U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Air Traffic Organization Policy

ORDER
JO 6850.2B

Effective Date:
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SUBJ: Visual Guidance Lighting Systems

This order contains installation criteria for all visual guidance lighting systems installed under the Facilities and Equipment (F&E) Program. This order was revised to Revision B and includes Changes 1 through 4 from the previous version dated February 8, 1989.

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Distribution: Selected Air Traffic Organization Offices;
A-W(AS/FS) – 1; A-X(AS/FS) – 2; A-Y(AY/DE) – 1; A-FAF-0 (STD)

Initiated By: AJW-45

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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 installed under the Facilities and Equipment (F&E) Program.

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

3. Where can I find this order. You can find this order on the My FAA Employee website. Select Tools & Resources, and then select Orders and Notices.

4. Cancellation. This order cancels Federal Aviation Administration (FAA) Order 6850.2A including Changes 1 through 4 dated 2/8/89.

5. Explanation of Policy Changes. FAA Order 6850.2A was updated to provide clarification and include additional definitions to specific requirements. This order was revised to Revision B and includes Changes 1 through 4, dated February 8, 1989. Editorial changes were incorporated to comply with the U.S. Government Printing Office Style Guide. Several paragraphs in the order were modified as a result of comments received from must evaluators during the Clearance Record review process. The REIL Flight Inspection information was added to Chapter 4. Appendices D and E were added. Chapter 3 is now included in Appendix E and Appendix D includes the requirements for the Low Impact Resistant structures mounted in flood plain areas.

6. Application. The requirements of this Order shall be applied 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. 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 covered by a waiver. Waivers shall be processed in accordance with the latest edition of FAA Order 1800.66, Configuration Management Policy. All deviation from the standard installation criteria shall be coordinated with the Office of Flight Operations. Systems existing and installed under previous criteria do not need a waiver to the criteria contained in this document because the criteria herein apply only to new and relocated systems, and systems being modified.

8. FAA/Military Joint-Use Agreement. An agreement for establishing approach lighting systems at joint-use airfields has been agreed to by the Air National Guard (ANG) and the (FAA). This agreement supersedes the previous agreement of June 1959, and is included as Appendix A. Joint-use airports are listed in the latest edition of Order 5000.5, List of Joint-use Airports.

9. Flight Inspection. Before commissioning, all visual guidance lighting systems, including VASI, PAPI, and REIL, installed at airports with a public-use or military instrument approach procedure will receive a commissioning flight inspection to ensure that the system meets the requirements of the latest edition of FAA Order 8200.1, U.S. Standard Flight Inspection Manual.

10. Visibility Requirements. Visibility requirements for visual guidance lighting systems 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 the installation criteria may be made by the Director, Navigation Services, in coordination with the Office of Flight Operations, 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 to provide pilots with a visual reference for guidance purposes while operating an aircraft during approach for landing. These facilities are visual aids to the pilot and 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 of the aircraft. Consequently, these facilities must be reviewed constantly to ensure that they satisfy the changing operational procedures. New engineering developments, new materials, and improvements in manufacturing processes are also reviewed continuously, and where judged superior to those in use, that is technically better, more cost-effective, state-of-the-art, more reliable, or maintainable, are incorporated for use in visual guidance lighting systems.

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 landing of an aircraft.

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 one 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 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; Springfield, VA 22161.

15. Approach Lighting Systems (ALS). An approach lighting system is a configuration of signal lights disposed symmetrically about the runway centerline extended, starting at the landing threshold and extending outward into the approach zone. This system provides visual information 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. A complete description of the system configuration is given in chapter 2. The approach lighting system is classified as a high intensity or a medium intensity system, the distinction being made on the type of lamps and equipment used. The following is a list of approach lighting systems and their intended use. The selection criteria for these systems for official planning purposes are contained in the latest edition of Order 7031.2, Airway Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Services.

a. Medium Intensity Approach Lighting System (MALS). An economy type system for non precision approaches.

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.

c. Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). An economy type system used as the FAA standard for category I precision runways.

d. Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR). Used the same as MALSR. Generally, the SSALR is not to be installed as a new system. This configuration is used when category I conditions exist on category II designated runways with a dual mode approach lighting system (ALSF-2/SSALR).

e. High Intensity ALS with Sequenced Flashers (ALSF-2). Used on category II and III precision approach runways. FAA Headquarters approval is required before installing a new ALSF-2.

f. Omnidirectional Approach Lighting System (ODALS). 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. Reserved. The VISUAL APPROACH SLOPE INDICATOR (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 end of a runway. The system consists of two synchronized flashing lights, unidirectional or omnidirectional, one on each side of the runway landing threshold. The unidirectional flashing lights face the approach area. The flashing feature of the lights provides an attracting characteristic, making the REIL effective for identification of a runway 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. An 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 shall 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 shall flash in sequence toward the runway. The light groups shall be spaced closely 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 shall be compatible with the requirements of U.S. Standards 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 multilamp units, referred to as lamp housing assemblies (LHA's), equally spaced, and (2) a power and control unit (PCU). The LHA's 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 5 minutes of arc at the beam center and results in a well-defined corridor of light consisting of white (top) and red (bottom) beams. Details of the system configurations are covered in chapter 5.

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 runway alignment indicator light (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 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 Service, Airway Facilities Service, Flight Standards Service, and Airports Service; and a letter dated November 28, 1975, to all regions from the Airports Engineering Division. These two letters are contained in appendix C and are 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 System Operations, Mission Support, Office of Airport Safety and Standards, and Flight Standards; to group level in the Safety and Operations Support, Aviation System Standards, Navigation Services, 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 Areas and the Service Centers; to the regional Airports and Flight Standards divisions; and to all Technical Operations field offices with a standard distribution.

23 – 199. Reserved.

CHAPTER 2. INSTALLATION CRITERIA - APPROACH LIGHTING SYSTEM (ALS)

200. System Configuration.

a. ALSF-2. This configuration is for category II and category III runways. The ALSF-2 consists of a light bar (approximately 13½ feet long with five equally spaced lights) at each 100-foot interval starting 100 feet from the runway threshold and continuing out to 2,400 feet from the threshold. 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 light bar of 100 feet and containing 21 lights. This bar is called the 1,000-foot distance marker crossbar (or simply 1,000-foot bar). Also, there is 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 five 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, both configurations are augmented with a system of sequenced flashing lights. One such light is 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 toward the runway threshold. The flashing lights have three intensities coordinated with the intensity of the steady-burning light in the approach lighting system. All lights are aimed into the approach to the runway and away from the runway threshold.

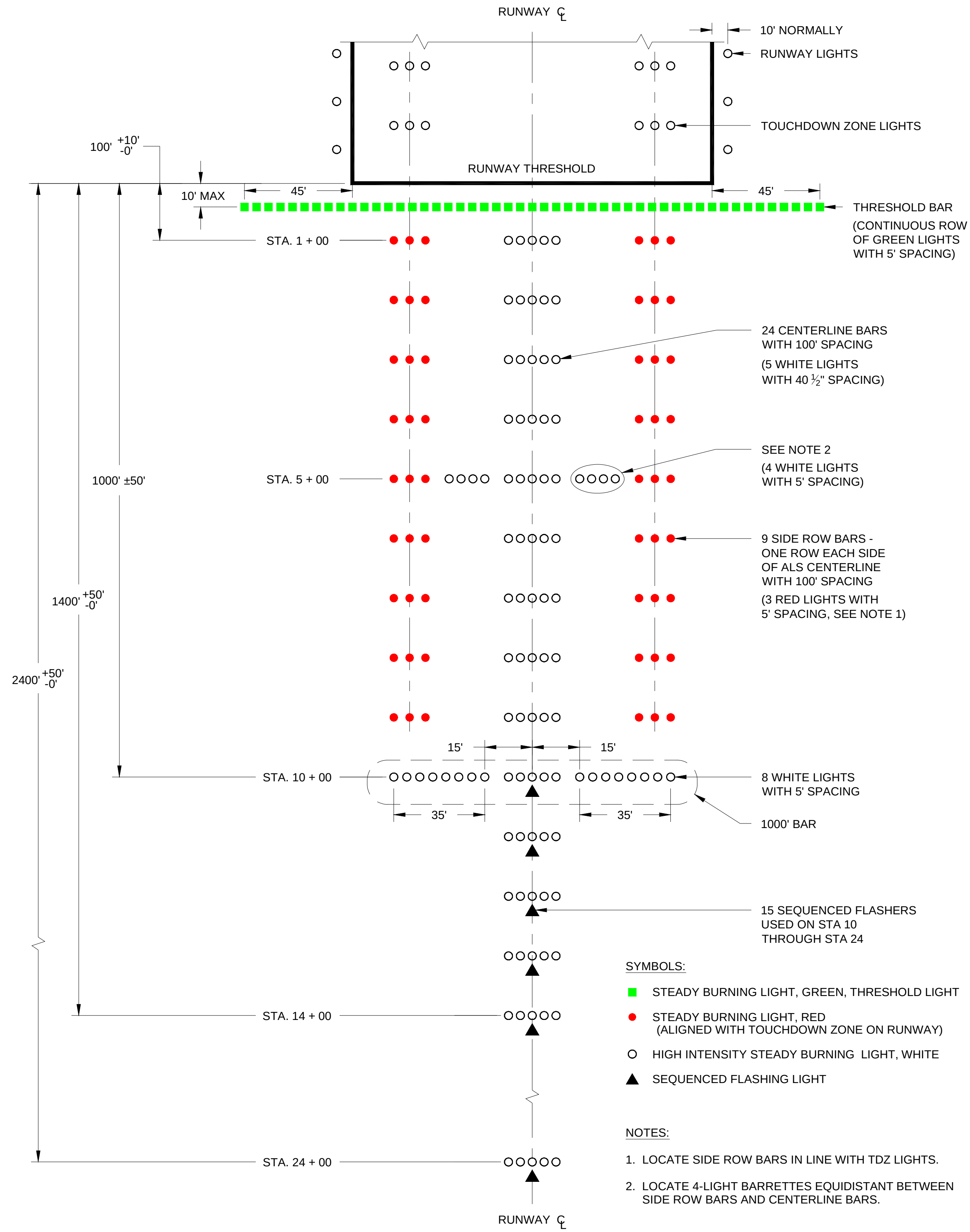


FIGURE 2-1. ALSF-2 CONFIGURATION

c. SSALR. The SSALR configuration consists of a threshold bar and seven five-light bars 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, 1,000 feet from the runway threshold forming a crossbar 70 feet long. The spacing between individual lights is 40½ inches for the centerline bars and five feet for other bars. All lights in the system are white except for the threshold lights. The threshold lights have green filters. The threshold lights are a row of lights on 10-foot centers located coincident with and within the runway edge lights near the threshold 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 operated as a subsystem of the ALSF-2.

d. MALS. The MALS consists of a threshold light bar and seven five-light bars located on the extended runway centerline with the first bar 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 five-light bars are located, one on each side of the centerline bar, 1,000 feet from the runway threshold forming a crossbar 66 feet long. 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. These lights have green filters. The threshold lights are a row of lights on 10-foot centers located coincident with and within the runway edge lights near the threshold and extend across the runway threshold. The MALS configuration is shown in figure 2-3.

e. MALSF. The MALSF consists of a MALS with three sequenced flashers located at the last three light bar stations. These flashers are added to the MALS at locations where high ambient background lighting, or other reasons, requires these lights to assist pilots in making an earlier identification of the system. 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.

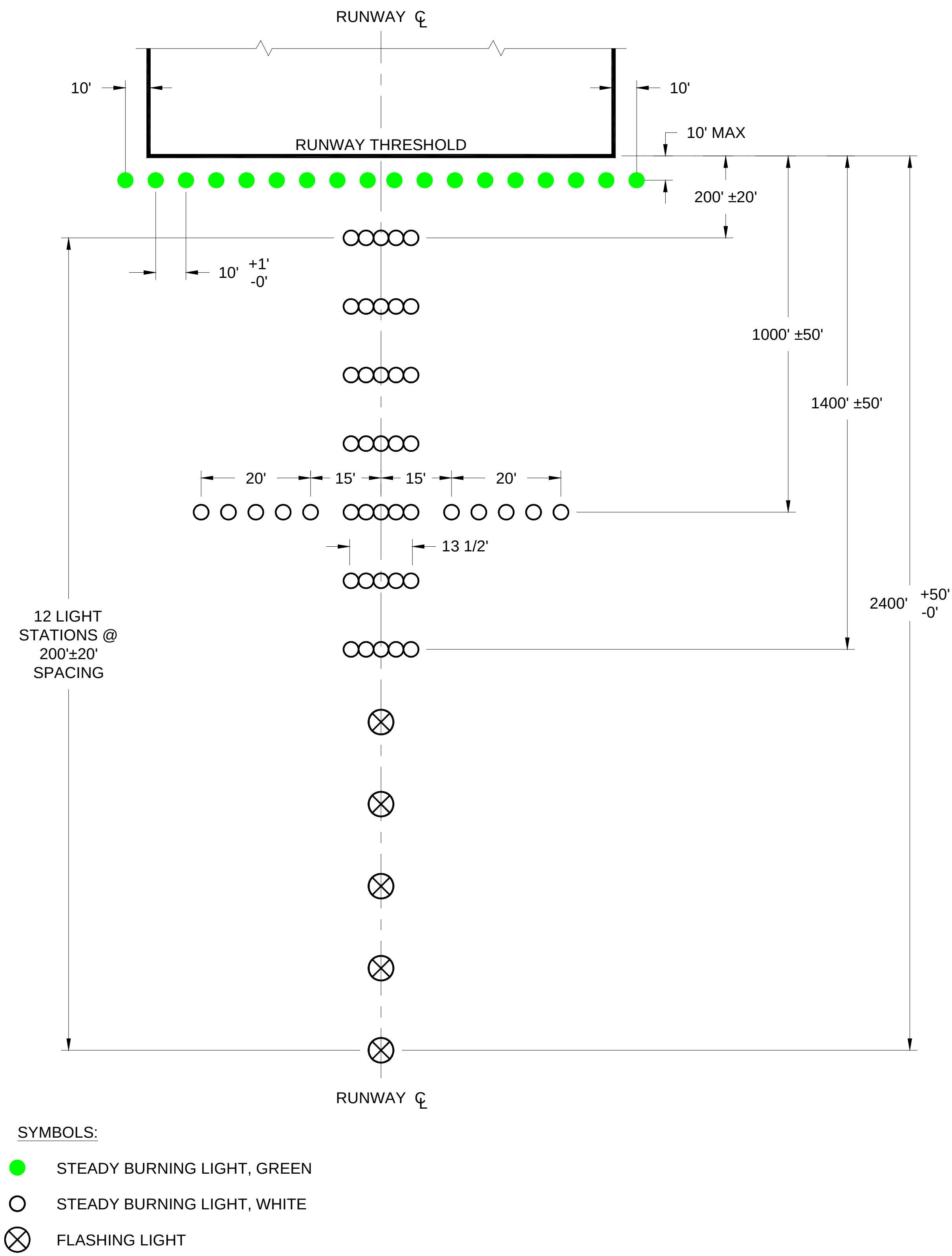
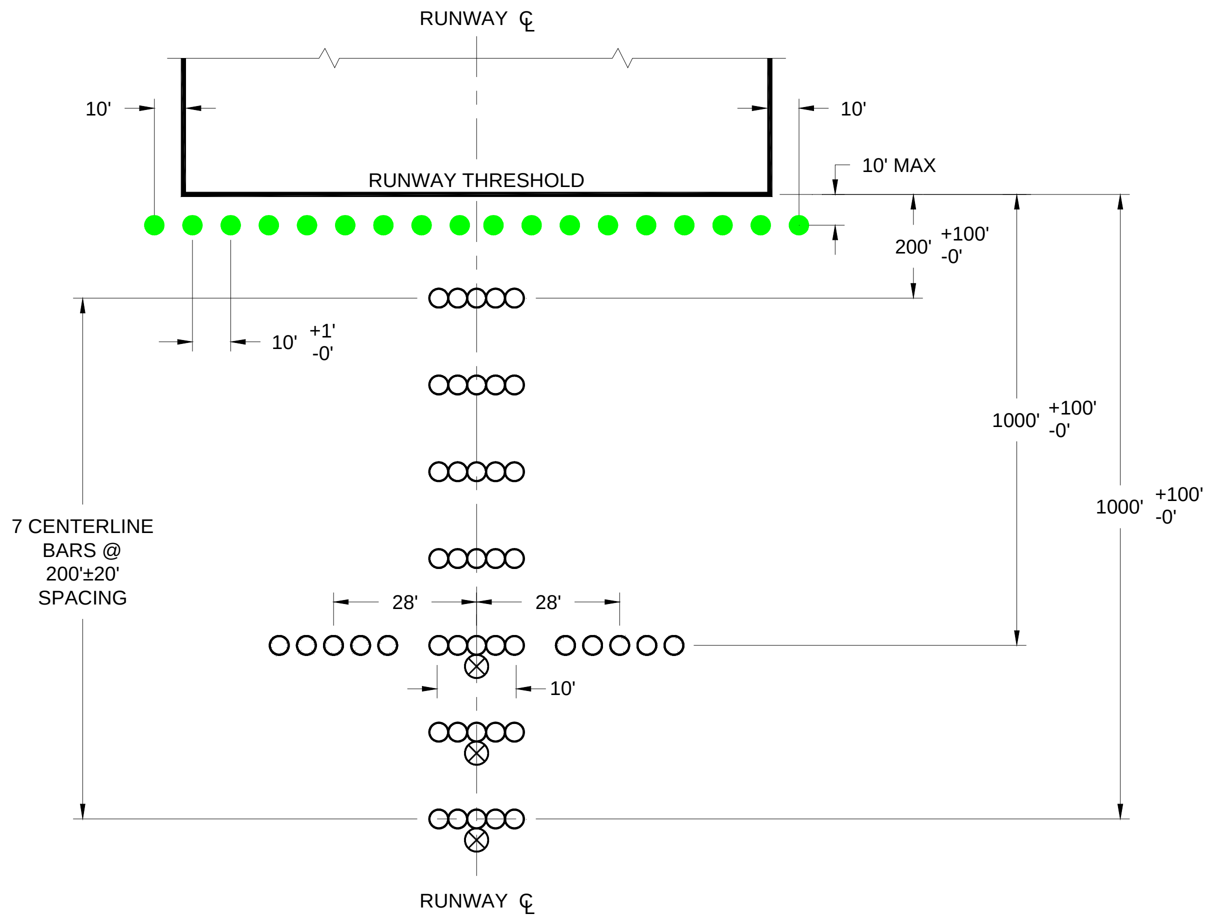


