FAA Guidance for Provincetown Airport Capital Improvements Plan (CIP) Project

The primary mission of the FAA is safety. As stated in FAA Order 5100.38C, Airport Improvement Program Handbook: "The highest aviation priority of the United states is the safe and secure operation of the airport and airway system." The authority to regulate the aviation system, and the extensive design standards are discussed below.

The purpose of the Provincetown Airport 2015 CIP project is to:

- Enhance Airport safety and security.
- Enhance the efficiency of the Airport to more fully meet the current and anticipated demand.

The CIP will provide operational safety and security improvements at Provincetown Municipal Airport that comply with current FAA, Massachusetts Department of Transportation (MassDOT) Aeronautics Division, and TSA safety and security design standards for a non-hub primary service airport. The use of these standards is mandatory for airport projects receiving Federal grant-in-aid assistance. It is the policy of the Airports Division of the FAA New England regional office that airport improvement projects must comply with the national airport design standards.

The CIP will also address existing and anticipated capacity needs. The proposed improvements to the parking lot and the turf apron are design to address the current and projected needs at the Airport.

The CIP projects are needed because:

- Certain airfield facilities do not meet current safety and security standards.
- The Airport's existing parking and terminal facilities cannot efficiently meet current and projected demand.

The following discussion of the FAA, MassDOT, TSA and other safety, security and wildlife management design guidelines is provided as background.

1. Background for Airport Safety and Security Design Standards and Guidelines

The following discussion is based on information obtained from FAA, MassDOT, and TSA. Additional information was obtained from staff at the FAA New England Regional Office, Planning Branch, and Safety & Standards Branch. Applicable portions of regulations and design standards are provided.

Acts of Congress

Safety

The Federal Aviation Administration has been given the authority to regulate civil aviation by several acts of Congress. Starting with the Air Commerce Act of 1926, the new aeronautics branch of the Department of Commerce assumed responsibility for aviation oversight and concentrated on safety rulemaking and certification of pilots and aircraft. It also took over operation of the nation's system of lighted airways from the Post Office Department. The Civil Aeronautics Act of 1938 transferred responsibilities to a new independent agency, the Civil Aeronautics Authority. The Federal Aviation Act of 1958 created a new independent body, the Federal Aviation Agency, with broader authority to combat aviation hazards. In 1966 Congress authorized the Department of Transportation and the Agency became the Federal Aviation Administration. The Airport and Airway Development Act of 1970 made FAA responsible for safety certification of airports served by air carriers. The Airport and Airway Improvement Act of 1982 established the Airport Improvement Program (AIP). The AIP provides grants to public agencies for the planning and development of public-use airports that are included in the National Plan of Integrated Airport Systems (NPIAS). The NPIAS is comprised of all commercial service airports, all reliever airports, and selected general aviation airports.

Security

The FAA became more involved in the field of aviation security during the hijacking epidemic of the 1960s. The Aviation Security Improvement Act of 1990 directed the FAA to develop guidelines for airport design to allow for security enhancement. The Aviation and Transportation Security Act (ATSA), signed into law November 2001, established the Transportation Security Administration (TSA) following the September 11, 2001 terrorist attacks. The TSA was given responsibility for securing all modes of transportation, including aviation. The establishment of the Department of Homeland Security (DHS) in 2002 further defined the responsibilities of TSA. Although the public is most aware of efforts to improve security relative to passenger and baggage screening, another area of aviation security pertains to the perimeters of airport properties. TSA has issued Recommended Security Guidelines for Airport Planning, Design and Construction, which includes guidelines for perimeter security and access points.

Laws and Regulations

The FAA has the statutory authority to issue rules on aviation safety under Title 14 and Title 49 of the United States Code. The United States Code is the codification by subject matter of the general and permanent laws of the United States. It is divided by broad subjects into 50 titles and published by the Office of the Law Revision Counsel of the U.S. House of Representatives.

Safety

Title 14 presents regulations governing the activities of the Department of Transportation and the National Aeronautics and Space Administration in the areas of aeronautics and space, including: aircraft, aviators, airspace, air traffic, certification of air carriers and operations, and airports. Chapter 1 of Title 14 includes the Federal Aviation Administration, Department of Transportation. The following section is relevant to the discussion of the proposed projects at the Airport:

- 14 CFR Part 77 applies to Objects Affecting Navigable Airspace. Part 77 establishes standards for determining obstructions in navigable airspace. These standards are established through imaginary obstacle free surfaces with relation to the airport and each runway.

Security

Regulations relative to airport security can be found at Title 14 CFR Part 107 and Part 121. Part 107 regulates airport security and Part 121 defines the operating regulations for commercial carriers.

Title 49 also relates to security at airports. Title 49 presents regulations governing research and special programs administration, railroads, highways, vessel cargo containers, traffic safety, surface transportation, transit administration, and transportation safety. The following section is relevant to the discussion of the proposed projects at the Airport:

- 49 CFR Subchapter C Part 1542 applies to Civil Aviation Security. Part 1542 requires airport operators to adopt and carry out a security program approved by TSA.
- 49 CFR Part 1544 applies to the security of airport operations.

Airport Operations Safety Design Standards and Guidelines

The FAA publishes documents known as Advisory Circulars (ACs) and Orders, while not regulations, provide accepted operational safety design standards to meet responsibilities pursuant to the regulations. The use of these standards is mandatory for airport projects receiving Federal grant-in-aid assistance. AIP funded projects are required to comply with certain FAA Advisory Circulars (AC). Applicable portions of regulations and design standards are provided and can also be found at <www.faa.gov/airports_airtraffic/airports/aip/media/aip_pfc_checklist_fy2007.pdf>.

FAA Airport Design Advisory Circular (AC 150/5300-13) includes the design standards for all civilian airports. As stated on the signature page of the Advisory, “For airport projects receiving Federal grant-in-aid assistance, the use of these standards is mandatory.” The design standards are important because they establish a uniformity and consistency of design that has been adopted by the FAA to promote the safe movement of aircraft at all airports in the United States. Whenever possible, existing airport facilities are brought to current standards as an adjunct to other projects, such as pavement reconstruction and other improvement projects.

Specific sections of relevant ACs and Orders that apply to the proposed projects are provided later in this section.

Airport Security Design Standards and Guidelines

FAA Airport Design Advisory Circular (AC 150/5300-13, Chapter 6, Paragraph 614) includes site requirements for NAVAID facilities and security of those facilities.

In June 2001, the FAA issued revised Recommended Security Guidelines pursuant to the Aviation Security Improvement Act of 1990. In June 2006, TSA issued Recommended Security Guidelines for Airport Planning, Design and Construction.

In Massachusetts, public-use airports are subject to requirements issued by the MassDOT Aeronautics Division Directive Airport Security AD-001a. Each airport is required to prepare an Airport Security Plan in accordance with the Directive and Federal guidelines.

On the local level, the Provincetown Airport Commission applies all the guidance documents to prepare a Security Plan for the Airport that is appropriate for the type of airport operations, secure areas, and other conditions specific to the Airport. The specifics of the PVC Security Plan cannot be discussed in this unclassified document for security reasons. However, the most visible impact has been the mandatory conversion of approximately 1,600 square feet (61%) of the passenger lobby to TSA restricted area.

2. PROPOSED SAFETY AND SECURITY PROJECTS

This section discusses the guidance for projects related to safety and security. The auto and aircraft parking projects are not discussed.

2.1 Westerly Taxiway (TW) System Improvements

The components of the TW system at the westerly end of Runway 7 are closely interconnected in terms of function and design. For these reasons the West End Connector TW, the westerly end of the Parallel TW, and the Mid Connector TW are included under the heading of Westerly TW System Improvements. The sub elements of the Westerly TW System are discussed separately in terms of purpose and need and for the alternatives analysis. They are combined as one project in terms of impacts and mitigation because the elements overlap and the entire taxiway system would be constructed together.

A. Relocate the West End Taxiway (TW D)

The purpose of relocating the West End Connector TW (West End TW) is to comply with FAA flight operation safety standards. There are three issues with the current alignment:

1. The West End TW is a jug-handle shaped taxiway. The jug-handle configuration was constructed years ago to accommodate the turning radius of the DC-3 airliners that were flown at the time. The DC-3s are no longer in operation. Currently, FAA design standards provide for an L-shaped intersection with a right angle to the runway for operational safety. Such a reconfiguration would generally be programmed when the taxiway pavement needs to be reconstructed.

2. The existing taxiway is located within the Runway 7 approach surface as defined by 14 CFR Part 77. Because of this condition, pilots waiting to depart Runway 7 are required to hold short of the runway, limiting their view of the runway, which makes the taxiing procedure especially hazardous during low visibility and peak operating times.

3. The taxiway intersects parallel to the end of the runway rather than at a right angle to the runway because the runway was shifted east to accommodate FAA required Runway Safety Areas (RSAs) and minimize environmental impacts. This intersection is not in compliance with the current FAA design standards. This increases the risks of runway incursions or collisions on the runway and must be corrected. This is a non-compliant safety issue for the Airport.

The West End TW is within the approach surface as a result of the shift of the runway to the east to accommodate runway safety areas (MEPA Certificate on FEIR #9386, January 14, 2000). At the time the runway was reconstructed with the safety areas, it was not feasible to include the reconstruction of the taxiways. It has always been the intention to correct this design deficiency as funds became available.

The West End TW needs to be relocated because it is within the approach surface, it intersects parallel to the end of the runway and it is not at a right angle with the runway so that approaching aircraft are not visible to taxiing planes. The fact that the Airport does not have a control tower adds to the need for a standard design taxiway at the Runway 7 end.

Reference: 14 CFR Part 77.25(d); AC 150/5300-13 (See Table 1 and attached specific sections)

B. Realign and Reconstruct the Westerly End of the Parallel Taxiway (TW A)

The purpose of realigning the parallel TW is to enhance safety by providing a straight alignment between the runway ends and the apron area in accordance with FAA design standards. The current taxiway shifts to the north at the mid-connector taxiway. An additional purpose of reconstructing the taxiway is to replace the section of aging pavement. Pavement is constructed according to FAA specifications, and the pavement is showing signs of deterioration. It is eligible for FAA reconstruction funding.

The Parallel TW needs to be realigned and reconstructed because the taxiway centerline shifts twenty feet to the north between the Mid Connector taxiway and the West End taxiway. This shift in the centerline requires the pilot to change speed and direction, which presents a hazardous situation to pilots during nighttime and low visibility conditions. There are periods when fog moves in over the Airport and is trapped by the dunes to the north and south which provide natural barriers so the fog cannot dissipate. This reduces visibility and increases the risk of pilots "missing the turn" in what they expect to be a straight taxiway. The aircraft could potentially hit another parked aircraft or veer off into the wetlands. This hazard is not in compliance with FAA design standards. The shift in centerline resulted from a 1984 project to address non-compliance with an FAA Object Free Area. The taxiway centerline was shifted approximately twenty feet to the south between the mid and east taxiway connectors. The section between the Mid Connector TW and West End TW was not shifted at the time but it has always been the intention to correct this issue when the pavement was reconstructed.

Installing taxiway edge lights alone would not address the operational safety issues. Taxiway edge lights would enhance safety during nighttime conditions, but the hazardous and non-standard geometry for a parallel taxiway still needs to be addressed.

The realignment also provides the opportunity to remove some pavement along the length of the parallel taxiway as discussed later in the document.

Reference: AC 150/5300-13 (See Table 1 and attached specific sections)

C. Realign the Mid Connector TW C

The purpose of realigning the Mid Connector TW is to bring the taxiway into compliance with FAA operational safety design standards when the pavement is reconstructed. Similar to the West End taxiway, the Mid Connector taxiway is a jug-handle shape that was designed for the old tailwheel-equipped Douglas DC-3 passenger plane. The taxiway does not meet at the current standard right angle with the runway. However, aircraft holding to depart are not located within any clear zones, and the current alignment does not pose any current operational hazards.

Reference: AC 150/5300-13 (See Table 1 and attached specific sections)

2.2 Relocate the East End TW B

The East End TW has the standard design of a ninety-degree intersection but does not comply with the design standard to connect with the end of Runway 25. Pilots are required to "back taxi" in order to reach the end of Runway 25 prior to takeoff. This creates the potential for collisions between a back-taxiing aircraft and one that may be landing.

This offset is a result of the necessary shift of the runway 200 feet to the east to provide Runway Safety Areas. The taxiway was in existence at the time, but was not part of the project to construct RSAs. FAA did not require that it be reconstructed at that time and it was not included in the 1999 EIS/EIR.

The project will eliminate the need to back-taxi on an active runway, in compliance with FAA operational safety and airfield design standards. The back-taxi maneuver creates a potential conflict with aircraft on final approach to landing. This operational hazard should be eliminated to be in compliance with FAA's runway Incursion Prevention Program.

Reference: AC 150/5300-13 (See Table 1 and attached specific sections)

2.3 Reconstruct the Terminal Apron

The purpose of the terminal apron project is to maintain airfield safety and operational access by reconstructing the pavement within the existing footprint.

In the Certificate on the DEIR/NPC, the Secretary of EOEEA allowed the project to go forward prior to completion of the FEIR/EA. The project does not result in an increase in pavement or change in the footprint. A Notice of Intent was filed with the Provincetown Conservation Commission and the project was constructed in 2008.

Reference: AC 150/5320-6d (See Table 1 and attached specific sections)

2.4 Reconstruct the Easterly End of the Parallel TW A within the Existing Footprint

The purpose of reconstructing the pavement within the existing footprint of the easterly portion of the partial parallel taxiway is to replace pavement that is in poor condition. In the Certificate on the DEIR/NPC, the Secretary of EOEEA allowed the project to go forward prior to completion of the FEIR/EA, if funding is available. The project does not result in an increase in pavement or change in the footprint. In the Certificate on the DEIR/NPC, the Secretary of EOEEA allowed the project to go forward prior to completion of the FEIR/EA.

Reference: AC 150/5220-6d (See Table 1 and attached specific sections)

2.5 Install TW Lighting and Construct an Electric Vault (and reconstruct the Sightseeing Shack)

The purpose of the TW edge lights, signs, and a new separate electric vault is to improve operational safety on the taxiways during nighttime operations and to upgrade the reliability of the power supply to the taxiway and runway lighting system.

Medium Intensity Taxiway Edge Lights (MITLs) are needed for the taxiway system. LED lights will be used. The taxiways currently have reflectors but the lack of lighting can be a safety hazard during inclement weather or sudden fog conditions. Improvements to the lighting system for the taxiways would require additional space for the airfield electric vault which is currently located inside the sightseeing shack. A separate electrical vault is required to support the new lighting system, to allow adequate space that meets electrical code, and bring the system up to standards. Since the building walls may need to be opened to remove the electrical equipment as part of the Install Taxiway Lighting and Construct Electric Vault improvements, and the structure is in poor condition, the sightseeing building needs to be repaired or replaced with a new structure.

Reference: DOT/FAA/AR-04/10, Section 4; AC 150/5300-13 (See Table 1 and attached specific sections)

2.6 Improve Access Road to the MALSF Approach Lights

The purpose of improving the existing access road to the Runway 7 approach lights is to address an operational safety issue.

Construction of the existing embankment for the access road to the Medium Intensity Approach Light System with Flashers (MALSF) at the Runway 7 end was permitted by the DEP Decision on the Request for a Variance, dated May 18, 2001, and a CCC DRI Decision dated April 13, 2000. A new survey was completed for the final design stage for that project. When the impact area was recalculated with the updated elevation information, a discrepancy was discovered. In order to build the road with shoulders and a turn-around, additional area of Bordering Vegetated Wetland (BVW) would have needed to be filled beyond the amount specified in the Variance. Staff at DEP, the Provincetown Conservation Commission, and the CCC was consulted at the time. A request to amend the Variance was not prepared because of time and legal constraints relative to funding, construction contracts, and runway closures. Therefore, in order to be in compliance with the Variance, the road was constructed on a filled embankment approximately 3 feet above the adjacent wetland area, but without shoulders and without a turn-around area. Permitting agencies reviewed and approved the access road as constructed.

Several years of vehicle operations on the access road have confirmed the need for an improvement to the road. Because of the narrow width and lack of a turn-around area, FAA service vehicles must back up for a distance of 400 feet before being able to turn around. Without shoulders, this maneuver has always been difficult because the drivers of the FAA utility vehicles have difficulty seeing the edge of the road, especially in poor weather. Recently a vehicle went off the road onto the side slope. A large crane parked within the runway safety area was required to extricate the van. The runway had to be closed while the crane was on location.

FAA design standards for access roads to FAA owned and operated facilities have specific pavement requirements for the roads when they join a runway or taxiway. FAA Order 6940.1 specifies a paved access road for a minimum of 300 feet if it comes off a runway or taxiway. The pavement minimizes the potential for a vehicle to track stones or other foreign material onto the runway or taxiways, which might damage a plane. Aircraft turbine engines can be damaged from the ingestion of stones or other foreign objects.

At the time the MALSF road was constructed trucks were able to drive on the abandoned runway pavement resulting from the shift in the runway. This pavement will be removed as part of the relocation of the West End TW. The area will be rehabilitated as grassland habitat as part of the proposed mitigation for the CIP projects. Because of that pavement removal, the Airport proposes to pave the first 300 feet of the access road in accordance with FAA Order 6940.1. The access road to the glide slope antenna is currently paved for the entire distance.

Reference: Order 6940.1; AC 150/5300-13 (See Table 1 and attached specific sections)

2.7 Construct Service Access Roads to the Localizer Equipment Shelter (LES) and to the Weather Station (AWOS)

The purpose of constructing access roads is to comply with FAA operational standards by providing vehicle access to the airfield equipment. The service access roads would improve maintenance access, especially in inclement weather or emergencies. As explained below, the access roads to the AWOS and LES have always been required, but at the time, construction of road access was put aside in order to complete the critical runway and MALSF improvements.

