

CHAPTER 2

AIRFIELD RUNWAY AND APPROACH LIGHTING SYSTEMS

2-1. General design and layout criteria

Figures 2-1 through 2-11 are intended to serve as guides in designing and installing typical airfield installations. Figure 2-1 is for a typical Army airfield having a runway 75 feet wide by 5,000 long, with connecting taxiways 50 feet wide and a fixed construction (permanent) airfield lighting system utilizing medium intensity elevated and semiflush lights. Figure 2-2 indicates a typical one line block control diagram and figures 2-3 and 2-4 indicate typical installation details of the light fixtures. Where a high intensity runway lighting system and/or an SALS is specifically authorized for installation, the general criteria to be used is stated below. For additional details that may be of help in designing lighting facilities peculiar to a particular airfield, attention is invited to the following references: Air Force Manual 88-14 and Army Manual TM 5-8034.

2-2. Description

a. Runway lighting system is a configuration of lights which define the lateral and longitudinal limits of the usable landing area. Two straight lines of lights parallel to and equidistant from the runway centerline define the lateral limits. The lights in these lines are called runway edge lights and emit aviation white (clear) light. The longitudinal limits of the usable landing area are defined at each end by a symmetrical pattern of 180 degrees aviation green/180 degrees aviation red lights designated as the threshold lighting configuration. Such a configuration includes inboard threshold lights, located between the lines of the runway edge lights, and winged-out threshold lights which extend outward from each end of the inboard threshold lights.

b. Approach lighting system presents in plan view a configuration of lights located symmetrically about and along the extended centerline of the runway. The system originates at the threshold of the useable landing area, and extends out therefrom a distance of 1,500 feet for a precision approach system and 1,400 feet for a medium intensity system. Condenser discharge lights may be provided as described in paragraph 2-6g(6) and will flash in sequence towards the threshold.

2-3. Criteria

The basic type of lighting installation used by the Army is a medium intensity runway lighting system without approach lights. However, where additional guidance is required because of operational criteria, such as poor weather conditions or low cloud base which restrict visibility, an

approach lighting system may be installed where specifically authorized.

a. Medium intensity approach lighting system (MALS). This system may be used where a precision approach is not available or justified. The runway lighting system will be of the medium intensity type. The approach lighting system will consist of light bars spaced on 200-foot centers extending outward 1,400 feet from the threshold. Where authorized, condenser discharge lights may be installed in the outer three bars. When the condenser discharge lights are used, this system will be indicated as MALSF.

b. High intensity short approach lighting system (SALS). This system will be used where a precision approach is authorized. A precision approach is defined as an instrument runway served by either an ILS, GCA radar approach aids, or other electronic guidance systems, and intended for use in IFR weather conditions. The runway lighting system will be of the high intensity type. The approach lights will consist of light bars spaced on 100-foot centers extending 1,500 feet outward from the threshold utilizing high intensity lights. Where authorized, sequenced flashing condenser discharge lights will be used as described in paragraph 2-6g(6).

c. Approach lighting system location. An approach lighting system will be installed normally on only that end of a runway most frequently used for the approach to the runway.

d. Medium intensity runway edge lights. Medium intensity runway edge lights will be installed in support of nighttime VFR and nonprecision instrument approaches only. The configuration for medium intensity lights will be the same as provided for high intensity runway edge lights in paragraph 2-3.e.

e. High intensity runway edge lights. High intensity runway edge lights will be installed only where specifically authorized. In such cases, where runways at Army installations are 7,500 feet or less in length, the high intensity runway lighting system and its associated equipment will be used with a standard 6.6-ampere series circuit. Where the runway length exceeds 7,500 feet, the system will be installed for a 20-ampere series circuit. The latter system will be as described in AFM 88-14.

f. Refueling area lights. Explosion-proof aviation light fixture assemblies and associated wiring will be used when lighting fixtures are required within 50 feet of an aircraft fuel inlet or fuel system vent and within 63 feet of an aircraft direct fueling outlet/hose reel pit.

2-4. Runway edge lighting configuration

Runway edge lights will be located longitudinally on both sides of the runway at a distance not to exceed 10 feet from the edge of the full strength paving designated for runway

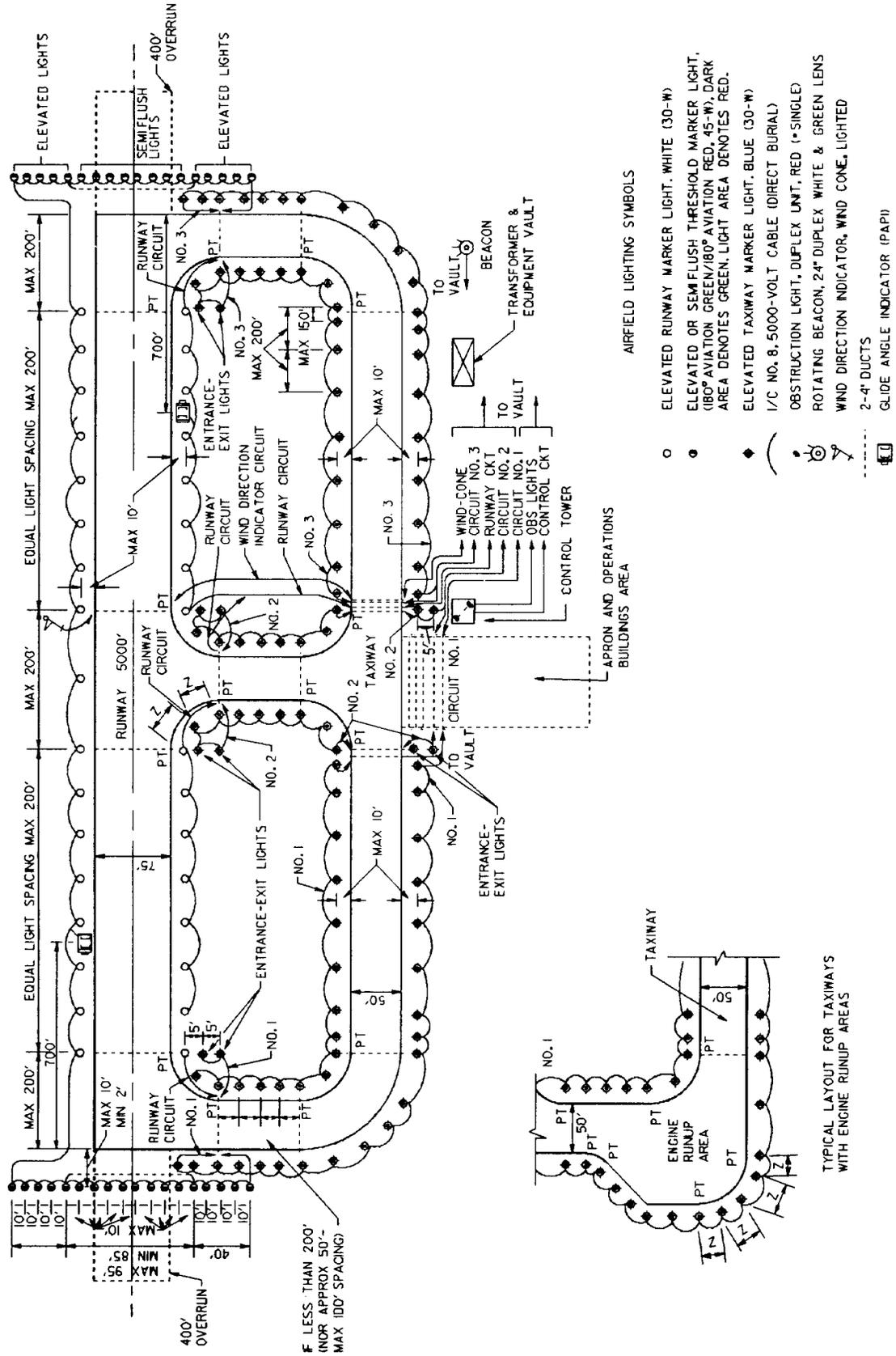
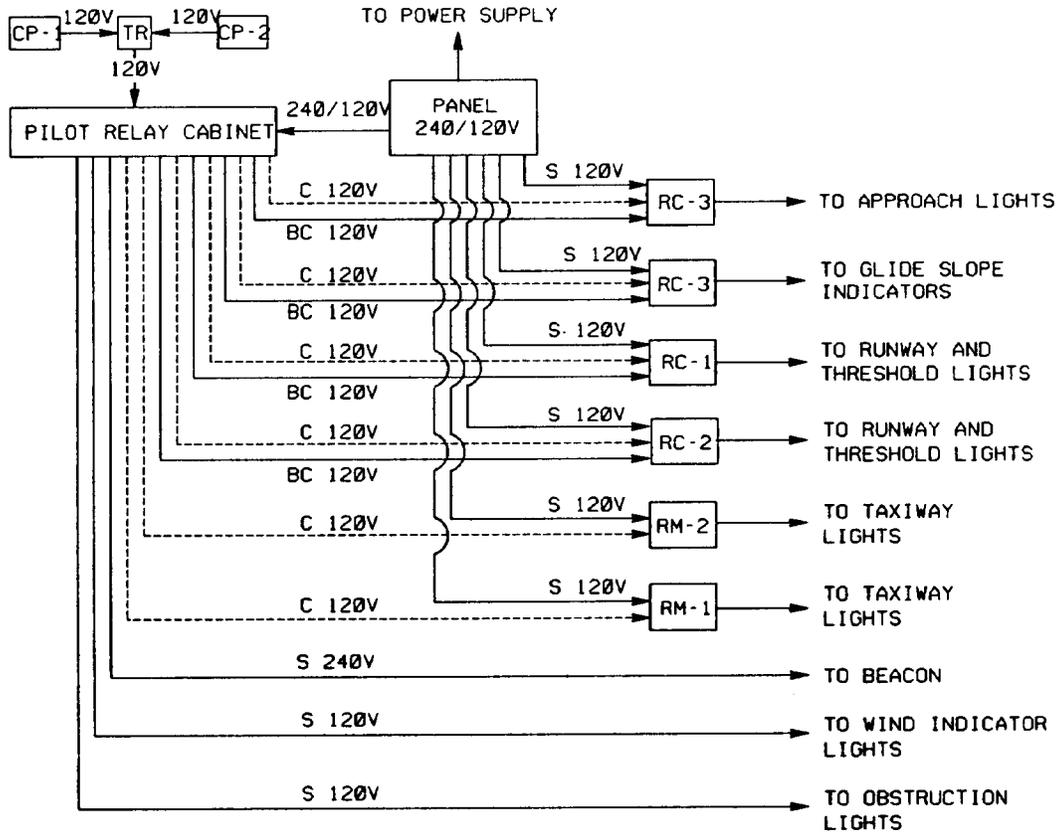