FIGURE 2-2. SSALR CONFIGURATION



SYMBOLS:

- STEADY BURNING LIGHT, GREEN
- STEADY BURNING LIGHT, WHITE
- SEQUENCED FLASHING LIGHT (FOR MALSF ONLY)

FIGURE 2-3. MALS AND MALSF CONFIGURATION

f. MALSR. This configuration is for category I runways. 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 being 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 centerline extended with the first light located 300 feet from the threshold and extending at equal 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.

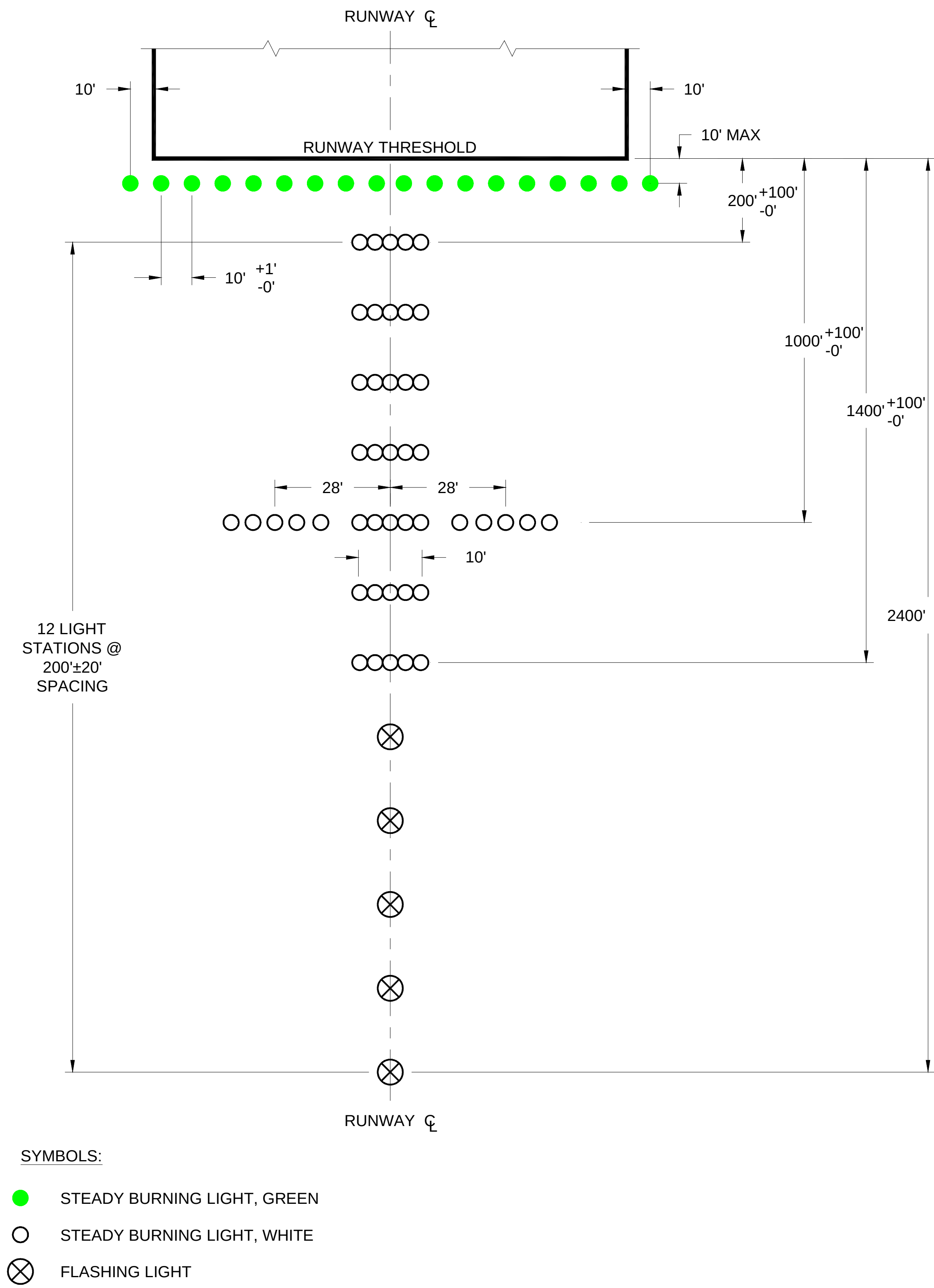
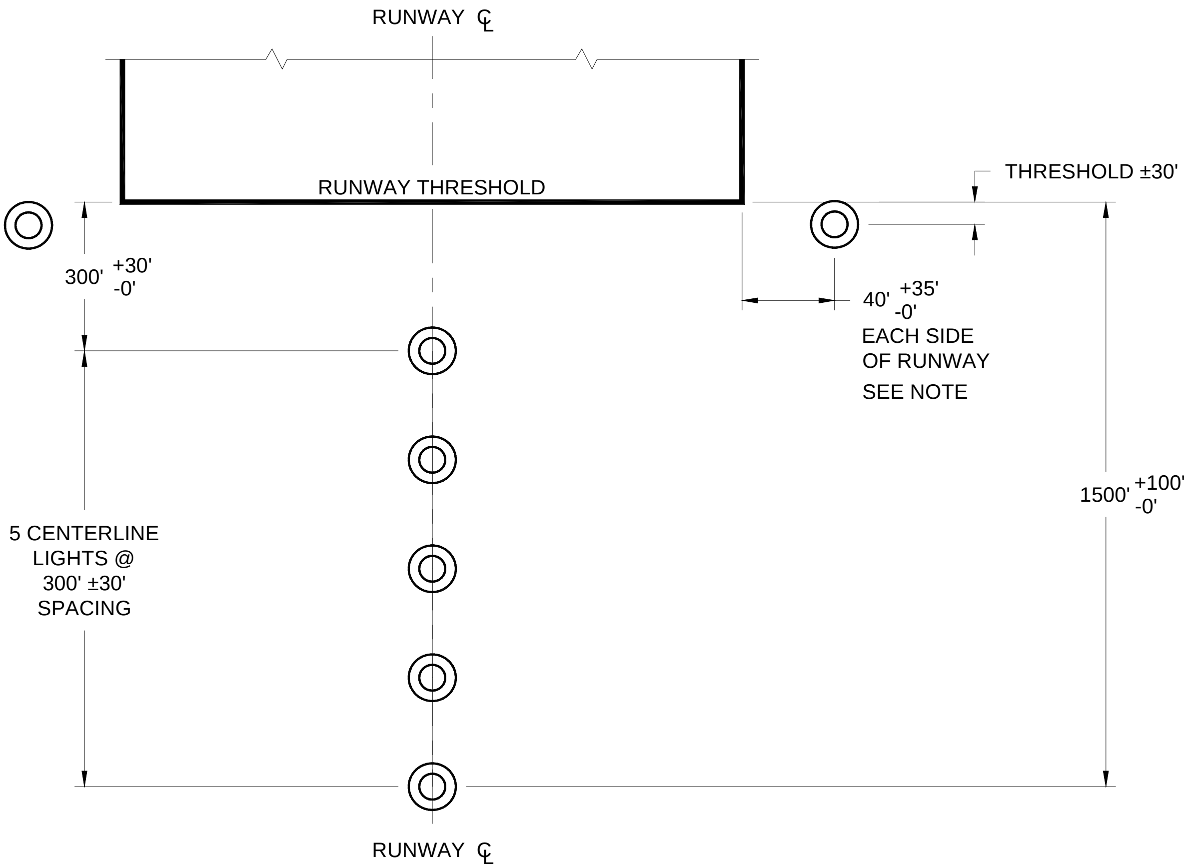
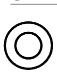


FIGURE 2-4. MALSR CONFIGURATION



SYMBOLS:



OMNIDIRECTIONAL FLASHING LIGHT

NOTE:

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

FIGURE 2-5. ODALS CONFIGURATION

201. Ideal installation. The ideal installation of an approach lighting system, which shall be accomplished whenever practicable, is accomplished when the following requirements are met:

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 above 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 shall be as shown in figures 2-1 through 2-5.

d. Visibility. There is a clear line-of-sight to all lights of the system from any point on a surface, one-half degree below the ILS glide path 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 ILS, a three degree glide path, intersecting the runway 1,000 feet from the landing threshold, is assumed for determining the visibility requirement.

e. RAIL. The ideal installation of the RAIL portion 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 runway centerline extended, and a surface that follows the plane of the RAIL System.

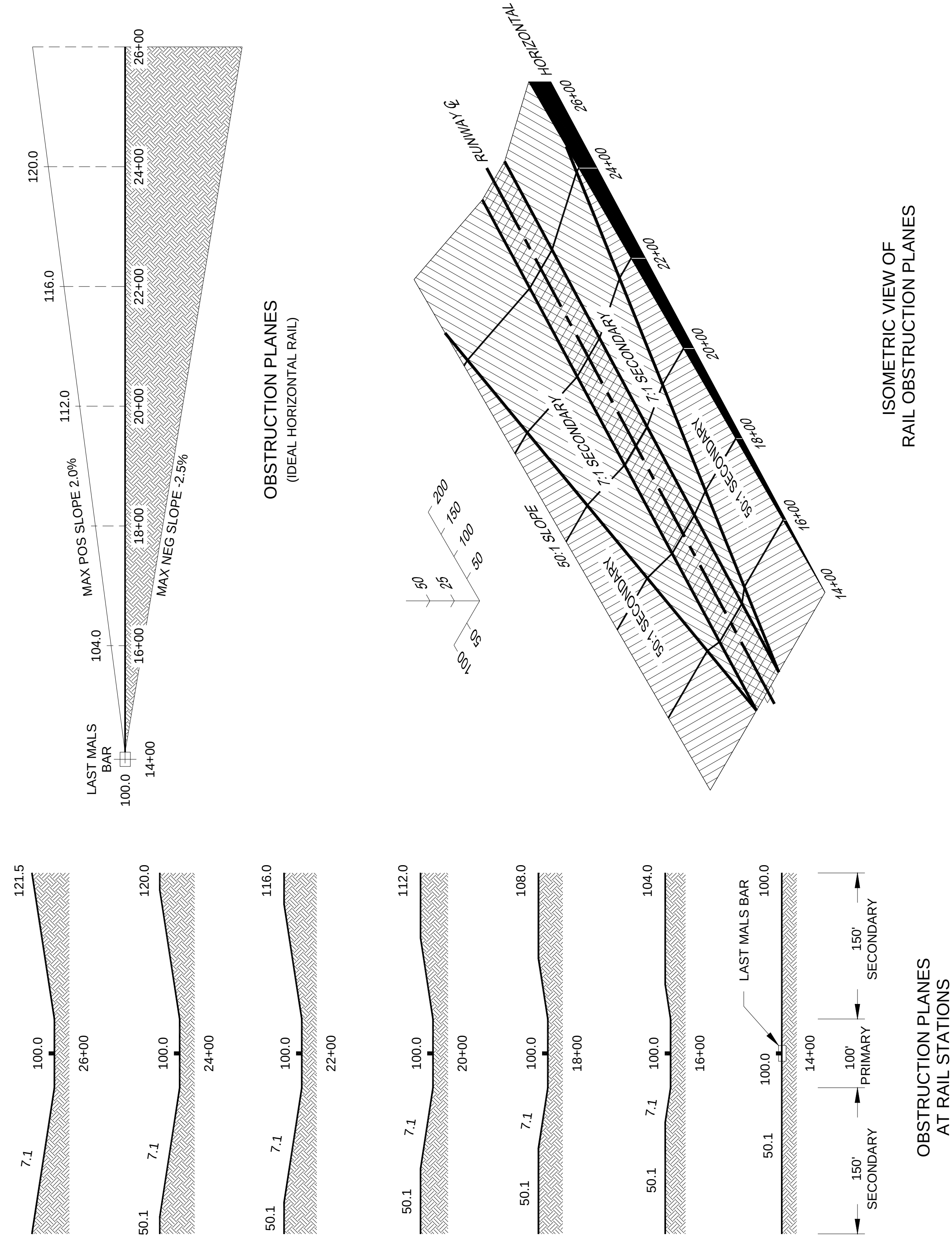


FIGURE 2-6. IDEAL RAIL OBSTRUCTION CLEARANCE

(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. No object shall penetrate either the primary or secondary plane.

202. Permissible deviations. The deviations discussed below are siting and installation tolerances, which do not require a formal waiver request.

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 end 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. Other variations of light assembly designs above the light plane are acceptable only where so designated on standard drawings. The light plane may also be lowered where sharply descending terrain makes it economically necessary.

(1) Slope Gradient. The slope gradient shall be kept as small as possible and shall not exceed two percent for a positive slope nor one 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 shall start at runway approach end elevation. Where the landing threshold is displaced greater than 200 feet from the runway approach end, the slope gradient shall start 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 shall 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 shall 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 centerline at the approach end of system.

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

b. Clearance.

