

# CHAPTER 1

## GENERAL

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### 1-1. Purpose.

This manual presents general provisions and criteria for planning, designing, and constructing lighting systems for Army airfields, heliports, and helipads.

### 1-2. Scope

Criteria herein are applicable to all Army airfields, heliports, and helipads in the Continental United States (CONUS), Alaska, and Hawaii. The criteria are recommended for use as a basis of design for overseas Army operations in order to promote standardization of requirements for flight safety.

### 1-3. References

Appendix A contains a list of references used in this document.

### 1-4. Deviations

Lighting facilities for airfields, heliports, and helipads other than those defined herein will not be provided without prior approval by HEADQUARTERS U. S. ARMY CORPS OF ENGINEERS (HQUSACE), CEMP-ET.

### 1-5. Procurement of lighting system materials and equipment for Army airfields, heliports, and helipads

Lighting system materials and equipment for Army airfields, heliports, and helipads will be included in the construction contract plans and specifications as contractor furnished and contractor installed. Construction contract plans and/or specifications will include a brief description of items, a brief design premise, with operational and inspection information, referenced Military Specification (Mil. Spec.) or other specification covering each item, and the Military designator or Federal Aviation Administration (FAA) designator with any specific reference material. This data may be obtained from AFM 88-14, and/or applicable FAA Standards. Use of names of equipment manufacturers in contract plans and specifications will be avoided. However, because of the special category of many of the material and equipment items, a general list of known equipment manufacturers prepared from those mentioned in the data for preparing contract plans and specifications may be furnished to prospective bidders and/or the contractor at the bidder's or contractor's request. When materials or equipment items submitted by the contractor for approval are listed in the data used for preparing the contract plans and

specifications, it may be considered as prima facie evidence that the items are satisfactory and may be approved for the installation.

### 1-6. Advertising for lighting facilities

The following criteria for the advertising of lighting facilities at airfields, heliports, or helipads is in effect for all Army projects in CONUS, Alaska, and Hawaii. Normally, the contract for installation of complete lighting facilities at an airfield, heliport, or helipad will not be combined with the general construction or paving contract for such facilities. An exception to this policy will be granted when satisfactory proof that a combination-type contract is in the best interest of the Government has been submitted to and approved by HQUSACE, CEMP-ET, WASH DC 20314-1000. When separate contracts are contemplated, ducts for cable crossings under movement area paving, concrete light bases in paved areas, handholes, manholes, longitudinal ducts, duct markers, and components of related work that can be accomplished under the general construction or paving contract will be so accomplished rather than deferred until the remaining portion of the lighting facilities contract can be separately advertised. Advertising of the remaining portion of the lighting facilities for the airfield, heliport, or helipad will be authorized at the appropriate time to complete the project on schedule.

### 1-7. Basis of measurement in procurement

Centerline measurements (in feet) will be used in programing, justifying, or budgeting for runway, threshold, taxiway, taxilane, hoverlane, and approach lighting systems. Linear feet will be used for programing, justifying, or budgeting perimeter lights at helipads. Lighting for apron access and engine runup area taxiways will be shown as a primary or supporting item, as applicable, and will be measured as taxiway lighting. Auxiliary lights and visual or electronic navigational aids, including but not limited to apron or parking area floodlights, helipad floodlights, protective and security floodlights, obstruction lights, beacons, and wind direction indicators will be measured on a per unit basis, and shown as primary or supporting items, as applicable.

### 1-8. Design analysis

A general design analysis covering the major features or components of the lighting facilities for the Army airfield, heliport, or helipad will be furnished for each project. Design analysis will include sufficient descriptive information computations, and data such as:

**TM 5-811-5**

- a. Applicable rules, regulations, and engineering manuals used or followed.
- b. Electric power supply characteristics and computed loads, with demand factors where applicable.
- c. General description and characteristics of the airfield, helipad, heliport lighting system, and lighting control system, including miscellaneous visual aids and auxiliary lighting.

- d. Computations and data used in determining sizes and selection of major items of equipment and conductors.

**1-9. Abbreviations used in this manual**

The following abbreviations pertaining to Army aviation lighting are used in this manual:

<u>Abbreviation</u>	<u>Term</u>
ALSF-2 .....	High Intensity Approach Lighting System with Sequenced Flasher.
AWG .....	American Wire Gage.
CHAPI .....	Chase Helicopter Approach Path Indicator.
EMT .....	Electric Metallic Tubing.
GCA .....	Ground Control Approach Radar System.
IFR .....	Instrument Flight Rules.
ILS .....	Instrument Landing System.
IMC .....	Instrument Meteorological Conditions.
KW .....	Kilowatt.
kVA .....	Kilovolt Ampere.
LDIN .....	Lead-In Lighting System.
MALS .....	Medium Intensity Approach Lighting System.
MALSF .....	Medium Intensity Approach Lighting System With Sequenced Flasher.
MALSR .....	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (RAIL).
ODALS .....	Omnidirectional Approach Light System.
PAPI .....	Precision Approach Path Indicator.
PT .....	Point of Tangency.
REIL .....	Runway End Identifier Lights.
SALS .....	High Intensity Short Approach Lighting System.
VFR .....	Visual Flight Rules
VMC .....	Visual Meteorological Conditions.

## 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

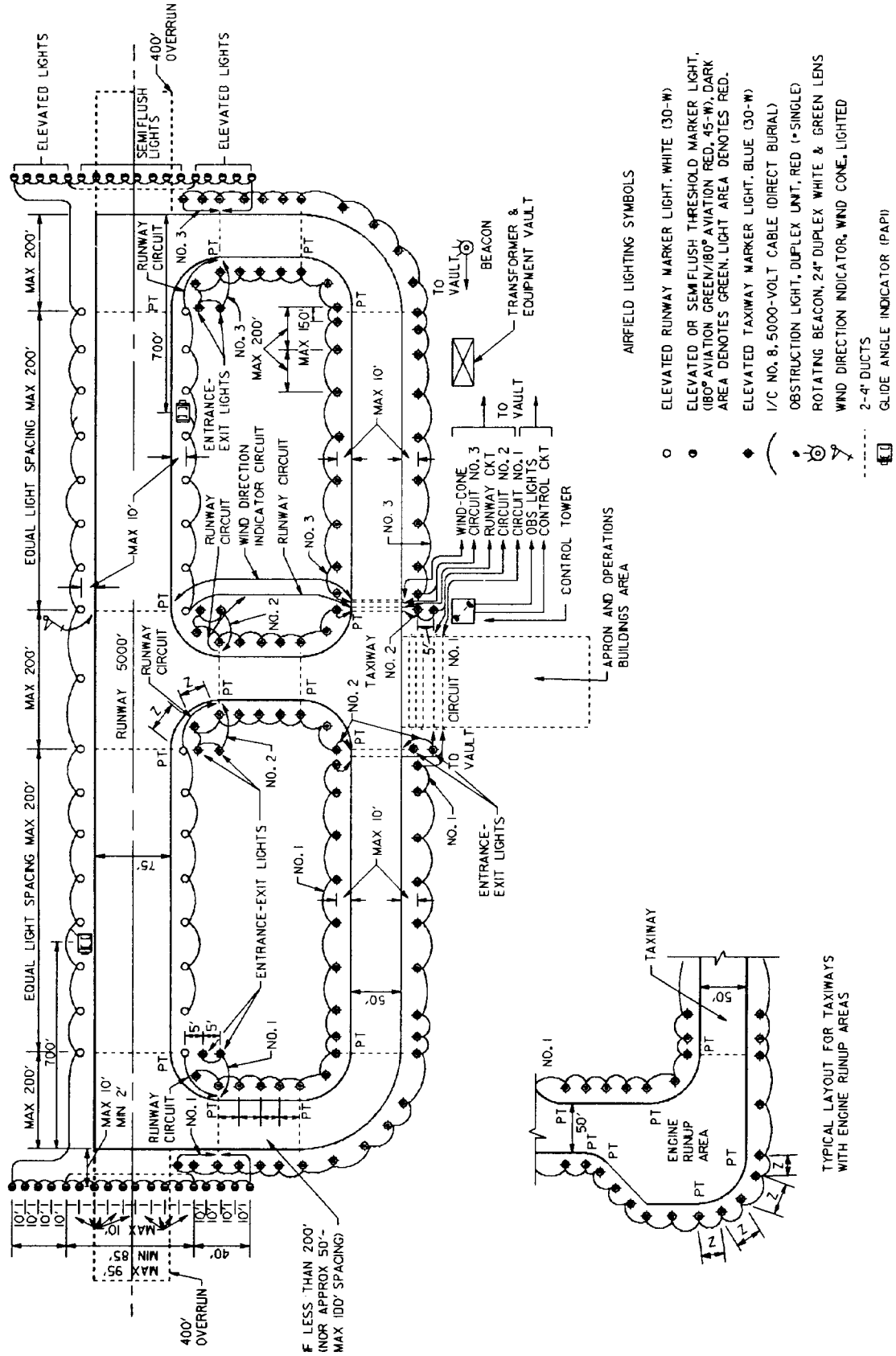
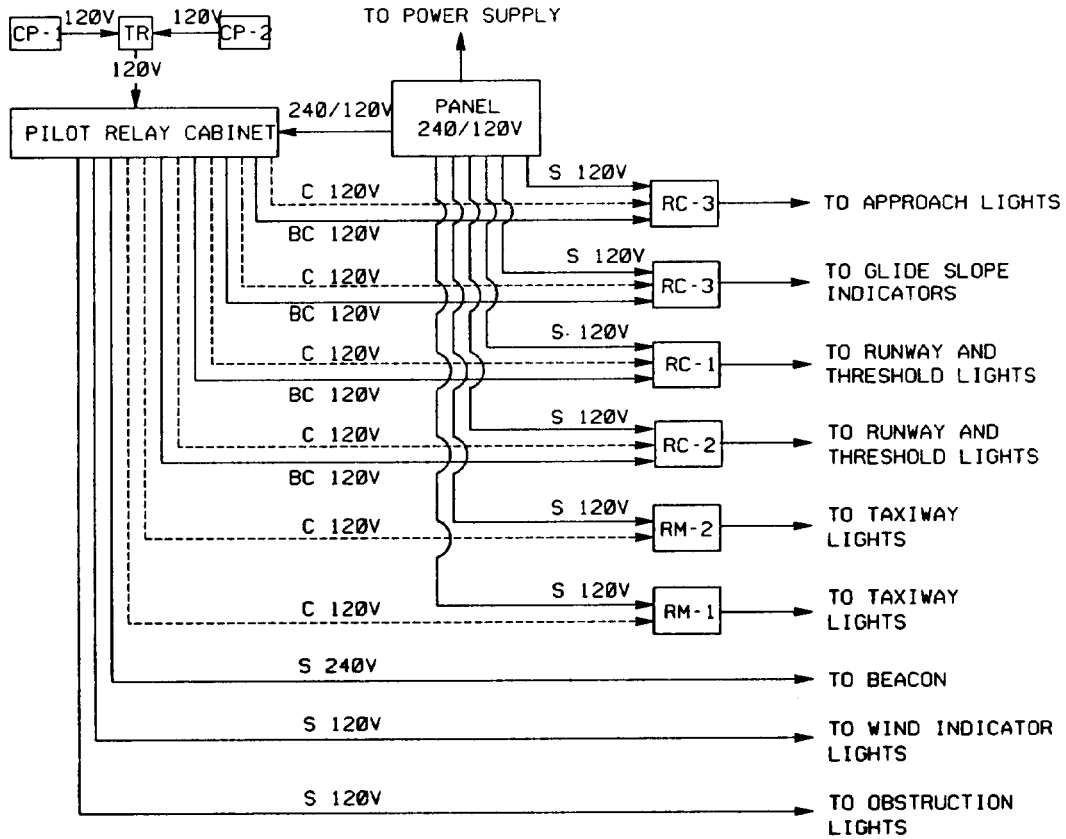


Figure 2-1. Typical layout Army airfield lighting facilities.

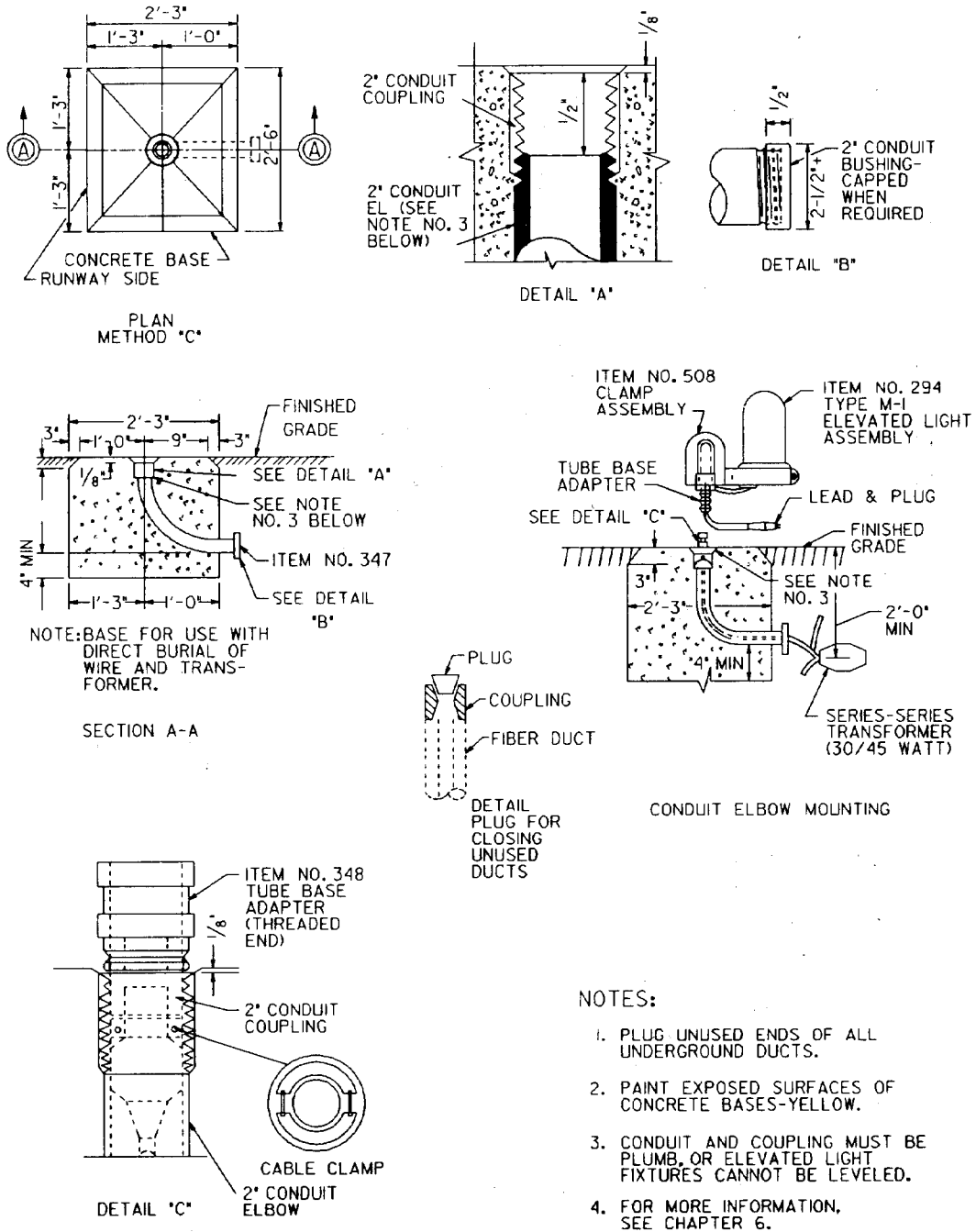


LEGEND

- 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.



- NOTES:
1. PLUG UNUSED ENDS OF ALL UNDERGROUND DUCTS.
  2. PAINT EXPOSED SURFACES OF CONCRETE BASES-YELLOW.
  3. CONDUIT AND COUPLING MUST BE PLUMB, OR ELEVATED LIGHT FIXTURES CANNOT BE LEVELED.
  4. FOR MORE INFORMATION, SEE CHAPTER 6.

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.

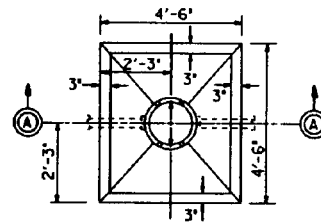
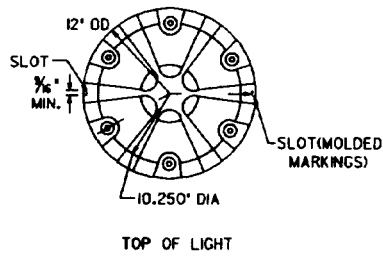
(4) *ALSF-2.* This configuration is for use in Category II and Category III runways and is shown in figure 2-8. All light bars are installed perpendicular to the extended runway centerline and all lights are aimed away from the runway threshold. The steady burning lights are augmented with a system of 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.

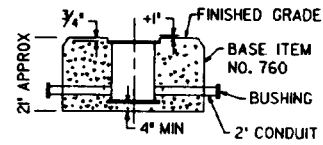


NOTE: LIGHT DISTRIBUTION IS OMNI-DIRECTIONAL

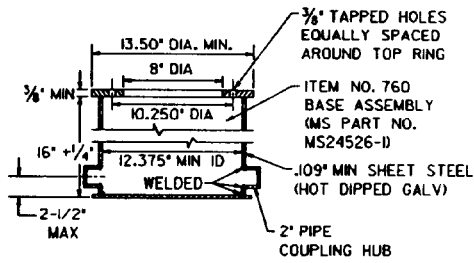


PAD WITHOUT HANDHOLE

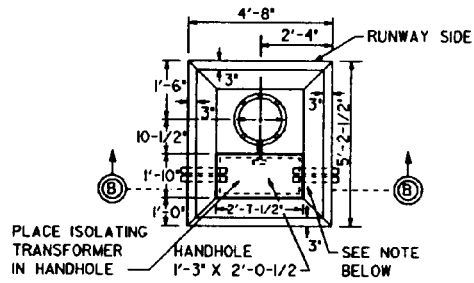
NOTE: TOP OF LIGHT APPROX 1" ABOVE CONCRETE



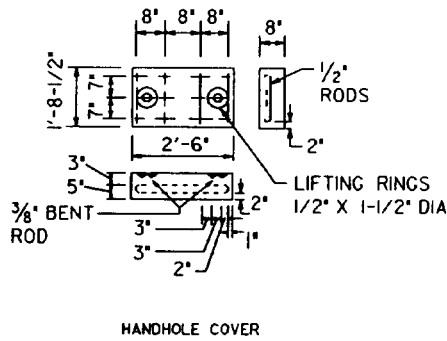
SECTION A-A  
PAD WITHOUT HANDHOLE



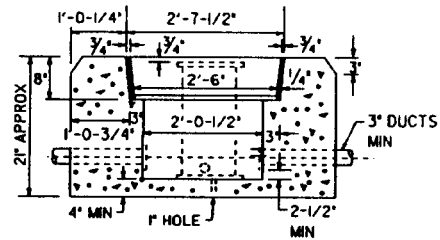
MARKER LIGHT ASSEMBLY



PAD WITH HANDHOLE



HANDHOLE COVER



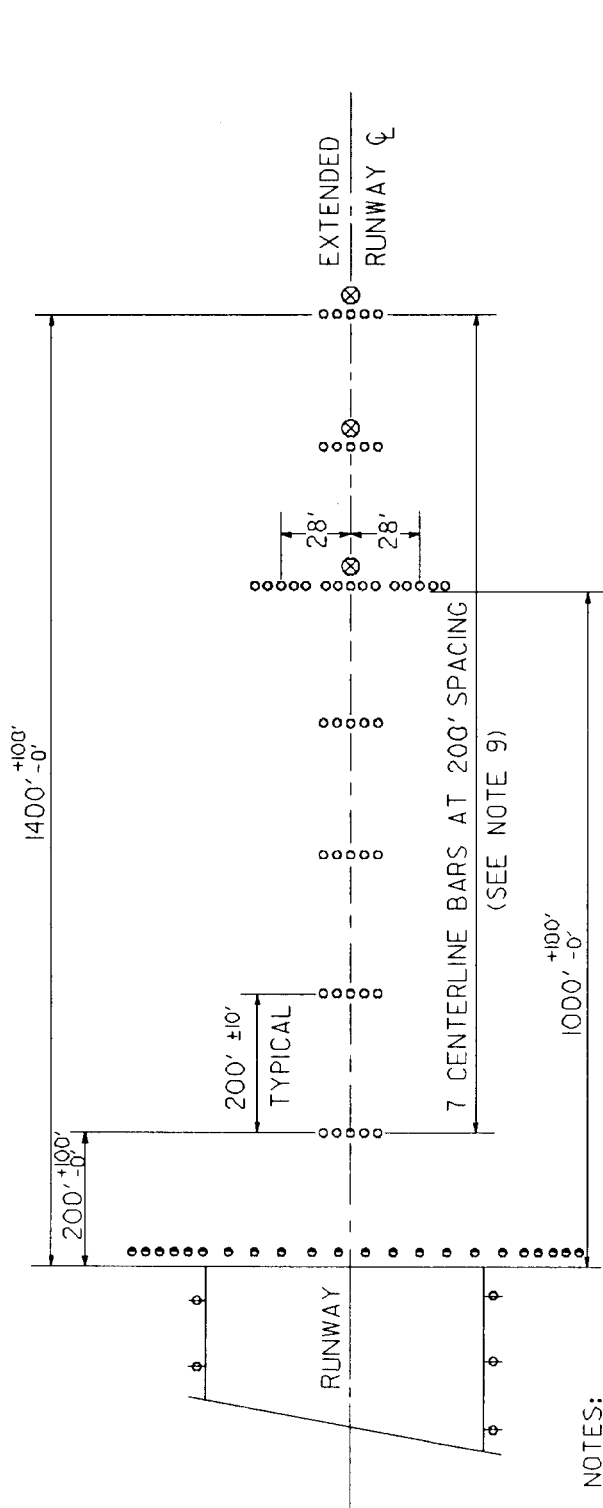
SECTION B-B

- NOTES: 1. PLUG UNUSED ENDS OF ALL UNDERGROUND DUCTS.
- 2. PAINT EXPOSED SURFACES OF CONCRETE BASES-YELLOW.
- 3. FOR MORE INFORMATION, SEE CHAPTER 6.

NOTE: INSTALLATION DETAILS FOR FLUSH THRESHOLD MARKER LIGHTS FOR ARMY AIRFIELD WILL BE SIMILAR.

NOTE: SEAL JOINT WITH JUTE AND SEALING COMPOUND

Figure 2-4. Installation details for runway, taxiway and threshold marker lights.



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.

