U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Air Traffic Organization Policy

ORDER
JO 6850.2C

Effective Date:
08/30/2022

SUBJ: Visual Guidance Lighting Systems

This order contains installation criteria for all visual guidance lighting systems. This order was revised to Revision C.

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Initiated By: AJM-322

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Chapter 1. General Information and Requirements

Section 1. General

1. Purpose of this order. This order contains installation criteria for all visual guidance lighting systems.

2. Audience. This order is intended for use by the Air Traffic Organization (ATO) Service Centers, Technical Operations engineers and all other personnel responsible for the planning and implementation of Visual Guidance Lighting Systems in the National Airspace System (NAS).

3. Where can I find this order? This order can be found on the main Federal Aviation Administration (FAA) website, select "Regulations and Policies" then select "Orders and Notices".

4. Cancellation. This order cancels FAA Order 6850.2B, Visual Guidance Lighting System, dated August 20, 2010.

5. Explanation of policy changes. This revision provides clarification and includes additional definitions for specific requirements. Editorial changes were incorporated to comply with the U.S. Government Printing Office Style Guide. Several paragraphs in this order were modified as a result of comments received from Must Evaluators during the Clearance Record review process. The principal changes include:

a. Paragraph 14, Definitions. Added definitions for Utility Runway, Baffles, and Runway Safety Area (RSA).

b. Paragraph 15, Approach Lighting Systems (ALS). Updated description of ALS types and added reference to FAA Order 8400.13, Procedures for the Evaluation and Approval of Facilities for Special Authorization Category I Operations and All Category II and III Operations, for guidance on approach category requirements and prescribed lighting and ancillary equipment. Referencing FAA Order 8400.13 removes the need to link each ALS to the associated approach category throughout the document.

c. Paragraph 204, Light fixtures and isolation transformers. Incorporated references to specifications for the respective isolation transformers. Included alternative incandescent PAR-38 lamp as available option for medium intensity systems.

d. Paragraph 205 (a), Control requirements. Verbiage added pertaining to ALS providing clarity on when the sequenced flashers must be on.

e. Paragraphs 205 (b) and (c), Control and monitoring requirements. Incorporated new Remote Control System capabilities.

f. Paragraph 209 (b), Access. Incorporated access road requirement to the power and control equipment station.

g. Paragraph 209 (c), Pier and other rigid structure installation. Revised threshold criteria for the distance between the light plane and rigid structure installations.

h. Paragraph 405 (b), Control from remote location. Removed listed conditions under which remote control equipment may be installed. Appendix B outlines the requirements for radio control.

i. Chapter 5, Precision Approach Path Indicator (PAPI) System. Removed Paragraph 509 (Deviations), and incorporated requirements in appropriate paragraphs throughout this chapter.

j. Paragraphs 500 (a) and (b), Description. Updated Precision Approach Path Indicator (PAPI) description by stating the added benefit on instrument approaches when transitioning from the instrument to the visual segment. Included identified obstructions to the list of conditions that may hinder the PAPI from being located on the left side of the runway.

k. Paragraph 501, General siting considerations. Removed all references to an electronic glide slope and replaced it with a “published glide path angle (GPA)/vertical descent angle (VDA)”.

l. Paragraph 502, Siting PAPI on a runway with published Instrument Approach Procedures with a GPA/VDA. Removed all references to an electronic glide slope and replaced it with a “published glide path angle/vertical descent angle”. Updated verbiage to state that where the glide path angle/vertical descent angle is not standard, the PAPI must be coincident with that non-standard glide path.

m. Paragraph 503 (a), Table 5-1, Visual Threshold Crossing Heights. Removed and replaced outdated aircraft in each height group.

n. Paragraph 503 (b), Glide Path Angle. Changed the maximum GPA limit for utility runway without jet aircraft operations from 4 degrees to 4.2 degrees.

o. Paragraph 504, PAPI Obstacle Clearance Surface (OCS). Updated to include baffling as an option if a site survey or if flight inspection determines that there is an obstacle penetrating the OCS that cannot be removed. Included procedural verbiage to address obstacle penetrations in areas outside the 10 degree lateral limits of the OCS.

p. Paragraph 506 (a), Distance from runway edge. Re-written to include correct tolerance notations for locating the inboard Lamp Housing Assembly (LHA) as a result of any deviations from the standard.

q. Paragraph 506 (g) (3), Other siting considerations. Clearly stated siting criteria as it applies to the LHA.

r. Paragraph 507 (a), Power and Control Assembly (PCA). Updated paragraph title and text to reflect PCA instead of Power and Control Unit (PCU). Included PAPI frangibility requirements in relation to the Runway Safety Area (RSA) and Runway Object Free Area (ROFA).

s. Paragraph 507 (b), Lamp Housing Assembly (LHA). Removed verbiage pertaining to the angle at which the LHA tilt switch is activated. Removed verbiage describing the maximum weight of the LHA.

t. Paragraph 508, Remote control. Removed requirement for PAPIs in the National Airspace System (NAS) to use a remote control system (landline or radio control).

u. Figures 2-2 through 2-4. Updated spacing between lights and corrected dimensions.

v. Figures 2-6 through 2-8. Added ratio sign for applicable slopes.

w. Figure 5-4. Updated to show correct tolerance for the LHA spacing. Note (1) (b) verbiage updated to reflect "chart supplement" instead of "Airport Facility Directory".

x. Appendix A. Joint Use Agreement between the FAA and Air National Guard. Removed.

y. Appendix B (2) (c), Air to ground criteria. Updated reference document for criteria.

z. Appendix B (6) (a), Radio control selection. Removed this section and remote radio configuration selection chart (figure 1).

aa. Appendix B (6) (b), Radio Control Address Selection. Removed section.

bb. Appendix B (6) (a), Coordination Requirements (currently the section B (6)). Included current coordination protocols with FAA Spectrum Engineering Services.

cc. Appendix E (3) (b), Determining obstruction clearance. Provided mitigation actions in cases where obstructions penetrate the VASI obstruction clear plane and cannot be removed. Included baffling as an option and verbiage to address areas outside the 10 degree lateral limits of the obstruction clear plane.

dd. Appendix E (4) (c) Visual Glide Path Angle. Removed outdated aircraft from list.

6. Application. The requirements of this order apply to all new establishment projects for visual guidance lighting systems, for previously commissioned systems that are to be relocated, and for systems to be modified to conform to the configuration of another system. These criteria are also applicable when environmental changes, airport improvements, operational changes, etc., cause an existing facility to no longer meet the required standards. Modification of existing systems for the sole purpose of conforming to new requirements is not required.

7. Deviation from standards. All deviations from the installation criteria contained in this directive must be approved by a Configuration Control Decision (CCD). A NAS Change Proposal (NCP) must be processed in accordance with the latest edition of FAA Order 1800.66, Configuration Management Policy. Systems existing and installed under previous criteria do not require a CCD because the criteria herein apply only to new and relocated systems.

8. Directive verbs. The material in this order contains FAA criteria, recommended practices, and other guidance materials, which require the use of certain directive verbs such as *Must, Shall, Should, Will,* and *May*. In this order the explicit meaning of the verbs are as follows:

a. ***Must/Shall***. The action is mandatory.

b. ***Should***. The action is desirable or recommended.

c. ***Will***. The action is to be taken in the future.

d. ***May***. The action is permissible.

9. Flight inspection. Before the commissioning of visual guidance lighting systems, refer to the latest edition of FAA Order 8200.1, U.S. Standard Flight Inspection Manual, to ensure that the lighting systems meet applicable requirements.

10. Visibility requirements. Approach visibility requirements are influenced by the availability of approach lights. These requirements can be found in the latest version of FAA Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS).

11. Corrections to installation criteria. Corrections to these installation criteria may be made by the Manager of Navigation Programs without further regional or additional interservice coordination. These may include misspellings, corrections of dimensional errors, and modification, addition or deletion of minor details.

Section 2. Visual Guidance Lighting System

12. Introduction. The term "Visual Guidance Lighting System" is used for identifying, as a type of facility, those configurations of lights located on and in the vicinity of an airfield. These facilities provide pilots with critical visual references for guidance during approach for landing. As visual aids to the pilot, they may be used with or without electronic landing aids, such as an Instrument Landing System (ILS), etc.

13. Development of visual facilities. Visual guidance lighting systems are designed and provided to improve the operational safety of aircraft during approach and landing operations. In order to meet this objective, the configurations, colors, equipment, and materials used for the various facilities must be consistent with and suited to the operational requirements. Consequently, these facilities are continually monitored to ensure that they satisfy the changing operational requirements.

14. Definitions. The following terms used herein are defined as follows:

a. Approach Lighting System (ALS) centerline. The ALS centerline is the extended centerline of the runway being served.

b. Landing threshold. A line perpendicular to the runway centerline marking the beginning of the runway surface that is available for aircraft landing.

c. Approach Light Plane. An imaginary horizontal plane that passes through the beam centers of the lights in the system. The plane is rectangular in shape, centered on the ALS centerline, originating at the landing threshold, and extending 200 feet beyond the last light (at the approach end of the system). The width varies according to the lighting system.

d. Light bar. A cluster of signal lights arranged in a row perpendicular to the runway centerline.

e. Semiflush lights. Lights designed for installation in paved areas and do not extend more than 1 inch above the surrounding paved area and capable of roll-over by aircraft.

f. Frangible lights. Lights mounted on structures up to 6 feet high, which are designed to present a minimum of mass and to break at the base when impacted.

g. Low-Impact Resistant lights. Lights mounted on structures 6 to 40 feet high, which are low-impact resistant, designed to present a minimum of mass, and designed to break when impacted.

h. Semifrangible lights. Lights mounted on two-element structures: the lower element being a rigid structure and the upper element being a 20-foot, low-impact resistant structure.

i. Rigid lights. Lights installed on all rigid structures. These lights are not authorized on new construction.

j. Positive slope. A slope of the approach light plane upward and outward from the landing threshold.

k. Negative slope. A slope of the approach light plane downward and outward from the landing threshold.

l. Primary plane. A plane that defines obstruction clearance for the Runway Alignment Indicator Lights (RAIL) portion of an approach lighting system.

m. Secondary plane. Gradients adjacent to the primary plane that define obstruction clearance for the RAIL portion of an approach.

n. Visual segment method. The visual segment method for determining the alignment of approach lights is defined and completely described in Report No. FAA-RD-78-137, Approach Light Aiming Criteria, by Charles A. Douglas dated December 4, 1978 available from the National Technical Information Service; Alexandria , VA 22312.

o. Utility runway. A runway that is constructed for and intended to be used by propeller driven aircraft of 12,500 pounds maximum gross weight and less.

p. Baffles. Devices that restrict the light signal from each individual lamp inside the Lamp Housing Assembly from being visible beyond a prescribed point. When baffles are installed, the overall effect reduces the usable light signal angular coverage of the PAPI or other VGSI system.

q. Runway Safety Area (RSA). A defined surface (typically 1,000 feet beyond both ends of the runway, 500 feet wide, centered on the runway centerline), used to reduce the risk of damage to aircraft in the event of a runway undershoot/overshoot, or excursion from the runway. The RSA is centered on the runway centerline. The RSA must be free of objects, except for objects that need to be located in the RSA because of their function (fixed-by-function). Objects higher than 3 inches above grade must be constructed, to the extent practical, on frangible mounted structures of the lowest practical height with the frangible point no higher than 3 inches above grade. The RSA and fixed-by-function designation for navigational aids (NAVAIDs) are described in the latest version of Advisory Circular (AC) 150/5300-13, Airport Design.

r. Runway Object Free Area (ROFA). A defined surface (typically 1,000 feet beyond both ends of the runway, 800 feet wide, centered on the runway centerline), used to provide wingtip protection in the event of an aircraft excursion from the runway. The ROFA and fixed-by-function designation for navigational aids (NAVAIDs) are described in the latest version of Advisory Circular (AC) 150/5300-13, Airport Design.

15. Approach Lighting System (ALS). An approach lighting system is a configuration of signal lights arranged symmetrically about the extended runway centerline, starting at the landing threshold and extending outward into the approach zone. This system provides visual information on runway alignment, height perception, roll guidance, and horizon references. The system used for precision approaches (in conjunction with an electronic aid such as an ILS) is normally 2,400 feet in length when the glide slope is 2.75 degrees or greater, and 3,000 feet in length when the glide slope is less than 2.75 degrees. When installation of a 2,400 foot system is not possible, a system 1,400 feet in length may be installed on nonprecision runways. An approach lighting system is classified as high intensity or medium intensity, depending on the type of lamps and equipment used. A complete description of each system configuration is provided in chapter 2. The selection criteria to determine the appropriate ALS are contained in the latest edition of FAA Order 7031.2, Airway Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Services. Refer to the latest version of FAA Order 8400.13, Procedures for the Evaluation and Approval of Facilities for Special Authorization Category I Operations and All Category II and III Operations, for guidance on approach category requirements and prescribed lighting and ancillary equipment. The following is a list of approach lighting systems and their intended use.

a. Medium Intensity Approach Lighting System (MALS). An economy type system for nonprecision approaches. The MALS is no longer installed by the FAA as a new facility.

b. Medium Intensity Approach Lighting System with Sequenced Flashers (MALSF). Same as MALS, but equipped with three sequenced flashers at locations where approach area identification problems exist. The strobes flash in sequence toward the threshold at the rate of twice per second.

c. Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). An economy type system that consists of 18 green lamps at the runway threshold (23 green lamps on a 200 foot wide runway), seven light bars with five lamps on each, and five sequenced flashers. The strobes flash in sequence toward the threshold at the rate of twice per second. The system starts at the runway threshold and extends outward into the approach area.

d. High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2). The ALSF-2 typically consists of 247 steady burning lights: including green threshold lights (49 lights), red side row-bar lamps (nine rows, 54 lamps), high intensity steady burning white lights (144), plus an additional 15 flashing lights referred to as strobes. The strobes flash in sequence starting with the strobe farthest from the runway and ending with the strobe closest to the runway threshold. FAA Headquarters (Navigation Programs) approval is required before installing a new ALSF-2.

e. Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR). The SSALR is not installed as a standalone system, but is a subsystem selection of the ALSF-2/SSALSR system, and is generally used in a similar manner as a standalone MALSR.

f. Omnidirectional Approach Lighting System (ODALS). The ODALS is no longer installed by the FAA as a new facility. The ODALS is a configuration of seven omnidirectional sequenced flashing lights located in the runway approach area. The ODALS provides circling, offset, and straight-in visual guidance for nonprecision approach runways.

16. Visual Approach Slope Indicator (VASI). The VASI system is no longer installed by the FAA as a new facility. Specific details and installation criteria have been moved to Appendix E to provide technical support for existing VASI equipment and facilities.

17. Runway End Identifier Lights (REIL). The primary function of the REIL is to provide rapid and positive identification of the approach end of a runway. The system consists of two synchronized flashing lights, unidirectional or omnidirectional, one on each side of the runway landing threshold, facing the approach area. The flashing feature of the lights provides an attracting characteristic, making the REIL effective for identification of the approach end of a runway. The REIL is especially effective when the runway is surrounded by a preponderance of other lighting or lacking contrast with surrounding terrain.

18. Lead-In Lighting System (LDIN). The LDIN provides positive visual guidance along an approach path, either curving or straight, where special problems exist with hazardous terrain, obstructions, or noise abatement procedures. Each LDIN is site specific and installation is based on the local airport environment. A LDIN consists of one or more series of flashing lights installed along the approach path at or near ground level. The series or groups of lights are positioned and aimed so as to be conveniently sighted and followed from the approaching aircraft under conditions at or above approach minimums. Each light group must contain at least three flashing lights in a linear or cluster configuration and may be augmented by steady-burning lights if required. Where practical, the lights comprising a given group must flash in sequence toward the runway. The light groups must be spaced close enough together (approximately 1 mile) to provide continuous lead-in guidance along each segment of the approach course. Sequencing of successive light groups is recommended. The LDIN may be terminated at any approved approach lighting system, or it may be terminated at a distance from the threshold compatible with authorized visibility minimums permitting visual reference to the runway environment. The design of all LDINs must be compatible with the requirements of FAA Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS) where such procedures are applied for established instrument minimums.

19. Precision Approach Path Indicator (PAPI). The PAPI system provides visual approach slope information. The system provides a definite white and red light projection pattern along the desired descent path to the touchdown point. The PAPI system consists of two parts: (1) a single horizontal bar with four sharp transition multi-lamp units, referred to as Lamp Housing Assemblies (LHAs), equally spaced, and (2) a Power and Control Assembly (PCA). The LHAs are located on a line perpendicular to the runway centerline, at a distance from the threshold chosen to provide the proper threshold crossing height and obstacle clearance. Each LHA projects a split beam of light, the upper segment being white and the lower segment being red. The transition from white to red, or vice versa, occurs within a vertical angle of 3 minutes of arc at the beam center and results in a well-defined corridor of light consisting of white (top) and red (bottom).

20. Land requirements for Approach Lighting Systems. The minimum land requirements for full-length approach lighting systems are as follows:

a. ALSF-2. 2,600 feet long by 400 feet wide.

b. MALS and MALSF. 1,600 feet long by 400 feet wide.

c. MALSR. The MALSR requires land that is 1,600 feet long by 400 feet wide for the MALS portion, plus an additional 1,000 feet in length by 25 feet in width for the RAIL portion. The minimum width of 25 feet for the RAIL portion is considered adequate for relatively clear and level terrain. However, where required to meet visibility, obstruction clearances, and/or access requirements, the width may be increased to a maximum of 100 feet to meet the requirements of Paragraph 201e. In some cases, the visibility or obstruction clearance requirement may be met by raising the RAIL structures. In such cases, an analysis should be made of the comparative cost of raising the structures versus acquiring additional land or removing obstructions, with the less expensive method being followed.

d. ODALS. The standard omnidirectional approach lighting system requires a rectangular surface 1,700 feet in length by a minimum width of 400 feet, beginning at the runway threshold and extending outward along the extended runway centerline.

21. Remote radio control. The remote radio control service requirements for the FAA were established by a letter dated July 25, 1975, to all regional directors and signed by the Director of Air Traffic Services, Airway Facilities Service, Flight Standards Service, and Airports Service; and a letter dated November 28, 1975, to all regions from the Airports Engineering Division. The letter dated July 25, 1975 is contained in Appendix C and is to be used only for reference. The specific application of the policy stated in these letters is applied within this directive. This directive states the applicable criteria as applied to specific facilities.

22. Distribution. This order is distributed in headquarters to the director level in the System Operations, Mission Support Services, Office of Airport Safety and Standards, and Flight Standards; to group level in the Safety and Operations Support, Aircraft Operations Group, Navigation Programs, and Acquisition Policy and Contracting directorates; to the director level at the FAA Academy and the FAA Logistics Center; to group level in the Technical Operations Service Area and the Service Centers; to the regional Airport and Flight Standards divisions; and to all Technical Operations field offices with a standard distribution.

23-199. Reserved.

Chapter 2. Installation Criteria - Approach Lighting Systems (ALS)

200. System configuration. Approach Lighting Systems (ALS) can be broken into two different types of approach lighting systems: High intensity and Medium intensity. The ALSF-2 is a high intensity system used to support Category II and III approaches, while the SSALR/MALS/MALSF/MALSR are medium intensity systems used to support Category I approaches. The SSALR is a mode of operation for the ALSF-2/SSALR system that will provide a medium intensity option for this system.

a. ALSF-2. The ALSF-2 system has steady burning and flashing signal lights that provide the aircraft pilot with visual information on runway alignment, height perception, roll guidance, and horizontal reference for precision approaches. The ALSF-2 has five light intensity settings that allow tailoring for different aircraft pilot and/or weather requirements. The ALSF-2 consists of light bars, with five equally spaced lights at 100-foot intervals starting 100 feet from the runway threshold and continuing out to 2,400 feet. All light bars are installed perpendicular to the extended runway centerline and all lights are aimed away from the runway threshold. The centerline light bar at 1,000 feet from the threshold is supplemented with eight additional lights on either side forming a 100 foot wide light bar containing 21 lights. This bar is called the 1,000-foot distance marker crossbar (or simply 1,000-foot bar). There is also a light bar (four white lights each) on each side of the centerline bar 500 feet from the threshold. These lights form a crossbar referred to as the 500 foot bar. All of the aforementioned lights are white. In addition, there are light bars (three red filtered lights each) on each side of the centerline bars at each light station in the inner 900 feet. These are called side row bars. A row of green filtered lights on 5 foot centers is located within 10 feet of the threshold and extends across the runway threshold and outwards a distance of approximately 45 feet from the runway edge on each side of the runway. These lights are called the threshold bar. All lights are aimed into the approach to the runway and away from the runway threshold. The ALSF-2 configuration is shown in Figure 2-1.

b. Sequenced flashers for ALSF-2. In addition to the steady-burning lights, the ALSF-2 consists of sequence flashing lights installed at each centerline bar starting 1,000 feet from the threshold out to the end of the system. These flashing lights emit a bluish-white light and flash in sequence toward the threshold at a rate of twice per second. The flashing lights appear as a ball of light traveling (pointing) toward the runway threshold. The flashing lights have three intensities coordinated with the intensity of the steady-burning lights in the approach lighting system. All lights are aimed into the approach to the runway and away from the runway threshold.