The CCC has asked in its comment letter on the ENF why the LES and AWOS access roads were not identified as a need during the RSA and MALSF approach lights project review. The need to relocate the AWOS was not anticipated during the design of the RSA and MALSF project. The AWOS wind tower has its own clearance requirements and the strict clearance requirements of the AWOS wind tower instrument became apparent after the design and environmental permitting process was completed and the project had advanced to the construction phase. Significant tree clearing would have been necessary to avoid moving the AWOS after the RSA project. To avoid the need to cut additional trees, the AWOS was relocated to the infield between the runway and the taxiway, next to the wind cone and segmented circle. The AWOS field design change was reviewed and approved by DEP, the Provincetown Conservation Commission, and CCC. Because of the constraints of construction contracts, runway closures, and committed funding, an access road was not included in the submission because it would have required additional design and permitting.

Similarly, the need to provide power service to the new localizer shelter (LES) was not included in the design and permitting process for the RSA and approach lights projects. Excavation to install the power cable was allowed by the CCC and DEP on the alignment of an existing foot path in Wetland B, provided the area was replanted and restored to the original narrow path. Although a narrow path walkway was allowed to be disturbed, there was not enough time to request a change to the DEP Variance and CCC DRI to include an access road to the localizer shelter.

Equipment used by FAA technicians to serve the Localizer and AWOS is heavy and not easily transported by foot. The FAA technicians support a regional network of equipment, driving their utility trucks and vans to each site. Navigational equipment is repaired and replaced during all weather conditions to ensure safe airline operating conditions. Airports with passenger service are priority for immediate equipment repairs. The project is needed because current vehicle access to the Localizer Equipment Shelter and the Automated Weather Observing Station (AWOS) is off the active runway over unpaved surfaces.

Reference: Order 6940.1; AC 150/5300-13 (See Table 1 and attached specific sections)

2.8 Install Perimeter Safety/Security Fence

The purpose of the perimeter fencing is both safety and security. First, the fencing would improve safety by deterring deer and coyote, as well as hunters and hikers, from encroaching on the airfield's operational area. Additionally, for the safety and security of all users of the CCNS, the perimeter fence is proposed to separate areas designated for airport operations from airport lease areas that are currently used by the public for recreational activities.

Secondly, fencing secures the Airport Operating Area (AOA), the Security Identification Display Area (SIDA), and other security areas from unauthorized access, in compliance with TSA Guidelines. The key concerns and concepts are to restrict access, control the flow of people, provide security screening, separate critical areas, protect areas and assets, and protect aircraft, people and property.

The Airport currently has fencing at the east end of Runway 25 which is adjacent to the CCNS bike path, and around the terminal apron and the fueling station.

Fencing is also needed to enclose currently unsecured areas and minimize unauthorized access for safety and security. The Airport is a commercial service airport with scheduled flights into Boston Logan International Airport via Cape Air. Since Cape Air flies directly to Logan's secure terminal areas for direct connections to Jet Blue and other passenger airlines, the Cape Air passengers must be pre-screened at Provincetown Airport. This direct connection to Logan means that airfield security at PVC must meet the rigid standards found under FAR Part 107.

Fencing is also needed to deter deer and coyote from coming onto the runways and other operating areas. There have been several collisions over the years between aircraft and deer, resulting in damage to the planes and death of the animals. There have also been incidences when coyotes were on the runway and interfered with landing operations.

On limited occasions, hikers and horseback riders have gone down the runway, mistaking it as a paved road. Additionally, since recreational activities at the CCNS include a hunting program for deer, waterfowl, rabbit, and other species, there is a need to identify and limit access to the Airport operating lease area for the safety of all users. Currently, hunting is allowed by NPS regulation up to the edge of the glide slope critical area, which is directly adjacent to Runway 7. Occasionally in hunting season, hunters have been observed crossing the runway and two hunting blinds were recently discovered as close as 200 feet from the runway. Despite signs, hunting activity is taking place within the airport operation area.

These incidents are considered runway incursions, which increase the risk of accidents and need to be addressed to be in compliance with FAA's Runway Incursion Prevention Program.

Reference: *Recommended Security Guidelines for Airport Planning, Design and Construction*, revised May, 2011, TSA; AC 150/5300-13; MassDOT Aeronautics Division Directive AD-001a, November 14, 2001 (See Table 1 and attached specific sections); Wildlife Hazard Management at Airports, Cleary and Dolbeer, July 2005.

Table 1 Summary of Design Guidelines Relevant to CIP Projects

Improvement Project	**Reference**
1. Westerly Taxiway System Improvements	
West Entrance	14CFR FAR Part 77.25(d) FAA Waiver No. 55 AC 150/5300-13, Appendix 16, Table A16-1A, Note 9 AC 150/5300-13, Paragraph 409 (holding bay) AC 150/5300-13, Paragraph 413 AC 150/5300-13, Paragraph 204
Mid Connector	AC 150/5300-13, Paragraph 407 AC 150/5300-13, Paragraph 413 AC 150/5300-13, Paragraph 204
Parallel TW	AC 150/5300-13, Appendix 16, Table A16-1A, Note 9 AC 150/5300-13, Paragraph 204
2. Relocate East End TW	AC 150/5300-13, Appendix 16, Table A16-1A, Note 9 AC 150/5300-13, Paragraph 413 AC 150/5300-13, Paragraph 204
3. Reconstruct Terminal Apron	AC 150/5320-6D, Paragraph 302a
4. Reconstruct Easterly End of Partial Parallel TW	AC 150/5320-6D, Paragraph 302a
5. Install TW Lighting and Construct Electric Vault	DOT/FAA/AR-04/10, Section 4 - AC 150 /5300-13, Paragraph 803,3, d
6. Sightseeing Shack Improvements	
7. Improve Access Road to Approach Lights (MALSF)	AC 150/5300-13, Paragraph 310 Order 6940.1
8. Construct Service Access Roads to AWOS and LES	AC 150/5300-13, Paragraph 310 Order 6940.1
9. Install Perimeter Fence	DHS/TSA June 2006 Guidelines, Part III, Section A <http://www.tsa.gov/assets/pdf/airport_security_design_guidelines.pdf> AC 150/5300-13, Paragraph 614 MassDOT Aeronautics Directive AD-001a, November 14, 2001, Wildlife Hazard Management at Airports, Cleary and Dolbeer, July 2005
10. Expand Auto Parking	*CCC Technical Bulletin 96-003
11. Expand Terminal Building	49CFR Part 1542.103(14) and Part 1544
12. Expand Turf Apron	*

Note: Referenced sections are provided in Appendix 6.

**: Project was developed as part of the 2005 Master Planning Process and in accordance with the Airport's Mission Statement.*

1. List of FAA Advisory Circulars required for use in AIP Funded Projects, March 21, 2007

CURRENT FAA ADVISORY CIRCULARS REQUIRED FOR USE IN AIP FUNDED AND PFC APPROVED PROJECTS

Dated: 3/21/2007

View the most current versions of these ACs and any associated changes at http://www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars/.

NUMBER	TITLE
70/7460-1K*	Obstruction Marking and Lighting
150/5000-13	Announcement of Availability--RTCA Inc., Document RTCA-221, Guidance and Recommended Requirements for Airport Surface Movement Sensors
150/5020-1	Noise Control and Compatibility Planning for Airports
150/5070-6B	Airport Master Plans
150/5070-7	The Airport System Planning Process
150/5200-28C	Notices to Airmen (NOTAMS) for Airport Operators
150/5200-30A and Changes 1 through 8	Airport Winter Safety and Operations
150/5200-33A	Hazardous Wildlife Attractants On or Near Airports
150/5210-5B	Painting, Marking and Lighting of Vehicles Used on an Airport
150/5210-7C	Aircraft Fire and Rescue Communications
150/5210-13B	Water Rescue Plans, Facilities, and Equipment
150/5210-14A	Airport Fire and Rescue Personnel Protective Clothing
150/5210-15	Airport Rescue & Firefighting Station Building Design
150/5210-18	Systems for Interactive Training of Airport Personnel
150/5210-19	Driver's Enhanced Vision System (DEVS)
150/5220-4B	Water Supply Systems for Aircraft Fire and Rescue Protection
150/5220-10C	Guide Specification for Water/Foam Type Aircraft Rescue and Firefighting Vehicles
150/5220-13B	Runway Surface Condition Sensor Specification Guide
150/5220-16C	Automated Weather Observing Systems for Non-Federal Applications
150/5220-17A and Change 1	Design Standards for Aircraft Rescue Firefighting Training Facilities
150/5220-18	Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials
150/5220-19	Guide Specification for Small, Dual-Agent Aircraft Rescue and Firefighting Vehicles
150/5220-20 and Change 1	Airport Snow and Ice Control Equipment
150/5220-21B	Guide Specification for Lifts Used to Board Airline Passengers With Mobility Impairments

NUMBER	TITLE
150/5220-22A	Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns
150/5300-13 and Changes 1 through 10	Airport Design
150/5300-14 and Changes 1 through 2	Design of Aircraft Deicing Facilities
150/5300-16	General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey
150/5300-17	General Guidance and Specifications for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey
150/5300-18	General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards
150/5320-5B	Airport Drainage
150/5320-6D and Changes 1 through 4	Airport Pavement Design and Evaluation
150/5320-12C and Changes 1 through 8	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces
150/5320-14	Airport Landscaping for Noise Control Purposes
150/5320-15 and Change 1	Management of Airport Industrial Waste
150/5325-4B	Runway Length Requirements for Airport Design
150/5335-5A	Standardized Method of Reporting Pavement Strength PCN
150/5340-1J	Standards for Airport Markings
150/5340-5B and Change 1	Segmented Circle Airport Marker System
150/5340-18D	Standards for Airport Sign Systems
150/5340-30B	Design and Installation Details for Airport Visual Aids
150/5345-3E	Specification for L821 Panels for Control of Airport Lighting
150/5345-5B	Circuit Selector Switch
150/5345-7E	Specification for L824 Underground Electrical Cable for Airport Lighting Circuits
150/5345-10F	Specification for Constant Current Regulators Regulator Monitors
150/5345-12E	Specification for Airport and Heliport Beacon
150/5345-13A	Specification for L841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
150/5345-26C	Specification for L823 Plug and Receptacle, Cable Connectors

FAA Advisory Circulars Required For Use In AIP Funded And PFC Approved Projects
March 21, 2007

NUMBER	TITLE
150/5345-27D	Specification for Wind Cone Assemblies
150/5345-28F	Precision Approach Path Indicator (PAPI) Systems
150/5345-39C	FAA Specification L853, Runway and Taxiway Retroreflective Markers
150/5345-42F	Specification for Airport Light Bases, Transformer Housings, Junction Boxes and Accessories
150/5345-43F	Specification for Obstruction Lighting Equipment
150/5345-44G	Specification for Taxiway and Runway Signs
150/5345-45B	Low-Impact Resistant (LIR) Structures
150/5345-46C	Specification for Runway and Taxiway Light Fixtures
150/5345-47B	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
150/5345-49B	Specification L854, Radio Control Equipment
150/5345-50A	Specification for Portable Runway and Taxiway Lights
150/5345-51A	Specification for Discharge-Type Flasher Equipment
150/5345-52	Generic Visual Glideslope Indicators (GVGI)
150/5345-53C	Airport Lighting Equipment Certification Program
150/5345-54A and Change 1	Specification for L-1884 Power and Control Unit for Land and Hold Short
150/5345-55	Lighted Visual Aid to Indicate Temporary Runway Closure
150/5345-56	Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)
150/5360-9	Planning and Design of Airport Terminal Facilities at NonHub Locations
150/5360-12D	Airport Signing and Graphics
150/5360-13 and Change 1	Planning and Design Guidance for Airport Terminal Facilities
150/5370-2E	Operational Safety on Airports During Construction
150/5370-10B	Standards for Specifying Construction of Airports
150/5370-11A	Use of Nondestructive Testing Devices in the Evaluation of Airport Pavement
150/5380-6A	Guidelines and Procedures for Maintenance of Airport Pavements
150/5390-2B	Heliport Design
150/5390-3	Vertiport Design
150/5395-1	Seaplane Bases

*This AC is available at http://www.faa.gov/ats/ata/ai/index.html or http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/MainFrame?OpenFrameSet.

THE FOLLOWING ADDITIONAL APPLY to AIP PROJECTS ONLY
Dated: 3/21/2007

NUMBER	TITLE
150/5100-14D	Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects
150/5100-15A	Civil Rights Requirements for the Airport Improvement Program
150/5100-17 and Changes 1 through 6	Land Acquisition and Relocation Assistance for Airport Improvement Program Assisted Projects
150/5200-37	Introduction to Safety Management Systems (SMS) for Airport Operators
150/5300-15	Use of Value Engineering for Engineering Design of Airports Grant Projects
150/5320-17	Airfield Pavement Surface Evaluation and Rating (PASER) Manuals
150/5370-6B	Construction Progress and Inspection Report—Airport Grant Program
150/5370-11A	Use on Nondestructive Testing Devices in the Evaluation of Airport Pavements
150/5370-12	Quality Control of Construction for Airport Grant Projects
150/5370-13A	Offpeak Construction of Airport Pavements Using Hot-Mix Asphalt
150/5380-7A	Airport Pavement Management System
150/5380-8	Handbook for Identification of Alkali-Silica Reactivity in Airfield Pavements

THE FOLLOWING ADDITIONAL APPLY to PFC PROJECTS ONLY
Dated: 3/21/2007

NUMBER	TITLE
150/5000-12	Announcement of Availability—Passenger Facility Charge (PFC) Application (FAA Form 5500-1)

2. 14 CFR FAR Part 77.25(d)

used or to be used for the passage of mobile objects only after the heights of these traverse ways are increased by:

(1) Seventeen 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.

(2) Fifteen feet for any other public roadway.

(3) Ten feet or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road.

(4) Twenty-three feet for a railroad, and,

(5) 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.

[Doc. No. 10183, 36 FR 5970, Apr. 1, 1971]

§77.25 Civil airport imaginary surfaces.

The following civil airport imaginary surfaces are established with relation to the airport and to each runway. The size of each such imaginary surface is based on the category of each runway according to the type of approach available or planned for that runway. The slope and dimensions of the approach surface applied to each end of a runway are determined by the most precise approach existing or planned for that runway end.

(a) *Horizontal surface.* A horizontal plane 150 feet above the established airport elevation, the perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the primary surface of each runway of each airport and connecting the adjacent arcs by lines tangent to those arcs. The radius of each arc is:

(1) 5,000 feet for all runways designated as utility or visual;

(2) 10,000 feet for all other runways. The radius of the arc specified for each end of a runway will have the same arithmetical value. That value will be the highest determined for either end of the runway. When a 5,000-foot arc is encompassed by tangents connecting two adjacent 10,000-foot arcs, the 5,000-foot arc shall be disregarded on the construction of the perimeter of the horizontal surface.

(b) *Conical surface.* A surface extending outward and upward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

(c) *Primary surface.* A surface longitudinally centered on a runway. When the runway has a specially prepared hard surface, the primary surface extends 200 feet beyond each end of that runway; but when the runway has no specially prepared hard surface, or planned hard surface, the primary surface ends at each end of that runway. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline. The width of a primary surface is:

(1) 250 feet for utility runways having only visual approaches.

(2) 500 feet for utility runways having nonprecision instrument approaches.

(3) For other than utility runways the width is:

(i) 500 feet for visual runways having only visual approaches.

(ii) 500 feet for nonprecision instrument runways having visibility minimums greater than three-fourths statute mile.

(iii) 1,000 feet for a nonprecision instrument runway having a nonprecision instrument approach with visibility minimums as low as three-fourths of a statute mile, and for precision instrument runways.

The width of the primary surface of a runway will be that width prescribed in this section for the most precise approach existing or planned for either end of that runway.

(d) *Approach surface.* A surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based upon the type of approach available or planned for that runway end.

(1) The inner edge of the approach surface is the same width as the primary surface and it expands uniformly to a width of:

(i) 1,250 feet for that end of a utility runway with only visual approaches;

(ii) 1,500 feet for that end of a runway other than a utility runway with only visual approaches;

(iii) 2,000 feet for that end of a utility runway with a nonprecision instrument approach;

(iv) 3,500 feet for that end of a nonprecision instrument runway other than utility, having visibility minimums greater than three-fourths of a statute mile;

(v) 4,000 feet for that end of a nonprecision instrument runway, other than utility, having a nonprecision instrument approach with visibility minimums as low as three-fourths statute mile; and

(vi) 16,000 feet for precision instrument runways.

(2) The approach surface extends for a horizontal distance of:

(i) 5,000 feet at a slope of 20 to 1 for all utility and visual runways;

(ii) 10,000 feet at a slope of 34 to 1 for all nonprecision instrument runways other than utility; and,

(iii) 10,000 feet at a slope of 50 to 1 with an additional 40,000 feet at a slope of 40 to 1 for all precision instrument runways.

(3) The outer width of an approach surface to an end of a runway will be that width prescribed in this subsection for the most precise approach existing or planned for that runway end.

(e) *Transitional surface.* These surfaces extend outward and upward at right angles to the runway centerline and the runway centerline extended at a slope of 7 to 1 from the sides of the primary surface and from the sides of the approach surfaces. Transitional surfaces for those portions of the precision approach surface which project through and beyond the limits of the conical surface, extend a distance of 5,000 feet measured horizontally from the edge of the approach surface and at right angles to the runway centerline.

[Doc. No. 10183, 36 FR 5970, Apr. 1, 1971; 36 FR 6741, Apr. 8, 1971]

§ 77.27 [Reserved]

§ 77.28 Military airport imaginary surfaces.

(a) *Related to airport reference points.* These surfaces apply to all military airports. For the purposes of this section a military airport is any airport operated by an armed force of the United States.