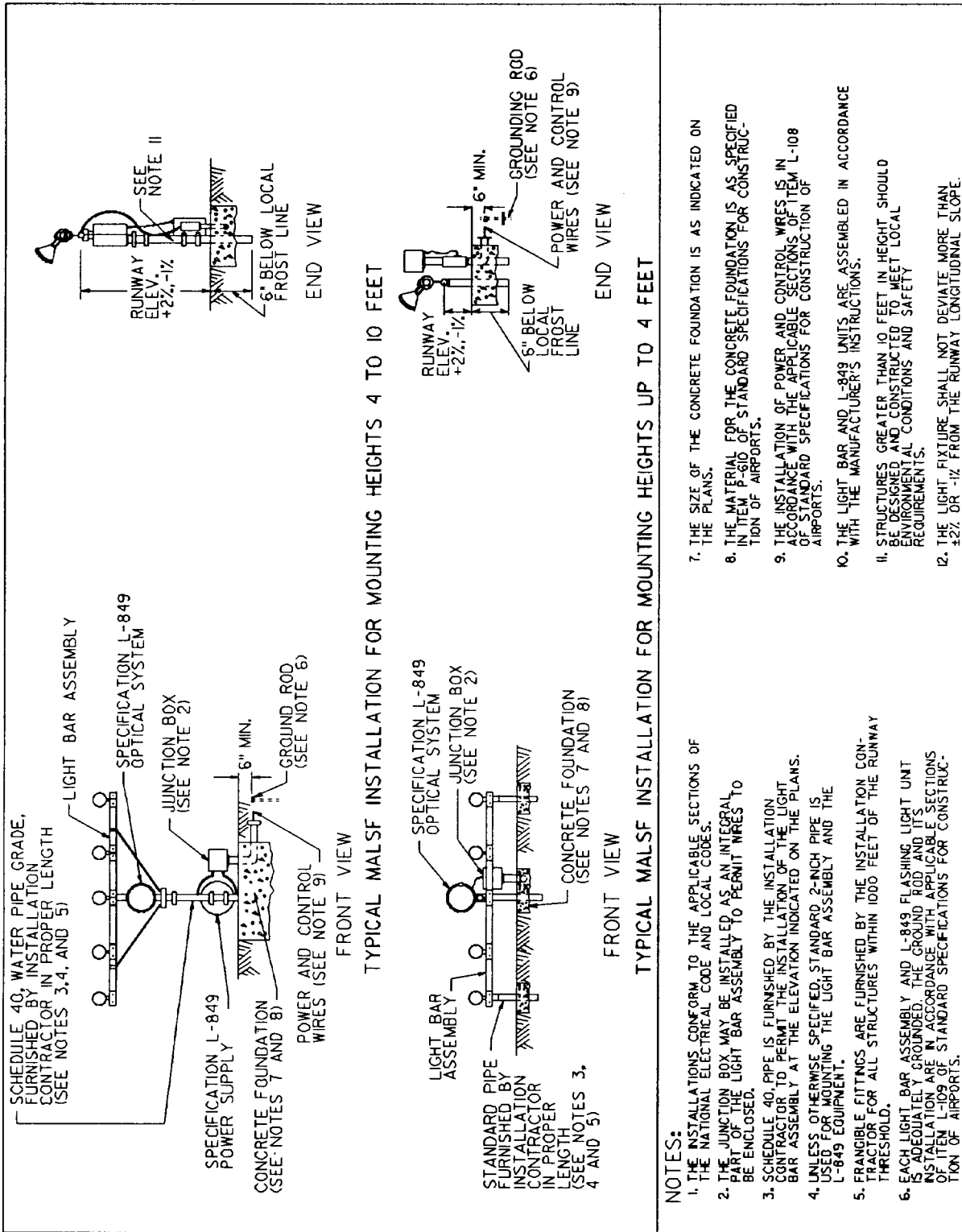


Figure 2-6. Typical installation details for MALSF equipment.

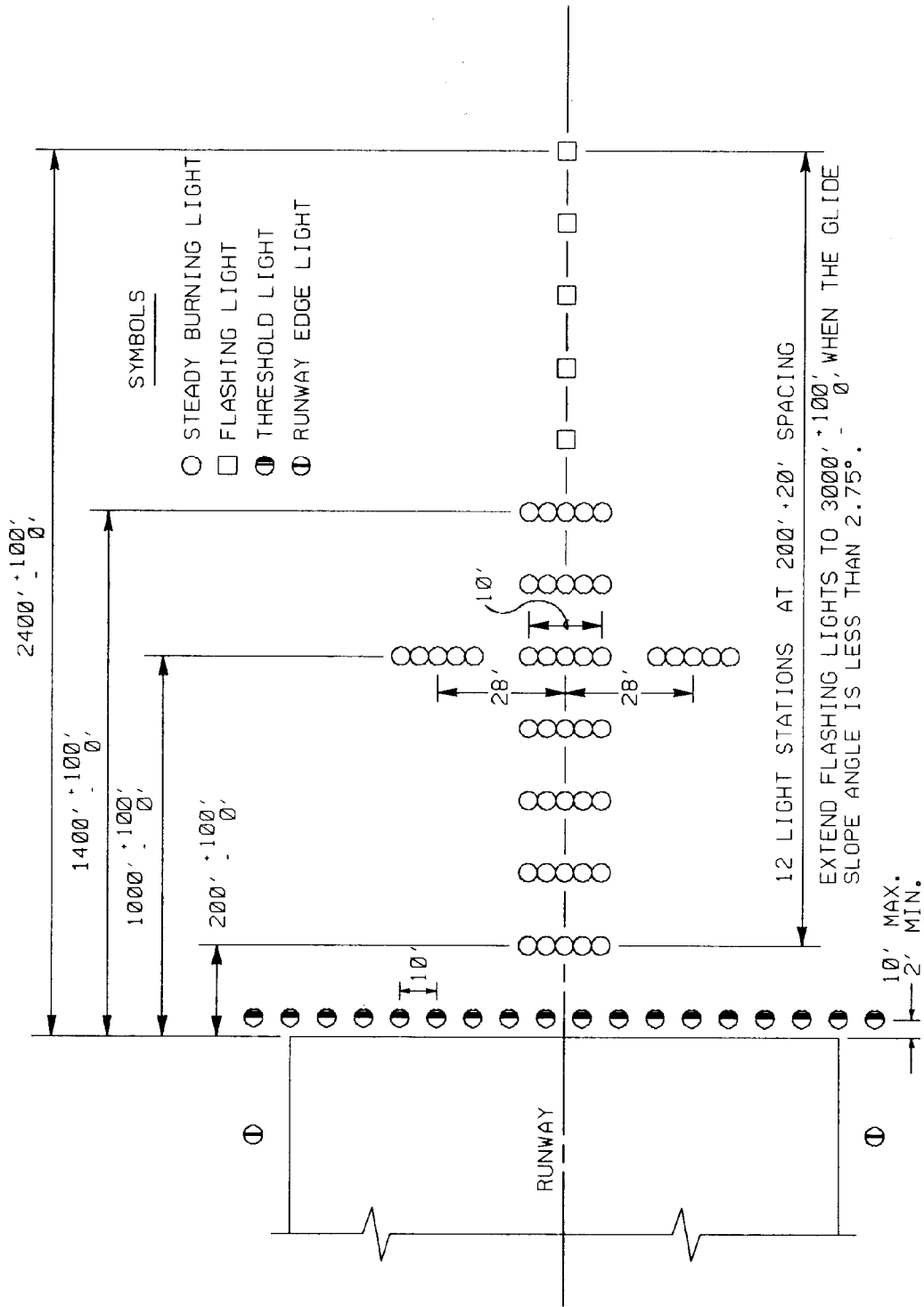


Figure 2-7. Typical layout for MALSR.

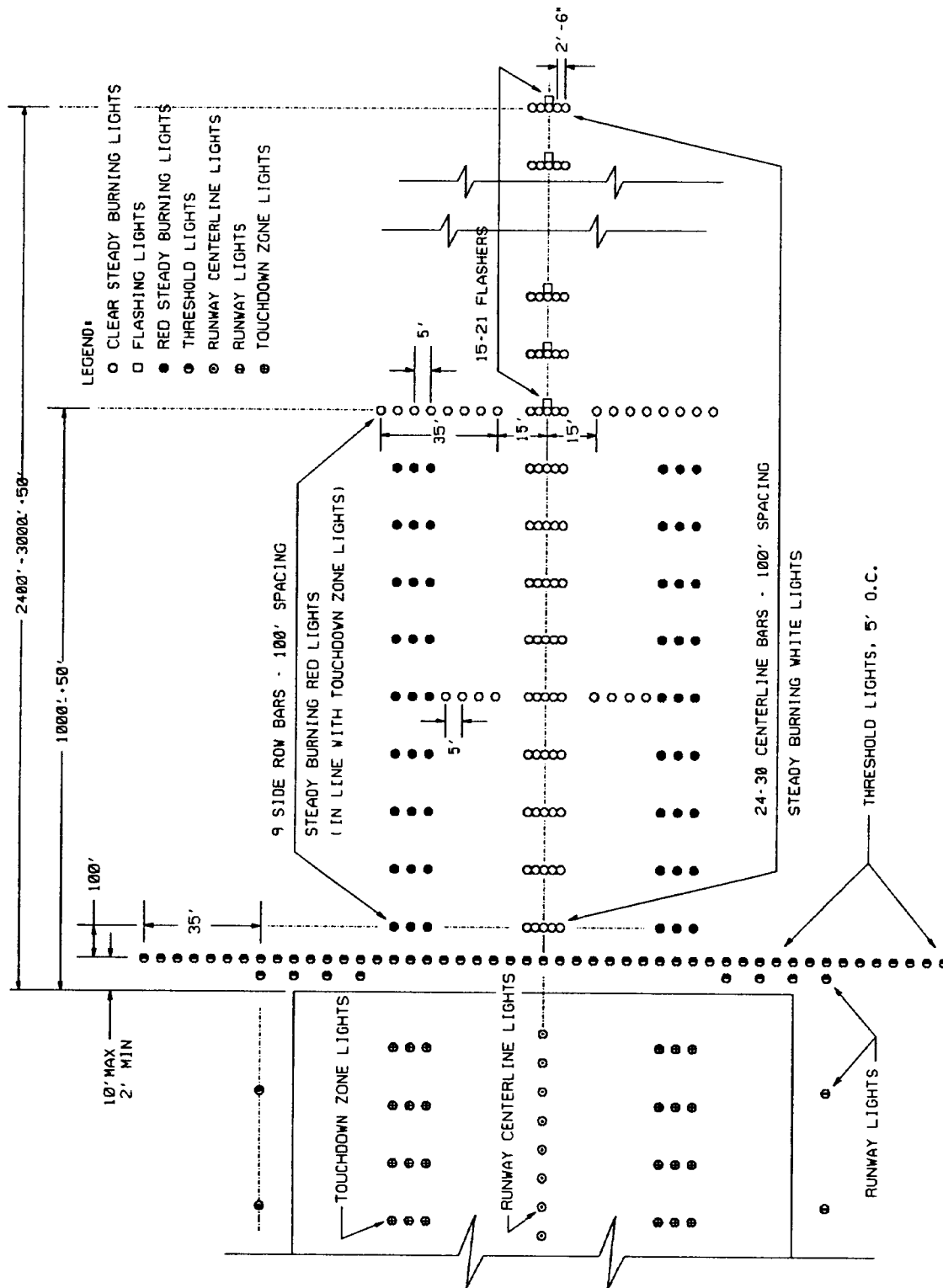


Figure 2-8. Typical layout for ALSF-2.

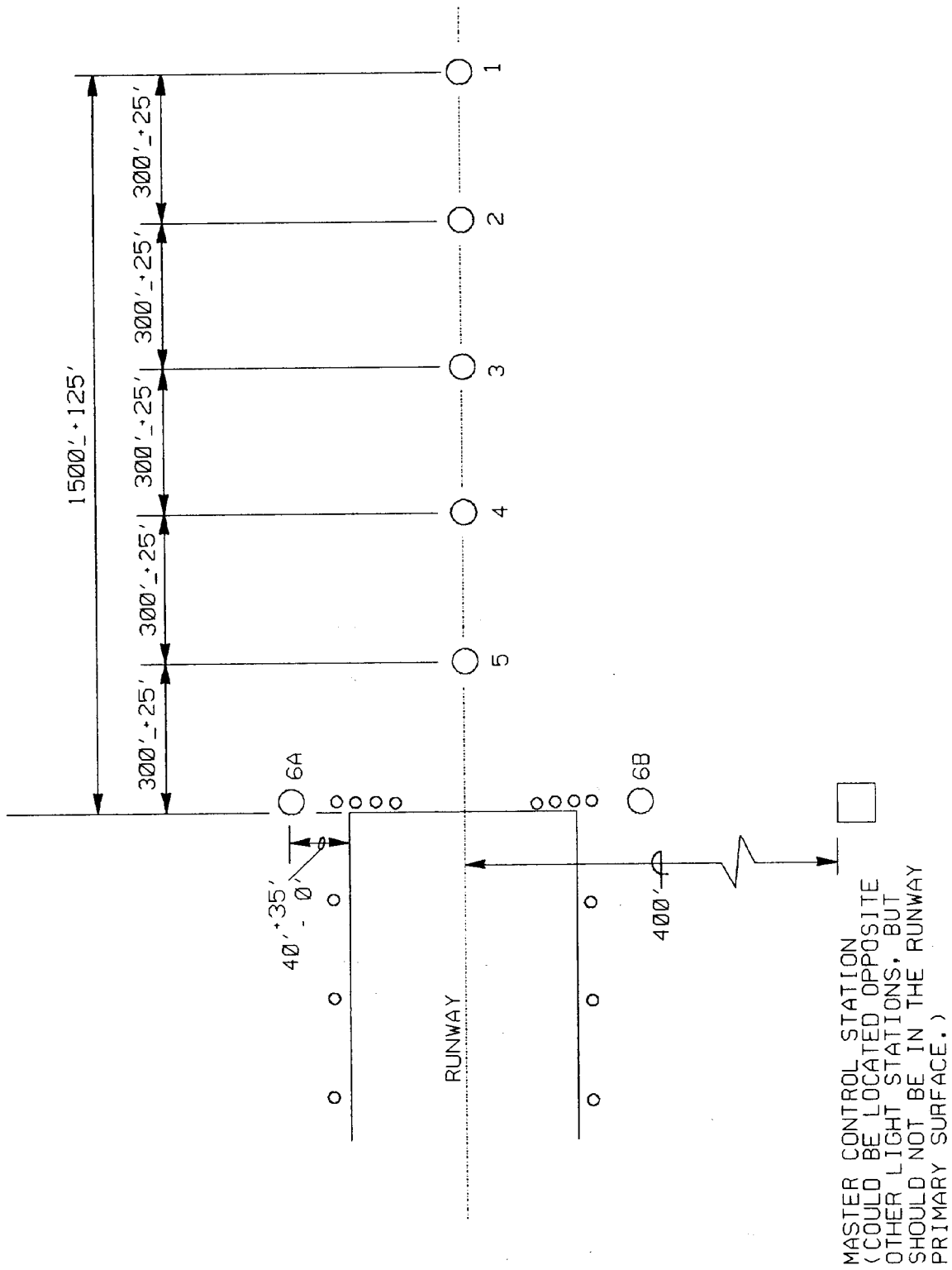


Figure 2-9. Typical layout for ODALS.

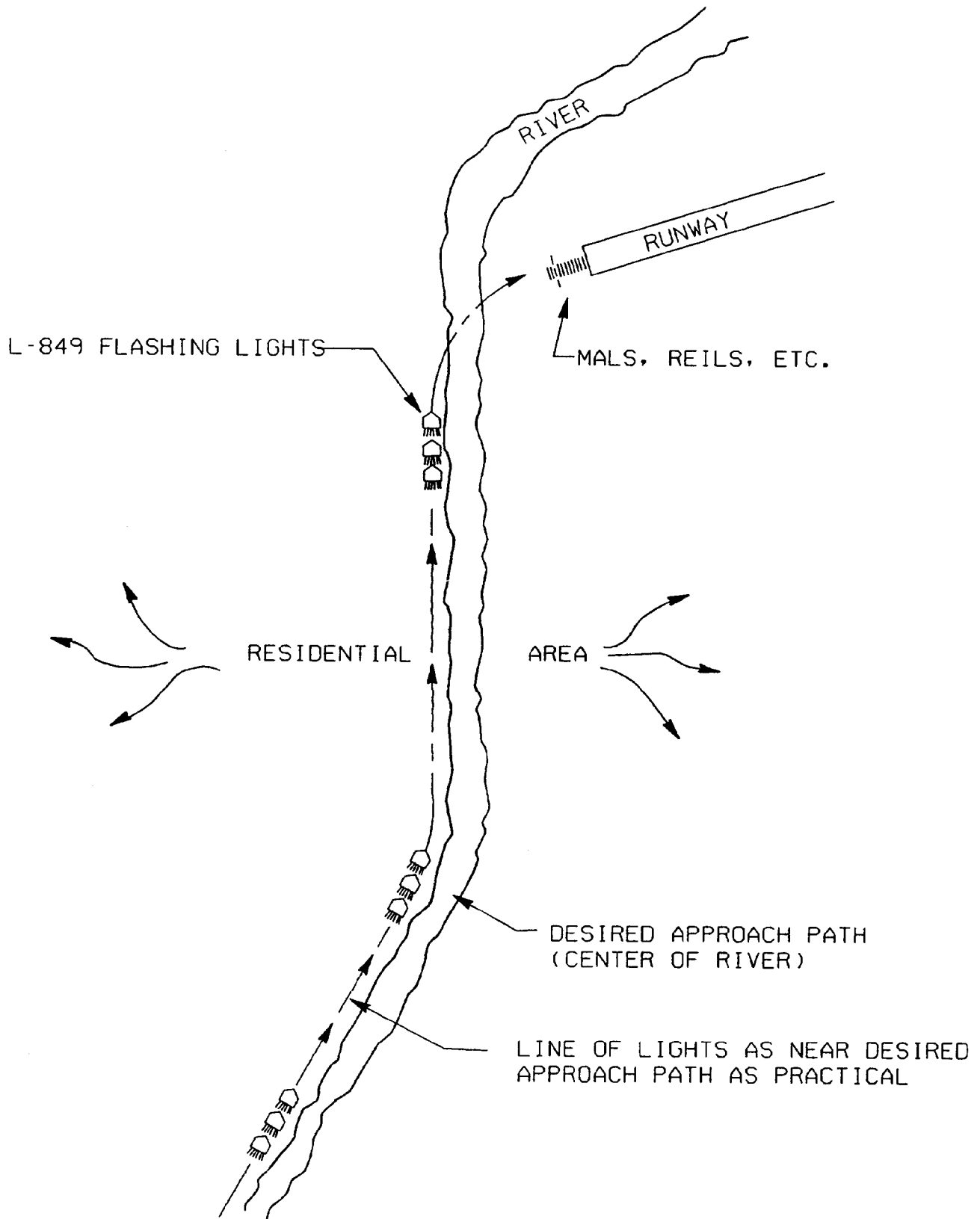


Figure 2-10. Example layout for LDIN.

*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:



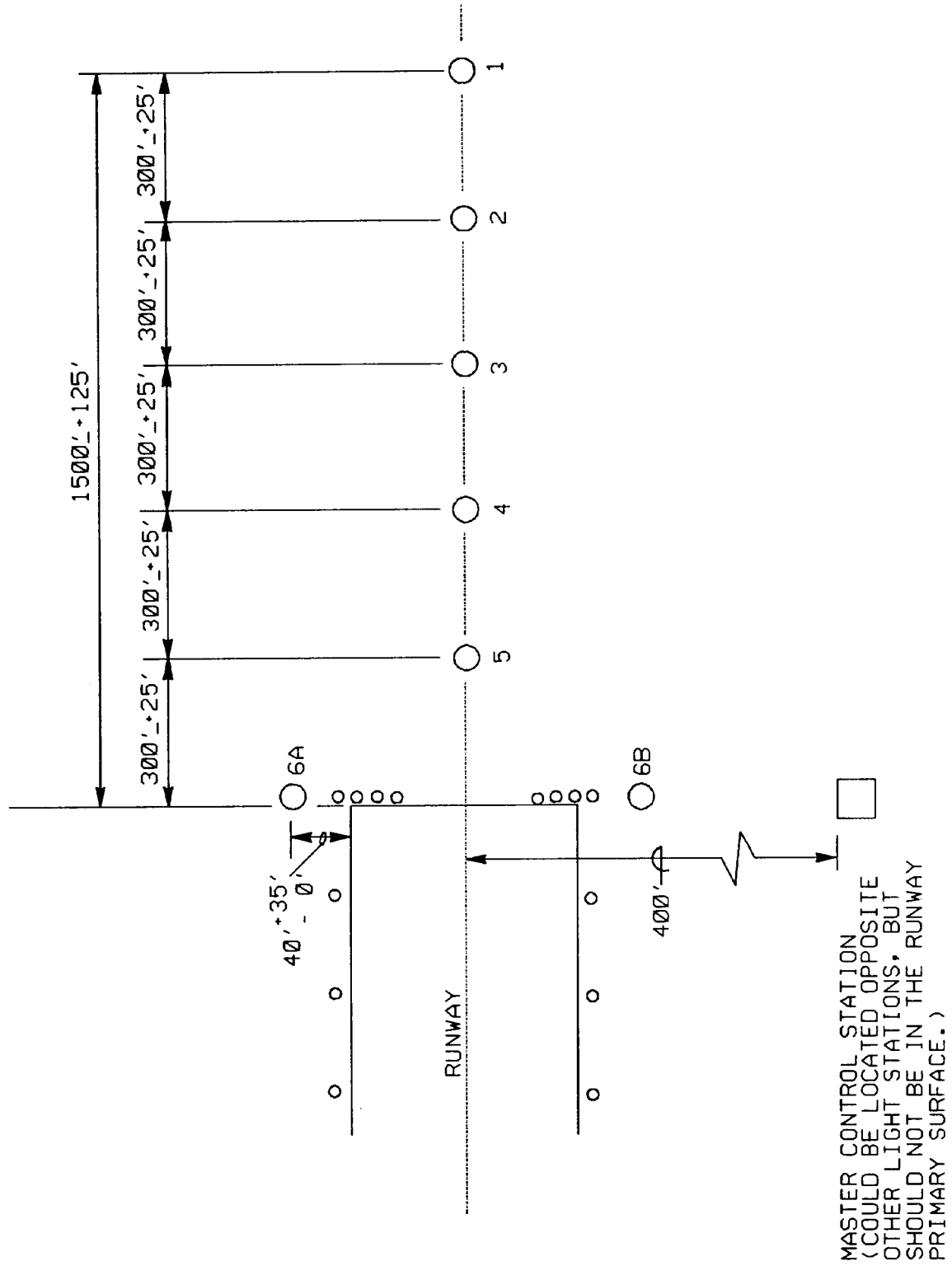


Figure 2-11. Modification for existing MALS installation.

(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.

## CHAPTER 3

# HELIPORT AND HELICOPTER STAGEFIELD LIGHTING SYSTEMS

### 3-1. General design and layout criteria

a. *Heliport runway.* Figures 2-1, 2-4, 3-1, 3-2, and the design criteria set forth herein are intended to guide in designing and installing a permanent Army heliport lighting system utilizing medium intensity elevated and semi-flush lights at a heliport having two 75-foot wide by 625-foot long intersecting runways with 40-foot wide connecting taxiways and 25-foot wide adjacent surface treated shoulders. Changes in the layout or design maybe to fit the requirements of a particular heliport runway installation, including the basic one runway configuration. Pavement configurations not specifically covered by these criteria will be lighted in accordance with the intent of these criteria.

b. *Helicopter stagefield.* Figure 3-3 and the associated design criteria contained herein are intended as a guide in designing and installing a permanent Army helicopter stage field lighting system.

### 3-2. Description

a. *Heliport runway.*

(1) *Runway lighting system.* The line of runway lights (alternate white and blue) located on each side of the heliport runway will be not less than 5 feet nor more than 10 feet from the paved edge of the runway; and will be of the elevated type. Spacing within the line of lights will be approximately 20 feet, but not less than 15 feet nor more than 25 feet. Where intersecting runways or intersections between runways and taxiways occur, spacing of runway lights will be uniform between paving intersection points of tangency (PTs) with each section calculated separately. White lights on each separate runway will be connected to the appropriate lighting circuit; the blue lights on each runway will be connected to the appropriate taxiway lighting circuit as shown on figure 3-1. Where the runways intersect at the extreme ends, all lights, both white and blue, for the particular runway not having a connecting taxiway thereto, will be connected to the appropriate runway circuit as shown on figure 3-2. Corner lights will be installed approximately 2 feet out from the paving edge, and in line with their respective runway lights. White and blue runway lights around threshold ends of runway intersections will be the semiflush type. Where only one runway is constructed, blue lights will not be provided along the runway edge; white lights only will be provided, with spacings as indicated above.

