AMI-100A

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6850.5C
CHG 5

7/25/2002

SUBJ: MAINTENANCE OF LIGHTED NAVIGATIONAL AIDS

1. PURPOSE. This change specifies the applicability of the lamp power requirements identified in this handbook Section 2 paragraph 24. This directive implements Configuration Control Decision (CCD) No. N23777, Change Order 6850.5C, Section 2, Obstruction Lights, paragraph 24, b to allow the use of Light Emitting Diode (LED) lamps.

2. DISTRIBUTION.

a. This directive is distributed to selected offices and services within Washington headquarters, the William J. Hughes Technical Center, the Mike Monroney Aeronautical Center, regional Airway Facilities divisions, and Airway Facilities field offices having the following facilities/equipment: ALS, LDIN, MALS, MALSR, ODALS, PAPI, REIL, SALS, SSALR, SSALS, VASI.

b. An electronic version and distribution report of this directive are available on an Intranet site located at **http://aos-ext.amc.faa.gov/** under the "Technical Documentation" heading.

c. To obtain additional hard copies of this publication, contact Printing & Distribution Team, AMI-700B, at (405) 954-3771.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
31	3/27/95	31	3/27/95
32	3/27/95	32	7/25/2002

Thu Jul 2002 07/25/02 15:53:27

Gregg W. Dvorak
Program Director for Operational Support

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-603

Initiated By: AOS-240

3/19/2002

SUBJ: MAINTENANCE OF LIGHTED NAVIGATIONAL AIDS

1. PURPOSE. This change revises the interval for testing of the Lighting Facilities. This directive implements Configuration Control Decision (CCD) No. N23229, Handbook 6850.5C "Maintenance of Lighted Navigational Aids", Section 4 "Periodic Maintenance" Change.

2. DISTRIBUTION.

a. This directive is distributed to selected offices and services within Washington headquarters, the William J. Hughes Technical Center, the Mike Monroney Aeronautical Center, regional Airway Facilities divisions, and Airway Facilities field offices having the following facilities/equipment: ALS, LDIN, MALS, MALSR, ODALS, REIL, SALS, SSALR, SSALS, VASI, and PAPI.

b. An electronic version and distribution report of this directive are available on an Intranet site located at **http://aos-ext.amc.faa.gov/** under the "Technical Documentation" heading.

c. To obtain additional hard copies of this publication, contact Printing & Distribution Team, AMI-700B, at (405) 954-3771.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii	3/27/95	iii	3/27/95
iv	12/11/97	iv	3/19/2002
v	3/27/95	v	3/27/95
vi	12/11/97	vi	3/19/2002
vii and viii	3/27/95	vii and viii	3/19/2002
ix and x	1/31/96	ix	3/19/2002
		x	1/31/96
53	12/11/97	53 thru 54-1/54-2	3/19/2002
54	3/27/95		

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-603

Initiated By: AOS-242

PAGE CONTROL CHART (Continued)

Remove Pages	Dated	Insert Pages	Dated
61 and 62	1/31/96	61 thru 68	3/19/2002
63	1/31/96		
64	12/11/97		
65 thru 68	12/11/97		
69	3/27/95	69	3/19/2002
70	3/27/97	70	3/27/97
71 and 72	3/27/95	71 and 72	3/19/2002
95	3/27/95	95	3/27/95
96	1/31/96	96	3/19/2002
96-1 and 96-2	1/31/96	96-1 and 96-2	3/19/2002

Tue Mar 19 10:48:59 2002

Gregg W. Dvorak
Program Director for Operational Support

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6850.5C
CHG 3

10/20/1999

SUBJ: MAINTENANCE OF LIGHTED NAVIGATIONAL AIDS

1. PURPOSE.

a. This change revises required equipment for the calibration of the output currents from the power and control assembly for the Visual Approach Slope Indicator (VASI) and the Precision Approach Path Indicator (PAPI). This directive implements Configuration Control Decision (CCD) No. N21550, 6850.5C VASI/PAPI True RMS.

b. This change has been reviewed and evaluated for impacts upon Y2K functionality and has no detrimental effect upon Y2K compliance issues.

2. DISTRIBUTION. This directive is distributed to selected offices and services within Washington headquarters, the William J. Hughes Technical Center, the Mike Monroney Aeronautical Center, regional Airway Facilities divisions, and Airway Facilities field offices having the following facilities/equipment: ALS, LDIN, MALS, MALSR, ODALS, REIL, SALS, SSALR, SSALS, VASI, and PAPI.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
	Chapter 5		
87 and 88	3/27/95	87	10/20/1999
		88	3/27/95

James H Pritchard

Wed Oct 20 11:36:14 1999

Raymond M. Long
Program Director for Operational Support

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-603

Initiated By: AOS-240

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6850.5C
CHG 2

12/11/97

SUBJ: MAINTENANCE OF LIGHTED NAVIGATIONAL AIDS

1. PURPOSE. This change transmits revised pages to Order 6850.5C, Maintenance of Lighted Navigational Aids. The change incorporates maintenance and certification requirements for the dual mode high intensity approach lighting system, type FA-10700, removes the requirement to replace PAR-38 lamps after 1800 hours of operation, deletes references that are no longer used, and corrects documentation errors. This directive implements Configuration Control Decision (CCD) No. N16975, Lighted Navigational Aids Handbook Revision to Optimize Preventive Maintenance.

2. DISTRIBUTION. This directive is distributed to selected offices and services within Washington headquarters, regional Airway Facilities divisions, the William J. Hughes Technical Center, the Mike Monroney Aeronautical Center, and Airway Facilities field offices having the following facilities/equipment: ALS, LDIN, MALS, MALSR, ODALS, PAPI, REIL, SALS, SSALR, SSALS, VASI.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii and iv	3/27/95	iii	3/27/95
		iv	12/11/97
v	3/27/95	v	3/27/95
vi	1/31/96	vi	12/11/97
43 and 44	3/27/95	43 thru 44-2	12/11/97
45	3/27/95	45 and 46	12/11/97
46	1/31/96		
47	1/31/96	47 thru 48-4	12/11/97
48	3/27/95		
53 and 54	3/27/95	53	12/11/97
		54	3/27/95
59 and 60	3/27/95	59 and 60	12/11/97
63	1/31/96	63	1/31/96
64	3/27/95	64	12/11/97
65 thru 68	3/27/95	65 thru 68	12/11/97
103 and 104	3/27/95	103	3/27/95
		104	12/11/97

James H. Pritchard for

George W. Terrell
Program Director for Operational Support

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-603

Initiated By: AOS-240

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6850.5C
CHG 1

1/31/96

SUBJ: MAINTENANCE OF LIGHTED NAVIGATIONAL AIDS

1. PURPOSE. This change transmits revised pages of Order 6850.5C to adjust maintenance schedules, change maintenance procedures to reduce maintenance time, and provide procedures for maintenance of the remote radio control systems (RRCS), types FA-10047 and FA-10266. This change implements Configuration Control Decision (CCD) No. N16975, Lighted Navigational Aids Handbook Revision to Optimize Preventive Maintenance.

2. DISTRIBUTION. This directive is distributed to selected offices and services within Washington Headquarters, regional Airway Facilities divisions, the FAA Technical Center, the Mike Monroney Aeronautical Center, and Airway Facilities field offices having the following facilities/equipment: ALS, LDIN, MALS, MALSR, ODALS, PAPI, REIL, SALS, SSALR, SSALS, VASI.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
v and vi	3/27/95	v	3/27/95
		vi	1/31/96
ix and x	3/27/95	ix and x	1/31/96
45 thru 48	3/27/95	45	3/27/95
		46	1/31/96
		47	1/31/96
		48	3/27/95
51 and 52	3/27/95	51	3/27/95
		52	1/31/96
61 and 62	3/27/95	61 and 62	1/31/96
63 and 64	3/27/95	63	1/31/96
		64	3/27/95
77 and 78	3/27/95	77	3/27/95
		78	1/31/96
83 and 84	3/27/95	83	3/27/95
		84	1/31/96
85 and 86	3/27/95	85 and 86	1/31/96
		86-1 and 86-2	1/31/96
95 and 96	3/27/95	95	3/27/95
		96	1/31/96

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-603

Initiated By: AOS-240

PAGE CONTROL CHART (CONTINUED)

Remove Pages	Dated	Insert Pages	Dated
		96-1 and 96-2	1/31/96
99 and 100	3/27/95	99	1/31/96
		100	3/27/95

David E. Campbell for
George W. Terrell
Program Director for Operational Support

FOREWORD

1. PURPOSE.

a. This handbook provides guidance and prescribes technical standards and tolerances, and procedures applicable to the maintenance and inspection of lighted navigational aids. It also provides information on special methods and techniques that will enable maintenance personnel to achieve optimum performance from the equipment. This information augments information available in instruction books and other handbooks, and complements Order 6000.15B, General Maintenance Handbook for Airway Facilities.

b. This revision implements Configuration Control Decision (CCD) N16975, Lighted Navigational Aid Handbook Revision to Optimize Preventive Maintenance.

2. DISTRIBUTION.
This Order is distributed to selected offices and services within Washington headquarters, the FAA Technical Center; the Mike Monroney Aeronautical Center; to branch level within regional Airway Facilities divisions; and to Airway Facilities sectors having the following facilities/ equipment: Lighting Facilities.

3. CANCELLATION.
Order 6850.5B, Maintenance of Lighted Navigational Aids, is canceled.

4. MAJOR CHANGES.
This revision removes obsolete technical material, changes the standards and tolerances, revises the periodic maintenance schedules, and reduces the performance check and maintenance task requirements.

5. MAINTENANCE AND MODIFICATION POLICY.

a. Order 6000.15B, this handbook, and the applicable equipment instruction book shall be consulted and used together by the maintenance technician in all duties and activities for the maintenance of lighted navigation aids. The three documents shall be considered collectively as the single official source of maintenance policy and direction authorized by the Program Director, Operational Support. References located in the chapters of this handbook entitled Standards and Tolerances, Periodic Maintenance, and Maintenance Procedures, shall indicate to the user whether this handbook and/or the equipment instruction book shall be consulted for a particular standard, key inspection element or performance parameter, performance check, maintenance task, or maintenance procedure.

b. Order 6032.1A, Modifications to Ground Facilities, Systems and Equipment in the National Airspace System, contains comprehensive policy and direction concerning the development, authorization, implementation, and recording of modifications to facilities, systems, and equipment in commissioned status. It supersedes all instructions published in earlier editions of maintenance technical handbooks and related directives.

6. FORMS LISTING.
In addition to the forms required by Order 6000.15B, FAA Form 6000-8, Technical Performance Record, Continuation or Temporary Record/Report Form, will be maintained for each facility. This form may be ordered in pads of 50 sheets on NSN 0052-00-686-0001.

7. RECOMMENDATIONS FOR IMPROVEMENT.
Preaddressed comment sheets are provided at the back of this handbook. Users are encouraged to submit recommendations for improvement.

James L. Hevelone
Acting Program Director for Operational Support

TABLE OF CONTENTS

Paragraph *Page*

Chapter 3. STANDARDS AND TOLERANCES

Section 1. APPROACH LIGHTING SYSTEMS

Section 2. VISUAL APPROACH SLOPE INDICATOR AND PRECISION APPROACH PATH INDICATOR

Paragraph *Page*

Section 1. PERFORMANCE CHECKS
Subsection I. ALSF CATEGORY-I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR)

Subsection 2. ALSF-2 CATEGORY-II AND III SYSTEMS AND ALSF-1 ON CATEGORY-II SYSTEMS

Subsection 3. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEM (MALS, MALSF, MALSR)

Subsection 4. ODALS AND LDIN

Subsection 5. VASI AND PAPI

Subsection 6. REIL

Paragraph Page

Subsection 7. OBSTRUCTION LIGHTS

Section 2. OTHER MAINTENANCE TASKS

Subsection 1. ALSE CATEGORY I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR)

Subsection 2. ALSF-2 CATEGORY-II AND -III SYSTEMS

Subsection 3. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEMS (MALS, MALSF, MALSR)

Subsection 4. ODALS AND LDIN

Paragraph *Page*

Subsection 4. ODALS AND LDIN (Continued)

Subsection 5. VASI AND PAPI

Subsection 6. REIL

Subsection 7. OBSTRUCTION LIGHTS

Subsection 8. HAZARD BEACONS

Chapter 5. MAINTENANCE PROCEDURES

Section 1. PERFORMANCE CHECK PROCEDURES

Paragraph Page

Subsection 1. HIGH-INTENSITY ALS SYSTEMS

Subsection 2. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEMS

Subsection 3. ODALS AND LDIN SYSTEMS

Subsection 4. VASI AND PAPI

Subsection 5. REIL

Paragraph		Page

Section 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

APPENDIX 1. CERTIFICATION REQUIREMENTS

APPENDIX 2. METRIC CONVERSIONS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figure *Page*

LIST OF ILLUSTRATIONS (Continued)

CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

1. OBJECTIVE.
This handbook provides the necessary guidance, to be used in conjunction with information available in instruction books and other handbooks, for the proper maintenance of lighted navigational aids.

2. SCOPE.
This handbook provides system-oriented maintenance information and establishes a maintenance program for all lighted navigational aids. The information provided covers the following systems, subsystems, or components:

a. High intensity approach lighting systems with sequenced flashers (ALSF-1 and ALSF-2).

b. Simplified, short approach lighting systems (SSALS) with flashers (SSALF) or with runway alignment indicator lights (SSALR).

c. Medium intensity approach lighting systems (MALS) with flashers (MALSF) or with runway alignment indicator lights (MALSR).

d. Visual approach slope indicator (VASI).

e. Precision approach path indicator (PAPI).

f. Lead-in light facility (LDIN).

g. Omnidirectional approach lighting system (ODALS).

h. Runway-end identification lights (REIL).

i. Omnidirectional runway end identifier lights (ODREIL).

j. Obstruction lights.

3. SAFETY.
In addition to the safety instructions found in Order 6000.15B, General Maintenance Handbook for Airway Facilities, special safety instructions are included throughout this handbook. Refer to advisory circulars AC 150/5210-5B, Painting, Marking and Lighting of Vehicles Used on an Airport; and AC 150/5340-1F, Marking of Paved Areas on Airports, for procedures for indicating temporary landing area hazards.

4. EMERGENCY STANDBY POWER.
Emergency standby power is furnished at MALSR, ALSF-1 and ALSF-2 installations located on designated continuous power airports. Equipment consists of van-mounted engine generators and switchgear adequate to furnish standby power to the facility. Engine generators are also furnished for ALSF-1 and ALSF-2 systems on category II and III runways. During category II and III weather conditions, when the approach lighting is required, the engine generator will be started and the approach lighting load will be placed on the engine generator; commercial power is then used as standby power. For additional details, refer to Order 6950.2C, Electrical Power Policy Implementation National Airspace System Facilities.

5. AIRCRAFT ACCIDENTS.
The following minimum actions are required of sector personnel after receiving information that an aircraft accident has occurred that might involve lighted navigational aid equipment for which they are responsible.

a. Before performing any corrective maintenance, make an as-found technical evaluation of the equipment or system, using the standards and tolerances in chapter 3 and the performance checks in chapter 4.

b. Consult Order 8020.11A, Aircraft Accident and Incident - Notification, Investigation, and Reporting. Record the results of the evaluation and all technical data involving key performance parameters on the Facility Maintenance Log, FAA Form 6030-1, or on the appropriate technical performance record form specified in paragraph 287 of this order.

c. Perform all required corrective maintenance, if any, after completion of the as-found evaluation. Record all changes on the facility log or on the technical performance record.

6. CERTIFICATION REQUIREMENTS.
Refer to Order 6000.15B, for general guidance on the certification of systems, subsystems, and equipment. Refer to appendix 1 of this handbook for the specific requirements applicable to the certification of lighted navigational aids equipment. The REIL is no longer a certifiable facility and has been deleted from appendix 1.

7.-9. RESERVED.

CHAPTER 2. TECHNICAL CHARACTERISTICS

10. PURPOSE.

The lighted navigational aids system is designed to provide visual ground contact, runway identification, and other guidance and hazard information to aircraft pilots. This chapter describes the approach lighting system (ALS), the visual approach slope indicator (VASI), the precision approach path indicator (PAPI) and miscellaneous lighted aids and controls. The approach lighting systems are particularly useful under adverse weather or other low visibility conditions. They provide assistance to the pilot in making the transition from instrument flight to visual flight on final approach. On a runway with an instrument landing system installed, the published approach minimums (ceiling and visibility) are automatically raised if the approach lights become inoperative. The visual approach slope indicator (VASI) and the precision approach path indicator (PAPI) provide the pilot of a landing aircraft with a visual indication of proper descent to a specified touchdown point during Visual Flight Rule (VFR) operations.

Section 1. VISUAL APPROACH AIDS

11. APPROACH LIGHTING SYSTEMS.

Approach lighting systems are installed symmetrically along an extended centerline of the runway with the lights facing in the direction of the approaching aircraft. The approach lighting system provides a ground reference aid for the pilot when making an approach to the runway, including lateral guidance or alignment to the runway, horizontal banking position of the aircraft with respect to the ground, impending touchdown position of the aircraft, and the threshold of the runway. The ideal installation of an approach lighting system is accomplished when the light units in the approach light plane are in a single horizontal plane at the elevation of the runway threshold centerline and no object protrudes above that plane. For approach light plane clearance purposes, all roads, highways, vehicle parking areas, and railroads are considered as vertical solid objects. Airport service roads controlled in a manner that will preclude a vehicle protruding above the light plane are not considered obstructions. There must be a clear line-of-sight to all lights of the system from any point on a surface, one-half degree below the instrument landing system (ILS) glide path and extending 250 feet each side of the centerline, up to 1600 feet in advance of the outer most light in the system. For specific clearance requirements, refer to Order 6850.2A, Visual Guidance Lighting Systems. A further aid for the pilot's visual approach to the runway is the high-intensity sequenced flasher lights (SFL) installed along the extended centerline of the runway. These high-intensity, bluish-white lights are flashed in sequence twice per second toward the runway threshold. The high-intensity sequenced flashing light emitted from the flasher produces an apparent motion toward the threshold. This enables pilots to quickly recognize the approach lighting system and orient themselves for the approach and touchdown. One such light is installed at each centerline bar starting 1000 feet from the threshold, to the end of the system, typically 2400 or 3000 feet from the threshold. The flashing lights appear as a ball of light traveling at approximately 4100 miles per hour. The flashing light assemblies are also used as the components for runway alignment indicator lights (RAIL), runway-end identifier lights (REIL), and lead-in light (LDIN) systems.

a. High Intensity Approach Lighting System with Sequenced Flashers, Category I (ALSF-1). The ALSF-1 consists of a series of centerline light bars each approximately 13 1/2 feet long with five equally spaced lights. The light bars are installed at 100-foot intervals, starting 300 feet from the threshold, and extending outward 2400 or 3000 feet from the threshold. The 2400-foot system is authorized by Order 6850.9, Revised Approach Light Criteria, when the glide slope angle is 2.75° or higher, while the 3000-foot system is authorized when the glide slope angle is less than 2.75°. All light bars are installed perpendicular to the extended runway centerline, and all lights are aimed away from the runway threshold. The centerline light bar at 1000 feet from the threshold is supplemented with eight additional lights on either side, forming a light bar of 100 feet and 21 lights. This bar is called the 1000-foot distance marker crossbar (or simply 1000-foot bar). All of the aforementioned lights are white. Another light bar 200 feet from the threshold is 50 feet long, contains 11 red lights, and is called the terminating bar. Two additional light bars, each containing five red lights, are located 100 feet from the threshold, one on either side of the centerline, and are called wing bars. The inner light (nearest to runway centerline) of each wing bar is located in line with the runway edge lights. A row of green lights on 5-foot centers is located near the threshold and extends across the runway threshold and outward to a distance of approximately 45 feet from the runway edge on either side of the runway. These lights are called the threshold bar. The ALSF-1 configuration is shown in figure 2-1. The intensity of the incandescent lamps can be adjusted for five brightness levels. The percent of maximum light on the various steps is as follows:

STEP	PERCENT OF MAXIMUM LIGHT
B-1	0.16
B-2	0.8
B-3	4.0
B-4	20.0
B-5	100.0

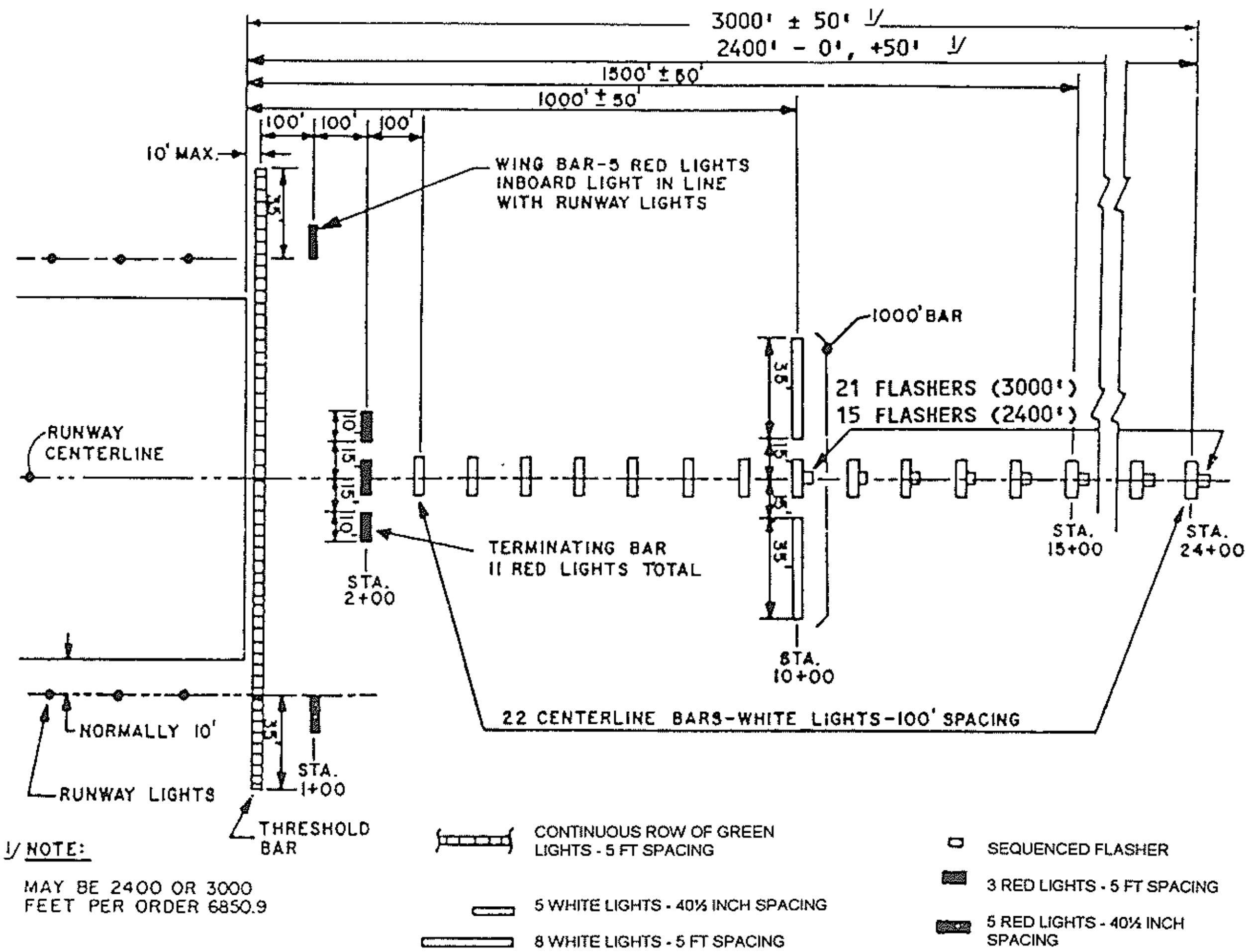


Figure 2-1. ALSF-1 Configuration

b. **High Intensity Approach Lighting System with Sequenced Flashers, Category II (ALSF-2).** The ALSF-2 differs from the ALSF-1 configuration only in the inner 1000 feet (nearest the threshold) of the system. The outer 1400 or 2000 feet of both systems are identical. The 2400-foot system is authorized by Order 6850.9 when the glide slope angle is 2.75° or higher while the 3000-foot system is authorized when the glide slope angle is less than 2.75°. The terminating bar and wing bars of the ALSF-1 configuration are replaced with centerline bars of five white lights each. In addition, there are light bars (three red lights each) on either side of the centerline bars at each light station in the inner 1000 feet. These are called side-row bars. Also, there is an additional bar 500 feet from the threshold. These lights form a cross bar referred to as the 500-foot bar. The ALSF-2 configuration is shown in figure 2-2.

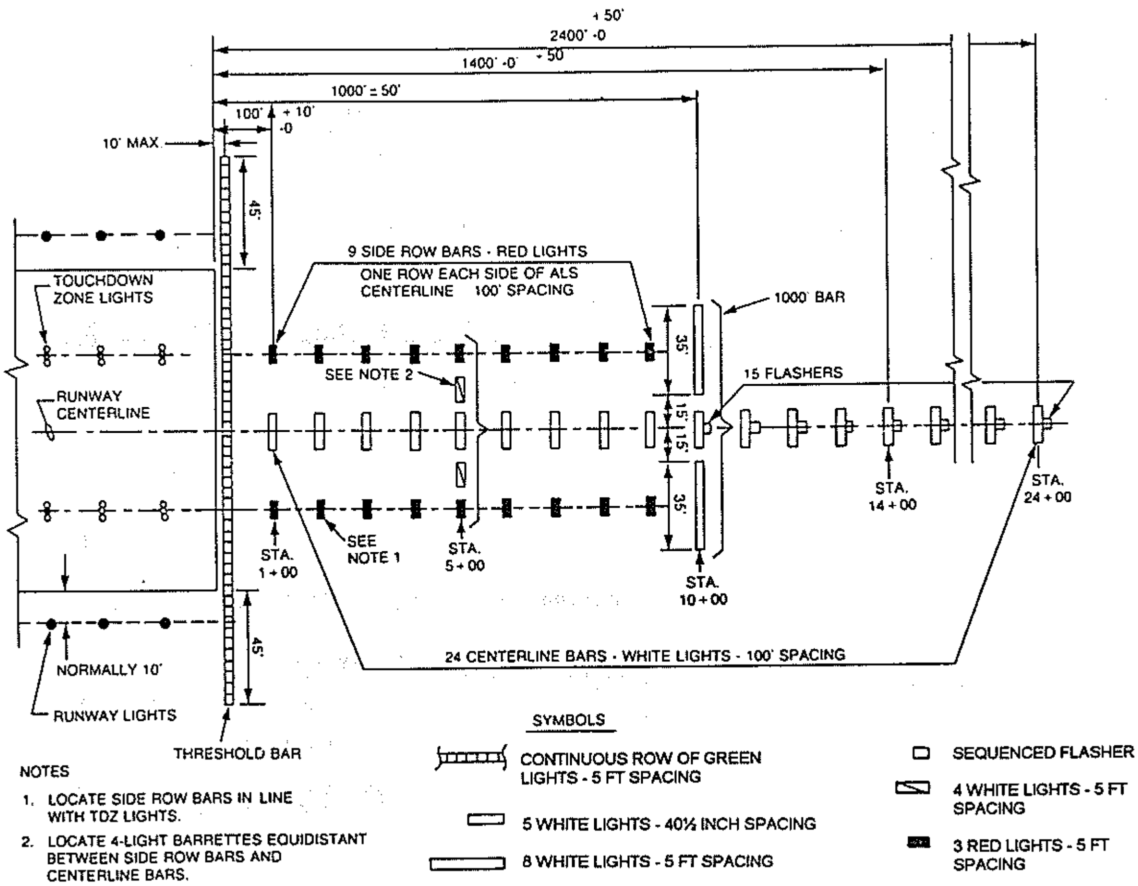


Figure 2-2. ALSF-2 Configuration

c. **Short Simplified Approach Lighting System (SSALS).** The SSALS consists of seven five-light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold. The threshold lights, where installed, will be a row of lights located coincident with and within the runway edge lights near the threshold and extend across the runway threshold. Two additional five-light bars are located one on each side of the centerline bar, 1000 feet from the runway threshold, forming a crossbar 70 feet long. All lights of the system are white except the threshold lights, which will have green filters installed. Only three brightness steps of approximately 100, 20, and 4 percent of maximum brightness are required. The system is a building block for the standard 2400 foot approach lighting system and uses standard ALS light-bar hardware. The SSALS configuration is shown in figure 2-3.

d. Short Simplified Approach Lights with Flashers (SSALF). The SSALF consists of a SSALS with three sequenced flashers that are located at the last three light bar stations. These flashers are added to the SSALS at locations where high ambient lighting, or other reasons, requires these lights to assist pilots in making an earlier identification of the system. These lights flash twice per second in sequence toward the threshold, have no intensity control, and operate on all brightness steps of the steady-burning lights. The SSALF configuration is shown in figure 2-3.

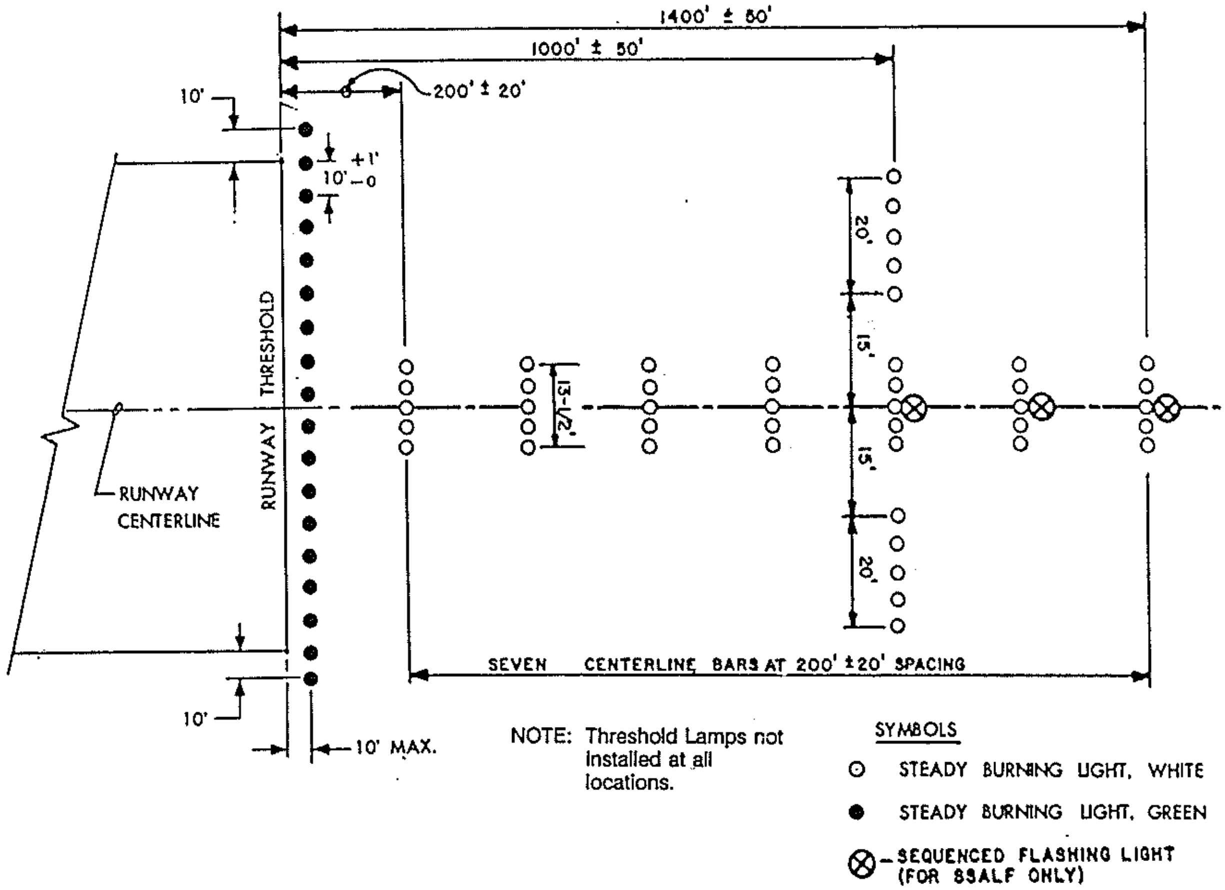


Figure 2-3. SSALS and SSALF Configuration

e. Short Simplified Approach Lighting with Runway Alignment Indicator Lights (SSALR). The SSALR configuration consists of a threshold bar and seven five-light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold. The remaining bars are located at 200-foot intervals out to 1400 feet from the threshold. Two additional five-light bars are located, one on each side of the centerline bar, 1000 feet from the runway threshold and form a crossbar 70 feet long. All lights in the system are white except for the threshold lights. The threshold lights have green filters. The threshold lights are a row of lights on 10-foot centers located coincident with and within the runway edge lights near the threshold and extends across the runway threshold. The runway alignment indicator lights (RAIL) portion of the facility consists of five sequenced flashers located on the extended runway centerline. The first flasher is located 200 feet beyond the approach end of the last steady-burning light bar, with successive flasher units at each 200-foot interval out to 2400 feet from the threshold. These flashing lights have three brightness levels and flash in sequence toward the threshold at a rate of twice per second. The SSALR configuration is shown in figure 2-4. This configuration is normally operated as a subsystem of the ALSF-2.

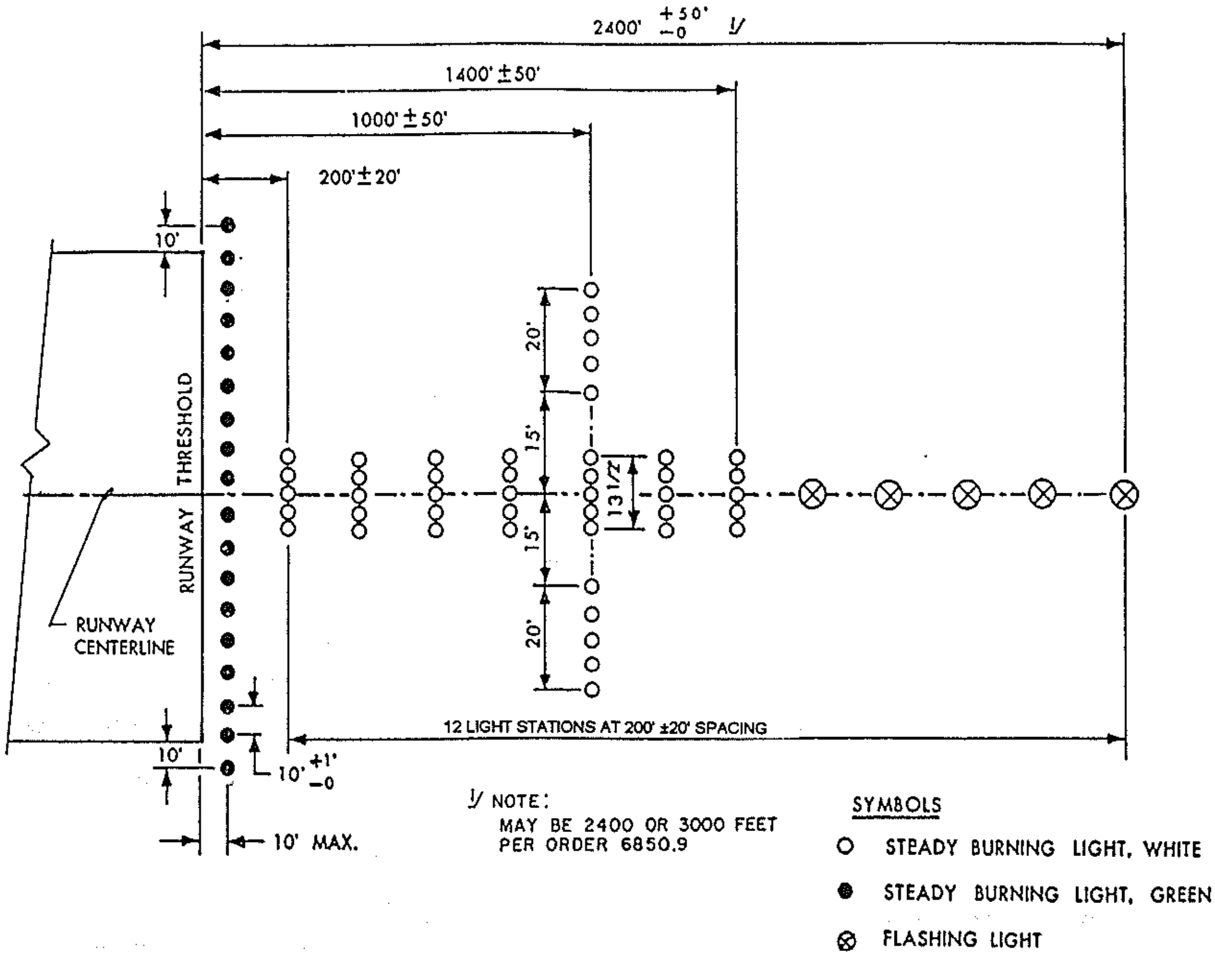


Figure 2-4. SSALR Configuration

f. Medium-Intensity Approach Lighting System (MALS). The MALS consists of a threshold light bar and seven five-light bars located on the extended runway centerline. The first bar is located 200 feet from the runway threshold and the remaining bars are located at each 200-foot interval out to 1400 feet from the threshold. Two additional five-light bars are located, one on each side of the centerline bar, 1000 feet from the runway threshold and form a crossbar 66 feet long. All lights are aimed into the approach to the runway and away from the runway threshold. All lights in the system are white, except for the threshold lights which have green filters. The threshold lights are a row of lights on 10-foot centers located coincident with and within the runway edge lights near the threshold and extends across the runway threshold. All lights in the system operate on three brightness steps at 100, 20, and 4 percent. The MALS is an economy-type system for nonprecision approaches. The MALS configuration is shown if figure 2-5.

g. Medium-Intensity Approach Lighting System with Sequenced Flashers (MALSF). The MALSF consists of a MALS with three sequenced flashers located at the last three light bar stations. These flashers are added to the MALS at locations where high ambient background lighting, or other reasoning, requires these lights to assist pilots in making an early identification of the system. These lights flash twice per second in sequence toward the runway threshold and operate on all three brightness steps of the steady burning lights. All lights are aimed into the approach to the runway and away from the runway threshold. The MALSF configuration is shown in figure 2-5.

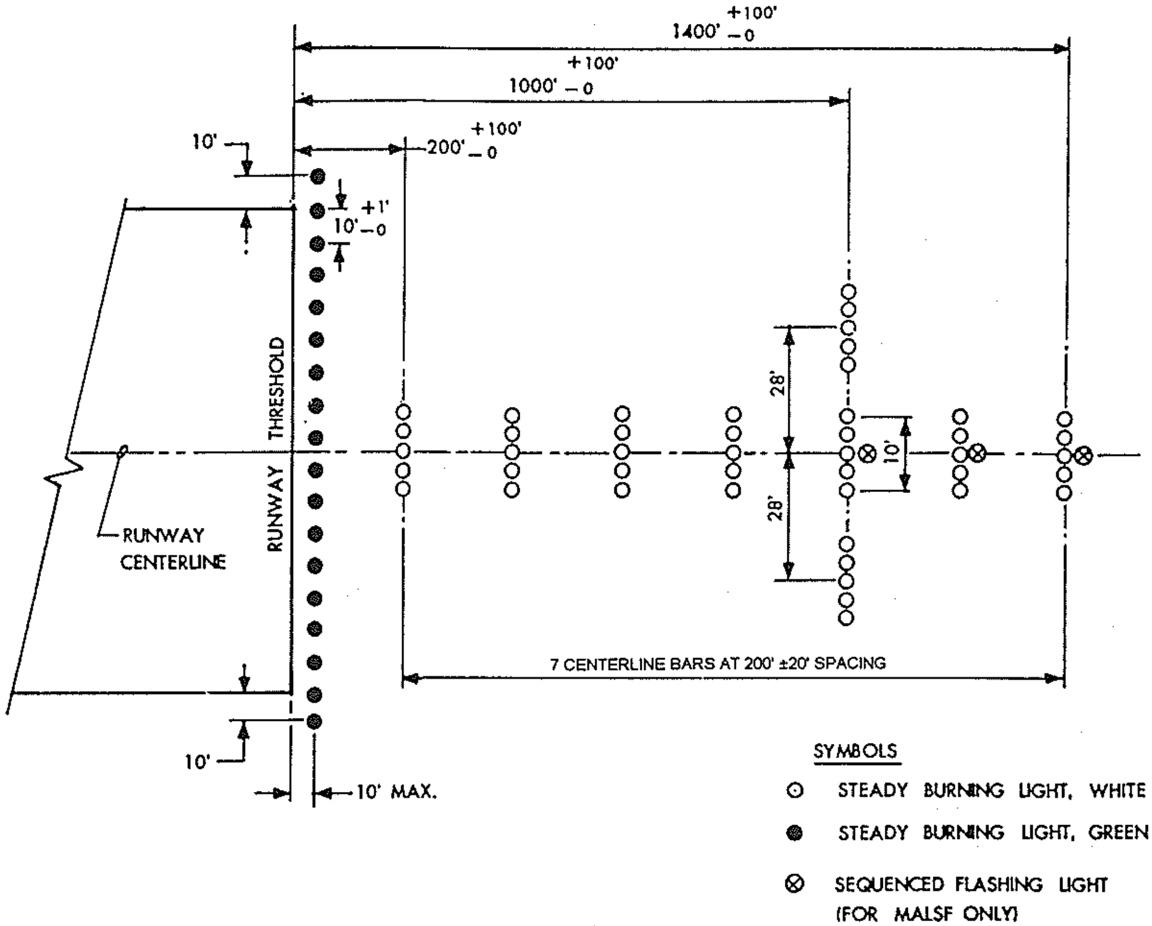


Figure 2-5. MALS and MALSF Configuration

h. Medium-Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). The MALSR consists of a MALS plus runway alignment indicator lights (RAIL). The RAIL portion of the system consists of five sequenced flashers located on the extended runway centerline. The first flasher is located 200 feet from the approach end of the MALS with successive units located at each 200-foot interval out to 2400 feet from the runway threshold. These lights flash in sequence toward the runway threshold at the rate of twice per second. All lights, both steady burning and flashers, operate on three brightness levels. The MALSR is used as the FAA standard for category I precision runways. The MALSR configuration is shown in figure 2-6.

i. Lead-In Light Facility (LDIN). The LDIN may be installed as a supplement to an approach lighting system. This portion of the facility consists of a number of sequenced flashing lights beginning at a distance from the threshold determined by the need and terrain. They are used primarily when background lighting or terrain prevents rapid Approach Lighting System or runway identification. These lights flash twice per second in sequence toward the approach lighting system or the runway threshold. An example of a LDIN configuration is shown in figure 2-7.

j. Omnidirectional Approach Lighting System (ODALS). The ODALS is an omnidirectional approach lighting system that provides circling, offset, and straight-in visual guidance for nonprecision approach runways. The ODALS consists of seven omnidirectional flashing lights located in the approach area of a nonprecision runway. Five of the lights are located on the extended runway centerline with the first light located 300 feet from the threshold and the other four located at equal intervals up to 1500 feet from the threshold. The other two lights are located, one on each side of the runway threshold, at a lateral distance of 40 feet from the runway edge, or 75 feet from the runway edge when installed on a runway equipped with a VASI. The five identical light units are visible from all directions and will flash in sequence toward the runway threshold, at a flash rate of one flash per second. The threshold is identified by the remaining two units, which will flash simultaneously at the end of the flash sequence. The system is designed for three brightness levels. Figure 2-8 shows the ODALS configuration.

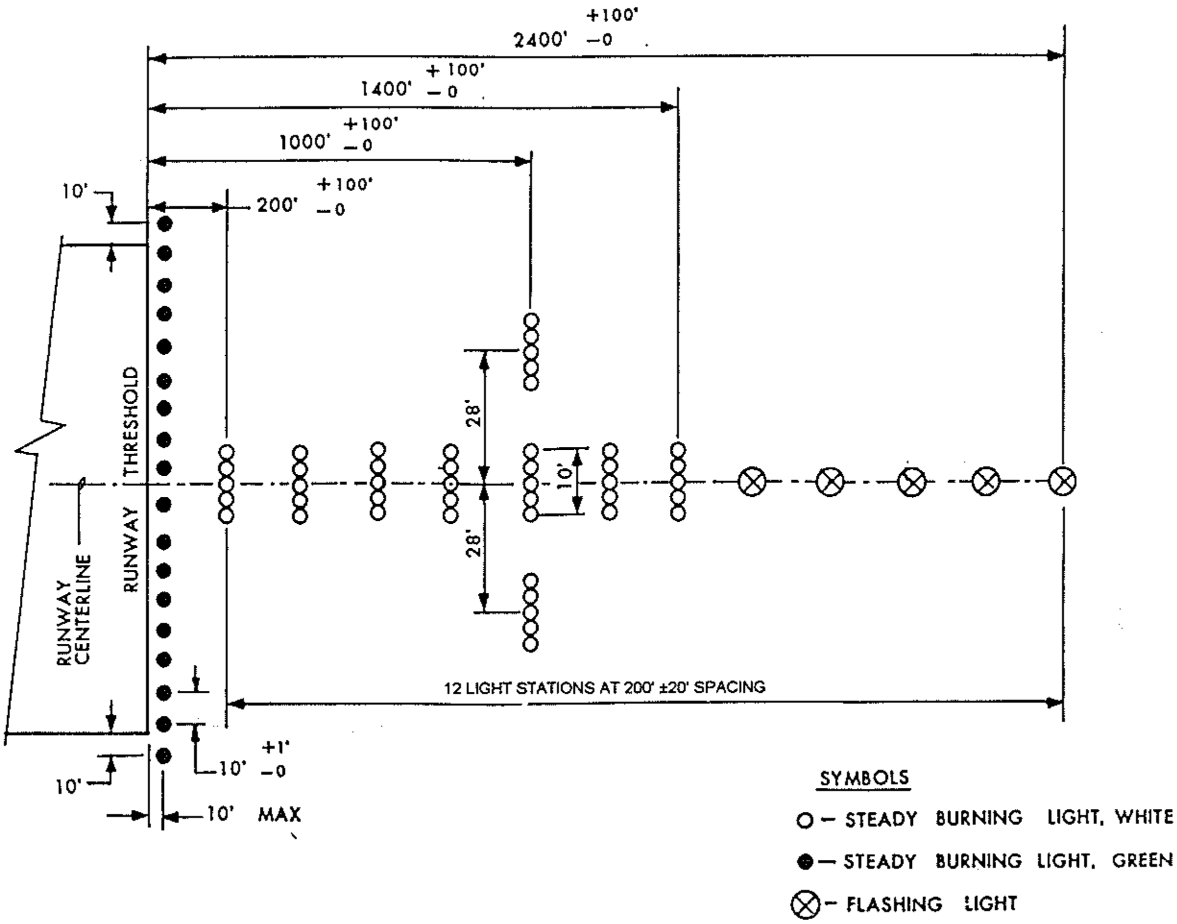


Figure 2-6. MALSR Configuration

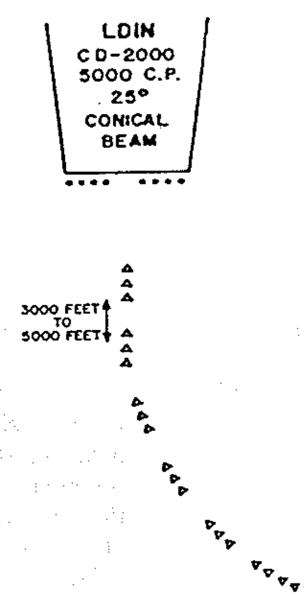


Figure 2-7. Lead-In Lights (LDIN)

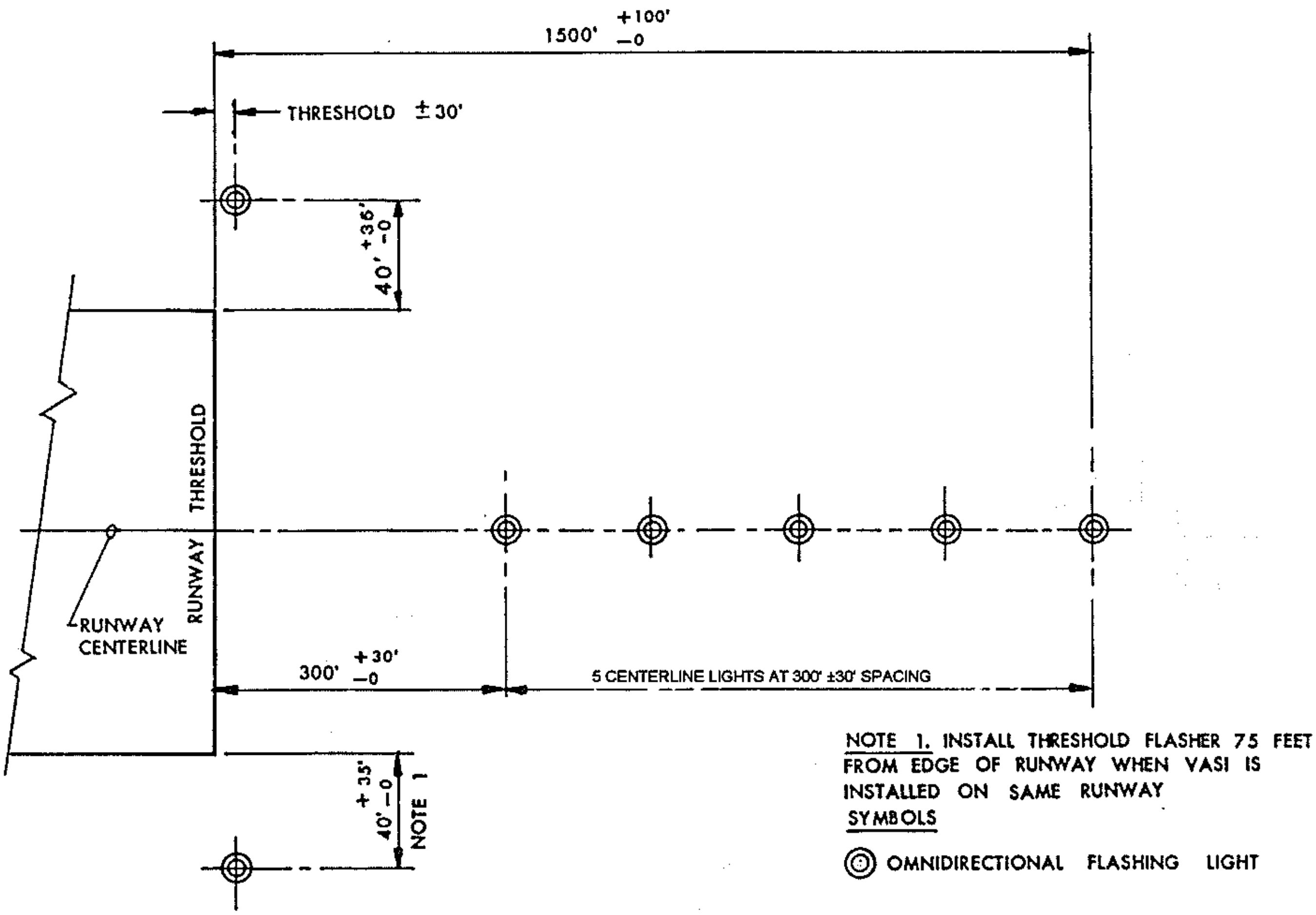


Figure 2-8. ODALS Configuration

12. HIGH INTENSITY APPROACH LIGHTING SYSTEMS.

a. Lamp Mountings. Approach Lighting Sytem lights are usually mounted on one of three types of mountings: a rigid mount, a frangible mount, or a semiflush mount. The type of mounting used depends upon the terrain and the location of the particular light bar within the system.