(1) *Inner horizontal surface.* A plane is oval in shape at a height of 150 feet above the established airfield elevation. The plane is constructed by scribing an arc with a radius of 7,500 feet about the centerline at the end of each runway and interconnecting these arcs with tangents.

(2) *Conical surface.* A surface extending from the periphery of the inner horizontal surface outward and upward at a slope of 20 to 1 for a horizontal distance of 7,000 feet to a height of 500 feet above the established airfield elevation.

(3) *Outer horizontal surface.* A plane, located 500 feet above the established airfield elevation, extending outward from the outer periphery of the conical surface for a horizontal distance of 30,000 feet.

(b) *Related to runways.* These surfaces apply to all military airports.

(1) *Primary surface.* A surface located on the ground or water longitudinally centered on each runway with the same length as the runway. The width of the primary surface for runways is 2,000 feet. However, at established bases where substantial construction has taken place in accordance with a previous lateral clearance criteria, the 2,000-foot width may be reduced to the former criteria.

(2) *Clear zone surface.* A surface located on the ground or water at each end of the primary surface, with a length of 1,000 feet and the same width as the primary surface.

(3) *Approach clearance surface.* An inclined plane, symmetrical about the runway centerline extended, beginning 200 feet beyond each end of the primary surface at the centerline elevation of the runway end and extending for 50,000 feet. The slope of the approach clearance surface is 50 to 1 along the runway centerline extended until it reaches an elevation of 500 feet above the established airport elevation. It then continues horizontally at this elevation to a point 50,000 feet from the point of beginning. The width of this surface at

3. FAA Waiver No. 55, August 1, 1980

NEW ENGLAND REGION

WAIVER OF AIRPORT STANDARDS (or Deviation) — Waiver No. 55

Airport: Provincetown Municipal Airport

Deviation Summary: Penetration of primary and transitional surfaces.

Standard: FAR Part 77, Para. 77.25, for other than utility airports with a precision instrument approach: Primary 1000' wide and 7:1 transitional surfaces. Approach 10,000' at 50:1 and an additional 40,000 at 40:1 with 7:1 transitions.

Deviation: Existing primary is only 500' wide without transitions. ANE-436 has requested a waiver of the 1000' primary to allow the existing 500' with 34:1 approach surface 1000' wide at the inner surface for an ILS to Runway 7.

Justification: The clearing of a 1000' primary with 7:1 transitions would cause irreparable environmental harm to the Cape Cod National Seashore Park in which the airport is located. It would have an adverse affect on the esthetics of the park as well as create potential erosion problems and constitute a major loss of wild life habitat in the area, conditions totally unacceptable to the Department of the Interior, National Park Services. This is a 3500' runway used primarily by small GA type aircraft with commuter service provided by Provincetown-Boston Airlines utlizing DC-3's.* Based on the type and use of aircraft the installation of the ILS will greatly increase safety at the airport even with the reduced width of the primary surface.

(cont. on separate sheet)

Additional documentation filed:

1. Evalutation of environmental impact report by National Park Service cooperative Research Unit of the University of Massachusetts is attached.
2. ANE-436's letter dated July 1, 1980.

Coordination:

ANE-620 (certification) — [signature] 8/1/80

ANE-220 — Hyman 8-1-80

Authority to waive: Order 5300.1A

Recommended: [signature] Chief, Airports Engineering & Safety Branch — Date 8/1/80

Approved: [signature] Chief, Airports Division — Date 8/1/80

Prepared by: [signature] Bradley A. Davis

Coordinated: ANE-610 [signature] 8/11/80

Justification: (cont.)

This waiver will not relieve the sponsor of the responsibility of providing the 7:1 transitional surfaces along both the primary and approach nor the requirements of an approach surface 1000' wide at the inner surface with a 34:1 approach slope.

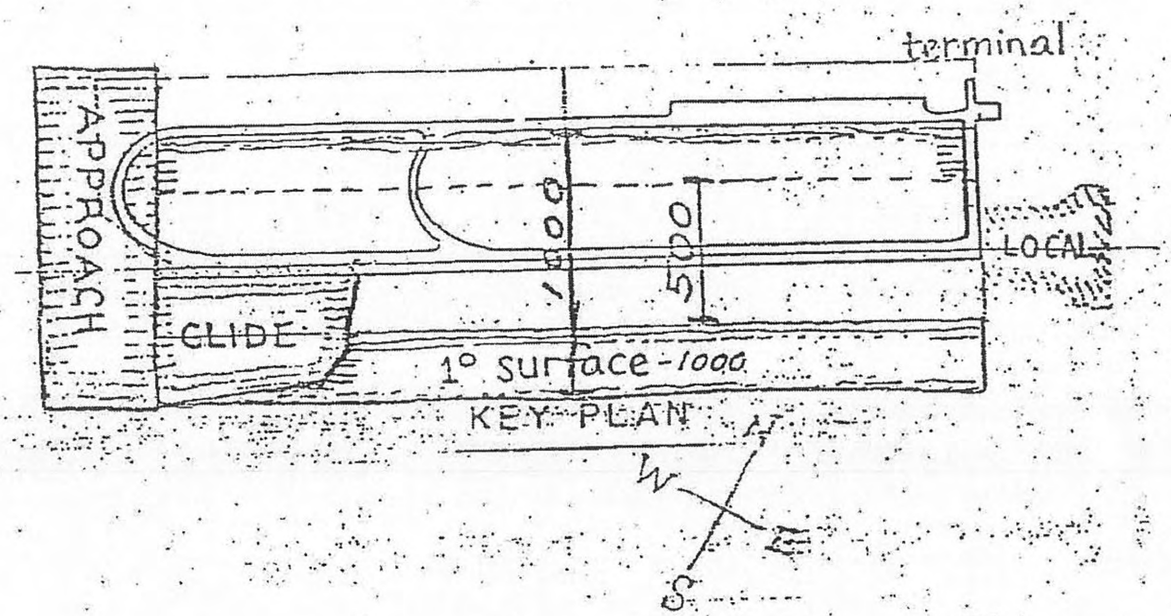
*The DC-3's are used only during the summer months to augment the normal commuter schedule.

The standard (FAR Part 77) requires a 1,000' wide primary surface with 7:1 transitions.

This waiver allows a 500' wide primary surface with 7:1 transitions and maximum penetrations beyond that on the north side of 9' and maximum penetrations beyond that on the south side of 16'.

These obstructions are determined to be non-hazardous, and need not be romoved or lighted since:

a) The runway is 3500' in length
b) Primary use is by small general aviation aircraft less than 12,500 lbs.
c) The maximum penetration is less than 20'
d) There are no future plans to extend the runway
(The current 500' ext. on the ALP was not economically and environmentally justified accorded to FAA funded study.)



EVALUATION OF ENVIRONMENTAL IMPACTS
AND REPLANTING OF SITES AFFECTED BY
PROPOSED NAVIGATIONAL AIDS
FOR PROVINCETOWN MUNICIPAL AIRPORT

NATIONAL PARK SERVICE
COOPERATIVE RESEARCH UNIT
UNIVERSITY OF MASSACHUSETTS
AMHERST 01003

I. GENERAL REMARKS

A. Endangered or threatened species. Neither endangered nor threatened species were encountered during field investigations within the areas affected by the proposal.

B. Groundwater. The proposed work at the airport would not be expected to alter the quality of the local groundwater, since any leachate from regraded or developed areas should be inert.

C. Habitat Changes. The proposal (exclusive of the 1000' primary surface clearance) does require the removal of shrubby vegetation, which would constitute a habitat loss for local fauna. The revegetation of these areas would provide some new, but different, habitat.

D. Visual effects. The Provincetown Airport has not been in compliance with FAA standards for clearance of either the Primary Surface or Approach Surface. To comply with present regulations, shrubs within 200 feet north-west of the runway must be removed so that no vegetation exceeds the elevation of the runway surface. Vegetation has not been cleared in recent years, and its removal will cause the airport to become more conspicuous when viewed from Race Point Beach and Visitor Center. The paved airport areas are now partially screened from view by shrubs growing in proposed cleared areas.

The proposed work at the Glide Slope, Localizer, and Approach Surface will not cause these areas to appear substantially different to visitors once these areas are revegetated.

The proposed expansion of the runway to 1000' centered at the runway center-line would cause a major change in the airport area's appearance. Trees to the southeast of the runway would be cleared under the proposal, making the runway highly visible from the Race Point Visitor Center. The removal of this vegetation would also expose some barren or low dune areas presently sheltered by the wooded strip. Thus, clearing of trees at this critical location would cause the total continuously open area created to significantly exceed the 500' cleared zone. Furthermore, to provide a 7.1 clearance beyond 500' would require the removal of some vegetation along the northern slope of this dune ridge, opening an even larger area to visitors' view. From the Race Point bathhouse, visitors look directly into this area.

E. Potential erosion problems. Under the 1000' clearance proposal, the loss of the windbreak provided by the existing stand of pitch pines will make adjacent barren dune areas more susceptible to wind erosion than they are with the present natural windbreak.

II. IMPACT ON AREAS PROPOSED FOR ALTERATIONS

A. Localizer

B. Glide Slope

C. Middle Marker

D. Approach Surface

E. Runway Primary Surface – 500 feet

F. Runway Primary Surface expansion – 1000 feet

1. Visual effects

2. Possible erosion problems

3. Expansion of the runway primary surface to 1000 feet centered on the runway centerline would involve the elimination of approximately 20 acres of pitch pine. These trees and their understory are used as shelter and browse for deer, fox, and birds, and are the only substantial continuous stand of trees on the Race Point swale area west of Race Point Road. The loss of these trees would constitute a major loss of wildlife habitat in the area.

III. REVEGETATION OF LOCALIZER, GLIDE SLOPE, AND MIDDLE MARKER AREAS

A. Type of fill. Glacial outwash sand has been imported previously to construct the existing runway primary surface. This material appears to support the local flora adequately. It is reccommended that glacial outwash sand be used where fill is needed. This material can be acquired at the Noons pit in Truro. Analyses of sand from Noons pit for pH, primary nutrients, and possible metal toxicity are being conducted at the University to Massachusetts.

B. Cover of fill. It is recommended that the upper 4-8 inches of existing soil be removed prior to site grading, and be reapplied as a veneer to the graded surface after construction. This local soil will provide plant seeds and fragments that will help to revegetate the area.

It is also recommended that no topsoil (loam), fertilizer, or wood chips be applied to any of the areas to be revegetated, since these amendments would encourage the establishment of vegetation uncharacteristic of the area.

C. Sources of vegetation. If nothing were done to the graded areas, local vegetation would completely cover the areas in an estimated three to five years. Abundant plant seeds and fragments incorporated in the soil scraped from the original surface, once spread back over the disturbed area, will favor very rapid revegetation.

Plugs of Hudsonia (beach-heather) and Arctostaphylos (bearberry) can also be removed prior to construction, and then be replanted on the altered surface after final grading. These two species are slower to establish than other local species.

Seeds of Deschampsia (hairgrass), Arctostaphylos, and Trifolium (hare's foot clover can be obtained in quantity and sown in the area.

D. Wind erosion. If it appears that the regraded surface deflates significantly after construction, measures should be taken to mitigate erosion.

IV. RECOMMENDATIONS TO MINIMIZE ADVERSE EFFECTS OF CONSTRUCTION.

A. Work should be limited to only those areas specified in the proposal.

B. In order to minimize the creation of ruts in damp areas, areas adjacent to alteration sites should not be used by big equipment during construction.

C. Shrubs and trees should be removed from the approach surface and the area between the runway and taxiway during the winter when the ground is frozen.

D. Brush cut during the airport alteration should be removed from Seashore property.

E. Trenching for the electrical line in the intertidal zone at Hatches Harbor should be as deep as possible to avoid exposure. This electrical line should be inspected periodically, since both dune and intertidal areas are unstable.

F. Access to Hatches Harbor should be limited to the access road used in the 1978 repairs to the dike. Vehicles should not turn on either the marsh surface or in the dunes to the northwest of the dike.

G. Fill can be obtained at the Noons pit in Truro, or any other area, but sand should first be tested for primary nutrients, pH, and potential toxicity.

H. The Seashore must not be used for a source of fill or plant material (except as designated), nor as a site for disposing unwanted vegetation.

I. The entire project should be monitored periodically by a representative of the Seashore to assure compliance with recommendations.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

NEW ENGLAND REGION
12 NEW ENGLAND EXECUTIVE PARK
BURLINGTON, MASS. 01803

TE: AUG 1 1980

Y TO: ANE-620

CT: Aeronautical Study 80-002, Provincetown Municipal Airport, Provincetown, Massachusetts

OM: Civil Engineer, ANE-620

TO: Aeronautical Study File

An Aeronautical Study was conducted by the FAA Airports Division on August 1, 1980, to establish the acceptable hazard lighting required to safely and efficiently define the penetrations to FAR Part 77 imaginary surfaces about Provincetown Municipal Airport, Provincetown, Massachusetts.

The following were consulted with:

Howard Maser, Flight Standards Division, ANE-221
Charles Taylor, Air Traffic Division, ANE-535
William Cronan, James Dirko and Bradley Davis, Airports Division, ANE-620

Background: As a result of the proposed installation of a full ILS by the FAA, the primary surface width will be increased from the present 500' width to 1000' in accordance with FAR Part 77, Paragraph 77.25. Additionally Part 77 would require a 50:1 approach slope for the first 10,000' and a 40:1 for an additional 40,000'.

Discussion: Granting a waiver to the Part 77 surfaces as requested by ANE-436 would leave a 500' primary surface with 7:1 transitions and an approach surface 1000' wide at the inner surface cleared to a 34:1 approach slope with 7:1 transitions. (see sketch)

There exist a small number of tree penetrations of the 1000' primary surface on the north side of the runway the maximum being a 9' penetration. On the southern side there are numerous penetrations caused by a grove of scrub pines with a maximum penetration of 16'.

Do to the esthetic concerns of the U. S. Department of the Interior, National Park Services to preserve the natural environment of the Cape Cod National Seashore Park any form of obstruction lighting outside the 500' primary surface would be totally unacceptable.

Summary: Based on the activity at this airport, primarily small GA type aircraft with commuter service augmented by the use of DC-3's during the summer only, the penetrations outside the 500' primary surface should not require obstruction lighting. The cost of providing obstruction lighting

2.

in these areas would provide little benefit to safety at this airport as compared to the benefit of the full ILS with or without such lighting.

BRADLEY A. DAVIS

Concur

8/6/80

WILLIAM M. CRONAN, ANE-620

Concur:

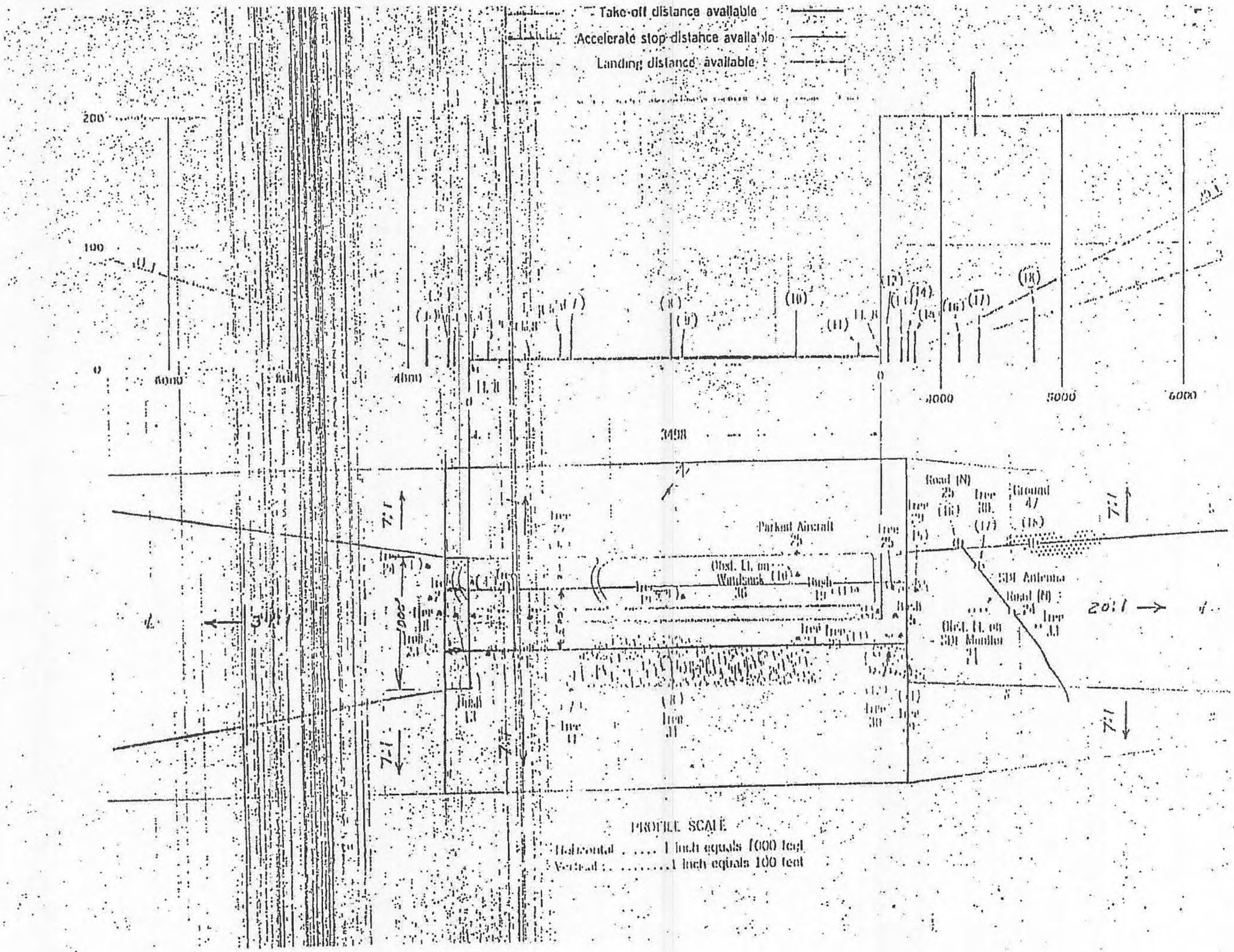
HOWARD MASER, ANE-220

Concur:

CHARLES TAYLOR, ANE-535

Concur

JAMES A. DIRKO, ANE-620



Take-off distance available
Accelerate stop distance available
Landing distance available
200
100
0
4000
5000
6000
3498
Parked Aircraft
25
Road (N)
25
Ground
47
7:1
20:1
Obst. Lt. on Windsack (10)
36
Obst. Lt. on SDI Monitor
71
SDI Antenna
Tree
Bush
PROFILE SCALE
Horizontal ..... 1 inch equals 1000 feet
Vertical .... 1 inch equals 100 feet

4. AC 150/5300-13, Section 2

Chapter 2. AIRPORT GEOMETRY

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

201. PRINCIPLES OF APPLICATION.

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

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

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

(a) Object free areas;

(b) Runway protection zones;

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

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

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

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

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

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

(4) The volume and mix of operations;

(5) The possible constraints on navigable airspace; and

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

c. Airport Layout Plan. When developing the airport layout plan, application of the standards and recommendations in this publication to the long range functions of the airport will establish the future airport geometry. See appendices 6 and 7 for detailed information on the development of the airport layout plan.