(l) Where necessary to ensure an acceptable level of performance of an instrument landing system (ILS), antennas and their associated supports for the marker beacon and/or localizer may on a category I approach penetrate the approach light plane. These antennas, or their supports, shall not, however, obscure any light of the approach lighting system. This exception applies only to penetration of the approach light plane and in no way refers to the ILS or non-ILS approach surfaces as defined in Terminal Instrument Procedure (TERPS) or Part 77 of the Federal Aviation Regulations (FAR). Penetration of the 50:1 surface or the approach light plane is prohibited 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 is located within the approach light system, the approach light plane shall be set so that the marker shelter is below the light plane.

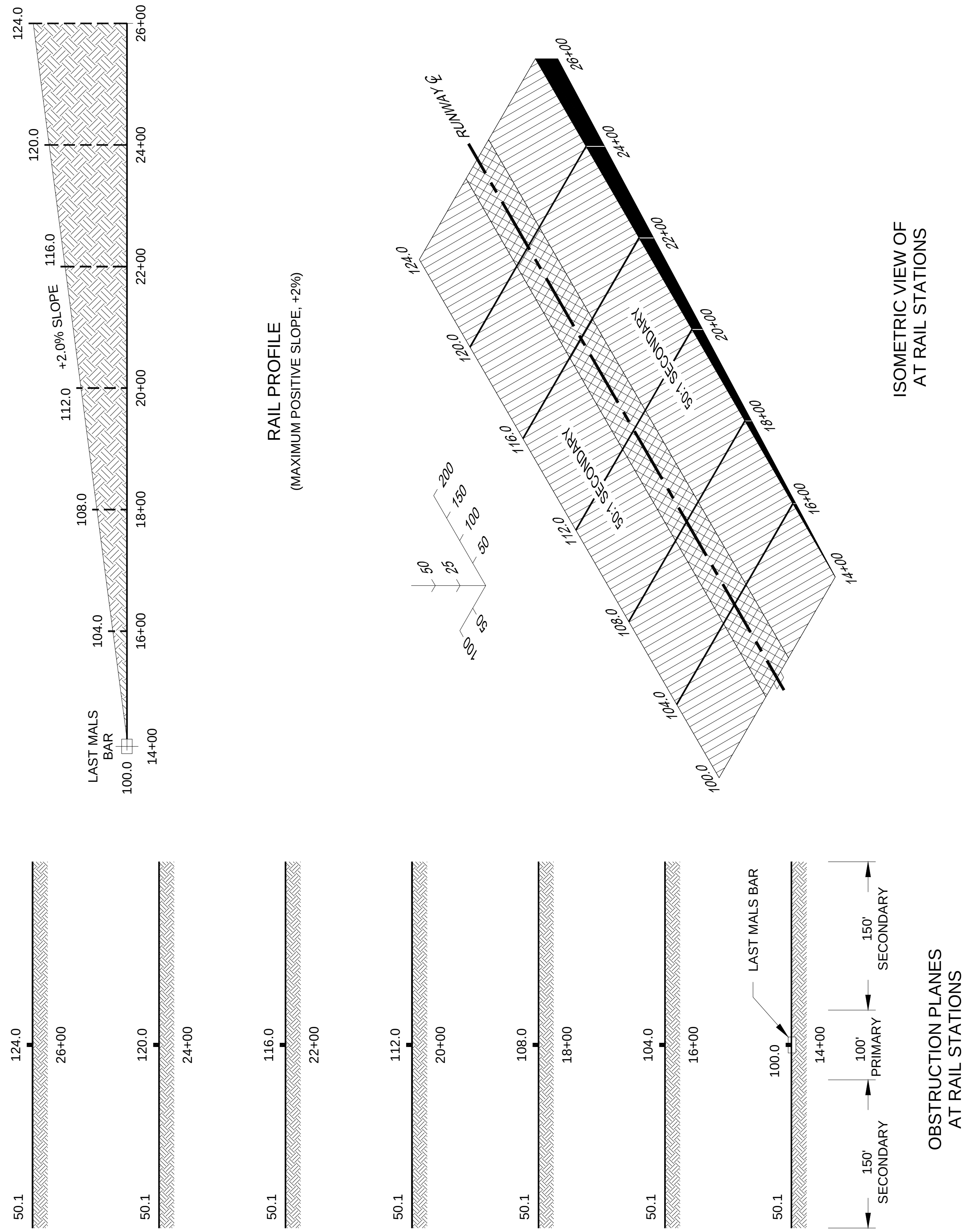


FIGURE 2-7. RAIL OBSTRUCTION CLEARANCE FOR +2.0% SLOPE

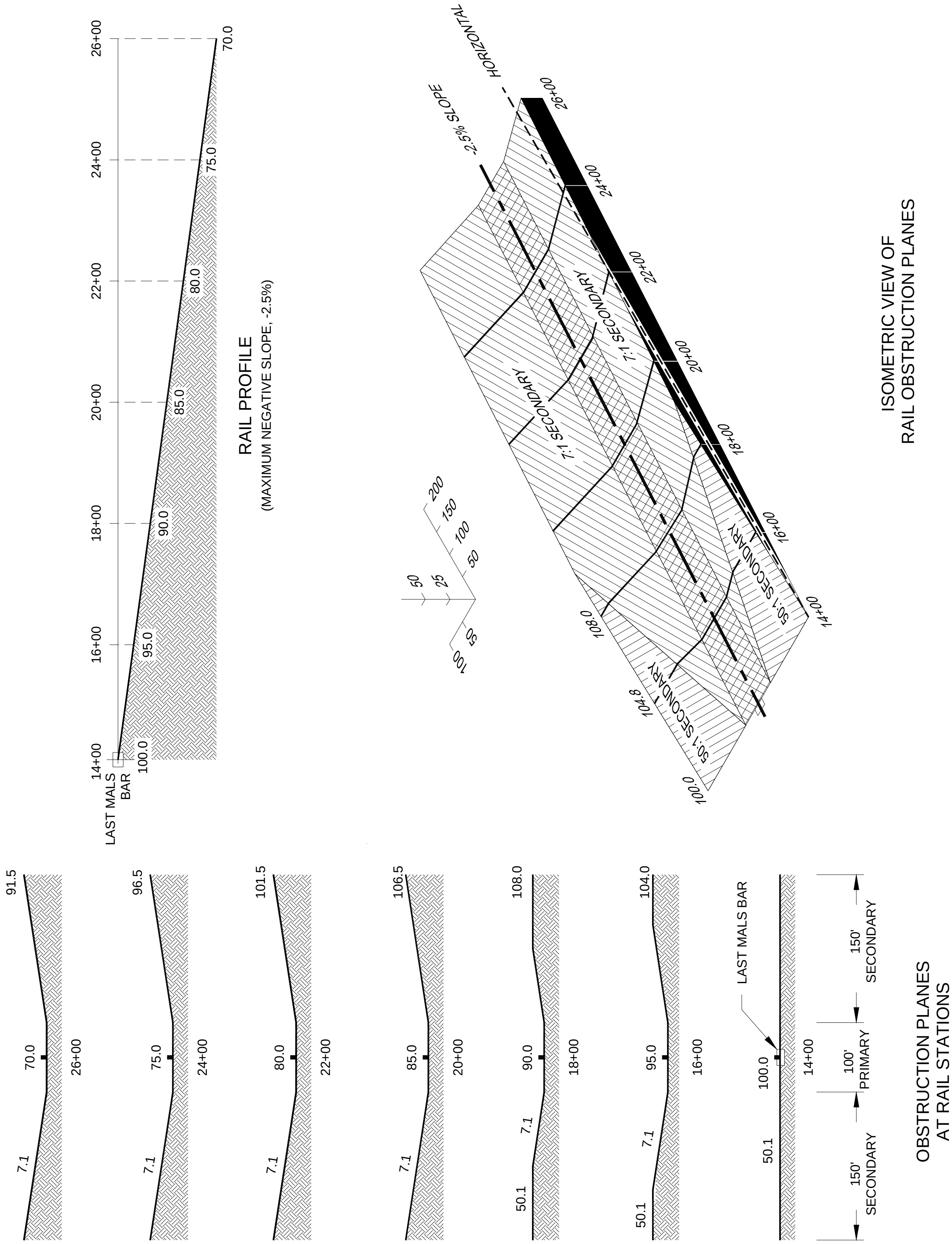


FIGURE 2-8. RAIL OBSTRUCTION CLEARANCE FOR -2.5% SLOPE

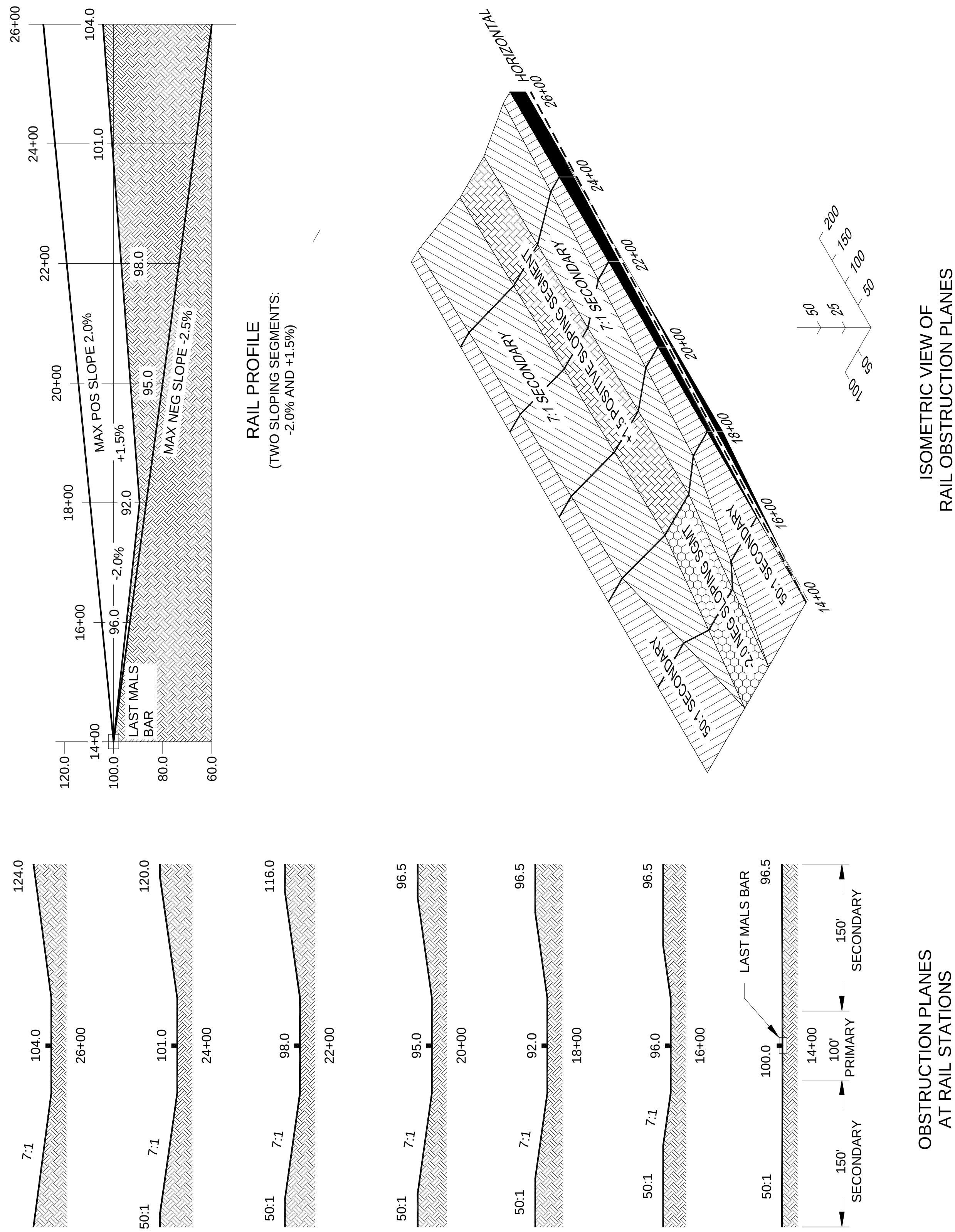


FIGURE 2-9. TYPICAL RAIL OBSTRUCTION CLEARANCE FOR TWO SLOPING SEGMENTS

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 of l0 feet. The threshold lights shall 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 four 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 of five feet along the ALS centerline into the approach from the steady-burning light bar.

(4) While the light support structures for light heights from six 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 six feet - ± 1 inch.

(b) Over six 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 shall be installed at runway centerline threshold elevation, + 1 foot to - 5 feet.

e. System Length. The system length shall 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 shall be used only in displaced threshold areas or in overrun areas at military-civil, joint-use airports when required by the military.

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

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

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

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

204. Lighting Fixtures.

a. High Intensity Systems.

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

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

(3) Specifications FAA-E-2952 or FAA-E-2491 approach lights, 500-watt, for all semiflush lights.

(4) Specifications FAA-E-2628b or FAA-E-2689a for all sequenced flashers.

b. Medium Intensity Systems.

(1) 120-watt, 120V, PAR-38, spot lamps, General Electric wattmiser or equal steady-burning lights (except threshold). Osram 14856, 120-watt, 120V, PAR-38; General Electric 26371, 150-Watt, 120V, PAR-38 spot lamps, or equal, for above ground steady-burning lights (except threshold).

(2) Specification L-850-B (Advisory Circular 150/5345-46), 200-watt, semiflush light units, unidirectional (except threshold). Specification FAA-E-2968, Steady Burning, Semiflush Approach Light units for Medium Intensity Approach Lighting System with Runway Alignment Indicator lights (MALSR).

(3) Specifications FAA-E-2325e, FAA-E-2980, and FAA-E-2628b, sequenced flashers.

(4) Specification L-850-E (Advisory Circular 150/5345-46), 200-watt, semiflush light units, unidirectional, with green filter. Specification (FAA-E-2891, Steady Burning, Semiflush Threshold Approach Light Assembly of the Medium Intensity Approach Lighting System with Runway Alignment Indicator lights (MALSR).

(5) 300-watt, 120V, PAR-56 lamps for steady-burning, above ground green lights for threshold with Specification FAA-E-982J lampholder.

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

205. Control and Monitoring Requirements.

a. Control Requirements. Remote control shall 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 shall have landline control. The remote control head has an indicating panel that indicates the last selection for each particular system. Sequenced flashers are 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 IIIa instrument approach procedures. Monitoring is not required for category I approach lighting systems. The monitoring equipment shall provide an indication of whether power is being delivered to the lamps when the system is energized.

c. Remote Maintenance Monitoring Requirements. Remote maintenance monitoring is required for maintenance purposes. The ALSF-2 remote maintenance monitoring shall monitor the system the same on all five brightness steps.

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

a. ALSF-2 Vertical Alignment. The ALSF-2 steady-burning lights are vertically aligned using a visual segment modified method that establishes the alignment as listed in table 2-1. The angular settings in table 2-1 are empirically determined for a three 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 VS-400 visual segment method that establishes the alignment as listed in table 2-2. The angular settings in table 2-2 are empirically determined for a three 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 shall be shifted by the amount that the glide slope is shifted from three degrees. The correction for vertical alignment due to displacement of lights above and below the horizontal plane through the threshold shall be calculated using the equation shown in figure 2-10. However, on the ALSF-2 no lamp elevation setting shall be greater than nine degrees or less than six 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 from the normal 1,000-foot touchdown point; subtract 0.1 degree when the glide slope touchdown point is moved 200 feet toward the threshold from a 1,000-foot touchdown point.