(2) *Runway threshold lighting system.* The line of semiflush threshold marker lights will be 180 degrees aviation green/180 degrees aviation red, located not less than 5 feet or more than 15 feet from the ends of the runway, with

lights spaced approximately 17 feet on centers. The outermost light of each group will be located in line with the corresponding row of runway lights. Each threshold light group will contain no fewer than six lights. When the lines of runway lights are located the maximum distance of 10 feet from the paved edges of the runway, an additional semiflush light will be installed in each group making a total of seven lights per group. The threshold lights will be connected in series with the appropriate runway lighting circuit.

b. *Helicopter stagefield.*

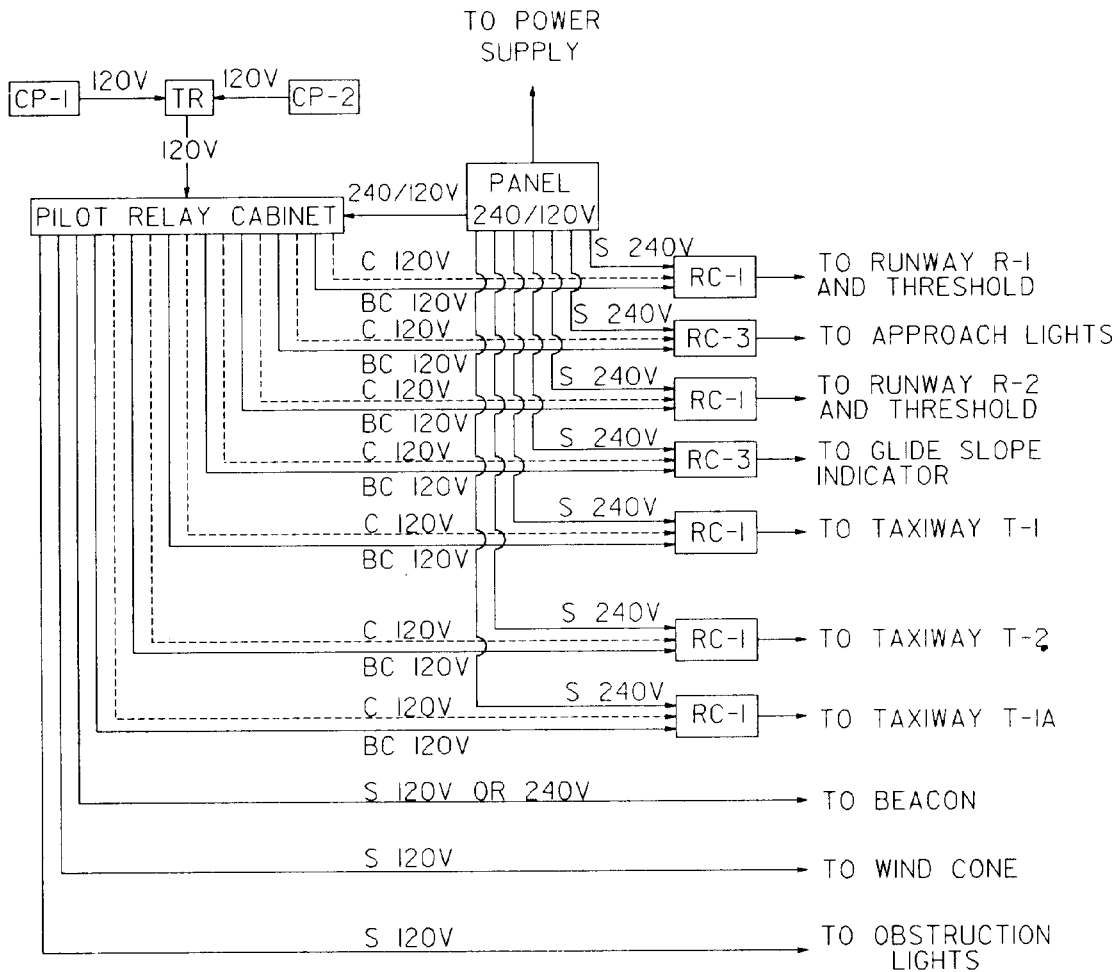
(1) *Location and spacing of lane edge lighting fixtures.* Aviation white lights will be located on a line not more than 3 feet from the edge of the full strength pavement that is designated for lane use as illustrated in figure 3-3. The longitudinal spacing should not be less than 100 feet nor greater than 200 feet. Spacing will permit a minimum of 5 lane edge lighting fixtures on each side of the stagefield. When two or more stagefields are located parallel and in close proximity to each other, the edge lights will be configured so as to not line up and create false runway orientations when helicopters are approaching from perpendicular or oblique angles to the stagefield centerline. The height of elevated fixtures will not exceed 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. The light should be mounted on a frangible post not more than 2 inches in diameter or be mounted with a breakaway coupling. Each lane will be equipped with a rheostat or 5 step regulator so as to vary the light intensity from a dull glow to full light intensity (see para 2-2 and FAA Advisory Circular AC 150/5340-24 for additional lighting information).

(2) *Lane threshold and lane end lighting fixtures.* Combination threshold and lane end lighting fixtures, will be located on a line perpendicular to the extended centerline of the stagefield lane. The fixtures should be not less than 2 feet nor more than 10 feet outboard from the designated threshold of the lane. These lights should consist of four groups of two lights symmetrically located perpendicular to the extended center line (see para 2-Sand FAA Advisory Circular AC 150/5340-24 for additional lighting information).

c. *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.

### 3-3. Lighting equipment

The types of lights described below will be used at runways and thresholds. Each type of light is described by a



LEGEND

- CP-1 CONTROL POINT-PRIMARY (CONTROL TOWER)
- CP-2 CONTROL POINT-ALTERNATE (VAULT)
- RC-1 REGULATOR
- RC-3(1) REGULATOR
- RC-3(2) REGULATOR
- 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 NOT SHOWN. INSTALLATION OF THESE ITEMS WILL BE DESIGNED TO MEET LOCAL CONDITIONS.

Figure 3-1. Typical one line block diagram for Army heliport lighting system.

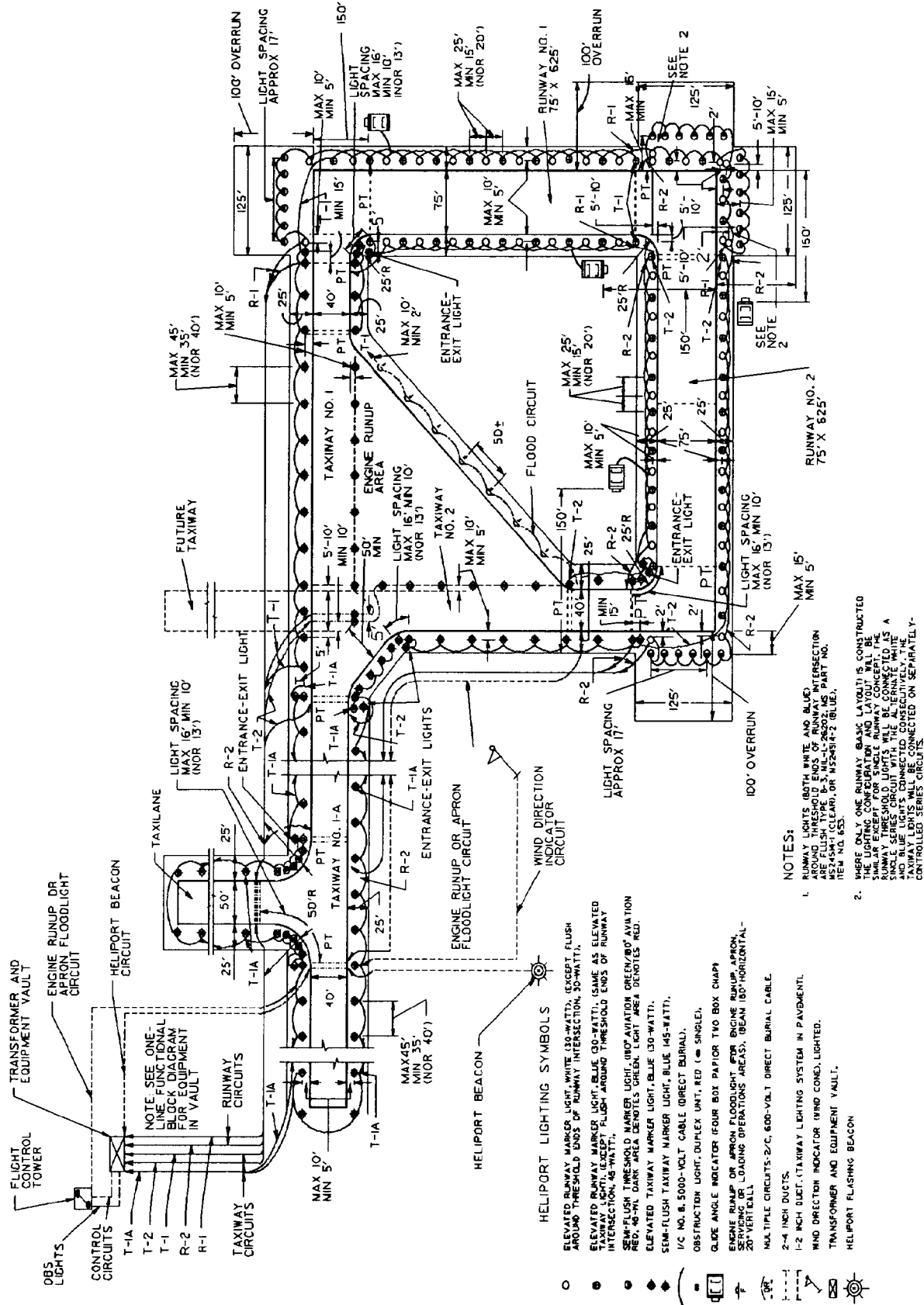


Figure 3-2. Layout Army heliport lighting facilities.

descriptive name, USAF Item Number, or FAA Number or Advisory Circular, and where existing, by Military Standard or 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 of this manual.

a. *Elevated runway lights.* Elevated runway lights will be omnidirectional, medium intensity, Type M-1, Item No. 294, conforming to Mil. Spec. MIL-L-7082. The lamp for this light will be 30 watts, 6.6-ampere, T-10 medium pre-focus base, item No.334, conforming to Mil. Std. MS-25012-1 and Mil. Spec. MIL-L-6363. The lens will be asymmetrical, clear, Item No.335, conforming to Mil. Spec. MIL-L-7082. FAA type L-861 fixtures may be used instead of type M-1 fixtures.

b. *Semiflush runway lights.* Semiflush runway lights will be medium intensity, class B-3, Item No.654, conforming to Mu. 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-852, class 2 fixtures may be used in lieu of military specification fixtures.

c. *Threshold lights.* Semiflush threshold lights will be similar to the semiflush runway lights noted above except that a 180 degrees aviation green/180 degrees aviation red filter conforming to Mil. Std. MS-24502 will be furnished with the light.

d. *Runway blue lights.* Blue lights at runways whether elevated or semiflush, will be as in chapter 6.

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.

### 3-4. Power supply and circuits

Runway lighting systems will be supplied through interleaved series circuits served by constant current regulators. The constant current regulators are designed for use on these heliport lighting systems and have provisions for varying output current from its rated value to lower values so that brightness of the lamps in the lighting system may be adjusted to suit the visibility conditions. This provision in the regulators is referred to as "Brightness Control". The regulators will be as described in chapter 10.

a. *Circuiting criteria.* The number and type of regulators required will be determined by the length and number of runways and the number of lights per runway. Losses in volt-amperes for the circuit cable feeder cables from the vault to the lights should also be considered when designing the system. Regulators should always be loaded to at least one-half of rated kW output. Where more than one regulator is required per system, the load should be divided equally between the number of regulators used.

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

c. 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.

d. Series transformers will be medium intensity type, 30/45 watts, 6.6/6.6-ampere, Item No.829 conforming to Mil. Spec. MIL-T-27535, and Mil. Std. 27289-1.

### 3-5. Control system

The heliport runway lighting control system is an integral part of the control system for all heliport lighting facilities. The function of this portion of the control system is to energize and deenergize the selected runway lighting system as well as to control the brightness of this system remotely, as required by the operations of the heliport. The runway lights will be controlled from the control tower and from the equipment vault as described in chapter 10. The control of heliport runway and taxiway lighting circuits will be somewhat different from that for airfields. The circuits will be provided and connected, as indicated on figure 3-1, with the runway-taxiway combination control panels and associated equipment connected, interlocked and/or non-interlocked as required to permit separate control of each runway lighting system, independent of the other, and permit simultaneous control of the taxiway lighting circuits T-1 and T-2 in combination. Taxiway lighting circuit T-1A will be connected for separate individual control. This will permit flexibility in operation of the runway and taxiway lights either singly or in combination, simultaneously, as required for the heliport operations by the control room operator. The layout will also provide facilities that will permit future changes in the type of method of operation of the heliport with minimum expense and interruption of service, should such conditions develop. The initial sequence of operations of the heliport lighting circuits anticipated is such that when a helicopter is utilizing the night lighting landing facilities of the heliport: (1) the blue taxiway lights (circuits T-1 and T-2) will be turned on, but (2) only the white and green/red runway threshold lights (circuits R-1 or R-2) of the runway in use will be turned on. Under condition (1) all blue lights will be turned on (for runways 1 and 2 and taxiways 1 and 2) except those around the threshold ends of the runway intersection; under condition (2) all white lights will be turned on for the selected runway in use, including alternate white and blue lights around the threshold ends of the runway intersection of the appropriate runway, thereby providing an alternate white and blue light runway configuration or pattern; also, the 180 degrees aviation green/180 degrees aviation red threshold lights at the ends of the appropriate runway will be lighted. For taxiing the helicopter to the hangar or to operations, apron, or parking areas, the helicopter pilot is provided, without any change in lighting circuit arrangement for runways 1 or 2, and taxiways 1 or 2, with the equivalent of taxi guidance (blue) lighting on the runway (alternate) being used temporarily

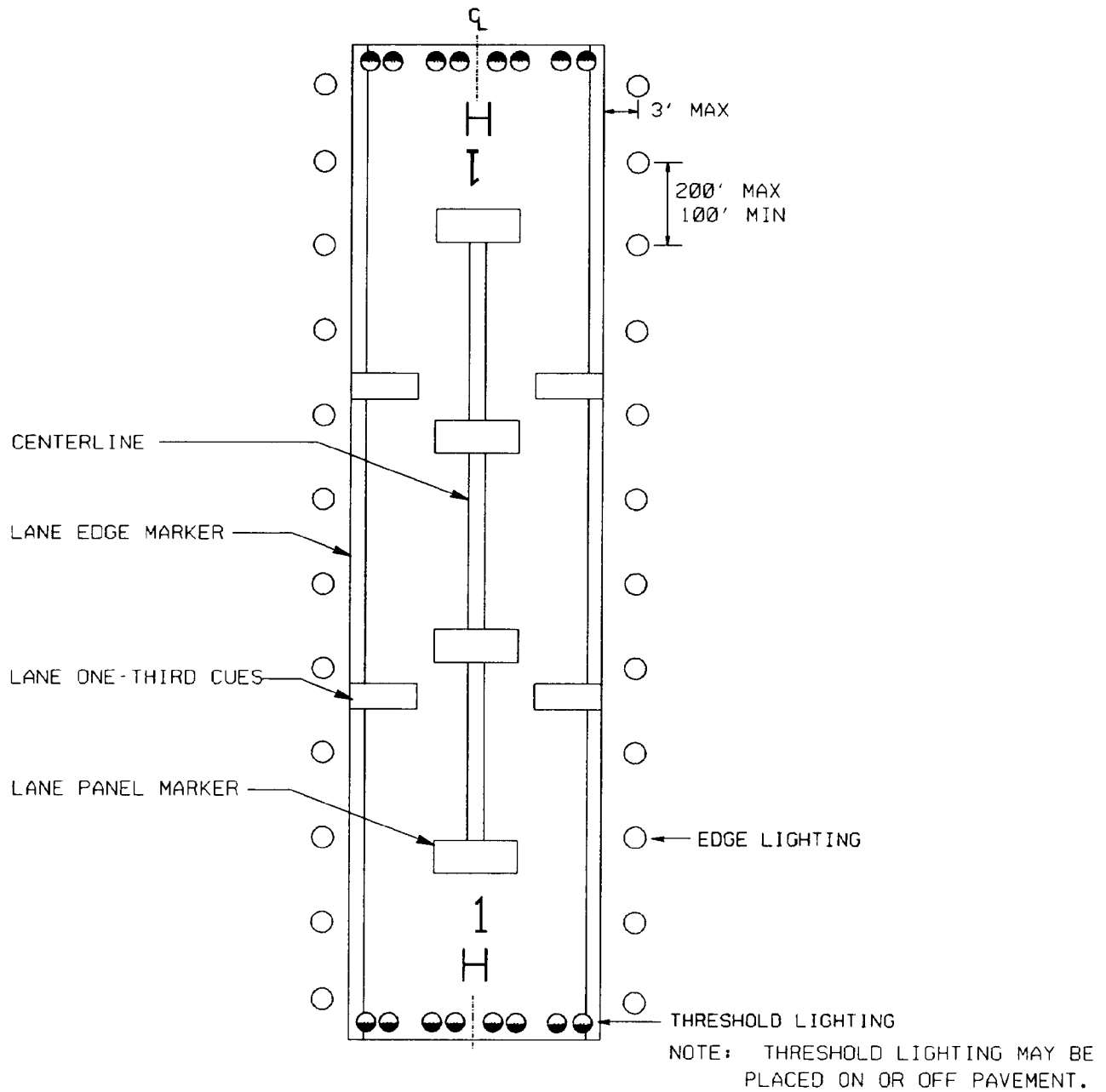


Figure 3-3. Typical layout of Army Helicopter stagefield lighting system.



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as a taxiway over to the proper connecting taxiway T-1A leading to the hangar, operations, apron, or parking areas. Taxiway circuit No. T- 1A will be turned on at the appropriate time as required to provide the proper helicopter taxiway guidance, in accordance with operational requirements. An exception to the above is where only the basic one runway configuration exists or will be constructed. In such an instance, runway lighting circuit R-2 and taxiway

lighting circuits T-1 and T-2 will not exist, and the heliport lighting system control sequence will be identical to that of an airfield. However, the control panel furnished and the lighting circuit designations will remain unchanged, to permit standardization of control procedures as well as provide for future installation of an intersecting runway with minimum system changes.

## CHAPTER 4

# HELIPAD LIGHTING SYSTEM FOR VISUAL FLIGHT RULES

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### 4-1. General design

Figures 4-1 through 4-6 and the design criteria set forth herein are intended to serve as a guide in designing and installing a typical helipad lighting system conforming to VFR operation requirements, and consisting of perimeter lights as the basic and only mandatory part of the overall lighting system, with permissive use of landing direction lights and approach direction lights. Also, additional permissive parts of the overall system, are the aids to depth perception helipad floodlights. Components of the system listed as permissive will be justified to and approved by HQUSACE, CEMP-ET, WASH DC 2031-1000. "Permissive" is defined, for the purpose of the lighting system, as: "The lights need not be installed as part of the helipad lighting system, but if installed, then they shall be installed to meet the criteria below." These systems normally will be provided for a helipad with sides 100 feet long, having 25-foot wide shoulders on each side of the helipad, and consist of medium intensity elevated and semiflush light fixtures.

### 4-2. Electric service

The preferred source of power will be the local electrical distribution system, with dependable low voltage secondary service distributed to the helipad equipment vault. The lighting system normally will be a multiple system, served at 120 volts from a source of 120/240-volts, single phase, 60 hertz, or from a source of 120/208-volts, three phase, 60 hertz.

### 4-3. Description of helipad lighting

*a. Perimeter lighting system.* The perimeter lighting system will consist of aviation yellow incandescent lights placed around the perimeter of the helipad with a light fixture installed at each corner and three additional lights equally spaced between the lights at the corners on each side of the helipad as shown in figure 4-1. Lights on opposite sides of the helipad should be opposite each other, equidistant from, and parallel to the extended centerlines of the helipad. Lights normally should be placed adjacent to the edge of the helipad paving. Perimeter lights as described herein are mandatory whenever the helipad is to be lighted. The perimeter lights will normally be of the elevated type except where damage may occur due to wheel mounted helicopters being taxied off the helipad. In these cases, semiflush lights will be in-stalled. All perimeter lights installed in the paved shoulders will be mounted on metal light bases. The elevated lights will be as light and frangible as is practicable and the overall height above grade kept to a minimum, but in no case exceeding 14 inches. If snow accumulations of 12 inches or more will be frequent,

mounting height may be increased to not more than 24 inches above grade.

*b. Landing direction lighting system.* The landing direction lighting system, where provided, will consist of aviation yellow incandescent light fixtures installed in a straight line along one or more of the extended centerlines of the helipad, perpendicular to the perimeter lights as shown in figure 4-2. Each row of lights (light bar) will consist of six light fixtures spaced 15 feet on centers with the innermost light located 25 feet from the centerline of the row of perimeter lights. Where the need for additional aid in landing direction visual guidance is required or would aid in the final maneuver to hover or touchdown at the helipad, these lights may be installed if authorized. The signal derived from this lighting configuration indicates to the pilot the path over which the pilot should fly to hover or touchdown. The lights, when not in paved areas, may be stake mounted. The light nearest the helipad will be in-stalled so that the top of the light will be at the same elevation as the top of the adjacent perimeter light fixture. The tops of the lights in each light bar should be level in the horizontal plane. Where a variation in elevation is necessary, plus 2 percent or minus 1 percent deviation in the longitudinal plane may be permitted.

*c. Approach direction lighting system.* The approach direction lighting system, where provided, will consist of aviation white incandescent light fixtures installed in two parallel rows extending out from the landing direction lights in the approach path to the helipad as shown in figure 43. Each row of approach lights will be 5 feet from the extended centerline of the helipad. These lights will be installed only where it has been determined that approach guidance is required to restrict the approach path to the helipad; or where additional guidance is needed by the pilot in the approach to the helipad; and where authorized for installation. The lights normally will be stake-mounted and have frangible fittings. Each pair of lights will be on 50 foot spacings. The first pair of lights will be located 125 feet from the line of perimeter lights perpendicular to the approach path and will extend 200 feet out from the first pair of lights (fig 43). Only one approach lighting system will be installed at helipad. The lights will be mounted in a horizontal plan, or will follow the slope of the finished grade in the longitudinal gradient above the horizontal plane. The longitudinal gradient should not slope upward more than two percent. Where the slope is below the horizontal, the lights should be mounted in a horizontal plane if practicable, but in no case should the downward slope of the lights exceed 1 percent. Approach direction lights, in line with the landing direction lights, should continue in the same slope as the landing direction lights. Approach direction lighting will not be installed without the landing direction lighting

system. The additional approach lights for IMC configurations will be controlled by approach direction lighting system.

d. *Helipad inset lights.* Helipad inset lights (pad inset lights) may be installed in the helipad as an aid in centerline alignment to the pilot while making approach to or touch-down on the helipad. Fixtures will be aviation blue omnidirectional semiflush type and will be located along the pad centerline in the normal direction of approach as illustrated in figure 44. The lights will be installed in the helipad and connected by conduit. The lights will be mounted on light bases designed to be capable of withstanding direct landings of wheel or skid-mounted helicopters without presenting a hazard to the helicopter.

e. *Helipad floodlights.* Helipad floodlights may be installed where authorized, parallel to the normal approach to the helipad. Floodlights should be opposite each other and equidistant from the extended centerline of the helipad, and located not closer than 50 feet from the edge of the helipad

paving (fig 44). Floodlights will be mounted on frangible fittings located as near to grade as the base of the floodlight stand will permit. The overall height of the floodlight above the helipad surface will be kept to a minimum that will permit the proper spread of light on the helipad, but in no case should this height exceed 4 feet above the grade of the helipad. Outside of operational areas, where it is not feasible to remain within the 4-foot limit above the surface of the helipad, the mounting height of the floodlights should be kept to a minimum above the finished grade at the floodlight location. A small obstruction light will be mounted on the top of the floodlight, visible from above and at ground level from any direction around the floodlight.

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.

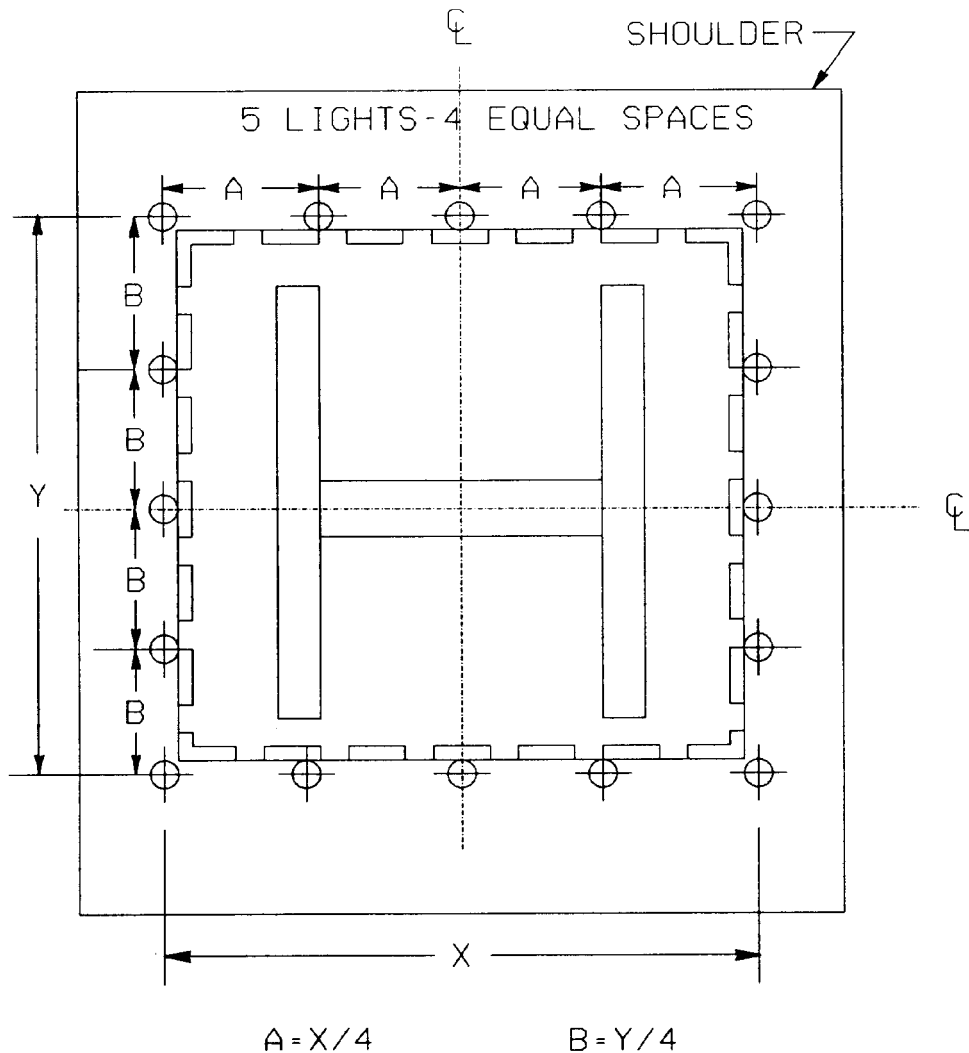


Figure 4-1. Layout of perimeter lighting fixtures.