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

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

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

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

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

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

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

g. Wildlife Hazards. In orienting runways, consider the relative locations of bird sanctuaries, sanitary landfills, or other areas that may attract large numbers of birds or wildlife. Where bird hazards exist, develop and implement bird control procedures to minimize such hazards. See AC 150/5xxx-xx, *Announcement of Availability,* FAA/USDA manual *Wildlife Hazard Management at Airports.* This manual may be used to determine, on a case-by-case basis, what uses may be compatible with a particular airport environment with respect to wildlife management. Guidance is also available through local FAA Airports Offices.

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

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

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

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

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

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

b. Design Principles:

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

(2) Build taxiways as direct as possible;

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

(4) Minimize crossing runways;

(5) Provide ample curve and fillet radii;

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

(7) Avoid traffic bottlenecks.

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

206. SEPARATION STANDARDS. Tables 2-1, 2-2, and 2-3 present the separation standards depicted in figure 2-1. *The separation distances may need to be increased with airport elevation to meet the runway obstacle free zone (OFZ) standards.* The computer program cited in appendix 11 may be used to determine the increase to these separation distances for elevation.

207. PARALLEL RUNWAY SEPARATION--SIMULTANEOUS VFR OPERATIONS.

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

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

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

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

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

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

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

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

(1) Simultaneous Departures.

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

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

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

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

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

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

209. RUNWAY TO PARALLEL TAXIWAY AND TAXILANE SEPARATION.

a. Standards. Tables 2-1 and 2-2 present the runway centerline to parallel taxiway/taxilane centerline separation standard. This distance is such to satisfy the requirement that no part of an aircraft (tail tip, wing tip) on taxiway/taxilane centerline is within the runway safety area or penetrates the obstacle free zone (OFZ). The computer program cited in appendix 11 may be used to determine the increase to these separation distances for elevation.

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

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

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

a. Standards. Object clearance requirements are as follows:

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

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

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

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

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

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

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

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

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

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

a. Standards.

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

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

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

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

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

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

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

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

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

214. to 299. RESERVED

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

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

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

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

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

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

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

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

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

Table 2-2. Runway Separation Standards for aircraft approach categories C & D 7/

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

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

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

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

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

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

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

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

Table 2-3. Taxiway and taxilane separation standards

ITEM	DIM 1/	AIRPLANE DESIGN GROUP					
		I	II	III	IV	V	VI
Taxiway Centerline to:							
Parallel Taxiway/ Taxilane Centerline	J	69 ft 21 m	105 ft 32 m	152 ft 46.5 m	215 ft 65.5 m	267 ft 81 m	324 ft 99 m
Fixed or Movable Object 2 and 3/	K	44.5 ft 13.5 m	65.5 ft 20 m	93 ft 28.5 m	129.5 ft 39.5 m	160 ft 48.5 m	193 ft 59 m
Taxilane Centerline to:							
Parallel Taxilane Centerline		64 ft 195. m	97 ft 29.5 m	140 ft 42.5 m	198 ft 60 m	245 ft 74.5 m	298 ft 91 m
Fixed or Movable Object 2 and 3/		39.5 ft 12 m	57.5 ft 17.5 m	81 ft 24.5 m	112.5 ft 34 m	138 ft 42 m	167 ft 51 m

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

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

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

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

Taxiway centerline to parallel taxiway/taxilane centerline equals 1.2 times airplane wingspan plus 10 feet (3 m).

Taxiway centerline to fixed or movable object equals 0.7 times airplane wingspan plus 10 feet (3 m).

Taxilane centerline to parallel taxilane centerline equals 1.1 times airplane wingspan plus 10 feet (3 m).

Taxilane centerline to fixed or movable object equals 0.6 times airplane wingspan plus 10 feet (3 m).

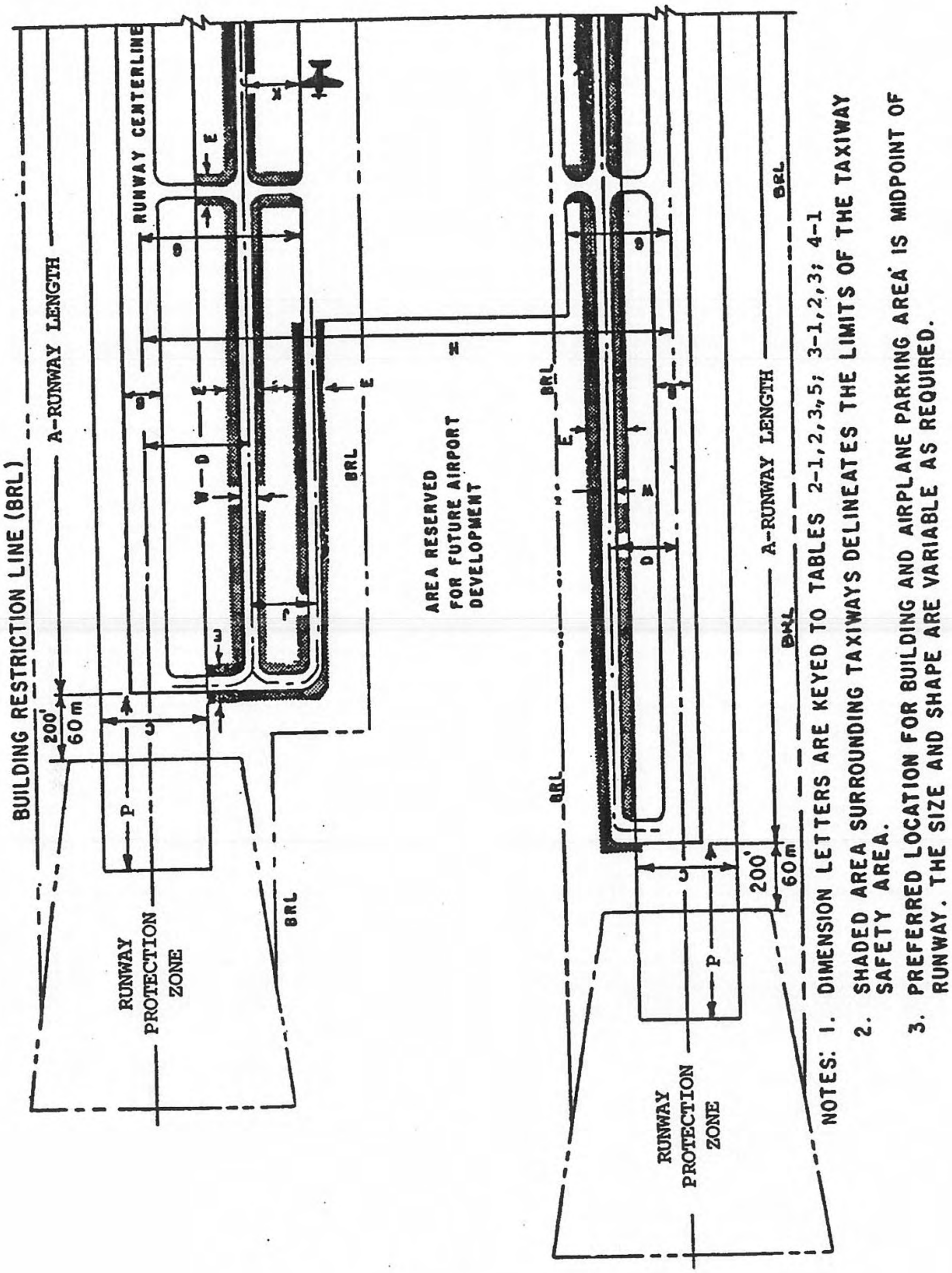
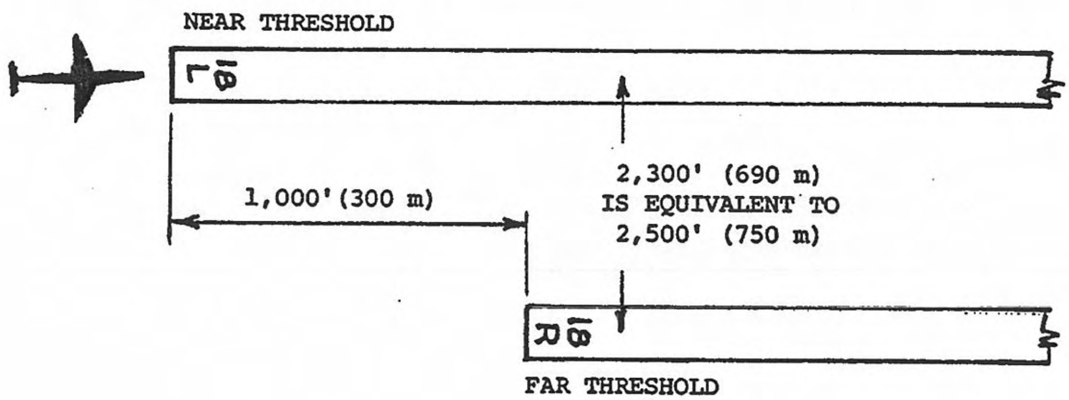


Figure 2-1. Typical airport layout



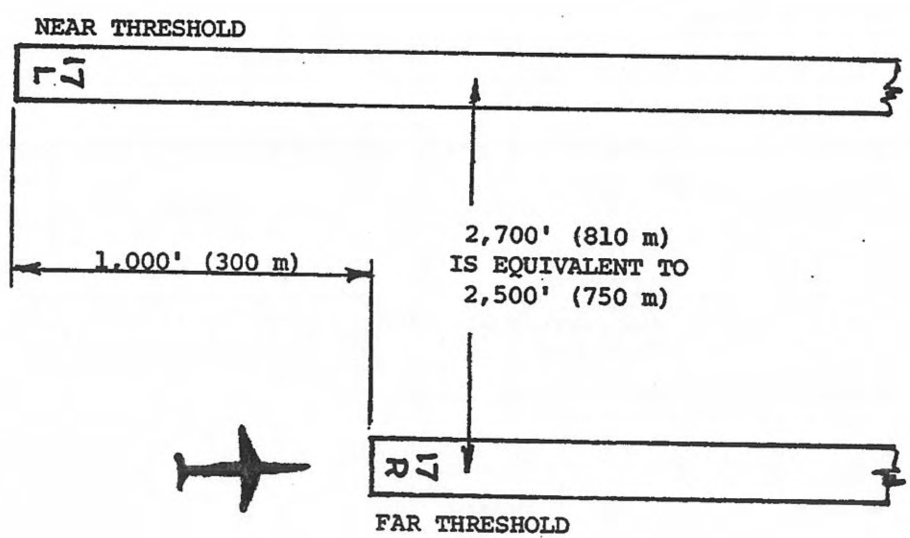
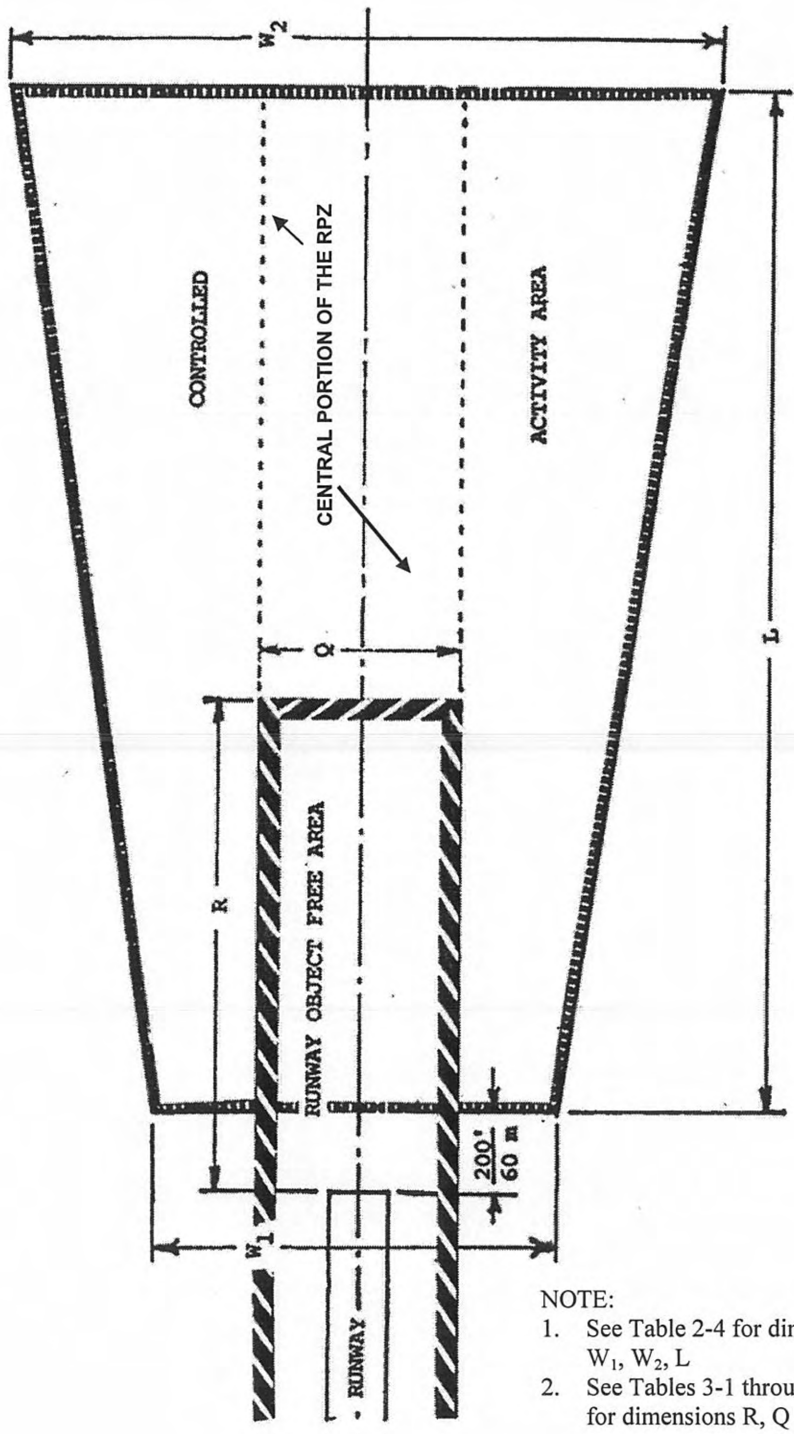


Figure 2-2. Parallel runway separation

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

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

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



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

Figure 2-3. Runway protection zone

5. AC 150/5300-13, Section 3

310. RESCUE AND FIREFIGHTING ACCESS. Rescue and firefighting access roads are normally needed to provide unimpeded two-way access for rescue and firefighting equipment to potential accident areas. Connecting these access roads, to the extent practical, with the operational surfaces and other roads will facilitate aircraft rescue and firefighting operations.

a. Recommendation. It is recommended that the entire runway safety area (RSA) and runway protection zone (RPZ) be accessible to rescue and firefighting vehicles so that no part of the RSA or RPZ is more than 330 feet (100 m) from either an all weather road or a paved operational surface. Where an airport is adjacent to a body of water, it is recommended that boat launch ramps with appropriate access roads be provided.

b. All Weather Capability. Rescue and firefighting access roads are all weather roads designed to support rescue and firefighting equipment traveling at normal response speeds. Establish the widths of the access roads on a case-by-case basis considering the type(s) of rescue and firefighting equipment available and planned at the airport. The first 300 feet (90 m) adjacent to a paved operational surface should be paved. Where an access road crosses a safety area, the safety area standards for smoothness and grading control. For other design and construction features, use local highway specifications.

c. Road Usage. Rescue and firefighting access roads are special purpose roads that supplement but do not duplicate or replace sections of a multi-purpose road system. Restricting their use to rescue and firefighting access equipment precludes their being a hazard to air navigation.

311. to 399. RESERVED.

6. AC 150/5300-13, Section 4

Chapter 4. TAXIWAY AND TAXILANE DESIGN

400. INTRODUCTION. This chapter presents the design standards for taxiways, taxilanes, and associated airport elements.

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

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

403. TAXIWAY SAFETY AREA (TSA). The taxiway safety area is centered on the taxiway centerline. Table 4-1 presents taxiway safety area dimensional standards.