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

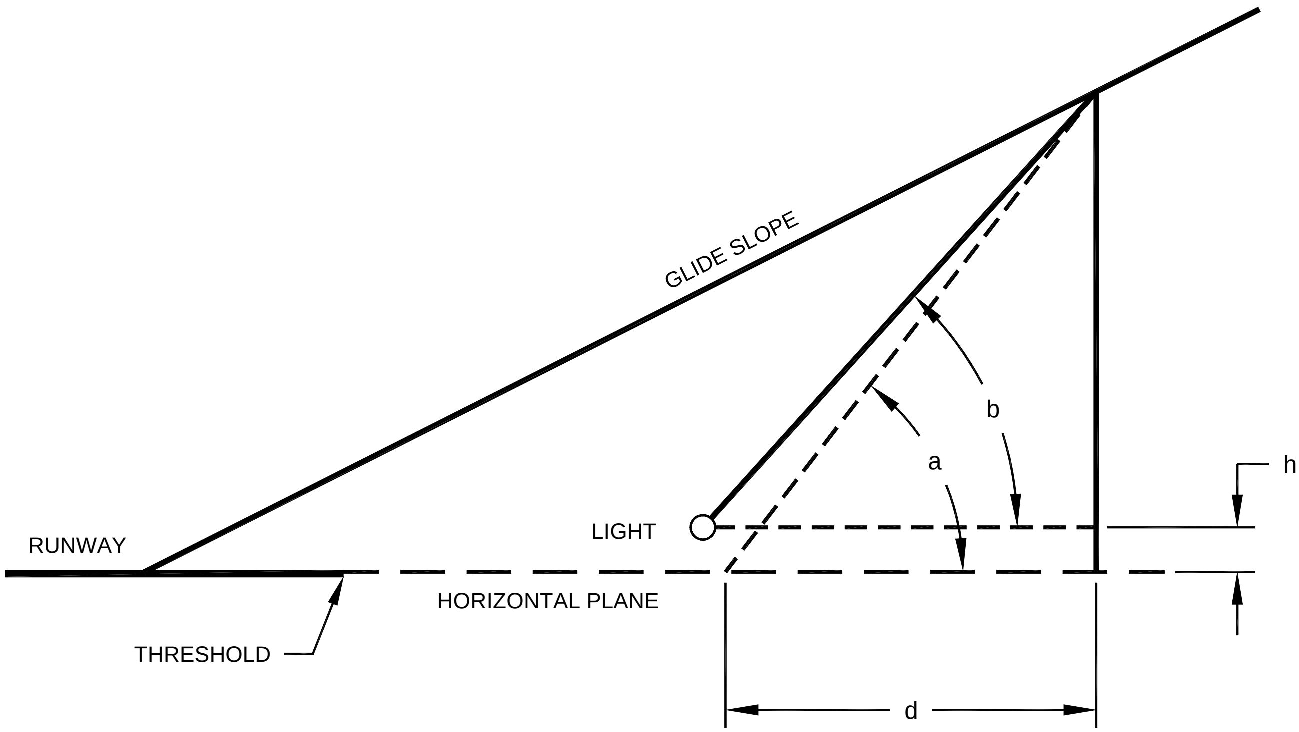
208. Penetration of Approach Surface. With the exception of the frangible lights at stations 0+00, 1+00, and 2+00, no other component of an approach lighting system may penetrate the ILS or non-ILS approach surface detailed for civil use in TERPS or Part 77 of the Federal Aviation Regulations.

TABLE 2-1. Elevation-Setting Angles for Q20A/PAR56 Approach Lighting 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 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 FOR ALSF-2.

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

NOTE:

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

FIGURE 2-10. CORRECTION OF ELEVATION-SETTING ANGLE FOR APPROACH LIGHTS DISPLACED FROM THE HORIZONTAL PLANE PASSING THROUGH THE THRESHOLD

209. MISCELLANEOUS PROVISIONS.

a. Location of Power Equipment. The ALSF-2 substation and the power and control station for the MALS (also MALSF and MALSR) and ODALS shall be located no closer than 400 feet to the ALS centerline. The location shall 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 indoor installation (1) where a storage shed 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 shall be provided for servicing all component parts of an approach lighting system. An access road is provided to the power and control equipment station. Existing access roads should be utilized as much as possible. 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. Access roads, where required, should meet the minimum requirements of the latest edition of Order 6940.2, Access Road Cross Sections and Typical Drawing Details for FAA Facilities.

c. Storage Shed. A suitable storage shed should be provided if there are no existing facilities adequate for this purpose. Only one storage shed per airport should be provided.

d. 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 shall be provided between the light plane and the rigid structure. In order to maintain the 20-foot separation, lights shall 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 National Air Space (NAS) Change Proposal 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 shall 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 Resistance (LIR) Installation. See Appendix D.

TABLE 2-3. Brightness Steps

	Steady-Burning Lights		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	2[c]	100-4	-	-
MALSF	2[c]	100-4	2[c]	100-8
MALSR	3	100-20-4	3	100-(26 and 8)[b]-1
MALSF	3	100-20-4	3	100-10-2.3
ODALS	-	-	3	100-30-1.4

a. The ALSF-2 has a subsystem SSALR, 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.

b. The middle step has 26 percent brightness on the four outermost (farthest from threshold) lights and eight percent on the four inner lights of a 3,000-foot system; eight percent brightness on the five lights of a 2,400-foot system.

c. Only two intensity steps are required for the MALS and MALSF; however, three intensity steps are desirable.

CHAPTER 3. RESERVED

(For INSTALLATION CRITERIA – VISUAL APPROACH SLOPE INDICATOR SYSTEM (VASI), see Appendix E)

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. Typical location of the lights is as shown in figure 4-1.

401. Location of light units. The light unit shall 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 should be employed as required to keep the light units a minimum distance of 40 feet from other runways or taxiways. The light units shall 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 exceeded 10 feet. The elevation of both units shall be within 3 feet of a horizontal plane through the runway centerline. Both light units shall 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 shall be located 75 feet from the runway edge (this does not apply for PAPI).

402. Orientation of light units.

a. Unidirectional Systems. The light units shall 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 utilized 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.

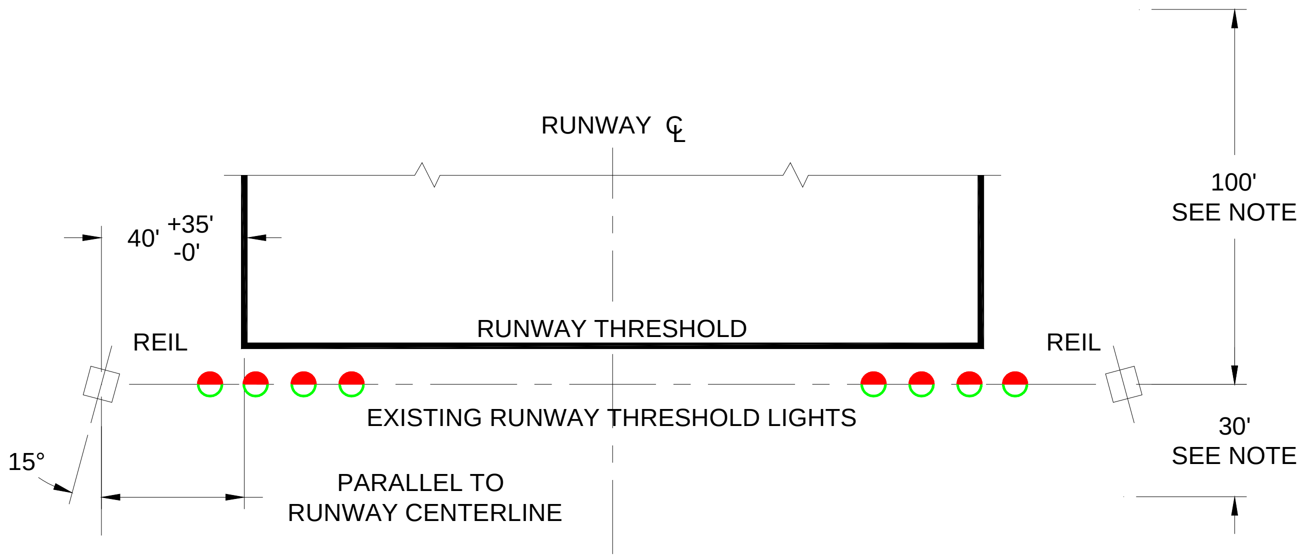
b. Omnidirectional Systems. The light units are aligned when light units are plumb.

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 5.

403. Lighting fixtures. Flashers made in accordance with the following specifications may be used:

a. FAA-E-2159, Runway End Identifier Lights System (REIL).

b. FAA-E-2325, Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR).



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

c. FAA-E-2628, Capacitor-Discharge Sequenced Flashing Lighting System with Runway Elevated, and Semiflush with Dimming and Monitoring.

404. Power source. The electric power shall be obtained from the most economical source, either from a constant voltage power source extension or from the constant current runway edge lighting circuit.

405. Control. The REIL shall 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 lighting circuit. The sensors changing brightness in conjunction with runway lighting brightness 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, shall be by landlines or radio control. Radio control shall meet the requirements of Appendix B. Radio remote control equipment, may be installed where any of the following conditions exist:

(1) Closely spaced, parallel, staggered runways.

(2) Closely spaced, parallel runways.

(3) Diverging runways where approach ends are in close proximity to each other.

(4) Runways with displaced thresholds.

(5) Where environmental considerations such a snow, fog, etc., prevail.

406. Monitoring. There are no operational or maintenance monitoring requirements for the REILs. It is not required that both lights automatically shut off in the event of failure of one light.

CHAPTER 5. INSTALLATION CRITERIA – PRECISION APPROACH PATH INDICATOR (PAPI) SYSTEM

500. Description.

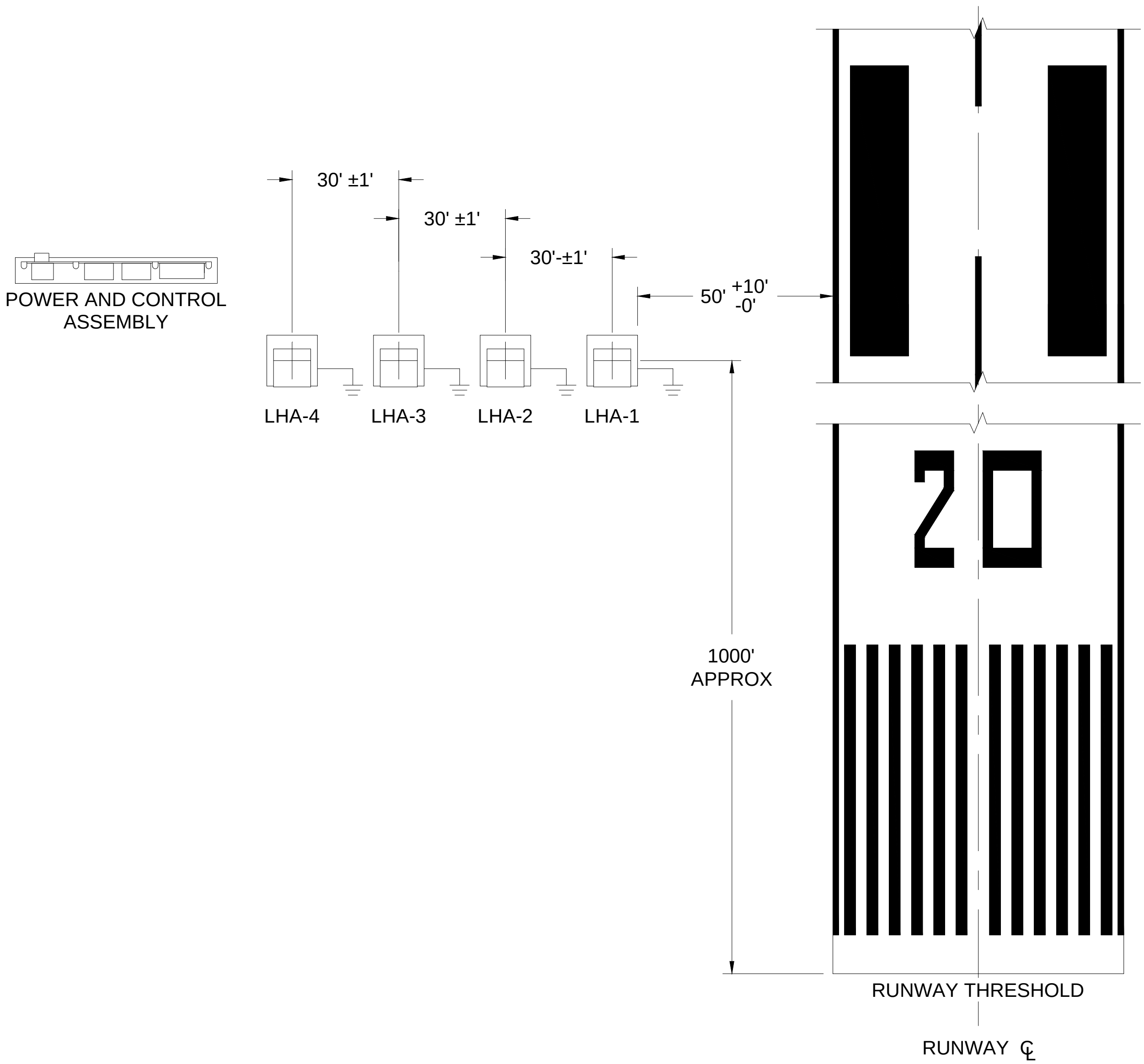
a. The Precision Approach Path Indicator (PAPI) System, when properly installed and oriented, will furnish the pilot with visual approach slope information to provide guidance for safe descent. The system is intended primarily for use during visual flight rule (VFR) weather conditions. The PAPI is provided 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 16, and is shown in figure 5-1. All lamphousing assemblies (LHA's) should be located on the left side of the runway, as viewed from the approach direction. However, where terrain, 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 LHA's 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. Figure 5-3 shows the glide path angles where the PAPI will provide different color patterns.

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. If the runway has an electronic landing system glide slope already established, the PAPI is installed as described in paragraph 502 so that the visual glide path angle will coincide with the electronic glide slope. If there is no electronic glide slope on the runway, the PAPI glide path angle is chosen as described in paragraph 503. Aiming of the LHA's is described in paragraph 504. Other siting tolerances and considerations which are common to all PAPI installations are described in paragraph 505.

502. Siting PAPI on a runway with an electronic ILS glide slope. When siting PAPI on a runway with an established electronic glide slope, the PAPI visual approach path should coincide, as much as possible, with the one produced electronically. To accomplish this, the PAPI is placed at the same distance from the threshold as the virtual source of the electronic glide slope within a tolerance of ±30 feet (±10 m). The PAPI is aimed at the same angle as the electronic glide slope. The procedure must be modified for runways that serve aircraft in height group 4 (see table 5-1) due to the distance between the pilot's eye and the electronic antenna. For these locations, the distance of the PAPI from the threshold shall equal the distance to the electronic glide slope source plus an additional 300 feet +50, -0 (90 m +15,-0). Where the glide slope path is not standard, the glide slope path NCP shall apply and shall determine the PAPI approach path.