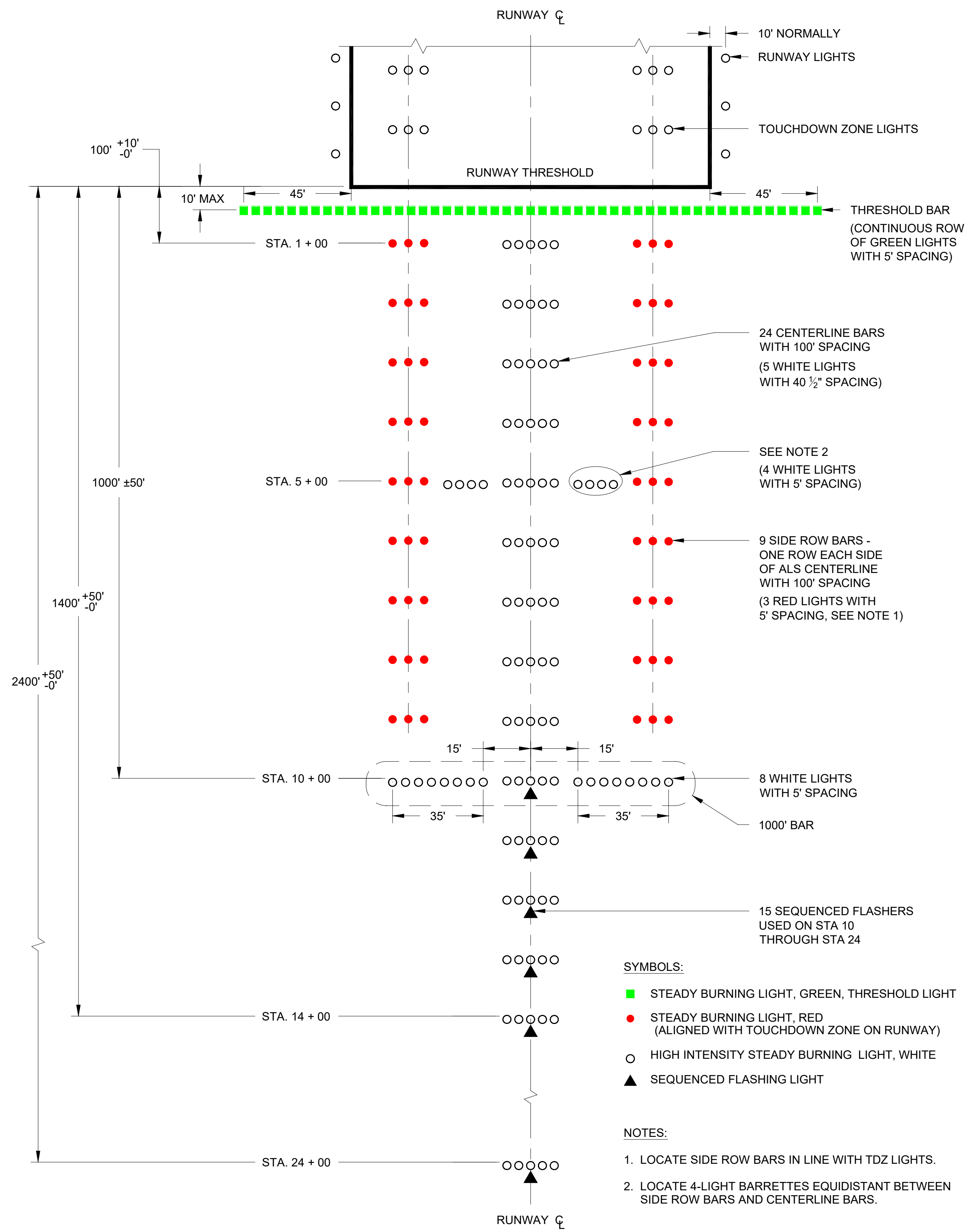


Figure 2-1. ALSF-2 Configuration

c. SSALR. The SSALR configuration consists of a threshold bar and seven bars (with five-lights on each bar) located on the extended runway centerline with the first bar located 200 feet from the runway threshold, and the remaining bars at 200-foot intervals out to 1,400 feet from the threshold. Two additional five-light bars are located, one on each side of the centerline bar, at 1,000 feet from the runway threshold forming a crossbar 70 feet wide. The spacing between individual lights is 40½ inches for the centerline bars and 5 feet for other bars. All lights in the system are white except for the threshold lights, which have green filters. The threshold lights are a row of lights on 10-foot centers located coincident with the runway edge lights and extends across the runway threshold. The RAIL portion of the facility consists of five sequenced flashers located on the extended runway centerline; the first being located 200 feet beyond the approach end of the last steady-burning light bar with successive flasher units at each 200-foot interval out to 2,400 feet from the threshold. These flashing lights emit a bluish-white light and flash in sequence toward the threshold at a rate of twice per second. All lights are aimed into the approach to the runway and away from the runway threshold. The SSALR configuration is shown in Figure 2-2. This configuration is a mode of operation for the ALSF-2/SSALR and not a standalone system.

d. MALS. The MALS consists of a threshold light bar and seven light bars, with five-lamps each located on the extended runway centerline. The first of the seven light bars is located 200 feet from the runway threshold, and the remaining bars at each 200-foot interval out to 1,400 feet from the threshold. Two additional light bars are located, one on each side of the centerline bar, 1,000 feet from the runway threshold forming a crossbar 66 feet wide. The spacing between individual lights in all bars is approximately 2½ feet. All lights are aimed into the approach to the runway and away from the runway threshold. All lights in the system are white, except for the threshold lights which have green filters. On 150 foot wide runways, 18 threshold lights are used, and for 200 foot wide runways, 23 threshold lights are used. The threshold lights consist of a row of lights on 10-foot centers located coincident with the runway edge lights and extend across the runway threshold. On 200 foot wide runways, the center threshold light is aligned with the runway centerline. The MALS configuration is shown in Figure 2-3.

e. MALSF. The MALSF consists of a MALS with sequenced flashers located on three light bar stations. The flashers are added to the MALS to assist pilots in acquiring the runway. The flashers are used at locations with high ambient background lighting, and assist pilots in making an earlier identification of the runway. These lights flash in sequence toward the threshold at the rate of twice per second. All lights are aimed into the approach to the runway and away from the runway threshold. The MALSF configuration is shown in Figure 2-3.

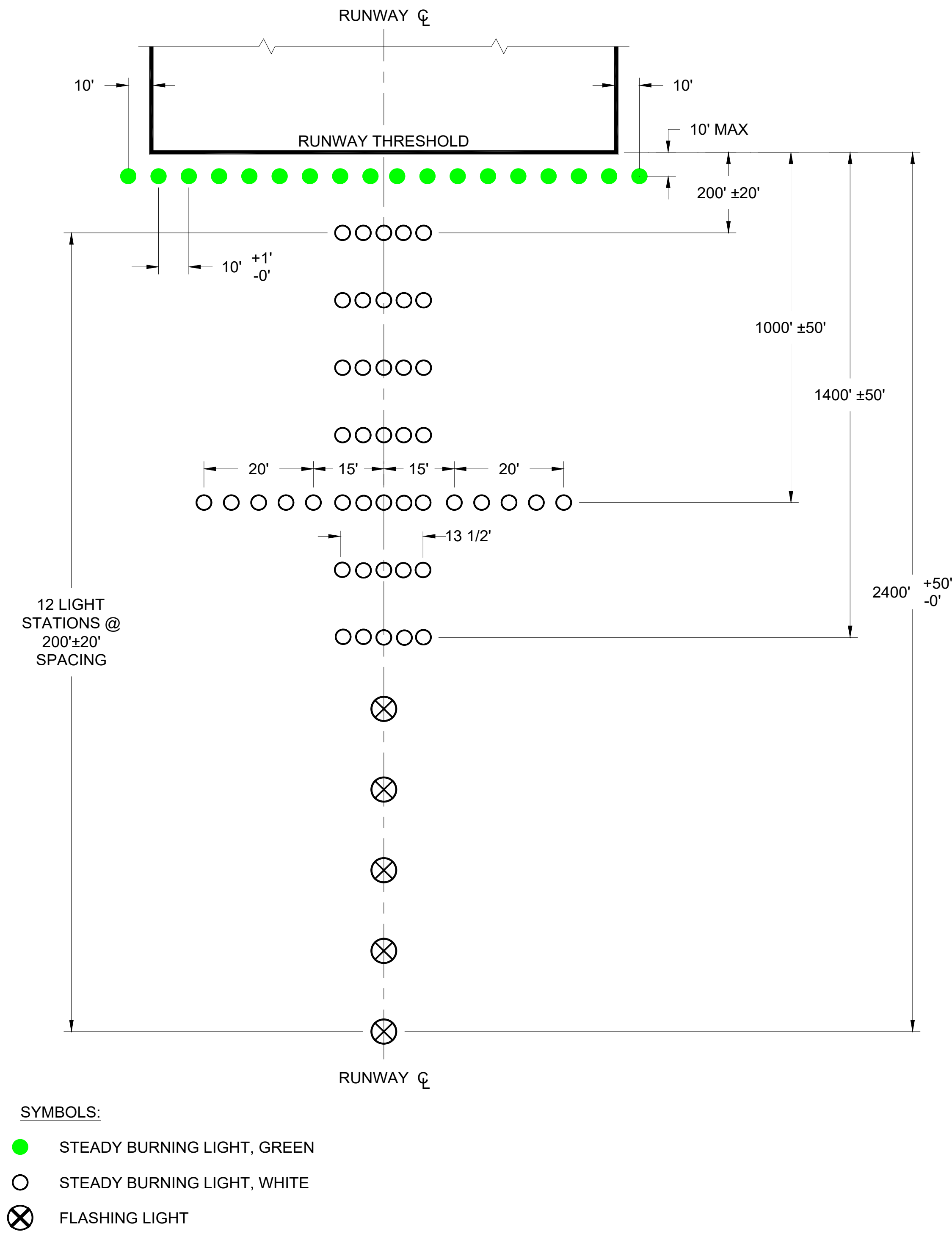


Figure 2-2. SSALR Configuration

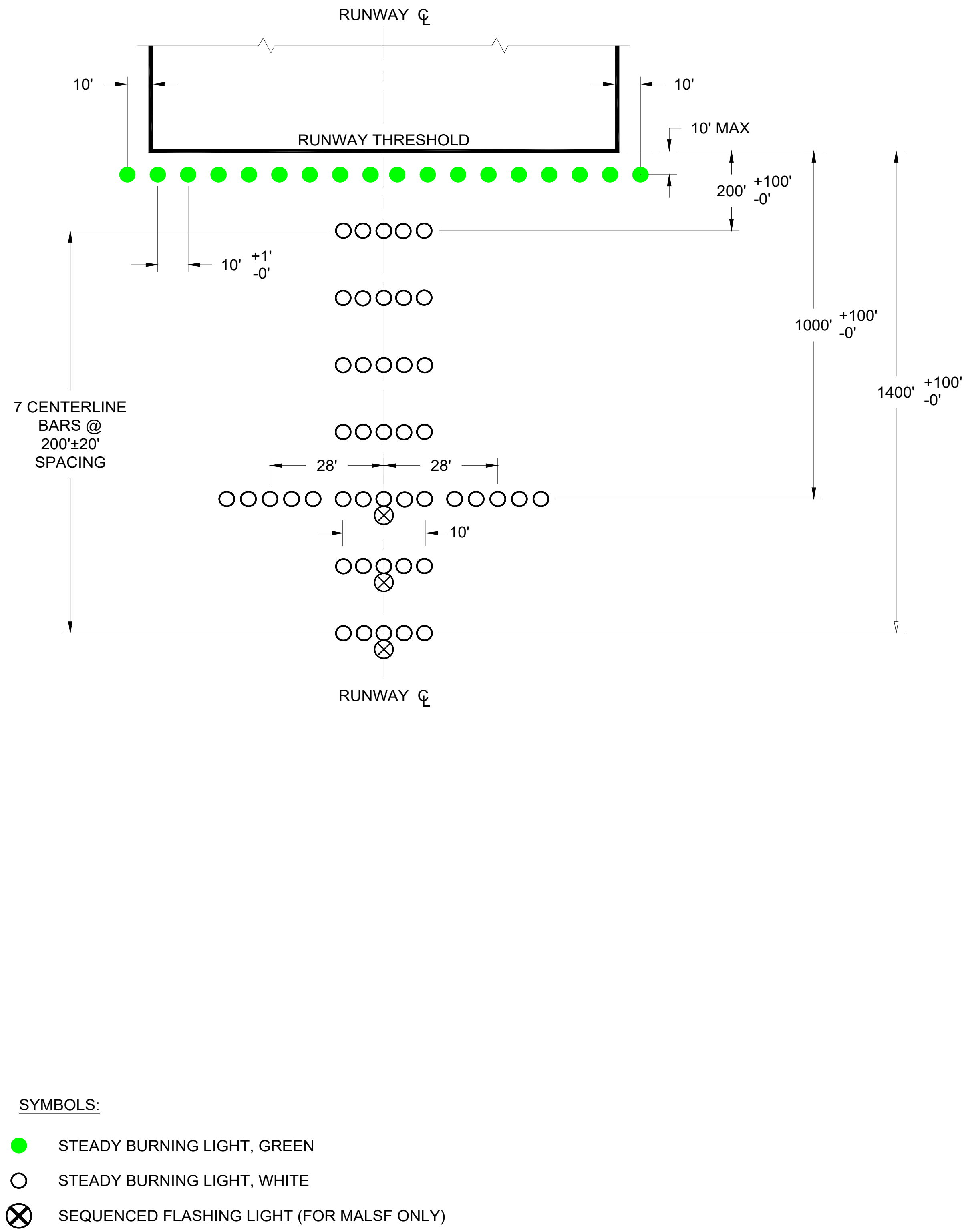


Figure 2-3. MALS and MALSF Configuration

f. MALSR. The MALSR consists of a MALS plus RAIL. The RAIL portion of the facility consists of five sequenced flashers located on the extended runway centerline. The first flasher is located 200 feet beyond the approach end of the MALS with successive units located at each 200-foot interval out to 2,400 feet from the runway threshold. These lights flash in sequence toward the threshold at the rate of twice per second. All lights are aimed into the approach to the runway and away from the runway threshold. The MALSR configuration is shown in Figure 2-4.

g. ODALS. The ODALS consists of seven omnidirectional flashing lights located in the approach area of a nonprecision runway. Five lights are located on the runway extended centerline with the first light located 300 feet from the threshold and extending at 300 foot intervals up to 1,500 feet from the threshold. The other two lights are located, one on each side of the runway threshold, at a lateral distance of 40 feet from the runway edge, or 75 feet from runway edge when installed on a runway equipped with a VASI. The ODALS configuration is shown in Figure 2-5.

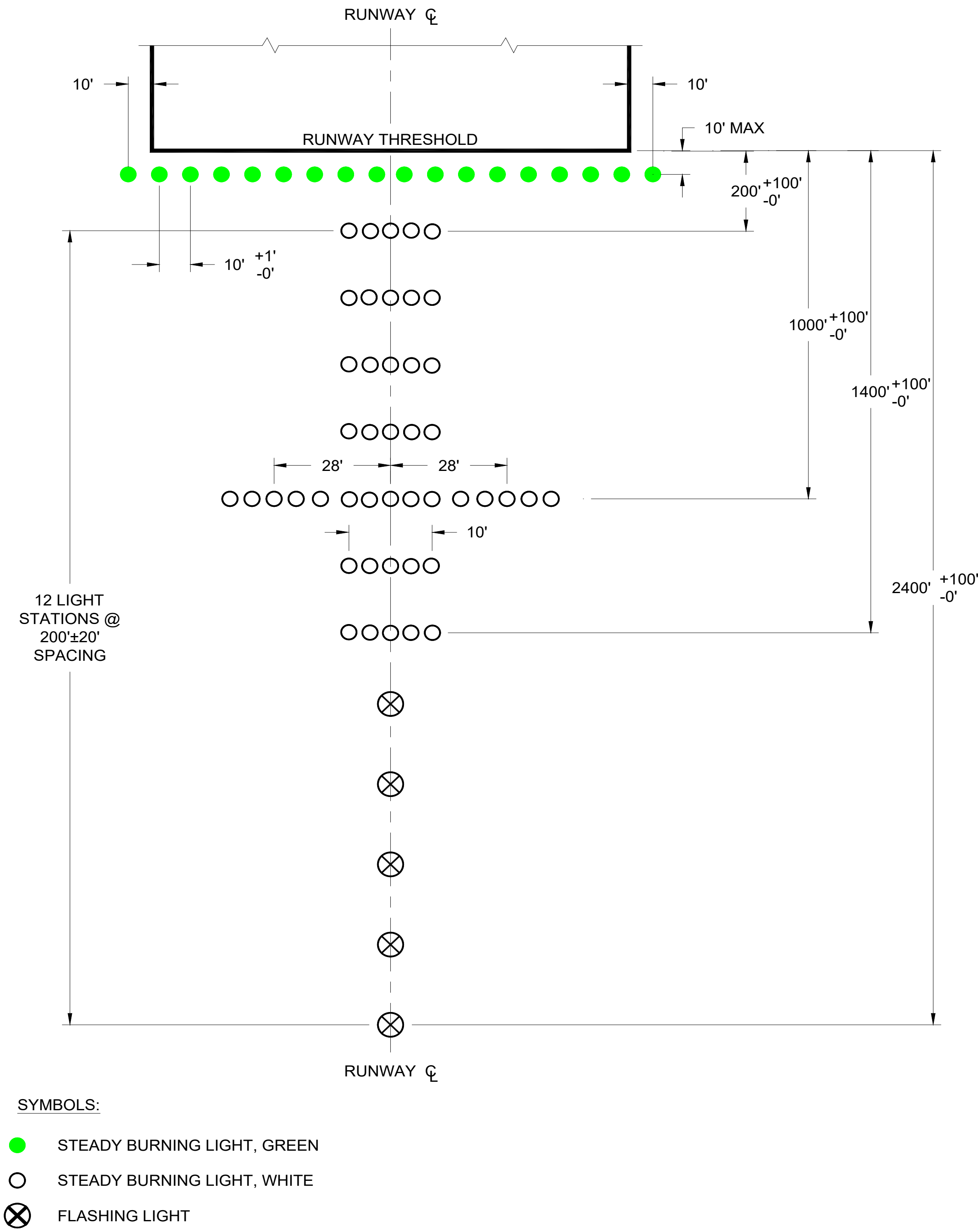
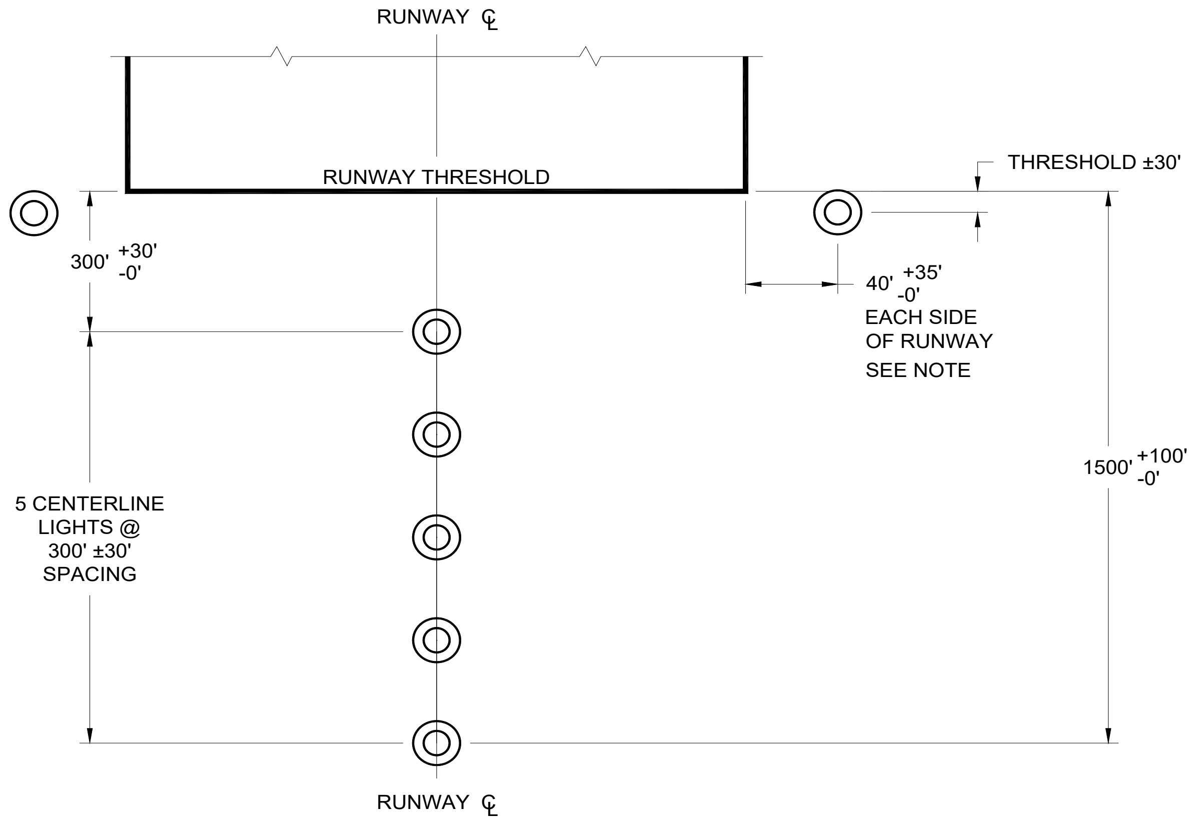


Figure 2-4. MALSR Configuration



SYMBOLS:

◎ OMNIDIRECTIONAL FLASHING LIGHT

NOTE:

INSTALL THRESHOLD FLASHER 75' FROM EDGE OF RUNWAY WHEN VASI IS INSTALLED ON SAME RUNWAY.

Figure 2-5. ODALS Configuration

201. Typical installation. The following requirements describe a typical ALS installation:

a. Approach Light Plane. The light units in the approach light plane are in a single horizontal plane at the elevation of the runway threshold centerline. The approach light plane is 400 feet wide centered on the extended runway centerline, RAIL excepted (See Paragraph 201e for RAIL approach light plane).

b. Clearance. No object protrudes into the approach light plane. For approach light plane clearance purposes, all roads, highways, vehicle parking areas, and railroads are considered as vertical solid objects. The clearance required above interstate highways is 17 feet; for railroads, 23 feet; and for all other roads, highways, and vehicle parking areas, 15 feet. The clearance for roads and highways is measured from the crown of the road and for railroads is measured from the top of the rails. This applies to the entire width of the approach light plane. For vehicle parking areas, clearance is measured from the average grade in the vicinity of the highest point. Airport service roads controlled in a manner that will preclude a vehicle blocking the view of the approach lights from landing aircraft or preclude vehicle protruding above the light plane, are not considered obstructions in determining the approach light plane.

c. Location and orientation. All light bars are installed perpendicular to the vertical plane containing the ALS centerline and are installed in their normal locations as shown in Figures 2-1 through 2-4. The total overall length of all systems must be as shown in Figures 2-1 through 2-5.

d. Visibility. There must be a clear line-of-sight to all lights of the system from any point on a surface, one-half degree below the precision approach (PA) or approach with vertical guidance (APV) glide path angle (GPA) and extending 250 feet each side of the centerline, up to 1,600 feet in advance of the outermost light in the system. For nonprecision approach systems (where there is no PA or APV), a 3 degree glide path, intersecting the runway 1,000 feet from the landing threshold, is assumed for determining the visibility requirement.

e. RAIL. The typical installation of an ALS RAIL is that all sequence flashing lights be in a horizontal light plane with no obstruction penetrating the primary and secondary RAIL planes. (See Figure 2-6).

(1) Primary plane. The primary plane of the RAIL system begins at the last steady-burning light of the MALS portion and extends 200 feet beyond the last flashing light in the RAIL portion of the MALSR system. The primary plane has a total width of 100 feet, 50 feet each side of the extended runway centerline, and a surface that follows the plane of the MALSR RAIL System.

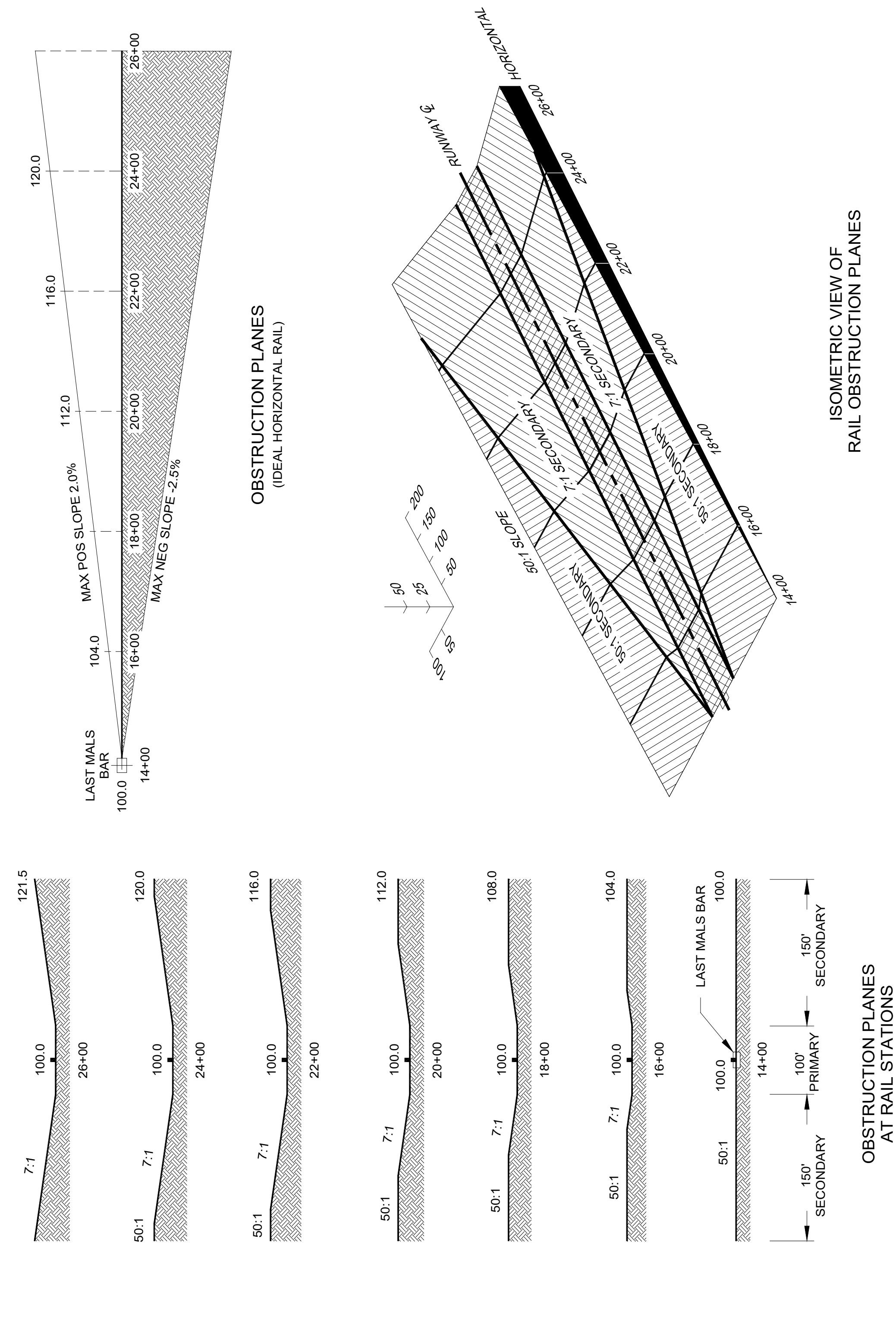


Figure 2-6. Ideal RAIL Obstruction Clearance

(2) Secondary plane. Beginning at the edge of the primary plane, a secondary plane having a slope of 7:1 extends outward from the edge of the primary plane for a distance of 150 feet. Both primary and secondary planes begin at the last steady-burning lights of the MALSR system and extend 200 feet beyond the last flashing light in the RAIL portion of the MALSR system. An additional secondary plane underlies the 7:1 plane, with a longitudinal slope of 50:1, beginning at the height of the last steady-burning light and extending outward (laterally) to 150 feet from the edge of the primary plane at zero gradient. The surface extends longitudinally to 200 feet beyond the last flashing light of the RAIL system. Objects must not penetrate either the primary or secondary plane.