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

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

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

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

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

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

404. TAXIWAY AND TAXILANE OBJECT FREE AREA (OFA). The taxiway and taxilane OFAs are centered on the taxiway and taxilane centerlines as shown in figures A9-2, A9-3, and A9-4.

a. The taxiway and taxilane OFA clearing standards prohibit service vehicle roads, parked airplanes, and above ground objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes. Vehicles may operate within the OFA provided they give right of way to oncoming aircraft by either maintaining a safe distance ahead or behind the aircraft or by exiting the OFA to let the aircraft pass. Provide vehicular exiting areas along the outside of the OFA where required. Table 4-1 specifies the standard dimensions for OFAs.

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

c. Offset taxilane pavement markings may be used at existing facilities where it is impracticable to upgrade the facility to existing standards or as a temporary measure to assure adequate wingtip clearance until upgraded facilities meeting design standards are completed. The offset taxilane pavement markings should be located on an arc offset and parallel to the curved centerline. The radius of the offset arc should be approximately $(R^2 + d^2)^{0.5}$. R being the radius of the taxilane turn and d being a representative distance from the center of cockpit to the center of the main undercarriage of the larger wingspan aircraft. Increasing the offset radius increases the clearance inside of the curve while decreasing the clearance outside of the curve. Both clearances for each of the larger wingspan aircraft need to be examined. Where offset taxilane pavement markings are provided, centerline lighting or reflectors are required.

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

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

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

406. TAXIWAY INTERSECTIONS. An airplane pilot may negotiate a taxiway turn by either maintaining the cockpit over the centerline or by judgmental oversteering.

a. Cockpit Over Centerline. Taxiway intersections designed to accommodate cockpit over centerline steering require more pavement, but enable more rapid movement of traffic with minimal risk of aircraft excursions from the pavement surface. Intersections should be designed to accommodate cockpit over centerline steering to the extent practicable. Where taxiway centerline lighting or reflectors are installed, intersections shall be designed for cockpit over centerline steering.

b. Judgmental Oversteering. Taxiway intersections designed to accommodate the judgmental oversteering method of maneuvering require the least pavement widening. However, judgmental oversteering requires complex maneuvering, increases the risk of aircraft excursions from the pavement surface, and slows the flow of traffic.

c. Design. Figure 4-1 shows the most common designs of taxiway-taxiway intersections and tables 4-1 and 4-2 present associated dimensional standards. The designs also apply to taxiway-apron intersections. Adjusting these shapes to achieve more efficient construction procedures may be desirable and should be a cost basis consideration. For example, squaring the venturi areas or designing the pavement fillets, by using either the methodology presented in appendix 10 or a computer program to provide the standard taxiway edge safety margin, may produce a more cost-effective design. Figure 4-4 is a printout from such a program that is operable on an IBM PC compatible computer. Appendix 11 gives details on availability of this program.

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

407. ENTRANCE TAXIWAYS.

a. Dual Use. An entrance taxiway also serves as the final exit taxiway on a bidirectional runway. It is normally in the form of an "L" taxiway intersection with a right angle connection to the runway.

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

c. Design. The entrance design shown in figure 4-5, with a centerline radius of 200 feet (60 m), will allow entrance speeds of 20 mph (30 km per hour), the minimum design speed for the taxiway system. Larger radii will permit higher entrance speeds. The design width requires at least the taxiway edge safety margin specified in table 4-1.

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

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

b. Design. Bypass taxiway widths require at least the standard taxiway edge safety margin. The separation and clearance standards are the same as for parallel taxiways.

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

a. Location. Although the most advantageous position for a holding bay is adjacent to the taxiway serving the runway end, it may be satisfactory in other locations. Place holding bays to keep airplanes out of the OFZ and the runway safety area, as well as avoiding interference with instrument landing system operations.

b. Design. Figure 4-8 shows some typical holding bay configurations. Paving the area between dual parallel taxiways may provide an acceptable holding bay.

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

411. DUAL PARALLEL TAXIWAYS. To accommodate high-density traffic, airport planners should consider multiple access to runways. For example, to facilitate ATC handling when using directional flow releases, e.g., south departure, west departure, etc., airplanes may be selectively queued on dual (or even triple) parallel taxiways. A dual parallel taxiway need not extend the full length of runway. Crossover taxiways between dual parallel taxiways increase flexibility. See figure 4-10.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(6) **Navigational Aid Consideration.** The following considerations should be given when determining

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

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

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

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

416. to 499. RESERVED.

Table 4-1. Taxiway dimensional standards

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

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

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

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

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

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

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

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

Taxiway safety area width equals the airplane wingspan;

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

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

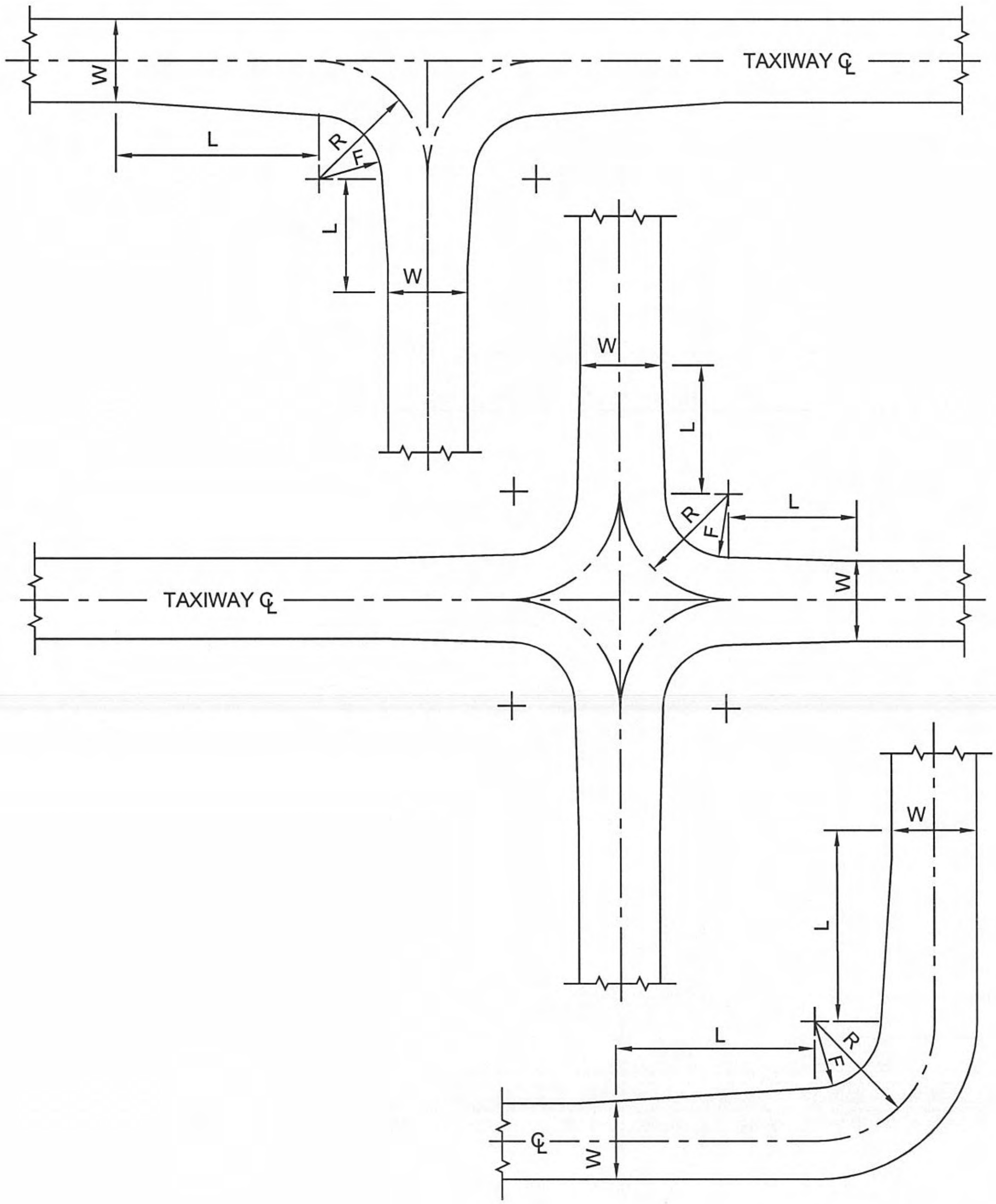


Figure 4-1. Taxiway intersection details

Table 4-2. Taxiway fillet dimensions

ITEM	DIM 1/	AIRPLANE DESIGN GROUP					
		I	II	III 2/	IV	V	VI
Radius of Taxiway Turn 3/	R	75 ft 22.5 m	75 ft 22.5 m	100 ft 30 m	150 ft 45 m	150 ft 45 m	170 ft 51 m
Length of Lead-in to Fillet	L	50 ft 15 m	50 ft 15 m	150 ft 45 m	250 ft 75 m	250 ft 75 m	250 ft 75 m
Fillet Radius for Tracking Centerline	F	60 ft 18 m	55 ft 16.5 m	55 ft 16.5 m	85 ft 25.5 m	85 ft 25.5 m	85 ft 25.5 m
Fillet Radius for Judgmental Oversteering Symmetrical Widening 4/	F	62.5 ft 18.75 m	57.5 ft 17.25 m	68 ft 20.4 m	105 ft 31.5 m	105 ft 31.5 m	110 ft 33 m
Fillet Radius for Judgmental Oversteering One Side Widening 5/	F	62.5 ft 18.75 m	57.5 ft 17.25 m	60 ft 18 m	97 ft 29 m	97 ft 29 m	100 ft 30 m

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

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

3/ Dimensions for taxiway fillet designs relate to the radius of taxiway turn specified. Figures 4-2 and 4-3 show taxiway fillet designs that provide the standard taxiway edge safety margin for a range of wheelbase and undercarriage width combinations. Custom-designed pavement fillet are necessary when the specified "R" or the undercarriage (also undercarriage to cockpit) dimensions fall outside of the standard taxiway edge safety margin of figures 4-2 and 4-3. The equations in appendix 10 or the use of a computer program offer this ability. Appendix 11 gives details on availability of this program.

4/ The center sketch of figure 4-1 displays pavement fillets with symmetrical taxiway widening.

5/ The lower sketch of figure 4-1 displays a pavement fillet with taxiway widening on one side.

Table 4-3. Wingtip clearance standards

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

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

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

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

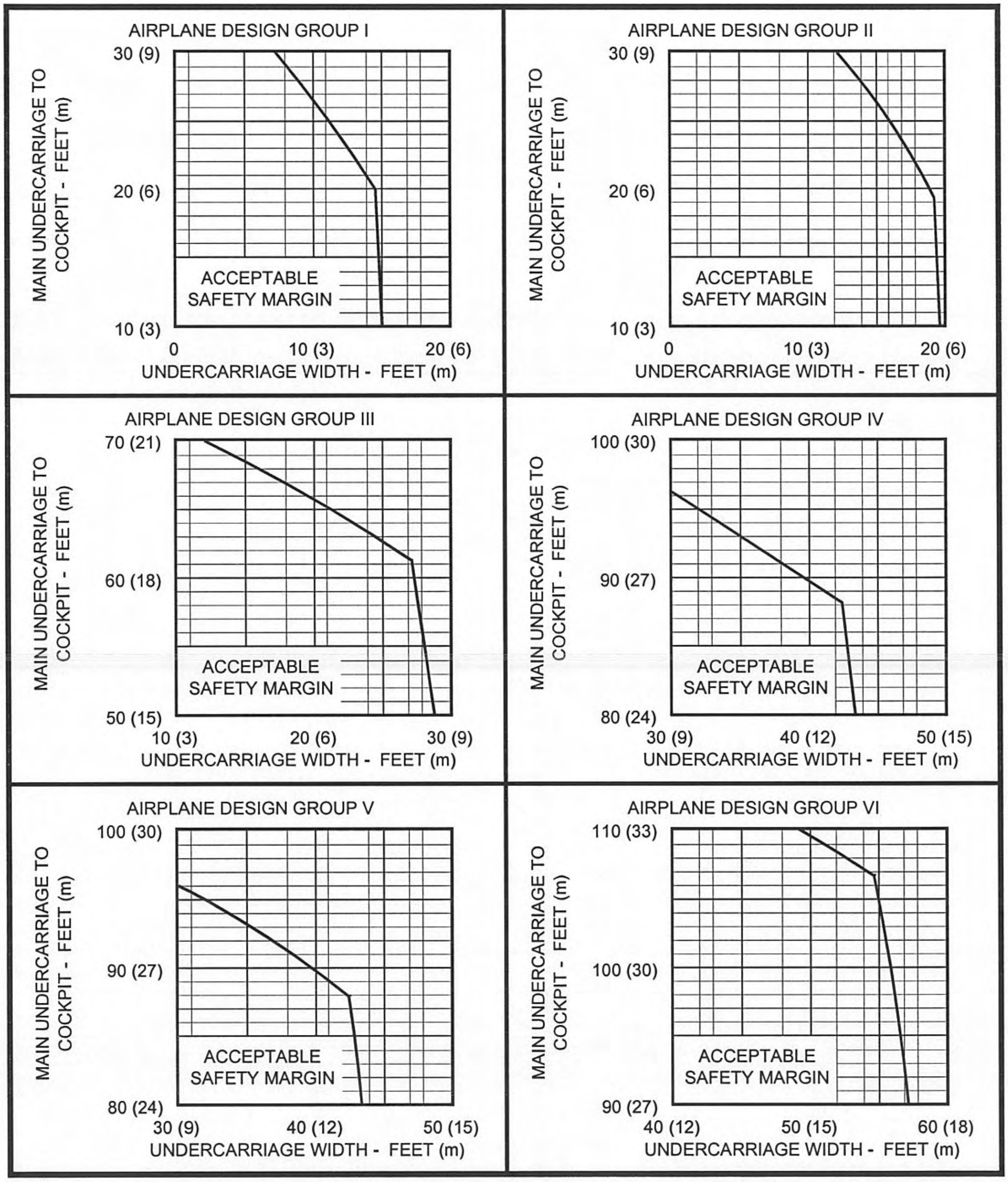


Figure 4-2. Maintaining cockpit over centerline

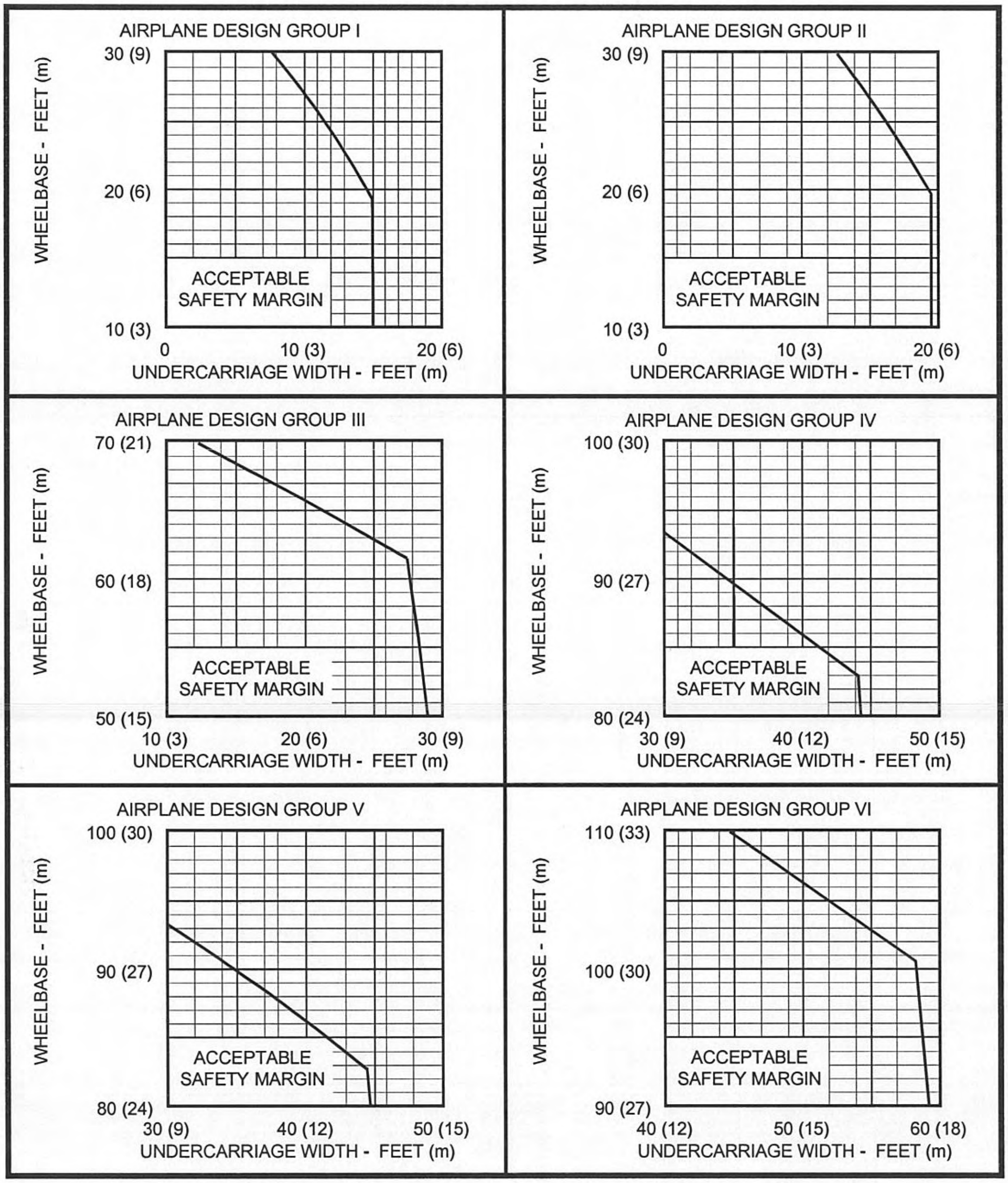


Figure 4-3. Judgmental oversteering

OFFSET DISTANCES ON A TAXIWAY INTERSECTION OR CURVE

Airplane wheelbase	84.000
Center of airplane cockpit to nosewheel	6.000
Airplane undercarriage width [1.15 x main gear track]	41.000
Taxiway edge safety margin	15.000
Taxiway width	75.000

AIRPLANE COCKPIT ON CENTERLINE

Entrance Station	0.000	Radius	150.000
Tangent Length	*************		
Intersection Angle	180.00000	Curve Length	471.239
Tangent Length	*************		
Exit Station	471.239	Radius	150.000

Entrance Station	471.239
Tangent Length	328.761
Exit Station	800.000

STATION	LEFT OFFSET	RIGHT OFFSET	STEERING ANGLES	X COORDINATE	Y COORDINATE	CENTERLINE ANGLE
0.000	43.57	28.58	0.000	0.000	0.000	0.00000
50.000	51.88	19.58	14.676	49.079	8.256	19.09859
100.000	56.92	15.00	23.246	92.755	32.117	38.19718
150.000	60.05	15.00	28.382	126.221	68.955	57.29577
200.000	62.03	15.00	31.528	145.791	114.714	76.39436
250.000	63.28	15.00	33.486	149.311	164.359	95.49295
300.000	64.08	15.00	34.717	136.395	212.422	114.59153
350.000	64.59	15.00	35.496	108.463	253.614	133.69012
400.000	64.74	15.00	35.992	68.591	283.399	152.78871
450.000	61.62	15.00	36.308	21.168	298.499	171.88730
471.239	58.29	15.00	36.405	0.000	300.000	180.00000
471.239	58.29	15.00	36.405	0.000	300.000	180.00000
500.000	51.79	19.88	26.870	-28.761	300.000	180.00000
550.000	44.70	26.51	15.609	-78.761	300.000	180.00000
600.000	40.74	30.32	8.993	-128.761	300.000	180.00000
650.000	38.50	32.52	5.167	-178.761	300.000	180.00000
700.000	37.22	33.79	2.966	-228.761	300.000	180.00000
750.000	0.00	0.00	1.702	-278.761	300.000	180.00000
800.000	0.00	0.00	0.977	-328.761	300.000	180.00000

NOTE: The offset distance is a perpendicular distance measured from the taxiway centerline. The hard surface needs to be widened at stations where the offset distance extends beyond the hard surface.