### 4-4. Helipad lighting equipment

The types of lighting fixtures used at helipad installations are described below. Each type of light is denoted by a descriptive name, USAF Item No. or FAA No. or Advisory Circular and, where existing, by Military Standard or Military Specification. Mounting accessories are not described or noted herein, but are shown on the installation detail drawings (fig 2-3 and 2-4).

a. *Perimeter lights.* Fixtures for perimeter lighting normally will be mounted on metal light bases as near as practicable to the edge of the helipad paving. Where the shoulders are of sufficient strength to support the metal light bases, the concrete pads around the light bases need not be installed. In areas where the helipad will not be paved, stake mounted lighting fixtures surrounding the touchdown area will be installed.

(1) Elevated perimeter lights will be aviation yellow, omnidirectional, FAA type L-861, provided with a 1-inch bottom hub. The lamps will be 116-watt, 120-volt, with a medium screw base.

(2) Semiflush perimeter lights will be aviation yellow, omnidirectional, class B-3 per Mil. Spec. MIL-L-26202 or AC 150/5345-46 type L-852E class 2 with yellow filter, modified to include a 100-watt to 120-watt, 120-volt lamp with factory installed socket and reflector assembly, mounted on a 10-inch (minimum) deep base.

b. *Landing direction lights.* Fixtures for landing direction lights will be installed in metal light bases when in paved areas and stake-mounted when in unpaved areas. All lights will be installed on frangible fittings. The lights will be aviation yellow and will be as described for perimeter light fixtures above for both elevated and semi-flush fixtures.

c. *Approach direction lights.* Fixtures for approach direction lights will be similar to PAR 56 fixed-wing approach lights. Lamps will be steady-burning.

d. *Helipad inset lights.* Fixtures for helipad (pad) inset lights will be as described for semiflush perimeter lights in a. (2) above, except that aviation blue will be used instead of yellow and the lamps will be 40 watt, 120 volt.

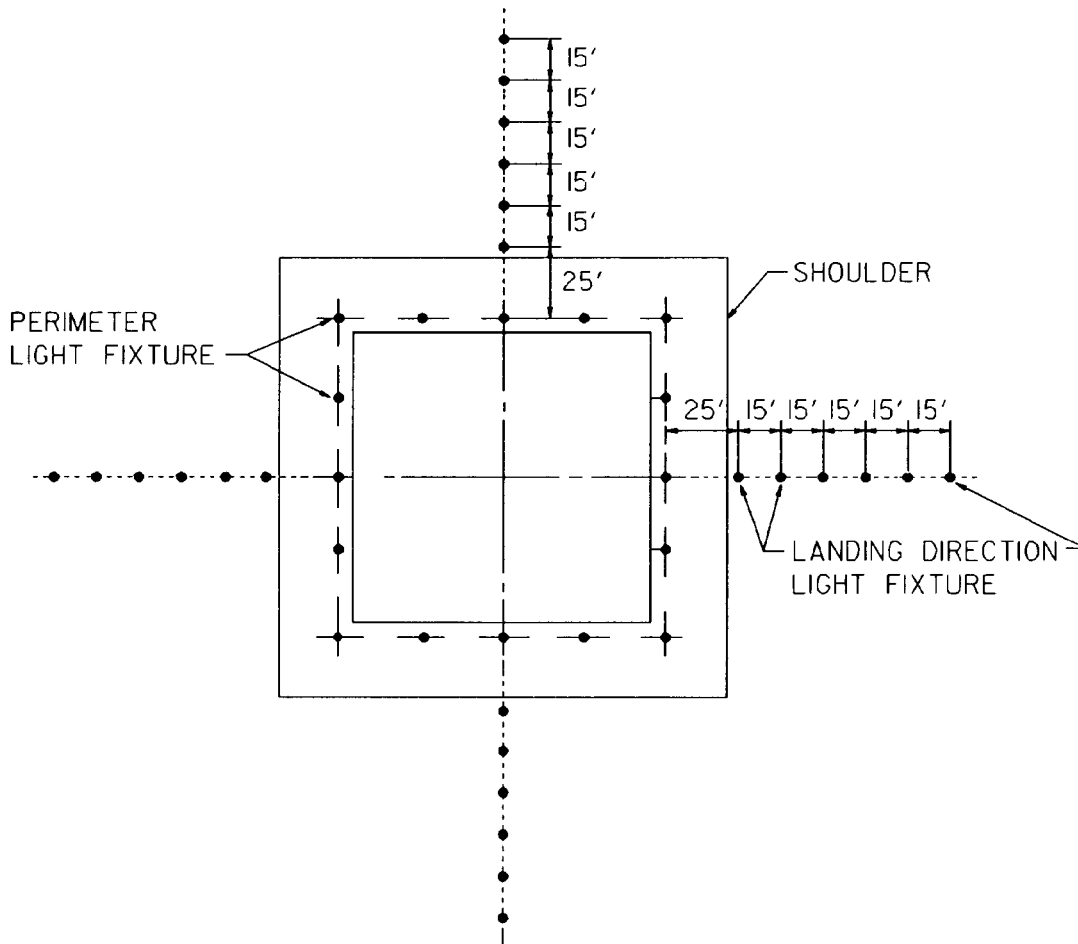


Figure 4-2. Layout of landing direction lighting fixtures.

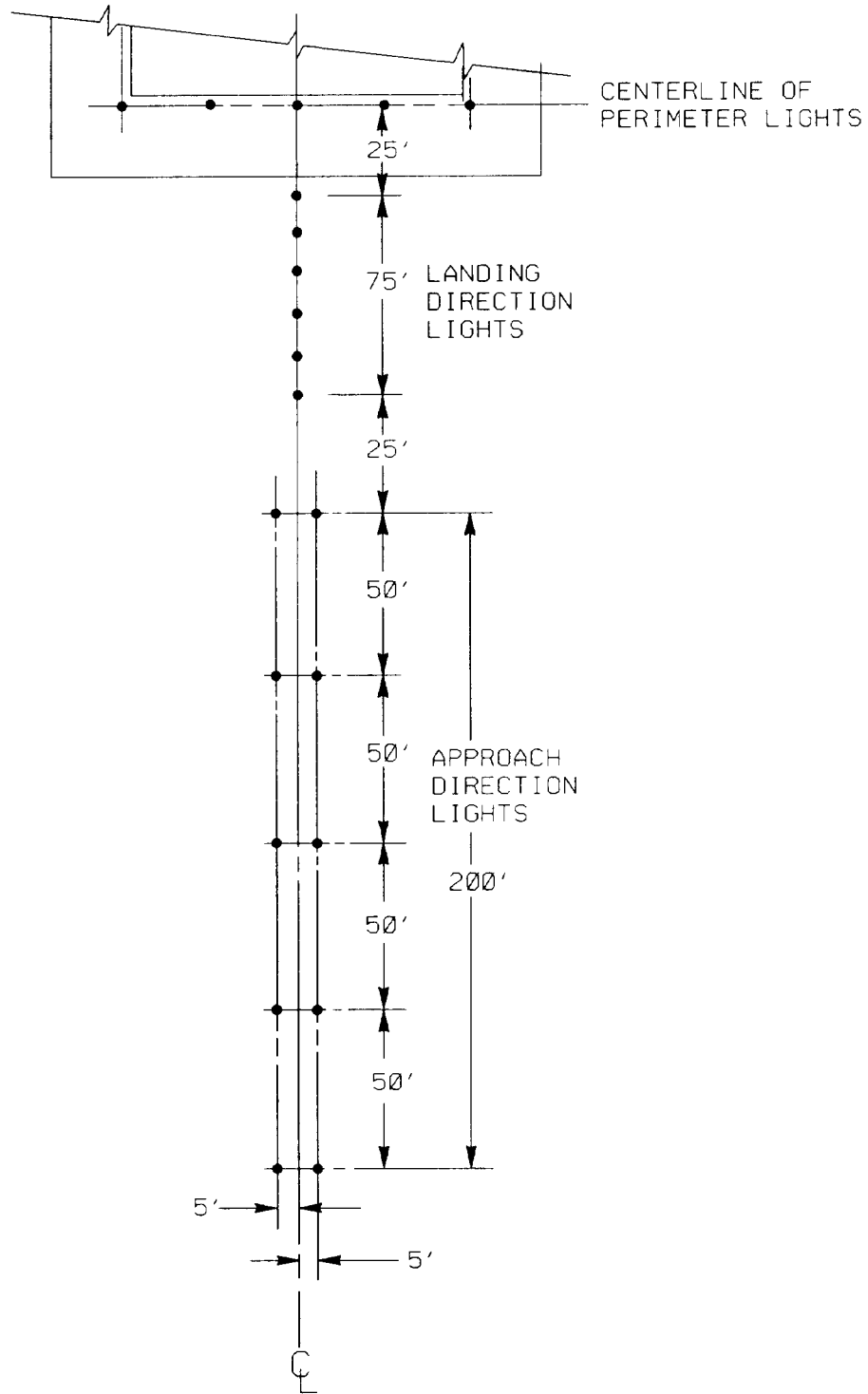


Figure 4-3. Layout of approach direction lighting fixtures.

e. *Helipad floodlights.* Helipad floodlights, except for the red light emitted by the obstruction light mounted on or near each unit, will have no upward component of light, the entire light output being directed below the horizontal. The fixture may utilize one or two lamps, with a total wattage of not more than 500 watts, and will conform to NEMA FA-1. Floodlight will be on an independently controlled circuit. Obstruction light will be controlled separately from floodlights.

f. *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.

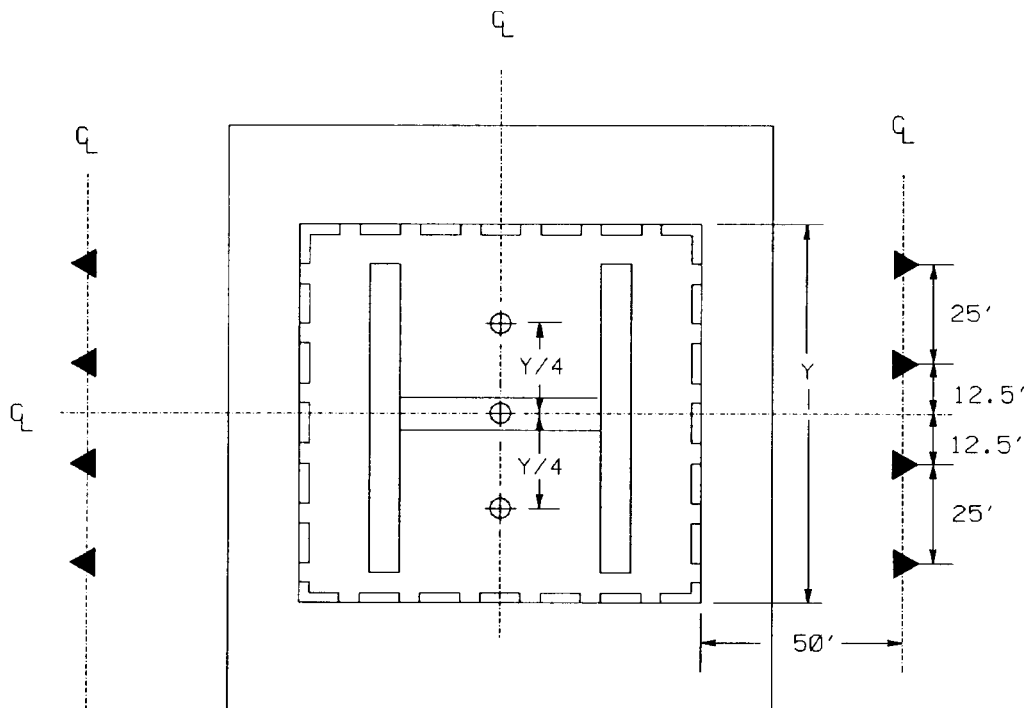
**4-5. Helipad lighting power supply and circuits**

The components of the helipad lighting system normally will be supplied from multiple circuits. Brightness control

will be varied by use of dimmers located in the structure housing the supply equipment for the helipad lighting system. The dimmers and controls will be described in chapter 10. Control diagrams are illustrated on figure 4-5 and 4-6.

a. *Dimmers.* The number and rating of the dimmers required to control the brightness of the light fixtures in the helipad lighting system will be determined by various components of the lighting system installed.

b. *Conductors.* Cables used for the multiple circuits will be single-conductor or two-conductor, 600-volts, cross-linked polyethylene suitable for direct burial. Conductors will be sized in accordance with the load and length of the circuits so that the voltage drop per circuit does not exceed two percent. Connections to light fixtures will be in accordance with the recommendations of the manufacturer of the light fixtures. No cable splices will be made between fixtures or in any feeders less than 500 feet in length to or from the control structure. Splices in cables, where required, will be in accordance with the recommendations of the cable manufacturer.



**LEGEND**

- ⊕ PAD INSET LIGHT
- ◀ FLOOD LIGHT

*Figure 4-4. Layout of optional floodlights and inset lighting fixtures.*

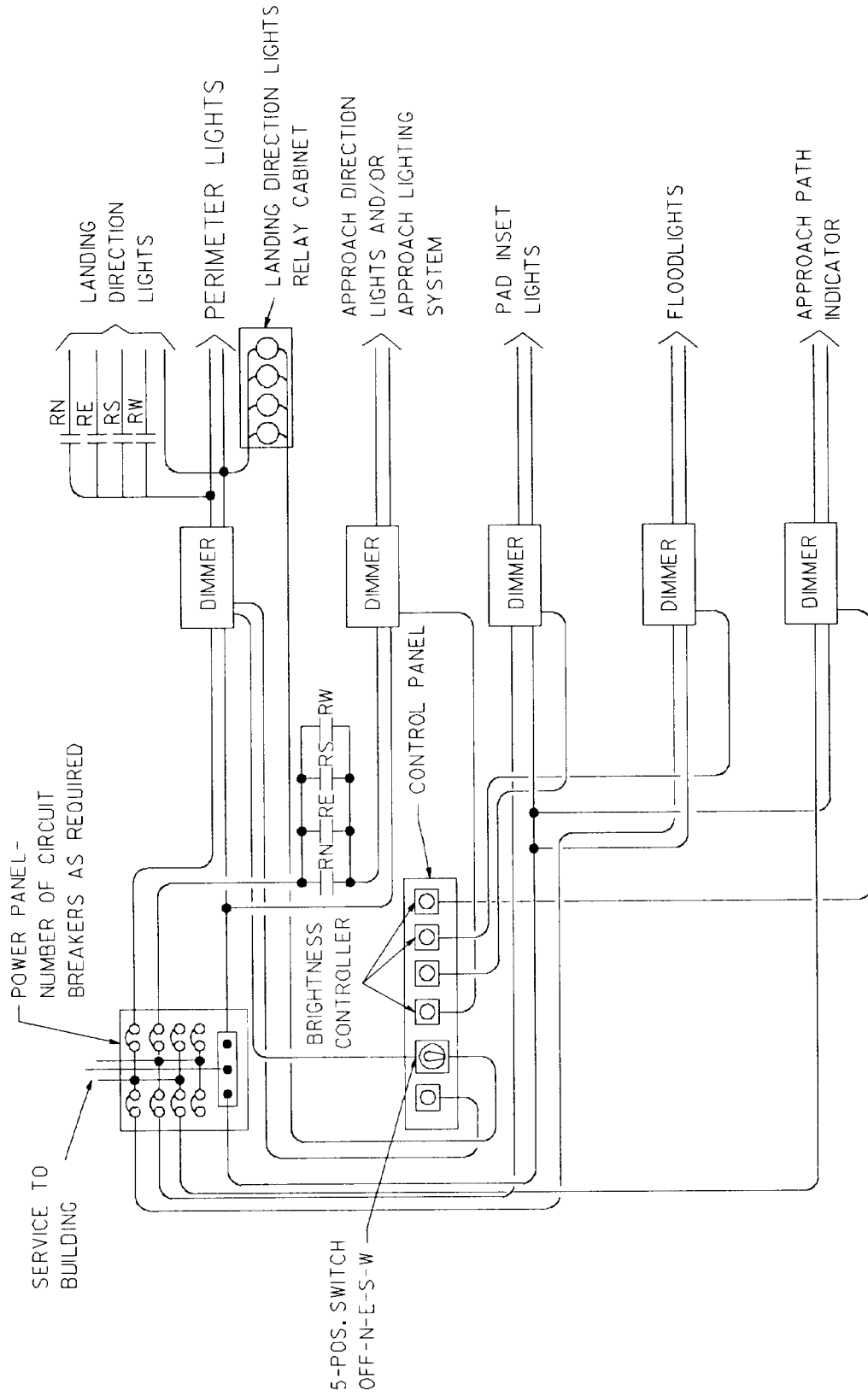


Figure 4-5. Control diagram for helipad lighting (w/o control tower).

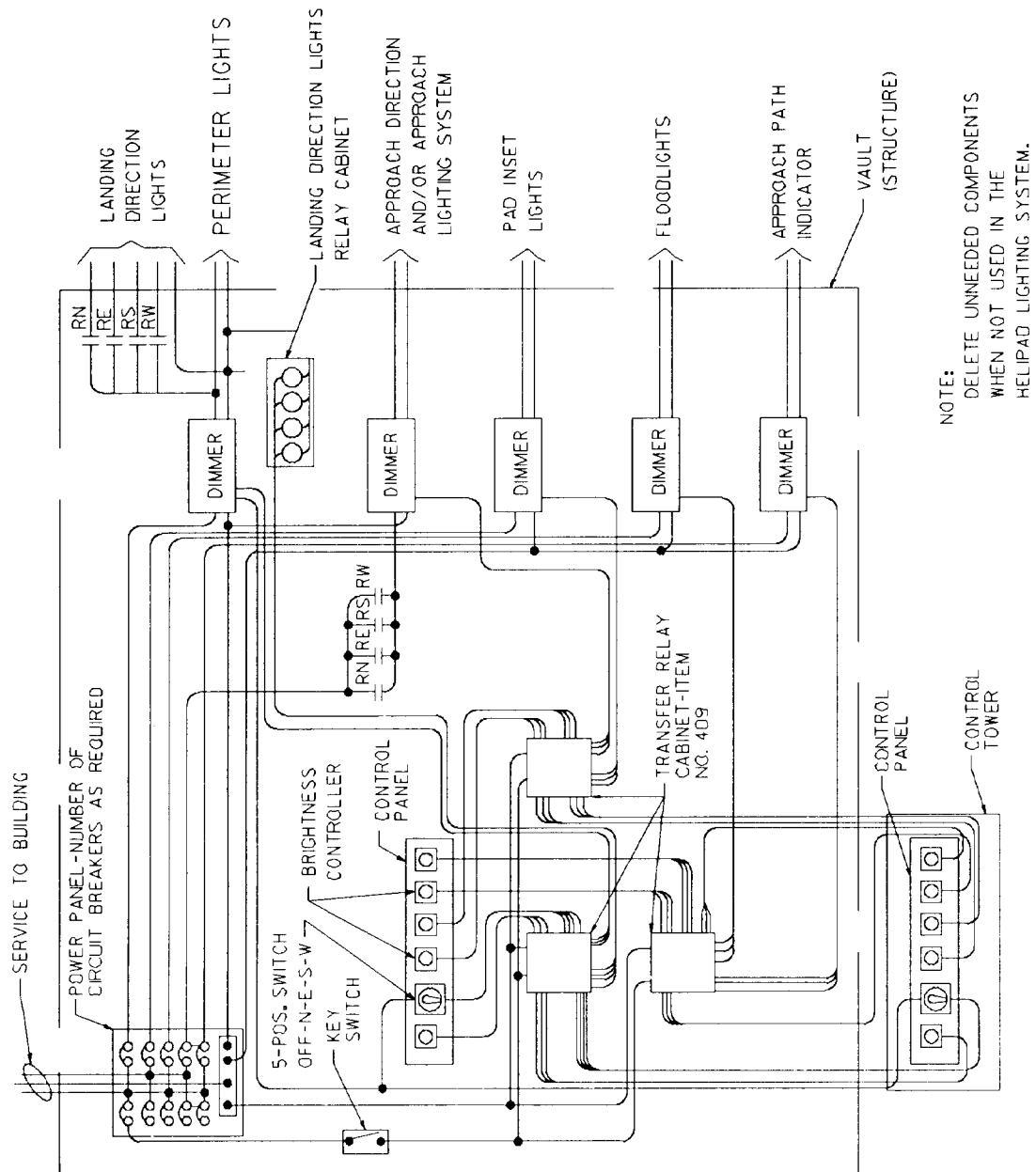


Figure 4-6. Control diagram for helipad lighting (with control tower).



## CHAPTER 5

### HELIPAD AND HELIPORT APPROACH LIGHTING SYSTEMS

#### 5-1. General Design

Figure 5-1 through 5-3 and the design criteria set forth herein are intended to serve as a guide in designing and installing a typical helipad or heliport VMC and/or IMC (precision and non-precision) approach lighting systems. Table 5-1 lists the operating categories and the applicable FAA standard or paragraphs of this technical manual pertaining to each facility. Landing directional lights and perimeter lighting systems will be designed in accordance with chapter 4.

#### 5-2. Terminology

The following are definitions of terms used in helipad and heliport lighting systems:

*a. Approach direction lights.* Two parallel rows of aviation white incandescent lights extending out from the landing direction lights into the approach path a distance of 900 feet.

*b. Category 1.* Approach lighting system which provides landing minima as low as a 200-foot decision height and one quarter of a mile visibility for a 6 degree approach to a helipad or heliport.