202. Siting and Installation Tolerances. The sections below discuss typical siting and installation tolerances.

a. Approach Light Plane. Because of the requirement for elevated frangible lights, the lights in the threshold bar and stations 1+00 and 2+00 are considered to be at runway threshold elevation even though they may be up to 14 inches above it. After station 2+00 the remainder of the light plane may extend from the actual centerline elevation of the lamp at station 2+00 or revert to the centerline threshold runway elevation extended to station 2+00. If a single horizontal light plane is not possible because of terrain or solid objects within its area, the plane may be raised if considered more economical than lowering, removing, or displacing interfering objects. The light plane may also be lowered where sharply descending terrain makes it economically necessary.

(1) Slope gradient. The slope gradient must be kept as small as possible and not exceed 2 percent for a positive slope nor 1 percent for a negative slope (RAIL excepted, Paragraph 202a (5)). The sloping segment may start no closer than 200 feet from the landing threshold. Where the threshold is established at the approach end or is displaced less than 200 feet, the slope gradient starts at runway approach end elevation. Where the landing threshold is displaced greater than 200 feet from the runway approach end, the slope gradient starts 200 feet from the displaced threshold at the elevation of the runway surface at the 200 feet point. The sloping segment begins and ends at a light station.

(2) ALSF-2 sloping segment. Only one sloping segment is permitted in a system. The sloping segment must contain a minimum of four light bars or 300 feet. The sloping segment may extend to the end of the system or may revert into a horizontal segment of at least three light bar stations (200 feet). Negative slope is not permitted in the inner 1,500 feet.

(3) MALS and ODALS sloping segments. A sloping or horizontal segment must contain at least three consecutive light bar stations. Only one positive sloping segment is permitted in a system. The sloping segment may start at the first light bar and extend to the end of the system, or may be preceded by a horizontal segment or followed by either a horizontal or negative sloping segment. For ODALS, the sloping segment may start at 200 feet from the threshold or at a height of 24 inches above the threshold elevation beginning at the first light on centerline (station 3+00).

(4) Semiflush lights. In determining the approach light plane, all semiflush lights installed in pavement with sloping gradient are considered as being in a horizontal plane at the elevation of the outermost semiflush light station on the ALS approach end centerline.

(5) RAIL slope gradient. The primary plane may have a maximum permissible slope of 2 percent positive (see Figure 2-7) and 2.5 percent negative (see Figure 2-8). The primary plane may also have one change of gradient (see Figure 2-9). A sloping or horizontal segment must contain at least three consecutive light stations.

b. Clearance.

(l) Where necessary, to ensure an acceptable level of performance of an ILS, antennas and their associated supports for the marker beacon and/or localizer may on a Category I approach, penetrate the approach light plane. However these antennas, or their supports, must not obscure any light of the approach lighting system. This applies only to a penetration of the approach light plane and in no way refers to the precision, APV or nonprecision approach surfaces as defined in FAA Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS). The 50:1 surface or the approach light plane must be clear of penetrations for Category II/III approach lighting systems.

(2) Since the approach light plane passes through the beam centers of the lights, a portion of the light unit and support hardware will, of necessity, penetrate the light plane. For example, this condition exists when the ALSF-2 is operated as a SSALR.

(3) When an ILS marker shelter is located within the approach light system, the approach light plane must be set so that the marker shelter is below the light plane.

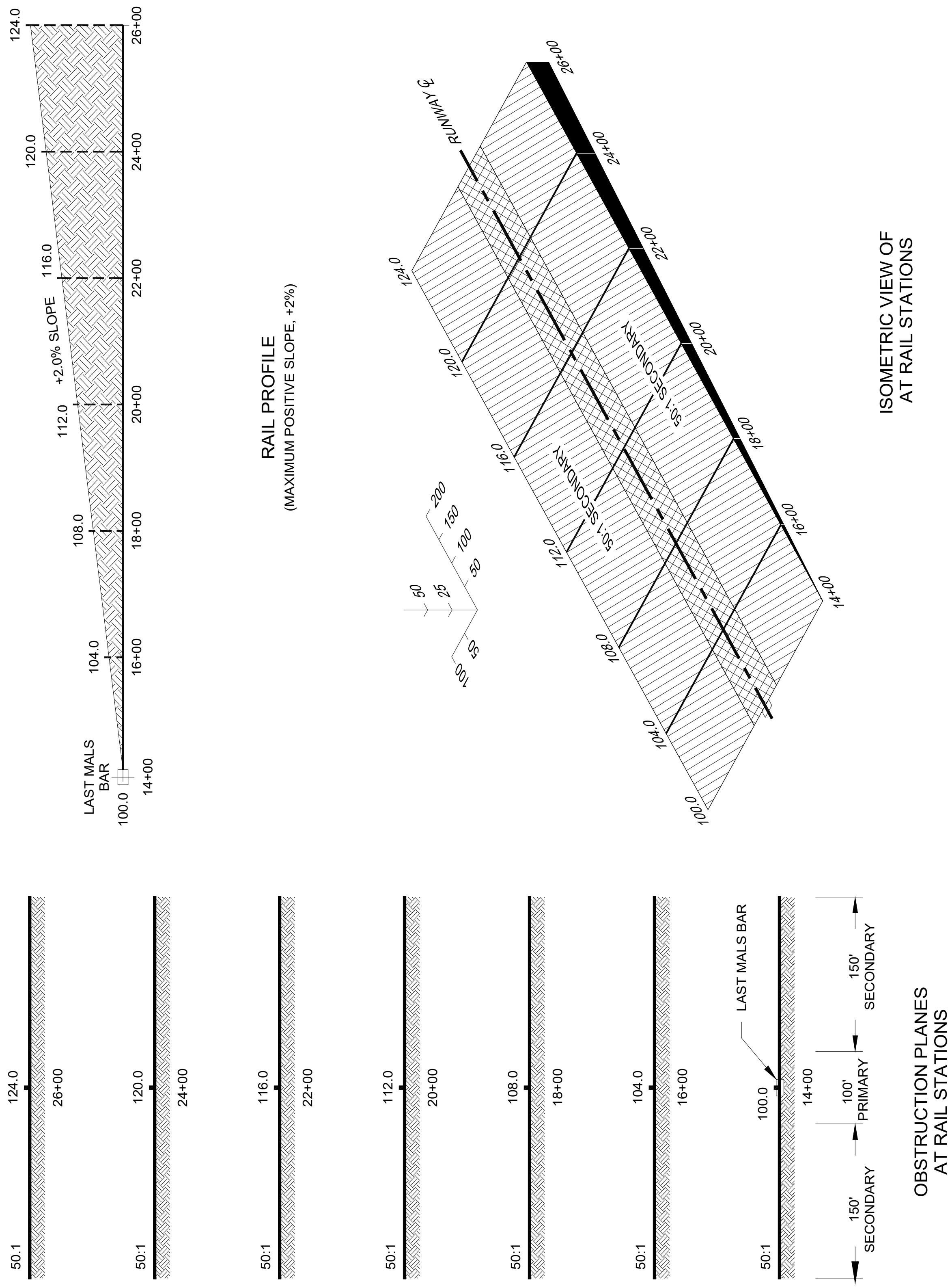


Figure 2-7. RAIL Obstruction Clearance for +2.0% Slope

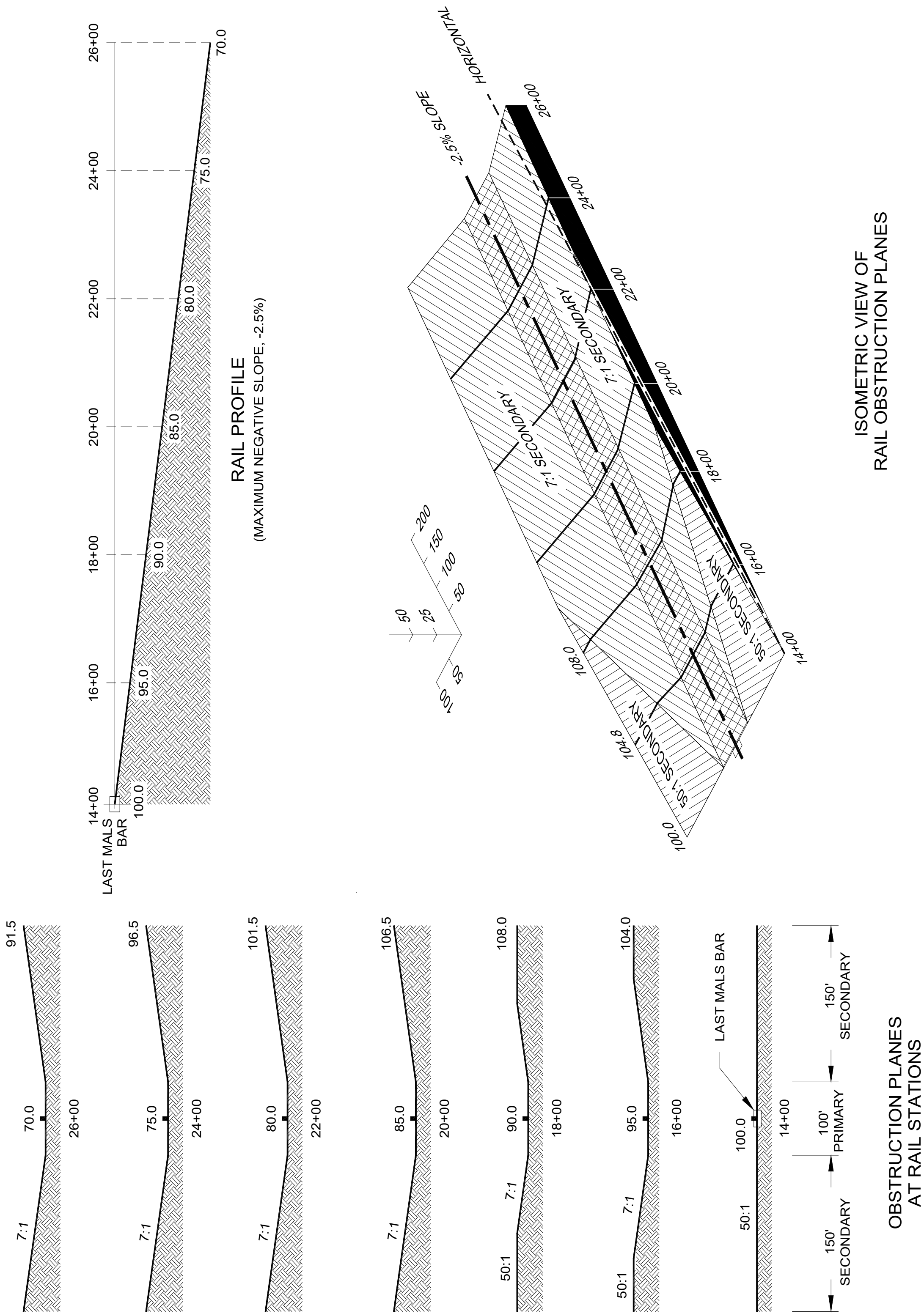


Figure 2-8. RAIL Obstruction Clearance for -2.5% Slope

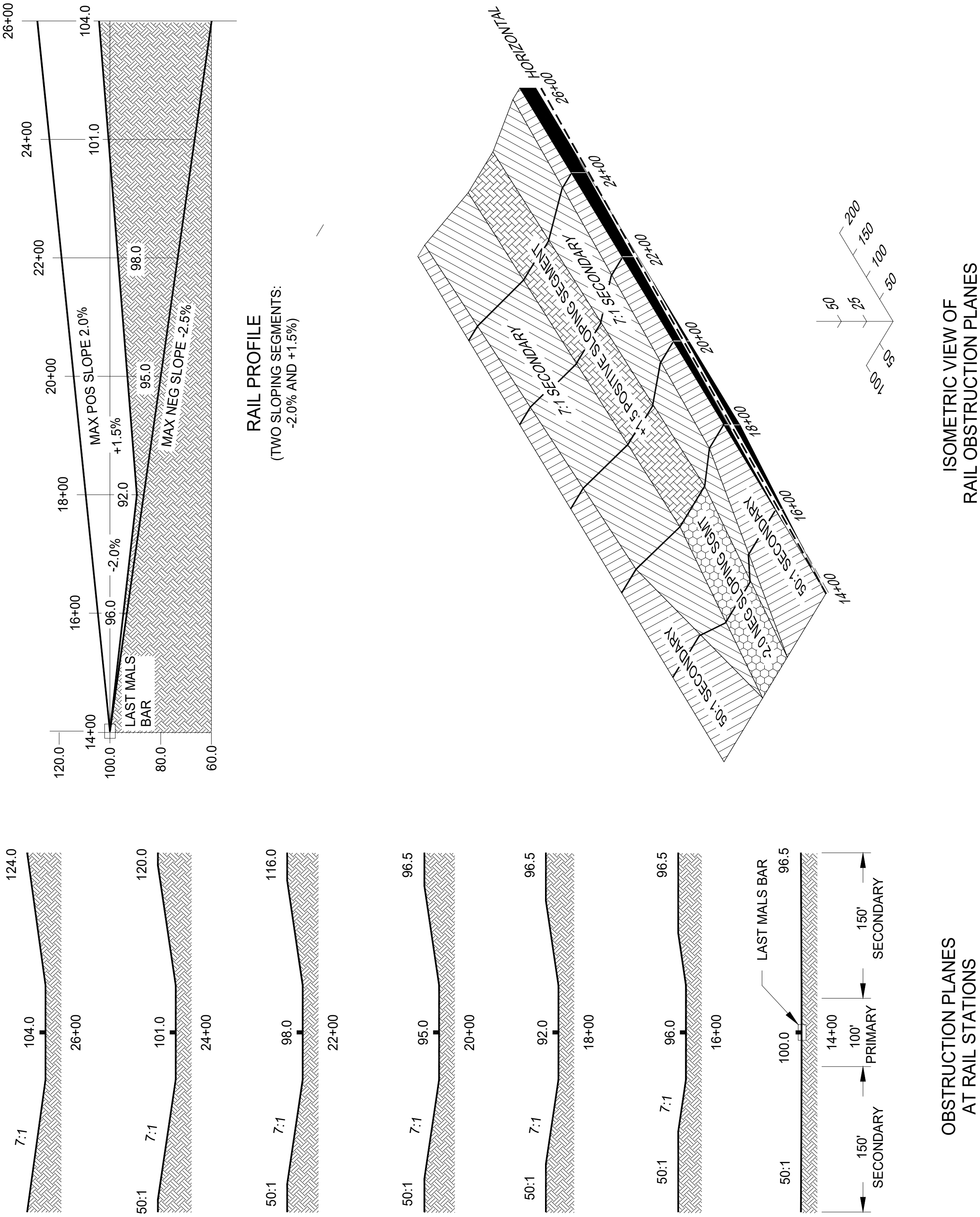


Figure 2-9. Typical RAIL Obstruction Clearance for Two Sloping Segments

c. Location and orientation.

(1) The position of light bars along the centerline may be adjusted, where necessary, to avoid roads, buildings, railroads, etc. Where a light bar must be displaced longitudinally from its normal position, the adjacent light bars should, where practicable, be displaced by appropriate amounts in order to maintain essentially equal longitudinal spacing.

(2) The threshold lights for the approach lighting system should be located as close to the landing threshold as possible but may, in order to avoid conflict with the existing runway lights, be displaced in front of the landing threshold a maximum distance of l0 feet. The threshold lights must not obstruct the existing runway lights or vice versa. The threshold lights may be installed to follow the transverse slope of the runway.

(3) Because of the physical arrangement and mounting problems associated with the sequenced flasher installed with steady-burning lights, the sequenced flasher light beam centers may be located up to a maximum distance of 4 feet below the approach light plane established by the beam centers of the steady-burning lights. The sequenced flasher light unit may be located a maximum distance of 5 feet along the ALS centerline into the approach from the steady-burning light bar.

(4) While the light support structures for light heights from 6 feet to 40 feet are normally sited to be lowered parallel to the ALS centerline, they may be aligned to be lowered at an angle to the ALS centerline to accommodate site-peculiar conditions.

d. Light station tolerances. The light station tolerances are as follows:

(l) Lateral (perpendicular to ALS centerline) - ± 3 inches.

(2) Distance between individual lights on a light bar - ± 1 inch.

(3) Mounting height.

(a) Up to 6 feet - ± 1 inch.

(b) Over 6 feet to 40 feet - ± 2 inches.

(c) Over 40 feet - ± 3 inches.

(4) All lights on a bar in a line perpendicular to the ALS centerline - ± 1 inch.

(5) Light unit vertical angular alignment - ± 1 degree.

(6) Light unit horizontal angular alignment - ± 5 degrees.

(7) Distance between stations:

(a) On 100 feet stationing, tolerance is 100 ± 10 feet.

(b) On 200 feet stationing, tolerance is 200 ± 20 feet.

(c) On 300 feet stationing, tolerance is 300 ± 30 feet.

(8) Longitudinal deviation from installation station designation (along ALS centerline) - ± 6 inches.

(9) ODALS threshold flashing lights must be installed at runway centerline threshold elevation, + 1 foot to - 5 feet.

e. System length. The system length must be 3,000 feet when the ILS glide slope is less than 2.75 degrees.

203. Use of various types of lights.

a. Semiflush lights. Semiflush lights must be used only in displaced threshold, overrun, and other paved operational surfaces.

b. Frangible lights. Frangible lights must be used at light bar stations having a ground level to approach light plane height of 6 feet or less.

c. Low-Impact Resistant lights. Low-impact resistant lights must be used at light bar stations having a ground level to approach light plane height greater than 6 feet but less than or equal to 40 feet.

d. Semifrangible lights. Semifrangible lights must be used at light bar stations having a ground level to approach light plane height greater than 40 feet.

e. Rigid lights. Rigid lights must not be installed in any new approach lighting systems.

204. Lighting fixtures and Isolation Transformers.

a. High intensity systems.

(1) Specification FAA-E-2408, 300-watt, 20A, PAR-56 lamps for steady-burning, aboveground, white lights with Specification FAA-E-982 PAR-56 Lampholder.

(2) Specification FAA-E-2408, 500-watt, 20A, PAR-56 lamps for steady-burning, aboveground, colored lights with Specification FAA-E-982 PAR-56 Lampholder.

(3) Specification FAA-E-2998, semiflush flasher light unit and interface and control unit for approach lighting systems.

(4) Specifications FAA-E-2952, approach lights, for ALSF semiflush lights.

(5) Specifications L-830-9 (AC 150/5345-47C), Isolation Transformers, 300-watt, 20A/20A, 60Hz.

(6) Specifications L-830-13 (AC 150/5345-47C), Isolation Transformers, 500-watt, 20A/20A, 60Hz.

(7) Specifications L-830-11, Isolation Transformers, 300-watt, 20A/6.6A, 60Hz.

(8) Specifications FAA-E-2690 Isolation Transformers, 1500-watt, 20A, 20A, 60Hz.

b. Medium intensity systems.

(1) PAR-38, 60-watt Halogen, 120V spot lamps or equal, for above ground steady burning lights (except threshold); ie: Amglo.

(2) Specification FAA-E-2998 semi-flush flasher light unit.

(3) 300-watt, 120V, PAR-56 lamps for steady-burning, above ground green lights for threshold with Specification FAA-E-982 PAR-56 Lampholder.

(4) Specification FAA-E-2968, steady burning, semi flush approach light units for the medium intensity approach lighting system with runway alignment indicator lights (MALSR), Style I and II.

(5) 180-watt, 120V/27.3V, Isolation Transformer per FAA-E-2803; ie: Amerace 180P120S27.3-01.

(6) 180-watt, 240V/27.3V, Isolation Transformers per FAA-E-2803-, ie: Amerace 180P240S27.3-01.

c. ODALS. Specification FAA-E-2651, Omnidirectional flashing light.

205. Control and monitoring requirements.

a. Control requirements. Remote control must be provided for all approach lighting systems defined in Paragraph 200. The remote control link may be either landlines or radio, except for ALSF-2. The ALSF-2 must have landline control as described in the FAA-E-2689, Dual Mode High Intensity Approach Light System. For ALS systems with both steady burners and sequenced flashers, the sequenced flashers must be on only when the steady-burning lights are on. Radio control requirements are contained in Appendix B and Advisory Circular AC 150/5345-49, Specification L-854, Radio Control Equipment.

b. Operational monitoring requirements. Monitoring is required on all brightness steps for all approach lighting systems that support Category II and III instrument approach procedures (ALSF-2 only). Monitoring is not required for Category I approach lighting systems. The monitoring equipment must provide an indication of whether power is being delivered to the lamps when the system is energized and any changes in the selected intensity brightness steps.

c. Remote maintenance monitoring requirements. Remote maintenance monitoring is required for maintenance purposes and is only required for new ALSF-2/SSALR installations. The ALSF-2/SSALR remote maintenance monitoring system must provide monitoring on all five brightness steps. Requirements for the ALSF-2/SSALR remote maintenance monitoring are contained in the FAA-E-2689, Dual Mode High Intensity Approach Light System.

206. Vertical alignment. All lights, except semiflush lights, must be aimed vertically. Semiflush lights have a preset vertical angle and do not require vertical aiming. All steady-burning lights in a bar must be aimed at the same vertical angle. All sequenced flashers must be aimed at 6 degrees in all circumstances.

a. ALSF-2 vertical alignment. The ALSF-2 steady-burning lights are vertically aligned using a Visual Segment-modified (VS-modified) method that establishes the alignment as listed in Table 2-1. The angular settings in Table 2-1 are empirically determined for a 3 degree glide slope. The angular settings in Table 2-1 provide for optimum use of the 12 degree vertical beam spread of the Q20A/PAR-56 approach light lamps and provides a smooth transition between the Category I and the Category II angular elevation settings.

b. MALS vertical alignment. The MALS steady-burning lights are vertically aligned using the Visual Segment-400 (VS-400) method that establishes the alignment as listed in Table 2-2. The angular settings in Table 2-2 are empirically determined for a 3 degree glide slope. The angular settings in Table 2-2 are established for the PAR-38 spot lamp.

c. Corrections for permissible deviations. The elevation angles of the steady-burning lights must be shifted by the amount that the glide slope is shifted from 3 degrees. The correction for vertical alignment due to displacement of lights above and below the horizontal plane through the threshold must be calculated using the equation shown in Figure 2-10. However, on the ALSF-2 the lamp elevation setting must not be greater than 9 degrees or less than 6 degrees. No correction of vertical alignment is necessary for light stations installed within the stationing tolerance listed in Paragraph 202d. (7). Add 0.1 degree to the angular siting of the light for each 200 feet the touchdown point is moved away from the threshold’s typical 1,000-foot touchdown point; subtract 0.1 degree when the touchdown point is moved 200 feet toward the threshold from the typical 1,000-foot touchdown point.