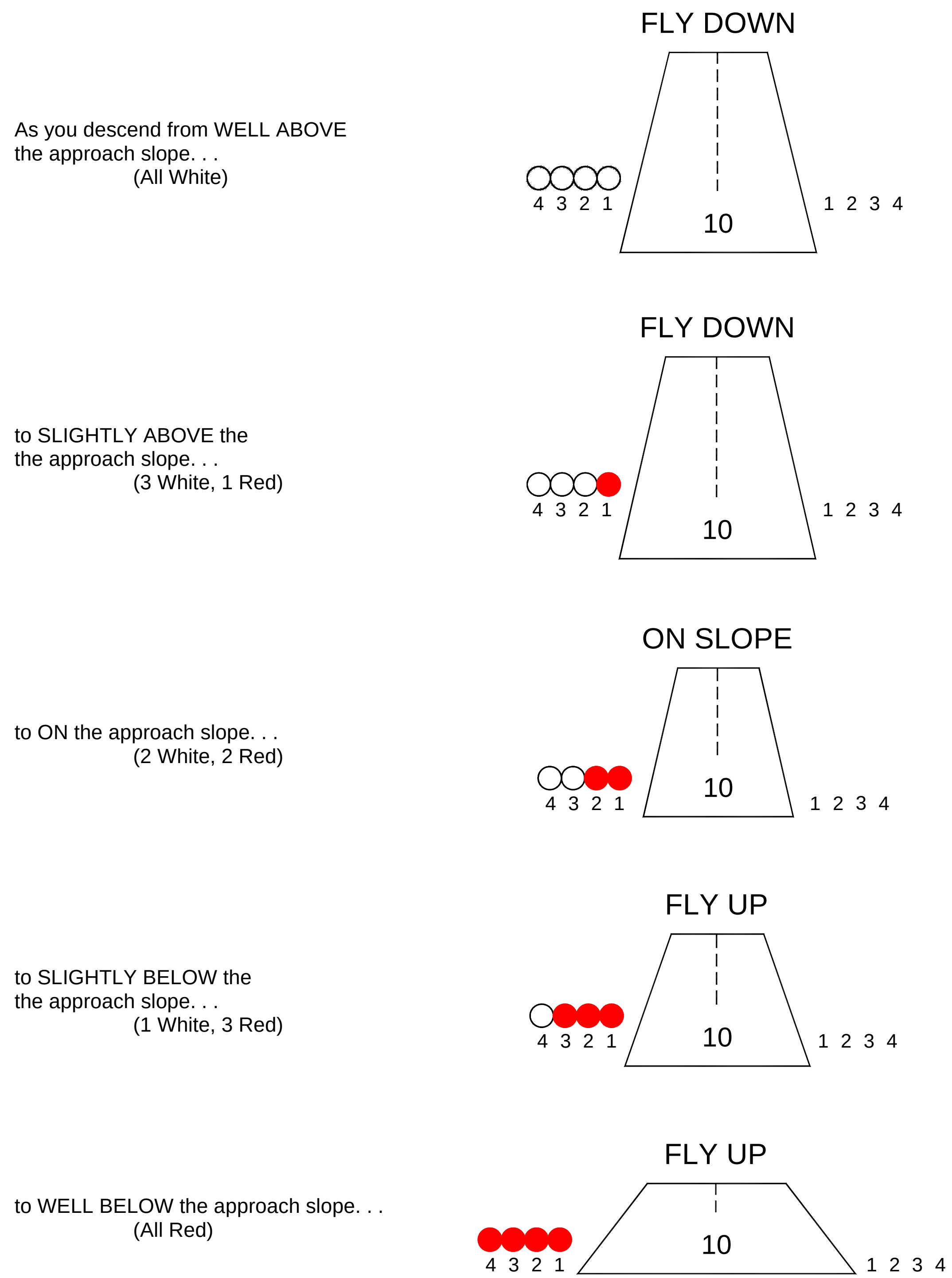
SYMBOLS:

LAMP HOUSING ASSEMBLY (LHA)

NOTE:

LHAs ARE NUMBERED SEQUENTIALLY OUTWARD FROM RUNWAY CENTERLINE

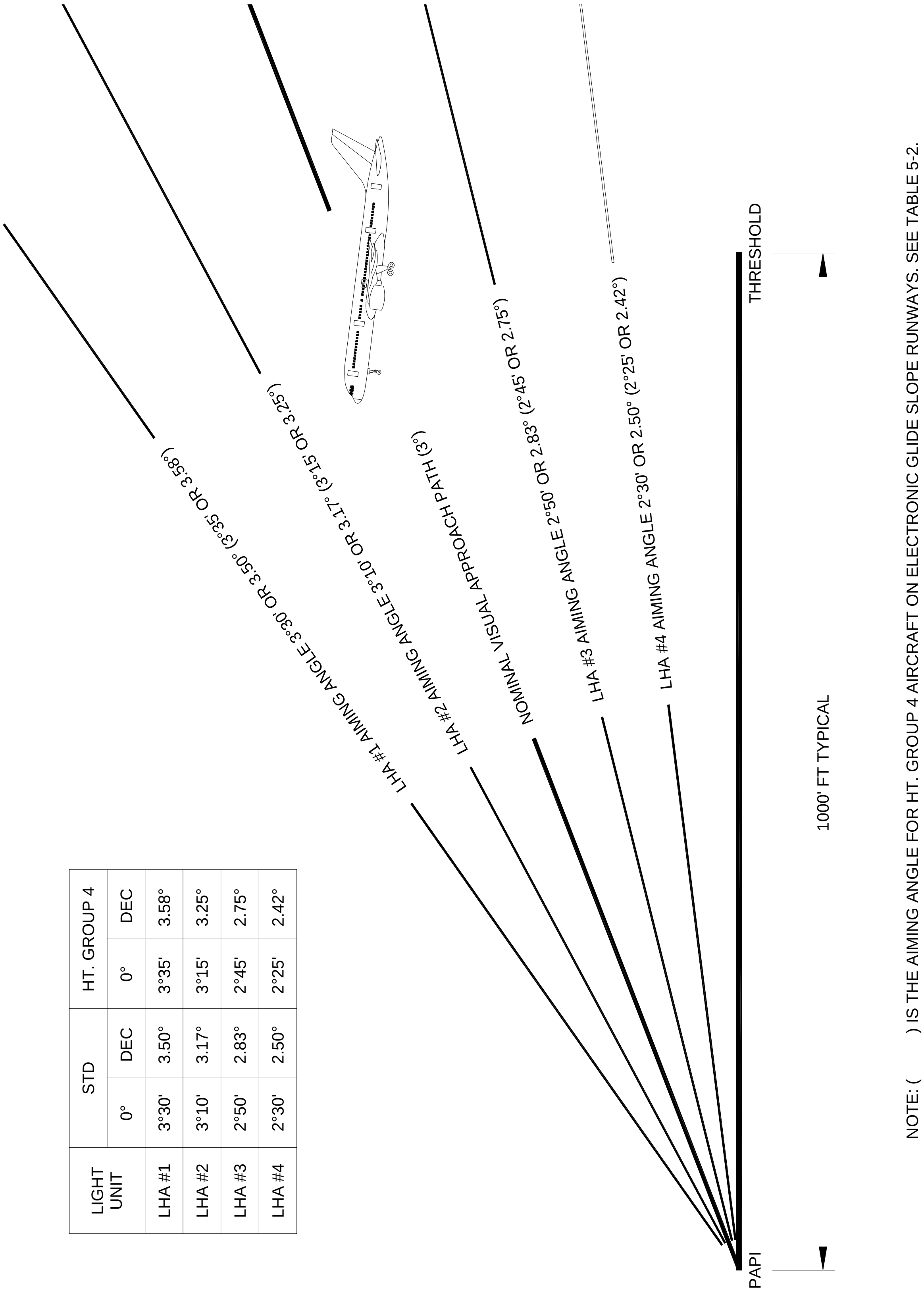
FIGURE 5-1. PAPI SYSTEM CONFIGURATION



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.

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.

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 an electronic glide slope. When an electronic glide slope is not present, determine a position and aiming for the PAPI which 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 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 most demanding height group that uses the runway.

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> F-28, CV-340/440/580 B-737, DC-9, DC-8	15 feet	45 feet +5, -20 14 meters +2, -6	Regional airport with limited air carrier service.
<u>Height group 3</u> B-727/707/720/757	20 feet	50 feet +5, -15 15 meters +2, -4	Primary runways not normally used by aircraft with ILS glidepath-to-wheel heights exceeding 20 feet.
<u>Height group 4</u> B-747/767, L-1011, DC-10, A-300	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 shall normally be 3 degrees when measured from the horizontal.

c. The PAPI Obstacle Clearance Surface. The PAPI obstacle clearance surface 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 surface begins 300 feet (90 m) in front of the PAPI system (closer to the threshold) 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 degrees glide path and 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 extended, and extends 4 statute miles from its point of origin. The surface is shown graphically in figure 5-4. If a site survey determines that there is an obstacle, which penetrates the obstacle clearance surface and cannot be removed, then the glide path angle must be changed or the PAPI system moved further from the threshold. By moving or re-aiming the PAPI, the PAPI obstacle clearance surface is repositioned so it will not be penetrated by an obstacle.

504. 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 OF PAPI RELATIVE TO A PRESELECTED GLIDE PATH

Light Unit	Aiming Angle (in minutes of arc)	
	Standard Installation	Height Group 4 Aircraft on Runway with Electronic Glide Slope
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

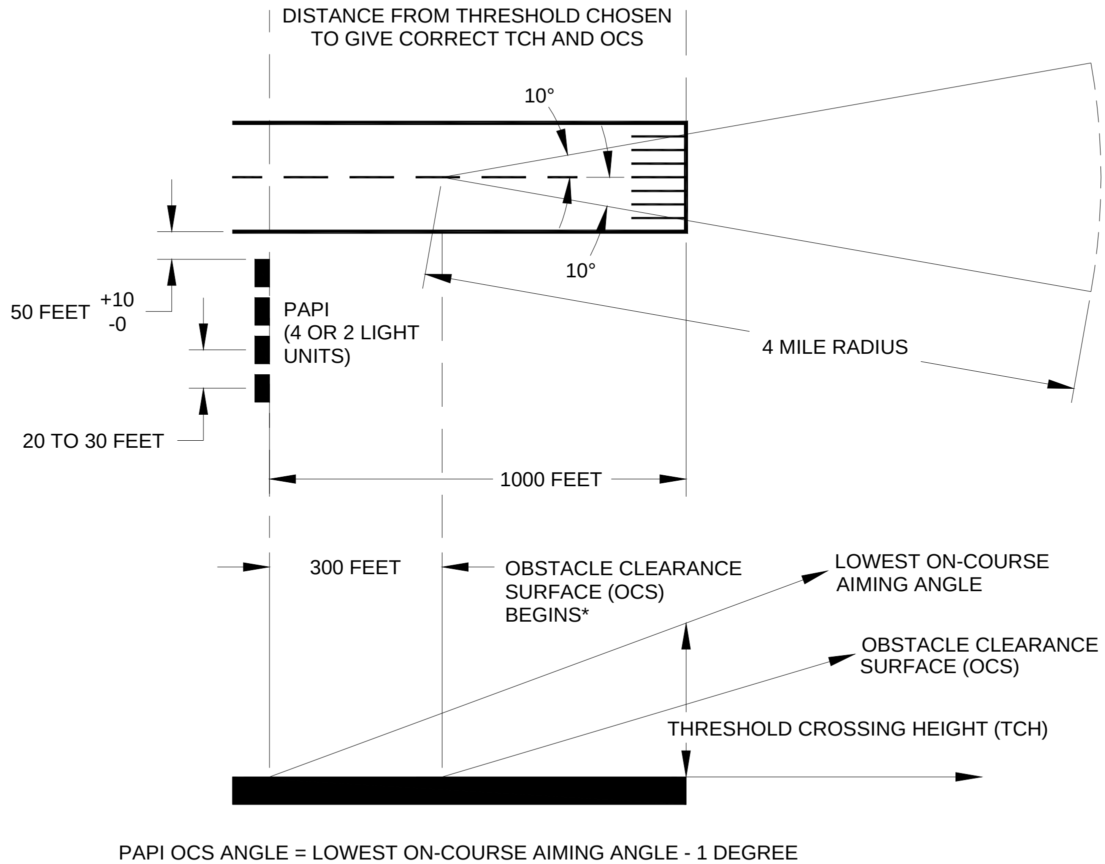
505. Other siting dimensions and tolerances.

a. Distance from Runway Edge. The inboard LHA shall be no closer than 50 feet, +10, -0 (15 m, +3, -0) from the runway edge or to other runways or taxiways. (See paragraph 509 a.)

b. Separation between LHAs. The PAPI LHAs shall have a lateral separation of 30 feet (9 m). The distance between LHAs shall vary no more than 1 foot (0.3 m). (See paragraph 509 b).

c. Azimuthal Aiming. Each LHA shall be aimed outward into the approach zone on a line parallel to the runway centerline within a tolerance of ± ½ degree.

d. Mounting Height Tolerances. The beam centers of all LHAs shall be within ±1 inch of a horizontal plane. This horizontal plane shall 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 (except in paragraph 509 e).



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 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 THEN 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

e. Tolerance Along Line Perpendicular to Runway. The front face of each LHA bar shall be located on a line perpendicular to the runway centerline within ±6 inches.

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 505 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.

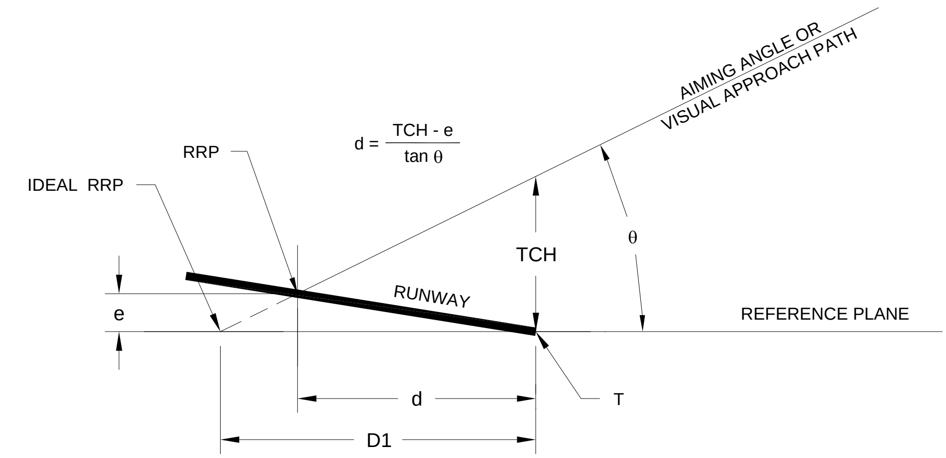
(6) Double check to see that the calculated location gives the desired threshold crossing height.

g. Other Siting Considerations.

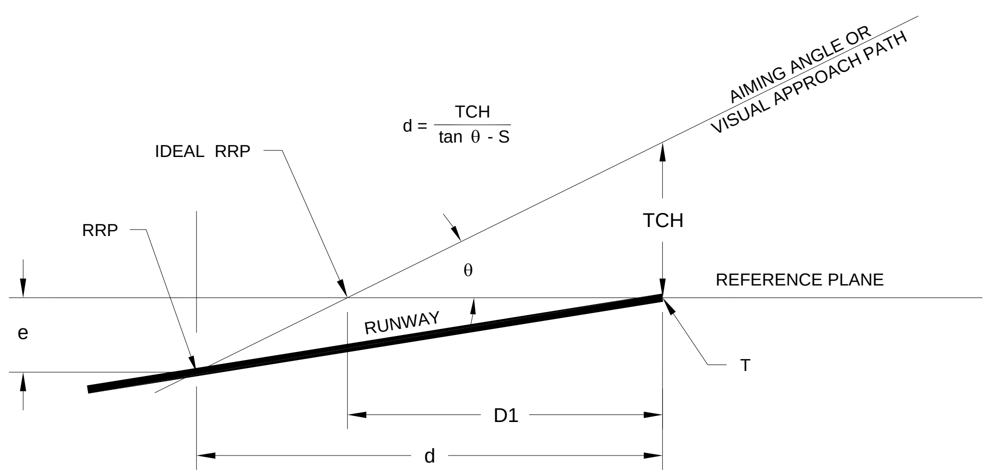
(1) Where the terrain drops off rapidly near the approach threshold and severe turbulence is experienced, the PAPI should be located farther from the threshold to keep the aircraft at the maximum possible threshold crossing height.