*Table 5-1. Operating categories.*

FACILITIES	HELIPAD			HELIPORT	REFERENCES
	VMC	IMC		IMC	
	NON INSTRUMENT	NON PRECISION INSTRUMENT	PRECISION INSTRUMENT CATEGORY 1	PRECISION INSTRUMENT CATEGORY 1	
APPROACH LIGHTING CATEGORY 1	0	0	X	X	CHAPTER 5
APPROACH LIGHTING	0	0	X	X	4-3,4-4,CHAPTER 5,10-1A,10-4B,10-8,10-12,10-13
APPROACH DIRECTION LIGHTS					
PRECISION	N/A	0	X	X	4-3C,5-2A,5-3B
NON-PRECISION	0	X	N/A	N/A	5-2A,5-3A,10-13C
LANDING DIRECTION LIGHTS	0	X	X	X	4-3B,4-4B,5-2F,10-4B,10-13C
PERIMETER LIGHTS	X	X	X	N/A	4-3A,4-4A,5-2G,10-13A
FLOODLIGHTS	0	0	0	0	4-3E,4-4E,10-13E
VISUAL GLIDE SLOPE INDICATOR SYSTEM	0	X	X	X	5-2H,7-7
PAD INSET LIGHTS	0	0	0	N/A	4-3D,4-4D,5-2J,10-13D
HIGH INTENSITY RUNWAY LIGHTS	N/A	N/A	N/A	X	10-1,10-12A(2)
THRESHOLD LIGHTS	N/A	N/A	N/A	X	3-2A(2),3-2B(2)
RUNWAY END LIGHTS	N/A	N/A	N/A	X	3-2A(2),3-2B(2)
TAXIWAY LIGHTS	0	0	0	X	3-2A(1),6-3B,6-3C,10-6B,10-6C,10-12C
ILLUMINATED RUNWAY DISTANCE MARKERS	N/A	N/A	N/A	X	AC 150/5345-44
ILLUMINATED TAXIWAY (MOVEMENT AREA) GUIDANCE SIGNS	N/A	N/A	N/A	X	6-3B,AC 150/5345-44
OBSTRUCTION LIGHTING	X	X	X	X	10-7,AC 70/7460-1
ELECTRICAL SUPPLY STANDBY GENERATOR	X	X	X	X	8-7,9-2B,9-2C
HOVERLANE	0	0	X	X	6-3C(3),10-6C
IDENTIFICATION BEACON	X	X	X	X	7-5B,10-7
APRON LIGHTING	N/A	N/A	N/A	X	7-3
EXPLOSION-PROOF LIGHTS	0	0	0	0	3-2C,3-3E,4-3F,4-4F
NOTES:	X-REQUIRED 0-OPTIONAL N/A-NOT APPLICABLE				

c. *Helipad.* A square or rectangle load bearing surface which has a minimum dimension of 40 feet and is designed and designated for the purpose of landing rotary-wing aircraft.

d. *Heliport.* An airfield consisting of one or more runways not less than 625 feet long and with a 100-foot overrun at each end.

e. *Helipad/heliport identification beacon.* A beacon used to identify the location of an operating helipad or heliport.

f. *Landing direction lights.* A set of six aviation yellow lights in a straight line which provides centerline alignment for pilots.

g. *Perimeter lights.* At least 16 aviation yellow incandescent lights spaced equidistant around the perimeter of the helipad with one light at each corner.

h. *Visual glide slope indicators.* An approach system using lights and/or filters to provide the pilot with visual reference as to whether or not he is on the proper glide slope.

i. *Centerline pad inset lights.* Three, aviation blue, semi-flush, 40-watt centerline pad inset lights will be used for pilot alignment with the short IMC non-precision approach lighting system.

**5-3. VMC and IMC approach directional lights**

Approach directional lights will not be used without landing directional lights. Lamps will be unidirectional 200 watt aviation white throughout the approach lighting system to assure sufficient intensity. Elevated, unidirectional, approach direction light fittings are acceptable throughout the approach system.

a. *Configuration for VMC is illustrated in figure 5-1.* Approach directional lights will consist of two parallel rows of elevated light fittings, each row 5 feet either side of the helipad extended centerline in the direction of approach. Each row will be spaced on 50-foot centers over a length of

200 feet with the first row located 125 feet from the centerline of the row of perimeter light fittings.

b. *Configuration for IMC is illustrated in figure 5-2.* The approach lighting system will be symmetrical about and extend for the entire length of the centerline of the helipad directional lights. The system will start at the pad perimeter light as depicted in figure 4-2 and extend out from there for a distance of 1,025 feet. An IMC approach lighting system will normally be installed only at the end of the helipad most frequently used for the approach to the helipad.

**5-4. Design**

Elevated light fittings will be as light and frangible as possible. The light fittings will be mounted in a horizontal plane or follow the slope of the finished grade. Where a deviation in the axis of the light beam is necessary, a tolerance of plus 2 percent or minus 1 percent in the longitudinal slope is permitted. Where a slope is established the landing direction lights in line with the approach direction lights, the same slope will be continued for the approach direction lights. Luminaire setting angles are determined by the approach angles or angles of descent established for the heliport. Table 5-2 gives the setting angles for the more common approach angles.

**5-5. Luminous features**

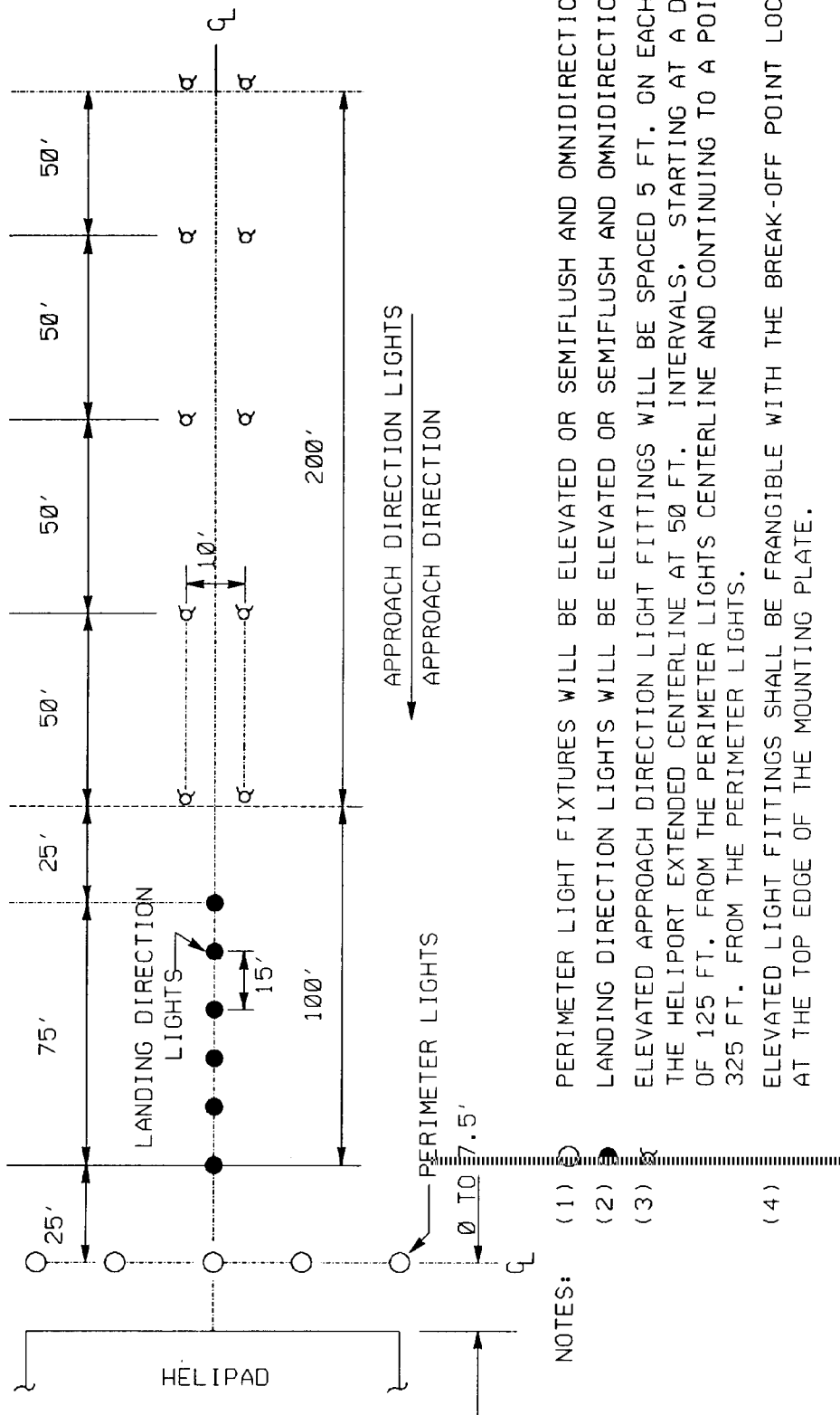
Aviation white approach directional lights will be unidirectional and elevated for a 9-degree light beam peak. The vertical divergence and stages of intensity will be as shown in figure 5-3. The approach lights will have the following intensity characteristics:

- a. At plus or minus 7.5 degrees beamspread in the horizontal plane, the light intensity will be 20,000 candelas.
- b. At plus or minus 12.5 degrees beamspread in the horizontal plane, the light intensity will be 5,000 candelas.
- c. Beamspread in the vertical plane must not be less than 30 percent of the horizontal plane beamspread.

**Table 5-2. Luminaire setting angles for given approach angles.**

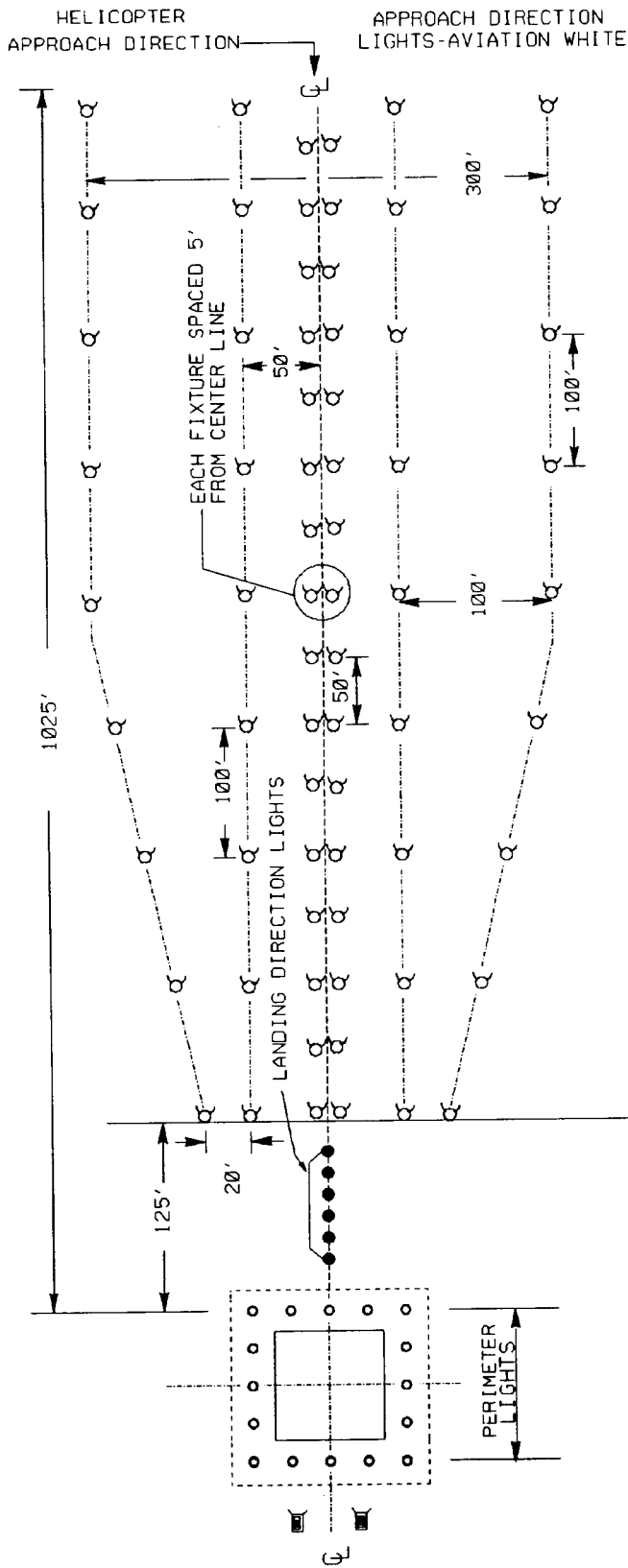
<u>Approach angle (degrees)</u>	<u>Setting angle (degrees)</u>
3	6
6	11
9	15

**NOTE:** If multiple approach angles are to be used, then setting angles should be a mean value for the range of approach angles. For example, if the approach angles are 4 or 8 degrees, the setting angle would 11 degrees.



- NOTES:
- (1) PERIMETER LIGHT FIXTURES WILL BE ELEVATED OR SEMIFLUSH AND OMNIDIRECTIONAL.
  - (2) LANDING DIRECTION LIGHTS WILL BE ELEVATED OR SEMIFLUSH AND OMNIDIRECTIONAL.
  - (3) ELEVATED APPROACH DIRECTION LIGHT FITTINGS WILL BE SPACED 5 FT. ON EACH SIDE OF THE HELIPORT EXTENDED CENTERLINE AT 50 FT. INTERVALS, STARTING AT A DISTANCE OF 125 FT. FROM THE PERIMETER LIGHTS CENTERLINE AND CONTINUING TO A POINT 325 FT. FROM THE PERIMETER LIGHTS.
  - (4) ELEVATED LIGHT FITTINGS SHALL BE FRANGIBLE WITH THE BREAK-OFF POINT LOCATED AT THE TOP EDGE OF THE MOUNTING PLATE.

Figure 5-1. VMC configuration

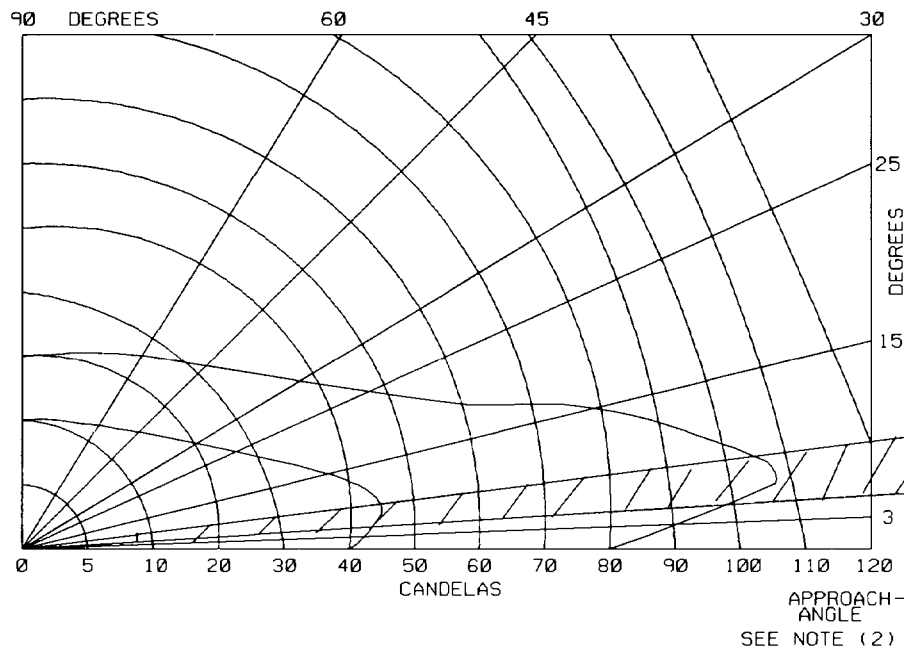


ELEVATED OR SEMIFLUSH OMNIDIRECTIONAL LIGHT FIXTURE WITH LUMINOUS FEATURES.  
 NORMALLY ELEVATED OMNIDIRECTIONAL LIGHT FIXTURES WITH LUMINOUS FEATURES.  
 VISUAL APPROACH SLOPE INDICATOR SYSTEM.  
 NORMALLY ELEVATED UNIDIRECTIONAL LIGHT FIXTURES.  
 ELEVATED LIGHT FITTINGS TO BE FRANGIBLE WITH BREAK-OFF POINT AT TOP EDGE OF BASE MOUNTED PLATE.  
 LIGHT FIXTURES SHALL BE MOUNTED ON A HORIZONTAL PLANE AND SHALL NOT BE GREATER THAN 18 INCHES ABOVE GRADE OF THE HELIPAD. WHERE DEVIATION OF THE HORIZONTAL PLANE IS NECESSARY, TOLERANCE IS TO BE  $\pm 2\%$  OR  $\pm 1\%$  IN THE LONGITUDINAL SLOPE, WHERE A SLOPE IS ESTABLISHED FOR THE LANDING DIRECTION LIGHTS, THE SAME SLOPE SHALL BE CONTINUED FOR THE APPROACH DIRECTION LIGHTS.  
 GLIDE SLOPE AND GLIDE SLOPE ANGLE  
 SETTING ANGLES:

- (1) ○
- (2) ●
- (3) ◻
- (4) ◻
- (5) ◻
- (6) ◻
- (7) 3 DEG.  
6 DEG.  
9 DEG.
- (8) 6 DEG.  
11 DEG.  
15 DEG.

IF MULTIPLE GLIDE SLOPE ANGLES ARE USED, THE MEAN VALUE OF 11 DEG. SETTING ANGLE SHALL BE USED.  
 THREE OR FIVE PROGRESSIVE STAGES OF BRILLIANCE ARE REQUIRED FOR APPROACH DIRECTION LIGHTS.  
 INTENSITIES: A. HORIZONTAL PLANE  $20,000$  CDS BEAM SPREAD  $\pm 7.5^\circ$ .  
 B. HORIZONTAL PLANE  $5,000$  CDS BEAM SPREAD  $\pm 12.5^\circ$ .

Figure 5-2. IMC configuration.



TYPICAL ISOCANDELA DIAGRAM

- NOTES: (1) COLOR OF AVIATION YELLOW LIGHT.  
 CHROMATICITY CO-ORDINATES.  
 BOUNDARY TOWARD RED  $Y=0.382$ .  
 BOUNDARY TOWARD WHITE  $Y=0.790-0.667X$ .  
 BOUNDARY TOWARD GREEN  $Y=X-0.120$
- (2) APPROACH ANGLE 5 DEGREES TO 9 DEGREES.

(3) VERTICAL DIVERGENCE AND INTENSITY

MINIMUM AVERAGE FROM	WHITE CANDELAS	YELLOW CANDELAS
3 TO 15 DEG.	100	40
15 TO 25 DEG.	40	15
25 TO 90 DEG.	10	5
ELEVATION OF BEAM PEAK, BETWEEN 7 AND 9 DEG.		

(4) PROGRESSIVE STAGES OF BRILLIANCE

AVERAGE FROM		WHITE CAN.	YELLOW CAN.
A	MAX AS SHOWN (P) 3-15 DEG.	100	100
B	30% BRILL (MAX) 3-15 DEG.	30	12
C	2 1/2% BRILL (MAX) 3-15 DEG.	2.5	0.5

- (5) ELEVATED OR FLUSH FITTINGS SHOULD GIVE EQUIVALENT CANDELAS AS SHOWN.
- (6) THE HEIGHT ABOVE THE GROUND OF ELEVATED LIGHT FITTINGS SHALL NOT EXCEED 18 INCHES.

Figure 5-3. Vertical divergence and intensity stages.

## CHAPTER 6

### TAXIWAY LIGHTING SYSTEMS

#### 6-1. Taxiway lighting description

A taxiway lighting system at an Army airfield is a configuration of lighting fixtures which define the lateral limits and direction of a "taxiing route." The configuration will normally consist of a line of aviation blue lights paralleling each side of the taxiway. The lights are denoted as taxiway edge lights. In addition, the entrance and exit points of a taxiway will be distinctly lighted. At Army heliports and helipads, taxiway lighting criteria will vary slightly from that for airfields, and will be as described below for the type of facility provided.

#### 6-2. Criteria for taxiway lighting

Taxiway lighting will be provided for all regularly used "taxiing routes." Where a runway or a portion of a runway is part of a regularly used taxiing route, taxiway lights may be provided in addition to the runway lights. Taxiway lights will be served from a taxiway lighting circuit and not from a circuit serving the runway lights. For a taxiway adjacent to or part of an apron, taxiway edge lights normally will be provided on only that side of the taxiway farthest from the apron. Taxiing routes through an apron will not be provided with taxiway edge lights.

#### 6-3. Lighting configurations

*a. Airfield taxiway lighting.* The line of taxiway edge lights on each side of the taxiway will be no farther than 10 feet from the edge of the full strength paving and no closer to the full strength runway paving than the runway edge lights. The line of taxiway lights on both sides of the taxiway will be equidistant from their respective taxiway sides.

(1) *Straight sections of taxiways.* On straight sections of taxiways, the longitudinal spacing may approach, but not exceed 200 feet, and will be substantially uniform, except as required below. The longitudinal spacing of the pairs of lights will be calculated from the nearest point of tangency (PT) of the fillet, curve, or corner at one end of the section to the nearest PT, curve, or corner at the other end of the section. Beginning at the PT or corner, each pair of lights marking opposite sides of a taxiway will be at right angles to the taxiway centerline.

(a) An additional pair of lights should be installed between the lights at the PT and the first pair of lights on the straight section of a taxiway. These additional lights will be placed at a distance approaching, but not exceeding, 50 feet from the PT (fig 6-1). This provision is not applicable to sections of taxiways less than 200 feet in length.

(b) On straight sections of taxiways less than 200 feet in length as measured from PT or corner to PT or corner,

closer spacing of pairs of lights will be utilized. This spacing normally will approximate 50 feet and in no case exceed 100 feet (fig 6-2).

(2) *Single straight edges of taxiways.* Where it is practicable to light only one straight edge of taxiway section, the longitudinal spacing of the lights may approach, but not exceed 100 feet. The lights will be uniformly spaced between the PTs or corners, or between the opposite PTs or corners, as applicable (fig 6-3). An additional light will be installed between the light at the PT and the first light from the PT at a distance approaching, but not exceeding, 50 feet (fig 6-3). Where the straight edge of the taxiway is less than 200 feet in length as measured from PT or corner to PT or corner, the spacing of the lights will not exceed 50 feet (fig 6-4).

(3) *Spacing on curved edges of taxiways.* The spacing of lights on curved edges of taxiways will be uniform and will not exceed the values determined from the table in figure 6-5. On all curves in excess of 30 degrees of arc, there will be not less than three light locations, including the PTs.

(4) *Entrance-exit points.* Entrance and exit points will be marked by means of blue taxiway (taxi guidance) lights or yellow entrance and exit signs. The taxi guidance lights normally will be used. Entrance and exit signs will be used only where specifically directed or approved for installation. Entrance and exit signs (movement area guidance signs) will not be used at intersections of taxiways with other taxiways.

(a) At intersections of taxiways with runways or aprons, taxi guidance lights serving as entrance and exit lights will be placed at the PTs of the taxiway and the runway or apron. These lights will be located at right angles to the paved edge of the taxiway runway, or apron, approximately 5 feet from the runway lights at these points. The pair of entrance and exit lights will be offset from the row of runway lights in order to produce minimum visual interference between entrance and exit lights and runway lights. The lighting configuration for taxiways with adjoining engine run up areas will be in accordance with typical layouts as shown in figure 2-1.

(b) Where directed or approved for installation, intersections of taxiways with runways will have lighted signs except where such signs would interfere with aircraft operations, in which case taxi guidance lights will be installed. Entrance and exit signs will be placed at the PT of the taxiway and the runway or apron, and not more than 20 feet from the edge of the full strength taxiway, runway, or apron pavement. Faces of the signs will be substantially at right angles to the adjacent runway or apron edge to achieve the best legibility. Lighted signs will be used in lieu of taxi guidance lights at these points. The nearest edge of each entrance and exit sign will be located a minimum of three

feet outside the row of runway lights in order to present minimum visual interference between the sign and the runway lights (fig. 6-6). When entrance and exit signs are used where taxiways join runways, the sign faces will show the word "EXIT" plus a small directional or plain arrow turned toward the taxiway fillet. The reverse face of each sign will show a legend which will designate and identify the particular taxiway, such as the legend "TAXI F" or a plain arrow and a capital letter, designating the sequence of the turn-off from the end of the runway. When entrance and exit signs are used where taxiways leave aprons, the signs will show the appropriate designation and/or identification legends. For detailed information covering the specification requirements for internally lighted entrance and exit signs, reference should be made to FAA Advisory Circular AC 150/5345-44, Specification for Taxiway and Runway Signs.

(5) *Color and characteristics.* Taxiway lights, including entrance and exit light, will emit aviation blue light. The entrance and exit signs will emit aviation yellow light. The taxiway lights (steady burning) will be fixed lights and elevated, except where they would interfere with aircraft operations. In the latter case they should be semiflush type. The intensity of the taxiway lights will provide adequate taxiing guidance for all meteorological conditions under which the system is used. Brightness control may be provided only when specifically authorized and specified for the taxiway light installation.

(6) *Location, height, and frangibility.* These factors will be applied to taxiway lighting installations in such manner that the installation does not interfere with normal aircraft operations.

(a) The lines of taxiway lights will be located not more than 10 feet from the edge of the designated full strength taxiway paving. Entrance and exit lights will be offset from the rows of runway lights to present minimum visual interference between the entrance and exit lights and the way lights as shown in figure 6-7. Entrance and exit signs will be located not more than 20 feet from the runway, taxiway, or apron edge.

(b) The height of the taxiway lights will be not more than 14 inches above the adjacent paved surfaces, but raised to an overall height of 30 inches to meet local requirements where the location does not interfere with normal aircraft operations. Entrance and exit signs will not project more than 30 inches above the nearest edge of the adjacent taxiway.