Figure 2-1. Typical layout Army airfield lighting facilities.



LEGEND

- CP-1 - CONTROL POINT - PRIMARY (CONTROL TOWER)
- CP-2 - CONTROL POINT ALTERNATE (VAULT)
- RC-1 (2) - REGULATORS
- RM-1 (2) - REGULATORS
- RC-3 (2) - REGULATORS
- RC-3 (1) - REGULATORS
- TR - TRANSFER RELAY
- BC - BRIGHTNESS CONTROL
- C - CONTROL
- S - SUPPLY

NOTE: ELECTRIC POWER SOURCE, MAIN SERVICE SWITCH, EMERGENCY GENERATOR AND TRANSFER SWITCH, AND MAIN DISTRIBUTION PANEL ARE NOT SHOWN. INSTALLATION OF THESE ITEMS WILL BE DESIGNED TO MEET LOCAL CONDITIONS.

Figure 2-2. Typical one line block diagram for Army airfield lighting systems.

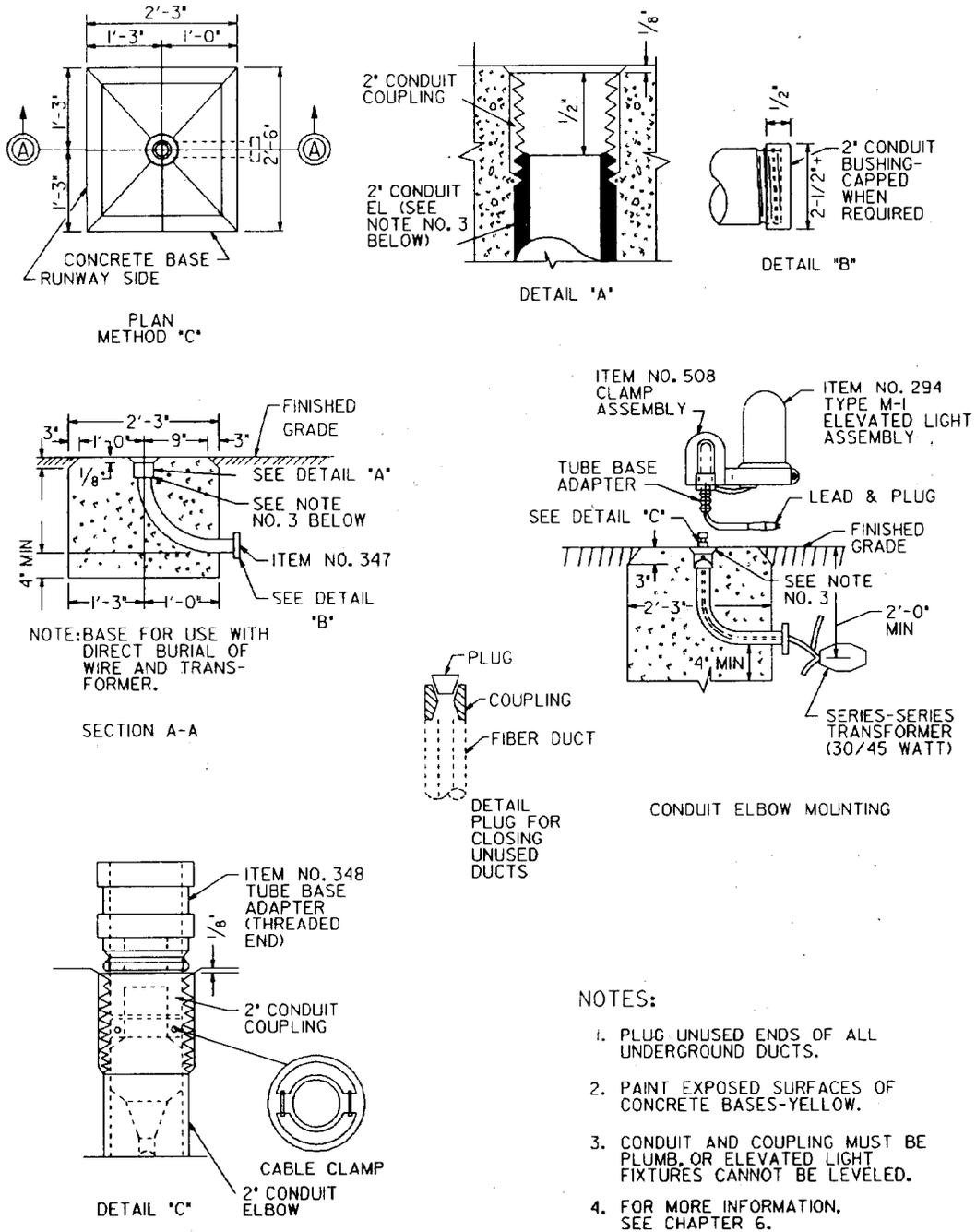


Figure 2-3. Installation details for elevated runway and taxiway marker lights.

use. Both lines of lights will be parallel to and equidistant from the runway centerline on spacings that will approach, but not exceed 200 feet. Elevated fixtures will be frangibly mounted a maximum of 14 inches above grade. If snow accumulations of 12 inches or more will be frequent, mounting height may be increased to not more than 24 inches above grade. Where runway intersections or taxiways intersections occur, the spacing of the runway lights will be uniform between paving intersection points of tangency (PT's) with each section calculated separately. Lights in paved areas will be omitted. Sections of runway lights opposite paved intersections will be treated as separate sections, with lights equally spaced between PTs of paved intersections (fig 2-1). For additional information see AFM 88-14.