(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) LHA shall not be located closer than 50 feet from a cross runway, taxiway, or warm-up apron. When it is proposed to locate LHAs within an ILS localizer or glide slope critical area, comply with FAA Order 6750.16D, Siting Criteria for Instrument Landing Systems, paragraph 1-15b(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

506. PAPI Assemblies.

a. Power and Control Unit (PCU). The PCU is the assembly that receives the input power and outputs constant current to the lamp housing assemblies (LHA). The PCU should be located as far from the runway as possible to present the minimum possible obstacle to aircraft. The PCU is a separate unit and is located adjacent to the LHA farthest from the runway. The PCU has a maximum weight of 75 pounds and a maximum height of 36 inches above finished grade and is mounted on frangible couplings. When either the weight of the PCU exceeds 75 pounds or the height exceeds 36 inches above finished grade, it shall be installed off the runway safety area. The runway safety area and obstacle-free zone are defined in AC 150/5300-13, Airport Design.

b. Lamp Housing Assembly (LHA). Each LHA is equipped with a tilt switch that activates when the LHA tilts ½ degree. Activation of any tilt switch extinguishes the lights of the PAPI system. All LHAs are mounted on frangible couplings. The LHA shall have a maximum weight of 100 pounds.

507. Remote control. The PAPI shall have a remote control system.

a. Ground-to-ground. Control of the PAPI shall be by landlines or by a remote radio control system in accordance with Appendix B.

b. Air-to-ground. Control of the PAPI shall be in accordance with Appendix B.

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

509. Deviations.

a. Location of Inboard Light Housing Assembly (LHA). Locate the inboard LHA up to 75 feet from the runway where it is less likely that damage to the LHA will occur due to jet blast and wing vortices. This distance may be reduced to 30 feet (10 m) for small general aviation 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 Light Units. On small general aviation runways, the PAPI LHAs may have a lateral separation of 20 feet ± 1 foot.

c. Glide Path Angle. For utility runways without jet aircraft operations, the glide path angle may be greater than 3 degrees but not more than 4 degrees for the proper threshold clearance height or obstacle clearance requirements. If an angle greater than 3 degrees is used, it must be specified in a Notice to Airmen (NOTAM) and be published in the Airport Facility Directory.

d. Obstacle Clearance. If a site survey determines that there is an obstacle, which penetrates the obstacle clearance surface, and cannot be removed, then the glide path angle must be changed or the PAPI system moved farther from the threshold. By moving the PAPI, the PAPI obstacle clearance surface is repositioned so it will not be penetrated by an obstacle.

e. Elevation of Lamphousing Assembly. 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.

APPENDIX A. JOINT-USE AGREEMENT

JOINT AGREEMENT BETWEEN THE FEDERAL AVIATION ADMINISTRATION AND THE AIR NATIONAL GUARD (ANG) FOR THE ESTABLISHMENT OF APPROACH LIGHTING SYSTEMS AT JOINT-USE AIRPORTS WHERE ANG OPERATION REQUIREMENTS ARE INVOLVED

The Federal Aviation Administration and the Air National Guard have agreed that the division of responsibility for the construction, operation, and maintenance of approach lighting systems at joint-use airports will be as stated below:

1. Type of system to be installed. The type of system to be installed may be one of the following:

a. U.S. Standard ALS/SFL, Category I configuration.

b. U.S. Standard ALS/SFL, Category II configuration.

c. Medium Intensity Approach Lighting System (MALS) (without flashers) or MALSF (with flashers).

d. Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR).

e. Simplified Short Approach Lighting System (SSALS) (without flashers) or SSALF (with flashers).

f. Simplified Short Approach lighting System with Runway Alignment Indicator Lights (SSALR).

2. Selection of system to be installed. The system selected by the FAA will be based on the most critical category of civilian aircraft to use the runway in accordance with the criteria contained in FAA Order 7031.2B, Airway Planning Standard #l. If, however, the ANG requires a higher cost system, the higher cost system will be installed by the FAA, and the ANG will reimburse the FAA for the cost difference. In cases where an existing system is satisfactory for ANG operations, and a new system is to be installed based on requirements of civilian aircraft, reimbursement by ANG is subject to negotiation between FAA, ANG, and the airport authority involved.

3. Installation standards.

a. The system will be installed in accordance with the FAA installation criteria as listed in paragraph 1 above. If an ANG has an operation requirement for the system to be installed, and the ANG requires the use of semiflush lights in the overrun area, they will be installed by the FAA subject to the following:

(1) The gradient of the overrun area meets the installation criteria for the system to be installed; if not, the ANG will perform the necessary work to accomplish this.

(2) The ANG will reimburse the FAA for any cost difference resulting from a change in FAA installation criteria in order to meet ANG requirements. This does not apply in cases where overruns and thresholds are being maintained in original condition of safety and the new system is of no benefit to the ANG operation. Reimbursement by ANG is subject to negotiation between FAA, ANG, and the airport authority involved.

b. In certain instances, the ANG may elect the use of frangible type light units in the overrun area. Frangible units will normally be installed in the inner 1,000 feet if the gradient is such that the mounting height of the lights is not over 6 feet. In those cases where the ANG desires all lights in the inner 1,000 feet to be frangible mounted, the ANG will perform the necessary work in raising the gradient of the overrun area to permit use of frangible lights, except where FAA criteria calls for frangible lights and requires raising of the gradient.

c. NGB reserves the option to prepare plans and specifications to flush-mount lights in the overrun in accordance with FAA criteria.

4. Operation and maintenance. The FAA will operate and maintain the system at no cost to the ANG with the exception that the ANG will reimburse the FAA for any damage to the system resulting from ANG operations.

5. Reimbursement of FAA by ANG.

a. In most foreseeable cases, reimbursement will be accomplished by Military Construction Program funds under separate reimbursable agreements. FAA will provide ANG at the Washington level with cost estimates sufficiently in advance to permit programming and receipt of funds prior to consummation of each agreement. Normally, this will be at least 18 months and preferably two years in advance.

b. Each agreement negotiated for a project shall provide for the following

(1) The ANG will reimburse the FAA for all direct costs incurred in furnishing the plant, labor, and materials required for the project.

(2) In addition, the ANG will reimburse the FAA overhead costs for engineering services and administrative services at the appropriate percentage in effect at the time each agreement is consummated. Each separately negotiated agreement will contain the percentage in effect at the time, and will be fixed for the project.

(3) Upon revocation or termination of the agreement for any cause, the NGB will reimburse the FAA for all necessary liquidating expenses. The FAA will make every reasonable attempt to utilize unused supplies and materials on other FAA projects, and in this event, there will be no reimbursement by the ANG for those supplies and materials which FAA uses in its own programs.

(4) Most projects negotiated under the terms of this agreement will be of the category discussed in paragraph 2 herein, where the ANG requirement dictates a higher cost system than that required civilian operations. ANG reimbursement is, of necessity in these cases, based on the estimated costs of the lower cost system. In the event the higher cost system required by the ANG is more or less than its estimated cost, the lower cost system will be reestimated based on the prevailing prices at the time the project is constructed to determine the reimbursement to the FAA. A detailed cost estimate of the lower cost system will be provided along with the actual cost of the system built.

c. Since the public laws governing ANG military construction limit the cost of the project to 115 percent of the amount authorized by Congress, and since it is recognized that each agreement is based on estimates, the ANG will provide contingency funds for each project to prevent delays and escalating costs caused by work stoppages. These contingencies will not exceed 10 percent on small projects and 5 percent on larger projects wherein ANG costs are in excess of $100,000. The FAA will advise the ANG of any anticipated cost overruns above the amount the ANG has allocated to the project as soon as they are known, providing a new total project cost to the ANG and in sufficient detail so that the ANG can provide the Congress with justification for additional authorization. The FM will not obligate funds in excess of 115 percent of the amount authorized until advised by the ANG that the authorization has been increased.

6. Coordination.

a. In order to provide funds, concurrent scheduling, and uniform instructions to the field offices, the FAA and ANG will coordinate their program plans at the Washington level.

b. Individual projects will be coordinated between the FAA and ANG at the local level on matters of design, military requirements, and work scheduling.

This agreement supersedes the previous agreement between the Federal Aviation Agency and the Air National Guard signed by FAA 16 June 1959, and the ANG 17 June 1959.

APPROVED FOR THE NATIONAL GUARD BUREAU	APPROVED FOR THE FEDERAL AVIATION ADMINISTRATION
ORIGINAL SIGNED BY: W. P. WILSON	ORIGINAL SIGNED BY: D. D. THOMAS
Major General Chief, National Guard Bureau	Deputy Administrator

Date: 3 December 1969 Date: 21 November 1969

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 the flying public. 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 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.

b. Implementation Clarification. The implementation policy was modified by a letter to all regions from the Airports Engineering Division, AAS-500, dated November 28, 1975.

c. Air-to-Ground Criteria. All requirements for air-to-ground remote control system was collected and issued in Advisory Circular AC 150/5340-27, Air-to-Ground Control of Airport Lighting Systems.

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. 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 five seconds. The receiver has three functions that can be selected. Three keyings of the pilot's microphone obtains the first function. Five keyings of the microphone obtains the first function momentarily, then the second function where it remains. Seven keyings of the microphone obtains the first function momentarily, then the second function momentarily, then the third function where it remains. Each time the pilot keys his microphone three or more times, the 15 minute automatic system shutdown is recycled.

b. Ground-to-Ground Operation. At the remote control point, the desired address and function numbers are selected on the encoder keyboard and then the "send" switch is pressed. The signal is transmitted to the remoted facility where the receiver-decoder performs the transmitted function by operating a relay.

c. Combination System Operation. The combination system is operated as a ground-to-ground system when the air traffic control facility is operating and is operated as described in Appendix B, paragraph 4b. When the air traffic control facility is closed, the air-to-ground system is switched "on". When the air-to-ground system is turned "on", it operates as described in Appendix B, paragraph 4a. The air-to-ground system shall be 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 currently being procured 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 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.

b. Ground-to-Ground Control. The ground-to-ground control unit provides multi-functions which may be selected by air traffic control personnel. As an example, 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.

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.

c. Ground-to-ground Control Head. The ground-to-ground control head shall be located in the air traffic control tower; where the ATCT is part-time, a control head shall be placed in the flight service station when the FSS has control of the runway edge lighting. The control head has an indicating panel showing the last transmission to each controlled facility.

6. Radio Control Selection.

a. Radio Control Configuration Selection. The selection of the remote radio control depends on the type of air traffic control service available at a particular site. The type of control system shall be selected from figure l.

FIGURE l. REMOTE RADIO CONFIGURATION SELECTION CHART

		F S S		
		None	Part Time	Full Time
A T C T	None	A-G	Comb / 0	G-G / 0
	Part Time	0 / Comb	0 / Comb	G-G / G-G
	Full Time	0 / G-G	0 / G-G	0 / G-G

b. Radio Control Address Selection. The address selection for the remote radio ground-to-ground control shall be taken from table l of this appendix.

TABLE 1. ADDRESS CODE VS. FACILITY TYPE

Item	Address Code	Function
1.	123	MALSR #1 (left-hand decoder)
2.	132	MALSR #1 (right-hand decoder)
3.	213	MALSR #2 (left-hand decoder)
4.	231	MALSR #2 (right-hand decoder)
5.	312	MALSR #3 (left-hand decoder)
6.	321	MALSR #3 (right-hand decoder)
7.	412	MALSR #4 (left-hand decoder)
8.	421	MALSR #4 (right-hand decoder)
9.	431	MALSR #5 (left-hand decoder)
10.	432	MALSR #5 (right-hand decoder)
11.	124	Future (ALS engine generator)
12.	142	Future (CAT II ALS engine generator)
13.	134	ASR engine generator
14.	143	Future (VTAC at CPA engine generators)
15.	214	Future engine generator control
16.	241	Future engine generator control
17.	234	Future engine generator control
18.	243	Future VASI control system (1&2)
19.	314	Future VASI control system (3&4)
20.	341	Future VASI control system (5&6)
21.	324	Future REIL control system (1&2)
22.	342	Future REIL control system (3&4)
23.	413	Spare
24.	423	Spare

7. Coordination Requirements.

a. Obtain a frequency authorization through Frequency Management. The 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. Each application for a frequency authorization shall be coordinated by FAA regional and Washington office frequency managers on a case-by-case basis prior to making an operational assignment.

(1) Ground-to-Ground System. The frequency assignment for the FM transmitters/receivers for the ground-to-ground radio remote control is 165.7125 MHz, 165.7625 MHz or, 172.175 MHz, unless otherwise justified.

(2) Air-to-Ground System. The region may obtain authorization to use the ATCT tower local control frequency for air-to-ground control during hours when the ATCT is shutdown. Similar authorization may be obtained for air-to-ground control on FSS frequencies at non ATCT airports. At non ATCT non FSS airports, authorization may be obtained for air-to-ground control on frequencies in the 121.95 to 123.05 MHz band. Air-to-ground control is not recommended on ATCT ground control frequencies.

b. 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.

c. Install the equipment per national standards.

d. The service area will issue a commissioning message to NFDC.

e. 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.

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

g. Advise Flight Inspection Central Operations (FICO) 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.

h. The service area will procure the necessary transmitter, receiver, encoder, and decoder.

i. The location of the ground-to-ground control head shall be coordinated with service area's Air Traffic division.

j. At airports having or programmed to have instrument flight procedures, coordinate with the Service Area Flight Procedures Office (FPO) to obtain a procedure effective date.

8. Non-FAA Radio Control Systems. During the site survey, it shall be determined whether or not there is an existing remote radio control system operated by the airport owner. Where there is an existing radio control for the runway lighting, the region shall coordinate and obtain agreements with the airport owner to install a control system in conformance with the criteria contained in this appendix. These agreements shall be obtained prior to installing a medium intensity approach lighting system at an airport without an air traffic control facility. The region will make the necessary modifications to the airport owner's radio equipment when the airport owner is not in a position to accomplish the needed changes.

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
WARREN C. SHARP
Director, Airway Facilities Service, AAF-1 Date: 7/25/75

Original signed by:
R.P. Skully
R.P. SKULLY
Director, Flight Standards Service, AFS-1 Date: 7/25/75

Original signed by
B.N. Lockett for
WILLIAM V. VITALE
Director, Airports Service, AAS-1 Date: 7/25/75

APPENDIX D. FLOODPLAIN LOW-IMPACT RESISTANT (LIR) STRUCTURES INSTALLATION

The following guidance shall 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 (inside versus outside the Runway Safety Area (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 2-11 and 2-12). A LIR structure shall 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 2-11 and 2-12 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://store.msc.fema.gov.

(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 2-4 below.)

TABLE 2-4. 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)

<u>NOTES</u>.