(1) Rigid-Mounted Lights. The rigid mountings were installed from the approach end of the approach lighting system (Station 24 or 30) up to the point at which frangible mountings are required. A typical installation of the rigid mountings is shown in figure 2-9. There are also other types of rigid structures used to mount the approach lighting system lighting bars. The type of rigid structure used depends upon the terrain. Rigid mounted lights shall not be installed in any new approach lighting systems.

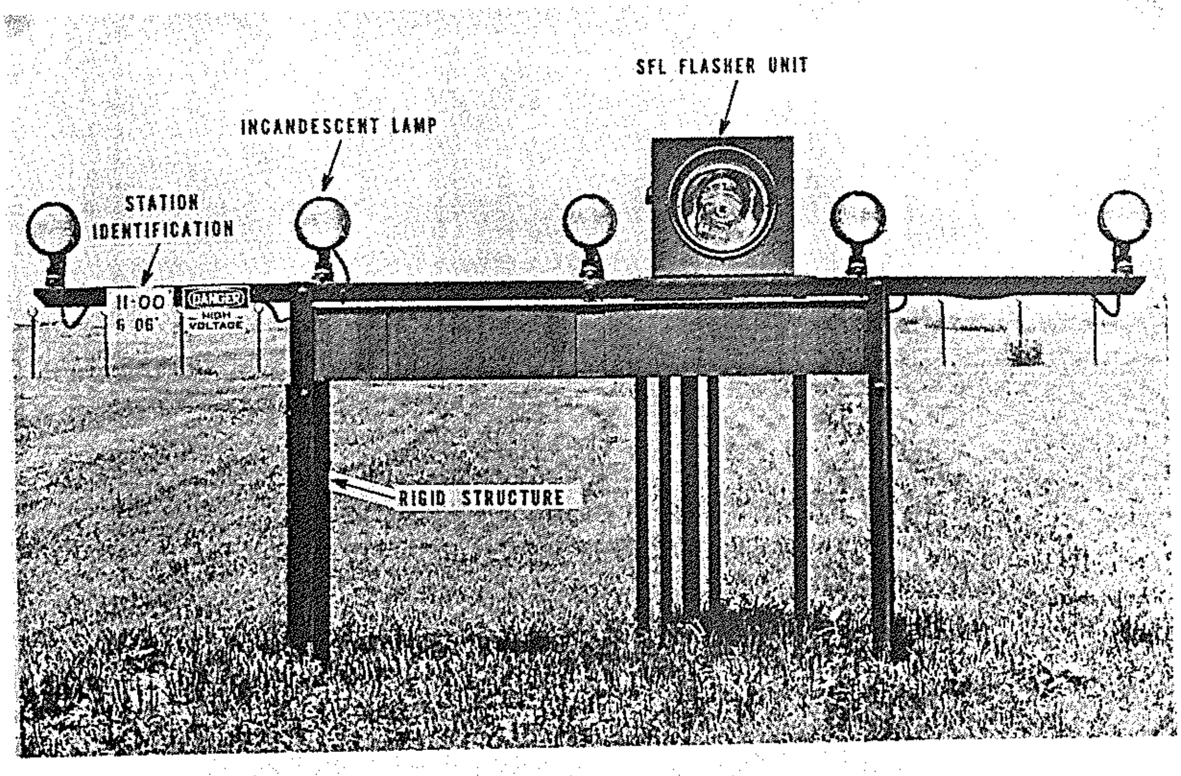


Figure 2-9. Rigid-Mounted Lights

(2) Frangible-Mounted Lights. The frangible lighting mounts, as shown in figure 2-10, are installed to reduce damage to an aircraft in the event of low approach or aircraft overrun. The overrun area is an area with frangible lights extending out from the runway threshold. This is the area where the aircraft may land short of the runway or overshoot the runway on a landing. The overrun length may extend up to 2000 feet. The frangible mounting is designed so that it will break loose from its mounting when a few pounds of pressure is applied to the unit. The break-away design is accomplished by installing a frangible coupling at the base of the mounting.

(3) Semiflush-Mounted Lights. Semiflush-mounted light units may be installed along the threshold bar out to the extended line of the runway lights. A typical semiflush-mounted light installation is shown in figure 2-11. The PAR-56/3 lamp assembly is mounted below the level of the ground in a container. The light from the lamp is directed upward toward a prism which refracts the light toward the approaching aircraft. The prism cover protrudes about 2 inches above the ground plane. The light from the fixed prism cannot be adjusted in the vertical plane like lights on frangible and rigid assemblies.

(4) Semiflush Lights. These lights are designed for installation in paved areas and do not extend more than 1 inch above the surrounding paved area. They are capable of "roll-over" by aircraft. Semiflush lights shall be used in displaced threshold areas or in overrun areas at military-civil joint-use airports when required by the military. They may also be used when crossing other runways and taxi-ways or where snow removal requires semiflush lights.

(5) Low-Impact Resistant Lights. Low-impact resistant lights shall be used at light bar stations having a ground level-to-approach light plane height from 6 to 40 feet. These lights are designed to present a minimum of mass, and to break when impacted. Only individual wire conductors shall be installed in these structures (multiwire cables are not acceptable).

(6) Semifrangible Lights. These lights are mounted on two-element structures: the lower element being a rigid structure and the upper element being a 20-foot, low-impact resistant structure. Semifrangible lights shall be used at light bar stations having a ground level-to-approach light plane height greater than 40 feet, and over water installations.

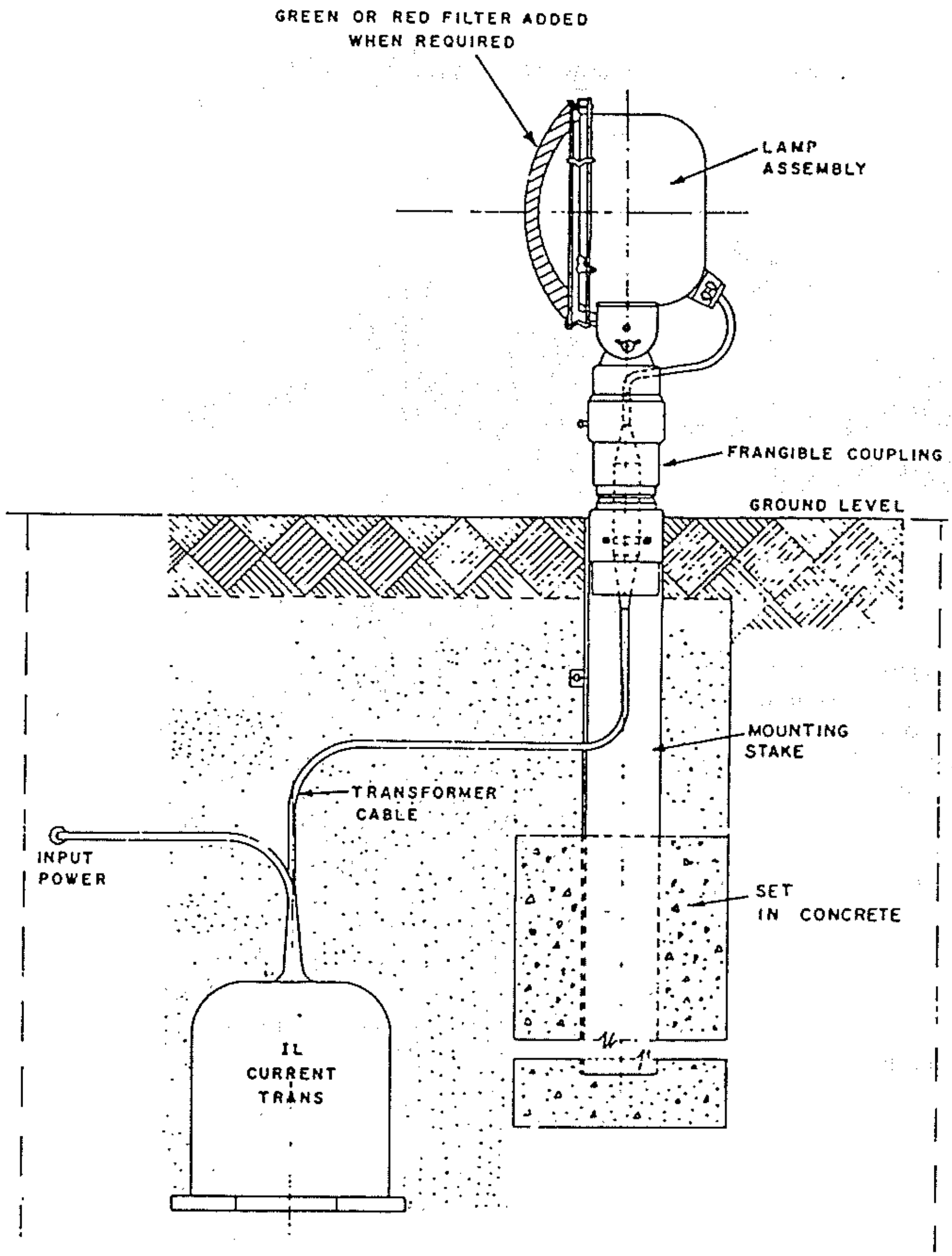


Figure 2-10. Frangible Lights

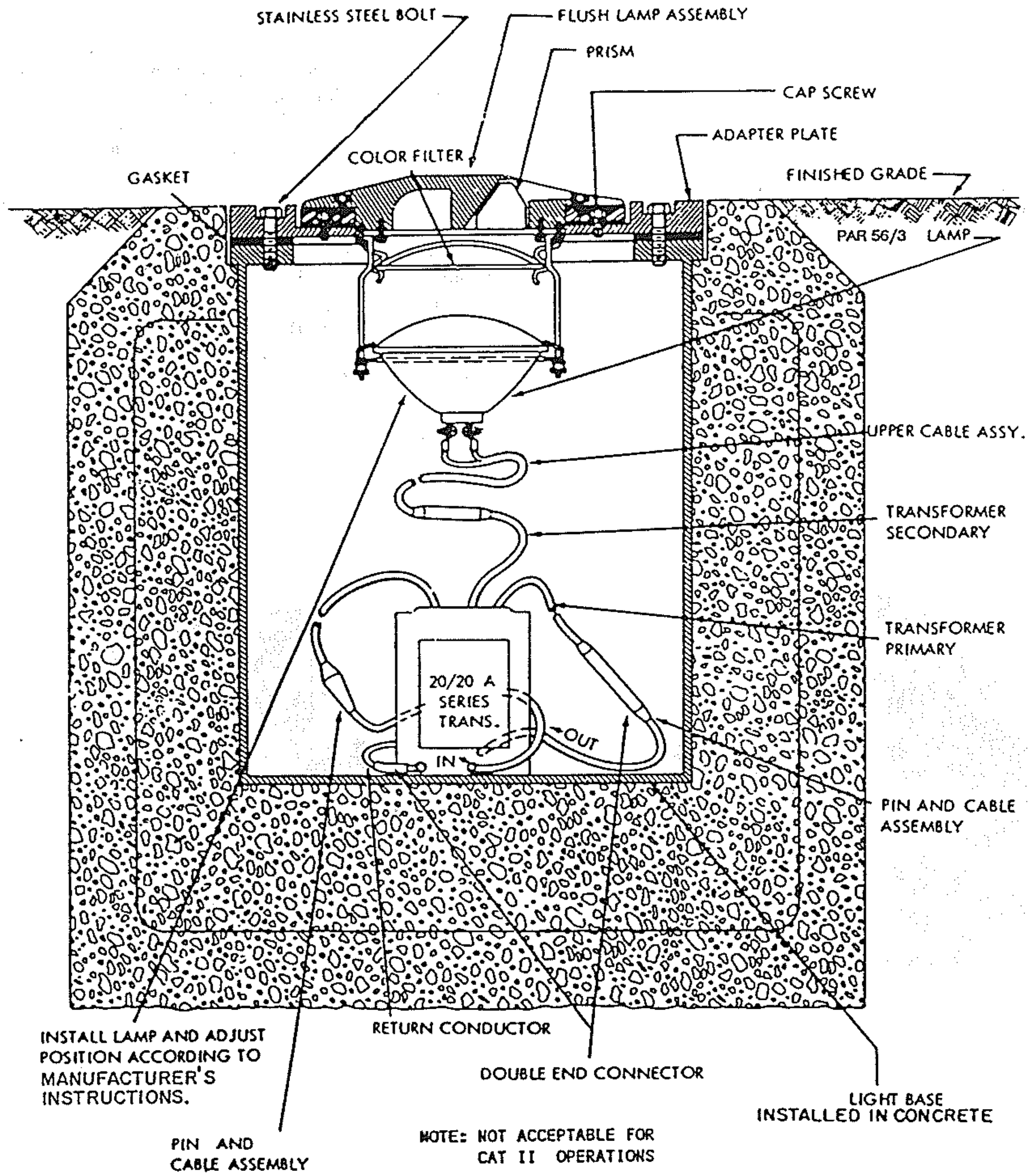


Figure 2-11. Typical ALS Flush Lamp Installation (LB-1 Light Base) (L-838)

b. Vertical Angle Setting of Approach Lighting System Incandescent Lamps. The incandescent lamps are beamed toward the aircraft at a vertical angle from the horizontal plane of the light bar. To get maximum benefit from the lights as a visual aid, the projected beam of light is set to intersect the glide slope 1600 feet ahead of the light, in the direction of the approaching aircraft. The vertical angle is adjusted by using one of several types of aiming devices. Figure 2-12 shows the type AD-1 aiming device that is used to adjust the vertical angle of the PAR-56 lamps. Figure 2-13 shows the No. 4611 aiming device used to adjust the vertical angle of the MALS PAR-38 lamps.

c. Horizontal Alignment of Approach Lighting System Lamps. All lamps must be maintained parallel to an extended centerline of the runway.

d. Approach Lighting System Crossbar Identification (Stations). In order to identify a crossbar at a particular location within the approach lighting system, a standard numbering system has been devised. Each crossbar location is called a station and is numbered from the threshold to the 3000-foot crossbar. The 3000-foot point is station 30 of the approach lighting system and is the location of flasher number one. For reporting purposes, however, the sequenced flashers may be identified by reference to the number of the approach light station on which they are installed. As shown in figure 2-9, the centerline crossbars have signs to identify a particular crossbar. The station identification in figure 2-9 identifies the crossbar as station 11, and it is located 1100 plus 00 feet (or 1100 feet) from the end of the runway. If the sign were marked 20 + 12, the crossbar would be station 20, located 2000 feet plus 12 feet (or 2012 feet) from end of runway. The degree and minute numbers identify the vertical elevation of the light beam from the incandescent lamps. As indicated, the vertical elevation angle of the light beam is 6°6'.

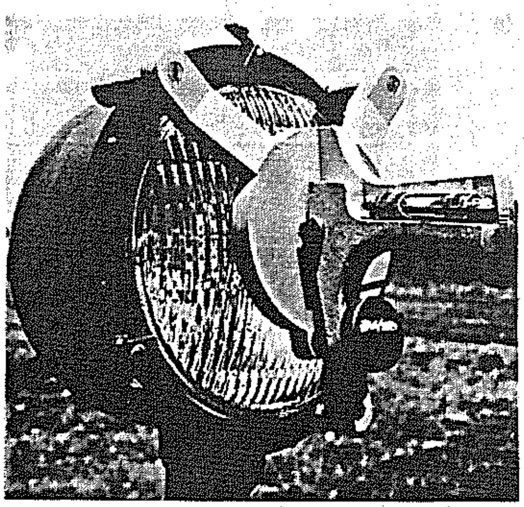


Figure 2-12. Type AD-1 Aiming Device for PAR-56

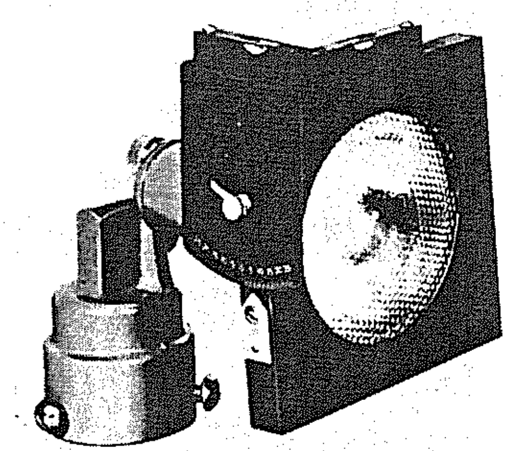


Figure 2-13. Number 4611 PAR-38 Aiming Device

e. Approach Lighting System Series Loop System Configuration. High-intensity approach lighting systems with sequenced flashers (ALSF-1, ALSF-2, etc.) contain, as an integral part, a constant current regulator which supplies selected current levels to a series loop. The lamps are connected in the series loop arrangement as illustrated in figure 2-14. Each lamp is isolated from the loop by a current transformer. The transformer has a current ratio of 1:1. The current transformer isolates the lamp so that when a lamp burns out (opens up), the series loop will not open and the selected current output of the regulator will continue to supply the remaining lamps. A high-intensity Approach Lighting System may have one, two, or three series loops depending on the light configuration and type of constant current regulator. The number of lights in the approach lighting system will vary from 45 lights in a SSALS without threshold lights to more than 275 for a ALSF-2. The exact number of lamps used depends on the width of the runway threshold and the length of the system. Generally, on systems with more than one loop, the lights are divided between loops so that each loop carries approximately the same load. A simplified series loop for a dual mode approach lighting system, shown in figure 2-15, will include both 300- and 500-watt individual lamp transformers for use on fixtures below 6 feet in height. All fixtures that require a colored filter will require 500-watt lamps. For fixtures above 6 feet in height, 1500-watt multiple light transformers will be used. For example, five 300-watt lamps for centerline bars or three 500-watt lamps for side row bars, can be operated in series across the secondary of a 1500-watt transformer. To provide continuity in the event of a lamp failure, each lamp must have a shorting device. The lamps-out monitor responds to the voltage change that results from a decrease in impedance with a lamp failure. For proper monitor indications, all lamps in the system must have a shorting device.

f. ALS Monitors.

(1) 155/175KVA Substations (General Electric, Westinghouse, Hollingsworth, Hevi-Duty).

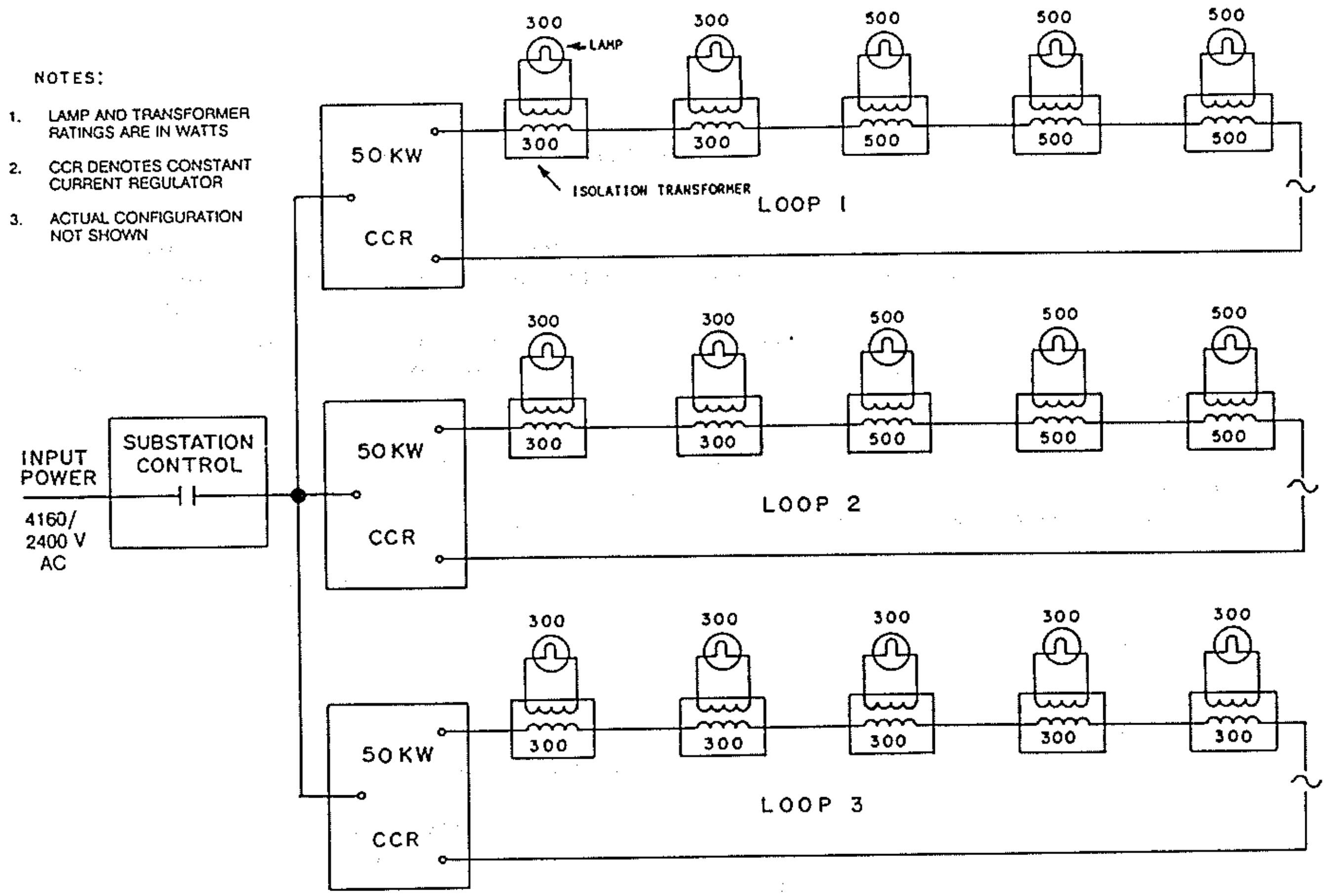


Figure 2-14. Simplified Constant Current Series Loop

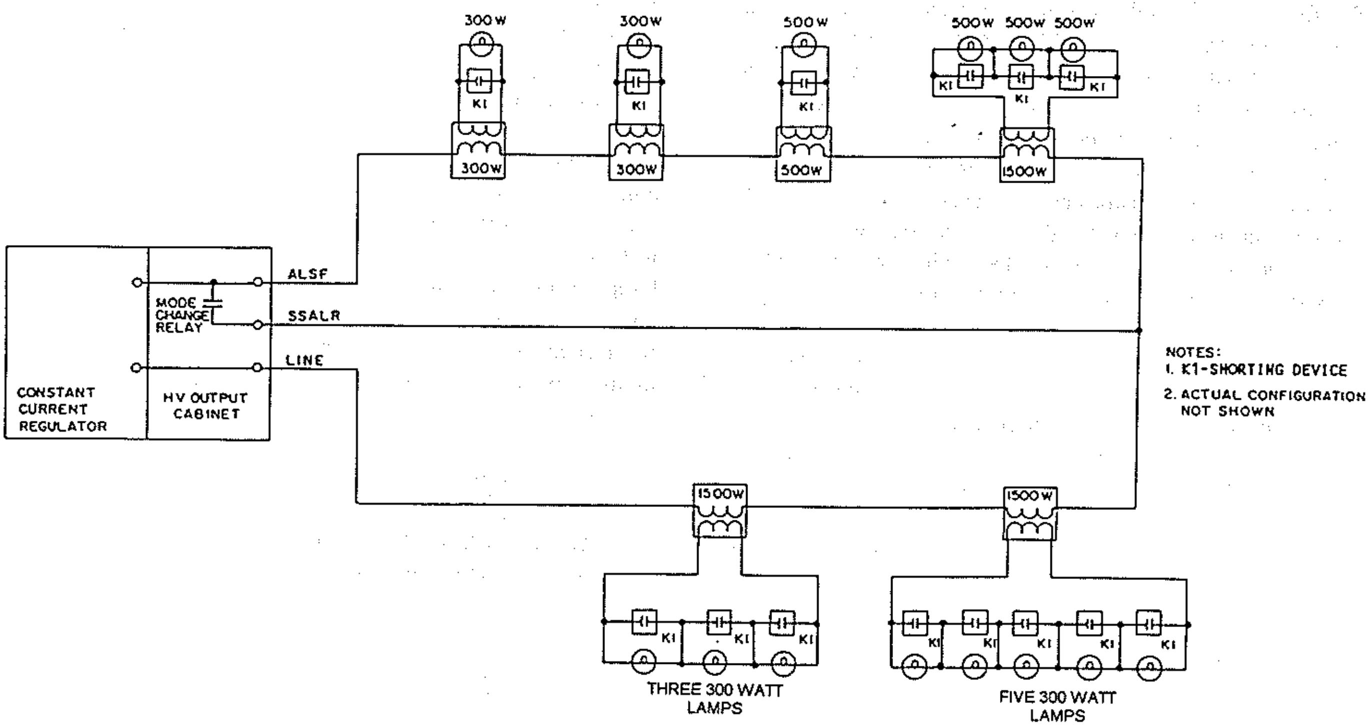


Figure 2-15. Simplified Dual Mode Constant Current Series Loop

(a) Load Monitor. The load monitor provides local and remote alarms when a predetermined number of lamps in a light loop have burned out. It is normally adjusted to warn the tower controllers of a six-lamps-out condition on one or more of the series light loops while the system is operating on brightness step 5.

(b) Protective Monitor. The protective circuits monitor the output voltage and current to provide both equipment protection and remote alarms if there is a system failure. If the loop voltage becomes excessively high, as a result of the constant current regulator trying to force current through an open circuit (open series loop), the substation shuts down and the remote panel receives an alarm. If the loop voltage becomes low as a result of a shorted loop, the substation may or may not shut down but the remote panel will receive a failure alarm.

(2) Dual Mode ALS (Godfrey FA-9993, Airflo FA-10048).

(a) Load Monitor. The load monitor provides the operator with either a caution or a failure alarm if more than the specified number of lamps fail in a prescribed brightness level. A caution alarm is an indication that the that the system meets minimum requirements for certification. A failure alarm indicates that the system may not meet certification requirements. When operating in the following configurations, the results are:

1 SSALR. Two lamps out in a loop result in a caution alarm. Three lamps out in a loop result in a failure alarm.

2 ALSF-2. Five lamps out in a loop result in a caution alarm, six lamps out in a loop result in a failure alarm.

(b) Protective Monitor. Other than normal fusing, each regulator will monitor the input voltage, the output loop voltage, and the loop current. The protective circuits will deenergize the affected regulator and will provide a remote alarm to the tower if an overcurrent is detected in a series loop (defective current regulator), if the output voltage to a loop becomes excessively high (open series loop), or if the input voltage drops below the regulator design level.

g. **High-Intensity Lamps.** The lamps used for the high-intensity approach lighting system are sealed beam incandescent lamps. They are rated at either 300 or 500 watts when operated at 20 amperes (high brightness). The lamps are quartz-halogen, with a tungsten filament. The quartz-halogen lamps are normally scheduled to be replaced after 400 hours of operation on high intensity. The 300-watt lamps are constructed in two different styles, PAR-56 and PAR-56/2. The PAR-56 lamp has a plug-in base with a fluted face and is used for the aboveground fixtures. The PAR-56/2 has a terminal type base with a clear face and is used in flush mounted fixtures, figure 2-11. The 500-watt lamps are also available in two styles: the PAR-56/1 with a plug in base for use in aboveground fixtures, and the PAR-56/3 with a screw terminal base for use in flush mounted fixtures. The intensity of the incandescent lamps can be adjusted for five brightness levels. The current and percent of maximum light on the various steps are as follows:

Step	Current (Amperes)	Percent of Maximum Light
B-1	8.3	0.16
B-2	9.9	0.8
B-3	12.1	4.0
B-4	15.3	20.0
B-5	20.0	100.0

h. **Medium Intensity Approach Lighting System.** The circuitry for a typical medium intensity Approach Lighting System with runway alignment indicator lights (MALSR) is shown in figure 2-16. The steady-burning light portion of the system is the same for a MALS or MALSF. The system is typically composed of a 15 kVA tapped power transformer and associated control circuitry that feeds parallel connected 120-watt or 150-watt, 120 V PAR-38 spot lamps in all fixtures except the threshold. The threshold lights use 300-watt, 120 V PAR-56 lamps behind a green filter. Both the steady-burning and flashing lights operate on three intensity levels. Intensity of the steady-burning lights is regulated by providing three voltage steps from the power transformer. Contactors in the control cabinet supply 120 or 240 volts from the input power source to several taps on the primary of the power transformer. This provides secondary power at any one of the following three voltage levels for the steady-burning lights:

Low	50 volts
Medium	75 volts
High	120 volts

The PAR-38 lamps are connected in parallel across the output of the power transformer as shown in figure 2-17. Half the lamps are connected to each output leg to balance the load on the transformer.

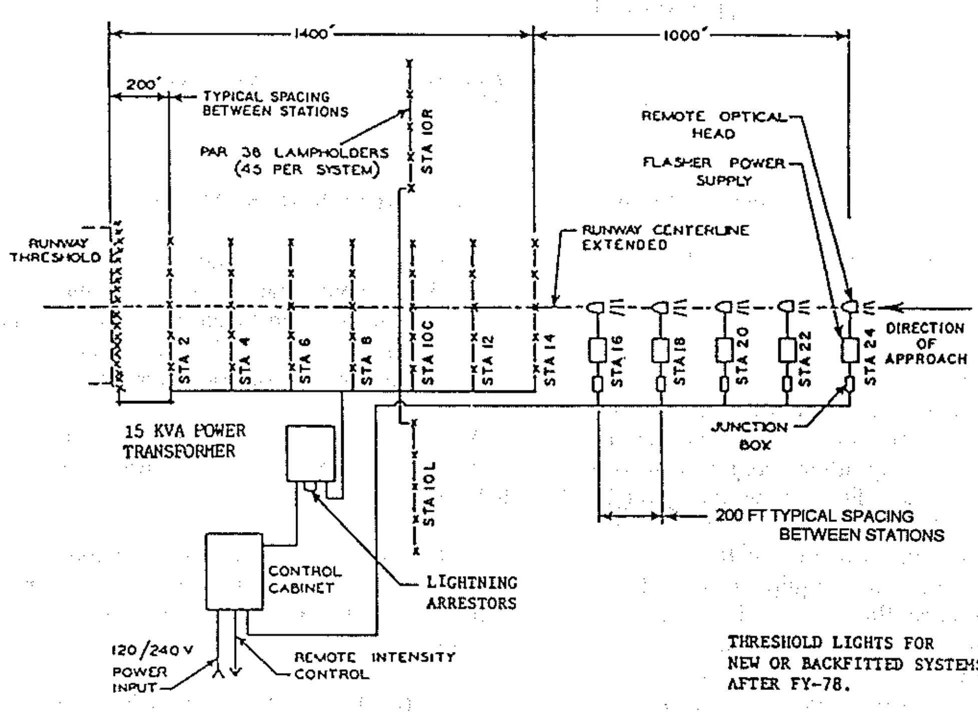


Figure 2-16. Typical MALSR (Constant Voltage System) Installation

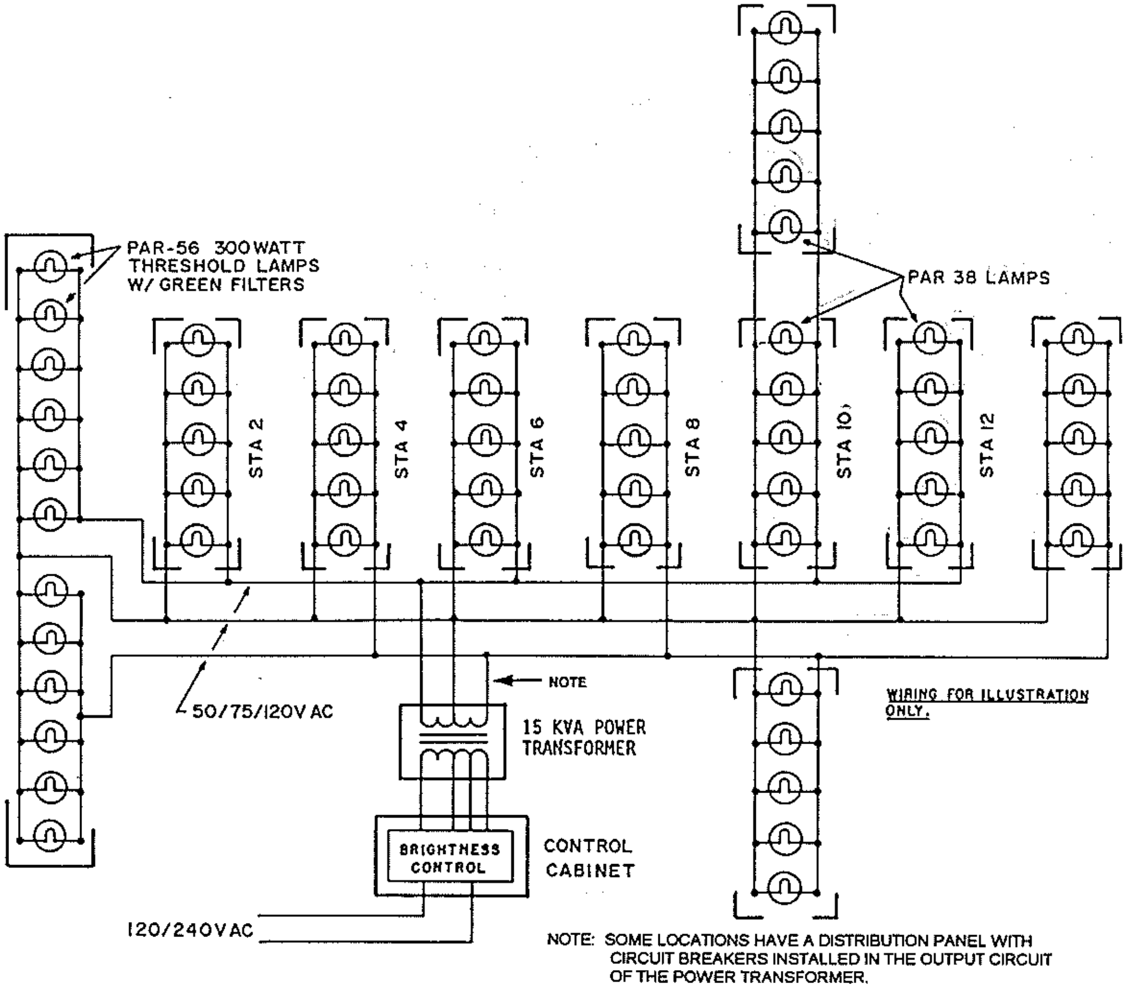


Figure 2-17. Medium Intensity Approach Lighting System (MALS)

13. RUNWAY-END IDENTIFIER LIGHTING (REIL) SYSTEM.

a. Configuration. The REIL system consists of two flashing lamp assemblies and associated power and control equipment. The system (shown in figure 2-18) is installed at the approach end of the runway and operates on power provided by either a commercial power source or the run-way edge lighting circuit through a REIL power adapter. The lamps flash simultaneously at 120 flashes per minute and have one or three intensity steps. Some REIL units are equipped with baffles installed in front of each flasher (see figure 2-19) to prevent a pilot from looking directly into the high-intensity lights as the aircraft approaches the runway. The runway end may also be identified with an omni-directional REIL (ODREIL). These lights flash simultaneously at 60 flashes per minute and are visible from all directions. The ODREIL configuration is the same as the REIL configuration shown in figure 2-18, except the light units are both installed plumb and the aiming line is omnidirectional. The ODREIL system utilizes standard ODALS flasher and control equipment.

b. Control. The REIL may be controlled from a remote location or controlled through activation of the runway-edge lighting.

(1) Control From Remote Locations. Remote control, where provided, is by landlines or radio control. Remote control may be installed where any of the following conditions exist. A waiver is not required.

(a) Closely spaced, parallel, staggered runways.

(b) Closely spaced, parallel runways.

(c) Diverging runways where approach ends are close to each other.

(d) Runways with displaced thresholds.

(e) Where environmental considerations such as snow and fog prevail.

(f) Where REIL's are installed on both ends of the same runway.

(2) Control From Runway-Edge Lighting Circuit. On-off and brightness control is accomplished by sensing the runway lighting circuit. The sensors change the brightness in conjunction with runway lighting brightness as follows:

Table 2-1. REIL INTENSITY CONTROL

Runway Edge Lighting			
Type	*Intensity Step*		*REIL Intensity*
LIRL	On	(Single-Intensity)	On (High)
MIRL	Low Med High	(Three-Intensity)	Low Med High
HIRL	1 & 2 3 4 & 5	(Five-Intensity)	Low Med High

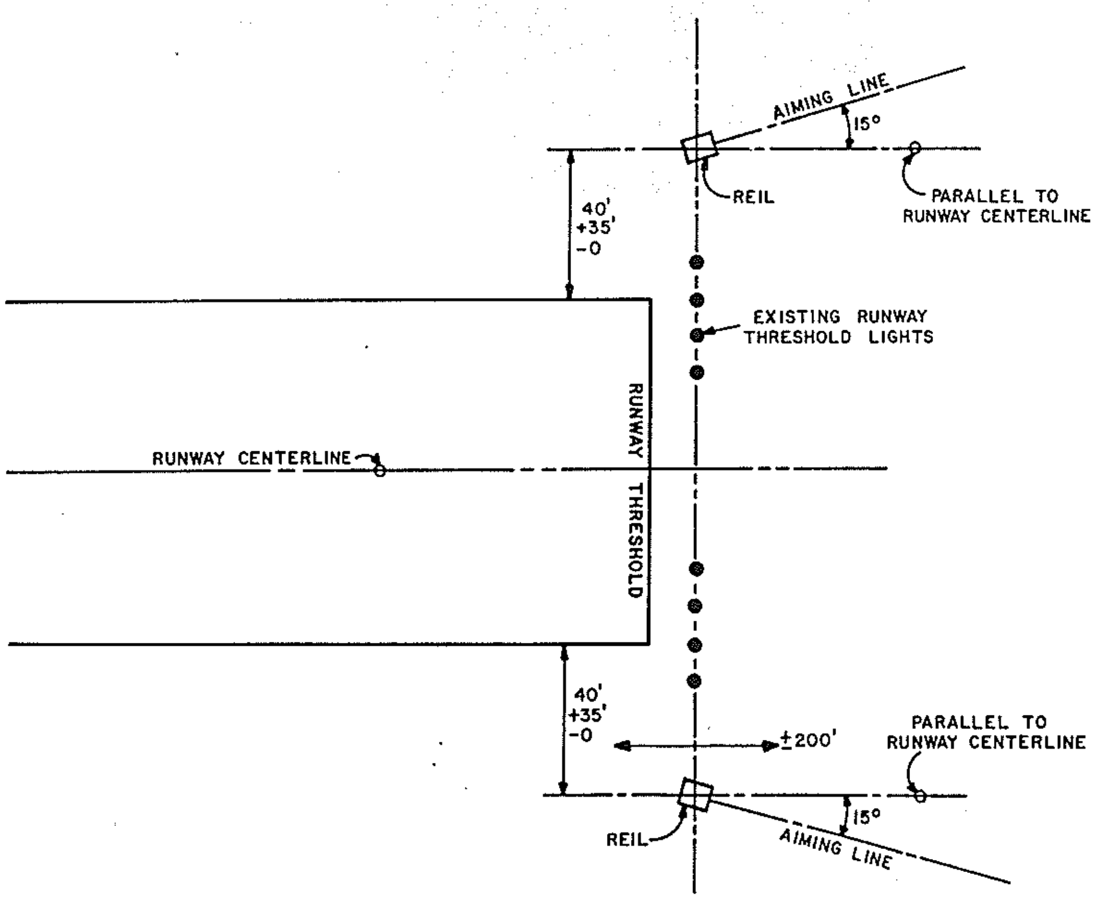


Figure 2-18. REIL Configuration

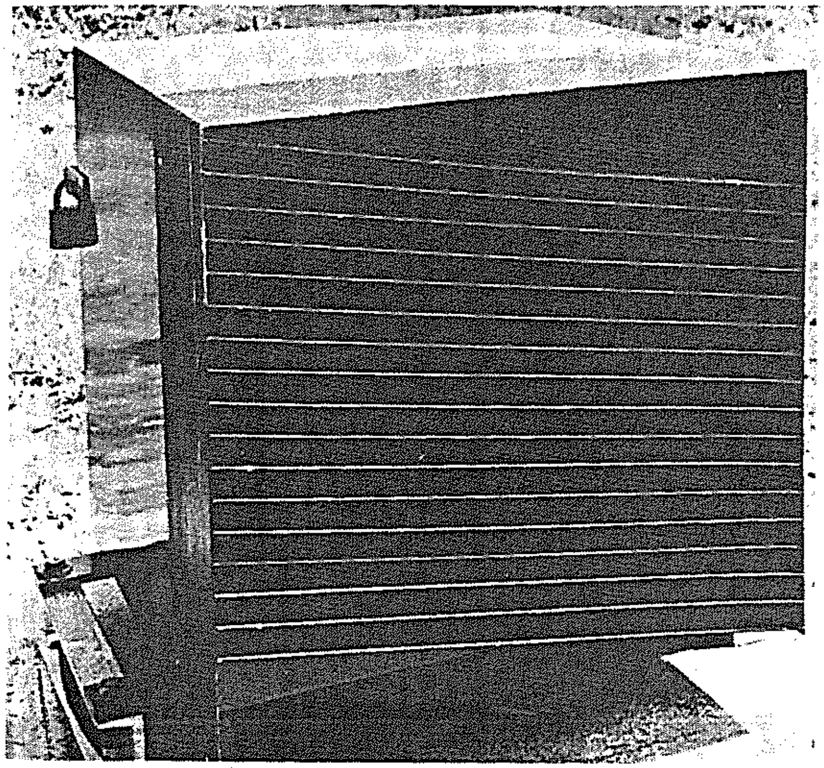


Figure 2-19. REIL Unit With Baffles

14. VISUAL APPROACH SLOPE INDICATOR (VASI) AND PRECISION APPROACH PATH INDICATOR (PAPI) SYSTEMS.

a. VASI System. The VASI system is a lighting facility that provides the pilot with a visual glide slope to descend to a touchdown point on the runway during visual flight rule (VFR) operations. The system is a valuable aid for defining a safe approach slope clearance over obstructions that cannot be lighted. Refer to Order 6850.2A, Visual Guidance Lighting Systems, for specific obstruction clearance requirements. The system further provides valuable aiming point information that reduces the possibility of aircraft undershoots or overshoots. The VASI may be installed on the back and front courses of an Instrument Landing System (ILS) or on airports where no ILS system exists.

(1) General. To provide the pilot with a visual descent glide angle, the VASI system uses a two-colored (red and white) light system. By observing the combination of these lights, it is possible to identify a visual glide angle for descent to the touchdown area of the runway. To provide rapid identification during daylight hours, the VASI is operated at maximum light intensity. During nighttime operation, the intensity is reduced to diminish the blinding effect and still provide maximum system identification. The VASI sighting diagram is illustrated in figure 2-20. The alignment of the glide slope corridor as shown in figure 2-21, is accomplished by the vertical adjustment of two light bars, each of which emits a white and a red light. If the aircraft is on the glide path angle, the pilot will see a combination of a red and white light, that is, the upwind bar light will be red and the downwind bar light will be white. If the aircraft is above the glide angle, both light bars will be white; and if the aircraft is below the glide angle, both light bars will be red. The light bar will appear pink at an angle of about 0.25 above and below the glide angle. At this angle, a transition is made from a red to a white or a white to a red light.