REFERENCE: AC 150/5300-13, AIRPORT DESIGN.

Figure 4-4. Example of pavement fillet computer program printout

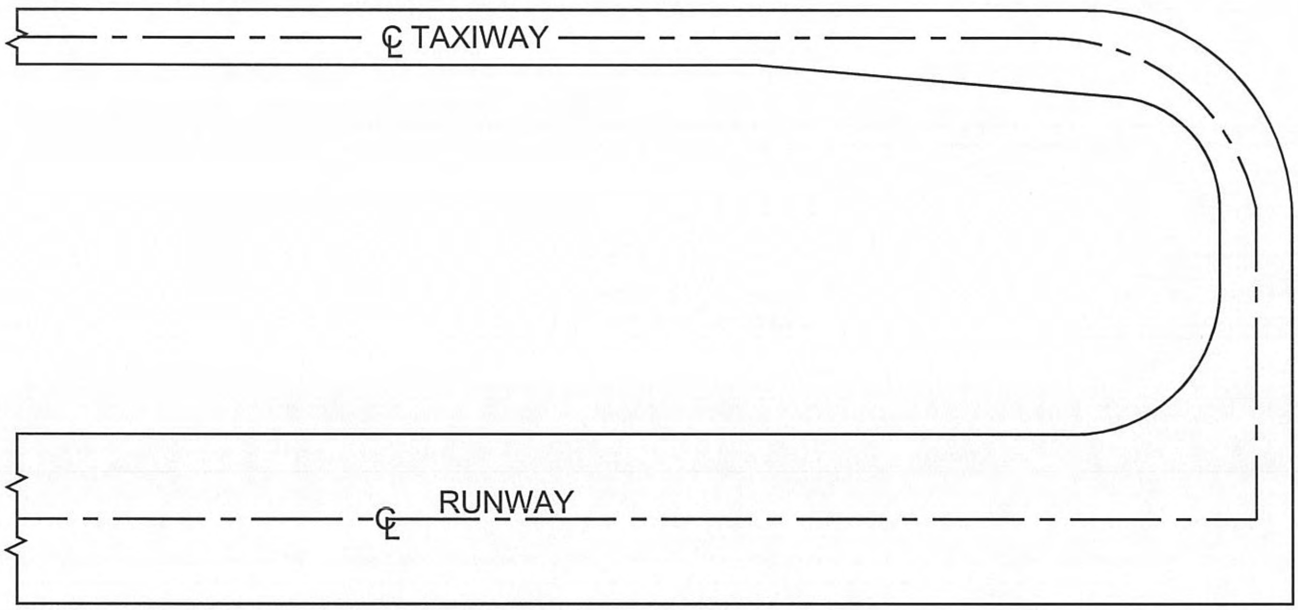


Figure 4-5. Entrance taxiway

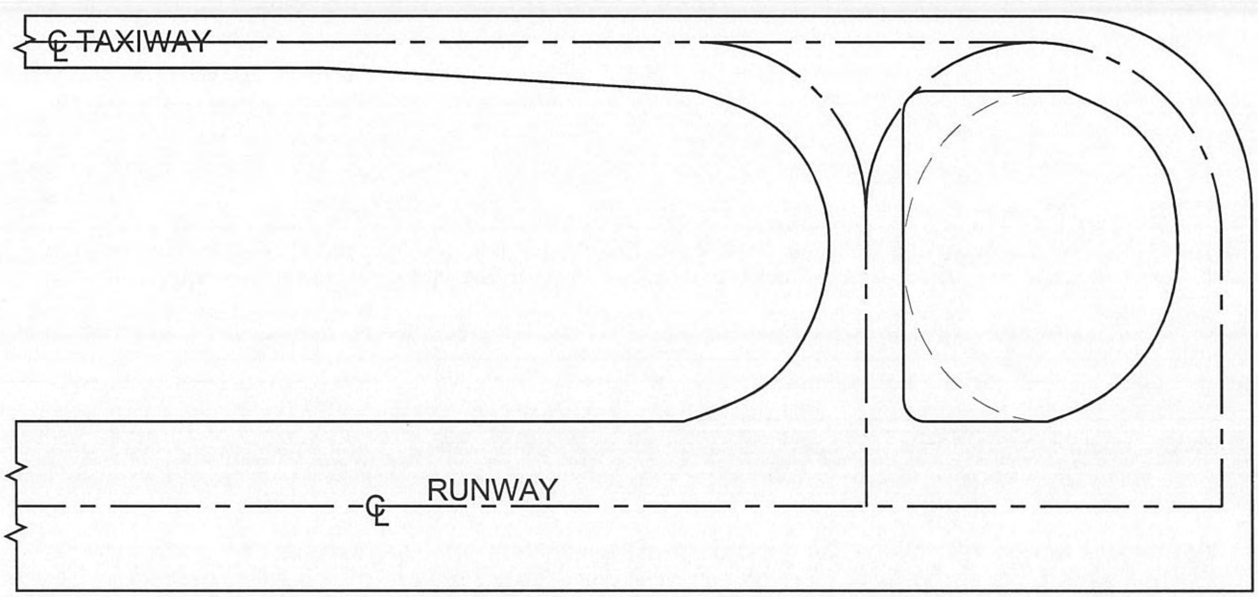


Figure 4-6. Bypass taxiway

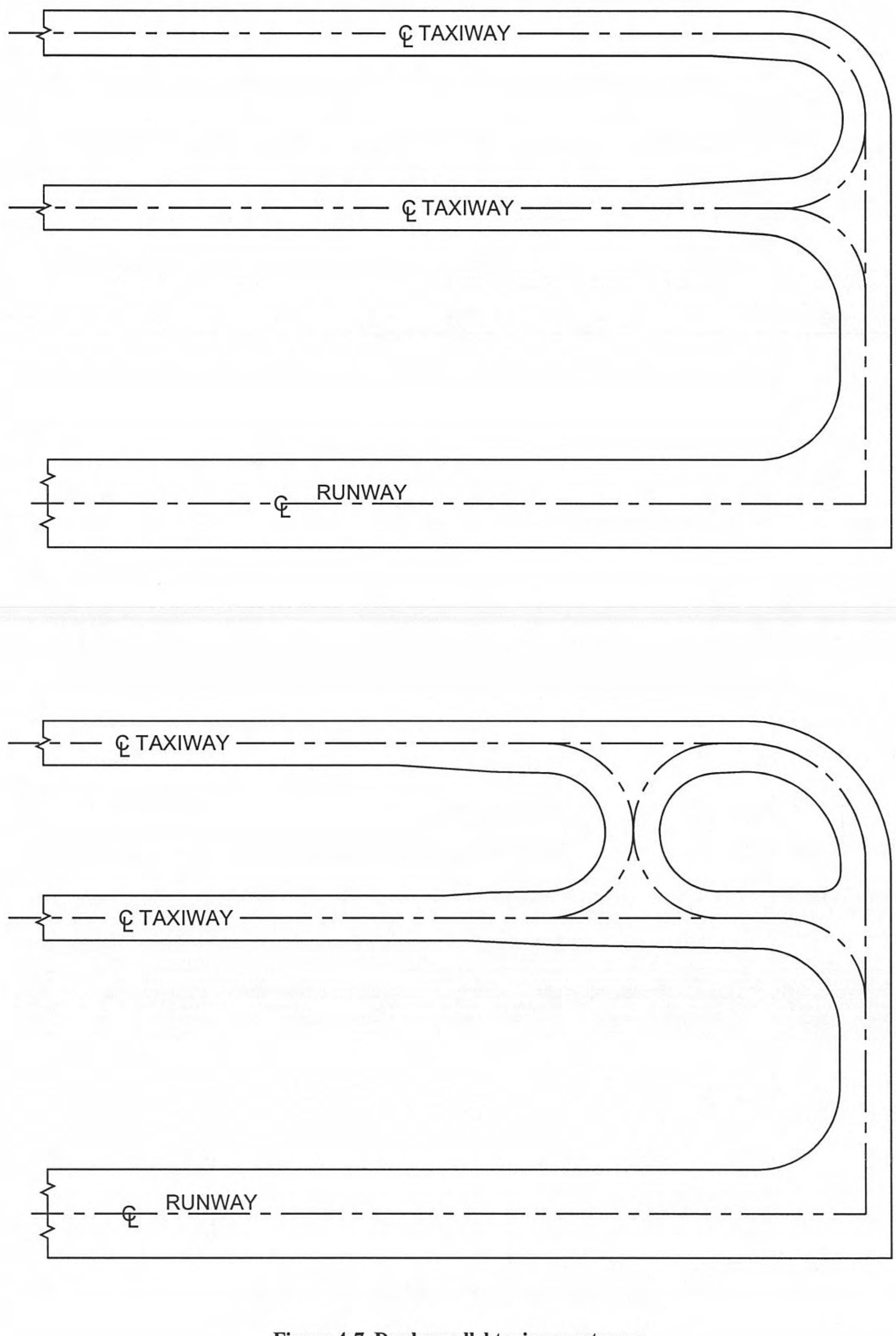


Figure 4-7. Dual parallel taxiway entrance

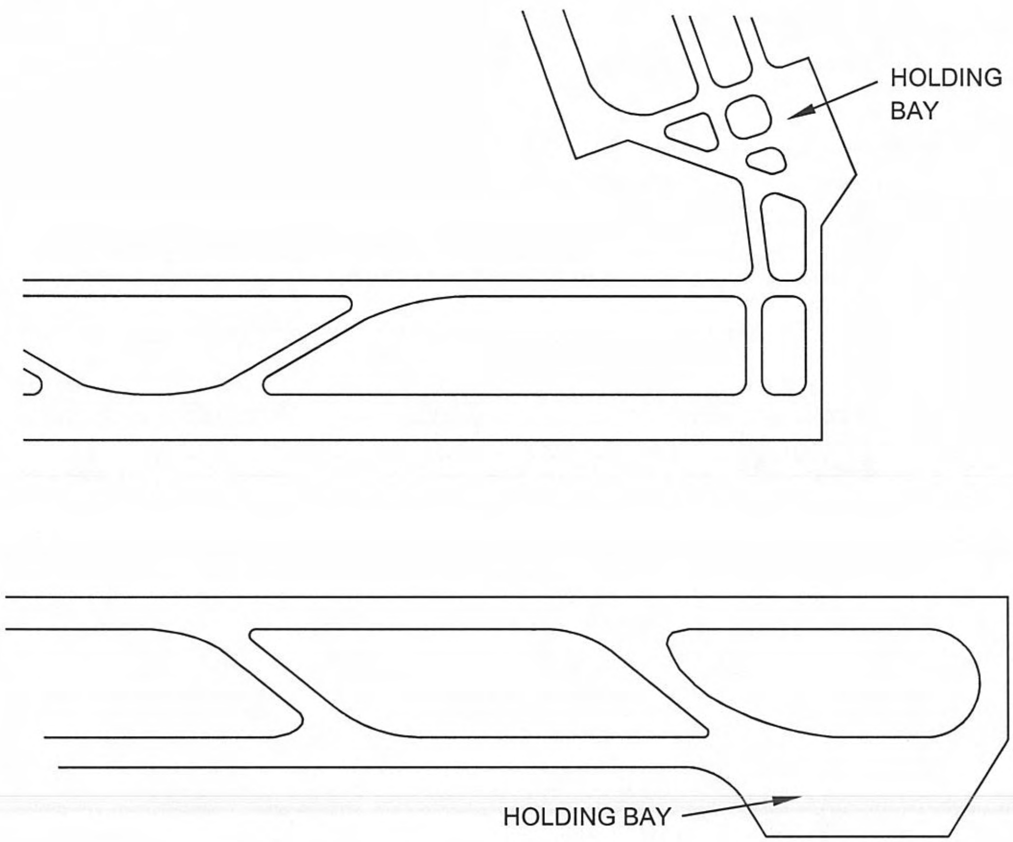


Figure 4-8. Typical holding bay configurations

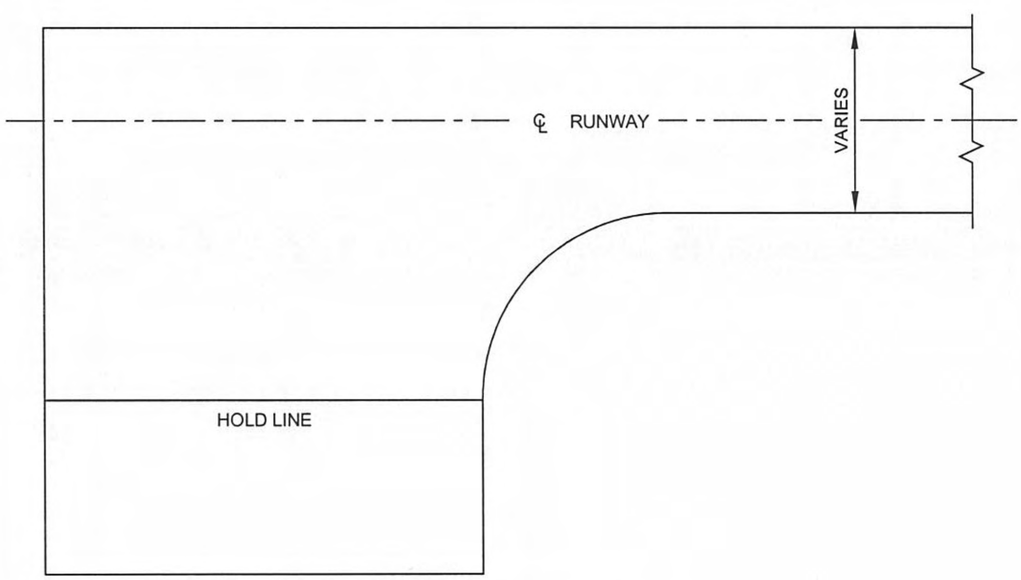


Figure 4-9. Taxiway turnaround

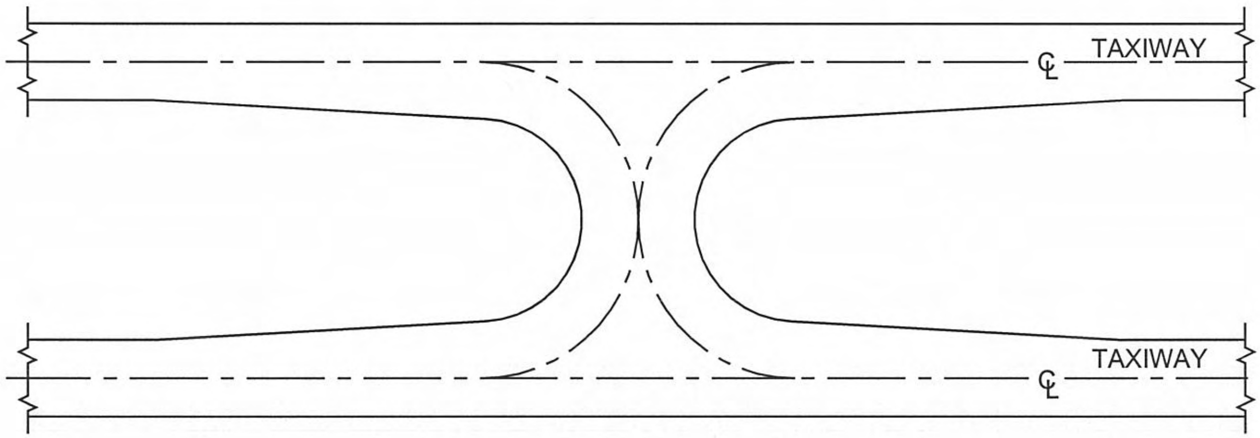


Figure 4-10. Crossover taxiway

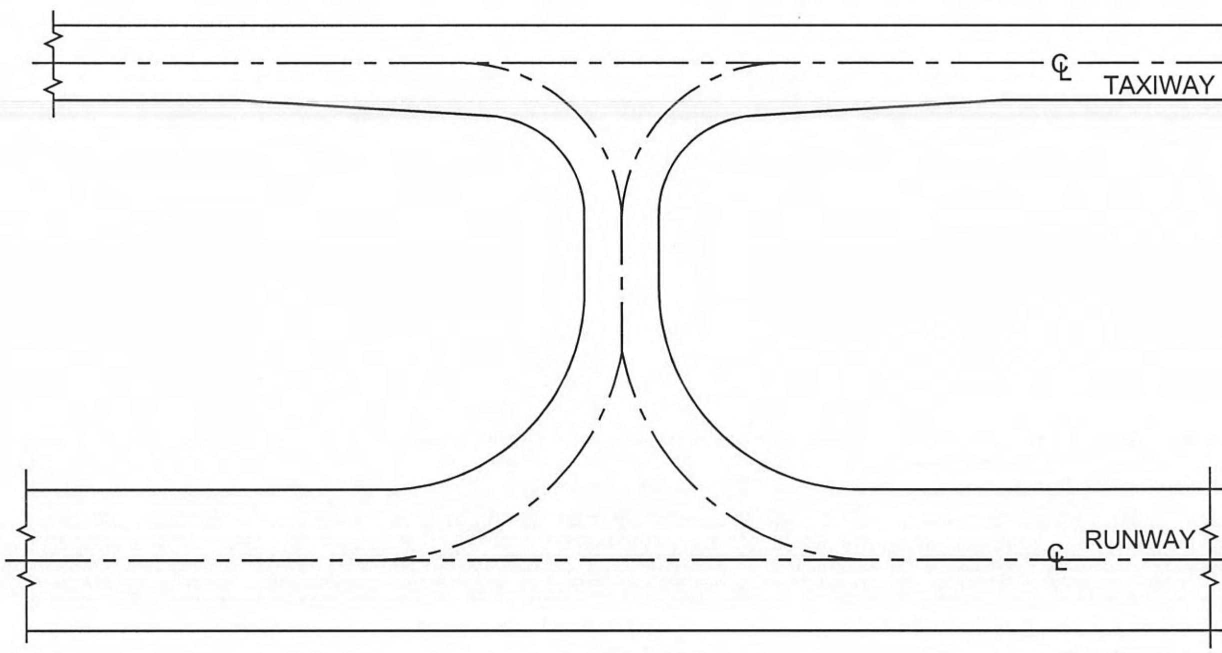


Figure 4-11. Right-angled exit taxiway

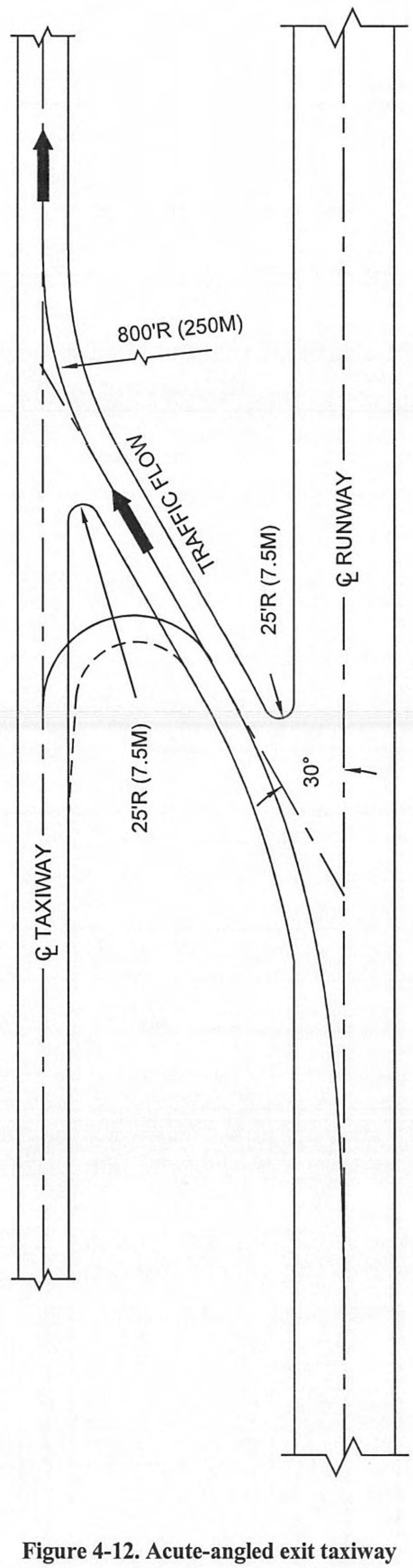


Figure 4-12. Acute-angled exit taxiway

OFFSET DISTANCES ON A RAPID RUNOFF EXIT TAXIWAY

Airplane wheelbase	84.000
Center of airplane cockpit to nosewheel	6.000
Airplane undercarriage width [1.15 x main gear track]	41.000
Taxiway edge safety margin	15.000
Taxiway width	75.000
Runway width	150.000
Runway centerline to parallel taxiway centerline	600.000

AIRPLANE COCKPIT ON CENTERLINE

Entrance Station	0.000		
Tangent Length	947.098		
Intersection Angle	30.00000	Spiral Length	1400.000
Tangent Length	479.205		
Exit Station	1400.000	Radius	1336.902
Entrance Station	1400.000		
Tangent Length	506.435		
Exit Station	1906.435		
Entrance Station	1906.435	Radius	800.000
Tangent Length	214.359		
Intersection Angle	-30.00000	Curve Length	418.879
Tangent Length	214.359		
Exit Station	2325.314	Radius	800.000
Entrance Station	2325.314		
Tangent Length	274.686		
Exit Station	2600.000		

STATION	LEFT OFFSET	RIGHT OFFSET	STEERING ANGLES	X COORDINATE	Y COORDINATE	CENTERLINE ANGLE
0.000	75.01	74.99	0.000	0.000	0.000	0.00000
50.000	75.06	74.94	0.032	50.000	0.011	0.03827
100.000	75.13	74.86	0.109	100.000	0.089	0.15306
150.000	75.20	74.76	0.212	149.999	0.301	0.34439
200.000	75.27	74.63	0.330	199.998	0.712	0.61224
250.000	75.33	74.49	0.456	249.993	1.391	0.95663
300.000	75.37	74.32	0.587	299.983	2.404	1.37755
350.000	75.38	74.12	0.721	349.963	3.818	1.87500
400.000	75.36	73.89	0.857	399.927	5.698	2.44898
450.000	75.31	73.62	0.994	449.868	8.113	3.09949
500.000	75.22	73.31	1.131	499.777	11.127	3.82653
550.000	75.09	72.96	1.268	549.641	14.808	4.63010
600.000	74.90	72.57	1.406	599.445	19.222	5.51020
650.000	74.67	72.11	1.543	649.172	24.432	6.46684
700.000	74.38	71.61	1.681	698.802	30.506	7.50000
750.000	74.02	71.04	1.819	748.308	37.506	8.60969
800.000	73.61	70.40	1.956	797.665	45.497	9.79592

Figure 4-13. Example of acute-angled exit taxiway computer layout data page 1

850.000	73.12	69.70	2.094	846.839	54.541	11.05867
900.000	72.56	68.92	2.232	895.795	64.699	12.39796
950.000	71.92	68.07	2.370	944.493	76.031	13.81378
1000.000	71.20	67.13	2.508	992.887	88.595	15.30612
1050.000	70.40	66.11	2.646	1040.928	102.447	16.87500
1100.000	69.51	65.00	2.784	1088.562	117.640	18.52041