207. Horizontal alignment. All lights must be aligned with their beam axis parallel to the extended runway centerline.

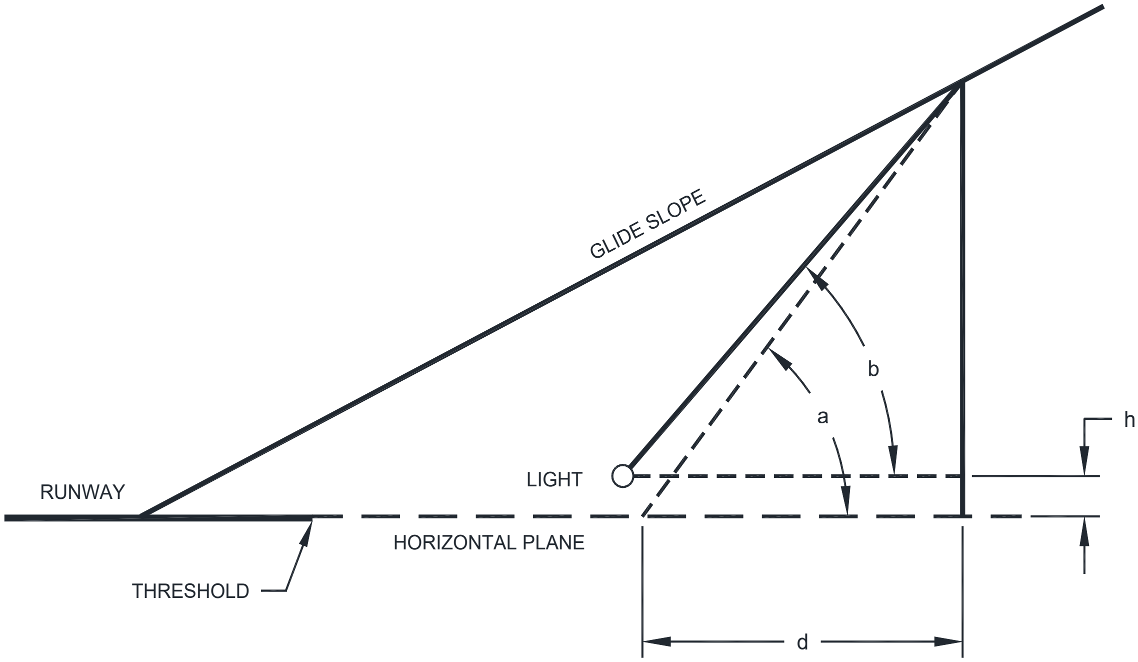
208. Penetration of approach surface. With the exception of the frangible lights at stations 0+00, 1+00, and 2+00, no other component of an approach lighting system may penetrate the precision, APV or nonprecision approach surface (detailed for civil use in TERPS).

Table 2-1. Elevation-Setting Angles for Q20A/PAR56 Approach Light Lamps (ALSF-2)

Station	Setting Angle (Degrees)	Station	Setting Angle (Degrees)
3000	8.0	1400	7.0
2900	7.9	1300	6.9
2800	7.9	1200	6.9
2700	7.8	1100	6.8
2600	7.7	1000	6.7
2500	7.7	900	6.7
2400	7.6	800	6.6
2300	7.6	700	6.5
2200	7.5	600	6.5
2100	7.4	500	6.4
2000	7.4	400	6.3
1900	7.3	300	6.3
1800	7.2	200	6.2
1700	7.2	100	6.2
1600	7.1	0	6.1
1500	7.0		

Table 2-2. Elevation-Setting Angles for 150PAR38/SP Approach Light Lamps (MALS)

Station	Setting Angle (Degrees)
0	3.1
200	3.2
400	3.3
600	3.4
800	3.4
1000	3.5
1200	3.6
1400	3.7



LIGHT ABOVE THE HORIZONTAL PLANE b = a - Arctan (h/d)

LIGHT BELOW THE HORIZONTAL PLANE b = a + Arctan (h/d)

LEGEND

a: THE ELEVATION SETTING ANGLE FOR THE PARTICULAR STATION TAKEN FROM TABLE 2-1 FOR ALSF-2 AND TABLE 2-2 FOR MALS.

b: CORRECTED ELEVATION SETTING ANGLE.

d: DESIGNATED DISTANCE: BEING 4732 FEET FOR MALS AND 1246 FEET FOR ALSF-2.

h: HEIGHT OF THE LIGHT ABOVE THE HORIZONTAL PLANE PASSING THROUGH THE THRESHOLD.

NOTE:

FOR ALSF-2 THE ANGLE b MUST BE ALWAYS 6° OR MORE AND 9° OR LESS.

Figure 2-10. Correction for Elevation-Setting Angle for Approach Lights Displaced from the Horizontal Plane Passing Through the Threshold

209. Miscellaneous provisions.

a. Location of power equipment. No part of the ALS substation or power control stations must be located closer than 400 feet from the ALS centerline. The location must also be such that cable and trenching costs are held to a minimum provided the location chosen minimizes disturbance to the ILS radiated signal and does not constitute an obstruction as defined in the Federal Aviation Regulations. The MALS, MALSF, MALSR, and ODALS power and control equipment are permitted to be installed indoors (1) where a shelter is included in the project or (2) where space is available in an adjacent facility and installation can be made without interference with maintenance and without impacting space intended for future facility expansion.

b. Access. A suitable access road, footpath, or catwalk must be provided for servicing all component parts of an approach lighting system. To prevent vehicles from depositing rocks and dirt (Foreign Object Debris (FOD)) onto the runways or taxiways, up to 300 feet of paved surface must be provided. Access roads, where required, must meet the minimum requirements of the latest edition of Order 6940.1, Access Roads to FAA Facilities. Catwalks should be employed only when the individual supports exceed 100 feet in height or when the area through which the approach lighting system passes is completely inaccessible to foot or vehicular traffic. Refer to the latest edition AC-150/5300-13, Airport Design, for additional access road requirements.

c. Pier or other rigid structure installation. Where an approach lighting system is installed on a pier or other rigid structure, a minimum of 20 feet must be provided between the light plane and the rigid structure. In order to maintain the 20-foot separation, lights must conform to Paragraph 203c, Low-Impact Resistant Lights. When the 20-foot separation between the light plane and the pier or rigid structure cannot be maintained, a NAS Change Proposal (NCP) is required.

210. Brightness steps. The number of brightness steps and approximate relative intensities for each system is shown in Table 2-3.

211. Displaced threshold lighting. When approach lighting systems are installed in a displaced threshold area having centerline lighting, the control of the two separate systems must conform to the latest edition of Advisory Circular AC 150/5340-30, Design and Installation Details for Airport Visual Aids, Installation Details for Runway Centerline and Touchdown Zone Lighting Systems.

212. Floodplain Low-Impact Resistant (LIR) installation. See Appendix D.

Table 2-3. Brightness Steps

	Steady-Burning Lights		Elevated Flashing Lights	
System	No. Steps	% Relative Intensity	No. Steps	% Relative Intensity
ALSF-2	5	100, 20, 4, 0.8, 0.16[a]	3	100, 20, 2.3
MALS	3	100, 20, 4	3	100, 10, 2.3
MALSF	3	100, 20, 4	3	100, 10, 2.3
MALSR	3	100, 20, 4	3	100, 10, 2.3
ODALS	-	-	3	100, 30, 1.4

a. The ALSF-2 has a subsystem SSALR, and both configurations have five brightness steps. On steady-burning light intensity steps four and five, the flashers are on high intensity. On steady-burning light intensity step three, the flashers are on medium intensity. On steady-burning light intensity steps two and one, the flashers are on low intensity.

Chapter 3. Reserved

Chapter 4. Installation Criteria - Runway End Identifier Lights (REIL)

400. Description. Runway End Identifier Lights (REIL) consist of two synchronized flashing lights located near the runway threshold to provide rapid and positive identification of the approach end of a runway. The typical location of the lights is as shown in Figure 4-1.

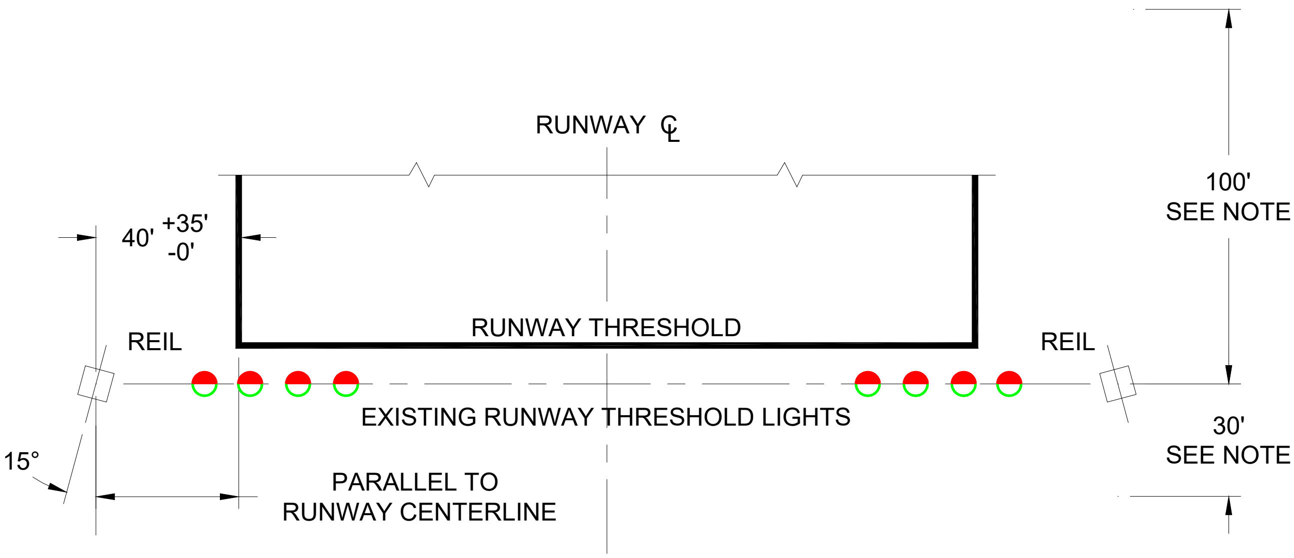
401. Location of light units. The light units must be located as shown in Figure 4-1. The optimum location is 40 feet from the runway edge and in line with the existing runway threshold lights. The light units may be located laterally up to 75 feet from the runway edge and longitudinally 30 feet downwind and 100 feet upwind from the line of threshold lights. These location tolerances must be employed to keep the light units a minimum distance of 40 feet from other runways or taxiways. The light units must be located as nearly equidistant from the runway centerline as practicable with the difference in the distance of the two lights to the centerline not exceeding 10 feet. The elevation of both units must be within 3 feet of a horizontal plane through the runway centerline. Both light units must be within 10 feet of a line perpendicular to the runway centerline. When a REIL is installed on the same runway as a VASI, the REIL light units must be located 75 feet from the runway edge (this is not applicable for PAPI).

402. Orientation of light units.

a. Unidirectional systems. The light units must be aimed at an angle of 10 degrees vertically and toed out (directed outward from a line parallel to the runway centerline) 15 degrees. Baffles should not be used unless warranted by user complaints of blinding effects, flight inspection findings, and/or environmental impact. In these cases, baffles may be installed as a system option without the necessity for waiver action.

b. Omnidirectional systems. The light units are aligned when light units are plumb.

c. Deviations. The aiming criteria as specified may not provide satisfactory results at some locations and readjustment of either or both the vertical and toed out angles may be required. In such instances, a deviation request must be submitted in accordance with Chapter 1, Section 1, paragraph 7.



NOTE:

LIGHTS MAY BE PLACED 30 FEET DOWNWIND AND 100 FEET UPWIND OF THE RUNWAY THRESHOLD LIGHTS. THESE LOCATION TOLERANCES KEEP THE REIL A MINIMUM OF 40 FEET FROM A RUNWAY OR TAXIWAY.

SYMBOL:

STEADY BURNING LIGHT, RED

STEADY BURNING LIGHT, GREEN

Figure 4-1. REIL Configuration

404. Power source. The power source for the REIL is site specific and may be determine during a site survey.

405. Control. The REIL must be remote controlled or indirectly controlled through activation of the runway edge lighting circuit.

a. Control from runway edge lighting circuit. Control is accomplished by sensing the existing runway edge lighting circuit. Due to safety concerns, a separate alternating current (AC) disconnect switch at the REIL control cabinet rack must be used to allow lock out/tag out of the runway edge lighting circuit (see National Installation Drawings for details). The REIL system runway lighting circuit sensors will change the REIL system intensity in conjunction with the runway edge lighting intensity as follows:

Lighting System	No. of Intensity Steps	Status During Non-Use Period	Intensity Step		
LIRL	1	Off or On	On	N/A	N/A
MIRL	3	Off or Low	Low	Medium	High
HIRL	5	Off or Low	Step 1 or 2	Step 3	Step 4/5
REIL	3	Off or Low	Low	Medium	High

b. Control from remote location. Remote control, where provided, must be by landlines or radio control. Radio control must meet the requirements of Appendix B.

406. Power and Control Assembly (PCA). The PCA is a separate unit which receives input power to be distributed to the REIL individual light units. The PCA must be located outside the RSA and ROFA. Where NAVAID operational performance is adversely affected by equipment installations, contact the local FAA airports district office (ADO) or Regional Office (RO) for information pertaining to the RSA and ROFA standards.

407. Monitoring. There are no operational or maintenance monitoring requirements for the REIL. It is not required that both lights automatically shut off in the event of failure of one light.
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Chapter 5. Installation Criteria – Precision Approach Path Indicator (PAPI) System

500. Description.

a. The Precision Approach Path Indicator (PAPI) System, when properly installed and oriented, will furnish the pilot with visual approach slope information to provide guidance for a safe descent. The system is intended primarily for use during visual flight rule (VFR) weather conditions. It also provides a benefit on instrument approaches when transitioning from the instrument segment to the visual segment. The PAPI can be installed with remote on and off control. Two light intensity settings, day and night, are provided and are photoelectrically controlled.

b. The basic PAPI configuration is described in Chapter 1, Section 2, Paragraph 19, and is shown in Figure 5-1. All LHAs should be located on the left side of the runway, as viewed from the approach direction. However, where terrain and identified obstructions, cross runways, or taxiways make this arrangement impractical, the light units may be located on the right side of the runway.

c. The PAPI system provides a definite white and red light projection pattern along the desired descent path to the touchdown point. The LHAs are arranged on a single bar on a line perpendicular to the runway centerline. Figure 5-2 shows the pilot's view of the PAPI for various positions on the glide path including the different PAPI color patterns. Figure 5-3 shows the corresponding glide path angles.

501. General siting considerations. The PAPI must be sited and aimed so that it defines an approach path with adequate clearance over obstacles and a minimum threshold crossing height (TCH). If the runway has a published instrument approach procedure with a glide path angle (GPA) (e.g. ILS or LPV) or a nonprecision approach (e.g. VOR or LNAV) with a published vertical descent angle (VDA), the PAPI is installed as described in Paragraph 502 so the visual glide path angle and TCH coincide with the published GPA/VDA and TCH of the instrument approach procedure. If there is no published instrument approach procedure with a GPA/VDA to the runway, the PAPI glide path angle and TCH is chosen as described in Paragraph 503. Aiming of the LHAs is described in Paragraph 505. Other siting tolerances and considerations which are common to all PAPI installations are described in Paragraph 506.

502. Siting PAPI on a runway with a published Instrument Approach Procedures with a GPA/VDA. When siting the PAPI on a runway with a published GPA/VDA, the PAPI visual approach path and TCH should coincide, as much as possible, with the GPA/VDA. To accomplish this, the PAPI angle is chosen to match the GPA/VDA (if the angle needed to clear the PAPI OCS is greater than that of the GPA/VDA, discuss with the Flight Procedures Team to see if the GPA/VDA can be adjusted to match the PAPI angle). The PAPI TCH is selected by siting the PAPI the same distance from the threshold as the virtual source of the instrument approach procedure GPA/VDA, within a tolerance of ±30 feet (±10 m). The procedure must be modified for runways that serve aircraft in height group 4 (see Table 5-1) due to the distance (difference) between the pilot's eye and the determined point of emanation. For these locations, the distance of the PAPI from the threshold must equal the distance to the GPA/VDA source, plus an additional 300 feet +50, -0 (90 m +15,-0). Where the GPA/VDA is not standard, the PAPI must be coincident with that non-standard glide path. Where multiple instrument approach procedures exist for the runway, the precision approach should be selected first for coincidence.

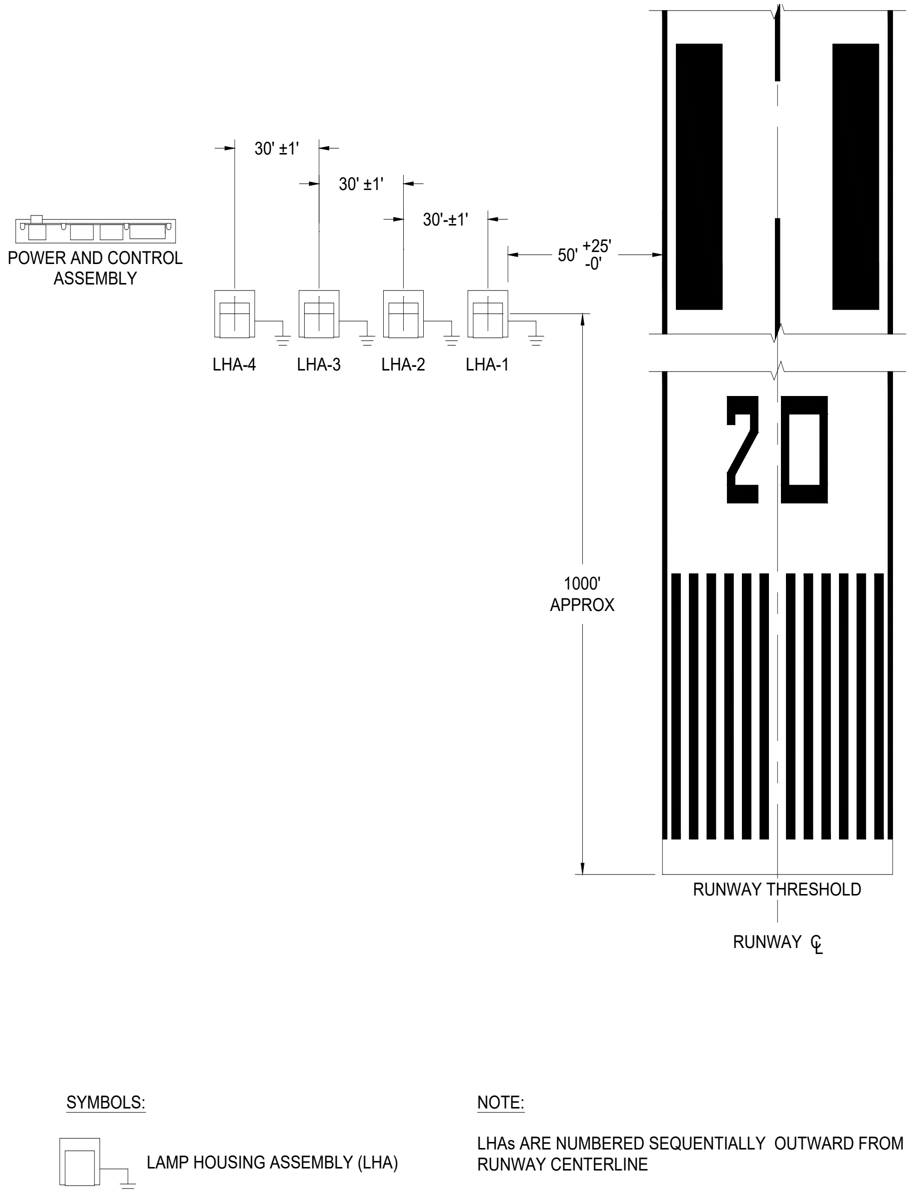
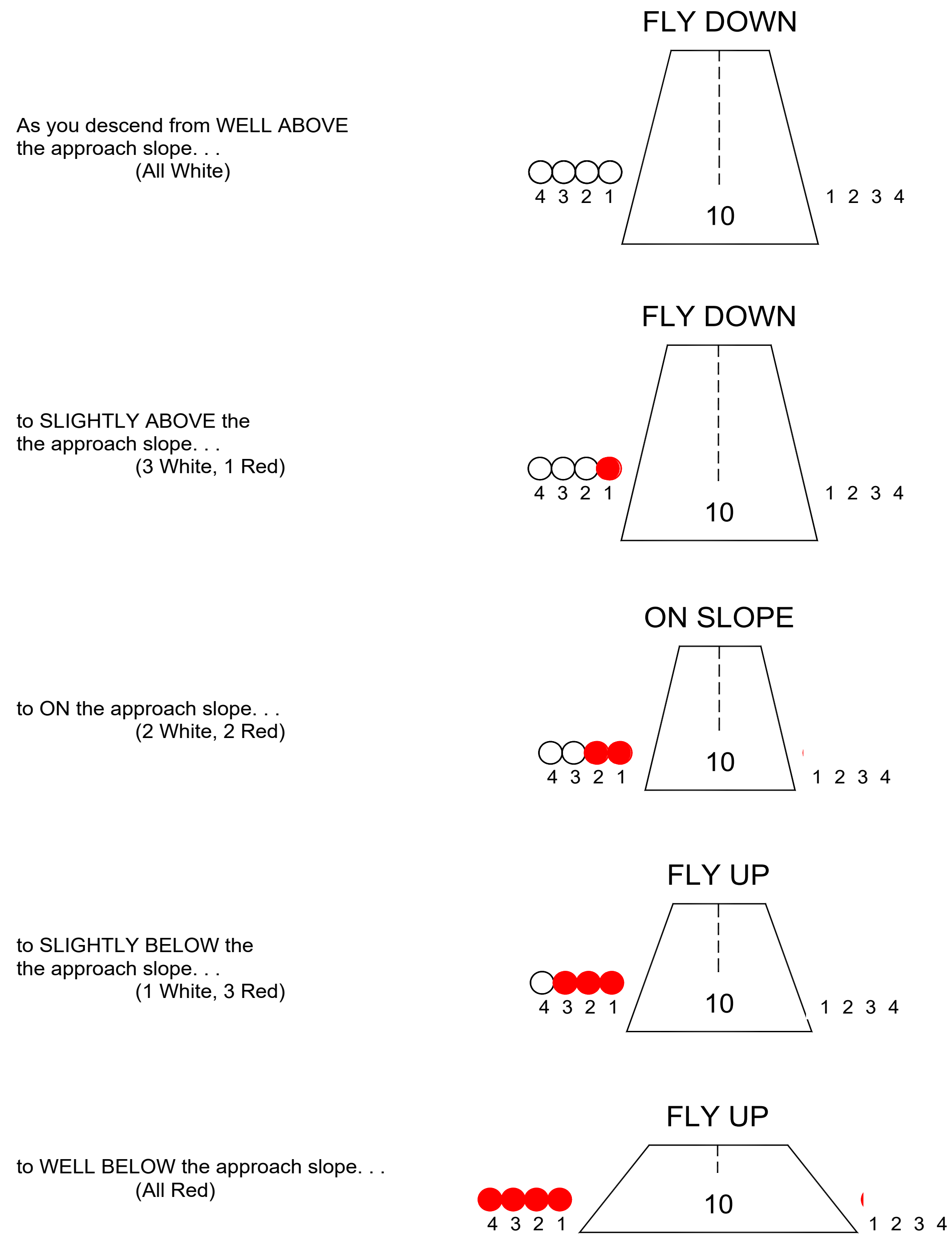