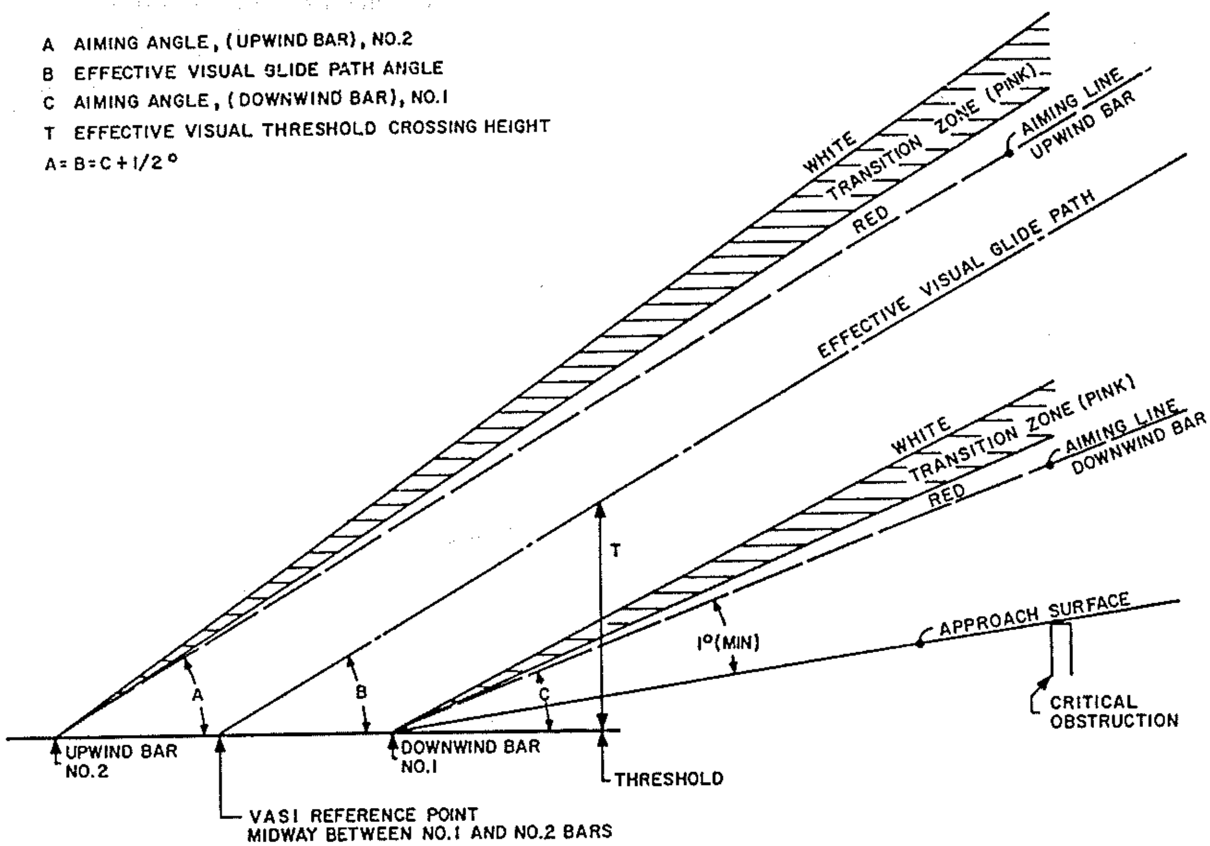


Figure 2-20. VASI Sighting Diagram

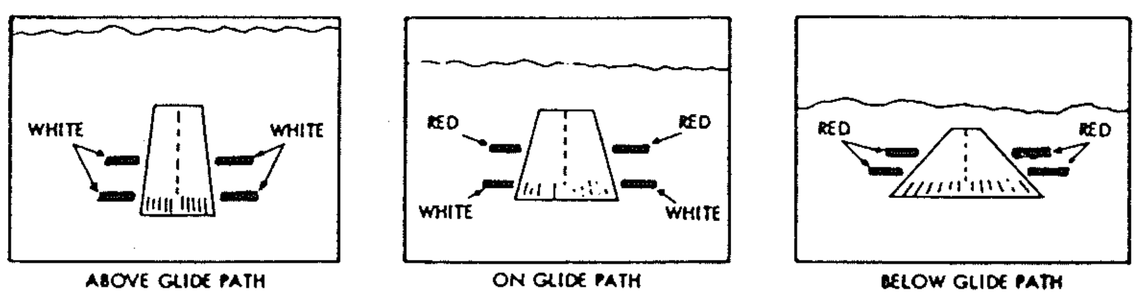


Figure 2-21. VASI Visual Presentation

(2) Two-Box VASI System (VASI-2). Figure 2-22 is a sketch of a two-box system. The VASI-2 is installed with one box at the upwind bar location and one box at the downwind bar location. Both boxes are normally installed on the left side of the runway when viewed from the approach direction. The system may be installed on the right side of the runway when airport paved surfaces prevent the normal left side installation or when significant cost reductions can be realized. The two-box system provides guidance information under daytime VFR conditions, up to 3 nautical miles. It provides the minimum boldness of signal required for daytime operations for nonjet aircraft. VASI-2 lamp housing assemblies shall have a tilt switch in each lamp housing assembly. The tilt switch shall shut the system "off" when tilted.

NOTES: 1. AT INSTALLATIONS INSTALLED IN ACCORDANCE WITH VISUAL GUIDANCE LIGHTING SYSTEM STANDARD DRAWING D-6127-1A, JANUARY 19, 1977, MEASURE THIS DIMENSION TO THE CENTERLINE OF THE INBOARD UNIT.

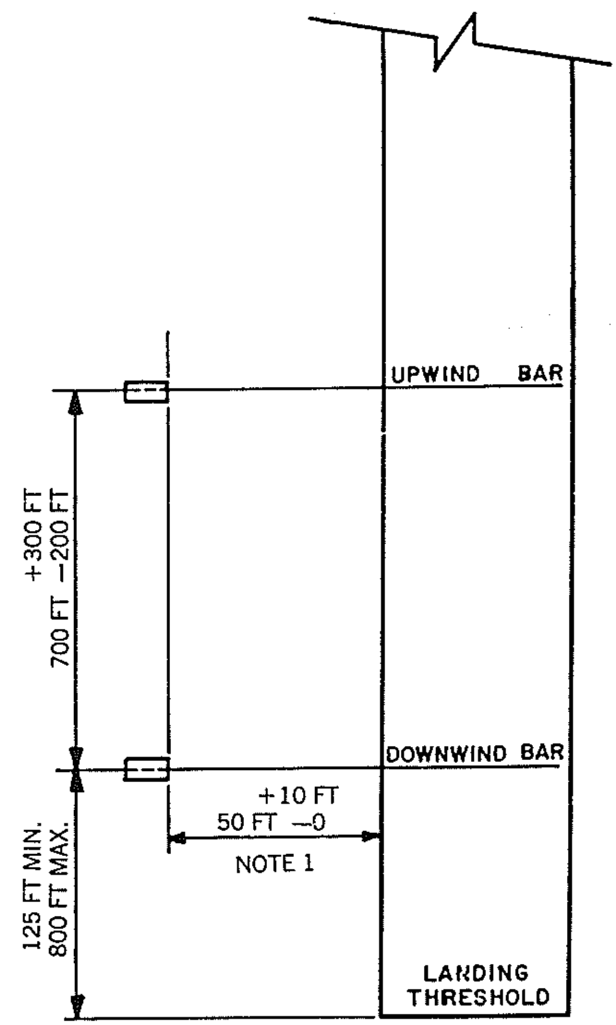


Figure 2-22. VASI-2, Two-Box VASI

(3) Four-Box VASI System (VASI-4). The VASI-4 is the standard FAA system. Figure 2-23 is a sketch of a four-box system. This system is normally installed with all boxes located on the left side of the runway when viewed from the approach direction. Two boxes are installed at the upwind bar location and two boxes are at the downwind bar location. The system may be installed on the right side of the runway when the same conditions exist as described in the two-box system above. It provides adequate guidance information under daytime VFR conditions, up to 4 nautical miles.

(4) Six-Box VASI System (VASI-6). The VASI-6 consists of six light units in a three-bar configuration and is a special FAA system which accommodates long bodied aircraft. Figure 2-24 illustrates the layout of a six-box VASI system.

(5) Twelve-Box VASI System (VASI-12). The VASI-12, figure 2-25, consists of 12 light units in a two-bar configuration. It is the international standard. It is symmetrically installed with three boxes located on each side of the runway at the upwind bar location and three boxes located on each side of the runway at the downwind bar location. The 12-box system provides the maximum boldness of signal and aiming point guidance under daytime VFR conditions, up to 5 nautical miles for all types of aircraft. It provides maximum attraction and identification when installed at airports having a very complex systems of runways and taxiways.

(6) Sixteen-Box VASI System (VASI-16). The VASI-16, figure 2-26, consists of 16 light units in a three-bar configuration. It is a special design to accommodate the long bodied aircraft.

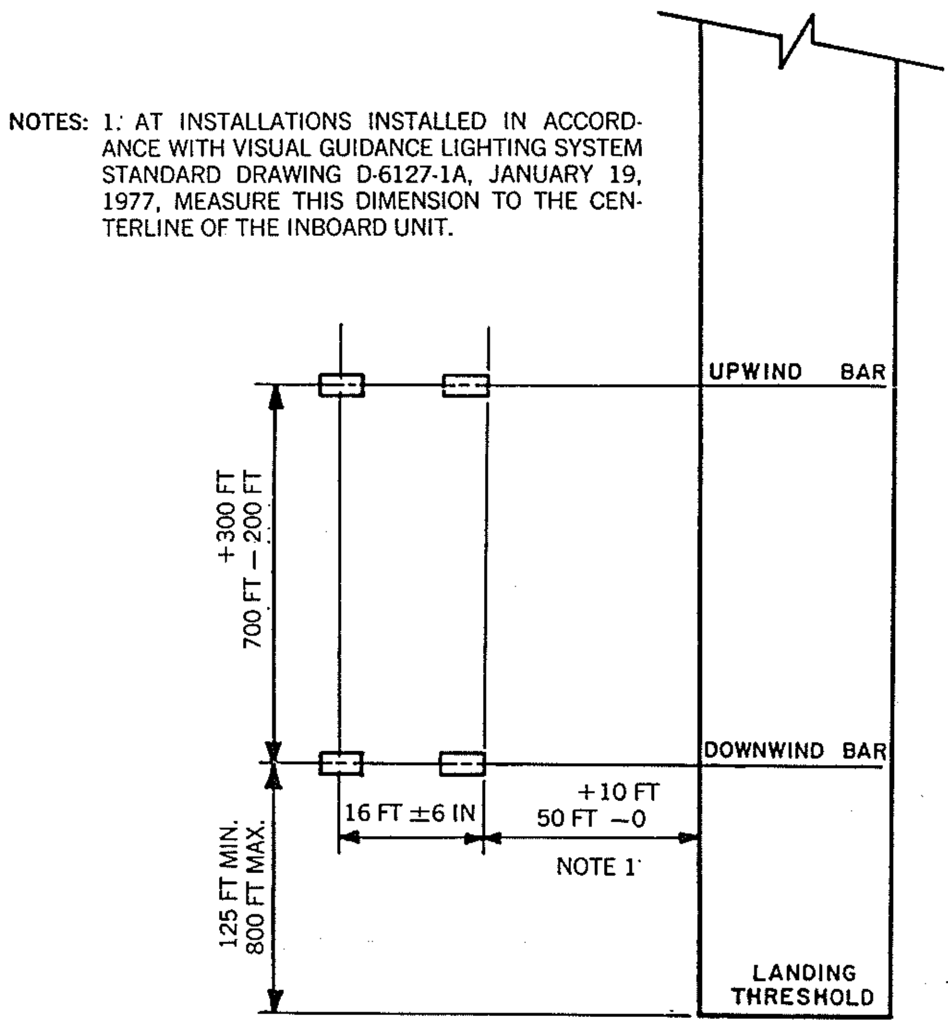


Figure 2-23. VASI-4, Four-Box VASI

NOTES: 1. AT INSTALLATIONS INSTALLED IN ACCORDANCE WITH VISUAL GUIDANCE LIGHTING SYSTEM STANDARD DRAWING D-6127-1A, JANUARY 19, 1977, MEASURE THIS DIMENSION TO THE CENTERLINE OF THE INBOARD UNIT.

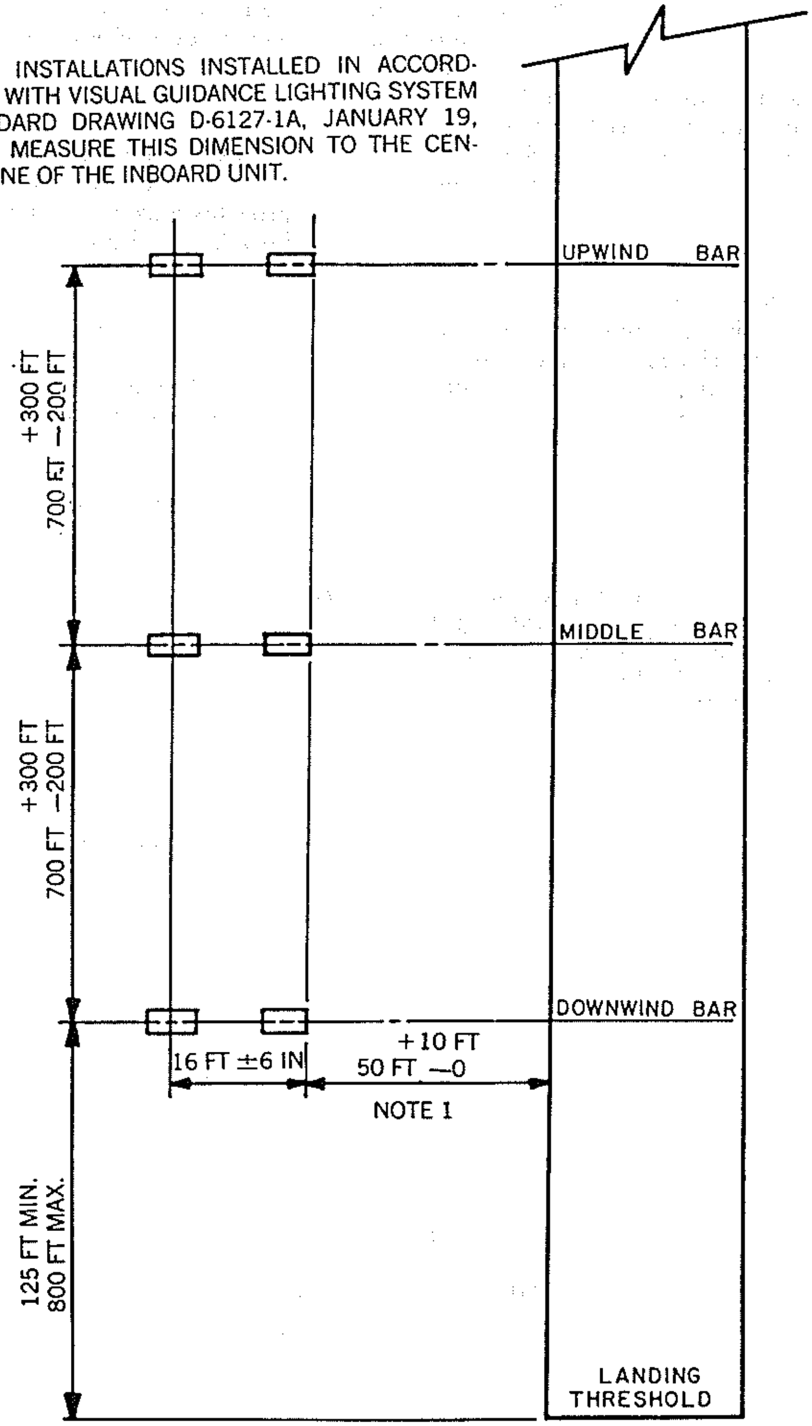


Figure 2-24. VASI-6, Six-Box VASI

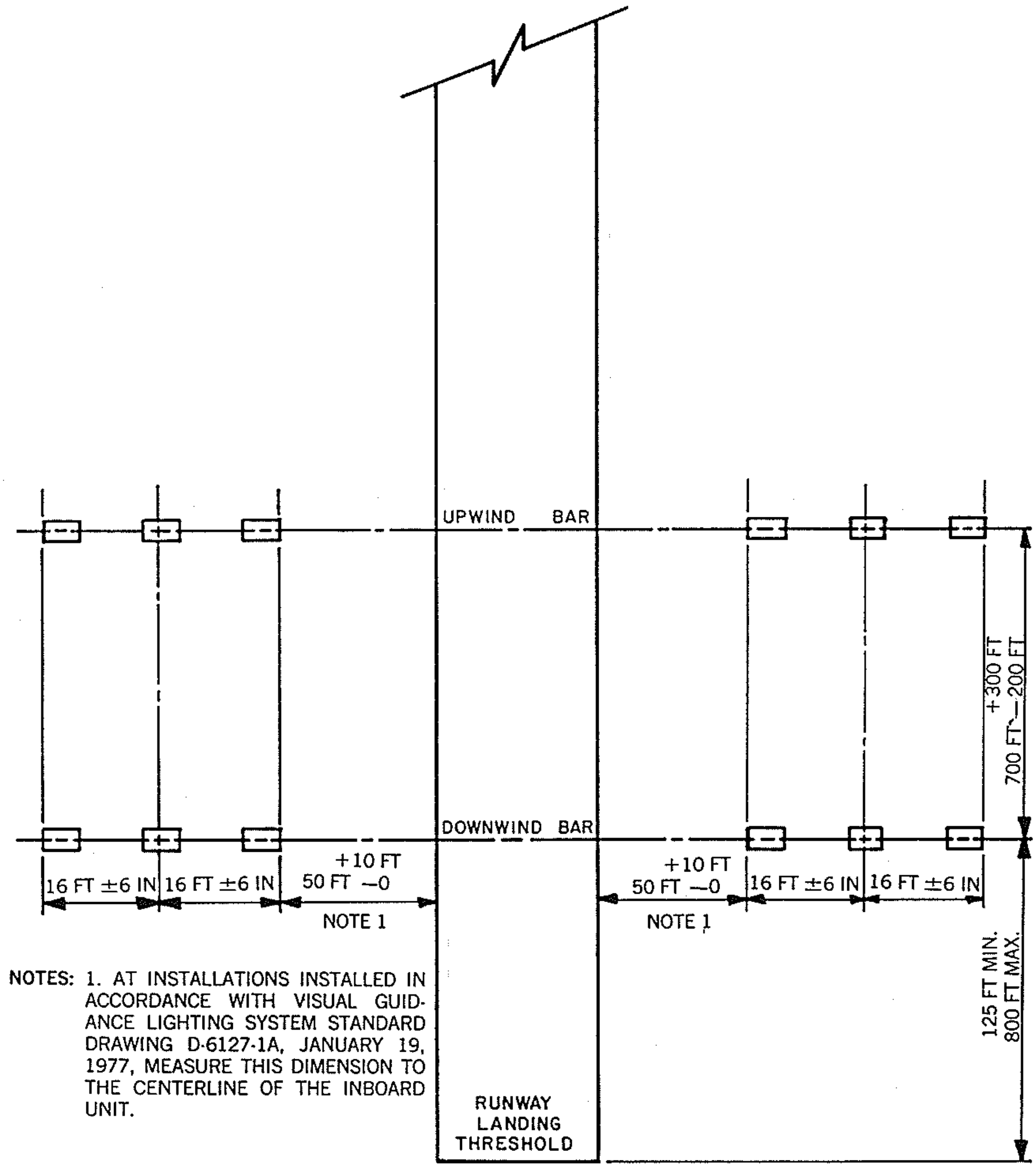
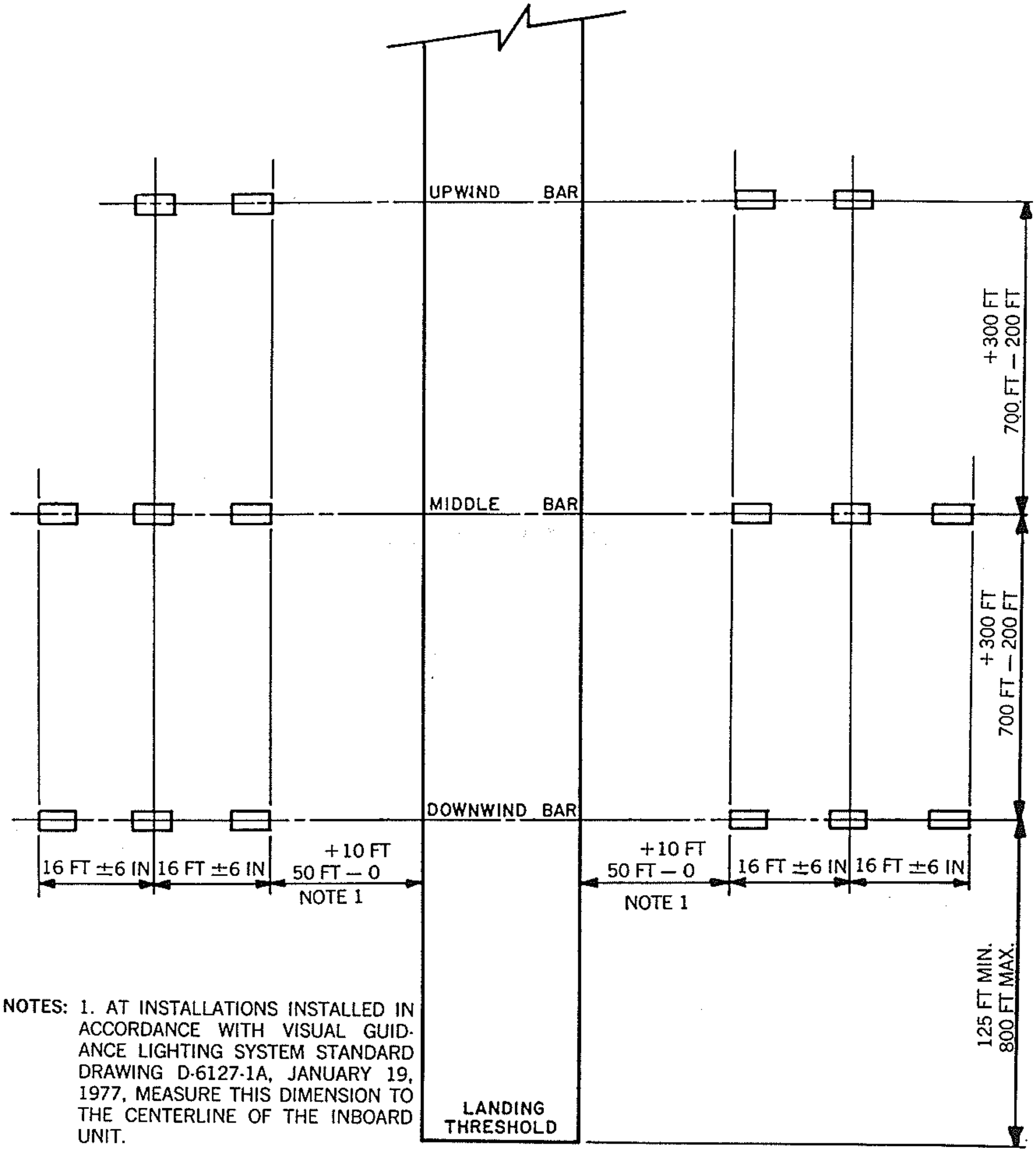


Figure 2-25. VASI-12, Twelve-Box VASI



NOTES: 1. AT INSTALLATIONS INSTALLED IN ACCORDANCE WITH VISUAL GUIDANCE LIGHTING SYSTEM STANDARD DRAWING D-6127-1A, JANUARY 19, 1977, MEASURE THIS DIMENSION TO THE CENTERLINE OF THE INBOARD UNIT.

Figure 2-26. VASI-16, Sixteen-Box VASI

b. PAPI System. The PAPI System is one that provides a pilot with a visual glide slope by which a descent can be made to a runway touchdown point during visual flight rule (VFR) operations. The system is a valuable aid for defining a safe approach clearance over obstructions. Refer to Order 6850.2A, Visual Guidance Lighting Systems, for specific obstruction clearance requirements. The system provides valuable aiming point information that reduces the possibility of aircraft undershoots or overshoots. Significant reduction of aircraft noise during landing operations can be accomplished by use of a PAPI system. The PAPI may be installed on the back and front courses of an ILS or on airports where no ILS system exists. The PAPI system differs from a VASI system only in the lamp housing assembly (LHA) configuration and the resulting visual descent presentation.

(1) General. The PAPI system provides the pilot with a visual descent glide angle. To accomplish this, the PAPI system uses a two-colored light system (red and white). By observing the combination of these two, it is possible to observe a visual glide angle for descent to the touchdown area of the runway. The composite PAPI lighting is illustrated in figure 2-27. The visual presentation of the glide slope corridor as shown in figure 2-28 is accomplished by the vertical adjustment of each LHA. If the aircraft is on the glide path angle, the pilot will see the two LHA's nearest the runway as red and the two LHA's farthest from the runway as white. If the aircraft is slightly above the glide path angle, the pilot will see the one LHA nearest the runway as red and the other three LHA's as white; and when farther above the glide path, the pilot will see all LHA's as white. If the aircraft is slightly below the glide path angle, the pilot will see the three LHA's nearest the runway as red and the LHA farthest from the runway as white; and when farther below the approach angle, the pilot will see all LHA's as red.

(2) PAPI System. Figure 2-29 shows the PAPI system. It consists of a single wing bar of four sharp transition multi-lamp LHA's equally spaced. The system is normally located on the left side of the runway, when viewed from the approach direction. The effective visual range of the system in clear weather is approximately 4 nautical miles.

15. VASI AND PAPI POWER EQUIPMENT.

a. VASI-2. The VASI-2 is powered from a power and control assembly (PCA) that furnishes two output current levels to control the intensity of the VASI lamps. When the ambient light intensity decreases to 35 foot-candles or below (night operation), the PCA will utilize either a contactor controlled tapped transformer or a solid state regulator to provide 4.8 amperes through the VASI lamps. When the ambient light rises to 58 foot-candles (daytime operation), the output from the PCA will increase to provide a current of 6.6 amperes through the VASI lamps. The PCA is powered by a 120/240 V ac source and will control two lamp housing assemblies (LHA's). Each LHA contains three 200-watt PAR-64 lamps operated in series.

b. VASI-4 and VASI-6 (Three-Bar). The standard PCA for the VASI-4 uses a two-channel, solid-state constant current regulator. Each channel is capable of supplying two levels of constant current controlled by a photoelectric device. Each channel will supply current for two lamp housing assemblies. A VASI-4 may be powered with two VASI-2 PCA's controlled by one photoelectric device. A VASI-6 may be powered with three VASI-2 PCA's or with two VASI-4 PCA's controlled by one photoelectric controller.

c. VASI-12 and VASI-16 (Three-Bar). These systems are operated by a 6.6 ampere series circuit supplied by a 15-kW or 20-kW constant current regulator substation. The regulator provides five brightness steps from local control. Only three steps are required from remote control, low (step 3), medium (step 4), and high (step 5). The percent of light on a particular setting is as follows:

Step	Current (Amperes)	Percent of Maximum Light
1	2.8	0.2
2	3.4	1.0
3	4.1	5.0
4	5.2	25.0
5	6.6	100.0

d. PAPI. The PAPI is powered from a PCA consisting of a photoelectric device for controlling the light intensity, a constant current regulator for controlling the current to two-series lamp loops, and other solid-state control circuitry. The power input is 120/240 volts, single-phase, 60 Hz. The output to the lamp loops is 6.6 amperes for the high intensity condition and 4.5 amperes for the low intensity condition. The PCA also contains micro-processor-based monitoring circuitry for remotely monitoring the operating status of the PAPI system.

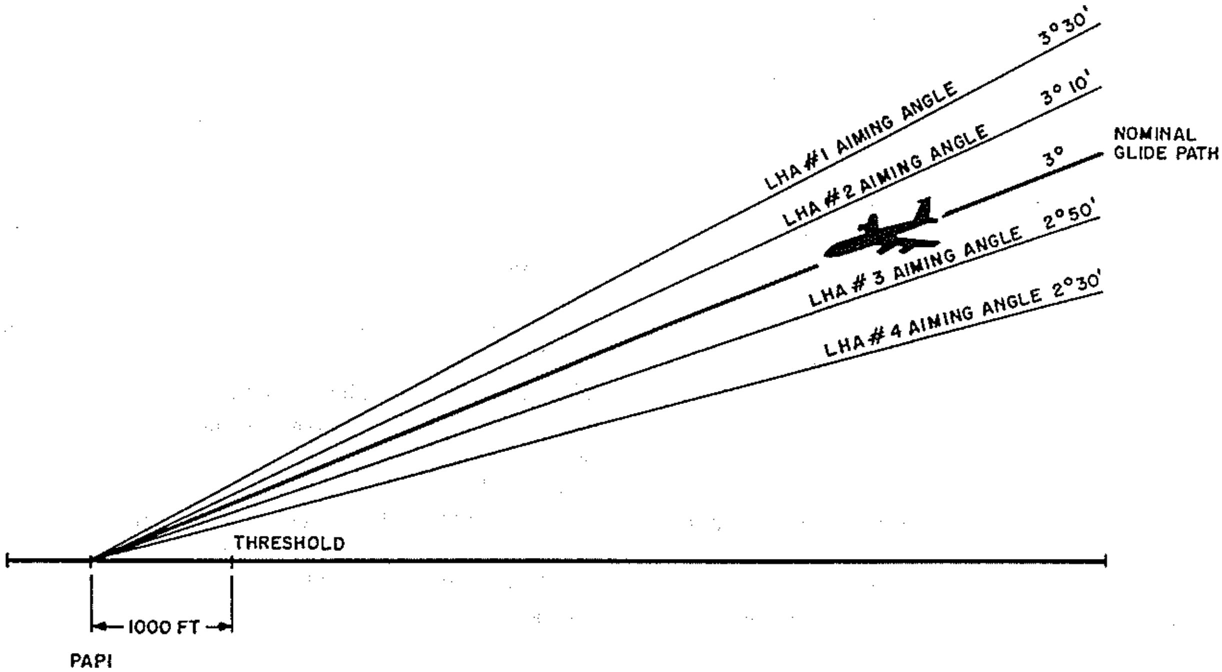


Figure 2-27. PAPI Siting Diagram

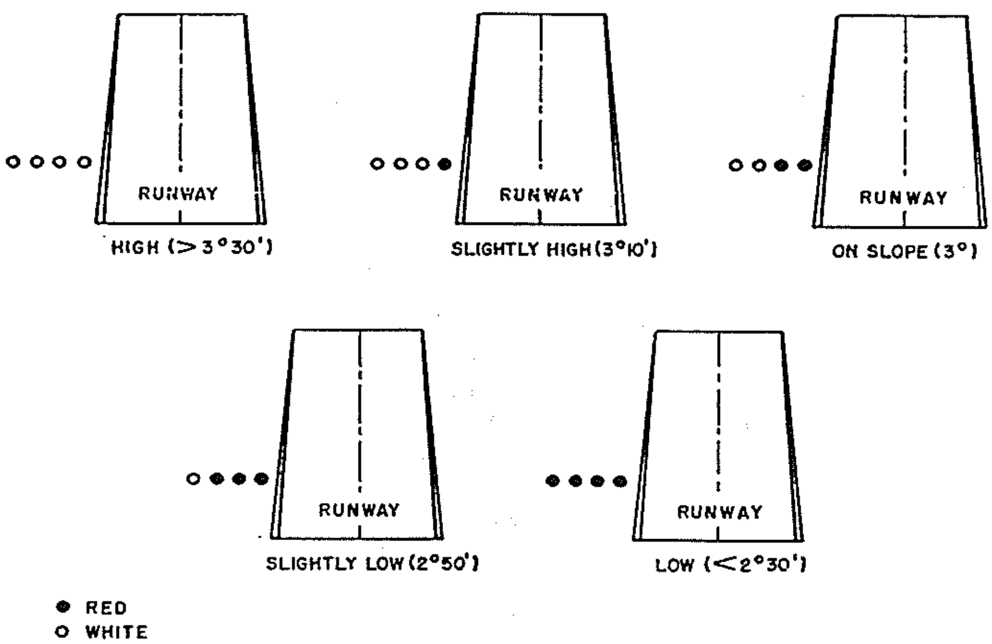


Figure 2-28. PAPI System Visual Presentation

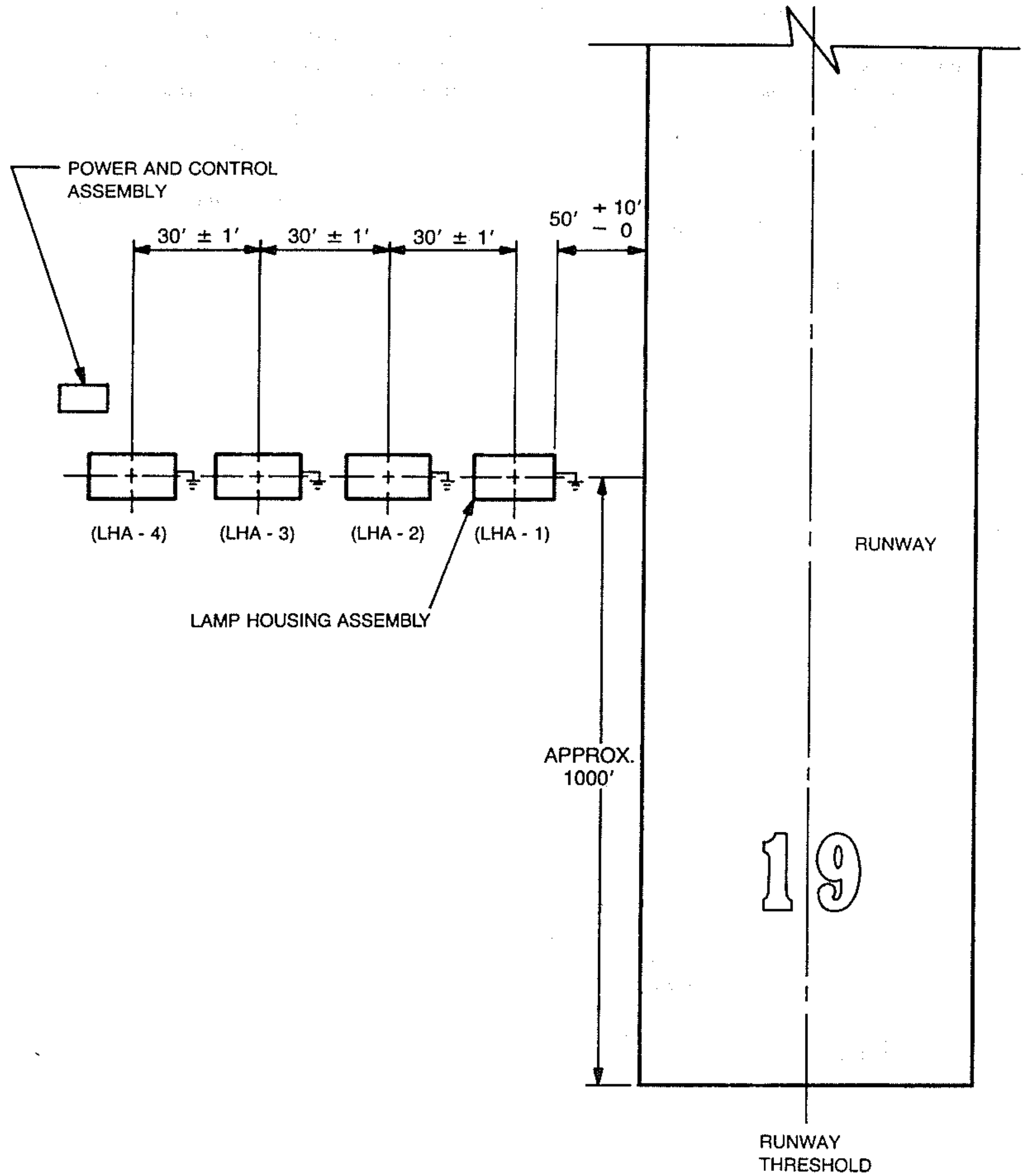


Figure 2-29. PAPI System Configuration

16. VASI AND PAPI LIGHT UNITS (BOXES).

a. **VASI.** Light units or boxes used in all the systems are similar. Each box contains three sealed-beam, 200-watt quartz-iodine Q6.6A/PAR-64 lamps with a design life of 2000 hours. These lamps are precision focused and are intended for direct replacement. Mounted in front of each of the three lamps are spread lens filters consisting of red upper sections and clear lower sections. These filters provide the two colors (red and white) which are basic to the system and also spread the light beam horizontally. Typical VASI LHA indications are shown in figure 2-30. For the VASI-2 system, each light unit has a tilt switch that interrupts power to both boxes, to prevent the system from giving a false signal due to incorrect alignment of the boxes.

b. **PAPI.** All light units or boxes used in the system are similar. Each box contains three 200-watt lamps with a design life of 2000 hours. These lamps are precision focused and are intended for direct replacement. Mounted in front of the top half of each lamp is a red filter. The resulting red and white beam of light is passed through a projection lens that provides both vertical and horizontal spread of the light beam. Typical indications are shown in figure 2-28. Each light unit has a tilt switch that interrupts power to all boxes to prevent the system from giving a false signal due to incorrect alignment of the boxes. All boxes are mounted on frangible couplings as illustrated in figure 2-31.

17.-20. RESERVED.

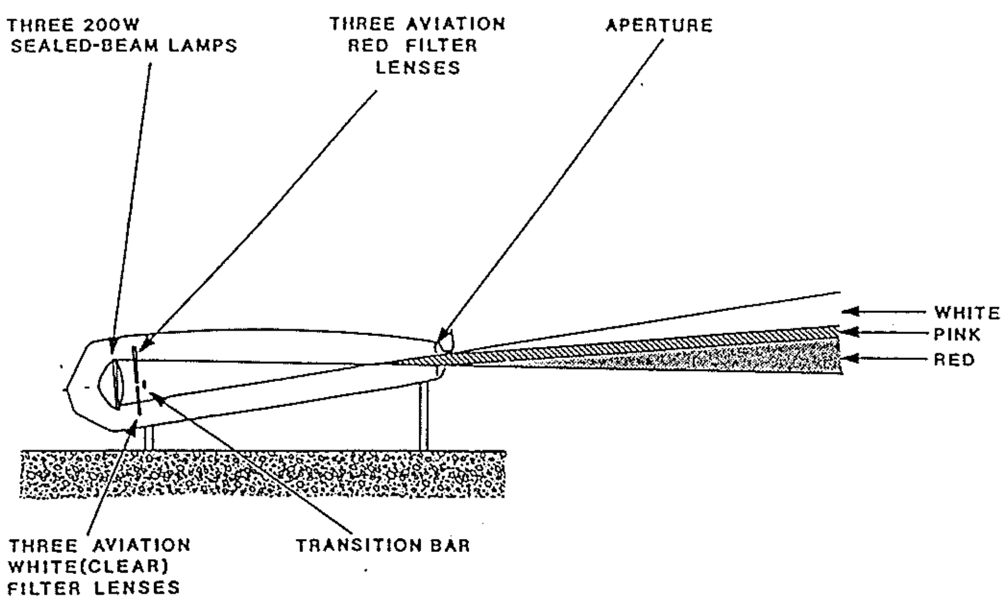


Figure 2-30. Typical VASI LHA Indications

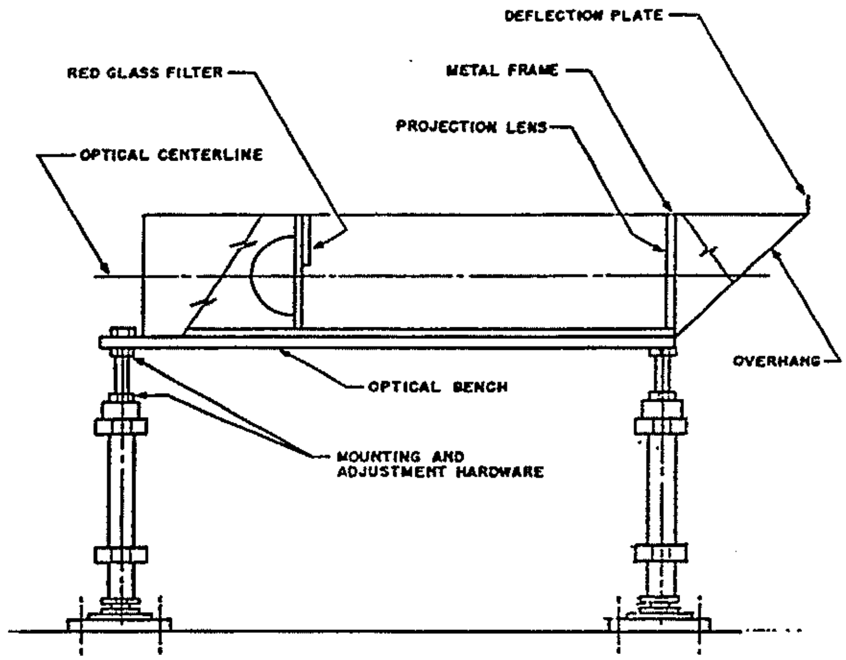


Figure 2-31. PAPI Light Box

Section 2. OBSTRUCTION LIGHTING

21. PURPOSE OF OBSTRUCTION LIGHTING.

Lighting a structure alerts airmen to its presence during both daytime and nighttime conditions. Whenever obstruction lights are displayed on any structure, they should be of sufficient intensity and installed in a manner to draw the attention of pilots approaching the obstruction from any normal angle and at any altitude up to 1500 feet above the obstruction. Obstruction lighting may be displayed in addition to marking (paint) for daytime operation, provided such lights more adequately warn airmen of the obstruction.

22. TYPES.

Red obstruction lights are used during the hours of darkness, during periods of limited daytime illuminance, and/or during reduced visibility. High-intensity white lights are used for both daytime and nighttime conditions, however the intensity may be reduced at night. Although red obstruction lighting systems and aviation surface orange-and-white point meet the minimum obstruction marking and lighting standards, the high-intensity white lights are far more effective and may be used in lieu of red obstruction lights. Obstruction lighting may be displayed on structures in any of the following combinations:

a. Aviation Red Obstruction Lights. Flashing aviation red beacons and steady-burning aviation red lights are used during nighttime operation.

b. High-Intensity White Obstruction Lights. Flashing high-intensity white lights should be used during daytime and twilight, and with reduced intensity for nighttime operation. When this type system is used, the marking of structures with red obstruction lights and aviation orange-and-white paint may be omitted.

c. Dual Lighting. A combination of flashing aviation red beacons and steady-burning aviation red lights may be used for nighttime operation, and flashing high-intensity white lights for daytime operation. Aviation orange-and-white paint may be omitted.

d. High-Intensity Obstruction Lights, Twilight/-Nighttime Only. Flashing high-intensity white lights may be used for twilight and nighttime operation, with aviation orange-and-white paint used for daytime marking. Obstruction lighting criteria and specification data may be obtained in Advisory Circular AC 70/7460-1F, Obstruction Marking and Lighting.

23. OBSTRUCTION LIGHT MONITORING.

Obstruction lighting should be visually observed at least once each 24 hours. If obstruction lighting is not readily accessible for visual observation, a properly maintained automatic visual or audible alarm indicator should be installed and operated to provide an indication that such lights are functioning properly. This alarm indicator should be designed to register the malfunction of any light on the obstruction. The automatic monitoring alarm indicator should be located in an area generally occupied by facility personnel. The side or intermediate aviation red obstruction lights on an obstruction may be excluded from the alarm circuit, provided the signaling device will indicate malfunctioning of all flashing and rotating beacons and/or high-intensity white lights and of all top lights; and that all obstruction lighting mounted on the obstruction is visually inspected at least once every 2 weeks.

24. AVIATION RED OBSTRUCTION LIGHTS.

* NOTE: All lamp power requirements (wattage) in this handbook Chapter 2, Section 2, paragraph 24 applies only to incandescent lamps (not approved LED lamp replacements). *

a. Flashing Red Hazard Beacon. This 300mm flashing beacon, figure 2-32, consists of two simultaneously flashing incandescent lamps of at least 620 watts with aviation red color filters. The steady-burning intensity should not be less than 2,000 candelas (in red). The flashing mechanism should produce not more than 40 flashes per minute nor less than 12 flashes per minute with a period of darkness equal to approximately one-half the luminous period. If the obstruction is located within 15,000 feet of a landing area, the flashing frequency should be at least 20 flashes per minute.

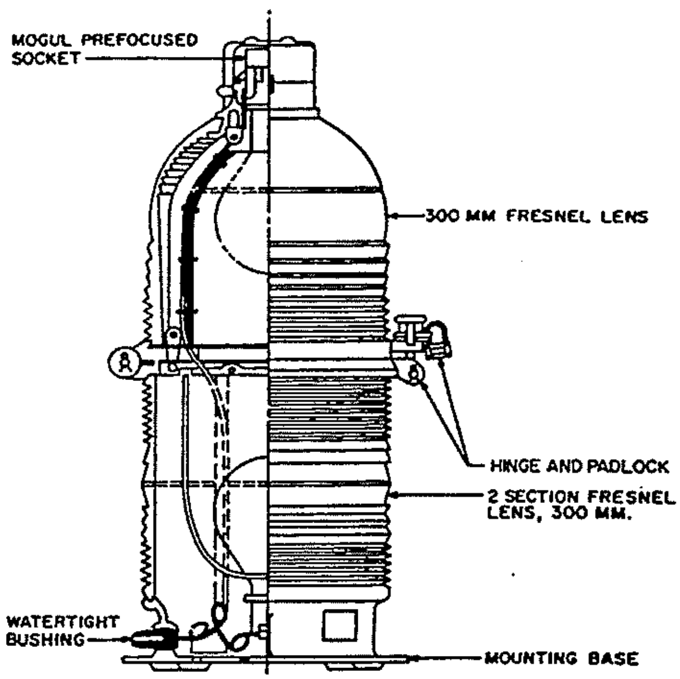


Figure 2-32. Flashing Red Hazard Beacon

b. Steady-Burning Red Obstruction Light. This obstruction light consists of one or more steady-burning lamps of at least 116 watts (when used in multiple circuit), enclosed in an aviation red obstruction light globe. The intensity should be at least 32.5 candelas. The simultaneous flashing of all lights is permissible.

(1) Single Obstruction Light. A single unit, figure 2-33, may be used when more than one obstruction light is required either vertically or horizontally to define an obstruction or when maintenance can be accomplished within reasonable time.

(a) Top Level. A single unit may be used to identify low structures, such as airport instrument landing system (ILS) buildings, or long horizontal structures, such as perimeter fences, and building roof outlines.

(b) Intermediate Level. Single units may be used on skeletal and solid structures when more than one level of lights is installed and there are two or more single units per level.

(2) Double Obstruction Light. A double light unit, figure 2-33, should be installed when used as top light and in areas or locations where the failure of a single unit could cause an obstruction to be totally unlighted from any normal angle of approach.

(a) Top Level. Structures not exceeding 150 feet should have one or more double units installed at the highest point. These should burn simultaneously.

(b) Intermediate Level. Double units should be installed at intermediate levels when a malfunction of a single unit could create an unsafe condition, and in remote areas where maintenance cannot be performed within reasonable time. A transfer relay may be used with these units to switch light sources if one side fails.

c. Rated Lamp Voltage. To ensure the proper lumen output, the operating voltage provided to the recommended obstruction lamp should not vary more than ±3 percent of the rated voltage of the lamp. The input voltage should be measured at the lamp socket with the lamp operating during the hours of normal operation.

d. Operation of Red Lights. Red obstruction lights should be operated by a control device adjusted so that the lights will be turned on when the north sky illuminance decreases on a vertical surface to not more than 35 foot-candles (376.7 lux). They should also be turned on during daytime when the flight visibility is restricted. In Alaska, however, the lights should be turned on during daytime when a prominent unlighted object cannot be seen at three statute miles. The control device should turn off the lights when the north sky illuminance rises to at least 58 foot-candles (624.3 lux), or the lights may remain on continuously. The sensing device should face the north sky.

25. HIGH-INTENSITY, WHITE OBSTRUCTION LIGHTS.

The following are the basic standards for high-intensity obstruction lighting systems on structures.

a. Effective Intensity.

(1) Day Mode: At least 200,000 candelas.

(2) Twilight Mode: Approximately 20,000 candelas.

(3) Night Mode: Approximately 4,000 candelas.

b. Intensity Step Changing. The systems should provide an automatic change in intensity when the north sky illumination on a vertical surface is as follows:

(1) Day-to-Twilight. This should not occur before the illumination drops to 60 foot-candles (645.8 lux), but should occur before it drops below 30 foot-candles (322.9 lux).

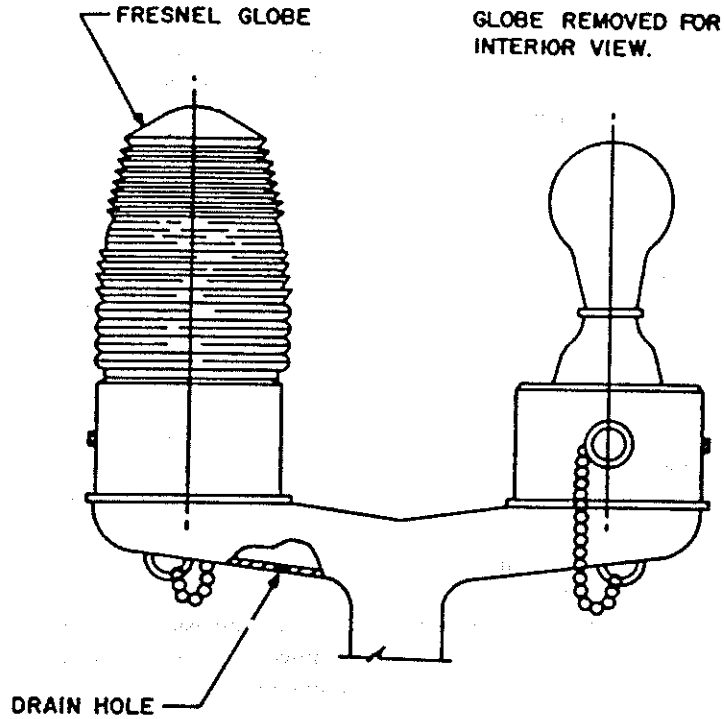
(2) Twilight-to-Night. This should not occur before the illumination drops to 5 foot-candles (53.8 lux), but should occur before it drops below 2 foot-candles (21.5 lux).