1150.000	68.52	63.80	2.921	1135.729	134.227	20.24235
1200.000	67.45	62.51	3.059	1182.363	152.255	22.04082
1250.000	66.27	61.11	3.197	1228.396	171.768	23.91582
1300.000	64.99	59.62	3.335	1273.752	192.807	25.86735
1350.000	63.53	58.11	3.473	1318.349	215.408	27.89541
1400.000	61.32	57.15	3.611	1362.102	239.603	30.00000
1400.000	61.32	57.15	3.611	1362.102	239.603	30.00000
1450.000	58.78	56.38	2.072	1405.404	264.603	30.00000
1500.000	56.62	55.25	1.189	1448.705	289.603	30.00000
1550.000	54.68	53.89	0.682	1492.006	314.603	30.00000
1600.000	52.87	52.42	0.391	1535.307	339.603	30.00000
1650.000	51.13	50.87	0.225	1578.609	364.603	30.00000
1700.000	49.43	49.28	0.129	1621.910	389.603	30.00000
1750.000	47.75	47.66	0.074	1665.211	414.603	30.00000
1800.000	46.08	46.04	0.042	1708.512	439.603	30.00000
1850.000	44.35	44.48	0.024	1751.814	464.603	30.00000
1900.000	41.70	43.86	0.014	1795.115	489.603	30.00000
1906.435	41.24	43.91	0.013	1800.688	492.820	30.00000
1906.435	41.24	43.91	0.013	1800.688	492.820	30.00000
1950.000	38.43	43.96	-2.465	1838.991	513.565	26.87989
2000.000	36.05	43.54	-4.163	1884.266	534.763	23.29890
2050.000	34.28	42.90	-5.138	1930.776	553.092	19.71791
2100.000	32.94	42.21	-5.699	1978.341	568.480	16.13693
2150.000	31.94	41.58	-6.022	2026.774	580.867	12.55594
2200.000	31.21	41.08	-6.208	2075.886	590.205	8.97495
2250.000	30.75	40.72	-6.314	2125.485	596.457	5.39397
2300.000	31.03	40.03	-6.376	2175.378	599.599	1.81298
2325.314	31.82	39.22	-6.396	2200.688	600.000	0.00000
2325.314	31.82	39.22	-6.396	2200.688	600.000	0.00000
2350.000	32.70	38.32	-4.864	2225.374	600.000	0.00000
2400.000	33.89	37.12	-2.792	2275.374	600.000	0.00000
2450.000	34.58	36.43	-1.602	2325.374	600.000	0.00000
2500.000	34.97	36.03	-0.919	2375.374	600.000	0.00000
2550.000	0.00	0.00	-0.527	2425.374	600.000	0.00000
2600.000	0.00	0.00	-0.303	2475.374	600.000	0.00000

NOTE: The offset distance is a perpendicular distance measured from the taxiway centerline. The hard surface needs to be widened at stations where the offset distance extends beyond the hard surface.

REFERENCE: AC 150/5300-13, AIRPORT DESIGN.

Figure 4-14. Example of acute-angled exit taxiway computer layout data page 2

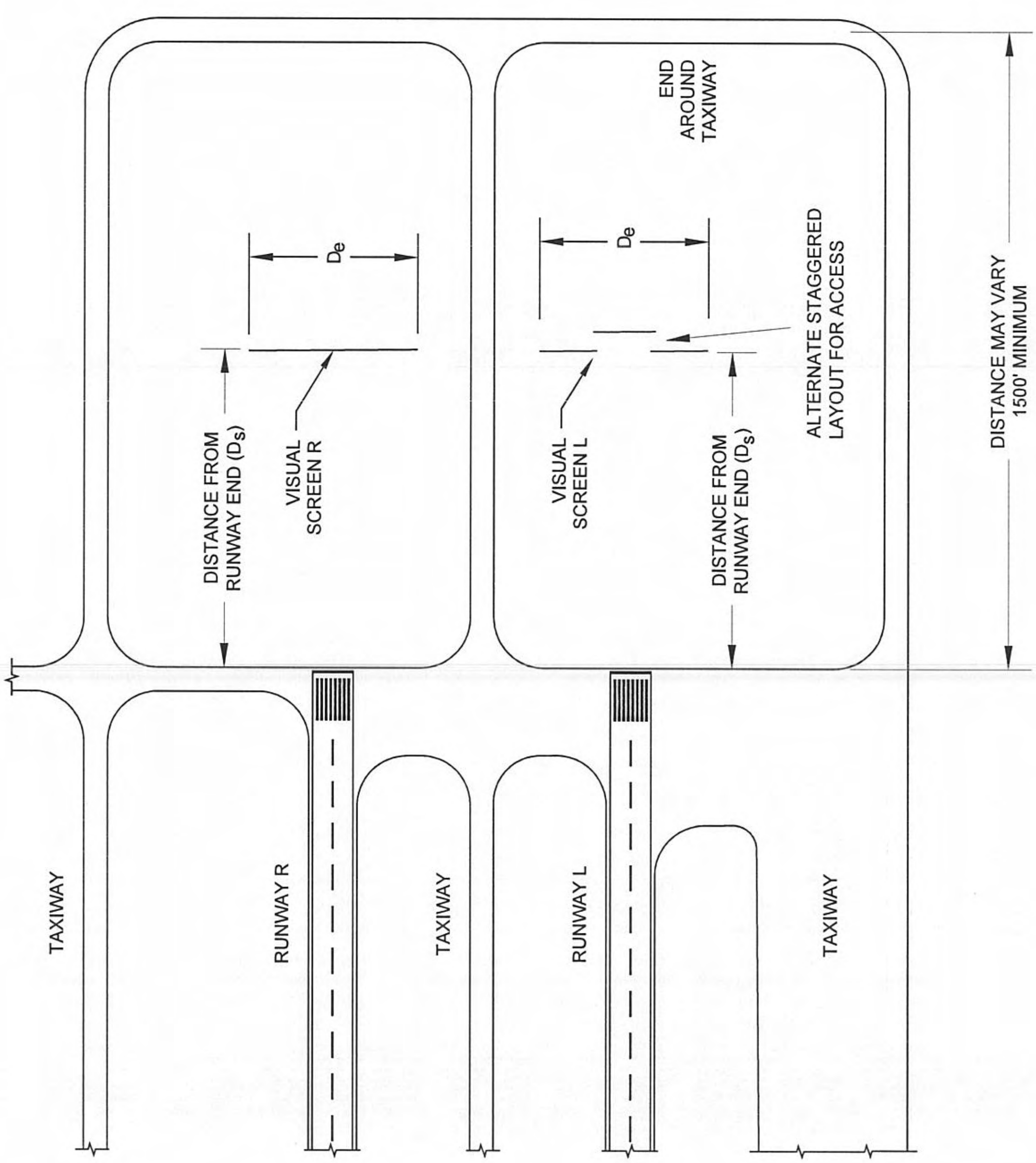


Figure 4-15. Typical end-around taxiway layout

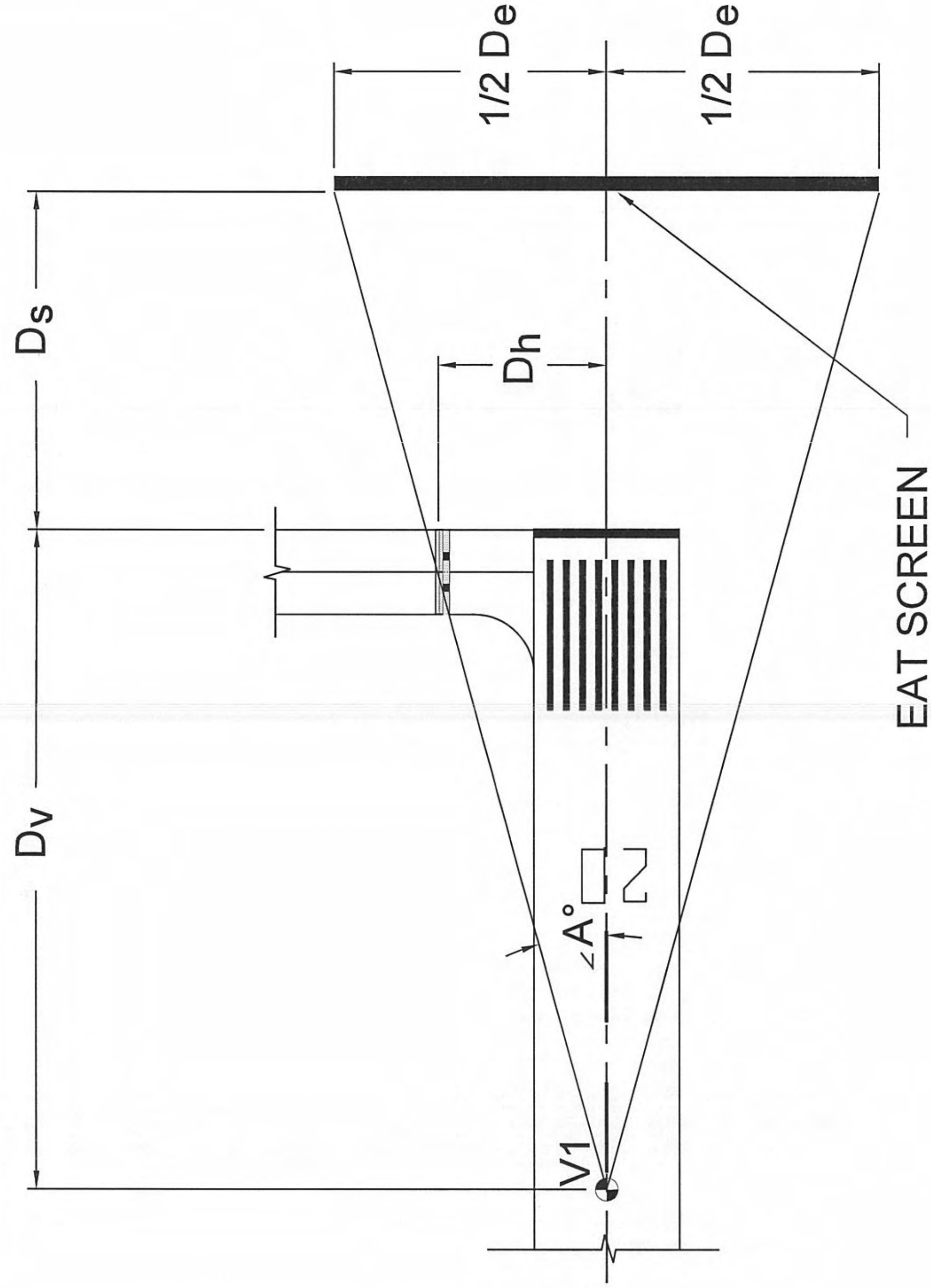


Figure 4-16. End-around taxiway visual screen width calculations

$$\angle A = \arctan \frac{D_h}{D_v}$$

$$\left(\tan \angle A(D_v + D_s)\right) = \frac{1}{2} D_e$$

Where: D_v = Distance from Average V1 location (defined in Federal Aviation Regulation 1.2 as takeoff decision speed) for Design Group aircraft to Departure Runway End.
D_s = Distance from Departure Runway End to the EAT Visual Screen Location
D_h = Distance from the Departure Runway End Centerline to the Centerline of Taxiway at Hold Position Marking
D_e = Total Width of EAT Visual Screen

