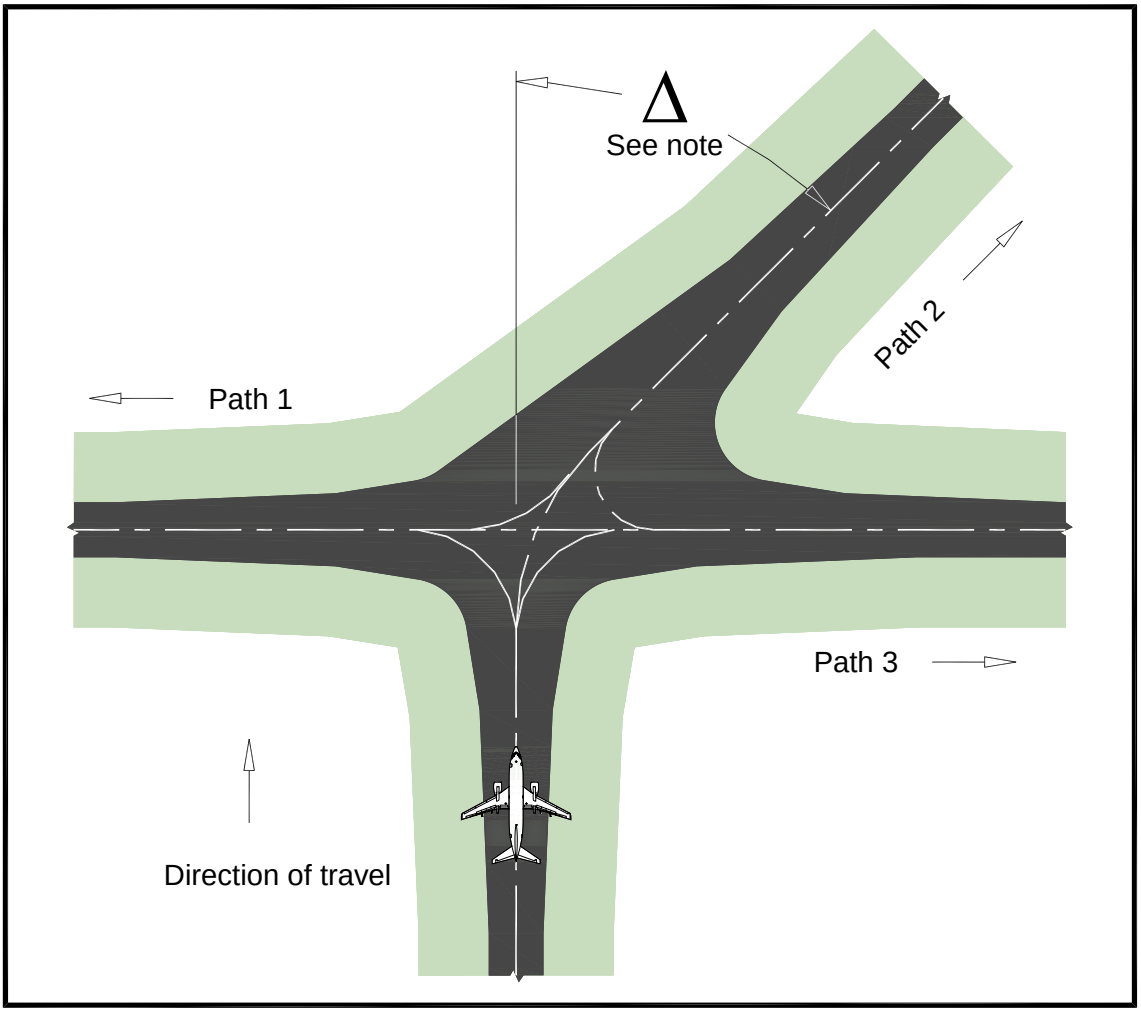
4.3.3.1 **Standards.**

1. Design all new taxiway intersections in accordance with the three-path concept.
2. For existing conditions not meeting the three-path concept, prioritize mitigation through the planning process to meet the standard in the future (see paragraphs 2.4 and 2.5).

4.3.3.2 **Recommended Practice.**

Reconfigure all existing taxiway intersections (even those not designated as hot spots) in accordance with the three-path concept when the associated taxiway is subject to reconstruction or rehabilitation. See paragraph 2.5.

Figure 4-1. Three-Path Concept Taxiway Intersection



Note: The angle (△) is measured from the initial direction of travel.

4.3.4 Channelized Taxiing.

Standard taxiway widths support visibility of airfield signage. Taxiway widths wider than the standard result in signs being located further from the centerline; pilots may not notice the signs due to the excessive distance.

4.3.4.1 **Standard.**

1. Design new taxiway/taxiway and taxiway/runway intersections to meet standard taxiway width and fillet geometry.
2. For existing conditions comprising wide pavement areas, develop a plan (e.g., ALP) to meet the standard (see paragraphs 2.4 and 2.5).

4.3.4.2 **Recommended Practice.**

Reconfigure all existing taxiway intersections (even those not designated as hot spots), in accordance with paragraph 4.3.4.1, when the associated taxiway is subject to reconstruction or rehabilitation (see paragraph 2.5).

4.3.5 Runway Access from Apron.

Taxiways connecting an apron directly to a runway can lead to confusion by creating a false expectation of a parallel taxiway prior to a runway. This loss of situational awareness can result in a pilot entering a runway unknowingly, thus resulting in a runway incursion.

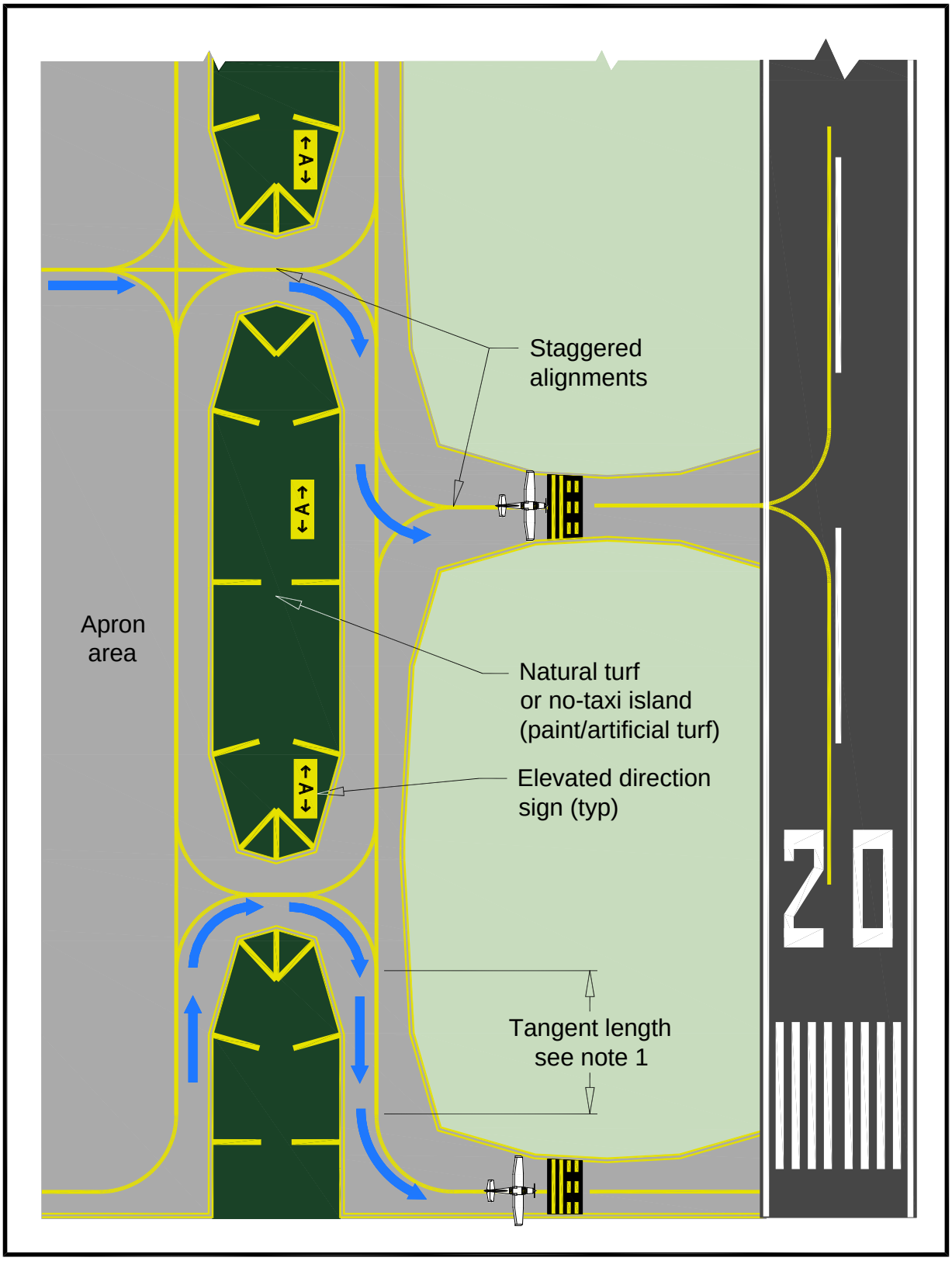
4.3.5.1 **Standards.**

1. Design taxiways leading from an apron to a runway to make at least one turn between 75 and 90 degrees prior to reaching the runway hold line.
   a. For runways with a parallel taxiway, stagger the alignment of connecting taxiway and taxiways/taxilanes originating from the apron. See Figure 4-2.
   b. For runways without a parallel taxiway, provide a no-taxi island on the apron aligned with the connecting taxiway to the runway. See Figure 4-3.
2. For existing conditions with direct access from an apron to a runway:
   a. Develop a plan (e.g., ALP) to meet the standard when it becomes practical to make such improvements (see paragraph 2.4).
   b. Reconfigure existing direct-access taxiways, including those not designated as hot spots, when the associated taxiway is subject to reconstruction (see paragraph 2.5.).

4.3.5.2 **Recommended Practices.**

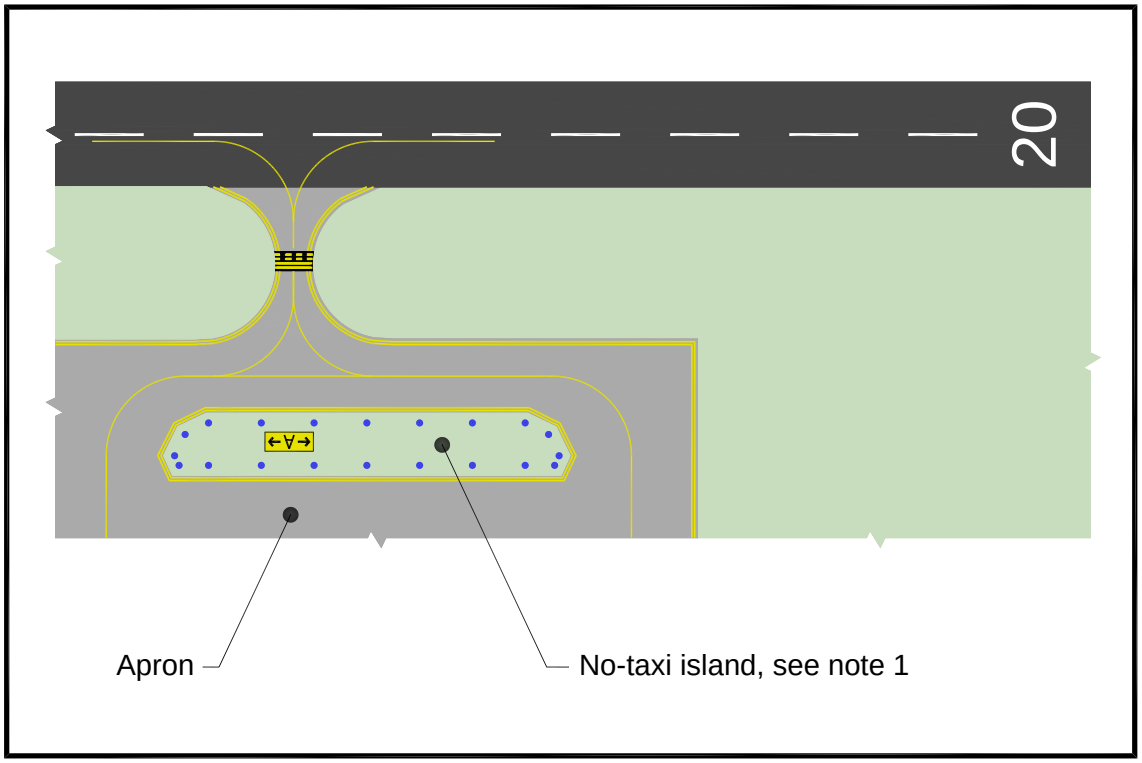
1. To the extent practical, design taxi routes between the apron and runway ends to include a turn onto a parallel taxiway and a second turn onto a connecting taxiway leading to the runway.
2. Design the taxi route between the apron and the runway to include the following:
   a. A turning movement from the apron taxiway/taxilane to the parallel taxiway.
   b. A turning movement from the parallel taxiway to the connecting taxiway that allows the critical aircraft to hold 90 degrees ±15 degrees to the runway centerline.
   c. A holding position that allows the critical aircraft to hold 90 degrees, ±15 degrees, to the runway centerline.

Figure 4-2. Apron-Taxiway Transition



Note 1: See paragraph 4.3.5.2.

Figure 4-3. Apron-Runway Transition



Note 1: Turf or paved no taxi island with edge lights/reflectors.

3. Provide a minimum tangent length between the connecting taxiway and runway entrance taxiway so that the pilot, after turning onto the parallel taxiway, has sufficient distance to align the fuselage of the critical aircraft along the parallel taxiway centerline to provide a clear view of the taxiway signs indicating the entrance to the runway.

4. During taxiway rehabilitation projects, evaluate the feasibility of reconfiguring existing direct-access taxiways (even those not designated as hot spots), in accordance with paragraph 4.3.5.1 (see paragraph 2.5).

4.3.5.3 **Design Considerations.**

1. Evaluate whether an increase to the standard runway to taxiway separation is necessary to allow the critical aircraft to hold 90 degrees, ±15 degrees, to the runway centerline, per paragraph 3.17.

2. Consider providing a partial parallel taxiway if the existing runway does not have a parallel taxiway.

4.3.6 Designated Hot Spots and Runway Incursion Mitigation (RIM) Locations.

4.3.6.1 **Standard.**

For locations the FAA designates as a hot spot or RIM location due to existing airfield geometric configurations, prioritize mitigation measures through the planning process of paragraph 2.4.

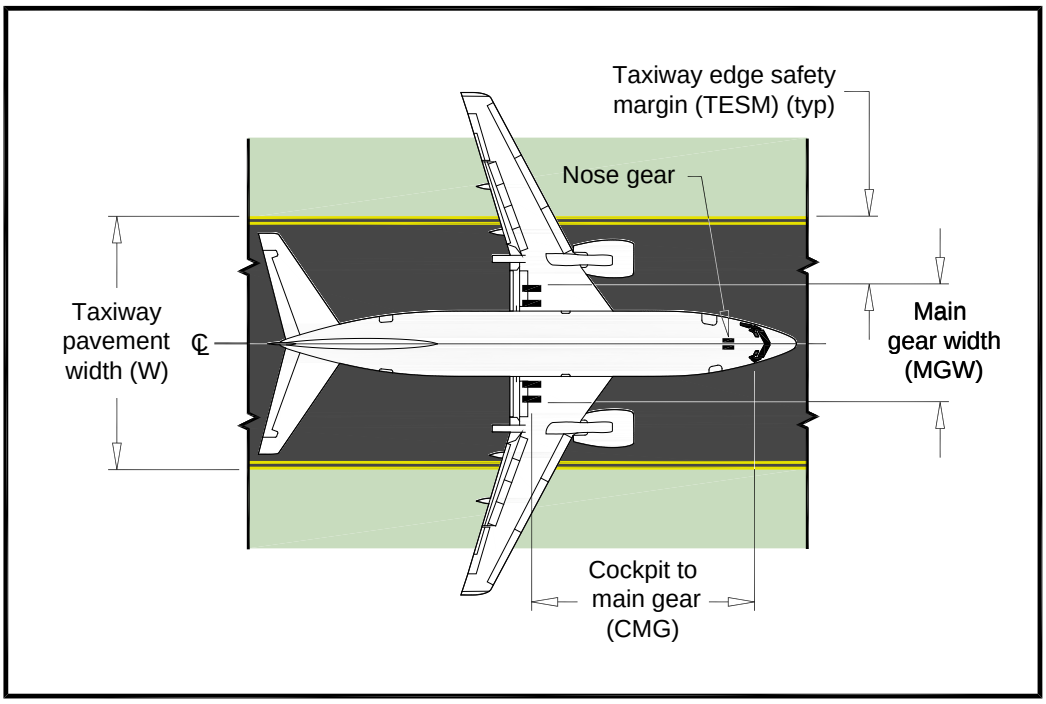
4.4 Straight Segment Taxiway/Taxilane Width.

Taxiway width standards derive from aircraft TDG classifications. The minimum width for straight segments ensures that the standard TESM is available for possible aircraft wander (see Figure 4-4). See Table 4-2 for standard minimum widths for straight segments. See paragraph 4.7 for guidance on fillet design.

4.4.1 Design Considerations.

1. The TDG minimum widths consider pilot perception of their ability to navigate their aircraft within the edges of a taxiway/taxilane.
2. Minimum taxiway/taxilane widths in Table 4-2 provide both physical separations for the critical aircraft to the pavement edge and visual reference for the pilot.

Figure 4-4. Taxiway Edge Safety Margin (TESM) – Straight Segment



Note 1: See Table 4-2 for pavement width and TESM values.
Note 2: See Appendix A for aircraft characteristic information and the FAA Aircraft Characteristics Database at http://www.faa.gov/airports/engineering/aircraft_char_database/ for CMG and MGW data.

4.5 Taxiway/Taxilane Clearance.

4.5.1 Taxiway/Taxilane Separations.

Pilots need ample wingtip clearance due to the pilots' limited ability to see their aircraft's wingtips from the cockpit. Wingtip clearance values ensure an acceptable level of safety when one airplane on a parallel taxiway wanders off the taxiway centerline toward an airplane on the adjacent taxiways. See Figure 4-5. The ADG of the critical aircraft determines the minimum separation distance between a taxiway/taxilane centerline and fixed or moveable objects.

4.5.1.1 Standards.

Table 4-1 lists minimum separation standards by ADG considering:

1. Wingspan dimensions of the critical aircraft in each ADG.
2. A lateral deviation allowance to provide protection in the event of deviation from the taxiway centerline.
3. A safety buffer allowance to provide for wingtip clearance in the event of deviation from the taxiway centerline.

4.5.1.2 Recommended Practices.

When space is available without causing relocation of existing facilities and structures, an airport may apply the separation values of the next larger ADG aircraft when constructing or re-constructing a taxiway or taxilane. This allows operation of more demanding aircraft without the need for:

1. Specific airport operational controls, or
2. Relocation of existing infrastructure when the larger ADG aircraft becomes the critical aircraft.

4.5.1.3 Design Considerations.

1. The minimum distance between centerlines of parallel taxiways or taxilanes may be a function of the critical aircraft TDG due to turning and fillet geometry requirements.
2. See paragraph J.4 for reduction in taxiway separation standards.

Table 4-1. Design Standards Based on Airplane Design Group (ADG)

Item	ADG					
	I	II	III	IV	V	VI
Taxiway and Taxilane Protection						
TSA (maximum ADG wingspan)	49 ft (14.9 m)	79 ft (24.1 m)	118 ft (36.0 m)	171 ft (52.1 m)	214 ft (65.2 m)	262 ft (79.9 m)
TOFA [2]	89 ft (27.1 m)	124 ft (37.8 m)	171 ft (52.1 m)	243 ft (74.1 m)	285 ft (86.9 m)	335 ft (102.1 m)
TLOFA [2]	79 ft (24.1 m)	110 ft (33.5 m)	158 ft (48.2 m)	224 ft (68.3 m)	270 ft (82.3 m)	322 ft (98.1 m)
Taxiway and Taxilane Separation						
Taxiway centerline to parallel taxiway centerline [1]	70 ft (21.3 m)	101.5 ft (30.9 m)	144.5 ft (44.0 m)	207 ft (63.1 m)	249.5 ft (76.1 m)	298.5 ft (91.0 m)
Taxiway centerline to fixed or movable object [2]	44.5 ft (13.6 m)	62 ft (18.9 m)	85.5 ft (26.1 m)	121.5 ft (37.0 m)	142.5 ft (43.4 m)	167.5 ft (51.1 m)
Taxilane centerline to parallel taxilane centerline [1]	64 ft (19.5 m)	94.5 ft (28.8 m)	138 ft (42.1 m)	197.5 ft (60.2 m)	242 ft (73.8 m)	292 ft (89.0 m)
Taxilane centerline to fixed or movable object [2]	39.5 ft (12.0 m)	55 ft (16.8 m)	79 ft (24.1 m)	112 ft (34.1 m)	135 ft (41.1 m)	161 ft (49.1 m)
Wingtip Clearance						
Taxiway wingtip clearance	20 ft (6.1 m)	22.5 ft (6.9 m)	26.5 ft (8.1 m)	36 ft (11.0 m)	35.5 ft (10.8 m)	36.5 ft (11.1 m)
Taxilane wingtip clearance	15 ft (4.6 m)	15.5 ft (4.7 m)	20 ft (6.1 m)	26.5 ft (8.1 m)	28 ft (8.5 m)	30 ft (9.1 m)

Note 1: See Figure 4-5.
Note 2: See Figure 4-6.
Note 3: See paragraphs 4.5.3.1 and 4.5.4.1 for TSA and TOFA standards at fillets.

Table 4-2. Design Standards Based on Taxiway Design Group (TDG)

Item	TDG							
	1A	1B	2A	2B	3	4	5	6
Taxiway/Taxilane Width [2]	25 ft (7.6 m)	25 ft (7.6 m)	35 ft (10.7 m)	35 ft (10.7 m)	50 ft (15.2 m)	50 ft (15.2 m)	75 ft (22.9 m)	75 ft (22.9 m)
Taxiway Edge Safety Margin [1]	5 ft (1.5 m)	5 ft (1.5 m)	7.5 ft (2.3 m)	7.5 ft (2.3 m)	10 ft (3.0 m)	10 ft (3.0 m)	14 ft (4.3 m)	14 ft (4.3 m)
Taxiway Shoulder Width [3]	10 ft (3.0 m)	10 ft (3.0 m)	15 ft (4.6 m)	15 ft (4.6 m)	20 ft (6.1 m)	20 ft (6.1 m)	30 ft (9.1 m)	30 ft (9.1 m)

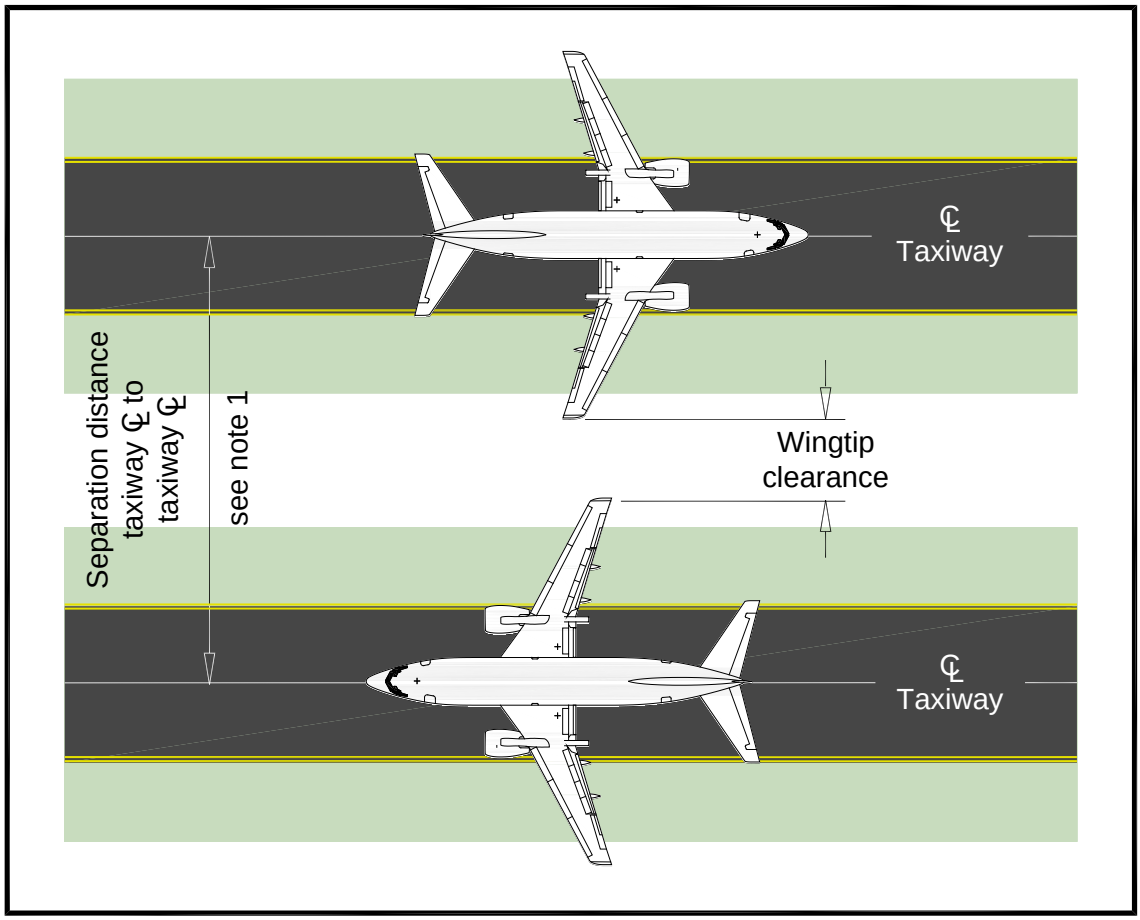
Note 1: See Figure 4-4.
Note 2: It is acceptable to reduce taxilane widths for TDG 1A and 1B to 20 feet (6 m).
Note 3: When the most demanding aircraft has four engines and is TDG 6, the standard taxiway shoulder width is 40 feet (12.2 m).

4.5.2 Parallel Taxiways/Taxilanes for Dissimilar ADGs.

For parallel taxiways/taxilanes serving critical aircraft with dissimilar ADGs, determine the distance between centerlines by applying the following method:

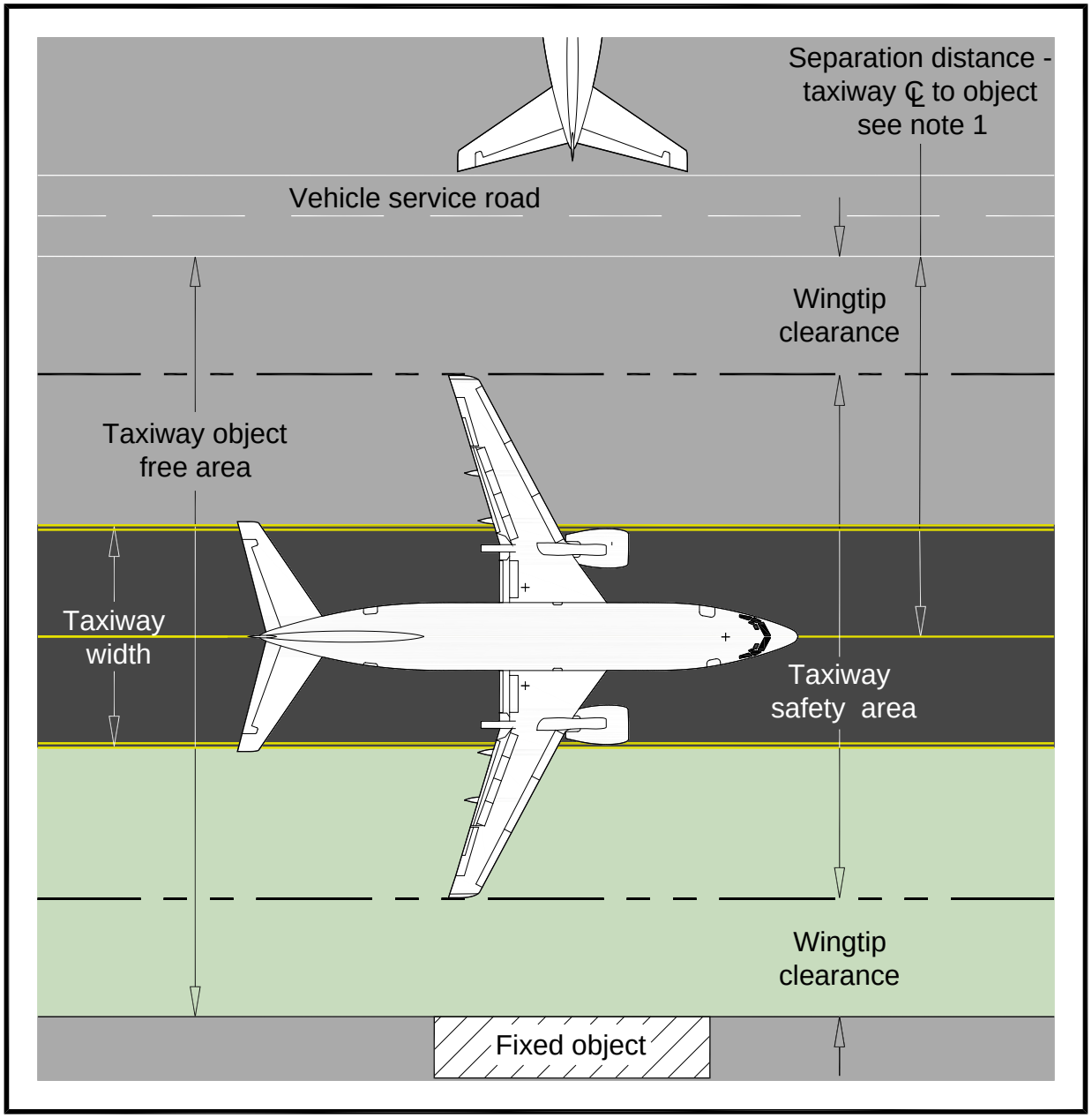
1. Establish the TOFA/taxilane object free area (TLOFA) dimension of the more demanding ADG.
2. Establish the maximum wingspan of the lesser ADG.
3. Determine the composite taxiway separation value by adding half the OFA of the more demanding ADG to half the wingspan of the lesser ADG.
4. TOFA Example:
   a. Half of ADG III TOFA is 85.5 ft (26.1 m).
   b. Half of ADG II wingspan is 39.5 (12.0 m).
   c. Composite separation distance is 125 ft (38.1 m).

Figure 4-5. Wingtip Clearance – Parallel Taxiways/Taxilanes



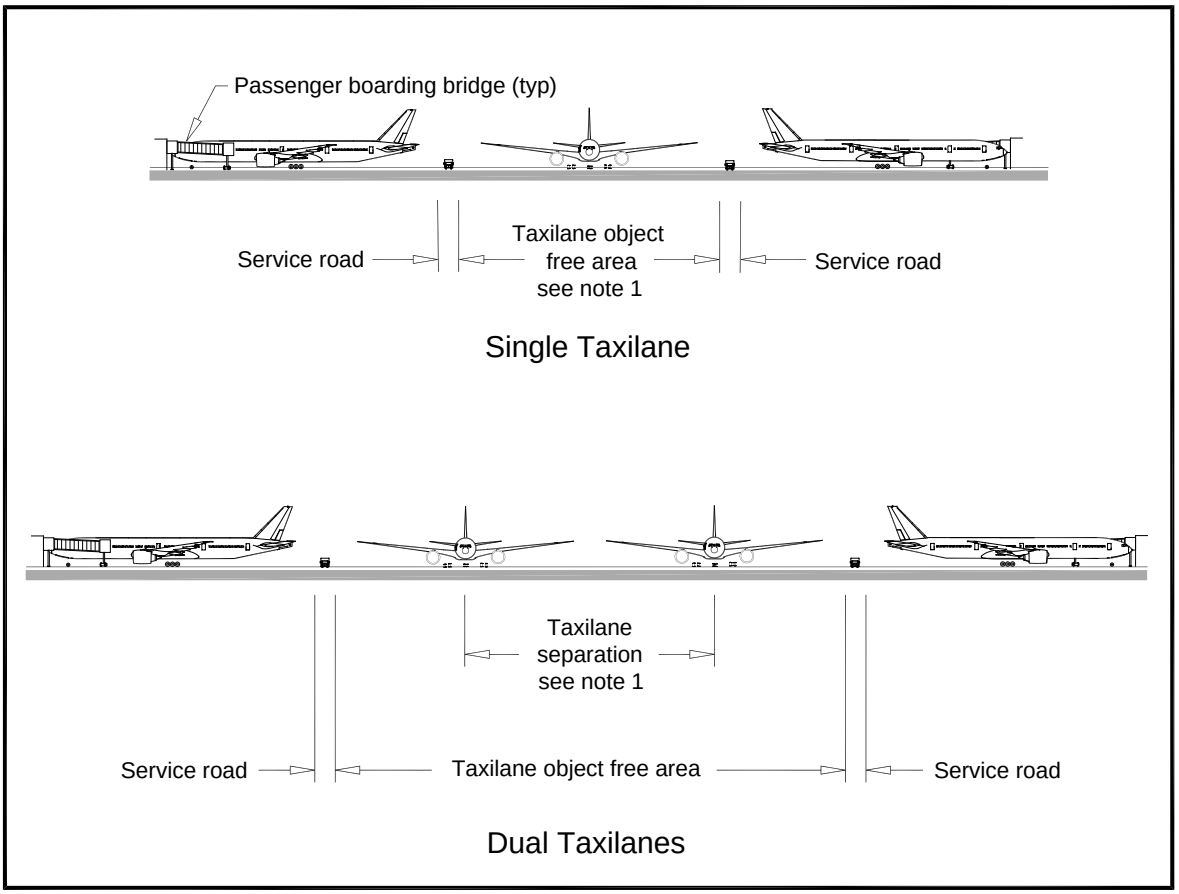
Note 1: See Table 4-1 for standard separation distances between parallel taxiways and parallel taxilanes.

Figure 4-6. Wingtip Clearance from Taxiway



Note 1: Refer to Table 4-1 for standard separation distances between taxiways and fixed or moveable objects.

Figure 4-7. Taxilane Separations and Clearances



Note 1: Refer to Table 4-1 for standard TLOFA and standard separation distances between parallel taxilanes.

4.5.3 Taxiway/Taxilane Safety Area (TSA).

The TSA is a defined surface prepared to support the occasional passage of aircraft and ARFF equipment.

4.5.3.1 **Standards.**

1. The TSA width equals the maximum wingspan of the ADG. See Table 4-1.
2. The TSA is symmetrical about the taxiway/taxilane centerline on straight segments.
   a. The TSA increases in width at intersections and turns by extending for a distance of (TSA Width – W)/2 from the taxiway/taxilane inner edge, based on the fillet design (see Figure 4-9) where W is the taxiway width.
   b. Where the taxiway edge extends beyond that necessary to maintain the TESM, design the widening of the TSA on a theoretical taxiway edge necessary to maintain the TESM.

c. Where existing fillets are not sufficient to maintain the TESM, design the widening of the TSA based on theoretical fillets that would maintain the TESM until the construction of adequate fillets.

3. Clear and grade the TSA to remove potentially hazardous ruts, humps, depressions, or other surface variations.

4. Prevent accumulation of surface water by grading the TSA to drain away from taxiway pavement or using flush grated catch basins.

5. Design the TSA to be capable, under dry conditions, of supporting SRE, ARFF equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.

   a. See AC 150/5370-10, Item P-152, Excavation, Subgrade and Embankment specifications for compaction specification criteria.

   b. Design structures including, but not limited to, manholes, handholes, and grates to support the occasional passage of aircraft and ARFF equipment.

6. The TSA is free of objects, except for objects that need to be located in the TSA because of their function.

   a. Design objects higher than 3 inches (76 mm) above grade on LIR supports (frangible mounted structures) of the lowest practical height with the frangible point no higher than 3 inches (76 mm) above the grade.

   b. Design foundations, concrete pads, and hand holes that reside in the TSA:

      i. To be capable of supporting SRE vehicles, ARFF vehicles, and the occasional passage of the most demanding aircraft.

      ii. Such that the top elevation is within a range between flush with grade and a height of 1 inch (25 mm) above the immediate surrounding grade.

4.5.4 Taxiway/Taxilane Object Free Area (TOFA/TLOFA).

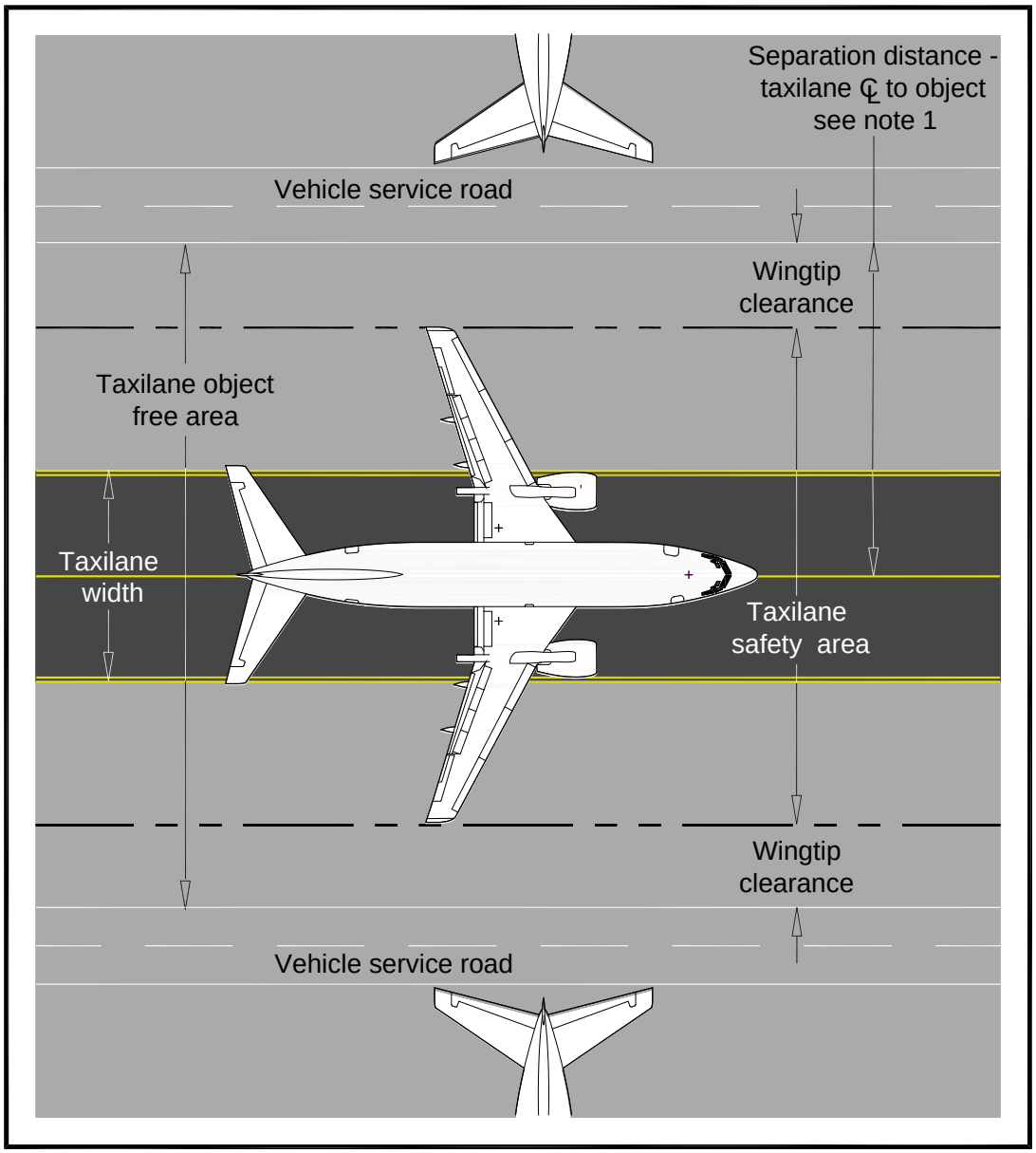
The TOFA/TLOFA is an area adjacent to the TSA that is clear of objects not fixed-by-function to provide vertical and horizontal wingtip clearance. Applying the taxiway/taxilane centerline to object separation values in Table 4-1 to both sides of the centerline establishes the TOFA/TLOFA. See Figure 4-6.

4.5.4.1 **Standards.**

Table 4-1 specifies the standard dimensions for TOFAs and TLOFAs. A standard TOFA/TLOFA is:

1. Symmetrical about the taxiway and taxilane centerlines, as shown in Figure 4-6 and Figure 4-8.

Figure 4-8. Wingtip Clearance from Apron Taxilane



Note 1: Refer to Table 4-1 for standard separation distances between taxilanes and fixed or moveable objects.

2. Cleared of roads used by baggage carts, fuel trucks, and other service vehicles, parked aircraft, and other objects, except for objects that need to be located in the TOFA/TLOFA for air navigation or aircraft ground maneuvering purposes.

   a. Vehicles may operate within the TOFA/TLOFA provided they give right of way to oncoming aircraft by either maintaining a safe distance ahead of or behind the aircraft or by exiting the TOFA/TLOFA to let the aircraft pass.

b. Provide vehicular exiting areas along the outside of the TOFA/TLOFA, where required.

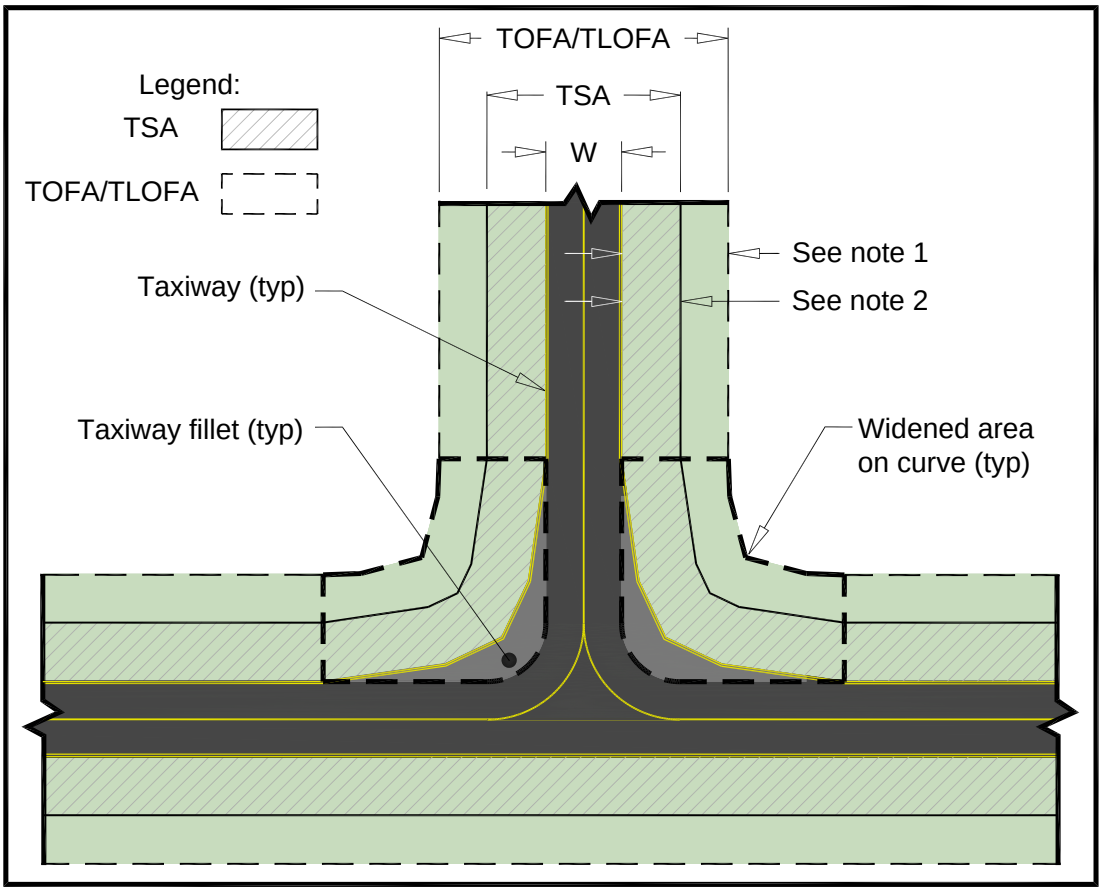
3. Increased in width at taxiway intersections and turns.

a. The TOFA/TLOFA clearing standard increases in width at intersections and turns by extending for a distance of (TOFA Width – W)/2 feet from the taxiway edge, based on the fillet design (see Figure 4-9), where W is the taxiway width.

b. Where the taxiway edge extends beyond that necessary to maintain the TESM, design the widening of the TOFA/TLOFA on a theoretical taxiway edge necessary to maintain the TESM.

c. Where existing fillets are not sufficient to maintain the TESM, design the widening of the TOFA/TLOFA based on theoretical fillets that would maintain the TESM until the construction of adequate fillets.

Figure 4-9. TSA and TOFA at Taxiway Intersections



Note 1: (TOFA Width - W)/2
Note 2: (TSA Width - W)/2
Note 3: See paragraph 4.5.3.1 and paragraph 4.5.4.1 for increased width of TSA and TOFA, respectively.

4.6 Parallel Taxiways.

A parallel taxiway eliminates using the runway for taxiing, thus increasing runway capacity and protecting the runway under low visibility conditions. A dual parallel taxiway provides ATCs flexibility in staging aircraft for takeoff and in routing inbound and outbound (opposite direction) traffic.

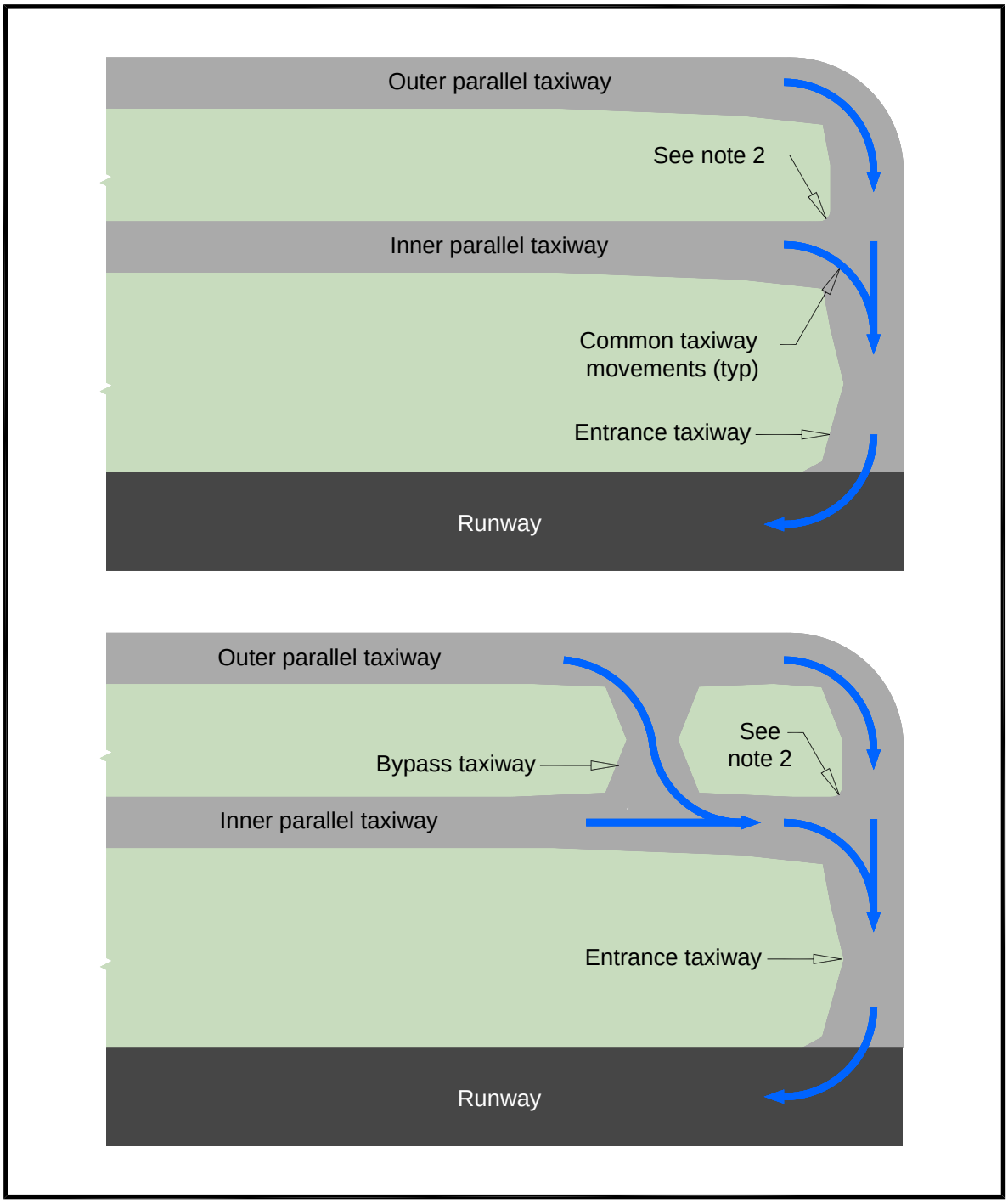
4.6.1 Standards.

1. Provide a full-length parallel taxiway, or equivalent taxi path (see parallel taxiway definition), for IFPs with visibility minimums below one mile (1.6 km).
2. Between dual parallel taxiways, provide fillets only for common turning movements (see Figure 4-10).

4.6.2 Recommended Practices.

1. Provide a full-length parallel taxiway, or equivalent taxi path (see parallel taxiway definition), for all runways with published instrument approaches (excluding circling approaches).
2. Provide a 50-foot (15.2) to 100-foot (30.5 m) parallel taxiway offset, per Figure 4-11, within 1,500 feet (457 m) of the runway end and conforming to curve criteria of paragraph 4.3.2 to address:
   a. Mitigating potential risks of taxiway landings and takeoffs by establishing a discontinuity in the taxiway alignment at the end of the runway.
   b. Providing wingtip clearance for aircraft on the parallel taxiway to aircraft holding at a bypass taxiway location. See Figure 4-10.
   c. Facilitating a perpendicular aircraft holding position relative to the runway centerline.
   d. Facilitating location of NAVAIDs (GS) and visual aids (wind cones) installation outside of an RSA or ROFA.
   e. Precluding the need for conditional holding position on the parallel taxiway by locating the taxiway clear of critical areas and approach/departure surfaces.

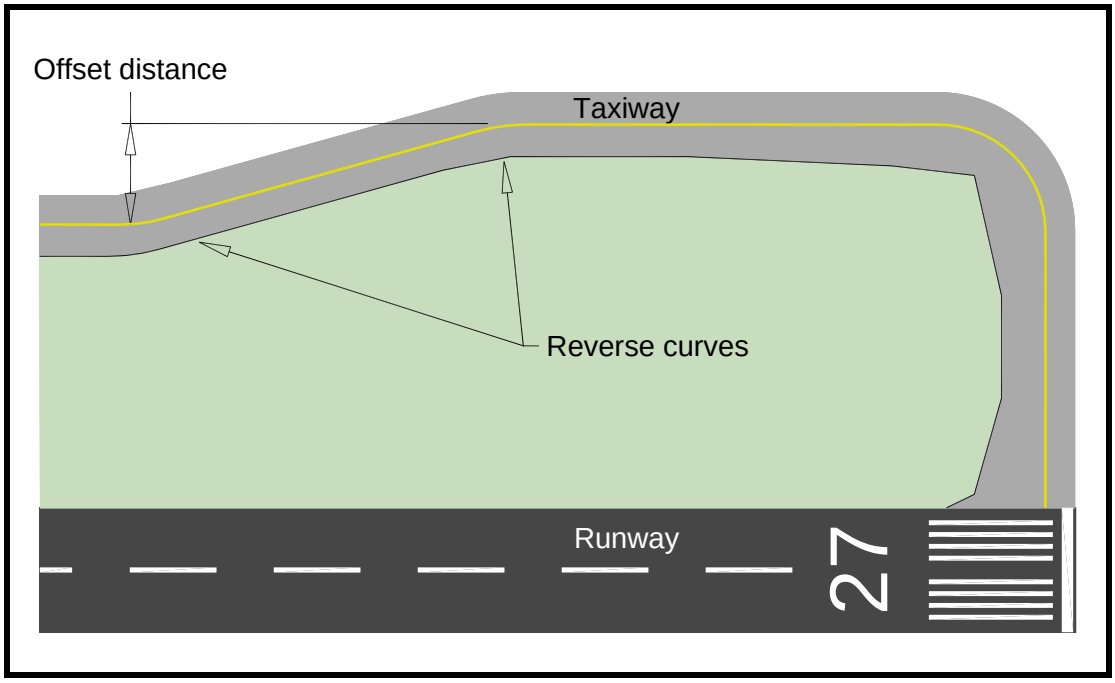
Figure 4-10. Parallel Taxiways



Note 1: Providing a centerline radius marking and standard fillet for the uncommon turn from the connecting taxiway to the inner parallel can create a risk for a taxiway departure. Refer to paragraph 4.6 for additional guidance on reducing this risk.

Note 2: To avoid risk of take-offs from the inner parallel taxiway, as well as to facilitate maneuvering of snow removal equipment, limit the fillet pavement from the connecting taxiway to the inner parallel taxiway to a 25-foot (9.1 m) ±5 feet (1.5 m) radius.

Figure 4-11. Parallel Taxiway Offset



4.6.3 Design Considerations.

1. Consider the use of multiple parallel taxiways to provide additional access paths to runway ends at airports with high-density traffic.
2. FAA Order 5090.5 provides relevant planning criteria.
3. A dual parallel taxiway need not extend the full length of the runway.
4. See paragraph 4.8.5.3, item 6, and online Runway Design Standards Matrix Tool (alternately Appendix G) regarding runway to taxiway separation standards.

4.7 Taxiway Fillet Design.

Apply these standards and recommended practices to intersections involving taxiways, taxilanes, and/or aprons. See Appendix J for guidance on the design of pavement fillets, including the Taxiway Intersection Dimensions by TDG tables. The FAA Office of Airports online Taxiway Fillet Design Tool, which calculates fillet dimensions for simple turns, is available on the FAA website at: http://www.faa.gov/airports/engineering/airport_design/. If there is a discrepancy between the tool and the AC standards, the AC has precedence.

4.7.1 Standards.

1. Design pavement fillets at intersections to accommodate the entire TDG of the most demanding aircraft while:
   a. Maintaining applicable TESM throughout the turning movement.

b. Minimizing excess pavement as illustrated in Figure 4-12, Figure 4-13, and Figure 4-14 using these dimensions:

- W-0 – the half-width of the straight taxiway section
- W-1 – the distance from the centerline of the straight taxiway section to the end of the first fillet taper
- W-2 – the distance from the centerline of the straight taxiway section to the end of the second fillet taper
- L-1 – the length of the first taxiway taper measured along the taxiway centerline
- L-2 – the length of the second taxiway taper measured along the taxiway centerline
- L-3 – the distance from the point of intersection of the turn to the start of any curved fillet
- R-CL – the radius of the centerline in the turn
- R-FILLET – the radius of the curved fillet (may be zero)
- R-OUTER – the radius of the outer edge of the pavement in the turn. This always equals R-CL + W-0.

2. See Appendix J.2.7 to address the asymptotic nature of tapers.

4.7.2 Recommended Practices.

1. Fillets designed to a specific aircraft using computer aided design (CAD) software may be acceptable after review via a modification of standard process.

2. When upgrading a non-standard intersection, it may be more economical to construct larger fillets rather than relocate existing centerline lighting.

3. To facilitate fillet constructability and snow removal operations:

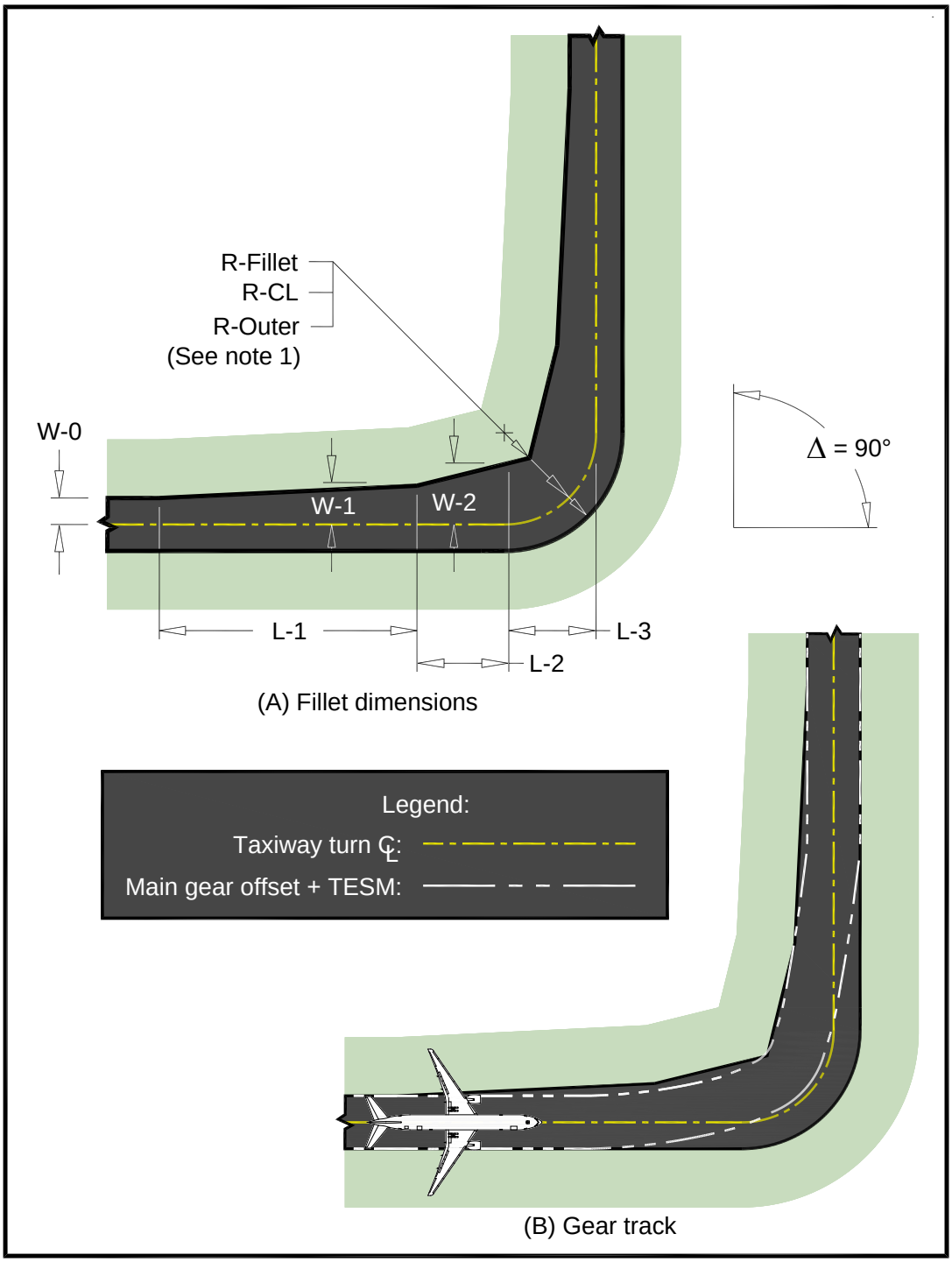
   a. Provide up to a 30-foot (9.1 m) fillet radius where straight taxiway edge lines intersect.

   b. Adjust fillet taper points to minimize narrow pavement sections, as shown in Figure 4-15.

   c. Maintain the TESM.

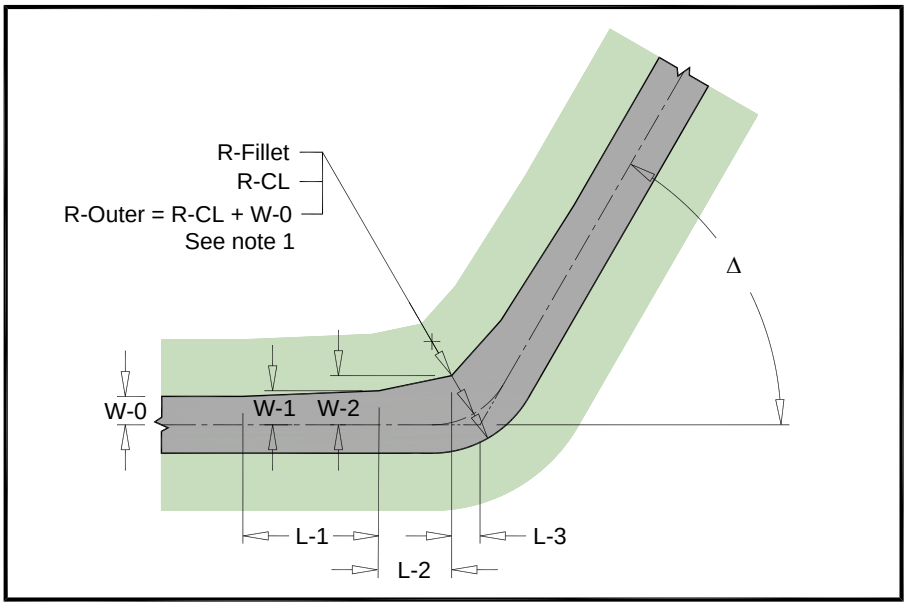
4. Refer to paragraph 4.3.2 for additional standards and recommendations.

Figure 4-12. Taxiway Turn – 90-Degree Delta



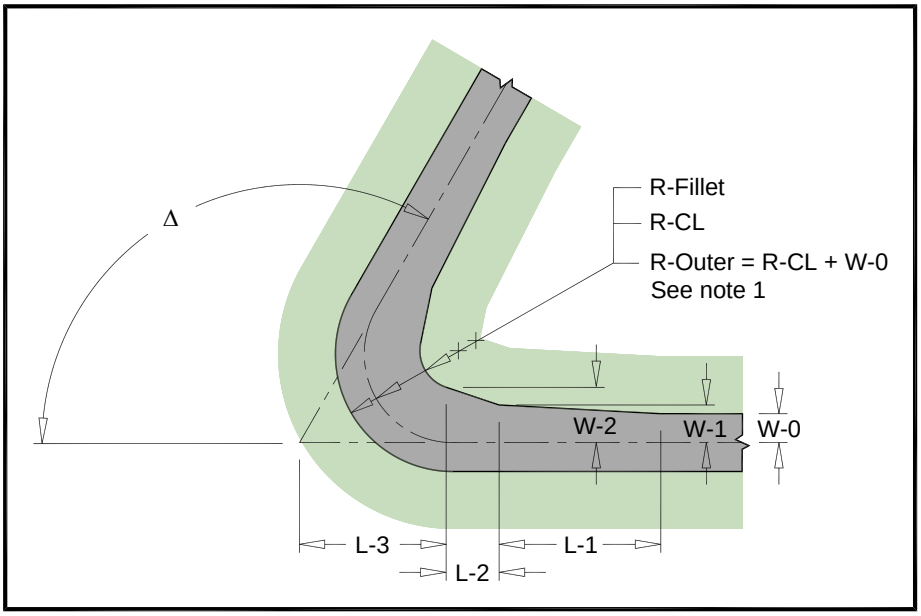
Note 1: Radii of the fillet and the taxiway centerline are not concentric. The radii of the centerline and the outer pavement edge are concentric.
Note 2: The design TDG establishes the dimensional values. See Appendix J.
Note 3: Offsets are shown in one direction, but offsets, and therefore fillets, are symmetrical.
Note 4: Dimensions used in this figure relate to the online Taxiway Fillet Design Tool

Figure 4-13. Taxiway Turn – Less Than 90-Degree Delta



Note 1: Radii of the fillet and the taxiway centerline are not concentric. The radii of the centerline and the outer pavement edge are concentric.
Note 2: The design TDG establishes the dimensional values. See Appendix J.
Note 3: Dimensions used in this figure relate to the use of the online Taxiway Fillet Design Tool.

Figure 4-14. Taxiway Turn – Greater Than 90-Degree Delta



Note 1: Radii of the fillet and the taxiway centerline are not concentric. The radii of the centerline and the outer pavement edge are concentric.
Note 2: The design TDG establishes the dimensional values. See Appendix J.
Note 3: Dimensions used in this figure relate to the use of the online Taxiway Fillet Design Tool.

4.7.3 Design Considerations.

1. The fillets designed using the online Taxiway Fillet Design Tool assume the aircraft aligns with the taxiway centerline at the start of a turn.
2. Aircraft may not be aligned with the taxiway centerline at the start of the turn when:
   a. Turns are close enough such that the lead-in (see dimension L-1) from one turn overlaps the lead-in to another turn.
   b. The ADG determines the runway to taxiway separation but the TDG controls the taxiway design, such as at crossover taxiways and at right-angle runway exits/entrances.
3. Turns greater than 90 degrees require a much larger fillet to maintain the TESM. See Appendix J for details.

4.8 Runway/Taxiway Intersections.

4.8.1 Right-angle Taxiways.

Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the runway to observe aircraft in both the left and right directions. They also provide the optimum orientation of the runway holding position signs to maximize visibility to pilots.

4.8.1.1 **Standards.**

1. Design right-angle intersections for runway/taxiway intersections, except where there is a need for acute angled exit taxiways, such as a high-speed exit.
2. If a true 90-degree angle with the runway is not practicable, it is acceptable to adjust the angle such that the critical aircraft is ±15 degrees from a 90-degree angle when at the hold line.
3. For opposite direction acute angle exit taxiways in close proximity, provide sufficient separation between the exits to limit a large expanse of pavement and allow standard locations for signs and markings.

4.8.1.2 **Recommended Practices.**

1. Increase the taxiway to runway separation for a segment of the parallel taxiway, as depicted in Figure 4-11, to allow for a 90-degree angle.
2. Design acute angle exit taxiways at an angle less than 45 degrees from the runway centerline.

3. Limit runway crossings to the outer thirds of the runway, keeping the middle third (high-energy area) of the runway clear so a pilot can maneuver to avoid a potential collision.
4. Minimize the number of runway crossings:
   a. to that necessary for efficient movement of aircraft.
   b. to reduce the number of potential conflict points with crossing aircraft operations.
5. Design a runway/taxiway intersection such that the sight distance along a runway from an intersecting taxiway is sufficient to allow a taxiing aircraft to safely enter or cross the runway.

4.8.1.3 **Design Considerations.**

1. Multiple intersecting taxiways with acute angles cause pilot confusion and poor visibility of signs due to:
   a. increased distance from the centerline.
   b. non-standard positioning of signs.
2. Right-angle intersections provide:
   a. a pilot with the best view of the runway and the approach ends.
   b. the optimum orientation of the runway holding position signs.

4.8.2 Entrance Taxiways.

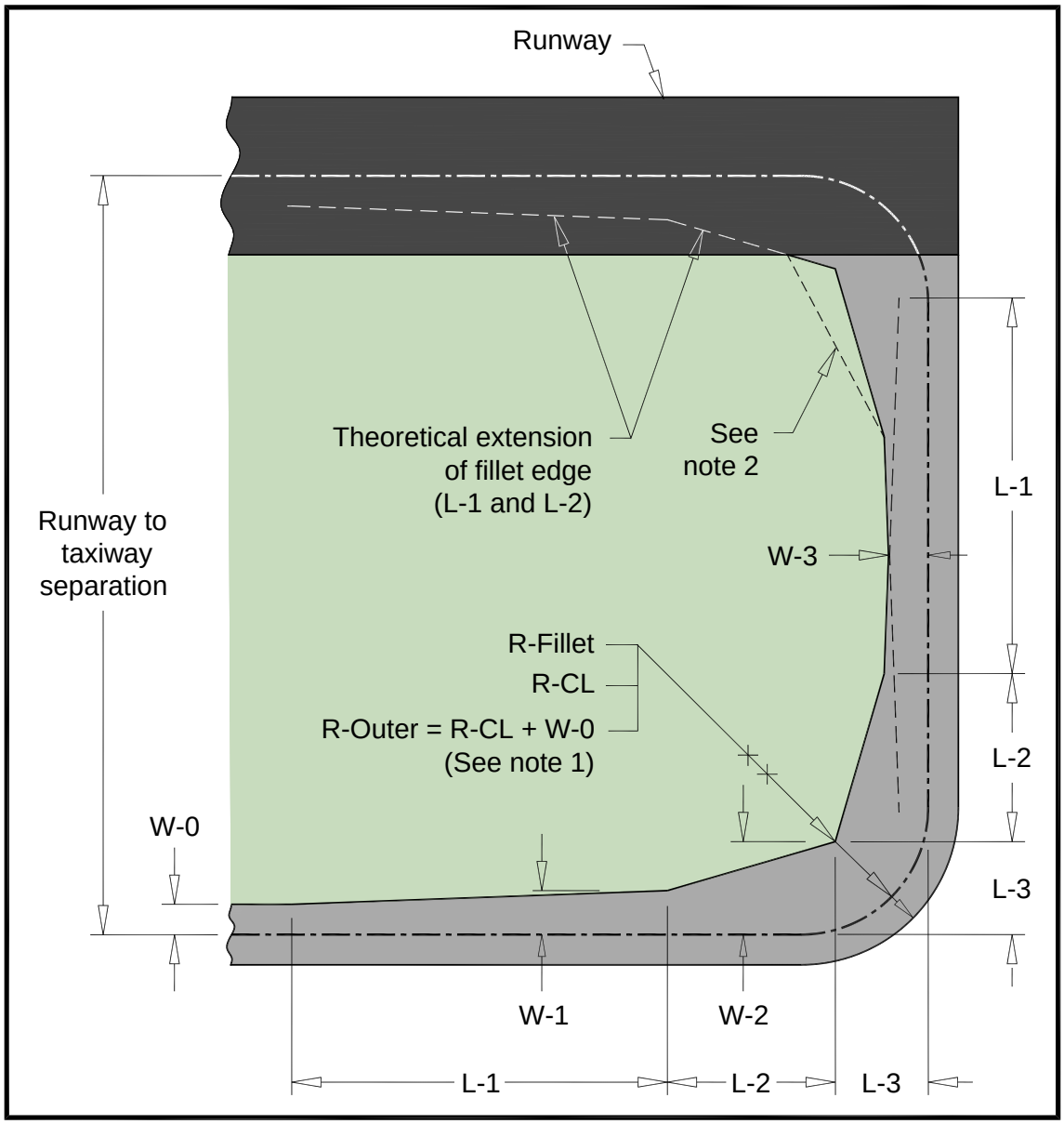
4.8.2.1 **Standards.**

1. Curve the outer edge of entrance taxiways located at runway ends to provide pilots a visual differentiation to the runway surface during landing (see paragraph 2.7.2).
2. When multiple parallel taxiways extend to the end of the runway, curve the outer edge of the outer parallel taxiway.
3. See Figure 4-15 for a standard entrance taxiway layout.
4. Design the entrance taxiway width based on Table 4-2.

4.8.2.2 **Recommended Practices.**

1. Design entrance taxiways to serve each runway end.
2. For fillet design, locate the point of tangency of the taxiway centerline curve at the runway centerline.
3. Entrance taxiways do not provide direct access from an apron (see Figure 4-2 and paragraph J.5.7).
4. Each entrance taxiway has its own taxiway designator, markings, and elevated signage.

Figure 4-15. Entrance Taxiway



Note 1: Radii of the fillet and the taxiway centerline are not concentric. The radii of the centerline and the outer pavement edge are concentric.

Note 2: It is acceptable to design a single fillet edge, as shown, to avoid a short and narrow fillet pavement section near the runway edge.

Note 3: Dimensional values are representative only. Determine these values to maintain the TESM while minimizing excess pavement.

Note 4: See paragraph 4.7.3 item 3 for constructability considerations.

4.8.2.3 **Design Considerations.**

1. Two standard 90-degree turns:

   a. Resulting in a steering angle of 50 degrees or less:

i. Design a runway entrance taxiway as two standard 90-degree turns.

ii. See paragraph 4.7.3.

b. Resulting in a steering angle of more than 50 degrees:

i. Increase the turn radius and fillets.

ii. An example of this condition is a right-angle runway exit or entrance where the runway to taxiway separation applies ADG-IV criteria, but the taxiway design uses TDG 6 criteria.

2. Design tools are available on the FAA website at http://www.faa.gov/airports/engineering/airport_design/.

3. Design the centerline radius and minimum fillet dimensions with the design TDG, as shown in the tables in paragraph J.3.

4. A displaced threshold may cause the location of the holding position to reside on the parallel taxiway to keep aircraft out of the POFZ and approach surfaces.

5. Entrance taxiways also serve as final exit taxiways for operations in the opposite direction.

4.8.3 Bypass Taxiways.

At busy airports, ATC routinely needs to re-sequence aircraft near the departure runway end in order to maintain optimum runway capacity. Bypass taxiways located near runway ends provide flexibility of runway operations by permitting necessary ground maneuvering based on clearance sequence.

4.8.3.1 **Standards.**

1. Conform to the standard taxiway separation and widths for the specific ADG and TDG, as shown in Table 4-1 and Table 4-2.

2. For existing conditions, mark, sign, and light paved islands between the entrance taxiway and the bypass taxiway to identify the area as closed to aircraft (see AC 150/5340-1).

3. For new design, install turf (natural or artificial) to create the no-taxi island between bypass taxiway(s) and the entrance taxiways. See Figure 4-10 and Figure 4-16.

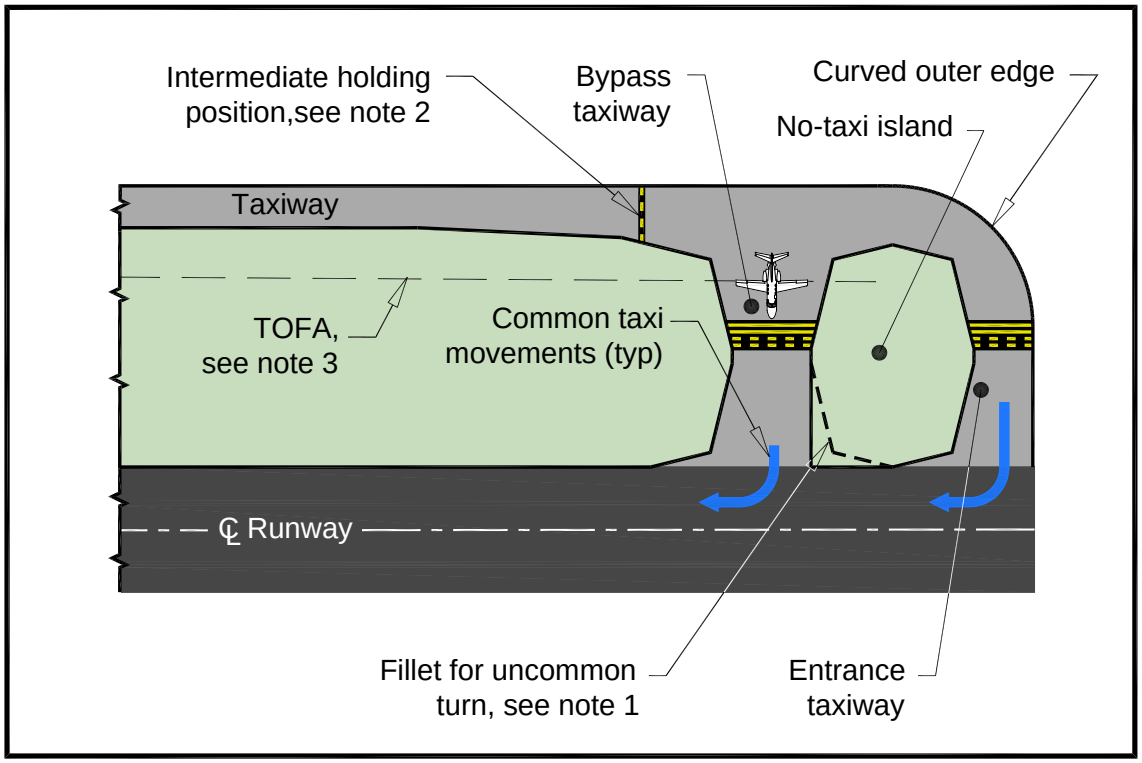
4.8.3.2 **Recommended Practices.**

1. Provide the fillet between the bypass taxiway and entrance taxiway only when there is a recurring operational need for this turning movement, as shown in Figure 4-16.

2. Consult with local ATC to assess if one or more bypass taxiways on a runway end provide optimum departure capacity.

3. Provide bypass taxiways at towered airports with regular IFR operations.

Figure 4-16. Bypass Taxiway Bay Configuration



Note 1: The turn from the near end of the runway to the bypass taxiway is an uncommon operation. See paragraph 4.8.3.2.

Note 2: Install an intermediate holding position marking (e.g., Pattern C) prior to the bypass taxiway if any part of a holding aircraft encroaches upon the TOFA.

Note 3: For unobstructed taxi operations on the parallel taxiway, consider an off-set parallel taxiway, per Figure 4-11, to preclude a holding aircraft from encroaching upon the TOFA.

4.8.4 Exit Taxiways.

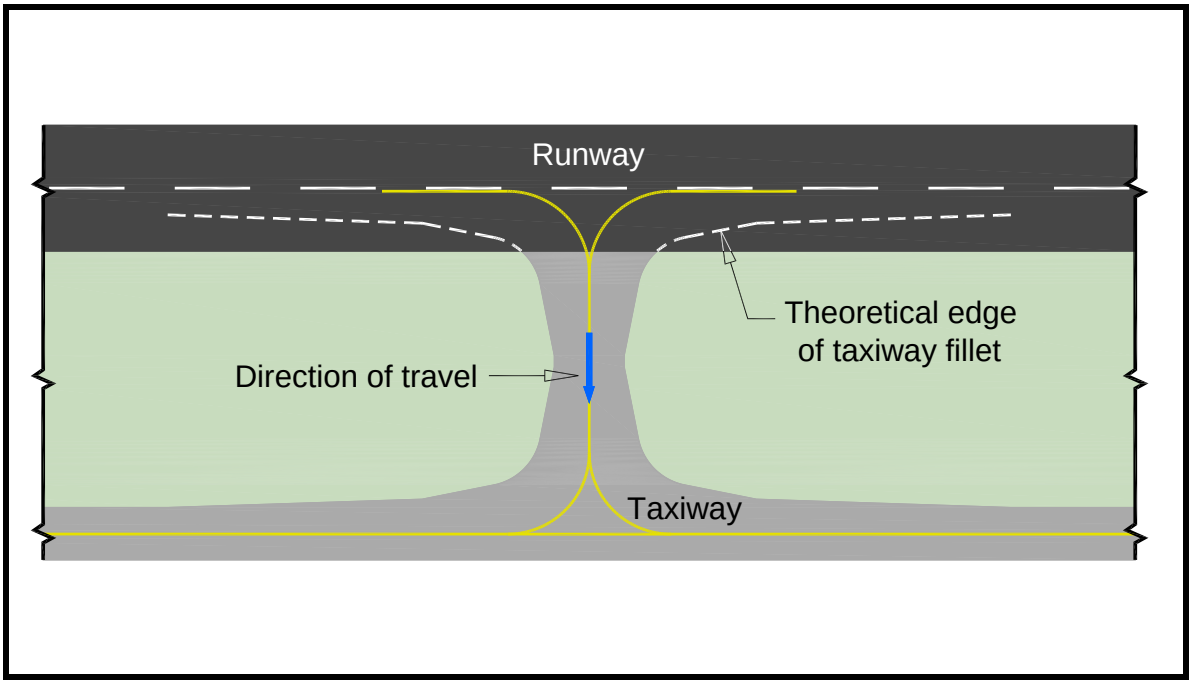
Exit taxiways permit free flow to the parallel taxiway or to a point where the aircraft is completely clear of the hold line.

4.8.4.1 **Recommended Practices.**

1. Design right-angle exit taxiways to provide for flexible operations in both directions and as a runway crossing point.

2. Figure 4-17 illustrates a design configuration for a right-angle taxiway, creating a mirror image of an entrance taxiway about the exit taxiway centerline.

Figure 4-17. Right-Angled Exit Taxiway



3. Assess the exit taxiway location's impact on runway occupancy time and capacity.

   a. The Runway Exit Design Interactive Model (REDIM) is the preferred quantitative method for determining the location and mix of high speed and right-angle runway exits. See https://www.faa.gov/airports/engineering/design_software/ for airport design software.