2-5. Threshold lighting configuration

a. *Medium intensity lighting system.* The use of winged-out elevated threshold lights only, or a combination of winged-out elevated lights and semiflush inboard lights, will be optional for Army airfield lighting, as appropriate, for the particular medium intensity lighting system.

b. *High intensity lighting system.* For a high intensity lighting system, the winged-out and inboard combination of lights will be used.

c. *Location of threshold lights.* The line of threshold lights will be not less than 2 feet nor more than 10 feet from the ends of the runway. Winged-out sections of elevated lights on each side of the ends of the runway will extend outward, at right angles to the runway, for a total distance not less than 40 feet, with lights spaced on 10-foot centers. Each winged-out section will contain not less than five lights. The innermost light of each section will be located in line with the corresponding row of runway lights. Where elevated lights only are employed at the threshold, a minimum gap of 40 feet will be provided on each side of the runway centerline. The maximum total gap for a 75-foot wide runway will be 95 feet. Uniformly spaced inboard semiflush lights, having a maximum spacing of 10 feet between lights, may be employed to fill the gap between the winged-out sections of elevated threshold lights at each end of the runway. Such a configuration will provide the spacing for the elevated threshold lights and require minimum changes in the threshold lights should an approach lighting system be installed at the runway at some future date. Also, this configuration will serve to increase the longitudinal definition of the runway under medium intensity runway lighting conditions. All threshold lights will be connected in series with the appropriate runway lighting circuit. For additional information, refer to AFM 88-14.

2-6. Approach lighting configurations

a. *Approach lighting systems (MALS, MALSF, MALSR, ALSF-2 and ODALS).* 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. These systems provide visual information on one or more of the following: runway alignment, circling guidance, roll guidance, and horizon references. Those systems used for precision approaches (in conjunction with an electronic aid such as ILS) are 2400 feet in length, provided the glide slope angle is 2.750 or higher. At locations with the glide slope angle less than 2.750, the light lane will be 3000 feet. For nonprecision approaches, the systems are 1400 or 1500 feet in length. Except for the ODALS, the systems are also classified into high intensity or medium intensity systems; 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.

(1) *MALS - Medium Intensity Approach Lighting System.* The layout of the MALS will consist of a configuration of steady burning lights arranged symmetrically about and along the extended runway centerline as shown in figure 2-5. The system will begin approximately 200 feet from the runway threshold and terminate 1400 feet from the threshold.

(2) *MALSF - Medium Intensity Approach Lighting System with Sequenced Flashers.* Same as MALS but equipped with three sequenced flashers collocated with the outer three light bars of the system. This system is used at locations where approach area identification problems exist.

(3) *MALSR - Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (RAIL).* An economy type system used for precision instrument approaches of a Category I Configuration (an ILS approach procedure which provides for approach to a decision height of not less than 200 feet).

(4) *ALSF-2 - High Intensity Approach Lighting System with Sequenced Flashers.* Standard system for precision instrument approaches of a Category II Configuration (an ILS approach procedure which provides for approach to a decision height of not less than 100 feet).

(5) *ODALS - Omnidirectional Approach Light System.* The ODALS provides runway end identifier lights and useful circling, offset, and straight-in visual guidance for nonprecision instrument approach runways.

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

c. *Lead-in lighting system (LDIN).* The lead-in lighting system consists of a series of flashing lights installed at or near ground level to describe the desired course to a runway or final approach. The system may be curved, straight, or a combination thereof, as required. The LDIN may be

terminated at any approved approach lighting system or at a distance from the landing threshold which is compatible with authorized visibility minimums.

d. Selection considerations. Prior to the selection of a particular lighting aid, individual site evaluation will be made to determine which aid will best serve in improving operations. The probable environmental effects of constructing and operating the proposed lighting aid should also be considered. Possible reductions in instrument approach minima will be determined by the FAA. The following information will be used as a guide in selecting a particular system.

(1) *Approach lighting systems (ALSF-2, MALSR, MALSF, MALS and ODALS).* Approach lighting is an essential adjunct to electronic aids in providing landing approach guidance. The ALSF-2 configuration is to be used with all Category II and III instrument landing systems (ILS). The MALSR is the standard approach light system to be used with a category I ILS. A requirement also exists for less sophisticated approach lighting systems for use with nonprecision instrument approaches to establish early runway identification and provide alignment and roll guidance. The MALS will generally fulfill these requirements and is desirable where local conditions such as terrain or areas of high ambient light requires this facility to enhance safety of operations. Flashers should be incorporated (MALSF) at locations where approach area identification problems exist. The ODALS does not provide roll guidance but gives better runway identification for circling procedures and is effective in providing runway alignment, especially in areas of high ambient light.

(2) *Runway end identification lights (REIL).* The unidirectional (L-849) REIL provides early runway end identification and limited circling guidance. The omnidirectional REIL (L-859) should be used when good circling guidance is required. The REIL is most beneficial in areas having a preponderance of lighting or featureless terrain. A REIL system is not installed on the same end of a runway as an approach lighting system.

(3) *Lead-in lighting systems (LDIN).* Due to hazardous terrain, obstructions, noise abatement, or other conditions, some runway approaches require an LDIN to provide positive visual guidance along a specific approach path, generally irregular, to the approach light system or the runway end itself. Each LDIN installation is unique and designed specifically to fill a particular requirement. The LDIN is a visual flight rule (VFR) aid.

e. Layout.

(1) *MALS.* The system will consist of seven stations on approximately 200 feet, spacing. Each station will have a bar with five steady burning lights. The 1000-foot station will have two additional bars, one on each side of the centerline bar, each approximately 10 feet in length with five steady burning lights. Where authorized, the outer three stations will have sequenced flashing lights in addition to steady burning lights, and will be designated as MALSF. All lights in the system will emit aviation white light. Only steady burning lights will be provided with brightness

control. Sequenced flashing lights will flash consecutively towards the threshold. For additional information on the MALSF system, reference may be made to FAA Advisory Circular AC 150/5340-14.

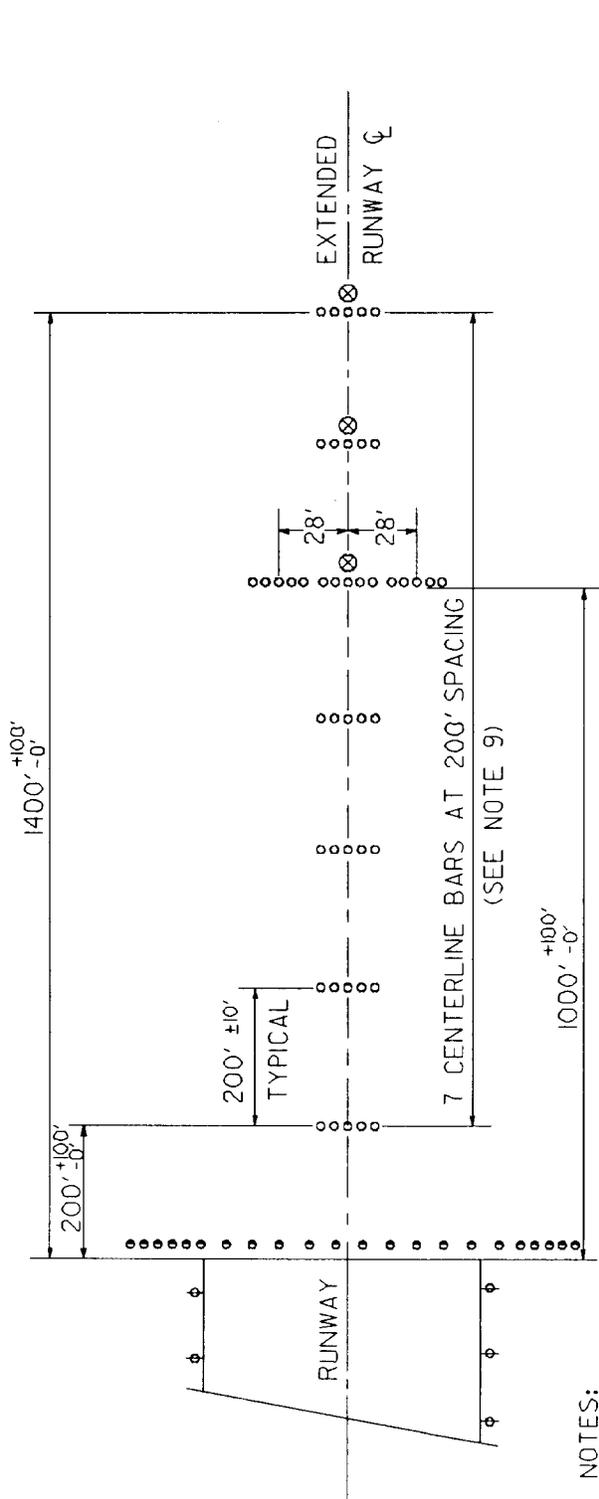
(2) *MALSF.* The MALSF consist of a MALS with 3 sequenced flashers which are located at the last three light-bar stations. These flashers are added to the MALS at locations where high ambient background lighting or other visual problems require these lights to assist pilots in making an earlier identification of the system. These lights flash in sequence toward the threshold at the rate of twice per second. The MALSF configuration is shown in figure 2-5, and typical installation details for the MALSF are shown in figure 2-6.