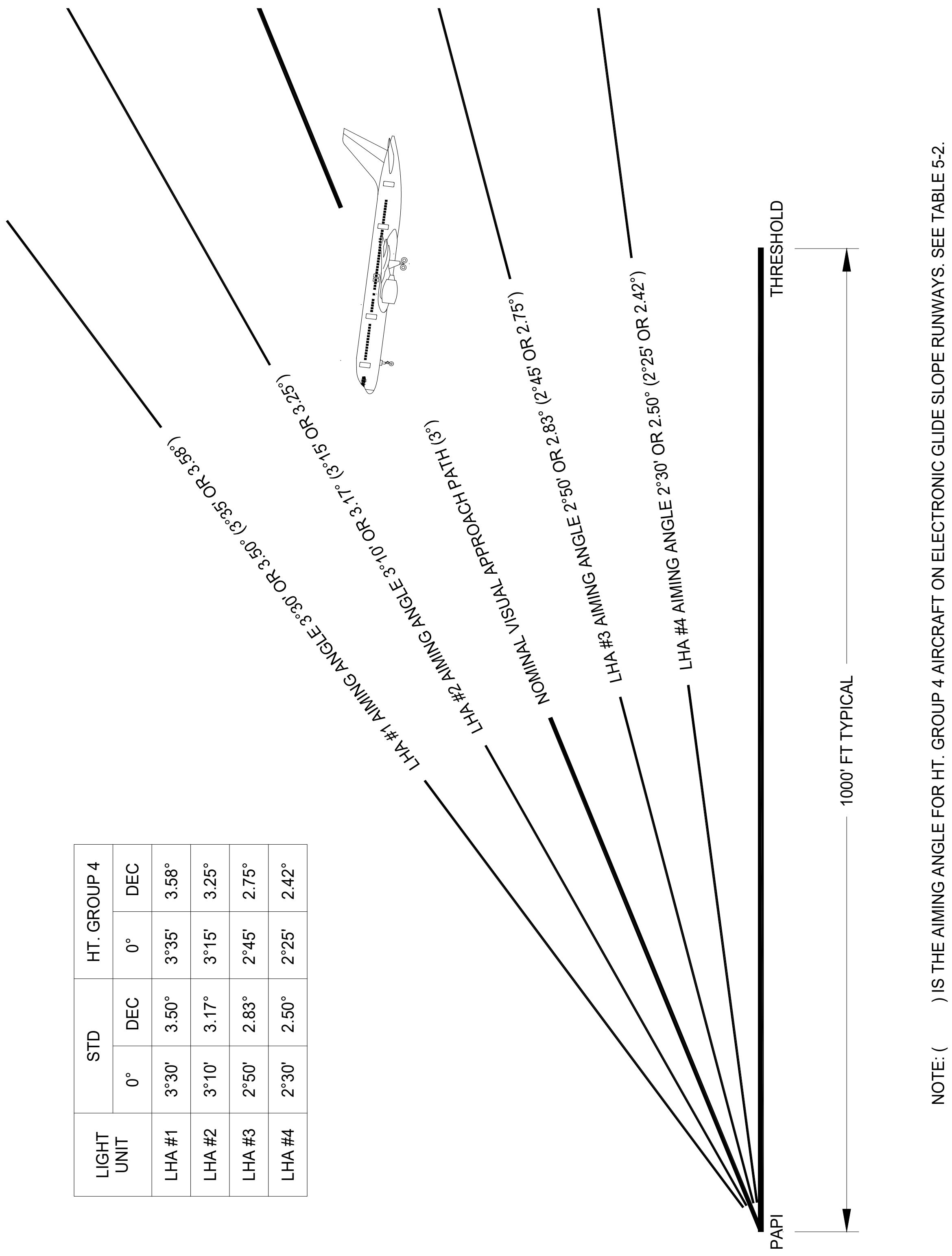
Figure 5-1. PAPI System Configuration



Note:
There is a progressive change from all white to all red lights. Normal installation is on the left side of the runway, unless it is physically impracticable to do so.

Note:
There is a progressive change from all white to all red lights. Normal installation is left side only, may be both sides or right side only.

Figure 5-2. PAPI Visual Cues



LIGHT UNIT	STD		HT. GROUP 4	
	0°	DEC	0°	DEC
LHA #1	3°30'	3.50°	3°35'	3.58°
LHA #2	3°10'	3.17°	3°15'	3.25°
LHA #3	2°50'	2.83°	2°45'	2.75°
LHA #4	2°30'	2.50°	2°25'	2.42°

Figure 5-3. PAPI Approach Path (Side View)

503. Siting PAPI on a runway without a published GPA/VDA. When a GPA/VDA is not published, determine a position and aiming angle for the PAPI that will produce the required threshold crossing height and clearance over obstacles in the approach area.

a. Threshold Crossing Height (TCH). The TCH is the height of the lowest on-course signal at a point directly above the intersection of the runway centerline and the threshold. The minimum/maximum allowable TCH varies according to the height group of aircraft that use the runway, and is shown in Table 5-1. The PAPI approach path must provide the proper TCH for the largest aircraft height group that uses the runway. If Table 5-1 is applied to a PAPI on a runway with an instrument approach procedure with vertical guidance, calculate the PAPI TCH using the angle of the lowest on-course signal, and not the glide path angle. To verify the appropriate aircraft height group for PAPI design, refer to the latest edition of AC 150/5300-13 Airport Design, for Aircraft Characteristics, which include Airplane Design Group (ADG)

Table 5-1. Visual Threshold Crossing Heights

Representative Aircraft Type	Approximate Cockpit-To-Wheel Height	Visual Threshold Crossing Height	Remarks
<u>Height group 1</u> General aviation small commuters corporate turbojets	10 feet or less	40 feet +5, -20 12 meters +2, -6	Many runways less than 6,000 feet long with reduced widths and/or restricted weight bearing, which would normally prohibit landings by larger aircraft.
<u>Height group 2</u> B-737, DC-9, C-130	15 feet	45 feet +5, -20 14 meters +2, -6	Regional airport with limited air carrier service.
<u>Height group 3</u> B-727/757, C-135, A-318/A-320/A-321	20 feet	50 feet +5, -15 15 meters +2, -4	Primary runways not normally used by aircraft with ILS glide path-to-wheel heights exceeding 20 feet.
<u>Height group 4</u> B-747/767/777, DC-10, A-300, A-310/A-330/A-340/A-350/A-380,	Over 25 feet	75 feet +5, -15 22 meters +2, -4	Most primary runways at major airports.

b. Glide Path Angle. The visual glide path angle is the center of the on-course zone, and is normally 3 degrees when measured from the horizontal. For utility runways without jet aircraft operations, the glide path angle may be greater than 3 degrees but not more than 4.2 degrees for proper threshold clearance height and obstacle clearance requirements.

504. The PAPI Obstacle Clearance Surface. The PAPI obstacle clearance surface (OCS) is established to provide the pilot with a minimum clearance over obstacles during approach. The PAPI must be positioned and aimed so that no obstacles penetrate this surface. The latest version of FAA Order 8200.1, United States Standard Flight Inspection Manual, contains information on how the PAPI system flight check will be performed. Additionally, FAA Engineering Brief No. 95, Additional Siting and Survey considerations for PAPI and other VGSI, which can be accessed via https://www.faa.gov/airports/engineering/engineering_briefs/, now includes requirements for additional obstacle penetration mitigation past ±10 degrees on either side of the runway centerline. The airport Design Engineer is strongly encouraged to thoroughly understand both documents before determining the final installation placement of the PAPI on the airport. A thorough understanding of both documents will help ensure a problem-free flight check. The OCS begins on the runway centerline 300 feet (90 m) in front of the PAPI system and proceeds outward into the approach zone at an angle 1 degree less than the aiming angle of the third LHA from the runway. For a 3 degree glide path with 20 minutes separation between LHAs, the third LHA from the runway would be aimed at 2 degrees, 50 minutes elevation. The surface extends 10 degrees on either side of the runway centerline, and extends outward from the threshold for 3.4 nautical miles (4 statute miles). The OCS is shown graphically in Figure 5-4.

a. Obstacle penetrations that cannot be removed. If a site survey determines that there is an obstacle that penetrates the OCS that cannot be removed, then the PAPI installation must be modified in a way to either change the effective visual coverage of the PAPI to avoid the penetration, or if that is not practical, restrict the usable distance of the PAPI. There are many factors to take into account when modifying the PAPI installation. These include path angle versus aircraft and instrument approach procedure limits, TCH vs. runway length, and whether the supported instrument approach procedure is straight-in or offset. Coordinate with the Flight Procedures and Airspace Group to ensure there are no conflicts with instrument procedures and planned information publication. Strategies for eliminating the penetration include:

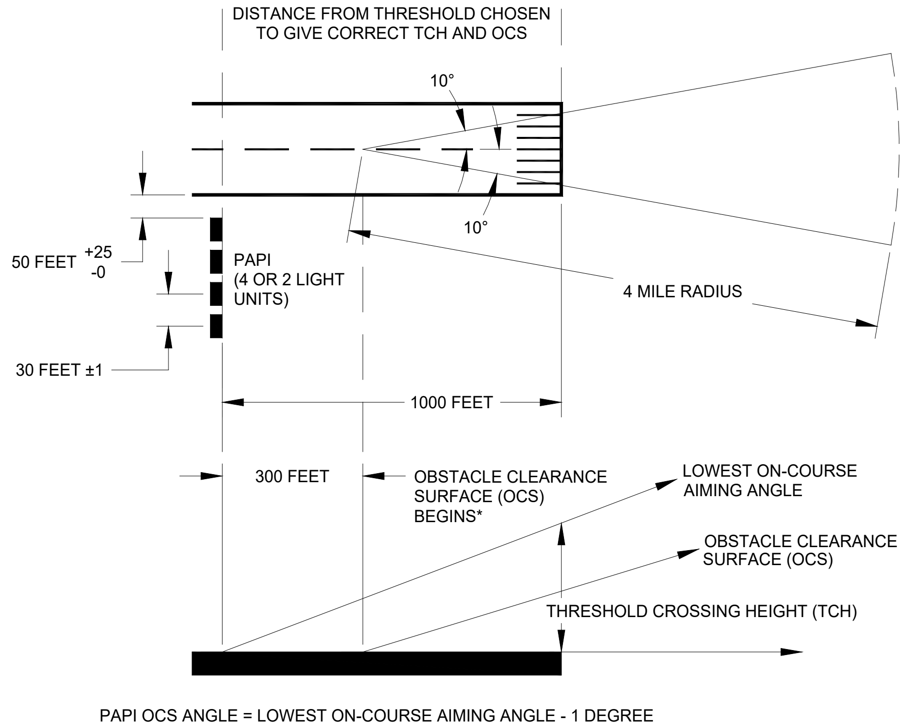
(1) Raise the glide path angle;

(2) Move the PAPI system farther from the threshold or to the other side of the runway;

(3) Rotate the PAPI or;

(4) Install baffles (sometimes called blanking device) to reduce the PAPI light signal angular coverage.

When these mitigation efforts reduce the size of the standard OCS area either in width or distance, the appropriate notifications must be implemented, including providing notification via Notice to Airmen (NOTAM) until the restrictive information is reflected in the Chart Supplement.



NOTES:

1. THE VISUAL GLIDE PATH ANGLE IS THE CENTER OF THE ON-COURSE ZONE, AND IS A NOMINAL 3 DEGREES WHEN MEASURED FROM THE HORIZONTAL SURFACE OF THE RUNWAY.
   A. FOR NON-JET RUNWAYS, THE GLIDE PATH MAY BE RAISED TO 4.2 DEGREES MAXIMUM TO PROVIDE OBSTACLE CLEARANCE.
   B. IF THE PAPI GLIDE PATH IS CHANGED TO A HIGHER ANGLE FROM THE NOMINAL 3 DEGREES, IT MUST BE COMMUNICATED IN A NOTICE TO AIRMAN (NOTAM) AND PUBLISHED IN THE AIRPORT FACILITY DIRECTORY.
2. PAPI OBSTACLE CLEARANCE SURFACE (OCS).
   A. THE PAPI OCS PROVIDES THE PILOT WITH A MINIMUM APPROACH CLEARANCE.
   B. THE PAPI MUST BE POSITIONED AND AIMED SO NO OBSTACLES PENETRATE ITS SURFACE.
   (1) THE OCS BEGINS 300 FEET [90M] IN FRONT OF THE PAPI SYSTEM.
   (2) THE OCS IS PROJECTED INTO THE APPROACH ZONE ONE DEGREE LESS THAN AIMING ANGLE OF THE THIRD LIGHT UNIT FROM THE RUNWAY FOR AN L-880 SYSTEM, OR THE OUTSIDE LIGHT UNIT FOR AN L-881 SYSTEM.

Figure 5-4. PAPI Obstacle Clearance Surface

b. Considerations for where a usable PAPI light signal is visible. An incandescent PAPI system's light signal can often be seen by pilots ±14 degrees on either side of the runway centerline, while LED PAPI systems will only emit light at ±10.5 degrees on either side of the runway centerline. Incandescent PAPIs may require mitigation for obstacle penetrations that are within ±14 degrees on either side of the runway centerline. Consider nearby trees and terrain when deciding which side of the runway to locate the PAPI. Prior to the threshold, Flight Inspection looks for any obstacle penetrations of the OCS area anywhere within the effective visual coverage of the PAPI (where all LHAs are visible), even beyond 10 degrees on either side of the runway centerline. If the penetration is outside the 10 degree OCS area, but deemed a hazard to aircraft by Flight Inspection, the penetration must be dealt with in the same manner as a penetration of the OCS within 10 degrees of runway centerline. An object upwind of the threshold on either side of the runway is not a hazard. However if it blocks the visibility of any of the PAPI LHAs at or above the angle of the lowest aimed LHA, it will result in a restriction in azimuth and may make the PAPI unusable. See FAA Engineering Brief No. 95 for greater detail on siting and survey considerations for the PAPI.

c. Procedures for mitigating obstacle penetration. If a site survey or flight inspection determines that there is an obstacle that penetrates the OCS area, including areas beyond the ±10 degrees of the standard OCS, but within an area where a usable light signal can be expected (as much as ±14 degrees for an incandescent PAPI), then the following procedures must be used to mitigate the obstacle intrusion:

Step one: Remove/adjust obstacle. Remove/adjust the obstacle; if the obstacle cannot be removed proceed to **Step two**.

Step two: Mitigate the obstacle. Mitigate the obstacle by using the following methods:

1. Locate PAPI to the other side of the runway;

2. Raise the design path angle for the PAPI (not to exceed 4.2 degrees) and/or;

3. Move the PAPI system upwind, shifting and effectively raising the OCS (taking limits on TCH into consideration) or;

4. If the efforts in **Step two** do not solve the problem or are not practical, continue to **Step three**.

Step three: Rotation. Consider rotating the PAPI Lamp Housing Assemblies, up to 8 degrees (left or right) so coverage is cutoff at least 2 degrees inside (safety margin) where the obstacle is located. See **Step four**.

Step four: Baffling. Baffling is an option when the offending obstacle is not too close to the runway centerline. The baffling should cut off the light signal at least 2 degrees from the penetrating obstacle as a safety margin. However, PAPI use should be maintained on the runway centerline. Baffling is not a good option when the penetration is closer than 4 degrees on either side of the runway centerline, which theoretically would allow a 2-degree buffer for the obstacle and still maintain 2 degrees of coverage near centerline. The limit on how close the obstacle can be to centerline and still be a candidate for baffling increases to 7 degrees for LED PAPI installations. This is because internal light sensors in the LED PAPI will turn the lights off, if baffling is used to reduce light to less than 5 degrees either side of centerline. When the offending obstacle is a suitable candidate for baffling:

1. Baffle the lights so coverage is cutoff at least 2 degrees inside where the obstacle is located. This action must not reduce the coverage on either side of runway centerline to fewer than 2 degrees (5 degrees for LED PAPI).

2. Additionally, consider baffling and rotating (up to 8 degrees) the PAPI light so that there is no light signal visible within 2 degrees of the offending obstacle.

Note: Contact the following FAA elements to arrange for PAPI baffling: FAA Engineering Services (ES), FAA Program Office and the FAA Technical Center.

Step five: Issue restrictive distance warning. By arriving at **Step five**, it means there is an obstacle penetration of the PAPI OCS plane or within the effective visual coverage of the PAPI that cannot be mitigated by PAPI movement, rotation or baffling.

1. If the offending obstacle is at least 1.8 NM from the runway threshold, then publish a restricted usable distance that provides a safety buffer of at least 0.5 NM inside the obstacle penetration location. At a minimum, users must be notified of the restriction with an entry in the Chart Supplement following an initial NOTAM. For example, "RWY XX PAPI does not provide obstruction clearance beyond 1.3 NM from threshold."

2. If the offending obstacle is less than 1.8 NM from the runway threshold then a PAPI service should not be established.

Note: Coordinate with the Flight Procedures and Airspace Group to ensure there are no conflicts with instrument procedures and planned information publication.

Step six: No PAPI service. If none of the mitigation steps will resolve the PAPI OCS or effective visual coverage penetration, a PAPI service should not be established.

d. Flight Inspection scheduling. When scheduling a FAA Flight Inspection, the following basic information must be provided to the flight inspection dispatcher with instruction to relay this information to the flight inspection pilots:

1 Any obstacle penetration

a. Left or right side of the approach to the runway (pilot's point-of-view);

b. The obstacle penetration's distance from the runway threshold (in nautical miles);

c. Obstacle penetration information (e.g., type of obstacle, elevation, etc.);

d. Angle of the obstacle penetration from the runway centerline.

2 Any use of Baffles

a. Baffles used or not;

b. Angle of the baffles (expected reduction in coverage).

Example: Runway 18, left side of the approach, 3 nautical miles, terrain obstruction penetrates at 8 degrees at 2450 ft. Baffles installed to remove coverage beyond 4 degrees left of centerline.

505. Aiming. After the visual glide path angle has been selected, the PAPI LHAs are aimed to define that path. The standard aiming angles for the PAPI system are shown in Table 5-2.

Table 5-2. Aiming PAPI Relative to a Preselected Glide Path

Light Unit	Aiming Angle (in minutes of arc)	
	Standard Installation	Height Group 4 Aircraft on Runway with a Published Glide Path/Descent Angle
Unit nearest runway	30’ above glide path	35’ above glide path
Next adjacent unit	10’ above glide path	15’ above glide path
Next adjacent unit	10’ below glide path	15’ below glide path
Next adjacent unit	30’ below glide path	35’ below glide path

506. Other siting dimensions and tolerances.

a. Distance from runway edge. Locate the inboard LHA 50 feet, +25,-0 from the runway edge where it is less likely that damage to the LHA will occur due to jet blast and wing tip vortices. Locate the inboard LHA 50 feet, +10,-20 from the runway edge for runways used by non-jet aircraft. NOTE: If a wider runway is narrowed, the existing PAPI may remain operational until it is relocated along with the runway edge lights.

b. Separation between LHAs. The PAPI LHAs must have a lateral separation of 30 feet (9 m). The distance between LHAs must vary no more than ±1 foot (0.3 m). The PAPI LHAs may have a lateral separation of 20 feet ± 1 foot for small general aviation runways (runway widths of 75 feet or less).

c. Azimuthal aiming. Each LHA must be aimed outward into the approach zone on a line parallel to the runway centerline within a tolerance of ± ½ degree, unless the LHAs are being angled to mitigate OCS penetrations. Some locations with offset approaches may find it beneficial to add a second set of PAPIs so one set is rotated to align with the approach (e.g., rotated 20 degrees), while the other set remains aligned with the runway.

d. Mounting height tolerances. The beam centers of all LHAs must be within ±1 inch of a horizontal plane. This horizontal plane must be within ±1 foot (0.3 m) of the elevation of the runway centerline at the intercept point of the visual glide path with the runway. At locations where snow is likely to obscure the light beams, the LHAs may be installed so the top of the unit is a maximum of 6 feet (3m) above ground level. This may require locating the LHAs farther from the runway edge to ensure adequate clearance for the most critical aircraft. Since raising the LHAs also raises the threshold crossing height for the visual glide path, the lights may also have to be relocated closer to the threshold to remain within specified tolerances.

e. Tolerance along line perpendicular to Runway. The front face of each LHA bar must be located on a line perpendicular to the runway centerline within ±6 inches (unless rotated to mitigate an obstacle penetration). If the LHAs have been rotated to mitigate an obstacle penetration, a consistent reference point on the front of the LHAs may be used to determine perpendicularity to the runway centerline.

f. Correction for runway longitudinal gradient. On runways where there is a difference in elevation between the runway threshold and the runway elevation at the PAPI, the location of the LHAs may need to be adjusted with respect to the threshold in order to meet the required obstacle clearance and TCH. Where such a condition exists, the following steps (shown in Figure 5-5) are taken to compute the change in the distance from the threshold required to preserve the proper geometry.

(1) Obtain the runway longitudinal gradient. This can be done by survey or obtained from As-Built drawings or airport obstruction charts.

(2) Determine the ideal (zero gradient) distance from the threshold in accordance with the instructions above.

(3) Assume a level reference plane at the runway threshold elevation. Plot the location determined in Paragraph 506 f (2) above.

(4) Plot the runway longitudinal gradient (RWY).

(5) Project the visual glide path angle to its intersection with the runway longitudinal gradient (RWY). Then solve for the adjusted distance from threshold (dimension d on Figure 5-5) either mathematically or graphically.

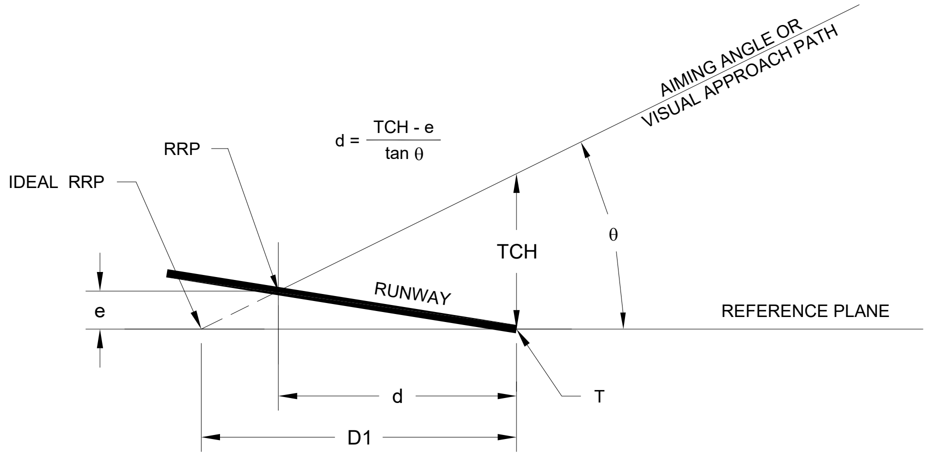
(6) Double check to see that the calculated location gives the desired threshold crossing height.

g. Other siting considerations.

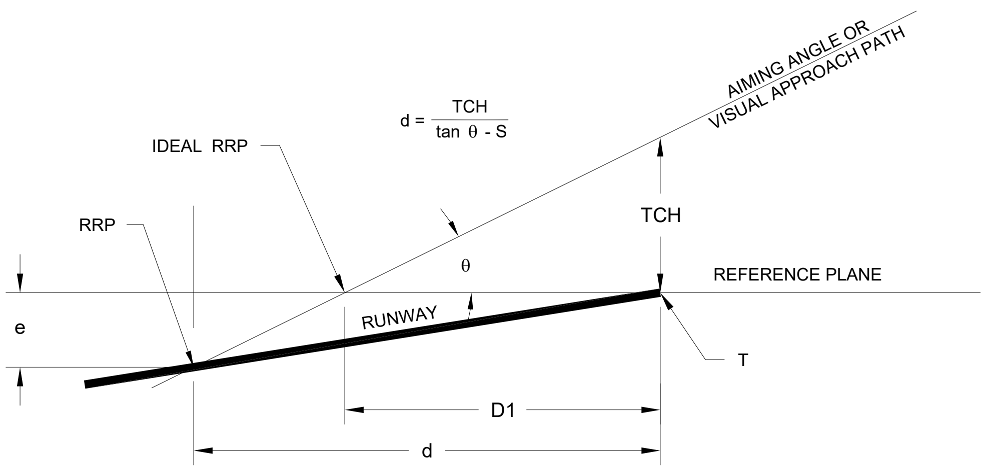
(1) Where the terrain drops off rapidly near the approach threshold and severe turbulence is experienced, the PAPI should be located farther from the threshold to keep the aircraft at the maximum possible threshold crossing height.