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

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

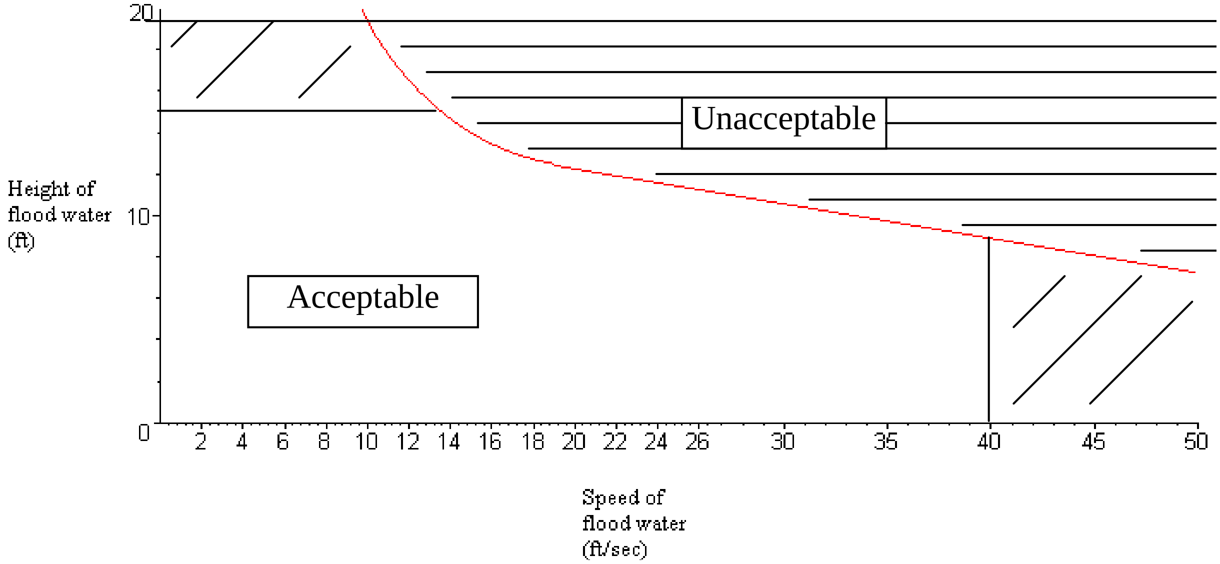


FIGURE 2-11. Floodplain LIR Siting Criteria for MG-20 Structures

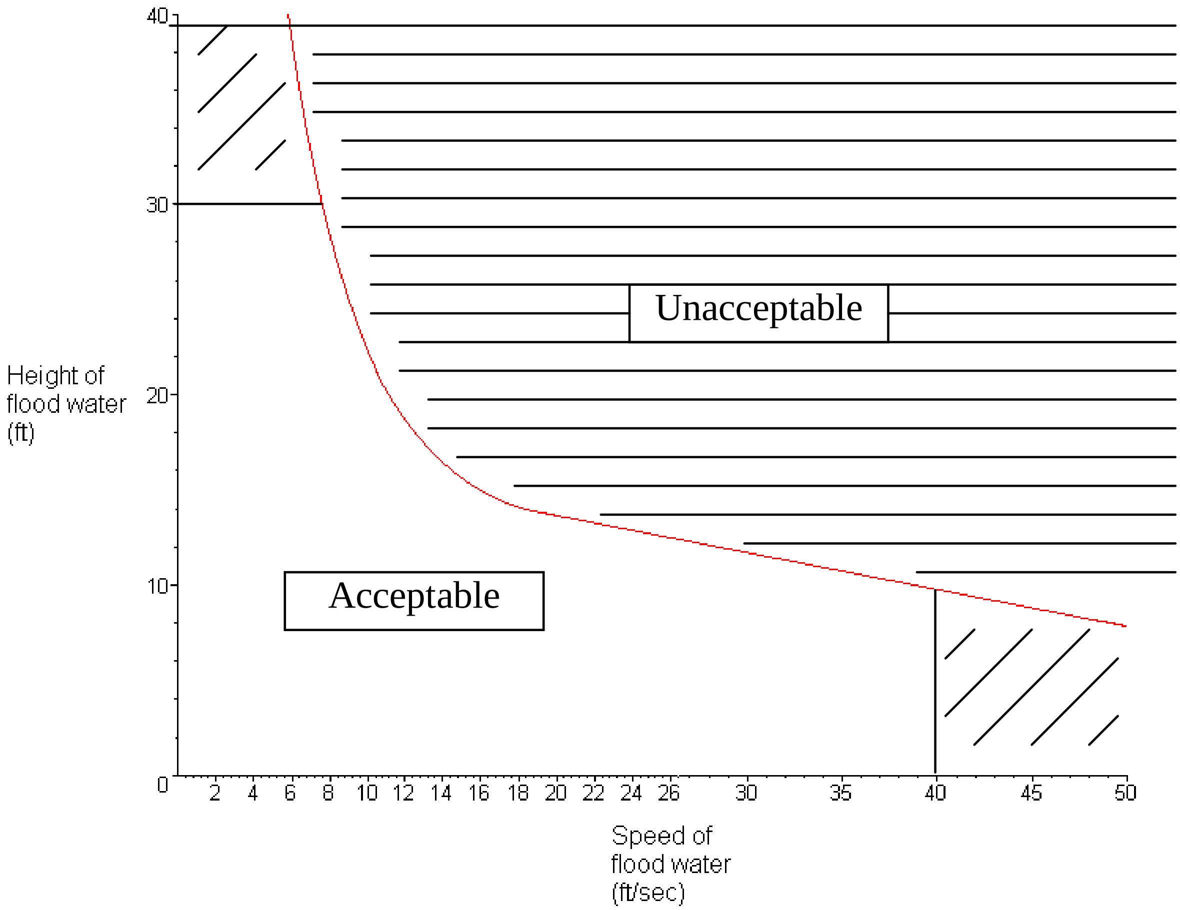


Figure 2-12. Floodplain LIR Siting Criteria for MG-30 and MG-40

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. 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 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 1, 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.

TABLE l. Three-Bar VASI Visual Cues

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, Appendix E.

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 rule (VFR) weather conditions.

b. The basic VASI configurations are described in appendix D, section 1, paragraph 1 and shown in figures 1, 2, 4, and 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 one 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 four nautical miles. In addition, the minimum aiming angle shall be within the glide path limitations of paragraph 4. When less than 10 degrees are used for determining the obstruction-clear plane, issue a NOTAM and request publication in the Airport/Facilities Directory.

4. Visual Glide Path Angle. The visual glide path angle shall 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 shall cross the landing threshold at a height of not less than 25 feet. Where the distance between pilot's eye and the lowest portion of the aircraft in landing altitude exceeds 10 feet, the minimum threshold crossing height of 25 feet shall be increased by an amount equal to that in excess of the 10 feet. This distance shall 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 pilot's eyes and lowest portion of the aircraft of 20 feet, then the minimum crossing height will be 35 feet.

b. For the three-bar VASI, the downwind effective visual glide path shall be sited to provide a threshold crossing height of 50 feet. The upwind effective visual glide path shall 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-8-50	22.6 feet	DC-10,30,40	35.0 feet
DC-8-61	20.3 feet	L-1011	36.8 feet
DC-8-62	22.1 feet	707-120	22.0 feet
DC-8-63	23.1 feet	727-200	23.2 feet
DC-9-10	13.7 feet	707-300	24.9 feet
DC-9-30	18.5 feet	727-100	22.3 feet
DC-9-40	18.5 feet	737-100	19.0 feet
DC-9-50	20.4 feet	747-100	44.0 feet

d. The preferred effective visual glide path angle shall be 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 three degrees, but not more than four degrees for obstacle clearance, may be used provided the commissioned angle is specified in a NOTAM and also published in the Airport/Facilities Directory.