(3) *MALSR.* The MALSR consists of a MALS plus Runway Alignment Indicator Lights (RAIL). The RAIL portion of the facility consists of 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 feet interval out to 2400 feet (3000 feet for ILS glide slope angles less than 2.75) from the runway threshold. These lights flash in sequence toward the threshold at the rate of twice per second. The MALSR configuration is shown in figure 2-7.

(4) *ALSF-2.* This configuration is for use in Category II and Category III runways and is shown in figure 2-8. All light bars are installed perpendicular to the extended runway centerline and all lights are aimed away from the runway threshold. The steady burning lights are augmented with a system of sequenced flashing lights installed at each centerline bar starting 1000 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 light lanes will be 2400 feet in length providing the ILS glide slope angle is 2.75 or higher. At locations with the glide slope angle less than 2.75 the light lane will be 3000 feet in length.

(5) *OALS.* The omnidirectional approach light system consists of seven omnidirectional flashing lights located in the approach area of a runway. Five of the flashing lights are located on the extended runway centerline starting 300 feet from the runway threshold and at 300-foot intervals out to 1500 feet from the threshold. The remaining two flashing lights are located 40 to 75 feet from each edge of the runway at the threshold as shown in figure 2-9. For additional information on ODALS, refer to FAA Advisory Circulars AC 150/5340-14 and AC 150/5345-51.

(6) *LDIN.* The lead-in lighting system has no standard layout but is tailored to give appropriate guidance as controlled by local conditions. The flashing lights are placed in groups of at least three in the approach path beginning at a point within easy visual range of a final approach fix. The light groups are spaced close enough together (approximately 5000 feet) to give continuous lead-in guidance. A group will consist of at least three flashing lights in a linear cluster that, where practicable, should flash in sequence toward the runway. Figure 2-10 gives an example layout for a lead-in system.



NOTES:

1. THE OPTIMUM LOCATION OF THE APPROACH LIGHTS IS IN A HORIZONTAL PLANE AT RUNWAY END ELEVATION.
2. A MAXIMUM 2 PERCENT UPWARD LONGITUDINAL SLOPE TOLERANCE MAY BE USED TO RAISE THE LIGHT PATTERN ABOVE OBJECTS WITHIN ITS AREA.
3. A MAXIMUM 1 PERCENT DOWNWARD LONGITUDINAL SLOPE TOLERANCE MAY BE USED TO REDUCE THE HEIGHT OF SUPPORTING STRUCTURES.
4. ALL STEADY BURNING AND FLASHING LIGHTS ARE AIMED WITH THEIR BEAM AXES PARALLEL TO THE RUNWAY CENTERLINE AND INTERCEPTING THE ESTABLISHED APPROACH SLOPE AT A HORIZONTAL DISTANCE OF 1600 FEET IN ADVANCE OF THE LIGHT.
5. ALL OBSTRUCTIONS, AS DETERMINED BY APPLICABLE CRITERIA FOR DETERMINING OBSTRUCTIONS TO AIR NAVIGATION, ARE LIGHTED AND MARKED AS REQUIRED.
6. ALL STEADY BURNING AND FLASHING LIGHTS IN THE SYSTEM EMIT WHITE LIGHT.
7. INTENSITY CONTROL IS PROVIDED FOR THE STEADY BURNING LIGHTS.
8. THE THREE FLASHING LIGHTS FLASH IN SEQUENCE.
9. THE MALS LIGHT BAR CLOSEST TO THE RUNWAY THRESHOLD IS LOCATED AT A DISTANCE OF 200 FEET. ALL OTHER LIGHTS BARS SHOULD BE INSTALLED AT 200-FOOT INTERVALS WITH A ±10-FOOT TOLERANCE AT EACH LIGHT BAR STATION. THE ABOVE TOLERANCES CAN BE USED WHERE IT IS IMPRACTICAL TO INSTALL THE LIGHT BARS AT THE OPTIMUM LOCATIONS.

SYMBOLS

- ◊ EXISTING RUNWAY EDGE LIGHTS
- EXISTING RUNWAY THRESHOLD LIGHTS
- STEADY BURNING APPROACH LIGHTS
- ⊗ SEQUENCED FLASHING LIGHTS

Figure 2-5. Typical layout for MALSF.

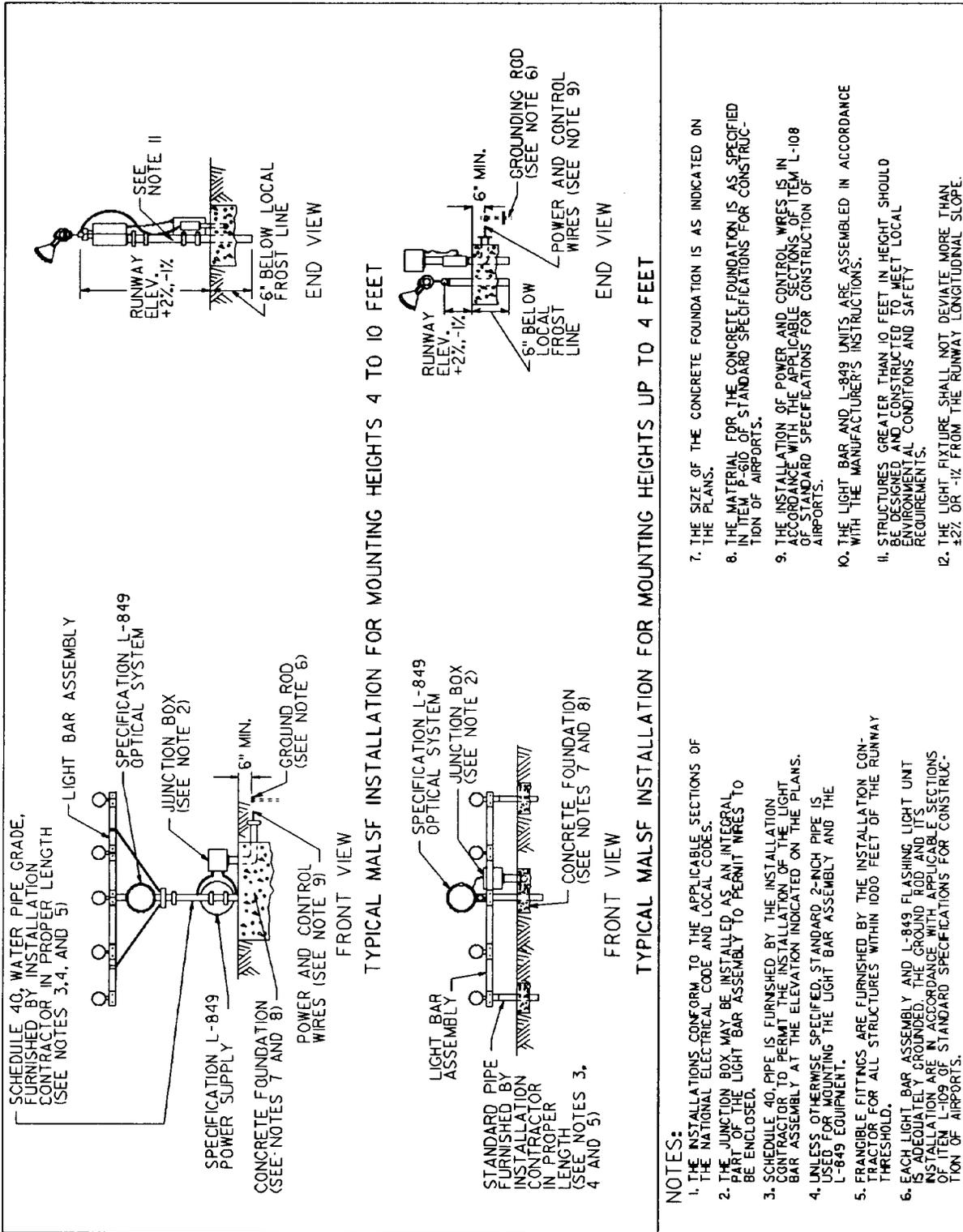


Figure 2-6. Typical installation details for MALSF equipment.