(3) Night-to-Day. The intensity changes listed in subparagraphs (1) and (2) above should be reversed in transitioning from the night to day mode.

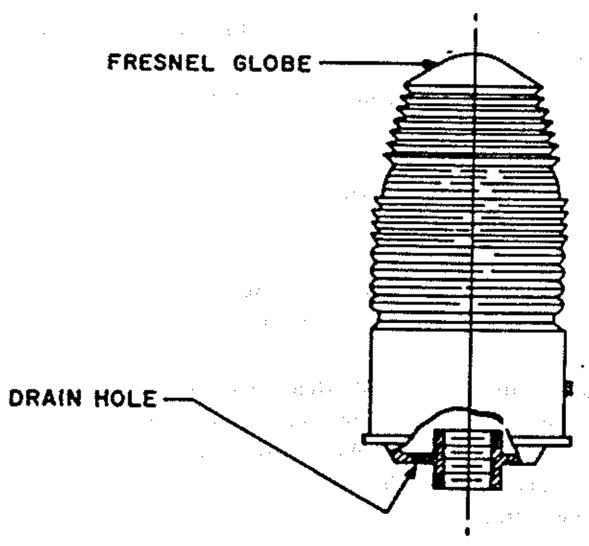
c. Flash Rate. All light units should flash simultaneously at 40 pulses per minute.

d. Beam Spread. The light should provide a relatively narrow vertical beam spread with full light intensity at possible collision altitudes with a structure. Viewers at lower altitudes or at altitudes above the structure should receive only stray light.

e. Antenna or Appurtenance Light. The high-intensity lighting system may include a small omni-directional white light, similar in size to the 300-mm red flashing beacon, for installation on top of antennas or similar appurtenances. This light should operate 24 hours a day, flash in synchronism with the high-intensity lighting system, be of approximately the same intensity as



DOUBLE OBSTRUCTION LIGHT FITTING



SINGLE OBSTRUCTION LIGHT FITTING

Figure 2-33. Obstruction Light Fittings

the twilight mode during daylight, and reduce in intensity to the night mode simultaneously with the remainder of the system. This appurtenance light should only be used as an adjunct to the high-intensity lighting system.

26. DUAL LIGHT SYSTEMS.

Red (nighttime) and high-intensity white (daytime) obstruction lighting systems may be jointly used under conditions when it is not feasible to operate the high-intensity white lighting systems at night. When high-intensity white obstruction lighting is displayed on an obstruction during daylight hours and only aviation red obstruction lighting is displayed on the obstruction during nighttime hours, the two lighting systems should be controlled by one or more control devices. The control device or devices used should be adjusted so that the high-intensity white obstruction lights (1) will be turned on and the red lights turned off when the north sky light rises to 0.5 foot-candles (5.38 lux), and (2) will be turned off and the red lights turned on when the north sky light falls to 3.0 foot-candles (32.38 lux) and before it reaches 0.5 foot-candles (5.38 lux).

27. ROTATING BEACONS.

All airport rotating beacons project a beam of light in two directions, 180° apart. The optical system consists of one green lens and one clear lens. The rotating mechanism is designed to rotate the beacon at 6 revolutions per minute (r/min) to produce alternate clear and green flashes of light.

a. Thirty-Six Inch Rotating Beacon. The 36-inch rotating beacon is the standard large rotating beacon. The optical system consists of a lens combination in each end of the housing with a single lamp in the center. Each combination consists of an 18-inch inner doublet lens and a 36-inch diameter clear outer lens assembly. The outer lens assembly is made of a one-piece bull's-eye center lens, 20 inches in diameter, surrounded by 12 two-piece, 30° sectors. The inner doublet lens is furnished in clear and green colors. The beacon operates on 115 volts, 60 Hz, and the rotating mechanism is designed to rotate the beacon at 6 r/min. Aviation beacon lamps, 1200-watt, 120-volt, T-20 bulb, mogul bipost base, are used with the beacon. Upon failure of the first lamp, a magnetic lamp changer is provided to automatically throw a spare lamp into focus and connect it to the power source. A telltale lighting circuit operates an indicating light when the spare lamp has been put into the operating circuit.

b. Ten-Inch Rotating Beacon. The 10-inch rotating beacon, figure 2-34, is the standard small beacon. The optical system consists of two semaphore lenses, one clear and one green, mounted on bracket support arms that are adjustable for beam elevation. The lamp used is a 620-watt, 120-volt, T-20, medium bipost lamp. A magnetic lamp changer as described in subparagraph a is provided.

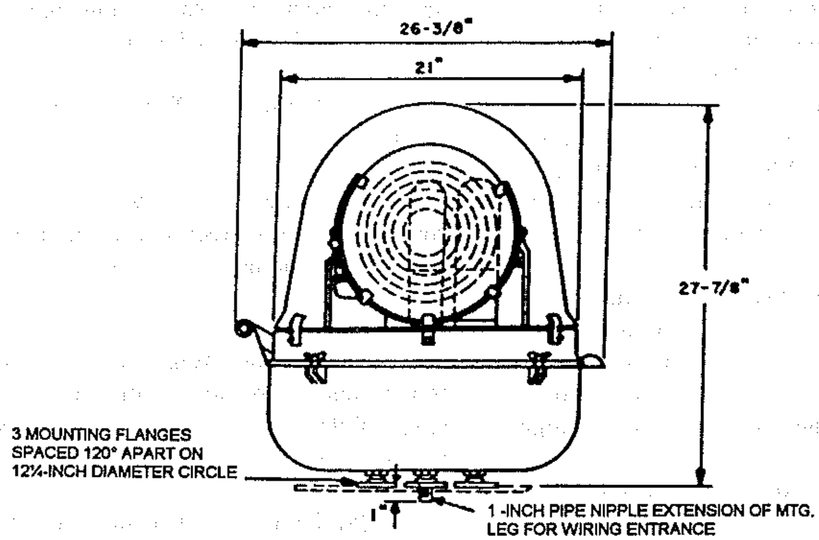


Figure 2-34. Typical 10-Inch Rotating Beacon

c. Hazard Beacons. Hazard beacons project a flashing red beam of light, 360° in the horizontal plane, from the horizon to the zenith. A hazard beacon warns airmen of an obstruction that is hazardous to air commerce during darkness and limited visibility conditions. The optical system consists of four 12-inch-diameter, cylindrical, Fresnel-lens components of heat-resistant clear glass and two red, glass screens. These comprise an individual optical unit for each lamp. Two separate 620-watt, PS-40P bulbs, with mogul-prefocused base at 120 volts are used in the beacon. When equipped with a flashing mechanism, the beacon produces a total of 12 to 40 flashes per minute.

28.-30. RESERVED.

Section 3. CONTROL EQUIPMENT

31. REMOTE CONTROL EQUIPMENT.

a. ALSF-1 Typical Remote Control. The remote control panel in the tower cab, figure 2-35, provides for operation of the approach lights and flashers. Dual green lights adjacent to the approach light on-off switch, when lit indicate that the substation is energized, is under the control of the tower, and is operating at the intensity set by the brightness control switch. Dual amber lights adjacent to each position 1 through 5 of the brightness control switch are lit when the lamps in the series loops are operating at a particular brightness step. When the approach lights are operating at maximum intensity (position 5), a timer is placed in operation. At the expiration of a preset time interval, usually 15 minutes, the brightness is reduced to position 4 intensity. Shortly before the 15-minute timing interval has elapsed (after 14 to 14.5 minutes) a warning buzzer will sound. This warns controllers that the approach lights are going to be reduced to brightness 4 level. The remote control panel includes a timer reset button designed to recycle the timer to permit additional uninterrupted time on brightness step 5. The buzzer also warns of a malfunction of the approach lights and/or the sequenced flashers. Dual red lights are mounted above the ALS normal-trouble switch and the SFL normal-trouble switch. When sequenced flashers have been incorporated into the system, dual green lights are mounted above the flashers on-off switch.

b. Dual Mode ALSF-2/SSALR. The dual mode remote control panel located in the tower cab, figure 2-36, provides control functions to the substation and receives the status indications from the substation. Information is transferred between the tower and substation over a single pair of conductors by frequency-shift keying (fsk). The commands from the remote control panel are encoded into serial information, a carrier is modulated at a downlink frequency of 1070 Hz or 1270 Hz. This modulated carrier is received at the substation, demodulated and decoded, to provide the parallel control functions that were initiated at the remote panel. The status information from the substation is simultaneously being modulated at an uplink frequency of 2025 Hz or 2225 Hz. This status information is demodulated and decoded to apply power for the proper monitor indication, either visual or aural, to inform the controller of the status of the dual mode approach lighting system ALSF-2/SSALR. The following status lights are located on the remote panel.

(1) Approach Lights On/Off. Indicates ALS on/off status.

(2) Flashers On/Off. Indicates flasher on/off status.

(3) Brightness Step Lamps. Will be on only if all regulators and the flashers are operating at the selected intensity.

(4) ALSF/SSALR. A steady light indicates the operating mode; a flashing light indicates a mode error, that is, the ALS mode and the flasher mode are not the same.

(5) Substation. When on, indicates that control is at the substation.

(6) Comm Fault. When on, indicates a loss of communication between the remote control panel and the substation. The last valid command will be in control of the system.

(7) Caution. When on, indicates more than a prescribed number of lamps either incandescent or flashers have failed but the system meets certification requirements.

(8) Failure. When on, indicates more than the prescribed number of either incandescent lamps or flashers have failed and the system may not meet certification requirements.

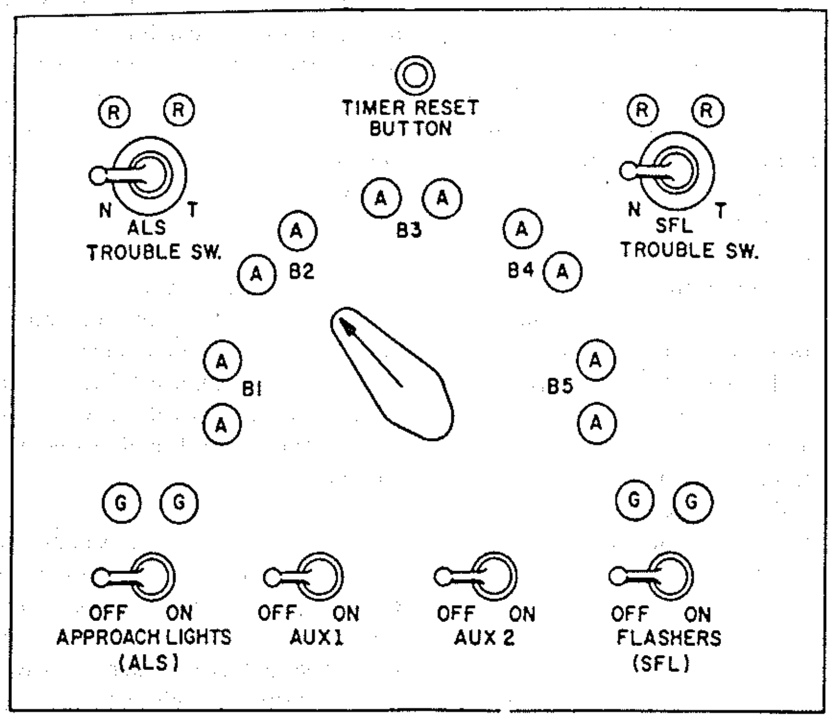


Figure 2-35. High-Intensity ALS Remote Control Panel

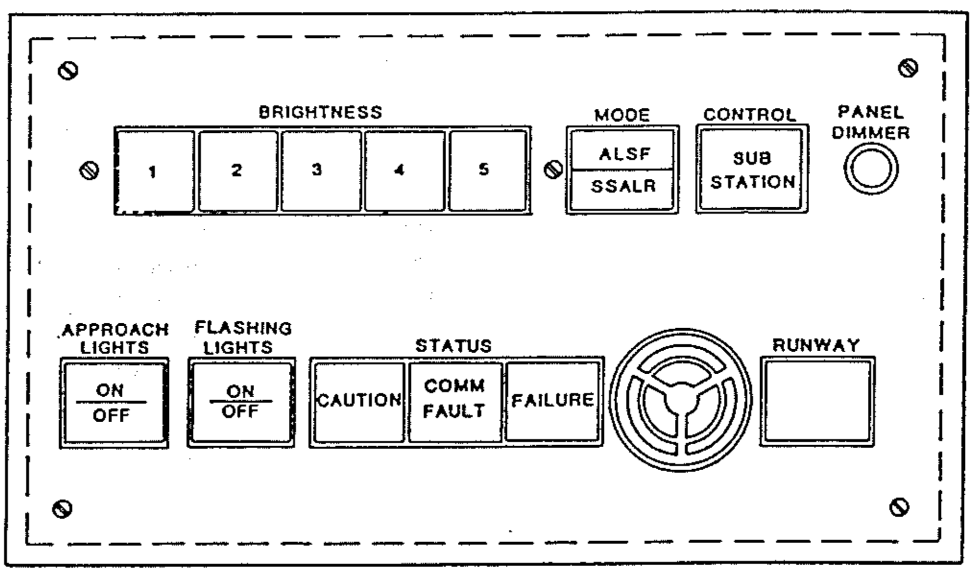


Figure 2-36. Dual Mode Remote Control Panel

c. Radio Remote Control. Radio remote control has been authorized for selected system types. The MALSR control is discussed here. For further information, see Order 6650.6B, Maintenance of Radio Control Equipment for Plant Facilities. At selected airports, MALSR facilities have been linked to air traffic control towers (ATCT) and flight service stations (FSS) by a ground-to-ground radio control. At airports lacking an ATCT or FSS, an air-to-ground receiver-controller provides to a pilot desiring to make an approach and landing, the capability to turn on the MALSR lights and to control their intensity. At airports with part-time ATCT's or FSS's, both ground-to-ground and air-to-ground links are installed. After the air traffic control facility shuts down for the day, departing personnel should enable the air-to-ground unit to receive commands from the air. Figure 2-37 is a system block diagram showing the ground-to-ground link as augmented for air-to-ground control. This configuration would be used at airports with part-time air traffic control service. Brief descriptions of the two radio links follow.

(1) Ground-to-Ground Radio Link.

(a) A narrow-band, frequency-modulated (fm) transceiver is provided at the ATCT or FSS control terminal for transmitting on the 162-MHz to 174-MHz band to an fm receiver-decoder at the MALSR site. The transmissions are a sequential series of audio frequency tones, the specific combinations of which are initiated by a pushbutton manual control panel located at the air traffic control towers (ATCT) or flight service stations (FSS). A tone sequence is interpreted at the receiver-decoder and operates corresponding relays in an interface unit (which connects with the MALSR control box) to command the desired function.

(b) For detailed theory and equipment trouble-shooting information for the components of this control system, refer to the manufacturers instruction book. Order 6650.6B, Maintenance Of Radio Control Equipment For Plant Facilities, provides complete maintenance guidance and system standards and procedures for the fm radio link equipment.

(c) Table 2-2 summarizes the Motorola 504 major control features currently provided for application to the MALSR, and shows typical tone frequencies for most FAA installations. Some locations may have different tone frequencies or they may be rearranged. Functions 7 and 8 are used at facilities with both air-to-ground and ground-to-ground control. Functions 9 and 10 are used at facilities requiring engine generator start and stop control.

Table 2-2. MALSR CONTROL FUNCTIONS

Function	*Tone Sequence Setting*	*Typical Pushbutton*	*MALSR Response*
1.	ABCA	1231	On at low intensity
2.	ABCB	1232	On at medium intensity
3.	ABCC	1233	On at high intensity
4.	ABAC	1213	MALSR off
5.	ACBA	1321	Sequenced flashers off
6.	ACBB	1322	Sequenced flashers on
7.	ACBC	1323	Ground control
8.	ACBD	1324	Aircraft control
9.	ACDA	1341	Engine generator control
10.	ACDC	1343	Engine generator control

Tone Frequencies (Hz) A. 1092.4 B. 1034.7 C. 879.0 D. 832.5

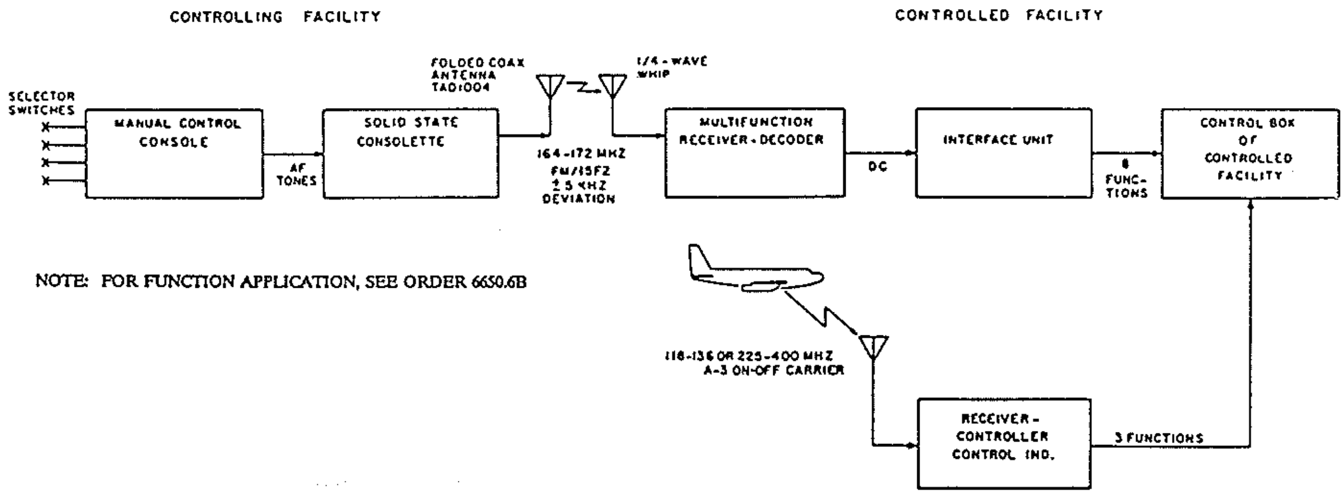


Figure 2-37. Typical MALSR Radio Frequency Remote Control System

(2) Air-to-Ground Radio Link.

(a) The air-to-ground link includes an airborne 118-MHz to 136-Mhz amplitude modulated (am) transmitter, a ground-based radio receiver with a decoder, and control relays. The relays interconnect with the normal control box circuits of the MALSR facility. The radio receiver receives on-off keying of the airborne transmitter's carrier and produces a series of impulses. These impulses are shaped by a trigger circuit and are counted over a 5-second interval. The number of pulses determines the MALSR intensity of low, medium, or high. To achieve this in the order given, the pilot keys the microphone switch 3, 5, or 7 times in 5 seconds. This turns the MALSR on and selects the desired intensity. In addition, the receiver-controller contains an integral 15-minute timer that automatically turns off the MALSR lights or other controlled facility after 15 minutes of operation. Although airborne transmitters normally activate the MALSR, vehicular or base-station transmitters (transceivers) may be used for testing if they are on the proper frequency. The air-to-ground link alone is used where there is no operational ATCT or FSS at any time during the day. The following summarizes the air-to-ground control features.

Controlling Aircraft Transmitter Keyed	MALSR Response
3 times in 5 seconds	On at low intensity
5 times in 5 seconds	On at medium intensity
7 times in 5 seconds	On at high intensity

NOTE: Automatic timer turns the MALSR or other controlled facility off 15 minutes after receipt of the last command.

(b) For theory of the equipment, refer to the manufacturers instruction book. Maintenance instructions are contained in Order 6650.6B.

(3) Interface Unit. The interface unit is made in accordance with specification FAA-E-2663. Although the interface unit was designed to be used with the

MALSR system, it is now used with all remote radio control systems (RRCS) controlling visual aid facilities. The facility operates as shown on Table 2-3 when connected to an interface unit.

Table 2-3. INTERFACE UNIT FUNCTIONS

RRCS Panel *From*	*To*	*Facility Condition*
Off, B2, B3	B1 (MALS 1, VASI on, PAPI on, REIL 1, ODALS 1)	Brightness step 1 or "on"
Off, B1, B3	B2 (MALS 2, REIL 2, ODALS 2)	Brightness step 2
Off, B1, B2	B3 (MALS 3, REIL 3, ODALS 3)	Brightness step 3
G-G	A-G	Facility is "off" until pilot selects facility "on" through a-g unit.
A-G	G-G	Facility goes to "on" and at full intensity. Desired intensity must be selected
RAIL off	RAIL on	RAIL portion of MALSR turned "on".
RAIL on	RAIL off	RAIL portion of MALSR turned "off".

32.-69. RESERVED.

CHAPTER 3. STANDARDS AND TOLERANCES

70. GENERAL.

This chapter prescribes the standards and tolerances for lighted navigational aids, as defined and described in Order 6000.15B, General Maintenance Handbook for Airway Facilities. References to the latest editions of Orders 6650.6, Maintenance of Radio Control Equipment for Plant Facilities; 6850.2, Visual Guidance Lighting Systems; 6950.17, Maintenance of Electrical Systems in Buildings; 6950.18, Maintenance of Electrical Distribution Systems; and 6650.5, Maintenance of Electrically Operated Remote Control Equipment; are in various sections of this chapter. Two or three digit references such as 71, 115, and 345 are located in this handbook. Those such as 3.3.2.2.3 are in TI 6850.87, Dual Mode High Intensity Approach Lighting System (ALSF-2/SSALR) System Type FA-10700. References such as "Instruction book" are located in the applicable equipment instruction book. All key performance parameters and/or key inspection elements are clearly identified by an arrow (→) placed to the left of the applicable item. If a parameter is not listed for a specific equipment, the standards and tolerances specified in the manufacturer's instruction manual shall be used.

Section 1. APPROACH LIGHTING SYSTEMS

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
→71. **LIGHT BAR LAMPS.**				
a. **ALSF-1**	294, 345			
(1) Overall system		All lamps on	Same as standard	Less than 4 consecutive centerline light bars out as defined in 71a(2), and less than 6 lamps out in a loop
(2) Centerline bars		All lamps on	Same as standard	Less than 3 lamps out in 5-lamp bar
(3) Threshold bar		All lamps on	Same as standard	Less than 6 lamps out
(4) Wing bars		All lamps on	Same as standard	Less than 3 lamps out
(5) Terminating bar		All lamps on	Same as standard	Less than 6 lamps out
(6) 1000-foot bar		All lamps on	Same as standard	Less than 6 lamps out

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* **b. ALSF-2/SSALR ...... FA-9993/FA-10048.**	294, 345			*
(1) Centerline bars, inner 1500-feet		All lamps on	Same as standard	Less than 3 consecutive light bars out as defined in 71b(3), and 20 percent or less (random) of lamps out
(2) Centerline bars, outer 1500-feet		All lamps on	Same as standard	Less than 3 consecutive light bars out, and 20 percent or less (random) of lamps out
(3) Centerline bar		All lamps on	Same as standard	Less than 3 lamps out in 5-lamp bar
(4) Side row bars		All lamps on	Same as standard	Less than 3 consecutive light bars out as defined in 71b(5), and 20 percent or less (random) of lamps out
(5) Side row bar.........		All lamps on	Same as standard	Less than 2 lamps out in 3-lamp bar
(6) Threshold bar.........		All lamps on	Same as standard	Less than 4 adjacent lamps out, and 20 percent or less (random) of lamps out
(7) 500-foot bar		All lamps on	Same as standard	Less than 4 adjacent lamps out, and 20 percent or less (random) of lamps out

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(8) 1000-foot bar		All lamps on	Same as standard	Less than 4 adjacent lamps out, and 20 percent or less (random) of lamps out
* **b-1. ALSF-2/SSALR LAMPS AND FLASHERS, FA-10700.**				
(1) ALSF-2	294. 345, 3.3.2.2.3-10			
(a) Centerline inner 1500 feet		All lamps on	Same as standard	[1]2 consecutive bars out, or 14 random lamps out
(b) Centerline outer 1500 feet				
1 2400-foot runway		All lamps on	Same as standard	2 consecutive bars out, or 8 random lamps out
2 3000-foot runway		All lamps on	Same as standard	2 consecutive bars out, or 14 random lamps out
(c) Side row bars		All lamps on	Same as standard	[1]2 consecutive bars out, or 9 random lamps out
(d) Threshold bar		All lamps on	Same as standard	3 adjacent lamps out, or 9 random lamps out
(e) 500-foot bar		All lamps on	Same as standard	3 random lamps out
(f) 1000-foot bar		All lamps on	Same as standard	3 random lamps out

[1] A 3-lamp bar is considered out when two or more lamps are out. A 5-lamp bar is considered out when three or more lamps are out. *

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* (g) Flashers		All flashers on	Same as standard	2 random flashers out
(h) Flasher rate		120 flashes per minute	Same as standard	±2 flashes per minute
(i) Overall		All lamps on	Same as standard	27 lamps/ flashers out
(2) SSALR	294, 3.3.2.2.5-6			
(a) Centerline		All lamps on	Same as standard	1 bar out
(b) Threshold bar		All lamps on	Same as standard	3 random lamps out
(c) 1000-foot bar		All lamps on	Same as standard	3 random lamps out
(d) Flashers		All flashers on	Same as standard	1 flasher out
(e) Flasher rate		120 flashes per minute	Same as standard	±2 flashes per minute
(f) Overall		All lamps on	Same as standard	11 lamps/ flashers out *
c. **MALS AND SSALS**	306			
(1) Overall system		All lamps on	Same as standard	Less than 2 light bars out as defined in 71c(2), (3), (4), and 20 percent or less (random) of lamps out
(2) 5-lamp bar		All lamps on	Same as standard	Less than 3 lamps out
(3) Threshold bar (where existing)		All lamps on	Same as standard	Less than 4 lamps out

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(4) 1000-foot bar		All lamps on	Same as standard	Less than 4 lamps out
→72. **VERTICAL ANGULAR ALIGNMENT.**				
* a. **FA-9993/FA-10048**	299, 308	Locally established vertical angle of lighted beam axis of light	Standard ±1°	Standard ±2°
b. **FA-10700.**				
(1) Flashers	6.2.8.5.1	6° or as installed	±1°	±2°
(2) Steady burning lights	6.2.9.3.1	As installed	±1°	±2°
→73. **HORIZONTAL ANGULAR ALIGNMENT.**	299, 308, 6.2.8.5.2, 6.2.9.3.2	Parallel to centerline of runway	Same as standard	Same as initial *
→74. **REGULATOR OUTPUT**	295			
a. **ALSF-1, ALSF-2, SSALR, SSALS, SSALF, ALL SYSTEMS EXCEPT DUAL MODE SYSTEMS.**				
(1) Step 1		8.3 A	±0.2 A	±0.4 A
(2) Step 2		9.9 A	±0.2 A	±0.4 A
(3) Step 3		12.1 A	±0.2 A	±0.4 A
(4) Step 4		15.3 A	±0.2 A	±0.4 A
(5) Step 5		20.0 A	+0.0 A, –0.2 A	+0.0 A, –0.4 A

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
* **b. ALSF-2/SSALR FA-9993/FA-10048/FA-10700 DUAL MODE SYSTEMS ONLY.** *				
(1) Step 1		8.5 A	±0.2 A	Same as initial
(2) Step 2		10.3 A	±0.3 A	Same as initial
(3) Step 3		12.4 A	±0.3 A	Same as initial
(4) Step 4		15.8 A	±0.4 A	Same as initial
(5) Step 5		20.0 A	+0.0 A, –0.4 A	Same as initial
→75. **MALS VOLTAGE**	307, Order 6950.17			
a. Control Cabinet Supply Voltage		120 V or 240 V	±3 percent	±5 percent (for exceptions see Order 6950.17)
b. Lamp Voltage (Measured at Transformer Output).				
(1) High step, 100 percent brightness		120 V	±3 percent	±5 percent
(2) Medium step, 20 percent brightness		75 V	±3 percent	±5 percent
(3) Low step, 4 percent brightness		50 V	±3 percent	±5 percent
c. Lamp Transformer Output (Line To Line).				
(1) High step, 100 percent brightness		240 V	±3 percent	±5 percent
(2) Medium step, 20 percent brightness		150 V	±3 percent	±5 percent
(3) Low step, 4 percent brightness		100 V	±3 percent	±5 percent
76. **APPROACH LIGHTING SYSTEMS BRIGHTNESS STEPS (NOT APPLICABLE TO MALS).**				
* → a. Change time from step 1 on initial turn on. *				

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* (1) FA-9993/FA-10048	Instruction book	Delay from step 1. Refer to instruction book for specified time.	Same as standard	Same as initial
(2) FA-10700	TI 6850.87, Table 3-14(5)	3.5 seconds	Same as standard	Same as initial
b. Automatic reduction from brightness step 5 to step 4.	298, TI 6850.87, Table 3-14 (6), (7)	15 minutes	±2 minutes	Same as initial *
→77. **FILTERS**	345	All in place	Same as standard	Same as initial
→78. **SEQUENCE FLASHING LIGHTS.**				
a. **ALSF-1**	294	All lamps on	Same as standard	Less than 3 lamps out
b. **ALSF-2**	294	All lamps on	Same as standard	Less than 3 lamps out
c. **ALSF-2/SSALR Dual Mode System.**				
(1) ALSF-2	294	All lamps on	Same as standard	Less than 3 lamps out (not consecutive)
(2) SSALR	294	All lamps on	Same as standard	Less than 2 lamps out
d. **MALSF, MALSR, SSALF, and SSALR**	306	All lamps on	Same as standard	Less than 2 lamps out
e. **Flashing Rate**	300	120 flashes per minute	±2 flashes per minute	Same as initial
f. **Unit Input Voltage**	Order 6950.17	240 V or 120 V	±3 percent	±5 percent (for exceptions see Order 6950.17)
g. **Vertical Angular Alignment ALSF-1, ALSF-2, MALSF, MALSR, SSALF, SSALR.**	299, 308, Order 6850.2	All flashers aimed at 6° or as installed	±1°	±2°

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* →79. **REMOTE CONTROL FUNCTIONS.**	306, 315, Order 6650.5	Operational	Same as standard	Same as initial *
→80. **OBSTRUCTIONS**	348	No obstruction	Same as standard	Same as initial
→81. **MONITOR SETTING.**				
a. **ALSF-1.**				
(1) Incandescent	296	Alarm with 6 lamps out, each loop	Standard +0, –2 lamps	Same as initial
(2) Flashers	297	Alarm with 3 lamps out	Same as standard	Same as initial
b. **ALSF-2.**				
(1) Incandescent	296	Alarm with 6 lamps out each loop	Standard +0, –2 lamps	Same as initial
(2) Flashers	297	Alarm with 3 lamps out	Same as standard	Same as initial
* c. **ALSF-2/SSALR Dual Mode System FA-9993/FA-10048.**				
(1) ALSF-2.				*
(a) Incandescent	296b, Instruction book	CAUTION - 5 lamps out per loop	Same as standard	Same as initial
		FAILURE - 6 lamps out per loop	Same as standard	Same as initial
(b) Flashers	296b, Instruction book	CAUTION - 2 random units out	Same as standard	Same as initial
		FAILURE - 2 consecutive units out, 3 random units out	Same as standard	Same as initial

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(2) SSALR.				
(a) Incandescent	Instruction book	CAUTION - 2 lamps out per loop	Same as standard	Same as initial
		FAILURE - 3 lamps out per loop	Same as standard	Same as initial
(b) Flashers	Instruction book	CAUTION - 1 unit out	Same as standard	Same as initial
		FAILURE - 2 units out	Same as standard	Same as initial
* d. **ALSF-2/SSALR, FA-10700 Monitor Setting.**				
(1) ALSF-2	3.3.2.2.3			
(a) Centerline (inner 1500 feet).				
1 Caution		2 consecutive bars out, or 13 random lamps out	Same as standard	Same as initial
2 Failure		3 consecutive bars out, or 15 random lamps out	Same as standard	Same as initial
(b) Centerline (outer 1500 feet).				
1 Caution.				
a 2400-foot runway		2 consecutive bars out, or 7 random lamps out	Same as standard	Same as initial
b 3000-foot runway		2 consecutive bars out, or 13 random lamps out	Same as standard	Same as initial *

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* 2 Failure.				
a 2400-foot runway		3 consecutive bars out, or 9 random lamps out	Same as standard	Same as initial
b 3000-foot runway		3 consecutive bars out, or 15 random lamps out	Same as standard	Same as initial
(c) Side row bars.				
1 Caution		2 consecutive bars out, or 9 random lamps out	Same as standard	Same as initial
2 Failure		3 consecutive bars out, or 10 random lamps out	Same as standard	Same as initial
(d) Threshold bar.				
1 Caution		3 adjacent lamps out, or 8 random lamps out	Same as standard	Same as initial
2 Failure		4 adjacent lamps out, or 10 random lamps out	Same as standard	Same as initial
(e) 500-foot bar.				
1 Caution		3 random lamps out	Same as standard	Same as initial
2 Failure		4 random lamps out	Same as standard	Same as initial
(f) 1000-foot bar.				
1 Caution		3 random lamps out	Same as standard	Same as initial *

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* 2 Failure		4 random lamps out	Same as standard	Same as initial
(g) Flashers.				
1 Caution		2 random flashes out	Same as standard	Same as initial
2 Failure		3 random flashers out, or 2 adjacent flashers out	Same as standard	Same as initial
(h) Flasher rate failure		±3 flashes per minute	Same as standard	Same as initial
(i) Overall.				
1 Caution		27 lamps/ flashers out	Same as standard	Same as initial
2 Failure		28 lamps/ flashers out	Same as standard	Same as initial
(2) SSALR	294, 345; 3.3.2.2.5			
(a) Centerline.				
1 Caution		1 bar out	Same as standard	Same as initial
2 Failure		2 consecutive bars out	Same as standard	Same as initial
(b) Threshold bar.				
1 Caution		3 random lamps out	Same as standard	Same as initial
2 Failure		4 random lamps out	Same as standard	Same as initial *

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* (c) 1000-foot bar.				
1 Caution		3 random lamps out	Same as standard	Same as initial
2 Failure		4 random lamps out	Same as standard	Same as initial
(d) Flashers.				
1 Caution		1 random flasher out	Same as standard	Same as initial
2 Failure		2 random flashers out	Same as standard	Same as initial
(e) Flasher rate failure		±3 flashes per minute	Same as standard	Same as initial
(f) Overall.				
1 Caution		10 lamps/ flashers out	Same as standard	Same as initial
2 Failure		12 lamps/ flashers out	Same as standard	Same as initial *
82. ALSF-2 POWER TRANSFER (CATEGORY II AND III).	360	1 second or less	Same as standard	Same as initial

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→83. **ODALS AND LDIN LIGHTS.**				
a. **Lamps Operational.**				
(1) ODALS	314, 315	All lamps on	Same as standard	20 percent or less (random) of lamps out
(2) LDIN	314, 315	All lamps on	Same as standard	Locally established
b. **Alignment Vertical and Horizontal.**				
(1) ODALS	Instruction book	Light units plumb	Same as standard	Same as initial
(2) LDIN	Instruction book	Locally established	±1°	±2°
c. **Flashing Rate.**				
(1) ODALS	Instruction book	60 flashes per minute	±1 flash per minute	Same as initial
(2) LDIN	Instruction book	120 flashes per minute	±1 flash per minute	Same as initial
d. **Operating Parameters**	316			
e. **Obstructions Due to Vegetation**	348	No obstruction	Same as standard	Same as initial
84. **LIGHT UNIT OR BAR LOCATION**	Order 6850.2A			
a. **Longitudinal (Along Centerline)**		At station	±6 inches	±12 inches
b. **Lateral (Perpendicular To Centerline).**				
(1) Light bar		At station	±3 inches	±6 inches
(2) Light units		In line	±1 inch	±2 inches
c. **Distance Between Individual Lights.**				
(1) Medium intensity				
(a) Centerline		2.5 feet	±1 inch	±3 inches

Section 1. APPROACH LIGHTING SYSTEMS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(b) Threshold		10 feet	–0.0 feet, +1.0 foot	–0.0 feet, +1.0 foot
(2) High intensity				
(a) Centerline		40-1/2 inches	±1 inch	±3 inches
(b) Treshold		5 feet	±1 inch	±3 inches
(c) Side row		5 feet	±1 inch	±3 inches
d. Mounting Height Tolerance.				
(1) 0 to 6 feet		Light plane	±1 inch	±6 inches
(2) Above 6 to 40 feet		Light plane	±2 inches	±1 foot
(3) Above 40 feet		Light plane	±3 inches	±1 foot
85.-89. RESERVED.				

Section 2. VISUAL APPROACH SLOPE INDICATOR AND PRECISION APPROACH PATH INDICATOR

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→90. **VASI AND PAPI LAMPS, OPERATIONAL.**	320	All lights on	All lights on	A minimum of two lights on/box
→91. **TWO-BAR VASI ANGULAR ELEVATIONS.**	324			
a. Downwind Bar (Bar No. 1)		1/2° (30 minutes) below glide path	±2 minutes	±6 minutes
b. Upwind Bar (Bar No. 2)		Glide path angle	±2 minutes	±6 minutes
→92. **THREE-BAR VASI ANGULAR ELEVATIONS.**	324			
a. Downwind Bar (Bar No. 1)		Commissioned angle (normally 2.75°)	±2 minutes	±6 minutes
b. Middle Bar (Bar No. 2)		Commissioned angle (normally 3.0°)	±2 minutes	±6 minutes

Section 2. VISUAL APPROACH SLOPE INDICATOR AND PRECISION APPROACH PATH INDICATOR

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
c. **Upwind Bar (Bar No. 2)**		Commissioned angle (normally 3.25°)	±2 minutes	±6 minutes
→93. **PAPI ANGULAR ELEVATIONS.**				
a. **Standard Installation**	324			
(1) Light unit 1 (unit nearest runway)		Glide path angle plus 30 minutes	±2 minutes	±6 minutes
(2) Light unit 2		Glide path angle plus 10 minutes	±2 minutes	±6 minutes
(3) Light unit 3		Glide path angle minus 10 minutes	±2 minutes	±6 minutes
(4) Light unit 4		Glide path angle minus 30 minutes	±2 minutes	±6 minutes
b. **Installations for Height Group 4 Aircraft.**	324, Order 6850.2A			
(1) Light unit 1 (unit nearest runway)		Glide path angle plus 35 minutes	±2 minutes	±6 minutes
(2) Light unit 2		Glide path angle plus 15 minutes	±2 minutes	±6 minutes
(3) Light unit 3		Glide path angle minus 15 minutes	±2 minutes	±6 minutes
(4) Light unit 4		Glide path angle minus 35 minutes	±2 minutes	±6 minutes
→94. **VASI LIGHT-BOX HORIZONTAL ALIGNMENT.**	324	Parallel to runway centerline ±1/2°	Same as standard	Same as initial
→95. **PAPI LIGHT-BOX HORIZONTAL ALIGNMENT.**	324	Collinear with line perpendicular to runway centerline within 6 inches	Same as standard	Same as initial
→96. **VASI LIGHT-BAR BOXES VERTICAL ALIGNMENT.**	324	Within 2 minutes of each other	Same as standard	Same as initial

Section 2. VISUAL APPROACH SLOPE INDICATOR AND PRECISION APPROACH PATH INDICATOR (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→97. **VASI TILT SWITCH OPERATION**	323			
a. **Upper Limit**		Aiming angle +0.5° to 1°	Same as standard	Same as initial
b. **Lower Limit**		Aiming angle –0.25° to –0.5°	Same as standard	Same as initial
→98. **PAPI TILT SWITCH OPERATION**	323			
* a. **Upper Limit**		Aiming angle +0.5° to 1° (30 to 60 min.)	Same as standard	Same as initial
b. **Lower Limit**		Aiming angle –0.25° to –0.5° (–15 to –30 min.)	Same as standard	Same as initial *
→99. **PHOTOELECTRIC CONTROL**	321			
a. **Switching Time to High Intensity**		Within one minute	Same as standard	Same as initial
b. **Switching Time to Low Intensity**		Within one minute	Same as standard	Same as initial
c. **Orientation**		Toward north sky	Same as standard	Same as initial
→100. **THREE-STEP BRIGHTNESS SYSTEM REGULATOR OUTPUT CURRENT.**	Instruction book			
a. **High**		6.6 A	+0 A, –0.2 A	Same as initial
b. **Medium**		5.2 A	+0.5 A, –0.2 A	Same as initial
c. **Low**		4.1 A	+0.8 A, –0.2 A	Same as initial
→101. **TWO-STEP BRIGHTNESS SYSTEM LAMP CURRENT.**	Instruction book			
a. **High**		6.4 A	±0.2 A	Same as initial
b. **Low**		4.5 A	+1.2 A, –0.3 A	Same as initial
102. **INPUT VOLTAGE**	Instruction book, Order 6950.17A	Rated input	±5 percent	±10 percent (for exceptions see Order 6950.17A)

Section 2. VISUAL APPROACH SLOPE INDICATOR AND PRECISION APPROACH PATH INDICATOR (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→ 103. RED FILTERS..........	Instruction book	All filters on	Same as standard	At least two filters on with lamp behind missing filter disconnected
→ 104. OBSTRUCTIONS	348	No obstruction	Same as standard	Same as initial
105. REMOTE CONTROL .... FUNCTIONS.	Order 6650.6	Operational	Same as standard	Same as initial
* 106 PAPI LAMP FAIL CIRCUITRY TESTING				
a. Annunciation Contacts Resistance with Lamp Breaker Closed.	325.b.5	17 kΩ	± 1kΩ	Same as Initial
b. Shorting Contacts Resistance with Lamp Breaker Closed	325.b.6	0 Ω	+ 1 Ω, - 0 Ω	Same as Initial
c. Annunciation Contacts Resistance with Lamp Breaker Open	325.b.9	0 Ω	+ 1 Ω, - 0 Ω	Same as Initial
d. Shorting Contacts Resistance with Lamp Breaker Open..........	325.b.10	0 Ω	+ 1 Ω, - 0 Ω	Same as Initial
107.-114. RESERVED.				*

Section 3. RUNWAY-END IDENTIFIER LIGHTS

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→ 115. LAMP OPERATION	329	All on	Same as standard	Same as initial
→ 116. REMOTE CONTROL .... FUNCTIONS.	Order 6650.6	Operation	Same as standard	Same as initial
→ 117. VERTICAL ALIGNMENT.				
a. With Baffles	330	3°	±1°	Same as initial
b. Without Baffles..........	330	10°	±1°	±2°
c. ODREIL..........	Instruction book	Lights plumb	Same as standard	Same as standard
→ 118. HORIZONTAL ALIGNMENT.				
a. With Baffles	330	10°	±1°	±2°
b. Without Baffles..........	330	15°	±1°	±2°

Section 3. RUNWAY-END IDENTIFIER LIGHTS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→ 119. FLASHING RATE.				
a. REIL	300, Instruction book	120 flashes per minute	±2 per minute	Same as initial
b. ODREIL	Instruction book	60 flashes per minute	±1 per minute	Same as initial
120. INPUT VOLTAGE	331, Order 6950.17	120 V, 240 V, or set transformer tap for the applied voltage	±3 percent	±5 percent (for exceptions see Order 6950.17)
121. OBSTRUCTIONS	348	No obstruction	Same as standard	Same as initial
122.-129. RESERVED.				

Section 4. OBSTRUCTION LIGHTS

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
130. FIXED OBSTRUCTION LIGHTS	335	All lamps on	Same as standard	Same as initial
→ 131. FLASHING HAZARD BEACON FREQUENCY (300MM CODE BEACON).	336	26 flashes per minute	±14 flashes per minute	Same as initial
→ 132. ROTATING HAZARD BEACON FLASHING FREQUENCY.	336	12 to 40 flashes per minute	Same as standard	Same as initial
→ 133. FLASHING FREQUENCY OF HIGH-INTENSITY, WHITE OBSTRUCTION LIGHTS.	336	40 flashes per minute	±2 flashes per minute	Same as initial
→ 134. LAMP SOCKET VOLTAGE FLASHING FREQUENCY.	Order 6950.17	Rated lamp voltage	±3 volts	±5 volts (for exceptions see Order 6950.17)
135. FUSES FOR TRANSFORMER AND FEEDER.	Order 6950.18	Not to exceed 200 percent of transformer rating	Same as standard	Standard +0.0, −25 percent

Section 4. OBSTRUCTION LIGHTS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
136. **ROTATING HAZARD BEACONS**	433			
→ **a. Beacon Drums.**				
(1) 36-inch		6 revolutions per minute	Same as standard	Same as initial
(2) 24-inch		12 revolutions per minute	Same as standard	Same as initial
→ **b. Lampchanger.**				
(1) Contacts with series coil................ energized.		3/32 inch	±1/32 inch	Same as initial

Section 4. OBSTRUCTION LIGHTS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(2) Spring tension, tilting table		7 1/2 ounces	±1/2 ounce	Same as initial
(3) Spring tension, rotating table		19 ounces	±1/2 ounce	Same as initial
(4) Trip coil (shunt coil) adjustment		As required	Same as standard	Same as initial
c. **Collector Ring**				
(1) Brush, percent of contact area		85 percent minimum	Same as standard	Same as initial
(2) Brush-holder, clearance to rings		3/32 inch	Same as standard	Same as initial
(3) Brush tension.				
(a) Carbon		12 ounces	±2 ounces	Same as initial
(b) Metite		2 1/2 pounds	±1/2 pound	Same as initial
(4) Brush Replacement		When worn to 1/3 of original length	Same as standard	Same as initial
d. **Beacon Motor.**				
(1) End-play.				
(a) Ball bearing		.003-inch maximum	Same as standard	Same as initial
(b) Sleeve bearing		.012-inch maximum	Same as standard	Same as initial
(2) Clutch drag, 24- and 36-inch		13 ft. lbs.	±2 ft. lbs.	Same as initial
→ e. **Input Voltage**		Same as lamp voltage rating	±5 percent	±10 percent
137.-144. RESERVED.				

Section 5. TIME SWITCHES AND PHOTOELECTRIC DEVICES

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
145. CONTROL DEVICES	431, 432, 337			
a. **Input Voltage**		120 V ac	±5 percent	±10 percent
b. **Time Switches.**				

Section 5. TIME SWITCHES AND PHOTOELECTRIC DEVICES (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→ (1) Time keeping		Exact time	±5 minutes per 14 days	Same as initial
→ (2) Turn-on time		15 minutes before sunset	±5 minutes	Same as initial
→ (3) Turn-off time		15 minutes after sunset	±5 minutes	Same as initial
(4) Dial setting at latitudes south of 36° north.		Operate at degree marked	±1°	Same as initial
(5) Dial setting at latitudes north of 36° north.		Operate at degree marked	±1/2°	Same as initial
c. Photocell.				
→ (1) Orientation from vertical		0° to 25°	Same as standard	Same as initial
→ (2) Orientation from true north		0° (true north)	±5°	Same as initial
→ (3) Turn-on		15 minutes before sunset	±5 minutes	Same as initial
→ (4) Turn-off		15 minutes after sunrise	±5 minutes	Same as initial
146.-150. RESERVED.				