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

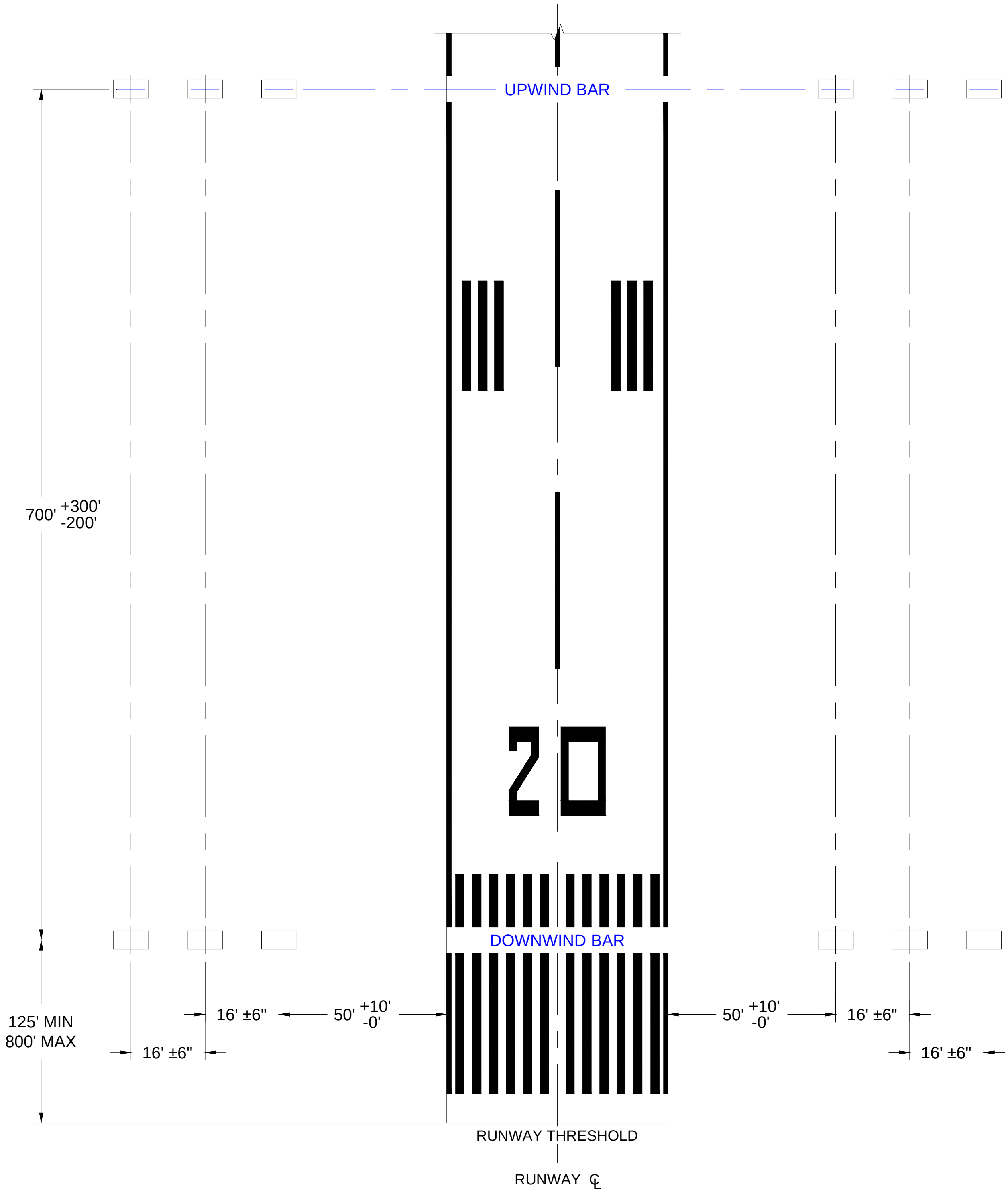


FIGURE 1. SYSTEM LAYOUT VASI-12

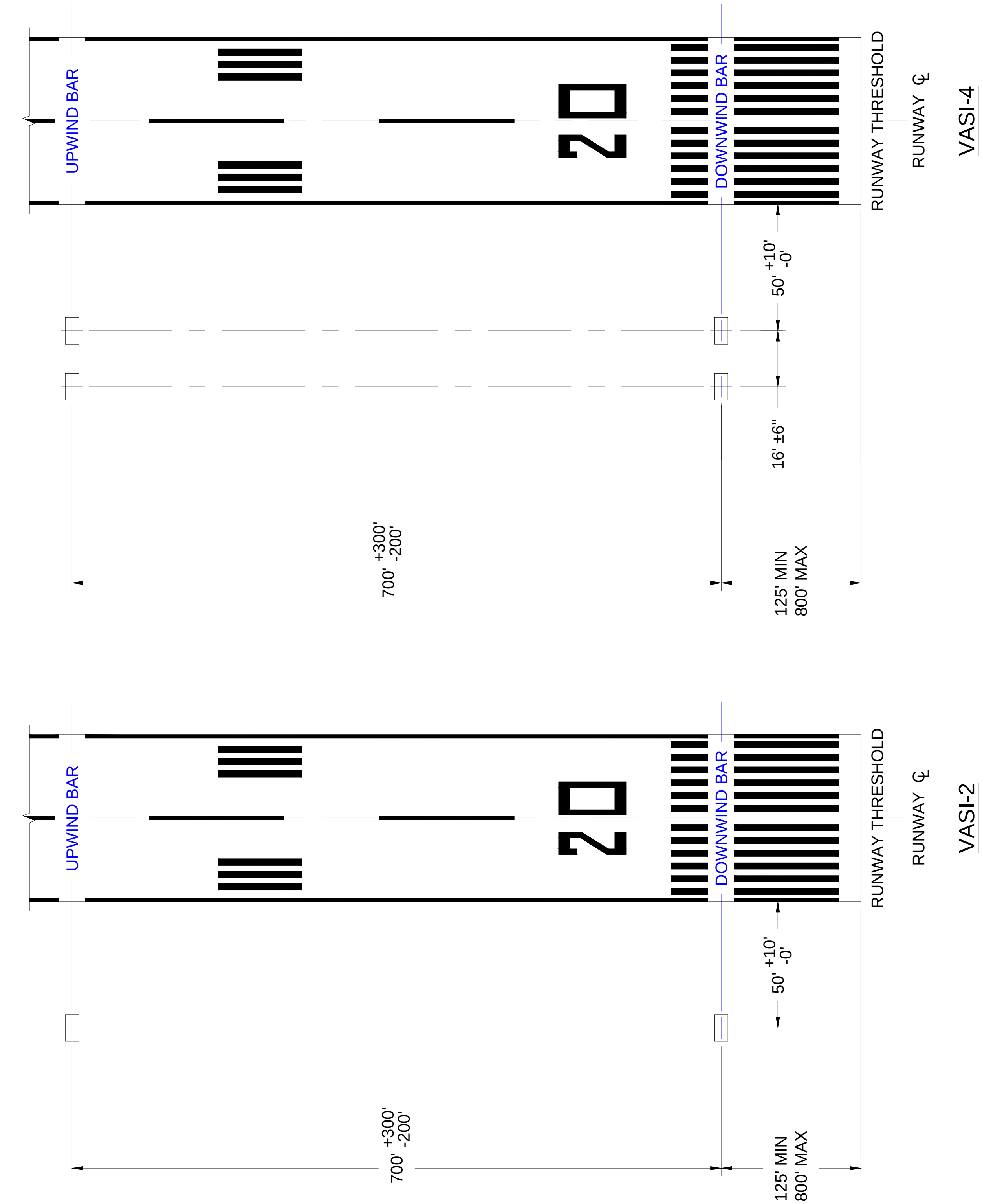


FIGURE 2. SYSTEM LAYOUT, VASI-2 AND VASI-4

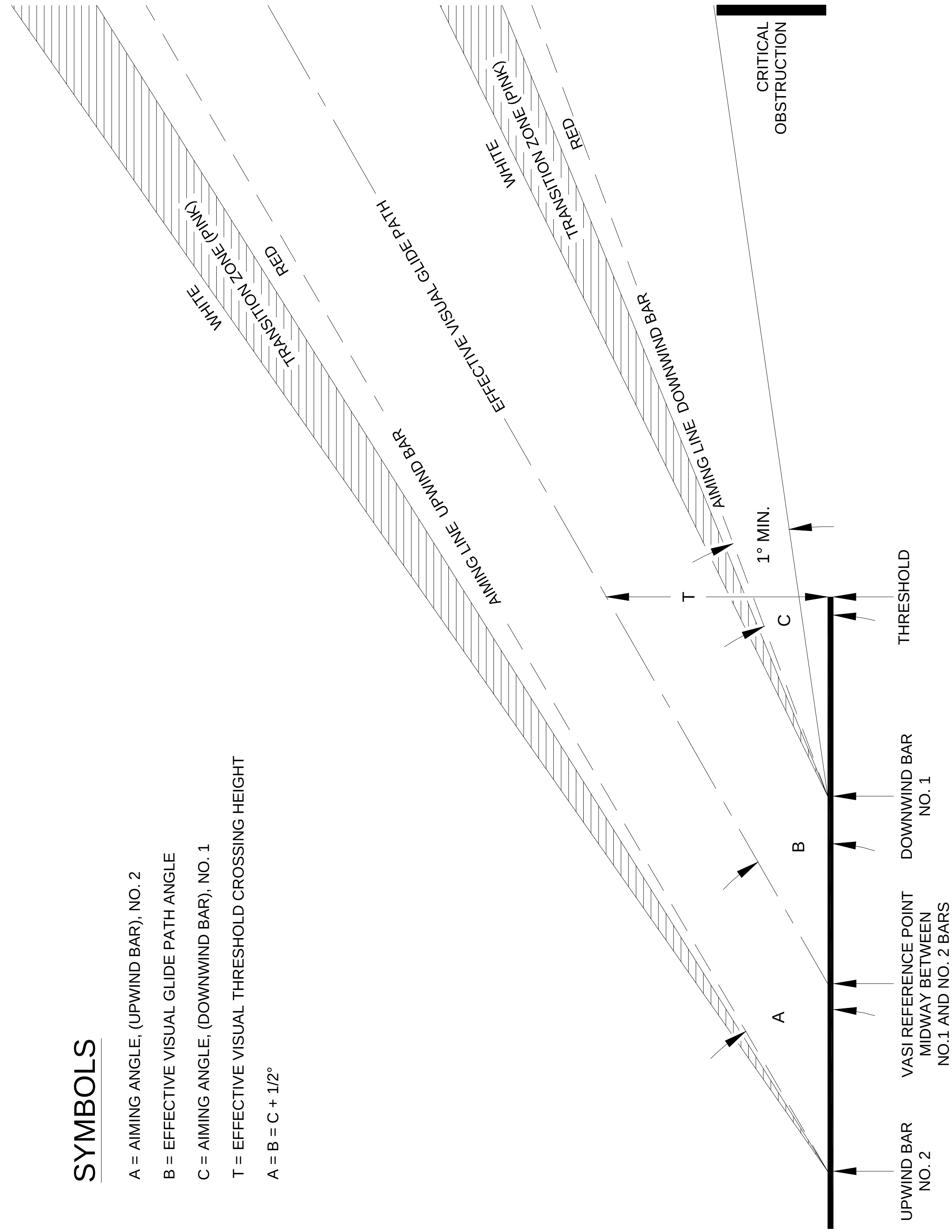


FIGURE 3. AIMING AND OBSTRUCTION CLEARANCE DIAGRAM FOR 2-BAR VASI

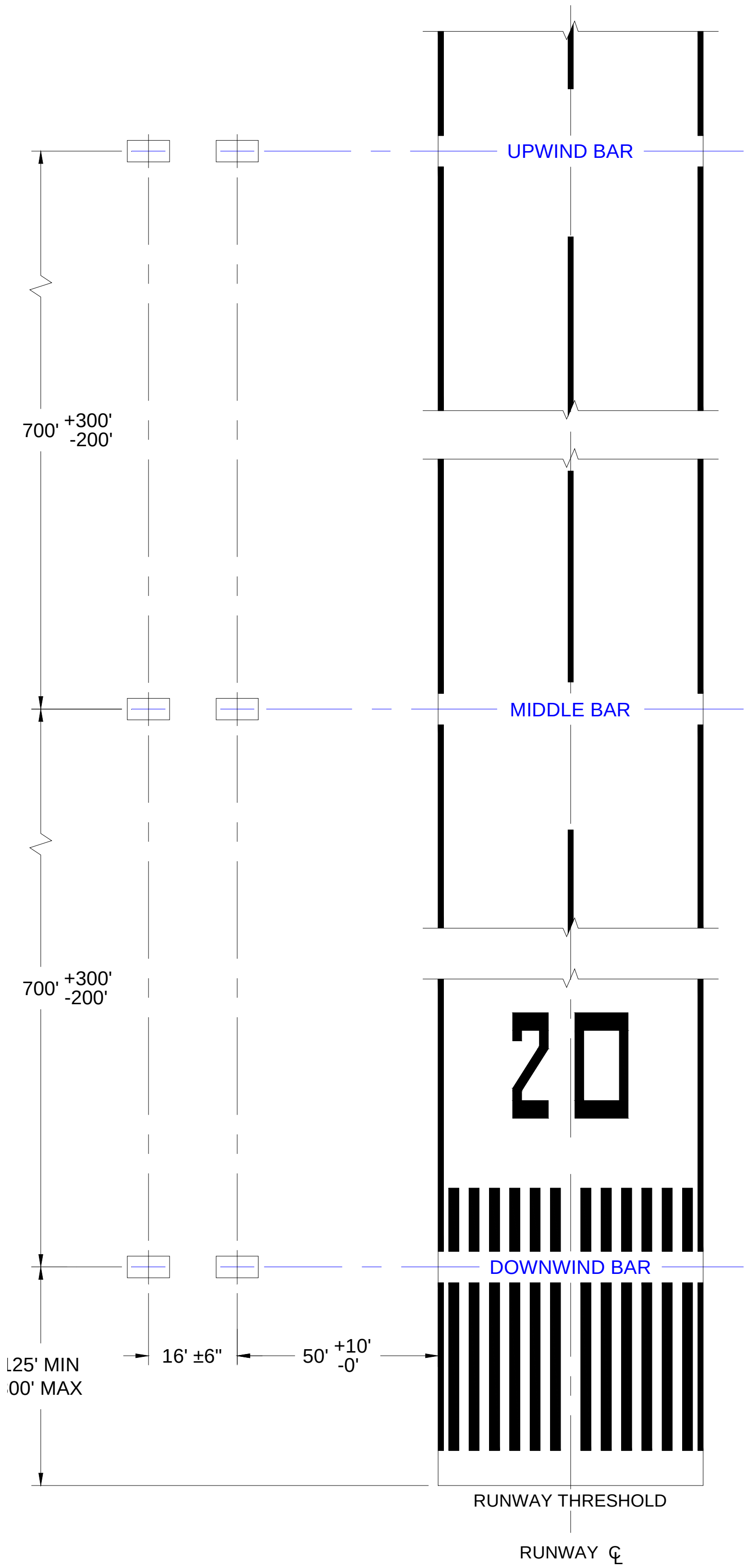


FIGURE 4. SYSTEM LAYOUT, VASI-6 (3-BAR)

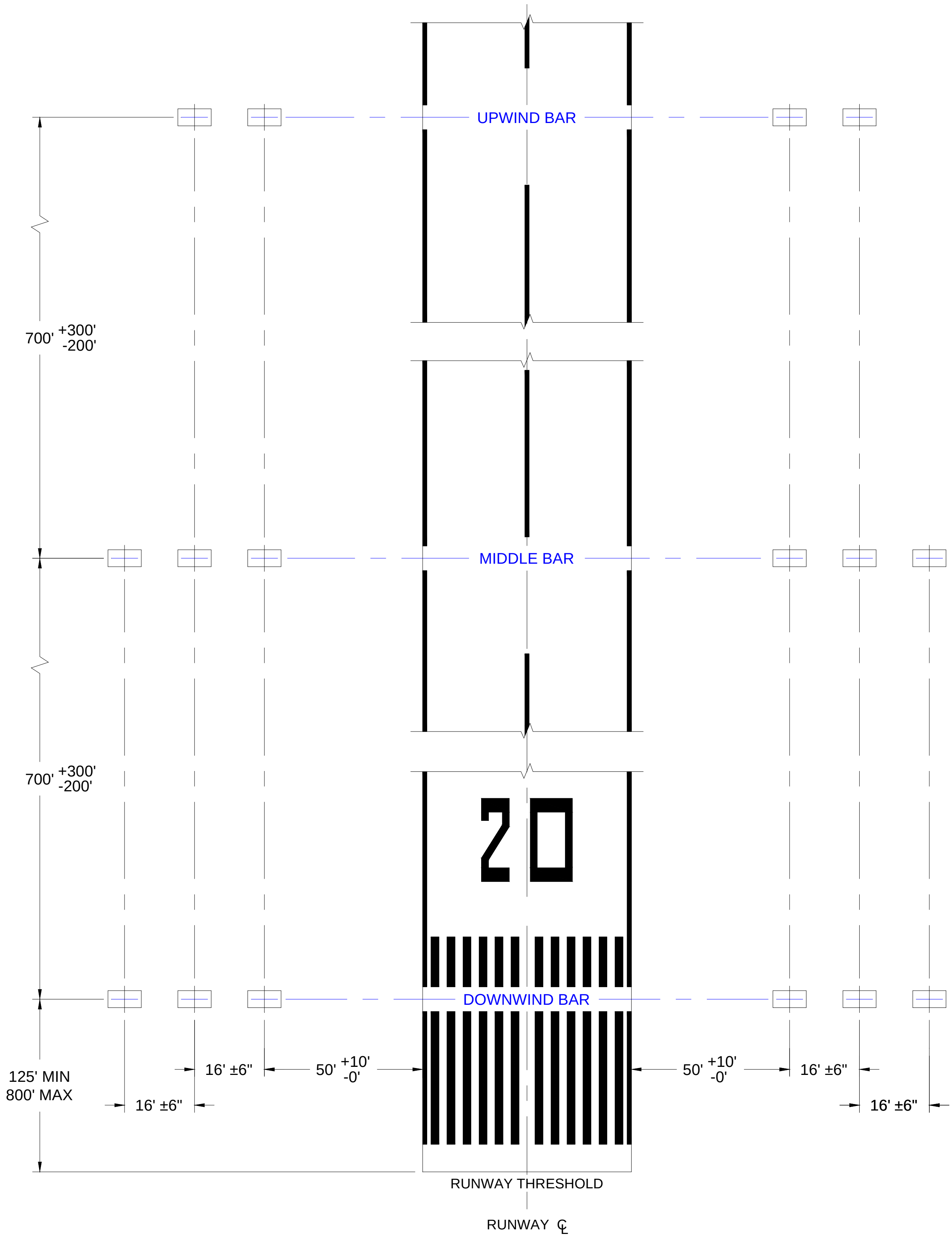


FIGURE 5. SYSTEM LAYOUT, VASI-16 (3-BAR)

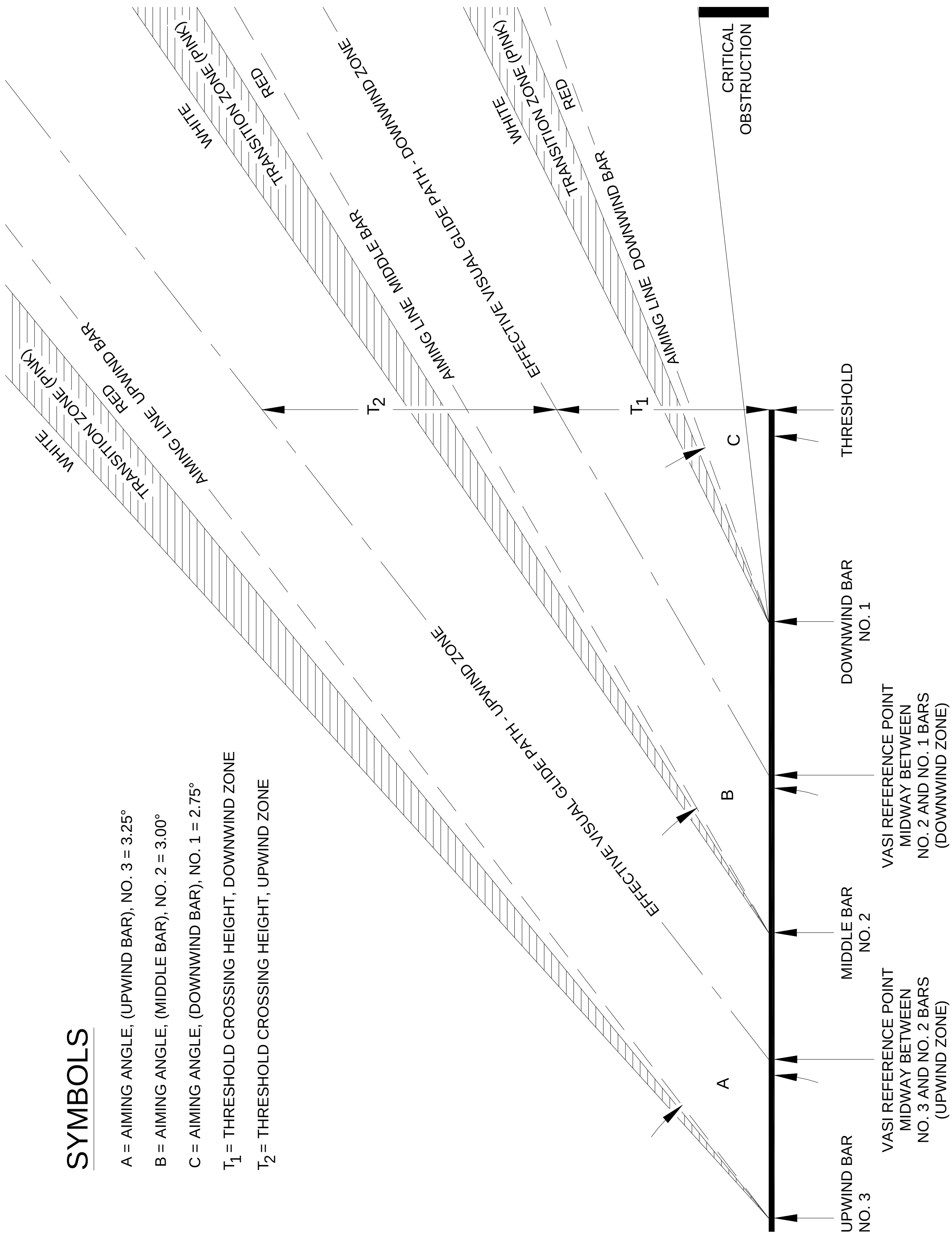


FIGURE 6. AIMING AND OBSTRUCTION CLEARANCE DIAGRAM FOR 3-BAR VASI

g. Where category D turbojet aircraft operations are conducted on a runway with no ILS, the light bars shall be positioned to provide a visual glide path intercept point with the runway a 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 shall be reduced to 2 degrees less than the protected width. The minimum width of the radiated light shall be 12 degrees.

5. Two-Bar VASI Light Bar Locations. The light bar locations shall provide not 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall be initially set to within ± 2 minutes of the established aiming angles. The light units shall be aimed using a Walker Bar.

a. Aiming of Two-Bar VASI. The two-bar VASI system shall have the upwind bar aimed at three 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 shall 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 shall be as follows:

a. The centerline of the inboard light unit in each bar shall 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 shall 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) shall 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 shall be within one 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 shall 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 shall 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 shall be 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 shall be located perpendicular to the runway centerline. The front face of each light unit shall be located within a tolerance of ± 6 inches from this line.

h. Each light unit shall 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 shall be provided throughout the area of coverage. The angle of rotation shall be issued in a NOTAM and published in the Airports/Facilities Directory.

i. No light unit may be located closer than 50 feet from a cross runway, taxiway, or warm-up apron or; 75 feet in areas A, B, and C, as defined in figure 3-lla of the latest edition of Order 6750.16, Siting Criteria for ILS.

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 shall be installed on frangible couplings.

9. Remote Control and Monitoring Requirements.

a. Control Requirements. A VASI shall have a remote control system.

b. Monitoring Requirements. Monitoring is not required.

10. Miscellaneous requirements.

a. The substation, when installed above ground, shall be located so that it will not form an obstruction or hazard to aircraft and in no case shall it be located closer than 400 feet from the centerline of any runway or 200 feet from the centerline of any taxiway. However, the substation or power supply may be located adjacent to the VASI units when the power supply weight is less than 75 pounds, dimensions of 24 inches by 24 inches by 12 inches or less, and an overall height of 36 inches or less when mounted on frangible couplings. The power supply shall be a minimum of 50 feet from the edge of the runway.

b. Since the effectiveness of the VASI System is dependent upon seeing a definite red and/or white signal from the light units only, care should 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 shall 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.