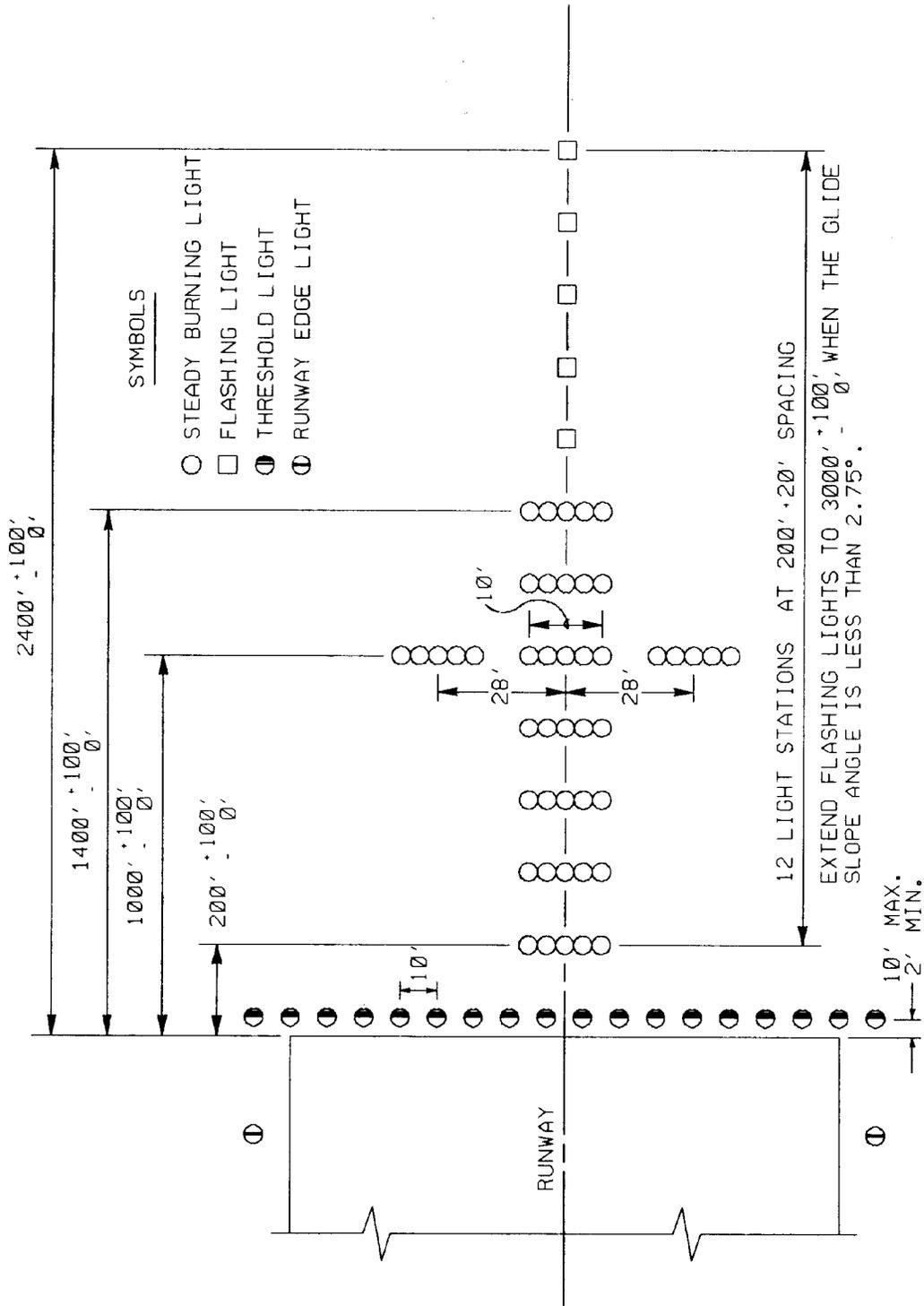


Figure 2-7. Typical layout for MALSR.

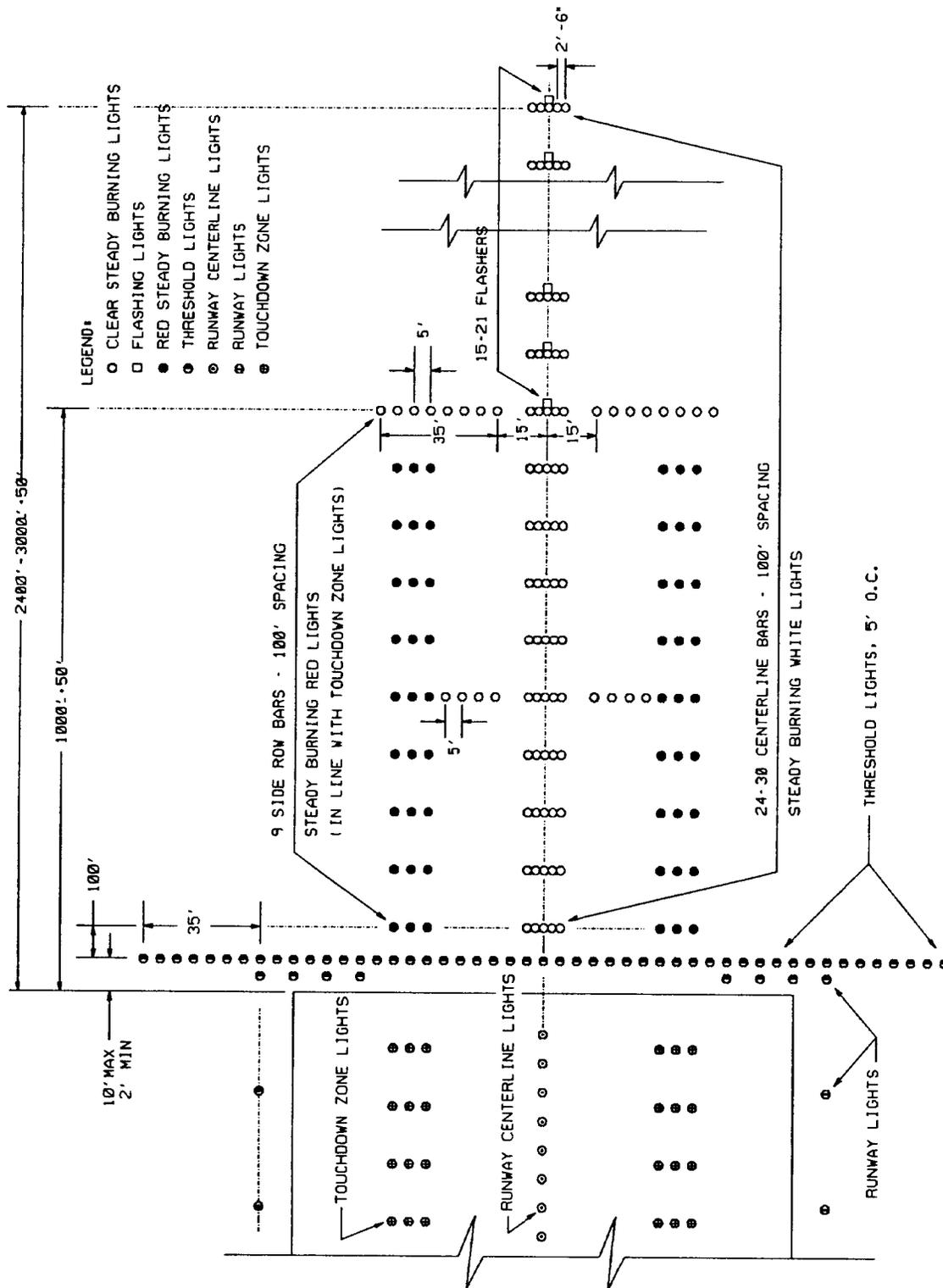


Figure 2-8. Typical layout for ALSF-2.