Section 6. FOCUSING AND LAMPING

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→**151. HAZARD BEACON (300MM CODE BEACON).**	338			
a. Light Source Center		3/8-inch below the focal plane (belt center)	Same as standard	Same as initial
b. Light Beam Elevation		4° above the horizontal plane	Same as standard	Same as initial

Section 6. FOCUSING AND LAMPING (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
→152. **ROTATING BEACON, 24-INCH**	434			
a. **Lamp Filament**		Image must be in the exact center of the parabolic reflector	Same as standard	Same as initial
b. **Light Beam Elevation**		1.5° above horizontal	Same as standard	Same as initial
→153. **ROTATING BEACON, 36-INCH**	434			
a. **Focal Length**		The distance between the presetter tip and each inner face of the doublet lens shall be equal. The focal length of the lamp filament to the doublet lens should be approximately 3 inches.		
b. **Light Beam Elevation**		1.5° above horizontal	Same as standard	Same as initial
→154. **BEACON LAMP, AUXILIARY AND PRINCIPLE REFLECTOR POSITIONS.**	434	Be positioned in relation to each other so that the reflecting image is superimposed on the filament itself. The reflecting image should be the same size as the actual lamp filament.		
155.-169. **RESERVED.**				

CHAPTER 4. PERIODIC MAINTENANCE

170. REQUIRED MAINTENANCE ACTIVITIES.

a. General. This chapter establishes all the maintenance activities that are required for lighted navigational aids on a periodic, recurring basis, and the schedules for their accomplishment. The chapter is divided into two sections. The first section identifies the performance checks (i.e., tests, measurements and observations) of normal operating controls and functions which are necessary to determine if operation is within established tolerances/limits. The second section identifies other tasks that are necessary to prevent deterioration and/or to ensure reliable operation. Refer to the latest edition of Order 6000.15, General Maintenance Handbook for Airway Facilities, for additional general guidance, and Orders 6950.17, Maintenance of Electrical Systems in Buildings; 6950.18, Maintenance of Electrical Distribution Systems; and 6950.22, Maintenance of Electrical Power and Control Cables, for specific procedures referenced in the various sections of * this chapter. Two or three digit references such as 71, 115, and 345 are located in this handbook. Those such as 3.3.2.2.3 are in TI 6850.87, Dual Mode High Intensity Approach Lighting System (ALSF-2/SSALR) System Type FA-10700. *

b. Supplemental Maintenance Instructions. For visual approach slope indicator (VASI), precision approach path indicator (PAPI), runway-end identifier lights (REIL), medium intensity approach lighting systems (MALS, MALSF, MALSR), omnidirectional approach lighting systems (ODALS), obstruction lights, short simplified approach lighting systems (SSALS, SSALF, SSALR), and lead-in lights (LDIN), sector managers shall:

(1) Arrange to obtain the regular visual checks from any reliable source available. This may be accomplished by an FAA maintenance technician while in the area for other work requirements, pilot reports, airport manager reports, fixed base operator reports, etc.

(2) Where required, negotiate an agreement (preferably written) with non-FAA personnel to visually check the facility operational status and immediately report any burned out lamps to the proper FAA office.

(3) Take appropriate action to correct any out-of-tolerance conditions.

Section 1. PERFORMANCE CHECKS
Subsection 1. ALSF CATEGORY-I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR)

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
* **171. MONTHLY** .... Make visual operational checks of all lights, including flashers, on all brightness steps.	71	294; 3.3.2.2.3-10
172. QUARTERLY.		
a. Record meter readings	74	295; 6.2.5
b. Check ALS monitor circuit to tower	81	296a(1), 296b(1), 296b(2)
c. Check SFL monitor	81	297
d. Check SFL flash rate	78e	300; 3.3.2.2.5
e. Check brightness step changing time	76a	Instruction book; TI 6850.87, Table 3-14(5) *

Section 1. PERFORMANCE CHECKS (Continued)
Subsection 1. ALSF CATEGORY-I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR) (Continued)

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
173. ANNUALLY.		
* a. Check ALS 15-minute timer for brightness step 5 at the tower	76b	298; TI 6850.87, Table 3-14(6), (7)
b. Check ALS monitor for each loop	81	296b(2) *
c. Check vertical and horizontal alignment of all light fixtures	72, 73	299
174. RESERVED.		

Subsection 2. ALSF-2 CATEGORY-II AND III SYSTEMS AND ALSF-1 ON CATEGORY-II SYSTEMS

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
175. WEEKLY.		
* a. Make visual operational checks for all lights, including flashers, on all brightness steps.	71	294; 3.3.2.2.3-10 *
b. Check ALS monitor circuit to tower	81	296a(1) 296b(1)
176. MONTHLY.		
a. Check ALS monitor for each loop	81	296a(2) 296b(2)
* b. Record meter readings	74	295; 6.2.5
177. QUARTERLY.		
a. Check brightness step changing time	76a	Instruction book; TI 6850.87, Table 3-14 (5)
b. Check SFL monitor	81	297
c. Check SFL flash rate	78e	300; 6.2.8.3
178. ANNUALLY.		
a. Check vertical and horizontal alignment of all light fixtures	72, 73	299; 6.2.8.5.1, 6.2.8.5.2, 6.2.9.3.1, 6.2.9.3.2 *
b. Check ALS 15-minute timer for brightness step 5 at the tower	76b	298
179.-180. RESERVED.		

Section 1. PERFORMANCE CHECKS (Continued)
Subsection 3. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEM - (MALS, MALSF, MALSR)

Performance Checks	Reference Paragraph	
	Standards and Tolerances	Maintenance Procedures
181. **MONTHLY** ... Make visual operational checks of all lights, including flashers, on all brightness steps.	71c	306
* 182. **QUARTERLY.** *		
a. Check SFL flash rate ...	78e	300
b. Check remote control function ...	79	306
183. **ANNUALLY.**		
a. Check all fixtures, including mirrors if installed, for vertical and horizontal alignment. ...	72, 73	308
b. Record meter readings ...	75, 78f	307, Order 6950.17A
184. **RESERVED.**		

Subsection 4. ODALS AND LDIN

Performance Checks	Reference Paragraph	
	Standards and Tolerances	Maintenance Procedures
185. **MONTHLY** ... Make visual operational checks of all lights on all steps.	83	314
* 186. **QUARTERLY** ... a. Check remote control functions.	79	315
b. Record Meter Reading	83	316
187.-188 **RESERVED.** *		

Section 1. PERFORMANCE CHECKS (Continued)
Subsection 5. VASI AND PAPI

Performance Checks	Reference Paragraph	
	Standards and Tolerances	Maintenance Procedures
189. MONTHLY.		
a. VASI. Visually check operation of all lights and lamp box alignment.	90, 91, 92, 94, 96	320
b. PAPI. Visually check operation of all lights and lamp box alignment.	90, 93, 95	320
189-1. QUARTERLY.		
a. VASI. Check vertical and horizontal alignment of all light boxes.	91, 92, 94, 96	324
b. PAPI. Check vertical and horizontal alignment of all light boxes.	93, 95	324
190. SEMIANNUALLY.		
a. VASI.		
(1) Check operation of controls	99	321
(2) Record meter readings	100, 101, 102	322, Instruction book
(3) Check VASI-2 tilt switch	97	323
(4) Withdrawn - CHG 1		
b. PAPI.		
(1) Check operation of controls	99	321
(2) Record meter readings	101, 102	322, Instruction book
(3) Check PAPI tilt switches	98	323
* (4) Check lamp fail circuitry.	106	325 *
191. ANNUALLY.		
a. VASI. Check remote control functions (if applicable)	105	321
b. PAPI. Check remote control functions (if applicable)	105	321
192. RESERVED.		

Section 1. PERFORMANCE CHECKS (Continued)
Subsection 6. REIL

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
* **193. QUARTERLY.**		
a. Make visual operation checks of all lights. Check and clean exterior as required.	115	329, 345 *
b. Check both fixtures for damaged or misaligned lights	117, 118	330
c. Record input voltage at power control cabinet	120	331, Order 6950.17
d. Check device that shuts down REIL if one flasher fails (if applicable).	NA	332
e. Check flasher rate	119	300
194. ANNUALLY Check remote control functions.	116	329

Subsection 7. OBSTRUCTION LIGHTS

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
195. WEEKLY Check for burned-out lamps on installations with single obstruction light fixtures.	130	335
196. MONTHLY Check for burned-out lamps on installations with double obstruction light fixtures.	130	335
197. ANNUALLY.		
a. Check frequency of flashing and/or rotating beacon	131, 132, 133	336
b. Check operation of automatic control devices and alarm circuits	145	337, 431, 432
c. Check focusing and aiming of lamps	151, 152, 153, 154	338, 434
198.-201. RESERVED.		

Section 2. OTHER MAINTENANCE TASKS
Subsection 1. ALSF CATEGORY I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR)

Maintenance Task	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
202. MONTHLY. Visually check for damaged or misaligned lamps, and cleanliness.	71, 72, 73, 77	345
203. QUARTERLY. Check the approach line-of-sight clearance for vegetation and other obstructions.	80	348
204. ANNUALLY.		
a. Check all light supports for rigidity, proper guy tensions, and obvious misalignment.	NA	346
b. Check oil level in regulators (if applicable)	NA	347
c. Check all structures for rot and corrosion	NA	NA
d. Clean substation compartments. (Observe safety precautions.)	NA	NA
e. Check for water in LB-1 light bases	NA	349
f. Check operation of oil circuit breaker mechanism (if applicable)	NA	350
g. Check all lightning arrestors, ground connections, electrical connections, and safety devices associated with power distribution equipment at terminal poles, substations and transformer pads.	NA	351
h. Open and clean all ALS open, flush fixtures, including flasher units, to maintain full light output. Clean all glass-ware, reflectors, color filters, surface lights and flashers.	NA	352
i. Check all main power switching equipment	NA	Order 6950.18
j. Inspect all relays	NA	353
* **k.** Service timer motor and timer contacts (if applicable)	NA	354 *
l. Check number and elevation angle data at each station	NA	355
205. EVERY 3 YEARS.		
a. Check insulation resistance and continuity of all main power and control cables. Record all measurements and compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 1. ALSF CATEGORY I SYSTEMS (ALSF-1, SSALS, SSALF, SSALR) (Continued)

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
b. Measure and record insulation and conductor resistance of ALS series loop. Compare measurements with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
c. Check accuracy of regulator loop ammeters	NA	356; 6.2.3.5, 6.3.3
d. Check dielectric strength and condition of insulation oil in the regulators (if applicable).	NA	347
206. AS REQUIRED.		
a. Change all PAR-56 incandescent lamps after 400 hours of operation on brightness 5.	NA	357
* b. Change all flasher lamps in accordance with maintenance procedures.	NA	357
c. Open and clean sealed type ALS flush fixtures if the need is observed during maintenance tasks.		*
207.-214. RESERVED.		

Subsection 2. ALSF-2 CATEGORY-II AND -III SYSTEMS

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
215. MONTHLY.		
a. Check for damaged or misaligned lights, abnormal intensity, and cleanliness.	71, 72, 73, 77	345, 352
b. Check approach line-of-sight clearance for vegetation and other obstructions	80	348
216. ANNUALLY.		
a. Check all light supports for rigidity, proper guy tensions, and obvious misalignment.	NA	346
b. Check oil level in regulators (if applicable)	NA	347
c. Check all structures for rot and corrosion	NA	NA

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 2. ALSF-2 CATEGORY-II AND -III SYSTEMS (Continued)

Maintenance Task	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
d. Clean substation compartments. (Observe safety precautions.)..........	NA	NA
e. Check for water in LB-1 light bases..........	NA	349
f. Check operation of oil circuit breaker mechanism (if applicable).......	NA	350
g. Check all lightning arrestors, ground connections, ... electrical connections, and safety devices associated with power distribution equipment at terminal poles, substations, and transformer pads.	NA	351
h. Open and clean standard open based ALS flush fixtures, ... including flasher units, to maintain full light output. Clean all glassware, reflectors, color filters, surface lights and flashers.	NA	349, 352
i. Check all main power switching equipment..........	NA	Order 6950.18
j. Inspect all relays..........	NA	353
* k. Service timer motor and timer contacts (if applicable)..........	NA	354 *
l. Check number and elevation angle data at each station..........	NA	355
m. Check power transfer for Category II conditions..........	82	360
n. Visually inspect electrical connections for signs of overheating........	NA	NA
217. EVERY 3 YEARS.		
a. Check insulation resistance and continuity of all main power.......... and control cables. Record all measurements and compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
b. Check accuracy of regulator loop ammeters..........	NA	356; 6.2.3.5, 6.3.3
c. Check dielectric strength and condition of insulation.......... oil in the regulators (if applicable).	NA	347
d. Measure and record conductor and insulation resistance of.......... dual mode ALS series loop cable. Compare measurements with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 2. ALSF-2 CATEGORY-II AND -III SYSTEMS (Continued)

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
218. AS REQUIRED.		
a. Change all PAR-56 incandescent lamps after 400 hours of operation on brightness 5.	NA	357
b. Change all sequenced flasher lamps after 900 hours of operation on high brightness or in accordance with the manufacturers technical instruction manual.	NA	357
c. Open and clean sealed type ALS flush fixtures if the need is observed during maintenance tasks.	NA	352
219.-225. RESERVED.		

Subsection 3. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEMS (MALS, MALSF, MALSR)

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
* **226. QUARTERLY.**		*
a. Visually check for damaged or misaligned lights or mirrors	71, 72, 73, 77	345
b. Check the approach line-of-sight clearance for vegetation and other obstructions.	80	348
227. ANNUALLY.		
a. Check all structures for rot or corrosion. Check all light supports for rigidity, guy tensions, and obvious misalignment.	NA	346
b. Inspect and clean, if required, interior of all cabinet-mounted flashing units.	NA	NA
c. Check safety devices, ground connections, lightning arrestors, and safety conditions of power distribution equipment terminal poles, light supports, and sub-station transformer pads.	NA	351
d. Clean exterior of lamp fixtures as required	NA	345

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 3. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEMS (MALS, MALSF, MALSR) (Continued)

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
e. Check for cleanliness and condition of all glassware and reflectors.	NA	345
f. Open and clean lighting fixtures (including flasher units) to maintain full light output. This may be scheduled for partial accomplishment semiannually.	NA	NA
g. Check fuseholders, circuit breakers, and contacts	NA	Order 6950.17
h. Inspect all relays	NA	353
* **i.** Service timer (if applicable)	NA	354 *
228. EVERY 3 YEARS. Check conductor and insulation resistance of all power and control cables. Record all measurements and compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
229. AS REQUIRED.		
a. Withdrawn - CHG 2		
b. Change all PAR-56 (threshold) lamps after 400 hours of operation on maximum brightness.	NA	358
c. Change all sequenced flasher lamps after 900 hours of operation on high brightness or in accordance with the manufacturer instruction manual.	NA	358
d. Open and clean sealed type ALS flush fixtures if the need is observed during maintenance tasks.	NA	352
230.-236. RESERVED.		

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 4. ODALS AND LDIN

Maintenance Task	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
* **237. QUARTERLY.** *		
a. Visually check for damaged or misaligned lights or mirrors	83a	314, 315
b. Check the approach line-of-sight clearance for vegetation and other obstructions.	83e	348
238. SEMIANNUALLY. Check all fixtures, including mirrors if installed, for alignment and elevation.	83b	Instruction book
239. ANNUALLY.		
a. Check for cleanliness and condition of all glassware and reflectors.	NA	345
b. Check all structures for rot or corrosion. Check all light supports for rigidity, guy tensions, and obvious misalignment.	NA	346
c. Inspect and clean, if required, interior of all cabinet mounted flashing units.	NA	Instruction book
d. Check safety devices, ground connections, lightning arrestors, and safety conditions of power distribution equipment at terminal poles, light supports, and substation pads.	NA	351
240. EVERY 3 YEARS Check conductor and insulation resistance of all power and control cables. Record all measurements and compare them with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
241. AS REQUIRED.		
a. Change all ODALS lamps after 500 hours on maximum brightness.	NA	359
b. Change all LDIN lamps in accordance with manufacturers instructions.	NA	359
242.-247. RESERVED.		

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 5. VASI AND PAPI

Maintenance Task	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
248. QUARTERLY.		
a. VASI.		
(1) Check lamps and filters for cleanliness and the lamp box for structural defects such as chipping, cracking, or bending.	NA	345b(1), (3), (4)
(2) Check lamp box for water or signs of water damage	NA	NA
(3) Check regulator oil level (if applicable)	NA	361
b. PAPI.		
(1) Check lamps and filters for cleanliness and the lamp box for structural defects such as chipping, cracking, or bending.	NA	345b(1), (3), (4)
(2) Check for water or signs of water damage and broken or missing screens in the lamp box.	NA	NA
c. Check approach slope line-of-sight clearance for vegetation and other obstructions.	104	348
249. ANNUALLY.		
a. VASI.		
(1) Inspect system	NA	363b(1)
(2) Check wiring	NA	363b(2)
(3) Inspect open-type relay	NA	363b(3)
(4) Check oil switch and fused cutout	NA	363b(4), (5)
(5) Check system grounding	NA	351
b. PAPI.		
(1) Inspect system	NA	363b(1)
(2) Check wiring	NA	363b(2)

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 5. VASI AND PAPI (Continued)

Maintenance Task	Reference Paragraph	
	Standards and Tolerances	*Maintenance Procedures*
(3) Inspect open-type relay	NA	363b(3)
(4) Check fused cutout switch	NA	363b(5)
(5) Check system grounding	NA	351
250. EVERY 3 YEARS.		
a. VASI.		
(1) Check conductor and insulation resistance of all power and control cables. Record all measurements and compare them with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
(2) Inspect grasshopper fuses (if applicable) Replace as required.	NA	Manufacturer's instruction book
* **b. PAPI.** Check conductor and insulation resistance of all power and control cables. Record all measurements and compare them with previous readings. Use FAA form 6000-8 or equal.	Order 6950.22	Order 6950.22 *
251. AS REQUIRED Change all VASI and PAPI lamps after 2000 hours of operation on high brightness.	NA	362
252.-257. RESERVED.		

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 6. REIL

Maintenance Task	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
258. QUARTERLY.		
a. Check approach line-of-sight clearance for vegetation and other obstructions.	121	348
b. Check cleanliness of reflectors	NA	345
* **259. ANNUALLY**	NA	351
a. Check ground connections at terminal pole and at each light fixture.		
b. Clean interiors of both the control panel and the flasher cabinets	NA	NA
c. Check safety devices	NA	364
d. Check light supports and control cabinet for rigidity	NA	346
e. Inspect all power distribution equipment and protective devices at terminal pole and at the lights.	NA	351
f. Inspect relays	NA	353
g Service timer motor and contacts (if applicable)	NA	354
260. EVERY 3 YEARS Check conductor and insulation resistance of all power and control cables. Record all measurements and compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
261.-267. RESERVED.		*

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 7. OBSTRUCTION LIGHTS

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
268. ANNUALLY	NA	365
a. Check contactor.		
b. Check conduit, and clear the water trap.		
c. Check fuses, switches, and wiring.		
d. Check telltale mechanism.		
e. Visually check ground connection.		
269. EVERY 3 YEARS Check and record conductor and insulation resistance of cables. Compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
270. AS REQUIRED	NA	366
a. Change lamp after 80 percent of rated lamp life.		
b. Check lamp voltage.		
c. Clean optical system.		
d. Clean fixture.		
e. Check condition of wiring and lamp sockets.		
f. Check weatherproofing seals.		
g. Check lightning protection system.		
271.-276. RESERVED.		

Section 2. OTHER MAINTENANCE TASKS (Continued)
Subsection 8. HAZARD BEACONS

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
277. ANNUALLY .... Check condition of wire, insulation, splices and fuses.	NA	Order 6950.22
278. EVERY 3 YEARS .... Check and record conductor and insulation resistance of cables. Compare with previous readings. Use FAA Form 6000-8 or equal.	Order 6950.22	Order 6950.22
279. AS REQUIRED	NA	366
a. Change lamps after 80 percent of rated lamp life.		
b. Clean glassware.		
c. Clean fixture.		
d. Clean flasher contacts.		
e. Check and clean contactor.		
f. Check booster transformer.		
g. Check lamp voltage.		
280.-284. RESERVED.		

CHAPTER 5. MAINTENANCE PROCEDURES

285. GENERAL.

This chapter establishes the procedures for accomplishing the various essential maintenance activities that are required for lighted navigational aids, on either a periodic or incidental basis. The chapter is divided into three sections. The first section describes the procedures to be used in making the performance checks listed in chapter 4, section 1. The second section describes the procedures for doing other maintenance tasks listed in chapter 4, section 2. The third section describes the procedures for doing special maintenance tasks, usually nonscheduled and not listed in chapter 4. Refer to Order 6000.15A, General Maintenance Handbook for Airway Facilities, for additional general guidance.

286. RESERVED.

Section 1. PERFORMANCE CHECK PROCEDURES

287. TECHNICAL PERFORMANCE RECORD ENTRIES.

Order 6000.15A contains policy, guidance, and detailed instructions for field utilization of the Technical Performance Record. Entries shall be made in accordance with the instructions published in Order 6000.15A. The requested information shall be recorded on the technical performance record form (form being developed) or temporary FAA form 6000-8. Figure 5-1, sheet 1 and 2, is a sample of FAA form 6000-8 which shows typical headings and entries for an ALSF-1 system. All entries below "nominal" block entries are indicators of system performance. If a parameter is found to be out of tolerance and is corrected at a later date, the date of the correction shall be indicated. Identify on the form the parameter to be recorded in each column, use continuation forms as required. The following subparagraphs describe the column headings and the type of information to be entered.

a. Date. Date of entry.

b. Time. Time of entry. Greenwich Mean Time (GMT).

c. Input Voltage. Use required columns to record requested input voltage. Measure ALSF voltage on brightness 4 (B4) with flashers operating. Measurements for other systems will be made with the system on high brightness. On single-phase systems, measure line 1 to neutral (L1-N), line 2 to neutral (L2-N), and line 1 to line 2, (L1-L2). On three-phase systems, record each phase to neutral as read from the panel-mounted meter.

d. Input kW/Input Current. Identify a column to be used to record the input kW or input line current. On systems with a panel-mounted kW meter, the information may be read from the panel-mounted meter. On other systems, portable instruments may be used to measure the input line current. For high intensity systems (ALSF-I, ALSF-II, SSALR, etc.), record the information with the system operating on brightness 4 (B4) with the flashers on. On other systems, record the information with the system on high brightness.

e. Output Current. Use the required number of columns to record the output current for all brightness steps, from each regulator or power and control assembly.

f. Output Voltage. Use the required number of columns to record the system output voltage as measured on high brightness. On parallel systems, record the voltage as measured from line 1 to neutral (L1-N), line 2 to neutral (L2-N), and line 1 to line 2 (L1-L2). When requested, record the voltage as measured at each light station. On series systems, record loop voltages as measured on the panel-mounted meter.

g. Flasher Voltages. If applicable, identify a column to record the flasher control cabinet (master timer) input and output voltage. Record voltage with the flashers operating on high brightness.

h. Monitor Current. If applicable, identify required columns to record the load monitor microamp/voltage reading for all monitored loops and brightness levels.

i. Elapsed Time Meters (ETM). If elapsed time meters are installed, identify the required columns and record the elapsed times.

j. Horizontal Alignment. Identify a column as "Horizontal Alignment" and use this column to indicate if the system meets standards. A check mark (√) means the system meets standards.

TECHNICAL PERFORMANCE RECORD — **CONTINUATION OR TEMPORARY RECORD/REPORT FORM**

FACILITY ALSF-1 (ATCT, FSS, ARTCC, VOR, LOC, ETC.)	DATES FROM TO	SUPERVISOR'S SIGNATURE
LOCATION (CITY, STATE, AIRPORT, OTHER)	EQUIPMENT WESTINGHOUSE FA-4404 (A/G, DF, COMPONENTS, ETC.)	FREQ.

DATE	TIME	INPUT VOLTAGE			OUTPUT CURRENT REGULATOR 1					REGULATOR 2					REGULATOR 3					REMARKS	INITIALS
		ØA	ØB	ØC	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
NOMINAL		2400	2400	2400	8.3	9.9	12.1	15.3	20	8.3	9.9	12.1	15.3	20	8.3	9.9	12.1	15.3	20		

FAA Form 6000-8 (3-76) FORMERLY FAA FORM 418-24

Figure 5-1. Sample FAA Form 6000-8. (Sheet 1 of 2)

TECHNICAL PERFORMANCE RECORD

CONTINUATION OR TEMPORARY RECORD/REPORT FORM

FACILITY ALSF-1 (ATCT, FSS, ARTCC, VOR, LOC, ETC.)	DATES FROM TO	SUPERVISOR'S SIGNATURE
LOCATION (CITY, STATE, AIRPORT, OTHER)	EQUIPMENT WESTINGHOUSE FA-4404 (A/G, DF, COMPONENTS, ETC.)	FREQ.

			OUTPUT VOLTAGE					LOAD MONITOR													
DATE	TIME	INPUT KW	REG 1	REG 2	REG 3	FLASHER INPUT VOLTAGE	FLASHER OUTPUT VOLTAGE	LOOP 1 B5	LOOP 2 B5	LOOP 3 B5	ALSF B5 ETM	FLASHER ETM	HORIZONTAL ALIGNMENT	VERTICAL ALIGNMENT	VISIBILITY OBSTRUCTIONS	VISUAL CHECKS				REMARKS	INITIALS
NOMINAL			1450	1150	1260	240	240	0	0	0			✓	✓	✓	✓					

FAA Form 6000-8 (3-76) FORMERLY FAA FORM 418-24

Figure 5-1. Sample FAA Form 6000-8. (Sheet 2 of 2)

k. Vertical Alignment. Identify a column as "Vertical Alignment" and use this column to indicate if the system meets standards. A check mark (√) means the system meets standards.

l. Visibility Obstructions. Identify a column as "Visibility Obstructions" and use this column to indicate if the system meets standards. A check mark (√) means the system meets standards. If an obstruction is noted, enter a description in the remarks column and record an (X) until the obstruction is removed.

m. Visual Checks. Identify a column as "Visual Checks," and use this column to indicate if the overall system condition and performance is normal. A check mark (√) means the system condition and performance is normal. If abnormal conditions are noted, enter a description in the remarks column, and record an (X) until condition is corrected.

n. Remarks. Make technical comments in the remarks column.

o. Initial. Initials of technician making entries.

288.-293. RESERVED.

Subsection 1. HIGH-INTENSITY ALS SYSTEMS

294. VISUAL CHECKS.

a. Purpose. This procedure verifies visually the operational status and condition of the system.

b. Procedure. Request air traffic (AT) personnel to turn on the ALS and operate the system through brightness steps 1 through 5. Observe system operation on all brightness steps and record all lamp failures or monitor alarms. Verify that the brightness step indicator lights indicate the proper step. Verify operation in both modes of dual mode systems.

295. METER READINGS.

a. Purpose. These readings are used to establish a record of the normal operating parameters and to provide reference data to be used for preventive maintenance and troubleshooting of the equipment in the event of an equipment failure.

b. Procedure. The following meter readings shall be recorded on the technical record form specified in paragraph 287. If there are no installed meters, use portable instruments. On dual mode systems, record the following meter readings when operating in the ALSF mode.

(1) Input voltage, on step 4 with flashers on.

(2) Input kilowatts, on step 4 with flashers on.

(3) Output current of each series loop on each step.

(4) Output voltage for each loop on step 5.

* (5) Flasher control input voltage with flashers on high brightness. *

(6) Load monitor microamperes or voltage for each loop while operating on step 5. (Record readings from panel-mounted meter.)

(7) Elapsed time meter(s) for steady-burning lights.

(8) Elapsed time meter for flashers.

c. Compare all readings with previous readings and investigate difference. A change may be an indication of impending failure. If readings are beyond tolerance, determine the cause and correct as required.

296. ALS MONITOR CHECK.

a. Single Mode Systems.

(1) Steady-Burning Lights Monitor.

(a) Purpose. This check ensures the normal operation of the monitor system.

(b) Procedure. Turn the substation on from the remote position. The monitor should alarm. After a delay of a few seconds the buzzer will stop and the monitor lights should come on.

(2) Steady-Burning Lights Load Monitor.

(a) Purpose. This check verifies normal operation of the system with five lights out. It also validates an alarm operation when six lights are out.

(b) Procedure.

1 Obtain local control.

2 With substation on, verify that all incandescent lamps are on prior to test.

CAUTION: Lamps may be hot.

3 With the station off, remove five lamps from each loop in the system. Do not remove the same set of lamps for each periodic check.

4 Energize the substation and select brightness 5.

5 Load monitor should indicate normal operation. If it does not, the monitor may require adjustment.

6 Turn substation off, remove one additional lamp from a single loop. (Total of six lamps out in one loop.)

7 Energize the substation and select brightness 5.

8 The load monitor on the selected loop should indicate a lamps-out alarm, both at the substation and at the remote panel.

9 If the load monitor is operational, replace all the lamps in the loop tested.

10 Repeat steps 6 through 9 for each loop to be tested.

11 If adjustment is required, refer to the manufacturer's instructions.

b. Dual Mode Systems.

(1) Steady-Burning Lights Monitor.

(a) Purpose. This check insures normal operation of the monitor system.

(b) Procedure.

1 Turn the substation on from the remote position, the remote panel should indicate normal system operation.

2 Operate the system for the duration of the monitor inhibit (approximately 5 minutes).

3 Operate the system on all monitored brightness levels, verify normal monitor indications. Monitor is inhibited after each on-off, brightness, or mode change.

(2) Steady-Burning Lights Load Monitor.

(a) Purpose. This check verifies proper display of a caution and/or failure monitor alarm when more than the prescribed number of lamps have failed.

(b) Procedure.

1 Obtain local (substation) control.

2 With approach lights on, select SSALR. Verify that all SSALR lamps are on. Operate the system on all of the monitored brightness steps, allowing approximately 5 minutes between steps.

NOTE: The caution/failure indicators on the local and remote control panel may be inhibited up to 4 minutes after each on-off, brightness, or mode change.

3 Monitor should indicate normal operation.

CAUTION: Lamps may be hot.

4 With approach lights off, remove two lamps from each SSALR loop. If relay type shorting device is used replace each removed lamp with a short jumper wire. If solid state shorting devices are used DO NOT replace lamp with a jumper wire.

5 With approach lights on, a caution should be indicated on each loop. After the duration of the monitor inhibit, a caution light on the local control panel should be on.

6 Select each of the successive monitored brightness levels. A caution should be displayed with two failed lamps, as in step 5.

7 With approach lights off, remove an additional lamp from each loop (three lamps out per loop). If

relay type shorting devices are used, replace lamp with a short wire. Do not jumper solid-state shorting device.

8 Select approach lights on, operate system on each monitored brightness step. A failure should be indicated on each loop, and after the monitor inhibit, a failure light on the local control panel should be on.

9 With approach lights off, remove two additional lamps from each of the ALSF loops, five total from each loop. If relay type shorting devices are used replace each lamp with a short jumper wire. Do not short solid state shorting devices.

10 With approach lights on, select ALSF and the lowest monitored brightness level. Each loop should indicate a caution. Operate system for the duration of the monitor inhibit. A caution light should be displayed on the local control panel.

11 Select, in turn, each of the monitored brightness steps and verify that a caution is indicated for each loop, as in step 10.

12 With approach lights off, remove one additional lamp from each loop (six lamps out per loop).

13 With approach lights on, select ALSF and the lowest monitored brightness level. A failure should be indicated on each loop. After the monitor inhibit, the failure light on the local control panel should be on.

14 Select, in turn, each of the monitored brightness steps and verify that a failure is indicated for each loop, as in step 13.

15 After monitor validation, replace all lamps and verify normal system operation.

16 If monitor requires adjustment, refer to the manufacturer's instructions for procedures.

c. Monitor Out-of-Tolerance. When a monitor is out of tolerance and not immediately restorable, a Notice to Airmen (NOTAM) should be issued stating that the specific monitor is not available. Category I operations may be continued, provided all other system tolerances are maintained as required in this handbook. Category II or Category III operations may be continued, provided all other system tolerances are maintained as required in this handbook; except that every 8 hours during Category II or Category III operations, the approach lighting system is visually checked to verify that the system lighting configuration is within tolerance limits.

297. SEQUENCE FLASHER (SFL) MONITOR CHECK.

a. Single Mode Systems.

(1) Purpose. This check insures the normal operation of the sequence flasher monitor system. The monitor should indicate normal operation with two lights out and alarm when three lights are out.

(2) Procedure.

(a) Obtain local system control.

(b) Verify that the monitor sensitivity selector switch on the SFL master timer panel is in position 3.

(c) Energize the flasher system, the approach lighting system must be on.

(d) To simulate two failed flashers, open two timer contacts at a time and verify that the monitor indicates normal operation for each pair checked. Check all contacts. Allow several seconds on each check to give the monitor time to operate.

NOTE: Use a thin sheet of plastic or other suitable insulating material cut to cover two or three contacts to open the timer contacts.

(e) To simulate three failed flashers, open three timer contacts and verify that the monitor lights will be extinguished both in the tower and on the local panel, and that the buzzer will sound in the tower. Check all used contacts and allow several seconds on each check to give the monitor time to operate.

b. Dual Mode Systems.

(1) Purpose. This check insures normal operation of the sequence flasher monitor system, both in the SSALR and the ALSF mode.

(2) Procedure.

(a) With the system operating in the ALSF mode, verify that all flashers are operating. Monitor should indicate normal operation.

(b) Select SSALR. Monitor should indicate normal operation.

(c) With system off, disable one flasher by removing the flash tube, or refer to the manufacturer's instructions for additional methods.

(d) With system on, select SSALR. The monitor should indicate a caution.

(e) Select ALSF. The monitor should indicate a caution.

(f) With system off, disable one adjoining flasher (two consecutive units out).

(g) With system on, select SSALR. The monitor should indicate a failure.

(h) Select ALSF. The monitor should indicate a failure.

(i) With system off, enable the flasher disabled in step (f) and disable the next flasher in the sequence (two failed flashers, but not consecutive).

(j) With system on, select ALSF. The monitor should indicate a caution.

(k) With system off, disable one additional flasher (three flashers total, but not consecutive).

(l) With system on, select ALSF. The monitor should indicate a failure.

(m) After monitor verification, restore all flashers and operate the system to insure that the system operates normally.

c. Monitor Out-of-Tolerance. When a monitor is out of tolerance and not immediately restorable, a NOTAM shall be issued stating that the specific monitor is not available. Category I operations may be continued, provided all other system tolerances are maintained as required in this handbook. Category II or Category III operations may be continued, provided all other system tolerances are maintained as required in this handbook; except that every 8 hours during Category II or Category III operations, the approach lighting system is visually checked to verify that the system lighting configuration is within tolerance limits.

298. FIFTEEN-MINUTE TIMER.

a. Purpose. This check is to insure that the ALS will perform required brightness reduction after 15 minutes of operation on brightness 5, with proper monitor indications.

b. Procedure.

(1) Coordinate test with Air Traffic Control.

(2) Select approach lights on at the remote (tower) control panel. Select brightness 5 and note the starting time.

(3) While operating in brightness 5, the brightness 5 indicator lights should be on.

(4) After a total elapsed time of 14.5 minutes, (13 minutes on Hevi-Duty systems) an audio alarm should operate. Brightness 5 indicator light may flash on a dual mode system.

(5) After a total elapsed time of 15 minutes, the brightness 4 indicator lamps should be on, indicating an automatic reduction of brightness to brightness 4.

(6) After verification of proper brightness reduction, return control to Air Traffic Control. Record the information on technical performance record form specified in paragraph 287.

299. VERTICAL AND HORIZONTAL ALIGNMENT.

a. Purpose. These checks insure that the vertical and horizontal alignment of the elevated light fixtures meet the operation requirements specified in chapter 3.

b. Procedure.

(1) Vertical Alignment.

(a) From the light bar identification (sign or stencil), obtain the proper angle setting for the light bar being inspected. All steady-burning lights on a particular bar shall be aimed at the same vertical angle.

(b) Install the aiming device on the light fixture per manufacturer's instructions for the aiming device being used.

(c) Check the vertical angle setting of each of the elevated steady-burning light fixtures.

NOTE: For vertical angular adjustment of lights mounted on low-impact-resistance (LIR) towers, follow the tower manufacturer's instructions.

(d) Adjust the light fixture as necessary to meet the requirements specified in chapter 3.

NOTE: The formulas shown on figures 5-2 and 5-3 are used when calculating the vertical angle for systems installed before December 17, 1981. For systems installed after that date, use table 5-1.

(e) Check the vertical angle setting of each of the SFL units by using the built-in inclinometer or an aiming device designed for the SFL head.

NOTE: All sequence flashing lights installed per Order 6850.2A after December 17, 1981, shall be aimed at 6°. Flashers installed prior to that date per Order 6850.2A shall be aimed at the locally established vertical angle.

(2) Horizontal Alignment.

(a) All lamps should project a light beam parallel to the extended centerline of the runway.

(b) Visually inspect each of the steady-burning light fixtures to determine its position relative to other light fixtures in the same bar. Use adjacent lamps or the mounting bar as a reference to determine the relative horizontal position of individual lamps.

NOTE: Supplied with the AD-1 aiming device is a sighting tool to visually determine the relative horizontal position of a lamp fixture. Clip the sighting tool onto the PAR-56 lamp holder to be adjusted and sight the lamp fixture at the same position on an adjacent bar. Adjust the lamp fixture so the line of sight is centered on the lamp in the adjacent lamp bar.

(c) If a light is askew, adjust the light as required to provide the proper horizontal beam angle.

NOTE: Flush fixtures are nonadjustable and should be maintained as installed. On LIR towers, follow the adjustment procedure in the manufacturer's instruction manual for horizontal lamp alignment.

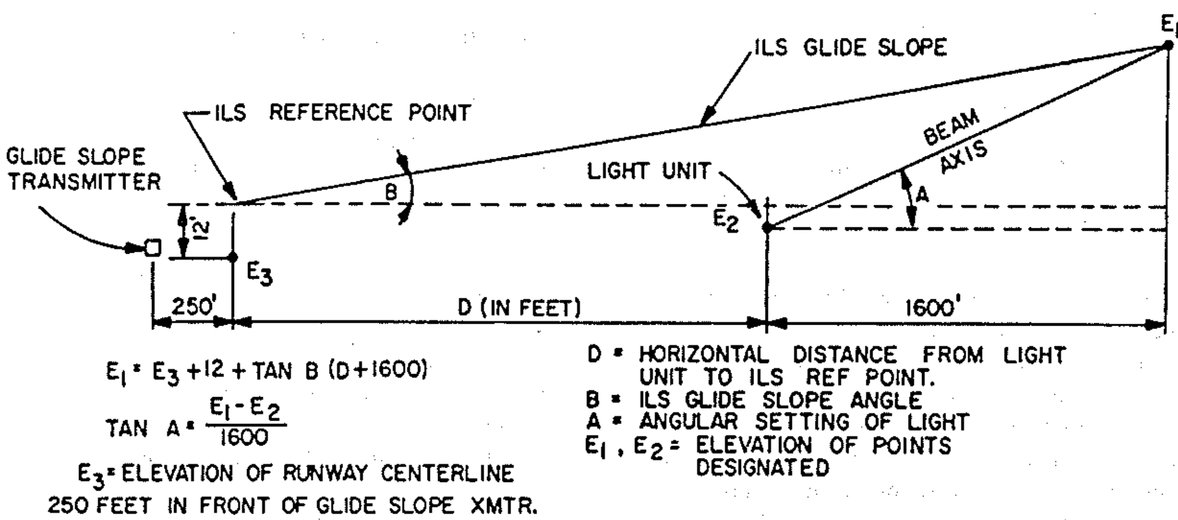
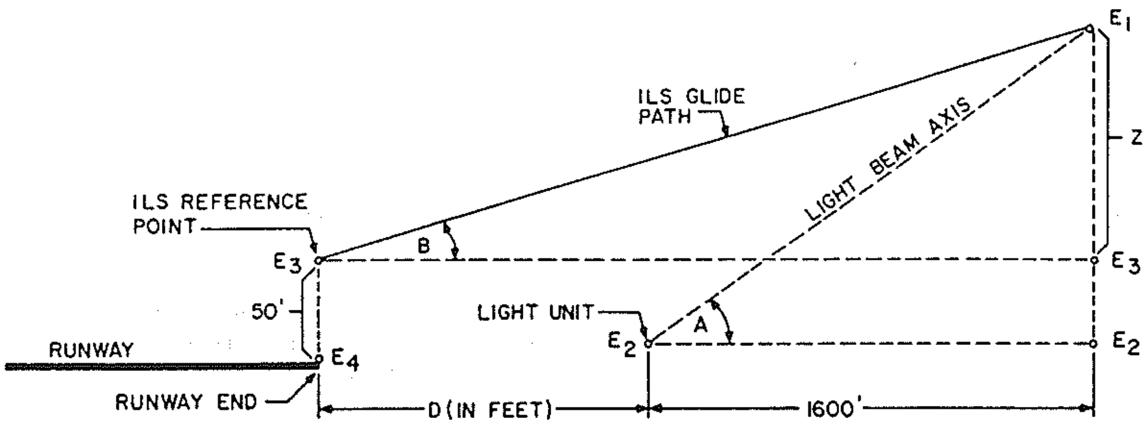


Figure 5-2. Calculation of Light Beam Angular Elevation (Systems Installed Before May 29, 1969)



E_1, E_2 ELEVATION OF POINTS DESIGNATED.
E_3 ELEVATION OF ILS REFERENCE POINT
E_4 RUNWAY END ELEVATION AT CENTERLINE
A ANGULAR ELEVATION OF BEAM AXIS
B ILS GLIDE PATH ANGLE
D HORIZONTAL DISTANCE OF LIGHT UNIT FROM RUNWAY END

$E_3 = E_4 + 50$

$E_1 = E_3 + Z = E_3 + \tan B \times (D + 1600)$

$\tan A = \frac{E_1 - E_2}{1600}$

NOTE:
ALL LIGHTS IN A LIGHT BAR SHALL HAVE THEIR BEAM AXES AT THE SAME ANGULAR ELEVATION.

Figure 5-3. Calculation of Light Beam Angular Elevation (Systems Installed from May 29, 1969 to December 17, 1981)

Table 5-1. Elevation-Setting Angles for Q20A/PAR-56 Approach Lighting Lamps (ALSF-2) (Systems Installed After December 17, 1981)

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

300. FLASHING RATE.

a. Purpose. This procedure verifies visually that the flashing rate of the flashing lights meets requirements.

b. Procedure. The flashers are designed to flash at 120 flashes per minute or 2 flashes per second. To determine the flash rate per minute, with system operating use a suitable timing device and count the number of flashes occurring in one minute.

301.-305. RESERVED.

Subsection 2. MEDIUM-INTENSITY APPROACH LIGHTING SYSTEMS

* 306. OPERATIONAL CHECKS.

a. Purpose. This procedure verifies the status of the system, and the operation of the local and remote control equipment.

b. Discussion. The order of depressing switches must be followed exactly for the MALSR to operate as indicated. The procedure should start with the system turned off.

c. Test Equipment Required. None.

d. Conditions. This test will require equipment down-time and therefore must be coordinated with the air traffic control supervisor. It must be performed when the controlled lighting aids can be clearly observed.

To obtain proper and consistent results the equipment must be set-up properly when starting the checks. This is achieved by pressing MALS 1, RAIL ON, MALS OFF, RAILS OFF, then proceeding with the checks.

e. Procedure.

(1) At the switch assembly cabinet, turn the steady burning lights on in low intensity by depressing G/G and MALS 1. Flashers should remain off.

(2) Change the lights to medium intensity by depressing MALS 2.

(3) Change the lights to high intensity by depressing MALS 3.

(4) Turn the flasher lights on by depressing RAIL ON. (The lights should be in high intensity.)

(5) With the system still in G/G mode, turn the steady burning and flasher lights off by depressing MALS OFF and RAIL OFF.

(6) Place the system in air-to-ground mode by depressing A/G.

(7) Using a transmitter located at least 1 mile away, turn the steady burning and flasher lights on at low intensity by keying the transmitter three times (transmitting three bursts of carrier energy) within a 5-second period of time.

(8) Change the lights to medium intensity by keying the transmitter five times within a 5-second period.

(9) Change the lights to high intensity by keying the transmitter seven times within a 5-second period.

(10) With the system remaining in A/G mode, let it time-out and the lights turn off. This should take approximately 15 minutes.

(11) Place the system in G/G mode by depressing the G/G switch. If the system has an interface unit attached, the steady burning and flasher lights will come on in high intensity. Otherwise the system will stay turned off.

(12) If the system is turned off, turn on the steady burning and flasher lights, in high intensity, by depressing the RAIL ON and MALS 3 switches.

(13) Change the lights to medium intensity by depressing the MALS 2 switch.

(14) Change the lights to low intensity by depressing the MALS 1 switch.

(15) Turn the lights off by depressing the MALS OFF switch.

(16) This completes the remote radio operational control check.

(17) Return the system to normal operation, and make an appropriate entry in the station log, form 6600-6. *

307. METER READINGS.

a. Purpose. These readings establish a record of the normal operating parameters and provide reference data to be used for preventive maintenance and troubleshooting of the equipment in the event of an equipment failure.

b. Procedure.

(1) Record the following meter readings on the technical performance record form specified in paragraph 287.

(a) Control cabinet input voltage.

(b) Control cabinet input line current.

* (c) Voltage to steady-burning lamps. (Measure at transformer output.) *

(d) Flasher control cabinet input voltage, if separate from MALS.

(e) Control cabinet output voltage to flasher lamp assemblies.

(2) Compare all readings with previous readings and investigate the difference. A significant change may be an indication of impending failure. If readings are beyond tolerance, determine the cause and correct as required.

308. VERTICAL AND HORIZONTAL ALIGNMENT.

a. Purpose. These checks ensure that the vertical and horizontal alignment of the steady-burning and the flashing lights meet the operational requirements specified in chapter 3.

b. Procedure.

(1) Vertical Alignment.

(a) From the light bar identification (sign or site drawings), obtain the proper angle setting for the steady-burning lights on the light bar being inspected. All steady-burning lights on a particular bar shall be aimed at the same vertical angle.

NOTE: To determine the vertical angle setting for systems installed after December 17, 1981, per Order 6850.2A, use table 5-2. Table 5-2 provides the vertical angle for the PAR-38 MALS steady-burning lights with a glide slope of 3°. If the glide slope is shifted from 3°, the elevation angle of the steady-burning lights shall be shifted by the amount that the glide slope is shifted from 3°. For systems installed prior to December 17, 1981, per Order 6850.2, all lights shall be aimed at the locally established vertical angle as specified on site drawings.

Table 5-2. Elevation-Setting Angles for 150 PAR-38/SP Approach Light Lamps (MALS)

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

(b) Install the aiming device on the light fixture per manufacturer's instruction for the aiming device being used.

NOTE: Aiming device number 4611 is used to aim the MALS PAR-38 lamps. To set the vertical angle, adjust the pointer of the aiming device on the protractor segment to the angle specified on the site drawings for the station being adjusted (the angle stenciled at that station). Place the aiming device over the lamp and adjust the vertical position by centering the bubble. If a different aiming device is used, follow the manufacturer's instructions for vertical alignment.

(c) Check the vertical angle setting of each of the steady-burning lights.

NOTE: For vertical angular adjustment of lights mounted on low-impact-resistance (LIR) towers, follow the tower manufacturer's instructions.

(d) Adjust the light fixtures as necessary to meet the requirement as specified in chapter 3.

(e) Check the vertical angle setting of each of the SFL units by using the built-in inclinometer or an aiming device designed for the SFL head.

NOTE: All sequence flashing lights shall be aimed at 6° in all circumstances.

(2) Horizontal Alignment.

(a) All lamps should project a light beam parallel to the extended centerline of the runway.

(b) Visually inspect each of the steady-burning light fixtures to determine its position relative to other light fixtures in the same bar. Use adjacent lamps or the mounting bar as a reference to determine the relative horizontal position of individual lamps.

(c) If a light is askew, adjust the light as required to provide the proper horizontal beam angle.

NOTE: On LIR towers, follow the adjustment procedure in the manufacturer's instruction manual for horizontal lamp alignment.

309.-313. RESERVED.

Subsection 3. ODALS AND LDIN SYSTEMS

314. VISUAL CHECKS.

a. Purpose. This check verifies visually the operational status and condition of the ODALS or LDIN system.

b. Procedure. Observe system operation on all brightness steps. Log lamp failures and note the flashing (or strobe) rates. Verify that all lamps are operating and the controls operate as designed.

315. OPERATIONAL CHECKS.

a. Purpose. This check verifies proper operation of the ODALS or LDIN system from both the local and remote control panels.

b. Procedure.

(1) ODALS

(a) Request air traffic (AT) personnel to relinquish control of the ODALS system.

(b) With the ODALS under local control, rotate the local control switch in the control unit from OFF to LOW, OFF to MEDIUM, OFF to HIGH. The intended intensity level of the strobe lights should be reached within 1.5 seconds.

(c) With the ODALS operating at low intensity, rotate the control switch to MEDIUM and then to HIGH. The indicated intensity level of the strobe lights should be reached within 1.5 seconds.

(d) Observe the ODALS operation. All strobe lights should be at the selected intensity level and should operate sequentially from the outermost strobe light. The cycle should repeat once per second.

(e) Request ODALS operation in the remote (auto) mode. Observe the ODALS operation and verify operation as specified in steps (b), (c), and (d) above.