(c) All elevated taxiway lights will be either frangible or mounted on frangible fittings. Entrance and exit signs may be frangible, but will be mounted on frangible fittings.

(7) *Portion of a runway used as a taxiway.* Where a portion of a runway is normally used as a taxiway to the runway in use, taxiway lighting will be installed on that portion of the runway (fig 6-8). Taxiway lights on a portion of a runway will be installed in addition to, and outside of, the line(s) of runway lights.

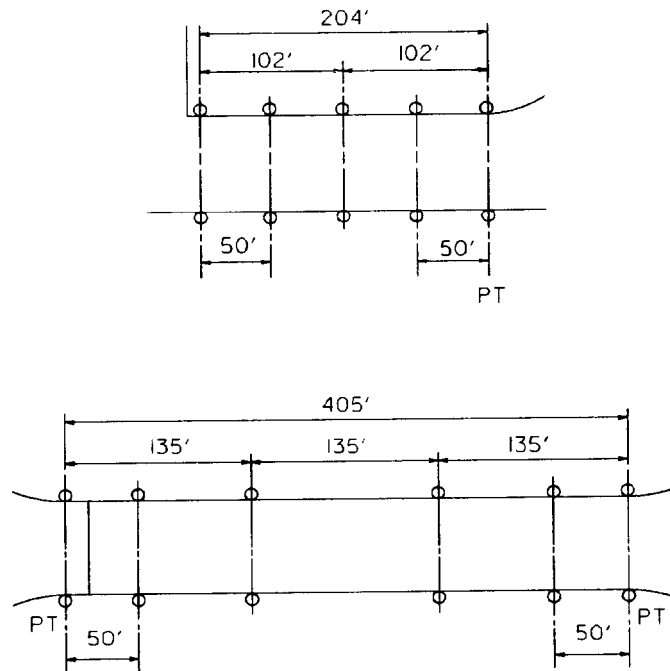


Figure 6-1. Typical examples straight sections- more than 200 feet.

b. *Helicopter taxiway lighting.* The taxiway lighting system will consist of a line of elevated and/or semiflush taxi guidance lights on each side of the taxiway, defining the lateral limits and direction of the taxiway. Taxiway lights will not be installed in those sections where surfaced aprons adjoin the taxiway. Brightness control ordinarily will be provided for the heliport taxiway lighting system.

(1) *Straight sections of taxiways.* On straight sections of taxiways, the pairs of lights will be uniformly spaced on centers of approximately 40 feet, but not less than 35 feet nor more than 45 feet. The longitudinal spacing of the pairs of lights will be calculated from the nearest PT of the fillet, curve, or corner at one end of the section to the nearest PT of the fillet, curve, or corner at the other end of the section. Companion lights on opposite sides of the taxiway will be located on lines perpendicular to the centerline of the taxiway. Where it is practicable to light only one straight edge of a taxiway section, the lights will be uniformly spaced between the PTs, or corners, or between points opposite the PTs or corners, as applicable. This spacing will be approximately 40 feet, but not less than 35 feet nor more than 45 feet. Semiflush lights will be used as taxiway lights in the engine run up area.

(2) *Curved sections of taxiways.* On curved sections of taxiways at heliports, taxiway lights will be uniformly spaced on lines radial from the center of the curves. The

spacing will be uniform and will be determined by the radius of the applicable curved edge of the taxiway. The taxiway lights will be spaced approximately 13 feet apart on the periphery of the curve, but not less than 10 feet nor more than 16 feet apart, except that no curve will have less than three light locations including those at the PTs. For example: For radii of 15,25,30,40, and 50 feet, the number of lights required would be 3, 5, 6, and 7, respectively, and the light spacing would be approximately 13 feet up to a 40-foot radius and approximately 16 feet for a 50-foot radius. At intersections of taxiways with runways or aprons, taxi guidance lights serving as entrance and exit lights will be placed at the PTs of the taxiway and the runway or apron. These lights will be placed at right angles to the paved edge of the taxiway, runway, or apron, approximately 5 feet from the taxiway lights at these points. The pair of entrance and exit lights will be offset from the rows of runway lights in order to present minimum visual interference between the entrance and exit taxiway lights and the runway lights.

(3) *Intersections.* Where taxiways intersect runways, aprons, or other taxiways, a close uniform spacing of taxiway lights as determined by the appropriate layout criteria cited above will be used along the pavement fillet on each side. Close spacing will extend from fillet PT to PT. When the intersection is not at right angles, close spacing

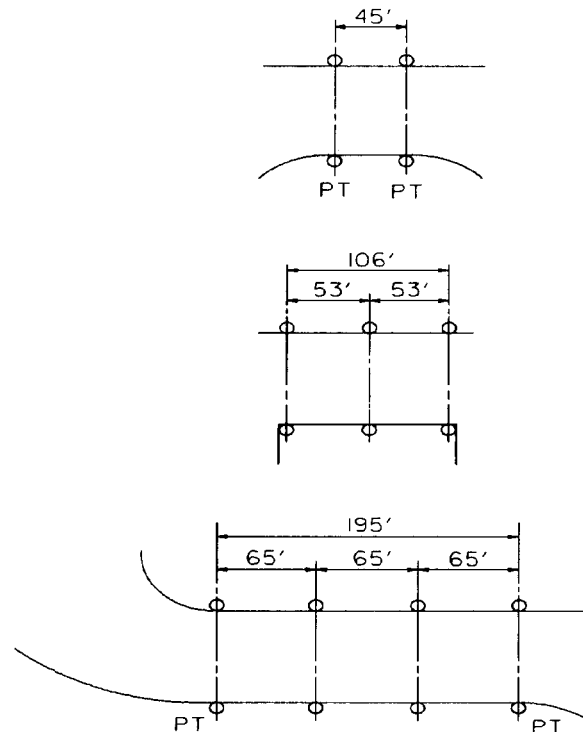


Figure 6-2. Typical examples straight sections-less than 200 feet.



will be continued from the PT of the fillet on one side of the taxiway to the PT on the other side of the taxiway. The pair of entrance and exit lights will be on a line at right angles to the pavement edge, and the nearest entrance and exit light not more than 10 feet from the pavement edge.

(4) *Entrance and exit signs.* If entrance and exit signs are specifically directed or approved for installation, the criteria should be as described in a(4), a(S), and a(6) above.

(5) *Runway used as a taxiway.* Where the runway is used as a taxiway to the runway in use, the taxiway lighting will be installed as described in runway lighting system.

c. *Helipad taxiway lighting.* Taxiway lighting for helicopter operation from helipads will be provided as for taxiways at heliports; taxilanes which are used for combination fixed-wing and rotary-wing operation; and hoverlanes which are taxiing routes for aircraft maneuvering in hover attitude along the taxiing route to and from the helipad and the apron areas.

(1) Taxiway lighting systems will be as described in heliport taxiway lighting.

(2) Taxilane lighting systems will consist of a row of elevated blue taxi guidance lights on each side of the taxilane. One side will be airfield taxiway lighting as described in airfield taxiway lighting. The opposite side of the taxilane will have lights opposite the taxiway lights required above, and additional lights located on equal spaces between these lights. The spacing of these additional lights normally will be 40 feet between lights, but not less than 35 feet nor more than 45 feet.

(3) Hoverlane lighting systems installed on load-bearing surfaces will consist of a single row of semiflush alternating aviation green and yellow taxiway light fixtures located along the centerline of the hoverlane. When lighting system is installed on nonload-bearing surfaces, elevated fixtures will be installed instead of semiflush. These fixtures will be spaced nominally 50 feet on center for long straight sections, and mounted on metal light base fittings. For curves, fixtures will be spaced nominally 25 feet on centers. When hoverlanes terminate adjacent to hanger access aprons or boundaries of other areas not intended for own-power operation, the desirable limit of helicopter travel along hoverlanes toward such areas will be indicated by three lighting fixtures emitting aviation red light. Two red hoverlane limit lights will each be installed on opposite sides of, and approximately 15 feet from, the hoverlane centerline. The third light, forming a line of three such lights perpendicular to the alternating aviation green and yellow hoverlane lights, will be located in line with the alternating aviation green and yellow hoverlane lights. Red hoverlane limit lights will provide unidirectional guidance by use of a combat-type hood attached to a taxiway light fitting. The row of alternating aviation green and yellow hoverlane lights described above will terminate approximately 25 feet from the red limit lights, outward from the apron or boundary. Hoverlane limit light mountings and types will be as for the alternating aviation green and yellow hoverlane lights described above. Hoverlane turnoffs to individual parking pads will be indicated by a aviation green and

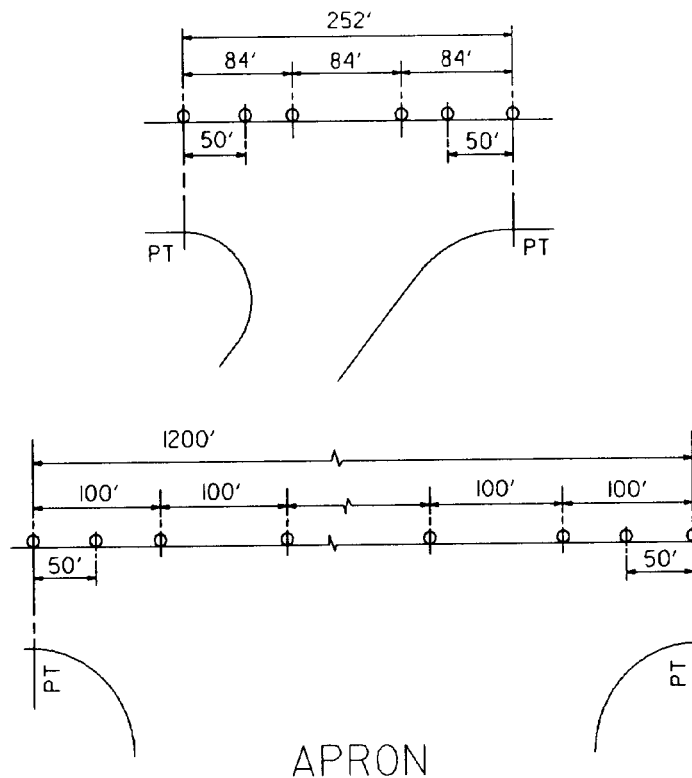


Figure 6-3. Typical examples single straight sides-more than 200 feet.

yellow hoverlane lights beginning approximately 25 feet from and perpendicular to the hover-lane, installed on nominal 25-foot centers. The line of hoverlane turnoff lights will terminate approximately 25 feet from the edge of the parking pad nearest the hover-lane. The limit of helicopter travel from the hoverlane toward the pad, along the turnoff, will be indicated by two parking pad limit lights, which will be located approximately 20 feet beyond the pad, 15 feet apart, perpendicular to the turnoff light line. Parking pad limit lights will emit aviation red light, and will provide unidirectional guidance with a combat-type hood, attached to a taxiway light fitting with red lens. All hoverlane limit and parking pad limit lights will be provided with brightness control and circuited separately, as a group, from other lights. Hoverlane lighting will not be installed in the rigid pavement area of mass parking aprons. On curved sections of hoverlanes, the criteria as described in b(2) above will apply.

**6-4. Lighting equipment for taxiways**

Taxiway (taxi guidance) lights will have a symmetrical photometric distribution of aviation blue light; except that hoverlane limit and parking pad limit lights will emit aviation red light. Normally these lights will be of the elevated type. However, where interference with aircraft movement may occur, semiflush lights will be installed. The electrical energy to these lights will be supplied by series circuits, through regulators as described in chapter 10. The lights

will be mounted in concrete bases as shown on the Installation Detail Drawings. Lights as described below are identified by a descriptive name, USAF Item Number and, where existing, by Part Number or Military Standard or Military Specification. Mounting accessories are not noted below, but are shown on the Installation Detail Drawings.

a. *Elevated taxiway lights.* Elevated taxiway (taxi guidance) lights will be by type M-1, Item No.294, conforming to Mil. Spec. MIL-L-7082. The lamp will be 30 watts, 6.6-ampere, T-10 medium pre focus base, Item No.334, conforming to Mil. Std. MS 25012-1 and Mil. Spec. MIL-L-6363. The blue lens will be Item No.324, and the red lens will be Item No.337, both conforming to Mil. Spec. MIL-L-7082.

b. *Semiflush taxiway lights.* Semiflush taxiway lights will be class B-3, Item No.653, conforming to Mil. Std. MS 27033 and Mil. Spec. MIL-L-26202. The lamp will be 45 watts, 6.6-ampere, PAR 56, Item No.577, conforming to Mil. Std. MS 24488 and Mil. Spec. MIL-L-6363. The filter will be blue, or red, as required above, suitable for use with the class B-3 fixture, and conforming to Mil. Std. MS 24502 and Mil. Spec. MIL-L-26202.

c. *Taxiway light hoods.* Air Force-type light directional control hoods on the elevated light fixtures, sometimes used in connection with taxiway lighting (including elevated entrance and exit lights) at Air Force Bases, normally will

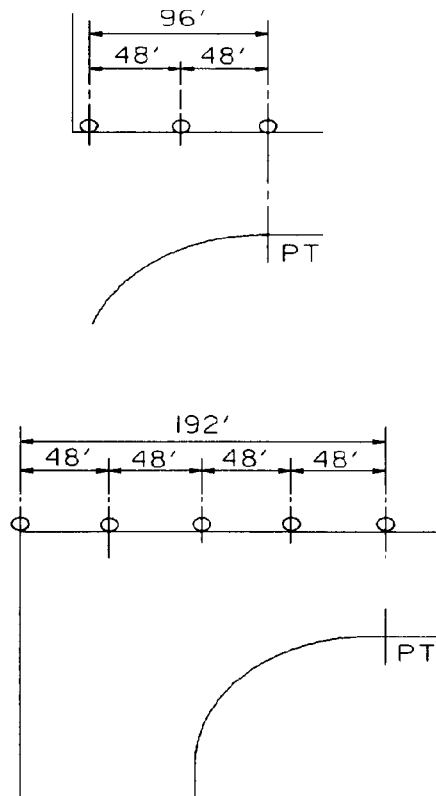


Figure 6-4. Typical examples single straight edge-less than 200 feet.

not be used unless authorized.

**6-5. Power supply and circuits**

Energy for taxiway lights (including taxilanes and hoverlanes) will be supplied from 6.6-ampere series circuits, with each circuit served from a low voltage regulator located in the equipment vault. Brightness control for taxiways at heliports will be determined on the basis of operational need. At heliports, taxiway lights will have brightness control. At airfields, brightness control normally will not be a part of the system. Regulators will be as described in chapter 10.

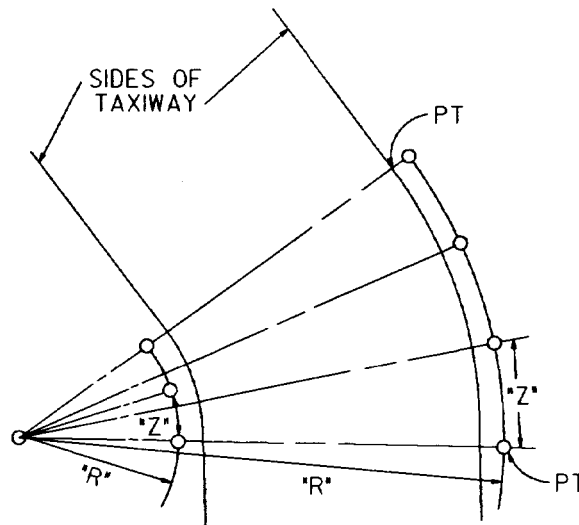
a. *Circuiting criteria.* The edge lights and entrance and exit lights for a taxiing route will be supplied from one circuit, if feasible. A taxiing route normally will be from one runway end to the other end of the same runway or to some terminal area, such as an apron. A section of the taxiing route will not be supplied from a separate circuit unless

justified for operational or engineering considerations. For exceptionally long taxiing routes, more than one regulator may be required. Where this occurs, the load should be divided equally between the regulators. Regulators should always be loaded to at least one half of rated kW output. However, where extensions to the taxiing routes are contemplated, exceptions to the above may be made. The criteria above shall also be used for circuiting the centerline lighting of hoverlanes.

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

(1) The cable used for the series circuits will be No. 8 AWG, 1/C stranded, 5,000 volt, cross-linked polyethylene, conforming to Mil. Spec. MIL-C-38359.

(2) The series transformers for the lighting systems (taxiways, taxilanes, and hoverlanes) will be 6.6/6.6 amperes



RADIUS 'R' OF CURVE IN FEET	DIMENSION 'Z' IN FEET	RADIUS 'R' OF CURVE IN FEET	DIMENSION 'Z' IN FEET
15	20	300	80
25	27	400	95
50	35	500	110
75	40	600	130
100	50	700	145
150	55	800	165
200	60	900	185
250	70	1000	200 MAX

NOTES:

- FOR RADII NOT LISTED, 'Z' SPACING SHALL BE DETERMINED BY LINEAR INTERPOLATION.
- 'Z' IS THE CHORD LENGTH.

*Figure 6-5. Spacing of lights on curve edges.*

30/45 watts, Item No. 829 conforming to Mil. Spec. MILT-27535 and Mil. Std. MS 27289.

**6-6. Taxiway lighting control system**

The taxiing route lighting control systems are an integral part of the overall control system for all airfield, heliport,

and helipad lighting facilities. The function of this portion of the control system is to energize and deenergize selected taxiing routes. The system normally will be controlled from the control tower and equipment vault unless otherwise indicated, and will be as described in chapter 10.

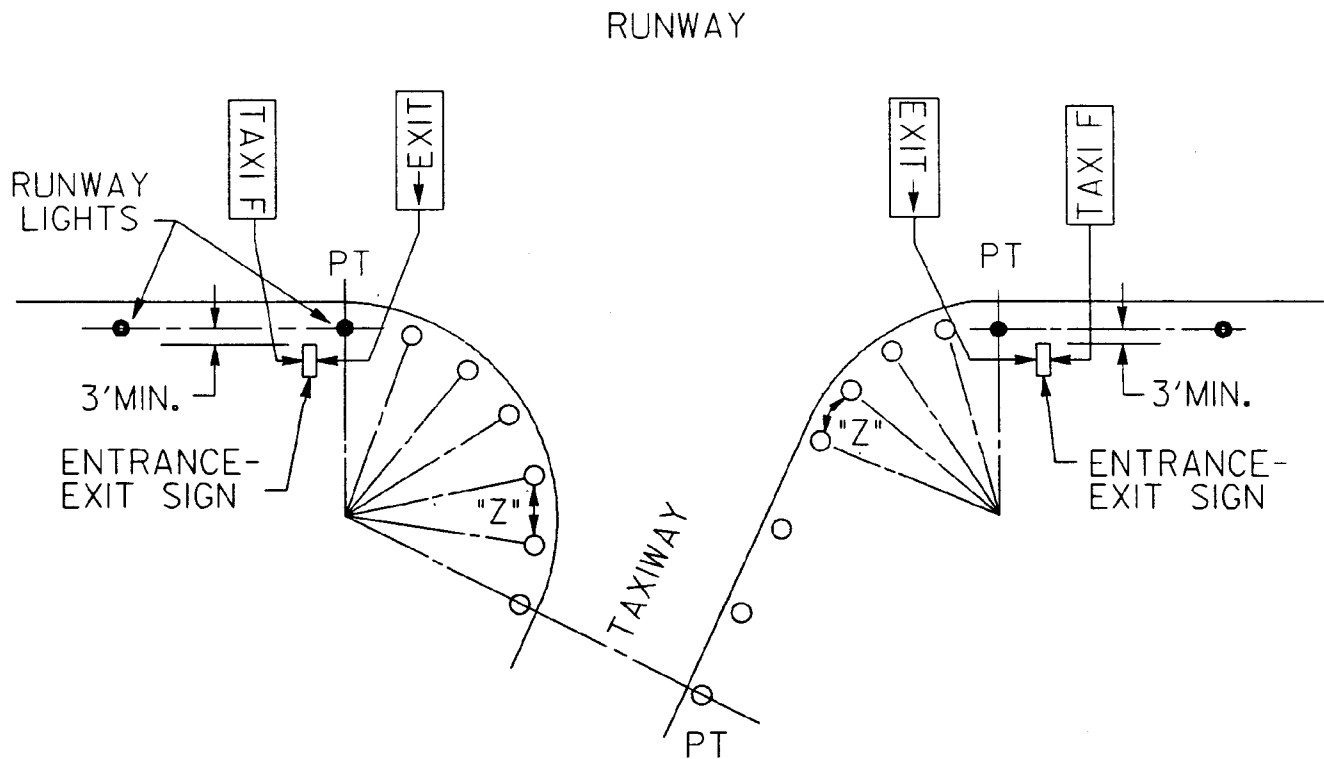


Figure 6.6 Location of entrance and exit signs.

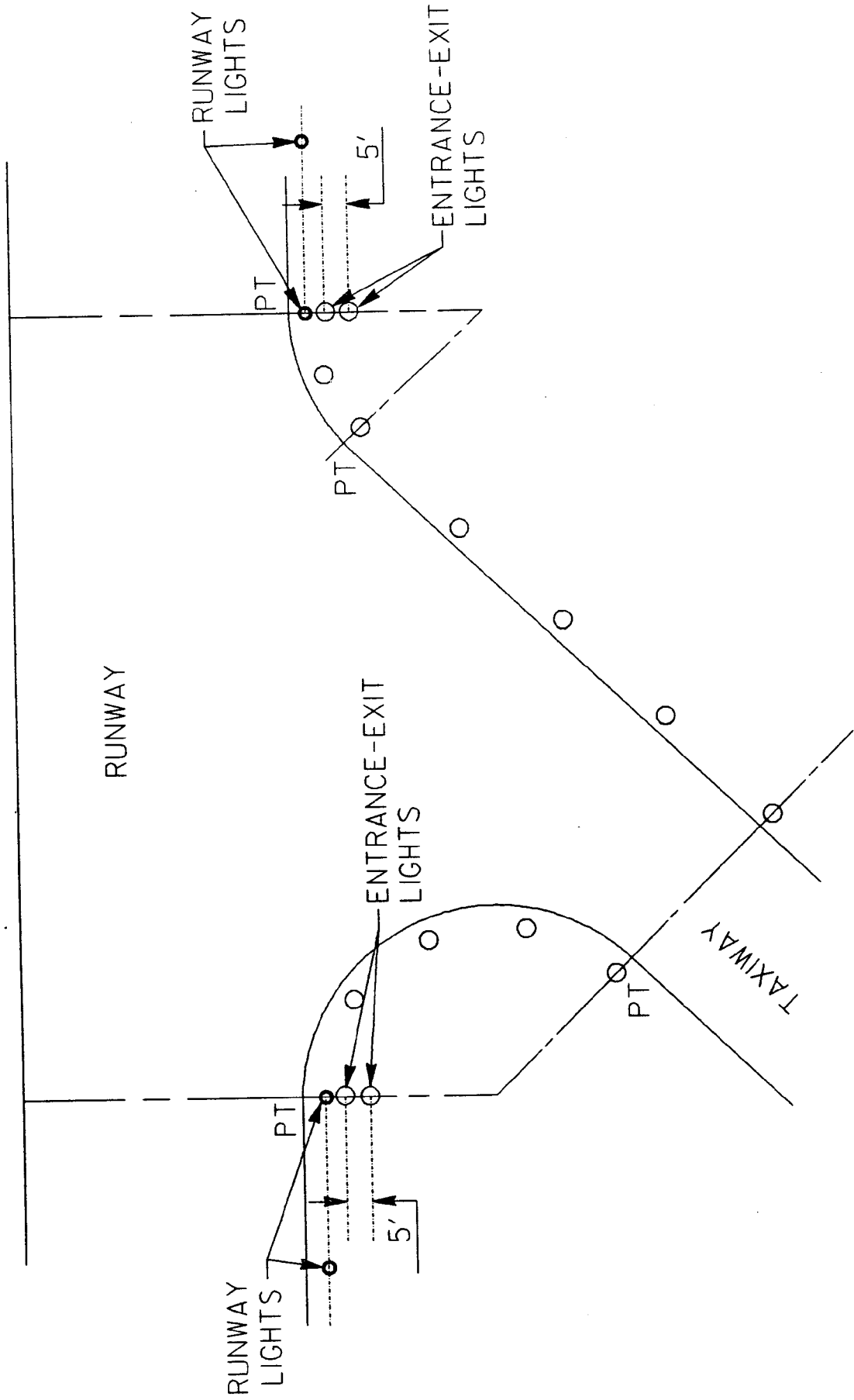


Figure 6-7. Location of entrance and exit lights.