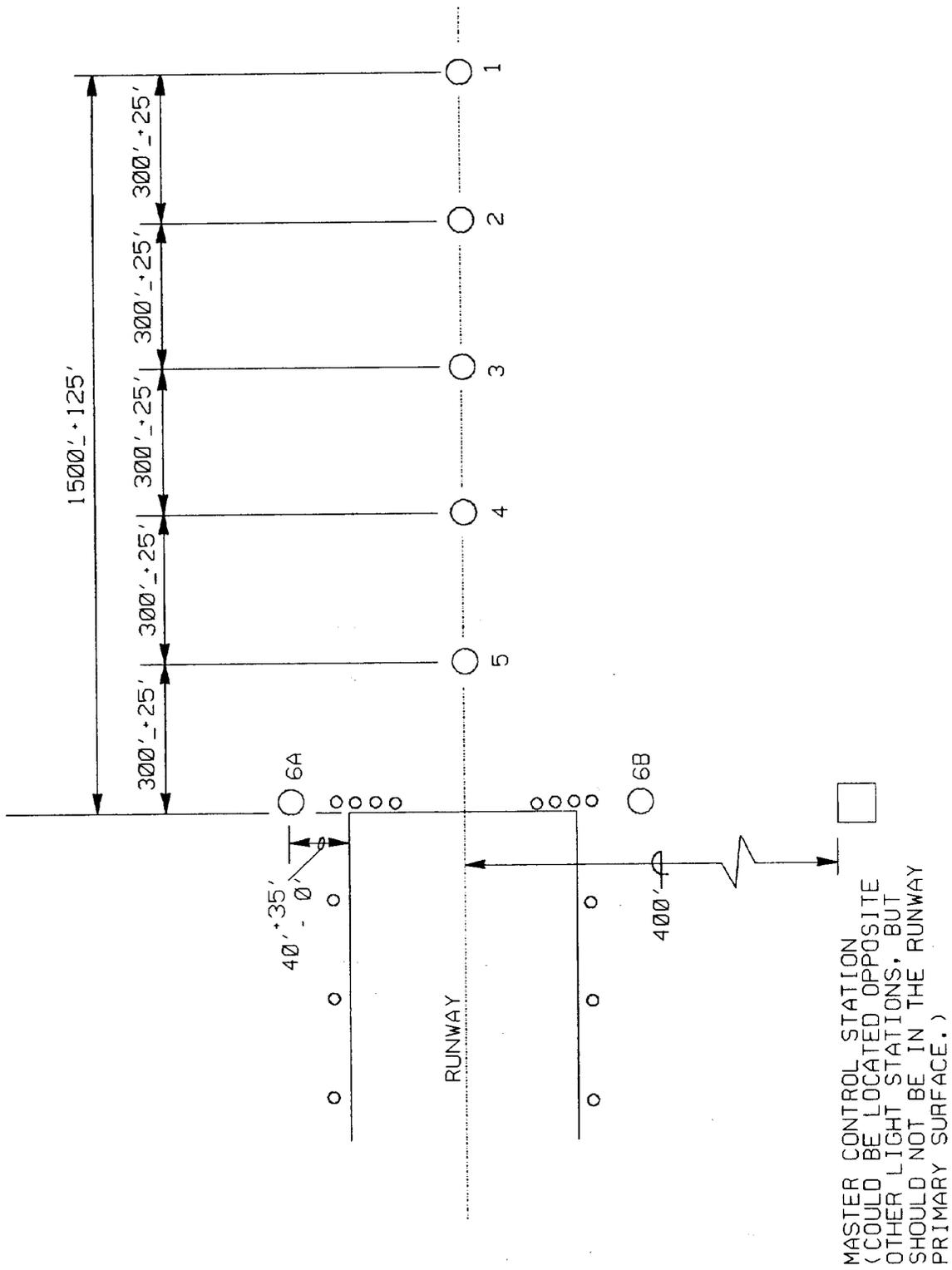


Figure 2-9. Typical layout for ODALS.

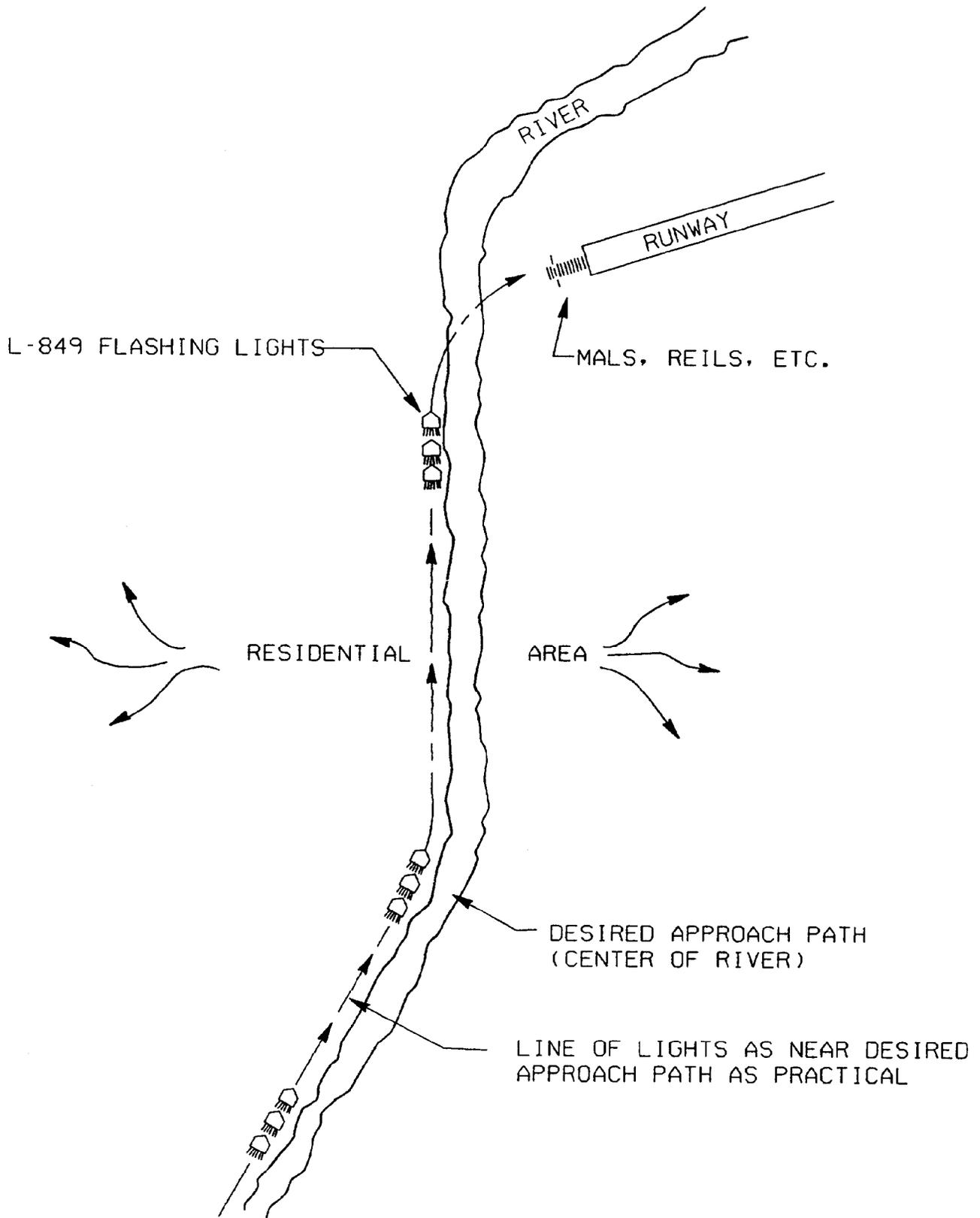


Figure 2-10. Example layout for LDIN.

f. Land requirements. The minimum land requirements, measured from the runway landing threshold, for the various approach lighting Systems are as follows:

(1) *MALS and MALSF.* 1600 feet in length by 400 feet in width.