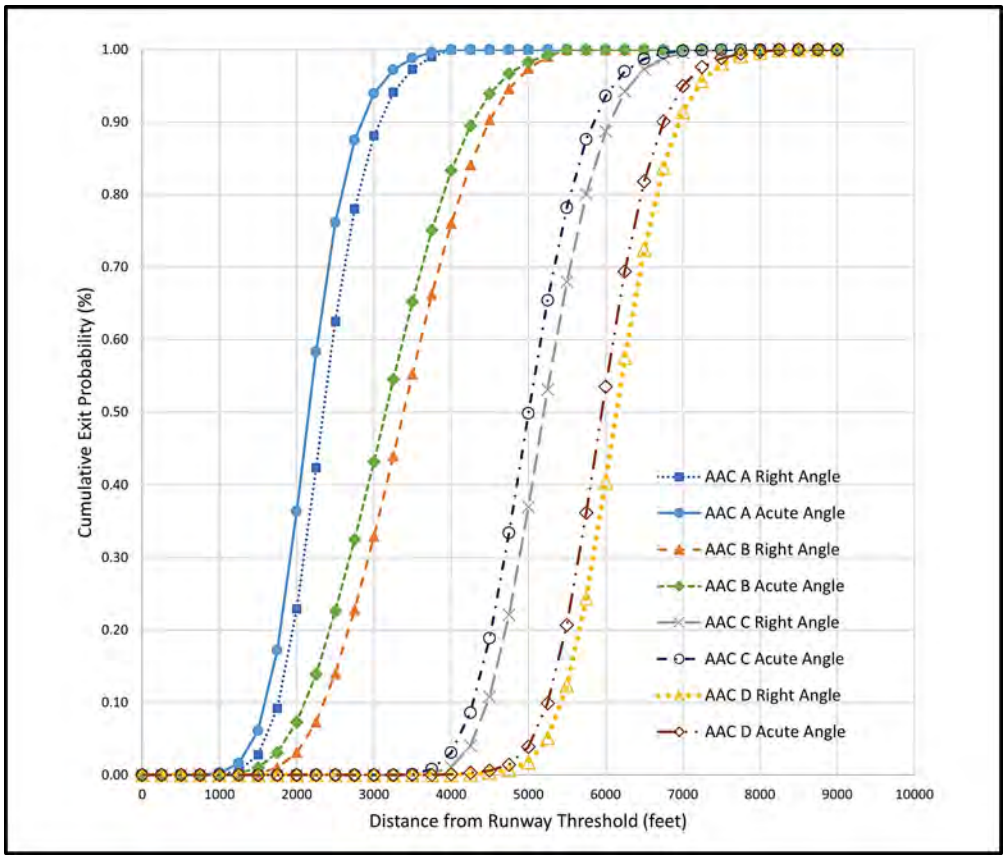
   b. Fast-time simulation modeling, used alone, is not a reliable means of locating exit taxiways.

   c. Figure 4-18 provides a simplified method using cumulative distributions of exit usage by the AAC at airports with an elevation under 2,000 feet (610 m) MSL.

      i. Figure 4-18 uses the same observed aircraft performance data contained in REDIM.

      ii. This method is appropriate to use for the initial, conceptual planning for location of exit taxiways.

Figure 4-18. Cumulative Probability of Aircraft Able to Exit by AAC at Airports with an Elevation Less Than 2,000 feet (610 m) MSL



Note: This figure provides a simplified method using cumulative exit probability distribution for airports with an elevation under 2,000 feet (610 m) MSL. This method is appropriate to use for the initial, conceptual planning. Analysis using REDIM-V3 to incorporate airport specific variables (e.g., elevation and fleet mix) is preferred, particularly when considering proper placement of high-speed exits.
Source: Virginia Polytechnic Institute and State University ("Virginia Tech") analysis using REDIM-V3 conducted in March 2021 with the following parameters: International Standard Atmosphere (ISA) temperature; sea level elevation; runway condition is 90% dry and 10% wet; representative U.S. fleet mix.

4.8.4.2 Design Considerations.

1. Exit taxiways, including high speed exit taxiways, may be located in the middle third of a runway to optimize runway capacity provided there is no accompanying crossing taxiway associated with the exit taxiway.
2. An acute angle exit taxiway is not suitable as a runway entrance or runway crossing point, as it provides a pilot with a limited field of view in one direction.
3. Runway exit taxiways are either "right angle" or "acute angle" taxiways.

a. The application of a right-angled exit taxiway versus acute-angled exit taxiway is a function of the existing and anticipated traffic in the interest of reducing runway occupancy time.

b. Acute angle taxiway turns require the pilot landing in the opposite direction to slow down considerably on the runway to negotiate the greater than 90-degree turn, resulting in additional runway occupancy time.

c. See paragraph 4.8.5 for guidance on high-speed exit taxiways.

4. The type of exit taxiway influences runway to parallel taxiway separation.

a. FAA Airports' online Runway Design Standards Matrix Tool provides runway/taxiway separations based on ADG.

b. Minimum turn radii based on TDG may affect runway/taxiway separation distance.

5. For existing runway/taxiway separations, it may not be possible to combine a standard high-speed 30-degree angle exit (see paragraph 4.8.5) with a subsequent 150-degree reverse turn while maintaining a nose gear steering angle of no more than 50 degrees.

6. Design tools related to exit taxiways are available at: http://www.faa.gov/airports/engineering/airport_design.

4.8.5 High-Speed Exit Taxiways.

A specific runway exit taxiway forming a 30-degree angle with the runway centerline to enhance runway capacity by reducing runway occupancy time. See Figure 4-19.

4.8.5.1 **Standards.**

1. A high-speed exit provides direct access to a parallel taxiway closest to the runway.

2. The radius of the high-speed exit from the runway is 1,500 feet (457 m).

3. When providing a reverse turn from a high-speed exit, provide additional fillet pavement on the inside of the reverse turn to maintain the applicable TESM throughout the turning movement. See Figure 4-20.

4.8.5.2 **Recommended Practices.**

To improve pilot recognition and acceptance of an exit taxiway, provide enhancements such as:

1. High intensity taxiway centerline lights

2. Widening the exit taxiway throat

3. Provide high speed exits to reduce runway occupancy time when runway operations meet criteria established in FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems (NPIAS) and the Airports Capital Improvement Plan (ACIP).*

4.8.5.3 **Design Considerations.**

1. A high-speed exit providing direct access to the outer of two parallel taxiways, a runway, or an apron, introduces safety risks related to runway incursions.
2. When a reverse taxiing movement is not necessary, provide an inside radius of 25-feet (9.1m), ±5 feet (1.5 m). See Figure 4-19.
3. Ideally, aircraft exiting the runway via a high-speed exit taxiway continue on the parallel taxiway in the landing direction.
4. When it is necessary for aircraft to reverse taxiing direction after exiting a runway with a single parallel taxiway, consider:
   a. providing an additional 90-degree exit taxiway beyond the high-speed exit to provide two 90-degree turns
   b. providing a second parallel taxiway with crossover taxiways (Figure 4-22, Figure 4-23, and Figure 4-24), or
   c. providing additional pavement per paragraph 4.8.5.1, item 3.
5. Reference Table 4-3 for guidance on reverse turns between runways and parallel taxiways based on TDG. The minimum separation shown provides for a full 30-degree exit and the following 150-degree turn requiring a nose gear steering angle of not more than 50 degrees.
   a. If a reverse turn is necessary when the runway to taxiway separation is less than the minimum shown in Table 4-3, decrease the initial exit angle and/or use a radius that will require a nose gear steering angle of more than 50 degrees for longer aircraft and increase pavement fillets (see paragraph 4.8.5.1, item 3). (See paragraph 4.6.3 for guidance on fillet design.)
   b. Design the fillet for the reverse turn considering that the aircraft movement on the exit taxiway is in the exiting direction only.
   c. The FAA design tool, “Acute Angle Exit Tool,” is a method to calculate centerline dimensions and steering angles based on TDG, runway to taxiway separation, exit radius, and exit angle. Airport Design tools are available at www.faa.gov/airports/engineering/airport_design/.
6. Provide sufficient spacing between opposite direction high-speed exit taxiways to avoid wide expanses of pavement at the runway-taxiway intersection and to allow for the standard location of signs, markings, and lighting. See Figure 4-21.

7. Use design tools (available at http://www.faa.gov/airports/engineering/airport_design/) to generate views of additional combinations.

Table 4-3. Runway to Taxiway Separation for Reverse Turns from a High-Speed Exit Based on TDG

Runway Centerline to Taxiway/ Taxilane Centerline	TDG			
	3	4	5	6
Recommended separation	350 ft (106.7 m)	450 ft (137.2 m)	450 ft (137.2 m)	600 ft (182.9 m)
Radius for 150-degree turn after 30-degree exit	79 ft (24.1 m)	121 ft (36.0 m)	121 ft (36.9 m)	152 ft (46.3 m)
Minimum separation [1]	348 ft (106.1 m)	427 ft (130.1 m)	427 ft (130.1 m)	485 ft (147.8 m)

Note 1: Minimum separation distance based on the standard 30-degree high speed exit and maximum 50-degree steering angle for the reverse turn.

Figure 4-19. High-Speed Exit

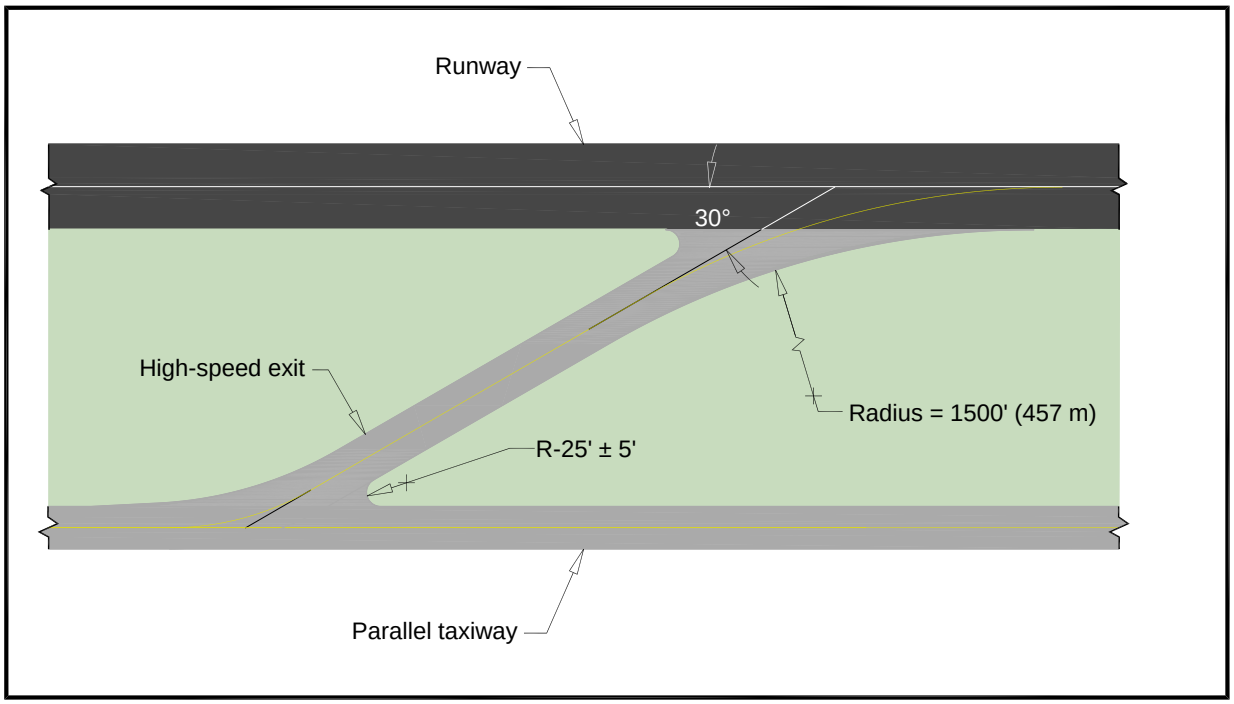
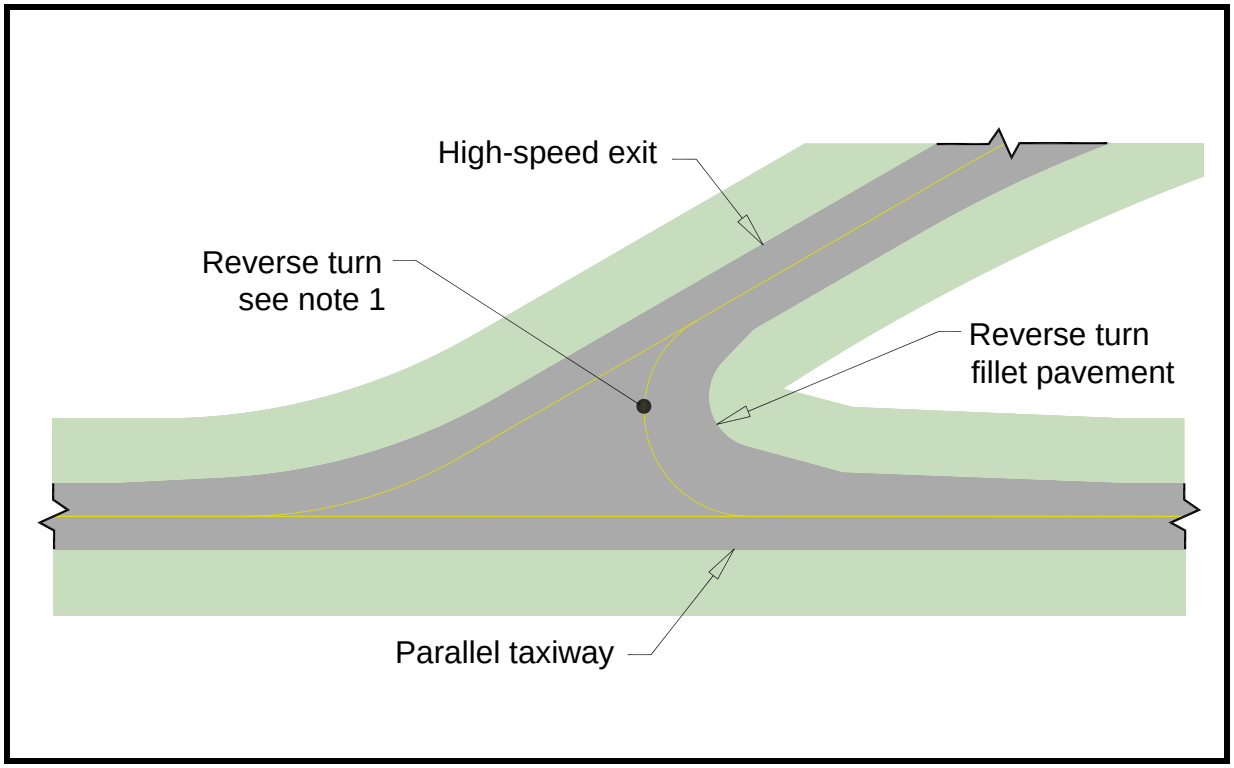
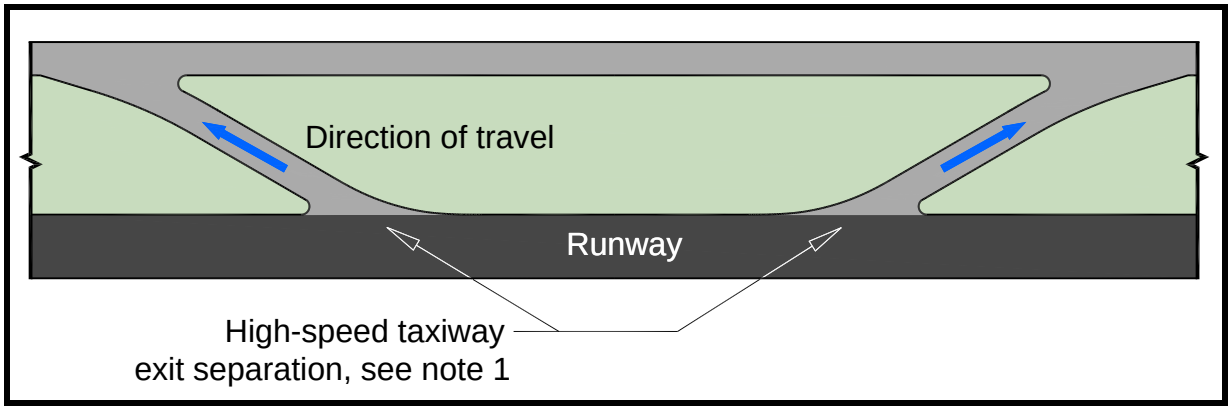


Figure 4-20. High-Speed Exit – Reverse Turn



Note 1: See paragraph 4.8.5.3, item 5.

Figure 4-21. High-Speed Exit Separation



Note 1: See paragraph 4.8.5.3, item 6.

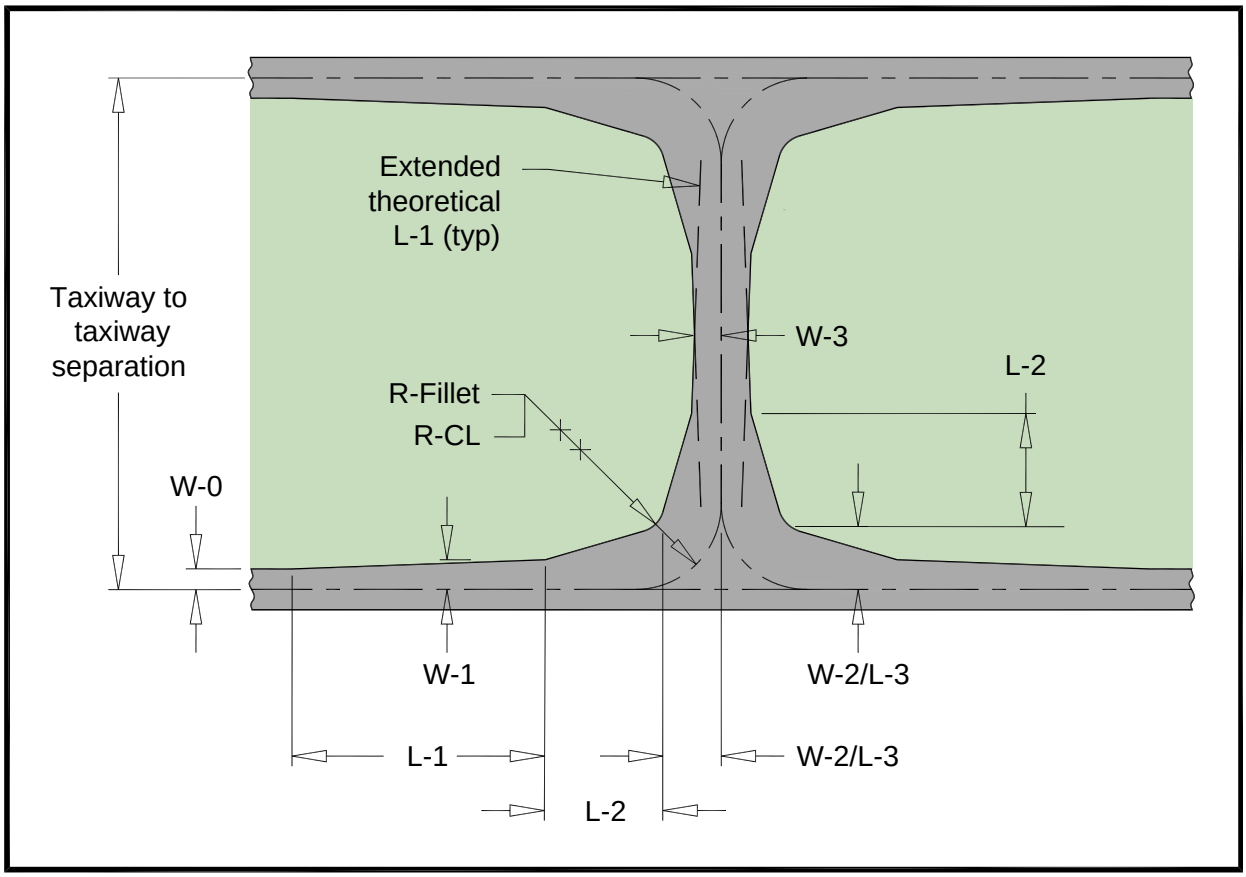
4.8.6 Crossover Taxiways.

Crossover taxiways, sometimes called “connector” or “transverse” taxiways, between parallel taxiways increase flexibility of operations. These design standards address two scenarios: (1) crossover taxiways with no reverse turn, and (2) crossover taxiways where there is an operational need for a reverse turn defined as a 180-degree turn between two parallel taxiways.

4.8.6.1 **Standards.**

1. When there is no reverse turn, design the taxiway-to-taxiway separation distance between parallel taxiways to be the greater of:
   a. Separation value based on ADG, per Table 4-1. See Figure 4-22.
   b. Twice the radius (R-CL) of a standard 90-degree turn based on TDG. See Figure 4-23.

Figure 4-22. Crossover Taxiway, Taxiway Separation Based on ADG



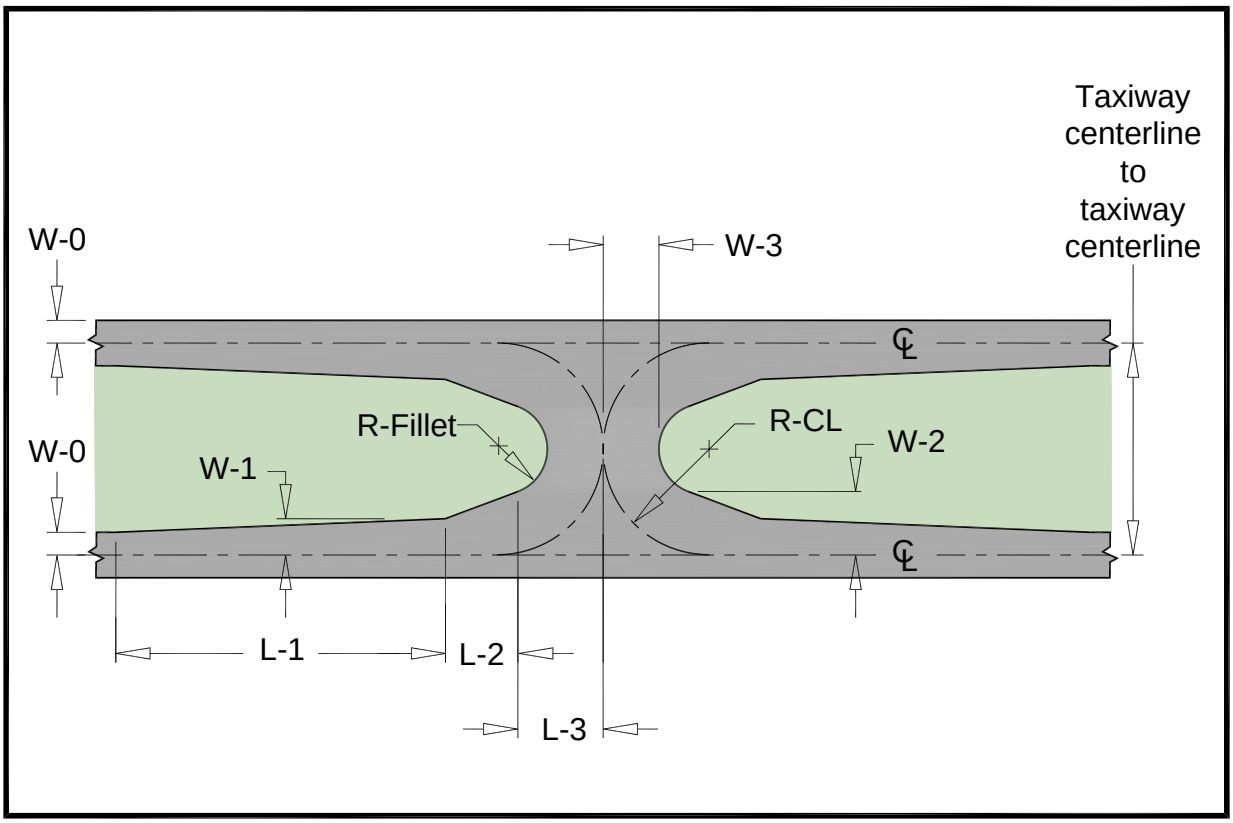
Note: See paragraph 4.7 for guidance on fillet design.

2. When there is an operational need for a reverse turn, design the minimum distance between parallel taxiways to be the greater of:

   a. Twice the radius (R-CL) of a 180-degree turn based on TDG. See Figure 4-23.

   b. Separation value based on ADG, per Table 4-1. See Figure 4-24.

Figure 4-23. Crossover Taxiway, Taxiway Separation Based on TDG



Note 1: See paragraph 4.7 for guidance on fillet design.
Note 2: R-CL varies depending on the need for a reverse turn.

4.8.6.2 **Recommended Practices.**

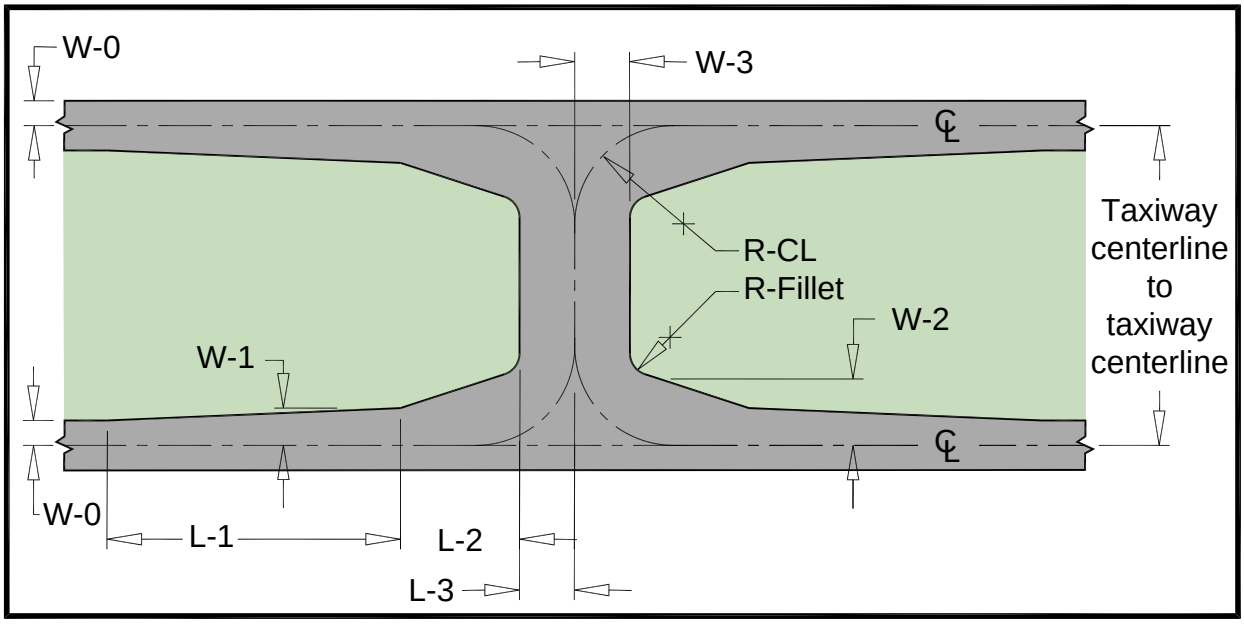
1. Design the taxiway system to minimize the need for reverse turns between parallel taxiways.

2. If it is not feasible to increase the separation between existing parallel taxiways, it is acceptable to design to a steering angle of more than 50 degrees.

4.8.6.3 **Design Consideration.**

1. In cases where the separation is based on ADG, a steering angle of more than 50 degrees may result from combining two 90-degree turns designed according to paragraphs J.2 and J.3.

Figure 4-24. Crossover Taxiway Reverse Turn, Taxiway Separation Based on ADG



Note: See paragraph 4.7 for guidance on fillet design.

4.9 **Holding Bays for Runway Ends.**

Providing holding bays instead of bypass taxiways enhances capacity. Holding bays provide a space for queuing of aircraft awaiting departure clearance. Holding bays also permit aircraft receiving clearance to bypass other aircraft to the runway takeoff position.

4.9.1 Standards.

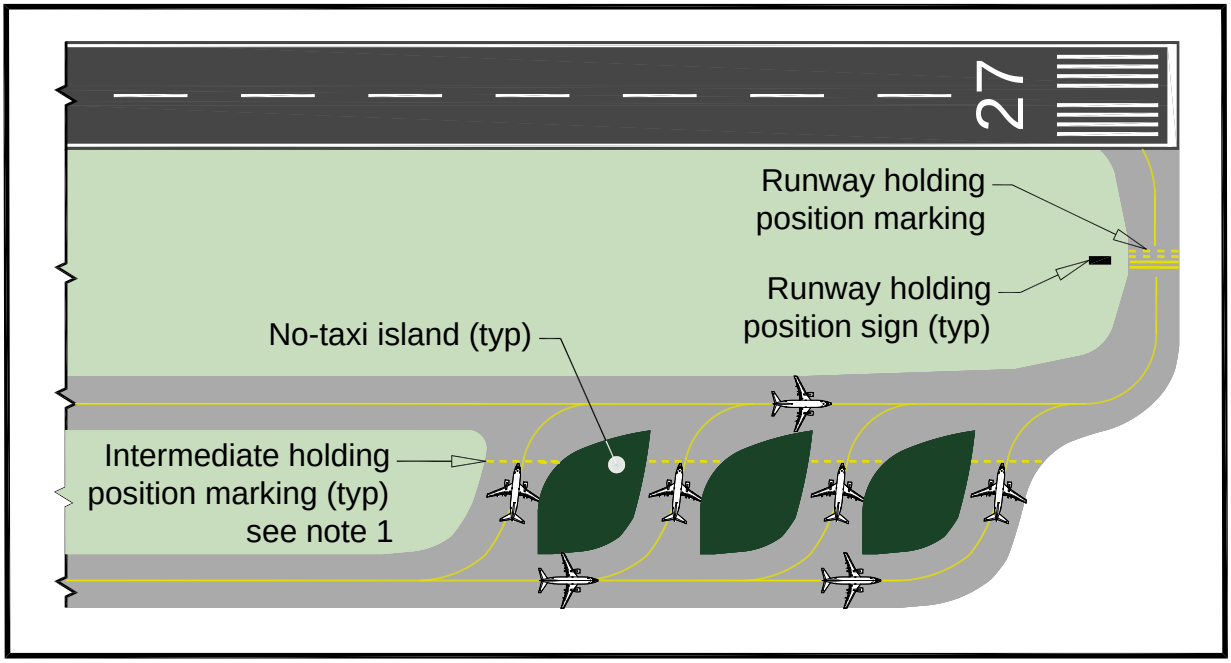
1. Locate holding bays to keep aircraft out of the OFZ, POFZ, RSA, and ILS critical areas.
2. Design the geometry per the applicable ADG and TDG standards.

4.9.2 Recommended Practices.

1. Provide a holding bay when runway operations meet criteria established in FAA Order 5090.5.
2. Design holding bays to allow independent aircraft movements to bypass one another to taxi to the runway based on the design ADG. See Figure 4-25.

3. Islands, either grass or properly marked pavement, between the parking positions provide visual cues to pilots that assist them with situational awareness. See Figure 4-25.

Figure 4-25. Holding Bay Configuration



Note 1: Locate intermediate hold lines at the outer limit of the inner TOFA.

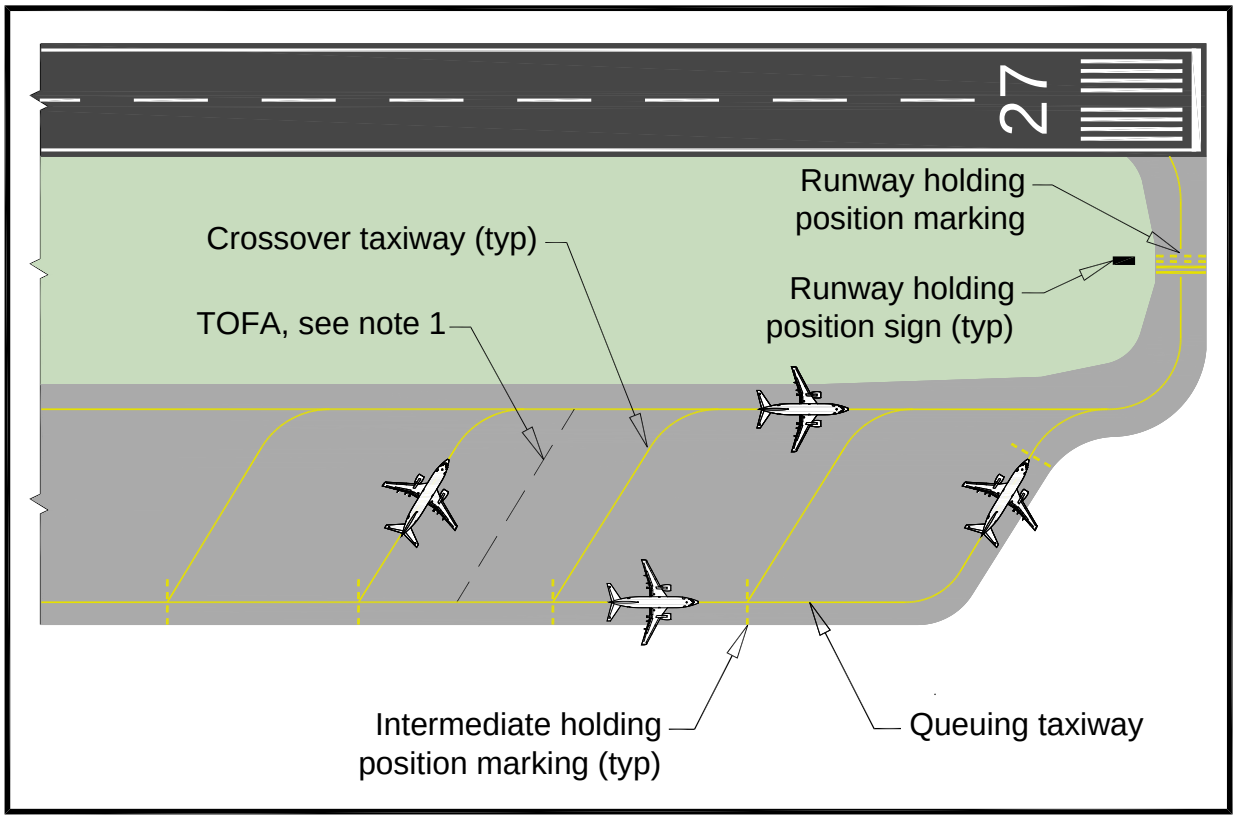
4. The alternate holding bay configuration consisting of a queuing taxiway and an access taxiway (see Figure 4-26) can provide an acceptable level of safety and efficiency provided:

   a. There is adequate TOFA separation between the marked centerlines of the connecting taxiways based on the ADG of critical aircraft.

   b. Spacing of intermediate holding positions allows sufficient wingtip clearance between an aircraft turning onto a connecting taxiway and the aircraft holding ahead of the turning aircraft.

   c. The airport and ATCT develop a standard operating procedure addressing the use of the queuing taxiway in a manner that establishes an acceptable level of safety.

Figure 4-26. Holding Bay – Alternate Configuration



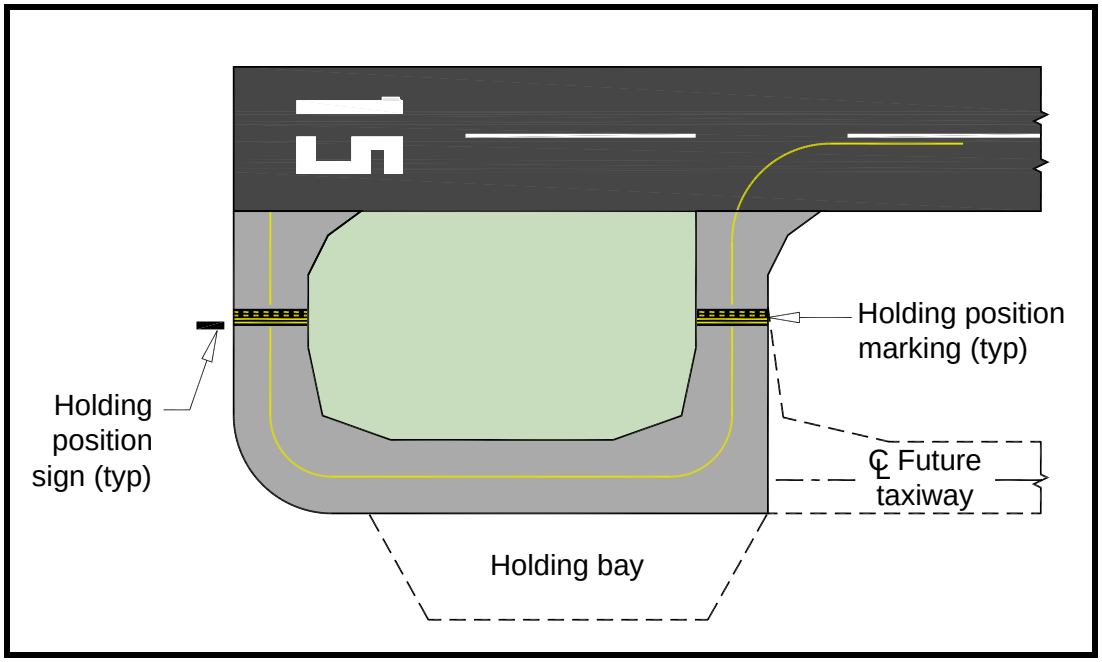
Note 1: See paragraph 4.9.2.
Note 2: Except for the end crossover taxiway, this configuration provides for active taxiing of aircraft on the crossover taxiways versus holding of aircraft.

4.10 Taxiway Turnarounds.

4.10.1 Recommended Practices.

The provision of a full parallel taxiway may be impractical for some GA airports. For such airports, consider turnarounds as an interim alternative to a full or partial parallel taxiway. This may include a limited-sized holding bay to allow more than one aircraft to hold at a runway end. Design the geometry of the turnaround and any holding bay to the applicable ADG and TDG standards. See Figure 4-27.

Figure 4-27. Taxiway Turnaround



4.11 **Apron Taxiways and Taxilanes.**

There is often a need for through-taxi routes across an apron to provide access to gate positions or other terminal areas.

4.11.1 Standards.

1. Provide a clear LOS from the ATCT to the movement area pavement.
2. Apron taxiways and taxilanes have the same separations as other taxiways and taxilanes.

4.11.2 Recommended Practices.

1. Provide a clear LOS from the ATCT for taxilanes not under ATCT control.
2. When an apron taxiway or taxilane is along the edge of the apron:
   a. Locate the centerline inward from the apron edge at a distance equal to half the width of the required taxiway/taxilane width.
   b. Provide shoulder along the outer edge, per paragraph 4.13.

4.12 **End-Around Taxiways (EAT).**

An EAT improves efficiency of runway operations and provides a safe means of aircraft movement from one side of a runway to the other side of the runway. The EAT allows the critical aircraft to taxi around the runway end during departure operations and to cross the extended runway centerline without specific clearance from ATC. The design

of an EAT considers parameters unique to each airport and each runway. See Figure 4-28 which illustrates EAT concepts per the design standards described below.

4.12.1 FAA Review.

4.12.1.1 **Standards.**

Before initiating formal feasibility studies, submit the proposed EAT and EAT screen design layout to the FAA Office of Airport Safety and Standards, Airport Engineering Division (AAS-100) through the local FAA Airports Regional Office or ADO for a preliminary review and comment. Subject to a favorable FAA assessment, the airport may proceed with feasibility studies and design efforts. The final EAT design is subject to an aeronautical study.

4.12.2 Design.

4.12.2.1 **Standards.**

1. Locate the EAT centerline a minimum of 1,500 feet (457 m) from the DER shown in Figure 4-28.
2. The minimum length of that portion of the EAT crossing the extended runway centerline at the minimum distance of 1,500 feet (457 m) is equal to the 1,000 feet (305 m) width of the departure surface of the DER, as shown in Figure 3-9.
3. Increase the minimum distances as necessary to prevent aircraft tails from penetrating the 40:1 departure surface and any surface identified in FAA Order 8260.3, as shown in Figure 4-28.
   a. Initiate an aeronautical study for each site to verify that the tail height of the critical design group aircraft operating on the EAT does not penetrate these surfaces.
   b. The aeronautical study will also confirm compliance with 14 CFR § 121.189, *Airplanes: Turbine Engine Powered: Takeoff Limitations*, which requires the net takeoff flight path to clear all obstacles either by a height of at least 35 feet (10.7 m) vertically, or by at least 200 feet (61 m) horizontally within the airport boundaries.
   c. In addition to the critical aircraft tail height, the elevation of the DER relative to the elevation of points along the EAT is a factor in determining conformance with clearance criteria.
4. Locate the EAT outside of ILS critical areas.

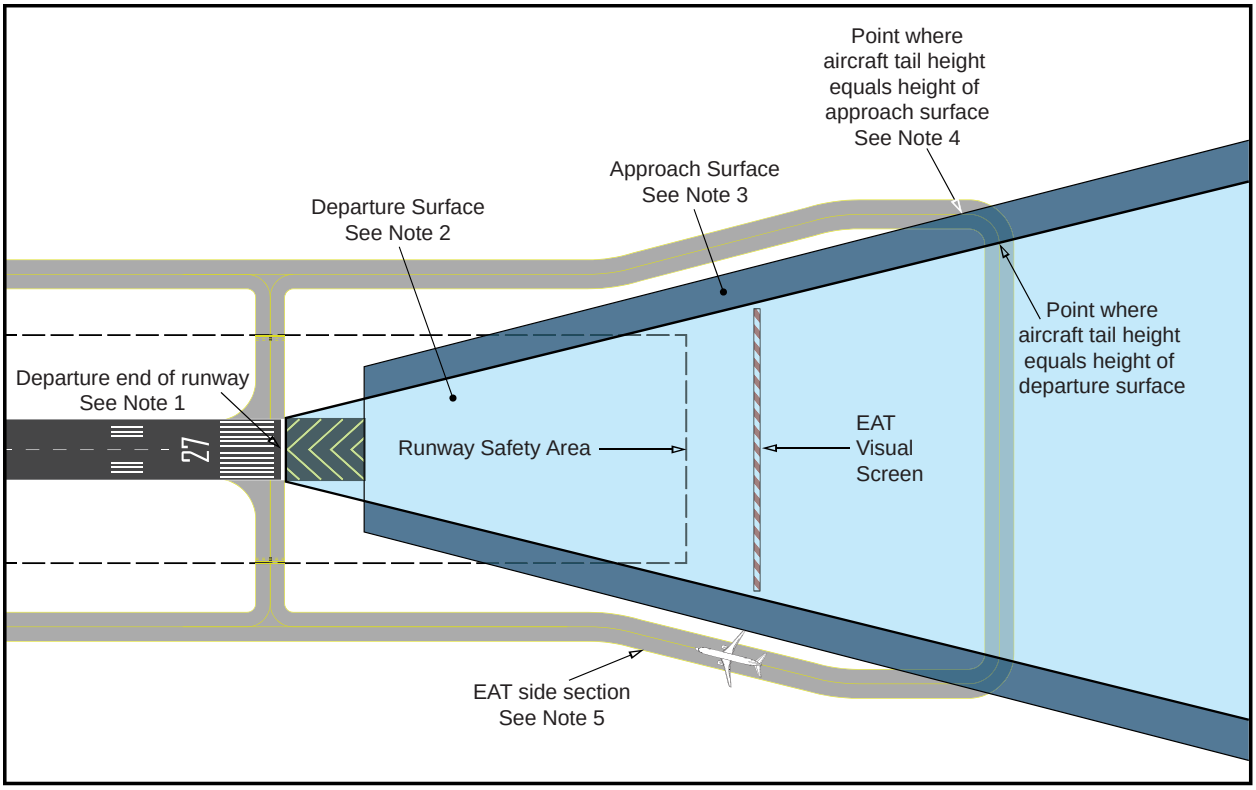
4.12.2.2 **Recommended Practices.**

1. Design the EAT below the departure end runway elevation to minimize the distance between the end of the runway and points along that portion of the EAT crossing the extended runway centerline.
2. Design the EAT to the most demanding aircraft.

4.12.2.3 **Design Considerations.**

Taxiways that do not conform to EAT standards but traverse through the approach and departure areas of a runway may need mitigations, such as signage and markings, to ensure an acceptable level of safety.

Figure 4-28. End-Around Taxiway (EAT)



Note 1: Assumes all centerline elevations are equal to the elevation of the DER.

Note 2: Section 2 (both left and right wings) of the runway departure surface is not shown for clarity purposes. Refer to paragraph 3.6.2 and Figure 3-11 for additional information regarding departure surfaces and the departure surface Section 1.

Note 3: Refer to paragraph 3.6.1, Table 3-4, and Figure 3-7 for additional information regarding the approach surfaces.

Note 4: To avoid an acute angle turn onto the transverse segment of the EAT, it is acceptable to align the taxiway relative to the outer edge of the surface such that the wings are under the controlling surface while the aircraft tail remains outside of the surface.

Note 5: The distance between the taxiway centerline and the outer edge of the approach surface edge is a minimum of half of the taxiway safety area.

4.12.3 EAT Visual Screens.

A visual screen masks, partially or completely, aircraft using the EAT from a viewpoint on the associated runway. This enables pilots operating on the runway to differentiate between an aircraft crossing the active runway or crossing on the EAT.

4.12.3.1 **Standards.**

1. Establish the height of the screen by masking the engine nacelles of the crossing aircraft from the pilot's view of a departing aircraft at the location on the runway the aircraft reaches V_1 speed during takeoff.
2. Locate the visual screen structure outside all RSAs, runway OFAs, taxiway OFAs, and ILS critical areas.
3. Locate the visual screen so that it does not penetrate the inner approach OFZ, the approach light plane, or other TERPS surfaces.

4.12.3.2 **Recommended Practices.**

Design the screen in accordance with the frangibility paragraph D.2.7 of Appendix D.

4.12.3.3 **Design Considerations.**

1. Determine the need for a visual screen during the design process.
2. The design of the visual screen and siting of visual aids are co-dependent. Refer to Appendix D for detailed planning and design guidance on EAT screens.

4.13 Taxiway and Taxilane Shoulders.

Unprotected or unstabilized soils adjacent to taxiways are susceptible to erosion which can result in engine ingestion problems for jet engines that hang near or over the edge of the taxiway pavement. Refer to Appendix C for information on the effects and treatment of jet blast.

4.13.1 Standards.

1. See Table 4-2 for taxiway shoulder width standards.
2. Provide paved shoulders for taxiways, taxilanes, and aprons accommodating ADG-IV and larger aircraft.
   a. When installed, provide paved shoulders for the full length of the taxiway(s).
   b. Design shoulder pavement to support:
      i. the occasional passage of the most demanding aircraft
      ii. the most demanding emergency or maintenance vehicle for the design life of the full-strength pavement.
      iii. See AC 150/5320-6.

c. Design the paved shoulder to be flush with the taxiway pavement.

3. Provide stabilized shoulders for taxiways serving a critical aircraft of ADG-I, ADG-II, and ADG-III consisting of one of the following:

   a. Turf shoulder (most common)

   b. Stabilizing soil treatments, per standards in AC 150/5370-10.

4. Design shoulders to provide proper surface drainage away from the edge of the taxiway pavement, per paragraph 4.14.2.

4.13.2 Recommended Practices.

1. Provide paved shoulders for taxiways, taxilanes, and aprons accommodating ADG-III aircraft.
2. Design shoulder base and subbase subsurface drainage to tie into the adjacent taxiway subsurface drainage system.
3. Provide a sub-drainage system with manholes or handholes to permit observation, inspection, and flushing of the system.
4. Provide base-mounted edge lights and conduit for power cables to facilitate maintenance.
5. When adding paved shoulders to existing taxiways, consider making improvements to the existing taxiway edge lighting to include base-mounted light fixtures and conduit-enclosed power cables.

4.13.3 Design Considerations.

A dense, well-rooted turf cover can prevent erosion and may be capable of supporting the occasional passage of aircraft, maintenance equipment, or emergency equipment under dry conditions. Refer to AC 150/5370-10, item P-217, Aggregate-turf Runway/Taxiway. For locations where it is not feasible to establish turf suitable for this purpose, provide soil stabilization or a low-cost paved surface.

4.14 Surface Gradient for Taxiways, Taxilanes, and TSAs.

4.14.1 Longitudinal Gradient.

4.14.1.1 **Standards.**

1. Design the maximum longitudinal grade to not exceed 1.50 percent.
2. For taxiways/taxilanes exclusively serving aircraft weighing 30,000 lbs (13,605 kg) or less, it is acceptable to increase the maximum longitudinal grade to 2.0 percent.
3. When longitudinal grade changes are necessary, design parabolic vertical curves as follows:

   a. The maximum longitudinal grade change is 3.0 percent.

b. The minimum length of the vertical curve is 100 feet (30.5 m) for each 1.0 percent of grade change.

c. The minimum distance between points of intersection of vertical curves is equal to 100 feet (30.5 m) multiplied by the sum of the grade changes (in percent) associated with the two vertical curves.

d. **Exception:** Where a taxiway intersects a runway or taxiway crown, adjust longitudinal grades as necessary to provide smooth transition over the pavement section.

e. **Exception:** A vertical curve is not necessary when the grade change is less than 0.40 percent.

4.14.1.2 **Recommended Practices.**

1. Use minimum longitudinal grades.
2. Design pavements to have no changes in longitudinal grades unless it is impractical to avoid a change in grade.
3. Design the taxiway crown elevation to be at or below the crown elevation of the corresponding point on the runway to avoid adversely affecting runway surfaces (e.g., ROFZ).
4. When developing the longitudinal gradient of a parallel taxiway (or any taxiways functioning as parallel taxiways) and connecting taxiways consider:

   a. Potential future connecting taxiways between the parallel taxiway and the runway, and between two taxiways.

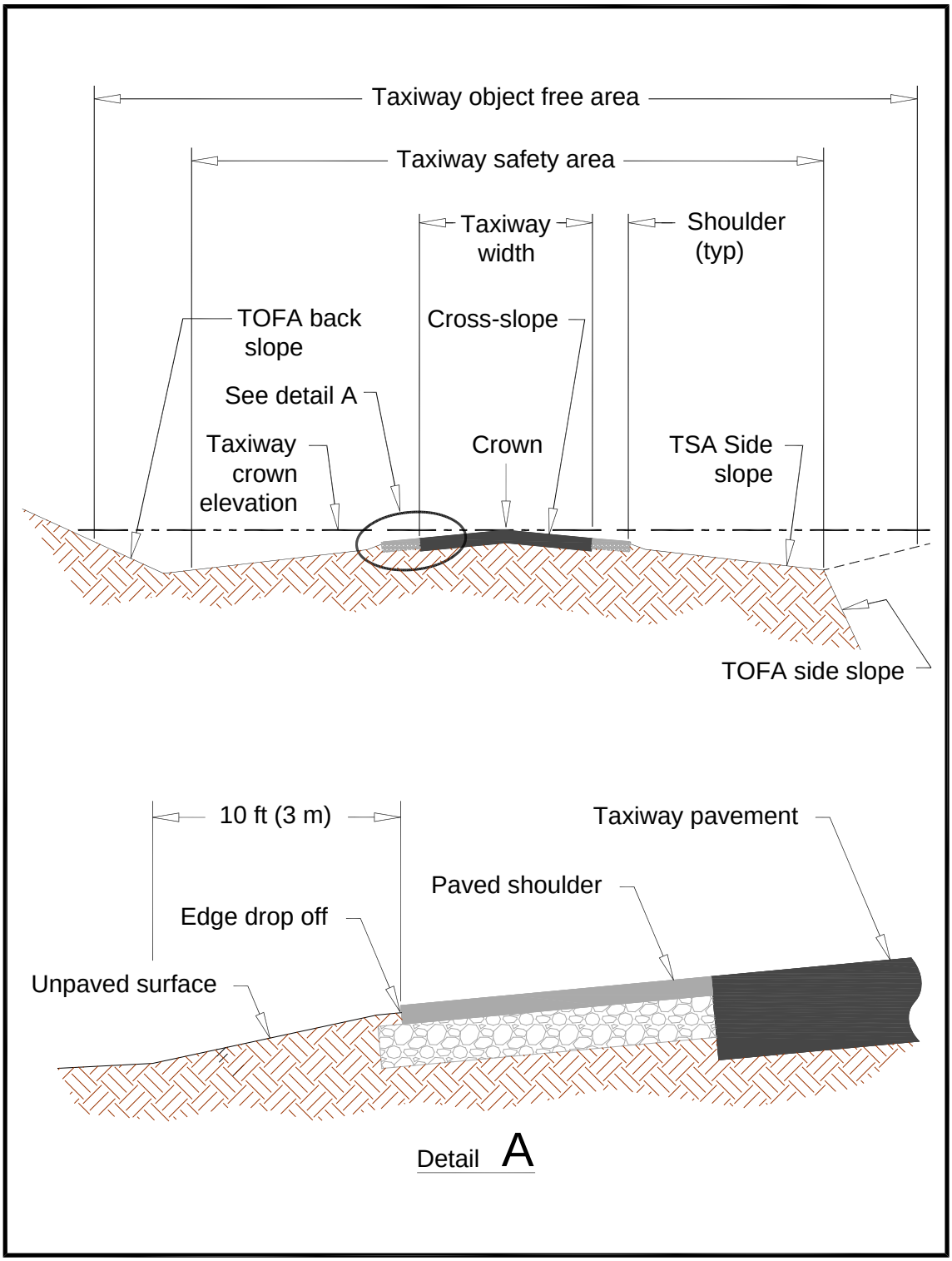
   b. Longitudinal gradient of connecting taxiways to future airfield facilities (future runways, taxiways, or aprons) that conforms to gradient design standards.

4.14.2 Taxiway/Taxilane Transverse Gradient.

4.14.2.1 **Standards.**

Design transverse gradients and drainage improvements for taxiways/taxilanes, shoulders, and safety areas per the following standards. See Figure 4-29.

Figure 4-29. Taxiway and Taxilane Transverse Gradients



Note: See paragraph 4.14.2 for specific transverse grade and drainage requirements shown in this figure.

1. Design taxiway/taxilane pavement transverse gradient as follows:
   a. 1.0 to 1.5 percent from centerline to pavement edge.
   b. For taxiways/taxilanes exclusively serving aircraft weighing less than 30,000 lbs (13,605 kg), it is acceptable to apply a cross-slope of 1 to 2 percent.
   c. A constant slope section (aka shed section) may be more suitable:
      i. For high-speed exit taxiways.
      ii. When existing terrain makes it impractical to provide a crown and slope cross section.
2. Design an edge drop-off of 1.5 inch ±1/2-inch (38 mm ±13 mm) between paved and unpaved surfaces to promote drainage off the pavement surface.
3. Design paved taxiway shoulders with a transverse gradient between 1.5 to 5 percent.
4. For an unpaved surface adjacent to a paved surface, design a 5 ±0.5 percent transverse gradient for a minimum distance of 10 feet (3 m) from the paved surface.
5. TSA transverse gradient: Design a 1.5 to 5 percent transverse gradient except as noted in subparagraph 4 above.
6. TOFA gradients:
   a. Side slope gradient: Design transverse gradient to promote positive drainage away from the TSA.
   b. Back slope gradient: When a back slope is necessary, design gradient not to exceed a maximum 4:1 slope provided the area immediately adjacent to the TSA edge permits positive drainage of surface water away from the TSA.

4.14.2.2 **Recommended Practices.**

1. Keep transverse gradients to a minimum to provide adequate surface drainage suitable for local conditions.
2. The ideal configuration is a center crown with equal, constant transverse grades on either side.
3. An off-center crown, with different gradients on either side, constant slope section (aka shed section), and changes in transverse gradients (other than from one side of the crown to the other) of no more than 0.5 percent are acceptable.

4.14.3 Taxiway/Taxilane Drainage.

4.14.3.1 **Standards.**

1. Design taxiways and taxilanes with transverse gradients, per paragraph 4.14.2, to prevent standing water on the pavement and within the limits of the safety area.
2. Locate ditches and drainage structure headwalls outside of the safety area, ensuring:
   a. The depth of water in a drainage ditch for a 5-year design storm does not encroach upon taxiway pavement including shoulders.
   b. The minimum 12-inch (0.3 m) vertical clearance between the most demanding aircraft wing and top of drainage structures located in the TOFA when the aircraft main gear is located at the edge of the taxiway shoulder.
3. Pavement inlets**:**
   a. Locate area inlets outside the limits of taxiway pavement.
   b. Ensure trench drains or slotted drain inlets are flush with the pavement across taxilane pavements to address surface sheet flow.
   c. Design drainage inlets flush with the surrounding grade.
   d. Design inlet grates in accordance with AC 150/5320-6 to:
      i. Withstand loads of the most demanding aircraft.
      ii. Account for load transition from the drainage inlet to the adjacent pavement.

4.15 Taxiway Line of Sight (LOS).

There are no specific LOS standards between intersecting taxiways. However, the sight distance along a taxiway from an intersecting taxiway needs to be sufficient to allow a taxiing aircraft to safely enter or cross the taxiway.

4.16 Markings/Lighting/Signs.

Refer to AC 150/5340-1, AC 150/5340-30 and AC 150/5340-18 for standards on airfield markings, lighting, and signs.

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CHAPTER 5. Aprons

5.1 General.

This chapter presents standards, recommended practices, design considerations, and requirements related to airport aprons. An airport apron is a dedicated portion of the airfield that serves as an interface between the airside and landside environments. Aprons serve multiple functions including:

- Loading and unloading of passengers, mail, and cargo
- Aircraft parking
- Aircraft fueling operations
- Aircraft maintenance operations
- Ground Service Equipment (GSE) operations
- Aircraft deicing operations

5.1.1 Terminology.

While other terms exist in the public domain (e.g., ramp, etc.), this AC uses the term "apron" for the airside area addressed by this chapter.

5.1.2 Airport Needs.

Aprons are present at all commercial service and public GA airports. The size and type of an airport are controlling factors in determining operational needs and capacity requirements that apply to apron design. The layout of an apron has a significant effect on airport operators and tenants as it relates to efficiency, safety, capacity, and operational costs.

5.1.3 Apron Elements.

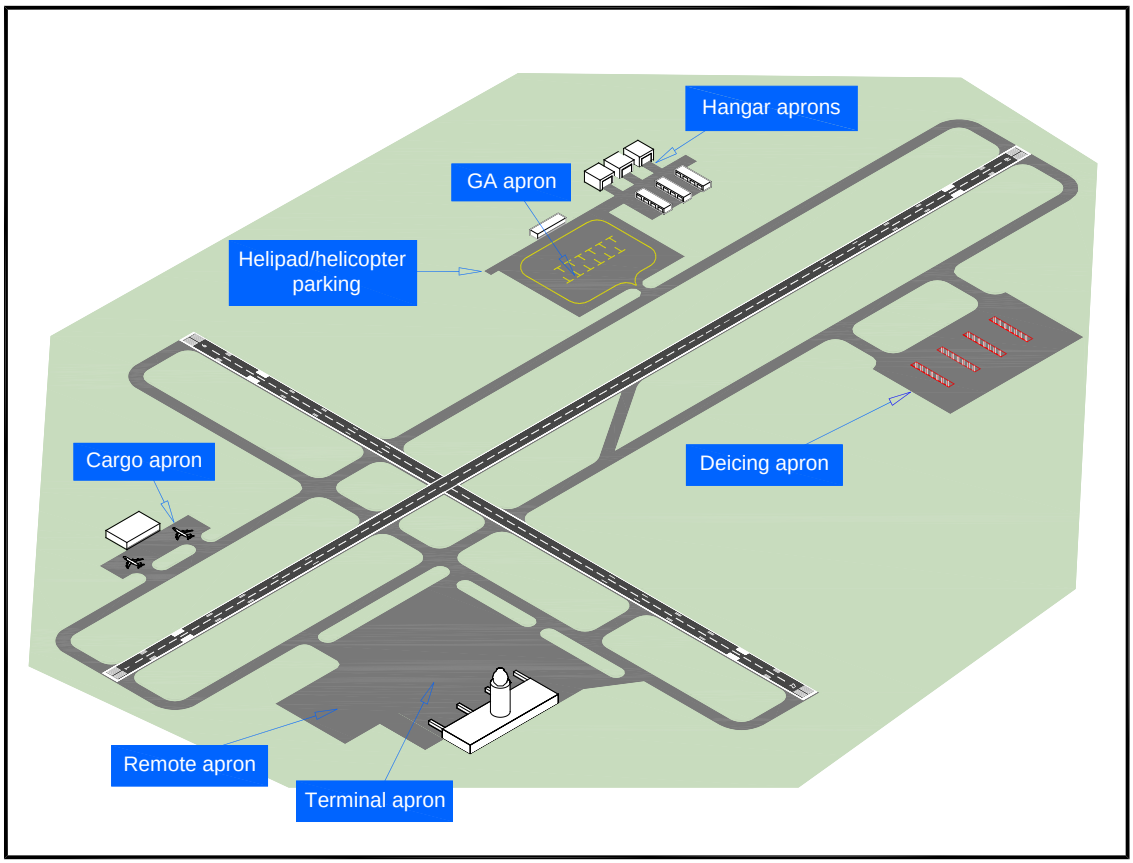
Apron elements vary per size and type of airport. Common apron elements include:

- Stabilized surface
- Taxilanes
- Parking positions
- Tie-downs
- Passenger loading and off-loading areas
- GSE areas
- Vehicle service roads
- Utility areas (fueling, lighting, power, etc.)
- Pavement marking
- Storm water drainage system

5.2 Apron Types.

The utility of an apron generally defines its type. Refer to Figure 5-1 for a depiction of the various types of aprons. The following describes common apron types.

Figure 5-1. Types of Aprons



Note: Image is conceptual for illustrative purposes only. The actual location of the various apron types is dependent upon factors specific to each airport.

5.2.1 Passenger Terminal Aprons.

A paved area between the face of the terminal building and the movement area boundary where aircraft taxi to a parking position for passenger boarding and deplaning and for aircraft servicing. Primarily associated with 14 CFR Part 139 certificated airports. Refer to paragraph 5.20 for additional information.

5.2.2 General Aviation (GA) Aprons.

A GA apron serves a broad range of civil aircraft activity exclusive of scheduled commercial service and military operations. The utility of a GA apron generally aligns with the aviation activities at the airport, which varies widely among airports. Refer to Appendix E for additional information.

5.2.3 Remote Apron.

Remote aprons are located separately from other aprons where aircraft perform remote boarding/deplaning operations, or to stage or store aircraft on a temporary basis (e.g., RON or to provide additional parking for passenger operations). Refer to paragraph 5.20.3 for additional information.

5.2.4 Hangar Apron.

Hangar aprons are paved areas adjacent to an associated aircraft hangar. Hangar aprons are for the exclusive use of the hangar occupants and thus not generally available for open public use. Refer to Appendix E for additional information.

5.2.5 Cargo Apron.

An apron area, typically adjacent to an air cargo terminal, dedicated to loading, unloading, and servicing cargo aircraft, as well as ground handling operations (e.g., GSE and unit load devices).

5.2.6 Deicing Aprons (Pads).

Deicing aprons are a unique form of remote apron dedicated for aircraft deicing operations, typically located apart from the terminal apron. However, deicing aprons may be a designated portion of the terminal apron. Refer to paragraph 5.20.4 for additional information.

5.2.7 Helicopter (Rotary Wing) Parking Position.

Parking positions for rotary aircraft are typically located separate from parking positions for fixed-wing aircraft. Helipads, where rotary aircraft land and take off, may also serve as a parking position. Refer to AC 150/5390-2 for guidance on helicopter parking positions.

5.2.8 Engine Run-Up Areas.

Engine run-up areas are open pads or enclosed facilities intended for performing engine ground run-ups, typically for aircraft maintenance purposes. When providing an engine run-up area, consider the effects of engine noise and jet blast on the surrounding area.

5.3 Apron Design Concepts and Considerations.

Effective apron design promotes acceptable levels of access, capacity, apron utilization, efficient flow management, safety of aircraft movements, and future development potential. A deficient design can increase the risk of wingtip conflicts, loss of situational awareness, and constrained capacity.

5.3.1 Apron Access Factors.

1. Optimize taxi distances to and from runway ends.
2. Provide safe and efficient aircraft maneuvering and GSE movements.
3. Design for aircraft access under self-power.

5.3.2 Utilization Factors.

1. Provide an apron layout accommodating the mix of aircraft types and sizes expected to use the facility.
2. Optimize apron layout by grouping aircraft parking areas and taxilanes based on wingspan classifications (e.g., larger vs small aircraft) and clearance requirements.

3. Separate jet aircraft from smaller aircraft to minimize risk of harmful jet blast effects.
4. Optimize GSE areas to promote efficient aircraft maneuvering.

5.3.3 Efficient Flow Management Factors.

1. Optimize location of taxiways and apron taxilanes to provide efficient taxi routes from parking areas to the airfield taxiways.
2. Provide secondary taxilane paths to maintain flow of taxiing aircraft.

5.3.4 Safety Factors.

1. Provide safe maneuvering of aircraft on the apron to avoid wingtip conflicts with fixed or moveable objects.
2. Provide apron layouts that limit risk for loss of situational awareness during taxiing operations.
3. Design apron/taxiway configurations to provide taxi paths that reduce the risk of runway incursions.

5.3.5 Future Development.

As part of planning and design efforts, consider airport expansion, future aircraft use trends, and future separation clearance values when establishing apron locations and airside buildings (terminal, hangar, FBO, etc.) in proximity to runways and taxiways. Key design considerations include:

1. Providing future expansion capability with minimal development constraints.
2. Avoiding configurations that may necessitate costly reconstruction or alteration of existing airfield infrastructure (e.g., aprons, taxiways, hangars, and terminal buildings).
3. Minimizing configurations that may result in future operational controls due to operation of larger aircraft at the airport.

5.4 Apron Location.

The location of apron elements can result in an adverse effect to operations on adjacent runways and taxiways. Application of standards and recommended guidelines when locating apron elements optimizes the utility of the apron, as well as the operational efficiency of adjacent runways and taxiways.

5.4.1 Standards.

5.4.1.1 **Apron Taxilanes.**

Locate apron taxilanes in conformance with the separation standards:

1. Per Table 4-1 for separation between apron taxilanes/taxiways.

2. Refer to the online Runway Design Standards Matrix Tool or Appendix G for separation between runway and parallel apron taxiway/taxilane.

3. Parking Positions.

Locate aircraft parking positions in a manner that ensures aircraft components (wings, tail, and fuselage) do not:

1. Conflict with the object free area for adjacent runways or taxiways:
   a. Runway Object Free Area (ROFA) (paragraph 3.12)
   b. Taxiway Object Free Area (TOFA) (paragraph 4.5.4)
   c. Taxilane Object Free Area (TLOFA) (paragraph 4.5.4)
2. Violate any of the following aeronautical surfaces and areas:
   a. Runway approach or departure surface (paragraph 3.6)
   b. Runway Visibility Zone (RVZ) (Figure 3-14)
   c. Runway Obstacle Free Zone (OFZ) (paragraph 3.11)
   d. Navigational Aid Equipment critical areas (paragraph 6.11)

5.4.2 Recommended Practices.

5.4.2.1 **Obstacle Evaluation.**

Locate aircraft parking positions in a manner to prevent exceeding the obstruction standards, as defined in 14 CFR Part 77.

1. Parking positions that result in aircraft exceeding the obstruction standards defined in Part 77 require an aeronautical study to determine if parked aircraft represent a hazard to air navigation.
2. Consult with the FAA Airports Regional Office or ADO for guidance.

5.5 Runway Access from Aprons.

The design of aircraft taxi paths from apron areas to runways affects airport capacity, as well as safety of aircraft operations. Properly located taxi paths enhance both airport efficiency and safety (see paragraph 4.3.5). Conversely, wide expanses of pavement at taxiway entrances and taxi paths that provide direct access to a runway can lead to loss of situational awareness for pilots and vehicle operators, which increases the risk of a runway incursion. Refer to Chapter 3 and Appendix J for information on problematic taxiway designs.

5.5.1 Standards.

5.5.1.1 Provide taxi paths to guide a pilot or vehicle operator to make a right angle turn onto a taxiway when departing an apron area (Figure 4-2). This action optimizes the range of vision for pilots and vehicle operators.

5.5.1.2 Stagger the alignment of an apron exit taxilane with that of a connector taxiway that crosses a parallel taxiway for access to a runway. Refer to Figure 4-2 and paragraph 4.3.5.

5.5.2 Recommended Practices.

5.5.2.1 Locate high activity aprons in a central location to minimize aircraft taxiing distances and runway crossings.

5.5.2.2 Avoid wide throat taxiway entrance/exit pavements from aprons that:

1. Exceed standard widths for taxiways and associated fillets.
2. Violate the three-path concept.
3. Create non-standard locations for signage, lighting, and markings.
4. Create surface drainage issues (e.g., ponding of storm water).

5.5.2.3 Mark and light wide apron pavement areas contiguous to a parallel taxiway to mitigate situational awareness risk. Paved islands, also known as no-taxi islands, channel aircraft departing the apron area using standard centerline markings and elevated signs.

5.5.2.4 For existing apron configurations not meeting standards of paragraph 5.5.1.

1. Refer to paragraph 2.4 for corrective planning actions.
2. Implement measures to mitigate the risk of runway incursions such as pavement closures or operational controls.

5.6 Lateral Object Clearance on Aprons.

Provide standard wingtip and fuselage clearances for the movement and parking of aircraft under self-power.

5.6.1 Standards.

5.6.1.1 **Apron Taxilanes.**

Refer to Table 4-1 for standard dimensions for TLOFA and wingtip clearance to fixed or moveable objects. Refer to paragraph 4.5 for explanation of wingtip clearance criteria.

5.6.2 Recommended Practices.

5.6.2.1 **Vehicle Limit Line.**

Consider the placement of a vehicle limit line marking to ensure adequate clearance of vehicles and equipment from the adjacent TLOFA.

1. For locations where the aircraft is under ATC ground control at push back, a non-movement area boundary marking may serve as the vehicle limit line.
2. For locations where the non-movement area boundary marking is remote from the gate area, consider placement of a vehicle limit line marking per the guidelines of Airports Council International (ACI), https://airportscouncil.org/, publication *Apron Markings and Signs* to visually define the near edge of an apron TLOFA.

5.6.2.2 **Parking Position.**

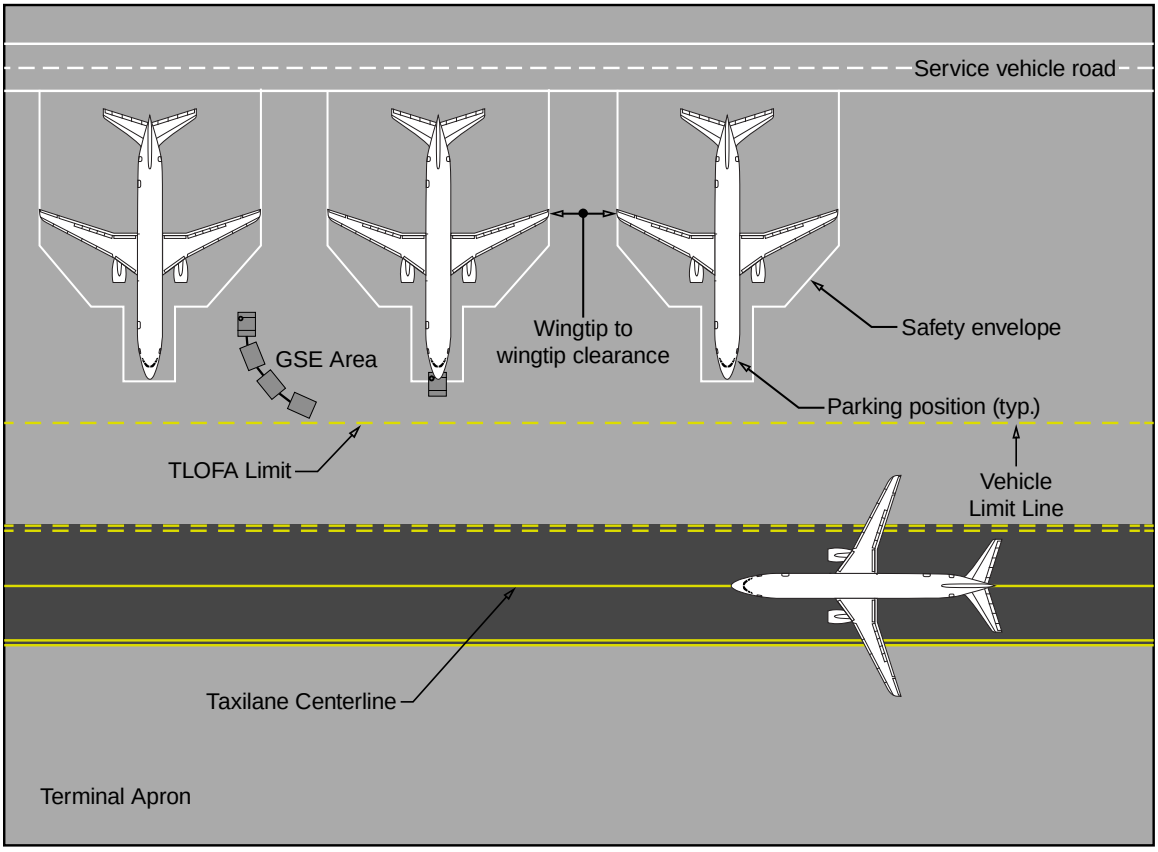
Provide sufficient clearance to limit risk of conflict between aircraft (wingtips and fuselage) and adjacent objects while entering or exiting the parking position. Refer to Table 5-1 for recommended minimum clearance dimensions. Increase clearance dimensions based on space necessary for personnel and equipment (GSE and ARFF) to operate safely around the perimeter of the parked aircraft.

1. Additional factors may influence increasing the clearance values such as an operator's GSE work area envelope, equipment storage, and the slope of the passenger boarding bridge ramp for conformance with the Americans with Disabilities Act (ADA) (42 U.S.C. § 12101, et al.).
2. An acceptable level of safety may be achievable with reduced clearance values if controls are in place that minimize the risk of conflict between aircraft and objects (e.g., gate operations rules, GSE management plan, training, etc.).
3. For parking positions parallel to terminal building structures, consider a minimum clearance of 45 feet (13.7 m) to accommodate equipment operations between the wingtip and the building.
4. Refer to Figure 5-2 for an illustration of parking position clearance for passenger terminals.
5. Refer to Figure E-3, Figure E-4, and Figure E-5 for illustrations of parking positions for GA aircraft.

Table 5-1. Parking Position Clearance.

Airplane Design Group (ADG)	Recommended Minimum Clearances
I and II	10 ft (3 m)
III, IV, V, and VI	25 ft (7.6 m)

Figure 5-2. Parking Position Clearance



5.7 **Apron Taxilanes.**

Lower speeds on taxilanes allow for precise taxiing operations.

5.7.1 Standards.

5.7.1.1 **Width.**

Refer to Table 4-2 for taxilane width standards based on TDG.

5.7.1.2 **Object Free Area.**

Refer to Table 4-2 for TLOFA values based on ADG.

5.7.1.3 **Surface Gradient.**

Refer to paragraph 5.9 for standards addressing gradients and grade change for apron taxilanes.

5.8 **Fueling on Aprons.**

The transport, storage, and distribution of aviation fuel on an apron presents fire hazard risks to passengers, employees, and property. Proper handling of aviation fuel in the

apron area minimizes this risk. Generally, aircraft fueling operations occur on an apron by one of four methods:

1. Delivery by fuel truck to the aircraft.
2. Delivery by fuel cart and hydrant located at the gate.
3. Centralized fueling at a fuel island located away from terminal buildings.
4. Self-fueling by the aircraft operator.

5.8.1 Standards.

Provide sufficient separation between the aircraft fueling operations, per the following standards.

1. AC 150/5230-4, *Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports.*
2. NFPA 407, *Standard for Aircraft Fuel Servicing*.
3. NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways.*

5.8.2 Design Considerations.

5.8.2.1 Minimize the potential for costly future relocation by considering future airside development in addition to current operational needs when locating fuel systems and components including:

- Fuel farms
- Underground fuel distribution loops
- Supporting facilities

5.8.2.2 Construct areas where fueling operations occur with materials that resist deterioration caused by fuel spillage.

5.9 Apron Surface Gradients.

The standards for surface gradient facilitate aircraft towing and taxiing while promoting positive drainage of surface water. Flat slopes facilitate aircraft maneuvering at parking positions and tiedown locations. Refer to paragraph 5.10 for drainage design considerations.

5.9.1 Standards.

5.9.1.1 Provide a minimum 0.5 percent apron gradient to facilitate aircraft maneuvering operations and apron drainage.

5.9.1.2 Comply with NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, pavement slope standards where fueling operations occur.

5.9.1.3 Limit maximum grade change to 2 percent.

5.9.1.4 Design and construct apron grades for positive drainage of surface water to inlets or off the apron pavement edge.

5.9.1.5 Design an edge drop-off of 1.5-inch ±1/2-inch (38 mm ±13 mm) between paved and unpaved surfaces to promote drainage off the pavement surface. See Figure 4-29.

5.9.2 Recommended Practices.

5.9.2.1 Limit apron gradients as follows:

1. Maximum: 1 percent for parking positions.
2. Maximum: 1.5 percent for apron taxilanes servicing aircraft over 30,000 lbs. (13,605 kg).
3. Maximum: 2.0 percent for aprons taxilanes servicing aircraft 30,000 lbs. (13,605 kg) or less.

5.9.2.2 For apron locations where it is impractical to meet recommended maximum gradient values due to grade or space constraints, solicit comments from airport users and assess whether exceeding the recommended values may have an adverse effect on:

1. Aircraft maneuvering,
2. Aircraft braking, or
3. Control of aircraft during periods when surface contaminants are present (e.g., water, snow, ice, etc.).

5.9.2.3 Provide a 10-foot (3 m) wide shoulder at the edge of the apron with a 1-3 percent slope to promote flow of surface water away from the apron pavement. Consider paved shoulders if there is an erosion risk in this area. Beyond the shoulder edge, provide a 3-5 percent slope to facilitate the flow of surface water away from the apron area.

5.9.3 Design Considerations.

1. Consider propeller clearance when transitioning between grade changes.
2. In lieu of a vertical curve for grade changes on apron taxilanes, consider an intermediate transitional grade section (e.g., 20 feet (6.1 m) to 25 feet (7.6 m)) to minimize abrupt longitudinal grade changes greater than 1 percent.

5.10 Apron Drainage.

Shallow grades and a wide expanse of impervious pavement in the apron area creates the potential for a significant volume of surface runoff. While hydroplaning is generally not a concern on aprons due to low taxi speeds, it is desirable to convey

surface water to a subsurface drainage system to prevent freestanding water on the apron.

5.10.1 Standards.

5.10.1.1 Design apron drainage systems for the design storm event in accordance with AC 150/5320-5.

5.10.1.2 Direct drainage away from buildings (e.g., terminal, hangar, FBO, etc.).

5.10.1.3 Where aircraft fueling operations occur, slope the pavement away from buildings and structures at a minimum of 1.0 percent for 50 feet (15.2 m), and at a minimum of 0.5 percent beyond 50 feet (15.2 m) in conformance with the standards of NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways.*

5.10.1.4 Limit the length of apron linear trench drains or slot drains to 125 feet (38 m) with minimum of 6-foot (1.8 m) interval between trench lines to act as a fire stop, in accordance with NFPA 415.

5.10.1.5 Design apron grades to prevent accumulation of surface water (e.g., ponding) exceeding 1/4-inch (6 mm) in depth as measured by 12-ft (3.7 m) straightedge.

5.10.1.6 Comply with Federal and local statutory and regulatory requirements for water quality with appropriate design consideration for control and collection of sediment, fuel/oil, and deicing fluids.

5.10.2 Recommended Practices.

5.10.2.1 Construct linear drains (e.g., slotted drains) for the collection of sheet flow; construct grated inlet catch basins for the collection of channelized flow.

5.10.2.2 Locate surface inlets apart from aircraft wheel paths to:

1. Avoid direct aircraft loading on drainage structures.
2. Limit premature pavement deterioration surrounding inlets.

5.10.2.3 Separate the apron drainage system in deicing areas from other airfield drainage systems to minimize the surface runoff volume collected for treatment.

5.10.2.4 Construct taxilanes with transverse grades that create positive flow of surface water off the taxilane pavement:

1. The continued presence of water on pavements increases the risk of premature pavement deterioration.

2. Avoid use of the taxilane as “V” bottom drainage conveyance.

5.11 Apron Snow Removal.

Snow removal from apron areas differs from snow removal from runways and taxiways. SRE for apron areas generally operate at slower speeds and need greater equipment maneuverability. Depending on the type and size of airport, removal responsibilities vary among airport operators, third party contractors, FBOs, and tenants. Snow removal from apron areas presents challenges such as:

1. Working in constrained areas,
2. Limited equipment access and exit routes,
3. Limited options for snow disposal,
4. Presence of GSE, and
5. Interaction with taxiing and parked aircraft.

5.11.1 Standards.

1. AC 150/5200-30, *Airport Field Condition Assessments and Winter Operations*, establishes standards for airfield priority areas and clearance times for a baseline snow event.
2. AC 150/5220-20, *Airport Snow and Ice Control Equipment*, establishes standards for airport snow and ice control equipment.

5.11.2 Design Considerations.

5.11.2.1 For airports regularly experiencing snowfall accumulation events, as part of apron design, consider how the airport will effectively manage snow removal.

5.11.2.2 Factors to consider:

1. Clearance priority of apron areas, per the snow and ice control plan (see paragraph 5.11.1).
2. Efficient access and exit routes for haul trucks and SRE that limit interaction with aircraft.
3. Partial closure of apron areas to facilitate snow removal operations while maintaining a minimum level of apron operations.
4. Use of designated areas (e.g., low priority areas) to serve as temporary snow pile storage in support of haul operations during low activity hours.
5. Effect of snow melt and re-freeze on apron areas serving aircraft maneuvering.

5.11.2.3 Airports that experience annual snowfall normal accumulations of 30-inches (0.8 m) or greater will typically have a higher frequency of snow events exceeding 1-inch (25 mm) depths.[i] Frequent snow events at a commercial service airport can adversely affect the capacity of the airport, as well as the efficiency of the NAS. For airports certificated under Part 139 having normal, annual snowfalls greater than 30 inches (0.8 m):

1. Consider increasing the size of the terminal apron pavement to facilitate snow removal operations.
2. Design additional apron pavement to have utility for aircraft operations during non-winter months (e.g., RON apron, secondary taxilane, non-contact gate, etc.)
3. Design additional pavement to serve as temporary storage of snow piles during a snow event (e.g., Priority 2 area).
4. For the purpose of this section, temporary means no greater than 48 hours from the end of a snow event.

5.12 Apron Markings.

Apron pavement markings provide a pilot visual guidance when maneuvering aircraft to and from a parking position or gate. Pavement markings also establish boundaries for vehicle operations, GSE areas, and ground crew operations. In addition to FAA standards, industry groups and airlines publish best practices for apron markings not addressed by FAA standards.