* (f) At the switch assembly cabinet, turn the lights on with low intensity by depressing G/G and ODALS 1.

(g) Change the lights to medium intensity by depressing ODALS 2.

(h) Change the lights to high intensity by depressing ODALS 3.

(i) Turn the lights off by depressing ODALS OFF.

(j) Put the system in air-to-ground mode by depressing A/G.

(k) Using a transmitter located at least a mile away, turn the lights on with low intensity by keying the transmitter three times (transmitting three bursts of carrier energy) within a 5-second period of time.

(l) Change the lights to medium intensity by keying the transmitter five times within a 5-second period.

(m) Change the lights to high intensity by keying the transmitter seven times within a 5-second period.

(n) Let the system time-out and the lights turn off by leaving it in A/G mode. This should take approximately 15 minutes.

(o) Place the system in ground-to-ground mode by depressing G/G. If the system has an interface unit attached, the lights will come on in high intensity. Otherwise the system will stay turned off. *

* (p) If the lights are off, turn them on with high intensity by depressing ODAL 3.

(q) Change the lights to medium intensity by depressing ODALS 2.

(r) Change the lights to low intensity by depressing ODALS 1.

(s) Turn the lights off by depressing ODALS OFF.

(t) This concludes the checks.

(u) Return the system to normal operation. *

(2) LDIN

(a) Request air traffic (AT) personnel to relinquish control of the LDIN system.

(b) Operate the system from both the local and remote control panels, if applicable; select each control function; and verify that the system operates as designed. If the system operation is monitored, verify monitor operation. Refer to the manufacturer's instruction book for recommended operational checks.

316. METER READINGS.

a. Purpose. These readings verify that the input voltage is correct, establish a record of the normal operating parameters, and provide reference data to be used for preventive maintenance and troubleshooting of the equipment.

b. Procedure.

(1) ODALS. Using portable instruments measure and record the normal operating parameters listed in the manufacturer instruction book. Record the readings on the technical performance form specified in paragraph 287.

(2) LDIN. Using portable instruments measure and record the normal operating parameters specified in the manufacturer instruction book. Record the readings on the Technical Performance Record specified in paragraph 287.

317.-319. RESERVED.

Subsection 4. VASI AND PAPI

320. VISUAL CHECKS.

a. Purpose. This check verifies visually the operational status and condition of the system.

b. Procedure.

(1) With the system operating, visually inspect each lamp housing assembly (LHA) to verify that all lamps are on.

(2) Visually inspect each LHA for obvious vertical and/or horizontal misalignment. If misaligned, see paragraph 324.

(3) Refer to paragraph 170b for supplemental visual checks.

321. CONTROLS.

* **a. Purpose.** This procedure verifies proper operation of the system controls. *

* **NOTE:** Some types of controls may not be installed at all sites.

b. Procedure.

(1) Photocell Control.

(a) With system operating during daylight hours (high intensity), cover the photocell with black paper, cloth, etc. to exclude all light. After a short time delay, the lights should switch from high to low intensity (nighttime mode).

(b) Remove the cover from the photocell. After a short time delay, the lights should switch back to the high intensity (daylight) mode.

(2) Remote Tower Control.

(a) Coordinate with air traffic (AT) personnel to request that the system be turned on. *

* (b) Request tower personnel to operate the system on both brightness levels. Observe and verify normal system operation.

(3) Local control. Obtain local control and switch through all brightness steps. Observe and verify normal operation.

(4) Landline control. Operate the system from both the local and remote control panels, if applicable. Select each control function, and verify that the system operates as designed.

(5) Ground-to-ground control. Operate the system from both the local and remote control panels, if applicable. Select each control function, and verify that the system operates as designed.

(6) Air-to-ground control. Switch to air-to-ground control. Use a transmitter located at least 1 * * mile or as far as practicable from the facility to control the system. Turn the system on and observe operation while selecting each control function. *

322. METER READINGS.

a. Purpose. These readings establish a record of the normal operating parameters and provide reference data to be used for preventive maintenance and troubleshooting of the equipment in the event of an equipment failure.

b. Procedure.

(1) Measure the following system parameters. Record readings on the technical performance record form specified in paragraph 287. If there are no installed meters, use portable instruments for the readings.

NOTE: Refer to the manufacturer's instructions for the specific location of measurement points.

(a) Input voltage to the power and control assembly.

(b) Input current to the power and control assembly.

(c) Output currents, for each output of the power and control assembly or regulator, at all brightness levels.

* **NOTE:** This test requires the use of a true RMS multimeter such as a Fluke Model 87, Tektronix Model DMM914, or a Hewlett-Packard 973A. *

(d) Elapsed time, if an elapsed time meter is installed.

(2) Compare all readings with previous readings and investigate the difference. A change may be an indication of impending failure. If readings are beyond tolerance, determine the cause and correct as required.

323. TILT SWITCH ADJUSTMENT.

a. Purpose. This check verifies that the tilt switches are properly adjusted and operate properly if a lamp housing assembly becomes misaligned.

b. Procedure.

(1) Refer to the manufacturer's instruction book for the detailed procedure for checking and adjusting the tilt switches.

(2) The tilt switch shall be adjusted to its normal operating position after the LHA has been aimed to the desired vertical angle.

NOTE: The VASI-2 and the PAPI systems require the use of tilt switches. The tilt switch deenergizes the lamps in the VASI-2 and PAPI systems when the optical pattern of the lamp housing is lowered between 0.25° and 0.5°, or raised between 0.5° and 1° with respect to a preset position. The tilt switch features a 1-second delay in the opening of the normally closed switch contacts. A tilt switch closure of 10 seconds turns off the lamps in the system.

324. VERTICAL AND HORIZONTAL ALIGNMENT.

a. Purpose. These checks and adjustments insure that the vertical and horizontal alignment of the VASI/PAPI lamp housing assemblies (LHA) meets the operational requirements specified in chapter 3.

b. Discussion.

(1) Vertical Aiming (Approach Path Angles).

(a) VASI. Aiming and obstruction clearance diagrams, figures 5-4 through 5-7, show the relationship between the effective visual glide paths, the aiming line of the upwind bar, the aiming line of the middle bar (where installed), and the aiming line of the downwind bar. Where an ILS and VASI (two-bar) serve the same runway, the glide slope angle and the effective visual glide path are the same. Therefore, if any change is made in the ILS glide slope angle, the VASI shall be adjusted immediately to conform with the new angle of the ILS glide slope. The box angle should be stenciled on the side of the box.

(b) PAPI. Aiming and obstruction clearance diagrams, figures 5-8 and 5-9, show the relationship between the effective visual glide paths, the aiming line of each light housing assembly. Where an ILS and PAPI serve the same runway, the glide slope angle and the effective visual glide path are the same. Therefore, if any change is made in the ILS glide slope angle, the PAPI shall be adjusted immediately to conform with the new angle of the ILS glide slope. The box angle should be stenciled on the side of the box.

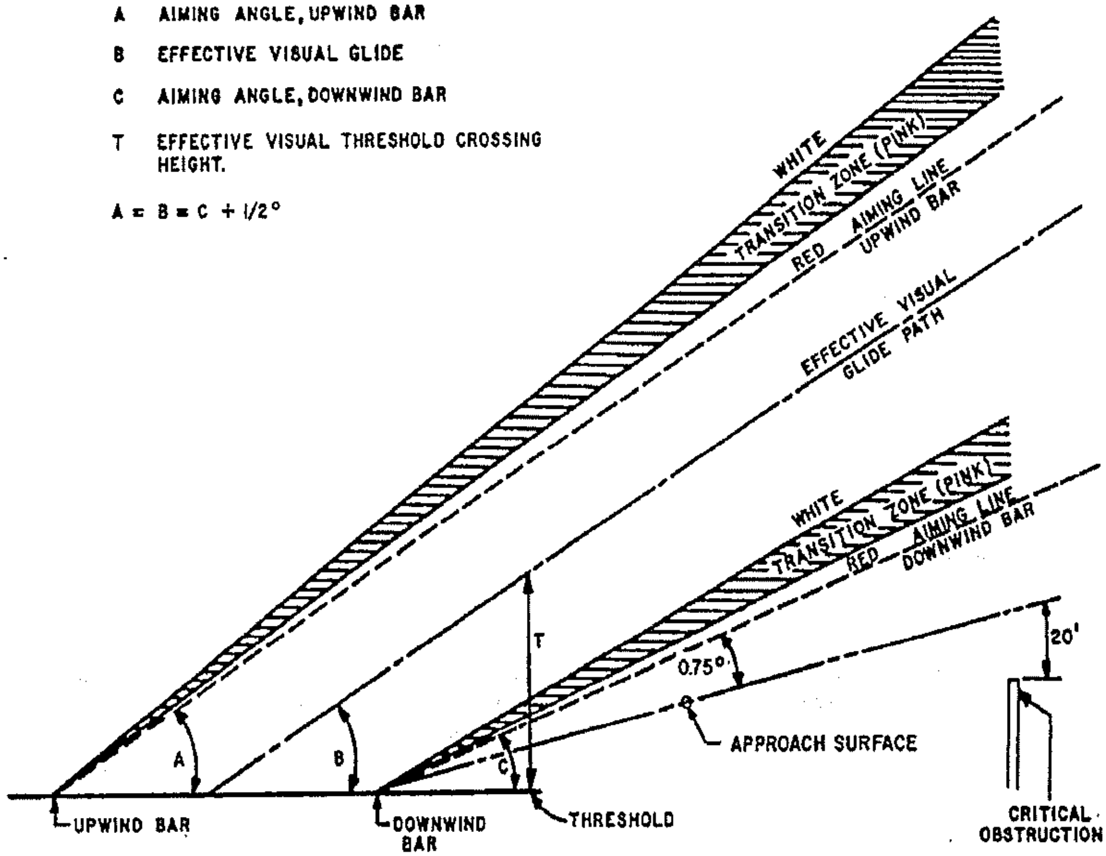


Figure 5-4. Aiming and Obstruction Clearance Diagram for Two-Bar VASI
(Systems Installed Before March 18, 1974)

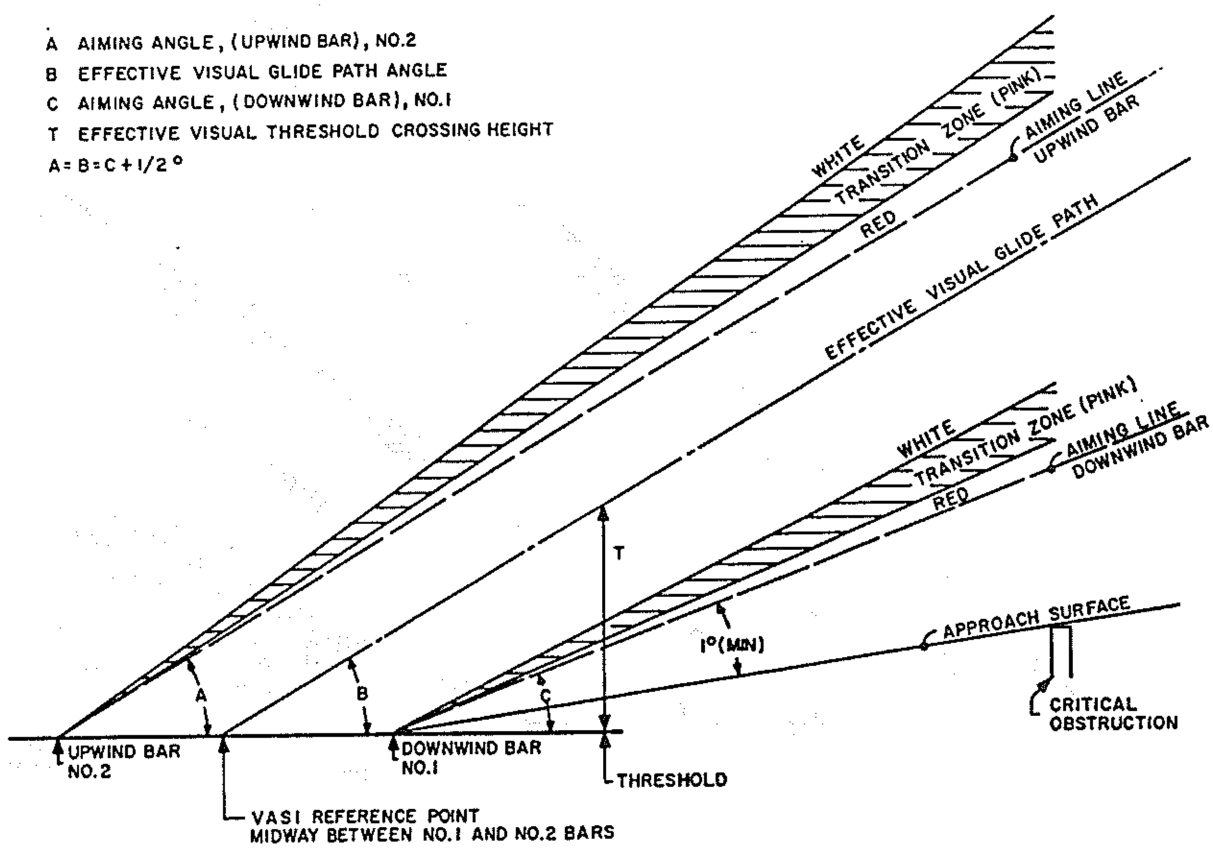


Figure 5-5. Aiming and Obstruction Clearance Diagram for Two-Bar VASI (Systems Installed After March 18, 1974)

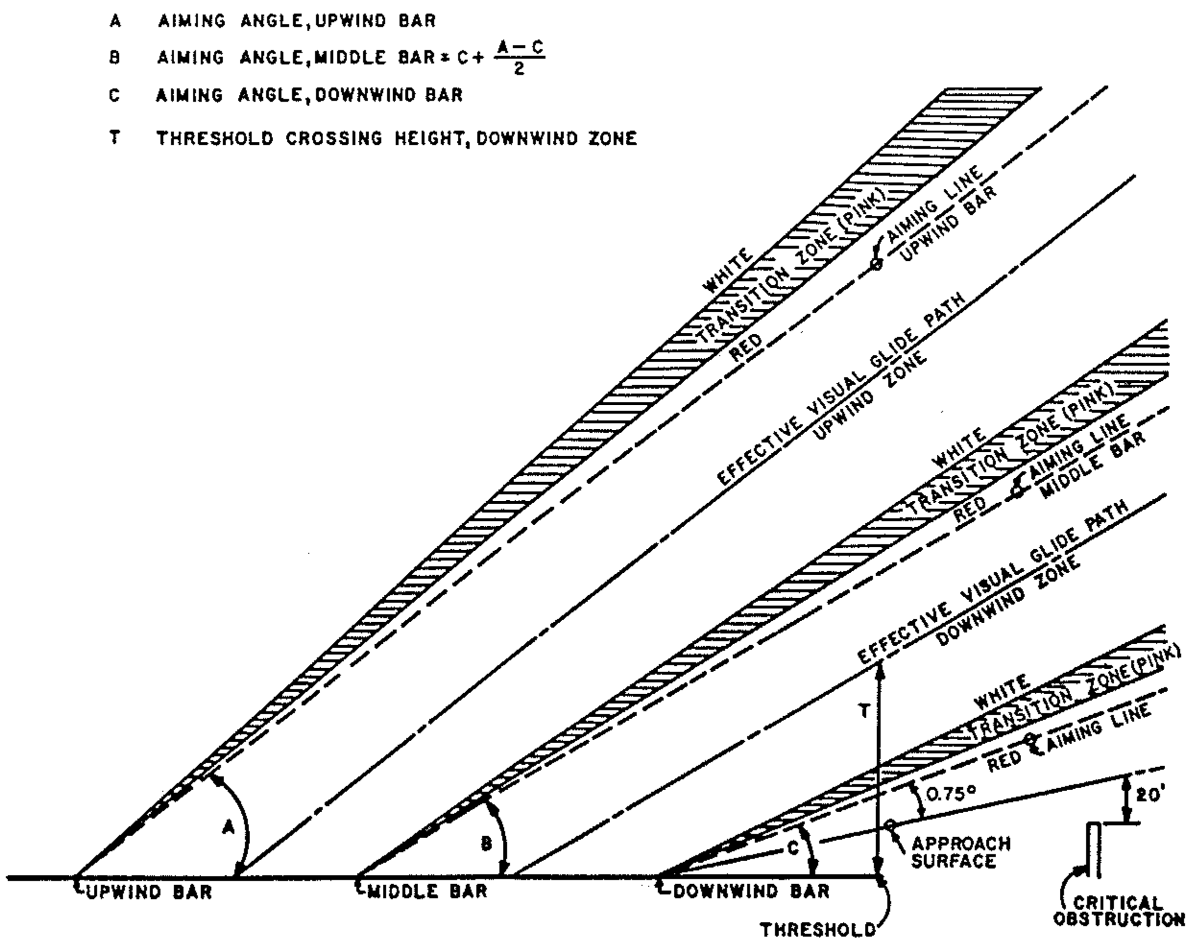


Figure 5-6. Aiming and Obstruction Clearance Diagram for Three-Bar VASI (Systems Installed Before March 18, 1974)

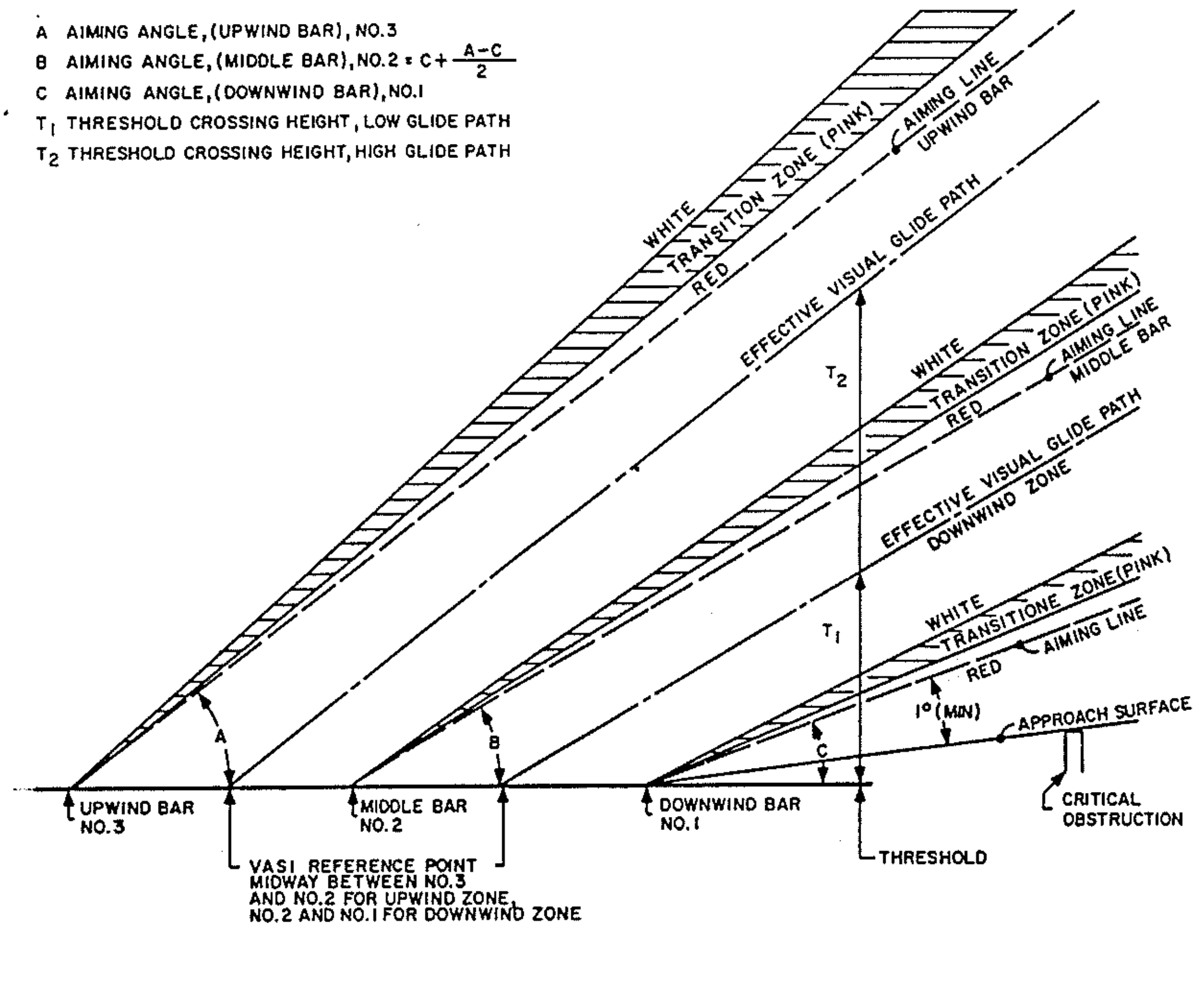


Figure 5-7. Aiming and Obstruction Clearance Diagram for Three-Bar VASI (Systems Installed After March 18, 1974)

Light Unit	Standard Aiming Angle		Height Group 4 Aiming Angle	
	Degree	Decimal Equiv.	Degree	Decimal Equiv.
LHA#1	3°30'	3.50°	3°35'	3.58°
LHA#2	3°10'	3.17°	3°15'	3.25°
LHA#3	2°50'	2.83°	2°45'	2.75°
LHA#4	2°30'	2.50°	2°25'	2.42°

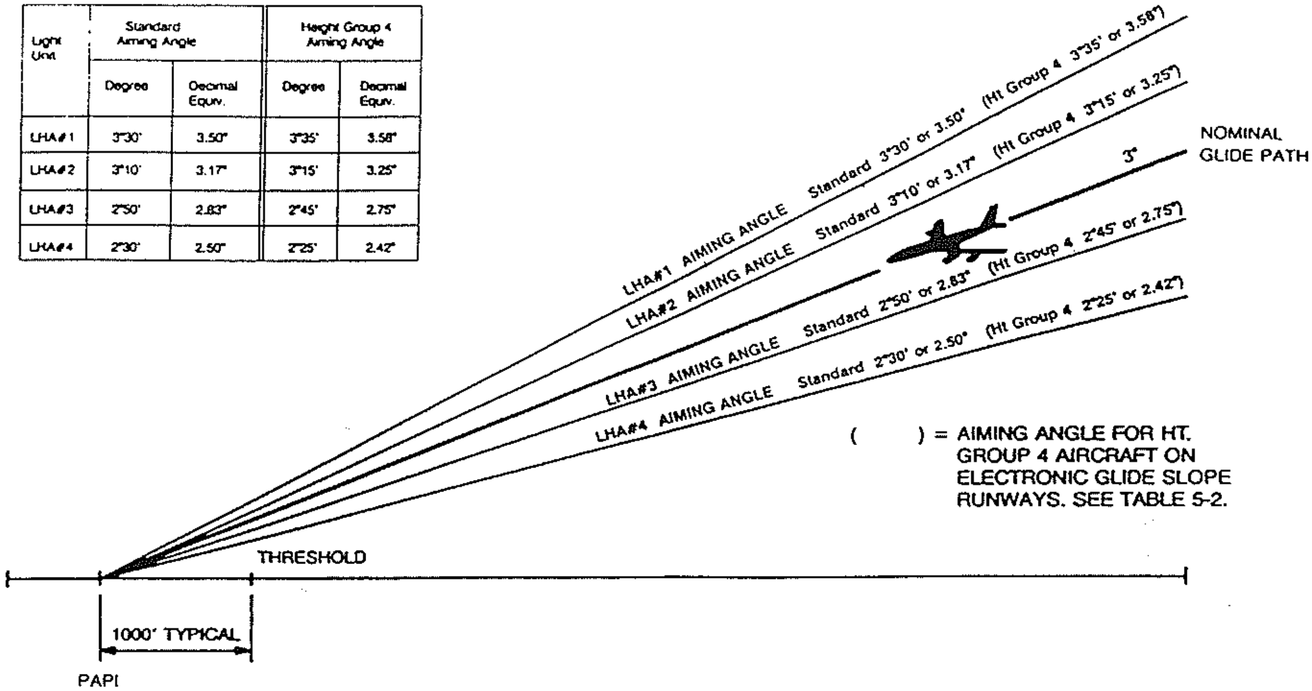


Figure 5-8. PAPI Approach Path Diagram

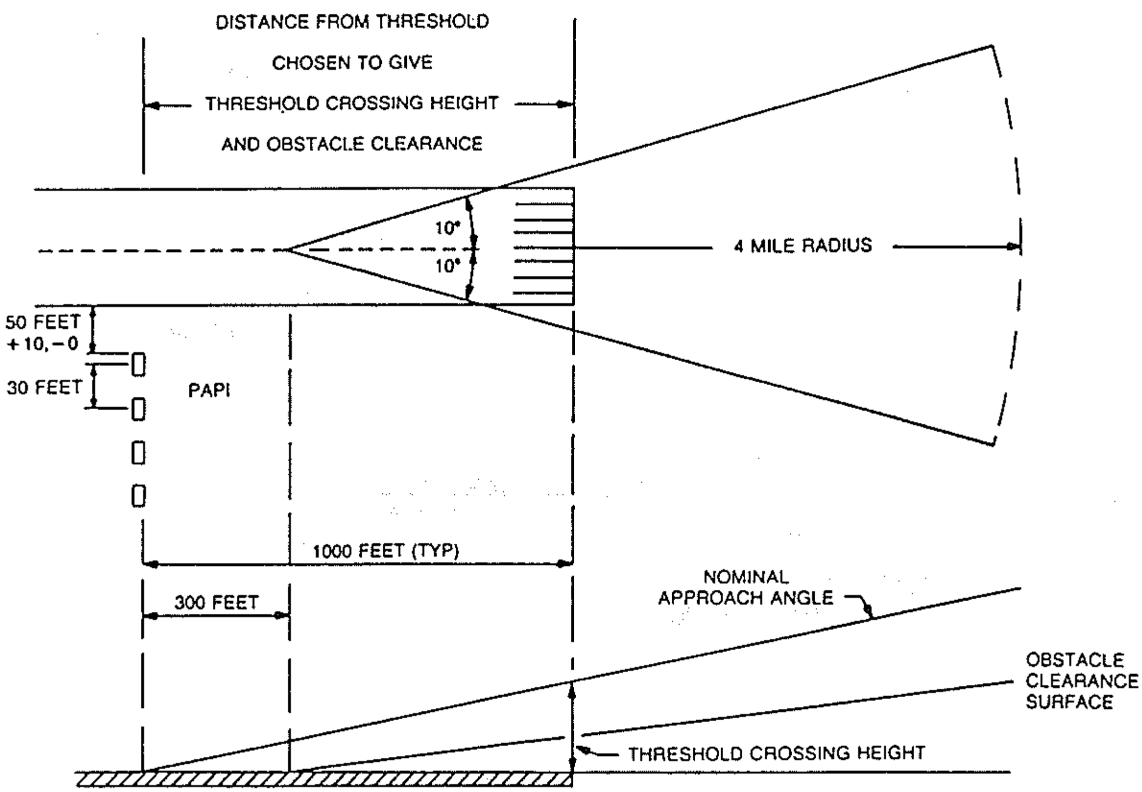


Figure 5-9. PAPI Obstacle Clearance Surface

c. **Procedure.**

(1) Record on FAA form 6030-1, Facilities Maintenance Log, the vertical angular setting made to the VASI or the PAPI system. Specify whether alignment was made using an aiming device, a transit, or both.

(2) Visually inspect the horizontal alignment of each of the lamp housing assemblies. Normally, no adjustment is necessary, however, if any units are displaced by mowing machines or other causes, reposition them to the originally installed position so they will meet the requirements of Order 6850.2A.

(3) Check and adjust, if necessary, the vertical alignment of the VASI lamp housing assemblies. Refer to the VASI manufacturer's instruction manual for proper use of the VASI aiming device supplied. The following paragraphs describe the various type of aiming devices.

(a) VASI. The light unit must be level along an axis at right angles to the runway. Place a carpenter's level along the top of the lamp bulkhead, transition bar, and/or aperture; then raise or lower the adjusting nuts on one of the back legs. When these are level in this direction, secure the nuts on the back legs and proceed with aiming by raising or lowering the two front legs. A precision aiming device is provided with each VASI so that the aiming of the upwind and downwind bars can be maintained to the prescribed angle. Use of the graduated dial on the aiming device simplifies the aiming of the composite beam to within the tolerances of the required glide path angle. And, use of the level bubble makes it easy to adjust all units in any one light bar to the prescribed tolerance. If the dial is disturbed during the aiming process, reset it and lock it. Also, recheck and re-aim units previously checked. Each division on the level tube represents 1.2 minutes, so the light units in each light bar can be set at angles that are within the specified tolerance of each other. Carefully handle and store the aiming device, and check the dial setting before each use.

(b) Rotating Head Aiming Device. The slotted head fits onto the transition bar inside the box when using this aiming device to aim a light unit. In order to achieve the 0.5° spread, the word "low" must be in view on the head when aiming the downwind units, and the word "high" when aiming the upwind units. Aim the box by adjusting the two front legs, first one and then the other. Insert the slotted-head, with level tube up, through one end of the 2-inch aperture at the front of the box. Fit the U-shaped bulkhead at the point where the red and white lenses meet. Reset the bottom side of the aiming device on the bottom edge of the aperture; the level tube and bubble will be in view outside the box. With the aiming device thus positioned along one edge of the box, raise or lower the front leg of the box until the bubble is centered in the tube, making sure the other front leg is free to move. Move the aiming device to the other edge of the box and adjust the other front leg. Tighten the locknuts on the leveling screws on both legs. Recheck the aiming of both edges after tightening to be sure the bubble is still centered in the level tube.

1 Style A Rotating Head Leveling Device. This leveling device (NSN 6210-00-867-4164) has a rotating slotted head on one end that makes the level read 0.25° high or 0.25° low, according to the slotted head setting, high or low. This feature permits setting the upwind and downwind bars with 0.5° angular spread for the two-bar VASI. The upwind units of the two-bar VASI are aimed parallel to the established glide slope path angle and the downwind bars 0.5° lower than the glide path angle. The on-path beam, as seen by the pilot, is not halfway between the two setting as would be expected, but is 0.25° higher. Rather than change the slotted head on the leveling device, the lower aiming is achieved by the following dial setting procedure. Set the rotating dial on the leveling device to read the desired angle minus 0.25°. After setting the dial, lock it in place, and insure that the movable support is in contact with the cam.

2 Style B Rotating Head Leveling Device. This leveling device was furnished under contract FA70AC1042-3. The predetermined glide path angle is set on the direct indicating scale. After setting the dial to the desired angle, lock it in place, being sure the movable support on which the bubble is mounted is in contact with the degree-marked cam.

(c) Fixed-Head Aiming Device. The fixed-head aiming device is a direct reading instrument. Set the predetermined angle for the particular light unit on the aiming device indicating scale. Be careful to differentiate between the upwind and downwind light bars. Aim the box by adjusting the two front legs, first one and then the other. Insert the slotted head, with level tube up, through one end of the 2-inch aperture at the front of the box. Fit the U-shaped bulkhead at the point where the red and white lenses meet. Reset the bottom side of the aiming device on the bottom edge of the aperture; the level tube and bubble will be in view outside the box. With the aiming device thus positioned along one edge of the box, raise or lower the front leg of the box until the bubble is centered in the tube, making sure the other front leg is free to move. Move the aiming device to the other edge of the box and adjust the other front leg and then tighten the locknuts on the leveling screws on both legs. Recheck the aiming of both edges after tightening to be sure the bubble is still centered in the level tube.

(d) Style C Walker Bar and Calibration Bar. These aiming and calibration bars are manufactured under FAA Specifications FAA-F-1328c. The Walker bar is an accurate, aluminum, alignment instrument, which may be operated by one person. The level is permanently mounted and has a fine adjustment to calibrate the instrument. For further information see the instruction book, VASI Aiming Instruments, contract DOT-FA73WAI-360; and figure 5-10. The aluminum calibration bar is used to field-check and calibrate the Walker bar. The calibration bar is designed for laying on a flat surface and has an adjustment feature to permit leveling in a horizontal plane. A level separate from the bar is used to level the calibration bar. The calibration bar has mounting points corresponding to the transition bar and aperture of the lamp housing on which the Walker Bar can be placed for accurate adjustment of the zero dialing setting.

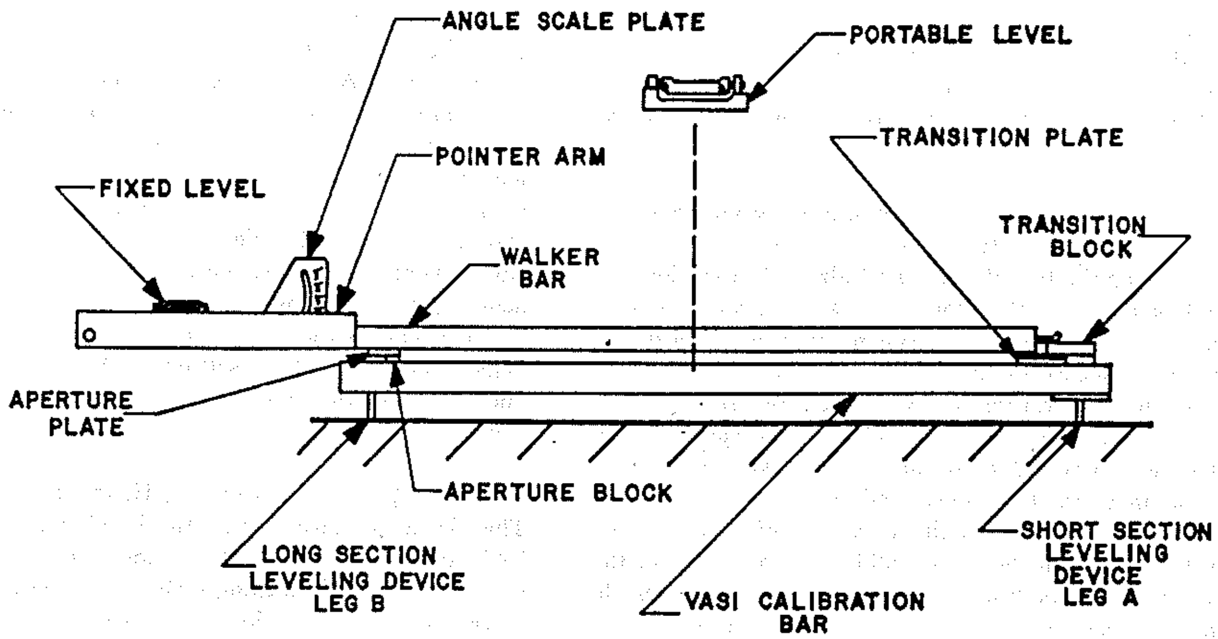


Figure 5-10. Walker Bar Aiming and Calibration Components

(e) Transit Aiming. Aiming can be accomplished using a transit mounted on a camera-type tripod with an elevating mechanism. The lamps in the light unit should be energized at low intensity. The transit is placed about 50 feet (15 meters) in front of the light unit to be aimed, and then set the desired angle on the vertical vernier of the transit. The transit elevation is adjusted such that the telescope intercepts the light beam. If the terrain is such that the light beam elevation at 50 feet (15 meters) is too high for ground mounting of the transit, use a stable elevated platform. Now adjust the VASI light unit so that the least discernible white light is visible below the transition bar and the telescope horizontal crosshair bisects the slit of white light.

(f) Aiming Device Calibration. The aiming device is a precision instrument, factory calibrated with a laboratory standard, and should be carefully handled and stored to retain its accuracy. With careful handling, it is unlikely that the instrument will be out of adjustment. However, the device can be checked for accuracy by the following method if a calibration bar is not available.

1 Select a flat, unwarped table or bench and level it with a carpenter's level.

2 Set the leveling device dial to 0°.

3 With equal size blocks inserted under the channel of the aiming device bar near each end, the bubble should appear very near or at the center of the level tube.

4 Rotate the aiming device 180° on the blocks. The bubble should appear at the same relative position in the level tube.

5 If the bubble is not centered within two divisions on the level tube (each division is 1.2 minutes), recalibrate the device by adjusting the level tube until the bubble appears centered with the level dial at 0°.

6 The angular adjustment dial is now precisely calibrated.

(g) Vertical Alignment for Maximum Light Intensity Through the Aperture. The light meter and tripod are used to adjust the vertical alignment of the lamps for the maximum intensity through the aperture of the lamp housing assembly. Two light meters and tripods are required at each sector maintaining VASI systems. After an individual lamp replacement, an interim check for uniform lamp intensity is to visually inspect the LHA light output from approximately 700 feet downwind. Adjust the lampholders as required for uniform light output with maximum intensity.

1 Systems Having Individual Lampholder Adjustments. Remove the power from the lamp housing assembly (LHA). Disconnect the electrical wires from two of the lamps. Place and tape the light meter on the tripod. Place the light meter and tripod directly in front of the lamp that is electrically connected. Adjust the height until the light meter is at the height of the aperture. Place the tripod and light meter as close as possible to the aperture. If possible, place the meter partially into the aperture, but not touching the LHA. This position decreases the amount of background light read by the meter. Reapply power to the LHA and adjust the vertical alignment of the lampholder to obtain the maximum intensity. Tighten any loose alignment adjustment hardware. Remove power from the LHA and then disconnect the electrical wires from the lamp that was adjusted. Reconnect the electrical wires to one of the other unadjusted lamps. Move the light meter and tripod opposite this lamp, and repeat the procedure. Remove power from the LHA and disconnect the electrical wires from the second adjusted lamp and reconnect the electrical wires to the third lamp. Repeat the alignment procedure. Remove power from the LHA and reconnect the electrical wires to the other two aligned lamps. All three lamps should now be properly aligned for maximum intensity. Use this procedure for each of the other LHA's.

2 Systems Not Having Individual Lampholder Adjustments. Place and tape the light meter on the tripod. Place the light meter and tripod in front of the LHA at the center of the aperture. Adjust the height until the light meter is at the height of the aperture. Place the tripod and meter as close as possible to the aperture. If possible, place the meter partially into the aperture, but not touching the LHA. This position decreases the amount of background light read by the meter. The maximum light intensity through the aperture occurs when the lamps are tilted downward approximately 1.8° from the center line of the lamps and the aperture. This small change of 1.8° will increase the intensity by approximately 56 percent from zero-degree tilt. The alignment of the lamps is dependent upon the position of the bulkhead. Remove either the bolts or screws at the top or bottom where the bulkhead is fastened to its mounting brackets. The entire bulkhead can be repositioned from the vertical allowing the lamps to tilt downward. Site adaptation may be required for each system. With the lamps on, monitor the light meter, and tilt the bulkhead to produce the maximum light intensity through the aperture. Use washers as shims to reposition the bulkhead. Site adaptation may be required for each LHA. After repositioning the bulkhead, replace mounting hardware. Repeat the procedure for other LHA's.

(4) Check the vertical alignment of the PAPI lamp housing assemblies and adjust if necessary. Refer to the PAPI manufacturer's instruction manual for proper use of the PAPI aiming device and the alignment procedures.

* **325. PAPI LAMP FAIL CIRCUITRY TESTING**

a. Purpose. The following checks ensure that the Lamp Fail Circuitry is functioning properly before the system is placed on line for normal operation.

b. Procedure.

(1) Remove all power from the system under test and disconnect the RMS battery pack.

(2) Remove the top cover to Lamp Housing Assembly (LHA) #1.

(3) Locate the circuit breaker for Lamp #1.

(4) Close the breaker or turn it "on".

(5) Measure the resistance across the circuit breaker lamp failed annunciation contacts. The resistance reading shall be as specified in paragraph 106a.

(6) Measure the resistance across the circuit breaker lamp shorting contacts. The resistance reading shall be as specified in paragraph 106b.

(7) Open the lamp circuit breaker or switch it "off".

(8) Disconnect one or more electrical leads from the lamp and ensure that the lamps leads are not shorted together and are isolated from any other conductors.

(9) Measure the resistance across the circuit breaker lamp failed annunciation contacts. The resistance reading shall be as specified in paragraph 106c.

(10) Measure the resistance across the circuit breaker lamp shorting contacts. The resistance reading shall be as specified in paragraph 106d.

(11) Replace the electrical leads to the lamp that were removed in step 8.

(12) Locate the circuit breaker for Lamp #2.

(13) Repeat steps 4 through 11 for Lamp #2.

(14) Locate the circuit breaker for Lamp #3.

(15) Repeat steps 4 through 11 for Lamp #3.

(16) Remove the top cover to Lamp Housing Assembly (LHA) #2.

(17) Repeat steps 3 through 15 for LHA #2

(18) Remove the top cover to Lamp Housing Assembly (LHA) #3.

(19) Repeat steps 3 through 15 for LHA #3.

(20) Remove the top cover to Lamp Housing Assembly (LHA) #4.

(21) Repeat steps 3 through 15 for LHA #4.

(22) Ensure that all LHA lamp circuit breakers are initially closed before proceding to step 23.

(23) Locate and open the lamp #2 circuit breaker only on all four LHA's.

(24) Turn on the system and verify that only lamps #1 and #3 illuminate in all four LHA's.

(25) Turn off system power.

(26) Open Circuit breaker #3 and verify that circuit breaker #2 is also open on all four LHA's.

(27) Turn the system power on.

(28) Ensure that all lamps are extinguished on all four LHA's.

(29) Turn off the system power.

(30) Reclose lamp circuit breaker #2 on all LHA's.

(31) Turn on system power.

(32) Verify that only lamp#1 and Lamp #2 are illuminated on all LHA's.

(33) Turn off the system power.

(34) Reclose all lamp circuit breakers on all LHA's.

(35) Replace all LHA enclosures and reconnect the RMS battery pack.

(36) Turn on power to the system and ensure that all lamps are illuminated on all four LHA's.

326.-328. RESERVED. *

Subsection 5. REIL

329. VISUAL AND OPERATIONAL CONTROL CHECKS.

a. Purpose. This procedure verifies system status and checks operation of the controls for the REIL.

NOTE: Some types of controls may not be installed at all sites.

b. Procedure.

(1) Control from ATC tower.

(a) Request air traffic control personnel to turn on the system.

(b) Verify that both lamps are on.

(c) Request operation on all brightness levels.

(d) Verify that both lamps operate on each level.

(2) Control from the switch assembly cabinet.

(a) Turn the lights on with low intensity by depressing G/G and REIL 1.

(b) Change the lights to medium intensity by depressing REIL 2.

(c) Change the lights to high intensity by depressing REIL 3.

(d) Turn the lights off by depressing REIL OFF.

(3) Air-to-ground control.

(a) Place the system in air-to-ground mode by depressing A/G.

(b) Using a transmitter located at least a mile away, turn the lights on with low intensity by keying the transmitter three times (transmitting three bursts of carrier energy) within a 5-second period of time.

(c) Change the lights to medium intensity by keying the transmitter five times within a 5-second period.

(d) Change the lights to high intensity by keying the transmitter seven times within a 5-second period.

(e) Leave the system in A/G mode until it times-out and the lights turn off. This should take approximately 15 minutes.

(4) Switch assembly control.

(a) Place the system in ground-to-ground mode by depressing G/G. If an interface unit is attached, the lights will come on in high intensity. Otherwise the system will remain turned off.

(b) If the system is turned off, turn it on with lights in high intensity by depressing REIL 3.

(c) Change the lights to medium intensity by depressing REIL 2.

(d) Change the lights to low intensity by depressing REIL 1.

(e) Turn the lights off by depressing REIL OFF.

(f) This completes the test.

(g) Return the system to normal operation.

330. VERTICAL AND HORIZONTAL ALIGNMENT.

a. Purpose. These checks ensure that the vertical and horizontal alignment of the REIL lights meet the operational requirements specified in chapter 3.

b. Discussion. The light units shall be aimed at an angle of 100 vertically and toed outward from a line parallel to the runway centerline 150. Baffles should not be used unless warranted by user complaints of blinding effects and/or flight inspection findings. In these cases, baffles may be installed as a system option without the necessity for NCP (National Change Proposal) action. Where baffles are installed, the light units shall be aimed at an angle of 30 vertically and toed outward 100. Systems installed with baffles should not be changed unless warranted by user complaints and/or flight inspection findings, or as needed due to snow or ice accumulation. Omnidirectional REIL (ODREIL) light units shall be maintained plumb.

c. **Procedure.**

(1) From site drawings, or as stenciled on the power and control box, determine the designed alignment and elevation angle.

(2) Visually inspect the horizontal position of each light to verify the lamps are in the position installed.

(3) Adjust the elevation angle using the built-in inclinometer or a suitable aiming device designed for flasher alignment.

(4) Refer to the manufacturer's instructions for alignment procedure for the ODREIL lights.

331. METER READINGS.

a. **Purpose.** These readings establish a record of the normal operating voltages and provide reference data to be used for preventive maintenance and troubleshooting in the event of an equipment failure.

b. **Procedure.**

(1) The following meter readings shall be recorded on the technical performance record form specified in paragraph 287.

(2) Measure the input voltage to the power and control cabinet.

(3) Measure the input voltage to each of the flasher lamp assemblies.

NOTE: Refer to the manufacturer's instructions to determine the specific terminal location.

332. MONITOR OPERATION.

a. **Purpose.** This check verifies monitor operation if the REIL system is so equipped.

b. **Discussion.** Some systems are designed so that if one light fails, both lights will shut off. There is no monitoring requirement for the REIL. It is not required that both lights automatically shut off in the event of failure of one light, per Order 6850.2A.

c. **Procedure.**

(1) This test is to be performed only on applicable systems.

(2) Coordinate this test with air traffic control.

(3) Open the door to unit no. 1; system should shut down.

(4) If the system is equipped with a remote monitor, verify its operation.

333.-334. RESERVED.

Subsection 6. OBSTRUCTION LIGHTS

335. VISUAL CHECKS.

a. Purpose. This check verifies the operational status and condition of the obstruction lights.

b. Procedure. All obstruction lights shall be checked periodically either by viewing the light or by observing an automatic, and properly maintained, indicator that registers any failure of such lights. All burned-out lamps shall be replaced immediately after detection. If the obstruction lighting is not readily accessible for this visual observation, an automatic alarm system may be installed. The side, or intermediate obstruction lights, may be excluded from the alarm circuit (1) if the signaling device will indicate malfunctioning of all flashing and rotating beacons and all top lights regardless of their positions on the obstruction, and (2) if all other obstruction lights are visually inspected once every month. Refer to paragraph 170b for supplemental maintenance instruction.

336. BEACON FREQUENCY.

a. Purpose. This check visually verifies that the beacons are flashing at the appropriate rate as specified in chapter 3.

b. Procedure.

(1) Flashing-300mm Electric Code Beacon.

(a) Using an accurate timing device, carefully measure the number of flashes over a full 2-minute period.

(b) Verify the count with the operating limits established in chapter 3.

(2) Rotating Beacons, Single or Double Ended.

(a) Using an accurate timing device, carefully count the number of flashes (times the light is visible) for a 2-minute period.

(b) Verify the count with the operating limits established in chapter 3.

337. CONTROL DEVICES.

a. Purpose. This check verifies the normal operation of the obstruction light automatic control devices and alarms.

b. Procedure.

(1) Cover the photocell and cause the switch to operate.

(2) Verify that the obstruction lights respond properly to the control action.

(3) Check the alarm operation with the following appropriate procedure.

(a) To check BEACON alarm circuits for the Hughey and Phillips control unit, open the appropriate single pole single throw (spst) switch (see partial schematic figure 5-11) when the system is operating. The opening of the switch causes the alarm relay (K-302 or K-303) to operate and closes the circuit between terminals F-G of TS-2.

(b) To check obstruction light alarm circuits for the Hughey and Phillips control unit, open the appropriate single pole double throw (spdt) switch (see partial schematic figure 5-11) when the system is operating. The opening of the switch causes relay K-304 to close, in turn closing the circuit between terminals G and H of TS-2.

(c) To test the lamp alarm circuit of the Crouse-Hinds control unit,open the appropriate spst switch (see partial schematic figure 5-12) when the system is operating. The opening of the switch causes the armatures of the corresponding relay K1, K2, K5, or K6 to release. The closing of the respective contacts causes the alarm.