(2) On short runways, the PAPI should be as near the threshold as possible to provide the maximum amount of runway for braking after landing.

(3) The inboard LHA must not be located closer than 50 feet from a cross runway edge, taxiway edge, or warm-up apron edge. When it is proposed to locate LHAs within an ILS localizer or glide slope critical area, comply with the latest edition of FAA Order 6750.16, Siting Criteria for Instrument Landing Systems, Paragraph 16b(1) Evaluation of Permanent Objects.



a. siting station displaced toward threshold



b. siting station displaced from threshold

SYMBOLS:

D1 = ideal (zero gradient) distance from threshold

RWY = runway longitudinal gradient

TCH = threshold crossing height

T = threshold

e = elevation difference between threshold and RRP

RRP = runway reference point (where aiming angle or visual approach path intersects runway profile)

d = adjusted distance form threshold

θ = aiming angle

S = percent slope of runway = e/d

Figure 5-5. Correction for Runway Longitudinal Gradient

507. PAPI assemblies.

a. Power and Control Assembly (PCA). The PCA is a separate unit and is located adjacent to the LHA farthest from the runway. The PCA receives input power which is distributed to the LHAs. The PCA should be located as far from the runway as possible to present the minimum possible obstacle to aircraft and must be mounted on frangible couplings. The LED PAPI PCA must be located outside the Runway Object Free Area (ROFA). Due to manufacturer design limitations, the incandescent PAPI PCA is fixed by function and must be located inside the RSA near the PAPI LHAs (see supporting memorandum in appendix F of this Order and National Installation drawings for details). The ROFA and RSA are defined in AC 150/5300-13, Airport Design.

b. Lamp Housing Assembly (LHA). Each LHA is fixed by function and is equipped with a tilt switch. Activation of any tilt switch extinguishes the lights of the PAPI system. All LHAs are mounted on frangible couplings.

c. Access. Suitable access (access roads, footpath, or catwalk etc.,) must be provided for servicing all component parts of a PAPI system. Access roads, where required, must meet the minimum requirements of the latest edition of Order 6940.1, Access Roads to FAA Facilities.

508. Remote control. There are no requirements for PAPIs in the NAS to use a remote control system (landline or radio control). However, if sites elect to use remote control systems based on operational needs, they must comply with the following:

a. Ground-to-ground. Control of the PAPI must be by landlines or by a Remote Radio Control System in accordance with Appendix B.

b. Air-to-ground. Remote radio control of the PAPI must be in accordance with Appendix B.

509. Monitoring. There are no operational or remote maintenance monitoring requirements for the PAPI.

Appendix A. Reserved

Appendix B. Remote Radio Control for Visual Guidance Lighting Systems

1. Purpose. This appendix provides policy and guidance on the selection and installation of remote radio controls for all FAA visual aid facilities.

2. Background. The prime source of support for the installation of remote radio control for visual aids in the agency has resulted from the requirement to separate the runway edge lighting operation from the operation of the medium-intensity approach lighting systems. Prior to installation of remote radio control, the MALSR systems were interfaced with the runway edge lights and the MALSR intensity was directly proportional to the runway edge lighting intensity. This operating configuration proved unacceptable to aircraft operations. To separate the runway lighting control from the MALSR control, the present remote radio control was identified, tested, and installed at all existing locations with medium-intensity approach lighting systems.

a. Implementation. The agency policy for the implementation of air-to-ground and ground-to-ground remote control for MALSR and other visual aids is contained in a letter to regional directors and signed by the Directors of Air Traffic Services, Airway Facilities Service, Flight Standards Service, and Airports Service dated July 25, 1975.

b. Implementation clarification. The implementation policy was modified by a letter to all regions from the Airports Engineering Division, AAS-100, dated November 28, 1975.

c. Air-to-Ground criteria. All requirements for air-to-ground remote control system was collected and issued in the latest edition of Advisory Circular AC 150/5340-30 Design and Installation Details for Airport Visual Aids.

3. Definitions.

a. Air-to-Ground system. The air-to-ground system consists of a receiver that automatically activates when it receives the proper coded radio signal. The receivers have the necessary relays to provide external control for the system to be controlled.

b. Ground-to-Ground system. The ground-to-ground system consists of an encoder, transmitter, receiver-decoder, and necessary interface equipment to allow control of the attached facility. The transmitter and receiver are frequency modulated and operate at the design frequency.

c. Combination Air-to-Ground and Ground-to-Ground system. The combination system consists of the components contained in the individual air-to-ground system and the ground-to-ground system.

4. Remote Radio control system operation.

a. Air-to-Ground operation. Actuation of the receiver is achieved by the pilot keying his microphone the appropriate number of times within 5 seconds. The receiver has three light intensities that can be selected. Three keyings of the pilot's microphone obtains the low intensity setting, five additional keyings of the microphone obtains the medium intensity setting, and seven additional keyings of the microphone obtains the high intensity setting. The engaged light intensity will remain active for 15 minutes before the lights are shut off.

b. Ground-to-Ground operation. At the remote control point, the desired light intensity (low, medium, or high) is selected on the Air Traffic Control Tower (ATCT) display. The signal is transmitted to the remote facility where the receiver-decoder commands the selected light intensity.

c. Combination system (Air-to-Ground/Ground-to-Ground) operation. The combination system is operated as a ground-to-ground system when the ATCT facility is operating, and as an air-to-ground system when the air traffic control facility is closed. The air-to-ground system is turned "off" whenever the ground-to-ground portion of the combination system is being operated.

5. Equipment requirements.

a. Air-to-Ground control. The air-to-ground system consists of a receiver which actuates, controls, and automatically deactivates the visual facility. To activate the system to the highest step of intensity, use proper frequency, key mic seven times within 5 seconds. To reduce system brightness to medium intensity key mic five times within 5 seconds, and to reduce the system to the lowest intensity key mic three times within 5 seconds. The system is on an automatic timer and will deactivate in 15 minutes. The 15 minute timing sequence can be reinstated at any time by keying the mic the number of times commensurate with the step intensity being used.

b. Ground-to-Ground control. The ATCT personnel can select the following MALSR control functions from the ground-to-ground system:

1. Off.
2. Low intensity.
3. Medium intensity.
4. High intensity.
5. RAIL off
6. RAIL on (in the selected intensity, the RAIL cannot be engaged without first selecting a light intensity for the steady burning lights)
7. A/G off.
8. A/G on.

c. Ground-to-Ground Controller Display. The ground-to-ground controller display is normally located in the ATCT.

6. Coordination requirements.

a. Obtain a Facility Transmitting Authorization (FTA) for ground-to-ground system through FAA Spectrum Engineering Services. The air-to-ground control frequencies are in the VHF aviation communications band and have already been assigned to the airport. A UHF frequency will also be provided at joint-use airports, or if a requirement exists, for military operations on other airports.

(1) Ground-to-Ground system. The frequency assignment for the FM transmitters/receivers for the ground-to-ground radio remote control is 165.7625 MHz unless FAA Spectrum determines that a different frequency is required per coordination with the National Telecommunications and Information Administration (NTIA).

(2) Air-to-Ground system. Local air-to-ground control uses the ATCT local control frequency for air-to-ground control during hours when the ATCT is closed. In Alaska, Flight Service Station (FSS) frequencies may be used for air-to-ground control at non ATCT airports. Additionally, UNICOM frequencies may be used for local air-to-ground control at non ATCT airports. Air-to-ground control is not recommended on ATCT ground control frequencies.

b. Install equipment per current directives and national standards.

c. The service area will issue a commissioning message to National Flight Data Center (NFDC).

d. Ensure publication in appropriate Flight Information Publications of the frequencies and coding for all VFR facilities (including Airport Development Aid Program (ADAP)) that are controlled by air/ground radio.

e. Advise Flight Inspection when the facility is ready for flight check. Only those systems incorporating air-to-ground radio control serving instrument approach runways require flight check prior to commissioning. Those systems incorporating only ground-to-ground radio control do not require flight check. The control features for ground-to-ground radio control on approach lighting systems will be flight-checked in conjunction with routine flight inspection of the instrument approach navigational aid to the runway.

f. The location of the ground-to-ground control display must be coordinated with the Air Traffic personnel.

Appendix C. Remote Radio Control Background

The agency policy for implementation of air-to-ground and ground-to-ground remote control for medium-intensity approach lighting systems with runway alignment indicator lights (MALSR) and other visual aids is contained in a letter to regional directors and signed by the Directors of Air Traffic Service, Airway Facilities Service, Flight Standards Service, and Airports Service dated July 25, 1975. For reference purposes the contents of that letter is presented below:

Date: July 25, 1975

Subject: Implementation of Air-to-Ground and Ground-to-Ground Remote Control for Medium Intensity Approach Lighting Systems with Runway Alignment Indicator Lights (MALSR) and Other Visual Aids

From: Directors, Air Traffic, Airway Facilities, Flight Standards, and Airports Services

To: Regional Directors

On April 9, 1975, the Acting Administrator signed Order 6850.9, subject: Revised Approach Lighting Criteria. This order reflects a broad change in our present approach light policy criteria. Implementation instructions for each phase of this order must be covered and regions will be advised as soon as they are prepared. It is deemed more important, however, to immediately provide guidance for the air-to-ground and ground-to-ground portion of radio control lighting aids of this order. Systems will be installed in the very near future and care must be exercised to ascertain that the public is properly notified that standardized implementation procedures are carried out. Each phase in implementing this order necessitates coordination within all elements of operations within the region and coordination is mandatory in all cases.

The following orders are offered as references for the implementation of these systems:

Order 7900.2 - Reporting of Navigation Aids and Facilities Data to the National Flight Data Center

Order 7030.20A - Scheduling of Changes of Components of the NAS

Order 7210.3B - Facility Management

Order 8260.20 - Revised Requirements and Concepts for Category I ILS (to be cancelled)

Order 8260.22 - Standard Instrument Approach Procedures minima Based on Medium Light System/Runway Alignment Indicator Lights (MALS/RAIL) (to be cancelled)

Order 8260.26 - Establishing and Scheduling Instrument Approach Procedure Effective Dates

Order 6850.2 - Visual Guidance Lighting Systems

Policy.

Consistent with the intent of Order 6850.9, all MALSR systems shall be controlled independently of all other lighting systems. Control shall be accomplished by landline or radio remote ground-to-ground/air-to-ground systems.

At locations with a full-time ATCT or locations with a full-time FSS and no ATCT, landline or radio remote ground to ground systems shall be used.

At locations with either part-time ATCT and a full-time FSS, landline or radio remote ground-to-ground systems shall be used with provisions for the FSS to control the MALSR when the part-time ATCT is closed, provided the FSS also has control of the runway edge lights.

At locations with either part-time ATCT or part-time FSS, landline and remote air-to-ground or radio remote ground-to-ground and air-to-ground systems shall be used.

Any situation involving an ATS facility which is not covered by the above, shall be considered on an individual basis.

MALSR systems at locations with no ATCT facilities shall be controlled by radio remote air-to-ground functions.

Any visual aid may be remotely controlled from the ground or from the air, however, priority will be given to approach lighting systems associated with IFR procedures.

Air to Ground Control.

The air-to-ground system currently being procured consists of a receiver which actuates, controls, and automatically deactivates the visual facility. Activation of the MALSR is achieved through pilot keying his microphone five times within five seconds on the correct frequency activating the MALSR on the high intensity step. Keying three times within five seconds will step the system down to medium intensity. After 15 minutes of operation the system will automatically turn off. Should additional time be required keying the mike five times or three times will reactivate the system for another 15 minutes. A limited number of these two intensity systems are being provided by F&E and not ADAP, and will be backfitted to include a third function at a later date.

A three function receiver shall be the MALSR standard for F&E and ADAP, and will perform as follows.

To activate the system to the highest step of intensity, use proper frequency, key mike seven times within five seconds. To reduce system brightness to medium intensity key mike five times within five seconds, and to reduce the system to the lowest intensity key mike three times within five seconds. The system is on an automatic timer and will deactivate in 15 minutes. The 15 minute timing sequence can be reinstated at any time by keying the mike the number of times commensurate with the step intensity being utilized.

Ground-to-Ground Control.

The ground-to-ground control unit provides multi-functions which may be selected by air traffic control personnel. Complete control of the MALSR can be achieved with six functions as follows:

1. Off.
2. Low intensity with RAIL.
3. Medium intensity with RAIL.
4. High intensity with RAIL.
5. RAIL off.
6. RAIL on.

NOTE: When three step intensity RAILs are provided with the MALSR, on/off flasher control selector shall be deactivated.

These six functions would suffice for the ground-to-ground remote control system to be used at 24-hour air traffic facilities. Two additional controls will be required at part-time facilities; one to enable the air/ground control unit upon tower closing, and a second to place MALSR control back in the facility when it opens for operation.

Implementation Responsibilities.

The regional director will assign the responsibilities which apply equally to F&E and ADAP, and assure that the following items are carried out:

1. Obtain a frequency authorization through Frequency Management. For F&E facilities only the region shall furnish the Airway Facilities Service, AAF-560, of the frequency requirement for the proposed MALSR system control. Note: This has been essentially completed for FY 1975 and prior years as well as existing systems.

2. Report to the National Flight Data Center (NFDC), the proposed commissioning date required by Order 7900.2. This is typically known as an advance NOTAM.

3. Install the equipment per national standards.

4. The region will issue a commissioning message to NFDC.

5. Ensure publication in appropriate Flight Information Publications of the frequencies and coding for all VFR facilities (including ADAP) that are controlled by air/ground radio.

6. Identify the airports with radio controlled lights and ensure the instructions and use of these aids are published in the AIM.

7. Advise sponsors of MALSR facilities already commissioned or programmed under the ADAP of the operational requirement for radio control and also advise that funding for this requirement is eligible under the ADAP.

8. For air-to-ground control assigned frequency will be in the VHF aviation communications band. A UHF frequency will also be provided at joint-use airports, or if a requirement exists, for military operations on other airports.

9. Advise National Flight Inspection Division (NFID) when facility is ready for flight check, whether F&E or ADAP.

The Airway Facilities Service will:

1. Furnish the regions with a delivery date of the transmitter, receiver, and interface kit. The delivery dates are currently being determined. Any revisions or changes shall be promptly forwarded to the regions.

2. Furnish the regions plant equipment modifications (PEMs) and installation drawings and specifications documentation for systems backfit and new facilities. The necessary PEMs and construction specifications are being developed and will be issued in the near future.

3. Furnish the region with the necessary transmitter receiver and interface kits. Initial procurement is underway.

4. Select and coordinate frequency assignments prior to activation.

The Flight Standards Service will:

1. Coordinate with the Regional Flight Standards Division when radio control devices are programmed at IFR airports, in order that the scheduling required by Order 8260.26 may be accomplished. This order normally requires nine weeks lead-time for proper changes, however, in the case of lighting aid notes the lead-time may be reduced to six weeks. Standardized notes for pilots will be developed.

2. Coordinate a policy that radio control of lighting systems will permit the lowest minimums commensurate with the procedure.

3. Determine that, where an IFR approach procedure is associated with lighting aids presently having air-to-ground radio control, the radio control system will be modified to meet the new radio control requirements, or landing minimum will be adjusted accordingly.

4. Provide operational requirements.

5. Provide information for the AIM, Part I and other Flight Information Publications on the operating procedures for air-to-ground radio control.

6. Accomplish a flight check of the radio control device when the modification to the lighting is completed or a new system installed. This will consist of a check to determine the lights operate in accordance with the information published for pilot control of the lights. After initial flight check surveillance checks will be accomplished in conjunction with other facilities.

The Air Traffic Service will:

1. Provide appropriate operating instructions to ATS personnel.

2. Assure that the control information of privately-owned and installed radio devices at IFR airports and identified on 8260 series forms is published in the AIM.

The Airports Service will:

1. Revise specification L-854 for radio control to meet new operational requirements for air-to-ground and ground-to-ground systems.

2. Supply installation instructions for field personnel to install equipment in accordance with new requirements.

Remote Control of All Visual Aids.

The ground-to-ground agency-owned remote control systems are capable of selecting 96 different functions. Accordingly, at airports where full time ground-to-ground systems are provided, the regions are authorized to control any visual aid by use of this system in lieu of separate control landlines. Facilities which are presently interlocked; i.e., the REIL lights with the runway edge lights may, at the region's discretion, separately control these facilities through the remote unit when funding is available.

At part-time air traffic facilities where ground-to-ground links are installed, individual function of visual aids may be provided. When the air traffic control facilities is closed, and the air-to-ground function is selected, control of any visual aid is permitted. However, priority will be given to the air-to-ground control of approach lights associated with IFR procedures. When IFR procedures are involved, only one frequency may be utilized to control the approach lighting system.

Air-to-ground control of the runway edge lighting system on that runway will not be permitted.

At non-controlled airports where the agency-owned air-to-ground link is the only method of controlling the approach lights, for an IFR procedure, no other system on that runway will be permitted to be controlled with that or another frequency. Where approach lights are not provided, the air ground link may be utilized for control of other visual aids as deemed appropriate and as permitted by funding.

APPROVED:

Original signed by:
Raymond G. Belanger
RAYMOND G. BELANGER
Director, Air Traffic Service, AAT-1 Date: 7/25/75

Original signed by:
Warren C. Sharp
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Director, Airway Facilities Service, AAF-1 Date: 7/25/75

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Director, Airports Service, AAS-1 Date: 7/25/75

Appendix D. Floodplain Low-Impact Resistant (LIR) Structures Installation

The following guidance must be used for consideration of siting LIR structures in areas subject to flooding (e.g., floodplains). Design engineers may also consider the use of standard LIR components to assemble LIR structures in flood-resistant configurations.

a. Feasibility of LIR structures in floodplain. The installation of LIR structures is not advisable for every floodplain situation; however, it should be considered in order to minimize or eliminate rigid approach light support structures. The final determination is to be made on a case-by-case basis by the design engineer, based on the various factors involved including: safety, maintainability, accessibility, stability, location (i.e., inside versus outside the RSA, and cost).

b. Floodplain design considerations. When approach light support structures must be placed in an area subject to flooding, LIR structures may be considered so long as the site design adheres to the criteria depicted in the graphs below (Figures D-1 and D-2). A LIR structure must not be installed in a location subject to flood conditions within the horizontally shaded regions marked "Unacceptable." A LIR structure may be installed in a location subject to flood conditions within the other regions, at the discretion of the design engineer. The curved line represents the most severe flood conditions under which a LIR structure is expected to survive. The use of Figures D-1 and D-2 should be based on the 100 Year Flood conditions. In order to minimize water damage to electronic components, it is recommended that the 100 Year Flood Elevation level (maximum design floodwater height) not exceed 75 percent of the height of the particular LIR pole height being considered (e.g., for a 20 foot LIR pole, the maximum design flood water height should not exceed 15 feet). Further, it is recommended that the floodwater velocity not exceed 40 feet per second. While the LIR structure may be capable of surviving more severe conditions, as represented by the diagonally shaded regions, it is not recommended.

c. Floodplain and 100 Year Flood Elevation information. Details regarding the floodplain and the 100 Year Flood Elevation at a specific location, as well as other information about floodwater conditions, can be found in the applicable Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) produced by the Federal Emergency Management Agency (FEMA). These documents can be obtained from multiple sources including:

(1) Directly from FEMA at the FEMA Flood Map Store http://msc.fema.gov/portal. .

(2) The Public Works, Engineering Department or similar office of the local government.

(3) The local district office of the Army Corp of Engineers (USACE). Contact information for the local district can be found at the USACE website. http://www.usace.army.mil.

d. Standard and floodplain LIR configurations. There are certain floodplain situations where it is reasonable to consider a modified LIR assembly concept that uses the larger mounting frame assembly along with the MG-30 stabilizer rod configuration to assemble "MG-30 type" LIR structures as short as 17-feet in height. In a similar situation, MG-40 components may be used to assemble “MG-40 type” LIR structures as low as 27-feet in height. (Reference Table D-1 below.)

Table D-1. Standard configuration and floodplain LIR assembly

LIR Type Configuration	Standard Design Minimum – Maximum Height (feet/inches)	“Floodplain LIR” modified assembly concept Minimum – Maximum Height (feet/inches)
MG-20	6'-1" to 21'-1"	2' to 16'-11" (see Note 1)
MG-30	21'-2" to 30'-0"	17' to 26'-11" (see Notes 2 & 3)
MG-40	30'-1" to 40'-0"	27' to 40'-0" (see Notes 2 & 3)

Notes.

(1) Lowest height poles use the non-tilt Z-Base and are limited to outside of the RSA.

(2) In this example, the bottom of the tee-brace clamp (Item 7 on drawing D-6155–1-1) is approximately 1 foot above the hoop wound ring.

(3) The minimum MG-30/40 pole heights can be reduced another 2 feet when there is no interference between the stabilizer rods and tee-brace.