5.12.1 Standards.

AC 150/5340-1 establishes FAA standards for the following apron pavement elements:

- Taxiway/taxilane centerline and edge marking
- Non-movement area boundary marking
- Intermediate holding position marking
- Vehicle roadway marking
- Surface painted apron entrance points
- Ramp control marking
- Surface painted gate identification signs
- VOR receiver checkpoint marking

5.12.2 Industry Best Practices.

Industry practices and guidelines are available for select apron markings including aircraft safety envelopes, passenger walk paths, equipment parking, passenger-board-bridge area, and engine hazard zones. Individual airlines may establish company standards for gate area markings at gates the airline contractually controls. To ensure

[i] Annual snowfall normal based on current National Oceanic and Atmospheric Administration (NOAA) three-decade Climate Normals.

consistent and clear markings, coordinate installation of such markings with affected parties (e.g., airport, airline operators, service providers, tenants, etc.).

- Airports Council International – Apron Markings and Signs
- Airlines for America – Recommended Apron Markings and Identifications

5.13 Apron Signage and Edge Lighting.

Elevated signage and edge lighting provide a pilot visual guidance during taxi operations. Due to the operational nature of aprons, application of elevated signage and edge lighting is generally suitable only at the outer limits of apron pavement. Typical apron signage includes outbound and inbound destination signs and no-entry signs. Apron surface lighting is typically suitable for taxiway/taxilane edge lights located at the outer limits of the apron pavement or around no-taxi islands. Complex commercial and cargo aprons may necessitate in-pavement centerline lights or reflectors to provide a visible taxi route to a parking stand.

5.13.1 Standards.

1. AC 150/5340-18, *Standards for Airport Sign Systems*
2. AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*

5.14 Area Lighting on Aprons.

Area lighting facilitates apron operations to take place in a safe and efficient manner during nighttime hours and low visibility conditions. Area lighting also enhances security of the AOA by illuminating vulnerable locations of the Security Identification Display Area (SIDA). Occupational Safety and Health Administration (OSHA) standard 29 CFR § 1926.56, *Illumination*, addresses illumination minimums (expressed in foot-candles) for select work-place activities. Comply with the standards of AC 150/5360-13, *Airport Terminal Planning*.

5.14.1 Associated Risks.

While area lighting is beneficial in the apron area, such lighting may introduce certain hazards to aircraft operations and control tower operations. This can involve obtrusive glare, misleading visual cues to pilots, impaired LOS, and obstructions to aeronautical activities.

5.14.2 Standards.

1. Submit required notification under Part 77 for proposed installation of apron lighting to allow FAA evaluation of potential adverse effects to air navigation and safe operation of the airfield.
2. Limit the height of lighting structures to preclude violation of a runway approach surface, departure surface, or OFZ.
3. Locate apron light poles outside of taxiway/taxilane OFAs and clear of aircraft parking stands.

5.14.3 Recommended Practices.

1. Aim apron luminaires downward towards apron pavement to limit the risk of spill light causing confusion for pilots and controllers.
2. Baffle or shield apron luminaires to prevent uplight.
3. Establish uniform illumination across lighted areas with overlapping light sources to minimize ground shadowing.
4. Coordinate installation of area lighting with appropriate stakeholders (e.g., airport operations, airline operators, ground service providers, tenants, ATCT, etc.).
5. Refer to Illuminating Engineering Society (IES), *Recommended Practice for Airport Service Area Lighting*, for industry practices, recommended illuminance values, and general guidance on designing apron area lighting.
6. Locate apron lighting in a manner to prevent exceeding the obstruction standards, as defined in Part 77.

5.14.4 Design Considerations.

When planning and designing apron area lighting, consider the following:

1. Avoid lighting configurations creating misleading visual cues that confuse a pilot's recognition of runway lighting systems.
2. Avoid light orientations obscuring or impairing a pilot's or ATC's view of the movement area pavement (e.g., runways and taxiways).

5.15 Apron Security.

Airport security involves maintaining the integrity of the air operations area from entry by unauthorized individuals. Risk to security varies per airport type and level of activity. Primary hub airports generally have a higher security risk than a small commercial service airport. The measures, procedures, and systems to counter risks to airfield security also vary at different locations at the same airport. Refer to paragraph 6.8 for additional information on airport security. Refer to Appendix E for guidelines addressing fencing at GA airports, which primarily serve as a safety measure for inadvertent entry to the AOA.

5.16 Apron Pavement Design.

Design apron pavements to provide adequate support for the most demanding loads imposed by aircraft, GSE, SRE, ARFF vehicles, fuel trucks, and other applicable aircraft servicing equipment. Isolated pavement areas of an apron may involve load consideration that does not apply to the entire apron area (e.g., mobile passenger boarding bridges, people movers, etc.).

5.16.1 Standards.

1. Refer to AC 150/5320-6 for standards addressing pavement structural design.

2. Refer to AC 150/5370-10 for standards addressing construction of apron pavements.

5.16.2 Design Considerations.

It is not necessary or economical to construct all apron pavements at an airport to the same pavement strength. Design apron pavement for individual apron sections for the most demanding loads for the intended apron use (e.g., commercial airlines, cargo operations, GA operations). This approach necessitates clear delineation of the different apron areas through signage or physical separation of pavement areas. Other apron design considerations include:

1. Structural design life of pavement (typically 20 years)
2. Surface resistance to fuel spills
3. Effect and control of aircraft deicing materials
4. Resistance to rutting from wheel loads and static loads (e.g., aircraft, passenger boarding bridges, etc.)
5. Resistance to applicable environmental and climate factors.

5.17 Jet Blast and Propeller Wash on Aprons.

Aircraft that maneuver on the apron under self-power introduce risk of property damage and personal injury from wind velocities due to jet exhaust and propeller wash. Wind forces from jet blasts and propeller wash are capable of projecting objects, displacing equipment, causing vehicle loss of control, and damaging infrastructure. These wind forces are a risk to ground crew, passengers, aircraft, and adjacent structures. Refer to Appendix C for information on the effects, assessment methodologies, and treatment of jet blast and propeller wash.

5.17.1 Recommended Practices.

As applicable, incorporate the following:

1. Configure parking positions such that the direction of wind forces from jet exhaust and propeller wash point outward and away from personnel, equipment, aircraft and structures.
2. Provide a pushback area (Figure 5-3) with sufficient space to push aircraft back to a point where aircraft initiate maneuvering under their own power.
3. Separate parking areas for GA and commuter aircraft from turbojet aircraft parking and maneuvering areas.
4. Provide tie-down anchors on apron areas serving small aircraft when adjacent taxiways/taxilanes serve turbojet aircraft.
5. Locate engine run-up areas and associated blast protection apart from parking positions, gate areas, and buildings.
6. Where practical, implement operational controls addressing the use of breakaway power in the apron area such as tug-only areas.

5.17.2 Design Considerations.

1. Consider providing a blast barrier for protection of GSE during aircraft power out maneuvers.
2. Assess terminal gate and hardstand aircraft parking layouts having "tail-to-tail" parking for the adverse effects of engine exhaust velocities and temperatures on aircraft, personnel, and structures behind the aircraft.
3. Consider blast risk potential to aircraft, structures, and personnel as aircraft enter or exit a parking position.
4. Assess risk to pedestrians (e.g., passengers and ramp personnel) at non-contact gates and hardstands.

5.17.3 Aircraft Parking Layout Methodology.

Identify aircraft jet blast contours (velocity and distance). Assess whether aircraft turning maneuvers create jet blast hazards.

5.17.3.1 **Wind Speed Design Factors.**

Consider the following wind exposure rates from the National Weather Service Beaufort Wind Scale as part of the planning and design of parking position layouts. Apply these values to assess the potential effect jet blast and propeller wash may have on adjacent areas of the apron.

5.17.3.2 **Terminal Tail-to-Tail Parking.**

1. Apply a 35 mph (56 km/hr) maximum wind velocity to assess harmful risk for adjacent aircraft, personnel, and objects.
   a. Assumes trained ramp personnel are aware of occasional wind peaks affecting their ability to walk or perform other tasks.
   b. Does not preclude locating service roads behind aircraft for tug/tractor service
   c. Avoid parking GA and commuter aircraft adjacent to turbojet aircraft.

5.17.3.3 **Terminal Parking at Parallel or Skewed Terminals Facing Each Other.**

1. Apply a 50 mph (80km/hr) maximum breakaway condition to determine the "reach" of initial jet blast from aircraft entering or exiting a gate position to the facing terminal concourse and service road.
2. Apply a 35 mph (56 km/hr) maximum wind velocity (breakaway conditions) when assessing the locations of facing terminal gate parking and service roads assuming:
   a. Trained ramp personnel are aware of occasional wind peaks affecting their ability to walk or perform other tasks.

b. There is no GA parking in the vicinity.

c. Parked commuter aircraft do not board or deplane passengers directly to or from the apron.

5.17.3.4 **General Aviation (GA)/Commuter Aircraft Parked Next to Turbojet.**

1. Apply a 24 mph (38 km/hr) maximum under idle and breakaway conditions:

   a. The lower exposure rate takes into account conditions experienced by passengers during bad weather when having to deal with umbrellas and slippery ramp/stairs.

   b. Consider both idle and breakaway conditions when assessing the variety of possible gate layouts, ramp taxiing, and tug policies and procedures.

5.17.3.5 **Hardstands.**

Focus on mitigating the effects of "power plus turn" when assessing the hazard to taxiing operation:

1. Apply a 24 mph (38 km/hr) maximum under idle conditions to locate an adjacent hardstand when passengers are boarding/deplaning directly to and from the apron.

2. Apply a 35 mph (56 km/hr) maximum under idle conditions when aircraft are arriving/departing from the hardstands only if the air carriers written ramp management plan prescribes the boarding and escort of all passengers in the adjacent hardstand locations occurs away from the active hardstand by trained ramp personnel.

3. Apply a 39 mph (62 km/hr) maximum under breakaway conditions for the location of service roads aft of parked turbojet aircraft.

   a. This value addresses drivers' control of vehicles/trucks when subjected to slightly higher winds and assumes no tug/tractor service operations at the hardstands.

4. Apply a 35 mph (56 km/hr) maximum wind velocity (breakaway conditions) on service roads next to a hardstand location.

5.18 Airport Traffic Control Tower (ATCT) Visibility/Line of Sight (LOS) on Aprons.

ATCT personnel require an unobstructed view from the ATCT cab to control aircraft movement. Parked aircraft, buildings, and equipment obstructing the controller's LOS increases the risk to safe aircraft movement. For airports certificated under Part 139, this means a clear view of the movement area, including the non-movement area boundary marking. For non-Part 139 airports, this generally means a clear view of the runway, taxiways, and apron area. FAA Order 6480.4, *Airport Traffic Control Tower Siting Process*, provides addition information on the ATCT visibility requirements.

5.18.1 Standard.

Configure apron layout to preclude parked aircraft, equipment, and structures from obstructing the controller's LOS from the ATCT cab to all points of the airport movement area.

5.18.2 Recommended Practice.

When designing new airfield development, evaluate the controller's LOS from the ATCT cab to points on the airport non-movement area. An online tool is available at www.hf.faa.gov/visibility/ to assist with this evaluation. Include the results of the evaluation with the FAA Form 7460-1 submittal when required under Part 77. The FAA determines whether a proposed development results in an adverse aeronautical effect.

5.19 Apron Vehicle Service Road (VSR).

Apron vehicle service roads are designated roadways that concentrate vehicle operations on the apron for safe maneuvering and interaction with taxiing and parked aircraft. Apron vehicle service roads are primarily for the exclusive use of vehicles and equipment that service aircraft and by airport operations personnel. Apron service roads often tie into airfield vehicle service roads which control vehicle movements to other portions of the AOA. See Chapter 6 for additional standards and recommended practices on VSRs.

5.19.1 Standards.

1. Clearance from vehicles to taxiway/taxilane.
   a. Except where necessary to intersect a taxiway or apron taxilane, provide applicable clearances from Table 4-1.
   b. Where applicable separation distance is not achievable, provide surface markings such as hold lines and signs as necessary to provide adequate clearance between taxiing aircraft and holding vehicles.
2. Clearance from vehicles to parking positions.
   a. Provide a minimum of 10-foot (3 m) lateral clearance from parked aircraft to the service road.
   b. It is acceptable to reduce the lateral clearance to a minimum of 6-foot (1.8 m) provided there is at least 5 feet (1.5 m) vertical clearance from the nearest point of the aircraft and the top of the tallest vehicle expected to operate on the apron service road.
3. Surface Marking – Refer to vehicle roadway marking standards in AC 150/5340-1.

5.19.2 Recommended Practices.

1. Minimize points where service vehicle roads intersect with taxiways and taxilanes.
2. Install surface painted vehicle road signs instead of vertical signs within the apron extents.

5.19.3 Design Considerations.

5.19.3.1 **Lane Characteristics.**

The activity level and type of ground vehicle traffic on an apron service road are key factors in determining the number and width of lanes.

1. Apron service roads for busy commercial service airports typically justify a two-way marked roadway between 20 to 25 feet (6.1 to 7.6 m) in total width.
2. For lesser active commercial airports (e.g., non-hub airport), a single lane marked roadway between 12 to 14 feet (3.7 to 4.3 m) is adequate.

5.19.3.2 **Location.**

Generally located in a non-movement area in the following areas:

1. In front of an aircraft nose (e.g., head of stand)
2. Immediately behind the aircraft tail (back of stand)
3. Apart from aircraft parking positions

5.19.4 Pavement Strength.

1. For commercial and cargo aprons, aircraft loads control the pavement design strength.
2. For GA aprons serving small aircraft, consider airport vehicle loading (e.g., fuel trucks) in addition to aircraft loads.

5.20 Design of Specific Apron Types.

5.20.1 Passenger Terminal Apron Factors.

Parking gates may be contact type (e.g., by passenger boarding bridge) or non-contact (e.g., by ground loading).

5.20.1.1 **Recommended Practices.**

1. Provide for the efficient and safe maneuvering of aircraft from the taxiway system to and from the parking position.
2. Provide safe and efficient passenger boarding and deplaning.
3. Provide sufficient space for GSE (e.g., baggage tugs, cargo tugs, catering trucks, etc.) and support vehicles such as fuel trucks and aircraft maintenance equipment.
4. Provide sufficient clearance at the gate area for the maneuvering of aircraft under self-power and for ground service vehicles. (See Figure 5-2.)
5. Provide a clear delineation of passenger walkways to the boarding area for non-contact gates.

6. Provide a clear demarcation of the SIDA at Part 139 airports with an airport security plan.
7. Segregate commercial aprons from GA aprons (preferably by physical separation of pavement areas) to limit interaction of aircraft and to maintain integrity of the SIDA.
8. See paragraph 5.8.1 for development standards for fueling operations.

5.20.1.2 **Design Considerations.**

1. When sizing a passenger apron, consider peak hour operations along with planning factors and design elements appropriate for the airport type and service level.
2. For airports with frequent congestion on apron taxilanes due to aircraft departing a gate, consider providing a push back area that allows unimpeded flow on the apron taxilane. (See Figure 5-3.)
3. Consider the range of aircraft sizes anticipated to operate at the airport when designing parking stands and gate configurations.

5.20.2 Cargo Apron.

Cargo aprons are typically located adjacent to a cargo facility building which acts as an interface with other transportation modes (e.g., freight trucks, rail cars, ships). A cargo apron may be exclusive-use, where cargo operators maintain control of designated areas; or the apron may be a common-use area, where all cargo operators may operate.

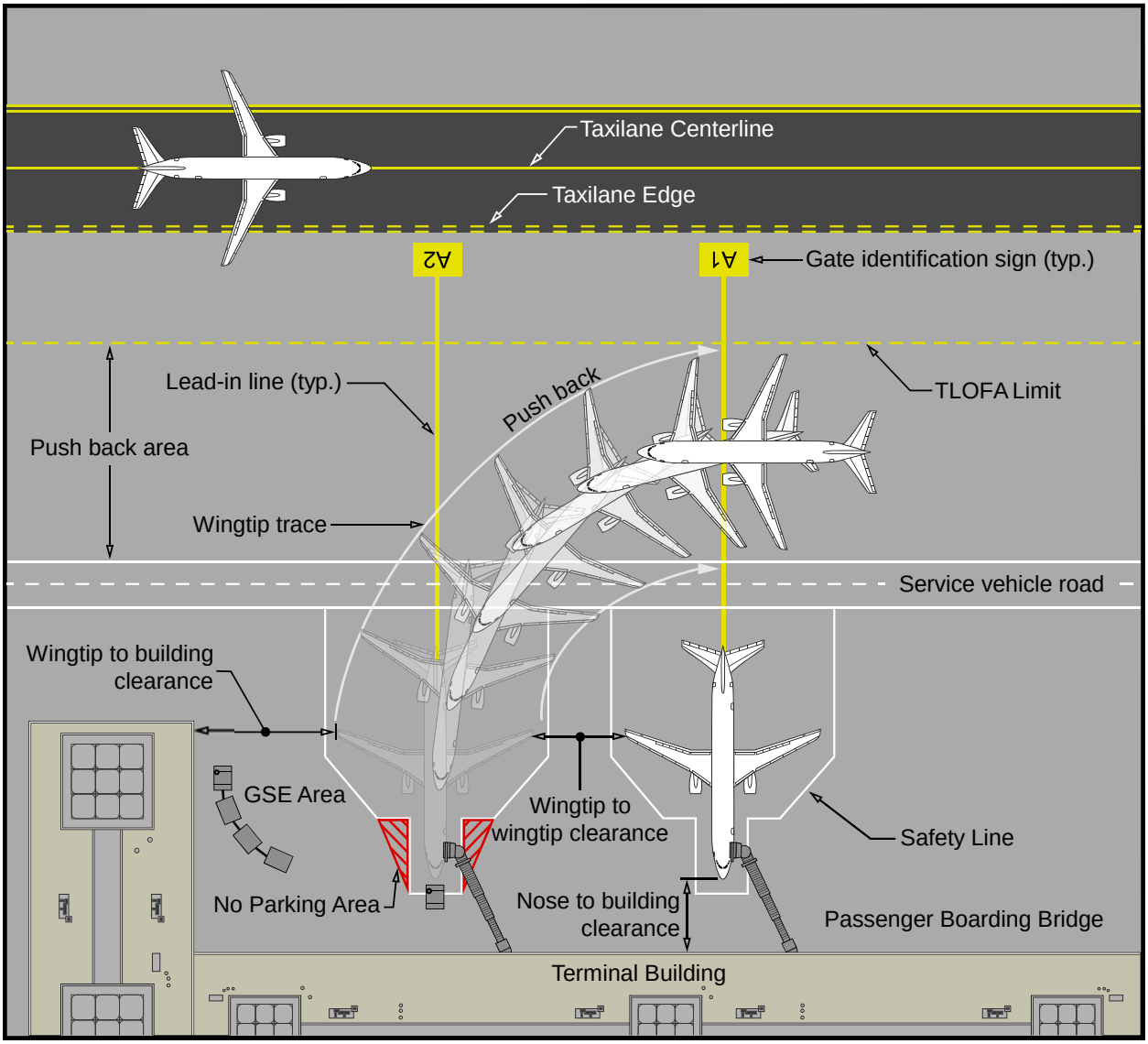
5.20.2.1 **Recommended Practices.**

1. Locate cargo aprons apart from passenger terminals due to different space requirements and different GSE needs.
2. Size a cargo apron for design peak volume of aircraft, aircraft servicing equipment, and cargo handling equipment.
3. Provide sufficient clearance at the parking position for aircraft maneuvering under self-power and operation of GSE and related equipment.
4. Locate service roads at the head-of-stand to allow movement of vehicles independent of aircraft maneuvering.

5.20.2.2 **Design Considerations.**

1. Consider providing space for a remote cargo aircraft-parking stand as a reserve location for empty aircraft during peak hours.
2. Consult Airport Cooperative Research Program (ACRP) Report 143, *Guidebook for Air Cargo Facility Planning and Development*, for industry practices.

Figure 5-3. Passenger Terminal Gate Area



Note 1: Image is conceptual for illustrative purposes only. Actual configuration is dependent upon factors unique to the airport.
Note 2: Refer to Table 5-1 for ADG III-VI wingtip clearance values
Note 3: Refer to paragraph 5.17.1 for jet blast and push back design considerations

5.20.3 Remote Apron.

Remote aprons relieve congestion in the terminal area by:

1. Providing an area to hold incoming aircraft at peak hours until a terminal gate becomes open.
2. Providing an area to park non-active aircraft overnight without occupying gate space; commonly known as RON positions.
3. Providing an area for ATC to stage aircraft for effective flow management of arrivals and departures (see paragraph 4.9).

4. Serving as a remote passenger gate during situations where operations exceed gate capacity and apron buses or other ground vehicles transport passengers from the terminal building to the aircraft (uncommon practice).

5.20.3.1 **Recommended Practices.**

When assessing the need and size of a remote apron, consider recurring space deficiencies observed during peak hours of operations.

5.20.3.2 **Design Considerations.**

Locate remote aprons in a non-movement area where parked aircraft do not impede the efficient flow of taxiing aircraft from the terminal to the runway/taxiway system.

5.20.4 Deicing Apron.

A deicing apron is a centralized facility typically located apart from the gate area to minimize conflicts between aircraft deicing and GSE operations in the gate area. Refer to AC 150/5300-14, *Design of Aircraft Deicing Facilities*, for standards and guidelines addressing layout, clearance, markings, and lighting.

5.20.4.1 **Recommended Practices.**

1. Size deicing pads to accommodate the aircraft receiving treatment, as well as space for maneuvering of deicing equipment around the aircraft.
2. Locate deicing facilities away from the terminal gate along taxiways leading to runway departure ends to minimize taxiing time from start of treatment to the expected departure.

5.20.4.2 **Design Considerations.**

Consider design of a containment system to collect deicing fluid runoff for subsequent treatment for compliance with Environmental Protection Agency (EPA) effluent guidelines.

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CHAPTER 6. Airfield Systems and Facilities

6.1 General.

This chapter presents information for various systems and facilities located on airports.

6.2 Airfield Bridges and Tunnels.

6.2.1 General.

6.2.1.1 This section presents guidance for general design standards and considerations for airfield bridges and tunnels only. It is not for use in structural design.

6.2.1.2 An airfield bridge or tunnel may be necessary due to airport physical constraints such as space, the presence of roadways, railways, terrain, bodies of water, or the need to construct systems to move passengers and luggage. For safety as well as economic reasons, assess whether relocation of the constraining feature (e.g., public roadway) prevents the need to construct a bridge or tunnel. Examples of airfield applications include:

1. Bridge for a runway or parallel taxiway over a public highway
2. Taxiway bridge crossing an airport entrance road
3. Tunnel under an apron for people mover trains or baggage tugs.

6.2.2 Bridge Siting.

6.2.2.1 **Recommended Practices.**

1. Route or reroute the constraining feature(s) to affect the fewest runways and/or taxiways.
2. Co-align the constraining feature(s), including utilities, so that a single structure resolves all conflicts.
3. Locate bridges and tunnels along runways and tangent portions of taxiways; away from intersections, exits, or curves.
4. Design bridge locations to prevent an adverse effect upon the airport's drainage systems, utility service lines, airfield lighting circuits, ILS, or ALS.
5. Design bridge elevations to facilitate implementation of standard runway or taxiway grading, as applicable. See paragraphs 3.16 and 4.14.
6. Where practical, make provisions for a separate bridge structure for service vehicles and ARFF equipment, per paragraphs 6.5.2 and 6.5.3, to ensure unimpeded access to their response path.

6.2.3 Bridge Structure Dimensions.

The standards of the authority having jurisdiction (e.g., state code) govern the structural design of a bridge. However, there are dimensional standards and design considerations unique to airports, as described below.

6.2.3.1 **Standards.**

1. Design the width of the bridge to be equal to or greater than the associated safety area, as measured perpendicular to the runway or taxiway centerline.
2. With the exception of parapets, design the bridge so that no structural members project more than 3 inches (76 mm) above the bridge surface:
   a. Parapets represent a safety feature by containing aircraft and vehicles that wander to the pavement edge.
   b. Construct parapets to a height of no more than 12 inches (305 mm) above the bridge deck and outside of the RSA and/or TSA limits.
   c. Construct parapets to the strength requirements, as prescribed in Federal highway standards.
   d. Coordinate parapet height with the obstruction lights in paragraph 6.2.5.1 item 2.

6.2.3.2 **Design Considerations.**

1. Minimize bridge length by aligning the structure with the runway or taxiway centerline.
2. Consider a combined structure (e.g., tunnel) spanning the full (combined) width of the runway and taxiway safety areas when both the runway and taxiway pass over a surface feature such as a highway. This approach facilitates access by emergency vehicles by eliminating the presence of a gap between the two safety areas.

6.2.4 Bridge Load Considerations.

6.2.4.1 **Standards.**

Design runway and taxiway bridges to support both static and dynamic loads imposed by the heaviest aircraft expected to use the structures.

6.2.4.2 **Design Considerations.**

Consider any concentrated loads due to the main gear configurations. Design load considerations unique to airfield bridges include:

1. Runway load factors due to dynamic loading.
2. Longitudinal loads due to braking forces.

3. Transverse loads caused by wind on large aircraft.
4. Braking loads as high as 0.7G (for no-slip brakes) on bridge decks subject to direct wheel loads.
5. Horizontal loads from vehicle wheels if a bridge is within the limits of a curve.
6. Evaluate the future needs to accommodate heavier aircraft:
   a. It is more economical to apply a reasonable load increase factor during design than it is to reconstruct or strengthen an existing bridge in the future.
   b. The FAA considers it reasonable to consider a load increase factor in the range of 20-25 percent to account for fleet growth over the anticipated service life of the bridge.

6.2.5 Airfield Marking and Lighting for Bridges and Tunnels.

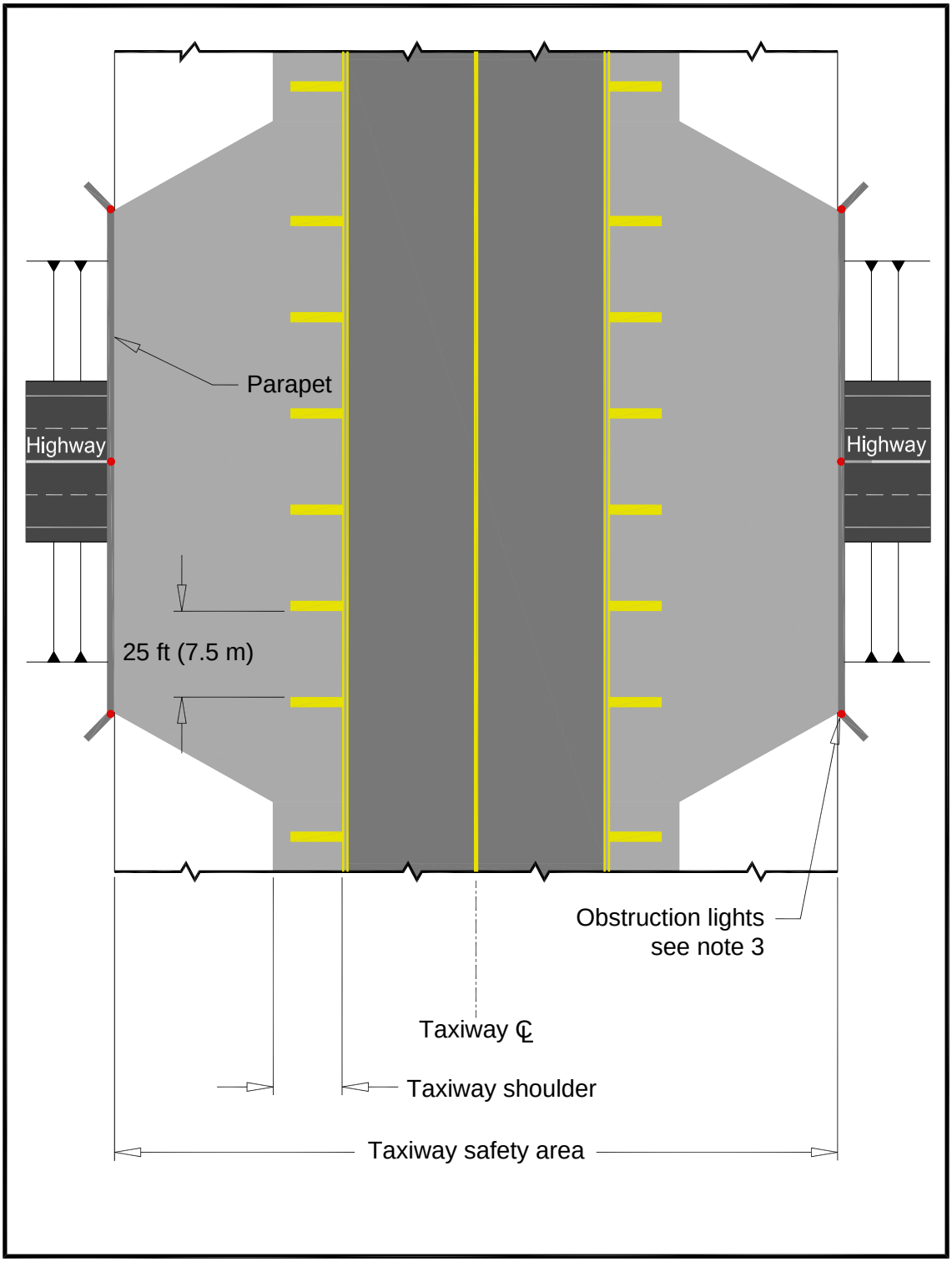
6.2.5.1 **Standards.**

1. Mark, light, and sign all taxiway routes and runways supported by bridges or tunnels according to the standards in AC 150/5340-1, AC 150/5340-18, and AC 150/5340-30.
2. Identify bridge edge portals with a minimum of three equally spaced L-810 obstruction lights on each side of the bridge structure, as shown in Figure 6-1.
3. Paint 3-foot (0.9 m) yellow stripes spaced 25 feet (7.6 m) apart on taxiway shoulders on bridge decks, as shown in Figure 6-1. See AC 150/5340-1 for additional information.

6.2.5.2 **Design Considerations.**

1. Consider installation of centerline lighting if aircraft use the taxiway bridge during nighttime operations and/or during low visibility conditions.
2. Airports may reduce the spacing between successive taxiway light fixtures (whether on the edge or centerline) from the standard values of AC 150/5340-30 on the segment of the taxiway pavement crossing the bridge or tunnel, but not below 50 feet (15.2 m).

Figure 6-1. Shoulder Markings for Taxiway Bridges



Note 1: The shoulder area assumes a fully closed cover instead of a partial cover open to traffic below.
Note 2: See AC 150/5340-1 for taxiway marking details.
Note 3: Spacing maximum 150 ft (46 m).

6.3 Airfield Drainage.

Airfield drainage systems collect, convey, and discharge storm water from airfield pavements to allow safe vehicle and aircraft operations during a storm event. An effective drainage system maintains the integrity of safety areas by diminishing the risk of erosion and providing a suitable surface for the operation of safety and emergency vehicles. Consider the following drainage design factors when undertaking airfield design projects.

6.3.1 Standards.

6.3.1.1 System Design.

Refer to AC 150/5320-5 for guidance on the design of airport drainage systems.

6.3.1.2 Regulatory Requirements.

Comply with Federal, state, and local requirements for storm water management. Federal requirements include compliance with the Clean Water Act.

6.3.1.3 Airfield Pavement and Safety Areas.

Comply with transverse gradient standards to prevent accumulation of surface water on airfield pavements and safety areas following a storm event. See paragraphs 3.16 and 4.14.

6.3.1.4 Wildlife Management.

Minimize the potential for the storm water system to attract wildlife to the airport. Refer to AC 150/5200-33 for guidance and requirements on land use management and storm water management facilities that minimize wildlife hazard attractants.

6.3.2 Design Considerations.

6.3.2.1 Drainage System.

Design the drainage system to collect, convey, and discharge storm water from the airfield in a manner that prevents accumulation on airport pavements and erosion of safety areas.

1. Locate ditches, channels, and collection structures (e.g., detention basins) outside of safety area limits.
2. Design the grate and structure to resist loading of the critical aircraft where it is impractical to install an inlet outside of a safety area.
3. Install a pavement sub-drain (e.g., edge drain) system to control and remove subsurface water to preserve and prolong pavement performance.

4. Locate open channels and watercourses away from runway approach and departure paths.
5. Consider the need for separate drainage systems to collect runoff containing aircraft and airfield deicing fluids.

6.3.2.2 **System Adaptability.**

Consider future airport expansion and grading requirements when establishing storm water management needs during planning and design efforts.

6.3.2.3 **Water Quality.**

Employ best management practices (BMPs) to mitigate the adverse impacts of development activity on water quality. Refer to the National Pollution Discharge Elimination System (NPDES) for permitting requirements. Refer to AC 150/5320-15, *Management Of Airport Industrial Waste*, for guidance on the management and regulations of industrial waste generated at airports.

6.4 Airfield Pavements.

Airfield pavements provide a suitable support surface for the safe and efficient operation of aircraft. In addition to resisting aircraft loads, airport pavements provide a firm skid resistant surface suitable for year-round aircraft operations under various environmental conditions. Proper pavement design considers the cumulative effects of repetitive aircraft loadings over the design life of the pavement section.

6.4.1 Standards.

6.4.1.1 **Pavement Design.**

Refer to AC 150/5320-6 for standards and guidance for airfield pavement design.

6.4.1.2 **Surface Treatment.**

Provide grooving or other surface friction treatment for primary and secondary runways at commercial service airports and runways serving turbojet operations. Refer to AC 150/5320-12 for information on skid resistant surfaces.

6.4.2 Recommended Practice.

Provide grooving or surface treatment for high-speed taxiways.

6.5 Airfield Roadways.

The operation of ground vehicles within the AOA introduces conflict risks with taxiing and parked aircraft. Airfield roads are dedicated routes that separate vehicle operations

from aircraft operations. AOA roadways are primarily used by vehicles that service aircraft, navigational equipment, airport operations, and airport security.

6.5.1 All Roadways.

6.5.1.1 **Recommended Practices.**

Where an airfield roadway crosses a taxiway or a taxilane, design the centerline of the roadway perpendicular to the centerline of the taxiway or taxilane.

6.5.1.2 **Design Considerations.**

1. Use of local, county, or state construction specifications are suitable for construction of airfield roadways.
2. Construct roads that traverse a safety area flush with the adjacent grade to allow a pilot to maintain control of the aircraft during an excursion event.
3. Where a road surface consists of granular material, pave the first 300 feet (91 m) adjacent to a paved surface to limit tracking of debris onto operational pavements.
4. Provide pavement markings to delineate roadway edges in apron areas (refer to AC 150/5340-1).
5. Provide surface pavement hold line marking and road signs when intersecting with taxiways and taxilanes.

6.5.2 AOA Vehicle Service Road (VSR).

AOA VSRs are dedicated routes within the AOA for passage of GSE and airport operations vehicles without impeding aircraft movements. VSRs enhance safety by channelizing ground vehicle traffic to areas that minimize interaction with aircraft operations. VSRs primarily reside in non-movement areas (e.g., airfield, non-controlled apron areas) but may also be present in movement areas of space constrained airports.

6.5.2.1 **Standards.**

1. Locate the roadway outside the limits of TSAs, TOFAs, and TLOFAs except where it is necessary to cross a taxiway or taxilane.
2. Route VSRs outside the limits of ROFAs and RSAs.
3. Refer to AC 150/5340-1 for standard marking details for airfield roadways.

6.5.2.2 **Design Considerations.**

1. Factors to consider when assessing the justification for a VSR include:
   a. Frequency of ground vehicle traffic in the non-movement area

b. Potential for conflict with parked or taxiing aircraft

2. Design the width of the VSR to accommodate two-way traffic for equipment and vehicles that operate at the airport. Typical VSR widths range from 20 to 25 feet (6.1 to 7.6 m).

3. Route VSRs in a manner that limits crossing of taxiways and taxilanes.

4. For locations that justify a need for ground service vehicles to traverse a similar path as a taxiway bridge, construct a separate bridge for vehicle use.

5. Locate airfield vehicular bridges outside of OFAs.

6. See Chapter 5 for guidance related to service roads located on the apron.

6.5.3 Aircraft Rescue and Fire Fighting (ARFF) Access Roads.

ARFF access roads provide ARFF vehicles unimpeded access to potential accident areas on a certificated airport. These roads also facilitate access for mutual aid vehicles, ambulances, and other emergency operations and equipment. ARFF access routes may consist of a combination of dedicated ARFF roads, taxiways, and runways.

6.5.3.1 **Standards.**

1. Provide a road surface suitable to permit emergency vehicle passage for all weather conditions that occur at the airport.

2. Design a route to provide unimpeded access to select points on the runway to achieve 14 CFR Part 139 response times from the ARFF building.

6.5.3.2 **Recommended Practices.**

1. Establish the width of the ARFF access road to provide safe passage of two-way traffic based on the dimensions of equipment at the airport, with typical roadway widths ranging from 20 feet to 30 feet (6.1 m to 9.1 m).

2. Provide sufficient radius curve to permit high center-of-gravity vehicles to navigate a turn at a high speed; use a typical maximum design speed of a fully loaded ARFF vehicle of 70 mph (113 kph).

3. Provide ARFF access to the RSA and RPZ so that no area is more than 330 feet (101 m) from a prepared surface (e.g., roadway, taxiway or runway).

6.5.3.3 **Design Considerations.**

1. Evaluate how mutual-aid vehicles and other emergency vehicles will access the AOA and movement area in the event of an incident.

2. VSRs may provide effective access for mutual-aid and other emergency vehicles; however, vehicle traffic precludes the use of VSRs as a primary ARFF access route in meeting Part 139 response times.

3. Consider installing boat launch ramps at airports where the AOA is located immediately adjacent to a large body of water.

6.5.4 Perimeter Security Road.

A Transportation Security Administration security vulnerability assessment may justify installation of a perimeter security road to facilitate monitoring of the AOA fence line at a certificated airport. See paragraph 6.8 for guidance on airport security programs.

6.5.4.1 **Standards.**

The following design criteria apply when the Transportation Security Administration determines a perimeter security road is necessary based on risk at the airport.

1. Construct the width of the roadway to be 12 to 15 feet (3.7 to 4.6 m).

2. Construct the roadway to be a well-graded, compacted, gravel surfacing:

   a. suitable for low volume traffic during all weather conditions at the airport.

   b. conforming to local, county, or state standards for aggregate surfaced roadways.

3. Locate the roadway:

   a. near the fence line to provide the vehicle operator a clear view of the AOA fence.

   b. outside the RSA, ROFA, OFZ, NAVAID critical areas, and TERPS surfaces.

6.5.4.2 **Design Considerations.**

1. Consider paving those segments of the roadway that have a higher volume of traffic due to multiple purposes (e.g., vehicle service).

2. Consider the effects that erosion may have on maintaining the integrity of the AOA fence installation due to storm water runoff from the roadway.

6.5.5 NAVAIDs Access Roads.

Some NAVAIDs facilities (e.g., PAPI, GS, runway visual range, wind cones, etc.) are fixed-by-function. This requires equipment to reside within or near safety areas and OFAs of runways and taxiways. Access to these facilities is necessary to ensure proper operation of the equipment. Responsibility for the road (e.g., construction,

maintenance, etc.) is generally a function of who owns and operates the equipment or facility.

6.5.5.1 **Standards.**

1. Locate entrances to NAVAID access roads from a vehicle service road or a taxiway to avoid entering the runway environment.
2. Where impractical to locate a NAVAID access road from other than the runway, provide a paved access road, per paragraph 6.5.1.
3. Provide "Stop", "Do Not Enter", or other necessary signs on NAVAID access roads traversing the ROFA to access the RSA.
   a. Install signs on the ROFA side of the ROFA/RSA boundary and clear of the ROFZ.
   b. Provide a frangible sign if the height exceeds 36 inches (0.9 m) above grade.

6.5.5.2 **Recommended Practices.**

1. Design NAVAID access road width as follows:
   a. Single Lane: 10 to 12 feet (3 to 3.7 m)
   b. Dual lane: 20 to 24 feet (6.1 to 7.3 m)
2. Provide a well-graded, compacted gravel or crushed rock surfacing:
   a. suitable for low volume traffic during all weather conditions at the airport.
   b. conforming to local, county, or state standards for aggregate surfaced roadways.
   c. Refer to paragraph 6.5.1.2 for intersections of granular surfaces with runways, taxiway, and aprons.

6.5.5.3 **Design Considerations.**

1. Locate access roads to minimize interference with protected surfaces such as safety areas, OFAs, and OFZs.
2. Consider parking areas and turnaround areas that are clear of safety areas, OFAs, and OFZs.

6.6 Blast Fences.

Blast fences substantially reduce or eliminate the damaging effects of jet blast by deflecting or dissipating aircraft-generated wind forces. Fences may also mitigate issues related to fumes and noise associated with jet engine operation. Blast fences near apron areas protect personnel, equipment, and facilities from the jet blast of aircraft using nearby taxilanes and maneuvering into or out of parking positions. Blast fences

may be necessary near runway ends, run-up pads, and the airport boundary to shield public roadways, structures, and individuals located near the AOA boundary.

6.6.1 Standards.

1. Locate blast fences clear of the following surfaces:
   a. RSA
   b. ROFA
   c. TSA
   d. TOFA
   e. ILS critical areas
   f. Approach and departure surfaces
   g. OFZ
2. Design blast fence structural members to resist and deflect the wind forces generated by the aircraft with the most demanding jet blast contours operating in the area needing protection.
3. Design placement of a blast fence relative to aircraft so that:
   a. The centerline of the jet exhaust stream falls below the top of the fence, and
   b. There is sufficient protection of individuals, vehicles, and facilities behind the fence.

6.6.2 Recommended Practices.

1. Install a blast fence only after determining it is impractical to provide a sufficient safety buffer between turbojet engines and the applicable sensitivity areas in Table C-1 of Appendix C.
2. Conduct an engineering analysis to identify factors affecting jet exhaust stream and to ensure the fence provides adequate protection to the sensitive areas of Table C-1.
3. Assess alternatives to blast fences such as for natural barriers (e.g., embankments) or structural walls.
4. Provide a minimum 50-foot (15.2 m) clearance from the tail of the aircraft to the front of the blast fence.

6.6.3 Design Considerations.

1. Consider wingtip clearance standards during aircraft maneuvering in run-up areas with blast protection.
2. Factors influencing blast fence design include:
   a. Aircraft fleet
   b. Engine exhaust velocities and temperatures

c. Distance to engine

d. Configuration of engines

e. Grading

f. Height of structures and LOS from the ATCT, if applicable

g. Desired protection area

6.7 Buildings within AOA.

6.7.1 Building Restriction Line (BRL).

The BRL is a line the airport establishes, for planning purposes, to indicate suitable locations for buildings and structures within the AOA, with appropriate consideration for the protection of aircraft operational surfaces. Structures located in close proximity to aircraft movement areas may result in operational controls and limitations on future expansion opportunities within the airside area of the airport (e.g., apron parking, proper taxiway to runway separations).

6.7.1.1 Elements to Consider.

1. Identify a suitable BRL on the ALP.
2. Establish the BRL to protect applicable operational surfaces to include:
   a. OFZs
   b. OFAs
   c. RVZ
   d. NAVAID critical areas
   e. TERPS surfaces
   f. ATCT clear LOS
   g. RPZs

6.7.1.2 Recommended Practice.

In addition to the surfaces in paragraph 6.7.1.1, establish the location of the BRL by ensuring an airport-established allowable structure height does not penetrate the transitional 14 CFR Part 77 imaginary surface. Typical structure heights for BRL establishment range from 25 feet (7.6 m) to 35 feet (10.7 m).

6.7.2 Standards for Buildings and Structures.

The standards listed below apply to new development as it relates to paragraph 3, *Applicability*.

1. Americans with Disabilities Act – Comply with ADA standards for accessible design, per 28 CFR Part 36, *Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities*, and 49 U.S.C. § 47102(3)(F).
2. ARFF Building – Comply with the standards of AC 150/5210-15, *Aircraft Rescue and Firefighting Station Building Design*.
3. Building Code – Comply with the building code requirements as adopted by the local governing body; or in the absence of a formally adopted code, comply with the current International Building Code.
4. Equipment Vault – Comply with the standards of AC 150/5340-30 which include standards from the National Electric Code.
5. SRE Building – Comply with the standards of AC 150/5220-18, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*.
6. Terminal Building – Comply with the standards of AC 150/5360-13.

6.8 Security of Airports.

The overall objective of airport security is to safeguard the AOA against acts, intentional or unintentional, that harm or disrupt airport operations. This includes protecting the safety of passengers, crew, ground personnel, and general users of the airport. The risks to airport security vary among airports. Airport size, type, location, topography, and activity are important factors that can affect risk. Establishing the appropriate level of security at a given airport involves applying a risk-based analysis including:

- Assessing vulnerabilities
- Identifying threats
- Implementing measures and controls that mitigate risk
- Monitoring implemented security measures

6.8.1 Regulations.

6.8.1.1 Transportation Security Administration.

The Transportation Security Administration is responsible for security in all modes of transportation including responsibilities for civil aviation security, per 49 U.S.C. Chapter 449, *Security*.[ii] The Transportation Security Administration regulations for airport security are codified at 49 CFR Part 1542, *Airport Security*.

1. Commercial Service Airports.

[ii] 49 CFR § 1502.1, *Responsibilities of the Administrator*.

a. Transportation Security Administration regulations for airport security apply to airports with commercial service operations.

b. Airports subject to Part 1542 must adopt and implement a security program acceptable to the Transportation Security Administration.

c. Key program elements maintaining security of the movement area, secured areas, and security identification area.

2. GA Airports.

a. Currently, there are no regulations that establish security requirements for GA airports.

b. The Transportation Security Administration publication, *Security Guidelines for General Aviation Airport Operators and Uses*, establishes voluntary guidelines and suggestions a GA operator may implement to address security at its airport.

6.8.1.2 **FAA Airport Security.**

FAA regulations for airport security apply to airports operating under Part 139. Part 139 airports must provide safeguards that prevent unauthorized person entry to the movement area. This includes installation of fencing, provision of access controls, and conformance to the Transportation Security Administration's approved airport security program. The FAA does not publish regulations or guidelines addressing security at a GA airport.

6.8.2 Standards.

The following standards represent basic measures and controls acceptable to the FAA for maintaining the security of the AOA at a certificated airport. Conducting a security risk assessment may support additional measures and controls, as approved by the Transportation Security Administration Federal Security Director (FSD) to address risks specific to an airport.

6.8.2.1 **Fencing.**

Use basic chain link fence conforming to the standards of section F-162, *Chain-Link Fence*, of AC 150/5370-10 and having the following characteristics:

1. Minimum height of 8 feet (2.4 m) measured from grade consisting of:

a. 7-feet (2.1 m) high chain link fabric.

b. 1-foot (0.3 m) high outrigger with 3-strand barbwire mounted at a 45-degree angle.

2. Fabric mesh consisting of 9-gauge galvanized wire in 2-inch (51 mm) mesh.

3. No more than a 2-inch (51 mm) gap between the bottom of the fabric and the grade.
4. Under fence intrusion prevention by:
   a. Adding a bottom tension wire or rail secured to a concrete footing at the mid-point of line posts, or
   b. Burying fence fabric a minimum of 12 inches (305 mm) below grade.

6.8.2.2 **Vehicle Barriers.**

Install vehicle barriers at the AOA boundary locations with identified risk for vehicle intrusion. Basic barrier characteristics include:

1. Barrier height ranging between 30 to 36 inches (0.8 m to 0.9 m) above grade.
2. Barrier types:
   a. Reinforced concrete barrier
   b. Steel bollards with a minimum 6-inch (152 mm) diameter and schedule 40 pipe.
   c. Steel guardrail between 30 to 36 inches (0.8 m to 0.9 m) in height.
   d. Steel guardrail consisting of 12-gauge W-beam and W6×9 steel posts at 6-foot, 3-inch (1.9 m) spacing.
   e. Multi-strand high tensile steel cables with anchors.

6.8.2.3 **Access Gate and Gate Operator.**

Comply with the ASTM International standard F-2200 for Class IV gate installation. Comply with Underwriters Laboratory (UL) 325 for Class IV gate operators. Position gate operators in a location that prevents tampering by individuals exterior to the fence line.

6.8.3 Design Considerations.

There is no obligation for an airport owner/operator with existing AOA physical barriers not meeting the basic features of paragraph 6.8.2 to take immediate corrective action. However, the FAA expects any replacement security fence at a Part 139 airport to conform to the minimum criteria of paragraph 6.8.2 whenever an FSD-approved security risk assessment determines:

1. the existing AOA barrier, or portions thereof, present an unacceptable security risk; or,
2. the existing fence, or portions thereof, have met its useful life and can no longer function properly.

6.9 Compass Calibration Pad.

A compass calibration pad is a paved area where aircraft position to calibrate the aircraft magnetic compass (see Figure 6-2). This allows the pilot to determine the deviation error in the magnetic compass. Pilots periodically check their magnetic compass to determine the accuracy of readings. The compass calibration pad is not the only means to perform aircraft compass calibration. See Appendix F for guidance on compass calibration pad surveys.

6.9.1 Compass Calibration Pad Location.

Site conditions and airport design criteria determine a suitable location for a compass calibration pad. Conducting a magnetic survey establishes the suitability of a final location. Determine a tentative site(s) by visual application of the following and then conduct a thorough magnetic survey of the site(s).

6.9.1.1 Standards.

Locate the pad to meet the following criteria:

1. The center of the pad is a minimum of 600 feet (183 m) from magnetic objects such as large parking lots, busy roads, railroad tracks, high voltage electrical transmission lines, or cables carrying direct current (either above or below ground).
2. The center of the pad is a minimum of 300 feet (91 m) from buildings, aircraft arresting gear, fuel lines, electrical, or communication cable conduits when they contain magnetic (iron, steel, or ferrous) materials and from other aircraft.
3. The center of the pad is a minimum of 150 feet (46 m) from runway and taxiway light bases, airfield signs, ducts, and grates for drainage if they contain iron, steel, or ferrous materials.
4. The location of the pad is clear of any critical area for electronic NAVAID facilities.
5. The location of the pad is clear of all airport design surfaces so that aircraft using the pad do not penetrate the OFZ, safety areas, OFAs, etc.
6. Perform preliminary magnetic surveys to determine that the angular difference between true and magnetic north measured at any point does not differ from the angular difference measured at any other point:
   a. By more than half a degree (30 minutes of arc) within a space between 2 feet and 6 feet (0.6 m and 1.8 m) above the grade elevation of the pad, and
   b. Over an area within a 250-foot (76 m) radius from the center of the pad.

6.9.1.2 **Recommended Practices.**

1. Conduct magnetic surveys at various times, as needed, to determine if the area experiences intermittent magnetic variations.
2. The optimum site has a uniform magnetic variation or declination. Magnetic declination is the difference between magnetic north and true north.
3. Have the geophysicist, surveyor, or engineer conducting the magnetic survey provide a compass rose report certifying the results and noting all anomalies.

6.9.1.3 **Design Considerations.**

Check for locally generated or natural magnetic anomalies.

1. A site may be unsatisfactory even if it appears to meet all visually applied criteria regarding distances from structures, etc.
2. Small anomalies may be acceptable if the magnetic surveys indicate no effect on any magnetic measurements on the paved portion of the compass calibration pad.

6.9.2 Compass Calibration Pad Size.

See Figure 6-2 for a typical compass calibration pad configuration. Apply the following design standards to ensure an effective calibration pad.

6.9.2.1 **Standards.**

1. Size the pad for the most demanding aircraft that will use the pad.
2. Design the pavement to support the most demanding aircraft and/or maintenance equipment loading.
3. Construct joint type and spacing in the concrete pavement in accordance with FAA standards and paragraph 6.9.3.1.
4. Slope the pavement to drain storm water from the center of pad to the edge of pavement, per paragraph 5.9.
5. Refer to the applicable portions of AC 150/5320-6 and AC 150/5370-10 for pavement design and construction standards respectively.

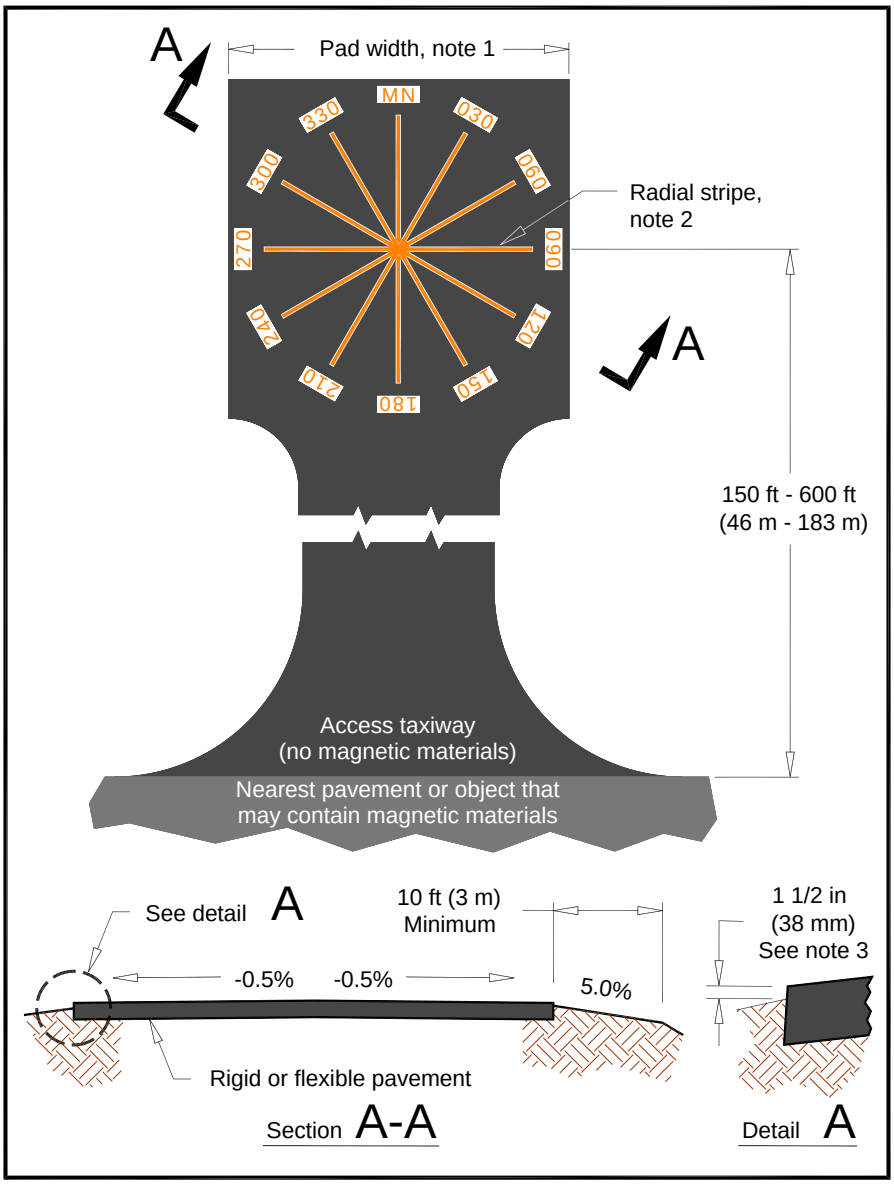
6.9.3 Compass Calibration Pad Construction.

6.9.3.1 **Standards.**

1. Construct pad(s) using either non-reinforced concrete or asphalt pavement.
2. Do not use magnetic materials such as reinforcing steel or ferrous aggregate.

3. Use dowels that are non-ferrous (e.g., aluminum, brass, bronze) or non-metallic (e.g., fiberglass).
4. Use non-metallic or aluminum material for any drainage pipe within a 150-foot (46 m) radius of the center of the pad site.
5. Do not use magnetic materials in the construction of any pavement within a 300-foot (91 m) radius of the center of the pad site.

Figure 6-2. Compass Calibration Pad



Note 1: Dimensions of the calibration pad vary depending on the requirements of user aircraft.
Note 2: The color of the radials is at the discretion of the airport operator provided there is adequate contrast with the pavement surface and the marking does not create pilot confusion with taxiway markings.
Note 3: Provide 1.5-inch (38 mm) drop-off, ±1/2 inch (13 mm) to promote drainage off the pavement surface.

6.10 Underground Power, Control, and Communications Cables.

Airports typically have a network of underground cables providing power, control, communication, and video functions that serve airfield facilities and equipment. The complexity of the underground cable network varies by size and type of airport. Ownership of underground cables may involve the airport, Federal government, local tenants, and utility companies. Typical airside facilities (see Appendix N for acronym definitions) served by underground cables include:

- Runway/taxiway edge lighting
- Airfield sign systems
- NAVAIDs (e.g., approach lights, ILS, PAPIs, etc.)
- NAS surveillance (e.g., radar, Airport Surface Detection Equipment – Model X (ASDE-X), Airport Surface Surveillance Capability (ASSC), multilateration, Automatic Dependent Surveillance – Broadcast (ADS-B)
- Communication systems (e.g., Remote Transmitter/Receiver (RTR))
- Weather systems (e.g., AWOS, Low Level Windshear Alert System (LLWAS), RVR, etc.)
- AOA security controls (e.g., gate access controls, perimeter cameras, etc.)
- Apron area lighting

6.10.1 Airfield Cable Management Plan.

Failure to maintain accurate and current information on subsurface utilities creates a situation for potential increase in risk of disruptions that may affect safe and efficient airport operations. Discovery of project conflicts with existing underground cables can lead to costly project delays. Establishing an underground cable management plan is a best practice reducing the risk of unscheduled interruptions and disruptive project conflicts. By maintaining accurate and current information on underground cables, an airport owner proactively identifies potential conflicts during the design phase rather than the construction phase.

6.10.1.1 Recommended Practices.

1. Maintain an information repository of all underground cables located on the airfield (e.g., design drawings, as-built drawings, GIS, asset management software) as projects occur.
2. Collect and maintain the following minimum information for each underground cable:
   a. Owner
   b. Servicing facility or equipment
   c. Type of cable (e.g., power, control, communication, fiber optic, etc.)
   d. Location (e.g., mapped points, geo-referenced, etc.)
   e. Structures (e.g., duct banks, handholes, manholes, etc.)
   f. Depth from surface (e.g., estimated or surveyed)

g. Dates (e.g., installation, verification, alterations, etc.)

3. Implement a no-cost permitting process for all airside projects to collect information on underground cables and utilities prior to installation.

4. Collect and verify as-built information as construction projects are completed.

5. Refer to ACRP Synthesis 34, *Subsurface Utility Engineering Information Management for Airports*.

6.10.2 Airport-Owned Underground Cables.

Consider the following when undertaking an airside project that installs or modifies underground cables:

1. Collect and maintain information on underground cables, per paragraph 6.10.1.1.

2. When practical and reasonable, install spare raceways in duct banks under airside pavements to preclude saw cutting of pavement for future airport development or utility expansion work.

3. Consider future airport development shown on the approved ALP in assessing future duct bank requirements.

4. When installing new underground cables and utilities, consider the pavement or foundation section depth of future airport facilities, as shown on the approved ALP, to avoid future conflicts.

5. The depth of underground cables can migrate in areas subject to repetitive freeze-thaw conditions.

6. Integrate subsurface utility engineering into project design.

6.10.3 FAA-Owned Underground Cable Systems.

The FAA installs and maintains a network of underground power, control, and communication cables that service communication, surveillance, NAVAIDs, and weather facilities. See FAA specification FAA-C-1391, *Installation, Termination, Splicing, and Transient Protection of Underground Electrical Distribution System Power Cables*. Take actions during the design phase of airside development project to identify and avoid adversely affecting FAA-owned cables.

6.10.3.1 **ATO Coordination.**

As part of the preliminary design phase, contact the local FAA ATO Technical Operations Organization for underground cable information specific to an airport.

6.10.3.2 **Cable Depths.**

The FAA installs underground cable up to 600V a minimum of 24 inches (0.6 m) below grade. For cable ducts under taxiway and runways, the depth increases to 48 inches (1.2 m) or greater. Due to as-built drawings

accuracy risks, the preferred method for positive identification of cable depths is by cable locators or by exposing existing cables using non-destructive methods (e.g., vacuum excavation).

6.10.3.3 **Cable Loop Systems.**

FAA Order 6950.23, *Cable Loop Communication Systems at Airport Facilities*, establishes FAA policy for the installation of cable loop systems at select airports. Cable loops provide the benefits of redundancy to facilitate uninterrupted facility service. Because the location of cable loop segments occurs apart from the facility it serves, there is increased risk of cable cuts due to unawareness. As part of the design process for airfield development projects, contact the local FAA ATO Service Center to determine the presence of cable loop systems at an airport.

6.10.3.4 **Continuous Power Airports (CPA).**

FAA Order 6030.20, *Electrical Power Policy*, establishes FAA policy for continuous power of select airport critical to NAS operations. This ensures continued operation of critical NAS facilities in the event of a power failure from a public utility company. Refer to Appendix A of FAA Order 6030.20 for CPA runways. For development projects at a CPA, consider the risk of power disruption to the CPA runway as part of the design process.

6.11 Communications, Navigation, Surveillance and Weather (CNSW) and Air Traffic Control (ATC) Facilities and Equipment.

This section presents information for CNSW facilities and ATC facilities that contribute to safe airport operations in the NAS. Figure 6-3 depicts the typical types and location of these facilities.

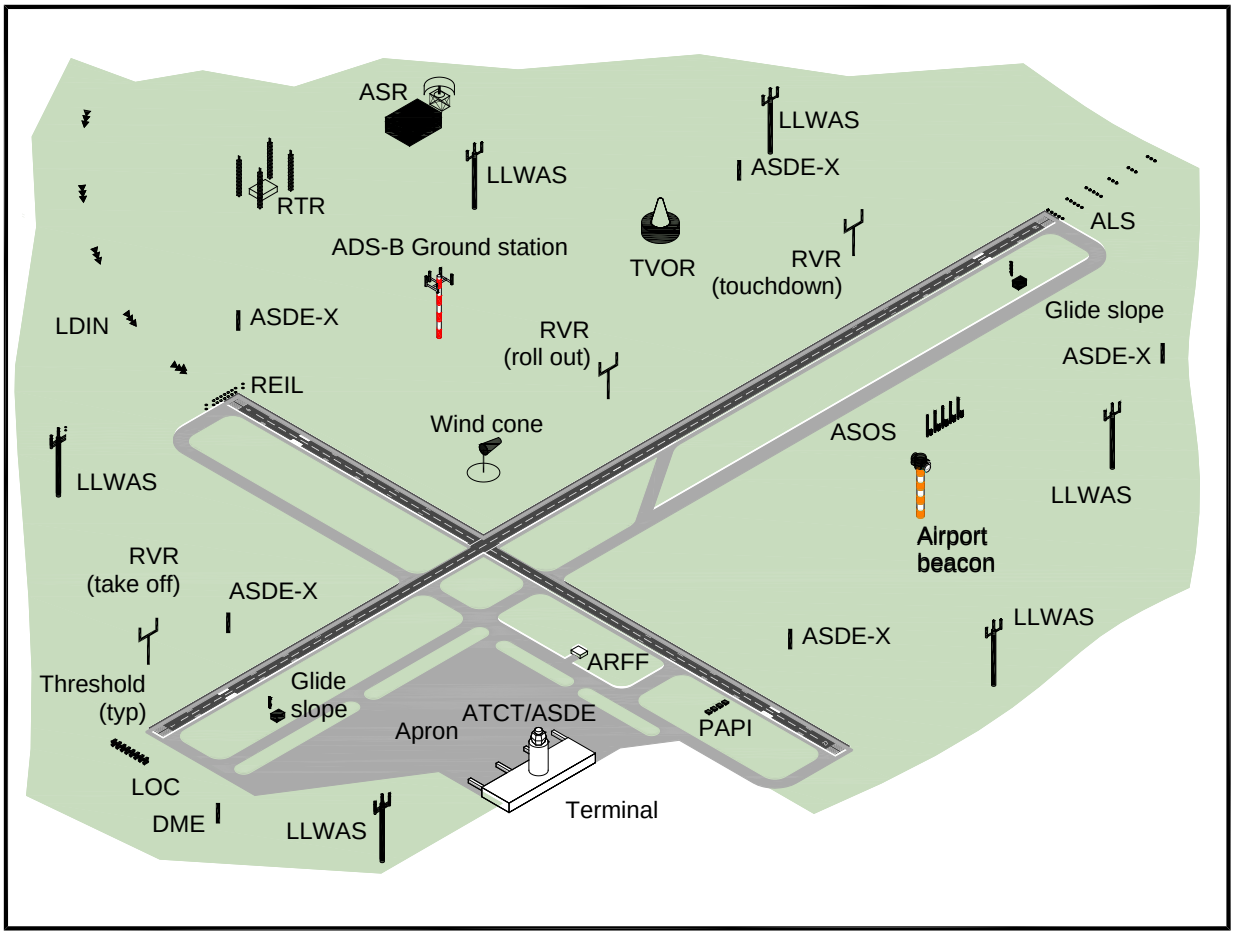
6.11.1 Purpose.

The FAA owns, operates, and maintains the majority of CNSW and ATC facilities at an airport. Federal requirements pertaining to non-Federal facilities are located at 14 CFR Part 171, *Non-Federal Navigation Facilities*, and FAA Order 6700.20, *Non-Federal Navigational Aids, Air Traffic Control Facilities, and Automated Weather Systems*. Use of the information in this section during airport planning and design will assist the airport with minimizing conflicts between future development and existing or future CNSW and ATC facilities.

6.11.2 Limitations of Information.

This information does not represent the complete guidelines and standards for the siting and establishment of CNSW or ATC facilities. Standards and requirements for facility siting and establishment are contained in the various FAA Orders referenced within this section.

Figure 6-3. Typical Communications, Navigation, Surveillance, and Weather (CNSW)



6.11.3 FAA-Owned Facilities Impacted by Airport Development.

Airport development can have an adverse effect on existing CNSW and ATC facilities. This includes unscheduled outages and the need to relocate an existing facility. Airports may not alter, remove, or relocate FAA-owned equipment (including ADS-B equipment) without approval from the FAA.

6.11.3.1 **Reimbursable Agreement.**

Airport development affecting FAA operations or FAA-owned facilities and equipment may require establishment of a reimbursable agreement for materials, supplies, equipment, and services provided by the FAA for a sponsor's proposed development. To limit the loss of operational service, provide at least three years advance notice to the FAA NAS Planning and Integration (NPI) Team responsible for the airport where the project is taking place.

6.11.4 General Facility Criteria.

Each CNSW facility has criteria for the device to function properly. The optimum location of a facility relative to the runway/taxiway or airport varies by the function of the facility. Consider the following factors during the planning and design of airport development to minimize impacts to existing FAA facilities.

6.11.4.1 **Notification.**

Proponents of development on an airport must submit a Notice of Proposed Construction or Alteration (FAA Form 7460-1), per Part 77. With this information, the FAA evaluates the potential impact of any proposed construction near an FAA-owned facility.

6.11.4.2 **Separation and Clearance.**

In addition to the physical area and land necessary for a CNSW or ATC facility, each facility may require meeting separation and clearance criteria for optimum performance. The basis for the criteria may be visual (e.g., LOS) or electronic (radio frequency (RF)). Visual aid facilities typically require an obstacle clearance surface to provide a clear LOS.

6.11.4.3 **Critical Areas.**

Some facilities have a defined critical area that require protection to ensure proper performance. Such areas may preclude the presence of objects that may induce electromagnetic interference (EMI). The size and shape of a facility's critical areas vary by facility type. Some facilities require conformance to specific grading criteria.

6.11.5 Jet Blast/Exhaust.

Locate CNSW facilities, monitoring devices, and equipment shelters at least 600 feet (183 m) from the source of any jet blast to minimize the accumulation of exhaust deposits on antennas.

6.11.6 Facilities and Equipment near Runways.

Objects located near an active runway present an increased risk to aircraft operations. The FAA standards for RSAs and ROFAs recognize that certain equipment is fixed-by-function and is located within the limits of the RSA or ROFA to function properly.

6.11.6.1 **Fixed-by-Function.**

The FAA classifies certain CNSW equipment as fixed-by-function. This means the safety benefit of the equipment residing in an RSA or OFA outweighs the potential risk of an aircraft striking the equipment. A fixed-by-function determination allows the equipment, or portions of the equipment, to reside within the RSA or ROFA. Table 6-1 identifies the CNSW equipment the FAA designates as fixed-by-function for location within an RSA or ROFA.

6.11.6.2 **Associated Equipment.**

Although a piece of equipment may have a fixed-by-function designation, it does not necessarily mean all components of the equipment can reside in the RSA or ROFA. Unless determined otherwise by the FAA, the associated equipment shelters and the power and control racks are not fixed-by-function.

Table 6-1. Fixed-by-Function Designation for CNSW Equipment

Item	Fixed-by-Function Designations		
	In RSA	In ROFA	Associated Equipment [5]
Automatic Dependent Surveillance – Broadcast (ADS-B)	No	No	No
Airport Beacon	No	No	N/A
Approach Lighting System (ALS)	Yes	Yes	No [1]
Airport Surface Detection Equipment – Model X (ASDE-X), Airport Surface Surveillance Capability (ASSC)	No	No	N/A
Automated Surface Observing System (ASOS), Automated Weather Observing Systems (AWOS)	No	No	N/A [3]
Airport Surveillance Radar (ASR)	No	No	N/A
Airport Traffic Control Tower (ATCT)	No	No	N/A
Distance Measuring Equipment (DME)	No	No	No
Glideslope (GS)	No [2]	No [2, 3]	No [3]
Inner Marker (IM)	Yes	Yes	Yes
Lead-in Lighting System (LDIN)	Yes	Yes	No [1]
Localizer (LOC)	No	No	No
Low Level Windshear Alert System (LLWAS)	No	No	No
Middle Marker (MM)	No	No	No
Non-directional Beacon (NDB)	No	No	N/A
Outer Marker (OM)	No	No	No
PAPI/VASI	Yes	Yes	No
Pedestrian Intrusion Detection Equipment	No	No	No

Item	Fixed-by-Function Designations		
	In RSA	In ROFA	Associated Equipment [5]
Precision Runway Monitor (PRM)	No	No	No
Runway End Identifier Lighting (REIL)	Yes	Yes	No [1]
Runway Guard Lights (RGL)	No	Yes	N/A
Runway Lights and Signs	Yes	Yes	No
Remote Transmitter/Receiver (RTR)	No	No	No
Runway Visual Range (RVR)	No	Yes	Yes
Runway Status Lights (RWSL)	Yes	Yes	No
Taxiway Lights and Signs	Yes	Yes	No
VHF Omnidirectional Range (VOR), Tactical Air Navigation (TACAN), VHF Omnidirectional Range Co-located Tactical Air (VORTAC)	No	No	N/A
Weather Camera (WCAM)	No	No	No
Wind Equipment F-400 (WEF)	No	No	No
Wind Cone (primary)	No	No	No
Wind Cone (supplemental)	No	No [4]	No [4]

Note 1: Flasher light power units (Individual Control Cabinets) are fixed-by-function.
Note 2: End Fire GSs are fixed-by-function in the RSA/ROFA.
Note 3: Space constraints may necessitate locating a GS facility within a ROFA. Conduct an aeronautical study of this non-standard condition for a possible wingtip conflict when positioning the critical aircraft outer wheel at the nearest edge of the RSA and for a possible IFR effect to an instrument approach procedure. Include an evaluation of the ASOS/AWOS facilities when co-located with the GS. Facility service power equipment are ancillary components of the facility.
Note 4: Space constraints may necessitate locating a supplemental wind cone L-806 within a ROFA. Evaluate on a case-by-case basis through an aeronautical study.
Note 5: Associated equipment located below the grade of the nearest point of the RSA is permitted within the ROFA.

6.11.6.3 **Frangibility.**

Mount equipment located within an RSA on frangible couplings. These couplings have a point of frangibility on the mounting legs no higher than 3 inches (76 mm) above the grade, designed to break away upon impact. This reduces the potential damage to aircraft inadvertently leaving the paved surface. The frangibility requirement is a standard for RSAs, whether or not the CNSW equipment is fixed-by-function. AC 150/5220-23 provides guidance on frangible connections.

Figure 6-4. Two Frangible Connections

6.11.6.4 **Non-Standard Installations.**

The FAA considers existing facilities and associated equipment residing within an RSA but not fixed-by-function or meeting frangibility requirements to be non-standard installations. The FAA expects the airport to develop plans to correct the non-standard installation by relocating the equipment as soon as practicable.

6.11.7 Airport Traffic Control Tower (ATCT).

The ATCT is a staffed facility that uses air/ground communications and other ATC systems to provide air traffic services both on the airport and for the surrounding airspace. The location of an ATCT gives controllers a clear LOS to all surface movement areas, takeoff areas, and landing areas. FAA Order 6480.4 contains guidance for FAA ATCT siting criteria.

6.11.7.1 **Key Factors Affecting Airport Development Projects.**

New airport development has the potential to affect the operations of an existing ATCT. Consider the following when planning and designing future airport development projects:

1. Maintain an unobstructed LOS from the ATCT cab to all points on movement area pavement.
2. Maintain the minimum angle of incidence from the ATCT cab to all points on the movement area at 0.80 degrees.

3. Ensure new light sources (e.g., area lighting) do not obscure the controller's view of the movement area.
4. Consider potential effects of threshold parallax as viewed from the ATCT when designing a new parallel runway.

6.11.8 Remote Transmitter/Receiver (RTR) and Remote Communications Outlet (RCO).

RTR and RCO are air-to-ground communications systems having transmitters and/or receivers for radio communications between the pilot and ATC. See Figure 6-5. See FAA Order JO 6580.3, *Remote Communications Facilities Installation Standards Handbook*, for additional information.

6.11.8.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Maintaining an unobstructed LOS among communications towers, aircraft, and the ATCT.
2. Ensuring development does not present a risk of electronic interference that distorts the RF signal or reduces receiver performance.

Figure 6-5. Remote Transmitter/Receiver (RTR) Communication Facility

6.11.9 Airport Surveillance Radar (ASR).

ASR is a radar facility used to detect and display azimuth, range, and elevation of aircraft operating within terminal airspace. Figure 6-6 shows a typical ASR. Typical ASRs range from 17 to 77 feet (5.2 to 23.5 m) Above Ground Level (AGL) with a standard antenna tower 24 feet × 24 feet (7.3 m × 7.3 m). See FAA Order 6310.6, *Primary/Secondary Terminal Radar Siting Handbook*, for information on ASR siting criteria.

6.11.9.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Locate buildings and other facilities at least 1,500 feet (457 m) from ASR antennas to avoid potential signal reflections.
2. Locate electronic equipment at least half a mile (0.8 km) from ASR antennas.
3. Ensure trees and structures remain below the elevation of the ASR mezzanine level.
4. Watch for proposed development (e.g., wind turbines) in the airport vicinity that causes potential reflectivity issues (resulting in false targets) or that otherwise affect the ASR's operation.

Figure 6-6. Airport Surveillance Radar (ASR) Steel Tower (17 feet (5.2 m) high)

6.11.10 Airport Surface Surveillance Capability (ASSC)/Airport Surface Detection Equipment Model X (ASDE-X).

ASSC/ASDE-X systems improve surface surveillance and situational awareness in all kinds of weather. ASSC is similar to the ASDE-X system deployed in the U.S. With

ASSC/ASDE-X, controllers may observe aircraft and ground vehicle positions on the airport surface, and on approach and departure paths within a few miles of the airport, during periods of reduced visibility. The systems consist of several transmitters and receivers located near runways and taxiways.

6.11.10.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure proposed development does not affect the continuous LOS among aircraft, surface vehicles, and ASSC/ASDE-X equipment, including data links to the ATCT base station.
2. Ensure proposed development does not cause relocation of remote units (multilateration) or create other signal or multipath constraints.

6.11.11 Approach Lighting System (ALS).

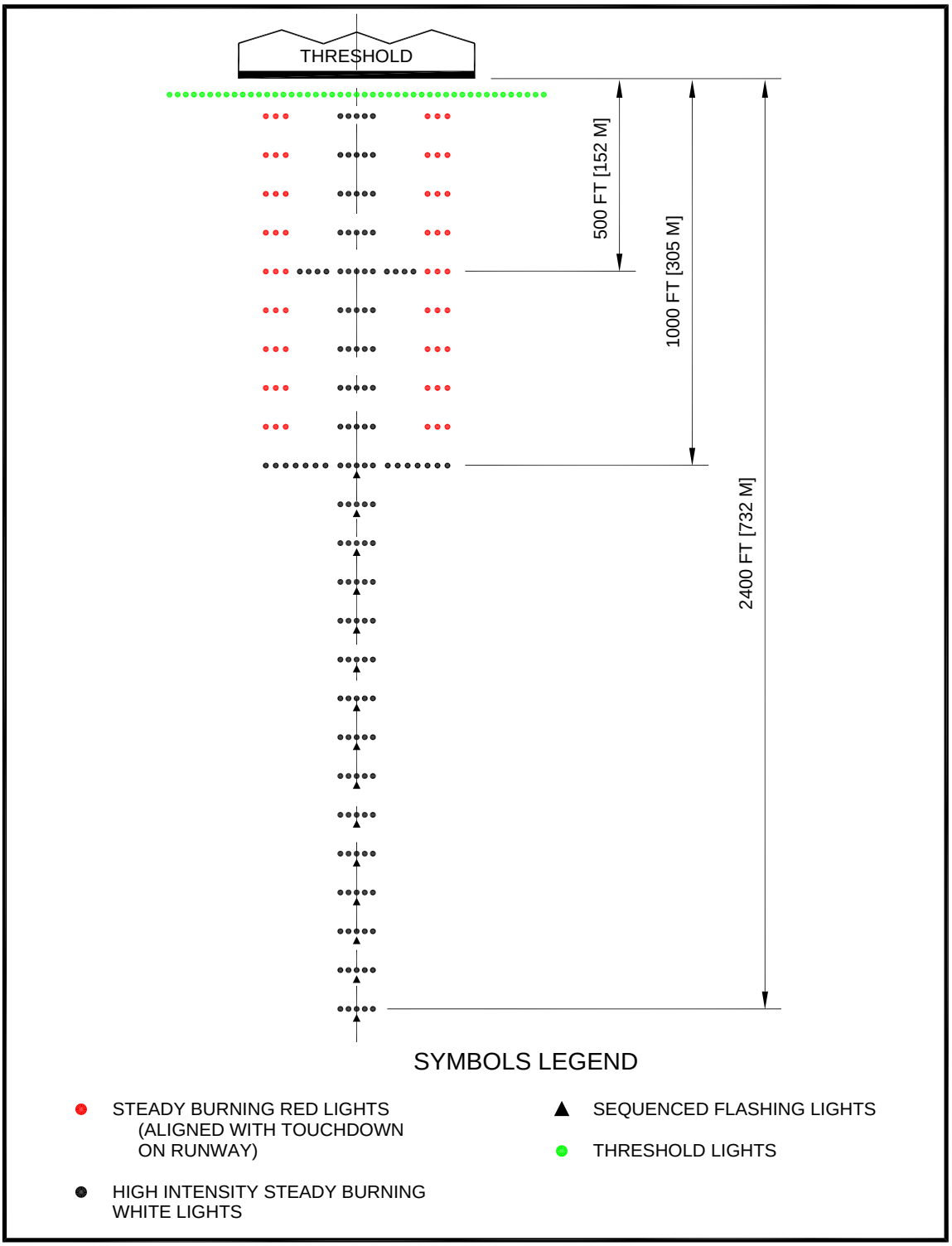
ALSs are light configurations positioned symmetrically along the extended runway centerline. They begin at the runway threshold and extend outwards towards the runway's approach area. The ALS may be controlled by the ATCT, the airport operator, or by pilot-controlled lighting systems. An ALS often supplements electronic NAVAIDs, resulting in lower visibility minimums. FAA Order JO 6850.2 contains guidance on ALS.

6.11.11.1 **ALS Configurations.**

The FAA uses many ALS configurations to meet visual requirements for precision and NPAs.