(2) *MALSR.* 1600 feet in length by 400 feet in width for the MALS portion, plus an additional 1000 feet (1600 feet for ILS glide slope angles less than 2.75°) in length by 25 feet for the RAIL portion. The minimum width of 25 feet for the RAIL portion is considered adequate for relatively clear and level terrain. However where required to meet visibility or access requirements, the width may be increased up to 100 feet. In some cases the visibility or obstruction clearance requirements 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 buying additional land or removing obstructions and the least expensive method followed.

(3) *ALSF-2.* For 3200 feet in length by 400 feet in width for ILS glide slope angles of less than 2.75°. For 2600 feet in length by 400 feet in width for ILS glide slope angles of 2.75° or higher.

(4) *ODALS.* The land requirement is a 400-foot wide strip centered on the extended runway centerline and extending out to 1700 feet from the landing threshold.

(5) *LDIN.* As each system must be designed to suit local conditions and provide the visual guidance intended, land requirements will vary from site to site. Generally, land or land rights should be obtained to provide for the installation of light units and to obtain and maintain the required visibility to the light units from approaching aircraft.

g. High intensity short approach lighting system. The layout of the SALS will conform to applicable requirements of AFM 88-14. Specific exceptions to criteria noted in the above reference for an Army airfield approach lighting system are:

(1) Application at joint use civil, military airfields as noted in AFM 88-14 is not applicable to Army airfields. Should such a condition develop at an Army airfield installation, HQUSACE, CEMP-ET, will be so informed.

(2) The approach lighting system will be a shortened system limited to a total length of 1500 feet to provide a 1000-foot overrun area with a 500-foot centerline bar tail. Where practicable, one circuit will be used for the shortened approach lighting system excluding the threshold lights. The threshold lights, in this instance, will be connected to the runway lighting circuit if sufficient capacity and proper current characteristics are available or can be made feasibly available.

(3) Obstruction free lights will be utilized within a minimum distance of 500 feet from the runway threshold, but not including the lights at the 500-foot overrun station. Obstruction-free lights on unpaved overrun areas will be elevated type mounted on frangible fittings. Obstruction-free lights on paved areas will be semiflush or elevated type mounted on frangible fittings. No aircraft arresting barriers will be required at Army airfields.

(4) The multiway centerline will be offset to provide connection to light fixture pads or supporting structures.

(5) Winged-out threshold lights will emit 180 degrees aviation green/180 degrees aviation red light and may be elevated or semiflush as operationally required. Elevated lights will normally be used. Five lights spaced on 10-foot center for a total length of 40 feet, will comprise the winged-out threshold lights on each side of the runway. Winged-out threshold lights may be mounted on separate concrete pads with or without handholes or duct lines as required.

(6) Condenser discharge lights, flashing consecutively towards the threshold in sequence, will be optional. Central monitoring of the individual lights in the system will not be required. For the standard 1500-foot system, condenser discharge lights will be installed from the 1600-foot station to the 2000-foot station, on 100-foot spacing but will not be installed from the 1000-foot station to the 1500-foot station. If the system of condenser discharge lights is not initially installed in the approach lighting system, a spare duct with a No.9 AWG galvanized pull-wire installed therein will be provided for future installation of cable for such lights.

(7) Roll guidance bars will not be installed nor will a spare duct be provided for any future installation.

2-7. New approach lighting systems at existing Army airfields

The criteria of this manual will apply to the installation of new approach lighting systems at existing Army airfields. Existing runway lighting systems at most Army airfields are of the medium intensity type, and should require a minimum of construction effort for conversion to a system compatible with new approach lighting systems.

a. When a new medium or high intensity short approach lighting system will be provided at an airfield having an existing medium or high intensity runway lighting system, respectively, the existing system will be modified as required to conform to the criteria of this manual. Modifications to the existing system will reuse as much of the existing system components as practicable.

b. When a new high intensity short approach lighting system will be provided at an airfield having an existing medium intensity runway lighting system, the existing system will be modified as required to conform to the criteria of this manual. Various medium intensity system components will generally not be reusable in a high intensity system. Such non-reusable components will include the lighting fixtures and associated hardware and the underground series-to-series transformers. However, existing regulators, various controls, circuits, and cable lead connections; and the emergency power generating system will be salvaged and reused wherever practicable. Figure 2-11 illustrates modification requirements for an existing MALSF installation. Modification to the threshold lighting configuration will conform to the following wherever practicable:

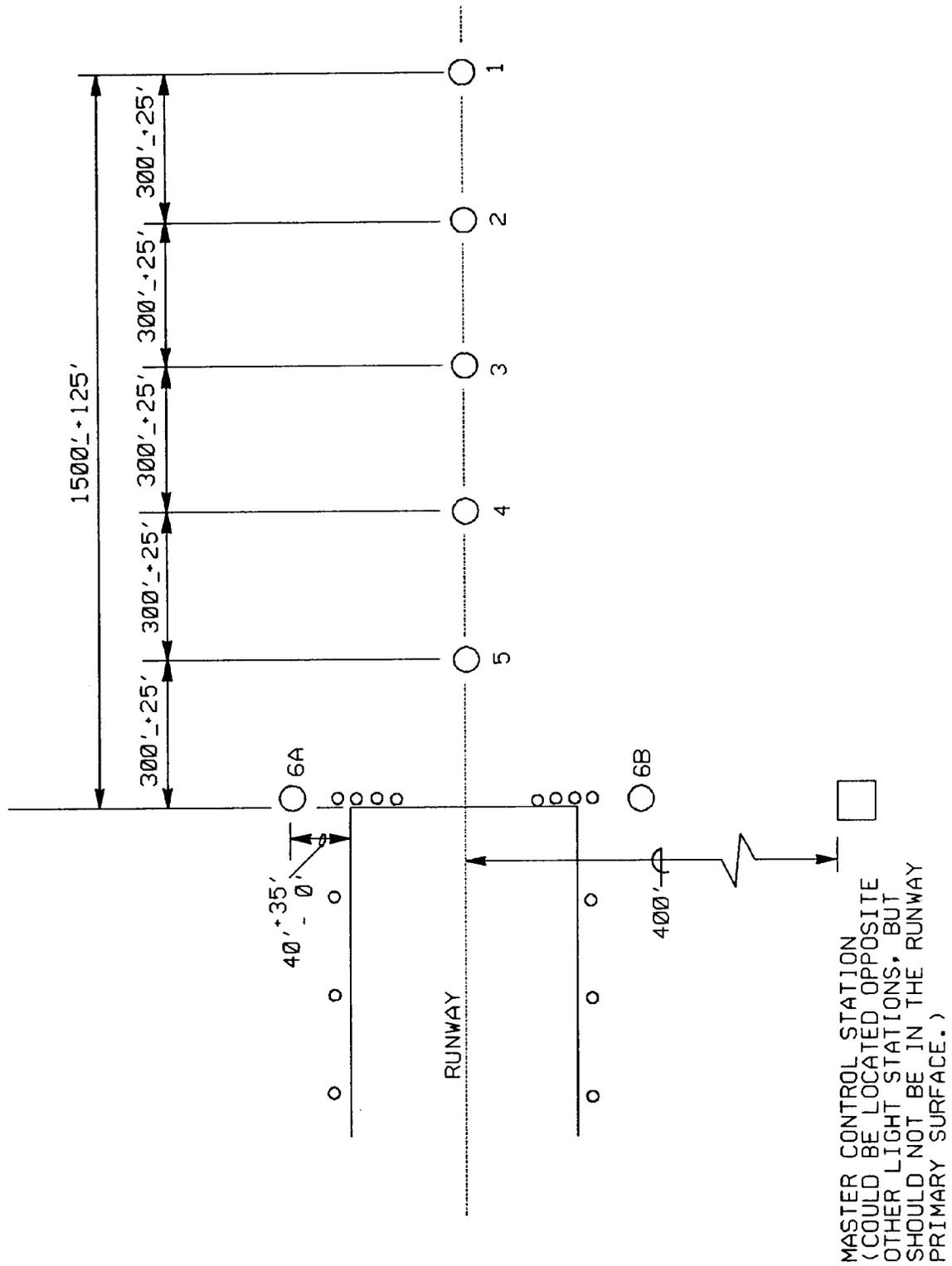


Figure 2-11. Modification for existing MALS installation.