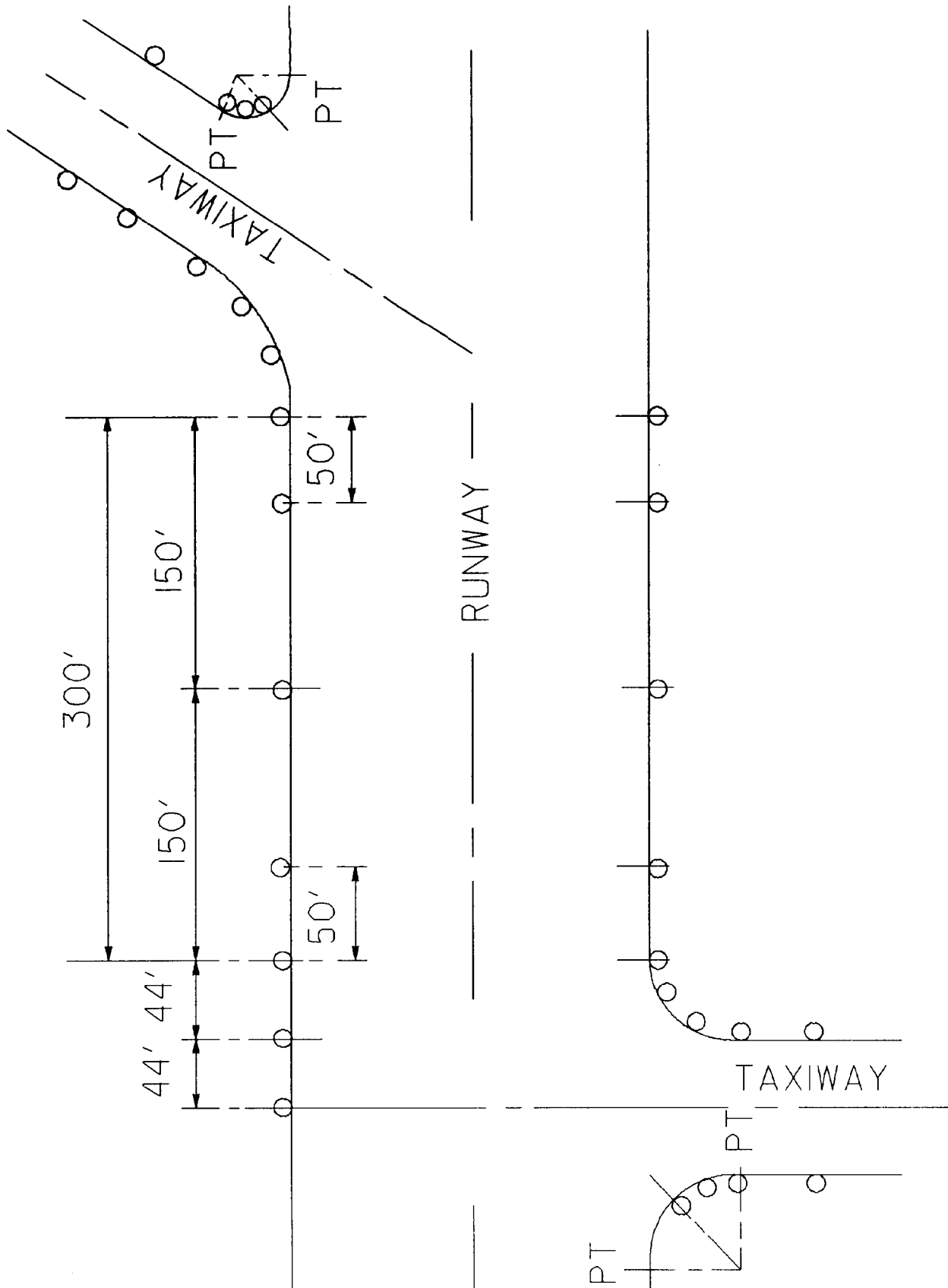


Figure 6-8. Typical example portion of runway used as taxiway.

## CHAPTER 7

# AUXILIARY LIGHTING AND ELECTRIC POWER

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### 7-1. Nature of auxiliary lighting and power

This chapter describes the auxiliary lights such as lighted wind cones, beacons, floodlights, and security lights, installed as required for the particular Army airfield, heliport, or helipad being constructed or modified. Electric power outlets, where installed, will be located as described in paragraph 7-4.

### 7-2. Wind direction indicator

A lighted wind direction indicator will be installed at new Army airfields, heliports, and helipads and at existing aviation facilities if such a device, or another device serving the same purpose, has not already been provided.

*a. Lighted wind cone.* The visual wind direction indicator normally will be a lighted cone, commonly known as a wind sock. It is the standard general-purpose wind indicator. It should be located outside the clearance zones in a conspicuous central location with respect to the airfield movement area, and in a location not influenced by turbulence created by adjacent structures or aircraft traffic. The wind cone normally will be mounted on a pipe assembly. Power for the wind cone may be from any available economic power supply source with the lighting circuit controlled from the control tower. Normally, the wind cone will be served by a low-voltage circuit that is fed from a branch circuit panel and is switched through one of the relays on the pilot relay cabinet assembly and the type MA-I Control Panel, as described in paragraph 10-4. The lighted wind cone will be Item No. 161A conforming to Part No. AN 2531-2 and Mil. Spec. MIL-I-7854 or Item No. 161B conforming to Part No. 2531-4 and Mil. Spec. MIL-I-7854, for tower and pipe mountings, respectively.

*b. Lighted wind tee.* A lighted-tee wind direction indicator will not be installed unless specifically directed or authorized. If approved for installation, however, only that part of the wind tee assembly that provides the visual function of this wind direction indicator will be utilized. The remote control wind director assembly with operator control will not be installed. The location, electric power supply, and control should be similar to that required for the lighted wind cone described above.

### 7-3. Other auxiliary lights

Special arrangements of lights, such as apron or parking area floodlights and protective and security lighting, may be required at an installation. These lights will not be connected to the airfield lighting circuits. Supply and/or control voltages for these lights will be obtained from appropriate supply and control panels located at suitable operating points. Fixed area lighting facilities, such as

floodlights for remote aircraft parking aprons and dispersed hardstands will not be provided unless specifically authorized or directed. However, portions of parking aprons and dispersed hardstands specifically designated for technical training or major maintenance activities will be provided with electrical outlets, for use with portable lighting equipment supplied from the local distribution system. Hangar access aprons (hangar entrances) will not be considered in the above category and may be lighted by floodlights installed around the apron or mounted on the hangar. Where lights mounted on the hangar are not sufficient to light the access apron, or supplemental lighting is required for maintenance operations, outlets will be provided for use by portable lighting equipment and will be integrated with the power outlets. Floodlights and outlets provided for these areas may be considered as part of the hangar construction.

*a. Floodlights.* Ground mounted floodlights normally will be of the portable type. However, where deemed appropriate for a particular installation, adjustable fixed type floodlights may be installed. Floodlights at ground level should be of a type developed primarily for the purpose of confining the light below the horizontal without glare to the pilot or ground personnel. The floodlight will have a lens providing a horizontal spread of approximately 180 degrees and will be designed to give an even illumination on the horizontally lighted surfaces. Floodlights will be mounted at low elevations, preferably not more than 3 feet above the surface of the apron or servicing area. Floodlights will be rugged construction, dustlight and weatherproof, suitable for outdoor installation on pipe stands, and will house a 200-watt minimum medium prefocus lamp. Floodlights for mounting on hangars will be of the general purpose type.

*b. Protective Lighting.* Where protective-security lighting is required for the boundary of an area, the type of floodlight used will be of the wide-angle type, equipped with a Fresnel heat resisting clear glass that will provide a horizontal beam spread of 180 degrees and a vertical spread not greater than 30 degrees. These floodlights may be suitable for operation on either multiple or series circuits, whichever is most appropriate for the particular installation. Each floodlight should be not less than 200 watts or 4,000 lumens, with rugged, dustlight and weatherproof construction. The mounting brackets will be adjustable to any position; the lamp focusing mechanism should be adjustable from the exterior of the fixture. Where areas inside the boundary, such as aprons and service areas, are floodlighted, floodlights mounted on poles or hangars should be of the general purpose type. When pole mounted, the height of the poles should ensure that, with proper adjustment of the floodlights, no glare or blinding light will

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affect aircraft operating in the traffic pattern or on the runways or taxiways. Poles should be located so as not to interfere with the line of sight from the control tower to the aircraft.

*c. Lighting intensities.* The various areas of the airfield, heliport, or helipad requiring normal and/or protective floodlighting will be lighted to meet the following intensities in foot-candles, in the horizontal plane.

*(1) Area lighting.*

Operations Building	
Parking Area	0.50
Loading Area	2.00
Apron	1.00
Maintenance	5.00*

**\*Note:** Outlets for power and lighting should be installed at this area to supplement the lighting intensity at the work area and to focus light on the part of the aircraft being served.

*(2) Protective lighting.*

Boundary	0.20
Entrances	
Active, pedestrian and/or conveyance	500
Inactive, normally locked, infrequently used	1.00
Building surroundings	1.00
Apron	1.00

### 7-4. Electrical outlets for power

Power outlets, where installed, will be located in accordance with the spacing criteria of TM 5-803-4. The outlets, when located off the paved areas, will be on pipe stands. Pipe stands will be located approximately 5 feet off the edge of the paving and have a minimum practical projection above adjacent paving. Where outlets may interfere with traffic movement, they should be installed in cast iron boxes with hinged top, mounted in concrete bases. The top of the base should be flush with the finished grade surrounding the base. All outlet installations should be of weatherproof construction and sized for the loads to be served.

### 7-5. Beacons

Aeronautical light beacons are high candlepower lights which present definite signals (colors and flashes) to identify the locations of airfields and heliport 5.

*a. Army airfields.* Station and identification beacons will be provided as follows:

*(1)* The station beacon, also known as the airfield or airport beacon, will flash alternate white and green flashes at the rate of 12 to 15 flashes per minute. The white flash will be double-peaked. The station beacon will be located no nearer than 750 feet nor farther than 5,000 feet from the control tower, and positioned so that the beacon is not in line of sight between control tower and the final approach to the runway. At Army airfield installations, an elevated water tank or similar type of structure normally will be found to be

an advantageous location for mounting the beacon. Where this type of structure is not available for mounting of the beacon, it will be mounted on a sufficiently high beacon tower, 50 to 75 feet in height, as most appropriate at the particular installation. The beacon will be installed so that the base is not less than 15 feet above the level of the floor of the platform or operations room of the control tower. Where surrounding terrain will unduly restrict visibility of the beacon, the 5,000-foot distance may be increased to a maximum of 2 miles from the nearest point of usable landing area, provided an identification beacon is installed on the airfield.

*(2)* If an identification beacon is required, it will be located as near as practicable to the appropriate inner limits noted for the airfield beacon at Army airfields above. This beacon will flash green, not more than 40 flashes or character elements (for coded signals) per minute.

*b. Army heliports (helipads).* The station identification beacon, also known as the heliport or helipad beacon, will be used to identify the location of heliport or helipad. This beacon will consist of a tricolored flashing beacon having a flash rate of 36 to 45 flashes per minute, 12 to 15 each of green, yellow, and white flash sequences per minute with the white flash being doubled peaked. Intensity of flashes will be such that the signal may be recognized for a distance of 1 mile in 1-mile meteorological visibility in daylight and 3 miles in 3-mile meteorological visibility at night, both from an altitude of 3,000 feet above ground level. The beacon will be located not nearer than 400 feet nor farther than 3,500 feet from the control tower, and positioned so that it is not in the line of sight between the control tower and the final approach to the heliport runway or the helipad. At Army installations, an elevated water tank or similar type structure may be used if located advantageously for the beacon. Where a structure of this type is not available for mounting the beacon, the beacon will be installed on a sufficiently high beacon tower, 50 to 75 feet in height, as most appropriate at the particular installation. The beacon will be installed so that its base is not less than 15 feet above the level of the platform or operations room of the control tower.

*c. Hazard beacons.* Hazard beacons are high-candlepower obstruction lights used to define particularly high or dangerous hazards to flight. Hazard beacons may be installed where an early or special warning is required, or used as an alternate to obstruction lights where obstructions are extensive and where use of obstruction lights would be impracticable or inadequate. Hazard beacons will emit a succession of aviation red flashes having a frequency of not less than 12 nor more than 40 flashes per minute.

*d. Electric service.* Beacons may be served by several methods depending upon local conditions. The methods of electric service include:

*(1)* A low-voltage electric service from the equipment vault if the beacon is located 800 feet or less from the vault.



(2) High-voltage electric service from the equipment vault having a distribution transformer of proper capacity located at the load sites. This method of supplying power normally will be used if the beacon site is located more than 800 feet from the equipment vault.

(3) A local source of electric power, either highvoltage or low-voltage, not from the equipment vault, controlled by a low-voltage control circuit or telephone relaying. These methods maybe used where the beacon site is remote from the vault, provided that experience of interruptions of service on the feeder to the beacon has been very frequent (one outage per year of less than 8 hours duration, averaged over the past 5 years).

*e. Beacon control system.* The station and identification beacons at an Army airfield or heliport will be controlled from the lighting control panel regardless of distance from vault to beacon. An auxiliary switch on the control panel will be used for this purpose.

*f. Voltage fluctuations.* For installations where the supply voltage to the station or identification beacons fluctuates five or more volts, a type E-1 constant voltage transformer, Item No.323, conforming to Mil. Spec. MIL-T-8368 should be installed ahead of the beacon lamp. Characteristics of the transformer are such as to accept an input voltage ranging between plus or minus 10 percent of normal while providing a steady 120-volt output. Use of this transformer materially reduces lamp burnouts. The transformer is designed to serve only the beacon lamp. The beacon motor and obstruction lights adjacent to the beacon lamp will not be connected to the transformer.

*g. Installation methods.* Installation of the beacon, electric power supply, control wiring, and construction of the beacon mounting will conform to applicable criteria of this manual and to other applicable criteria, FAA Advisory Circulars, and the manufacturers' recommendations.

*h. Description of beacons.*

(1) The airport or station beacon will be a 24-inch rigid drum, duplex rotating beacon, Item No.307 conforming to Part No. MS 25444 and Mil. Spec. MIL-L-7158. It has one double-beam white lens and a single-beam green lens. Each drum is provided with a lamp changer using two 1,200-watt, 120-volt, T-20 mogul bipost base lamps. The lamps will be Item No. 585, conforming to Part No. MS-25015-2

and to Mil. Spec. MIL-L-6363. Four lamps are required for the beacon. The lamp changer assures dependable operation and is equipped with an adjustment for beam elevation. The beam rotates at six r/min.

(2) The identification beacon, also known as the auxiliary beacon, will be a type G-1 beacon, Item No.266, confirming to Mil. Spec. MIL-L-6273. It will be equipped with two green filters, Item No.270, conforming to Mil. Spec. MIL-L-6273, and two 620 watt, 120-volt, PS-40 mogul prefocus base lamps, Item No.590 conforming to Mil. Spec. MIL-L-6363. A type D-1 flasher, Item No.302, conforming to Mil. Spec. MIL-K-6046 is used to produce a coded signal.

(3) Hazard beacons will be the same as the identification beacon, above, except that it will be equipped with two red filters, Item No.269, conforming to Mil. Spec. MIL-L-6273 in lieu of the green filters. A type D-1 flasher will be used to produce the periodic flashes.

## 7-6. Obstruction lights

Obstruction lights will be as indicated in FAA Advisory Circular AC 70/7460-1, Obstruction Marking and Lighting.

## 7-7. Visual glide slope indicators

The use of glide slope or approach angle indicators at an Army fixed wing airfield or heliport/heliport is not mandatory for non-instrument and non-precision instrument operations. Indicators will be installed only where specifically authorized or where required for precision instrument, category I operations (table 5-1). Where indicators are authorized for fixed wing airfield, the four box PAP! will be used. Installation will be in accordance with FAA Advisory Circular AC 150/5345-28. Where indicators are authorized for heliports, the four box PAPI or the two box CHAPI may be used. Where authorized for helipads, the two box CHAPI will be used. Visual glide slope indicators will be controlled independently of any other lighting system. When a four box PAP! is installed, the inner two boxes will be fed separately from the outer two boxes. Separate feeds will allow two box operation simulating a visual approach slope indicator (VASI) system when one circuit fails.

## CHAPTER 8

# INSTALLATION OF AVIATION LIGHTING SYSTEMS

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### 8-1. Coverage

This chapter describes the design details and methods used for the installation of permanent airfield, heliport, and heliport lighting Systems, including the installation of the system components called for in other sections of this manual. Installation will comply with NFPA 8-2. Underground materials and equipment.

### 8-2. Underground material and equipment

The materials and equipment of airfield, heliport, and heliport lighting systems, such as wire, cable, isolating transformers, lightning protection, and other system components, are designed to be installed in a direct manner or in a system of conduits (ducts), handholes, and manholes.

*a. Cables.* Where there is a multiplicity of cables, such as from the vault to runways, helipads, and taxiways, or to the control tower, cables will be installed in ducts. Where only a few cables are involved and there are no foreseeable maintenance problems in replacing such cables without disturbing others, direct burial cables will be installed. Conduits will be installed under paved areas or other stabilized areas regardless of the number of cables. Conduits will be as noted in b, below. Direct buried cables will be installed so that all requirements of the applicable criteria will be met. Either the plug and receptacle system or cable-splicing kits will be used for joining cable leads between lights. The plug and receptacle system only will be used for connecting isolating transformers to lights. Where the plug and receptacle system is used, plastic tape will be wrapped around each connection to prevent the intrusion of foreign materials into the connection. For additional information on airfield lighting cable systems, see AFM 88-14. Cables for heliport lighting systems, where the lights are of the multiple type, should be connected directly to the lighting fixtures.

*b. Conduits.* Conduits (ducts) for transverse crossings under traffic area paving at new installations will not be a part of the airfield or heliport lighting work, as these ducts will normally be provided as part of the paving operation. However, caution should be taken to clarify this in both the paving and lighting contracts and the layout of the ducts clearly shown in both contracts. The ducts should be noted as existing in the lighting contract when they are installed in the paving contract. However, at existing installations where it is necessary to install additional ducts under existing pavements, the work may be considered as part of the lighting system. Typical cross-section layouts for ducts may be found in TM 5-811-1. Additional criteria and information may be found, as required for the particular layout, by reference to applicable criteria contained in AFM 88-14. Ducts under paved traffic areas will be concrete encased.

Ducts away from paved areas maybe direct burial, Type II, where most economical and practicable. An adequate number of ducts will be installed in a duct bank to allow for future construction. Conduits stubbed up through concrete for connection to equipment or devices will be either PVC, bituminous coated rigid steel or immediate metal conduit.

*c. Cable splices.* Cable splices will be of the following type:

- (1) Cast splice with kit.
- (2) Vulcanized splice with mold.
- (3) Plug-in splice with cable connector kit.
- (4) Taped splice with vinyl tape.

*(a)* In addition to the splicing of wires and cables, cable splices may be required in runway lighting systems at visual glide slope indicators, if such are authorized. For information on splices at glide angle indicators see FAA Advisory Circular AC 150/5340-14.

*(b)* For detailed information on above types of cable splices, see AFM 88-14.

*d. Isolating transformer.* Series-to-series isolating transformers of the rating required will be buried in the earth at a minimum depth of 24 inches, or located in the handholes or light bases of the concrete pads, as appropriate.

### 8-3. Lights in concrete pads

Runway, threshold, taxiway, and, where authorized, approach lights, will be mounted in concrete pads. Concrete pads will be located so that the lights are on the centers required for proper spacings as noted elsewhere in this manual for the system of lights being installed. Pads may be with or without reinforcing, as considered necessary. Handholes with covers will be provided in the concrete pads only where required for the installation. Covers will be of reinforced concrete when located in the traffic pattern, and will be of 1/4-inch thick steel plate when located outside the traffic pattern. All concrete pads will be painted with nonreflective yellow paint, conforming to Fed. Spec. TT-P-85. During simulated combat conditions, pads may be painted olive drab, if desired, to provide maximum security for the airfield or heliport. All lights must be level. To ensure that elevated marker lights will be level, the conduit and coupling must be plumb and held firmly in place during concrete pouring operations. For flush fixtures, the top of the light bases must be held firmly in place in a level position while the concrete pad is poured. See figures 2-3 and 2-4 for details on medium intensity light fixture installations. Concrete bases as shown on figures 2-3 and 2-4 are normally maximum in size and may be smaller where soil

and frost problems will not be encountered. For information on high intensity lighting installations, see AFM 88-14.

#### **8-4. Lightning protection**

In lightning prevalent areas having isokeraunic incidence of 60 or more, a counterpoise network will be used throughout medium intensity airfield, heliport and helipad lighting systems. The counterpoise may be used where the isokeraunic incidence is 30 or more where local conditions and experience indicate the need for such a requirement. The counterpoise will be installed for all high intensity lighting systems (AFM 88-14). Where it is determined that a counterpoise will be installed, the following procedures will be followed. A No.4 AWG stranded bare copper wire will be laid continuously for the entire length of all circuits supplying the lighting systems. The counterpoise will be laid approximately 6 inches above the uppermost layer of direct burial cables or direct burial ducts, or on top of the concrete envelope of a concrete-encased duct bank. Under paved areas such as runways, taxiways, and aprons, a spare duct should be installed in each duct bank for the counterpoise. The duct for the counterpoise will be located above the ducts for the lighting system cables. In instances where a duct bank exists under a paved area, the counterpoise may be placed in a duct above the duct containing the lighting circuit conductor. Only one counterpoise will be installed for all cables in the same trench or duct bank. All counterpoise wires leading to a trench or duct bank will be connected to the counterpoise wire in the trench or duct bank. Where located parallel to a paved area, the counterpoise will be installed on the pavement side of the conductors. The counterpoise will be grounded at the vault, at the feeder connection to the light circuit, at the panel connection to the grounding electrode conductors, at the midpoint of the light circuit, at each light station, power station, and control station of a MALS or MALSF, and at one point at taxiway and runway intersections. Ground resistance at each ground connection should be 25 ohms or less. The counterpoise will be connected by No.8 AWG bare copper wire to the metal base (or metal mounting structure) of each light unit except for high intensity lighting system narrow gauge and centerline lights mounted in holes drilled in the pavement. Mechanical connectors or exothermic welding process will be used for all connections to the counterpoise network. Solder connections will not be used.

#### **8-5. Decisions regarding continued use of obsolete lighting equipment**

Continued use of obsolete airfield and heliport equipment and materials at an existing Army installation will be determined at each particular installation, after due consideration of all pertinent factors. Some factors to consider include age and condition of the obsolete equipment and materials; suitability, reliability, and safety of continued use;

economics; cost of replacement and funding; operational requirements of the airfield or heliport in connection with functional requirements of the equipment; and availability of new equipment and materials.

#### **8-6. Testing and maintenance of Army airfield and heliport lighting systems**

Reference data for acceptance testing and for use as a guide for preventive maintenance and troubleshooting of Army airfield and heliport lighting systems may be obtained in accordance with the applicable parts of AFM 88-14. Appropriate portions of these data will be included in installation contracts as an acceptable testing specification. Tests, procedures, and technical data outlined therein generally are acceptable for equipment and materials installed for Army airfield and heliport lighting systems. Backfilling of trenches will be held in abeyance pending visual inspection and testing of cables in the presence of the authorized representative of the Contracting Officer. When conducting electrical tests required in AEM 88-14 for underground cables, connectors, and transformers, such tests will be made with approximately 6 inches of compacted select backfill over the cables. Necessary arrangements may be made with the appropriate Air Force Regional Civil Engineer for loan of the type MD-1 Insulation Breakdown Test Set during acceptance testing, and type MM-I Airfield Lighting Test Set during checking and testing of the Army airfield and heliport lighting systems. The helipad lighting system will be tested in accordance with the applicable portion of AFM 88-14 for low voltage installations.

#### **8-7. Electrical supply**

The source of electrical energy will normally be the base electrical distribution system. When specifically approved for the installation, a standby generating plant will be furnished at the electrical vault. The generator set, sized for the airfield or heliport lighting system including beacon; obstruction lights in the immediate vicinity of the installation; and power requirements of the vault necessary for operation of equipment in the vault, will be approved for the particular installation by the Army command or technical service concerned with operation of the airfield or heliport. Electrical energy normally will be fed through a transformer or transformer bank to the electrical equipment vault. The primary of the transformer will match the voltage of the base distribution feeder. Output of the transformer or transformer bank and output of the emergency generator will be designed for input voltage of the regulators and the electrical characteristics of equipment other than regulators, in the vault. This will normally be 120/240-volts, single phase, or 120/208-volts, three phase, 60 hertz. For high intensity runway and approach lighting systems for long runways, see AFM 88-14.