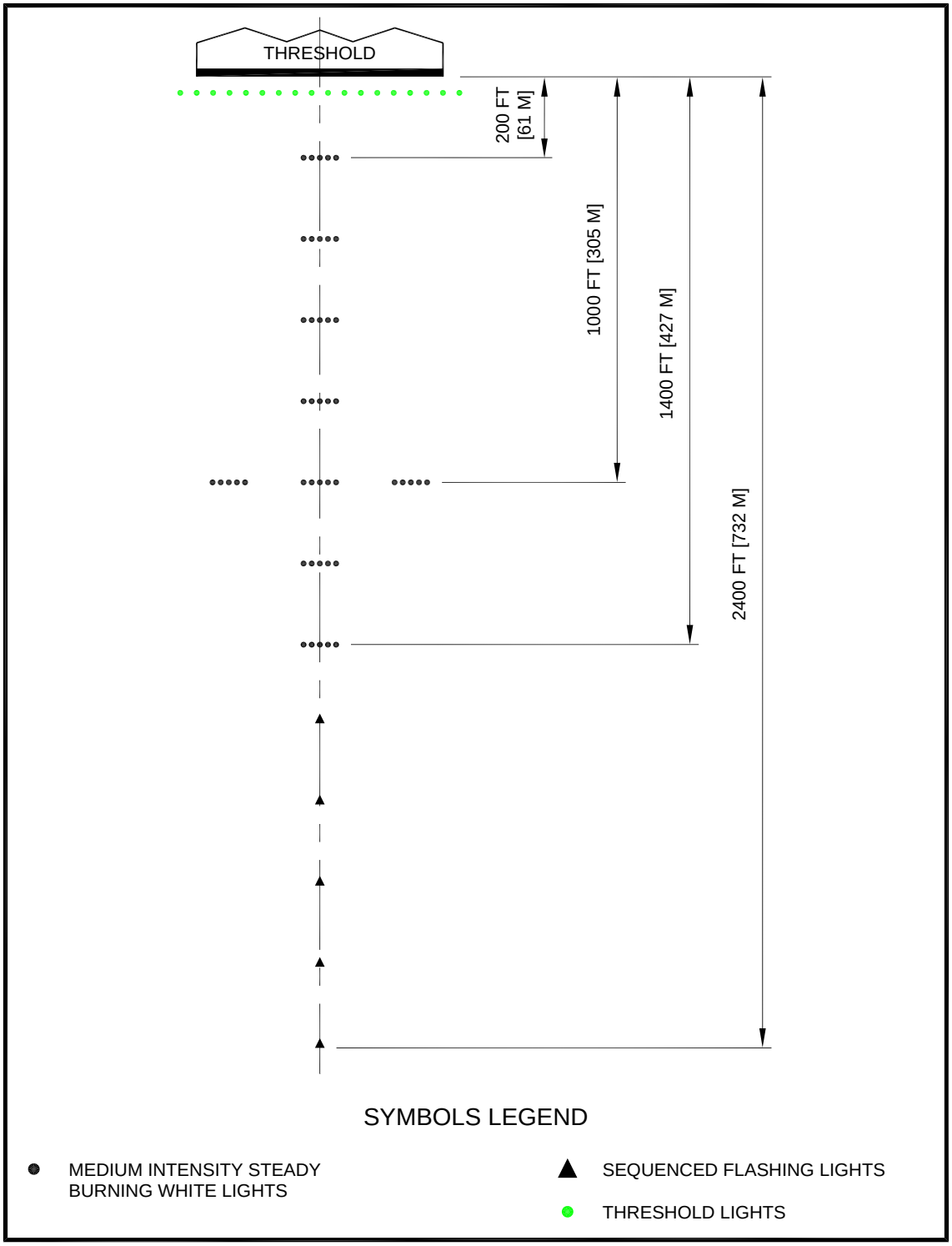
1. Precision approaches use ALS with Sequenced Flashing Lights (ALS with Sequenced Flashers I (ALSF-1) or ALS with Sequenced Flashers II (ALSF-2)). See Figure 6-7.
2. CAT-II and CAT-III precision approaches require high intensity ALS.
3. CAT-I precision approaches and special authorization CAT-II approaches use Medium Intensity ALS with Runway Alignment (MALSR). See Figure 6-8.

Figure 6-7. Approach Lighting System (ALS) with Sequenced Flashers



Note: ALSF-2 is depicted.

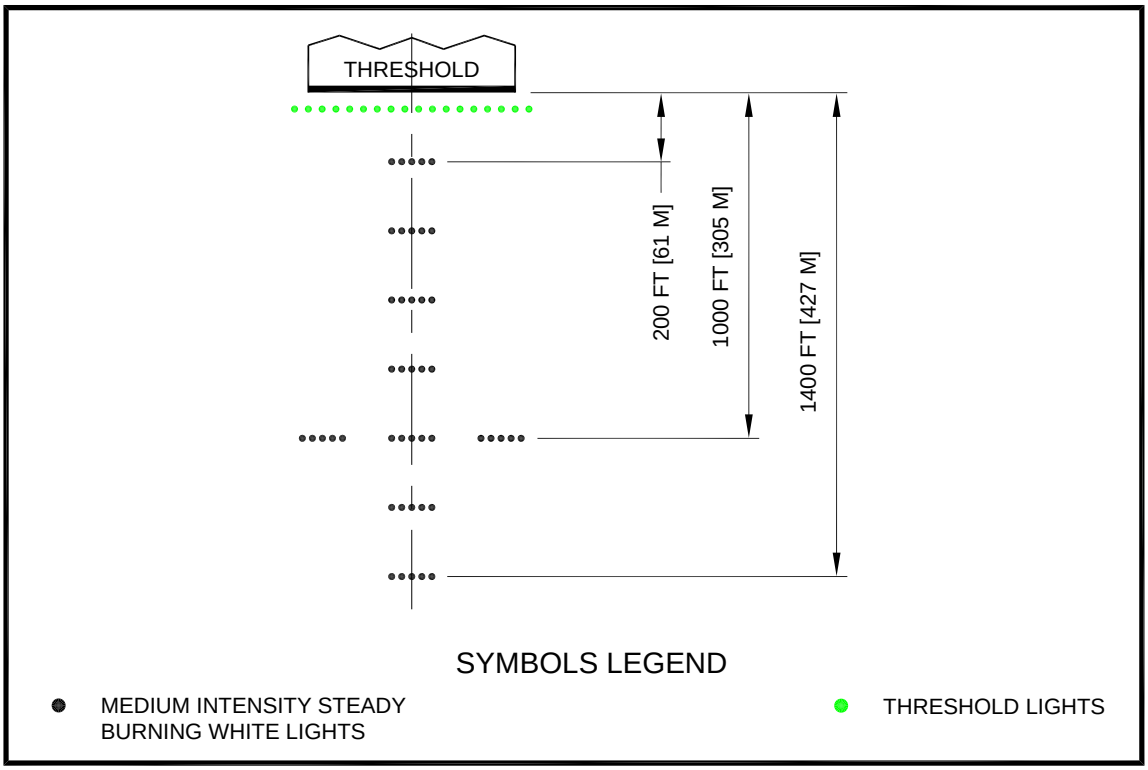
Figure 6-8. Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR)



6.11.11.2 **Medium Intensity Approach Lighting System (MALS).**

1. An economy approach lighting aid that enhances visual recognition of the runway end for non-precision instrument and visual approaches.
2. Simplified Short Approach Light Systems (SSALS) have the same configuration as a MALS but use high intensity lights.
3. See Figure 6-9.

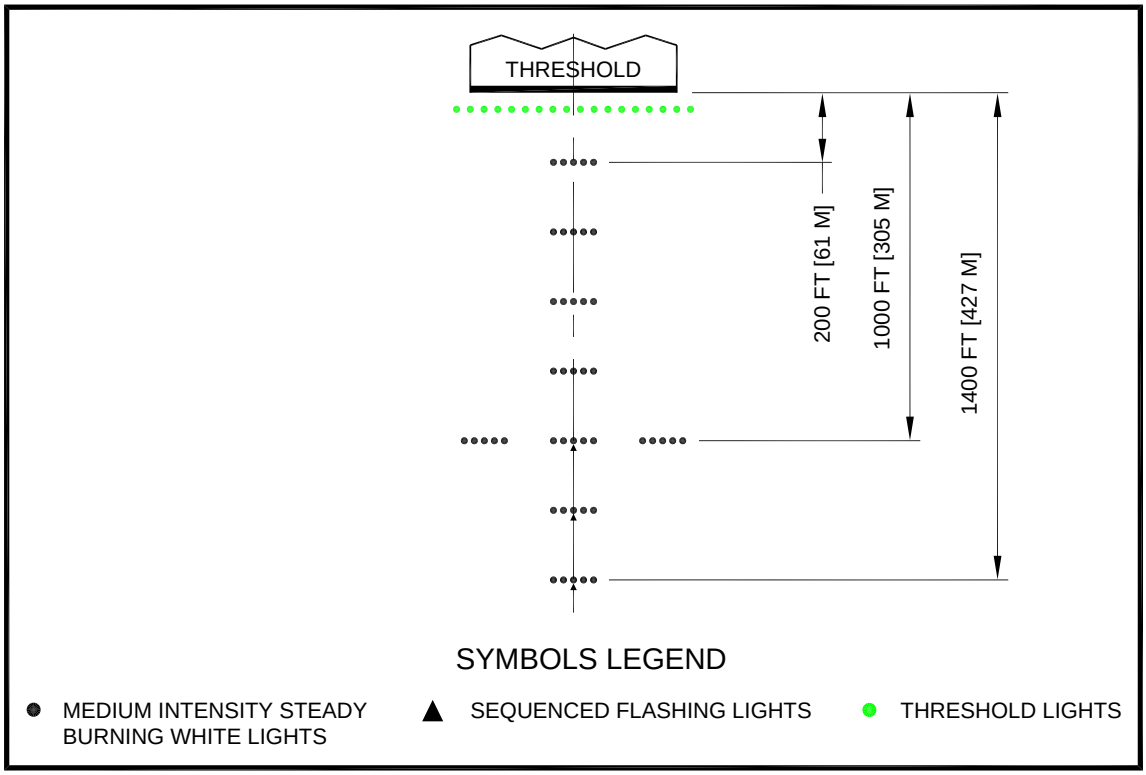
Figure 6-9. MALS



6.11.11.3 **Medium Intensity ALS with Sequenced Flashing Lights (MALSF).**

1. An economy approach lighting aid that enhances visual recognition of the runway end for non-precision instrument and visual approaches.
2. Simplified Short Approach Light System with Sequenced Flashing Lights (SSALF) have the same configuration as a MALSF but use high intensity lights.
3. See Figure 6-10.

Figure 6-10. MALS with Sequenced Flashers (MALSF)



6.11.11.4 **An Omnidirectional Approach Lighting System (ODALS).**

1. Provides for circling, offset, and straight-in visual guidance to non-precision runways.
2. Consists of seven 360-degree flashing light stations that extend up to 1,500 feet (457 m) from the runway threshold.
3. Two of the lights positioned on either side of the runway threshold effectively function as REIL.
4. See Figure 6-11.

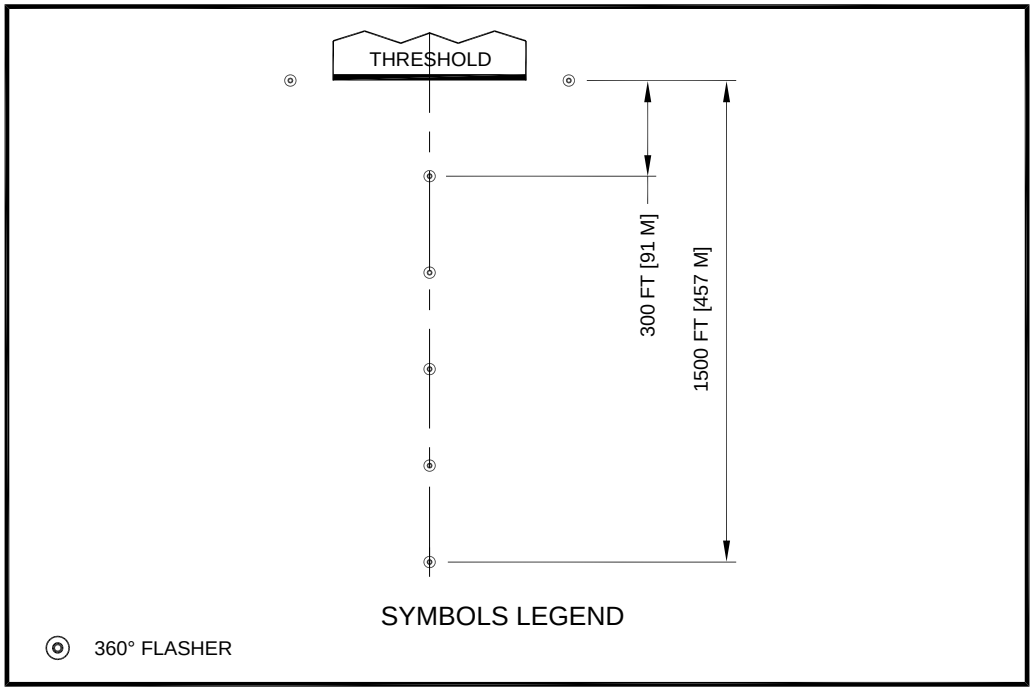
6.11.11.5 **Land Requirements.**

An ALS requires a site centered on the extended runway centerline that is 400 feet (122 m) wide, starts at the runway threshold, and extends 200 feet (61 m) beyond the outermost light of the ALS.

6.11.11.6 **Obstacle Clearance Requirements.**

A clear LOS is necessary between approaching aircraft and all lights in an ALS.

Figure 6-11. Omnidirectional Airport Lighting System (ODALS)



6.11.11.7 **Key Factors Affecting Airport Development Projects.**

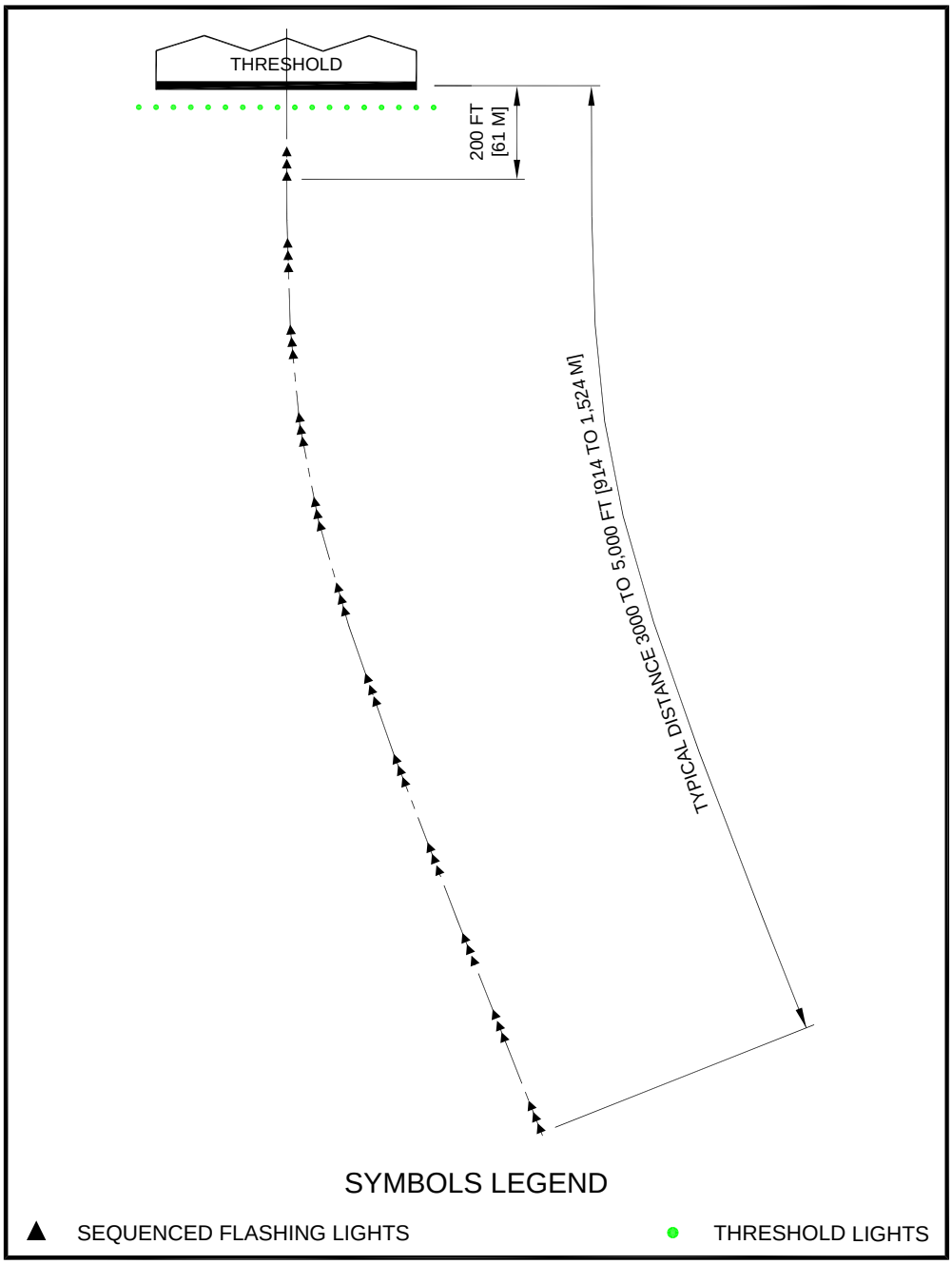
Consider the following when planning and designing future airport development projects:

1. Ensure the obstacle clearance surface, as applicable for each type of ALS facility, has no objects protruding through the approach light plane or the secondary plane.
2. Maintain approach light lane clearance over highways, rail lines, and public roadways as follows:
   a. Highways – 17 feet (5.2 m)
   b. Rail lines – 23 feet (7 m)
   c. Public roadways and parking – 15 feet (4.6 m)
3. Ensure that components of airport-installed ALS systems meet obstacle clearance criteria, per Chapter 2 and Chapter 3.
4. FAA Order JO 6850.2 and AC 150/5340-30 guidance and standards for each ALS.

6.11.11.8 **Approach Lead-In Lighting System (LDIN).**

LDINs consist of at least three flashing lights installed at or near ground level to define the desired course to an ALS or to a runway threshold. See Figure 6-12.

Figure 6-12. Lead-in Lighting System (LDIN)



6.11.11.9 **LDIN Configuration and Clearance for LOS.**

Each LDIN installation is unique. LDINs serve to address problems related to the approach area associated with hazardous terrain, obstructions, noise sensitive areas, etc. LDIN systems may be curved, straight, or a combination thereof, consisting of a grouping of flashing lights located on the desired approach path. The spacing between light groups is typically at 3,000-foot (914 m) intervals.

6.11.11.10 **Key Factors Affecting Airport Development Projects.**

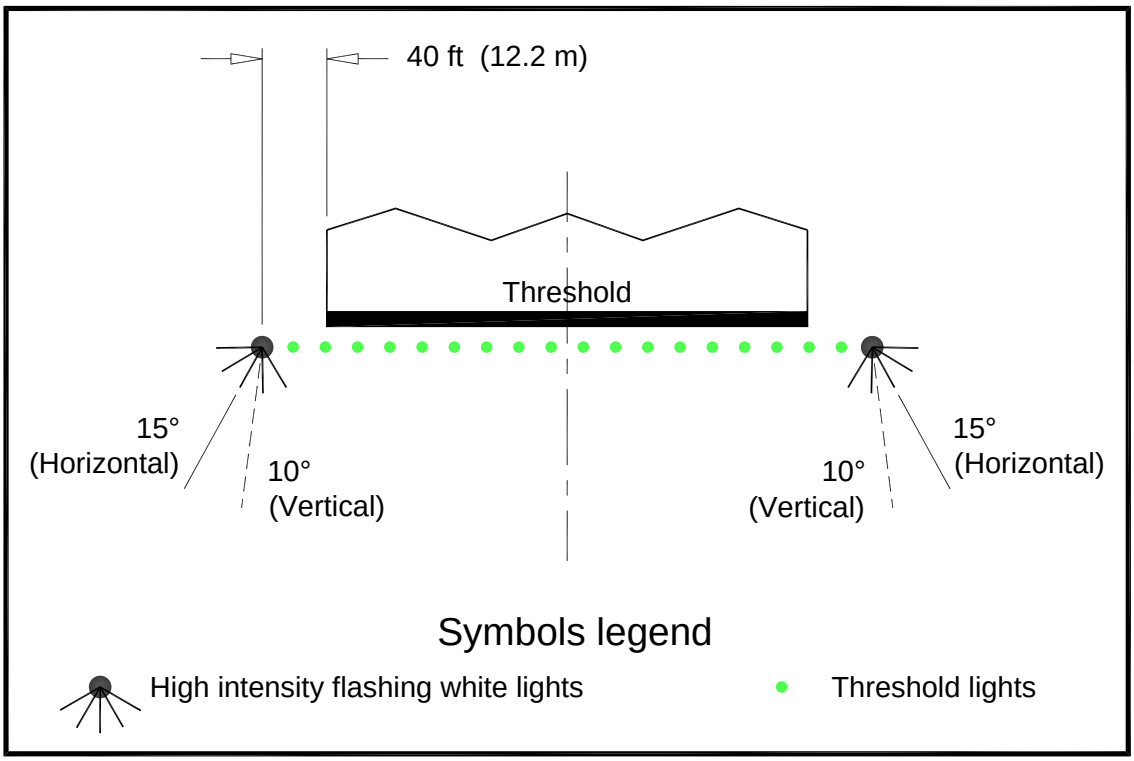
Consider the following when planning and designing future airport development projects:

1. Ensure development does not interfere with a clear LOS between approaching aircraft and the next light ahead of the aircraft.
2. Maintain the minimum obstacle clearance.

6.11.12 Runway End Identifier Lighting (REIL).

A REIL consists of two synchronized flashing unidirectional or omnidirectional lights, located laterally with one on each side of the runway threshold facing the approaching aircraft (see Figure 6-13). The function of the REIL is to provide rapid and positive identification of the runway end, particularly for a runway surrounded by other ground lighting sources or lacking contrast with the surrounding terrain. FAA Order JO 6850.2 and AC 150/5340-30 provide guidance and standards for REILs.

Figure 6-13. Runway End Identifier Lighting (REIL)



6.11.12.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Maintain a clear LOS to the REILS for approaching aircraft.

2. Verify pavement edge separation distance compliance when constructing new taxiway pavement in proximity to a REIL.

6.11.13 Airport Rotating Beacons.

Airport rotating beacons indicate the location of an airport by projecting beams of light spaced 180 degrees apart. Airport rotating beacons are a requirement for all Part 139 airports (reference 14 CFR § 139.311). For all other airports, a rotating beacon is standard for any airport with runway edge lights. See AC 150/5340-30 for design and installation standards.

6.11.13.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. New runway construction may necessitate relocation of an existing beacon in order to maintain a location within 5,000 feet (1,524 m) of the runways.
2. Ensure that new installations do not interfere with the pilot's or ATCT controller's use of required visual observations.
3. Maintain the beam sweep, aimed 2 degrees or more above the horizon, from obstruction by any natural or manmade objects.

6.11.14 Precision Approach Path Indicator (PAPI).

A PAPI is a light array of equally spaced light units color-coded to provide a visual indication of an aircraft's vertical position relative to the glidepath to a touchdown point on the runway. PAPIs are a type of VGSI that assists pilots with maintaining a safe altitude over objects. FAA Order JO 6850.2 and AC 150/5340-30 provide guidance and standards for PAPIs.

6.11.14.1 **Application.**

1. A 2-box PAPI system is suitable for visual and non-precision runways with runway edge lights or when obstacle mitigation is necessary in the runway approach.
2. A 4-box PAPI is suitable for Part 139 runways and runways serving jet aircraft operations (see Figure 6-14).

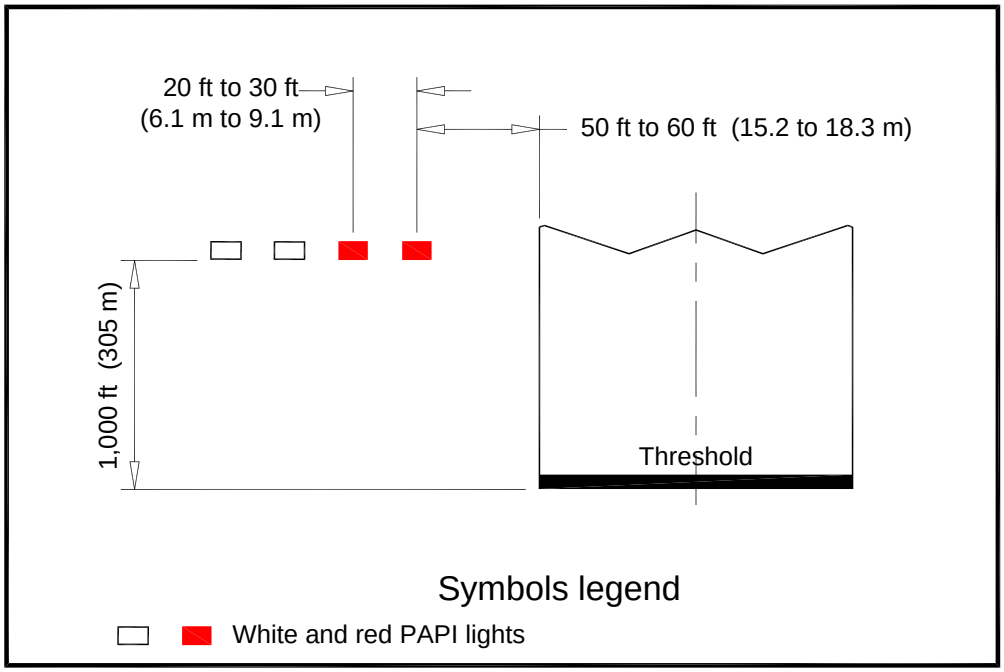
6.11.14.2 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Maintain the approach and departure surfaces clear of penetrating objects.
2. Assess the effect of any change to the runway threshold location on:
   a. The minimum TCH.

b. The PAPI runway reference point relative to an existing GS runway reference point.

Figure 6-14. 4-Unit Precision Approach Path Indicator (PAPI)



Note: This figure depicts a pilot on the proper glide path. Light color may change depending on whether the pilot is below or above the glide path.

6.11.15 Instrument Landing System (ILS).

The ILS provides pilots with electronic guidance for aircraft alignment, descent gradient, and position for landing safely under conditions of reduced ceilings and visibility. An ILS uses a LOS RF signal path from the LOC and GS antennae to provide horizontal and vertical guidance to pilots. The FAA owns and operates the majority of ILS systems in the NAS. FAA Order 6750.16, *Siting Criteria for Instrument Landing Systems*, provides guidance on siting ILS components.

6.11.15.1 **Key Factors Affecting Airport Development Projects.**

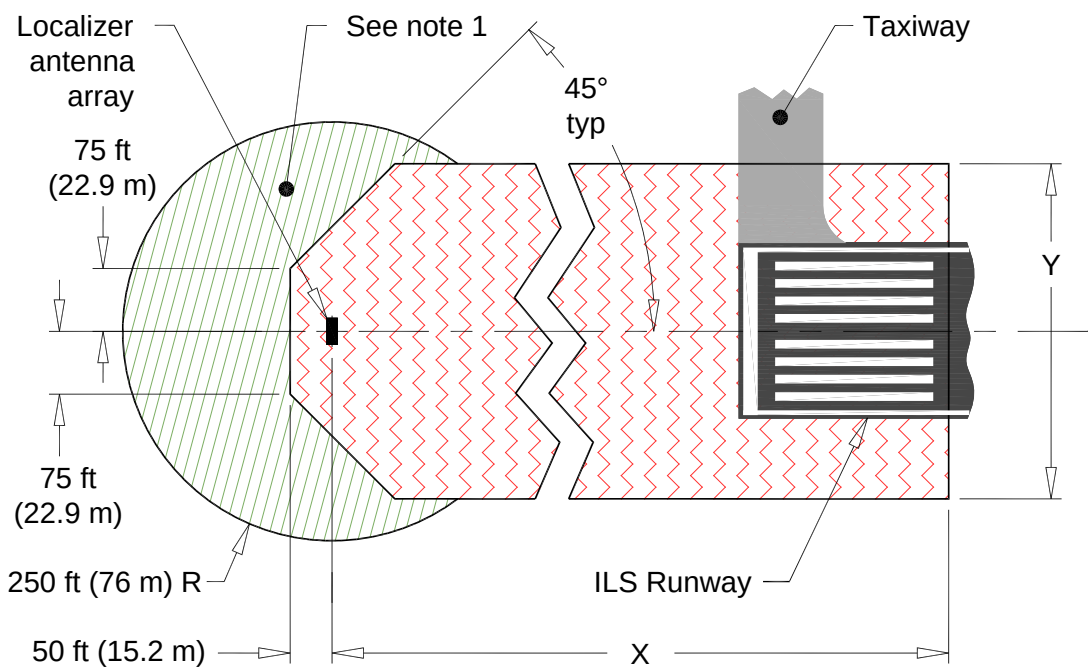
Consider the following when planning and designing future airport development projects:

1. Ensure critical areas remain clear of signal interference sources such as power lines, fences, buildings, dense or tall vegetation, aircraft surface operations, ground vehicles, etc., that could adversely affect ILS system performance.
2. Potential impacts to ILS components in the event of a change in runway length or runway threshold location.

6.11.16 Localizer (LOC) Antenna.

The LOC signal provides lateral course guidance for a pilot to maintain the aircraft's position relative to the runway's extended centerline. The LOC antenna array is typically located beyond the RSA on the extended runway centerline. Depending on the length of the RSA, the distance of the antenna array from the DER varies between 600 to 2,000 feet (183 to 610 m). See Figure 6-15 and Figure 6-16.

Figure 6-15. Instrument Landing System (ILS) Localizer (LOC) Siting and Critical Area



Legend:

Critical area "A":

Critical area "B":

	Critical area dimensions	
ILS Category	X	Y
I	2,000 ft (610 m)	400 ft (122 m)
II /III (Note 2)	2,000 ft (610 m)	400 ft (122 m)
II	4,000 ft (1,219 m)	500 ft (152 m)
III	7,000 ft (2,134 m)	500 ft (152 m)

Note 1: Additional critical area when back course localizer is available.
Note 2: Dimensions apply when aircraft length is equal to or less than 135 ft (41 m).

Figure 6-16. LOC 8-Antenna Array

6.11.16.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Maintain the critical area clear of objects.
2. Maintain the longitudinal grade between the antenna array and runway end, clear of surface irregularities similar to RSA grading standards.
3. Maintain -0.5 to -3.0 percent symmetrical transverse grades from the centerline to the outer edges of the critical area.
4. Assess the effect relocation of a runway end (near or far end) has on localizer performance.
5. Assess the effect proposed development may have on existing localizer ground-check points.

6.11.17 Glide Slope (GS) Antenna.

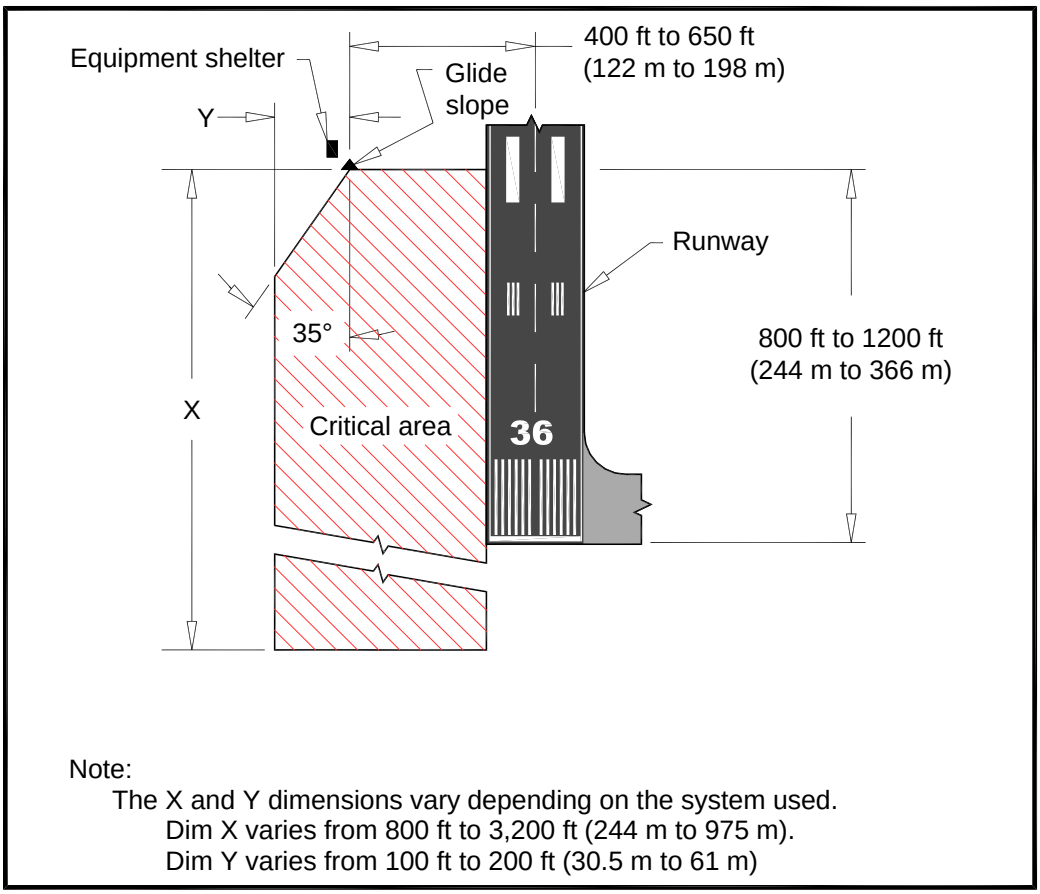
The GS signal provides vertical descent guidance for a pilot to land at a designated point on the runway. The GS is located along the side of the runway, optimally outside of the ROFA limits. The desired threshold crossing height and runway slope control the location of the GS antenna from the runway threshold. See Figure 6-17 for the GS critical area. The GS equipment shelter is located behind the antenna and optimally outside the ROFA. See Figure 6-18.

6.11.17.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure development does not alter the terrain within the GS critical area beyond acceptable grading tolerances for the GS ground plane.
2. Ensure development does not create any signal interference sources (e.g., buildings, power lines, surface vehicles, aircraft, etc.) adversely affecting GS performance.
3. In the event of a change to the runway threshold location, verify the effect the new location will have on GS performance with respect to touchdown point, TCH, and PAPI runway point of intersection.

Figure 6-17. Glide Slope (GS) Siting and Critical Area



Note: FAA ATO engineering services is the authoritative source for ILS critical area dimensions.

Figure 6-18. GS Antenna and Equipment Shelter

6.11.18 Distance Measuring Equipment (DME).

A DME provides pilots with a slant range measurement of distance to the runway in nautical miles. DME is usually co-located with the LOC when used as an ancillary aid of the ILS. DME also serve as an alternate position, navigation, or timing service for aircraft in the event of a GPS outage. The FAA typically owns and operates DME (see Figure 6-19).

6.11.18.1 **Key Factor Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure new airport development does not introduce EMI sources that may degrade performance of the DME signal.

Figure 6-19. Distance Measuring Equipment (DME) Antenna

6.11.19 Runway Visual Range (RVR).

RVR measures the atmospheric transmissivity along runways and translates this visibility value to the air traffic user. RVRs support increased precision takeoff and landing capacity per the authorized ILS minimums. RVR visibility readings assist ATCT controllers when issuing control instructions and to avoid ground operations that may interfere with ILS critical areas. FAA Order 6560.10, *Runway Visual Range (RVR)*, provides guidance for standards for RVRs. See Figure 6-20.

Figure 6-20. Runway Visual Range (RVR)

6.11.19.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

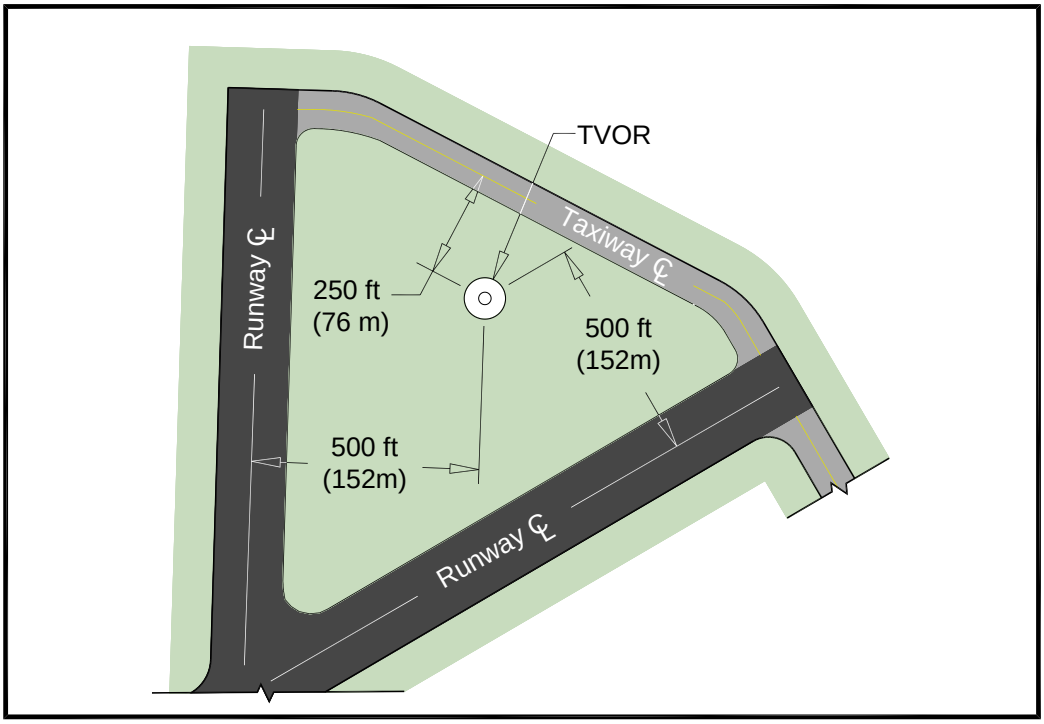
1. In the event of a change in runway length, runway operations, or runway threshold location, verify the effect of the change on the proper location(s) and functioning of all RVR units.
2. Consider the potential for RVR sharing in the event of construction of a new adjacent runway.

6.11.20 Very High Frequency Omnidirectional Range (VOR).

VORs are ground-based navigation systems that transmit RF signals that allow a pilot to establish course heading. VORs located at an airport are also known as Terminal VOR (TVOR). See Figure 6-21 and Figure 6-22. The VOR Minimum Operational Network provides a conventional navigation backup service in the event of a loss of Global Positioning System (GPS) signal. The Minimum Operational Network enables pilots to revert from performance-based navigation (PBN) to conventional navigation for approach, terminal, and en route operations. The Minimum Operational Network also allows aircraft to use ILS or VOR approach procedures without the necessity of GPS, DME, automatic direction finding, or surveillance. FAA Order 6820.10, *VOR, VOR/DME and VORTAC Siting Criteria*, provides guidance for standards for VORs.

Figure 6-21. Enroute VHF Omnidirectional Range (VOR) Facility

Figure 6-22. Terminal Very High Frequency Omnidirectional Range (TVOR) Facility



Note: See FAA Order 6820.10 for VOR siting details.

6.11.20.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure development does not create signal interference sources (e.g., buildings, power lines, surface vehicles, aircraft, etc.) that adversely affects VOR performance.
2. In the event of construction of new runways or taxiways, comply with lateral offsets from runways and taxiways to ensure proper VOR performance.

6.11.21 Non-Directional Beacon (NDB).

An NDB is a radio beacon that aids the pilot of an aircraft equipped with direction finding equipment. NDBs also serve as a compass locator for the outer marker of an ILS. See Figure 6-23.

6.11.21.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure development does not establish sources of EMI that degrades the NDB performance.

2. Use caution when grading near an NDB facility as subsurface ground radials can extend outward from the antenna a distance of 40 feet (12.2 m).

Figure 6-23. Non-Directional Beacon (NDB) Facility

6.11.22 Segmented Circles and Wind Cones.

A wind cone visually indicates prevailing wind direction at a particular location on an airfield or heliport. See AC 150/5340-30 for guidance on wind cones. A segmented circle (see Figure 6-24) provides visual indication of current airport operations such as active landing direction and traffic patterns. See AC 150/5340-5, *Segmented Circle Airport Marker System*, for guidance on segmented circles.

6.11.22.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. In the event of a change in runway length or runway threshold relocations, verify the proper location(s) of segmented circles and wind cones, per the standard.
2. Evaluate the need for a supplemental wind cone for both landing and takeoff operations in the event of a runway extension.
3. Ensure adequate wingtip clearance to existing wind cone assemblies when constructing a new parallel taxiway.

Figure 6-24. Segmented Circle and Wind Cone

6.11.23 Automated Surface Observing System (ASOS) and Automated Weather Observing System (AWOS).

An ASOS and AWOS are multi-sensor climate recording instruments that measure cloud cover and ceiling; visibility; wind speed and direction; temperature; dew point; precipitation accumulation; icing (freezing rain); and sea level pressure for altimeter settings. See Figure 6-25. Some configurations may also detect cloud-to-ground lightning. ASOS/AWOS facilities are often co-located with glide slopes. Refer to FAA Order 6560.20, *Siting Criteria for Automated Weather Observing Systems (AWOS)*, and AC 150/5220-16, *Automated Weather Observing Systems (AWOS) for Non-Federal Applications*, for additional information.

Figure 6-25. Automated Surface Observing System (ASOS) Weather Sensors Suite

6.11.23.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Airport development or changes in runway category changes (e.g., visual/non-precision or precision) may adversely affect the proper location of the ASOS/AWOS relative to the runway.
2. New runway and taxiway development may result in the existing ASOS/AWOS facilities violating OFAs.
3. Proposed development may create conditions that cause false or incorrect sensor readings (e.g., wind speed sensor).

6.11.24 Weather Camera (WCAM).

A WCAM provides aircraft with near real-time photographical weather images via the Hypertext Transfer Protocol (HTTP). These cameras are common in the western region of the United States and specifically in Alaska where rapid changes in weather conditions require remote weather monitoring equipment. See Figure 6-26.

6.11.24.1 **Key Factor Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure proposed airport development does not adversely affect the camera's visual LOS.

Figure 6-26. Weather Camera (WCAM) Pole

6.11.25 Wind Equipment F-400 (WEF)/Wind Measuring Equipment (WME).

WEFs and WME measure wind speed and direction for areas near runways. See Figure 6-27. These systems feed wind data to ATC facilities and automated broadcast systems. A typical WEF pole is 30 feet (9.1 m) tall and located away from structures that may cause artificial wind profiles. See FAA Order 6560.20 for additional information.

6.11.25.1 **Key Factor Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure airport development near the facility does not create conditions that cause inaccurate wind readings.

Figure 6-27. Weather Equipment Sensor Pole

6.11.26 Low Level Windshear Alert System (LLWAS).

An LLWAS measures wind speed and direction at remote sensor station sites situated around an airport. See Figure 6-28. Equipped airports may have as few as six or as many as twelve remote anemometer stations. The system transmits remote sensor data to a master station and generates warnings upon detecting windshear or microburst conditions. Refer to FAA Order 6560.21, *Siting Guidelines for Low Level Windshear Alert System (LLWAS) Remote Facilities*, for LLWAS siting guidelines.

Figure 6-28. Low Level Windshear Alert System (LLWAS) Sensor Pole

6.11.26.1 **Key Factor Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure airport development (e.g., buildings, structures, and other man-made features) does not cause conditions that alter wind speed or direction in the vicinity of the anemometer stations.

6.11.27 Runway Status Lights (RWSL).

RWSL are a fully automated system providing runway status information to pilots and surface vehicle operators to indicate when it is unsafe to enter, cross, or begin takeoff on a runway. RWSL are suitable only at airports with ASDE-X or ASSC, which are necessary to trigger the safety logic that activates RWSL. The RWSL system processes information from surveillance systems and activates Runway Entrance Lights (REL) and Takeoff Hold Lights (THL) along with the motion and velocity of the detected traffic. The RWSL system provides lights on runways and taxiways increasing a pilot's situational awareness and reducing the risk of runway incursions.

6.11.27.1 **Key Factor Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Ensure airport development does not adversely affect circuitry and functioning of the RWSL components.

6.11.28 Automated Dependent Surveillance Broadcast (ADS-B) Ground Station.

ADS–B is a NextGen surveillance technology that relies on satellites and a network of ground station transceivers rather than radar to accurately observe and track aircraft. See Figure 6-29. Aircraft equipped with an ADS-B Out transmitter send their position, altitude, heading, ground speed, vertical speed, and call sign through the data communications network to ATC facilities. Pilots may also have the capability to receive air traffic information and other advisories.

Figure 6-29. Automated Dependent Surveillance Broadcast (ADS-B) Ground Station

6.11.28.1 **Key Factors Affecting Airport Development Projects.**

Consider the following when planning and designing future airport development projects:

1. Development may introduce RF interfering sources affecting performance of the ground station.
2. Development may adversely affect the LOS to airborne aircraft.
3. Be aware of underground communications cables when trenching in the vicinity of an ADS-B ground station.

APPENDIX A. AIRCRAFT CHARACTERISTICS

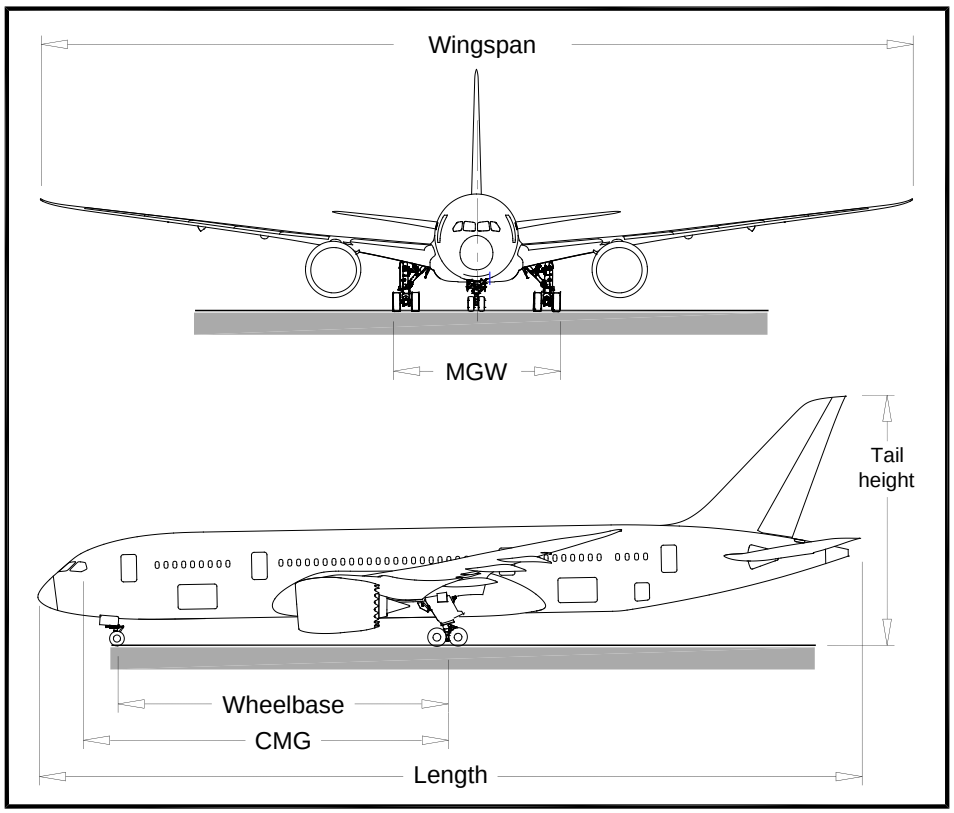
A.1 Basic Aircraft Characteristics.

A.1.1 This appendix provides basic aircraft characteristics for common aircraft as needed to perform design functions. For convenience, the FAA consolidated the best manufacturers' information available at the time of issuance of this AC, which is online in the Aircraft Characteristic Database (see paragraph A.3.1).

This data does not include all aircraft or aircraft versions. The FAA does not guarantee the accuracy of the data values. Consult the manufacturer's technical specifications if there is a question on a specific aircraft.

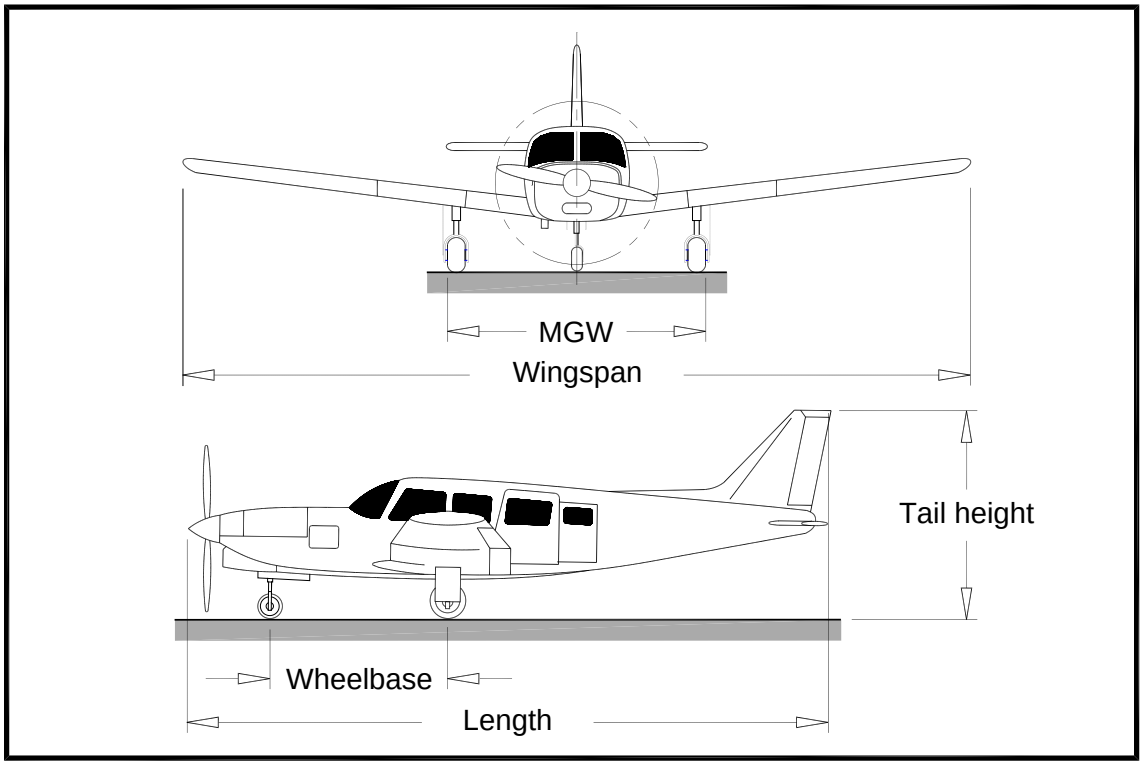
A.1.2 In accordance with the cockpit over centerline fillet design method, use the CMG dimension in lieu of wheelbase for aircraft (typically larger) where the cockpit is located forward of the nose gear. For aircraft with the cockpit located aft of the nose gear, use the wheelbase in lieu of CMG to determine the TDG. Refer to Figure A-1 and Figure A-2. The Aircraft Characteristics Database will continue to be updated periodically as new aircraft are certified and as more complete information becomes available for existing aircraft.

Figure A-1. Key Dimensions – Large Aircraft



Note: Wingspan includes extent of winglets.

Figure A-2. Key Dimensions – Small Aircraft



Note: Wingspan includes extent of winglets.

The sources of the information provided in this appendix include aircraft manufacturers' websites and various databases:

- FAA Aircraft Characteristics Database: http://www.faa.gov/airports/engineering/aircraft_char_database/
- Eurocontrol Aircraft Performance Database
- Airbus Airplane Characteristics for Airport Planning
- Boeing Airplane Characteristics for Airport Planning
- Embraer Aircraft Characteristics for Airport Planning

A.2 Background.

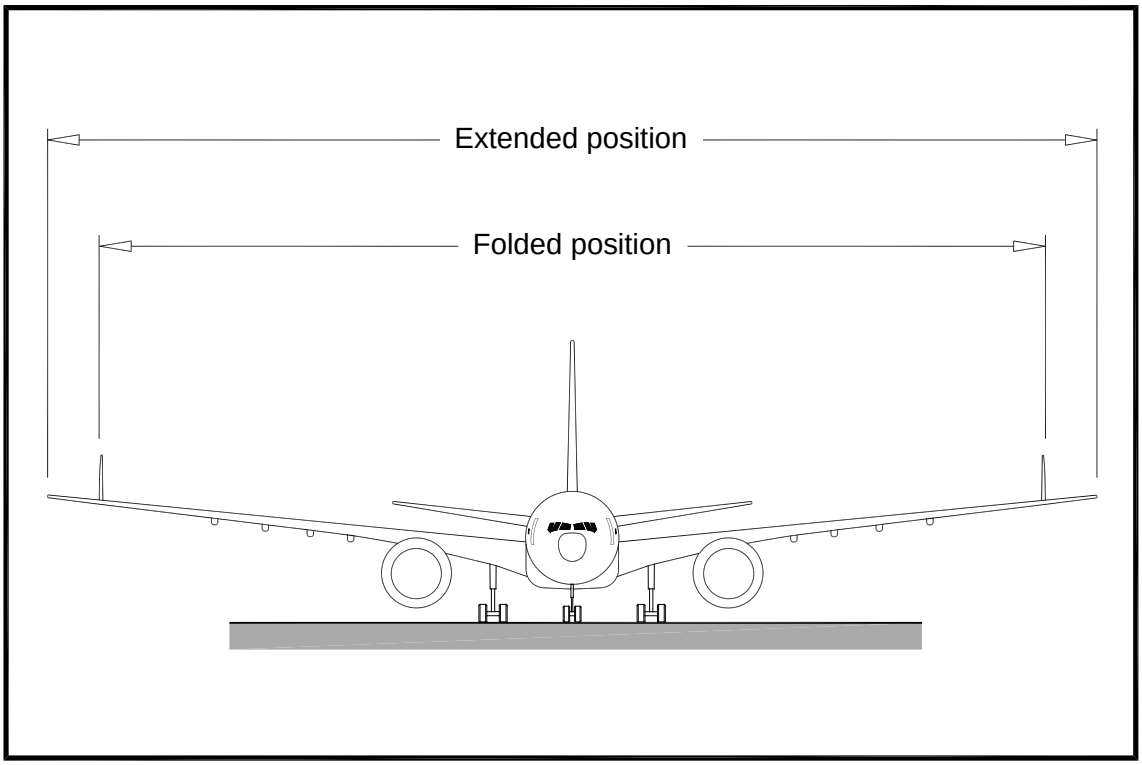
A.2.1 Aircraft physical characteristics have operational and economic significance affecting an airport's design, development, and operation. They influence the design aspects of runways, taxiways, ramps, aprons, servicing facilities, gates, and life safety facilities. Their consideration when planning a new airport or improving existing airport facilities maximizes facility utilization and safety.

A.2.2 Military aircraft frequently operate at civil airports. Consider the physical characteristics for military aircraft at joint-use airports during airport facility planning

and design, including routine military operations such as medical evacuation and Reserve and National Guard training missions.

A.2.3 Aircraft with folding wingtip technology occupy two different ADGs depending on the status of the wingtips. Folded wingtips allow aircraft with this technology to access parts of the airport with a smaller critical ADG than with the wingtips extended, without a need for operational mitigations. See Figure A-3.

Figure A-3. Folding Wingtips



A.3 Aircraft Arranged by Aircraft Manufacturer, and Runway Design Code (RDC).

A.3.1 Aircraft Characteristics Database.

Aircraft characteristics guides (sometimes known as Airport Planning Manuals, or APMs) provide relevant information and are available from aircraft manufacturers. The FAA's Aircraft Characteristics Database is located at http://www.faa.gov/airports/engineering/aircraft_char_database/.

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APPENDIX B. WIND ANALYSIS

B.1 Objective.

This appendix provides guidance on the basics of wind coverage, allowable crosswind components to aid in runway orientation, wind data sources, and methods of analyzing wind data. Accurate analysis of the wind coverage adds substantially to the safety and utility of an airport. Airport planners and designers conduct an accurate wind analysis to determine primary runway orientation and coverage, and if a crosswind runway is necessary at an airport.

B.1.1 Wind conditions affect all aircraft to some degree. Generally, wind affects smaller aircraft to a greater degree than larger aircraft having larger rudders. Adverse crosswind conditions are often a contributing factor in small aircraft accidents. When wind conditions exceed the allowable crosswind component for an aircraft type (or the pilot's skill level), during approach, the pilot may divert to another airport in the interest of maintaining flight safety. If departing, the pilot may elect to wait until more favorable conditions occur.

B.2 Coverage and Orientation of Runways.

Wind coverage is the percent of time crosswind components are below an acceptable velocity. Normally, the best runway orientation, based on wind, is the one providing the greatest wind coverage with the minimum crosswind components.

B.2.1 The desirable wind coverage for an airport is 95 percent of the time based on the total number of weather observations during the recording period of at least ten consecutive years. Use all weather winds to assess overall wind coverage needs. Using the Instrument Meteorological Conditions (IMC) wind analysis may help identify the best runway end for an IFP. Conduct supplemental analyses for Visual Meteorological Conditions (VMC), Category II/III, nighttime, and other specific conditions as needed, but not for wind coverage. The FAA does not consider other conditions (such as gusts) in reviewing wind coverage.

B.2.2 If the primary runway orientation provides less than 95 percent wind coverage, evaluate the need for a crosswind runway.

B.2.3 When analyzing wind data, consider:

B.2.3.1 Operationally weight the wind data to reflect the shift in use periods at airports where operations are predominantly seasonal, or if operations decline substantively after dark. Only use operational weighting if there are significant variations in operational levels during the applicable conditions. Note that except for the above, the FAA does not consider shorter-term, seasonal variations in wind coverage as a rationale for a crosswind runway.

B.2.3.2 For locations that justify a crosswind runway for an RDC with regular use but provision of a crosswind is impractical or cost prohibitive, it is acceptable to increase the width of the primary runway to the next standard width in lieu of providing a crosswind runway. The greater width allows for better operational tolerance to crosswinds. However, if the existing primary runway is already wider than what is necessary for the RDC with crosswind constraints, a further increase in width to the primary runway is unwarranted. Ensure that wider runways intended to mitigate crosswind coverage meet all relevant criteria, as identified in this paragraph.

Example: Consider an airport with a primary B-II runway with a width of 75 feet (22.9 m) and less than 95 percent wind coverage for the B-II RDC. If it is impractical to provide a crosswind runway, it is acceptable to increase the width of the primary runway from 75 feet (22.9 m) to 100 feet (30.5 m) as an alternate means of meeting crosswind needs. However, if the RDC (with regular use) needing a crosswind is an A-I aircraft, which has a standard runway width of 60 feet (18.3 m), the existing 75-foot (22.9 m) primary runway is already sufficiently wide for crosswind purposes. No further increase in width is justified.

B.2.3.3 Analyses normally consider all weather and IMC wind conditions, but supplemented with VMC, Category II/III, and other conditions, as needed. For example, the IMC wind analysis may help with identifying the best runway end for an IFP. The FAA does not consider other conditions (such as gusts) in reviewing wind coverage.

B.2.3.4 The FAA recommends a wind coverage of 95 percent. Rarely do a primary and crosswind runway (if provided) yield a wind coverage of 100 percent. Having wind coverage of less than 100 percent is not a deficiency on the part of an airport.

B.3 Allowable Crosswind Components.

See Table B-1 for the allowable crosswind component(s) of each RDC percentage of wind coverage determination. Note that individual aircraft types may have crosswind components differing from the values indicated in Table B-1. However, use the indicated crosswind component by RDC where the maximum crosswind component of the critical aircraft is less than the allowable crosswind component by RDC.

Table B-1. Allowable Crosswind Component per Runway Design Code (RDC)

RDC	Allowable Crosswind Component
A-I and B-I *	10.5 knots
A-II and B-II	13 knots
A-III, B-III, C-I through D-III D-I through D-III	16 knots
A-IV and B-IV, C-IV through C-VI, D-IV through D-VI	20 knots
E-I through E-VI	20 knots

Note: * Includes A-I and B-I small aircraft.

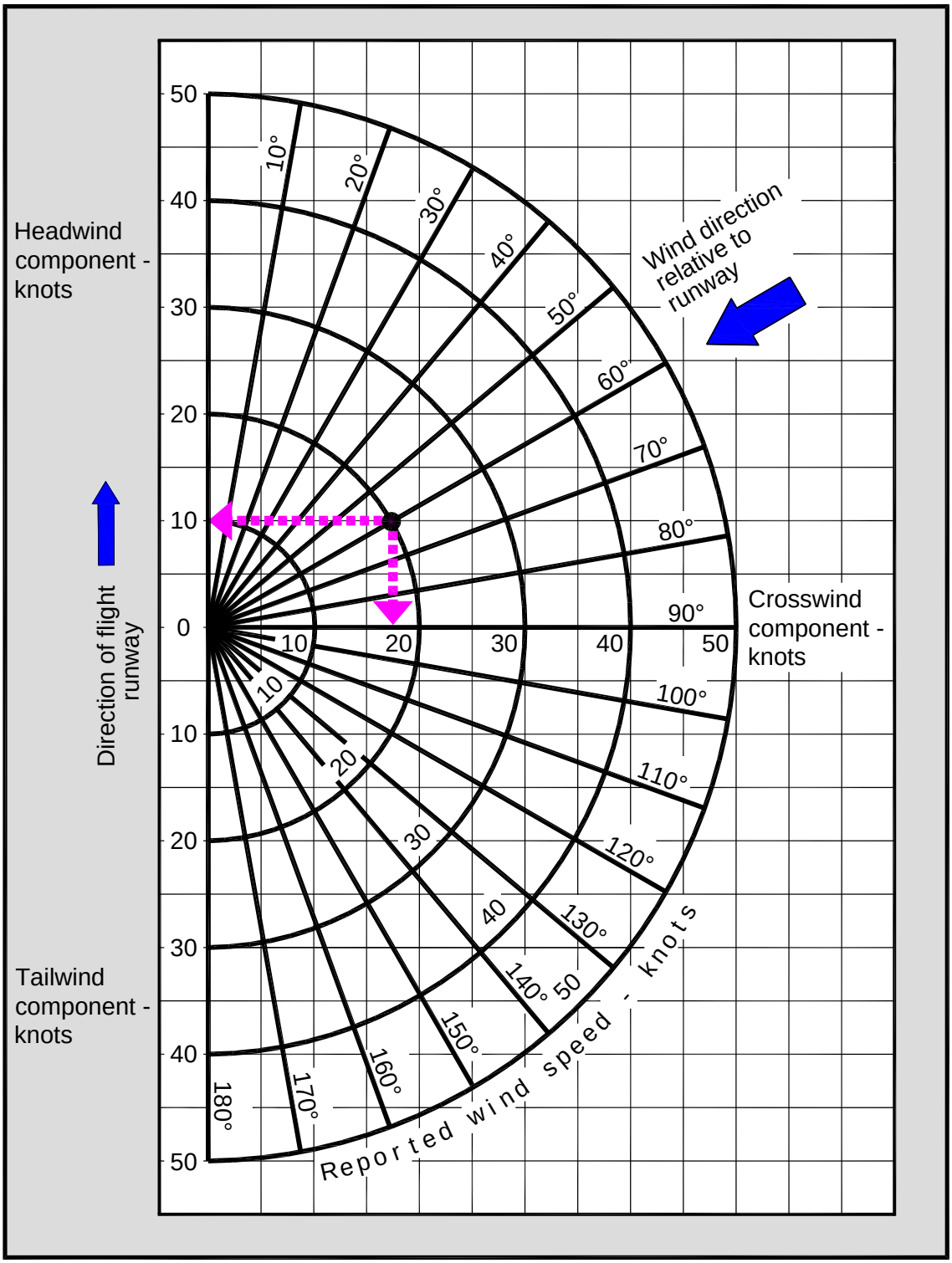
B.3.1 Crosswind Components.

The crosswind component of wind direction and velocity is the resultant vector acting 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. Solve the wind vector triangles graphically, as shown in Figure B-1 to determine the headwind and tailwind components for different combinations of wind velocities and directions.

B.4 Wind Data Sources.

1. Use the latest, most reliable wind information to carry out a wind analysis. Wind observations recorded on the airfield are more suitable than offsite observations.
   a. The FAA recommends a data period covering at least the last ten consecutive years of wind observations. Calm wind conditions are always included in the wind data.
   b. Use up to 30 years of consecutive data if needed to assess long-term trends in weather; a 10-year sample of data is insufficient for use in trend analysis (e.g., to assess if winds are shifting with time).
2. Records of lesser duration may be acceptable on a case-by-case basis, but this requires approval by the FAA Airports Regional Office or ADO prior to proceeding.
3. Wind data of recent vintage (newest observations are less than five years) are acceptable for analysis purposes.

Figure B-1. Wind Vector Diagram



Note: Example: Wind speed 20 knots angle between runway and direction of wind – 60° crosswind component – 17 knots. Headwind component – 10 knots.

B.4.1 National Climatic Data Center (NCDC).

Wind information is available from the NOAA, and the NCDC. The NCDC has long-term repositories of the weather data collected at most U.S. airports. The hourly data is available at the following website: https://www1.ncdc.noaa.gov/pub/data/noaa/. NCDC data is also available via the FAA ADIP website, as described in paragraph B.5.1. NCDC wind directions are based on true north. The magnetic declination for the airport determines the magnetic-based runway headings.

B.4.2 Data Not Available.

B.4.2.1 When NCDC or local AWOS data is not available for the site, develop composite wind data using wind information obtained from two or more nearby recording stations. However, exercise caution because the composite data may have limited value if there are significant changes in the topography (such as hills/mountains, bodies of water, ground cover, etc.) between the sites. Augment limited records with personal observations (wind-bent trees, interviews with the local populace, etc.) to determine if a discernible wind pattern can be established.

B.4.2.2 Obtain onsite wind observations when there is a question on the reliability of, or lack of, wind data. The FAA recommends at least a one-year monitoring period to produce reliable data and account for daily wind fluctuations and seasonal changes at the site. Acquire adequate wind data before proceeding with airport development.

B.5 Analyzing Wind Data.

The most common wind analysis procedure uses a computer program to assess wind coverage, as discussed in paragraphs B.5.1 and B.5.3. In addition, provide a scaled graphical presentation of the wind information for the ALP, per paragraph B.5.2. Analyses normally consider all weather and IMC wind conditions and supplemented with VMC, Category II/III, and other conditions as needed.

B.5.1 Standard Wind Analysis Tool.

The Standard Wind Analysis Tool is on the FAA's ADIP website https://adip.faa.gov. The Standard Wind Analysis tool performs the wind analysis specified in this AC and stores the uploaded data and calculated results to a text file (*.TBW), an AutoCAD Drawing Interchange file (*.DXF), or a scalable vector graphics file (*.SVG). Additionally, the data and results display in a browser window as a report or the traditional windrose graphic. This tool requires the wind data files in FAA data format. Generate wind data files by selecting the Windrose File Generator as a tool option on the ADIP website.

B.5.1.1 The Windrose File Generator:

1. Connects to the Integrated Surface Hourly/Integrated Surface Data (ISH/ISD) inventory from the NCDC.

2. Compiles and summarizes the latest ten years of wind observations by hours from the recording station associated with the airport location ID (ICAO Identifier).

3. Produces three different types of wind data files (ALL_WEATHER, IFR, and VFR) in the standard tool format with the recording station number as a part of the filename and PRN as its file type.

B.5.1.2 Generate and download these wind summary files and later upload them into the wind table for each particular type of windrose analysis.

B.5.1.3 For background information on the NCDC's ISH/ISD wind data inventory, visit the NCDC website. If the PRN files are in the standard tool format, use the Upload Wind Data File link to load wind data into the standard tool for analysis.

B.5.2 Windrose Graphic.

The standard graphical windrose (Figure B-2) is a series of concentric circles cut by radial lines. The perimeter of each concentric circle represents the division between successive wind speed groupings (Figure B-2). Radial lines divide the windrose into 36 wind sectors, the area of each sector centered on the reported wind direction. Figure B-3 is an example of a typical wind summary.

B.5.2.1 **Plotting Wind Data.**

Each segment of the windrose represents a wind direction and speed grouping, based on the number of hourly observations. Within each segment, the recorded directions and speeds of the wind summary convert to a percentage of the total recorded observations. Figure B-4 illustrates a completed windrose analysis based on data from Figure B-3. Plus (+) symbols indicate direction and speed combinations occurring less than one-tenth of one percent of the time.

B.5.2.2 **Runway Wind Box.**

A runway wind box is a useful aid to visualize the windrose analysis (Figure B-4). The wind box is a series of three parallel lines drawn to the same scale as the windrose. The allowable crosswind component for the runway, as determined by the RDC, establishes the physical distance between the outer parallel lines and the centerline. Draw the allowable crosswind component lines directly on the windrose when analyzing the wind coverage for a runway orientation.

B.5.3 Spreadsheets.

For analyses purposes, wind coverage calculations use spreadsheets that calculate the crosswind component of each hourly wind observation. Such calculations are accurate and facilitate analysis of specific conditions such as IMC or Cat II/III weather, or seasonal or daytime/nighttime wind coverage, as discussed in paragraph B.2. When requested, furnish calculations to the FAA for validation.

Table B-2. Standard Wind Analysis Results for ALL_WEATHER

TITLE: Anytown, USA

RUNWAY ORIENTATION: 270 DEGREE
CROSSWIND COMPONENT: 13 KNOTS
TAILWIND COMPONENT: 60 KNOTS

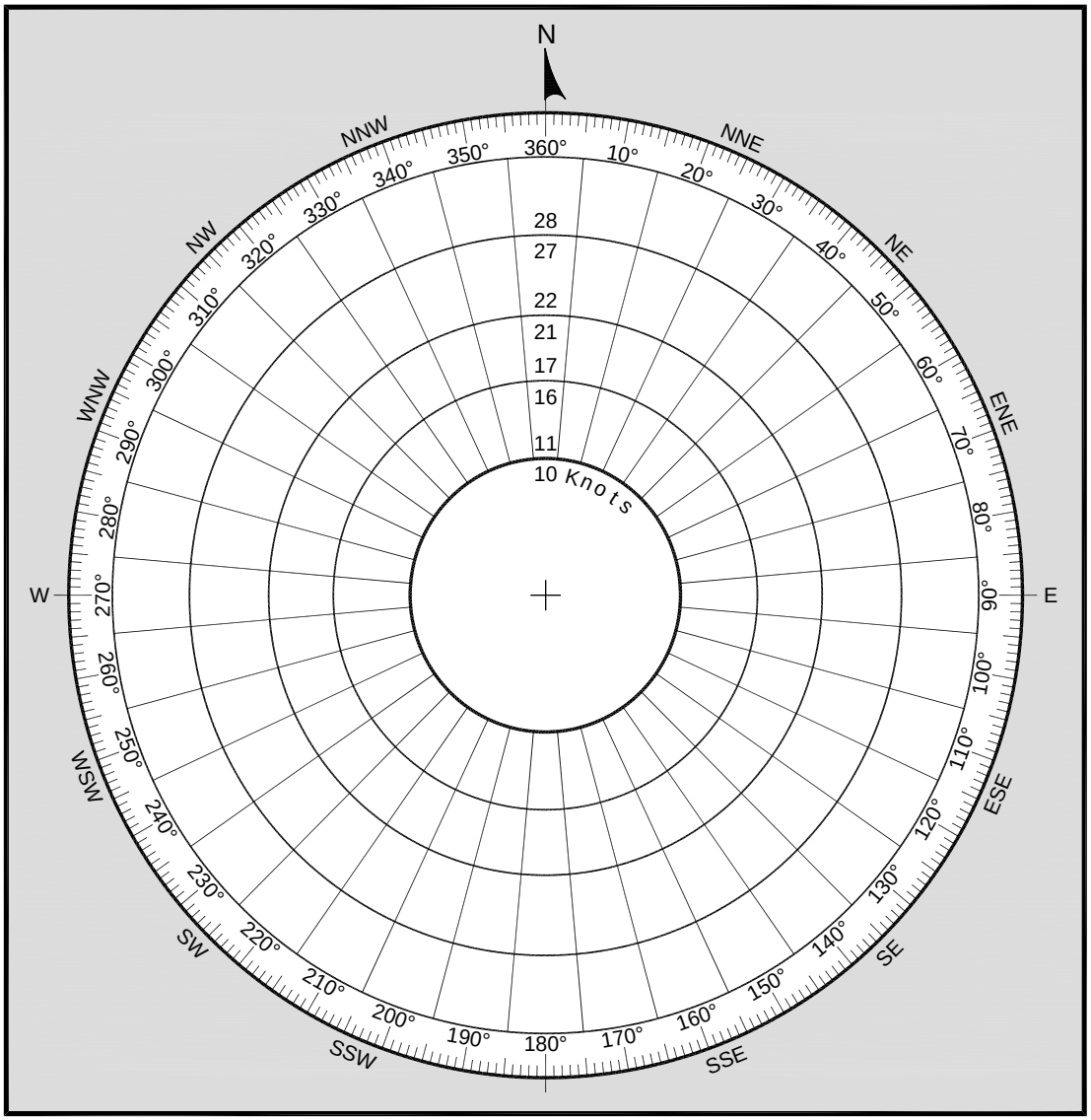
WIND COVERAGE: 97.79%

HOURLY OBSERVATIONS OF WIND SPEED (KNOTS)

DIRECTION	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	> 41	TOTAL
10°	174	652	586	247	6	0	0	0	0	1665
20°	213	816	698	221	7	0	0	0	0	1955
30°	235	894	656	158	4	0	0	0	2	1949
40°	167	806	559	88	0	0	0	0	0	1620
50°	182	809	345	44	1	0	0	0	0	1381
60°	199	753	332	30	5	0	0	0	0	1319
70°	158	550	187	20	0	0	0	0	1	916
80°	134	453	194	22	1	0	0	0	0	804
90°	145	373	169	16	2	0	0	0	0	705
100°	103	321	115	19	1	0	0	0	2	561
110°	92	293	138	25	0	0	0	0	0	548
120°	90	283	207	33	3	0	0	0	0	616
130°	93	279	188	28	0	0	0	0	0	588
140°	65	246	195	55	2	0	0	0	1	564
150°	64	213	194	42	4	0	0	0	0	517
160°	61	236	201	105	16	1	0	0	1	621
170°	80	254	306	140	10	2	0	0	1	793
180°	88	372	485	194	25	2	0	0	0	1166
190°	125	499	608	278	17	2	0	0	0	1529
200°	184	717	700	370	27	2	0	0	0	2000
210°	264	950	725	331	26	0	0	0	2	2298
220°	321	1419	1030	445	40	5	0	0	0	3260
230°	396	1658	1355	630	97	9	1	0	0	4146
240°	415	1600	1465	782	83	13	2	0	1	4361
250°	323	1166	1093	730	119	33	5	0	0	3469
260°	311	979	918	715	139	23	4	0	0	3089
270°	248	760	810	660	143	28	3	0	0	2652
280°	226	625	815	666	105	14	2	0	0	2453
290°	162	572	865	710	98	11	0	0	0	2418
300°	130	470	788	590	68	5	0	0	0	2051
310°	82	394	659	325	31	1	0	0	0	1492
320°	97	302	485	246	15	0	0	0	0	1145
330°	66	281	450	196	6	1	0	0	0	1000
340°	85	265	369	151	4	1	0	0	0	875
350°	102	314	323	152	12	0	0	0	0	903
360°	140	394	457	223	16	0	0	0	0	1230
Calm	18705									18705
TOTAL	24725	21968	19670	9687	1133	153	17	0	11	77364

SOURCE: Anytown, USA ANNUAL PERIOD RECORD 1995-2004

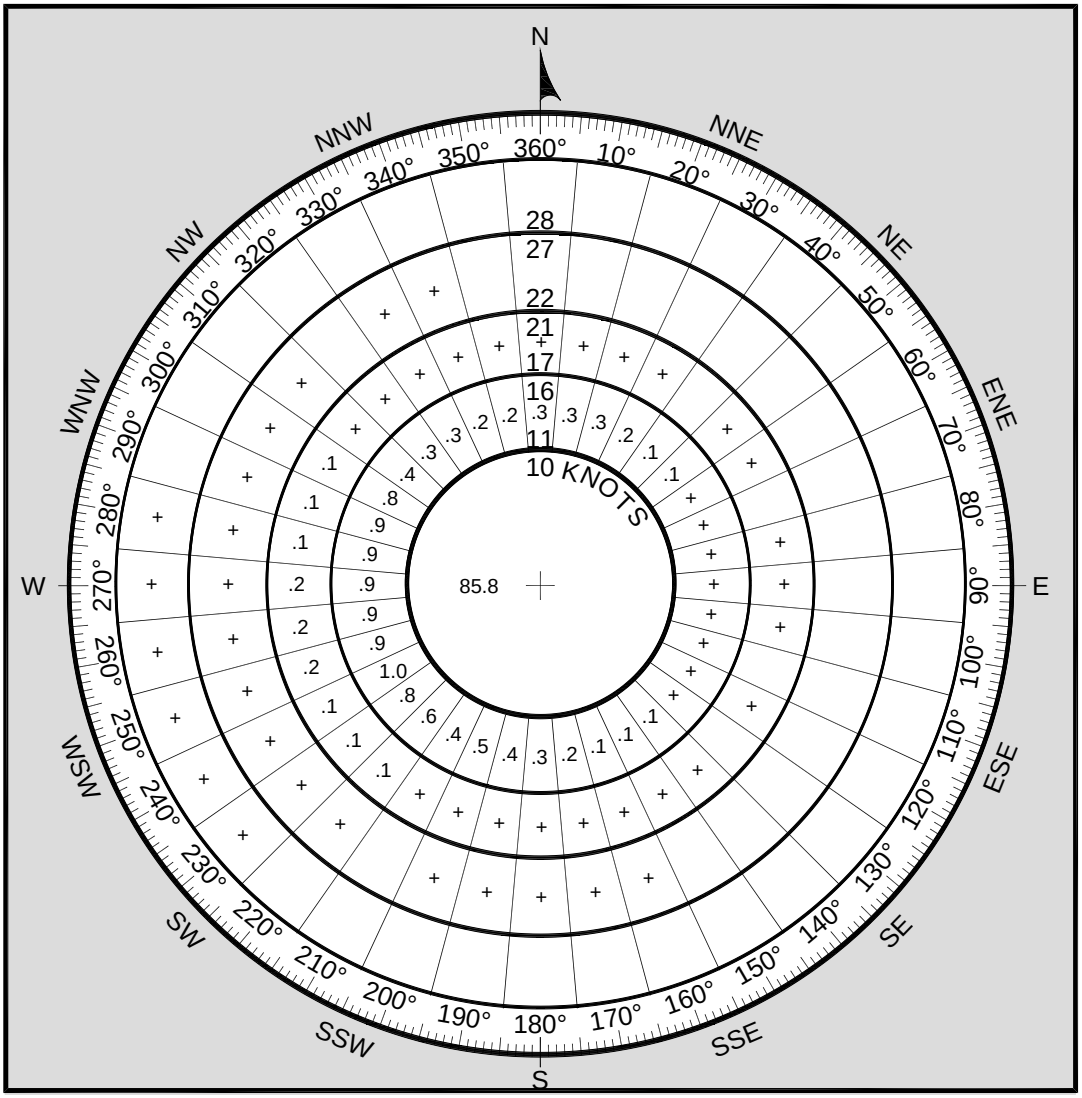
Figure B-2. Blank Windrose Graphic Showing Direction and Divisions



Wind Speed Divisions		Radius of Circle
Knots	MPH	Knots
0 – 3.5	0 – 3.5	*3.5 units
3.5 – 6.5	3.5 – 7.5	*6.5 units
6.5 – 10.5	7.5 – 12.5	10.5 units
10.5 – 16.5	12.5 – 18.5	16.5 units
16.5 – 21.5	18.5 – 24.5	21.5 units
21.5 – 27.5	24.5 – 31.5	27.5 units
27.5 – 33.5	31.5 – 38.5	*33.5 units
33.5 – 40.5	38.5 – 46.5	*40.5 units
40.5 – over	46.5 – over	

Note: * May not be needed for most windrose analyses.

Figure B-3. Completed Windrose Graphic Using Table B-2 Data



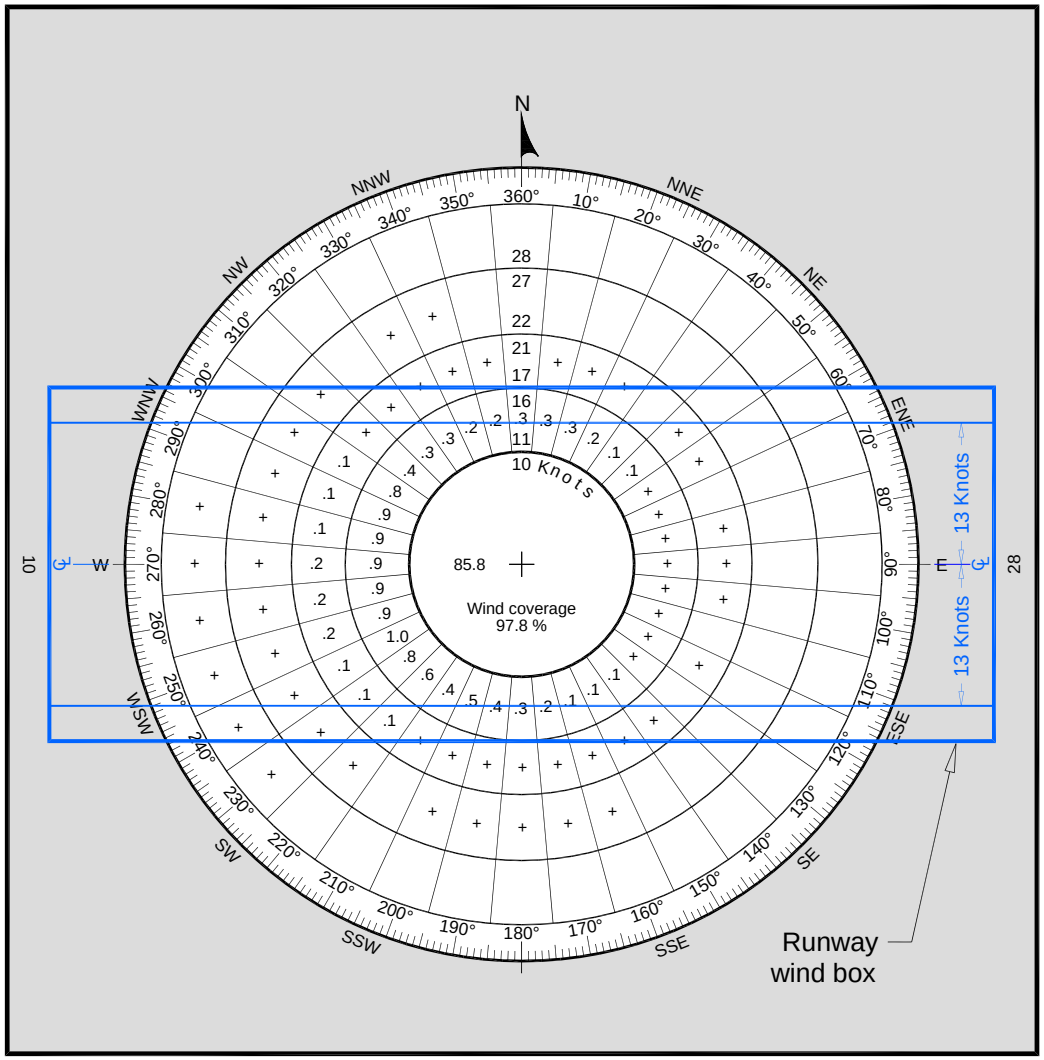
B.5.4 Example: Analysis Procedure for New Runway Location.

B.5.4.1 For a new airport location, the analysis determines the runway orientation providing the greatest wind coverage within the allowable crosswind component limits. This process involves rotating the runway wind box about the windrose center point to maximize the sum of the individual segment percentages appearing between the outer "crosswind limit" lines.

B.5.4.2 Figure B-4 illustrates the analysis procedure used in determining the wind coverage for a 90 – 270-degree runway orientation intended to serve RDC B-II. The wind information is from Figure B-3. For a new runway, iterate on several orientations to determine the orientation that maximizes wind coverage.

B.5.4.3 Example Figure B-4 wind analysis shows the optimum wind coverage possible with a single runway and a 13-knot crosswind component of 97.8 percent. If the analysis had shown it was not possible to obtain at least 95.0 percent wind coverage with a single runway, then evaluate a crosswind runway oriented to bring the combined wind coverage of the two runways to at least 95.0 percent.

Figure B-4. Windrose Analysis



Note 1: Runway oriented 90 degrees – 270 degrees (true) would only have 2.2 percent of the winds exceeding the 13-knot crosswind component.

Note 2: Wind directions are recorded based on true north. The magnetic runway headings are determined based on the magnetic declination for the area.
Example: If the magnetic declination is 12 degrees west, the runway designators for the above runway would be 10 – 28.

APPENDIX C. JET BLAST AND PROPELLER WASH

C.1 Introduction.

Aircraft engines, both reciprocating and turbojet, establish thrust by accelerating air to high velocities. This thrust, whether from a propeller (propeller wash) or jet engine (jet blast), has the potential to create safety risks to personnel, aircraft, equipment, and airfield infrastructure. This appendix provides information on propeller wash and jet blast characteristics, as well as evaluation factors and considerations for airport planning and design.

C.2 Aircraft Generated Air Currents.

C.2.1 Air Velocity Sensitivities for Planning and Design.

Air velocities above 12 mph can displace unsecured debris presenting potential distractions in the AOA environment. Air velocities greater than 30 mph (48 km/hr) can cause loose objects (sand, rocks, debris, etc.) on the pavement to become airborne, risking injury to personnel, structures, and equipment. The turbulent and irregular nature of jet blast introduces vibrations and forces to buildings that may damage facades and compromise structural integrity. For airfield planning purposes, the FAA recommends applying the air velocities in Table C-1, derived from the National Weather Service Beaufort Scale, as sensitivity thresholds at which safety risks increase. These values do not represent restrictions or structural design load criteria.

Table C-1. Air Velocity Sensitivity Thresholds

Air Velocity Threshold	Item or Area
13-18 mph (21 - 29 km/h)	• Unsecured trash, paper, and light weight debris
24 mph (38 km/h)	• Pedestrian areas (boarding passengers, GA parking areas, etc.)
30 mph (48 km/h)	• Light objects and empty containers, etc. • Ramp personnel (marshals, baggage handlers, etc.)
35 mph (56 km/h)	• General area aft of aircraft parking position • Service roads and areas adjacent to parking positions and taxi routes
50 mph (80 km/h)	• Area behind aircraft after pushback • General structures, passenger boarding equipment, etc.

C.2.2 Estimating Forces Due to Aircraft Generated Air Currents.

C.2.2.1 Several factors affect the force air velocities impose on objects such as object shape, direction of air current, uniformity of pressure, distance from source, turbulence, and drag coefficients. The irregular and turbulent nature of aircraft-generated air velocities creates pressure pulses capable of generating vibrations in structures. Computer modeling and wind

tunnel analysis may be necessary to establish the accurate effects of aircraft-generated air velocities in complex airside environments.

C.2.2.2 For general planning purposes, the following formulas provide an approximation of the pressure that uniform air velocity impose on a surface perpendicular to the air stream. The resulting values do not account for turbulence or non-uniformity of pressure. To determine the estimated force, multiply the pressure value by the effective area.

$$\mathbf{P = 0.00256\ V^2}$$

Where:
P = pressure (lbs/ft^2)
V = velocity (mi/hr)

or

$$\mathbf{P = 0.04733\ V^2}$$

Where:
P = pressure (pascals)
V = velocity (km/hr)

C.3 Propeller Wash.

Comparatively, propeller wash does not produce the degree of hazard that jet blast produces. However, propeller wash is capable of generating ground winds and vortices causing loose objects from the pavement surface to become airborne, as well as displace large objects. Propeller wash can endanger individuals and property in close proximity to the aircraft. Wind velocities from large turboprop aircraft have the potential to lift and overturn lighter aircraft, vehicles, and GSE. Engine size and the configuration on the aircraft influences the extent of hazardous effect, including the distance necessary to mitigate hazardous velocities. Another important consideration is the associated emissions from piston engine GA aircraft which can burn leaded fuels. Engine run-ups can contribute to lead concentrations near run-up areas (see National Academies of Sciences, Engineering, and Medicine, 2021, *Options for Reducing Lead Emissions from Piston-Engine Aircraft*, Washington, DC: The National Academies Press).

C.3.1 Recommended Practice.

Locate engine run-up facilities and bays to minimize exposure of engine exhaust streams to areas of public congregation and areas outside of the AOA.

C.4 Jet Blast.

The exhaust from jet engines produces high-velocity air streams at elevated temperatures creating potential hazardous risks for significant damage to airport infrastructure, ground equipment, and other aircraft, as well as serious injury to people. Jet blast creates turbulence with oscillatory and wave-type behavior capable of inducing destructive vibrations in adjacent structures. The combination of high temperature and velocity from jet blast is also capable of damaging pavement in close proximity to the engine exhaust point.

C.4.1 Jet Engine Thrust Levels.

An airport serving turbojet aircraft experience three general categories of engine thrust levels at the ground surface. Each thrust level presents varying degrees of hazards to various areas of the airport.

C.4.1.1 **Idle Thrust.**

Idle thrust is the jet thrust with the engine power control level set for the lowest thrust position. Idle thrust levels are common at apron parking positions (e.g., gate and hardstands) but also present on taxiways at holding positions and when aircraft do not use all engines to taxi. Refer to 14 CFR § 1.1 for the definition.

C.4.1.2 **Breakaway Thrust.**

Breakaway thrust generally refers to the level of thrust necessary to overcome inertia and tire friction and initiating aircraft movement from a static position. Factors influencing breakaway thrust include aircraft total weight, pavement slope, the number of engines providing power, and headwind. Breakaway thrusts occur in the apron area, along taxiways, and at runway ends.

C.4.1.3 **Takeoff Thrust.**

Takeoff thrust is the jet thrust developed under static conditions at a specific altitude and atmospheric temperature for normal takeoff and limited in continuous use. Refer to 14 CFR § 1.1 for the full definition. Takeoff thrust ranges from a minimum value necessary to create lift to the maximum engine rated value. Most departures apply a reduced thrust level to limit engine wear. Takeoff thrust in the airfield environment predominantly occurs from a point at the runway ends, down the runway, through aircraft rotation. However, takeoff thrust also occurs at designated areas at an airport such as run-up areas and bays.

C.4.2 Jet Engine Exhaust Velocity and Temperature.

Jet engine exhaust velocities and temperatures extend a considerable distance behind the aircraft before dissipating to safe levels. The distance until reaching safe levels varies per thrust level and atmospheric conditions. Generally, exhaust temperatures diminish to safe levels at a lesser distance than exhaust velocities. Crosswinds are capable of moving the exhaust envelope left or right of the area behind the aircraft. Application of this knowledge during planning and design efforts helps limit the adverse effects of exhaust velocity and temperature in the air operations area.

C.4.2.1 **Exhaust Contour Information.**

Exhaust contours for velocity streamlines and temperatures vary among aircraft types and models. Most commercial aircraft manufacturers publish airport planning manuals that include information on exhaust velocities and temperatures for the three thrust levels. For smaller aircraft, consult the pilot’s operating handbook. The contour data is commonly

available in plan and elevation views and typically includes qualifying notes addressing assumptions such as standard atmosphere and thrust levels. Consult aircraft manufacturer websites for airport planning manuals containing jet engine exhaust information.

C.4.2.2 **Aircraft Path Modeling Software.**

Commercially available path modeling software includes exhaust information for velocity and temperature. Application allows planners and designers to simulate aircraft movement and identify potential risks for hazardous jet blast. Consult the software provider for limitations of use and the source of jet blast information.

C.5 Recommended Practices.

1. Research the aircraft using the airport for jet exhaust and propeller wash characteristics to assess hazard risks.
2. Assess the effect of aircraft-generated winds' areas within the AOA based on the sensitivity values of Table C-1.
3. Assess the potential risks to public spaces from aircraft-generated wind in areas exterior to the AOA fence including walkways, bike paths, parking areas, waiting areas, etc.
4. Provide adequate distance buffers behind parked and taxiing turbojets to commuter aircraft conducting boarding and de-boarding operations.
5. Position parking locations for light aircraft away from turbojets to limit risk of damage during power outages and taxi operations of turbojet aircraft.
6. Provide tie-down anchors on aprons serving light aircraft in close proximity to taxiways/taxilanes serving turbojet aircraft.
7. Provide an engine run-up area (e.g., open pad or enclosed facility) for performing engine ground run-ups.

C.6 Design Considerations.

1. Consider site specific aircraft movement practices to identify areas where the three thrust levels are most likely to occur.
2. Consider the exhaust stream footprint during power-up, push back, and turn maneuvers.
3. Consider the effects of engine noise and jet exhaust on the areas surrounding an engine run-up area.
4. Consider whether operation of aircraft auxiliary power units (APU) create exhaust hazards.

C.7 **Mitigation Measures.**

1. Erosion Protection:
   a. Runway shoulders, per paragraph 3.7.3
   b. Runway blast pads, per paragraph 3.7.4
   c. Taxiway shoulders, per paragraph 4.13
2. Apron configuration, per paragraph 5.17
3. Blast protection, per paragraph 6.5
4. Surface marking of hazardous jet blast zones in the apron area.

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APPENDIX D. END-AROUND TAXIWAY (EAT) VISUAL SCREENS

D.1 Screen Sizing.

The size of the EAT visual screen is dependent on the runway geometry, the RDC of the aircraft operating on that particular departing runway and EAT, and the relative elevations of the EAT, the V_1 point, the ground elevations at the screen, and the DER.

D.1.1 Horizontal Geometry.

Base the design of the screen width on a departing aircraft's view from a location at the V_1 point through the farthest point on the runway hold line at the DER. See Figure D-1. To calculate the screen width:

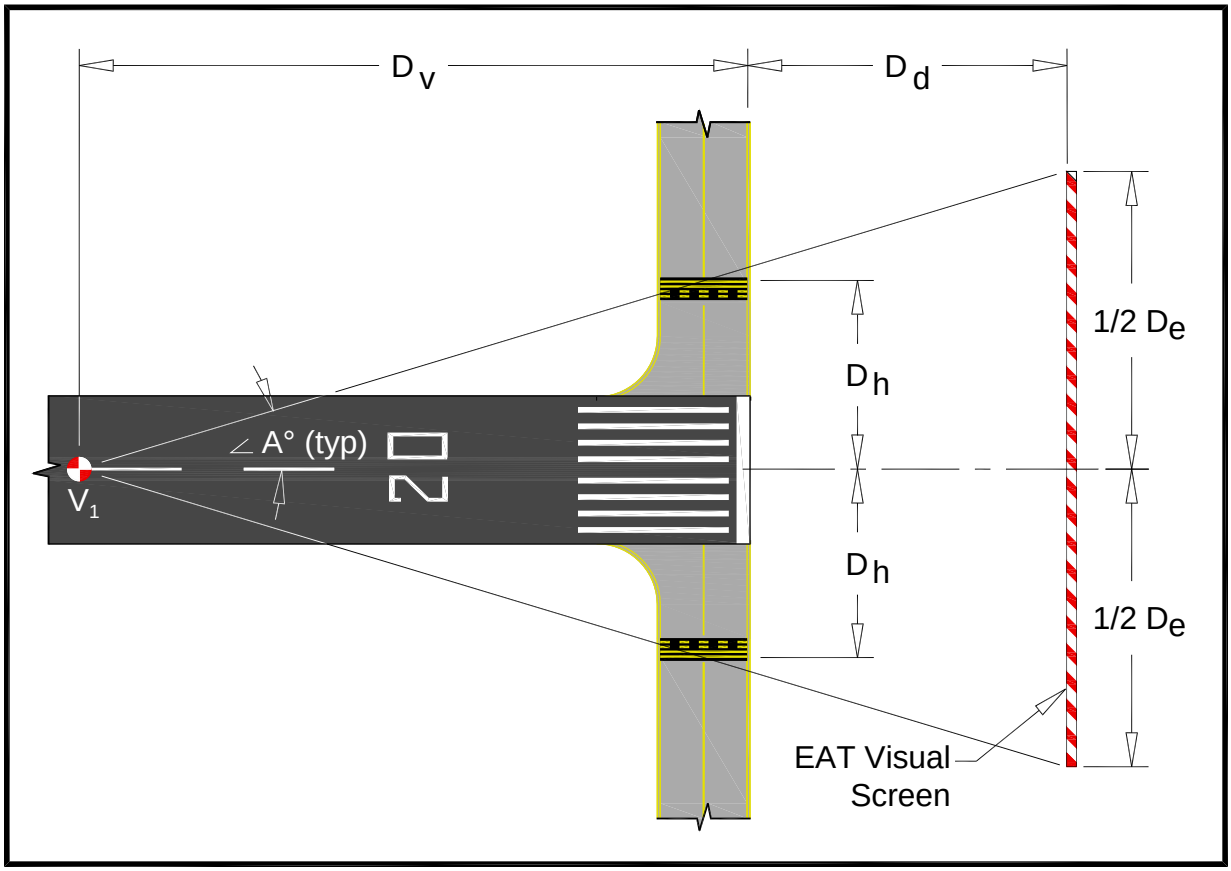
1. Determine the distance between the screen location and the DER (D_d).
2. From the runway centerline V_1 point, draw lines through the runway holding position marking closest to the DER (normally derived from the runway centerline to holding position) in Appendix G and the online Runway Design Standards Matrix Tool.
3. Extend the lines to intersect with a line perpendicular to the runway at the screen location.
4. Using the formula in the Figure D-1 notes, calculate the width of the visual screen.

D.1.2 Vertical Geometry.

Design the height of the screen so the top of the screen masks that portion of an aircraft that extends to the top of an engine nacelle of the ADG taxiing on the EAT, as viewed from the cockpit of the same ADG at the V_1 point on the departure runway (see paragraph A.1.1).

1. Extend the visual screen from the ground to the calculated height.
2. For ADG-III and above, it is permissible to have the lower limit of the visual screen up to two feet (0.6 m) above the DER elevation.
3. Consider variations in terrain at the site where the screen is constructed.
4. It may be feasible to grade the site of the visual screen to allow for an additional 2-foot (0.6 m) separation between the visual screen panels and the ground for mowing access.
5. A visual screen is not necessary if terrain masks the engine nacelle of the aircraft on the EAT (see Figure D-4).

Figure D-1. End-Around Taxiway (EAT) Screen Sizing and Location



$$\angle A = \arctan \frac{D_h}{D_v}$$

$$(\tan \angle A(D_v + D_d)) = \frac{1}{2} D_e$$

Where:

D_V = 0.4 × runway length
D_d = Distance from the DER to the screen
D_h = Distance from the runway centerline to the hold line
D_e = Width of the EAT visual screen

D.1.3 Visual Screen Vertical Dimension Calculation.

To calculate the required height of the screen above grade, H_S:

$$H_s = \frac{(ELEV_{V1} + H_{EYE} - H_{NACELLE} - ELEV_{EAT})\,(D_{EAT} - D_d)}{(D_{EAT} + 0.4 \times L_{RWY})} + H_{NACELLE} + ELEV_{EAT} - ELEV_{GAS}$$

Where:

$ELEV_{V1}$ = MSL elevation of the runway centerline at the V_1 point, 60% of the length of the runway from the takeoff threshold

H_{EYE} = Height of the pilot's eye above the runway (see Table D-1)

$H_{NACELLE}$ = Height of the engine nacelle above the taxiway (see Table D-1)

$ELEV_{EAT}$ = MSL elevation of the centerline of the EAT

D_{EAT} = Distance from the DER to the centerline of the EAT

D_d = Distance from the DER to the screen

L_{RWY} = Length of the runway

$ELEV_{GAS}$ = MSL elevation of the ground at the screen

Check that the screen is below the 40:1 departure surface:

$$H_s + ELEV_{GAS} < D_d/40 + ELEV_{DER}$$

Where:

$ELEV_{DER}$ = MSL elevation of the departure end of the runway

D.1.4 Visual Screen and Vertical Elevation Difference.

A visual screen is not required if the grading or elevation changes mask the engine nacelle of the ADG aircraft on the centerline of the EAT at the $ELEV_1$ plus H_{EYE}. If this is the case, using the values in Table D-1, provide calculations and/or drawings to the FAA that prove an EAT is not necessary. See paragraph 4.12.1.1.

Table D-1. Aircraft Characteristics

ADG	Nacelle Height (feet) ($H_{NACELLE}$)	Pilot's Eye Height (feet) (H_{EYE})
III	9	15
IV	12	21
V	18	29
VI	18	29

Note: 1 ft = 0.305 m

D.2 **Screen Construction.**

Construct the visual screen to perform as designed and to be durable, resistant to weather, have a failure mechanism, and resistant to expected wind load. The visual screen comprises the foundations, frame structure, connection hardware, and front panels.

D.2.1 Failure Mechanism.

The failure (or breakaway) mechanism is a connection designed to yield, fracture, and/or separate in the event of an aircraft strike. Refer to AC 150/5220-23 for information regarding energy imparted to the aircraft in the event of an aircraft strike.

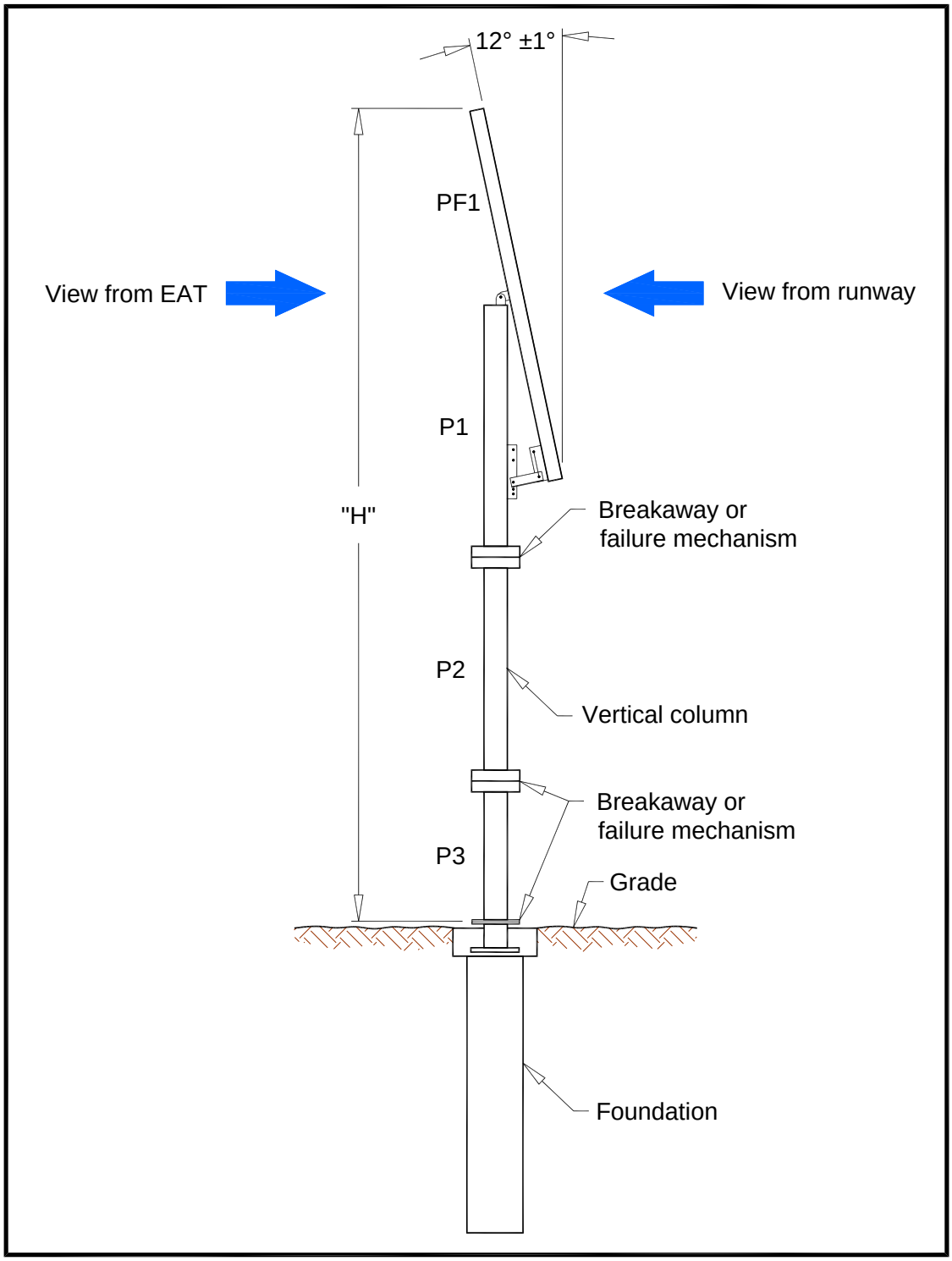
D.2.2 Foundations.

Design foundation supports to maintain the visual screen in a stable position. Provide a sufficient mow strip around the base of the foundation to provide a safety buffer between mowing equipment and the screen structure.

D.2.3 Frame.

Construct the frame structure so it is durable and able to withstand wind loads. Design the frame structure connections to break away from the structure in the event of an aircraft strike. Figure D-2 illustrates examples for constructing the frame structure, depending on the overall height of the structure. Application of the described hollow structural sections (HSS) includes examination and verification of accuracy, suitability, and structural sufficiency by a licensed professional engineer. Ensure no HSS damage occurs due to water infiltration and freezing. Construct the visual screen structure to allow the front panels of the screen to be angled upward 12 (±1°) degrees from the vertical plane.

Figure D-2. Example Visual Screen Structure



Note 1: See Table D-2, Table D-3, and Table D-4 for framing schedules.
Note 2: Refer to AC 150/5220-23 for additional information regarding breakaway or failure mechanism.

Table D-2. Notes for Figure D-2 – High Frame Elevation

Framing Schedule Visual Screen 26 ft (7.9 m) < H ≤ 32 ft (9.8 m)			
	Wind Speed (mph)		
Member	**90**	**130**	**150**
P1	HSS 8×6×5/16	HSS 8×8×1/2	HSS 12×8×3/8
P2	HSS 10×6×1/2	HSS 12×8×9/16	HSS 16×8×1/2
P3	HSS 12×6×1/2	HSS 16×8×1/2	HSS 20×8×1/2
PF1	HSS 6×4×3/16	HSS 6×4×5/16	HSS 6×4×5/16

Table D-3. Notes for Figure D-2 – Intermediate Frame Elevation

Framing Schedule Visual Screen 18 ft (5.5 m) < H ≤ 26 ft (7.9 m)			
	Wind Speed (mph)		
Member	**90**	**130**	**150**
P1	HSS 8×6×5/16	HSS 8×8×1/2	HSS 12×8×3/8
P2	HSS 10×6×1/2	HSS 12×8×9/16	HSS 16×8×1/2
P3	N/A	N/A	N/A
PF1	HSS 6×4×3/16	HSS 6×4×5/16	HSS 6×4×5/16

Table D-4. Notes for Figure D-2 – Low Frame Elevation

Framing Schedule Visual Screen H ≤ 18 ft (5.5 m)			
	Wind Speed (mph)		
Member	**90**	**130**	**150**
P1	HSS 8×6×5/16	HSS 8×8×1/2	HSS 12×8×3/8
P2	N/A	N/A	N/A
P3	N/A	N/A	N/A
PF1	HSS 6×4×3/16	HSS 6×4×5/16	HSS 6×4×5/16

D.2.4 Front Panel.

The front panel of the visual screen is conspicuous from the runway side of the screen. Replaceable front panels 12 feet (3.7 m) long and 4 feet (1.2 m) high and attached to the frame structure allow easy replacement. See Figure D-4. The following is acceptable in meeting design criteria.

D.2.4.1 **Aluminum Honeycomb Criteria.**

The screen panels are constructed of aluminum honeycomb material.

1. The front panel of the screen consists of 4-foot-tall (1.2 m) panels, with the remaining difference added, as needed.
   a. For example, three 4-foot (1.2 m) high panels plus one 1-foot (0.3 m) tall panel creates a 13-foot (4 m) tall screen.
2. Provide a 0.5-inch (13 mm) space between panels to allow for thermal and deflection movements.
3. Specify the front and back panel faces to:
   a. meet the required deflection allowance, and
   b. be a minimum 0.04 inches (1.1 mm) thick.
4. Provide honeycomb material of sufficient thickness to meet the deflection allowance, but not more than 3 inches (76 mm) thick.
5. Design the internal honeycomb diameter for the sufficient strength needed to meet the deflection allowance, but not more than 0.75 inches (19 mm).
6. Provide panel edge closures that consist of aluminum tubing that is:
   a. 1-inch (25 mm) times the thickness of the honeycomb, and
   b. sealed.
7. The deflection allowance for the screen is 0.5 inches (13 mm) maximum at the center of the panel when supported by four points at each corner of the panel.
8. Provide panel faces with a clear anodized finish on both front and back.

D.2.4.2 **Pattern.**

The front panel of the screen visually depicts a continuous, alternating red and white, diagonal striping of 12-foot (3.7 m) wide stripes set at a 45-degree angle ±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 is opposite the slope of aircraft tails operating in the predominant flow on the EAT, as shown in Figure D-4.

D.2.4.3 **Color.**

The front panel of the screen is retroreflective red and white. The colors of the retroreflective sheeting used to create the visual screen conform to daytime color specification limits, shown in Table D-5, when measured in accordance with ASTM D4956.

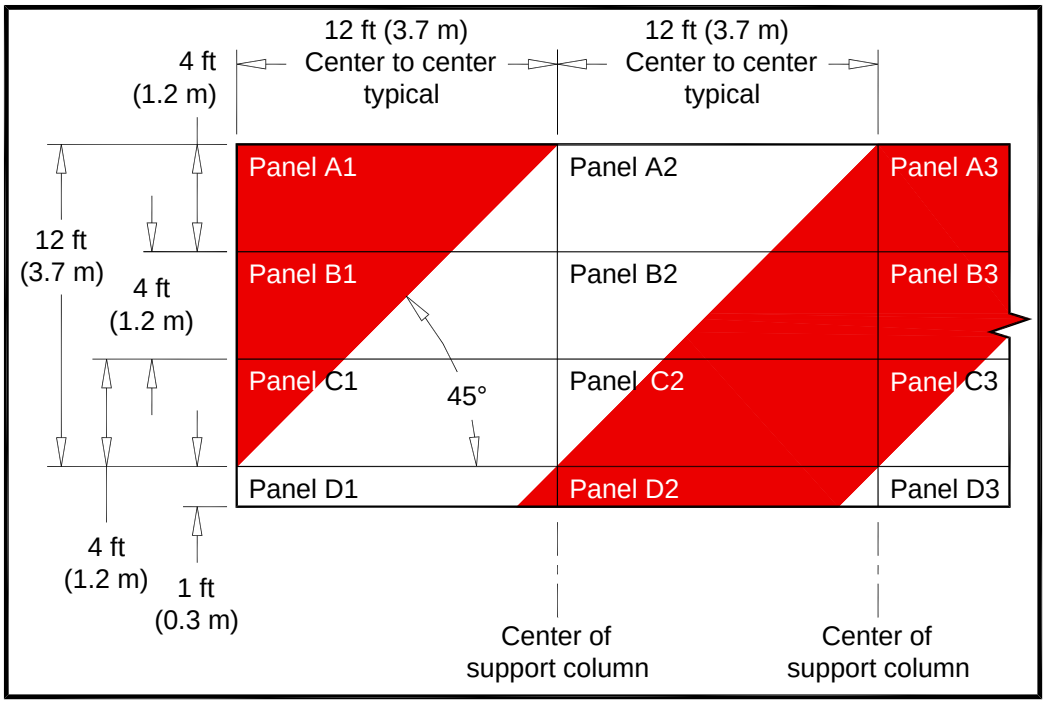
D.2.4.4 **Reflectivity.**

The surface of the front panel is reflective on the runway side of the screen. Perform reflectivity measurements in accordance with ASTM E810. Acceptance requires the sheeting maintain at least 90 percent of its values, as shown in Table D-6, with water falling on the surface, when measured in accordance with the standard rainfall test of Section 7.10.0 of the American Association of State Highway and Transportation Officials (AASHTO) M268.

D.2.4.5 **Adhesion.**

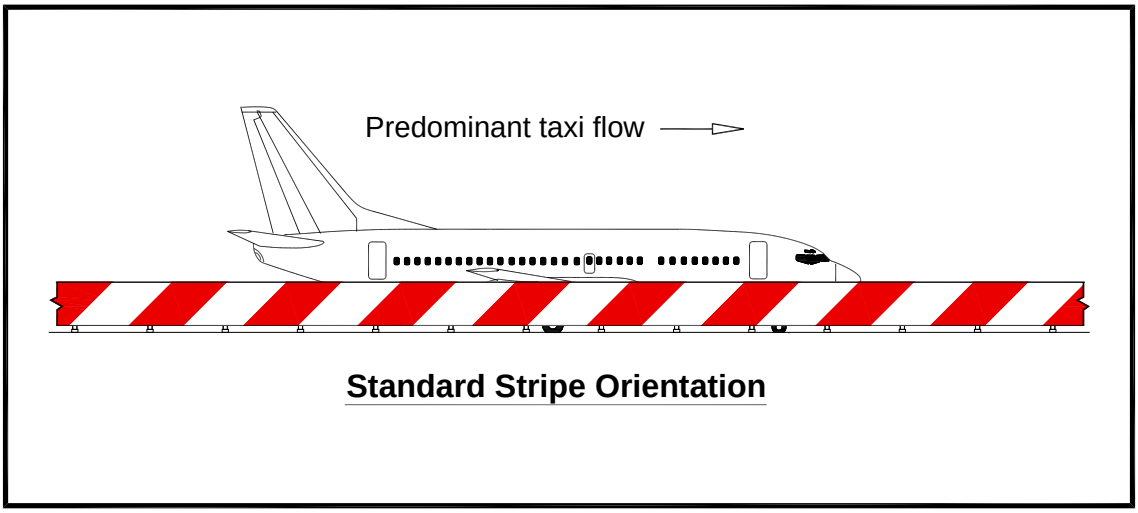
The screen surface material has a pressure-sensitive adhesive, which conforms to adhesive requirements of ASTM D4956 (Class 1).

Figure D-3. Example Panel Layout for 13-foot (4 m) High Screen



Note 1: Unless otherwise noted, dimensions are expressed as feet (meters).
Note 2: The front panels of the screen are retroreflective red and white.
Note 3: Panel A2 is the same as panel C1 rotated 180°.
Note 4: Panel B2 is the same as panel B1 rotated 180°.
Note 5: Panel C2 is the same as panel A1 rotated 180°.

Figure D-4. Visual Screen Stripe Orientation



Note: The front panel of the screen is retroreflective red and white (see paragraph D.2.4.3).

Table D-5. Daytime Color (x, y, Y) Specification Limits

Color	1		2		3		4		Reflectance Limit (Y)	
	x	y	x	y	x	y	x	y	Min	Max
White	.303	.300	.368	.366	.340	.393	.274	.329	27	
Red	.648	.351	.735	.265	.629	.281	.565	.346	2.5	15

Note: The four pairs of chromaticity coordinates determine the acceptable color in terms of the International Commission on Illumination (CIE) 1931 Standard Colorimetric System.

Table D-6. Minimum Coefficient of Retroreflection Candelas/Foot Candle/Square Foot/Candelas/Lux/Square Meter

Observation Angle [1] (Degrees)	Entrance Angle [2] (Degrees)	White	Red
0.2	-4	70	14.0
0.2	+30	30	6.0
0.5	-4	30	7.5
0.5	+30	15	3.0

Note 1: Observation (Divergence) Angle – The angle between the illumination axis and the observation axis.
Note 2: Entrance (Incidence) Angle – The angle from the illumination axis to the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.
Note 3: Reflectivity acceptance criteria: conform to ASTM D4956.

D.2.5 Environmental Performance.

Design the front panel of the screen and all its components for continuous outdoor use under the following conditions:

D.2.5.1 **Temperature.**

Design screen surface material to withstand an ambient temperature range of -4°F to +130°F (-20°C to +55°C).

D.2.5.2 **Wind Loading.**

Design the screen to sustain exposure to a wind speed of at least 90 mph (145 k/h) or the appropriate wind speed anticipated for the specific airport location, whichever is greater. See Table D-7 for design wind pressures.

Table D-7. Visual Screen Panel Wind Loads

Wind Speed (mph [k/h]) (3 second gust)	Wind Load (PSI)
90 mph (145 k/h)	0.17
130 mph (209 k/h)	0.35
150 mph (241 k/h)	0.47

D.2.5.3 **Rain.**

Design screen surface material to withstand exposure to wind-driven rain.

D.2.5.4 **Sunlight.**

Design screen surface material to withstand exposure to direct sunlight ultraviolet rays without fading outside of Table D-5 criteria.

D.2.5.5 **Lighting.**

If required, the top edge of the visual screen is illuminated with steady burning, L-810 FAA-approved obstruction lighting, as provided in AC 150/5345-43, *Specification for Obstruction Lighting Equipment*, and positioned as specified in AC 70/7460-1, *Obstruction Marking and Lighting*.

D.2.6 Provision for Alternate Spacing of Visual Screen.

If access is necessary through the area where the visual screen is constructed, stagger the various segments of the screen up to 50 feet (15.2 m) from each other, as measured from the runway end, so an emergency vehicle can safely navigate between the staggered segments of screen. Overlap the screen segments so that the screen appears to be unbroken when viewed from the runway at the V_1 takeoff position.

D.2.7 Frangibility.

Design the screen structure, including all of its components, to be of the lowest mass possible to meet the design criteria while minimizing damage should the screen structure be struck. Design the foundations at ground level so the steel structure will shear on impact; design the vertical supports so they will give way; and design the front panels so they release from the screen structure if struck. Tether the vertical support posts at the base so they will not tumble when struck. See Figure D-2 for an example of a frangible structure.

D.2.8 NAVAIDs Considerations.

When designing the location and orientation of the visual screen, consider the possible effects the screen may have on nearby NAVAIDs. Due to the complexity of various airport configurations, each installation will have different factors and limitations to consider. Design visual screens to mitigate potential impacts to NAVAID performance.

D.2.8.1 **Approach Light Plane.**

No part of the visual screen may penetrate the approach light plane.

D.2.8.2 **Radar Interference.**

Research shows that a visual screen erected on an airport equipped with ASDE may reflect signals and adversely affect ASDE performance. To avoid this, tilt the visual screen 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. See Figure D-2.

D.2.8.3 **Instrument Landing System (ILS) Interference.**

Research shows that a visual screen on a runway equipped with an ILS system (LOC and GS) will generally not affect or interfere with the operation of the system. Perform an analysis for GSs, especially null reference GSs, prior to the installation of the screens.

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APPENDIX E. GENERAL AVIATION (GA) FACILITIES

E.1 Background.

This appendix addresses design considerations and guidelines for GA facilities that include:

- GA Aprons
- Hangars
- Terminal buildings
- Airport Support Facilities
- Fencing

E.1.1 Standards.

1. Refer to Chapter 5 for FAA standards that apply to aprons.
2. Refer to Chapter 6 for FAA standards that apply to airfield buildings.

E.1.2 Location.

GA facilities may exist at an airport primarily for GA operations, or within a segregated portion of a commercial service airport.

E.1.3 Basic Design Principles.

Consider the following basic design guidelines when planning and designing GA facilities.

1. Maintain safety of taxiing and parked aircraft.
2. Develop facilities in a manner that does not adversely affect runway surfaces (e.g., approach/departures surfaces, OFZs, etc.), imaginary surfaces for air navigation (see paragraph 3.4.12), and equipment critical areas (e.g., ILS, VOR, etc.).
3. Design facilities to optimize aircraft movement paths between parking positions, hangars, support facilities (e.g., fueling), and any FBO facilities.
4. Provide planning and design to accommodate varying aircraft types and sizes anticipated to use the airport.
5. Develop facilities in a manner that minimizes or precludes reconstruction or relocation of infrastructure in order to accommodate future growth.
6. See ACRP Report 113, *Guidebook on General Aviation Facility Planning*, for additional information.

E.2 General Aviation Apron.

E.2.1 General Design Considerations.

1. Evaluate apron parking positions and tie-downs for aircraft entry and exit under self-power and by tow.

2. Segregate parking areas for small aircraft (e.g., ADG I) from larger aircraft (e.g., ADG II) to optimize utility and efficiency of apron space.
3. Design separate apron areas to accommodate the critical aircraft intended to use the segment of apron.
4. Account for the effects of jet blast and propeller wash on adjacent aircraft and facilities, per guidelines of paragraph 5.17.

E.2.2 Parking Position.

A parking position represents a location where aircraft can park without impeding other aircraft when parking, and aircraft taxi operations on adjacent taxilanes.

E.2.2.1 **Markings.**

Parking positions consist of marked locations (e.g., tiedowns and lead-in lines) or unmarked positions.

1. Marked parking positions provide a measure of safety for aircraft maneuvering but reduces flexibility on the size of aircraft able to park at the position.
2. Unmarked positions:
   a. Provide flexibility to accommodate a diverse mix of aircraft types.
   b. Requires judgmental maneuvering and possibly assistance from a parking marshal or wing-walkers.

E.2.2.2 **Parking Position Sizing.**

To optimize space, establish separate parking areas for the different groupings of aircraft anticipated to use the airport. Table E-1 provides area values based on the common tiedown size groupings of paragraph E.2.3.3, plus clearance values of Table 5-1. Airport operators may apply these values or establish custom values based on specific aircraft dimensions using its airport.

Table E-1. Minimum Parking Position Sizing

Wingspan	Length	Area
49 ft (14.9 m)	< 30 ft (9.1 m)	2,065 sf (192 m^2)
49 ft (14.9 m)	30 to 45 ft (9.1 m to 13.7 m)	2,950 sf (274 m^2)
79 ft (24.1 m)	45 to 60 ft (13.7 m to 18.3 m)	5,785 sf (537 m^2)
79 ft (24.1 m)	60 to 75 ft (18.3 m to 22.9 m)	7,120 sf (661 m^2)
79 ft (24.1 m)	75 to 90 ft (22.9 m to 27.4 m)	8,455 sf (786 m^2)

Note 1: Values for area are calculated by multiplying the sum of the wingspan dimension plus 10 feet (3 m) by the sum of the maximum aircraft length plus 5 feet (1.5 m) and rounding up to the nearest multiple of 5.

Note 2: Values for area do not include the TLOFA in front of the parking position.

E.2.3 Tiedowns.

A tiedown is a distinct type of parking stand designed to accommodate a specific range of aircraft sizes.

E.2.3.1 **Benefits.**

Securing aircraft reduces risk of damage to parked aircraft due to wind forces from weather events (e.g., storms, wind gusts, microbursts, etc.) and mechanical forces (e.g., jet blast, propeller wash). Unsecured parking locations expose aircraft to risk of damage from wind forces by becoming airborne, spun around, or flipped over.

E.2.3.2 **Tiedown Characteristics.**

1. The three-point method is a common tiedown involving two tiedown anchors along the wing axis and one anchor at the tail of the aircraft.
2. Commonly includes a 6-inch (152 mm) yellow striped marking in the shape of a tee to demonstrate the location for wing axis and tail location.
3. Tiedown locations typically occur on paved aprons but may also occur in turf areas (e.g., overflow parking or tail tiedown anchor located off edge of paved apron).

E.2.3.3 **Tiedown Area Guidelines.**

The sizing of tiedown parking locations at an airport is a function of the aircraft using the airport. Base tiedown area dimensions on aircraft wingspan and length. To determine suitable tiedown area dimensions, each airport operator needs to assess aircraft activity on its apron. The following guidelines show common aircraft groupings based on aircraft lengths for an airport operator to consider for its airport.

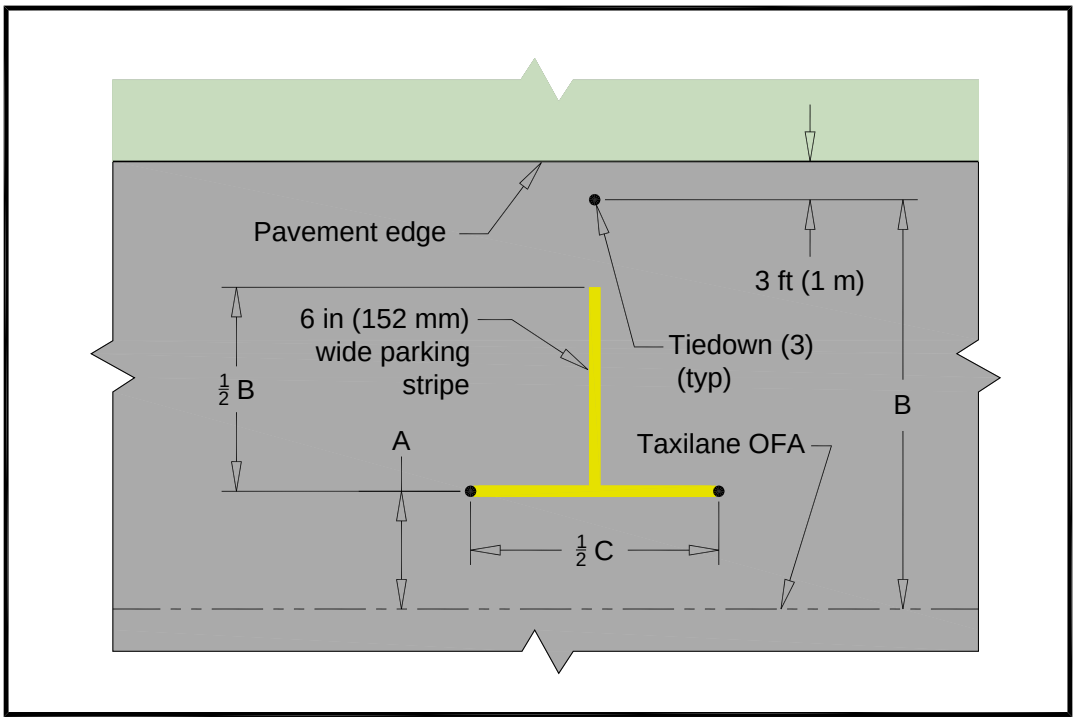
1. ADG I aircraft
   a. 30 ft (9.1 m) aircraft length
   b. 45 ft (13.7 m) aircraft length
2. ADG II aircraft
   a. 60 ft (18.3 m) aircraft length
   b. 75 ft (22.9 m) aircraft length
   c. 90 ft (27.4 m) aircraft length
3. ADG III aircraft
   a. 100 ft (30.5 m) aircraft length
   b. 115 ft (35 m) aircraft length

E.2.3.4 **Tiedown Anchor Layout.**

Refer to Figure E-1 for an example of a tiedown layout. Airport operators may customize the tiedown layout dimensions to address local needs. Consider providing separate groupings of different tiedown layouts to accommodate the varying aircraft sizes that use the airport.

1. Provide two wing tiedown anchors at the end of the marked stripe spaced at least half the wingspan of the critical aircraft.
2. From the edge of the TLOFA:
   a. Locate wing tiedown anchors at a distance so the nose of aircraft using the tiedown does not penetrate the adjacent TLOFA.
   b. Locate the tail tiedown anchor from the TLOFA at a distance not less than the length of the critical aircraft.
3. Ensure no part of the tiedown anchor protrudes above the pavement surface; or no more than 1 inch (25 mm) above surrounding turf.

Figure E-1. Tiedown Layout



Note 1: Figure keys:

A. Distance from main gear to nose of critical aircraft assuming nose of aircraft at the outer edge of the TLOFA.
B. Overall length of the critical aircraft.
C. Wingspan of the critical aircraft.

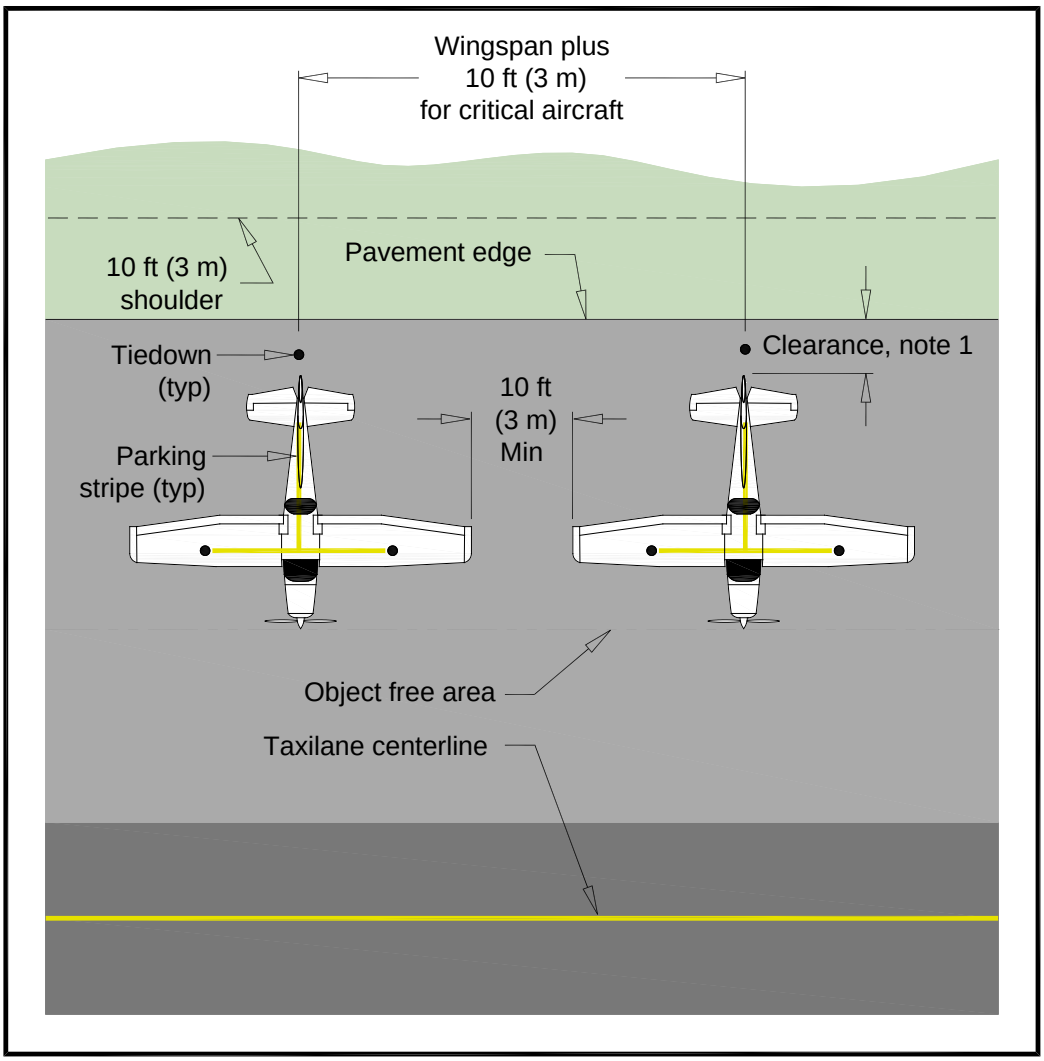
Note 2: Refer to paragraph E.2.3 for tiedown design considerations.
Note 3: Ensure the aircraft using the tiedown does not violate the TLOFA.
Note 4: Take into account the length of tiedown ropes and the risk to propeller entanglement.

E.2.4 Apron Layout Considerations.

E.2.4.1 **General.**

1. Refer to Figure E-2 for an illustration of tiedown spacing relationship.

Figure E-2. Tiedown Spacing

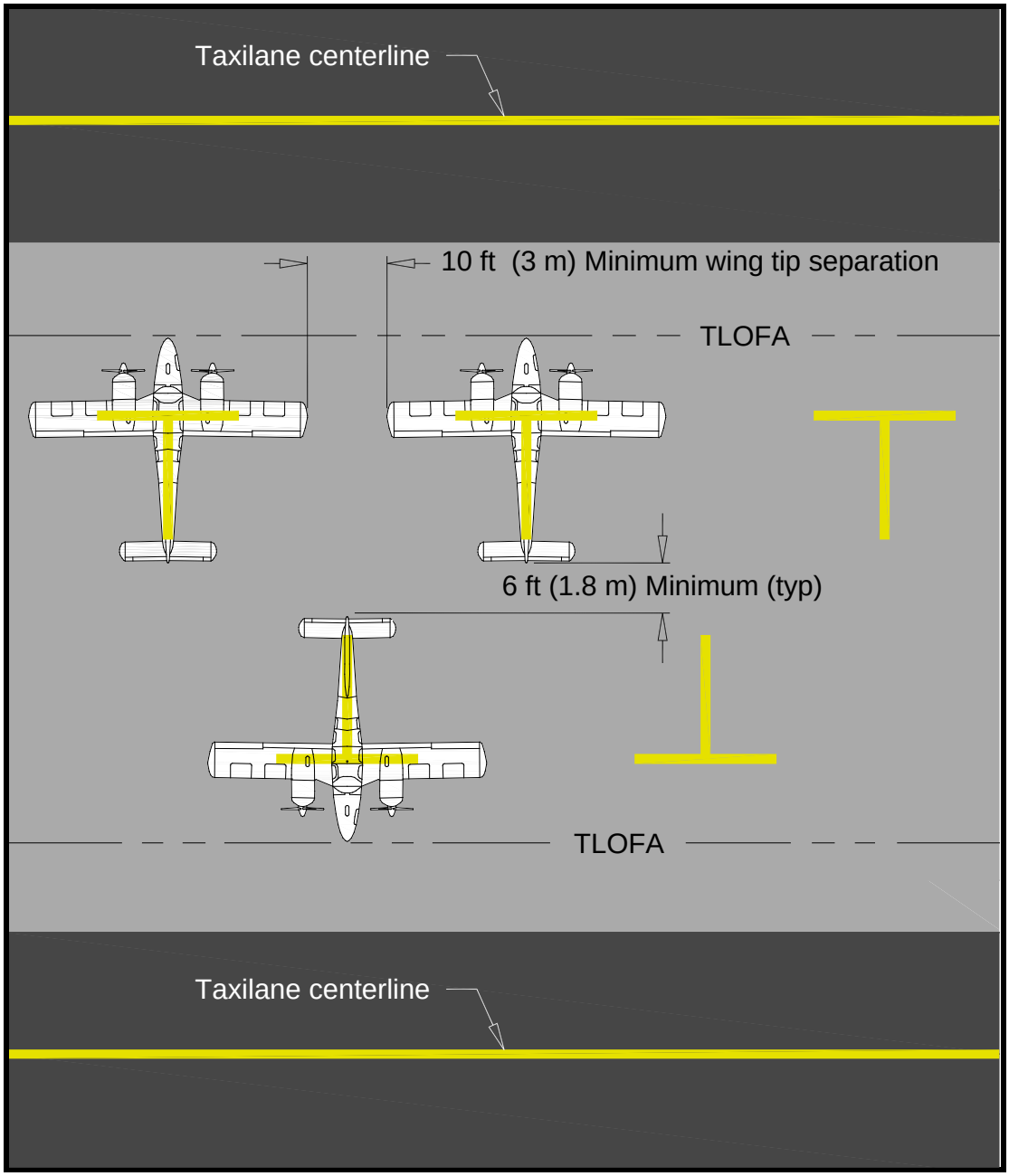


Note 1: Provide sufficient space between the pavement edge and the tail to permit pilots to walk around aircraft during preflight check.
Note 2: Layout tiedowns so that no part of a parked aircraft violates a TLOFA, TOFA, or ROFA.
Note 3: Depth of tiedown position is dependent on critical aircraft. Refer to paragraph E.2.3.3.
Note 4: Ensure no part of parked aircraft violates a TOFA or TLOFA.
Note 5: Maintain recommended obstruction clearances, per Table 5-1.
Note 6: Orient parking positions to align with the direction of prevailing winds at the airport.
Note 7: Group parking positions for similar aircraft wingspan and length to facilitate efficient layout of the apron.
Note 8: Incorporate flexibility for infrequent operations by large aircraft (e.g., ADG-III) by designating and marking an area capable of accommodating both large and medium (ADG-II) size aircraft.

E.2.4.2 **Nested Parking Positions.**

Applying a nested parking position configuration optimizes available apron space and shortens the length of the associated taxilanes. Refer to Figure E-3 for a typical nested parking position layout. Nested parking positions also offer flexibility by accommodating both small and large aircraft.

Figure E-3. Nested Tiedowns



Note 1: Maintain clearance of TLOFA.
Note 2: Tighter clearances may be suitable when aircraft enter and exit a parking position by tug.

E.2.4.3 **Transient Aircraft.**

1. Provide an area on the apron that enables convenient access to airport facilities (GA terminal, FBO, fuel, etc.) for transient aircraft parking.
2. Design parking positions and taxilanes to accommodate the range of aircraft sizes and types (e.g., single engine, multi-engine, and jet) expected to use the airport.
3. Parking stands for transient aircraft sometimes rely on wheel chocks rather than tiedown anchors.

E.2.4.4 **Based Aircraft.**

1. Design parking positions to accommodate aircraft types and sizes based at the airport with consideration given to forecasted activity.
2. Parking stands for based aircraft commonly rely on tiedowns to secure aircraft.

E.2.4.5 **Apron Taxilanes.**

Apron activity levels, prevailing winds, the ratio of transient versus based aircraft, and available space, are critical factors controlling the layout and orientation of apron taxilanes. Assess the optimum layout best serving the airport's needs using these factors and the following considerations:

1. The width of a GA taxilane equals the value of the taxiway width in Table 4-2 for the applicable TDG.
2. The entire TLOFA generally consists of paved surface for interior apron taxilanes.
3. Perimeter taxilanes do not need paved surface beyond one edge of the taxilane width.
4. Single path entry/exit taxilanes are generally suitable for based aircraft parking for extended periods and where there is low potential for taxi conflict. (See Figure E-4.)
5. Dual path entry/exit taxilanes are generally suitable for transient aircraft and aprons where there is high potential for taxi conflicts. (See Figure E-5.)

Figure E-4. Single Path Entry/Exit Taxilane

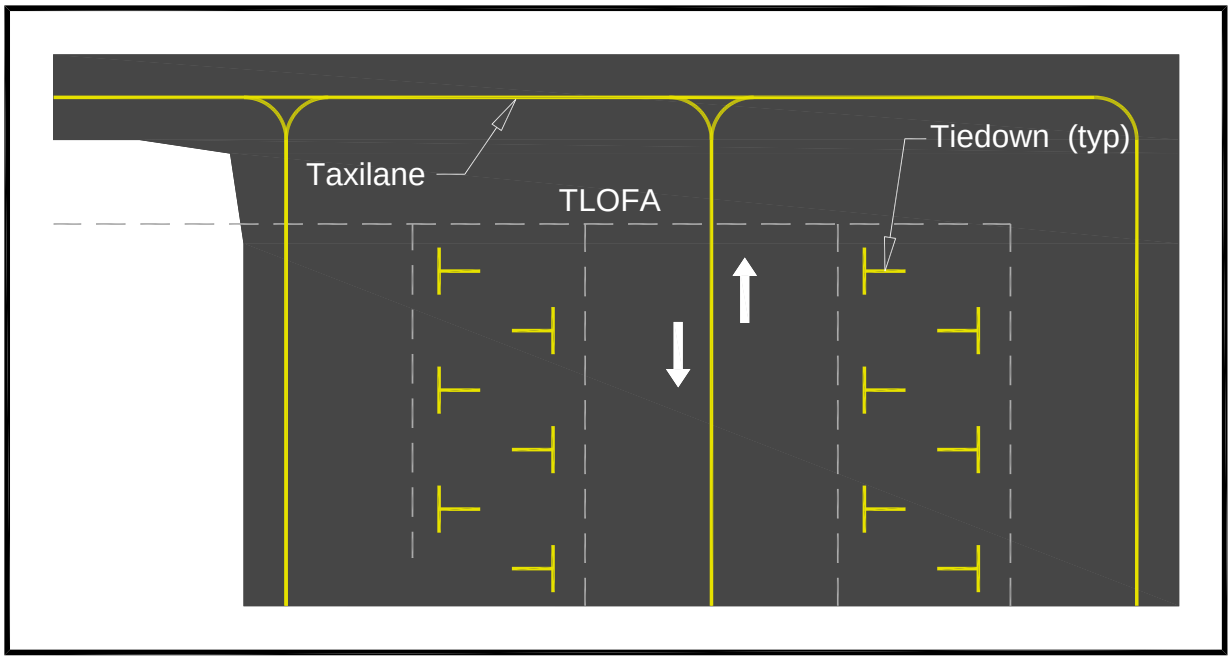
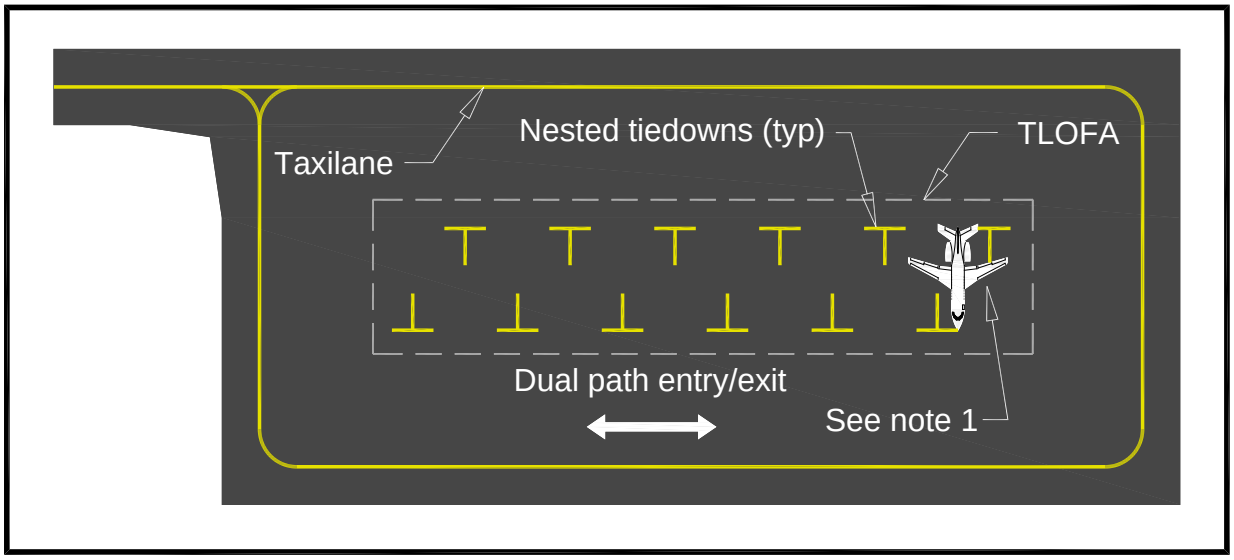


Figure E-5. Dual Path Entry/Exit Taxilane



Note 1: Nested parking position can provide flexibility by accommodating parking of larger aircraft. Ensure tiedowns for smaller aircraft do not pose a hazard to larger aircraft.

E.2.4.6 **Hangar Aprons and Taxilanes.**

Depending on activity level, aircraft or vehicles parked on hangar aprons may affect operations on the associated taxilane, as illustrated in Figure E-6. Hangar aprons extending into the TLOFA can impede aircraft taxi

operations. This may not be an issue if low activity levels exist at the hangar complex.

1. If space is sufficient and activity levels support the need for uncongested use of the taxilane, locate hangar aprons outside of TLOFA to avoid interfering with taxilane operations.
2. Ensure the TLOFA is clear from the taxilane centerline to the face of the T-hangar of all above-ground objects (e.g., utilities boxes, hydrants, bollards, etc.).
3. Locate drainage structures outside of aircraft wheel paths on taxilanes.
4. Refer to the AOPA's *Hangar Development Guide* for additional information.

E.2.5 Apron Area Sizing.

Determining a suitable area size for a GA apron varies for each airport. Airport operators need to assess activity at their airport to determine the optimum size of the GA apron. Determining a suitable apron size involves summing the areas for individual parking positions with the area necessary for the TLOFA configuration. The primary factors influencing the GA apron size include:

1. Size and type of parked aircraft groupings, per Table E-1.
2. Number of transient aircraft at average peak period.
3. Number of based aircraft not stored in a hangar.
4. Length and orientation of taxilanes.
5. Ancillary services (e.g., fueling area).

E.2.5.1 **Transient Aircraft.**

Determine the number of suitable parking positions for transient aircraft from observed activity levels and projected growth.

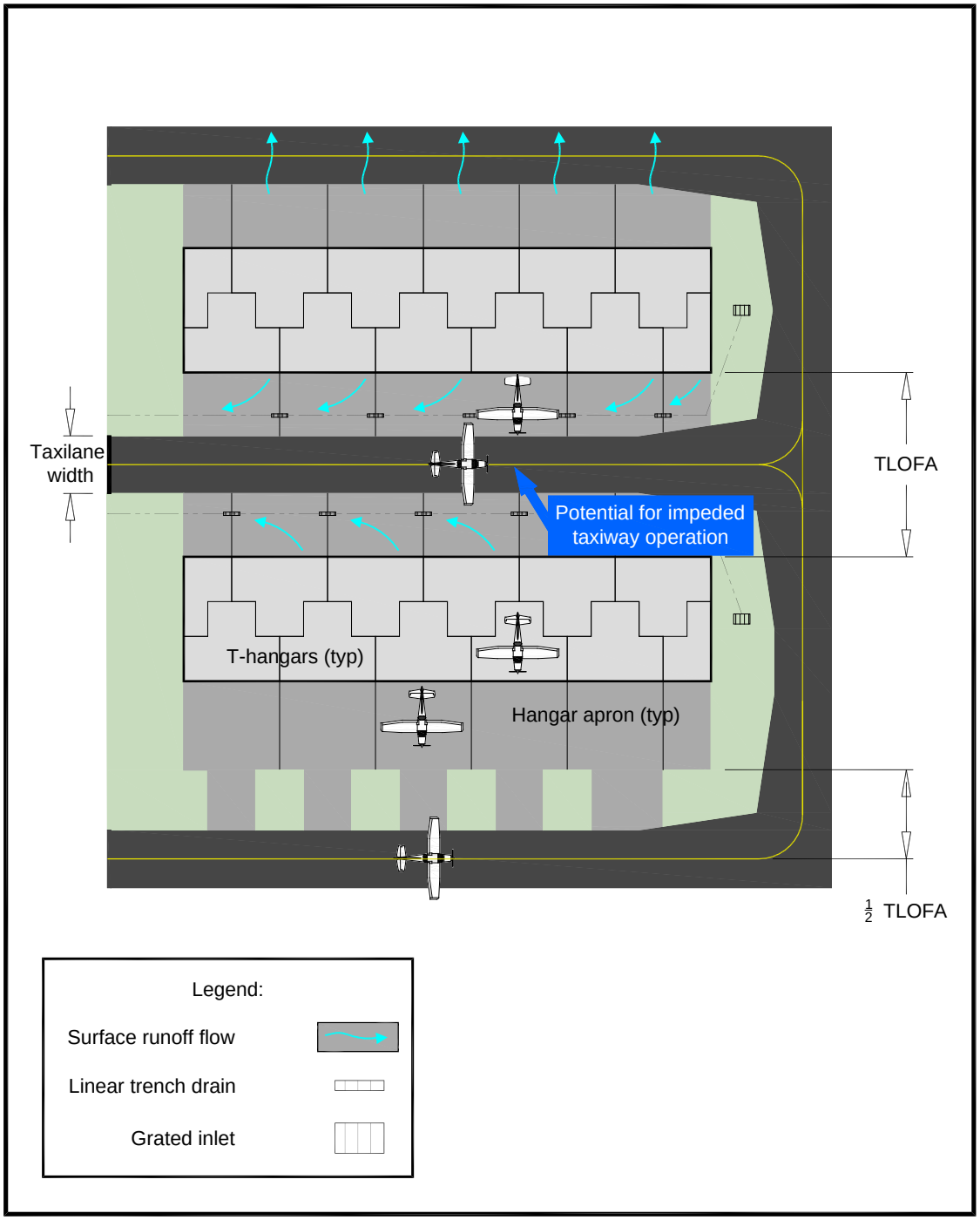
E.2.5.2 **Based Aircraft.**

Establish the number of parking positions from based aircraft not stored in a hangar, plus an additional 10 percent for supplemental parking positions.

E.2.5.3 **Apron Taxilanes.**

Determine the area for apron taxilanes by establishing the cumulative length for both interior and perimeter apron taxilanes. Consider that different taxilanes may serve specific ADG aircraft.

Figure E-6. T-Hangar Complex



Note 1: The bottom taxilane illustrates a T-hangar apron configuration clear of aircraft operating on the taxilane. This arrangement may be appropriate when space is available and hangar activities justify unimpeded taxi movements.

Note 2: The center taxilane illustrates how an aircraft positioned in front of the hangar can impede aircraft operations on the taxilane. This configuration may be suitable for low activity hangar complexes and space-constrained airports. Consider providing two taxi paths for this configuration.

Note 3: Locate drainage inlets outside of aircraft wheel paths. Consider intermittent trench style inlets to address flat slopes between hangars.

E.3 Hangars.

GA hangars provide a variety of benefits and uses that include:

1. An enclosed structure to protect parked aircraft from weather elements such as wind, rain, snow, and ice.
2. Security for owner protection of aircraft investments.
3. A place to service aircraft for maintenance and repair activities.
4. Combination hangar/office for corporate and FBO entities.

E.3.1 Hangar Construction Regulations and Standards.

Submit the Notice of Proposed Construction, as required by 14 CFR Part 77 (see paragraph 6.11.4.1) for evaluation of the potential impact on air navigation. Standards applicable for hangar construction include:

1. Building code requirements as adopted by the local governing body or International Building Code (IBC) in the absence of a formally adopted code.
2. ADA requirements for public accommodation, per 28 CFR Part 36.
3. Provisions of local fire code or NFPA 409, as applicable.

E.3.2 Hangar Types.

E.3.2.1 Conventional (Box) Hangar.

A square or rectangular hangar sized for protective storage of multiple aircraft types ranging in size and type. Conventional hangars are typically stand-alone structures spaced according to size and separation distance required by fire protection.

E.3.2.2 T-Hangar.

A rectangular structure with a tee shape floorplan primarily used for storage of small aircraft. Common T-hangar bay arrangements include a standard configuration (Figure E-7) or a nested configuration (Figure E-8).

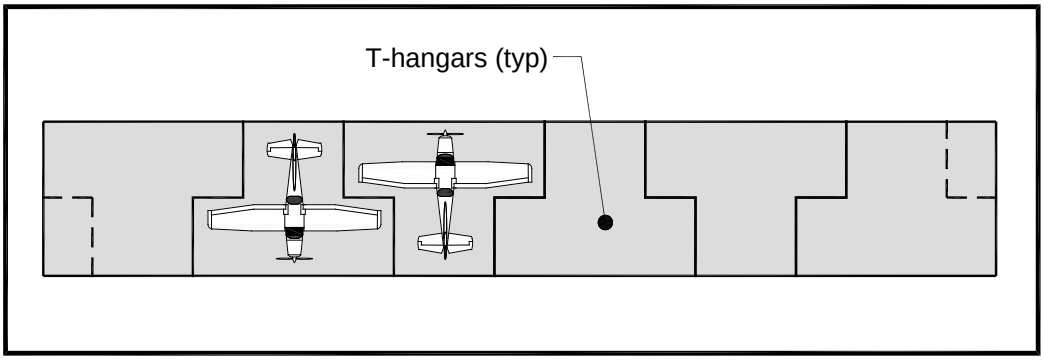
E.3.2.3 Corporate Hangar.

A conventional hangar with office space integrated near the back or the side of the structure.

E.3.2.4 Shade Shelter.

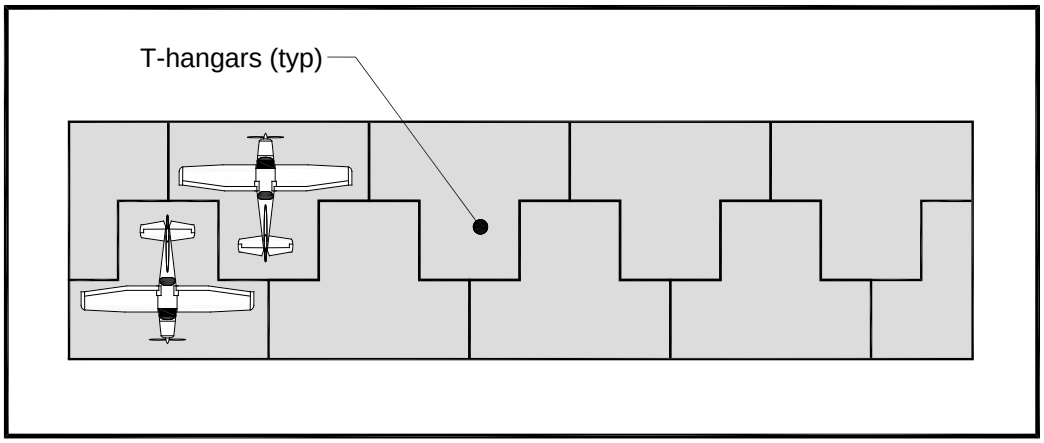
An open-air structure with a roof that provides limited protection from weather elements (e.g., sun and precipitation). A less common but economical option compared to fully enclosed hangar units.

Figure E-7. Standard T-Hangar Layout



Note: The standard T-hangar configuration offers the advantage of minimizing the structure depth when length is not a controlling factor.

Figure E-8. Nested T-Hangar Layout



Note: The nested T-hangar configuration offers the advantage of minimizing the structure length when depth is not the controlling factor.

E.3.3 Hangar Size.

The type and number of aircraft based at an airport are the primary factors in determining hangar width, height, depth, and number of bays. Aircraft maneuvering to hangar space is typically under low speeds, thus allowing precise maneuvering and tighter clearance values.

1. Size hangar interior space to provide sufficient clearance between aircraft and the structure to limit risk of wingtip conflict.
2. Provide a minimum of five feet (1.5 m) clearance between aircraft and the structure to permit the pilot to walk around aircraft when parked in the hangar.
3. For public community hangars, allow for flexibility in design to accommodate various sizes of aircraft.

E.3.4 Hangar Location.

Locate hangars in a manner consistent with the FAA-approved ALP avoiding conflict with the BRL and the standards in Chapter 6. Other design factors to consider include:

1. Locate hangars in a manner that does not adversely affect the use of adjacent taxilanes and aprons.
2. Spacing and clear distance around hangars based upon fire protection ratings, per the governing body's adopted building code (e.g., International Fire Code or NFPA 409).
3. Airport growth and expansion to minimize or avoid the need for relocation or special airfield operational controls.
4. Separate vehicle roadways and parking from aircraft movement areas (see Figure E-9) by locating vehicle parking for hangars outside of the AOA.
5. Hangar orientation to address regional environmental and climate factors such as snow/ice accumulation, exposure to solar heating, and prevailing winds.
6. Effect of wind eddies from flow around hangar structure on small aircraft during landing operations:
   a. Consider an area of influence due to wind vortices equal to ten times the height of the structure.
   b. Limit taller structures from areas abeam the runway touchdown zone.
7. LOS from the ATCT to avoid obstructing a controller's view of aircraft that transition to and from the movement area.

E.3.5 Hangar Doors.

Size hangar doors to provide sufficient clearance between the aircraft and the doorframe. Typically, a minimum clearance of 1-2 feet (0.3-0.6 m) is adequate.

E.3.5.1 **Design Considerations.**

1. Consider the position of the door when in the open position to avoid the door becoming a potential wingtip hazard for adjacent taxilanes.
2. Providing a window in the doorframe is a safety feature that allows an operator to view for the presence of objects in front of the hangar before opening the door.

E.3.5.2 **Door Types.**

There are generally four types of basic hangar doors with variants of each type:

1. Sliding hangar doors:
   a. Door panels slide horizontally, typically to opposite sides, to create the clearance opening.

b. This method generally requires space to the side of the entrance to store the door panels when in the open position.

2. Vertical panel doors:

a. Typically, a single or double panel door that lifts upward to a horizontal position.

b. Typically operates with a combination of hydraulic cylinders, counterweights, tracks, steel cables, and motor/operator.

3. Bi-fold doors:

a. An articulated, two-panel door that folds up to a horizontal position.

b. Bi-fold doors can create a canopy in front of the hangar when in open position.

4. Fabric doors:

a. An entrance barrier consisting of fabric panels or fabric membrane that typically retracts upward to provide opening clearance.

E.3.6 Hangar Utilities.

E.3.6.1 **Design Considerations.**

1. Route underground utilities in a manner that minimizes or avoids installations under existing and future apron and taxilane pavements.

2. When space constraints require installation under airfield pavements, install underground duct banks with a spare conduit to facilitate future installations.

3. Where aircraft fueling and maintenance activities occur, provide an oil/water separator for the hangar drainage system and floor grounding receptacles.

4. Lay out and locate above-ground facilities such as transformers, fire hydrants, etc., outside of OFAs.

E.4 GA Terminal Building.

The terminal area is commonly a focal point of activity at GA airports. GA terminal buildings facilitate transfer of passengers and cargo from the airside to the landside. GA terminals also provide space for pilot preflight planning.

E.4.1 Standards.

Refer to Chapter 6 for discussion on standards applicable to airfield buildings.

E.4.2 Design Considerations.

1. Relationship between the terminal building and aircraft parking areas to facilitate travel paths for passengers and pilots.
2. Provision of clear paths within the terminal building from landside to airside that promotes awareness of individuals accessing the AOA.
3. Public waiting area.
4. Secluded area for pilot flight planning.
5. Public restroom accommodations.

E.5 Airport Support Facilities.

E.5.1 Fuel Facilities.

Refer to Chapter 5 for standards applicable for fueling facilities.

E.5.1.1 Siting Considerations.

1. Locate GA fueling facilities at the peripheral of the apron in a position to provide convenient access to aircraft and fuel distribution trucks without interfering with other apron aircraft movements.
2. Locate hydrant fueling to avoid fuel truck deliveries crossing pavements used by aircraft.
3. Locate service roads for fuel delivery trucks to minimize or avoid interaction with aircraft.
4. Install a minimum 6-ft (1.8 m) high fence around above-ground fuel tanks located on the landside and accessible to the public.

E.5.2 Vehicle Access and Parking.

E.5.2.1 Associated Risks.

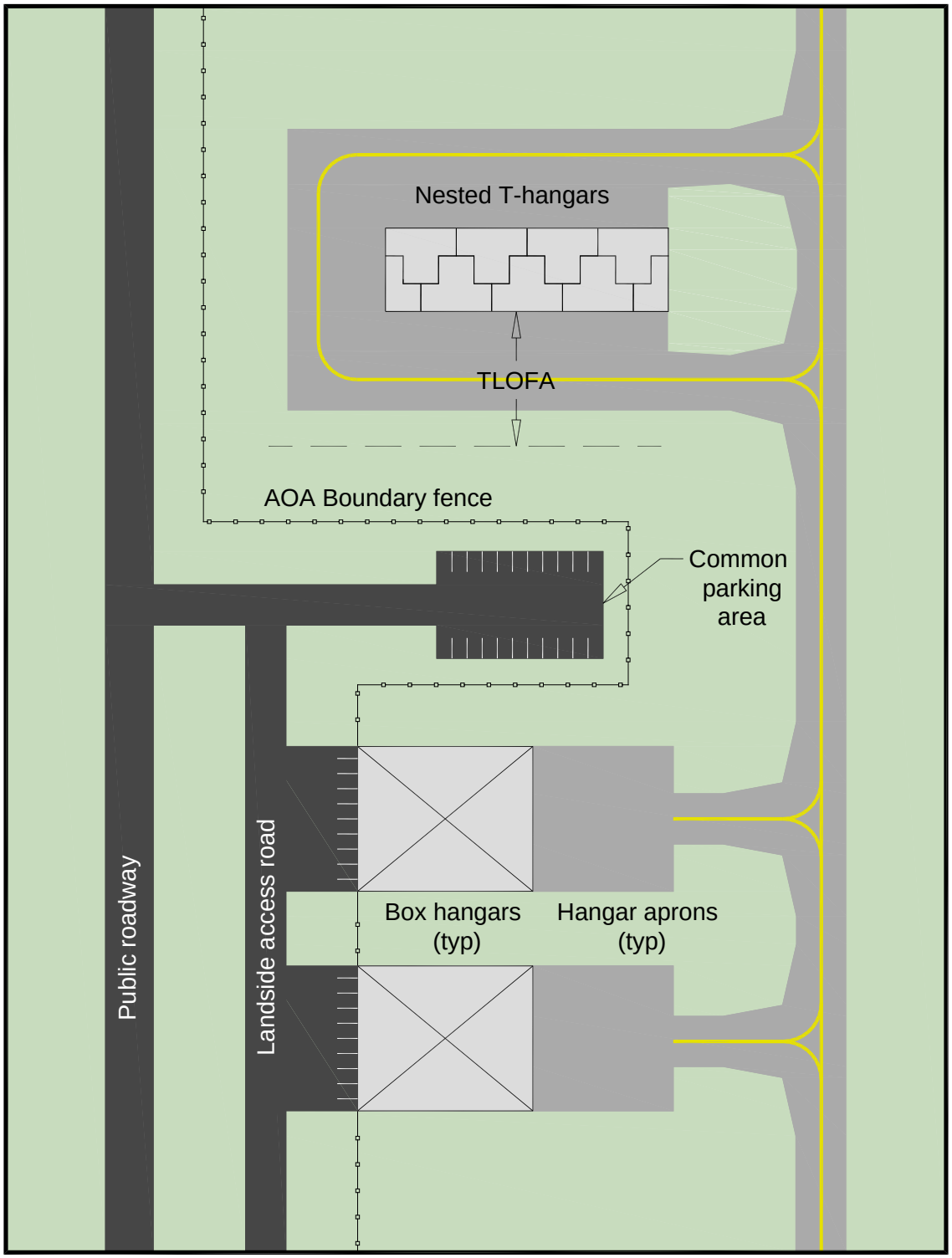
The interaction of vehicles and aircraft within the same area creates a risk for aircraft/vehicle accidents. Limit vehicle operations in the AOA to those necessary to service and maintain aircraft and airport operations.

E.5.2.2 Design Considerations.

Refer to Figure E-9 for an illustration showing separation of vehicle parking from hangar taxilanes.

1. Locate general public access roads and parking areas outside of the AOA.
2. Locate the AOA boundary fence clear of TLOFA limits.

Figure E-9. Separation of Vehicle Parking and Aircraft Pavement



Note 1: Refer to paragraph E.5.2.2 for design considerations.
Note 2: The layout depicted is an example of separating vehicle pavements from pavements for aircraft movements.

3. Refer to the applicable building code for clearance requirements between the parking area and the hangar facilities.
4. When vehicle access to AOA is necessary:
   a. Locate airside roadways apart from pavement for aircraft operations (e.g., aprons, taxilanes, and taxiways).
   b. Minimize roadway interference with TOFA and TLOFA.

E.5.3 Wash Racks.

Wash racks are designated areas where aircraft owners wash and clean their aircraft. Local demand is the primary factor in determining the need for a wash rack facility.

E.5.3.1 **Wash Rack Characteristics.**

1. May be open air (e.g., no overhead cover) or under a canopy roof (e.g., open sides).
2. Paved platform for aircraft washing that also collects wash water.
3. Typically designed for single aircraft occupancy.

E.5.3.2 **Design Considerations.**

1. Locate the wash rack facility in a manner that:
   a. Avoids overspray affecting other aircraft and airfield facilities.
   b. Isolates the facility to avoid interfering with aircraft movements and other apron facilities.
2. Pavement:
   a. Design the strength for the most demanding aircraft anticipated to use the facility.
   b. Construct pad with materials that will not prematurely deteriorate from frequent exposure to water and cleaning agents.
3. Conform to clearance guidelines of Table 5-1 based on critical aircraft.
4. Design entry and exit of aircraft to be by self-power or by tow.
5. Size the wash rack pad to provide a minimum of 5-feet (1.5 m) paved surface around the aircraft for space to walk and for safe maneuvering of aircraft.
6. Locate water hose bibs, control equipment, electric equipment, vacuums, payment systems devices, and related accessories in a manner that facilitates cleaning of aircraft but minimizes wingtip conflict hazards during aircraft maneuvering.
7. Consult local governing authorities regarding requirements for runoff management or treatment of wash water collected from the pad:

a. Provide paved surfaces and curbs with a minimum slope of 0.5% to collect wash water runoff for discharge to drainage system.

b. The facility may require installation of an oil/water separator for collection of degreaser agents.

8. Provide suitable area lighting if the facility is available for nighttime use.

E.6 Fencing for GA Airports.

Fencing of the AOA contributes to the safety of the airport by establishing a physical barrier that limits or impedes inadvertent entry of individuals and vehicles into the AOA. Although there are no Transportation Security Administration standards or requirements for GA security, AOA fencing does represent a basic deterrent feature that discourages unauthorized entry.