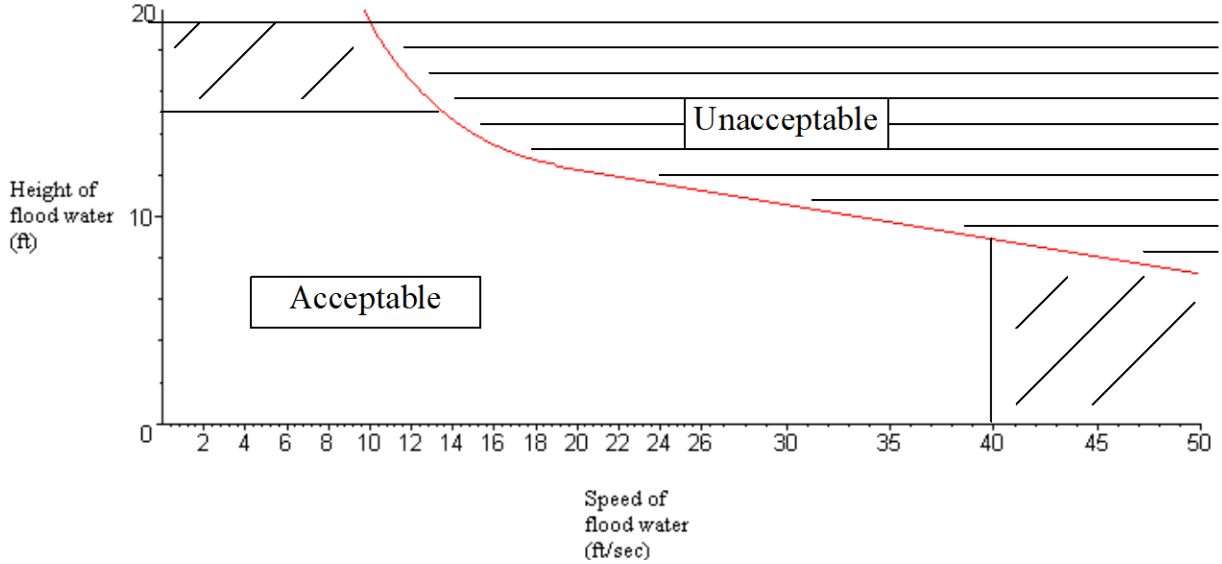

Figure D-1. Floodplain LIR Siting Criteria for MG-20 Structures

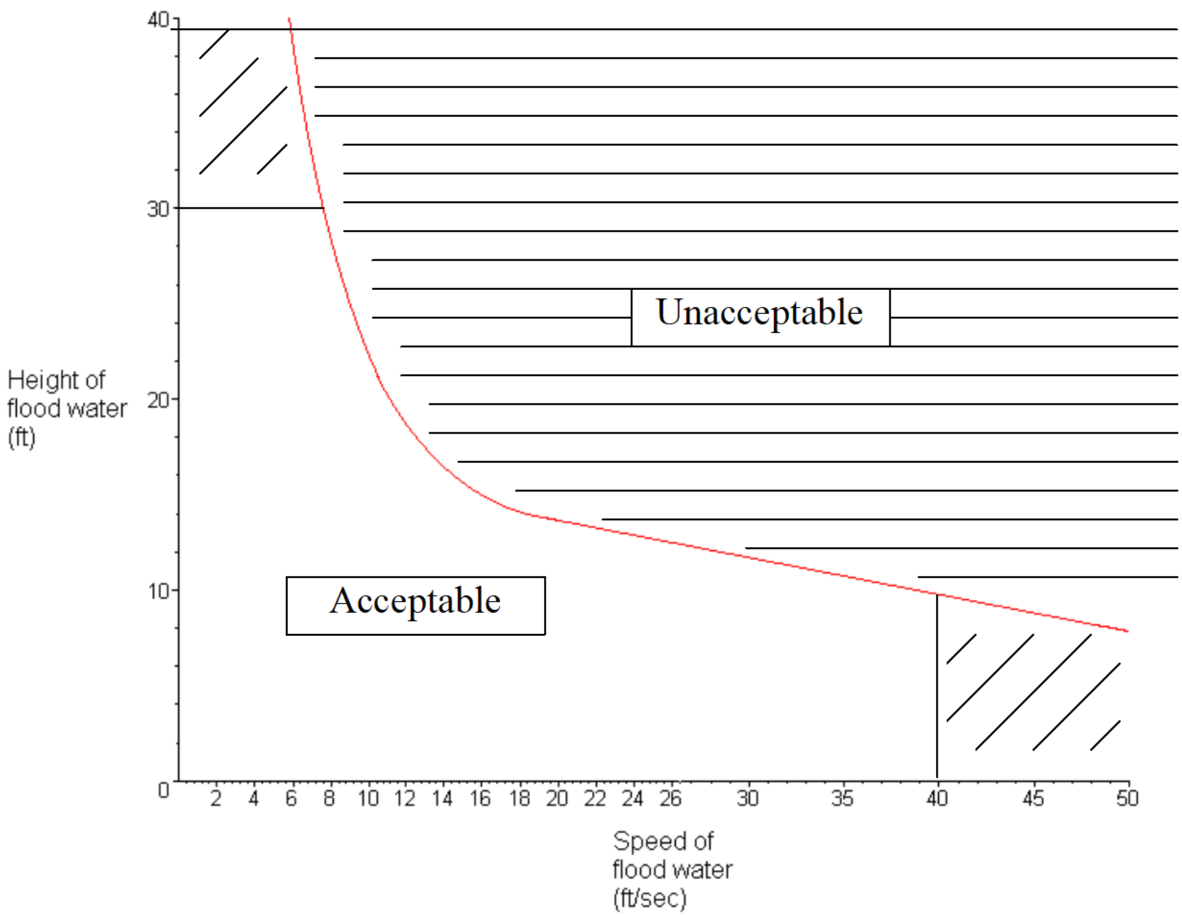

Figure D-2. Floodplain LIR Siting Criteria for MG-30 and MG-40

Appendix E. Visual Approach Slope Indicator (VASI) System Configurations and Installation

Section 1. Visual Approach Slope Indicator (VASI) system configurations

1. Visual Approach Slope Indicator system. VASI systems are no longer being newly installed and if a VASI needs to be relocated, there should be a consideration and evaluation for replacing it with a PAPI system. The VASI system provides visual approach slope information. The system provides a definite white and red light projection along the desired descent path to the touchdown point. The light units are arranged in bars. The light units in each bar are located on a line perpendicular to the runway centerline. Each light unit projects a split beam of light, the upper segment being white and the lower, red. The transition from red to white, or vice versa, occurs over a vertical angle of approximately one quarter degree, with the light in this area being pinkish in color. The system produces a well-defined corridor or corridors of light consisting of red and white beams. Detailed system configurations are covered in Appendix E, section 2.

a. Two-Bar VASI systems. The two-bar system light units are arranged in bars called the upwind and downwind bar. The downwind bar is the one nearest to the runway threshold and the upwind bar is the farthest from the threshold. When on the proper glide path, the downwind bar appears white and the upwind bar appears red. If the approach is too low, both bars are seen as red. The two-bar VASI systems are as follows:

(1) VASI-2. An economy system consisting of two light units, one light unit in each bar. This system is not installed on runways used by turbojet aircraft.

(2) VASI-4. Consists of four light units, two light units in each bar. This is the basic FAA standard.

(3) VASI-12. Consists of 12 light units, 6 light units in each bar. This is the basic international standard for International Civil Aviation Organization (ICAO) designated airports serving scheduled foreign flag air carrier aircraft.

b. Three-Bar VASI Systems. The three-bar VASI system was developed to provide dual glide paths to accommodate aircraft of varying wheel-to-cockpit heights. Further, the three-bar VASI is installed only at locations having 747, C5A, or other similar long-bodied aircraft operations. The three-bar system light units are arranged in bars called the upwind, middle, and downwind bar. The downwind bar is the one nearest to the runway threshold and the upwind bar is the farthest with the middle bar in between. There are two glide paths projected by the three-bar system that are seen by the pilot as shown in Table E-1 below, the upwind zone for long-bodied aircraft and the downwind zone for other aircrafts. The three-bar VASI systems are as follows:

(1) VASI-6. Consists of six light units, two light units in each bar. This is the basic FAA standard.

(2) VASI-16. Consists of 16 light units; 6 light units in the downwind and middle bars, and 4 light units in the upwind bar. This is the basic international standard for ICAO designated airports serving scheduled foreign flag air carrier aircraft.

This table identifies the visual indications received by a pilot on various approach glide paths to a three-bar VASI system; also see Figure 6 in Appendix E of this document.

Table E-1. Three-Bar VASI visual cues

Approach Position	Observed Light Bar Color	Downwind (No.1) Bar		Middle (No.2) Bar		Upwind (No.3) Bar	
		White	Red	White	Red	White	Red
Upwind Zone Glide Path	Above	X		X		X	
	On	X		X			X
	Below	X or	X		X		X
Downwind Zone Glide Path	Above	X		X		X or	X
	On	X			X		X
	Below		X		X		X

Section 2. Visual Approach Slope Indicator (VASI) systems installation criteria.

2. Description.

a. The visual approach slope indicator (VASI) system when properly installed and oriented, will furnish the pilot visual approach slope information to provide safe descent guidance. The system is primarily intended for use during Visual Flight Rules (VFR) weather conditions.

b. The basic VASI configurations are described in Appendix E, Section 1, Paragraph 1 and shown in Figures E-1, E-2, E-4, and E-5. All boxes (or light units) of the two-box; four-box, and six-box configurations are located on the left side of the runway (as viewed from the approach direction). However, where terrain or cross runways, etc., make this impractical, they may be located on the right side of the runway.

c. The VASI provides a definite white and red light projection along the desired descent path to the touchdown point. The light units are arranged in bars, which are called the upwind and downwind bar for a two-light bar system and the upwind, middle, and downwind for a three-light bar system. The light units in each bar are located on a line perpendicular to the runway centerline. The downwind bar is the nearest to the runway threshold and the upwind bar is the farthest. On the three-bar system, the middle bar is located between the downwind and upwind bars.

3. Determining obstruction clearance.

a. The downwind bar (one nearest the landing threshold) is the critical bar insofar as physical location and aiming are concerned. To determine the location of the downwind bar, it is necessary to identify the location and height of critical objects in the runway approach. Any necessary surveys should be limited to those locations at which the necessary information is not available from the Coast and Geodetic Survey or from the local airport authorities and should be limited to the extent necessary to satisfy installation requirements.

b. Determine the minimum aiming angle by plotting all objects within an area established by two lines each diverging at 10 degrees from runway centerline extend to 4 nautical miles, and starting at the runway centerline at the number one bar. A line drawn from the runway centerline at the number one bar at an angle that will clear the highest object by not less than 1 degree establishes the minimum aiming angle. This line and a horizontal line perpendicular to the runway centerline at the number one bar (downwind) establishes an obstruction - clear plane 10 degrees (6 degrees in special applications where 10 degrees is not obtainable) on both sides on the extended runway centerline. The obstruction clear plane starts at the number one bar and extends outward from the threshold for 4 nautical miles. In addition, the minimum aiming angle must be within the glide path limitations of Paragraph 4. If a site survey or flight inspection determines that there is an obstruction which penetrates the obstruction-clear plane and cannot be removed, then the glide path angle must be changed, the VASI system moved farther from the threshold, or the VASI is baffled such that its light signal angular coverage is restricted/limited. Coordinate with the Flight Procedures and Airspace Group to ensure there are no conflicts with instrument procedures and planned information publication. If the VASI light output is restricted to less than 10 degrees on either side of the runway centerline, issue a NOTAM and request publication in the Chart Supplement. Obstacle penetrations outside 10 degrees of the VASI obstruction-clear plane may also create a problem, as determined by flight inspection.

4. Visual Glide Path Angle. The visual glide path angle must meet the following general criteria in addition to the obstruction clearance requirement of paragraph 3.

a. For the two-bar VASI, the effective visual glide path angle must cross the landing threshold at a height of not less than 25 feet. Where the distance between the pilot's eye and the lowest portion of the aircraft in landing altitude exceeds 10 feet, the minimum threshold crossing height of 25 feet must be increased by an amount equal to that in excess of the 10 feet. This distance must be based on the most critical aircraft that will normally operate on the runway. For example, where an aircraft operating at a specific airport has a distance between the pilot's eyes and lowest portion of the aircraft of 20 feet, then the minimum threshold crossing height will be 35 feet.

b. For the three-bar VASI, the downwind effective visual glide path must be sited to provide a threshold crossing height of 50 feet. The upwind effective visual glide path must be sited to provide a threshold crossing height to accommodate the B-747 aircraft.

c. The following are common aircraft and the pilot's eye-to-wheel distance:

Aircraft	Distance	Aircraft	Distance
DC-9-10	17.4 feet	A330-300	35.9 feet
DC-9-30	21.7 feet	737-700	19.2 feet
A320-200	22.5 feet	747-400	44.4 feet
A350-900	35.2 feet	777-300	35.2 feet

d. The preferred effective visual glide path angle are as follows:

Two-bar VASI	- 3°
Three-bar VASI	- 3.25° high glide path
	- 3° low glide path

e. Where a VASI is installed on a utility runway, a visual glide path angle may be greater than 3 degrees, but not more than 4 degrees for obstacle clearance, may be used provided the commissioned angle is specified in a NOTAM and also published in the Chart Supplement.

f. At locations where a two-bar VASI is installed or where a runway with a VASI is later updated by the addition of a precision approach (PA)/approach with vertical guidance (APV), the point of intersection of the visual glide path angle on the runway must be within ± 50 feet of the point on the runway where the projected straight line path of the PA/APV glide path touches the runway centerline. The vertical aiming angle of the upwind bar must be the same as the PA/APV glide path angle, and the downwind bar must be aimed one-half degree lower.

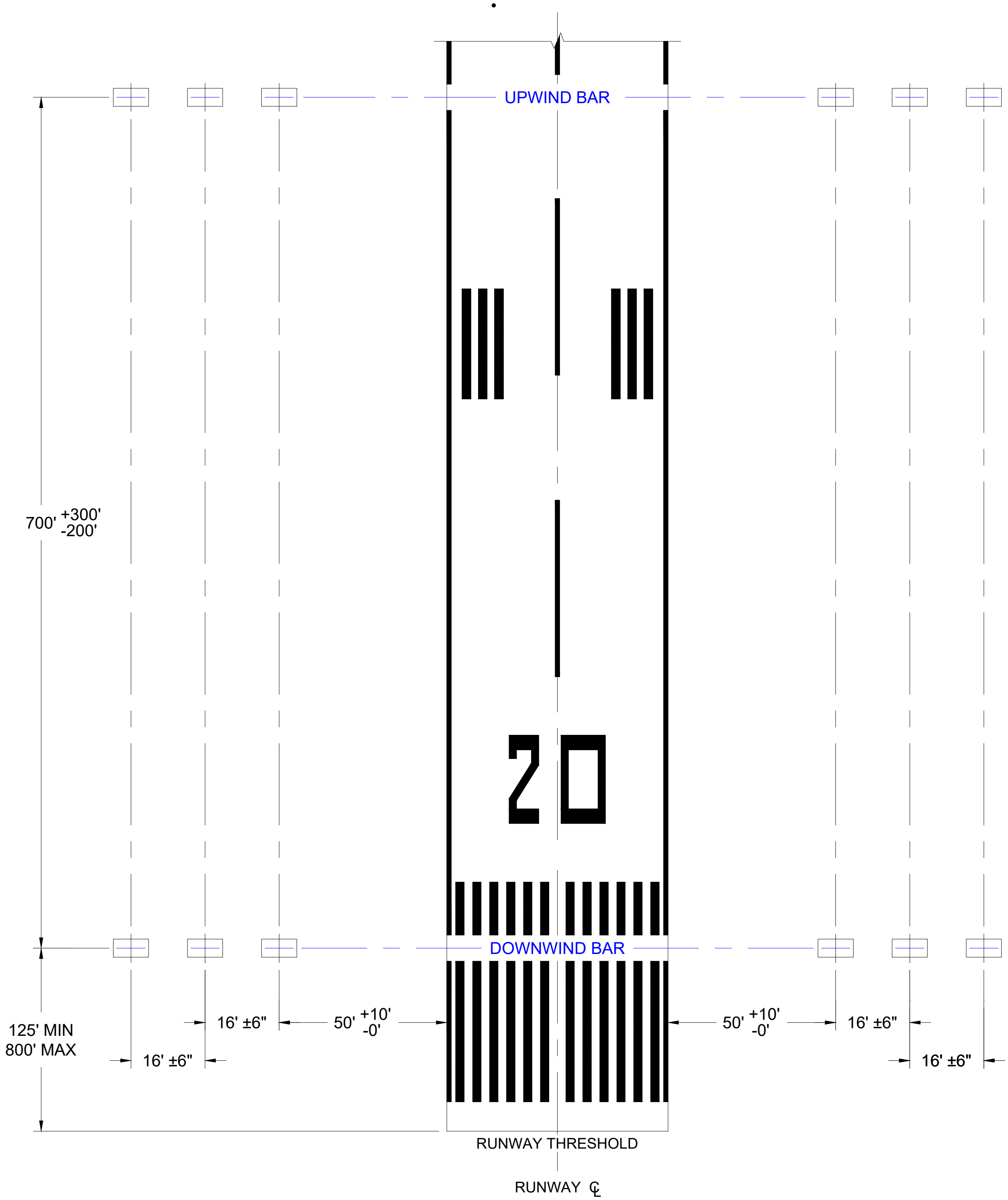

Figure E-1. System layout VASI-12

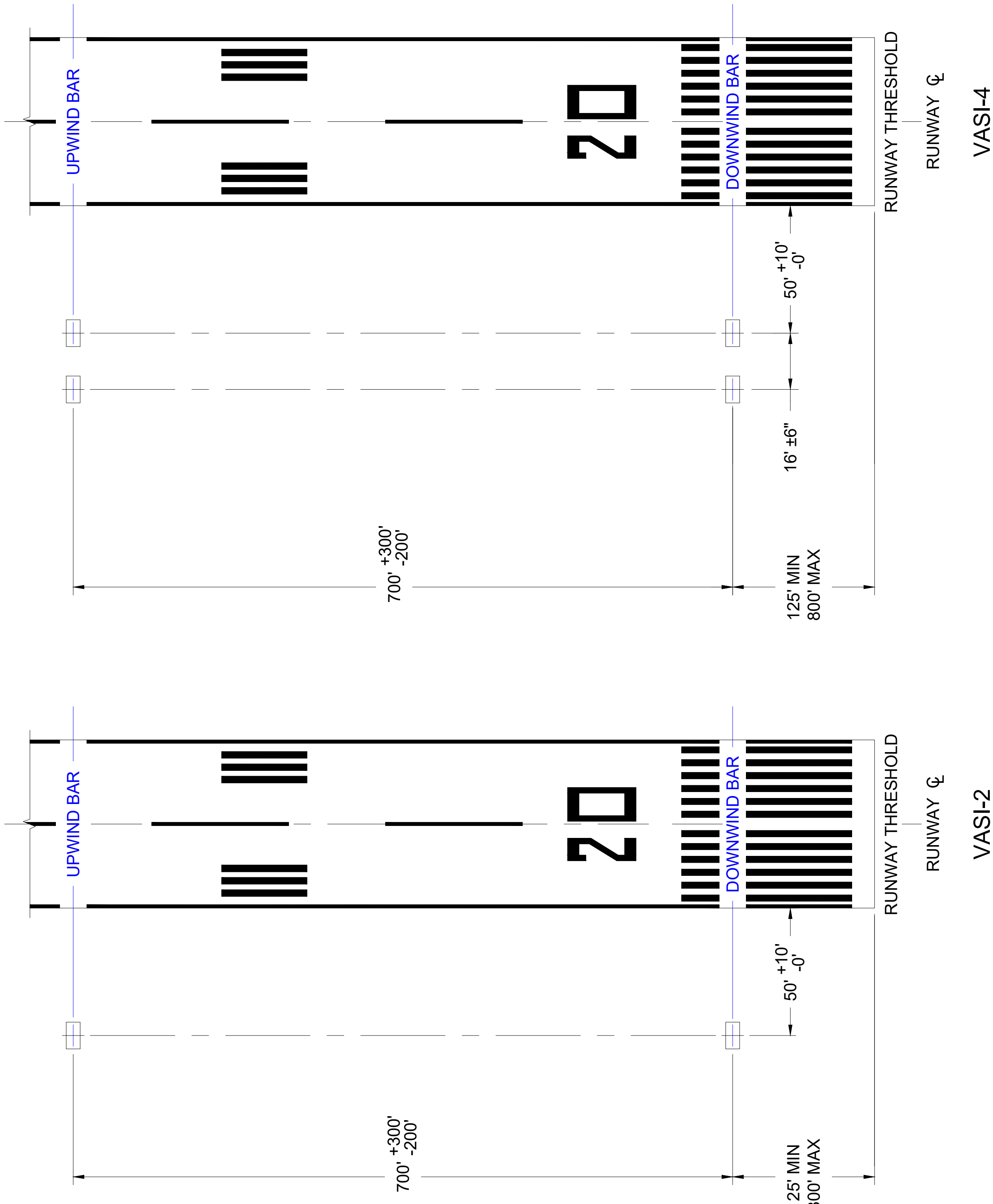

Figure E-2. System layout, VASI-2 and VASI-4

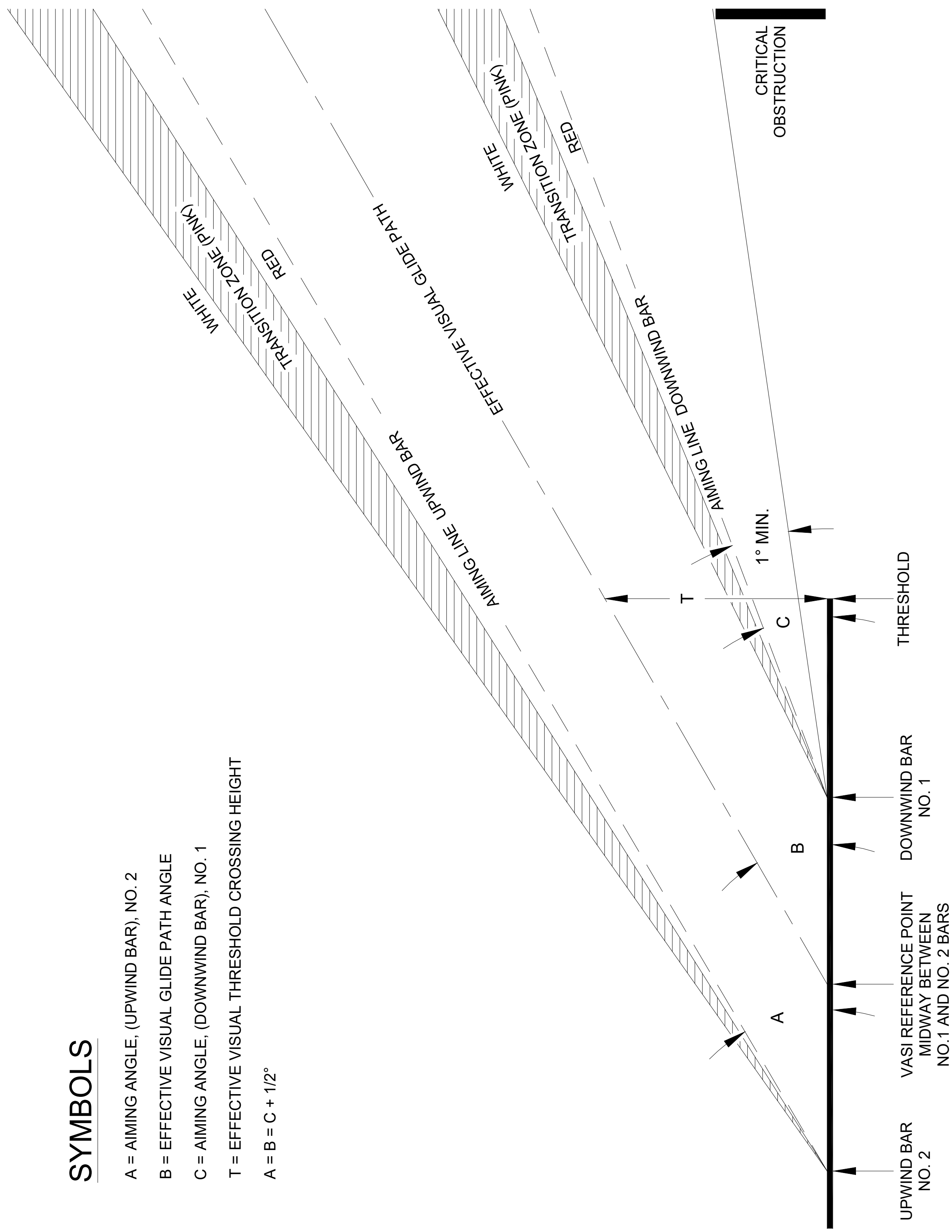

Figure E-3. Aiming and obstruction clearance diagram for 2-bar VASI

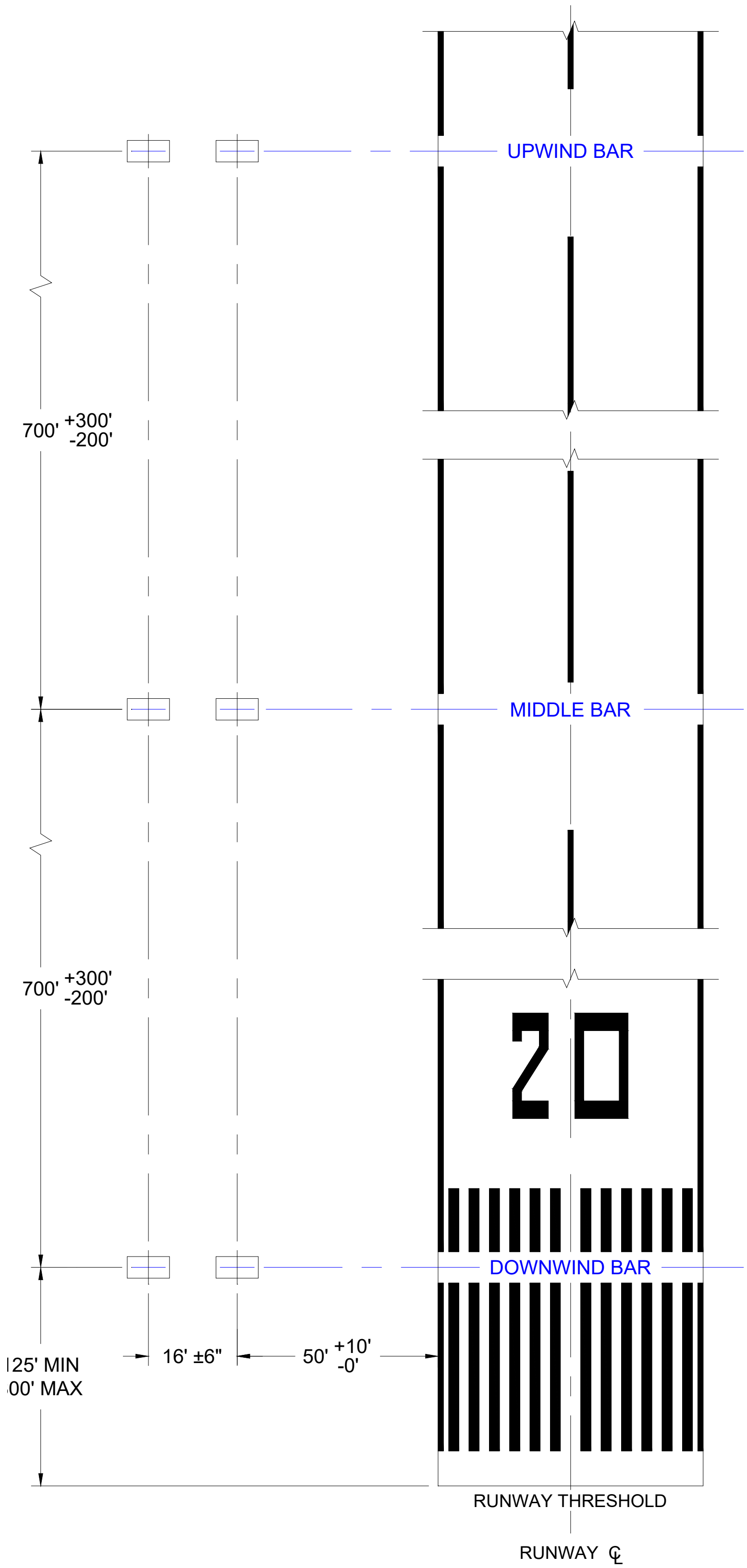

Figure E-4. System layout, VASI-6 (3-bar)