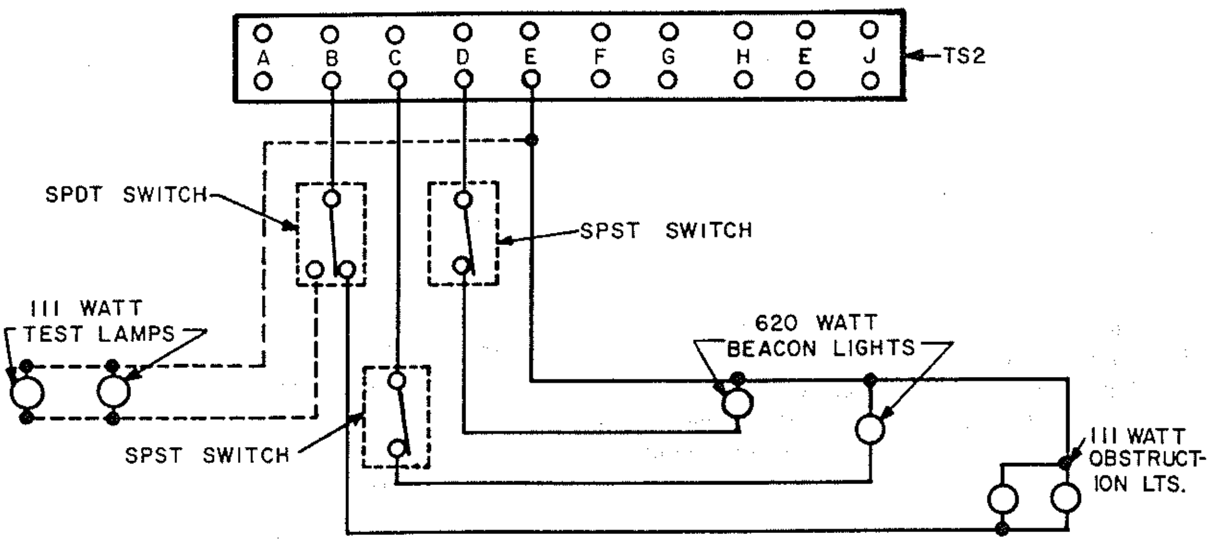


Figure 5-11. Partial Schematic, Hughey and Phillips LC-201 Control

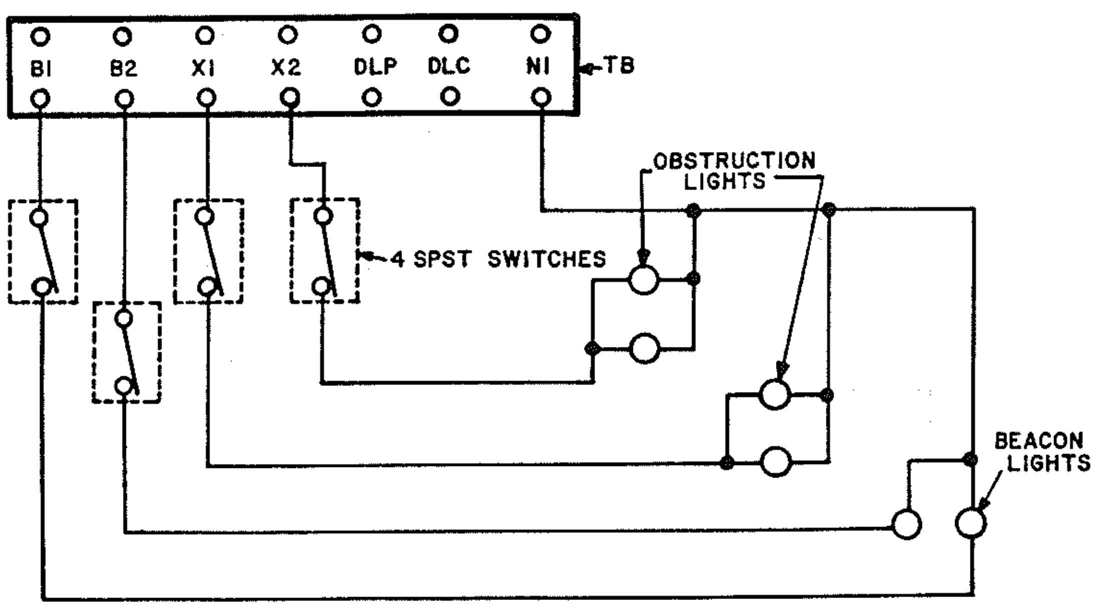


Figure 5-12. Partial Schematic, Crouse-Hinds No. 47079 Control

338. LAMP REPLACEMENT.

a. Purpose. This check visually inspects the lamps to determine their usefulness and replaces the lamps as conditions indicate.

b. Discussion. Maintenance personnel should always ensure that the proper size and type of lamp is provided for each receptacle and is properly focused. If any lamp, even though still burning, appears near failure, it should be replaced immediately. Good judgement should be exercised so that lamps having a remaining useful life are not prematurely replaced.

c. Procedure. Inspect the lamps and replace them under the following conditions.

(1) When the interior of high wattage lamps has blackened appreciably from the top to about three-fourths inch above the top of the filament. (This necessitates replacement regardless of filament conditions, because the blackening of the glass materially decreases the light output.)

(2) When the lamp has been blistered from reflected sun rays or other causes.

(3) When there is excessive sagging of the filament or broken fused filament supports.

(4) When rated lamp life has been attained. When replacing lamps in major apparatus such as beacons, the date the lamps are installed in the operating receptacle shall be recorded in facility maintenance log and retained at the facility. This will be a ready reference, indicating to maintenance personnel the approximate hours of service.

(5) Refer to the manufacturers instruction manual for specific lamp replacement data and adjustment procedures.

NOTE: When replacing a beacon's No. 1 lamp, remove the No. 2 lamp and install it in the No. 1 operating position. Install the new lamp in the No. 2 position. When replacing a lamp, the new lamp shall always be burned for approximately 5 minutes to ascertain that the lamp has operated satisfactorily and that it will not fail after a few minutes of operation.

339. RESERVED.

* **Subsection 7. WITHDRAWN - CHG 1**

340. Withdrawn - CHG 1
341.-344. RESERVED. *

Section 2. OTHER MAINTENANCE TASKS PROCEDURES

345. GLASSWARE, REFLECTORS, AND FILTERS.

a. Purpose. This procedure checks the brilliance, color, beam spread, and light visibility of each light in the system.

b. Procedure.

NOTE: Refer to paragraphs 299 and 308 for corrective maintenance procedures.

(1) Visually check the condition of all glassware.

(a) Inspect for cracks, pits, and leaks at the lens edge and for cleanliness.

(b) Inspect all lamps for damage or misalignment.

(c) Look for damaged, missing, or misaligned filters and reflectors. A missing filter constitutes a lamp outage. To prevent pilot confusion, disconnect the affected lamp until filter can be replaced.

(2) Inspect semi-flush lights for visibility.

(a) Semi-flush lights are particularly susceptible to a reduction of light output by relatively small accumulation of snow, sand, mud, leaves, oil film, or other matter which may accumulate in front of the prisms. Prisms should be kept clean by frequent and careful maintenance. Semi-flush fixtures should be carefully cleaned with a broom, compressed air, or a vacuum cleaner.

(b) Airport maintenance personnel should be advised against running snowplow blades over semi-flush fixtures, because of the resulting damage or misalignment.

(3) Clean all glassware, reflectors and filters as required to insure maximum light output. Cleaning of glassware, reflectors, and filters can best be accomplished by applying a liquid glass cleaner and wiping dry with a soft, cotton cloth. Avoid using a strong caustic or abrasive cleaner.

(4) Repair or replace as required any damaged or missing glassware, lamps, reflectors or filters.

346. SUPPORTS.

a. Purpose. This check verifies the reliability and physical condition of the light support structures.

b. Procedure.

(1) Check light supports and guys for rigidity, by grasping them firmly and trying to move the support or guy wire.

(2) Inspect structures for rust, loose paint, or obvious misalignment.

347. TRANSFORMER AND REGULATOR OIL.

a. Purpose. This check determines the oil level and insulating properties of the insulating oil.

b. Procedure.

(1) Inspect the constant current regulator for the proper oil level as indicated by the oil level gauge. The indicator should be approximately in the center of the dial when the oil temperature is 25°C or 77°F.

(2) Inspect the regulator tanks and all oil filled transformers for oil leaks. If leaks exist, repair or replace as necessary. Refer to the manufacturer's instruction book for maintenance procedures.

(3) Check the dielectric strength of the insulating oil by using a Hipotronics, Inc., Model OC-51MG liquid dielectric tester. See the tester instruction book and Order 6950.18A, Maintenance of Electrical Distribution Systems, for the testing procedure.

348. APPROACH LINE-OF-SIGHT CLEARANCE.

a. Purpose. This check insures that the required approach line-of-sight clearance is maintained.

b. Procedure.

(1) Visually inspect the approach zone for obstructions which may have penetrated the approach line-of-sight clearance.

(2) Refer to Order 6850.2A for visibility requirements.

(3) If an obstruction is noted, report it to the proper authority and make an entry on the technical performance record form specified in paragraph 287.

349. TYPE LB-1 LIGHT BASES.

a. Purpose. The following procedures are used to check and remove water, install new incandescent lamps and perform maintenance on semi-flush/frangible flashers installed in the LB-1 light base.

b. Procedure. The LB-1 light base (figure 2-11) is used with the type AL-1 semi-flush approach lights, the frangible approach lights, and with the semi-flush/frangible flasher lights. Although the base was designed to be waterproof, ground and surface water will find a way in. Water accumulation can be a serious problem and for that reason the bases must be checked periodically or as required by local conditions.

*U.S. GOVERNMENT PRINTING OFFICE:1996-769-016/20129

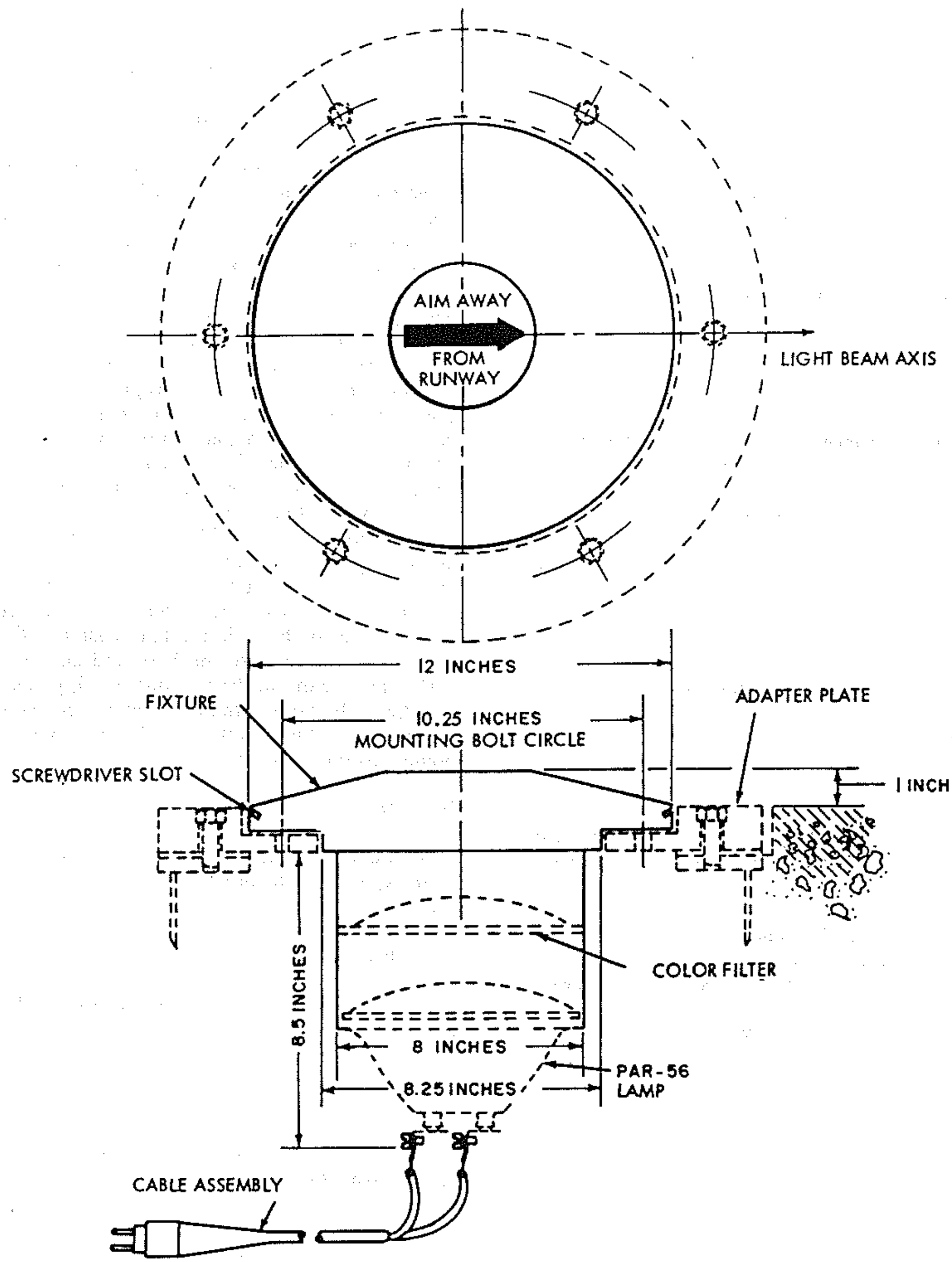


Figure 5-13. Type AL-1 Semi-flush Approach Light

350. OIL CIRCUIT BREAKER MECHANISM.

a. Purpose. This procedure provides a means of detecting potential problems with the oil circuit breaker (OCB) operating mechanism.

b. Procedure.

(1) Obtain local system control.

(2) Visually inspect the operating mechanism while the oil circuit breaker (OCB) is being closed (latched) and opened (tripped).

(3) Observe the closing, latching, and trip mechanism for proper operation.

(4) Check pins, linkages and switch arms for wear, tightness and freedom of movement.

(5) If maintenance is required, refer to the manufacturer's instructions for specific maintenance procedure.

351. ELECTRICAL CONNECTIONS.

a. Purpose. This procedure checks the electrical connections to insure a more reliable system operation.

b. Procedure.

(1) Coordinate with air traffic control.

(2) Remove all power from the system. Use hot stick to ground all exposed terminals.

(3) Refer to Order 6950.18A for maintenance of lightning arrestor connections, electrical connections, and safety conditions of power distribution equipment at terminal pole, substation, and transformer pads.

(4) Check that all connections, terminal lugs, and cable connections are tight and clean. Replace or tighten all connections and terminal lugs that show signs of heating.

(5) Clean all high-voltage wiring and components to prevent leakage and corona discharges.

352. ALS LIGHT FIXTURES.

a. Purpose. This check insures the full light output, brilliance and color from the ALS light fixtures.

b. Procedure.

(1) Surface Mounted Fixtures.

(a) Check all surface mounted light fixtures for missing glassware, reflectors, and filters.

(b) Replace all damaged or missing parts.

(2) Flush Fixtures.

(a) Check all flush mounted light fixtures for missing glassware, reflectors, and filters.

(b) Replace all damaged or missing parts.

(c) Flush Fixture Removal and Reinstallation. Most mounting plates have a drilled and tapped hole for insertion of an eyebolt so that a bar may be used to remove the plate. A flush-mounted plug must be removed to permit insertion of the eyebolt and must be replaced after the plate has been reinstalled. In cases where the older type cover plates are still in use, an alternate method must be used. One method of removing the type A adapter plate is to remove the frangible coupling from the plate and replace it with a piece of 2-inch pipe approximately 3 feet long. This allows sufficient leverage to be applied to remove the adapter plate. The removal of the adapter plate is necessary only when servicing the flasher power assembly. Before reinstalling adapter plates, tighten all sealing bushings. If this is not done carefully, water will leak into the light base. When adapter plates are removed, the gasket should be inspected very carefully. Deteriorated gaskets can be replaced as follows: Make certain the "O" ring gasket holes match the holes in the light base exactly. Be sure the mounting flange of the base and adapter plate and gasket are clean and free of dirt, sand, grease, pebbles, etc. Coat the bolts with pipe-joint compound to prevent water leakage through threads. Tighten bolts to 15 foot-pounds torque. (See figure 5-13).

353. RELAYS.

a. Purpose. This check is a visual inspection of all open type relays to provide early detection of potential problems.

b. Procedure.

(1) With system off, visually inspect all open type relays.

(a) Look for indications of arcing, pitted, or burned contacts.

(b) Look for loose connections, frayed or broken insulation, loose mounting screws, and loose coils.

(2) Operate system and observe the relays while they are being operated. Look for arcing, contact bounce, sluggish operation, loose return springs, etc.

(3) Repair, replace, or adjust relays as necessary to insure a more reliable system operation.

354. FLASHER MASTER TIMER.

a. Purpose. This check is a visual inspection of the motor driven flasher master timer contacts and associated components.

b. Procedure.

(1) Inspect the timer motor and look for excessive bearing wear, indications of overheating, loose electrical connections, or mounting hardware.

(2) Inspect the timer contacts and look for burned contacts, loose electrical connections or mounting hardware, and sluggish operation.

(3) Inspect the overall flasher master timer for obvious defects.

(4) Make necessary repairs or adjustments.

355. WARNING AND IDENTIFICATION SIGNS.

a. Purpose. This is a visual check to insure that all approach light stations are properly identified with the appropriate station number and the proper elevation angle.

b. Procedure. Visually inspect each of the approach light stations to verify that each station is properly identified according to the following standards.

(1) Approach Lighting Stations. Approach lighting stations shall be fitted with a numbered identification sign as shown in figure 2-9. Sequenced flashers and medium-intensity approach lighting stations shall be numbered either by signs or stenciling. Except for equipment with signs already attached, warning signs (FAA standard drawing C-4676) shall be placed on each ALSF-1 and ALSF-2 end structures, and/or in other locations as required due to design location of the approach light stations, and on such intermediate structures as will assure that the distance between the signs will be no more than 500 feet. High-voltage signs (FAA standard drawing C-4850) shall be conspicuously placed on each structure.

(2) ALSF-1 and ALSF-2 Installations. Each 100-foot station shall be numbered consecutively from the runway threshold (station 0+00) to the last light station numbered. The as-built facility drawings will show the correct light bar numbering.

(3) SSALS, SSALF, SSALR, MALS, MALSF, and MALSR installed prior to August 31, 1979. Begin numbering at the runway threshold with number 1, and the next light station number 2 and so on, continuing to and including the last or outermost unit. Systems installed after August 31, 1979, shall be numbered as indicated in paragraph (2).

(4) Flashing Light Systems. Flashers are numbered beginning with the outermost flasher as number 1 and proceeding in consecutive order to the innermost flasher. However, when flashers are an integral part of an ALS, they should be identified by reference to the number of the approach light station on which they are installed.

NOTE: All flashers installed after August 31, 1979, shall be numbered as indicated in paragraph (2).

(5) Rigid Structures. Rigid structures shall be identified as shown in figure 2-9. The sign shall be located on the access road or ladder side of the structure, either on the platform or the vertical structure support, preferably within 6 feet of the ground level. The sign shall have black lettering on a white background.

(6) Frangible Assemblies. The station number and elevation settings shall be stenciled on the side of the lampholder of the outer lamp assembly facing the access road or substation side of the light lane. The configuration of the sign shall be similar to that shown in figure 2-9 with minimum size 1-inch black lettering on a white background. A separate identification showing the required information sign may be attached to the vertical supporting column in lieu of stenciling.

(7) Flush Type Installation. The station number shall be stenciled on the concrete pad between the fourth and fifth lamp assembly facing the access road or the substation side of the light lane.

356. AMMETER.

a. Purpose. This procedure validates the accuracy of the loop current ammeters.

b. Procedure.

(1) Obtain a known calibrated root-mean-square (RMS) ammeter with sufficient range to measure the loop current. Loop current, as measured on the panel mounted meter, may be reduced by a 25/5 current transformer. Check manufacturer's instructions for specific current transformer ratio.

CAUTION: Do not open the meter circuit when the power is on.

(2) With system off, install the known calibrated meter in series with the panel mounted meter.

(3) Operate the system on all brightness steps and compare the meter readings. Meters should agree within the manufacturer's specified tolerance.

357. HIGH-INTENSITY APPROACH LIGHTING SYSTEM GROUP LAMP REPLACEMENT.

a. Purpose. This procedure restores the ALS to its original brilliance and reduces the frequency of lamp failures as a result of exceeding the lamp's rated life expectancy.

b. Procedure.

(1) Group lamp changes for 300W Q20A PAR-56 and PAR-56/2 or 500W Q20A/PAR-56/1 and 56/3 lamps shall be programmed after 400 hours of operation on brightness step 5. Care should be taken to replace all lamps in the system before 450 hours of operation on step 5.

(2) Maintain an accurate record of flash tube replacements to include the reading of the flasher elapsed time meter, date of flash tube installation, and station number. Replace flash tubes on an individual basis.

(a) Elevated Flashers, Single Intensity. Replace flash tube after 500 hours of operation.

(b) Flush/Frangible Flashers, Single Intensity. Replace flash tubes after 1000 hours of operation.

(c) Elevated Three Intensity Flashers. Replace flash tubes after 900 hours and before 950 hours of operation on high brightness.

(d) Other Flashers. If above steps are not applicable to a specific system, follow manufacturer's flash tube replacement schedule.

358. MEDIUM INTENSITY APPROACH LIGHTING SYSTEM GROUP LAMP REPLACEMENT.

a. Purpose. This procedure restores the ALS to its original brilliance and reduces the frequency of lamp failures as a result of exceeding the lamps rated life expectancy.

b. Procedure.

* (1) Withdrawn-CHG 2 *

(2) Group lamp replacement for all PAR-56 type threshold lights shall be programmed after 400 hours of operation on high brightness. Care should be taken to change all PAR-56 type threshold lamps before 450 hours of operation on high brightness.

(3) Sequenced flasher lamps shall be replaced after 900 hours and before 950 hours of operation on high brightness, or in accordance with the manufacturer's technical instruction manual.

359. ODALS/LDIN/REIL GROUP LAMP REPLACEMENT.

a. Purpose. This procedure restores the system to its original brilliance and reduces the frequency of lamp failures as a result of exceeding the lamps rated life expectancy.

b. Procedure.

(1) Replace all ODALS flash tubes after 500 hours of operation on high brightness per manufacturer's instruction book, TI 6850.47 ODALS Omnidirectional Approach Lighting System.

(2) Replace all LDIN/REIL sequenced flasher lamps in accordance with the manufacturer's technical instruction manual.

(3) Replace ODREIL flash tubes per manufacturer's technical instruction manual.

360. ALSF-2 POWER TRANSFER OPERATION CHECK.

a. Purpose. This check verifies ALSF-2 transfer requirements for category II and III operating conditions.

b. Procedure.

(1) Coordinate with air traffic control before beginning tests.

(2) Both power sources, commercial and standby engine generator (E/G), must be available.

(3) Start the E/G and place the ALSF-2 load on the E/G.

(4) Simulate a power failure to the E/G by loss of fuel or other means, and determine if the power transfer to commercial source is made within the time specified in chapter 3.

(a) If the transfer is not within tolerance, the E/G transfer switch shall be checked in accordance with the latest edition of Order 6980.11, Maintenance of Engine Generators.

(b) To determine the transfer time.

1 Connect a recording oscilloscope to the output (load side) of the E/G transfer switch.

U.S. GPO: 1997-568-016/60184

2 Start the E/G. Place the ALSF-2 load on the E/G and select brightness 2.

3 Simulate an engine failure by loss of fuel, and measure the time when the voltage is below 90 percent of the normal output. This is accomplished by observing the voltage trace and noting where the peak-to-peak voltage decreases by 10 percent to the point where the load is supplied by the commercial source.

361. VASI REGULATOR.

a. Purpose. This check verifies the proper oil level required for cooling and insulation of the transformers within the VASI regulator.

b. Procedure.

(1) Visually inspect the regulator tank and look for signs of oil leaks.

(2) Observe the oil level indicator located on the side of the tank. The indicator should be approximately in the center of the dial when the oil temperature is 25°C or 77°F.

(3) To add oil or make repairs to the regulator, refer to the manufacturer's instructions.

362. VASI AND PAPI GROUP LAMP REPLACEMENT.

a. Purpose. This procedure restores the system to its original brilliance and reduces the frequency of lamp failures as a result of exceeding the lamps rated life expectancy.

b. Procedure. Replace all PAPI and VASI lamps after 2000 hours of operation on high brightness. Good lamps removed at this time may be used for interim replacement of those which may have blackened or failed.

363. VASI AND PAPI ANNUAL TASK.

a. Purpose. This task is to prevent the deterioration of the equipment and increase system reliability.

b. Procedure.

(1) System Inspection.

(a) Visually inspect the power and control assembly, and lamp housing assemblies (LHA's) for excessive dirt or dust accumulation.

(b) Inspect all feed-thru insulators, bushings, lightning arrestors, etc., for chipped, cracked or broken parts.

(c) Clean or replace components as necessary.

(2) Wiring Inspection.

(a) Visually inspect the insulation for signs of deterioration such as brittle, cracked, or damaged insulation.

(b) Check all terminal connections to ensure they are tight and corrosion free.

(3) Open-Type Relay Inspection.

(a) Visually inspect all open-type relays, for signs of overheating, arcing, and pitted or burned contacts. Do not attempt to file or burnish burned or pitted contacts.

(b) Inspect the armature for freedom of movement.

(c) Repair or replace a relay as necessary.

(4) Oil Switch and Oil Fused Cutout Inspection (if applicable).

(a) Visually inspect for oil seepage around bushings or terminals. Repair as necessary.

(b) Check oil level. Refer to manufacturer's instructions for procedure of checking and adding oil.

(c) When adding oil, use recommended transformer oil.

(5) Fused Cutout Switch (Open Type) Inspection.

(a) Visually inspect fuse contact and wiring terminals for indications of heating (discoloration, loss of fuse clip spring tension, burned insulation, etc.).

(b) Check fuses for proper type and size.

(c) Tighten all terminal connections.

364. REIL SAFETY DEVICES.

a. Purpose. This procedure insures reliable operation of safety devices incorporated in the REIL system to help prevent electrical shock.

b. Procedure.

(1) Check interlocks for smooth and free operation. Refer to manufacturer's instructions for location of interlocks. Open cabinet doors and verify that the power is removed.

(2) Check flash capacitor bleeder circuit relay on each lamp assembly for clean contacts and operation. Use a hot stick to verify that the flash capacitors have been discharged.

365. OBSTRUCTION LIGHT CHECKS.

a. Purpose. These checks help prevent the deterioration of the equipment and increase the system reliability.

b. Procedure.

(1) Load Contactor. Check the load contactor to determine if the contacts are rated for the load connected. Look for pitted, burned, or misaligned contacts. Make certain the armature moves freely and that the spring tension is sufficient to pull the armature away from the coil when deenergized.

(2) Conduit. Check all conduit for loose support. If necessary, replace broken fastenings. Clear water trap that may be plugged with paint or dirt. Standing water in conduit will damage conductor insulation.

(3) Fuses, Switches, and Wiring. Note that the fuse size is within the tolerance of not more than 200 percent of rated load. The fuseholder must be tight, and the fuse must be clean and not burned. Check the wiring for loose connections and the insulation for breaks or fraying. Check switches for loose, burned, or misaligned contacts. Replace items if necessary.

(4) Telltale Circuit. Check the connections and the contacts. Test the circuit to make certain the circuit is functioning properly.

(5) Ground. Make certain the ground connections are tight and in good condition. Check ground resistance with a reliable ground checker. It should measure 25 ohms or less.

366. OBSTRUCTION LIGHT/BEACON SCHEDULED LAMP CHANGE TASKS.

a. Purpose. This procedure restores the lights to their original brilliance and reduces the chance of lamp failure as a result of exceeding the lamp's rated life expectancy.

b. Procedure. The following shall be accomplished for lamps requiring change at 80 percent of lamp life.

(1) Lamp Replacement. Replace lamps when the burning time has attained 80 percent of the rated lamp life according to tables 5-3 and 5-4. Make certain correct lamp is installed. Allow the new lamp to burn a few minutes to make certain the lamp is not defective.

(2) Lamp Voltage. Record the voltage measured at the lamp socket when the lamp is changed. Compare the voltage with its past record and resolve the discrepancies. See tables 5-3 and 5-4 and associated information.

(3) Clean the Optical System. DO NOT USE strong caustic or abrasive cleaners. Fresnel lens surfaces shall be cleaned and polished using an approved glass cleaner. Dirt and dust shall be removed from the grooves. A stenciling brush is especially good for this purpose. Paint spots and streaks along the edge of the glass must be removed.

(4) Clean Fixture. Using a brush or cloth, clean the dirt and dust from fixture and open all drain holes. Check the condition of sockets. Look for burned or galled screw bases and loose conductor connections and frayed or broken insulation.

(5) Check Weatherproofing Seals. Adequate weatherproofing is necessary for the protection of lights. Renew all gaskets when cracked or deteriorated. Before installing new gasket, thoroughly clean the gasket channel to make the gasket seat properly. When it is necessary to secure the gasket with rubber cement, coat both the gasket and seat with approved cement and permit to dry until tacky before the gasket is placed in position.

(6) Lightning Protection System. Check all connections for tightness and continuity. Check lightning arresters for cracked or broken porcelain and missing mounting brackets.

(7) Booster Transformer. Check the transformer's input and output voltage to determine that it is functioning correctly.

(8) Electrical contacts. Check the flasher and main power contactor for dirty, burned or pitted contacts. Clean or replace as required.

Table 5-3. Recommended Lamp Equipment

Type of Service	*Watt or Lumen*	*Volt or Ampere*	*Bulb*	*Base Medium*	*Base Mogul*	*Filament*	*Light Center Length (Inches)*	*Over All Length (Inches)*	*Rated Life (Hours)*
Beacon, 36-inch	1,000	30 volt	T-20	.....	Bipost..	C-13	4	9-1/2	500
	1,000	100/130	T-20	.....	Bipost..	C-13	4	9-1/2	1,000
Course light	500	100/300	T-20	Bipost..	.....	C-13B	3	7-1/2	500
Beacon, 24-inch	500	100/130	T-20	Bipost..	.....	C-13B	3	7-1/2	500
	500	30 volt	T-20	Bipost..	.....	C-13B	3	7-1/2	500
Code beacon, 300 mm, electric	620	100/130	PS-40	.....	Prefocus.	C-7A	5-11/16	10-1/16	3,000
Obstruction light:									
Radio towers 200 feet and less, antenna poles, other "off-airport" obstructions.	67	100/130	A-21	Screw..	.....	C-9	2-7/16	4-7/16	3,000
Intermediate levels on radio towers above 200 feet, localizer, glide path, ASR, and ALS towers, other "on-airport" obstructions.	116	100/130	A-21	Screw..	.....	C-9	2-7/16	4-7/16	6,000

Table 5-4. Recommended Lamp Equipment (Multiple Circuits and Series Circuit)

Typical Service	*Watts*	*Volts or Ampere*	*Bulb*	*Base*	*Average Rated Lab. Life (Hours)*	*Approx. Lumens*	*Specifications FAA*	*MIL*
Double and Single Obstruction Lights	125	120 V	A-21	Md. Pf.	6,000	1,220		L-7830
	116	120 V	A-21	Md. Scr.	6,000	1,260	L-810	L-7830
Airport Beacon	1,000	120 V	T-20	Mg. Bip.	600	20,500	291	
	1,200	115 V	T-20	Mg. Bip.	750	27,500		L-7158
Code Beacon	700	120 V	PS-40	Mg. Pf.	6,000	11,200		L-6273
	620	120 V	PS-40	Mg. Pf.	3,000	11,200	446	L-6273
High-Intensity White Obstruction Lights		440 V 240 V 120 V						L-856
Series Circuit								
Obstruction Lights		6.6 A	A-21	Md. Pf.	2,000	1,020	L-810	L-7830

367.-419. RESERVED.

Section 3. SPECIAL MAINTENANCE PROCEDURES

420. ALS SAFETY PRECAUTIONS.

a. Purpose. This paragraph provides extra safety precautions applicable to the ALS substations. These precautions are not set forth in Order 6000.15B.

b. Precautions. In addition to the safety precautions set forth in Order 6000.15B, extra precautions are necessary when servicing ALS substations. Maintenance technicians responsible for ALS equipment should also be qualified for maintenance of high voltage electrical systems.

CAUTION: Do not open any high voltage compartment when the power is on.

(1) The metal-clad substation has been carefully designed to protect personnel against accidental contact with high voltage. Interlocked doors are provided so they may be opened only after deenergizing the oil fuse cutouts on Hevi-Duty regulators or the oil circuit breakers on General Electric and Westinghouse equipment.

(2) Certain high voltage portions of the substation equipment, such as the input pothead, lightning arrestors, primary metering transformers, the control power distribution transformer, and the input to the ganged oil fuse cutouts or oil circuit breakers remain energized even when the oil circuit breakers are opened.

(3) Power (120/240 V ac) is available through the circuit breaker panel to operate lights, power tools and test equipment.

(4) The entire substation can be deenergized only by opening the main power pole-top disconnect switch, the fuse cutouts, or the oil switch that supplies the high voltage to the substation. See order 6950.18A regarding pole-top switches.

(5) Before opening any high voltage compartment, the main power pole-top or oil switch should be locked open. If the main power is disconnected with fuse cutouts, the fuse cutout covers should be removed before working in any high voltage compartment.

(6) Access to certain high voltage compartments can be gained only by removing bolted panels. Do not remove any bolted panel until the entire substation has been deenergized.

421. ALS OIL CIRCUIT BREAKER.

a. Purpose. The following paragraphs provide guidance for preventive maintenance to the oil circuit breaker linkage.

b. Procedure.

(1) Before removing any panels or performing maintenance on the oil circuit breaker (OCB) linkage, lock open the incoming power to the substation.

(2) Remove the bolted subpanels that are located within the OCB compartment that cover the OCB operating mechanism.

(3) Apply a thin film of oil to all bearing surfaces and linkages. DO NOT over lubricate. Use care that no oil gets on the breaker closing solenoid, breaker trip coils, or associated plungers.

NOTE: In moist climates, the metal clad substation is subject to moisture condensation on the metal surfaces. This condensation contributes to the corrosion of the OCB mechanism, relay armatures, contacts, etc. If moisture condensation is a problem, it can be reduced by continuous operation of the substation space heaters.

422. MOVING COIL CONSTANT CURRENT REGULATOR MAINTENANCE.

a. Purpose. This procedure provides general guidance when performing maintenance to the moving coil constant current regulator.

b. Procedure.

(1) General.

(a) A regulator tank should be opened only if necessary for maintenance.

(b) Open regulator tank only in clear, dry, and calm weather.

(c) When using hand tools in and above the open regulator tank, each tool should be cleaned and safety tied, either to the technician's hand or to the tank, to prevent dropping the tool into the tank. No object, particularly metal objects such as tools, and nuts and bolts, can be allowed to remain in the tank. The magnetic field inside the regulator tank will attract bits of metal into the moving coil assembly and destroy it.

(2) Refer to the manufacturer's instructions for specific detanking and maintenance procedures.

(3) When a regulator tank is opened for maintenance, make a thorough mechanical and electrical inspection of the moving coil regulator.

(4) Check and tighten each terminal screw and lug.

(5) Tighten all bolts in the mechanical assembly.

(6) Check brightness contactors for wear and adjust or replace as necessary.

(7) Replace cracked, torn, or hard tank gaskets.

(8) Check the insulating oil dielectric strength in accordance with paragraph 343.

423. LOAD CURRENT ADJUSTMENT OF MOVING COIL REGULATORS.

a. Purpose. This paragraph provides general guidance for adjusting the output current from a moving coil constant current regulator.

b. Discussion. The output current from a moving coil regulator is adjusted by the amount of weight added to or removed from the moving coil. The moving coil provides the maximum current, 20 amperes for brightness 5 and supplies the auto transformer that determines, by a designed turns ratio, the level of the lower four steps. When making an adjustment to General Electric regulators, add weight to increase current, and on Westinghouse regulators, add weights to decrease current. Load current adjustment procedures are fully described in the manufacturer's technical instruction manual. Regulator adjustments are not normally required, however, to make an adjustment to the constant current regulator, the following general steps are required.

c. Procedure.

(1) Remove all power to the substation.

(2) Open the regulator tank, and follow all precautions required when opening a regulator tank.

(3) Lower the insulating oil level to provide access to the adjustment weights.

(4) Add or remove weights as required. The amount of weight required is determined by individual regulator operation. Adjustment of the weights will effect all brightness steps a proportionate amount.

(5) Add new insulating oil to bring the oil to the proper level.

(6) Replace tank cover.

(7) Apply power to the substation and verify the current levels.

(8) If refinement in the current level is needed, repeat the above process.

424. LOAD CURRENT ADJUSTMENT OF SATURABLE REACTOR AND RESONANT NETWORK REGULATORS.

a. Purpose. This paragraph provides general guidance for adjusting the output current from a saturable reactor constant current regulator manufactured by Hevi-Duty and directions for adjusting resonant network regulators.

b. Discussion. The output current from a saturable reactor regulator manufactured by Hevi-Duty is controlled by the amount of direct current in the control winding of the saturable reactor. All output current adjustments are made external to the regulator tank.

c. Procedure.

(1) Saturable Reactor Regulators.

(a) Refer to the manufacturer's instructions for specific adjustment procedures and component identification.

(b) Make all output current adjustments by adjusting the sliding taps on resistors located on each of the regulator control panels.

(c) Each brightness step output current may be adjusted individually, however, when making adjustments, adjust brightness 5 first, as it will effect all other adjustments.

(2) Resonant Network Regulator. Refer to the manufacturer's instruction for adjustment procedures.

425. INDUCTION VOLTAGE REGULATOR.

a. Purpose. This paragraph provides general guidance for maintenance of induction voltage regulators.

b. Procedure.

(1) Refer to the manufacturer's instructions for specific adjustment and maintenance procedures.

(2) Inspect the motor limit switches for correct location and condition. The control motor travel is extremely critical. The limit switches are required to interrupt a highly inductive load, therefore requiring frequent replacement. The frequency of replacement will be dictated by the location and operational conditions.

(3) Record the voltage and current readings specified in the instruction book. The tolerance of the output voltage is much wider than for other types of regulators because of the inertia in the motor-driven assembly. It will be found that one set of voltage values will be obtained when the regulator is stepping down, and another when stepping up. Record readings when the regulator is stepping up.

426. FLASHER LAMP ASSEMBLY MAINTENANCE.

a. **Purpose.** This paragraph provides some additional safety requirements when performing flasher lamp assembly maintenance, it also includes activities to be performed on a periodic basis.

b. **Safety Precautions.**

(1) Do not look directly at an operating flasher lamp; momentary blindness may be caused by the extremely bright light. For shop maintenance, a light shield is available for use with the Sylvania CD-2000 series and the General Electric CD-100 elevated lamp assemblies. It is stocked at the FAA Logistics Center (NSN 6210-00-538-5709).

(2) Before performing maintenance on the flasher lamp assembly, remove power and use a hot stick to discharge the flash capacitors.

(3) Handle flash tubes only by the base. Do not touch the tube with bare hands because oil from the skin may cause hot spots, resulting in early tube failure.

c. **Procedure.**

(1) Refer to the manufacturer's instruction manual for troubleshooting guide and maintenance instructions.

(2) Check internal wiring and look for signs of insulation deterioration.

(3) Check and tighten screw terminals on terminal boards.

(4) Inspect lamp assembly components for signs of overheating. Look for discoloration of components, electrolyte leaking from flash capacitors, and burned or pitted relay contacts, etc.

(5) Inspect the flasher reflector. If cleaning is required, use a non abrasive cleaner-polish. Strong alkaline cleaners should not be used.

427. FLASHER MONITOR ADJUSTMENTS.

a. **Purpose.** This paragraph provides guidance in verifying the operation and adjustment of the ALSF-1, single-intensity flasher monitor and a reference for dual mode systems.

b. **Procedure.**

(1) ALSF-1 Single Intensity Flasher System.

(a) Monitor operation. The failure of a flasher will result in the dropout of a monitor relay in that unit and it will connect a 22-kilohm resistor from the common monitor line to ground. If two flashers have failed, two 22-kilohm resistors will be connected in parallel from the common monitor line to ground, resulting in a monitor line to ground resistance of 11 kilohms. Similarly, three defective flashers will place three 22-kilohm resistors in parallel for an approximate 7 kilohms from the monitor line to ground. When the monitor is properly adjusted, and the third flasher fails, sufficient current is applied to a monitor relay on the master timer panel, causing it to energize and turning off the monitor lights.

(b) ALSF-1 Monitor Verification.

1 Disconnect, from the terminal board, the common monitor line that connects the SFL units to the master timer.

2 Connect an ohmmeter from the disconnected monitor line to ground.

3 With the SFL system off, the monitor line resistance should be approximately 1.5 kilohms (22 kilohms divided by 15 SFL units).

4 Turn the SFL on and allow at least 1 minute for system to stabilize.

5 Verify that all lamps are flashing.

6 Ohmmeter should read infinity. If the ohmmeter reads less than infinity, check for inoperative SFL unit or grounded monitor line.

(c) SFL Unit Verification.

1 With the ohmmeter connected to the disconnected monitor line and with the SFL system on, interrupt the timing signal sent from the master timer to the individual lamp assemblies. Use plastic, paper, or similar insulating material to open contacts.

2 Check each of the SFL units in the system and verify that, as each lamps timing pulse is interrupted, that the monitor line to ground resistance is 22 kilohms. The monitor line will clear when the timing pulse is restored.

3 After verification that each SFL units monitor operates properly, reconnect the common monitor line to the master timer.

(d) Monitor Adjustment. The monitor should be adjusted to indicate an alarm when three lamp units fail. To make adjustments, proceed as follows.

1 Set the sensitivity selector switch on position 3.

2 Turn the adjustable monitor sensitivity resistor to maximum resistance (full clockwise).

3 Cause three flashers to fail by opening three master timer contacts. (Use non-conductive material to open contacts, wood, paper, plastic, etc.)

4 With three flashers disabled, turn the sensitivity adjustment slowly toward less resistance (counterclockwise) until the monitor relay operates. This causes the green monitor lights on the local control panel to go out.

5 Remove the insulating material from the three master timer contacts. The green monitor lights should come on, indicating normal operation.

6 Verify operation by opening three master timer contacts, one at a time. The monitor lights should remain on (with two SFL units out) but still alarm with three failures. Refine adjustment if required to provide proper monitor operation.

(2) Dual Mode Systems. Refer to the manufacturer's technical instruction manual for monitor verification and adjustment procedures.

428. ALSF TEMPORARY TWO REGULATOR OPERATION.

a. Purpose. This procedure provides guidance when, at the discretion of the sector manager, it is desirable to operate an ALSF system on two regulators.

b. Procedure. This procedure is applicable to the three-phase ALS substations equipped with three 50 kW constant current regulators. When a regulator is out of service for maintenance or repair, emergency operation of the full approach light system is possible on the remaining two regulators. An ALSF-1 may normally be operated at the desired brightness level, an ALSF-2 may have to operate at something less than full brightness.

(1) Determine the rated wattage load of the series loop connected to the defective regulator. Add to the wattage load of the series loop of one of the remaining good regulators. If the total of the two does not exceed 50 kW, both series loops can be operated in SERIES and fed from one regulator, without brightness restrictions. If the combined load is over 50 kW (ALSF-2), one regulator can supply two series loops, but at a reduced brightness.

CAUTION: Before performing any of the work described below, ALL power to the ALS substation shall be removed by disconnecting the incoming 2400/4160 volt power to the substation. Ground all exposed terminals before handling.

(2) Disconnect the incoming 2400-volt supply feeder from the defective regulator and insulate the free end.

(3) If the system has power-factor correcting capacitors that are external to the regulator, isolate the capacitor from the disconnected phase. The capacitor can be isolated either by removing the capacitor fuse or removing the phase lead from the capacitor.

(4) Disconnect the low-voltage controls for the regulator that is out of service.

(5) Disable the monitor and protective circuits from the disabled regulator, if required. Refer to the manufacturer's instruction manual for the specific details.

(6) Disconnect the series loop from either the defective regulator output terminals or at the high voltage output cabinet. Refer to manufacturer's instruction manual for the specific terminal identification.

(7) Reconnect this loop in SERIES with the loop connected to the selected operable regulator. To do this, remove one lead from the operable regulator. Connect one lead (just removed from the defective regulator) to the selected operable regulator. Splice together the other two leads and insulate splice for 5000 volts.

(8) Reconnect the 2400/4160-volt service to the substation. Energize system and check operation on each brightness level. Make sure that the regulator output does not exceed 50 kW.

(9) Check all monitors for proper operation, readjust if required.

429. EMERGENCY VASI-4 TO VASI-2 OPERATION.

a. Purpose. This procedure provides guidance on how a VASI-4 system may be operated as a VASI-2 system.

b. Procedure.

(1) A VASI-4 may be operated as a VASI-2 pending repairs and/or electrical service restoral, providing the following conditions are met.

(a) The system is otherwise certifiable.

(b) Weekly checks are performed to ensure proper glide path angle if the temporary VASI-2 is operating without tilt switches. The results of these checks shall be noted in the Facility Maintenance Log, FAA for 6030-1.

(c) A local Notice to Airman (NOTAM) is issued to advise users that a partial VASI system is temporarily in operation pending repair/restoral.

(2) Refer to manufacturer's instruction book for specific temporary changes required to isolate the unused portion of the system.

430. SERIES LOOP CUTOUTS.

a. Purpose. This procedure provides instructions for the use and maintenance of series loop cutout plugs.

b. Procedure.

(1) With system off, remove the series cutout plug. Due to oxidation of the contact making surface, the cutout is sometimes difficult to remove. To prevent chipping or breaking the porcelain when a porcelain cutout is removed, pull the cutout straight out with a minimum of rocking motion.

(2) When the cutout plug is removed, lubricate the contact making surface with a thin film of conductive lubricant to ensure safe and reliable future removal of the plug.

431. TIME SWITCHES.

a. Purpose. This paragraph provides general guidance for the maintenance and adjustment of the sauter time switch.

b. Procedure.

(1) Maintenance.

(a) Check relays for pitted or burned contacts.

(b) Inspect time switch motor brushes and armature.

1 If needed, clean commutator with a soft cloth dampened with solvent and wipe dry. Commutator arcing may be caused by sticking brushes or brushholder arms, improper tension of brushes, grease on the commutator, or high mica. To remedy these conditions, dress the commutator with fine sandpaper and, if necessary, undercut the mica. Be careful to not damage the insulation on the armature windings. The final burnishing should be done with crocus cloth.

2 Inspect the brushes for excessive wear. If necessary, install new brushes. They must be properly seated with at least 85 percent contact. Check brush tension; it should be 1 1/2 to 2 ounces. Check the free movement of the brushes in the brush holders. Check the end play of the motor. Use fiber spacers equally distributed between the front and rear bearings to obtain proper end play.

(c) Clean and lubricate all moving parts in accordance with manufacturer's instructions.

(d) Use an appropriate vacuum-tube tester on questionable vacuum tubes. Replace tubes with the proper type.

(e) Check input voltage at the master switch and record reading. Verify that the voltage is within tolerance.

(f) Check motor and gear bearings for excessive wear by attempting to move shaft. Check gears for excessive backlash.

(g) Check the flexible leads to the mercury switch by looking for broken strands and frayed insulation. Check electrical connections for tightness and replace any wiring showing signs of deterioration. Make certain the leads do not interfere with the operation of the switch.

(h) Check motor lubrication. The time switch motor bearings require very little lubrication. Give those equipped with grease cups an amount equal to one-half turn of the grease cup every 6 months. On motors not provided with grease cups, the bearings are packed with grease and should require lubrication annually. White vaseline is the approved lubricant.

(i) Properly dress the contact faces of the master switch contacts and polish them with No. 0000 sandpaper. Also, polish auxiliary contacts with nonabrasive cleaner, and adjust as necessary. If the auxiliary contact arm tension becomes weakened, increase the pressure by slightly bending the arms to ensure good electrical contact.

(j) Inspect the mercury switch operation and, if necessary, bend the tube support arm slightly to obtain proper make-and-break positions.

(2) Adjustment. To correct the minute dial setting, rotate the dial or arm clockwise. A counterclockwise correction may damage the clock movement. If the movement is gaining or losing time, adjustment should be made accordingly. Advance or retard the regulator only one-fourth of a graduation on the regulator scale each time an adjustment is made. Continue this procedure, if necessary, over a period of several visits until the clock keeps correct time. Each graduation of the scale equals approximately 3 minutes in 24 hours.