E.6.1 Design Considerations.

Key factors and considerations for design of GA fencing include:

1. AOA fencing is primarily a safety feature that protects the integrity of airfield operations.
2. An appropriate fence height relates to the level of safety risk present at the airport.

E.6.2 Key Risk Factors.

The factors that contribute risks to safety for GA airports vary among types of airports, as well as between different areas of the same airport. Common risk factors for GA airports include:

1. Airport activity – The risk to safety will generally be greater at a high activity airport than that at a low activity airport:[iii]
   a. High activity (e.g., national and regional airports)
   b. Moderate activity (e.g., local airports)
   c. Low activity (e.g., basic airports)
2. Proximity to populated area – The potential for individuals to enter the AOA and pose a safety risk is generally less at a rural GA airport than a GA airport near a metropolitan area:[iv]
   a. Urbanized area (50,000 or more people)
   b. Urban clusters (2,500 to 50,000 people)
   c. Rural areas (less than 2,500 people)

[iii] Refer to FAA Report General Aviation, *Airports: A National Asset - May 2012*, for airport category descriptions.
[iv] Refer to the U.S. Bureau of Census for definition of urban areas, urban clusters and rural areas (76 FR 53030, 53043 (Aug. 24, 2011)).

3. Airport Sensitive Areas – The risk to airport safety varies around the perimeter of the AOA based upon distance to airport sensitive areas such as the following:
   a. Terminal area
   b. Runways, taxiways, and aprons
   c. Hangar complexes
   d. Fuel facilities

E.6.3 Basic Fencing Guidelines.

The following represents recommended basic fencing guidelines based upon select risk factors that can influence the safety of airport operations:

1. National and Regional GA airports:
   a. Install a minimum 5-foot (1.5 m) high chain link fence around the perimeter of AOA boundary.
   b. Consider installation of a gate operator to manage access of authorized vehicles into the AOA.
2. Local and Basic GA airports:
   a. Urban and urban cluster locations – Install a minimum 4-foot (1.2 m) high chain link fence around the perimeter of AOA boundary.
   b. Rural locations – Install a minimum 4-foot (1.2 m) high chain link fence out to 500 feet (152 m) from sensitive areas of the airport; and a minimum 4-foot (1.2 m) high woven wire fence (Class A or Class C fence) around the remaining perimeter of AOA boundary.

E.6.4 Managing Access to the AOA.

1. Minimize the number of vehicle and pedestrian gates to manage access to the AOA.
2. Locate access points in key visible locations to facilitate monitoring and awareness of individuals entering the AOA.
3. Limit vehicle access gates to vehicles having an aviation need to enter the AOA:
   a. For basic airports, manual gates are appropriate for managing access to the AOA.
   b. For local, regional, and national airports, consider one Class 3 gate operator, as defined by ASTM F2200-17, for access to the terminal apron area and manual gates elsewhere.

E.6.5 Additional Risk-based Measures.

An airport may have unique circumstances increasing the risk to airport safety beyond what the basic fencing guidelines provide. Conducting a risk-based assessment may justify modifications to the basic fencing guidelines to mitigate that unique risk to safety at that airport. This includes increased fence heights, addition of 3-strand barbed wire, smaller fence mesh, etc.

E.6.6 Signage.

Install warning signs at access points and intermediate points along the boundary fence to establish notice to individuals they are entering the AOA.

E.6.7 Wildlife Fencing.

For non-Part 139 airports, a Wildlife Hazard Site Visit (WHSV) determines whether fencing to deter wildlife is necessary. If an airport's WHSV supports wildlife fencing, the recommendations in the WHSV for fence type, height, and location supersede the basic fencing guidelines of paragraph E.6.2. For additional information, refer to AC 150/5200-38, *Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans*.

APPENDIX F. COMPASS CALIBRATION PAD SURVEY

F.1 Survey of the Compass Calibration Pad.

1. Resurvey the pad after all construction is complete to:
   a. establish the current magnetic headings, and
   b. demonstrate that the pad is free of magnetic materials.
2. Mark the center of the calibration pad with a bronze survey marker.
3. Establish a permanent monument at a remote location along the true north radial for future reference.
4. Mark the date of observation and any annual change in direction of magnetic north durably and legibly on the surface of the calibration pad near the magnetic north mark.
5. Any qualified state-registered geophysicist, surveyor, or engineer may perform the compass windrose survey.
6. The U.S. Geological Survey (USGS) Geomagnetism Group historically provides information on the necessary surveys and equipment to certify a compass rose, as well as the calibration of magnetometers and other suitable instruments used to measure the magnetic field. Services and contact information are available at the Geomagnetism Group website: https://www.usgs.gov/natural-hazards/geomagnetism.

F.2 Resurvey of In-service Pads.

The FAA recommends:

1. Conducting magnetic surveys of existing compass calibration pads at regular intervals of five years or less.
2. Conducting magnetic surveys after:
   a. Major construction of utility lines, buildings, or any other structures within 600 feet (183 m) of the center of the pad, or
   b. Any construction within 150 feet (46 m) of the center of the pad.

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APPENDIX G. RUNWAY DESIGN STANDARDS TABLES

Table G-1. Runway Design Standards Matrix, A/B-I Small Aircraft

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		**A/B – I Small Aircraft**			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	60 ft	60 ft	60 ft	75 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		80 ft	80 ft	80 ft	95 ft
Blast Pad Length		60 ft	60 ft	60 ft	60 ft
Crosswind Component		10.5 knots	10.5 knots	10.5 knots	10.5 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	240 ft	240 ft	240 ft	600 ft
Length prior to threshold	P	240 ft	240 ft	240 ft	600 ft
Width	C	120 ft	120 ft	120 ft	300 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	240 ft	240 ft	240 ft	600 ft
Length prior to threshold	P	240 ft	240 ft	240 ft	600 ft
Width	Q	250 ft	250 ft	250 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	N/A
Width		N/A	N/A	N/A	N/A
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	250 ft	250 ft	1,000 ft	1,000 ft
Outer Width	V	450 ft	450 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	250 ft	250 ft	250 ft	250 ft
Outer Width	V	450 ft	450 ft	450 ft	450 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		125 ft	125 ft	125 ft	175 ft
Parallel taxiway/taxilane centerline [2, 4]	D	150 ft	150 ft	150 ft	200 ft
Aircraft parking area	G	*Refer to paragraph* 3			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-2. Runway Design Standards Matrix, A/B-I

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		A/B – I			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	60 ft	60 ft	60 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		80 ft	80 ft	80 ft	120 ft
Blast Pad Length		100 ft	100 ft	100 ft	100 ft
Crosswind Component		10.5 knots	10.5 knots	10.5 knots	10.5 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	240 ft	240 ft	240 ft	600 ft
Length prior to threshold	P	240 ft	240 ft	240 ft	600 ft
Width	C	120 ft	120 ft	120 ft	300 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	240 ft	240 ft	240 ft	600 ft
Length prior to threshold	P	240 ft	240 ft	240 ft	600 ft
Width	Q	400 ft	400 ft	400 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	700 ft	700 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	700 ft	700 ft	700 ft	700 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		200 ft	200 ft	200 ft	250 ft
Parallel taxiway/taxilane centerline [2, 4]	D	225 ft	225 ft	225 ft	250 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-3. Runway Design Standards Matrix, A/B–II Small Aircraft

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		**A/B – II Small Aircraft**			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	75 ft	75 ft	75 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		95 ft	95 ft	95 ft	120 ft
Blast Pad Length		150 ft	150 ft	150 ft	150 ft
Crosswind Component		13 knots	13 knots	13 knots	13 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	C	150 ft	150 ft	150 ft	300 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	Q	500 ft	500 ft	500 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	250 ft	250 ft	1,000 ft	1,000 ft
Outer Width	V	450 ft	450 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	250 ft	250 ft	500 ft	500 ft
Outer Width	V	450 ft	450 ft	700 ft	700 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		125 ft	125 ft	125 ft	175 ft
Parallel taxiway/taxilane centerline [2, 4]	D	240 ft	240 ft	240 ft	300 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-4. Runway Design Standards Matrix, A/B–II

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		A/B – II			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	75 ft	75 ft	75 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		95 ft	95 ft	95 ft	120 ft
Blast Pad Length		150 ft	150 ft	150 ft	150 ft
Crosswind Component		13 knots	13 knots	13 knots	13 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	C	150 ft	150 ft	150 ft	300 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	Q	500 ft	500 ft	500 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	700 ft	700 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	700 ft	700 ft	700 ft	700 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		200 ft	200 ft	200 ft	250 ft
Parallel taxiway/taxilane centerline [2, 4]	D	240 ft	240 ft	240 ft	300 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-5. Runway Design Standards Matrix, A/B-III

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		A/B – III			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	100 ft	100 ft	100 ft	100 ft
Shoulder Width		20 ft	20 ft	20 ft	20 ft
Blast Pad Width		140 ft	140 ft	140 ft	140 ft
Blast Pad Length		200 ft	200 ft	200 ft	200 ft
Crosswind Component		16 knots	16 knots	16 knots	16 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	600 ft	600 ft	600 ft	800 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	300 ft	300 ft	300 ft	400 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	600 ft	600 ft	600 ft	800 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	700 ft	700 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	700 ft	700 ft	700 ft	700 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [7]		200 ft	200 ft	200 ft	250 ft
Parallel taxiway/taxilane centerline [2, 4]	D	300 ft	300 ft	300 ft	350 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-6. Runway Design Standards Matrix, A/B-IV

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		A/B – IV			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	150 ft	150 ft	150 ft	150 ft
Shoulder Width		25 ft	25 ft	25 ft	25 ft
Blast Pad Width		200 ft	200 ft	200 ft	200 ft
Blast Pad Length		200 ft	200 ft	200 ft	200 ft
Crosswind Component		20 knots	20 knots	20 knots	20 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	700 ft	700 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	700 ft	700 ft	700 ft	700 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [8]		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	400 ft	400 ft	400 ft	400 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-7. Runway Design Standards Matrix, C/D/E-I

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – I			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	100 ft	100 ft	100 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		120 ft	120 ft	120 ft	120 ft
Blast Pad Length		100 ft	100 ft	100 ft	100 ft
Crosswind Component		16 knots	16 knots	16 knots	16 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width [13]	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	300 ft	300 ft	300 ft	400 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-8. Runway Design Standards Matrix, C/D/E-II

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – II			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	100 ft	100 ft	100 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		120 ft	120 ft	120 ft	120 ft
Blast Pad Length		150 ft	150 ft	150 ft	150 ft
Crosswind Component		16 knots	16 knots	16 knots	16 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width [13]	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	300 ft	300 ft	300 ft	400 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-9. Runway Design Standards Matrix, C/D/E-III

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – III			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width [12]	B	100 ft	100 ft	100 ft	100 ft
Shoulder Width [12]		20 ft	20 ft	20 ft	20 ft
Blast Pad Width [12]		140 ft	140 ft	140 ft	140 ft
Blast Pad Length		200 ft	200 ft	200 ft	200 ft
Crosswind Component		16 knots	16 knots	16 knots	16 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [8]		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	400 ft	400 ft	400 ft	400 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-10. Runway Design Standards Matrix, C/D/E-IV

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – IV			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	150 ft	150 ft	150 ft	150 ft
Shoulder Width		25 ft	25 ft	25 ft	25 ft
Blast Pad Width		200 ft	200 ft	200 ft	200 ft
Blast Pad Length		200 ft	200 ft	200 ft	200 ft
Crosswind Component		20 knots	20 knots	20 knots	20 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [8]		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	400 ft	400 ft	400 ft	400 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-11. Runway Design Standards Matrix, C/D/E-V

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – V			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	150 ft	150 ft	150 ft	150 ft
Shoulder Width		35 ft	35 ft	35 ft	35 ft
Blast Pad Width		220 ft	220 ft	220 ft	220 ft
Blast Pad Length		400 ft	400 ft	400 ft	400 ft
Crosswind Component		20 knots	20 knots	20 knots	20 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [8]		250 ft	250 ft	250 ft	280 ft
Parallel taxiway/taxilane centerline [3, 5]	D	400-500 ft	400-500 ft	400-500 ft	400-500 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Table G-12. Runway Design Standards Matrix, C/D/E-VI

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E – VI			
ITEM	DIM [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs* 3.3 *and* 3.7.1			
Runway Width	B	150 ft	150 ft	150 ft	150 ft
Shoulder Width [14]		35 ft	35 ft	35 ft	35 ft
Blast Pad Width [14]		220 ft	220 ft	220 ft	220 ft
Blast Pad Length		400 ft	400 ft	400 ft	400 ft
Crosswind Component		20 knots	20 knots	20 knots	20 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Obstacle Free Zone (OFZ)					
Runway, Inner-approach, Inner-Transitional		*Refer to paragraph* 3.11			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph* 3.9			
Holding Position [8]		280 ft	280 ft	280 ft	280 ft
Parallel taxiway/taxilane centerline [2, 6]	D	500 ft	500 ft	500 ft	500 ft
Aircraft parking area	G	*Refer to paragraph* 3			
Helicopter touchdown pad		*Refer to* AC 150/5390-2			

Note 1: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.
Note 2: See the Footnotes on the page after Table G-12.

Footnotes:

1. Letters correspond to the dimensions in Figure 3-1.

2. The runway to taxiway/taxilane centerline separation standards are for airports at sea level. For airports at higher elevations, increase these separation distances to keep taxiing and holding aircraft clear of the inner-transitional OFZ (refer to paragraph 3.11.4). This standard cannot be used to justify a decrease in runway to taxiway/taxilane separation. See paragraph 4.6.2 for recommendations to increase this separation distance.

3. The standard runway centerline to parallel taxiway centerline separation distance is 400 feet (122 m) for airports at or below an elevation of 1,345 feet (410 m); 450 feet (137 m) for airports between elevations of 1,345 feet (410 m) and 6,560 feet (2,000 m); and 500 feet (152 m) for airports above an elevation of 6,560 feet (2,000 m).

4. For approaches with visibility less than 1/2-statute mile (0.8 km), runway centerline to taxiway/taxilane centerline separation increases to 400 feet (122 m).

5. For approaches with visibility less than 1/2-statute mile (0.8 km), the separation distance increases to 500 feet (152 m).

6. If the runway elevation is greater than or equal to 100 feet (30.5 m) above sea level, with approaches with visibility less than 3/4 statute mile (1.2 km), the separation distance increases by an elevation adjustment. For approaches with visibility less than 1/2-statute mile (0.8 km), the separation distance increases to 550 feet (168 m).

7. Increase this distance 1 foot (0.3 m) for each 100 feet (30.5 m) above 5,100 feet (1,555 m) above sea level.

8. Increase this distance 1 foot (0.3 m) for each 100 feet (30.5 m) above sea level. For C-III aircraft, see footnote 7.

9. The RSA length beyond the runway end begins at the runway end when a stopway is not present. When a stopway is present, the length begins at the stopway end.

10. The RSA length beyond the runway end may be reduced to that required to install an EMAS (the designed set-back of the EMAS included). See the latest edition of AC 150/5220-22 for additional guidance.

11. This value only applies if that runway end is equipped with electronic or visual vertical guidance. ILS, GLS, LPV, VNAV, and RNP lines of minima provide electronic vertical guidance. A PAPI or VASI provides visual vertical guidance. If there is no such guidance for that runway, use the value for "length beyond departure end."

12. For airplanes with maximum certificated takeoff weight greater than 150,000 lbs (68,027 kg), the standard runway width is 150 feet (46 m), the shoulder width is 25 feet (7.6 m), and the runway blast pad width is 200 feet (61 m). A 150 feet (46 m) runway width may be acceptable to the FAA for MTOW as low as 134,000 lbs (60,781 kg), subject to the operator of the critical aircraft providing documentation from the aircraft manufacturer demonstrating an operational need for a 150 feet (46 m) wide runway.

13. When an RSA width of 500 feet (152 m) is not practical, an RSA width of 400 feet (122 m) is permissible.

14. Standard paved runway shoulders for aircraft with four or more engines in ADG VI and TDG 6 are 50 feet (15.2 m) and the paved blast pad width of 250 feet (76 m).

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APPENDIX H. DECLARED DISTANCES

H.1 Application.

Declared distances represent the maximum distances available and suitable for meeting aircraft takeoff, rejected takeoff, and landing distance performance requirements.

1. Declared distances apply to the certification and operation of turbine-engine powered transport category aircraft operating under 14 CFR Part 135, 14 CFR Part 121, and 14 CFR Part 91, *General Operating and Flight Rules*, (turbine include turbojets or turboprop powered aircraft).
2. The declared distances are:
   a. TODA and TORA, which apply to takeoff;
   b. ASDA, which applies to a rejected takeoff; and
   c. LDA, which applies to landing.
3. For turbine powered aircraft operations, the TODA includes a clearway, if present (reference 14 CFR Part 1). The ASDA includes a stopway, if present:
   a. By treating these distances independently, declared distances is a methodology resulting in declaring and reporting the TORA, TODA, ASDA, and LDA for each operational direction.
4. While there are not similarly stringent operating rules applicable to other aircraft types (e.g., reciprocating engine), declared distances are useful as advisory information to assist pilots with becoming familiar with all available information concerning the intended flight (see 14 CFR § 91.103).
5. Implementing declared distances is a reasonable alternative to mitigate existing runway shortcomings and thus better meet design standards, even when the critical aircraft is not a turbine-engine powered transport category aircraft:
   a. The full operational use of the paved runway is optimum.
   b. As part of the master plan process, the FAA expects all airport operators to review all reasonable mitigation alternatives prior to implementing declared distances.
   c. When it is not practical to meet all runway design standards, the use of declared distances is an interim condition ensuring flight safety until the airport implements improvements to the airport.
   d. The FAA does not recommend reducing the TORA on runways to mitigate incompatible land uses in the departure RPZ.
6. The FAA Airports Regional Office or ADO review and approval is necessary to implement proposals for declared distances not equal to the physical length of the runway.
7. Declared distances are normally published for all runways with turbine operations (even if not the critical aircraft) or runways with charted IFPs that have C and D

minima. At 14 CFR Part 139 airports, declared distance data are listed for all runway ends that are specified as Part 139 use.

H.1.1 Using Declared Distances.

Use declared distances as a way for incremental improvements when it is not practical to fully meet runway design standards. However, the optimum and preferred condition is a runway fully meeting design standards without the need for declared distances.

H.1.2 Declared distances either limit or increase runway use. The use of declared distances may result in a displaced runway threshold and may affect the beginning and ending of the RSA, ROFA, and RPZ (see Table H-1). For runways without published declared distances, the declared distances are equal to the physical length of the runway unless there is a displaced threshold. With a displaced threshold, the LDA is shortened by the length of the threshold displacement in the direction of landing at that displaced threshold. Declared distances that use a clearway or stopway to increase TODA and/or ASDA can provide turbine-engine powered, transport category aircraft using that runway, additional performance capability, and increased maximum allowable takeoff weights in some operating conditions.

Table H-1. Relation of Declared Distances to Design Standards

Declared Distance	Runway Design Standard
TORA	• Departure RPZ
TODA	• Departure Surface
ASDA	• RSA • ROFA
LDA	• RSA • ROFA • Approach Surface • Approach RPZ

H.2 RSA, ROFA, and RPZ Lengths and Related Nomenclature.

The nomenclature referenced in the following paragraphs is used throughout the rest of this section and is always based upon the direction of operation.

H.2.1 RSA and ROFA Standards.

The online Runway Design Standards Matrix Tool specifies the length “R” as the standard length of the RSA and ROFA beyond the runway departure end. The tool specifies length “P” as the standard length of the RSA and ROFA prior to the threshold. A full dimension RSA and full dimension ROFA extend the length of the runway plus 2 × R when there is no stopway. Where a stopway exists, measure R from the far end of

the stopway based upon the takeoff direction, and the RSA and ROFA extend the full length of the runway plus the length of the stopway(s) plus 2 × R.

H.2.2 Effective Length of RSA and ROFA beyond the Runway Ends.

As used in Figure H-6, Figure H-7, Figure H-10, Figure H-11, Figure H-10, Figure H-13, and Figure H-14, the RSA length "$\mathcal{L}_{RSA}$" is the effective length of the RSA beyond the runway ends. The ROFA length "$\mathcal{L}_{ROFA}$" is the effective length of the ROFA beyond the runway ends.

H.2.3 RPZ Lengths.

The online Runway Design Standards Matrix Tool specifies the standard RPZ length "L" for both the Approach RPZ and the Departure RPZ. See Figure 3-26, Figure 3-27, and Figure 3-28.

H.3 Background.

H.3.1 It is helpful to understand the relationship among aircraft certification, aircraft operating rules, airport data, and airport design for the application of declared distances in airport design. Aircraft certification provides the aircraft's performance distances.

H.3.2 The takeoff decision speed (V_1), and the following distances to take off or decelerate from V_1 are established by the manufacturer, and confirmed during certification testing for varying climatological conditions, operating weights, etc.

H.3.2.1 **Takeoff Run.**

The distance to accelerate from brake release to lift-off, plus safety factors. (See TORA, paragraph A.1.1.)

H.3.2.2 **Takeoff Distance.**

The distance to accelerate from brake release past lift-off to start of takeoff climb, plus safety factors. (See TODA, paragraph H.4.2.)

H.3.2.3 **Accelerate-Stop Distance.**

The distance to accelerate from brake release to V_1 and then decelerate to a stop, plus safety factors. (See ASDA, paragraph H.4.3.)

H.3.2.4 **Landing Distance.**

The distance from the threshold to complete the approach, touchdown, and decelerate to a stop, plus safety factors. (See LDA, paragraph H.5.1.)

H.3.3 Aircraft operating rules provide a minimum acceptable level of safety by controlling the aircraft maximum operating weights and limiting the aircraft's performance distances as follows:

- Takeoff run does not exceed the length of runway.
- Takeoff distance does not exceed the length of runway plus clearway (if applicable).

- Accelerate stop distance does not exceed the length of runway plus stopway (if applicable).
- Landing distance does not exceed the length of runway.

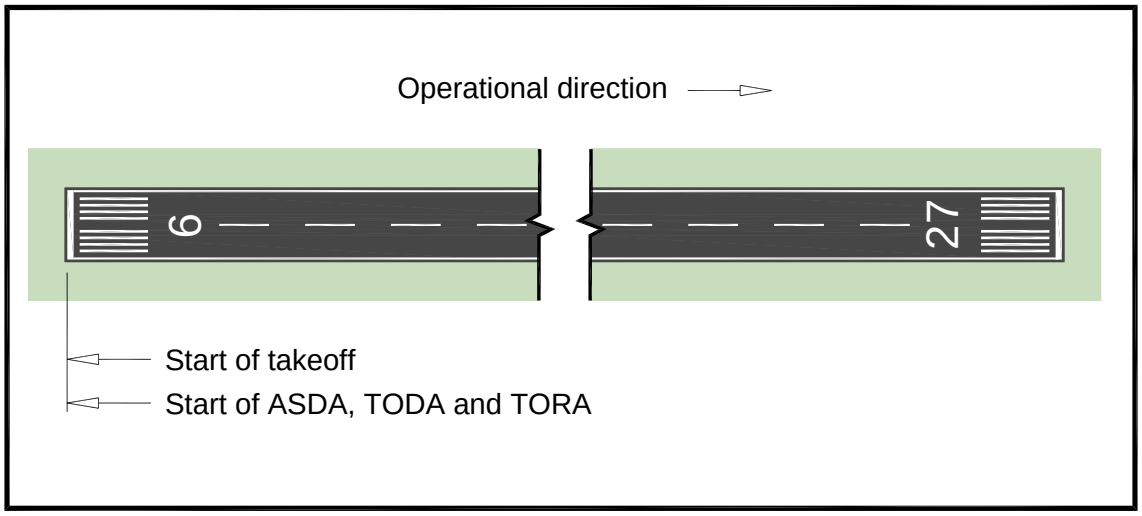
H.3.4 Airport data provides the runway length and/or the following declared distance information for calculating maximum operating weights and/or operating capability.

H.4 **For Takeoff.**

Start of takeoff ends of runway:

1. The start of takeoff for TORA, TODA, and ASDA will always be co-located.
2. Do not consider the threshold locations, the RPZs, nor the RSA and ROFA behind the start of takeoff, in establishing the start of takeoff.
3. The start of takeoff is most often at the beginning of the runway but may also be located farther down along the operational takeoff directions of the runway (see Figure H-1).
4. Declare TODA, TORA, and ASDA when starting at a location other than the beginning of the runway.

Figure H-1. Typical Starting Point for ASDA, TODA, and TORA



H.4.1 TORA.

The TORA is the length of runway declared available and suitable for satisfying takeoff run requirements.

1. When the full runway beyond the start of takeoff is available for the takeoff run, the departure end of the TORA is located at the DER.

2. Since TORA can never be longer than the TODA (see paragraph H.4.2), whenever the TODA is shortened to less than the runway length to mitigate penetrations to the departure surface, the TORA is limited to the length of the TODA (see Figure H-4).

3. If a clearway exists and it begins prior to the DER, the TORA ends at the beginning of the clearway (see Figure H-3).

H.4.2 TODA.

The TODA is equal to the TORA plus the length of any remaining runway or clearway (if applicable) beyond the departure end of the TORA available for satisfying takeoff distance requirements.

1. Considerations for determining the TODA:

   a. the start of takeoff,

   b. departure surface requirements, and

   c. any clearway.

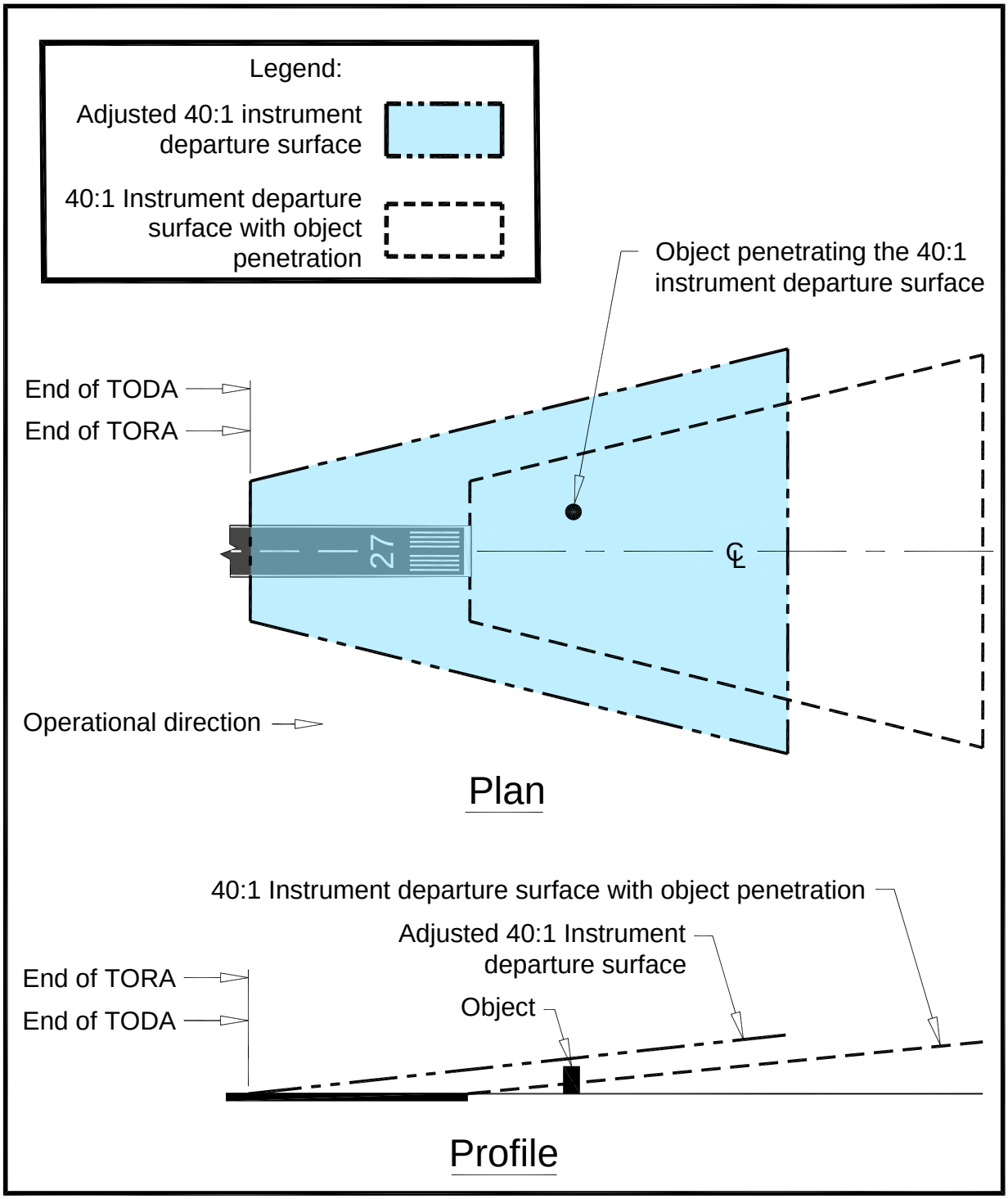
2. When only the full runway beyond the start of takeoff is available for takeoff distance, locate the departure end of the TODA at the DER (see Figure H-4).

3. Limiting the TODA from extending to the runway end is one method to mitigate penetrations to the 40:1 instrument departure surface, where applicable (see Figure H-4).

4. The TODA may also extend beyond the runway end through the use of a clearway (see Figure H-3 and Figure H-5).

5. The full length of the TODA may not be usable for a particular operation and may be limited by obstacles in the departure area and aircraft performance.

Figure H-2. Modified TODA and TORA due to Object Penetration of 40:1 Surface



Note 1: The penetration to the instrument departure surface has been mitigated by the decreased length of the TODA (see paragraph 3.6.2).

Note 2: TORA has been limited by TODA. TORA can never be longer than TODA.

Note 3: Sections 1 and 2 of departure surfaces not shown for clarity. Refer to Figure 3-9, Figure 3-11, and paragraph 3.6 for information on departure surfaces.

Figure H-3. Extended TODA with Clearway – Shortened TORA

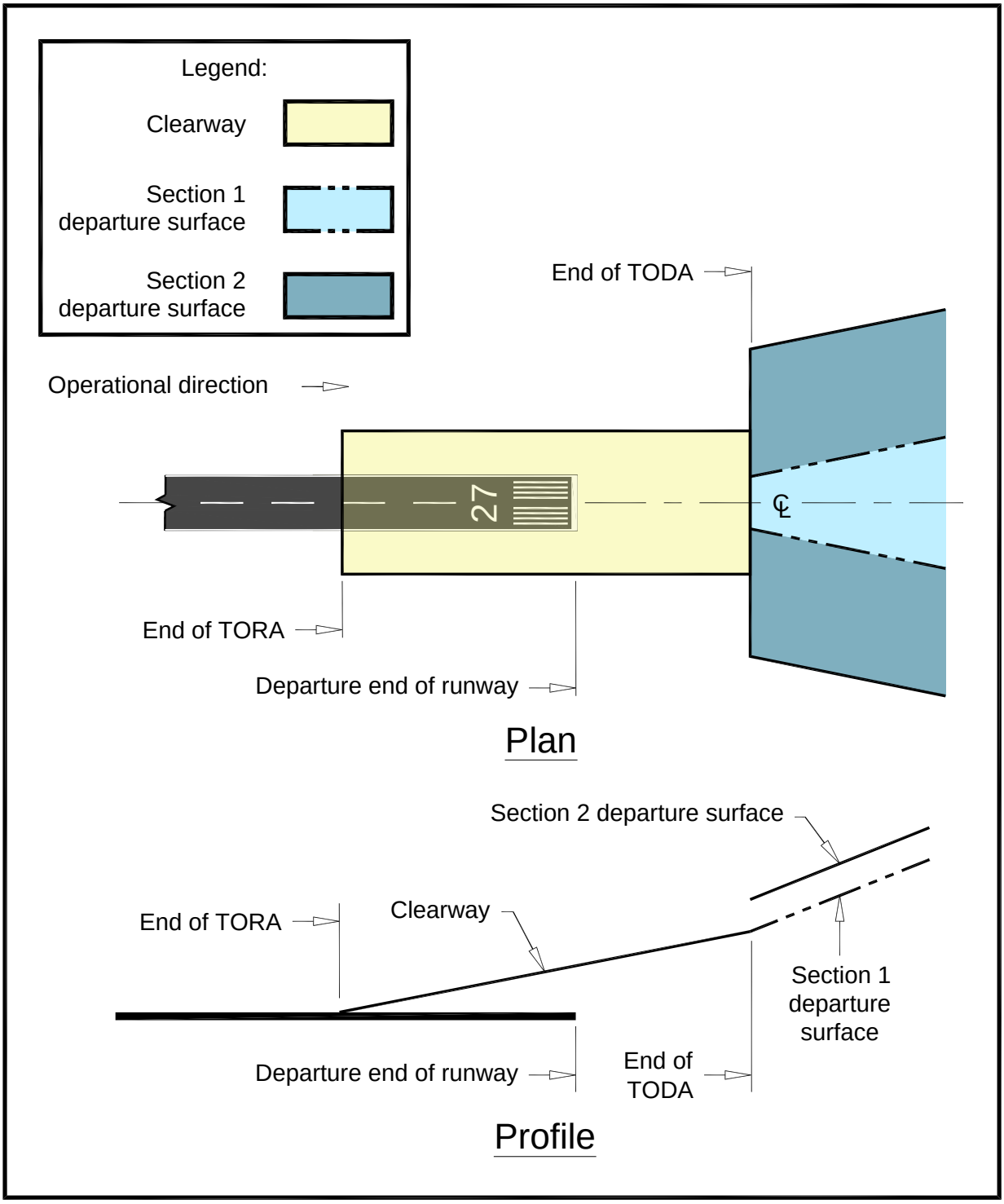


Figure H-4. Typical Location of TODA Departure End of Runway (DER) – No Clearway

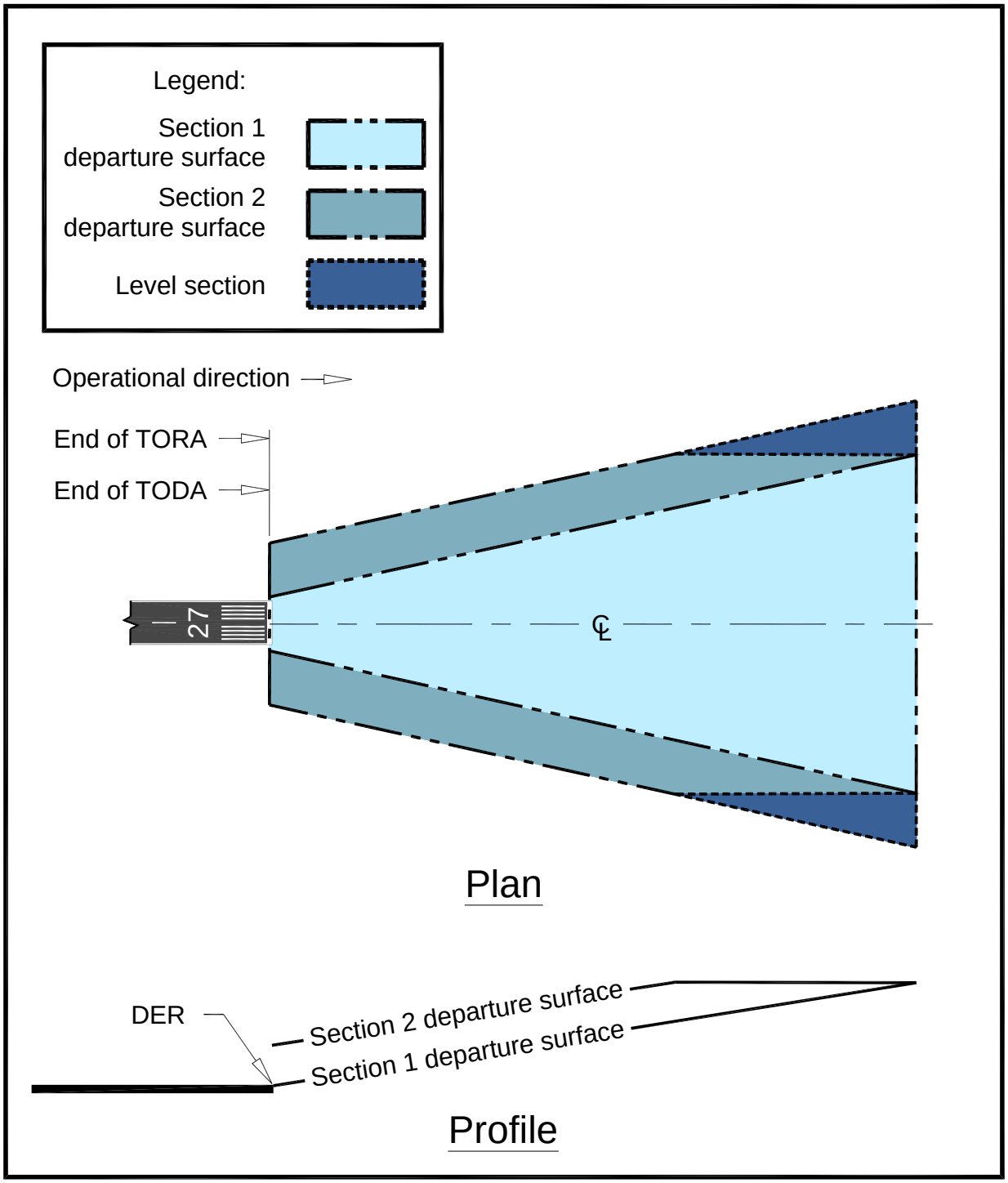
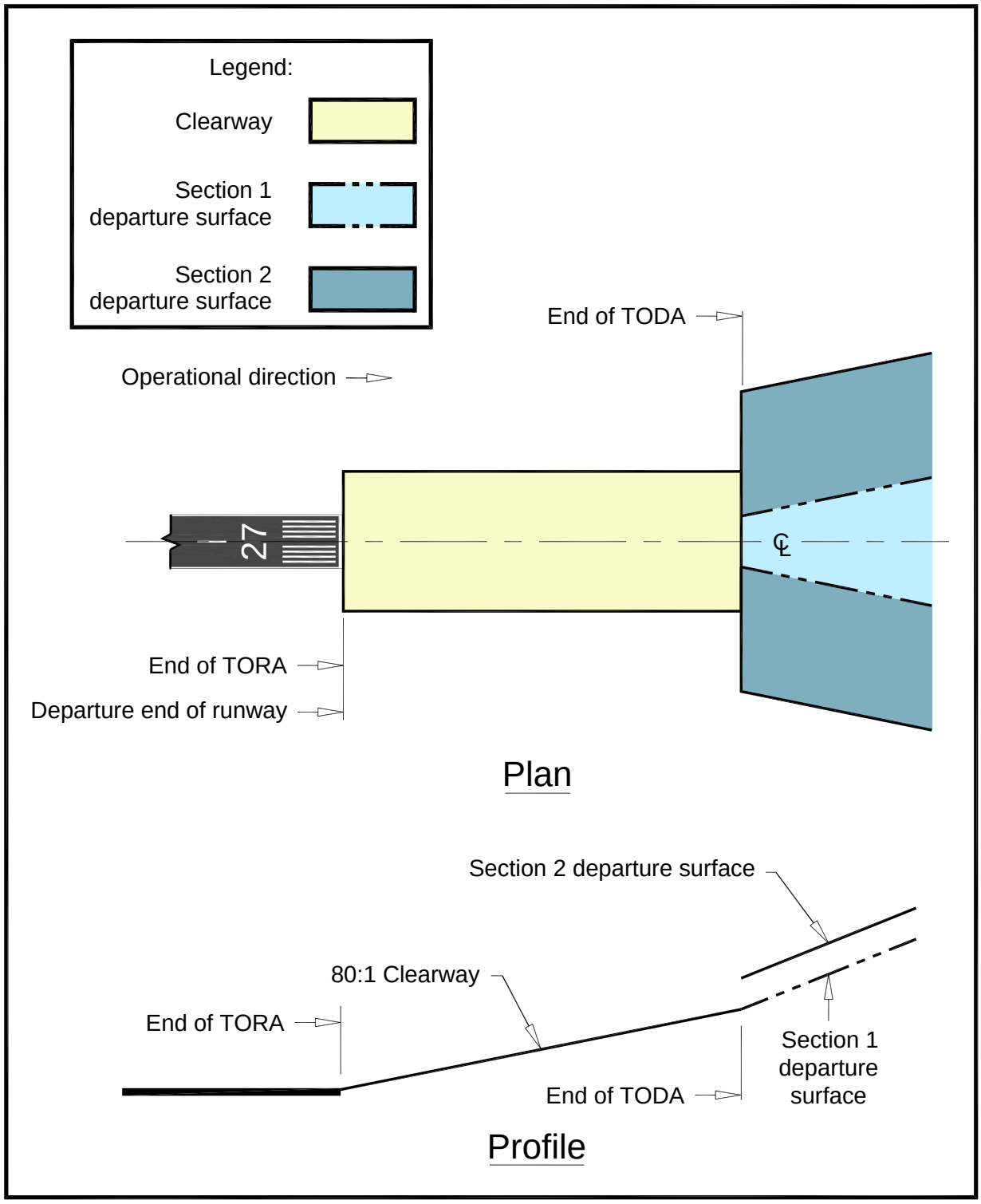


Figure H-5. Extended TODA with Clearway – Typical TORA



H.4.2.1 **Clearway.**

When present, a clearway only affects the TODA declared distance value. It is located at the departure end of the TORA. See paragraph 3.14.

1. When the TORA does not extend to the end of the runway, a clearway (if any) extends beyond the end of the TORA and may extend beyond the end of the runway.
2. Any portion of the runway extending into the clearway is unavailable and/or unsuitable for takeoff run computations.
3. Add the length of the clearway to the TORA to determine TODA, which is used for takeoff distance calculations.
4. A clearway may increase the allowable aircraft operating takeoff weight without increasing runway length.

H.4.3 ASDA.

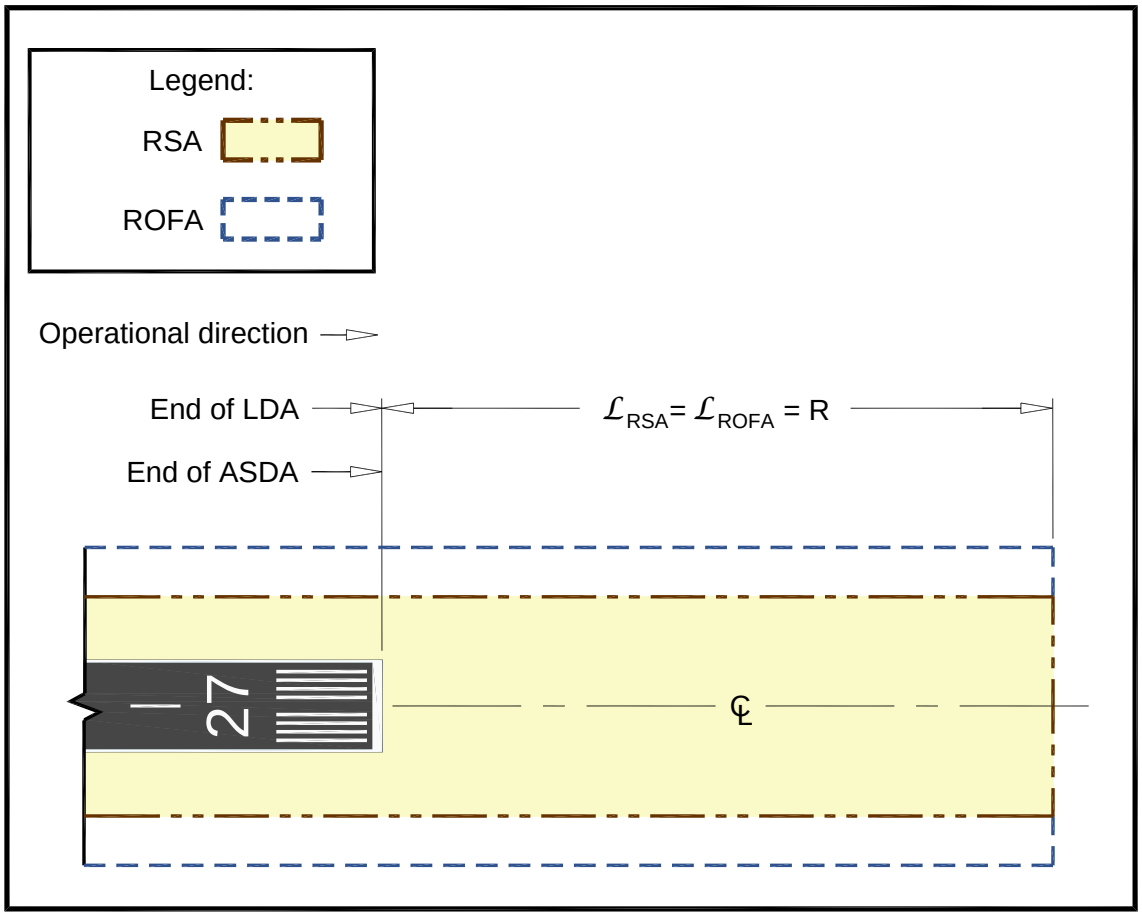
The ASDA is the length of runway plus stopway (if any) declared available and suitable for satisfying accelerate-stop distance requirements for a rejected takeoff.

1. Consideration for determining the ASDA:
   a. the start of takeoff,
   b. the RSA beyond the ASDA, and
   c. the ROFA beyond the ASDA.
2. When only the full runway beyond the start of takeoff is available for completing a rejected takeoff, locate the departure end of the ASDA at the end of the runway, with the standard RSA and ROFA length R beyond the DER (see Figure H-6).
3. When the standard RSA length R beyond the end of the runway does not exist or is not obtainable, reducing the ASDA is one way to obtain additional RSA beyond the ASDA, as illustrated in Figure H-7.
4. When using declared distances to provide ROFA not obtainable beyond the DER, and $\mathcal{L}_{ROFA}$ is less than $\mathcal{L}_{RSA}$, obtain additional ROFA beyond the ASDA by reducing the ASDA, as illustrated in Figure H-10.
5. When a runway includes a stopway, the RSA and ROFA extend R beyond the stopway (see Figure H-11).
6. It may be necessary to use EMAS in conjunction with declared distances.
7. The portion of runway beyond the ASDA is unavailable and/or unsuitable for ASDA computations.

H.4.3.1 **Stopway.**

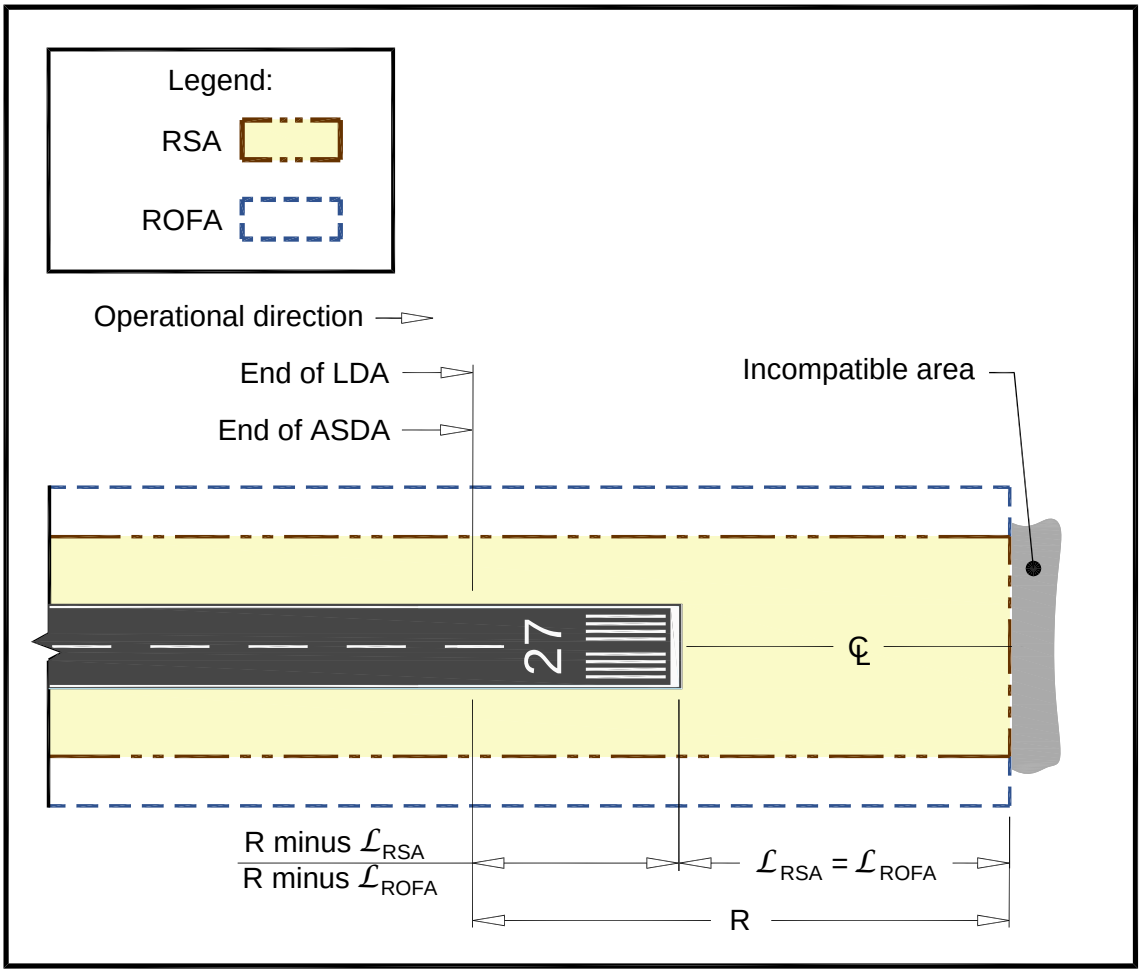
When present, a stopway only affects the ASDA declared distance value. See the definition of a stopway in paragraph 1.5, item 87.

Figure H-6. Typical Location of Departure End of ASDA and LDA



Note 1: When a stopway exists, see Figure H-11 for the departure end of the ASDA.
Note 2: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.
Note 3: R denotes standard RSA and ROFA.

Figure H-7. Adjusted ASDA and LDA Departure End for the RSA



Note 1: When a stopway exists, see Figure H-11 for the departure end of the ASDA.

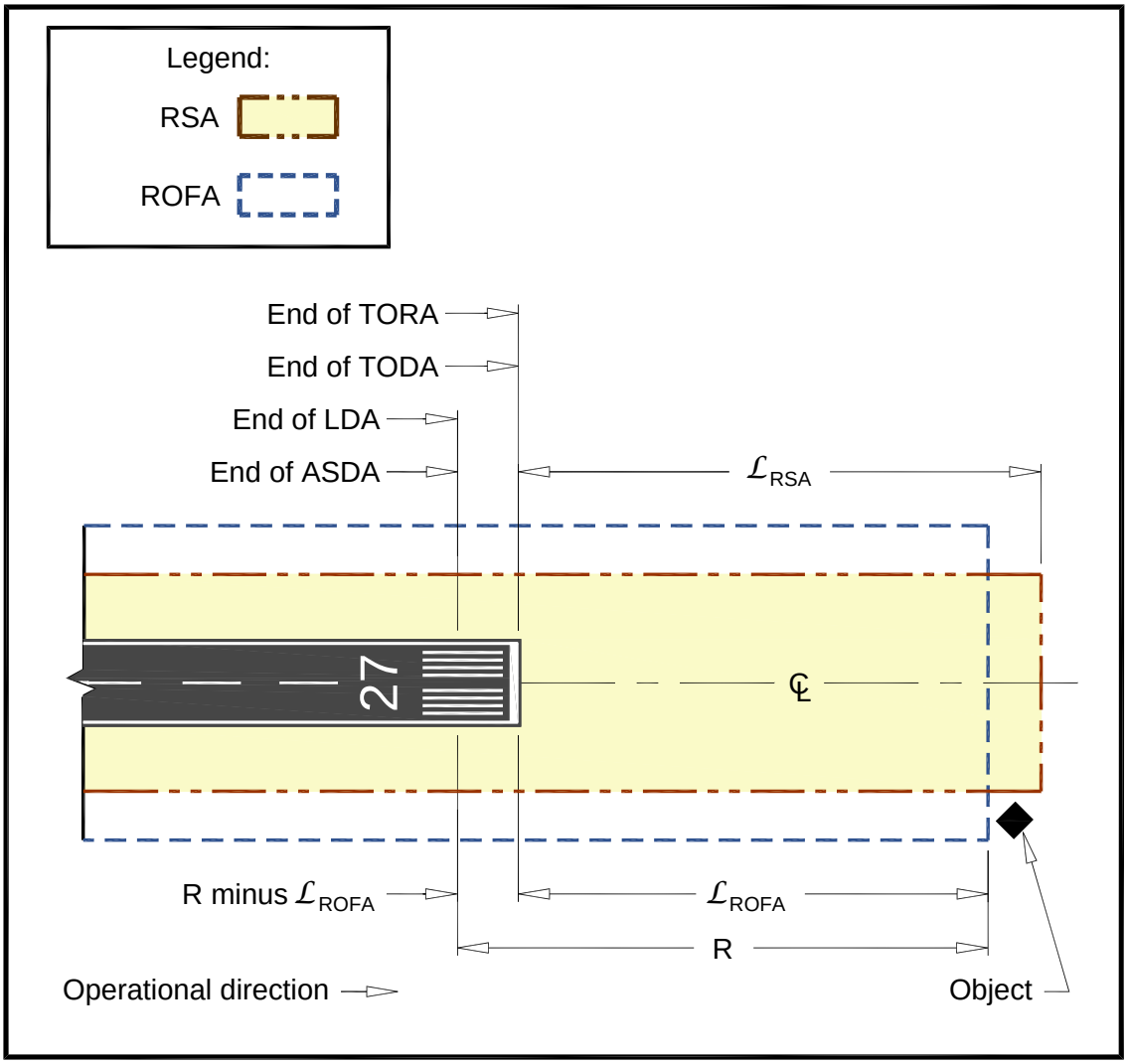
Note 2: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.

Note 3: R denotes standard RSA and ROFA.

Note 4: When declared distances are used as an incremental improvement, and R is not obtainable beyond the LDA, this dimension equals the length of RSA obtainable beyond the ASDA.

Note 5: When declared distances are used as an incremental improvement, and R is not obtainable beyond the LDA/ASDA, this dimension may equal the length of RSA obtainable beyond the LDA/ASDA minus $\mathcal{L}_{RSA}$.

Figure H-8. Adjusted ASDA and LDA Departure End for ROFA



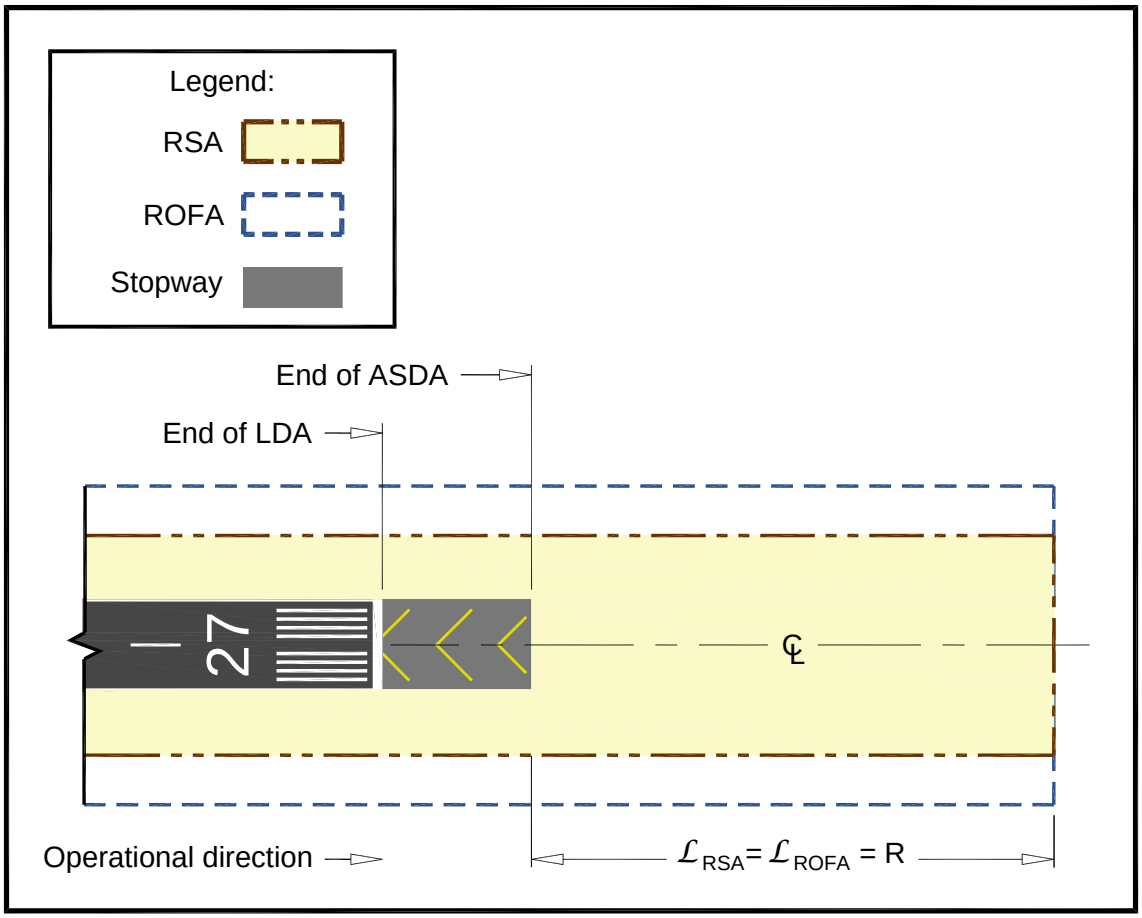
Note 1: When a stopway exists, see Figure H-11 for the departure end of the ASDA.

Note 2: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.

Note 3: R denotes standard RSA and ROFA.

Note 4: When declared distances are used as an incremental improvement and R is not obtainable beyond the LDA/ASDA, this dimension may equal the length of ROFA obtainable beyond the LDA/ASDA minus $\mathcal{L}_{ROFA}$.

Figure H-9. Departure End of ASDA with Stopway



Note 1: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.
Note 2: R denotes standard RSA and ROFA.

H.5 For Landing.

H.5.1 LDA.

The LDA is the length of runway declared available and suitable for satisfying landing distance requirements.

1. Considerations for determining the LDA:
   a. approach surface,
   b. approach RPZ,
   c. RSA and ROFA prior to the threshold, and
   d. RSA and ROFA beyond the LDA.

H.5.1.1 The Beginning of the LDA.

The LDA begins at the threshold. When the RSA, ROFA, approach RPZ, and threshold siting requirements are met, the threshold is normally placed at the beginning of the runway (see Figure H-10). When these standards do not exist, displacing the threshold is an option to attain them.

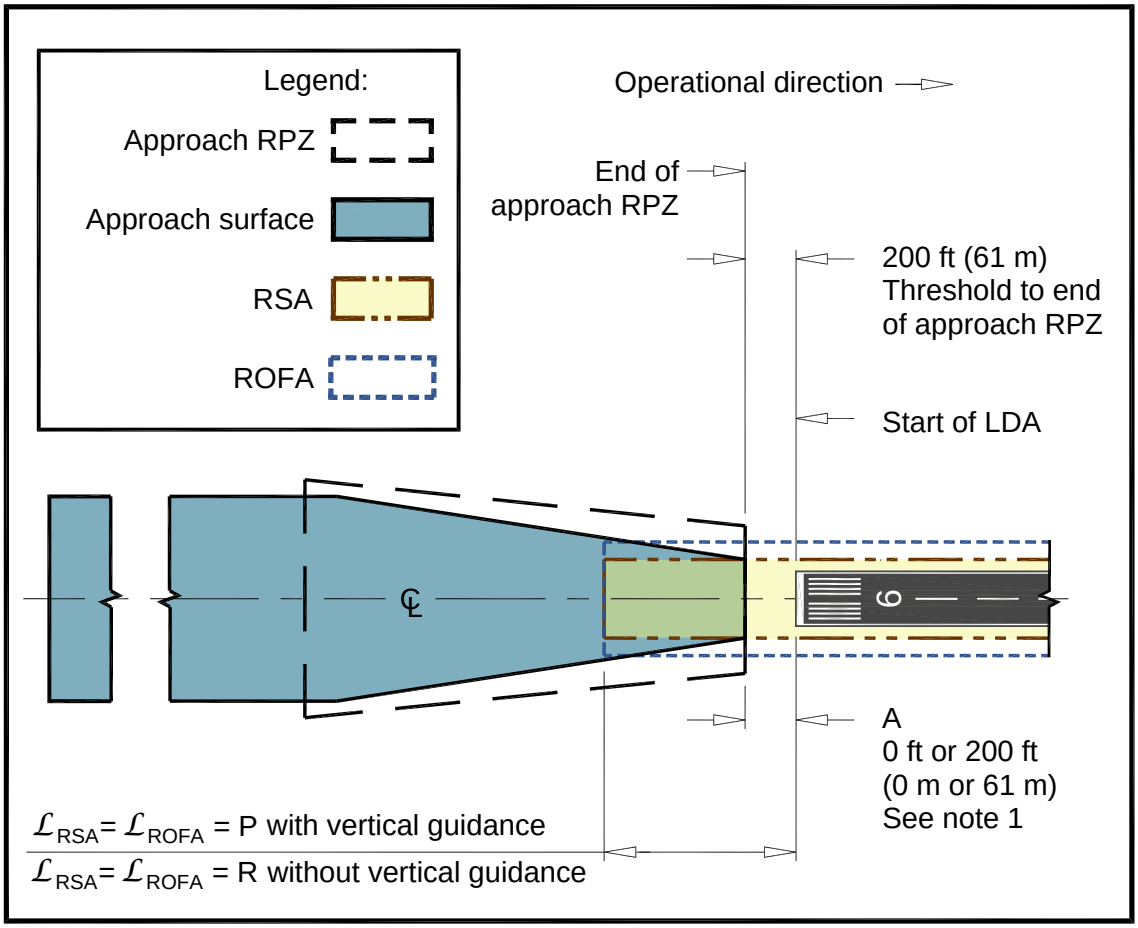
1. If there are multiple reasons to displace a threshold:
   a. Calculate each displacement requirement.
   b. Select the longest displacement.
   c. Re-evaluate all other criteria from the calculated threshold location to ensure that they are not violated, such as new obstacle penetrations due to the splay of the approach surface that is associated with the new threshold.
2. Displacing the threshold is an option to obtain additional RSA and ROFA, to mitigate unacceptable incompatible land uses in the RPZ, and to meet approach surface requirements (see Figure H-10, Figure H-13, Figure H-12, Figure H-13, and Figure H-14).

H.5.1.2 The End of the LDA.

When the LDA extends to the end of the runway, the full dimension RSA and ROFA extend beyond the runway end by length R.

1. Except when a stopway exists as part of the ASDA, the LDA ends at the same location as the end of the ASDA.
2. A stopway cannot be part of the LDA.
3. When the full dimension RSA/ROFA length R beyond the runway end is not obtainable, obtain additional RSA beyond the LDA by reducing the LDA, as illustrated in Figure H-7.
4. When the full dimension ROFA length R is not obtainable and $\mathcal{L}_{ROFA}$ is less than $\mathcal{L}_{RSA}$, obtain additional ROFA beyond the LDA by reducing the LDA, as illustrated in Figure H-10.
5. EMAS can be used to meet RSA standards; it may be necessary to use EMAS in conjunction with declared distances.
6. The portion of runway beyond the LDA is unavailable for LDA computations (see Figure H-7 and Figure H-10).

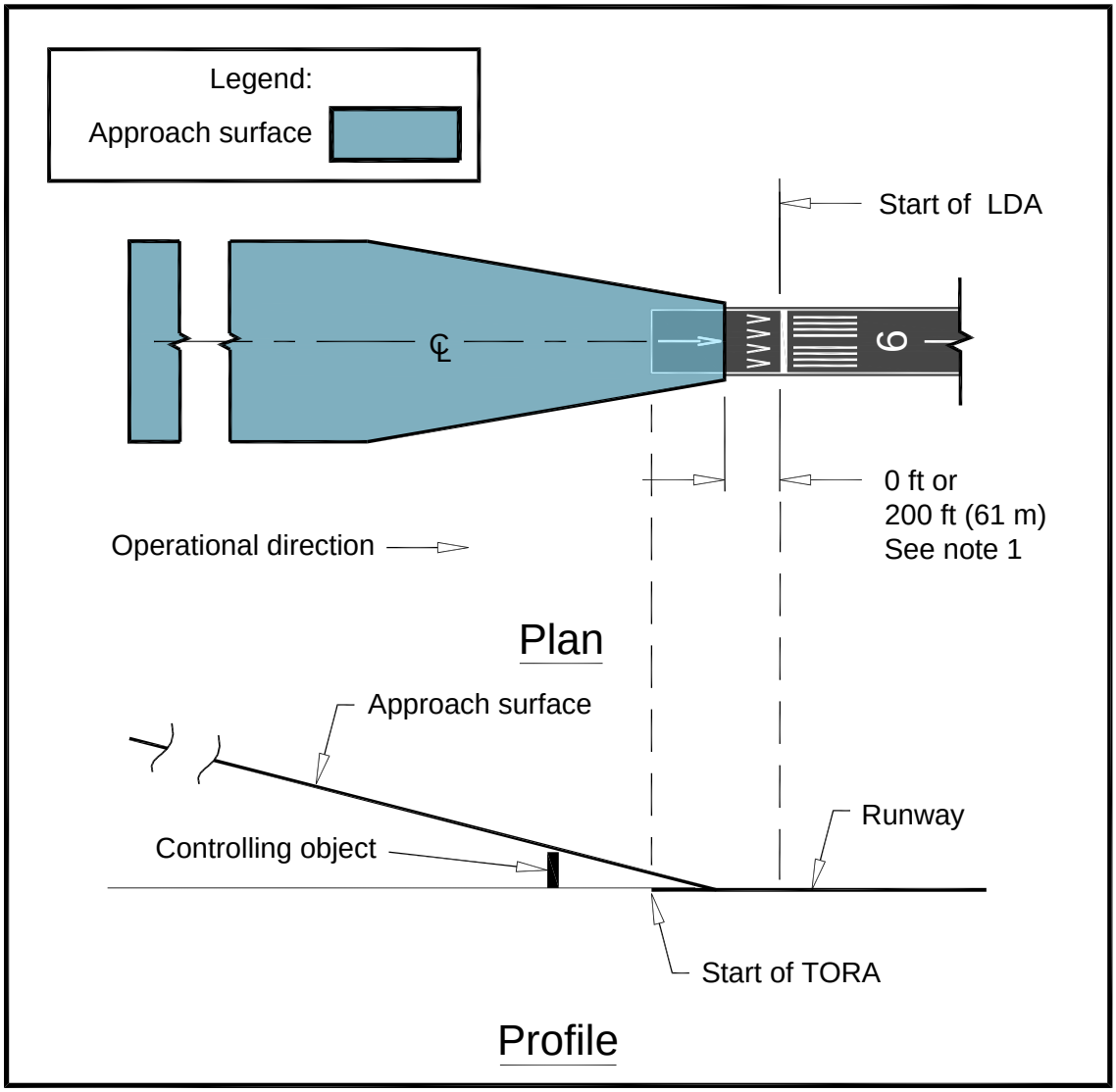
Figure H-10. Typical Start of LDA



Note 1: See Table 3-2, Table 3-3, and Table 3-4.

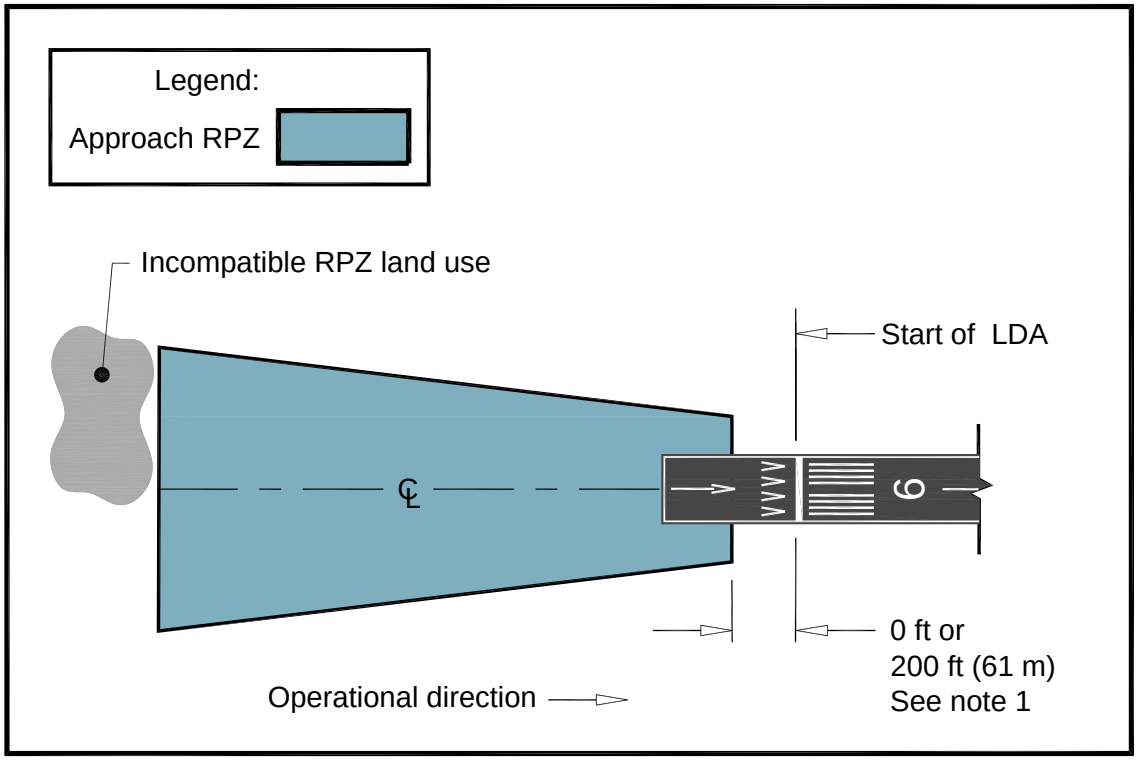
Note 2: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.

Figure H-11. LDA Starting Point – Displaced Threshold for Approach and Departure Surfaces



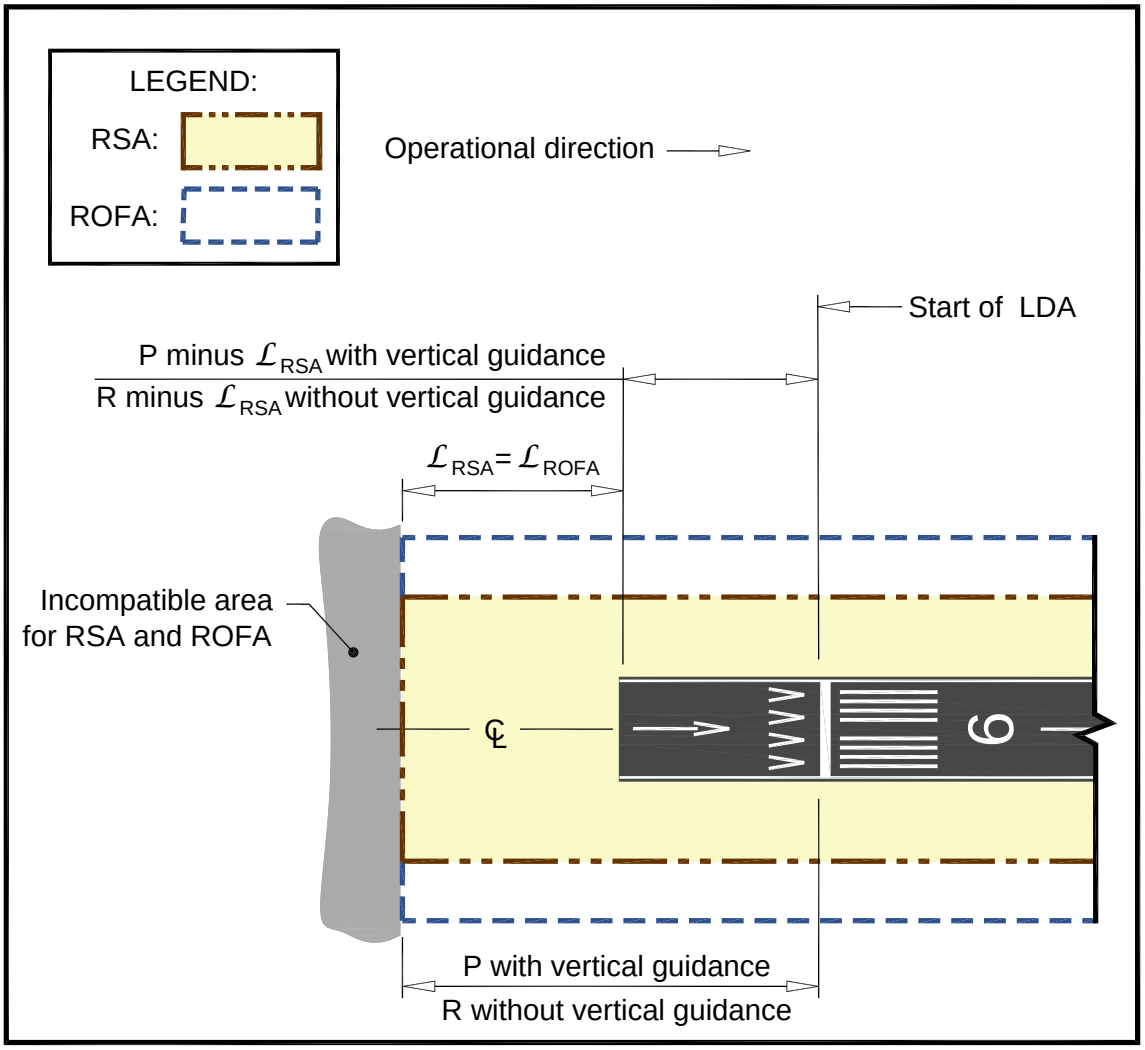
Note 1: See Table 3-2, Table 3-3, and Table 3-4.

Figure H-12. LDA Starting Point – Displaced Threshold for Adjusted RPZ



Note 1: See paragraph 3.13.1.1.

Figure H-13. LDA Starting Point – Displaced Threshold for Adjusted RSA



Note 1: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.

Note 2: When declared distances are used as an incremental improvement, and the applicable P or R is not obtainable prior to the LDA, this dimension equals the length of RSA obtainable prior to the LDA.

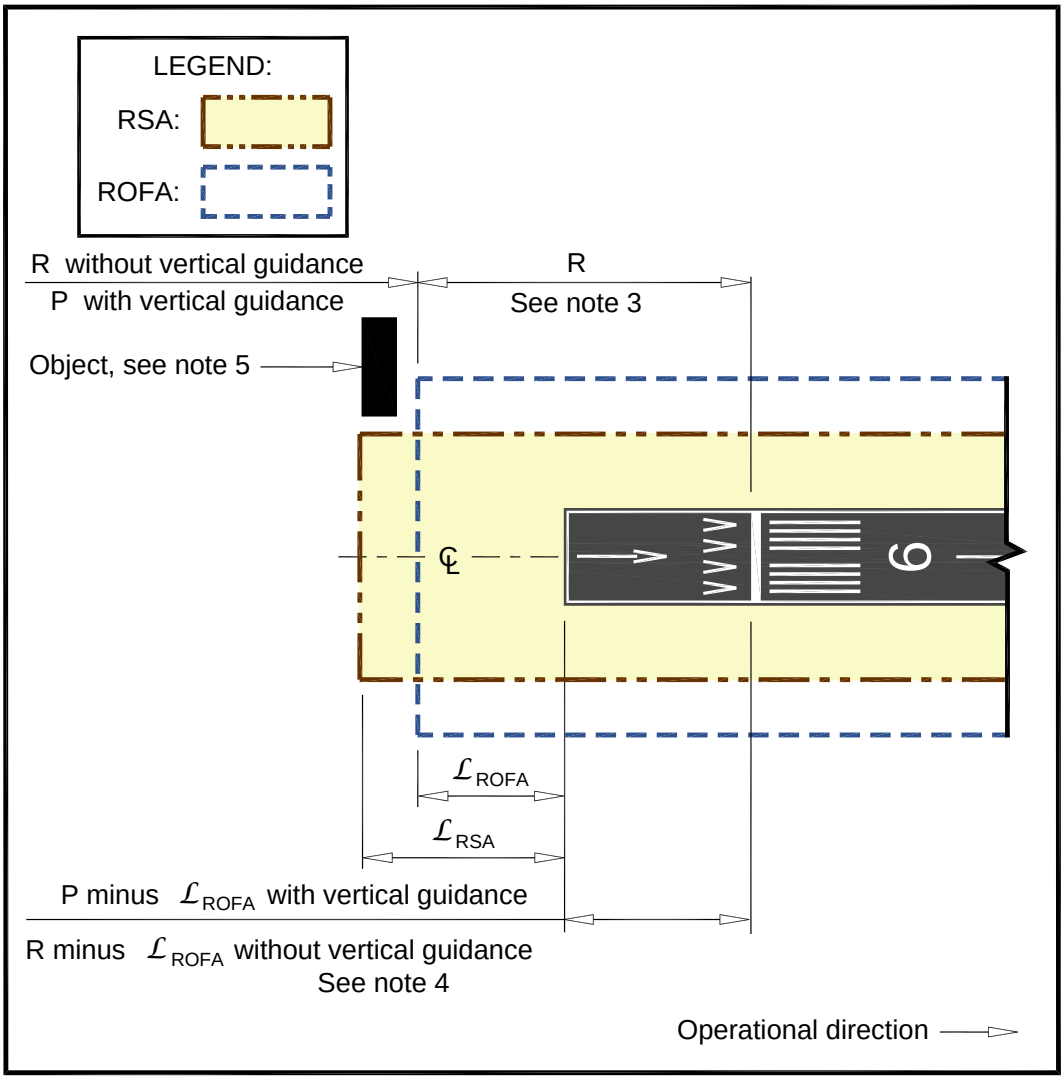
Note 3: When declared distances are used as an incremental improvement, and the applicable P or R is not obtainable prior to the LDA, this dimension equals the length of RSA prior to the LDA minus $\mathcal{L}_{RSA}$.

H.6 Notification.

H.6.1 The airport owner provides the clearway and stopway lengths, if necessary, and declared distances (TORA, TODA, ASDA, and LDA) for inclusion in the Airport Master Record (FAA Form 5010, see https://adip.faa.gov), Chart Supplement (and in the Aeronautical Information Publication for international airports) for each operational runway direction.

H.6.2 Publish declared distances for all international airports and Part 139 certificated airports, even when the distances are equal to the runway length in both directions. When the threshold siting is for small airplanes, report LDA as "LDA for airplanes of 12,500 lbs (5669 kg) or less maximum certificated takeoff weight."

Figure H-14. LDA Starting Point – Displaced Threshold for Adjusted ROFA



Note 1: $\mathcal{L}_{RSA}$ and $\mathcal{L}_{ROFA}$ denote the effective lengths of the RSA and ROFA beyond the runway end, respectively.

Note 2: R denotes standard RSA and ROFA.

Note 3: When declared distances are used as an incremental improvement, and the applicable P or R is not obtainable prior to the LDA, this dimension equals the length of ROFA obtainable prior to the LDA.

Note 4: When declared distances are used as an incremental improvement, and the applicable P or R is not obtainable prior to the LDA, this dimension equals the length of ROFA prior to the LDA minus $\mathcal{L}_{ROFA}$.

Note 5: Object within the ROFA and protruding above the nearest point of the RSA.

H.7 Documenting Rationale for Declared Distances.

On the ALP, identify the declared distance values that are not the same as the physical runway length. Include the rationale on how implementing declared distances satisfies runway design standards.

1. Indicate (when applicable):
   a. the controlling obstacle or noise mitigation triggering the threshold displacement
   b. the reason for a takeoff starting at a location other than the typical start of takeoff
   c. all reasons for limiting the TORA, TODA ASDA, and LDA to less than the runway length
2. Document the controlling limitations and the reason for the ASDA or TODA extending beyond the runway end.
3. Where a controlling limitation is removed, ensure that there are no other limiting conditions impacting the TORA, TODA, ASDA, or LDA before revising (increasing) a respective declared distance(s).

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APPENDIX I. RUNWAY ADDITIONAL INFORMATION

I.1 Purpose.

This appendix provides additional runway design guidance including:

1. RSA development
2. RPZ background
3. Using a runway as a taxiway
4. Object clearing
5. Threshold displacement on a visual runway
6. Overlapping RSAs

I.2 Additional Information and Guidance on Runway Safety Area (RSA) Development.

The RSA enhances the safety of aircraft which undershoot, overrun, or veer off the runway, and provides greater accessibility for ARFF equipment during such incidents. Figure I-1 depicts the approximate percentage of aircraft overrunning the runway which stay within a specified distance from the runway end. The current RSA standards are based on 90% of overruns being contained within the RSA. The RSA is depicted in Figure 3-19 and its dimensions are given in the online Runway Design Standards Matrix Tool.