## CHAPTER 9

### LIGHTING EQUIPMENT VAULT

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#### 9-1. Purpose or vault

The primary purpose of the airfield and heliport lighting equipment vault, referred to below as the vault, is to house the regulator equipment, the alternate source of control (secondary control panel), the transfer and low burden relays of the lighting system controls, the emergency generator and power transfer switch, the service entrance feeder and service entrance switch, and other electrical equipment needed for operation of the airfield and/or heliport lighting system. The vault may be a separate building or structure, or an enclosure within a larger structure, as appropriate. At installations where both airfield and heliport are to be constructed, a combination airfield heliport vault may be constructed if considered practicable.

*a. New vault.* Where a new vault is required and constructed as a separate structure, it will be of concrete masonry construction. The vault will be located a minimum horizontal distance of 350 feet from the control tower to prevent radio interference with control equipment. The maximum horizontal distance between the vault and the control tower is 7,350 feet. Control leads from the control tower to the vault will terminate in the vault at the actuating coils of the relays in the Pilot Relay Cabinet Assembly via the Transfer Relay Cabinets, also located in the vault. Power switches, regulators, and contactors located in the vault will be actuated by the control panel switches through the Pilot Relay Assembly. Above equipment will be as described in chapter 10.

*b. Existing vault.* An existing vault not meeting the above described location may be used provided the existing structure is otherwise adequate to serve the overall purpose, or can be modified economically to provide the desired facility.

#### 9-2. Design of vault

The vault will be sized in accordance with the space allowances indicated in TM 5-803-4. Design, construction and clearance criteria for the vault and the installation of equipment therein will be in accordance with the applicable requirements of NFPA 70, for this type of structure. All equipment cases, frames, and cabinets will be solidly grounded. The design of the vault may vary with local conditions and the amount and type of equipment installed, both initially and in the future, and may be modified as necessary to conform to the needs of a particular installation. Where high ambient operating temperatures are anticipated, exhaust fans with electrical connections therefore will be provided in the vault. The vault will have a concrete slab that will slope to drain through floor drains connected to an exterior pit or other similar means. No floor drains will be connected to the storm sewer system. The pad for the

emergency generator will be isolated from the remainder of the floor slab. Interior walls will be of concrete masonry blocks. The roof will be built up roofing design, with slope of 3/8 inch per foot. The operator's control area may have a window. The remainder of the vault will not have windows, but will be ventilated through louvers where required. The vault will be heated, where required, by unit heaters in the equipment area and baseboard heaters in the operator's area. Doors to the equipment area will be louvered if required. Generators will require louvers for proper cooling of the units. A motor operated louver, interlocked with the starting of the generator, will be installed to permit air movement over the generator. An exhaust louver from the generator radiator will be installed with a duct system from the generator radiator to the exhaust louver. The exhaust louver will be closed when the generator is idle and open automatically from the force of the exhaust air currents when the generator is operating. The fill under the slab and the building footings will be determined by site conditions and size of building.

*a. Operator's control area.* A section at one end of the building will be isolated from the remainder of the building by a concrete masonry wall. This section will house the alternate source of airfield lighting control (control panel), the key switch for transfer of the control from the control tower to the vault and vice versa, and two telephone outlets. One telephone outlet will be for normal telephone, and the other for a tieline between the operator's area in the control tower and the operator's area in the vault. The tieline will be used when the alternate source of control in the vault is used, thereby allowing the operator in the tower to have direct and uninterrupted contact with the operator in the vault. Above criteria also will apply if the vault is for a heliport lighting system. Where a combination airfield heliport vault is utilized, the control area will be installed so that both control systems can be installed. However, where such occurs, a barrier will be installed between the two control panels so that the operator cannot operate the wrong panel inadvertently.

*b. Power supply area.* This area will house the service entrance feeder, the main service switch or breaker, emergency generator and transfer switch, regulators, fused cut-outs for regulators if needed, and the relay and terminal cabinets. High voltage conductors, where used, will be run in rigid steel galvanized conduits or intermediate metal conduit. These conduits will be noted as high voltage when voltage exceeds 600 volts. Two red bands, spaced 8 inches apart, will be painted near each conduit coupling. Space between the red bands will be painted white; on the white space, the voltage will be stenciled in black, in locations clearly visible from all angles. Low voltage feeders and

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control wires will be installed in coated rigid steel galvanized conduits or coated intermediate metal conduit when run under the floor slab; in rigid steel galvanized conduits, intermediate metal conduit, or electric metallic tubing (EMT) when run on the walls or ceilings; and in cable trays supported from the ceiling or walls when there is a multiplicity of cables and possible need for expansion in the future. Conduits will not be installed in concrete slabs on grade. Cabinets, panels, and fused cut-outs when used, will be mounted on the walls. Regulators will be floor mounted close to the walls so as to keep exposed conductor lengths to a minimum. Series feeders from regulators and various other feeders from the control panel will be brought out of the vault in coated rigid steel galvanized conduits or coated intermediate metal conduit 2 feet below grade. Where feasible, a floor trench may be used for conductors leaving the vault. Feeders to this trench and from this trench to the exterior will be run in rigid steel galvanized conduits or intermediate metal conduit.

*c. Emergency power.* Where emergency power is required for the operation of the airfield or heliport, the generator and its control panel, the starting equipment, and the automatic transfer switch will be located in the vault, not the control tower. The unit will be sized in accordance with the lighting system load and the essential power requirements other than the airfield or heliport lights, such as the vault lighting, ventilation, heating, future expansion of the lighting systems and, when the control tower is connected to the same transformer bank and fed through the vault, the essential control tower loads. However, where the loads in

the control tower are large enough or the distance between the vault and the control tower great enough to cause feeders between vault and control tower to be uneconomical, a separate service with transformer bank should be installed at the control tower and where authorized, a separate emergency generator with its related equipment will be installed at the control tower. If the latter emergency generator is used, it will normally carry all of the control tower loads and control circuits except for the airfield and heliport lighting control circuits. The latter will be in all cases part of the vault emergency system. The generator and the fuel system will be in accordance with the applicable portions of TM 5-811-1.

### **9-3. Helipad lighting control vault or house**

Where helipads are constructed at existing Army airfield and/or heliports, the vaults described above, if practicable, will be used for power supply and control of the helipad lighting system. Where distances are too great to service the helipads feasibly from the vault, a separate vault or structure to house the electrical service and the intensity controllers will be erected near the helipad, but outside flight clearance zones. Electrical circuits to the helipads will normally be low voltage, 120-volts, single phase, 60 hertz. Each feeder will be from a circuit breaker on a panelboard mounted in the vault or structure, and fed through a dimmer as described in chapter 10. Where a separate structure is erected near the helipad, it should be lighted and heated as described for the vaults for the airfield and heliport lighting equipment.

## CHAPTER 10

# CONTROL SYSTEMS AND REGULATORS

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### 10-1. Energizing and brightness control

The control systems and regulators for Army airfields and heliports will consist of properly rated regulators having a constant current output to the lights, and a control system to energize, deenergize and control the brightness (intensity) of the lighting systems (figs 2-2 and 3-1). Medium intensity lighting systems and high intensity lighting systems for short runways and the lighting systems for heliports will be 6.6-ampere series. High intensity lighting systems for long runways will be as in AFM 88-14. The lighting system for helipads, whether at airfields, heliports, or independently located, will normally be 120-volts, single phase, 60 hertz multiple circuits, as described below. Operational safety requires that the air traffic controllers be able to energize, deenergize, change brightness, and switch the various aviation lighting circuits instantly as required by the dictates of the operation of the moment. It is essential that the controls in the tower be maintained at all times. Control of aviation lighting is accomplished by the specifically designed combinations of circuit breakers, single pole switches, and single and multistage rotary switches, all mounted on a frame-work control panel, circuited in such manner that the lighting system may be energized from a remote station, as conditions demand.

### 10-2. Lighting system control points

At Army airfields and heliports there normally will be two points of control for the lighting system. The primary point of control will be in the operations room of the control tower. The alternate (secondary) point of control will be located in the equipment vault unless specifically directed or approved for location elsewhere. A single pole, single throw, key operated switch will be provided in the vault adjacent to the control panel for switching of the control circuits from the tower to the vault and vice versa through the transfer relay cabinet. When a helipad is located at an Army airfield or heliport, and located so that control from the tower is feasible, the primary location of the control panel should be the control tower. The alternate location will be the vault or structure housing the circuits to the helipad lighting system. Where the helipad is remote from the control tower, or located at a separate location where there is no control tower, the controls may be in the structure convenient to the helipad which houses the circuits to the helipad lighting system, a building remote from the helipad, or both locations.

### 10-3. Airfield control tower

When a new control tower is constructed it may be constructed as part of a hangar or other approved structure, or

may be an independent structure. The entire airfield or heliport lighting system will be controlled from the control tower. Construction of a new control tower at an existing airfield or heliport will require the installation of a new control panel in the new control tower and the transfer of controls from the existing control tower or other point of control to the new control tower. All existing equipment in the existing control location will be salvaged. At installations where both an Army airfield and an Army heliport are to be constructed, a combination airfield heliport control tower may be constructed if considered practicable, provided suitable separate space and location of control equipment for each facility will be maintained and proper vision for control of both facilities is also available. Design of the control tower will be in accordance with the applicable requirements of DA Technical Bulletin, TB 95-1. Where a helipad is constructed at an Army airfield or heliport, the controls for the helipad should be located, if feasible, in the control tower. If the control tower houses control panels for airfield, heliport, or helipad, runways and taxiways, or any combination of the three, the panels should be physically separated in the tower so that the controller will not operate the incorrect control inadvertently.

### 10-4. Lighting control panels and relays

The following requirements apply to control equipment at airfields, heliports, and helipads.

#### *a. Airfields and heliports.*

(1) *Control panel.* The standard method for controlling an Army airfield or Army heliport lighting system for runways, taxiways, approach lighting where authorized, and auxiliary lights will be by means of a control panel conforming to Mil. Spec. MIL-P-8944. This type of panel will be located in the control tower as the primary control location and in the vault as the alternate location, unless another location is directed or authorized as the alternate location. The control switches for all of the airfield or heliport lighting systems will be mounted in this control panel. Where the control tower is for a combination airfield and heliport, two control panels will be installed, one for each lighting system.

(2) *Transfer of control point of airfield and heliport lighting systems.* The transfer of the control point of the airfield or heliport lighting system from the control tower to the alternate location will be by use of 8-pole, double throw transfer relay assemblies. Each assembly will be designated "Cabinet and Relay Assembly-Transfer Relay," Item No.409, conforming to Mil. Spec. MIL-P-4971. The number of these assemblies required for the system will be determined by the number of control cables from the control tower to the Cabinet and Relay Assembly-Transfer Relay.

This assembly will be located in the vault; where more than one unit is required, all of the 110-volt coils will be connected in parallel.

(3) *Pilot relay equipment.* A system utilizing low burden pilot relays is used because of the distance between vault and control tower at many Army airfield and heliport installations. In this type of system, switches on the control panel actuate low burden relays which in turn actuate power switches, contactors, and relays controlling the regulators and transformers supplying airfield and heliport lighting circuits. The low burden relaying equipment is contained in the "Cabinet and Relay Assembly-Pilot Relay," Item No.406, conforming to Mil. Spec. MIL-P-8945. This equipment will be wall mounted in the equipment vault and used to supply primary power to the low voltage and low wattage equipment and/or the primary control current for the larger pieces of electrical equipment.

(4) *Wiring diagrams and circuiting.* For additional information such as wiring diagrams and circuiting for the equipment described above, see AFM 88-14.

(5) *Limitations or restrictions on use of control panels.* Control panels will not be used to control older type regulators manufactured under the provisions of Army-Navy Specification AN-R-17, due to elimination of the push to turn feature from the rotary switches. The control panel is not intended to be a replacement item of equipment, and will not be installed where control panels conforming to Army Navy Specification AN-P-59 are already on hand. When a control panel is already in place in an existing control tower, and a new control panel will be installed at an alternate control point, the new panel will be installed in the control tower. The existing control panel (s) will be reinstalled at the alternate control point. When control panels already in place in an existing control tower and at an alternate location(usually the vault) at an Army airfield or heliport installation are in good operating condition and not considered obsolete, the existing control panels should be reused, with the necessary connections made to accommodate new circuits or equipment wherever practicable. The control panel combines the control features of the Type II control panel, Item No. 157B-1, and the type N-1, taxiway control panel, Item No. 301.

(6) *Control panel mounting.* The control panel may be wall-mounted, bracket mounted or table mounted at the alternate source of control (usually the vault). In the control tower, the panel may be table mounted separately or, if approved, maybe used in connection with the VFR control console, similar and equal to Air Force Model CY-442/CRC, where space is provided. The control console will not be installed as part of an Army airfield or heliport lighting system unless specifically directed or authorized. Where authorized or directed, the control console will be mounted in the control tower, and should be specified as furnished by the contractor. Mounting of the control panel chassis either (outer case removed) in the control console or table mounted, and the connections

to the control panel, should be a part of the airfield or heliport lighting work. When appropriate for the standard method of wiring the control panel may be used to control two independent or intersecting runways and an approach lighting system.

*b. Helipads.*

(1) A control panel will be provided to house the applicable helipad lighting system controls, including the remote brightness controllers and, if required, the rotary switch for Landing Direction Light Bar selection. Controls for taxiway, taxilane, hoverlane, and auxiliary lights needed to control traffic to and from the helipad will also be housed in the helipad control panel, except where such lights are controlled from the airfield or heliport control panel. The helipad control panel should be mounted with a clearance separation from the airfield and/or heliport control panel, to prevent inadvertent operation of the wrong control panel by the panel operator. Construction of the helipad control panel should be similar to that of the control panel indicated above, and suitable for control of the helipad lighting system installed.

(2) Transfer of the control point of the helipad lighting system from the primary location to the alternate location will be by use of Cabinet and Relay Assembly-Transfer Relay, Item No.409 conforming to Mil. Spec. MIL-P-4971. These relays will be connected as described in 4a above.

(3) Landing direction lighting system relays will be housed in a metal cabinet similar to the housing for the other relay assemblies described above. The number of relays will correspond to the number of landing direction light bars installed at the helipad. These relays will be suitable for operation under load and will have two normally open contacts. One contact will energize the circuit for the selected landing direction light bar and the second contact will be the interlock permitting the approach direction lighting system, if installed, to be energized only when the landing direction lighting system is energized.

## 10-5. Runway lighting controls

The design of the runway lighting controls for airfields and heliports should assure that lighting on intersecting runways cannot be energized simultaneously. It should also insure that all the lights used for the runway will be energized simultaneously. The runway edge lights and the threshold lights are to be controlled to operate at the same brightness. The lights to be energized, and the brightness control of these lights, are controlled from the control panel and the related relay panels, through the regulator(s). The control of the high intensity runway lighting system is similar to that of the medium intensity runway lighting system. A miniature facsimile of the airfield or heliport runway(s) to be controlled will be mounted on the face of the control panel. The facsimile will be part of the taxiway facsimile described below. Insofar as practicable, the facsimile will be oriented with the airfield or heliport when viewed from the control operator's position.

## 10-6. Taxiway lighting controls

All taxiway lighting circuits will be controlled from the control panels in the control tower and in the vault. The taxiway portion of the control panel will be arranged so that the taxiway circuits can be operated independently. A miniature facsimile of the airfield or heliport, showing the layout of the runways and taxiways, should be either a scaled drawing or an aerial photograph. Each taxiway lighting switch should be installed on the facsimile near the center of the taxiing route for which the lighting is controlled. These switches will be singlepole, push-pull type, installed on the control panel as described in AFM 88-14.

*a. Airfield taxiway control.* Each taxiway circuit will be controlled by a switch mounted on the facsimile near the center of the taxiway circuit that it controls.

*b. Heliport taxiway control.* The control of the heliport taxiway lighting circuits will be as described in paragraph 3-5.

*c. Helipad taxiway control.* The helipad taxiway, taxilane, and hoverlane lighting systems will be controlled similar to such systems at airfields and heliports. When a helipad is at an airfield or heliport, lights on taxiways from helipad to the hangars and aprons, and to operations and parking areas should be controlled from the control tower by use of the control panel, if feasible. Where a helipad is in a remote location on an airport or heliport and the taxiways are of such length as to make a series circuit feasible, a separate control panel will be used for taxiway lighting control. This panel should be a regular product of the manufacturer making the control panel and should have the facsimile and control switches circuit breaker built into the panel. The panel should be similar in physical characteristics to the main control panel described above.

## 10-7. Auxiliary lighting controls

Control of obstruction lights, beacons, wind cones or tees, floodlights, and other lights performing similar functions should be obtained on the control panel or, in case of a remote helipad, from the control panel for the helipad lighting system.

## 10-8. Approach lighting controls

Approach lighting control at airports, heliports, and helipads should be installed only where approach lighting systems are specifically directed or authorized. Control at airfields and heliports will be from a control panel, and at helipads from the helipad lighting system control panel.

## 10-9. Grounding

All control panels and equipment will be electrically grounded in accordance with NFPA 70.

## 10-10. Control cables and terminations

The standard control cable is a seven conductor, 600-Volt, buna insulated, polychloroprene sheathed cable, item No.364, conforming to Mil. Spec. MIL-C-38359. One conductor (black) is a No.12 AWG and the remaining conductors of the cable are No.16 AWG. The No.12 AWG is used as the hot lead and the No.16 AWG conductors are used as switch legs. Where more than one 7/C control cable is used in a system, all of the No.12 AWG conductors should be connected together as one lead. Terminal blocks are to be used for terminating the control cables at the end of the underground run in the base of the control tower, and at the end in the equipment vault. Terminal blocks may be used at other locations for convenience of wiring and distribution. Commercially available junction boxes of the proper size equipped with compression-type terminal blocks will be used at all such terminations.

## 10-11. Lighting power supply and circuits

At airfields, runway lighting, approach lighting, and taxiway lighting systems will be supplied through series circuits served by constant current regulators, except for the MALS or MALSF, which will be supplied from a 120/240 volt, single phase, 60-hertz circuit. At heliports, the runway and taxiway lighting systems will be supplied through series circuits served by constant current regulators. At helipads the lighting system will be fed normally by 120-volt, single phase, 60-hertz circuits. Each part of the system will have its brightness controlled through a motor operated dimmer capable of withstanding the loads of the circuits to which it is connected. The taxiway, taxilane, and hoverlane lighting system normally will be supplied through series circuits served by constant current regulators.

## 10-12. Constant current regulators

The constant current regulators are designed for use on aviation facilities requiring series circuits for the lighting systems. Regulators, except those for taxiway systems at Army airfields, will have provisions for varying the output current from rated value to lower values so that brightness of the lamps in the lighting systems may be adjusted to suit visibility conditions.

*a. Runway regulators.* Each runway circuit will be served from a regulator designed to suit the system installed. The regulators considered as standard equipment are the packaged-type, containing necessary devices for protective relaying, on-off operation, 5-step brightness control, and line and load connections. Provisions are made in the regulators for local and remote control of the on-off operation and brightness control. The remote control points will normally be the control tower and the operators' room in the equip-



ment vault. The controllers will be as indicated above in this section.

(1) Medium intensity runway lighting regulators for airfields and heliports will normally be Type C-I, 4-kilowatt, single phase, 60-hertz, alternating current input, with primary taps at 190, 200, 210, 220, 230, and 240 volts. Rated secondary output is 6.6 amperes. A regulator conforming to FAA Advisory Circular AC 150/5345-10 will be used.

(2) High intensity runway lighting regulators normally will be type C-3 regulators as described immediately above. The number of lights that may be placed on a circuit from this regulator is substantially less for a high intensity system than for a medium intensity system. Where a regulator requiring a 20 ampere output is to be used, the regulator will conform to FAA Advisory Circular AC/150-5345, having a single phase, 2,400 volts, 60-hertz, alternating current input with a rated output of 20 amperes. These regulators will have a 5-step brightness control.

*b. Approach lighting regulators at airfields.*

(1) The regulators for the high intensity approach lighting systems will be type C-3 as described above.

(2) The MALS or MALSF will not utilize regulators as described above. The power supply for this system of steady burning lights may be a variable output magnetic amplifier dimmer or a commercial transformer. The rating of either of the above will be 10 kilowatts, single-phase, 60-hertz. If the transformer is used, it should be connected to provide a minimum of two brightness steps to give 100 percent and approximately 10 percent of the steady burning lamp intensity. Ten percent of the steady burning intensity is obtained when the lamp voltage is 55 percent of rated value. The transformer will be tapped to provide the additional 5 percent of rated output voltage above the transformer center tap. The power supply for the sequenced flashing lights will be a transformer capable of supplying a minimum of 1.5 kW at rated current and voltage.

*c. Taxiway regulators.* Each taxiway circuit at airfields, heliports, and helipads will be served from a regulator-designed for a normal input voltage of 240 volts, provided with taps for input voltages of 210, 220, 230, 240, and 250 volts. The output will be constant at 6.6 amperes where brightness control is not a requirement. Where brightness control is a requirement, the regulator will be designed for a normal input voltage of 240 volts with taps at 190, 200, 210, 220, 230, and 240 volts. The output will have five steps of brightness control.

(1) Type M-1 regulators will be 1.5 kilowatts, single phase, 240-volts, 60-hertz input, 6.6 amperes constant output, Item No.291, conforming to Mil. Spec. MIL-R-4707. The maximum number of 30-watt lights that may be connected to this regulator is 35.

(2) Type M-2 regulators will be 4.0 kilowatts, single phase, 240-volts, 60-hertz input, with 6.6 amperes constant

output, conforming to FAA Advisory Circular AC 150/5345-10. The maximum number of 30-watt lights that may be connected to this regulator is 90.

(3) Where brightness control is used on taxiway lighting circuits, the regulators will be type C-I as described above.

(4) Where extremely long taxiways are to be lighted, it maybe necessary to use two taxiway circuits on a single taxiway section. The regulators for the taxiway circuits will be fed from branch circuit panelboards located in the equipment vault and controlled from the control panels as indicated above.

### 10-13. Helipad lighting system control components

The various components of the helipad lighting system, that is, the perimeter lights, landing direction lights, approach direction lights, helipad inset lights, and helipad floodlights, will be supplied through multiple circuits (figs 4-5 and 4-6). Intensity of lighting fixtures will be varied by use of dimmers. Dimmers will be located in the equipment vault, or in a structure convenient to the helipad when the helipad is remote from the vault, or no vault exists. The dimmers will be capable of controlling brightness from 0 to 100 percent intensity for the lights in different components of the overall system. The dimmers will be rated for 120-volt input, single phase, 60-hertz, with wattage ratings as required for the component of the system being controlled. The dimmer will be operated and the level of intensity adjusted by remote controllers. These controllers will be located in the control tower where the tower is used as the primary control location. Where the tower is so used, the vault or structure located near the helipad will be the alternate control location. The dimmers will have the capability of being preset to a specific value. The dimmers for the various components of the system are:

*a. Perimeter lights.* The perimeter lighting system consisting of 16 lights, will be controlled from a dimmer and brightness controller having a suitable kVA output for constant impedance load.

*b. Landing direction lights.* The landing direction-lighting system consists of one or two light bars having six lights per bar. The number of bars will be determined by the operation of the helipad. When used, these lights will be controlled from the perimeter lighting system dimmer, thereby increasing the output rating of that dimmer for a constant impedance load. The landing direction lights will be so circuited that only one light bar may be energized at any time, and only when the perimeter lighting system is energized.

*c. Approach direction lights.* The approach direction-lighting system will consist of 18 lights requiring a dimmer and controller with suitable output for a constant impedance load. The approach direction lighting system will be on a separate dimmer and controller, but interlocked with the landing direction lighting system so that the former is

operable only when one of the tight bars of the landing direction lighting system is energized.

*d. Helipad inset lights.* The helipad inset lighting system will be operated through a dimmer and controller independent of any other component of the helipad lighting system. The dimmer and controller will control a multiple circuit which feeds lights as described above and will have a suitable output for a constant impedance load.

*e. Helipad floodlights.* The helipad flood lighting system will be controlled by a dimmer and controller independent of any other component of the helipad lighting system. The dimmer and controller will be similar to others of the helipad lighting system except that the dimmer will be sized to suit the load required for the number of floodlights installed at the helipad.