(1) Inboard threshold lights of the semiflush type are required between the rows of runway edge lights at each end of the runway. Where semiflush inboard lights do not exist, new semiflush lights will be installed on spacing not exceeding 10 feet. Where semiflush inboard lights exist, but spacing exceeds 10 feet, new semiflush lights will be installed midway between the existing lights. Existing light fixtures, hardware, transformers, and other equipment will be replaced or modified as required to provide a high intensity system. Inboard threshold lights will be mounted on concrete pads, with or without handholes or duct lines, as required, and will be connected to the existing runway lighting circuit if sufficient regulatory capacity is available or can be made feasibly available. If such is not feasible, a new circuit and regulator will be provided, with the control arranged so that the threshold lights will be energized by the runway lighting circuit switch.

(2) Winged-out threshold lights will require no changes to existing spacing. However, existing light fixtures, hardware, transformers, and other equipment will be replaced or modified as required to provide a high intensity system. Connection and control requirements will be as for inboard threshold lights above.

2-8. Lighting of parallel runways

Lighting of parallel runways will be treated as for separate airfields and controlled independently.

2-9. Lighting of intersection runways

Where two or more intersecting runways are provided with the same type of runway lighting system, both systems may be served from a single group of regulators by the use of cabinet and relay assembly runway selector (similar and equal to USAF Item No. 148D) or series circuit switch assembly runway selector (similar and equal to USAF Item No.408).

2-10. Lighting equipment

Several types of light fixtures are used in Army airfield runway and approach lighting systems. The type of fixture used depends upon whether the system is of medium or high intensity, and the location and service to be given by the light. Series circuits are used for supplying electrical energy to the lights. The types of lights required for use in runway and approach lighting systems are described below. Each type of light is denoted by a descriptive name, Air Force Item Number or FAA Number or Advisory Circular and, where existing, by Part Number and Military Specification. Mounting accessories are not noted herein, but are shown on the installation detail drawings, figures 2-3 and 2-4.

a. *Runway edge lights.* Runway edge lights will be installed on concrete pads as shown on the installation detail drawings. The color of the runway edge lights will be aviation white (clear).

(1) Elevated medium intensity lights will be omnidirectional, Type M-1, Item No.294, conforming to Mil. Spec. MIL-L-7082. The lamp for the elevated light will be 30 watts, 6.6-ampere, T-10 medium pre-focus base, Item No. 334, conforming to Part No. MS 25012-1 and Mil. Spec. MIL-L-6363. The lens will be asymmetrical type, clear, Item No.335 conforming to Mil. Spec. MIL-L-7082. FAA type L-861 fixtures may also be used.

(2) Semiflush medium intensity lights will be omnidirectional, Class B-3, Item No.654, conforming to Mil. Std. MS-27033 and Mil. Spec. MIL-L-26202. The lamp for this fixture will be 45 watts, 6.6-ampere, PAR-56, conforming to Mil. Std. MS-24488 and Mil. Spec. MIL-L-6363. FAA type L-852E, class 2 fixtures may be used in lieu of military specification fixtures.

(3) High intensity lights for elevated and semiflush installations will be as described in AFM 88-14.

b. *Inboard threshold lights.* Inboard threshold lights will be installed in concrete bases as shown on the installation detail drawings, figures 2-3 and 2-4, and will emit aviation green and red light by use of 180 degrees aviation green/180 degrees aviation red filters. Type and number of filters will suit the fixtures furnished.

(1) Semiflush medium intensity lights will be omnidirectional, Class B-3, Item No.654, conforming to Mil. Std. MS-27033 and Mil. Spec. MIL-L-26202. The lamp will be 45 watts, 6.6-ampere, PAR 56 conforming to Mil. Std. MS-24488 and Mil. Spec. MIL-L-6363. FAA type L-852E, class 2 fixtures may be used instead of the military specification fixtures.

(2) Semiflush high intensity lights will be as described in AFM 88-14.

c. *Winged-out threshold lights.* Winged-out threshold lights will be installed on concrete pads as shown in the installation detail drawings, figures 2-3 and 2-4, and will emit aviation green and red light by use of 180 degrees aviation green/180 degrees aviation red filters. Type and number of filters will suit the fixtures furnished. Winged-out threshold lights normally will be elevated. Semiflush fixtures will be used where an elevated light will cause interference with aircraft movement, such as at a taxiway area.

(1) Elevated medium intensity lights will be omnidirectional, Type M-1, Item No.294, conforming to Mil. Spec. MIL-L-7082. The lamp will be 45 watts, 6.6-ampere, T-10, medium prefocus base, item No.289, conforming to Mil. Std. MS-25012 and Mil. Spec. MIL-L-6363. FAA type L-861 fixtures may be used instead of type M-1 fixtures.

(2) Semiflush medium intensity lights will be omnidirectional, Class B-3, Item No.654, conforming to Mil. Std. MS -27033 and Mil. Spec. MIL-L-26202. The lamp will be 45 watts, 6.6-ampere, PAR 56 conforming to Mil. Std. MS-24488 and Mil. Spec. MIL-L-6363. FAA type L-852E, class 2 fixtures may also be used.

(3) High intensity light fixtures, elevated and semiflush, will be as described in AFM 88-14.

d. Approach lighting system. The requirements for approach lighting systems are set forth in paragraphs 2-6 and 2-7, above.

(1) Information concerning medium intensity approach lighting fixtures, locations, and mounting, is set forth in FAA Advisory Circular AC 150/5340-14. Only the MALS and MALSF portion of this advisory circular will be applicable.

(2) Information concerning high intensity approach lighting fixtures, locations, and mountings is set forth in AFM 88-84.

e. Refueling area lights. Fixture assembly must meet Underwriters Laboratories (UL) test and approval requirements as stated in UL 844 for class 1 division 1, group D hazardous locations as defined in NFPA 70. The fixture assembly will include a light fixture, frangible-coupling, power disconnect switch that will kill power to the fixture if the frangible-coupling is broken, and a junction box. The lens/filter colors will meet MIL-C-25050.

2-11. Power supply and circuits

Runway and approach lighting systems are supplied through interleaved series circuits served by constant current regulators, except for the MALS and MALSF, which will be supplied from a 120/240-volt, 60-hertz multiple circuit. Constant current regulators designed for use on these airfield lighting systems have provisions for varying output current from rated value to lower values so that the brightness of the lamps in the lighting system may be adjusted to suit visibility conditions. This provision is referred to as "Brightness Control." Regulators will be as described in chapter 10.

a. Circuiting criteria. The number and type of regulators and/or magnetic amplifier dimmers or transformers required will be determined by length and number of runways, approach system types, lighting system intensities, and the number of lights in each system. Losses in volt-amperes for the circuit cables and the feeder cables from the vault to the lights should also be taken into

consideration when designing the systems. Regulators should always be loaded to at least one-half of rated kW output. Where more than one regulator is needed, the load should be divided equally between the number of regulators used for that circuit. Where future extensions to runways are planned, an exception to the above may be made in that regulators may be loaded at less than half of rated output for first increment construction, to permit future load additions with no change in regulator circuiting.

b. Transformers, cables, and connectors. For information on installation of such items, see chapter 8.

(1) The cable used for series circuits will be No.8 AWG, 1/C stranded, 5,000-volt, cross-linked polyethylene, conforming to Mil. Spec. MIL-C-38359. Conductors for the MALS and MALSF will be 1/C stranded, 600 volt, sized as required for the installation, conforming to the applicable portions of FAA Advisory Circular AC 150/5345-7.

(2) The series transformers used for various types of systems are as follows:

(a) *Medium intensity* - 6.6/6.6 amperes, 30/45 watts, Item No.829 conforming to Mil. Spec. MIL-T-27535, and Mil. Std. MS-27289-1.

(b) *High intensity* - 6.6/6.6 amperes, 200 watts, Item No.831 conforming to Mil. Spec. MIL-T-27535, and Mil. Std. MS-27288-1.

(c) *High intensity* - 20/6.6 amperes, 200 watts, Item No.832 conforming to Mil. Spec. MIL-T-27535, and Mil. Std. MS-27286-1.

2-12. Control system

The runway and approach lighting Systems controls are an integral portion of the control system for all airfield lighting facilities. The function of this portion of the control is to energize and de-energize the selected runway and approach lighting systems as well as control the brightness of such systems remotely, as required by the operations of the airfield. Runway and approach lighting systems will be controlled from the control tower and the equipment vault as described in chapter 10.