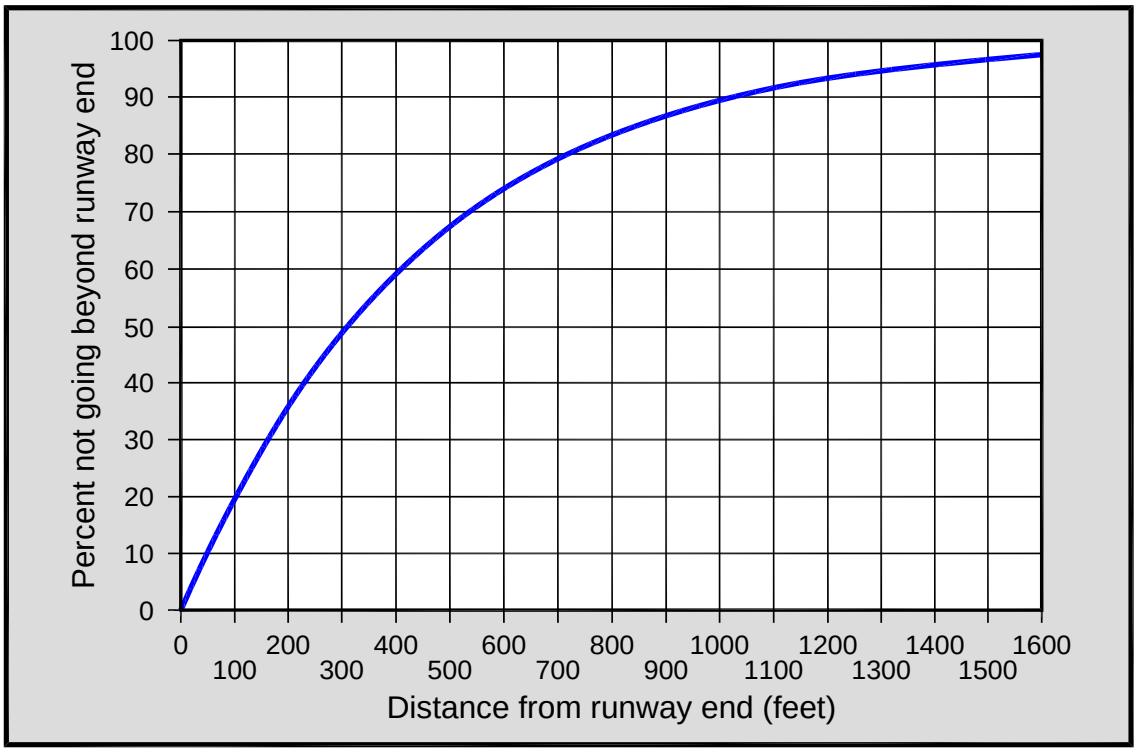
I.2.1 Historical Development.

In the early years of aviation, all aircraft operated from relatively unimproved airfields. As aviation developed, the alignment of takeoff and landing paths centered on a well-defined area known as a landing strip. The requirements of more advanced aircraft necessitated improving or paving the center portion of the landing strip. Retaining the term “landing strip” to describe the graded area surrounding and upon which the runway or improved surface was constructed, the primary role of the landing strip changed to that of a safety area surrounding the runway. This area had to be capable under normal (dry) conditions of supporting aircraft without causing structural damage to the aircraft or injury to its occupants. Later, the designation of the area changed to “runway safety area” to reflect its functional role.

I.2.2 Incremental Improvements.

The FAA recognizes that incremental improvements inside full RSA dimensions enhance the safety margin for aircraft. The airport owner and the FAA continually analyze a non-standard RSA with respect to operational, environmental, and technological changes and revise the safety area determination, as appropriate. Include incremental improvements in the determination. The concept of incremental improvement precludes the placing of objects within the standard RSA dimensions even if that runway does not fully meet RSA standards.

Figure I-1. Percent of Aircraft Overrun Versus Distance Beyond the Runway End



Note: Values in the graph are rounded to the nearest foot. 1 foot = 0.305 meters.

I.3 Runway Protection Zone (RPZ) Background.

Approach protection zones were originally established to define land areas beneath aircraft approach paths where control by the airport operator prevented the creation of air navigation hazards. Historical development:

1. A 1952 report by the President's Airport Commission (chaired by James Doolittle), entitled *The Airport and Its Neighbors*, recommended the establishment of clear areas beyond runway ends.
2. Provision of these clear areas was not only to preclude obstructions potentially hazardous to aircraft, but also to control building construction to protect from nuisances and hazards to people on the ground.
3. The Department of Commerce concurred with the recommendation on the basis that this area was "primarily for the purpose of safety and convenience to people on the ground."
4. The FAA adopted "Clear Zones" with dimensional standards to implement the Doolittle Commission's recommendation.
5. Guidelines were developed recommending that clear zones be kept free of structures and any development creating a place of public assembly.

I.3.1 In conjunction with the introduction of the RPZ as a replacement term for Clear Zone, the RPZ was divided into "extended object free" and "controlled activity" areas. The extended OFA has subsequently been renamed as the "central portion of the RPZ." The FAA has since dropped this designation for differentiating the RPZ into different zones. The extended RSA and ROFA protect the areas most critical to the runway ends.

I.3.2 The RPZ function is to enhance the protection of people and property on the ground. Where practical, airport owners own the property under the runway approach and departure areas to at least the limits of the RPZ. It is desirable to clear the entire RPZ of all above-ground objects to minimize risk to the public. See AC 150/5190-4, *Airport Land Use Compatibility Planning*, for guidance on incompatible activities within an RPZ.

I.4 Using a Runway as a Taxiway.

Using runways as a taxiway introduces an elevated risk to operational safety. Performing taxi operations on a runway can lead to potential pilot confusion due to the wider pavement surface and the lack of standard taxiway pavement markings, signage, and lighting. If the operational use of a runway as a taxiway is necessary for airport capacity and local conditions preclude standard parallel taxiways, establish a Letter of Agreement with the ATCT describing the operation. Refer to AC 150/5340-1 for marking holding positions on a runway.

I.5 Object Clearing.

I.5.1 Safe and efficient landing and takeoff operations at an airport require that certain areas on and near the airport are clear of objects or restricted to objects with a certain function, composition, and/or height.[v] These clearing standards and criteria create a safer environment for the aircraft operating on or near the airport. The airport operator is not required to prevent or clear penetrations to the 14 CFR Part 77, Subpart C, imaginary surfaces when the FAA determines these penetrations are not hazards. However, any existing or proposed object, whether man-made or of natural growth that penetrates these surfaces is classified as an "obstruction" and is presumed to be a hazard to air navigation. These obstructions are subject to an FAA aeronautical study, after which the FAA issues a determination stating whether the obstruction is in fact considered a hazard. The airport operator conducts a detailed analysis considering the

[v] The heights of traverse ways are adjusted as explained in 14 CFR § 77.9(c): "Any highway, railroad, or other traverse way for mobile objects, [is] adjusted upward 17 feet for an Interstate Highway that is part of the National System of Military and Interstate Highways where overcrossings are designed for a minimum of 17 feet vertical distance, 15 feet (4.6 m) for any other public roadway, 10 feet or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road, 23 feet for a railroad, and for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it…"

requirements of FAA Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS)*, to ensure all applicable surfaces are captured.

I.5.2 OFZs require clearing of object penetrations including aircraft fuselages and tails. Frangible NAVAIDs that need to be located in the OFZ because of their function are exempt from this standard. Paragraph 3.11 specifies OFZ standard dimensions.

I.5.3 Remove penetrations or locate the runway end such that there are no penetrations to the approach and departure surfaces. See paragraphs 3.5 and 3.6 for runway end establishment and approach and departure surfaces.

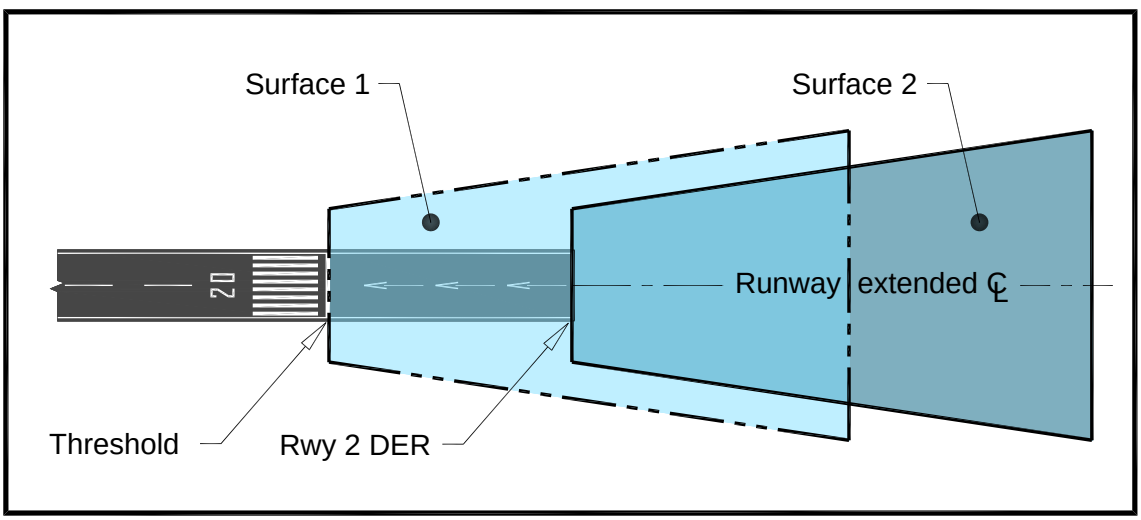
I.6 Threshold Displacement.

A displacement to a runway threshold may be necessary to ensure vertical separation from obstructions by arriving aircraft, or to remove incompatible land uses from the RPZ. See paragraph 3.5 for runway end siting criteria.

I.6.1 The pavement prior to the displaced threshold (marked by arrows) remains available for departures from either end.

I.6.2 Applying the relevant approach surface at the two surfaces, shown in Figure I-2, provides vertical protection for both landing, Surface 1, and takeoff, Surface 2.

Figure I-2. Threshold Displacement on a Visual Runway



I.6.3 Do not consider existing objects as obstacles to air navigation that penetrate Surface 2, unless otherwise identified as a hazard to air navigation through an aeronautical study.

I.6.4 Protecting the Surface 2 area is a recommended practice to guard against the introduction of objects penetrating the surface. If future mitigation actions succeed in removing the limiting obstacle causing the threshold displacement, then restoration of

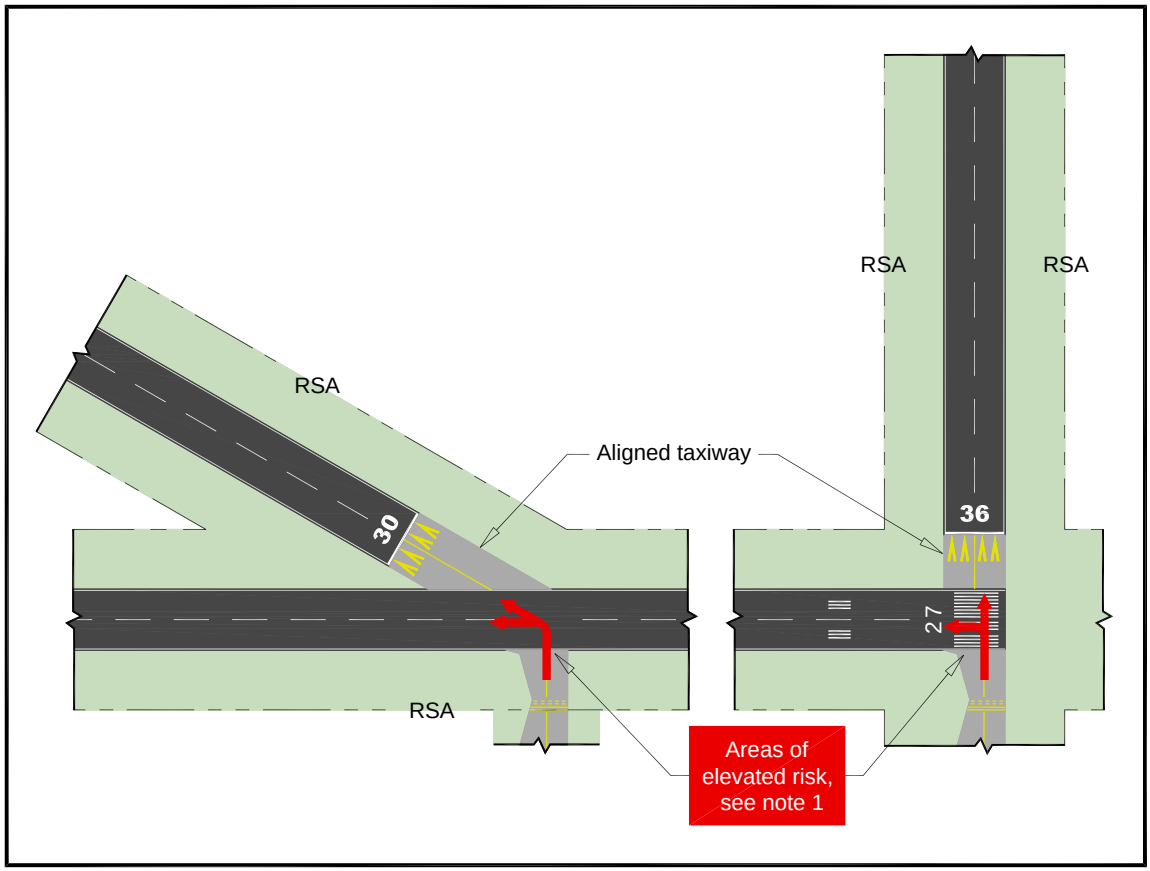
the threshold to the full runway length can occur without removing new objects clear of Surface 1 but penetrating Surface 2. With the application of Surface 2 to guard against new objects, the approach surface from the physical end of the runway will already be clear of obstacles.

I.6.5 The FAA recommends airports enact local zoning, easements, or other means to prevent future airport encroachment that can adversely affect aircraft operations.

I.7 Overlapping RSAs.

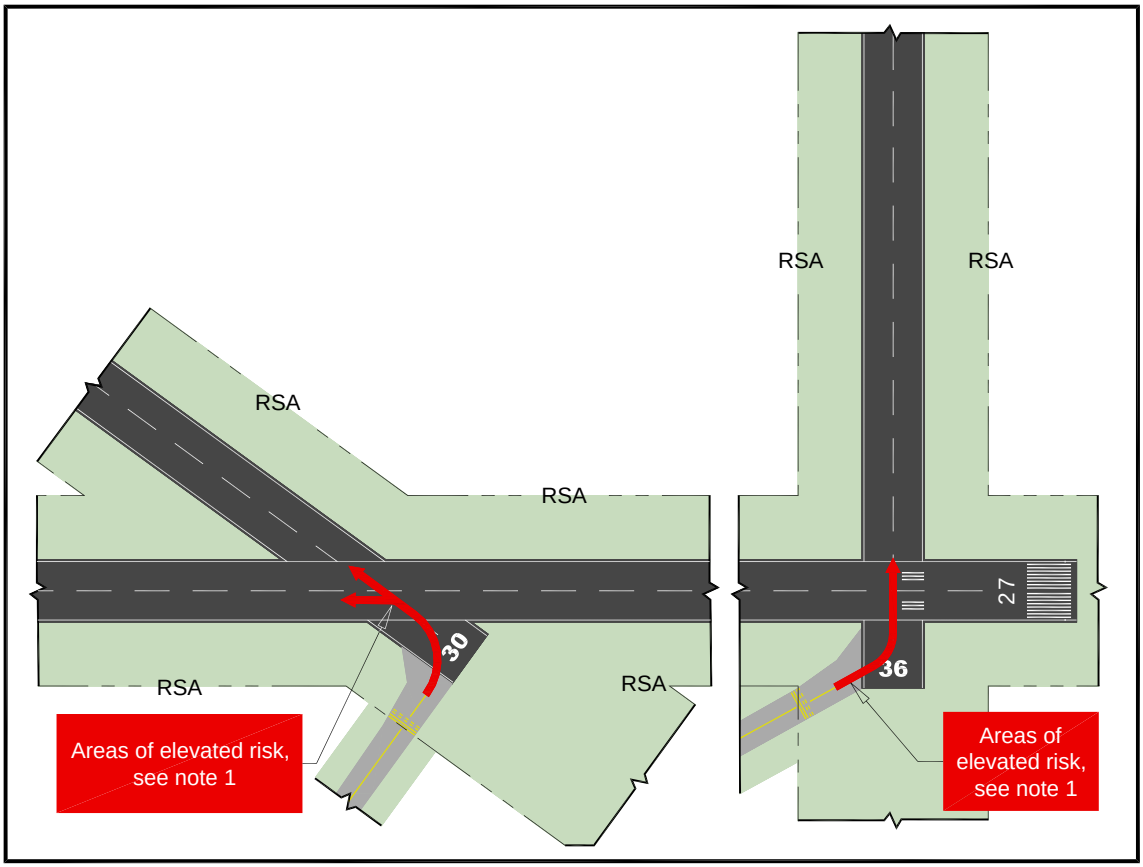
Runway configurations resulting in a runway threshold being located in close proximity to another runway or runway threshold, create an elevated risk for runway incursions and wrong surface events. Two typical scenarios are: the RSAs overlap (Figure I-3) or the runways intersect (Figure I-4). These configurations do not provide sufficient physical space for designing entrance taxiways or associated markings and signage, thus increasing the potential for pilot confusion and loss of situational awareness. Refer to Chapter 2 for standards addressing converging and intersecting runways.

Figure I-3. Overlapping Runway Safety Areas – Elevated Risk



Note 1: These configurations present an elevated risk for vehicle operators and for pilot loss of situational awareness that can contribute to a wrong runway takeoff.

Figure I-4. Intersecting Runways – Elevated Risk



Note 1: These configurations present an elevated risk for pilot loss of situational awareness that can contribute to a wrong runway takeoff or runway incursion.

I.8 Runway Object Free Area (ROFA) Background.

The ROFA serves two principal purposes:

1. Development buffer in proximity to a runway, and
2. Wing clearance for a runway excursion event to the outer limit of the RSA.

I.8.1 History.

The initial version of AC 150/5300-13 established the ROFA clearing standard to preclude location of objects and parked aircraft near the runway, excluding objects fixed-by-function. Prior to this, the BRL and separation to aircraft parking served to control development in the Part 77 primary surface of a runway. Subsequent updates clarified the characteristics of the ROFA to preclude agricultural operations, tie the ROFA elevation to the RSA edge elevation, and define fixed-by-function objects as those necessary for air navigation or ground maneuvering purposes.

I.8.2 Development Buffer.

The development buffer limits placement of objects to those necessary for air navigation and ground maneuvering (e.g., signs). The ROFA provides sight lines from the runway to intersecting taxiways and runways, as well as visual aids (e.g., wind cones). Protection of the ROFA also reserves space for future development of a parallel taxiway that permits proper alignment of aircraft at a holding position on an entrance taxiway.

I.8.3 Wing Obstacle Clearance.

In the event of a runway excursion, the ROFA provides a measure of wing protection if the aircraft reaches the lateral limit of the RSA. Objects necessary for air navigation or ground maneuvering do not pose a conflict with the wing if the object is below the elevation of the RSA edge, or if the location of the object is a distance from the RSA greater than half the wingspan of the critical aircraft. Use of frangible mounts minimize risk for fixed-by-function objects exceeding the RSA elevation.

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APPENDIX J. TAXIWAY ADDITIONAL INFORMATION

J.1 Purpose.

This appendix provides additional taxiway design guidance including:

1. Additional information and guidance on taxiway fillet design supplementing the design standards and recommended practices in paragraph 4.7.
2. Background and rationale for fillet design, including a step-by-step fillet design example.
3. Tables containing intersection details and dimensions for a range of turn angles for all TDG groups.
4. Methodology and calculations for reductions in TOFA standards.
5. Discussion and examples of taxiway geometries with elevated runway incursion and other safety risks.

J.2 Taxiway Fillet and Turn Design.

J.2.1 Development of Taxiway Design Groups (TDGs).

The FAA's TDG concept designs airport taxiways based on the path of airplanes' landing gear. Developing the TDGs included the adoption of certain initial parameters. These are:

1. Standards for the width of straight taxiway sections are unchanged.
2. Standards for TESM are unchanged.
3. Centerline radii in turns minimize tire scrubbing by limiting nose gear steering angles to 50 degrees, as recommended by airframe manufacturers.
4. Designs are based on cockpit over centerline steering.

J.2.2 When known, use the following to calculate the path of an airplane's main gear in a turn:

1. The centerline radius.
2. The point of the airplane that follows the centerline.
3. The distance from that point to the center of the main landing gear (see paragraph 4.2).
4. The overall width of the MGW.

J.2.3 The FAA plotted the CMG and MGW of 125 airplanes, with the MGW limits equal to current taxiway widths minus the TESM on each side. Apparent separations in length groupings determined the CMG limits.

J.2.4 Each TDG represents a theoretical airplane with the maximum CMG and maximum MGW for that group. Computer modeling of the airplane negotiation of a turn of a particular change in direction, or delta, determines the taxiway turn radii and fillets.

J.2.5 Description.

As an airplane maneuvers through a turn designed for cockpit over centerline taxiing, the main gear requires additional pavement in the form of fillets to maintain the TESM.

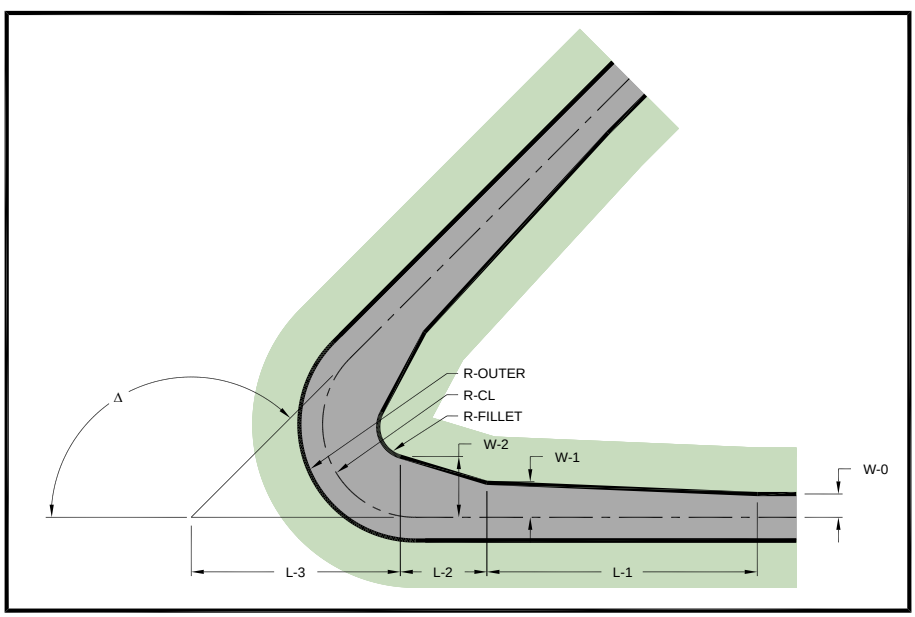
1. Design the fillets based on the TDG of the most demanding aircraft.
2. Base the outer radius of the curve design on the centerline radius.
3. The nose gear is not a factor in pavement requirements for a taxiway turn.

J.2.6 Fillet Design Rationale.

Refer to Figure J-1 for the following fillet design rationale:

1. At the start of the turn, the taxiway taper starts on the inside of the turn for length L-1, with the distance from the taxiway centerline to the pavement edge tapering from W-0 to W-1.
2. As the airplane continues, the distance from the taxiway centerline to the pavement edge taper increases further, for length L-2, from width W-1 to W-2, ending at distance L-3 from the point of intersection.

Figure J-1. Fillet Design Example



3. The tapers associated with dimensions L-1 and L-2 are symmetrical about a line bisecting the angle between the two centerlines, and the L-2 tapers connected by a fillet of radius R-Fillet, tangent to both.

4. The track of the main gear controls the fillet dimensions as the airplane exits the turn and the main gear returns to a symmetrical track about the taxiway centerline.

5. Since the main gear follows an asymptotic curve, it can take over 1000 ft (305 m) for the airplane to become re-centered. For this reason, the intersection of the L-1 taper and the straight taxiway edge is at a point where the actual TESM is within 6 inches (152 mm) of the applicable standard. See Figure J-7.

J.2.7 Taper Transitions.

Base the transition point from the "L-1" taper to the "L-2" taper on minimizing excess pavement, maximizing constructability, and ensuring compatibility with taxiway edge lighting standards. Determine W-1 by the location of this transition point.

J.2.8 Common Turning Angles.

Table J-1 through Table J-8 provide dimensions for a range of common turning angles, assuming sufficient distance is available to develop lead-in lengths.

J.2.9 Adjoining Taxiway Turns.

The standard fillet dimensions may not be suitable for taxiway turns close to each other. An indication of this is when the "L-1" tapers overlap, thus not allowing the critical aircraft to straighten out before entering the second turn. This is often the case for 90-degree runway entrances and exits connecting to a parallel taxiway. Applying the standard fillet dimensions may not adequately maintain the TESM and/or maximum 50-degree nose gear steering angle.

J.2.10 Design Tools.

J.2.10.1 Use the Taxiway Fillet Design Tool, available on the FAA website at https://www.faa.gov/airports/engineering/airport_design/, to determine the radius and taper lengths for single turns and two closely spaced turns.

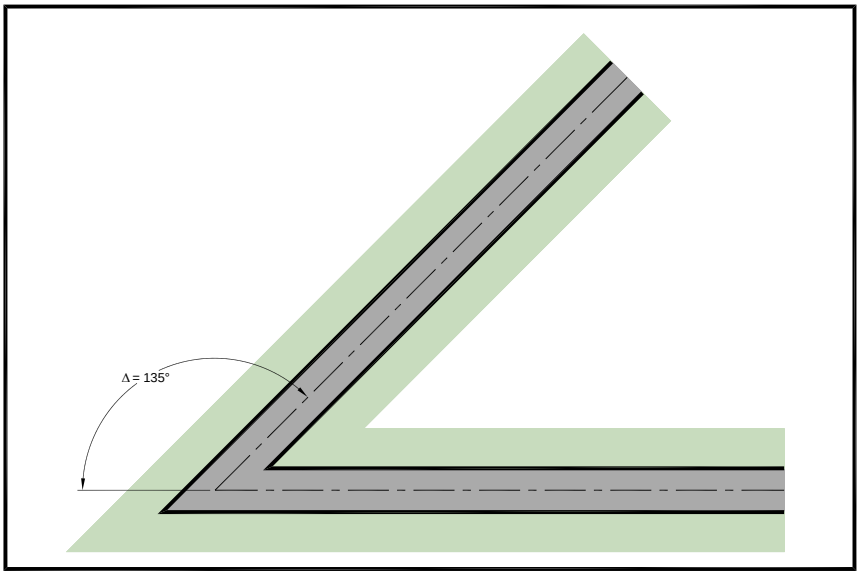
J.2.10.2 CAD modeling assists with selection of the centerline turn radius, outer pavement, and fillet dimensions for separation distances and turns not listed in the tables located in this appendix.

J.2.11 Examples Using CAD Modeling.

Refer to Figure J-2 through Figure J-10 for examples of curve designs that were generated using CAD modeling of aircraft ground maneuvering.

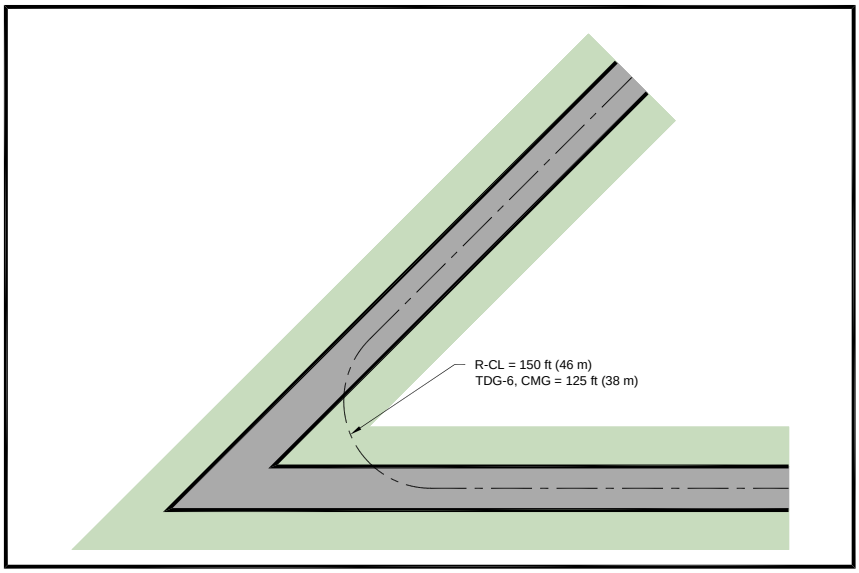
J.2.11.1 Figure J-2 illustrates the design of a curve for an angle of intersection (e.g., delta) of 135 degrees for TDG 6 aircraft.

Figure J-2. Angle of Intersection (Delta)



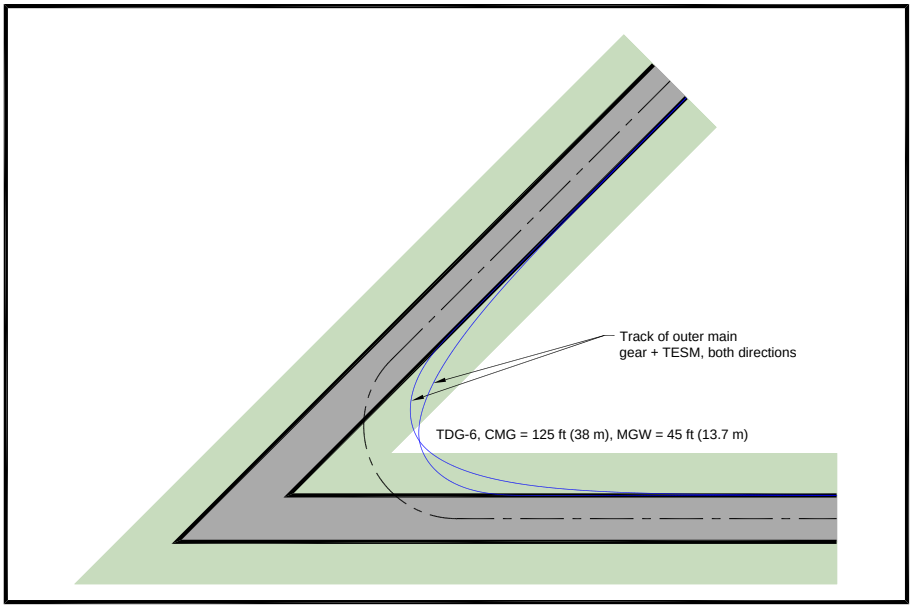
J.2.11.2 Per Figure J-3, connect the two centerlines with a radius calculated that will result in a steering angle of no more than 50 degrees based on the maximum CMG of the TDG. Per Figure 1-1, the maximum CMG for TDG 6 is 125 feet (38 m).

Figure J-3. Steering Angle of No More Than 50 Degrees



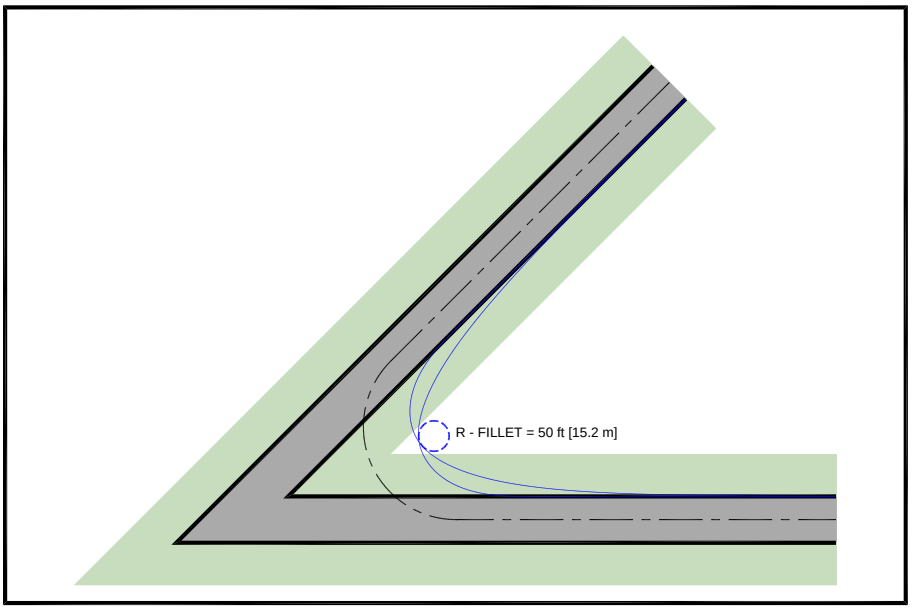
J.2.11.3 As shown in Figure J-4, model the track of the main gear of the longest CMG and widest MGW using an offset equal to the TESM. For TDG 6, the TESM is 14 feet (4.3 m).

Figure J-4. Track of the Main Gear is Modeled, Offset by the Taxiway Edge Safety Margin (TESM)



J.2.11.4 Per Figure J-5, select a fillet radius minimizing excess pavement while providing the standard TESM. This example uses an R-fillet equal to 50 feet (15.2 m).

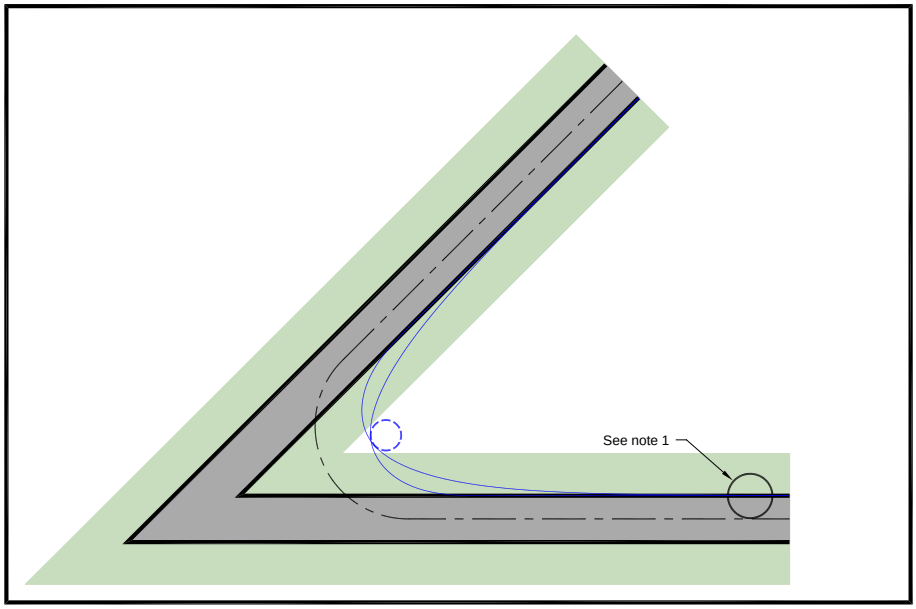
Figure J-5. Minimize Excess Pavement While Providing the Standard TESM



J.2.11.5 In Figure J-6, the pavement edge (or main gear track + TESM) is offset by 6 inches (152 mm), for the determination of the intersection between the

main gear track and the pavement edge. Either method may be used to apply the 6-inch (152 mm) reduction in TESM, noted in paragraph J.2.6.

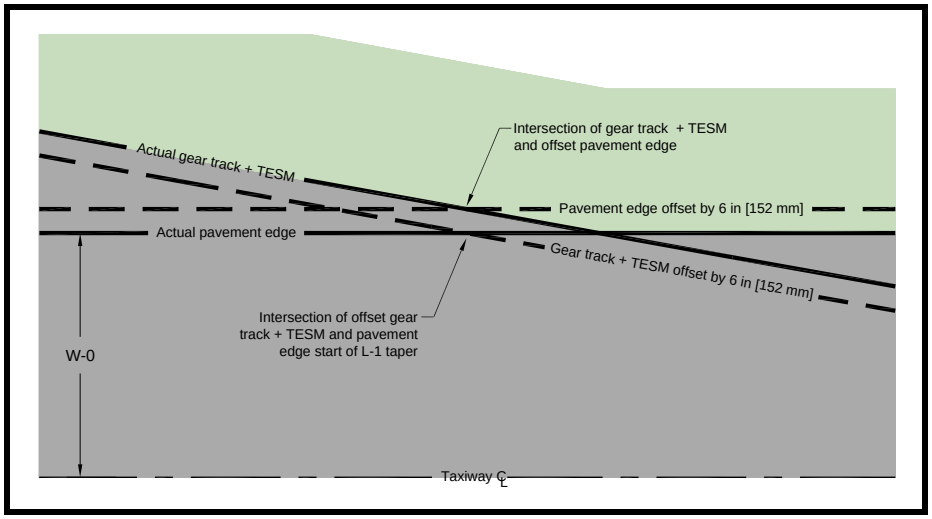
Figure J-6. Pavement Edge (Main Gear Track + TESM) Offset by 6 inches (152 mm)



Note 1: See Figure J-7 for details of this area.

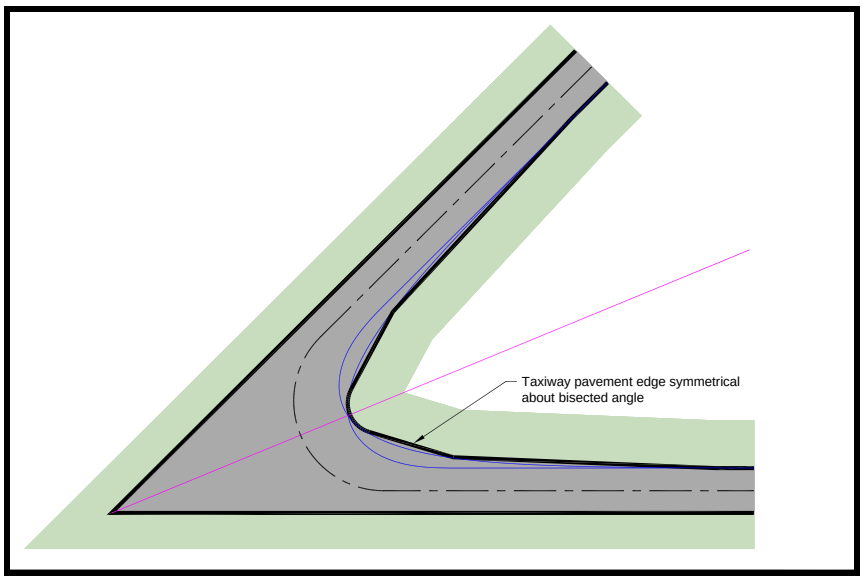
J.2.11.6 Figure J-7 shows offsetting either the actual pavement edge or the gear track plus TESM. As noted in paragraph 4.7.1, calculating this point recognizes the asymptotic nature of an airplane aligning with the taxiway centerline upon exiting a turn.

Figure J-7. Detail of Figure J-6



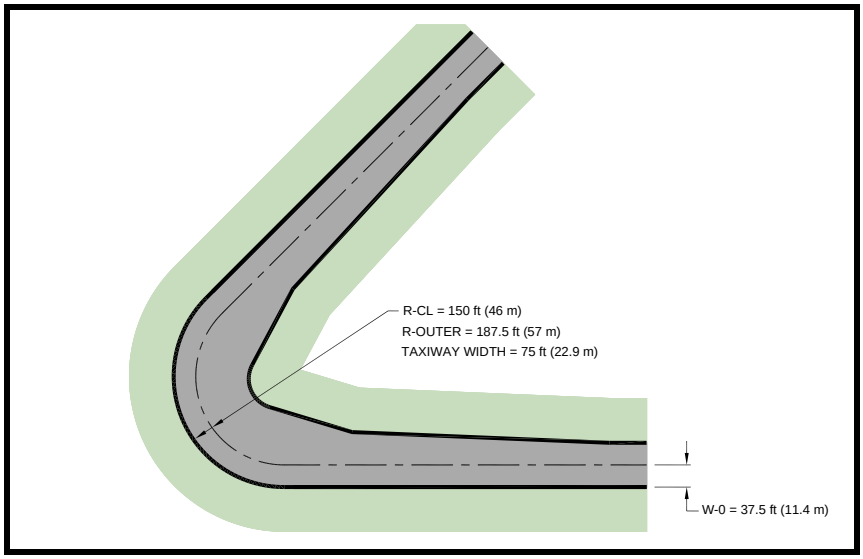
J.2.11.7 In Figure J-8, select tapers to minimize excess pavement while considering constructability. The point of intersection of the tapers determines the dimension W-1, as shown in Figure J-1.

Figure J-8. Taper Selection to Minimize Excess Pavement with Consideration for Constructability



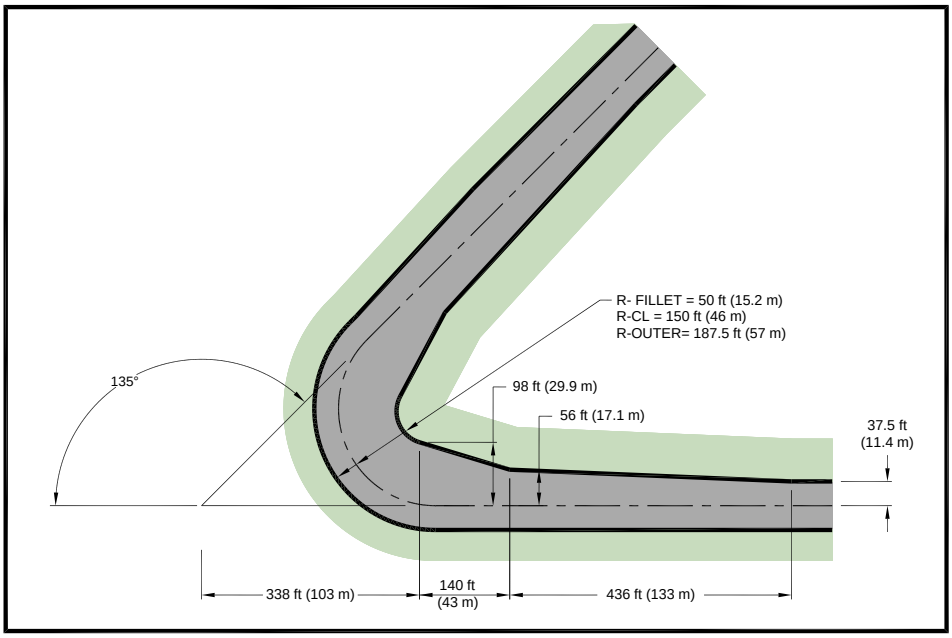
J.2.11.8 Per Figure J-9, establish the outer radius for the taxiway by adding half the taxiway width (W-0) for a given TDG to the taxiway centerline curve radius.

Figure J-9. Establishing Radius of Outer Taxiway Pavement Edge Based on the Centerline Radius and Taxiway Width for Each TDG



J.2.11.9 Per Figure J-10, identify applicable fillet dimensions.

Figure J-10. Dimensioning the Fillet Design



J.3 TDG Tables for Common Intersection Angles.

The following tables provide dimensions for a common range of intersection angles (deltas). Consider site specific factors affecting the fillet design and dimensions. The FAA's Taxiway Fillet Design Tool is available to calculate fillet dimensions for intersection angles not shown in the tables. This design tool provides curve design for turning angle (delta) between 5 degrees and 175 degrees. Visit the FAA website at https://www.faa.gov/airports/engineering/airport_design/.

Table J-1. Taxiway Intersection Dimensions for TDG 1A

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	12.5	12.5	12.5	12.5	12.5	12.5	12.5
W-1 (ft) *	17	19	21	21	22	23	24
W-2 (ft) *	17	19	21	21	22	23	24
L-1 (ft) *	40	47	53	52	55	56	57
L-2 (ft) *	0	0	0	0	0	0	0
L-3 (ft) *	5	8	12	21	38	55	87
R-Fillet (ft)	0	0	0	0	0	0	0
R-CL (ft)	50	50	50	19	23	24	24
R-Outer (ft)	62.5	62.5	62.5	31.5	35.5	36.5	36.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-2. Taxiway Intersection Dimensions for TDG 1B

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	12.5	12.5	12.5	12.5	12.5	12.5	12.5
W-1 (ft) *	20	24	27	18	18	18	18
W-2 (ft) *	20	24	27	31	29	29	30
L-1 (ft) *	107	121	130	94	89	90	92
L-2 (ft) *	0	0	0	47	45	45	45
L-3 (ft) *	6	10	16	31	78	112	177
R-Fillet (ft)	0	0	0	0	20	20	20
R-CL (ft)	50	50	50	37	45	47	48
R-Outer (ft)	62.5	62.5	62.5	49.5	57.5	59.5	60.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-3. Taxiway Intersection Dimensions for TDG 2A

Dimension (see note)	Δ (degrees)						
	30	**45**	**60**	**90**	**120**	**135**	**150**
W-0 (ft)	17.5	17.5	17.5	17.5	17.5	17.5	17.5
W-1 (ft) *	25	28	22	23	20	20	20
W-2 (ft) *	25	28	31	35	23	22	20
L-1 (ft) *	105	119	84	91	60	54	48
L-2 (ft) *	0	0	45	46	31	25	9
L-3 (ft) *	7	12	18	35	121	168	257
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	50	50	50	37	45	47	48
R-Outer (ft)	67.5	67.5	67.5	54.5	62.5	64.5	65.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-4. Taxiway Intersection Dimensions for TDG 2B

Dimension (see note)	Δ (degrees)						
	30	**45**	**60**	**90**	**120**	**135**	**150**
W-0 (ft)	17.5	17.5	17.5	17.5	17.5	17.5	17.5
W-1 (ft) *	30	35	24	26	23	23	23
W-2 (ft) *	30	35	41	48	38	37	36
L-1 (ft) *	205	228	162	176	156	155	152
L-2 (ft) *	0	0	83	84	78	78	78
L-3 (ft) *	8	15	24	48	141	199	310
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	75	75	75	60	73	76	78
R-Outer (ft)	92.5	92.5	92.5	77.5	90.5	93.5	95.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-5. Taxiway Intersection Dimensions for TDG 3

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	25	25	25	25	25	25	25
W-1 (ft) *	29	30	31	33	32	33	33
W-2 (ft) *	37	42	47	54	52	53	55
L-1 (ft) *	131	148	159	172	169	172	173
L-2 (ft) *	72	78	81	83	81	80	80
L-3 (ft) *	10	18	28	54	125	180	286
R-Fillet (ft)	0	0	0	0	25	25	25
R-CL (ft)	75	75	75	60	73	76	78
R-Outer (ft)	100	100	100	85	98	101	103

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-6. Taxiway Intersection Dimensions for TDG 4

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	25	25	25	25	25	25	25
W-1 (ft) *	31	32	34	36	35	36	36
W-2 (ft) *	44	52	60	73	67	69	72
L-1 (ft) *	233	261	280	303	294	300	302
L-2 (ft) *	126	134	138	141	135	136	135
L-3 (ft) *	12	22	35	73	188	272	435
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	110	110	110	92	111	117	120
R-Outer (ft)	135	135	135	117	136	142	145

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-7. Taxiway Intersection Dimensions for TDG 5

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	37.5	37.5	37.5	37.5	37.5	37.5	37.5
W-1 (ft) *	43	45	46	48	46	47	47
W-2 (ft) *	56	64	71	82	74	75	76
L-1 (ft) *	232	257	276	296	282	286	287
L-2 (ft) *	124	133	135	139	133	133	132
L-3 (ft) *	15	27	41	82	202	289	453
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	110	110	110	92	111	117	120
R-Outer (ft)	147.5	147.5	147.5	129.5	148.5	154.5	157.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

Table J-8. Taxiway Intersection Dimensions for TDG 6

Dimension (see note)	Δ (degrees)						
	30	45	60	90	120	135	150
W-0 (ft)	37.5	37.5	37.5	37.5	37.5	37.5	37.5
W-1 (ft) *	44	46	48	50	50	50	51
W-2 (ft) *	61	71	81	95	92	96	100
L-1 (ft) *	311	346	370	398	394	400	407
L-2 (ft) *	164	173	178	179	175	174	174
L-3 (ft) *	17	30	47	95	231	336	538
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	150	150	150	115	139	146	150
R-Outer (ft)	187.5	187.5	187.5	152.5	176.5	183.5	187.5

Note 1: See Figure 4-12, Figure 4-13, and Figure 4-14.
Note 2: * Dimensions are rounded up to the nearest foot. 1 foot = 0.305 meters.

J.4 Methodology and Calculations for Reductions in TOFA/TLOFA Standards.

Studies on aircraft wander during taxi operations indicate taxi deviations from the centerline and that taxiway excursions are infrequent and of limited severity. The FAA's taxiway standards for clearance to fixed or moveable objects provide an acceptable level of safety by establishing OFAs and taxiway separation values. The FAA's methodology for wingtip clearance calculation applies the following:

1. A lateral deviation from the taxiway centerline.
2. A safety buffer in the event of a lateral deviation of the aircraft from the taxiway centerline.

J.4.1 TOFA/TLOFA Standards.

TOFA/TLOFA of Table J-9 and Table J-10 apply a lateral deviation and safety buffer distance for each ADG. Figure J-11 illustrates this methodology. Due to lower aircraft taxi speeds on taxilanes versus taxiways, the applied lateral deviation and safety buffer distances for taxilanes are less than for taxiways.

Figure J-11. TOFA/TLOFA Width

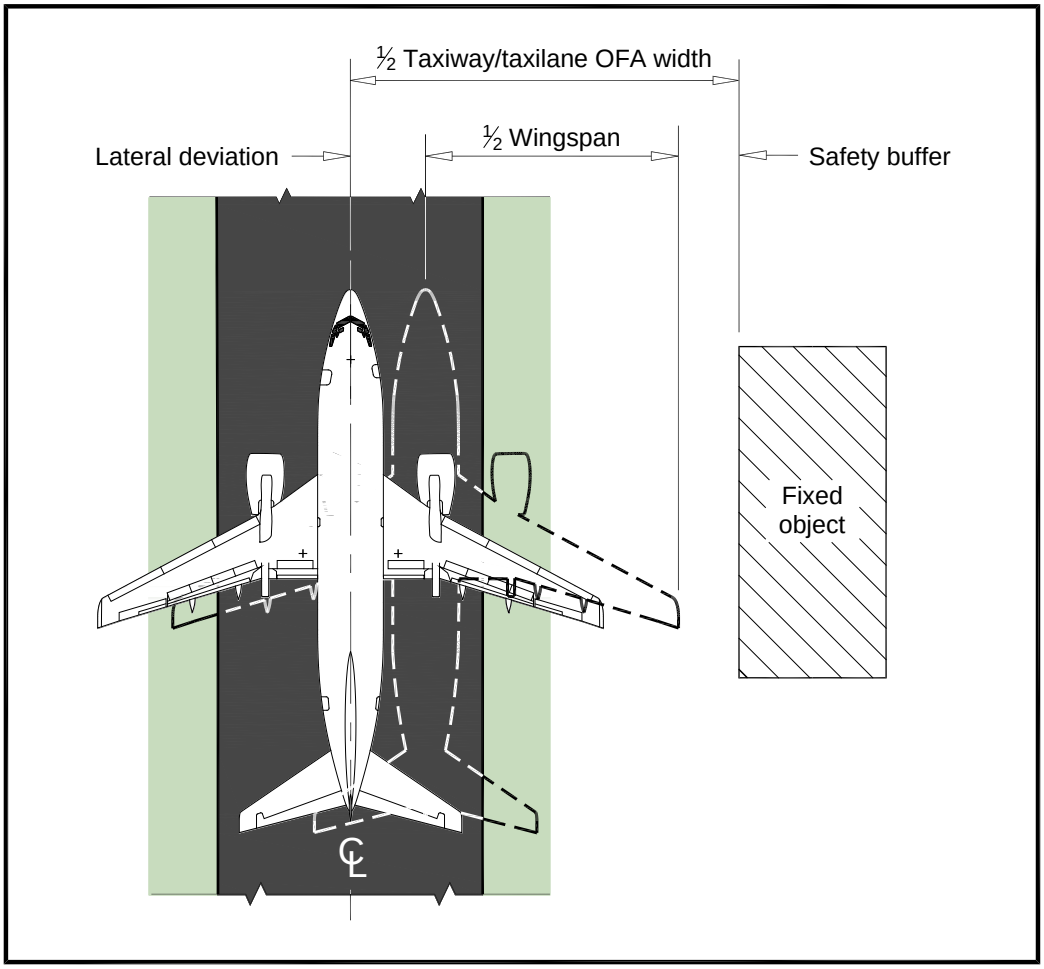


Table J-9. TOFA Calculations (feet)

ADG	1/2 ADG WS	Lateral Deviation	Safety Buffer	1/2 TOFA	Full TOFA
I	24.5	5	15	44.5	89
II	39.5	7.5	15	62	124
III	59.0	10	16.5	85.5	171
IV	85.5	15	21	121.5	243
V	107.0	14.5	21	142.5	285
VI	131.0	14.5	22	167.5	335

Note: 1 ft = 0.305 m

Table J-10. TLOFA Calculations (feet)

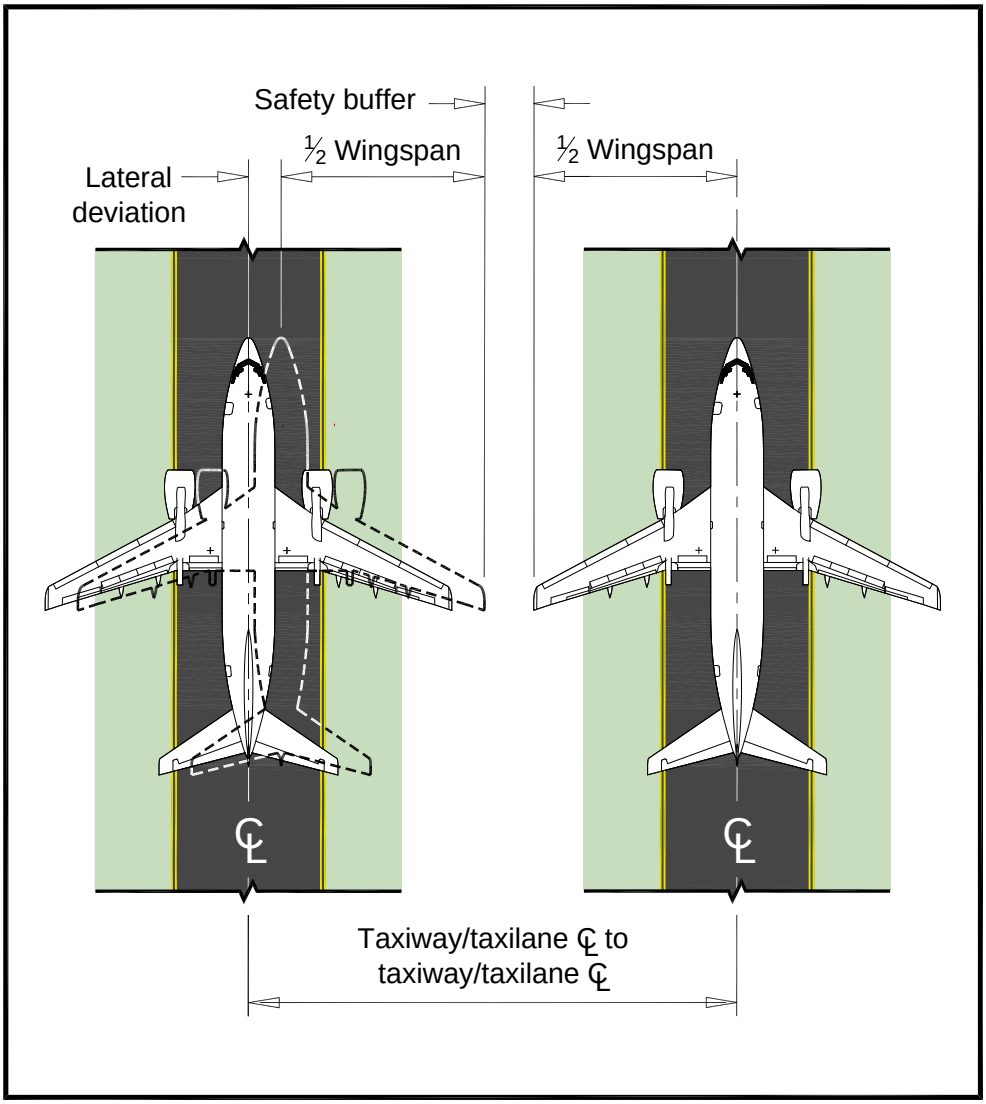
ADG	1/2 ADG WS	Lateral Deviation	Safety Buffer	1/2 TLOFA	Full TLOFA
I	24.5	5	10	39.5	79
II	39.5	5	10.5	55	110
III	59	8	12	79	158
IV	85.5	10	16.5	112	224
V	107	10	18	135	270
VI	131	10	20	161	322

Note: 1 ft = 0.305 m

J.4.2 Taxiway/Taxilane Centerline to Parallel Taxiway/Taxilane Centerline Separation.

The calculation of the separation distance between parallel taxiways/taxilanes for each ADG assumes a lateral deviation from centerline for one aircraft with the second aircraft remaining on the centerline of the parallel taxiway/taxilane. The separation distance equals half the OFA of the first parallel taxiway/taxilane plus half the wingspan of the ADG on the second taxiway/taxilane. See Figure J-12.

Figure J-12. Separation Distance between Parallel Taxiways/Taxilanes



J.4.3 Example: Critical Aircraft TOFA Calculation.

If an airport or part of an airport is space-constrained, modifying the standard TOFA (or TLOFA) to accommodate a specific aircraft may be necessary. For example, calculating the TOFA for a B767-300 using the values in Table J-9:

1. B767-300 wingspan = 156.08 ft (47.6 m); or ½ wingspan = 78.04 ft (22.6 m)
2. This aircraft is an ADG IV aircraft, therefore:
   a. Lateral Deviation is 15 ft (4.6 m)
   b. Safety Buffer is 21 ft (6.4 m)
3. ½ TOFA for B767-300 = 78.04 ft (22.6 m) + 15 ft (4.6 m) + 21 ft (6.4 m) = 114.04 ft (34.8).

4. The resulting full TOFA dimension for a B767-300 is 228.1 ft (69.5 m).

Be mindful of rounding dimensions too early in the calculation, as the resultant TOFA dimension may not be sufficient. The TLOFA calculation process is the same as above, using the values in Table J-10.

J.5 Taxiway Geometries with Elevated Risk to Safety.

This section identifies taxiway geometries with an elevated risk to safety (e.g., runway incursions, wrong surface events, etc.). Understanding the risks associated with these undesirable configurations is beneficial when planning and designing the relationship among taxiways, aprons, and runways. This information supplements the design standards on taxiways and taxilanes provided in Chapter 4. Refer to AC 150/5340-1, *Standards for Airport Markings*, for information on select mitigation measures including "no-taxi" islands.

J.5.1 Background.

The information presented in this section addresses: (1) data and incident analysis on past runway incursions, and (2) the impact of specific runway, taxiway, and apron configurations on the likelihood of runway incursions. See Report DOT/FAA/TC-18/2, *Problematic Taxiway Geometry Study Overview.*

J.5.2 Select Risk Configurations.

The following list, which is not all-inclusive, identifies select pavement configurations that introduce a safety risk:

- Wide expanse of pavement at runway-taxiway intersection
- Entrance taxiway intersecting runway at other than a right angle
- Complex runway-taxiway and taxiway-taxiway intersections
- Direct access from the apron to a runway
- High-speed exit crossing another taxiway
- High-speed exits leading directly into or across another runway
- Wide expanse of pavement at apron-taxiway interface
- Short (stub) taxiway connection to a runway
- Wide expanse of holding bay pavement
- Co-located high-speed exit taxiways
- Fillet pavement between parallel taxiways
- Aligned taxiways
- Taxiway connections to V-shaped runways

J.5.3 Existing Sub-Standard Configuration.

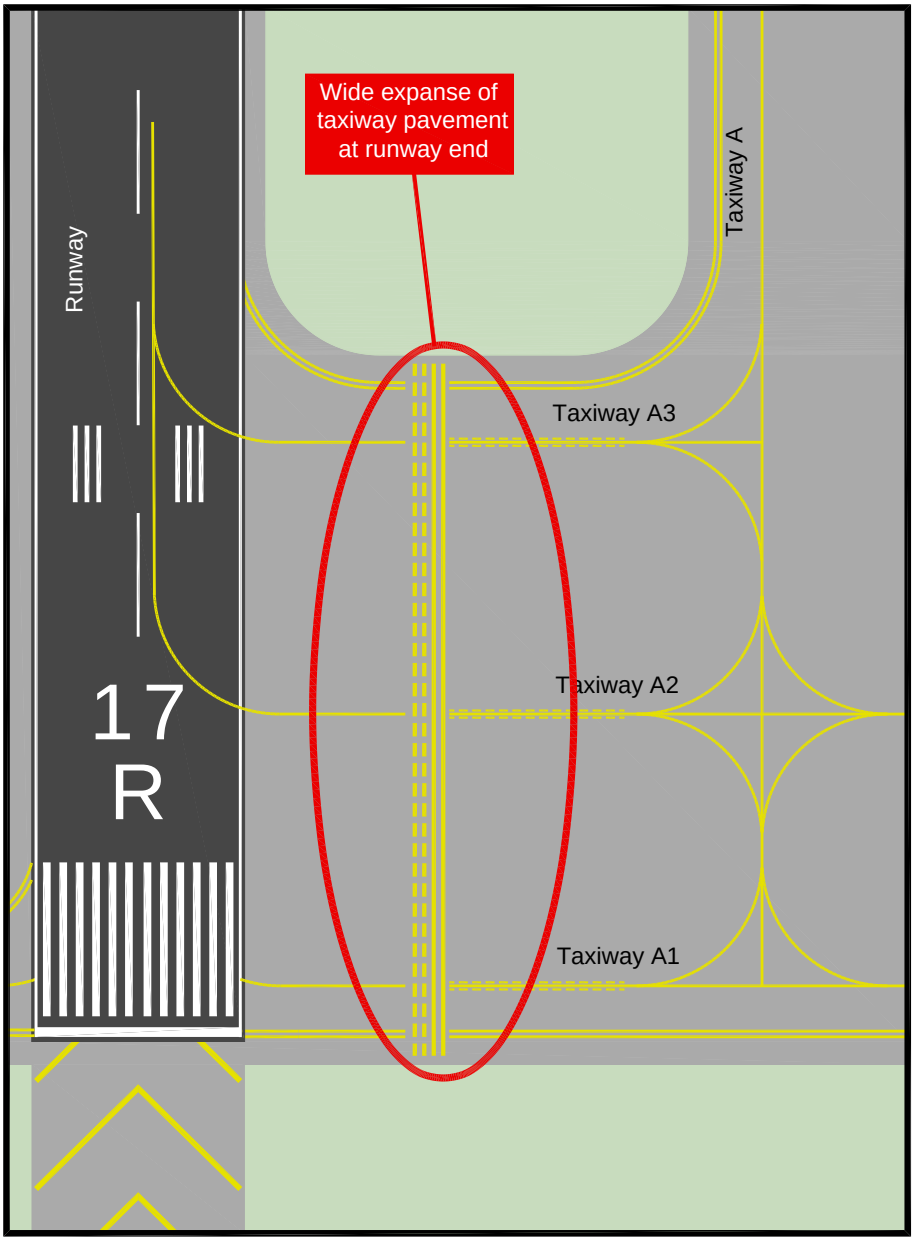
Each airport has specific factors affecting the risk associated with sub-standard geometric configurations. Various mitigating measures or corrective actions may be necessary to minimize risk when "elevated risk" configurations exist at an airport. This is particularly important for high-risk "hot spots" (ranked in the Hot-Spot Improvement Program by Airports Regional Offices) and locations identified under the RIM program

(https://www.faa.gov/airports/special_programs/rim/). The FAA expects Federally obligated airports to develop a plan to address existing areas with unacceptable risk to safety. The FAA further expects such airports to take corrective action as soon as practical (see paragraphs 2.4 and 2.5).

J.5.4 Wide Expanse of Pavement at Runway-Taxiway Interface.

Wide pavement areas result in the placement of airfield signs far from a pilot's view, thus reducing the conspicuousness of critical visual cues (signs, markings, lighting). This increases the risk for pilot loss of situational awareness. See Figure J-13. The diminished visual cues, particularly under low visibility conditions, increases the probability of a runway incursion.

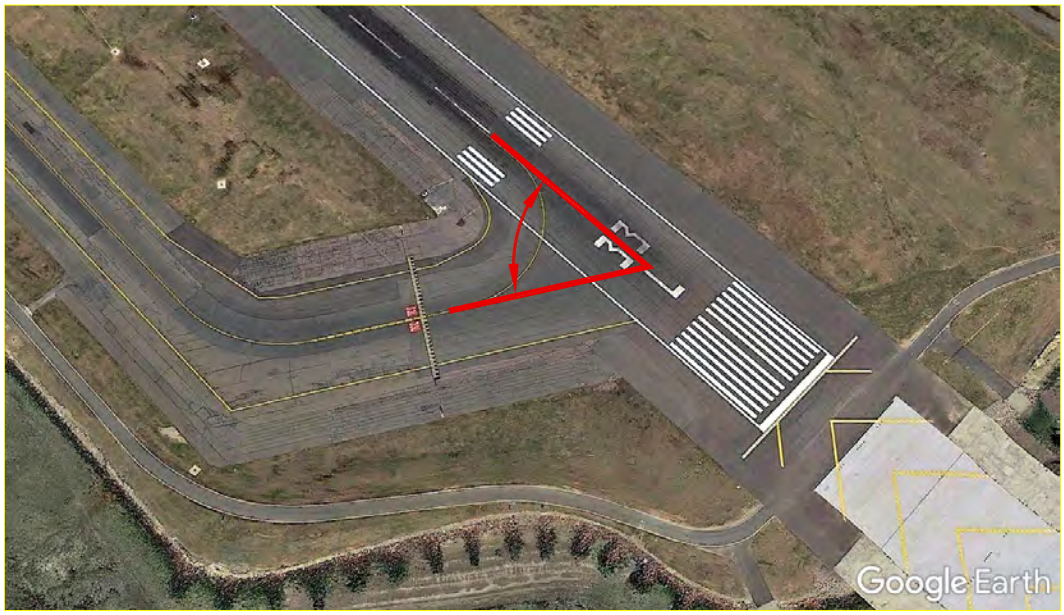
Figure J-13. Extra-Wide Pavement Area at Runway Entrance



J.5.5 Entrance Taxiway Intersecting Runway at Other Than a Right Angle.

Entrance taxiways intersecting a runway at other than a right angle increase the risk of a runway incursion. The acute angle reduces a pilot's field of view in one direction making it difficult for a pilot to detect an aircraft operating on the runway. This configuration also increases the width of the entrance pavement reducing the pilot's ability to maintain situational awareness. The RIM program has demonstrated taxiway configurations that intersect runways at angles other than 90-degrees increase the probability of runway incursions. Refer to paragraph 4.8.2 for standards addressing entrance taxiways. See Figure J-14 and Figure J-15.

Figure J-14. Entrance Taxiway Intersecting Runway End at an Angle less than 90 Degrees



Note: A pilot at the holding position has an enhanced viewing range of the approach area but a limited field of view down the runway.

Figure J-15. Entrance Taxiway Intersecting Runway End at an Angle Greater Than 90 Degrees

Note: A pilot at the holding position has an enhanced viewing range of the runway but a limited field of view in the approach area.

J.5.6 Complex Runway-Taxiway and Taxiway-Taxiway Intersections.

Complex intersections increase the possibility of pilot error due to loss of situational awareness. Complex intersections can preclude standard installation of signs, markings, and lighting that provide key visual cues for navigation.

J.5.6.1 **Complex Intersections Exceeding the "Three-Path Concept."**

1. Excessive options at complex intersections create the potential for loss of situational awareness that increases the risk of runway incursions and wrong surface takeoffs.
2. Complex intersections often produce wide expanses of pavement, which place signs, markings, and lighting in non-standard or unexpected locations.
3. Refer to paragraph 4.3.3 for taxiway intersection design based on the "three-path concept."
4. See Figure J-16 and Figure J-17 for examples of complex taxiway intersections.

Figure J-16. Aerial Image of Complex Taxiway Intersection Exceeding the "Three-Path" Concept

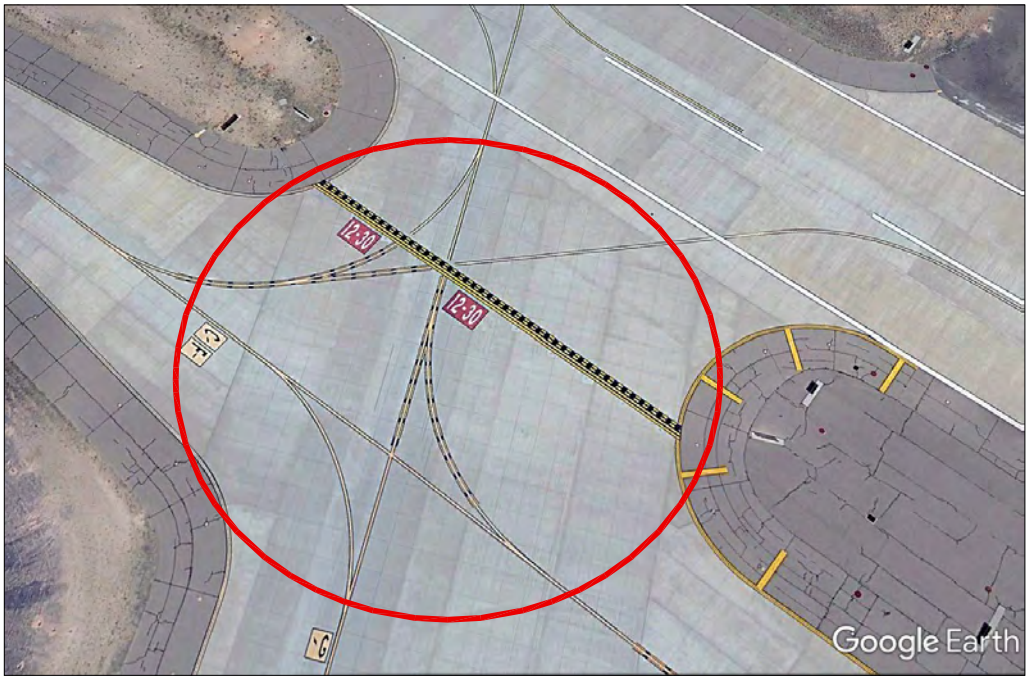
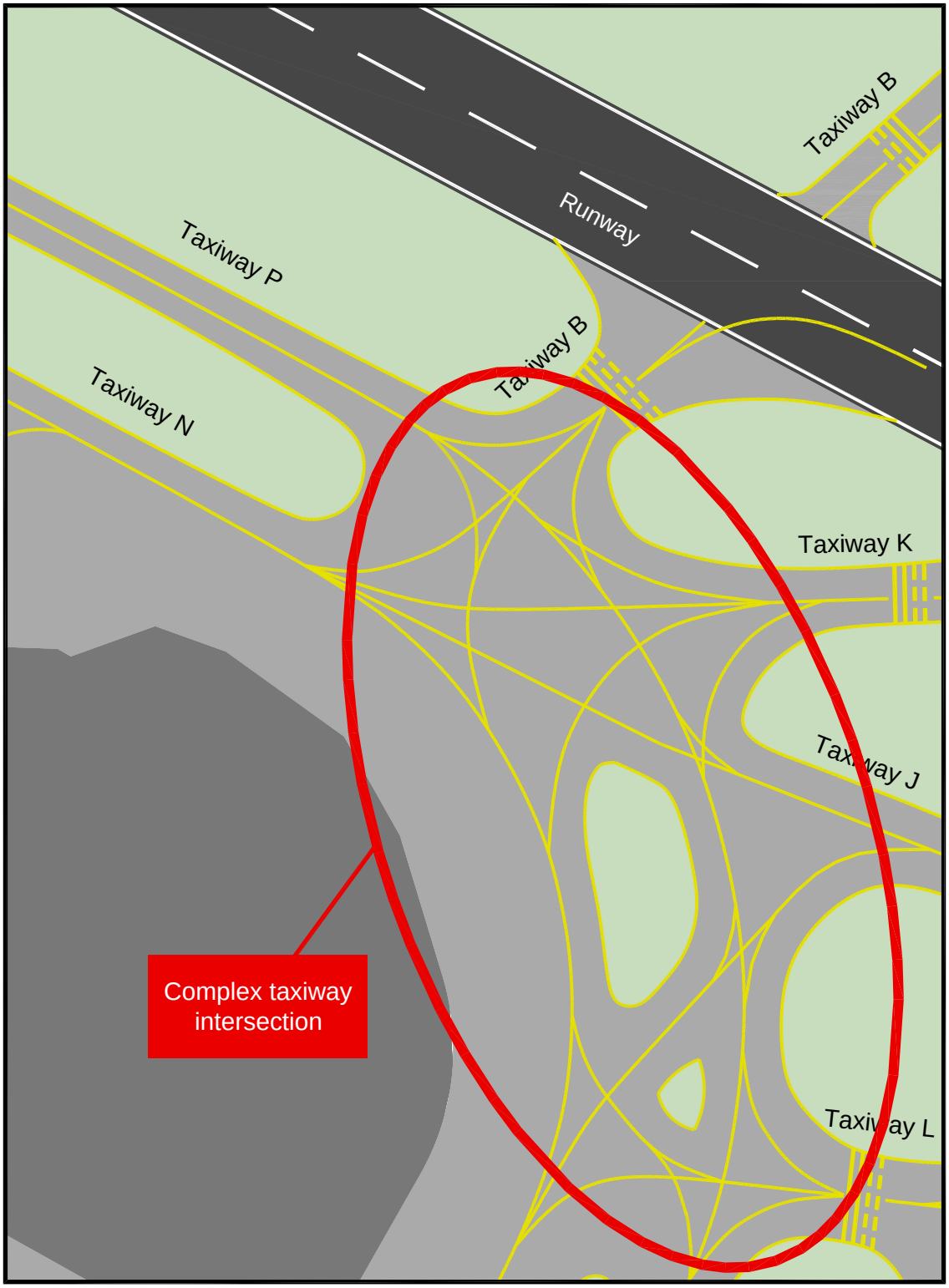


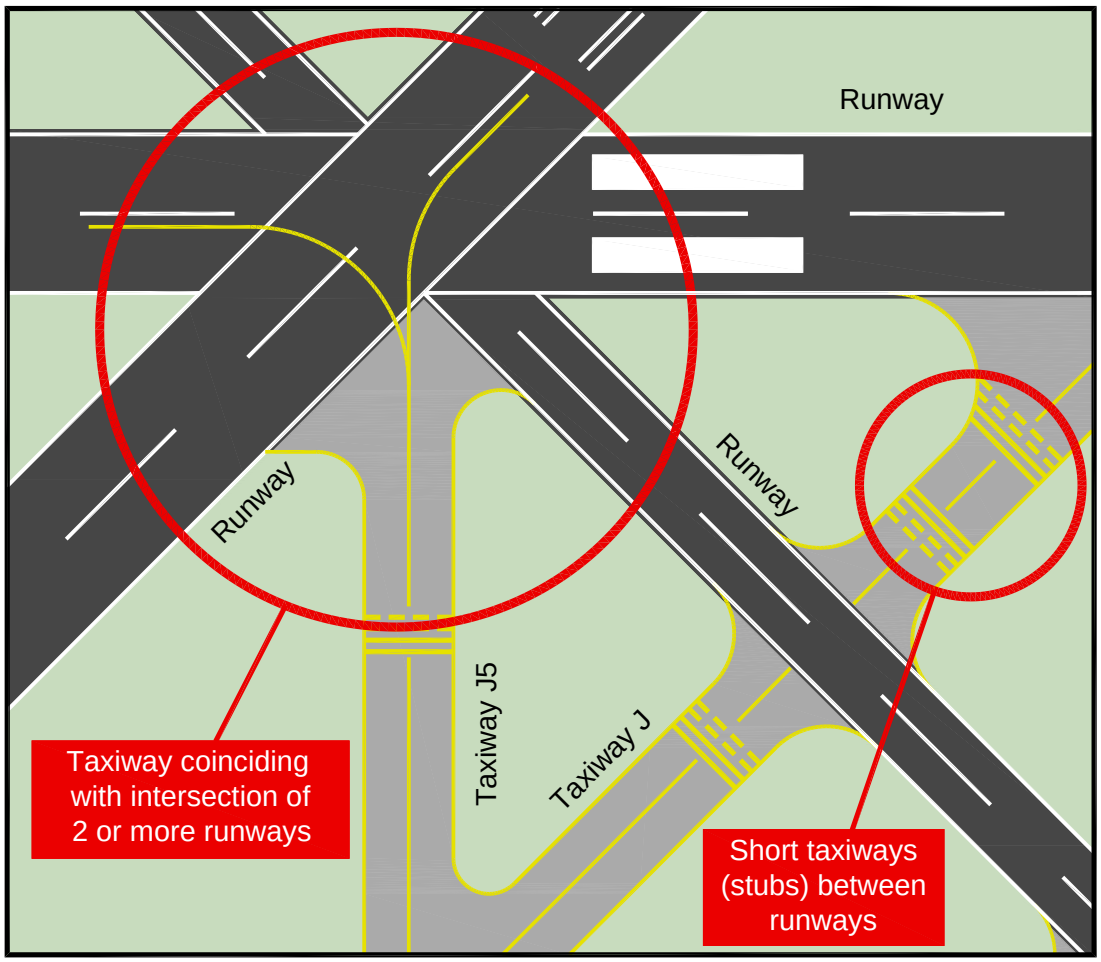
Figure J-17. Complex Taxiway Intersection Not Meeting the "Three-Path Concept"



J.5.6.2 **Runway-Taxiway Intersections that Coincide with Two or More Runways.**

1. The large expanse of pavement prevents standard placement of signs, markings, and lighting.
2. Potential for pilot loss of situational awareness can contribute to a wrong runway takeoff.
3. See Figure J-18.

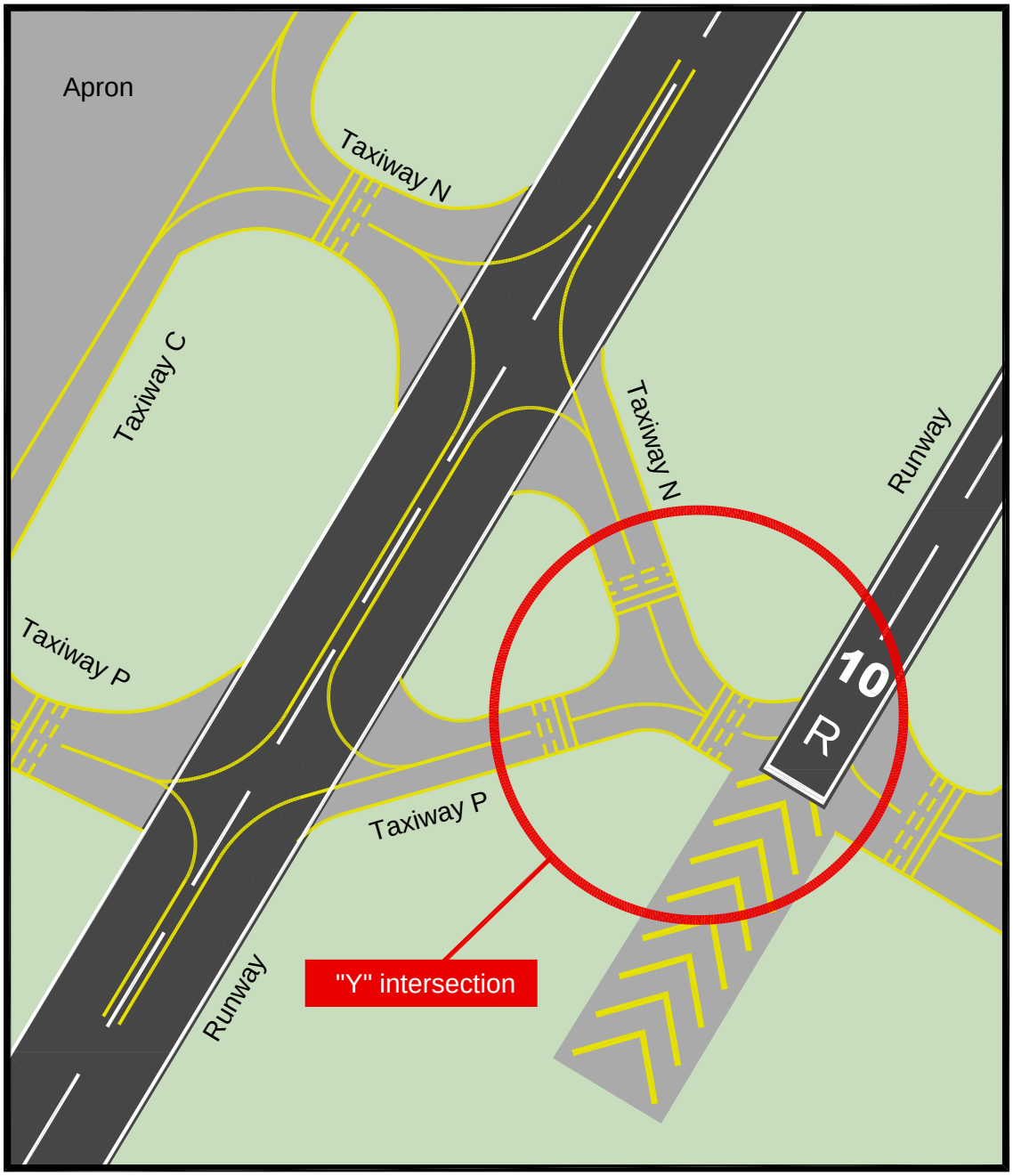
Figure J-18. Taxiway Intersection that Coincides with Multiple Runways



J.5.6.3 **Y-Shaped Taxiways.**

1. Multiple path choices present opportunities for ground navigation errors that can lead to a runway incursion.
2. Potential for conflict with two aircraft or two vehicles converging to a single taxiway.
3. See Figure J-19.