Figure 4-17. Visual screen width calculation formula

Table 4-4. Visual screen height calculation formula (same elevation as runway)

EAT Visual Screen Height Calculation – EAT and Runway at Same Elevation

Design Group	Typical Design Group Engine Nacelle Height	Required Screen Surface Height	Required Height of Top Edge of Screen (Above Runway Centerline Elevation)
III	9 ft	10 ft	10 ft
IV	12 ft	13 ft	13 ft
V	18 ft	16 ft	18 ft
VI	18 ft	16 ft	18 ft

Table 4-5. Visual screen height calculation formula (EAT below DER elevation) for Design Group III

Design Group III Aircraft
EAT Visual Screen Height Calculation –
EAT At or Below DER Elevation

Elevation Difference (ft)	Required Screen Surface Height (ft)	Required Height of Top Edge of Screen (+ DER Centerline Elevation) (ft)
0	10	10
1	10	10
2	10	10
3	10	10
4	10	10
5	10	10
6	10	10
7	10	10
8	10	10
9	10	10
10	10	10
11	9	9
12	9	9
13	9	9
14	9	9
15	9	9
16	9	9
17	9	9
18	9	9
19	9	9
20	8	8
21	8	8
22	8	8
23	8	8
24	8	8
25	8	8
26	8	8
27	8	8
28	8	8
29+	0	0

Table 4-6. Visual screen height calculation formula (EAT below DER elevation) for Design Group IV

Design Group IV Aircraft
EAT Visual Screen Height Calculation –
EAT At or Below DER Elevation

Elevation Difference (ft)	Required Screen Surface Height (ft)	Required Height of Top Edge of Screen (+/- DER Centerline Elevation) (ft)
0	13	13
1	13	13
2	13	13
3	13	13
4	13	13
5	13	13
6	13	13
7	13	13
8	13	13
9	13	13
10	13	13
11	13	13
12	13	13
13	13	13
14	12	12
15	12	12
16	12	12
17	11	11
18	11	11
19	11	11
20	10	10
21	10	10
22	10	10
23	9	9
24	9	9
25	9	9
26	8	8
27	8	8
28	8	8
29+	0	0

Table 4-7. Visual screen height calculation formula (EAT below DER elevation) for Design Groups V and VI

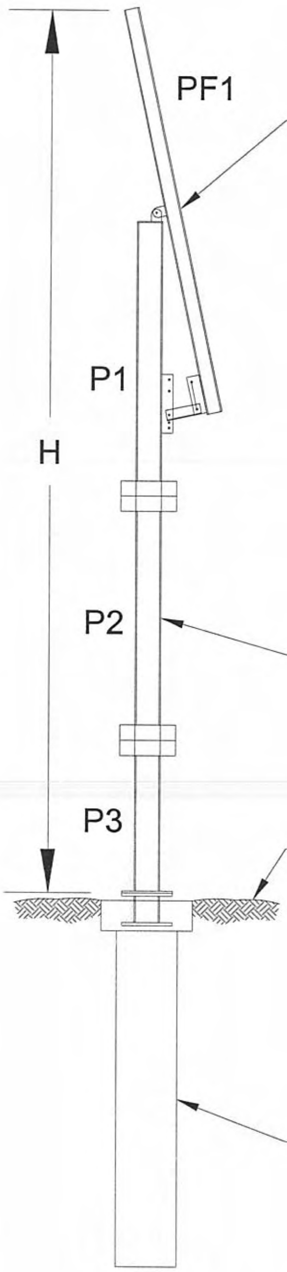
Design Group V and VI Aircraft
EAT Visual Screen Height Calculation –
EAT At or Below DER Elevation

Elevation Difference (ft)	Required Screen Surface Height (ft)	Required Height of Top Edge of Screen (+/- DER Centerline Elevation) (ft)
0	13	18
1	13	18
2	13	18
3	13	18
4	13	18
5	13	17
6	13	16
7	13	15
8	13	14
9	13	13
10	13	13
11	13	13
12	13	13
13	13	13
14	12	12
15	12	12
16	12	12
17	11	11
18	11	11
19	11	11
20	10	10
21	10	10
22	10	10
23	9	9
24	9	9
25	9	9
26	8	8
27	8	8
28	8	8
29+	0	0

Table 4-8. Visual screen vertical height calculation tables

Design Group III -VI Aircraft EAT Visual Screen Height Calculation – EAT Above DER Elevation

Design Group	Required Height of Top Edge of Screen (Above Runway Centerline Elevation) (ft)	Add Elevation Difference – EAT above DER	Calculate: NEW Required Height of Top Edge of Screen (Above DER Centerline Elevation) (ft)
III	10	+ Elevation Difference	= New Required Height of Top Edge of Screen
IV	13		
V	18		
VI	18		



HIGH FRAME ELEV: 26'< H ≤ 32'

FRAMING SCHEDULE - VISUAL SCREEN 26'< H ≤ 32'			
	WIND SPEED (MPH)		
MEMBER	90	130	150
P1	HSS 8x6x5/16	HSS 8x8x1/2	HSS 12x8x3/8
P2	HSS 10x6x1/2	HSS 12x8x9/16	HSS 16x8x1/2
P3	HSS 12x6x1/2	HSS 16x8x1/2	HSS 20x8x1/2
PF1	HSS 6x4x3/16	HSS 6x4x5/16	HSS 6x4x5/16

INTERMEDIATE FRAME ELEV: 18'< H ≤ 26'

FRAMING SCHEDULE - VISUAL SCREEN 18'< H ≤ 26'			
	WIND SPEED (MPH)		
MEMBER	90	130	150
P1	HSS 8x6x5/16	HSS 8x8x1/2	HSS 12x8x3/8
P2	HSS 10x6x1/2	HSS 12x8x9/16	HSS 16x8x1/2
P3			
PF1	HSS 6x4x3/16	HSS 6x4x5/16	HSS 6x4x5/16

LOW FRAME ELEV: H ≤ 18'

FRAMING SCHEDULE - VISUAL SCREEN H ≤ 18'			
	WIND SPEED (MPH)		
MEMBER	90	130	150
P1	HSS 8x6x5/16	HSS 8x8x1/2	HSS 12x8x3/8
P2			
P3			
PF1	HSS 6x4x3/16	HSS 6x4x5/16	HSS 6x4x5/16

Figure 4-18. Examples of mounting screen to vertical column

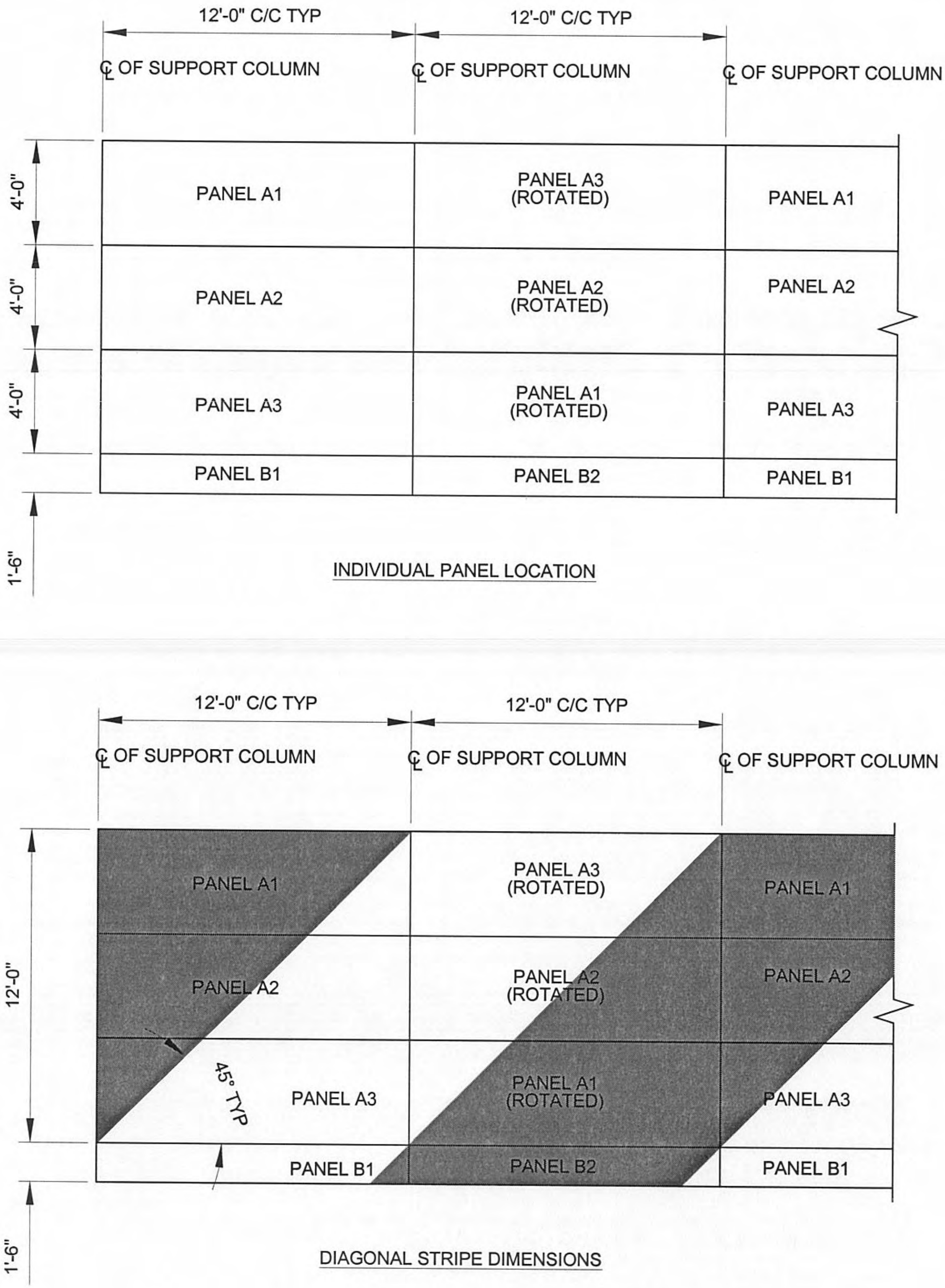


Figure 4-19. Examples of panel layout for 13-foot-high screen

Table 4-9. Visual screen panel wind-loading deflection allowance

WIND SPEED (3 SEC GUST)	DEFLECTION	STRENGTH
90 MPH	.074 PSI	.17 PSI
130 MPH	.074 PSI	.35 PSI
150 MPH	.074 PSI	.47 PSI

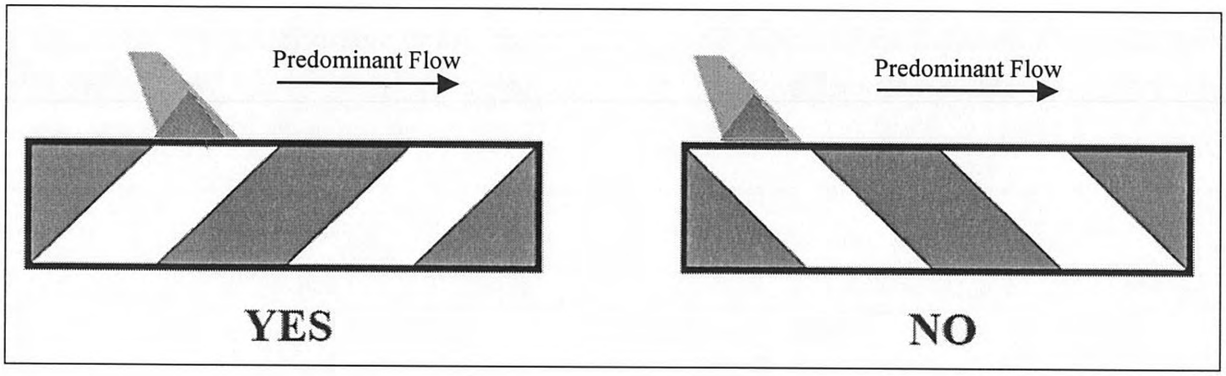


Figure 4-20. Diagonal stripe orientation

Table 4-10. CIE chromaticity coordinate limits

Color	x	y	X	Y	x	y	x	y	Min	Max	Munsell Paper
White	.303	.287	.368	.353	.340	.380	.274	.316	35.0		6.3GY 6.77/0.8
Red	.613	.297	.708	.292	.636	.364	.558	.352	8.0	12.0	8.2R 3.78/14.0

Table 4-11. Minimum reflection levels

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	14.5
0.2	+30	30	6.0
0.5	-4	30	7.5
0.5	+30	15	3.0

(Reflectivity must conform to Federal Specification FP-85 Table 718-1 and ASTM D 4956.)

1/ Observation (Divergence) Angle–The angle between the illumination axis and the observation axis.

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.

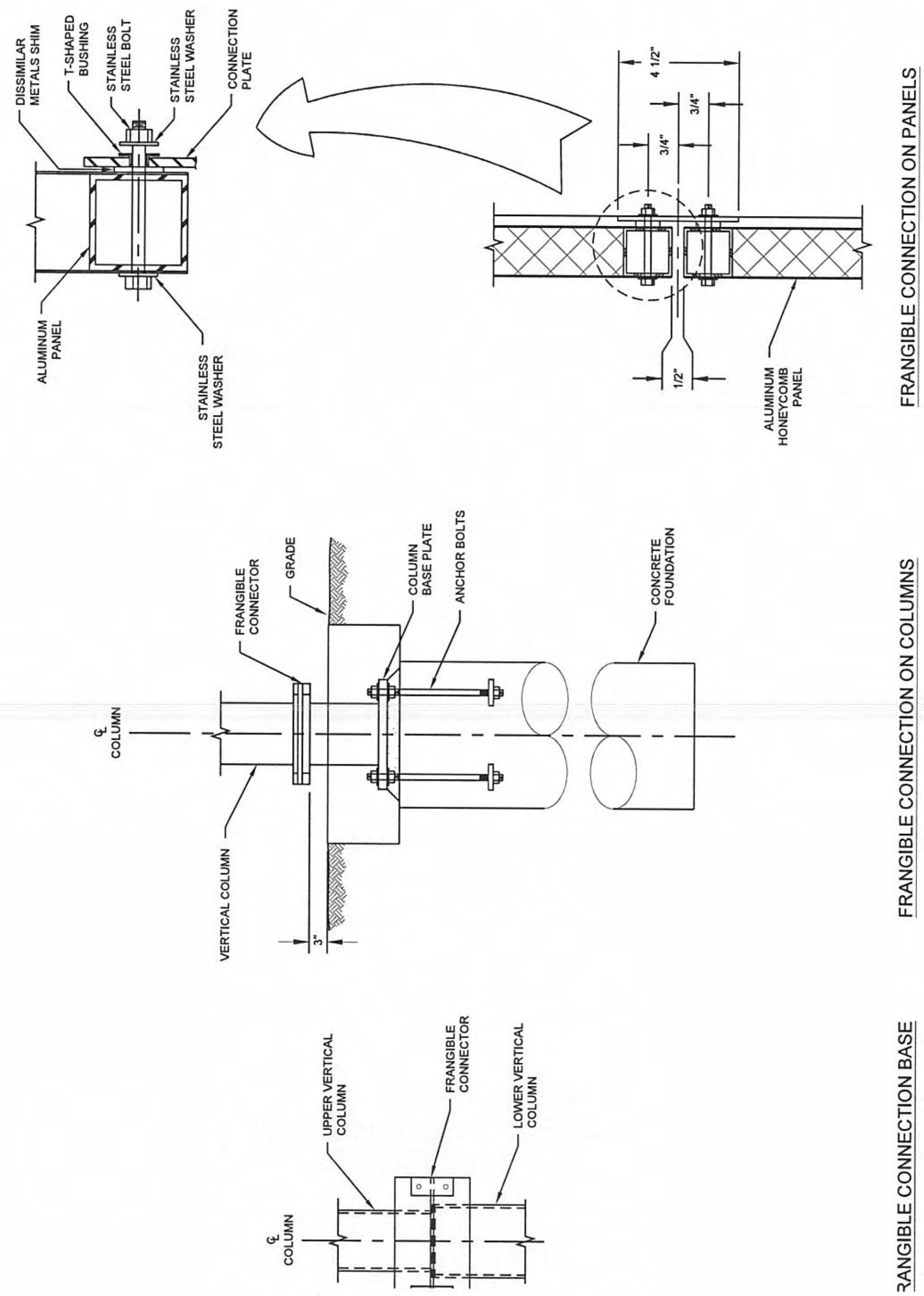


Figure 4-21. Examples of frangibility connections