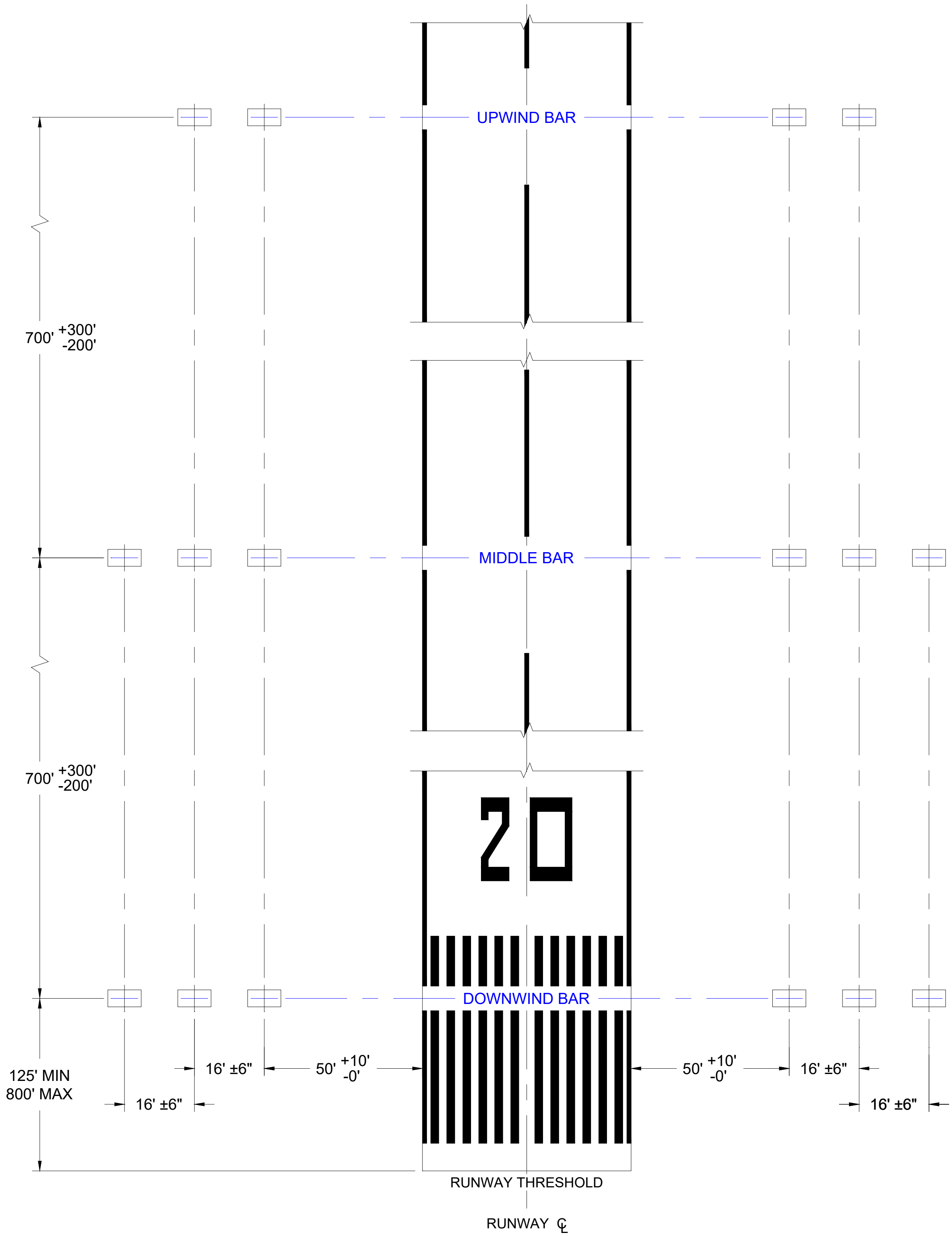

Figure E-5. System layout, VASI-16 (3-bar)

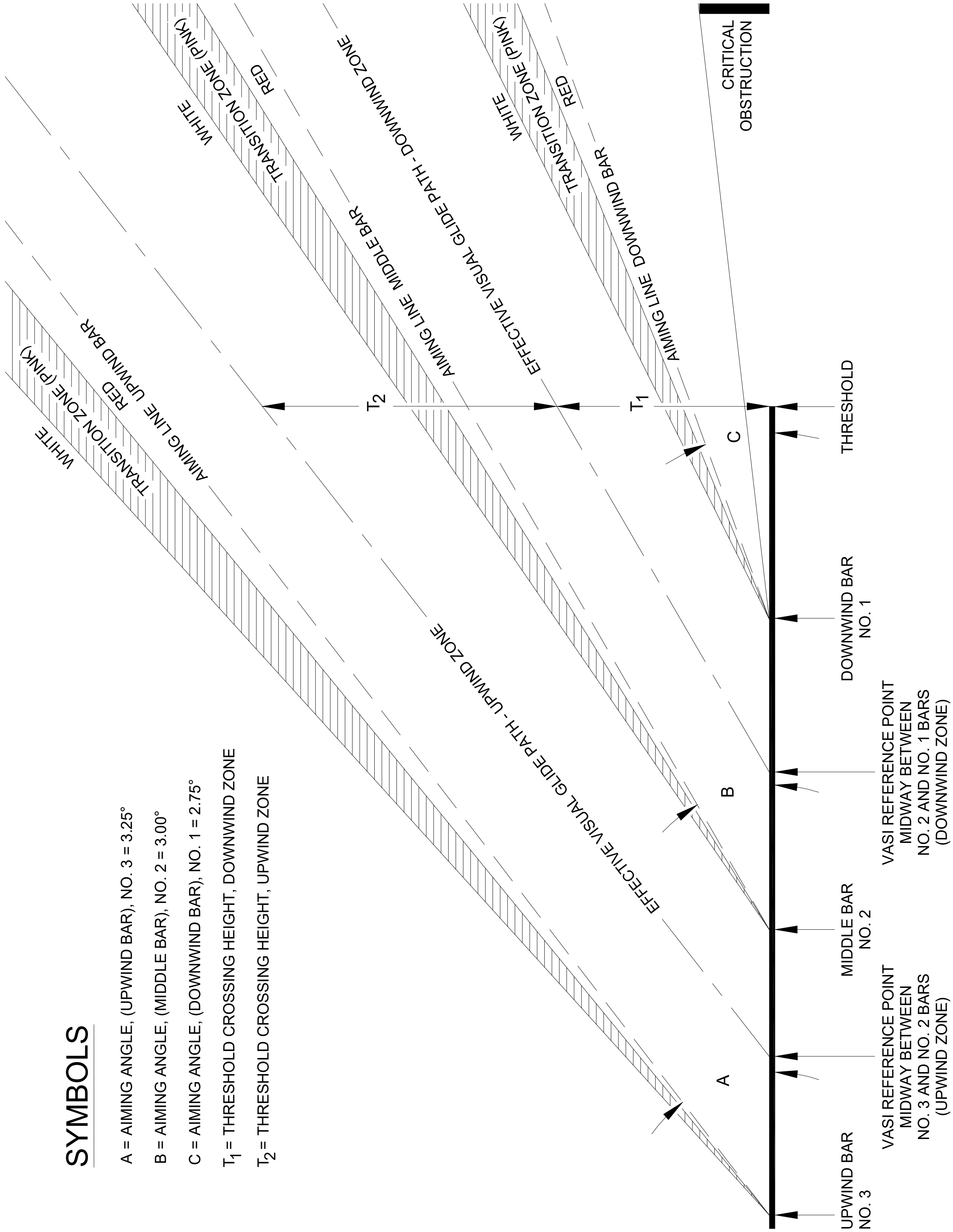

Figure E-6. Aiming and obstruction clearance diagram for 3-bar VASI

g. Where category D turbojet aircraft operations are conducted on a runway with no ILS, the light bars must be positioned to provide a visual glide path intercept point with the runway at 1,000 feet ± 100 feet from the threshold, and aimed to meet the criteria specified in paragraphs 4a, b, c, and d.

h. Where the width of the protected glide path is reduced to less than 20 degrees because of unusual approach conditions, the width of the radiated light must be reduced to 2 degrees less than the protected width. The minimum width of the radiated light must be 12 degrees.

5. Two-Bar VASI Light Bar Locations. The light bar locations must provide no less than 15 feet between the aircraft wheels and the threshold when on glide path.

a. Location of Downwind Bar. The downwind bar may be located a minimum of 125 feet and a maximum of 800 feet upwind from the threshold, except for those cases specified in Paragraphs 4f and 4g. The exact location of the downwind bar will depend on the desired touchdown point. Where the terrain drops off rapidly near the approach threshold and severe turbulence may be experienced, the downwind bar should be located at its maximum permissible distance from the threshold in order to keep aircraft at the maximum permissible threshold crossing height.

b. Location of Upwind Bar. The upwind bar must be located 700 feet +300 feet or -200 feet from the downwind bar. These tolerances are to be used to avoid interference with cross runways, taxiways, etc., or where critical runway lengths make it desirable to have a touchdown as close to the threshold as possible, consistent with threshold crossing height and obstacle clearance requirements.

6. Three-Bar VASI Light Bar Locations. The spacing between the three bars should be as nearly equal as possible. If a three-bar VASI is located on an ILS runway, the intercept point of the downwind zone must coincide with the ILS intercept point within the tolerance specified in Paragraph 4f. The visual glide path intercept with the runway for the upwind zone must be no greater than 1,800 feet from the landing threshold. It is recommended that separation between the light bars be 700 feet to provide a distinct visual approach path.

a. Location of Downwind Bar. The downwind bar may be located a minimum of 125 feet and a maximum of 800 feet upwind from the threshold, except for those cases specified in Paragraph 4f. The exact location of the downwind bar will depend on the desired touchdown point and the type of aircraft using the runway. Where the terrain drops off rapidly near the approach threshold and severe turbulence may be experienced, the downwind bar should be located at its maximum permissible distance from the threshold in order to keep aircraft at the maximum permissible threshold crossing height.

b. Location of Middle Bar. The middle bar must be located 700 feet +300 feet or -200 feet from the downwind bar. These tolerances are to be used to avoid interference with cross runways, taxiways, etc.

c. Location of Upwind Bar. The upwind bar must be located 700 feet +300 feet or -200 feet from the middle bar. These tolerances are to be used to avoid interference with cross runways and taxiways.

7. Aiming VASI Light Bars. The vertical aiming of all light units must be initially set to within ± 2 minutes of the established aiming angles. The light units must be aimed using a Walker Bar.

a. Aiming of Two-Bar VASI. The two-bar VASI system must have the upwind bar aimed at 3 degrees and the downwind bar aimed one-half degree lower at 2.5 degrees; however, where necessary to provide obstacle clearance, the downwind bar may be aimed at 2.75 degrees. (See Paragraph 4e for Utility Airports.)

b. Aiming of Three-Bar VASI. The three-bar VASI system must have the upwind bar aimed at 3.25 degrees, the middle bar aimed at 3.0 degrees and the downwind bar aimed at 2.75 degrees.

8. Installation of light units. The installation of the light units in each bar must be as follows:

a. The centerline of the inboard light unit in each bar must be located a distance of 50 feet, +10 feet or -0.0 feet, from the runway edge. Tolerances should be used only to avoid construction such as drainage ditches, catch basins, manholes, etc. Where damage to the light unit may occur from jet blast and wing vortices, the plus distance may be increased to +25 feet.

b. The distance between the centerline of light units in a light bar must be 16 feet, ± 6 inches.

c. The light beam centers (measured from center of the transverse slot in the front of the light units) of all units in a portion of a bar (those located on one side of a runway) must be in a horizontal plane within a tolerance of ± 1 inch.

d. The horizontal plane passing through the light beam centers of the units on one side of the runway must be within 1 foot of the corresponding horizontal plane for the units on the other side of the runway.

e. The elevation of the horizontal plane passing through the light beam centers of the units in a portion of a bar must be within ± 1 foot of a horizontal plane passing through the crown of the runway.

f. At locations where snowfall is likely to obscure the lights, the light units may be installed up to a maximum height of 6 feet above ground level. Consideration should be given, however, to locating (within specified tolerance) the light units farther from the runway edge to ensure adequate clearance for the largest type of aircraft expected to use the runway. All light units must be raised to the same elevation. Since raising the light units also changes the touchdown point, the light bars should be relocated downwind a distance sufficient to compensate for this. The distance the bars are moved is determined from the following formula:

$$d = \frac{h}{\tan(X)}$$

where:

d = Distance in feet both bars should be moved toward threshold.

X = Visual glide path angle.
h = The difference between the average elevation of the upwind and downwind bars from the elevation of a point on the runway centerline midway between the upwind and downwind bars.

g. All units in a bar must be located perpendicular to the runway centerline. The front face of each light unit must be located within a tolerance of ± 6 inches from this line.

h. Each light unit must be aligned outward into the approach zone on a line parallel to the runway centerline within a tolerance of ± 1/2 degree. Where it is necessary to provide vertical guidance for a curved approach, the light units may be rotated off runway centerline into the approach direction up to a maximum of 5 degrees. When light units are rotated, straight-in guidance and obstacle clearance must be provided throughout the area of coverage. The angle of rotation must be issued in a NOTAM and published in the Chart Supplement.

i. No light unit may be located closer than 50 feet from a cross runway, taxiway, or warm-up apron.

j. Where the nature of the terrain, operational requirements, or some other condition prohibits installation of a VASI on the opposite side of the runway from an ILS glide slope, the VASI may be installed on the inside of the glide slope critical area provided a flight check proves that the light bar and appurtenances do not interfere with the glide slope signal. All VASI light units must be installed on frangible couplings.

9. Remote Control Requirements. All VASI systems installed after December 17, 1981, and systems installed prior to December 17, 1981 that have been relocated or modified, require remote control (landline or radio control).

a. Ground-to-ground. Control of the VASI must be by landlines or by a Remote Radio Control System in accordance with Appendix B.

b. Air-to-ground. Control of the VASI must be by a Remote Radio Control System in accordance with Appendix B.

Any deviation from these requirements must be approved through a local NCP. The NCP must include a Safety Risk Management Analysis and;

a. Concurrence from local Air Traffic Operations.

b. Procedures to address runway/approach closures.

10. Miscellaneous requirements.

a. The PCA is a separate unit which receives input power to be distributed to the VASI individual light units. The PCA must be located outside the RSA and ROFA. . Where NAVAID operational performance is adversely affected by equipment installations, contact the local FAA airports district office (ADO) or Regional Office (RO) for information pertaining to the RSA and ROFA standards.

b. Since the effectiveness of the VASI System is only dependent upon seeing a definite red and/or white signal from the light units, care must be taken to assure that no other lights are located close enough to the system to confuse the pilot.

c. The two-bar, two-box VASI must have a tilt-switch in each VASI box to prevent the system from giving a false signal due to incorrect alignment of the boxes caused by settling of concrete bases, being struck by a vehicle, etc.

Appendix F. Memorandum: Amendment to Engineering Clarification for Navigational Aids Runway Safety Area Improvements

Federal Aviation Administration

Memorandum

Date: APR 23 2010

To: All Regions
Attn: Manager, Airports Division

Jeff Tague, Manager, Central Service Area
Program Implementation Manager, AJV-C35

From: Rick Marinelli, Manager, Airport Engineering Division, AAS-100

Lansine Touré, Manager, Ground Based NAVAIDS and Lighting Systems Group, AJW-45

Subject: Amendment to Engineering Clarification for Navigational Aids Runway Safety Area Improvements

Background

This engineering clarification provides guidance for mitigating Runway Safety Area (RSA) violations for Navigational Aids (NAVAIDS) that are fixed-by-function. On July 13, 2009, the Airport Engineering Division distributed guidance for determining whether NAVAIDS are fixed-by-function and whether they meet frangibility requirements if located inside the RSA. A key part of this effort is to determine the corrective actions for NAVAIDS in the RSA and identify certain models that are fixed-by-function.

Fixed-By-Function Clarification

To optimize the operational performance of Precision Approach Path Indicator (PAPI) Power Control Assembly (PCA); Runway End Identifier Lights (REILs) Control Cabinet and Junction Box; Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) Individual Control Cabinets (ICC); High Intensity Approach Lighting System with Sequenced Flashers (ALSF-2) ICC; REIL ICC; End Fire Glide Slope (EFGS) subsystem and ancillary equipment, it is necessary for the ancillary items listed in attachment A to be considered fixed-by-function in accordance with the fixed-by- function definition in FAA Advisory Circular AC15/5300-13 Chapter 1, subsection 2 Definitions.

PAPI Power Control Assembly

The PAPI PCA was designed by the manufacturers to operate at a maximum distance of 25 feet from thefarthest Lamp Housing Unit's. The Technical Instruction Book, which provides the installation instructions from the manufacturers, identifies the recommended distance limits for the PCA. The operational performance of the NAVAID may be adversely affected if the PCA installation deviates fromthe manufacturers recommendations. However, the installation of the PCA requires a frangibility point no greater than three inches above the surrounding grade in accordance with FAA Advisory Circular AC 150/5220-23 Chapter 3, subsection 3.2 Frangibility Requirements. Refer to attachment A for a list of Facility Services and Equipment Profile (FSEP) facility identification codes that are fixed-by-function.

REIL Control Cabinet

The control cabinets were designed in accordance with FAA-E-2159, to operate at a maximum distance of 3000 feet from the ICC. However, due to airport physical constraints, some facilities may require the control cabinet to be installed closer to the ICC. If the airport physical constraints limit the location of the control cabinet inside the RSA then the control cabinet must be installed with a frangible point no greater than three inches above the surrounding grade.

REIL/MALSR/ALSF-2 Individual Control Cabinet

The ICCs were designed to operate with a maximum distance of 200 feet from the flasher unit. To ensure optimum performance of the flasher unit, the ICC is required to operate within the limits defined in FAA-E-2689 paragraph 3.2.5.2.1 Individual Control Cabinet. If relocated beyond the specified maximum distance, the operational performance of the Flasher Unit will be adversely affected. However, the ICC must be installed with a frangibility point no greater than three inches above the surrounding grade and the farthest distance away from the centerline without exceeding the maximum distance from the flasher unit. Refer to attachment A for a list of FSEP facility identification codes that are fixed-by-function.

REIL Junction Box (DME Corp FA-19900)

The FA-19900 REIL Identifier Unit Assembly (IUA) includes a small 10x8x6 junction box to terminate the conductors originating from the Control Cabinet. The IUAs were designed to operate with a maximum distance of 3,000 feet from the control cabinet. At this distance the power conductors required are #2 AWG to achieve a maximum voltage drop of three percent at the IUA junction box. The junction box contains the terminal blocks used to terminate the larger conductors coming from the control cabinet and transition to the smaller #22 AWG conductors that terminate into a quarter-turn quick-connect plug. The plug mates with a receptacle at the bottom of the IUA. There ·is no room available inside the IUA to install a terminal block to terminate the large conductors coming from the control cabinet. Therefore a junction box is required by the design to terminate the power and control conductors originating from the control cabinet. This design requirement makes the junction box fixed-by-function in accordance with AC 15/5300-13 Chapter 1, subsection 2 Definitions.

End Fire Glide Slope Antenna

The EFGS are installed at runways where image type glide slopes are unable to perform, due to limited terrain or geographical terrain constraints. The EFGS antenna is sited within close proximity of the runwayedge, with the front course antenna array located 25 feet off the runway edge. This distance is within the RSA. The operational requirements of the EFGS prevent relocation and is fixed-by-function in accordance with the fixed-by-function definition of AC 15/5300-13 Chapter 1, subsection 2 Definitions. The EFGS must be installed with a frangibility point no greater than three inches above the surrounding grade.

If you have any questions, please contact Rick Marinelli, Manager, Airport Engineering Division or LansineToure, Manager, Ground Based NAVAIDS and Lighting Systems Group, at (202) 267-7669 or (202) 493- 4771 respectively.

Attachment A NAVAIDs Fixed-by-Function

Facility ID Code	Manufacturer	Facility Type
3191	Sonicraft	PAPI
3192	Crouse-Hinds	PAPI
3193	AVW	PAPI
3194	NBP (FA-10620)	PAPI
3195	NBP (FA-17700)	PAPI
NCO1	DME Corp (FA-24000)	PAPI
313A	Sylvania	REIL
313B	Godfrey	REIL
313C	ADB-Alnaco	REIL
313E	DME Corp (FA-10264)	REIL
313F	DME Corp (FA-18300)	REIL
3130	Sonicraft (FA-9955)	REIL
313H	Multi-Electric (FA-8767-1)	REIL
313J	Hughney Phillips	REIL
313K	Electric Light Inc.	REIL
313L	Unitro International	REIL
313M	Visual Vector	REIL
NEA0	DME Coro (FA-19900)	REIL
326A	Multi-Electric	MALSR
326B	GTE-Sylvania	MALSR
326C	SEPCO-Crouse Hinds	MALSR
326E	AVW	MALSR
326F	ADB-Alnaco	MALSR
3260	Godfrey	MALSR
326H	DME-Corp (FA-11500)	MALSR
NW0I	DME Corp (FA-17900)	MALSR
NW02	DME Corp (FA-17900) with NBP (FA-21000)	MALSR
NW03	Godfrey (FA-10098) with NBP (FA-21000)	MALSR
NW04	Godfrey (FA-10267) with NBP (FA-21000)	MALSR
317A	General Electric	ALSF-2
317B	Westinghouse	ALSF-2
317C	Heavy-Duty	ALSF
317D	Hollingsworth	ALSF
317E	Godfrey	ALSF
3170	Airflow	ALSF
317H	NBP	ALSF

Note: Manufacturer's not listed will be evaluated on a case-by-case basis.