Figure J-19. Y-Shaped Taxiway Crossing a Runway

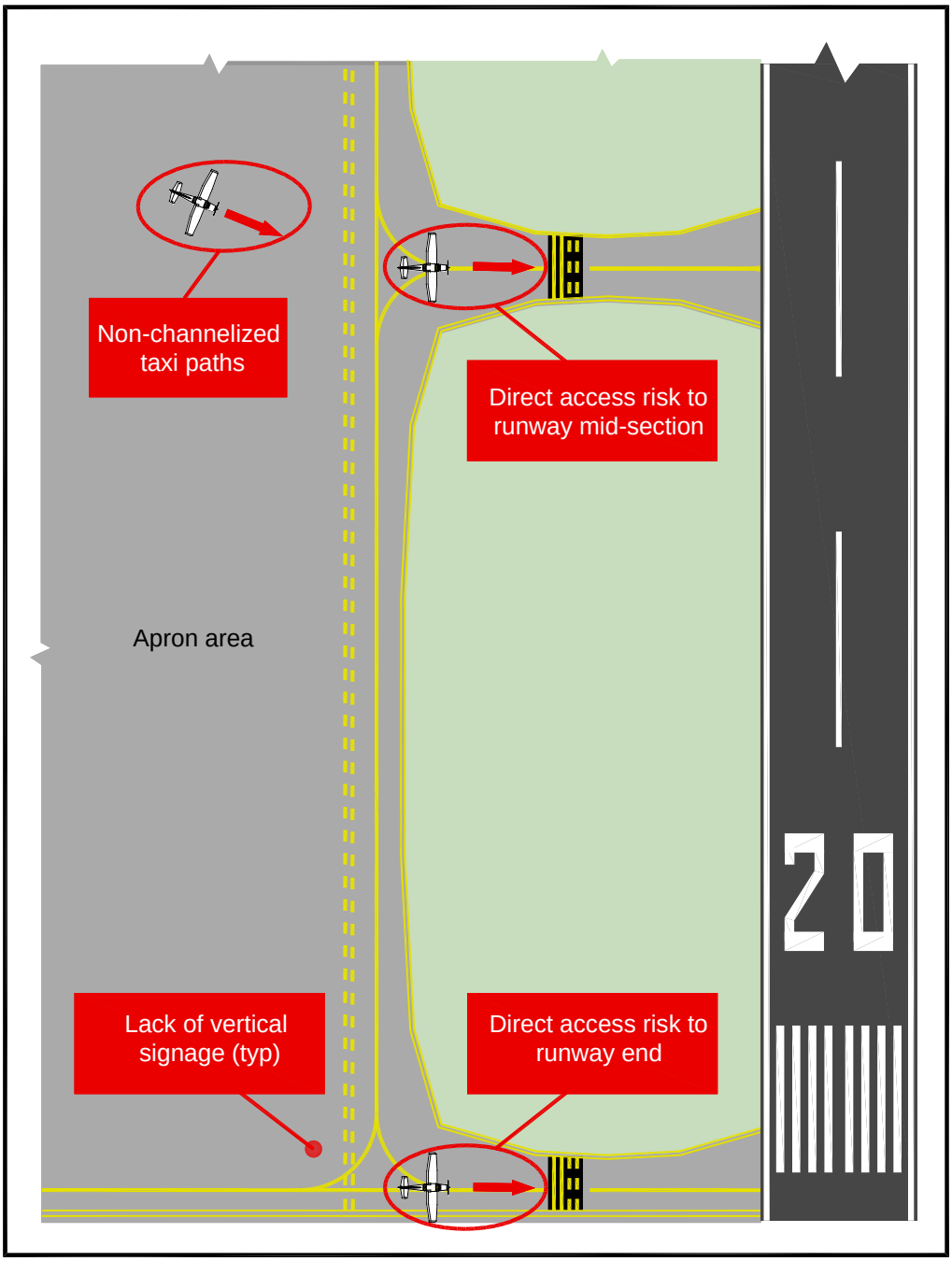


J.5.7 Direct Access from the Apron to a Runway.

Taxiways leading directly from an apron to a runway, as shown in Figure J-20, can create the false expectation of a parallel taxiway prior to the runway. This results in pilot confusion that could lead to a runway incursion. Taxiway geometries forcing the pilot to make turns promotes situational awareness and minimizes the risk of runway incursions. Refer to Figure 4-2 for standard taxiway configurations between the apron and a runway.

1. Taxiways from the terminal area with a straight path to the middle third of a runway present a risk of taxiing aircraft entering a high-energy area of a runway during an operation.
2. Taxiways from an apron area or holding bay leading directly to a runway end present the risk of a taxiing aircraft entering the runway during an operation.

Figure J-20. Apron-Taxiway Configuration – Elevated Risk

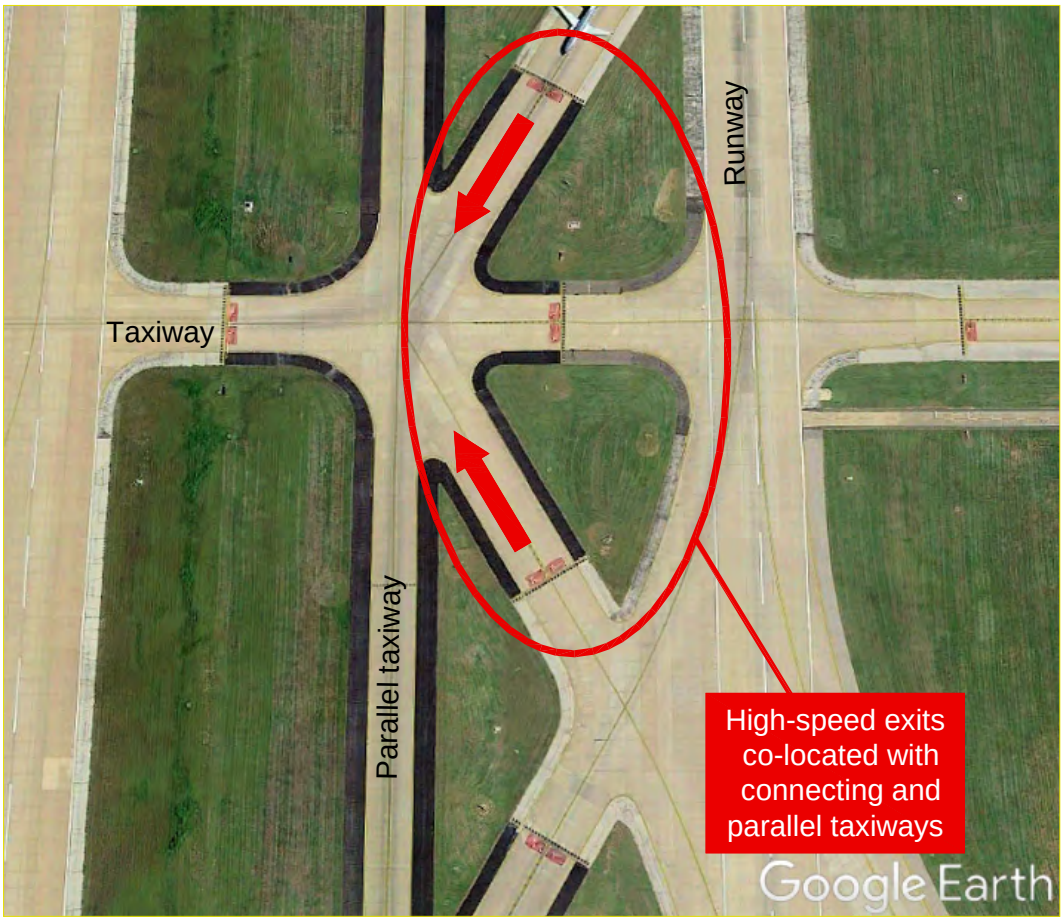


J.5.8 High-Speed Exit Crossing a Connecting Taxiway.

This configuration, as depicted in Figure J-21 and Figure J-22, results in a wide expanse of pavement creating non-standard signs, markings, and lighting.

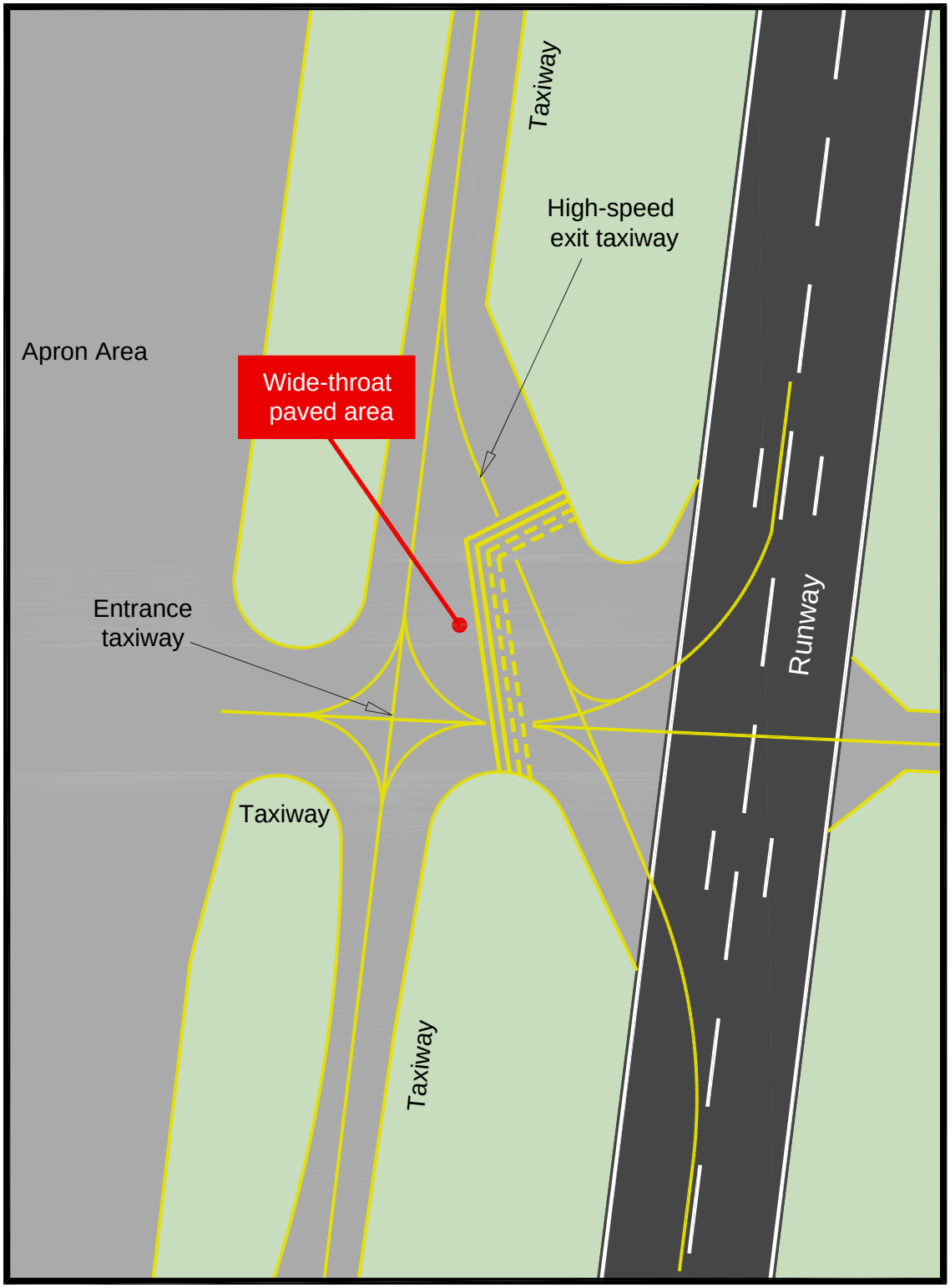
1. The lack of visual cues can lead to pilot confusion, increasing risks to safety.
2. High-speed taxiways co-located with another taxiway increase the risk of a pilot using the exit taxiway as a runway entrance or crossing point, thus providing a limited range of view when entering a runway. See paragraph 4.8.5 for additional information.

Figure J-21. Aerial Image of High-speed Exit Co-located with Connecting Taxiways



Note: High-speed exit leading directly across a connecting taxiway.

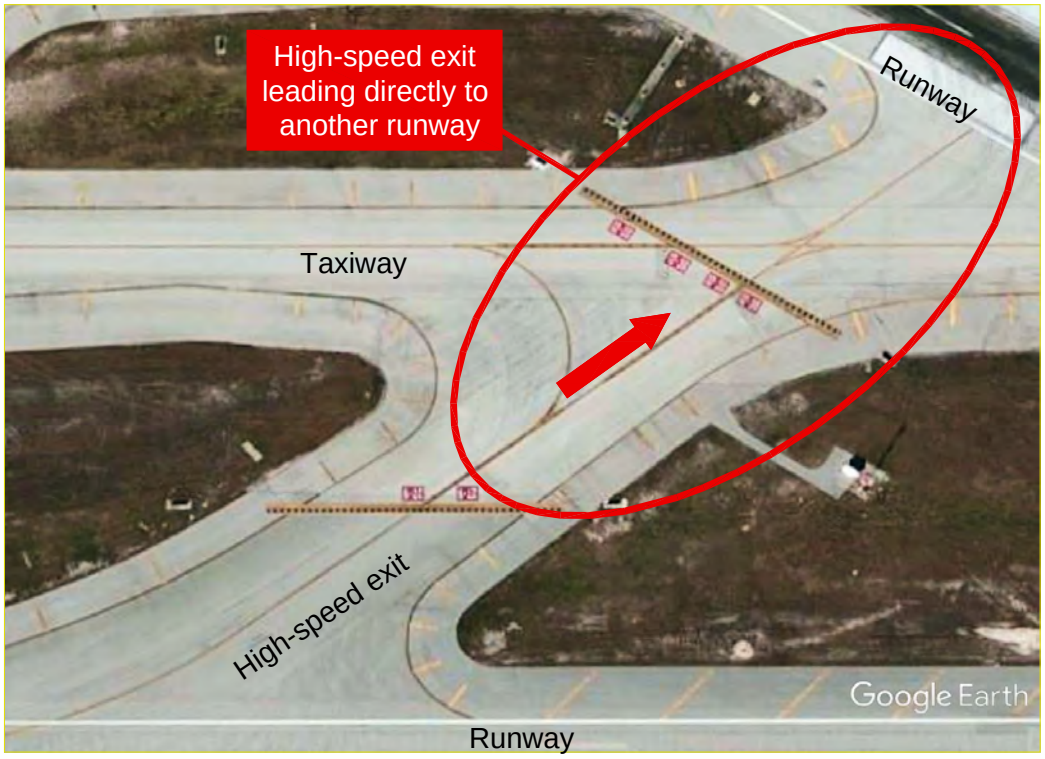
Figure J-22. High-Speed Exit Co-located with Connecting Taxiway



J.5.9 High-Speed Exits Leading Directly into or Across Another Runway.

Aircraft exiting from a high-speed exit may not have sufficient distance to decelerate and stop prior to encountering an adjacent runway hold line. See Figure J-23. This configuration increases the probability of a runway incursion.

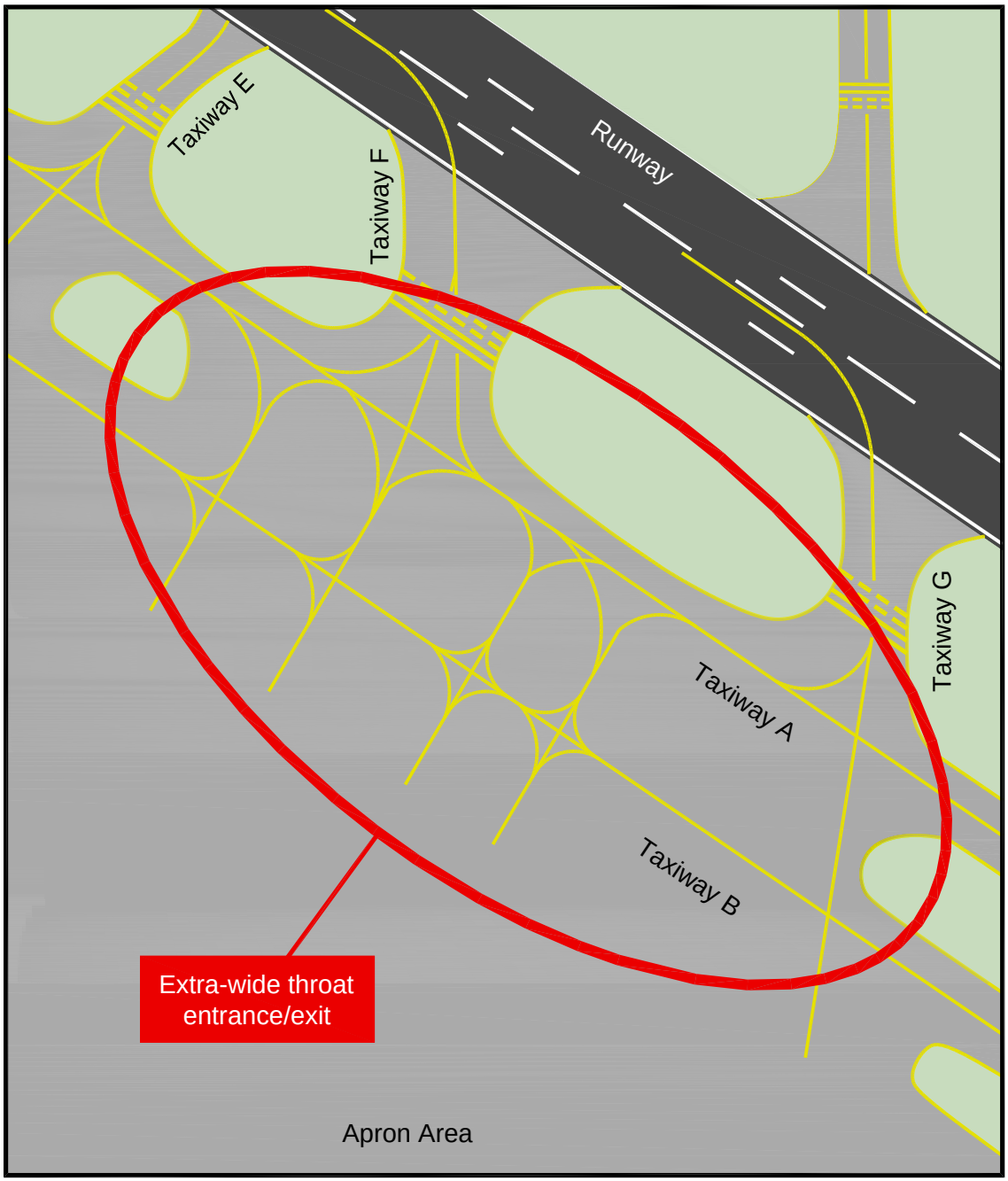
Figure J-23. Aerial Image of High-speed Exit Leading to Another Runway



J.5.10 Wide Expanse of Pavement at Apron-Taxiway Interface.

Contiguous, parallel taxiways with apron pavement create a wide expanse of pavement void of critical visual cues such as elevated signs (e.g., taxiway location and direction signs). See Figure J-24. This lack of visual cues can contribute to pilot loss of situational awareness. Additionally, the lack of surface markings induces non-channelized taxiing, which increases the risk of wingtip conflicts.

Figure J-24. Parallel Taxiway Adjacent to Apron Pavement



J.5.11 Short (Stub) Taxiway Connection to a Runway.

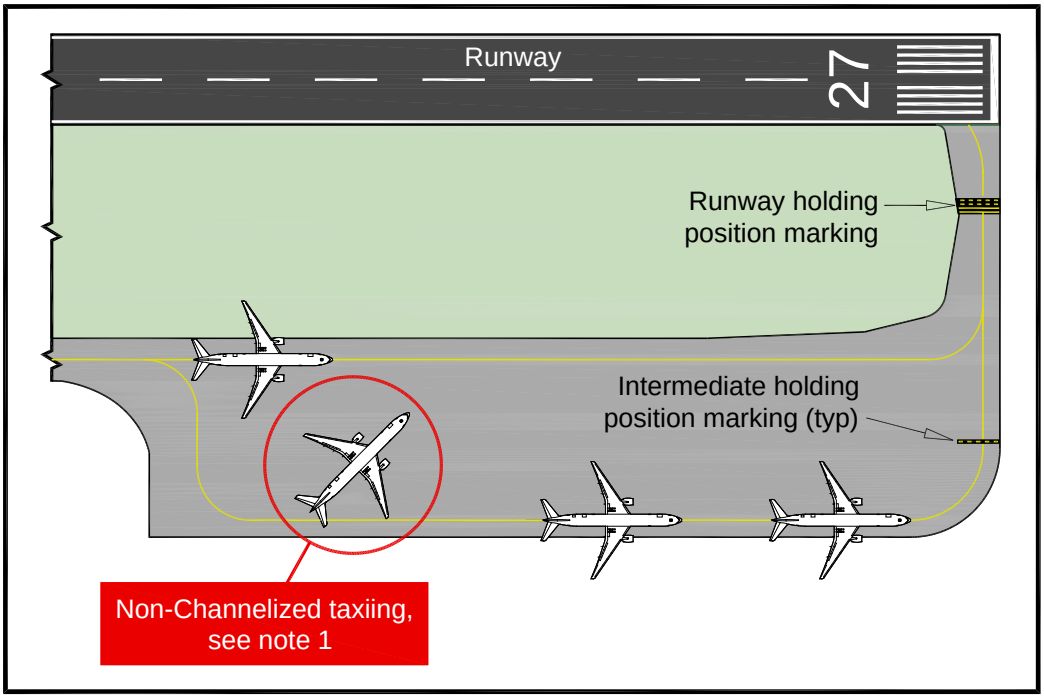
Short (stub) taxiway configurations between runways result in aircraft encountering a runway holding position almost immediately upon entry onto the taxiway segment. Pilots not familiar with the location may fail to hold short, thus resulting in a runway incursion. Taxiway stubs also create challenges of holding an aircraft or vehicle without adversely affecting one of the runways. See Figure J-19 and Figure J-25.

Figure J-25. Aerial Image of Short (Stub) Taxiway Connection to a Runway

J.5.12 Wide Expanse of Holding Bay Pavement.

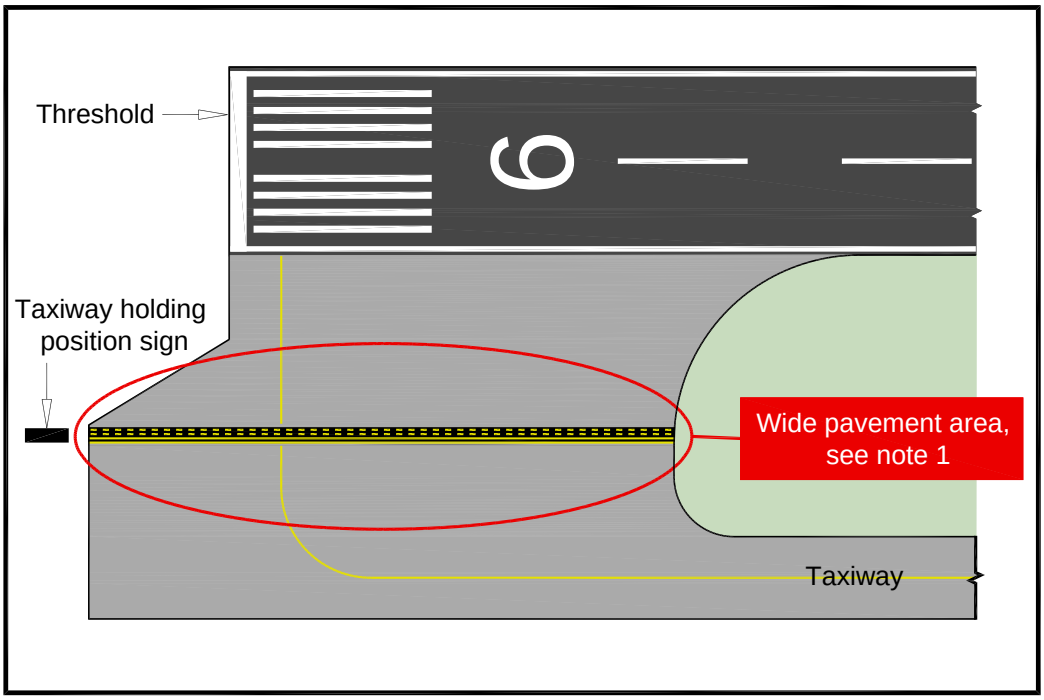
The wide pavement area of holding bays limits the proper placement of signs, surface markings, and lighting. See Figure J-26 and Figure J-27. The diminished visual cues increase the risk of pilot loss of situational awareness. Certain wide holding bay configurations encourage non-channelized taxiing involving judgmental steering, particularly when pavement markings are insufficient. This situation does not ensure proper wingtip clearance during maneuvering of aircraft into and out of the holding bay. Refer to paragraph 4.9 for holding bay design standards.

Figure J-26. Poor Holding Bay – Moderate Risk Configuration



Note 1: Non-channelized taxiing does not ensure standard wing-tip clearance availability.

Figure J-27. Poor Holding Bay – Elevated Risk Configuration

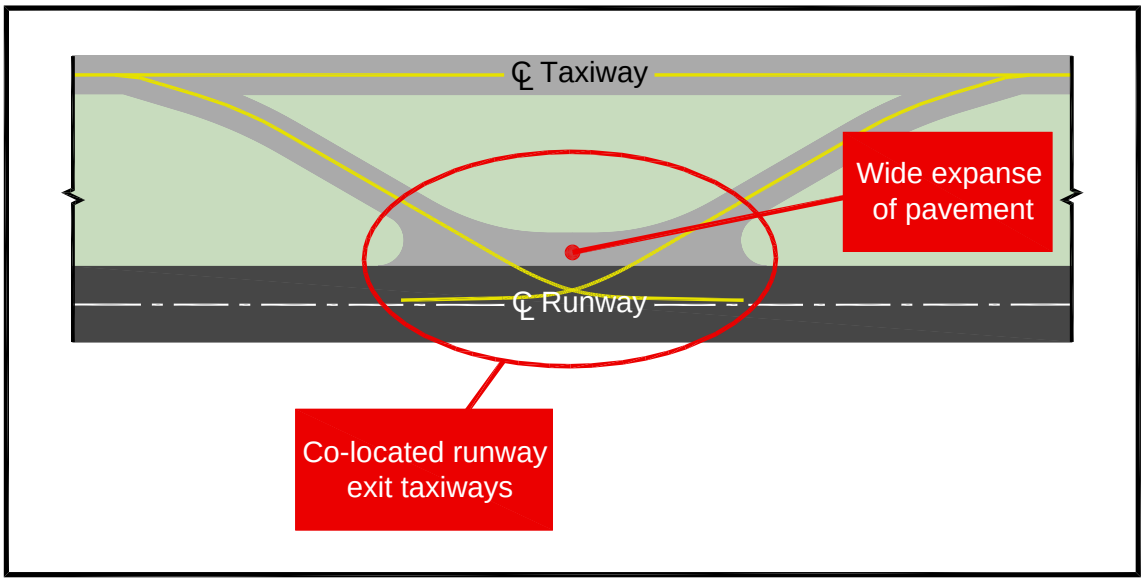


Note 1: The wide distance of the holding bay places the vertical signs outside of the pilot's normal viewing range.

J.5.13 Co-located High-speed Exit Taxiways.

Co-located high-speed exit taxiways create a wide, expansive pavement area at the runway-taxiway interface that precludes proper placement of lighting and signage. See Figure J-28. Refer to paragraph 4.8.5 for high-speed taxiway exit design standards.

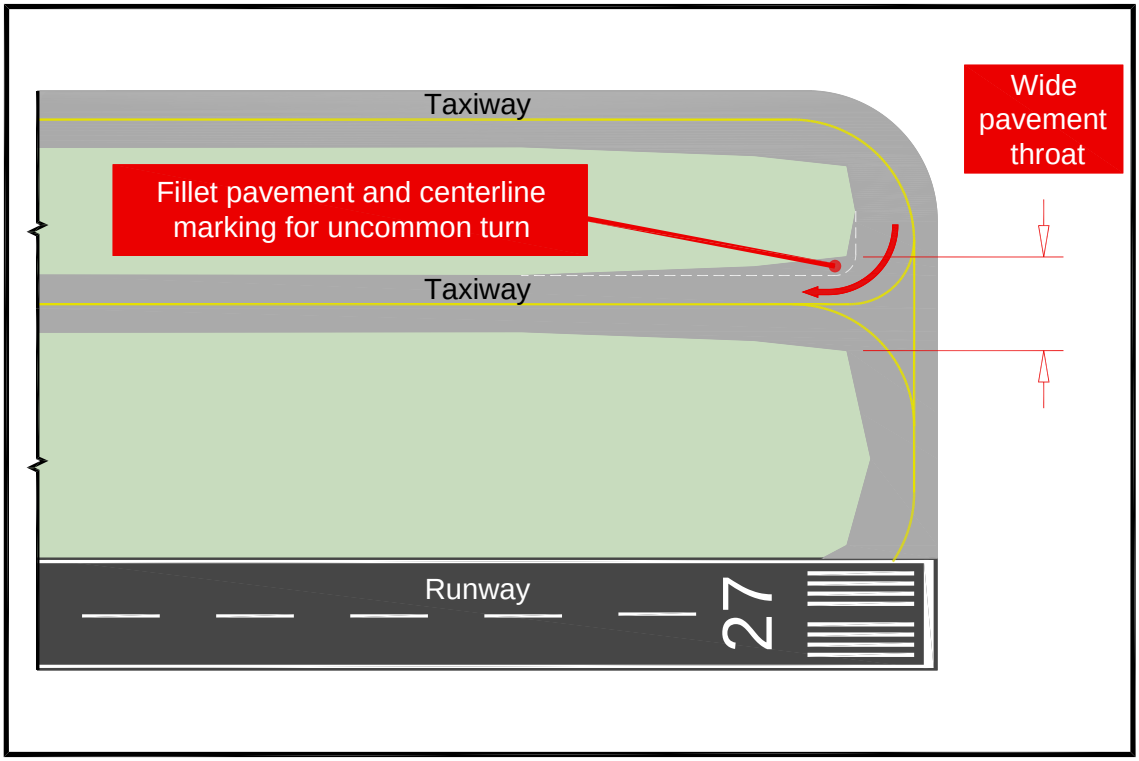
Figure J-28. Co-located High-Speed Runway Exit Taxiways



J.5.14 Fillet Pavement Between Parallel Taxiways.

Turning movements from an outer parallel taxiway to an inner parallel taxiway at the runway end are uncommon. Providing fillet pavement for this uncommon turn creates a wide pavement throat a pilot may misconstrue as the runway. This loss of situational awareness can lead to a wrong surface departure event. See Figure J-29.

Figure J-29. Taxiway Fillet Pavement for Uncommon Turn



J.5.15 Aligned Taxiways.

An aligned taxiway is one whose centerline coincides with a runway centerline. See Figure J-30. Aligned taxiways represent an elevated hazard risk due to the potential for taxiing aircraft to take a position in direct line with departing or landing aircraft. Aligned taxiways also contribute to a pilot's loss of situational awareness.

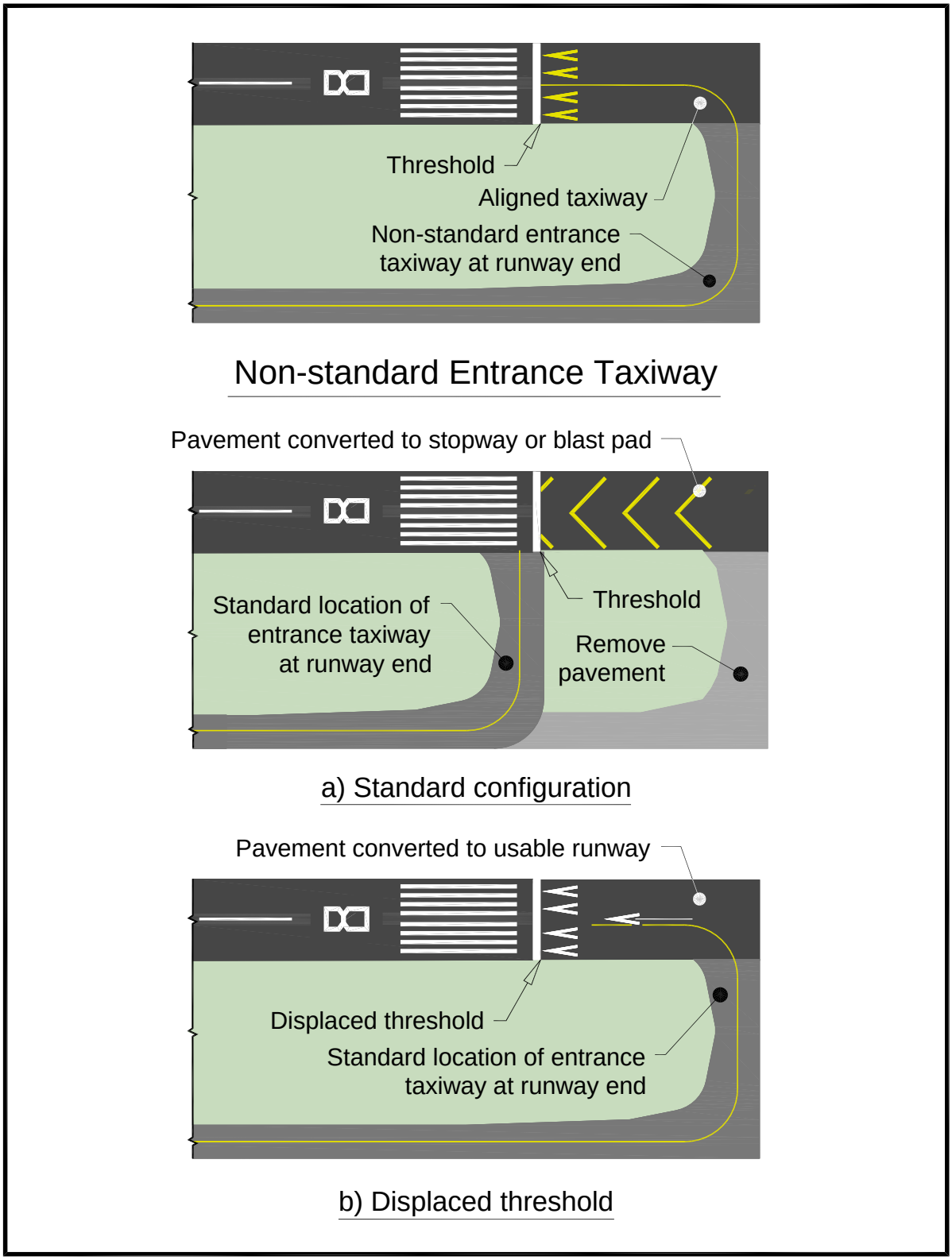
1. For locations with existing aligned taxiways, the FAA expects the airport to have a plan on file to correct the non-standard aligned taxiway as soon as practical (e.g., next reconstruction project; see paragraphs 2.4 and 2.5.).

2. Figure J-30 shows alternative taxiway configurations to mitigate an existing aligned taxiway. These include converting the aligned taxiway pavement into:

   a. a blast pad and constructing a new entrance taxiway at the standard location.

   b. usable runway with a displaced threshold and creating a standard entrance taxiway.

Figure J-30. Aligned Taxiway and Common Mitigations



J.5.16 Taxiway Connections to V-shaped Runways.

Crossing-taxiways (or connecting taxiways) located between runways that converge (e.g., V-shaped runways) can increase runway incursion risks when the taxiway length between runways is short. See Figure J-31 and Figure J-32. The associated risks include:

Figure J-31. Taxiway Connections to V-shaped Runways

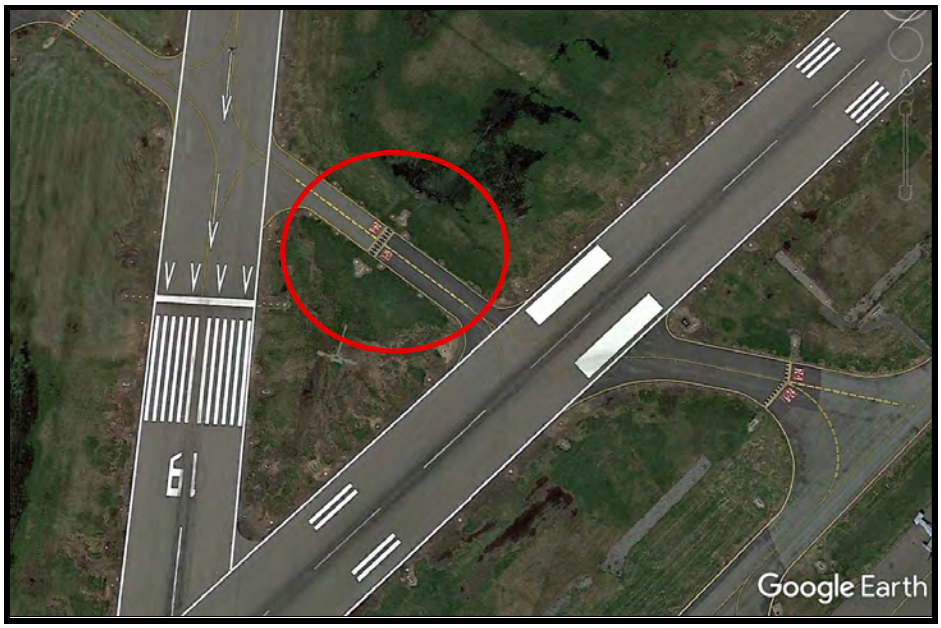
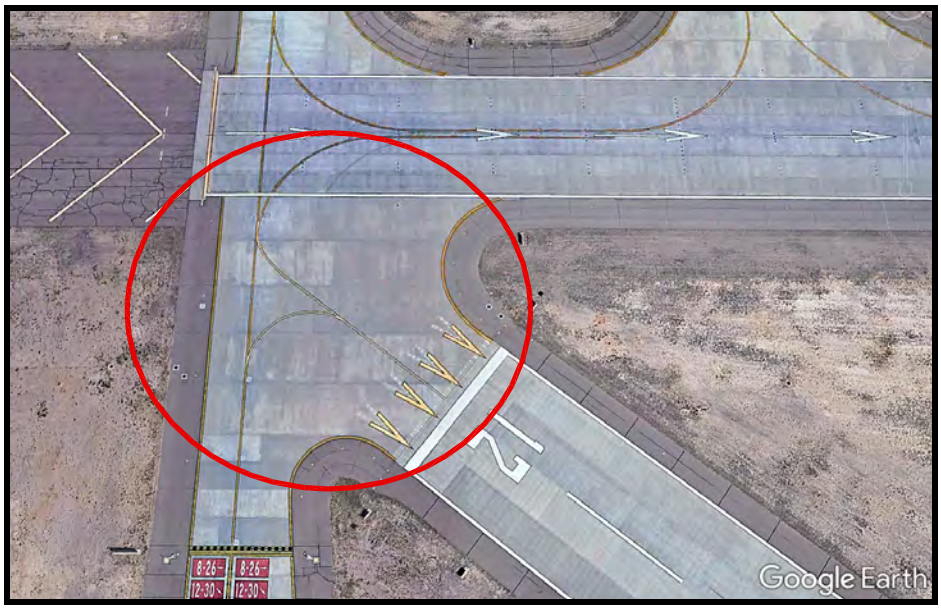


Figure J-32. Taxiways to Converging, Non-Intersecting Runways



1. Hold lines in close proximity to each other similar to the risk associated with a short-stub taxiway, per paragraph J.5.11.
2. Taxiways that intersect runways at other than 90 degrees, thus providing pilots a limited field of view to a portion of the runway. Align the taxiway to reach the runway end.

J.5.17 Parallel Taxiways/Runway Intersection.

The intersection of a parallel taxiway with a crossing runway may induce runway incursion risks if the intersection angle is less than 75 degrees. Long straight taxi paths prior to a runway intersection also increase the risk of a pilot missing the hold line. Additionally, the pavement fillets for an acute angle intersection can create non-standard conditions for pavement markings and signage. It is not necessary for a parallel taxiway to be equidistant to the runway it serves for the entire length of the taxiway. When intersecting a crossing runway, adjust the alignment of the parallel taxiway to establish a 90-degree angle, ±15 degrees, with the runway centerline. Interrupting the straight taxi path also represents a cue to the pilot they are approaching a runway environment. See Figure J-33 and Figure J-34.

Figure J-33. Parallel Taxiway/Runway Intersection – Elevated Risk

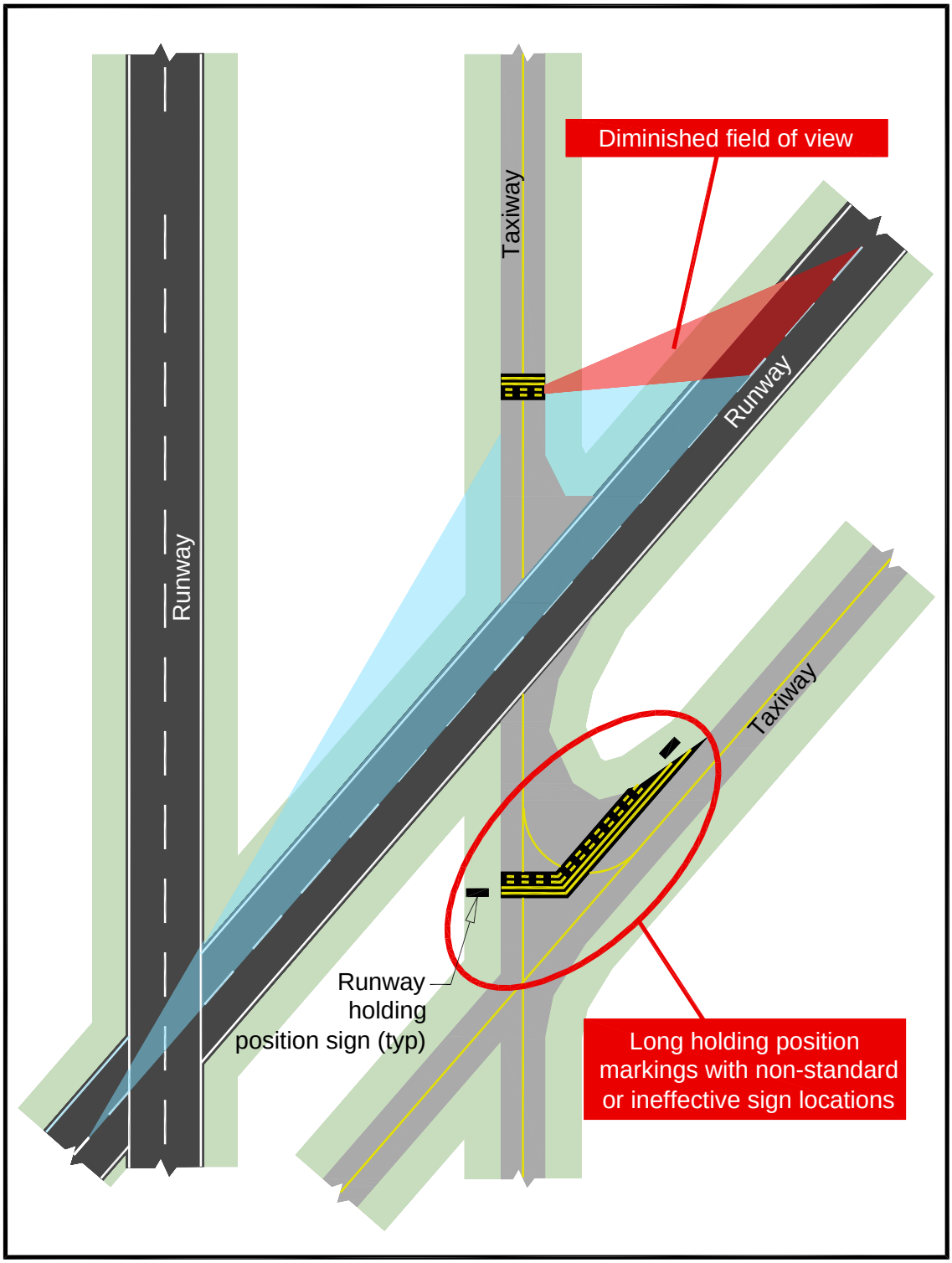
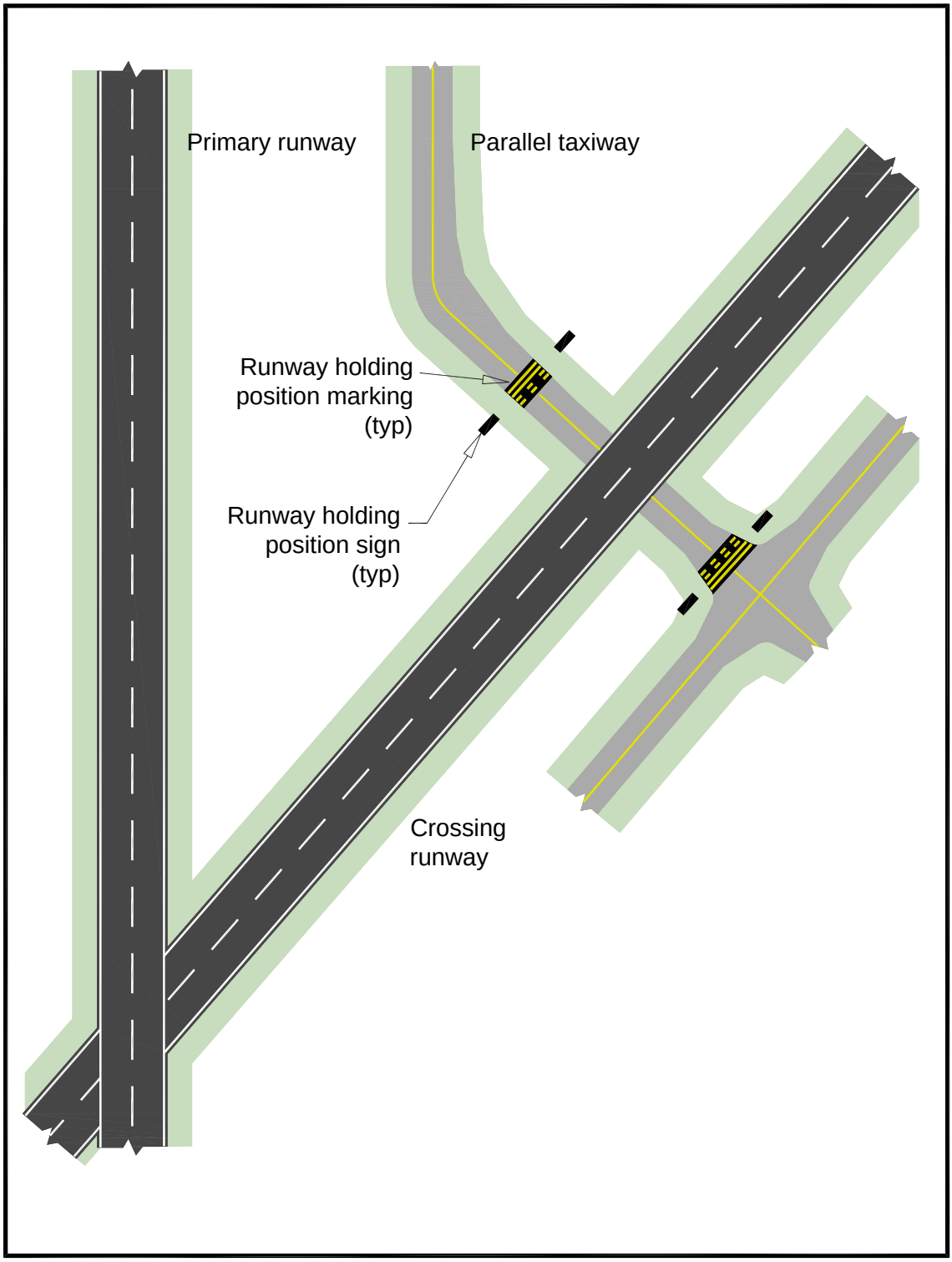


Figure J-34. Parallel Taxiway/Runway Intersection – Optimum Configuration



APPENDIX K. INSTRUMENT FLIGHT PROCEDURES

K.1 Instrument Flight Procedures (IFP).

This appendix applies to the establishment of new and revised authorized IFPs. Title 14 CFR Part 97, *Standard Instrument Procedures*, prescribes the criteria for instrument flight procedure development through incorporation of FAA Order 8260.3.

K.1.1 Background.

The overarching FAA strategy for navigation services is to provide pilots with vertical guidance on approach whenever possible. This results in more stabilized approaches and landings and ensures clearance from existing obstacles and terrain. IFPs improve flight safety even during visual conditions and nighttime. This paragraph identifies airport landing surface criteria to assist airport operators in their evaluation and preparation of the airport landing surface in support of a new or revised IFP. It also lists the airport data the FAA needs from the sponsor in order to conduct the airport airspace analysis specified in FAA Order JO 7400.2.

K.1.1.1 A favorable determination for IFR status is necessary for an airport to qualify for IFR operations (refer to 14 CFR Part 157).

K.1.1.2 Use the requirements specified by FAA Order 8260.3 when planning for IFPs capable of achieving normal landing minimums. This order references 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 consideration applies regardless of whether or not the proposal involves a reduction in approach minimums.

K.1.1.3 For planning purposes, use Table K-1 to determine the lowest obtainable minimums. Consideration of all pertinent factors ultimately determines the lowest minimums obtainable.

K.1.1.4 Lighting enhances the safety of an IFP by providing visual cues to the pilot.

1. An ALS installation enhances the safety of an instrument procedure and may permit lower minimums.
2. Installation of economy light systems, such as REIL, aids the pilot's recognition of a runway end for lighted runways without an ALS.
3. VGSIs, such as PAPI, provide visual glide path information to a pilot.

K.1.1.5 Under FAA JO 7110.41A, *Performance Based Navigation Implementation Process*, additional requirements apply for certain types of Performance Based Navigation procedure requests, including RNP.

K.1.2 Prerequisite Actions.

K.1.2.1 **Instrument Runway Designation.**

FAA authorization for a new IFP requires, per Part 157, an airport to submit FAA Form 7480-1 to change its status from VFR to IFR. For Federally obligated airports, the airport updates their ALP in lieu of submitting the form. The FAA then conducts an aeronautical study and issues a determination. The FAA's determination is a composite of the airspace review and findings and indicates if the FAA supports IFR status.

K.1.2.2 **Airport Landing Surface.**

As a condition of FAA authorization for an IFP under Part 97, the airport landing surface must meet the criteria in Table K-1 for each specified runway direction and have adequate airspace to support the IFP. For obligated NPIAS airports, the sponsor must provide a copy of the FAA-approved ALP showing the instrument procedure(s). For all other airports, submittal of an ALP facilitates the IFP development process.

K.1.3 Requesting an IFP.

Following establishment of a threshold and the appropriate approach surface, the following actions are necessary:

1. The airport operator or aircraft operator files a request with the FAA's Aeronautical Navigation Products (https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/ifp_initiation/). Specify the runway direction, the desired approach minimums, and whether the proponent desires circling approach and departure procedures.
2. The FAA:
   a. Validates, prioritizes, and designs the procedure, if the request is approved by the FAA under FAA Order 8260.43, *Flight Procedures Management Program*.
   b. Designs the procedure (normally, LNAV, VNAV, and LPV minima are charted with any IFP request, per the FAA's NAS Navigation Strategy).
   c. Develops IFR takeoff minima and/or procedures for all runway ends at an airport, unless otherwise requested by the airport (normally, at least one runway end will have IFR takeoff minima to support aircraft that depart under IFR).
   d. Performs a flight check.
   e. Publishes the procedure for pilots.
3. When approach surfaces are entirely clear of obstacles, the resulting procedure provides the optimum and most versatile situation for the pilot.
4. If not entirely clear, the mitigation measures determination is on a case-by-case basis, including:
   a. Higher instrument landing minimums,

b. Higher than normal GPAs,

c. Installation of VGSIs,

d. Non-standard TCHs, and

e. Final approach offset.

K.1.4 Airport Aeronautical Surveys.

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

2. Provide vertically guided approaches, whenever possible. For vertically guided approaches and all departures, complete surveys using the Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18.

3. Providing pilots with vertical guidance results in more stabilized approaches and landings, so only use the Non-Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18 in rare circumstances.

4. Absence of a survey does not preclude authorization to establish an IFP to a runway but may restrict the procedure to only daytime operations.

Table K-1. Criteria to Support Instrument Flight Procedure Development

Standards [1]	Visibility Minimums [1]			
	< 3/4 statute mile (1.2 km)	**3/4 (1.2 km) to < 1 statute mile (1.6 km)**	**≥ 1 statute mile (1.6 km) straight-in**	**Circling [2] ≥ 1 statute mile (1.6 km)**
HAT [3]	≤ 250 ft	≥ 250 ft	≥ 250 ft	≥ 350 ft
POFZ (PA and APV only)	Required	Not Required	Not Required	Not Required
IT-OFZ	Required	Not Required	Not Required	Not Required
ALP [4]	Required	Required	Required	Required
Minimum Runway Length	4,200 ft	3,200 ft [5]	3,200 ft [5]	3,200 ft [5]
Paved Surface	Required	Recommended [6]	Recommended [6]	Recommended [6]
Runway Markings (See AC 150/5340-1)	Precision	Non-precision	Non-precision	Visual
Holding Position Signs and Markings (See AC 150/5340-1, AC 150/5340-18)	Required	Required	Required	Required [6]
Runway Edge Lights [7]	HIRL or MIRL	HIRL or MIRL	MIRL or LIRL	MIRL or LIRL (Required only for night minimums)
Parallel Taxiway [8]	Required	Required	Recommended	Recommended
Approach Lights [9]	Required	Recommended [10]	Recommended [10]	Not Required
VGSI [11]	Recommended	Recommended	Recommended	Recommended
Applicable Runway Design Standards, (Reference online Runway Design Standards Matrix Tool or Appendix G)	Lower than 3/4-mile (1.2 km) visibility minimums	Not lower than 3/4-mile (1.2 km) visibility minimums	Not lower than 1 mile (1.6 km) visibility minimums	Not lower than 1 mile (1.6 km) visibility minimums
Approach or Departure Surface to be Met (Reference paragraph 3.6.1)	See Table 3-3 or Table 3-4	See Table 3-3 or Table 3-4	See Table 3-3 or Table 3-4	Table 3-3
Optimum Survey Type [12]	VGS	VGS	NVGS	NVGS [13]

Note: 1 ft = 0.305 m

Numbered Notes for Table K-1:

Note 1: Visibility minimums and described standards are subject to the application of FAA Order 8260.3 (TERPS) and associated orders. For each level of visibility, meet or exceed the optimum conditions within the column.

Note 2: For runways authorized for circling, meet requirements for threshold siting (reference paragraph 3.5) and OFZ (reference paragraph 3.11).

Note 3: HAA for circling. The HAT/HAA indicated is for planning purposes; actual obtainable HAT/HAA is determined by TERPS and may be higher due to obstacles or other requirements.

Note 4: An ALP is only required for obligated airports in the NPIAS; it is recommended for all others.

Note 5: Runways less than 3,200 ft (975 m) are protected by 14 CFR Part 77 to a lesser extent (reference §77.9(b) and §77.17(a)(2)). However, runways as short as 2,400 ft (732 m) could support an instrument approach provided the lowest HAT is based on clearing any 200-ft (61 m) obstacle within the final approach segment.

Note 6: Unpaved runways require case-by-case evaluation by the IFP Validation Team (IVT).

Note 7: Runway edge lighting is required for night approach minimums. High intensity lights and an RVR touchdown zone sensor are required for RVR-based minimums.

Note 8: A full-length parallel taxiway leading to and from the thresholds is advisable to achieve the lowest possible minimums, and minimizes the time aircraft are on the runway. Refer to the minimum visibility requirements on airport conditions in FAA Order 8260.3. Construction of a parallel taxiway, while advisable, is not a requirement for publication of an IFP with visibility minima ≥ 1 statute mile (1.6 km).

Note 9: Not applicable to Performance Based Navigation procedures. The following standards are applicable to conventional, ground-based procedures. A full approach light system (ALSF-1, ALSF-2, Simplified Short Approach Light System with Runway Alignment (SSALR), or MALSR) is required for visibility < 3/4 statute mile (1.2 km). Intermediate (MALSF, MALS, SSALF, SSALS, Short Approach Lighting System (SALS)/SALSF) or Basic (ODALs) systems will result in higher visibility minimums. An ALSF-1 or ALSF-2 is required for CAT II/III ILS. HAT < 250 ft (76 m) without MALSR, SSALR, or ALSF is permitted with visibility not less than 3/4 statute mile.

Note 10: ODALS, MALS, SSALS, and SALS are acceptable. Approach lights are recommended where a visibility minima improvement of at least 1/4 statute mile (0.4 km) can be achieved.

Note 11: To preclude a non-standard IFP, it is critical the instrument approach vertical descent angle (VDA) or glidepath angle (GPA) is coincident with the VGSI angle.

Note 12: See AC 150/5300-18 for VGS and non-Vertically Guided Survey (NVGS) requirements. When an AC 150/5300-18 VGS is not available, the equivalent legacy vertically guided (VG) surveys are area navigation approach precision vertical landing (ANAPV)/ localizer performance with vertical guidance (LPV)/PC, and PIR.

Note 13: Absence of a survey does not preclude authorization to establish circling to a runway but may result in the procedure being restricted to daytime only operations.

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APPENDIX L. APPROACH AND DEPARTURE REFERENCE CODES

L.1 General Overview.

The Approach and Departure Reference Codes (APRC and DPRC) are specifically for runway to taxiway separations. The APRC and DPRC are not design standards. They identify aircraft operations on a runway and its associated taxiway with no operating controls. These codes may help ATC and the airport operator determine the capabilities of their airfield based on existing runway to parallel taxiway separation. Airports often serve aircraft exceeding their airport's or specific runway's design standards. A runway's pavement strength or a taxiway fillet radius are other examples used to assess operational conditions.

L.1.1 Runway to Taxiway Separation.

Plan and design the runway to taxiway separations, per paragraph 3.17 and Appendix G for new infrastructure. A parallel taxiway increases capacity and improves safety by eliminating the need for aircraft to use the runway for taxiing. The landing and takeoff flight path profiles and physical characteristics of an aircraft determine this separation. Adhering to the separation standard prevents any part of a taxiing aircraft (located on a centerline) from penetrating the RSA or the OFZ.

L.2 Approach Reference Code (APRC).

Based on existing runway to taxiway separation, the APRC is a three-component code describing a combination of aircraft and visibility scenarios that allows concurrent operations on the runways and taxiways without generating ATC operational controls.

1. The codes in Table L-1 mimic the RDC (see paragraph 1.6.4), using the APRC convention AAC/ADG/RVR (example: B/II/4000).
2. Within the limits of the APRC, airplanes up to the listed AAC and ADG, and operating down to the visibility minimums noted per runway to taxiway separation, taxiing on the parallel taxiway may be conducted without operational mitigation.

Table L-1. Approach Reference Code (APRC)

Visibility Minimums	Runway to Taxiway Separation (ft)										
	≥ 150	≥ 200	≥ 225	≥ 240	≥ 250	≥ 300	≥ 350	≥ 400	≥ 450	≥500	≥550
Not lower than 3/4 mile (1.2 km) [4000 RVR]	B/I(S)/ 4000	B/I(S)/ 4000	B/I/ 4000	B/II/ 4000	B/II/ 4000	B/III/ 4000 D/II/ 4000	B/III/ 4000 D/II/ 4000	D/IV/ 4000 D/V/ 4000 [1]	D/IV/ 4000 D/V/ 4000 [2]	D/V/ 4000 [3] D/VI/ 4000	D/IV/ 4000
Lower than 3/4 mile (1.2 km) but not lower than 1/2 mile (0.8 km) [2400 RVR]	N/A	B/I(S)/ 2400	B/I(S)/ 2400	B/I(S)/ 2400	B/I/ 2400	B/II/ 2400	B/III/ 2400	D/IV/ 2400 D/V/ 2400 [1]	D/IV/ 2400 D/V/ 2400 [2]	D/V/ 2400 [3] D/VI/ 2400	D/IV/ 2400
Lower than 1/2 mile (0.8 km) but not lower than 1/4 mile (0.4 km) [1600 RVR]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	D/IV/ 1600	D/IV/ 1600	D/V/ 1600	D/VI/ 1600
Lower than 1/4 mile (0.4 km) [1200 RVR]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	D/IV/ 1200	D/IV/ 1200	D/V/ 1200	D/VI/ 1200

Note 1: Airport elevation at or below 1,345 ft (410 m).
Note 2: Airport elevation between 1,345 ft (410 m) and 6,560 ft (2,000 m).
Note 3: Airport elevation above 6,560 ft (2,000 m).

General Notes:

- (S) denotes small aircraft
- Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.
- For ADG-VI aircraft with tail heights of less than 66 feet (20.1 m), ADG-V separation standards apply.
- 1 ft = 0.305 m

L.2.1 APRC Example.

XYZ airport currently has a runway to taxiway separation of 350-feet (107 m). The RDC for this runway is C/II/2400, and in accordance with the online Runway Design Standards Matrix Tool requires a 400-foot (122 m) separation.

L.2.1.1 Using Table L-1, the APRC in this example is B/III/4000 and D/II/4000 at visibility minimums not lower than 3/4 mile (1.2 km) [4000 RVR], and

B/III/2400 at visibility minimums lower than 3/4 mile (1.2 km), but not lower than 1/2 mile (0.8 km) [2400 RVR]. This means that the following aircraft may land and taxi on the parallel taxiway without an operational restriction:

1. **Visibility minimum at not lower than 3/4 mile (1.2 km) [4000 RVR].**
   a. Within Approach Categories A and B, Airplane Design Groups I(S), I, II, & III.
   b. Within Approach Categories C and D, Airplane Design Groups I and II.
2. **Visibility minimum at lower than 3/4 mile (1.2 km), but not lower than 1/2 mile (0.8 km) [2400 RVR].**
   a. Within Approach Categories A and B, Airplane Design Groups I(S), I, II, and III.
   b. The airport operator (sponsor) and the ATC manager may implement operational controls of aircraft on the parallel taxiway to maximize the runway's capability.
   c. Coordinate these procedures with the Airport's Division and document in a Letter of Agreement between the airport operator and ATC.

L.2.1.2 With operational controls implemented by the ATC Manager:

1. **Visibility minimum not lower than 3/4 mile (1.2 km) [4000 RVR].**
   a. The parallel taxiway is to remain clear of ADG IV or larger aircraft when any aircraft is on final approach and within two miles (3.2 km) of the runway threshold.
   b. No aircraft will be on final approach and within two miles (3.2 km) of the runway threshold when the parallel taxiway is occupied by an ADG IV aircraft or larger.
2. **Visibility minimum lower than 3/4 mile (1.2 km), but not lower than 1/2 mile (0.8 km) [2400 RVR].**
   a. The parallel taxiway is to remain clear of ADG III or larger aircraft when any aircraft is on final approach and within two miles (3.2 km) of the runway threshold.
   b. No aircraft will be on final approach and within two miles (3.2 km) of the runway threshold when an ADG III or larger aircraft occupy the parallel taxiway.

L.3 Departure Reference Code (DPRC).

Based on existing runway to taxiway separation, the DPRC is a two-component code (AAC and ADG) describing the type of aircraft that can depart a runway while any aircraft is on the parallel taxiway. Table L-2 summarizes the minimum runway to taxiway separation for each DPRC. Within a DPRC, airplanes up to the AAC and ADG may conduct unrestricted operations.

Table L-2. Departure Reference Code (DPRC)

Runway to Taxiway Separation (ft)					
≥ 150	**≥ 225**	**≥ 240**	**≥ 300**	**≥ 400**	**≥ 500**
B/I(S)	B/I	B/II	B/III D/II	D/IV D/V	D/VI [1]

Note 1: Refer to Figure L-1. ADG-VI airplanes may depart with aircraft on the parallel taxiway where the runway to taxiway separation is as little as 400-feet (122 m) under these two scenarios:

a. No ADG-VI aircraft is occupying the parallel taxiway beyond 1,500 feet (457 m) of the point of the start of takeoff roll.
b. No aircraft, regardless of size, is occupying the parallel taxiway beyond 1,500 feet (457 m) of the point of the start of takeoff roll when there is snow, ice, or slush contamination on the runway.

General Notes:

- (S) denotes small aircraft
- Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.
- 1 ft = 0.305 m

L.3.1 DPRC Example.

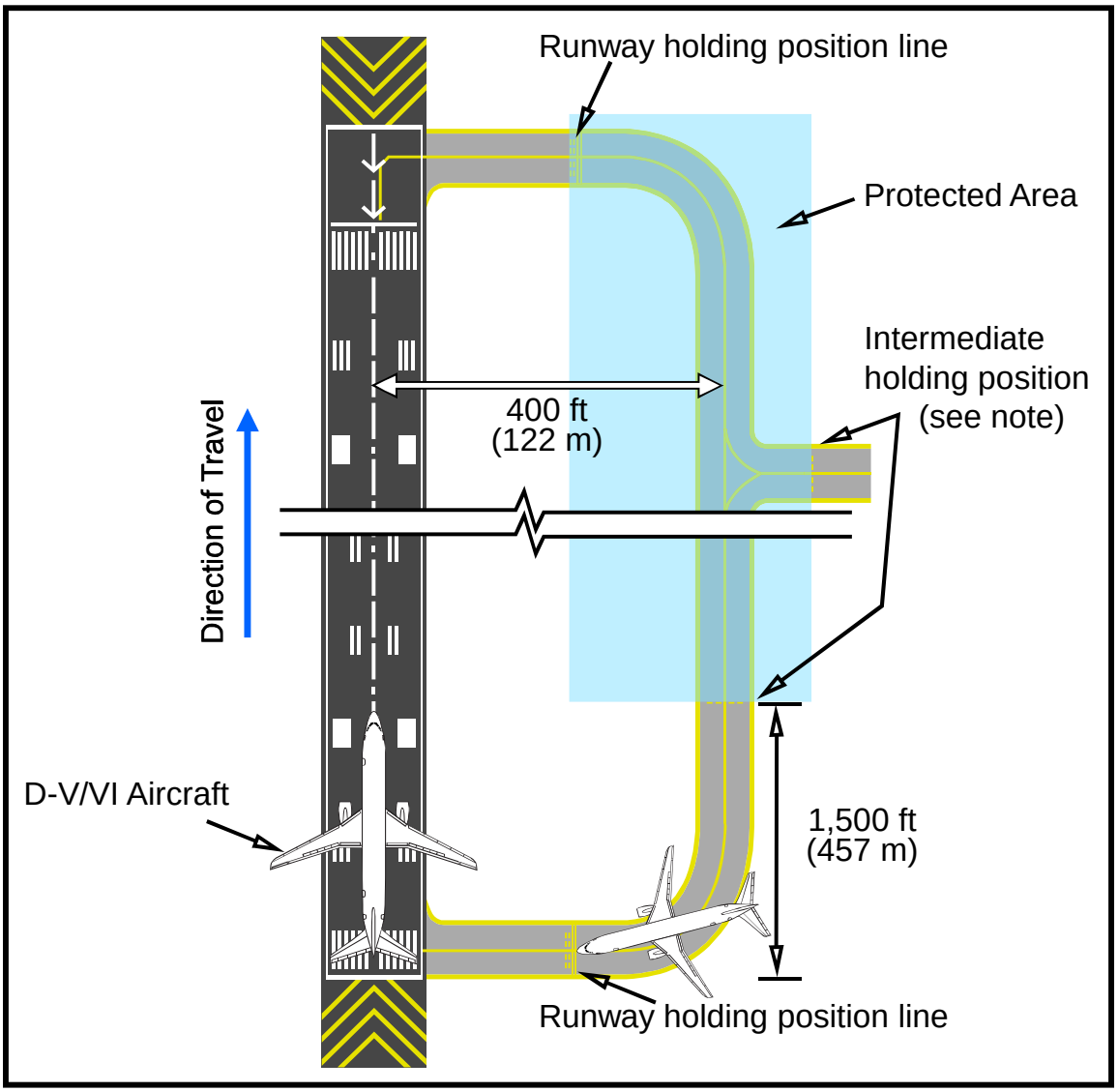
XYZ airport currently has a runway to taxiway separation of 240-feet (73 m). The DPRC, in this example, is B/II. The following aircraft may depart with any aircraft on the parallel taxiway without operational mitigation:

- Within Approach Categories A and B, Airplane Design Groups I(S), I, and II.

The ATC Manager may implement the following operational controls for the parallel taxiway:

- Remain clear of aircraft ADG III or larger when aircraft larger than B/II is departing the runway.

Figure L-1. ADG V-VI Departures



Note: Refer to AC 150/5340-1 for intermediate holding position marking.

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APPENDIX M. DIFFERENCES IN AIRPORT DESIGN STANDARDS AND RELATIONSHIP OF AIRCRAFT CHARACTERISTICS TO DESIGN COMPONENTS

Table M-1 depicts the differences in design standards associated with an increase in the AAC and ADG. Table M-2 depicts the differences in design standards associated with a decrease in visibility minimums. Table M-3 relates aircraft characteristics to various design components.

Table M-1. Differences in Design Standards with Upgrade in Aircraft Approach Category (AAC) and Airplane Design Group (ADG)

AAC/ ADC Upgrade	Differences in Airport Design Standards	Reference
A-I* to B-I*	No change in airport design standards.	
B-I* to C-I	Increase in crosswind component.	Refer to paragraph B.3 and Table B-1.
	Increase in runway separation standards.	Refer to interactive online Runway Design Standards Matrix Tool and Table 4-3.
	Increase in RPZ dimensions.	Refer to online Runway Design Standards Matrix Tool and paragraph 3.13.1.
	Increase in OFZ dimensions.	Refer to paragraph 3.11.
	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.
	Increase in surface gradient standards.	Refer to paragraph 3.16, Figure 4-29, paragraph 4.14, and paragraph 5.9.
	Increase in threshold siting standards.	Refer to paragraph 3.5.
A-I to B-I	No change in airport design standards.	
B-I to C-1	Increase in crosswind component.	Refer to paragraph B.3 and Table B-1.
	Increase in runway separation standards.	Refer to online Runway Design Standards Matrix Tool and Table 4-3.
	Increase in RPZ dimensions.	Refer to online Runway Design Standards Matrix Tool and paragraph 3.13.1.
	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.
	Increase in surface gradient standards.	Refer to paragraph 3.16, Figure 4-29, paragraph 4.14, and paragraph 5.9.

AAC/ ADC Upgrade	Differences in Airport Design Standards	Reference
A-II to B-II	No change in airport design standards.	
B-II to C-II	Increase in crosswind component.	Refer to paragraph B.3 and Table B-1.
	Increase in runway separation standards.	Refer to online Runway Design Standards Matrix Tool and Table 4-3.
	Increase in RPZ dimensions.	Refer to online Runway Design Standards Matrix Tool and paragraph 3.13.1.
	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.
	Increase in surface gradient standards.	Refer to paragraph 3.16, Figure 4-29, paragraph 4.14, and paragraph 5.9.
A-III to B-III	No change in airport standards.	
B-III to C-III	Increase in runway separation standards.	Refer to online Runway Design Standards Matrix Tool and Table 4-3.
	Increase in RPZ dimensions.	Refer to online Runway Design Standards Matrix Tool and paragraph 3.13.1.
	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.
	Increase in surface gradient standards.	Refer to paragraph 3.16, Figure 4-29, paragraph 4.14, and paragraph 5.9.
A-IV to B-IV	No change in airport design standards.	
B-IV to C-IV	Increase in RPZ dimensions.	Refer to online Runway Design Standards Matrix Tool and paragraph 3.13.1.
	Increase in surface gradient standards.	Refer to paragraph 3.16, Figure 4-29, paragraph 4.14, and paragraph 5.9.
C-I to D-I	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.
C-II to D-II	Increase in runway design standards.	Refer to online Runway Design Standards Matrix Tool.

Note: * These airport design standards pertain to facilities designed for small aircraft.

Table M-2. Differences in Airport Design Standards with Lowering Approach Visibility Minimums

Visibility minimums*	Differences in Airport Design Standards	Reference
Visual to Not lower than 1-mile (1.6 km)	No change in airport design standards.	Refer to Table K-1.
Not lower than 1-mile (1.6 km) to Not lower than 3/4-mile (1.2 km)	Parallel Taxiway:	Refer to Table K-1.
	• Increase in RPZ dimensions.	Refer to the Runway Design Standards Matrix Tool.
Not lower than 3/4-mile (1.2 km) to Not lower than CAT-I	For runways with aircraft approach categories A and B runways:	Refer to design standards in Chapter 2.
	• Increase in runway separation standards.	Refer to the online Runway Design Standards Matrix Tool and Table 4-3.
	• Increase in RPZ dimensions.	Refer to the online Runway Design Standards Matrix Tool.
	• Increase in OFZ dimensions.	Refer to paragraph 3.11.
	• Increase in runway design standards.	Refer to the online Runway Design Standards Matrix Tool.
	• Increase in threshold siting standards.	Refer to paragraph 3.5.
	For runways with aircraft approach categories C, D, and E runways:	Refer to design standards in Chapter 2.
	• Increase in runway separation for runways standards with ADG-I and ADG-II standards.	Refer to the online Runway Design Standards Matrix Tool and Table 4-3.
	• Increase in RPZ dimensions.	Refer to the online Runway Design Standards Matrix Tool.
	• Increase in OFZ dimensions.	Refer to paragraph 3.11.
	• Increase in threshold siting standards.	Refer to paragraph 3.5.
Not lower than CAT-I to Lower than CAT-I	Increase in OFZ dimensions for runways serving large aircraft.	Refer to paragraph 3.11.
	Increase in threshold siting standards.	Refer to paragraph 3.5.

Note: ** In addition to the changes in airport design standards as noted, providing for lower approach visibility minimums may result in an increase in the number of objects identified as obstructions to air navigation, in accordance with 14 CFR Part 77. This may result in the need for object removal or markings and lighting. Refer to paragraph 3.7.

Table M-3. Relationship of Aircraft Characteristics to Design Components

Aircraft Characteristics	Design Components
Approach Speed	RSA, ROFA, RPZ, runway width, runway to taxiway separation, runway to fixed object
Landing and Takeoff Distance	Runway length
CMG Distance	Fillet design, apron area, parking layout
MGW	Taxiway width, fillet design
Wingspan / Tail Height	Taxiway and apron OFA, parking configuration, hangar locations, taxiway to taxiway separation, runway to taxiway separation

APPENDIX N. ACRONYMS

AAA	Airport Airspace Analysis
AAC	Aircraft Approach Category
AAS-100	FAA Office of Airport Safety and Standards, Airport Engineering Division
AASHTO	American Association of State Highway and Transportation Officials
AC	Advisory Circular
ACI	Airports Council International
ACM	Airport Certification Manual
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
ADG	Airplane Design Group
ADIP	Airport Data and Information Portal
ADO	Airports District Office
ADS-B	Automatic Dependent Surveillance - Broadcast
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AIP	Airport Improvement Program
ALP	Airport Layout Plan
ALS	Approach Lighting System
ALSF	Approach Lighting System with Sequenced Flashing Lights
ALSF-1	ALS with Sequenced Flashers I
ALSF-2	ALS with Sequenced Flashers II
ANAPV	Area Navigation Approach Precision Vertical Landing
AOA	Aircraft Operations Area
AOPA	Aircraft Owners and Pilots Association
APRC	Approach Reference Code
APU	Auxiliary Power Units
APV	Approach Procedure with Vertical Guidance
ARFF	Aircraft Rescue and Fire Fighting
ARP	Airport Reference Point
ASDA	Accelerate Stop Distance Available
ASDE	Airport Surface Detection Equipment (Radar)
ASDE-X	Airport Surface Detection Equipment – Model X
ASOS	Automated Surface Observing System
ASR	Airport Surveillance Radar
ASRS	Aviation Safety Reporting System

ASSC	Airport Surface Surveillance Capability
ASTM	ASTM International
ATC	Air Traffic Control
ATC-F	Air Traffic Control Facilities
ATCT	Airport Traffic Control Tower
ATO	Air Traffic Organization
AWOS	Automated Weather Observing Systems
AWSS	Automated Weather Sensor System
BMP	Best Management Practice
BRL	Building Restriction Line
CAD	Computer Aided Design
CAT	Category
CFR	Code of Federal Regulations
CIE	International Committee of Illumination
CL	Centerline
CMG	Cockpit to Main Gear Distance
CNSW	Communications, Navigation, Surveillance and Weather
CPA	Continuous Power Airport
DA	Decision Altitude
DER	Departure End of Runway
DME	Distance Measuring Equipment
DPRC	Departure Reference Code
DXF	Drawing eXchange Format
EAT	End-Around Taxiway
EMAS	Engineered Materials Arresting System
EMI	Electromagnetic Interference
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FBO	Fixed Base Operator
FOD	Foreign Object Debris
FPAG	Flight Procedures and Airspace Group
FSD	Transportation Security Administration Federal Security Director
GA	General Aviation
GIS	Geographic Information System
GLS	Ground Based Augmentation System (GBAS) Landing System
GNSS	Global Navigation Satellite System
GPA	Glide Path Angle

GPS	Global Positioning System
GS	Glide Slope
GSE	Ground Service Equipment
HAA	Height Above Airport
HAT	Height Above Touchdown
HIRL	High Intensity Runway Lights
HSS	Hollow Structural Section
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IA-OFZ	Inner-Approach OFZ
IATA	International Air Transport Association
IBC	International Building Code
ICAO	International Civil Aviation Organization
IES	Illuminating Engineering Society of North America
IFP	Instrument Flight Procedure
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
ISA	International Standard Atmosphere
ISH/ISD	Integrated Surface Hourly/Integrated Surface Data
IT-OFZ	Inner-Transitional OFZ
IVT	IFP Validation Team
LDA	Landing Distance Available
LDIN	Lead-in Lighting System
LIR	Low Impact Resistant
LIRL	Low Intensity Runway Lights
LLWAS	Low Level Windshear Alert System
LNAV	Lateral Navigation
LOC	Localizer
LOS	Line of Sight
LP	Localizer Performance
LPV	Localizer Performance with Vertical Guidance
LSA	Light Sport Aircraft
MALS	Medium Intensity Approach Lighting System
MALSF	MALS with Sequenced Flashers
MALSR	MALS with Runway Alignment Indicator Lights
MDA	Minimum Descent Altitude
MGW	Main Gear Width

MIRL	Medium Intensity Runway Lights
MM	Middle Marker
MMLS	Mobile Microwave Landing System
MPH	Miles Per Hour
MSL	Mean Sea Level
NAS	National Airspace System
NAVAID	Navigational Aid
NCDC	National Climatic Data Center
NDB	Non-directional Beacon
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Air Missions
NPA	Non-Precision Approach
NPDES	National Pollution Discharge Elimination System
NPI	NAS Planning and Integration
NPIAS	National Plan of Integrated Airport Systems
NVGS	Non-Vertically Guided Survey
ODALS	Omnidirectional Airport Lighting System
OE/AAA	Obstruction Evaluation/Airport Airspace Analysis
OFA	Object Free Area
OFZ	Obstacle Free Zone
OM	Outer Marker
OSHA	Occupational Safety and Health Administration
PA	Precision Approach
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PFC	Passenger Facility Charge
PIR	Precision Instrument Runway
POFZ	Precision Obstacle Free Zone
PRM	Precision Runway Monitor
PSI	Pounds per Square Inch
PVC	Point of Vertical Curve
PVI	Point of Vertical Intersection
PVT	Point of Vertical Tangency
RAM	Runway Airspace Management
RCO	Remote Communications Outlet

RDC	Runway Design Code
REDIM	Runway Exit Design Interactive Model
REIL	Runway End Identifier Lighting
REL	Runway Entrance Lights
RF	Radio Frequency
RIM	Runway Incursion Mitigation
RNAV	Area Navigation
RNP	Required Navigation Performance
ROFA	Runway Object Free Area
ROFZ	Runway Obstacle Free Zone
RON	Remain Over Night
RPZ	Runway Protection Zone
RSA	Runway Safety Area
RTR	Remote Transmitter/Receiver
RVR	Runway Visual Range
RVZ	Runway Visibility Zone
RW	Runway
RWSL	Runway Status Lights
SALS	Short Approach Lighting System
SALSF	Short Approach Lighting System with Sequenced Flashing Lights
SBGP	State Block Grant Program
SI	International System of Units
SIDA	Security Identification Display Area
SMS	Safety Management System
SRE	Snow Removal Equipment
SRM	Safety Risk Management
SSALF	Simplified Short Approach Light System with Sequenced Flashing Lights
SSALR	Simplified Short Approach Light System with Runway Alignment
SSALS	Simplified Short Approach Light System
SVG	Scalable Vector Graphics
TACAN	Tactical Air Navigation
TBW	Total Bytes Written
TCH	Threshold Crossing Height
TDG	Taxiway Design Group
TDZ	Touchdown Zone
TERPS	Terminal Instrument Procedures
TESM	Taxiway Edge Safety Margin
TH	Threshold

THL	Takeoff Hold Lights
TL	Taxilane
TLOFA	Taxilane Object Free Area
TODA	Takeoff Distance Available
TOFA	Taxiway Object Free Area
TORA	Takeoff Run Available
TPP	U.S. Terminal Procedures Publication
TRACON	Terminal Radar Approach Control Facility
TSA	Taxiway/Taxilane Safety Area
TVOR	Terminal Very High Frequency Omnidirectional Range
TW	Taxiway
UAS	Unmanned Aircraft Systems
UFC	Unified Facilities Criteria
UHF	Ultra-High Frequency
U.S.C.	United States Code
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VGS	Vertically Guided Surface
VGSI	Visual Guidance Slope Indicator
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VORTAC	VHF Omnidirectional Range Collocated Tactical Air
V_{EF}	Velocity Engine Failure
V_{REF}	Reference landing speed
V_{SO}	Stall speed
VSR	Vehicle Service Road
WCAM	Weather Camera
WEF	Wind Equipment F-400
WHSV	Wildlife Hazard Site Visit
WME	Wind Measuring Equipment

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