(3) Sauter Time Switch Calibration. On the periphery of the dial of the Sauter time switch are five marks, each intervening space representing 15 minutes. The center mark corresponds to 12:00 noon at each time meridian. Some dials can be advanced or retarded 1 full hour, others only one-half hour. This is governed by the length of the elongated holes in the dial face. If the time switch is located on a standard meridian, no compensating adjustment of time differential is required. To set the time switch at other locations, remove the dial from the time switch. Turn the dial sprocket wheel from the current date to March 21, which is the vernal equinox date when sunrise occurs in all latitudes within the continental United States at approximately 6:30 a.m. and sunset at 6:12 p.m., local standard time. (Autumnal equinox date is September 23, when sunrise occurs at approximately 5:49 a.m., and sunset at 5:56 p.m.) Loosen the two screws on the face of the dial. Shift the dial face clockwise 26 minutes, using as a starting point the center mark on the periphery of the dial. (If the site is located east of the standard meridian, shift the dial face counterclockwise the required amount.) After this adjustment is made, tighten the screws and replace the dial. The dial switch mechanism, which is composed of trip-on and trip-off pins, and the toggle switch must be accurately adjusted so that its operation synchronizes with the exact time indicated on the dial by the time pointer. The ON and OFF pin adjustment scale is graduated into 15-minute divisions. The center mark on the trip-on pin slot is for 15 minutes after sunset, therefore, this pin must be moved to the right two notches in order to start the lighted aid 15 minutes before sunset. The center mark on the trip-off pin slot is for 30 minutes before sunrise, therefore, this pin must be moved to the left three notches in order to stop the operation of the lighted aid 15 minutes after sunrise. The toggle switch, operated by the trip-on and trip-off pins, shall be located as near center as possible. This can be determined by the distance from the fastening screws to the edge of the toggle switch base plate. The time pointer shall also be located in the center of the switch. Turn the dial to the right; the toggle switch should operate completely when the time pointer is directly over the center of the ON and OFF pinhead. If it moves past the pointer before the switch operates, or if the switch operates before the pin is centered directly under the time pointer, loosen the screws and slide the switch assembly right or left until the correct position is obtained for each cycle of operation. After making the foregoing adjustments, the dial should be turned by hand to a point just before the switch functions; then, let the clock complete the operation in order to check the exact time the switch functions. After the adjustment of toggle switches and dial has been made correctly, turn the date sprocket wheel back to the current date, and set the dial to the required correct standard time.

432. PHOTOELECTRIC OR LIGHT SENSITIVE CONTROLS.

a. Purpose. This paragraph provides general guidance for the maintenance and adjustment of the Weston, Hughey and Phillips, and Crouse Hinds control units.

b. Procedure.

(1) Weston Controls.

(a) Check the electrical circuits and relays for signs of deterioration and repair as needed to maintain reliability.

(b) Clean the photocell glass cover. In order to obtain maximum efficiency in the operation of the sensitive turn-on and turn-off relays, thoroughly clean the photocell cover glass upon each visit to the site. Dust and dirt reduce the electrical energy generated by the photocell.

(c) Examine photocell for indications of moisture. If any condensation, or trace thereof, is noted inside the cover glass, examine the unit for leaks. Install a new gasket if necessary. Maintain a good coat of paint on the housing and connections to aid in keeping moisture out.

(d) If it becomes necessary to return the photocell unit or the control cabinet for exchange or repair, return both units in order to have the calibration of the sensitive relay accurately checked and adjusted to the photocell.

(e) Clean and adjust the ON and OFF relays. These relays, in both the model nos. 609 and 709 control cabinets, are very delicate instruments and must be handled accordingly. Move the contacts up and down lengthwise, parallel with the actuating arm, to avoid forcing the points out of alignment. Adjustment of the stationary contacts should be very slight and carefully performed so that the small binding wire located to the rear of the adjusting screw is not broken or loosened. Take precautions to keep dust out of these relays when the covers are removed.

(f) Clean contacts U and W in the no. 630 relay with a nonabrasive material such as chalk, jewelers rouge, etc. Clean the face of the magnetic contactor with a soft, lint-free cloth. Where no provisions are made for the adjustment of the contact points, the arms may be bent slightly to increase the tension.

(g) Visually inspect the heating element in relay no. 613. Because of the constant heat applied to the bimetallic heat element, look for intermittent open circuits, broken insulation, or loose solder connections at the rear of the relay.

(h) Check and clean the 110-volt motor switch contacts in the model no. 709 control cabinet upon each visit to the site. If the motor stops before it has completed its one-half revolution on the cam, the trouble is likely the motor switch contacts. Visually observe the make-and-break of the mercury contacts while the control equipment is put through its cycle of operation. If necessary, bend the tube support arms slightly to obtain a positive make-and-break. Adjust and secure the mercury tube leads so that the operation of the contact is in no way impaired by the improper position of the leads. On the mercury contacts of the model no. 709 control device, it may be necessary to increase or decrease the spring tension so that the contact assumes its correct position at the termination of each respective cycle of operation.

(2) Hughey and Phillips Control.

(a) System Operation Check. Apply power to the lighting control. Refer to figure 5-14, and observe the following operational sequence.

1 All obstruction lights and the beacon lamps should burn continuously for 30 to 60 seconds, until the filament of time-delay tube K-202 has heated.

2 When K-202 is energized, power is removed from the coil of K-201, and the beacon should start to flash.

3 After approximately 30 seconds, all lights should go off if the illumination level is higher than 58 foot-candles.

4 The photoelectric unit is factory adjusted to turn the tower lights on at an illumination level of 35 footcandles ±2. A light meter and some means of reducing the illumination striking the phototube should be used to test the ON-OFF points.

(b) On-Off Adjustment. The following procedure should be followed if adjustment of the photoelectric control is necessary. Use a light meter to measure the light intensity at the location of the phototube.

NOTE: With the time-delay circuit, it is necessary that the controls be moved slowly in order to insure that operation of the units is at the desired level. As a recheck, change the light level falling on the phototube in small increments and determine the point at which the light control operates.

1 Rotate ON control (R-106) all the way counterclockwise.

2 Set illumination level at remote phototube to approximately 35 foot-candles.

3 Rotate ON control (R-106) clockwise SLOWLY until the light comes on.

4 Set illumination level at phototube to approximately 58 foot-candles.

5 Rotate OFF control (R-107) clockwise SLOWLY until the lights go off. There is some interaction between ON and OFF controls and steps (2) through (5) should be repeated to insure accurate settings.

(3) Crouse Hinds Control.

(a) Operational Check of Flasher Unit. Apply power to the control unit and verify the following operational sequence.

NOTE: Proper operation of the unit will be achieved in approximately 30 seconds after first application of power, allowing the tubes of the photoelectric control time to heat up. During daylight, operation can be tested by excluding light from the phototube or disconnecting temporarily one wire of the separate phototube circuit at connection U. See figure 5-15.

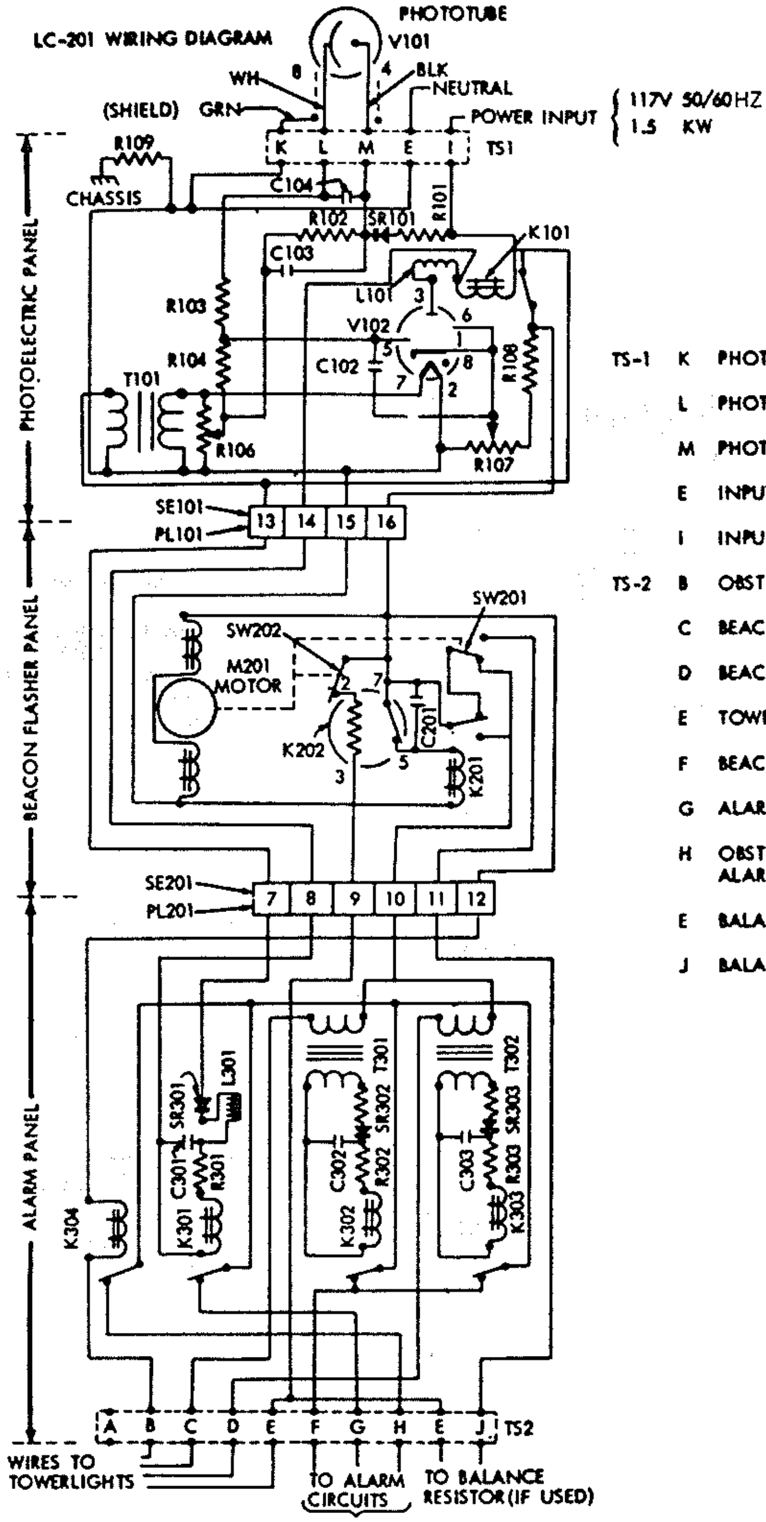
1 Proper operation of the photoelectric unit will close relay K7.

2 Proper connection and operation of the tower lights causes the armatures of relays K1, K2, K4, and K6, to close, opening their alarm circuits.

3 During a short period of warm up, contactor K3 closes even though the flasher is operating properly.

4 A time span of 30 to 60 seconds is necessary for the heating of thermal relay K4 and release of its contact circuit, which in turn opens K3, restoring normal operation to the beacon circuit.

5 Test the fail-safe feature by stopping the flasher and manually operating switches SW1 and SW3 to the OFF position. This actuates the flasher fail-safe feature, causing relay K3 to close.



TERMINAL CODE

TS-1	K	PHOTO-TUBE SHIELD
	L	PHOTO-TUBE PIN 8 (WHITE)
	M	PHOTO-TUBE PIN 4 (BLACK)
	E	INPUT POWER (LINE NEUTRAL)
	I	INPUT POWER (LINE)
TS-2	B	OBSTRUCTION LIGHTS
	C	BEACON LAMP 1
	D	BEACON LAMP 2
	E	TOWER LIGHTS (NEUTRAL)
	F	BEACON LAMP FAILURE ALARM CIRCUIT
	G	ALARM CIRCUIT(NEUTRAL)
	H	OBSTRUCTION LAMP FAILURE ALARM CIRCUIT
	E	BALANCE RESISTOR (NEUTRAL)
	J	BALANCE RESISTOR (LINE)

Figure 5-14. Wiring Diagram, Hughey and Phillips Model LC-201 Tower Lighting Control Unit

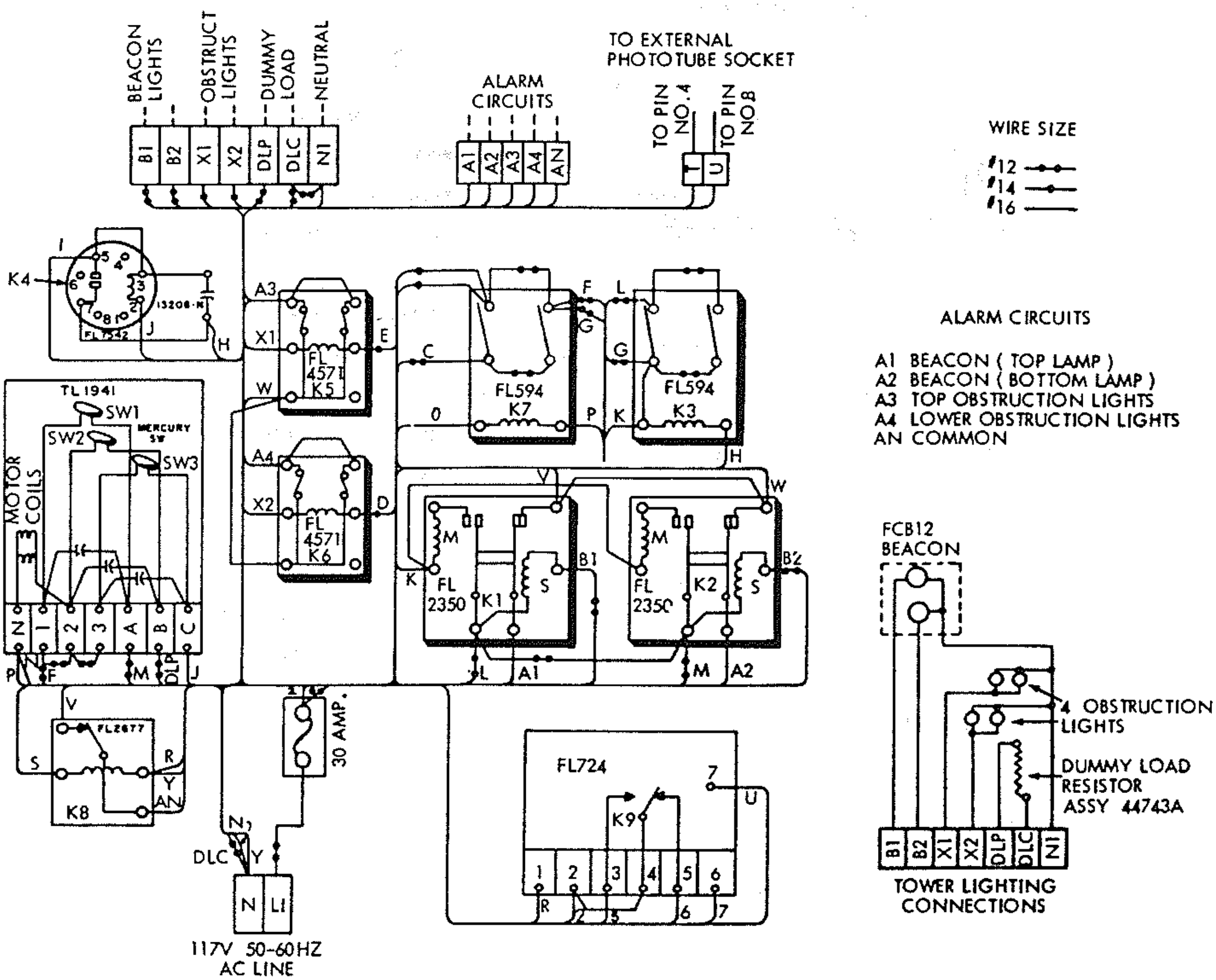


Figure 5-15. Wiring Diagram, Crouse Hinds No. 47079 Tower Lighting Control Unit

(b) Adjustment of Lamp Failure Relays. The FL-2350 relay (single-lamp type) is used to indicate lamp failure of only one lamp of the type FCB-12 beacon. The FL-4554 relay (two-lamp type) is used to indicate failure of one or both lamps of the FCB-12 beacon. The relays close a pilot light circuit when a lamp fails. These relays have been adjusted at the factory for proper operation, but due to local variations of supply voltage and different lengths of line between beacon and relay, slight adjustment of the relay after installation may be necessary. The procedure outlined below should be followed for proper adjustment.

1 In the normal condition with the beacon lamps burning, if the relay remains open or closes and opens on each cycle of the flasher, then it may be assumed that the relay tension springs are too tight and should be loosened. Releasing the spring tension by turning the adjusting nut of each spring one turn counterclockwise should be sufficient. Avoid too much loosening of the spring tension.

2 For the warning signal condition when a beacon lamp has failed, the relay assumes the open position and remains open, lighting the pilot light. If this is not the case with the FL-4554 relay, it is apparent that the current drawn by the one remaining beacon lamp is sufficient to close the relay against its spring tension, and that the spring tension is insufficient. Increase the tension by turning the adjusting nut of each spring in the clockwise direction until the relay does remain open. Avoid too much tightening as this holds the relay open with both beacon lamps in the normal condition.

(c) Adjustment of Control Unit. The adjustment of the control unit is accomplished through the use of the potentiometer in the cathode circuit of the 117P7GT. This control allows compensation of variations in supply voltage, mounting and sensitivity in supply voltage, mounting and sensitivity of the phototube, and variation normally encountered in component values and tubes. This potentiometer adjusts the operating range of the amplifier plate current to the desired value and should be set by using a footcandle meter while varying the light intensity. Make all adjustments with covers in place and the phototube in its proper position to prevent the introduction of uncompensated variations between the normal and test conditions. Adjust the control to turn on the tower lights when the light intensity falls below 35 foot-candles, and off when the intensity is above approximately 57 foot-candles. The manufacturer states this should occur when the potentiometer is set on position 8. Due to variation in components, this exact ratio may not be obtainable. If this occurs, make the turn-on adjustment to 35 foot-candles (±2), allowing the turn-off value to be random above or below the nominal 58 foot-candles. If radical variations occur, all components should be checked against the manufacturer's specifications to determine and correct the cause. (See figure 5-16.) The photoelectric control governs the operation of the flasher unit, or it may be used to operate lamp loads up to 400 watts on smaller towers without flashing. When a separate flasher unit is used, the photoelectric control operates the load contactor K-7 in the flasher cabinet to supply all circuits of the flasher.

(d) Flasher Unit. The flasher unit is operated by an electric-motor-driven cam, which controls the operation of mercury switches that supply the power to the tower lights and operate the fail-safe feature. The details of this mercury switch operation are adequately covered in the manufacturer's instruction booklet. It is important to note, however, the fail-safe feature of this unit. This consists of a thermal relay K-4 which, when the lights are flashing properly, maintains its contacts open in the circuit to the coil of bypass relay K-3. When the flasher circuit fails, K-3 operates to bypass the flasher switches and energize the tower lights continuously. Monitor relays K-1 and K-2 in the flasher provide an alarm circuit if the code beacon lamps fail. Operation of the relays is primarily dependent on the load current to the lamps flowing through the series coil of the relay. A multiple coil is also used across the circuit to the lamps to hold the alarm circuit open during the off period of the lamp flashes. Separate relays with series type (current operated) coils are used to monitor the load currents to the steady-burning side lights of the towers. These relays are designed to sense the decrease in current in the side lamp circuit from the failure of one lamp. Each relay is designed to monitor the circuits to two 100-, 107-, or 111-watt lamps in parallel. Test the monitor circuits by interrupting power to the lamps, stopping the flasher motor, or interrupting power to the flasher or control units.

ELECTRONIC COMPONENT LIST

44870 PHOTOELECTRIC CONTROL

R1	100 OHMS	5 WATT
R2	680 OHMS	1 WATT
R3	1750 OHMS	5 WATT
R4	1000 OHMS	5 WATT
R5	220 OHMS	1 WATT
R6	250 OHMS VARIABLE	
R7	4.7 MEGOHMS	1/2 WATT
R8	2.2 MEGOHMS	1 WATT
C1	20-20 MICROFARADS	
C2	0.02 MICROFARADS	

RELAY, 5000-OHM COIL

44871 PHOTOELECTRIC CONTROL

R7	1.0 MEGOHMS	1/2 WATT
R8	10 MEGOHMS	1 WATT

SAME AS 44870 OTHERWISE

NOTE: THE 117P7GT TUBE USED WITH THE 44870 UNIT IS OBSOLETE. AN ACCEPTABLE REPLACEMENT IS THE 117L7M7GT. THIS REQUIRES REWIRING THE TUBE SOCKET BY MOVING THE WIRE ON PIN 6 TO PIN 8, THE WIRE ON PIN 7 TO PIN 6 (LEAVE THE HEATER CONNECTED), AND THE WIRE ON PIN 8 TO PIN 1.

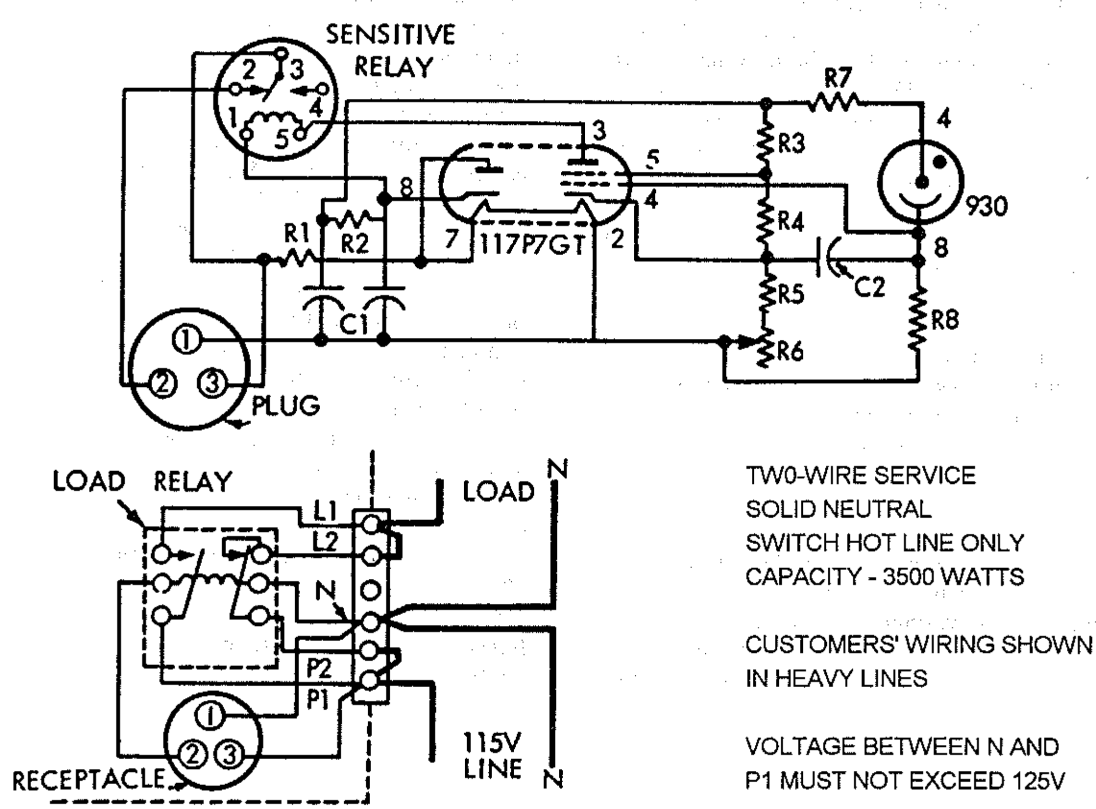


Figure 5-16. Wiring Diagram, Crouse Hinds Nos. 44870 and 44871 Photoelectric Controls

433. ROTATING BEACONS.

a. Purpose. This procedure provides maintenance guidance and adjustment procedures for rotating beacon equipment.

b. Procedure.

(1) Lamp Removal.

(a) The lamp receptacles for airway beacons are of the fixed bipost type with one fixed and one floating block. Each block has a wing-head clamping screw. Before removing the lamp, loosen the wing-head screws sufficiently so that the terminals do not bind when the lamp is removed. This will prevent possibly breaking the glass.

(b) Lamp Replacement. When replacing the lamp, always tighten the screws in the solid block first, then in the floating blocks. This eliminates the possibility of cramping the bipost, which results in a broken lamp. When the No. 1 lamp in the beacon is to be renewed, remove the No. 2 lamp from its socket and install it the No. 1 position. Insert the new replacement lamp in the No. 2 position. Tighten the wing screws by hand; never use pliers or a wrench.

(c) Testing. Test the new lamp that has been placed in the No. 2 changer position by tripping lamp changer so that the No. 2 lamp is in the burning position and illuminated for 5 minutes. This ensures that the lamp is not defective.

(2) Lamp Changer.

(a) Clean Contacts. The main contacts (mechanical) located under the lamp changer table shall be kept clean and polished.

(b) Adjust Main Contacts. If necessary, adjust the mercury tube holder so that a positive contact is obtained in both the no. 1 and no. 2 positions. This can be accomplished by bending the tubeholders the required distance so that the mercury is level at both positions. Make certain the mercury tube leads do not interfere with the operation of the lampchanger.

(c) Free Movement. Check the movable parts of the lamp changer for sluggish operation. If the operation is sluggish, disassemble the movable parts, clean them with crocus cloth, apply dry graphite to the cleaned surfaces and reassemble. Before attempting any adjustment on the spring tension, be sure the lamp changer operates freely.

CAUTION: Never use petroleum-based or liquid lubricants on moving parts since the high temperatures in the drum will cause evaporation, leaving a gummy residue.

(d) Spring Tension. If the lamp changer operation is free and the tension insufficient, the tilting or rotating spring should be adjusted so that the lamp changer table will operate with sufficient force to lock in the no. 2 position. DO NOT SET THE SPRING TOO TIGHT. This rotates or tilts the lamp changer with such force that the lamp filament will be damaged and the lamp life considerably shortened. It may also place too much tension on the locking device so that it will not release under the impact of the tripping plunger. When measuring spring tension on the tilting table changer, place a thin piece of paper between the pawl and the pawl-lock in the latching device. Hook the spring scale directly to the operating arm or table next to the lamp-changer spring. Adjust the spring tension so that the paper will be released under a 7- to 8-ounce direct pull applied to the spring scale. See figure 5-17.

(e) Latching Device. Due to frequent operation, the notch in the pawl in the no. 1 position of the lampchanger becomes worn and rounded to a point where an involuntary tripping may occur due to vibration. With a file, square off the notch and smooth the face and edges with emery cloth.

(f) Coils and Leads. Inspect the coils and leads for damage due to sun reflection. Check all leads for tightness and abrasions. Repair or renew areas where necessary.

(g) Shunt-Coil Plunger. Check the shunt-coil plunger operation and adjust it to proper length, if necessary.

(h) Leads. Make certain the various leads are adjusted and fastened so that they do not interfere with the lamp changer operation.

(i) Testing. Test the lamp changer operation by simulating lamp failure at each visit to the site. To accomplish this, remove the single wire from the terminal of the no. 1 lamp socket. Close the circuit to the lamp changer and observe operation. It should be adjusted so that the table will tilt or rotate to the spare position with sufficient force to lock positively.

(3) Brushes and Collector Rings. To prevent severe arcing, properly seat the brushes to fit the radius of the collector ring and set to lead or trail at an angle of 5° to 10° and have sufficient spring tension. At least 85 percent of the brush surface areas shall make contact. New brushes can be seated properly by inserting a piece of light-grade sandpaper toward brush, pulling the sandpaper through past the brush in one direction only. Then, carefully lift the brush and repeat action. The one direction is the one that causes the brush to assume the position in the brush-holder as when it is powered and operating. Figure 5-17 shows the method for seating brushes and gauging the tension.

(a) Brush Guides. The brushholder shall be kept clean so that the brushes and springs are operating freely in the guides. A sticking brush will arc and damage the commutator or collecting ring. If brush guides are badly worn, due to side friction of the brush, install new brush guides. Brushes should fit snugly in guides. Brushes should fit snugly in the brush guides without binding. Caution should be exercised when replacing guides so as to not reverse them.

(b) Collector Ring Cleaning. Collector rings must be kept clean and free from arcing. A suitable way of cleaning collector rings is to remove collector ring brushes and run beacon motor only. While the beacon is rotating, hold a piece of crocus cloth, treated with a few drops of light oil, against the collector rings. Wipe collector rings with clean cloth and replace collector brushes when finished (figure 5-17).

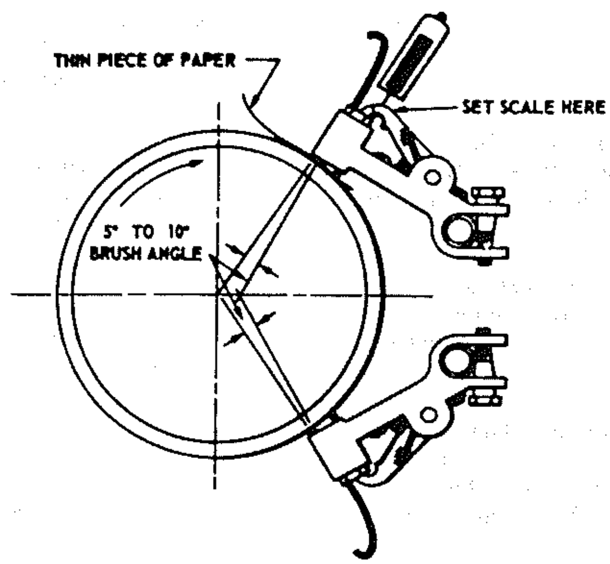


Figure 5-17. Beacon Collector Ring and Brushes

(4) Clutch. The slip-clutch is designed to protect the motor and gears from damage if the drum is not free to rotate. The tension on all beacon clutches shall be in foot pounds drag on the clutch plate. The drag, foot pounds, is the amount of force required to overcome the friction of the clutch plate when it is 1 foot from the center of the clutch shaft.

(a) To check the clutch-plate adjustment, the scale should be attached horizontally 1 foot out from the center of the beacon shaft. (See figure 5-18.) The clutch tolerance should be adjusted to conform to standards and tolerances (paragraph 136).

(b) Adjustment Method One. For beacon in which the collector ring support is also the clutch adjusting device, disconnect and remove brush-holder support plate and collector ring assembly to expose the collector ring support.

1 Cleaning Before Assembling. If the clutch washer is badly worn, renew and clean all parts thoroughly. Before assembling the clutch, inspect the wire lugs for tightness; replace lugs if necessary. Tape and shellac wire and terminal lugs. Clean flat portion of terminal lug for good contact.

2 Assembly and Adjustment. Align the adjusting device with holes in the shaft. Insert the set-screws and tighten unit so that the adjusting device is securely locked. Reassemble the remaining parts and see that all fastenings are tightened.

(c) Adjustment Method Two. For beacons where the clutch is adjusted by a plate under the ring gear, remove the hexagon capscrews located on the top of the ring gear and turn the adjusting plate in the direction necessary for loosening or tightening the clutch. After adjustment is made, replace capscrews.

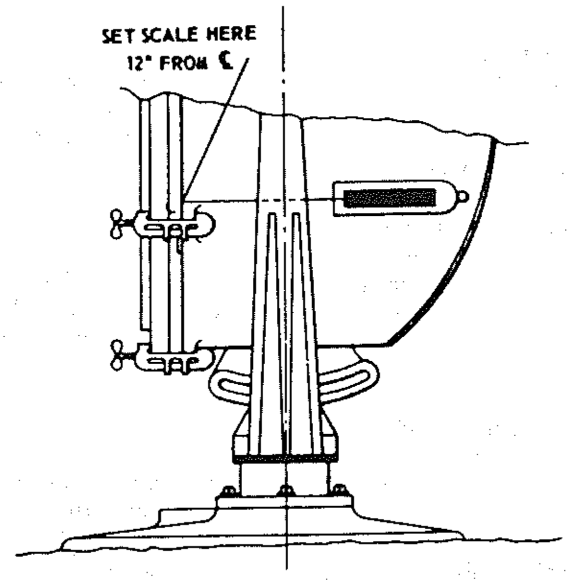


Figure 5-18. Measuring Clutch Tension

(d) Adjustment Method Three. For beacons where clutch is adjusted by large hexagon nut over clutch plate, remove setscrews from this hexagon nut and adjust clutch by tightening or loosening the nut. After clutch adjustment, line up holes in hexagon nut and shaft. Replace set screws and tighten them securely.

(5) Beacon Drum. Clean the interior of the beacon drum each time the facility is serviced. The interior of the drums and housings shall be painted flat black. Paint the focusing cross marks white so that they can be seen when observed through the focusing peephole.

(6) C-Clamp Screws. The C-clamp screws on the cover glass doors and the latching nutscrew on the code beacon shall be kept clean and free from paint so that a uniform pressure will be applied to the gasket without tools.

(7) Optical System. The optical system is the most important factor affecting the projection of the light beam. The intensity of the light beam is considerably reduced when the reflecting surface and lenses are not kept clean. For detailed information on focusing, see paragraph 434.

(a) Reflector. Reflecting surfaces shall be cleaned and polished with approved glass polish. Do not use abrasive cleaners. When reflecting surfaces show evidence of discoloration, peeling, and cracking, or otherwise damaged condition, replace the reflector.

(b) Cover Glass. Thoroughly clean cover glass surfaces and remove paint spots and paint streaks along the edge of the glass.

(8) Worm and Ring Gear Alignment. There are various types of gear combinations required for longer life and quieter operation in the rotating mechanism of the various types of airway beacons: i.e., bronze worm gear for use with micarta ring gear, etc. Adjust the alignment of the motor worm gear with the beacon ring gear as follows to prevent excessive wear and noisy operation.

(a) Adjust the vertical alignment of the worm gear with the ring gear by either adding or removing shims between the motor base and the bosses in the beacon base.

(b) There should be adequate clearance between the worm gear and the ring gear around the entire perimeter of the ring gear to ensure freedom of movement.

(c) A fairly close check of the alignment can be obtained by removing all grease from a few sections of the ring gear. The area so cleaned should be approximately 2 inches in length, and the sections should be spaced about 45° apart. Rotate the motor shaft by hand and observe closely the imprint left by the worm gear on the cleaned sections of the ring gear. Raise or lower the motor until the imprint of the worm gear is equally distributed over the gear face on the ring-gear.

(d) Keep the collar and nut that secure the worm gear to the motor shaft tightened so that no backlash or play will occur at this point.

(9) Fuses. Fuses shall be checked for good electrical connections in their receptacles, and for correct fusing of circuits. There shall be no fuses in the neutral or ground circuits. All circuits shall be fused according to Order 6950.18A, Maintenance of Electrical Distribution Systems. Clean receptacles and fuse body with abrasive cloth to ensure a good electrical contact. Check renewable fuses for loose component parts.

(10) Lightning Protection Systems. Check lightning rod connections for tightness. Check the ground resistance. Refer to Order 6950.18A, Maintenance of Electrical Distribution Systems.

(11) Padlocks. Padlocks shall be lubricated with dry graphite powder or equivalent.

(12) Switches. Check operation of electrical switch blades and the clips for good contact. Switches should have tension between the blades and hinges, but must also be free to move. Loose fitting hinges or clips will cause overheating and deterioration of the switch parts. Severe overheating can usually be detected by a bluish color of the switch part affected.

(13) Weatherproofing and Gaskets. Good weatherproofing for the protection of light sources and mechanisms is a necessity. Poor, leaky, improperly seated gaskets will permit moisture, dirt, and insects to enter the units, resulting in the premature failure of equipment. When caulking material is cracked and dry and allows water leaks, replace it. Gaskets shall be renewed when cracked and deteriorated. Before installing new gaskets, clean the gasket channels and seats thoroughly. When it is necessary to secure the gaskets with rubber cement, both the gasket and the seat should be coated with appropriate cement and permitted to dry until tacky before the gasket is positioned.

(14) Beacon Leveling. Check the level of the beacon by placing a level on the leveling boss. Remove all paint or other material to assure a true level. Loosen holddown bolts and insert or remove spacers as required for proper level. Check the level of the beacon in four directions. Be sure to tighten down the base.

(15) Motor Servicing.

(a) Brushes. On brush-type motors, remove brushes and, if worn to one-third of the original length, install new brushes. When replacing brushes, make sure the brush is properly seated. Before installing new brushes, make certain the collector ring surface is polished and free of grooves. On dc motors, be especially careful of seating to make certain the brush has a minimum of 85 percent surface contact. Check the under cut for protruding mica and carbon deposits.

(b) End-Play. Adjust excessive end-play as follows:

1 To determine the proper tolerance on a ball-bearing motor, tighten the thrust bearing adjustment until a slight drag is felt when the motor shaft is rotated by hand. Then back up the thrust bearing adjustment one-quarter to one-half of a turn.

2 On sleeve-bearing motors, it is necessary to hold a small measuring scale against the motor housing adjacent to the drive shaft (worm gear end). Scribe a line on the drive shaft and adjust the end-play of the shaft to one sixty-fourth of an inch.

(c) Cleaning. The interior of the beacon drive motor housing will accumulate carbon dust and grease, requiring periodic dismantling and cleaning. When cleaning, special attention shall be given to the starting switch, brush holders, and bearings for proper operation. Adjust, clean, and renew unit if necessary.

(d) Noisy Motor. If the motor is noisy, check ball bearings, raceways, and balance of armature. Usually, a chipped ball bearing or scored raceway is the cause. Ball bearings should be cleaned in a solvent to remove old, hardened grease, and should be repacked with proper grease. When repacking ball bearings, the bearing should be filled to no more than one-half its capacity. Clean and polish commutator of collector rings. If necessary, undercut the mica, clean it with paper, and finish by polishing it with crocus cloth. When motor is reassembled, care should be exercised in alignment of the end bells. Improper alignment of the end bells can affect both the air gap between the armature and field poles and bearing alignment.

(e) Lubrication. The oil groove on sleeve-type motors shall be cleaned to permit the oil to flow freely around the motor shaft. Examine the oil wick to determine if it will absorb oil. Wash wick in solvent or replace if necessary.

(16) Wiring, Electrical Connections, and Conduit.

(a) Wiring. Inspect for abrasions, breaks, and loose connections. Repair or renew wiring when necessary. All repair patches shall be covered with suitable insulating cement. Check the position of the wiring and, if necessary, reposition to maintain neat appearance. Verify that wiring is not being caught by cabinet doors and covers.

(b) Terminal Lugs. Check terminal lugs for tight electrical connection. The insulation should be wrapped at the terminal lugs with a good plastic tape (no. 88 Scotch brand). The completed job should then be covered with insulating cement. The flat portion of the lug should be cleaned and free of corrosion so that good electrical contact is maintained. Check for and replace cracked or broken insulators and bushings.

(c) Conduit. Inspect conduit for loose supports and connections. Replace broken brackets.

(17) Beacon Bearings. The main beacon bearing requires little attention and should be greased only when needed. DO NOT OVER GREASE. If a water leak develops, completely dismantle the beacon and install new felt and grease and water retainers.

(18) Grounds and Ground Connections. For information on grounding, see Order 6950.18A, Maintenance of Electrical Distribution Systems.

(19) T and G Cabinets. The interior and exterior of T and G cabinets should be kept clean and well painted to prevent deterioration. Door hinges and latching devices should be lubricated. Check the fit of the door on the gaskets or seals. Repair areas if necessary.

434. ROTATING BEACON LAMPING.

a. Purpose. This procedure restores the beacons to their original brilliance and increases the reliability by replacing lamps and properly focusing the replacement lamps.

b. Procedure.

(1) Refer to lamp charts, tables 5-3 and 5-4. Lamps should be changed after 80 percent of the rated lamp life has elapsed and before 90 percent of its rated life has expired . Verify that the new lamp is the correct size and type.

(2) Focus and Aim Rotating Beacons, 24-inch, Single-End, and Duplex. The procedure for adjusting the lamp filament into proper focus with the reflecting surface (mirror) involves several steps of operation which, once established, will reduce future focusing procedures considerably.

(a) The lamp filament image must be in the exact center of the parabolic reflector, and the filament shall be the correct distance from the reflecting surface. Due to considerable variations in the parabolic mirrors, the focal length (distance from filament to reflecting surface) will vary with each beacon.

(b) In order to obtain the correct center of the reflector, it is necessary to use a focusing gauge and a presenter gauge for bipost lamps.

(c) First remove both lamps. Then insert the bipost presenter in no. 1 lamp socket. Then by use of the focusing gauge properly mounted on the reflector, adjust the mounting plate of the lamp changer by manipulating the thumbscrews so that the tip of the presenter accurately meets the tip of the focusing gauge.

(d) The lamp sockets, as adjusted, must bring the lamp filament, when reinstalled in a vertical plane, parallel to the reflector.

(e) Mark with a dot of black paint not exceeding one-fourth inch in diameter, the center point of the reflector (the point at which the focusing gauge strikes the reflector). Remove the gauge and reinstall the no. 1 lamp.

(f) Project the beam on a screen (ground or surroundings) at a distance of not less than 200 feet away from the source of light. Loosen the two machine screws holding the lamp changer to the boss at the base of the drum. The entire lamp changer should then be moved in or out (away from or toward the reflector) as found necessary to obtain the sharpest image of the lamp filament on the screen. The filament shadows may sometimes be seen better if the entire drum is moved (jiggled) back and forth horizontally.

(g) After locating the filament shadows, it will be observed that they are less distinct and scattered when the lamp is either too close or too far away from the reflector. Gently move the lamp changer until the lamp filament shadows coincide. At this point, the image is the sharpest and the lamp is in perfect focus. Tighten the two machine screws, holding the lamp changer in place.

(h) Remove the no. 1 lamp and insert the presenter which will permit a correct readjustment of the targets, which should be reset and painted to align with the no. 1 lamp filament. The distance from the presenter tip of lamp filament to the reflector (focal length) should be carefully measured and recorded for future reference, especially for those beacons not equipped with focusing sights and targets.

(i) The measurement will vary slightly on each reflector. Therefore, the recorded focal length of each reflector will be of considerable value if the lamp changer position is disturbed during service and repairs to the changer unit.

(3) Refer to the manufacturers instruction manual for additional lamp replacement instructions and specific adjustment procedures.

APPENDIX 1. CERTIFICATION REQUIREMENTS

Table 1. ALSF-1 SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Light plane	Light bar lamps illuminated	71a(1)
2. Light intensity	Vertical angular alignment Horizontal angular alignment Regulator output currents	72, 78g 73 74
3. Brightness control capability	Brightness step changing time	76a
4. Identify threshold	Green threshold bar filters	71a(3), 77
5. Identify 100 feet from threshold	Red wing bar filters	71a(4), 77
6. Identify 200 feet from threshold	Red terminating bar filters	71a(5), 77
7. Identify 1000 feet from threshold	1000-foot bar	71a(6)
8. Identify approach path	Sequenced flashing lights operation Flashing rate	78a 78e
9. Visibility	Obstructions	80
10. Monitoring	Incandescent light operation Flasher operation	81a(1) 81a(2)

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 120 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted navigational aid.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: ALSF-1 certified.

Table 2. ALSF-2 SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Light plane	Light bar lamps illuminated	71b(1), (2) (3), (4)
2. Light intensity	Vertical angular alignment Horizontal angular alignment Regulator output currents	72, 78g 73 74
3. Brightness control capability	Brightness step changing time	76a
4. Identify threshold	Green threshold bar filters	71b(5), 77
5. Identify 500 feet from threshold	500-foot bar	71b(6)
6. Identify area from threshold to 1000 foot bar	Red side-row bar filters	77
7. Identify 1000 feet from threshold	1000-foot bar	71b(7)
8. Identify approach path	Sequenced flashing lights operation Flashing rate	78b 78e
9. Visibility	Obstructions	80
10. Monitoring	Incandescent light operation Flasher operation	81b(1) 81b(2)

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 120 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted navigational aid.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: ALSF-2 certified.

Table 3. ALSF-2/SSALR DUAL SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Light plane	Light bar lamps illuminated	71b(1), (2), (3), (4), 71c
2. Light intensity	Vertical angular alignment Horizontal angular alignment Regulator output currents	72, 78g 73 74
3. Brightness control capability	Brightness step changing time	76a
4. Identify threshold	Green threshold bar filters	71b(5), 71c(3), 77
5. Identify 500 feet from threshold	500-foot bar	71b(6)
6. Identify area from threshold to 1000 foot bar	Red side-row bar filters	77
7. Identify 1000 feet from threshold	1000-foot bar	71b(7), 71c(4)
8. Identify approach path	Sequenced flashing lights operation Flashing rate	78c 78e
9. Visibility	Obstructions	80
10. Monitoring	Incandescent light operation Flasher operation	81c, and instruction book 81c, and instruction book

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 120 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted navigational aid.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: ALSF-2/SSALR certified.

CERTIFICATION ENTRY (WITH EXCEPTION)
IN FACILITY MAINTENANCE LOG: ALSF-2/SSALR certified except:

1. ALSF-2 Out of Tolerance/Limit
2. Flasher Out of Tolerance/Limit
3. Monitor Out of Tolerance/Limit
4. Light Bar (Number) Out of Tolerance/Limit

Table 4. SSALS, SSALF, AND SSALR SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Light plane	Light bar lamps illuminated	71c
2. Light intensity	Vertical angular alignment Horizontal angular alignment Regulator output currents	72, 78g 73 74
3. Brightness control capability	Brightness step changing time	76a
4. Identify threshold	Green threshold bar filters	71c(3), 77
5. Identify 1000 feet from threshold	1000-foot bar	71c(4)
6. Identify approach path	Sequenced flashing lights operation Flashing rate	78d 78e
7. Visibility	Obstructions	80

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 120 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted navigational aid.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: SSALS, SSALF, SSALR certified.

Table 5. MALS, MALSF, AND MALSR SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Light plane	Light bar lamps illuminated	71c
2. Light intensity	Vertical angular alignment Horizontal angular alignment Light unit input voltage	72, 78g 73 75
3. Identify threshold	Green threshold bar filters where applicable	71c(3), 77
4. Identify 1000 feet from threshold	1000-foot bar	71c(4)
5. Identify approach path	Sequenced flashing lights operation Flashing rate	78d 78e
6. Visibility	Obstructions	80
7. Remote control capability	a. Ground-to-ground control functions	79
	b. Air-to-ground control functions	79
	c. Landline control functions	79

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 150 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted navigational aid.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: MALS, MALSF, or MALSR certified.

Table 6. ODALS AND LDIN SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Guidance to runway	Lamps operational	83a
2. Light intensity	Angular alignment (vertical and horizontal)	83b
3. Flashing light	Flashing rate	83c
4. Visibility	Obstructions	83e
5. Remote control capability	a. Ground-to-ground control functions	79
	b. Air-to-ground control functions	79
	c. Landline control functions	79

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 150 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at lighted LDIN or ODALS.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: LDIN or ODALS certified.

Table 7. VASI SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Visible glide slope	Vertical angular alignment Red filters	91, 92 103
2. Light intensity	Light box lamps illuminated Regulator output currents	90 100, 101
3. Visibility	Obstructions	104
5. Remote control capability	a. Ground-to-ground control functions	79
	b. Air-to-ground control functions	79
	c. Landline control functions	79

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 150 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at VASI.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: VASI certified.

Table 8. PAPI SYSTEMS

Service	Certification Parameter	Reference Paragraph STDS and TOL/Limits
1. Visible glide slope	Vertical angular alignment Red filters	93 103
2. Light intensity	Light box lamps illuminated Regulator output currents	90 101
3. Visibility	Obstructions	104
4. Remote control capability	a. Ground-to-ground control functions	79
	b. Air-to-ground control functions	79
	c. Landline control functions	79

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 150 days.

PERSON RESPONSIBLE FOR CERTIFICATION: Maintenance person at PAPI.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: PAPI certified.

APPENDIX 2. METRIC CONVERSIONS

Table 1. METRIC CONVERSION TABLE

Unit	Abbreviation	Approximate equivalent
Millimeter	mm	0.039 inch
Centimeter	cm	0.39 inch
Meter	m	39.37 inches/3.28 feet
Kilometer	km	0.62 mile
Inch	in	2.54 centimeter
Foot	ft	0.3048 meter
Yard	yd	0.9144 meter
Mile	mi	1069 meters
Nautical Mile	nmi	1852 meters

U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: INFORMATION: Suggested improvements to Order 6850.5C, Maintenance of Lighted Navigational Aids

Date:

From:

____
Signature and title

Reply to
Attn of

____
Facility Identifier
AF Address

To: Manager, National Airway Systems Engineering Division, AOS-200

Problems with present instruction book:

Recommended improvements: