ELECTRICAL TECHNICAL PAPER 20
VISUAL AIR NAVIGATION FACILITIES: QUALIFYING EQUIPMENT

Information in this technical paper was excerpted from previous versions of UFC 3-535-01. This information has been updated to reflect current practices and technology.

1.0 GENERAL EQUIPMENT REQUIREMENTS.

This technical paper covers equipment and equipment specifications that meet the associated standards in UFC 3-535-01. This technical paper does not include cables, auxiliary or main power generating systems, or common use items such as convenience outlets or interior electrical fixtures.

1.1 EXISTING FACILITIES.

Do not use this document as a sole basis for advancing standards of existing facilities and equipment, except where necessary for a minimum acceptable level of safety, quality, and performance. You may continue to support existing systems with equipment fabricated to the original specifications until the system is upgraded. If mixing of new generation equipment with older equipment is required, make sure the difference in performance does not degrade the system in any way.

1.2 EQUIPMENT SPECIFICATIONS.

The equipment specifications used in this technical paper fall into two broad categories: FAA Advisory Circulars (ACs) and FAA-E Series specifications (FAA-E-XXXX). Use the latest edition of a specification if the performance requirements continue to satisfy the appropriate standard in UFC 3-535-01. If specifications are canceled and replaced by specifications with new numbers, use the new specification if the applicable standards of UFC 3-535-01 are met. FAA standards specify the minimum requirements for equipment. For some products, options or characteristics available from manufacturers that are in addition to or exceed FAA requirements have been shown important to achieving proper or improved system performance. Consider mission requirements, as appropriate, when specifying equipment for new installations.

1.3 QUALIFIED PRODUCTS.

The FAA maintains lists of manufacturers of products meeting Advisory Circular specifications. For equipment meeting FAA Advisory Circular specifications use FAA AC 150/5345-53. Qualification or approval in listing does not mean automatic acceptance of the equipment for a particular project. Satisfactory evidence of the production tests**,** such as certification of compliance by ETL Testing Laboratories or other approved third party certifiers, included in the specifications is required for acceptance for each project. All equipment specified in an FAA AC and proposed for the project must be listed in FAA AC 150/5345-53. In addition, all light fixtures must meet the requirements of UFC 3-535-01. The Visual Guidance Lighting Equipment Approval Program (VGLEAP) uses third party approvals for vendors conforming to FAA

E specifications. See the FAA VGLEAP website at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap, for additional information about approved vendors and FAA E specifications. Information concerning current sources of this equipment may be obtained from regional FAA offices and manufacturers' product literature. The specified production tests are also required for these products.

1.4 COMMERCIAL EQUIPMENT.

Commercial equipment, not covered by appropriate military or FAA specifications, must meet applicable industry standards such as the National Electrical Manufacturers Association (NEMA) or Institute of Electrical and Electronic Engineers (IEEE). Contract documents must specify the methods for verifying conformance.

1.5 ALTERNATIVE EQUIPMENT.

You may consider equipment using new technologies but must make sure the standards in UFC 3-535-01 are met; cost effectiveness, reliability, availability, maintainability, and service life are not compromised; and adequate training and logistic support for the substitute equipment is available. The waiver requirements of UFC 3-535-01 paragraphs 1-11 and 1-12 apply.

1.6 EMERGENCY SUBSTITUTION.

In emergency situations where facility restoration would be significantly delayed by non-availability of replacement parts, equipment or devices not meeting the applicable specifications may be substituted. Base Civil Engineering, airfield operations, and flying safety offices must all coordinate these substitutions and notify the major command. Remove the substitute equipment from service and replace it with approved equipment as soon as it becomes available.

1.7 COMMON USE EQUIPMENT.

This paragraph lists equipment commonly used in most or all airfield lighting system installations. Wherever required, listed equipment conforming to the cited specifications may be used. Other special application equipment is specified in the paragraphs covering the particular lighting system involved:

1.7.1 Control Panels.

For Army facilities, use panels meeting FAA AC 150/5345-3 Type L-821. Recommended design for new systems or major upgrades include newer types of FAA approved controls. Touch-screen control is recommended.

1.7.1.1 **Power Line Carrier System.**

In this system each fixture is connected to an Addressable Control and Monitoring Unit (ACMU) on the secondary of an L-830/L-831 isolation transformer. There is an interface in the vault (Series Circuit Interface) that sends messages onto the series lighting circuit. The ACMUs in the field receive these signals and provide a response to the interface in the vault, providing control and monitoring functionality for the lights on the circuit. At the time of this writing, this type of system requires a sophisticated level of maintenance. Such a system may be used for individual light fixture monitoring requirements (operation below 1200 RVR), however, they are not recommended for controlling individual or groups of light fixtures.

1.7.2 **Pilot Relay Cabinets.**

Use cabinets meeting FAA AC 150/5345-13 Type L-841 for 48 VDC control systems.

1.7.3 **Series Circuit Selector Switches.**

Use switches in accordance with FAA AC 150/5345-5, Type L-847. Series circuit selector switches can be high-maintenance equipment and should be avoided whenever possible.

1.7.4 **Control Cables.**

Control cables for 120 VAC control systems must be multi-conductor, 600 volts, 12 AWG (4 mm^2) copper, rated for direct earth burial. Cables for 48 VDC control circuits must be multi-conductor, stranded 19 AWG (1 mm^2) copper, with 300 volt polyvinyl insulation suitable for installation in wet locations and meeting REA Bulletin 1753F-205. Color-code all conductors.

1.7.5 **Constant Current Regulators (CCR).**

Use CCRs per FAA AC 150/5345-10 of a suitable type and style. The size selected should normally provide for approximately 20 percent expansion of the load.

1.7.6 **Engine/Generators.**

Use engine/generators meeting Specification FAA-E-2204 with Type I automatic power transfer. Also see AFI 32-1062.

1.7.7 **Series Cable Selection.**

Cables must be unshielded, 5000 volt FAA AC 150/5345-7 (Latest Issue) L-824 cable.

1.7.8 **Connectors.**

Use connectors meeting FAA AC 150/5345-26 for L-823 plug and receptacle cable connectors to interconnect fixtures, isolation transformers, and distribution cables.

1.7.9 Isolation Transformers.

Use isolation transformers meeting FAA AC 150/5345-47. When specifying, ensure the input/output currents are compatible with the regulator and current rating of the lamp.

1.7.10 Mounting Bases and Transformer Housings.

Use bases meeting FAA AC 150/5345-42. When specifying FAA type bases, use Type L-867 for non-traffic areas (such as elevated light systems located on the edges of runways and taxiways) and Type L-868 for load bearing applications (subject to loading by aircraft, including overruns) containing lights that are in-pavement. Non-metallic bases (FAA Class II) must not be used.

1.7.11 Frangible Supports.

If frangible mounting is required and the device is not provided with an integral fracture mechanism, mount the device on electric metallic tubing (EMT) or intermediate metallic conduit attached to the mounting base by a frangible coupling meeting FAA Drawing C-6046. For additional detailed information about and requirements for frangible supports, see FAA AC 150/5220-23.

1.7.12 Fixtures, Filters, and Lamps.

Use fixtures and lamps as specified for each system. If more than one fixture is connected to an isolation transformer, the fixture must have a shorting device or bypass relay to avoid multiple light outage if a lamp fails. Filter colors must meet the latest FAA Advisory Circular criteria, also refer to the CIE color coordinate diagram (see Figure 1).

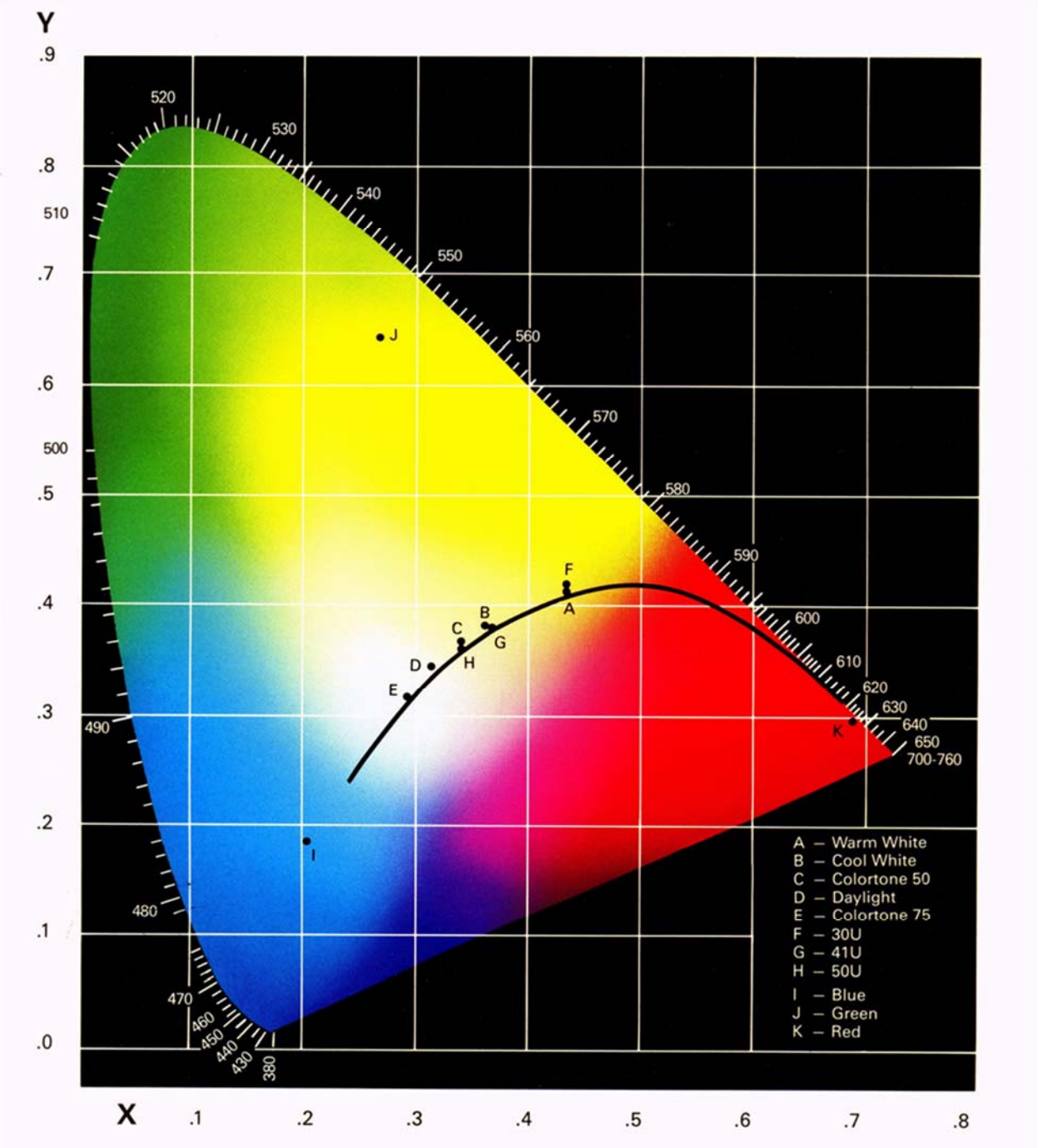


Figure 1
1931 CIE Color Coordinate Diagram

1.8 EQUIPMENT FOR APPROACH LIGHT SYSTEMS.

In-pavement approach lights in overrun areas use FAA Type L-850E fixtures which are red or white as required. For additional information about approach light system support structures, see FAA AC 150/5345-45.

1.8.1 High Intensity Approach Light System ALSF-1.

See UFC 3-535-01 paragraph 3-1.

1.8.1.1 Pre-Threshold Bar.

Use fixtures meeting PAR-56 in FAA-E-982 with red filters (see Figure 2).

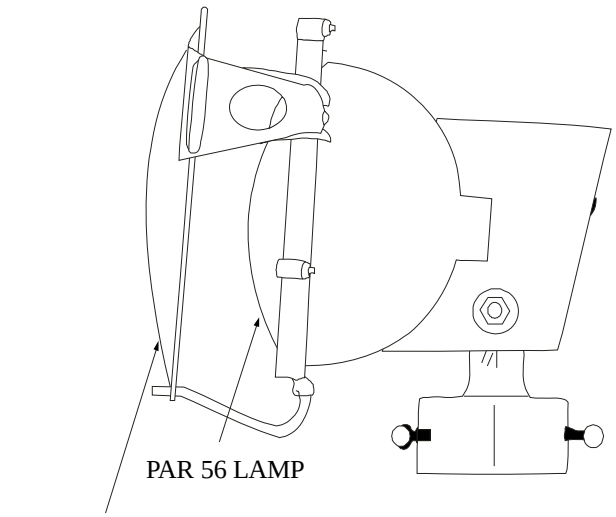


Figure 2
FAA-E-982, Elevated, Unidirectional, PAR-56, Lamp Holder

1.8.1.2 Terminating Bar.

Use fixtures meeting PAR-56 in FAA-E-982 with red filters (see Figure 2).

1.8.1.3 1,000-Foot Light Bar.

Use fixtures meeting PAR-56 in FAA-E-982 with no filter (see Figure 2).

1.8.1.4 **Centerline Light (Barrettes).**

Use fixtures conforming to FAA AC 150/5345-46, type L-850E without filters (see Figure 3).

1.8.1.5 **Centerline Light (Barrettes).**

For stations 10+00 to station 30+00 and unpaved end zone areas use fixtures meeting FAA-E-982 without filters (see Figure 2).

1.8.1.6 **Approach Threshold Lights.**

Use fixtures conforming to FAA AC 150/5345-46, type L-850E with green filters (see Figure 3).

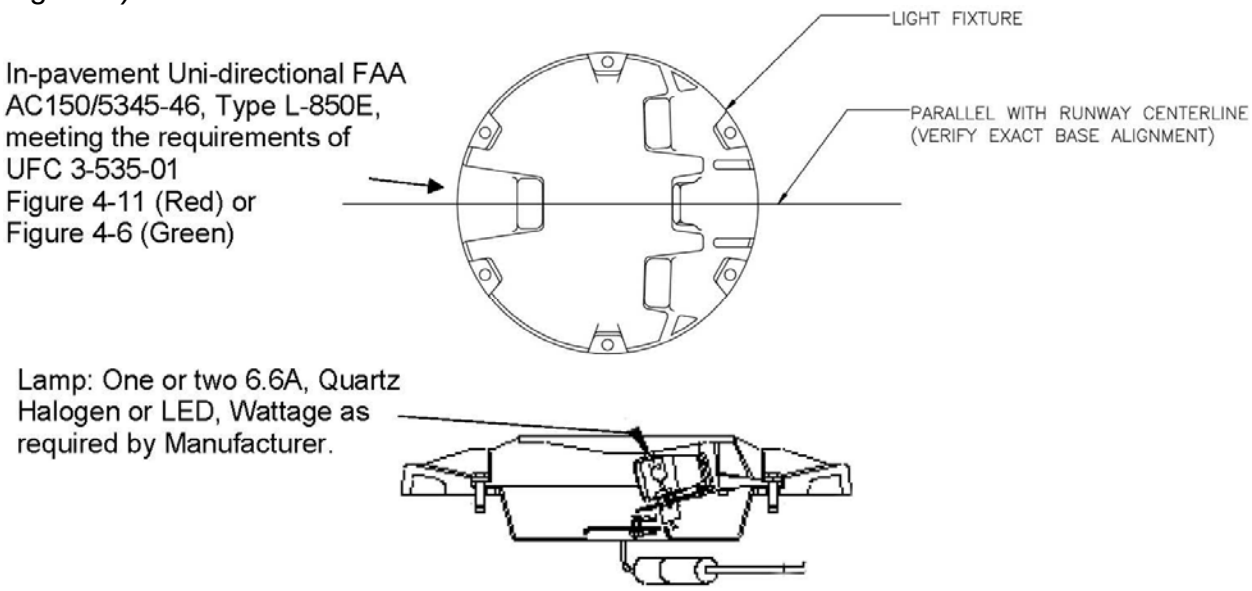


Figure 3
FAA L-850E, In-Pavement, Unidirectional

1.8.1.7 **Sequence Flashing Lights SFL.**

Use fixtures meeting FAA-E-2628 Type I or conforming to FAA AC 150/5345-51 type L-849 Style E (see Figure 5).

1.8.2 **High Intensity Approach Light Systems ALSF-2.**

See UFC 3-535-01 paragraph 3-2. This system is a modified ALSF-1 system, the following areas have additional light fixtures:

1.8.2.1 **500 Foot Light Bar.**

Use fixtures conforming to FAA AC 150/5345-46, type L-850E without filters (see Figure 3).

1.8.2.2 **Side Row Lights.**

Use fixtures meeting FAA-E-982, with red filters (see Figure 2).

1.8.3 **Short Approach Lighting System (SALS).**

This system is a shortened version of the ALSF-1 system with the same fixtures as in Figure 2 used.

1.8.4 **Simplified Short Approach Light System with Runway Alignment Indicators (SSALR).**

This system is a simplified version of the ALSF-1 and ALSF-2 systems, the same fixtures as in Figure 2 and Figure 3 are used.

1.8.5 **Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR).**

See UFC 3-535-01 paragraph 3-5.

1.8.5.1 **Centerline Light Barrettes.**

Use fixtures meeting FAA-E-2325, PAR-38 lamp holders (see Figure 4).

LAMPHOLDER: PAR-38, OUTDOORS, COMMERCIAL TYPE AS DETERMINED BY THE MANUFACTURER.

LAMP: 120V 120W PAR-38 TYPE 120PAR/SP ENERGY SAVING, OR 120V 150W PAR-38 TYPE 150PAR/SP.

POWER UNIT: (NOT SHOWN) DISTRIBUTION VOLTAGE TO 120V RATED, 3-INTENSITY SETTINGS AS REQUIRED BY MANUFACTURER (ONE UNIT FOR SYSTEM)

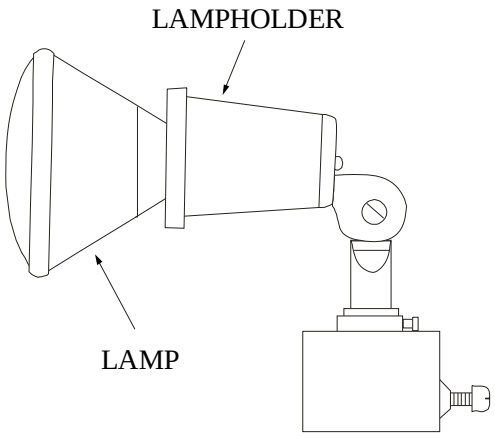


Figure 4
FAA-E-2325, Elevated, Unidirectional, PAR-38 Lamp Holder

1.8.5.2 **General Lamp Guidelines.**

Use lamps recommended by the manufacturer to meet the requirement. Different manufacturers may meet the requirement using different lamps. In the interest of energy conservation, the lower wattage lamps are preferred. When using lamps rated at 6.6 amps, they must be connected to individual 6.6/20A isolation transformers. When using lamps rated at 20A, they must be connected to individual 20A/20A isolation transformers. Use 200W isolation transformers, or as otherwise recommended by the lamp manufacturer. If the overall mounting height is greater than 6 feet (1.8 meters), the lights in a light bar must be connected in series to the transformer specified in paragraph 1.8.5.1.

Fixtures connected in series to a single isolating transformer must have bypass relays to bypass failed lamps.

1.8.5.3 **1,000-Foot Light Bar.**

See paragraph 1.8.5.1.

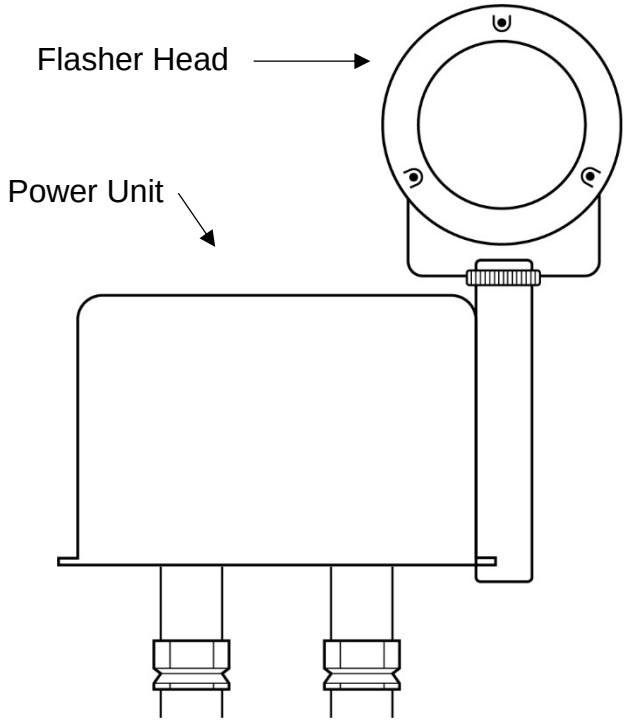


Figure 5
FAA-E-2628, or FAA L-849E Elevated, Condenser Discharge
(Sequenced Flashing Light)

1.8.6 **Paved Areas.**

When the system is installed in a paved over run area, use fixtures conforming to FAA AC 150/5345-46, type L-850B (see Figure 6).

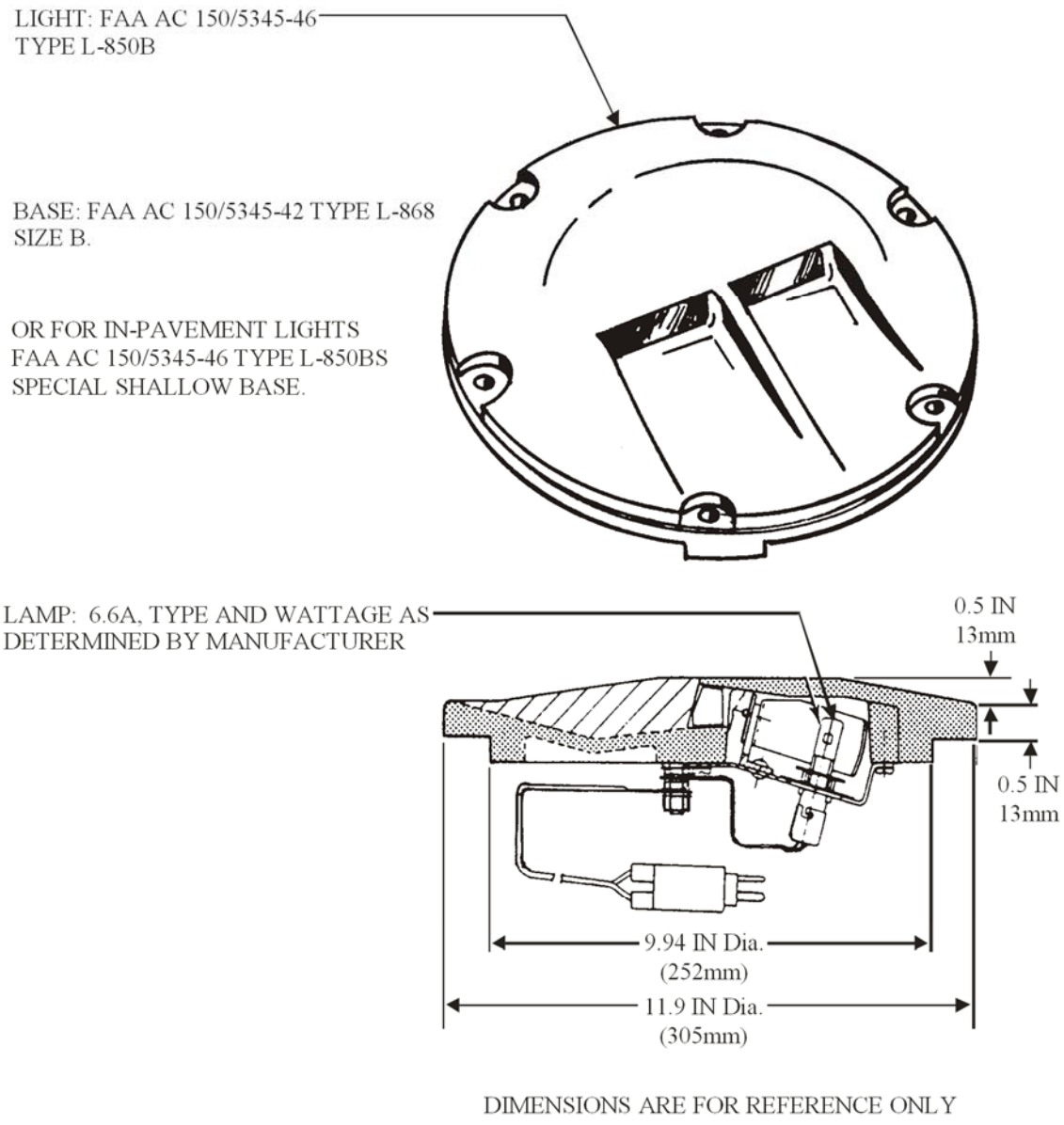


Figure 6
FAA L-850B, In-Pavement, Unidirectional

1.8.7 **Light Fixture Supports.**

1.8.7.1 For mounting light fixtures up to 6 feet (1.8 meters) above ground level, use 2 inch (53 mm) diameter EMT which is fitted at the bottom with a frangible coupling conforming to FAA Drawing C-6046.

1.8.7.2 For light fixtures elevated between 6 feet (1.8 meters) and 40 feet (12 meters) above ground level, use fiberglass low impact resistant (LIR) frangible support structures meeting FAA AC 150/5345-45, L-891, FAA-E-2702 and FAA Drawing Series D-6155.

1.8.7.3 For light fixtures elevated above 40 feet (12 meters) above ground level, a 20 ft ±1.5 in (6.1 m ±38.1 mm) LIR must be mounted on a rigid support. LIR must meet the requirements of FAA AC 150/5345-45, L-892. For rigid support requirements see paragraph 1.8.8.

1.8.8 **Rigid Supports, Over 40 Feet (12 Meters).**

For rigid supports for fixtures over 40 feet (12 meters) above ground level, use a structural steel tower with a 20 feet (6 meter) LIR fiberglass mast supporting the light bar (MS-20 assembly), which lowers vertically through the rigid tower platform for maintenance of the light fixtures. A diagram of a rigid tower with MS-20 assembly is provided in UFC 3-535-02. The tower manufacturer should have at least 10 years continuous experience in the fabrication of structural steel towers. An acceptable tower is the SSV series rigid steel tower manufactured by Rohn Industries, or equivalent. The manufacturer should develop the tower design details based on height and load requirements, certified by a structural engineer. See FAA AC 150/5345-45 for information about FAA Type Numbers and tower requirements. The rigid steel tower should have the following minimum characteristics:

1.8.8.1 Designed for the appropriate wind speed and ice load based on latest revision of ANSI/EIA-222.

1.8.8.2 Steel pipe and solid rod legs with minimum yield strength of 50 ksi (345 Mpa). Braces, plates and bolts must be of size and strength required by design. Welding must be by AWS Gas Metal Arc Process, by AWS certified welders.

1.8.8.3 Hot-dipped galvanized inside and out, after fabrication, in accordance with ASTM A-123 for structural materials and ASTM A-153 for hardware.

1.8.8.4 Service platform to be fabricated of the same materials as the tower. Platform must accommodate the safe movement and activity of maintenance personnel (via railing or gate/trap door, for example) and the mounting and lowering of the telescoping LIR mast. The working facilities (such as platform, hand or guardrails) must meet the latest revision of ANSI/EIA-222.

1.8.8.5 Service ladder must include a safety climbing device (e.g., rigid rail or cable style hook-up) for the safe ascent/descent of maintenance personnel. The service ladder must be a fixed ladder meeting the latest revision of ANSI/EIA-222, and climbing device must meet the requirements of ANSI A14.3.

1.8.8.6 Foundation design must, as a minimum, be adequate for a 4,000 psf (190 kPa) soil bearing capacity, and must be adequate to meet the maximum reaction loads of the tower as defined by the tower designer.

1.9 RUNWAY END IDENTIFIER LIGHTS (REIL).

See UFC 3-535-01 paragraph 3-6. Use equipment meeting FAA-E-2628 or FAA AC 150/5345-51, Type L-849, Style D and F for unidirectional and omnidirectional REIL installations (see Figure 7).

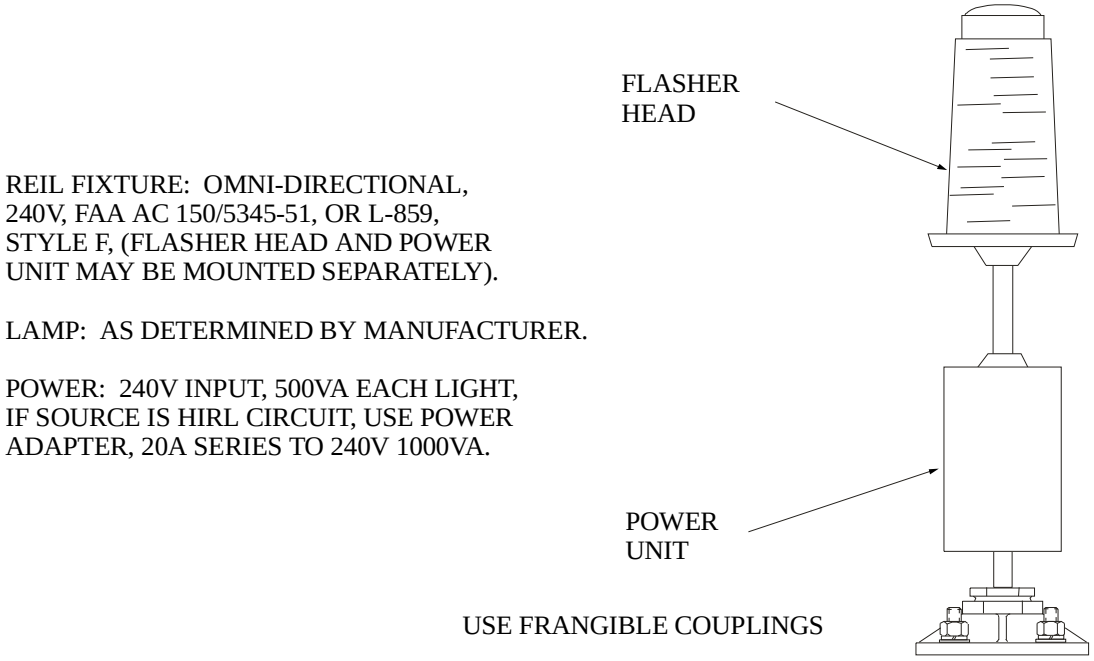


Figure 7
FAA L-849 Style D or F, Omnidirectional, Flashing

1.10 **PAPI/CHAPI.**

For four-box Precision Approach Path Indicator (PAPI) systems use equipment meeting FAA-E-2756 or FAA AC 150/5345-28, type L-880. For 2-box systems use a CHAPI or FAA AC 150/5345-28, type L-881 PAPI. For installation and equipment see UFC 3-535-01 Figure 12-7 (1 and 2 of 2) and Figure 8.

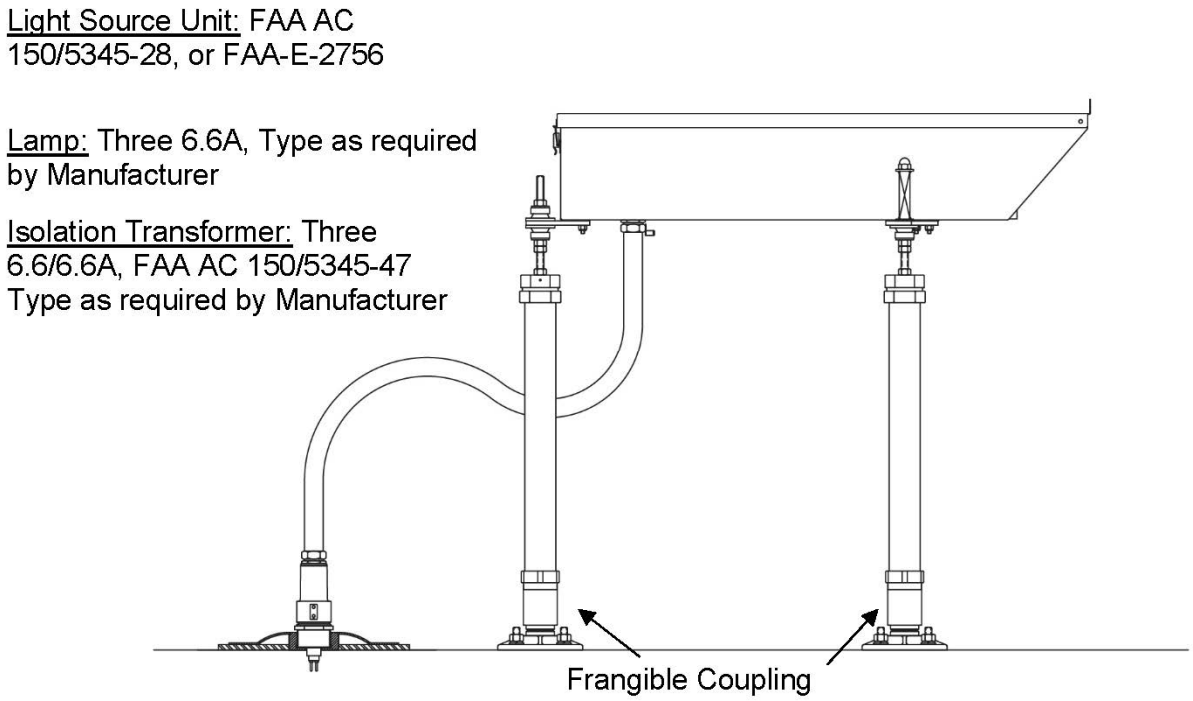


Figure 8
FAA L-880, or FAA-E-2756, L-881, PAPI or CHAPI System

1.11 RUNWAY LIGHTS.

1.11.1 High Intensity Runway Edge Lighting Equipment.

See UFC 3-535-01 paragraph 4-2.

1.11.1.1 Elevated Fixtures.

Use light fixtures meeting FAA AC 150/5345-46, Type L-862 (see Figure 9). Colored filters, where required for displaced threshold areas, must meet the requirements of the specification and be compatible with the fixture. Use lamps recommended by the manufacturer. Different manufacturers may meet the requirement using different lamps. In the interest of energy conservation, lower wattage lamps are preferred.

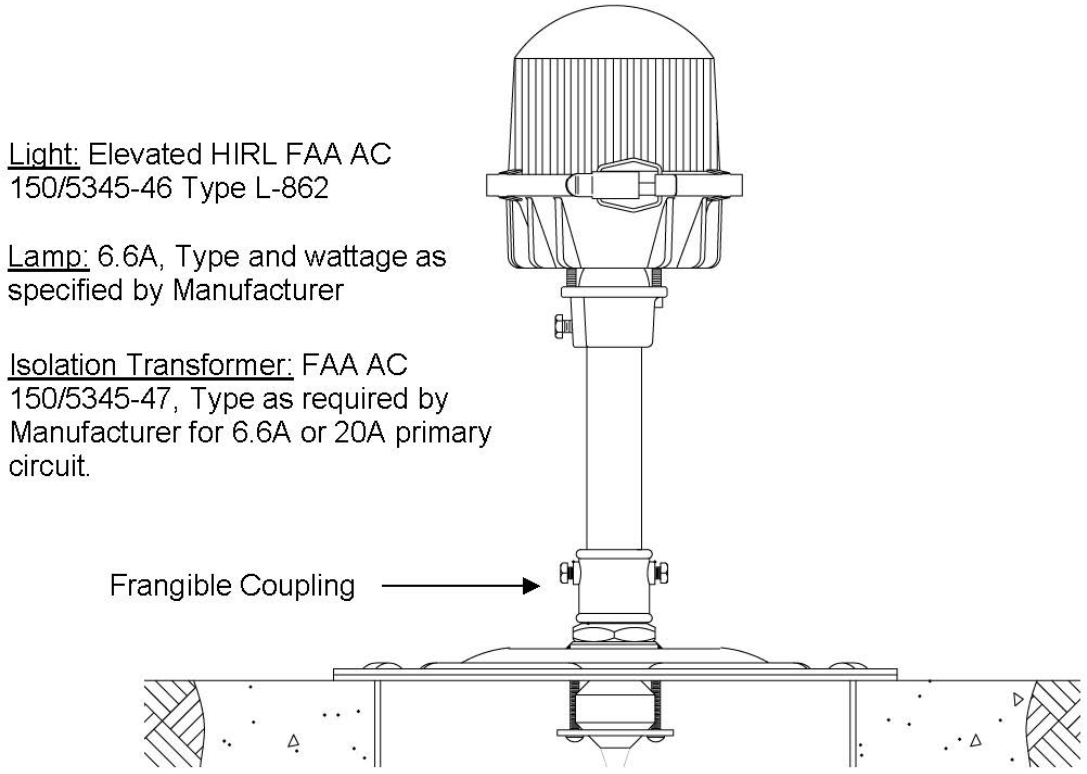


Figure 9
FAA L-862, Elevated, Bidirectional

1.11.1.2 **In-Pavement Fixtures.**

Use fixtures meeting FAA AC 150/5345-46, Type L-850C (see Figure 10). Use lamps recommended by the manufacturer. Different manufacturers may meet the requirement using different lamps. For runways utilizing remotely piloted aircraft (RPA) or unmanned aerial systems (UAS) or vehicles (UAV), FAA Type 3, low profile (0.25") fixtures must be used on the runway where in-pavement fixtures are required. In the interest of energy conservation, lower wattage lamps are preferred.

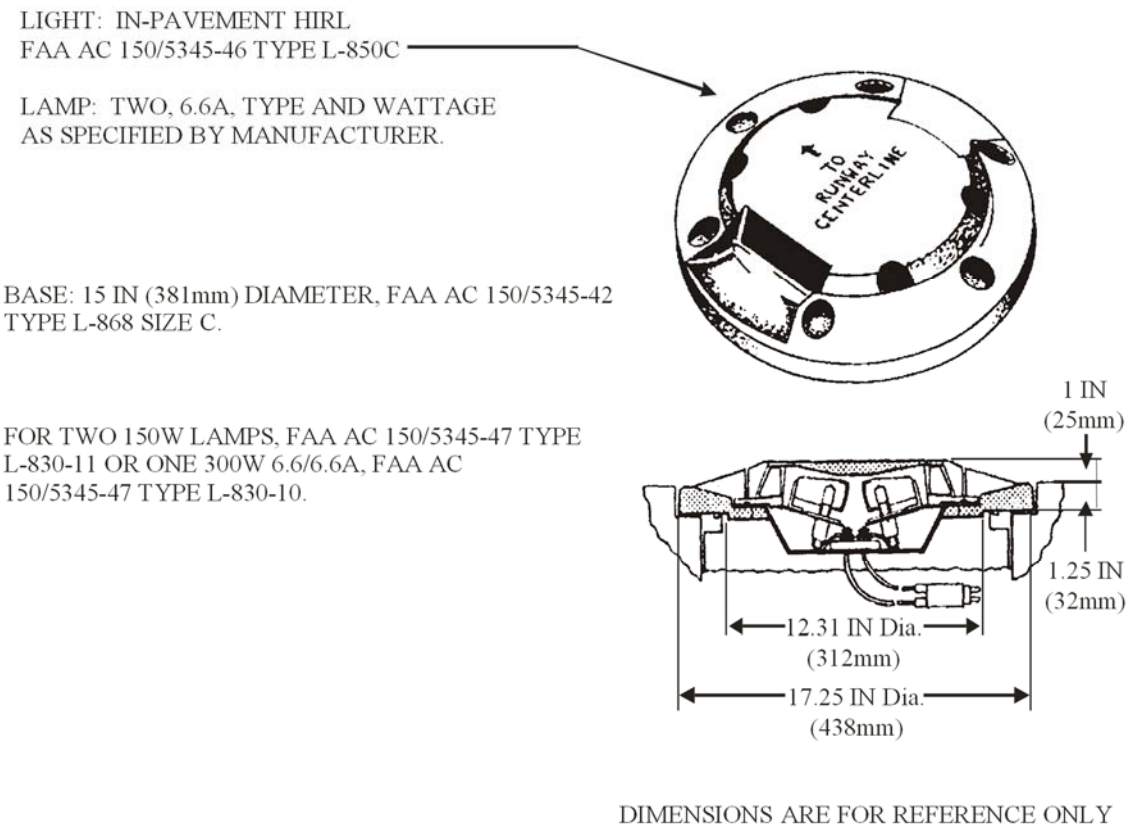


Figure 10
FAA L-850C, In-Pavement, Bidirectional

1.11.2 Medium Intensity Runway Edge Lights.

See UFC 3-535-01 paragraph 4-3.

1.11.2.1 Elevated Fixtures.

Use fixtures meeting FAA AC 150/5345-46, Type L-861 (see Figure 11). In displaced threshold areas, provide colored filters meeting the specification and compatible with the fixture.

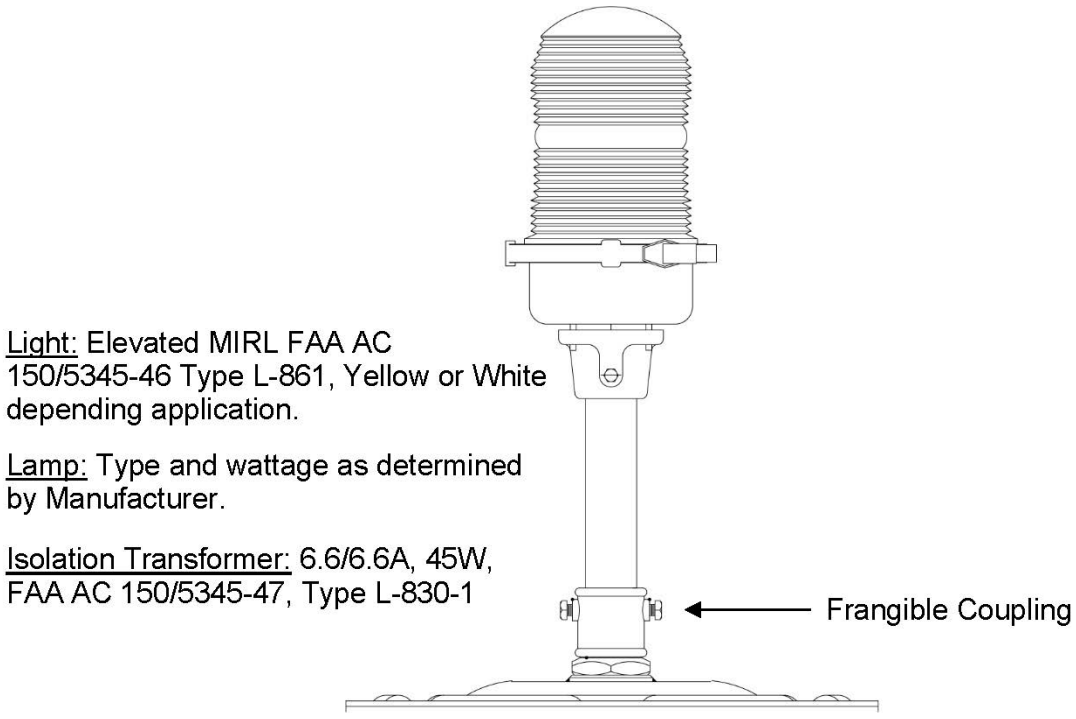


Figure 11
FAA L-861, Elevated, Omnidirectional

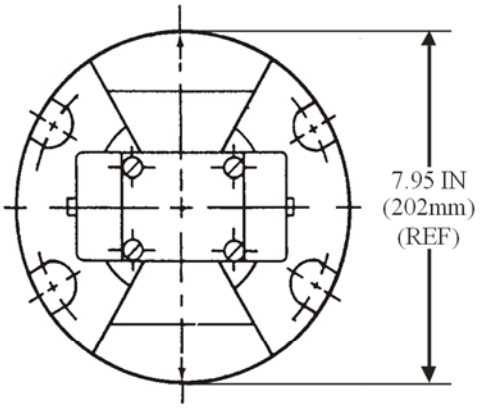
1.11.2.2 **In-Pavement Fixtures.**

Use bidirectional fixtures meeting FAA AC 150/5345-46, Type L-852D without filters (see Figure 12). Use lamps recommended by the manufacturer. Different manufacturers may meet the requirement using different lamps. In the interest of energy conservation, lower wattage lamps are preferred.

LIGHT: IN-PAVEMENT, BI-DIRECTIONAL OR UNI-DIRECTIONAL, FAA AC 150/5345-46 TYPE L-852A,B,C, OR D, AS DETERMINED FOR NARROW-BEAM, WIDE-BEAM, OR CATEGORY III.

LAMP: 6.6A, WATTS AND TYPE AS DETERMINED BY THE MANUFACTURER.

FILTERS: AVIATION COLORS, TYPE AS DETERMINED BY APPLICATION.



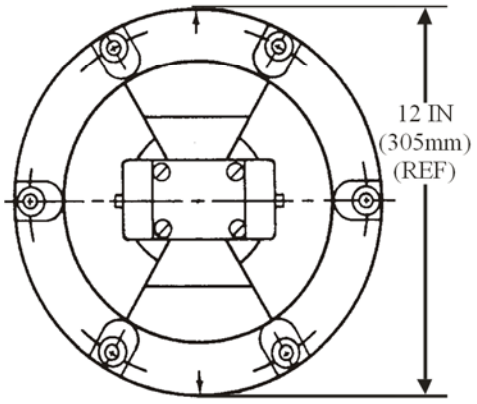


Figure 12
FAA L-852, (A, B, C, D), In-Pavement, Bidirectional

1.11.3 **Runway Threshold Lighting.**

See UFC 3-535-01 paragraph 4-4.

1.11.3.1 **In-Pavement Fixtures, Unidirectional, Green or Red.**

Use light fixtures meeting FAA AC 150/5345-46, Type L-850E and photometric requirements in UFC 3-535-01 Figure 4-6 (for green light) or UFC 3-535-01 Figure 4-11 (for red light) (see Figure 13). FAA Type L-850D (Figure 13) does not meet the threshold light photometric requirements so are not acceptable. For displaced thresholds and thresholds adjacent to strengthened pavements, in-pavement fixtures must be used for in-board threshold lights.

1.11.4 **High Intensity Elevated Light Fixtures.**

Use Par 56 fixtures meeting FAA-E-982. For Army installations only, fixtures meeting FAA AC 150/5345-46 Type L-862E may be used.

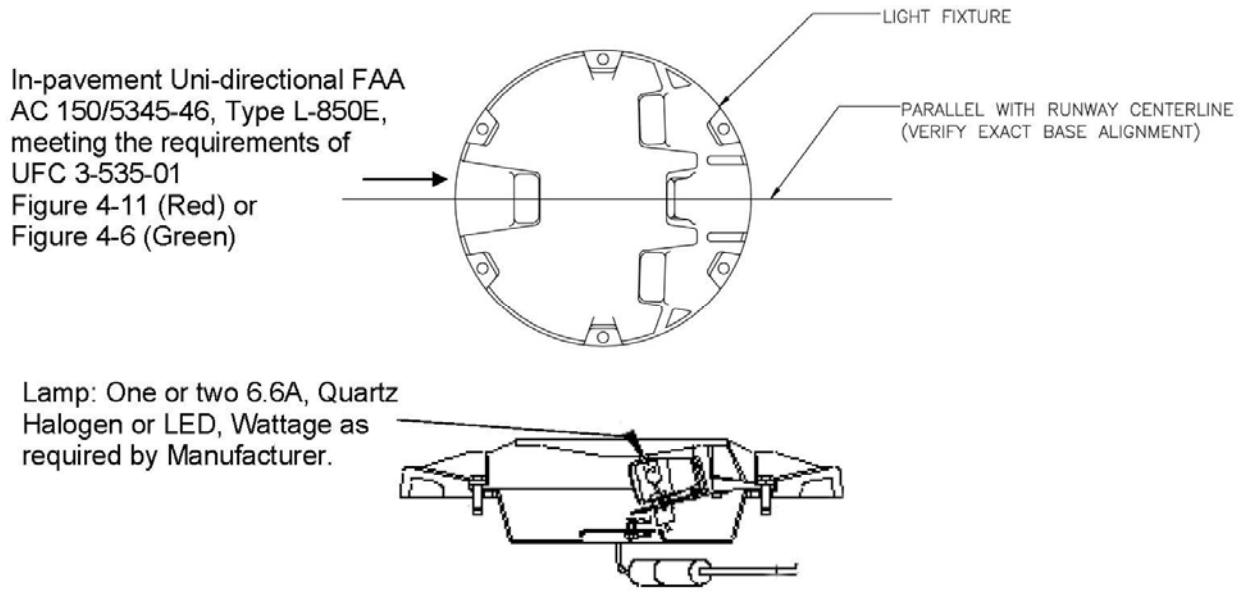


Figure 13
FAA L-850D, In-Pavement, Bidirectional

1.11.5 **Runway End Lights (High Intensity).**

See UFC 3-535-01 paragraph 4-6.

1.11.5.1 **Light Fixtures, In-Pavement, Unidirectional, Red.**

Use fixtures meeting FAA AC 150/5345-46, Type L-850E with red filter where threshold and runway ends are not relocated (see Figure 3).

1.11.6 **Medium Intensity Threshold/End Lighting (Army Only).**

See UFC 3-535-01 paragraph 4-4.

1.11.6.1 **In-Pavement Fixtures, Bidirectional, Red/Green (Army Only).**

Use fixtures meeting FAA AC 150/5345-46, Type L-852D, with red and green filters where bidirectional runway end/threshold fixtures are required. If unidirectional light is required use type L-852K (green) or L-852 S (red) (see Figure 12).

1.11.6.2 **Elevated, Bidirectional, Red/Green.**

Use light fixtures meeting FAA AC 150/5345-46, L-861SE, when elevated combination runway end light/threshold light are required (see Figure 14).

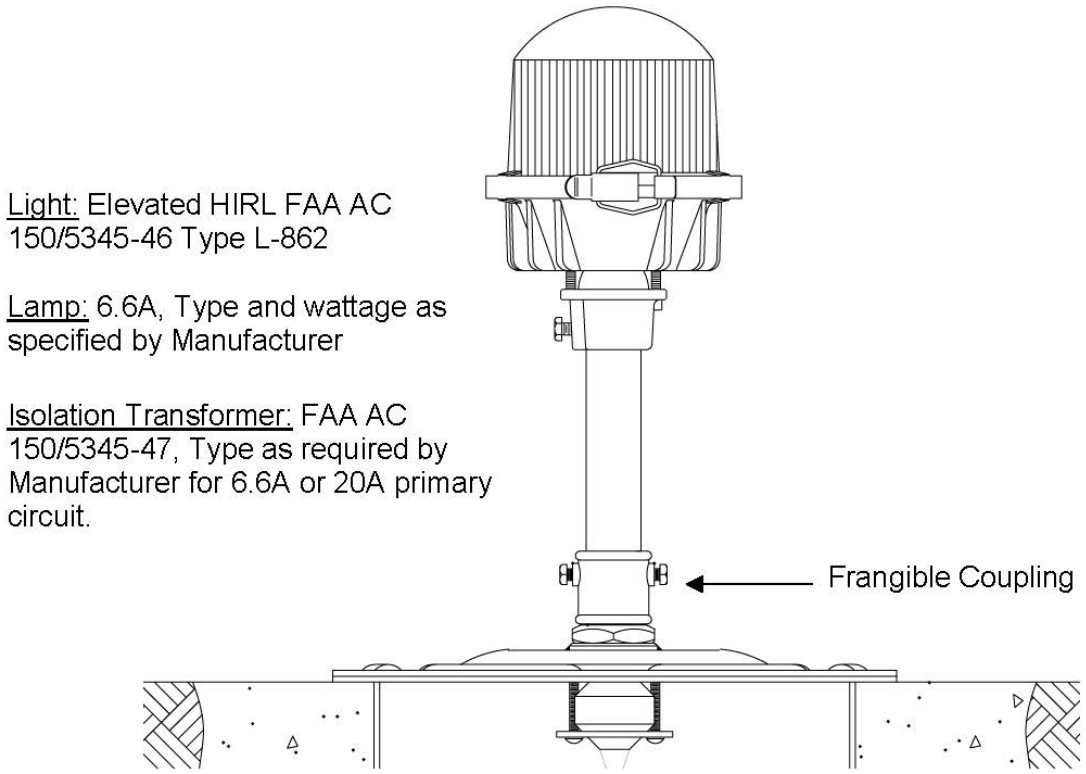


Figure 14
FAA L-861SE, Elevated, Bidirectional

1.11.7 **Runway Centerline Lights (RCL).**

See UFC 3-535-01 paragraph 4-7. Use fixtures meeting FAA AC 150/5345-46, Type L-850A, Class I or II. Use red filters where required to meet the requirements in paragraph 4-7 (see Figure 15).

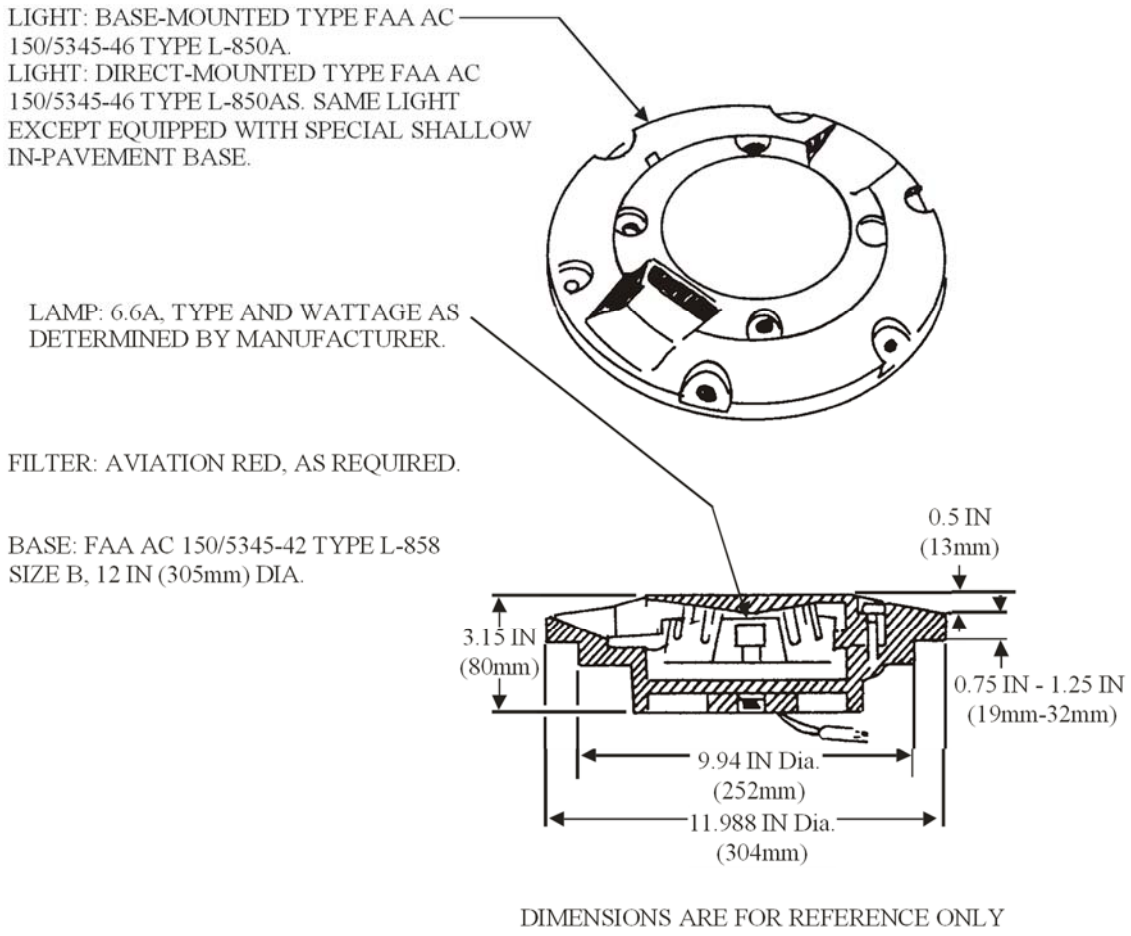
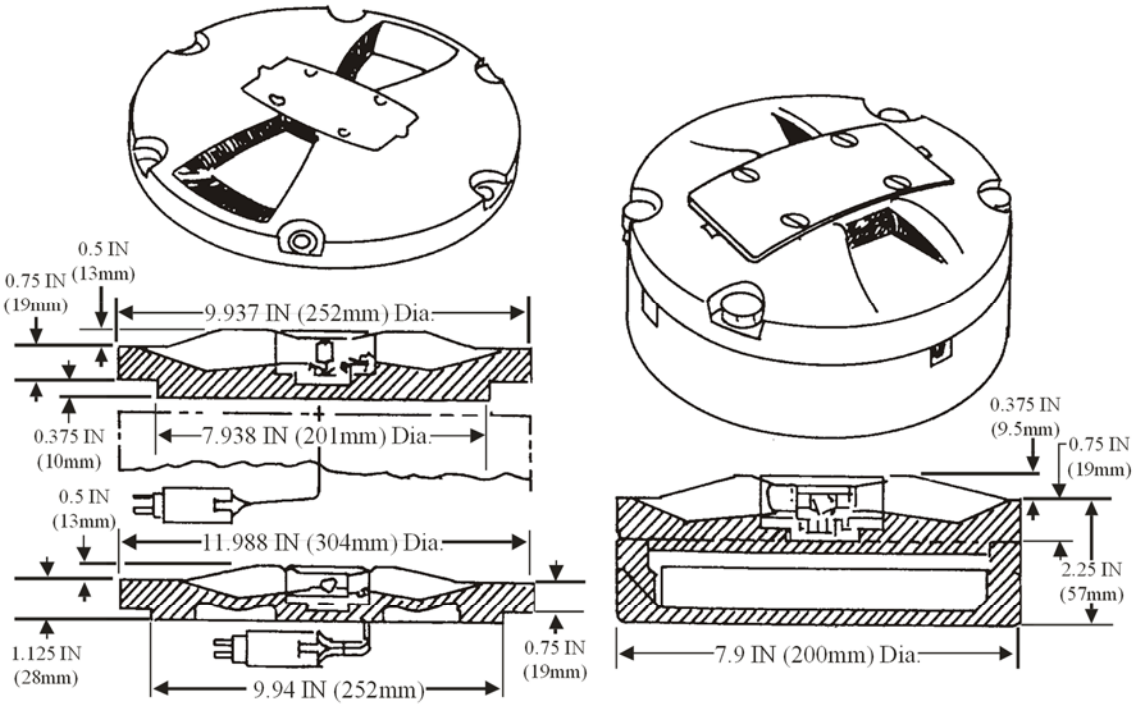


Figure 15
FAA L-850A, In-Pavement, Bidirectional

1.11.7.1 Where centerline lights are subject to aircraft tail hook impact use a high strength steel design designated as L-852N (NAVY) (see Figure 16).



NOTE: DIMENSIONS ARE FOR REFERENCE ONLY

LIGHT, BASE MOUNTED: TYPE L-852N NAVY TYPE VII OR VIII, WITH SHORTING DEVICE FOR FAILED LAMP

LIGHT, DIRECT MOUNTED: TYPE L-852N NAVY TYPE VI, WITH SHORTING DEVICE FOR FAILED LAMP

LAMP: 6.6A, TYPE AND WATTAGE AS DETERMINED BY MANUFACTURER

FILTER: AVIATION RED OR WHITE, AS REQUIRED

BASE: FAA AC 150/5345-42 TYPE L-858 SIZE A 10 IN (254mm) DIA. FOR LIGHT TYPE VII OR SIZE B 12 IN (305mm) FOR LIGHT TYPE VIII

BASE: SPECIAL SHALLOW FOR DIRECT MOUNTED LIGHTS BY MANUFACTURER

Figure 16
FAA L-852N, In-Pavement, Bidirectional (Hook-Resistant)

1.11.8 **Touchdown Zone Lights (TDZL).**

See UFC 3-535-01 paragraph 4-8. Use fixtures meeting FAA AC 150/5345-46, Type L-850B, Class I or II (see Figure 6).

1.11.9 Runway Distance Remaining Signs (RDR).

See UFC 3-535-01 paragraph 9-6. Use signs meeting FAA AC 150/5345-44 (figures in Appendix H), Type L-858B, size 4. When connected to the runway lighting circuits, specify style 3 (see Figure 17). See FAA AC 150/5340-18 for RDR sign installation information. These signs may be LED type, but mixture of incandescent and LED are not allowed.

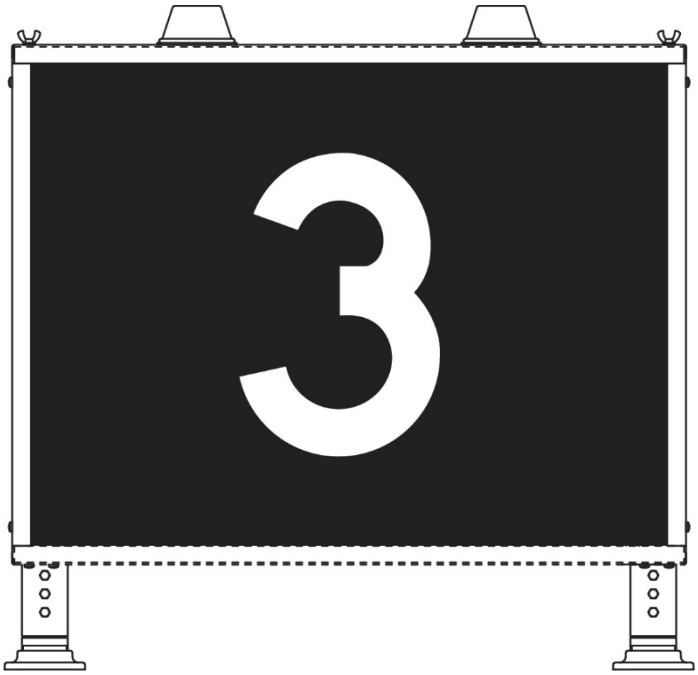
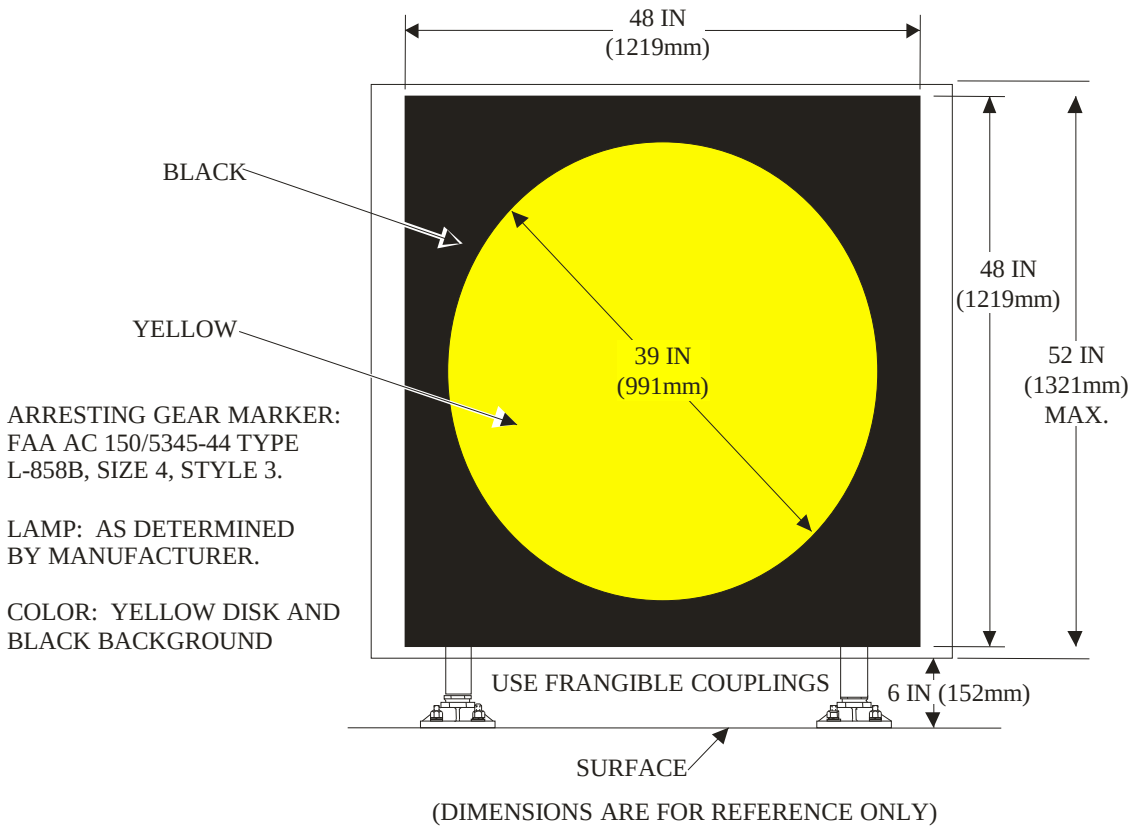


Figure 17
Runway Distance Remaining Sign (Lighted)

1.11.10 **Arresting Gear Markers (AGM).**

See UFC 3-535-01 paragraph 9-7. These markers are a modified RDR sign with a yellow circle in lieu of a number (see Figure 18).



NOTE: BASE MARKER MAY BE TRIANGULAR OR RECTANGLE.

Figure 18
FAA L-858B, Sign, Elevated, AGM

1.12 TAXIWAY LIGHTS.

1.12.1 Taxiway Edge Lights, Elevated Fixtures.

See UFC 3-535-01 paragraph 5-1. Use light fixtures meeting FAA AC 150/5345-46, Type L-861T. Where in-pavements fixtures are required, use FAA L-852E light fixtures (see Figure 19). Use lamps recommended by the manufacturer to meet the requirements of UFC 3-535-01 paragraph 5-1. Different manufacturers may meet the requirement using different lamps. In the interest of energy conservation, lower wattage lamps are preferred. Where an in-pavement taxiway edge light is needed use an FAA AC 150/5345-46. These taxiway fixtures may be LED, but mixture of incandescent and LED are not allowed and a mixture of fixture manufacturers on a single taxiway are not allowed.

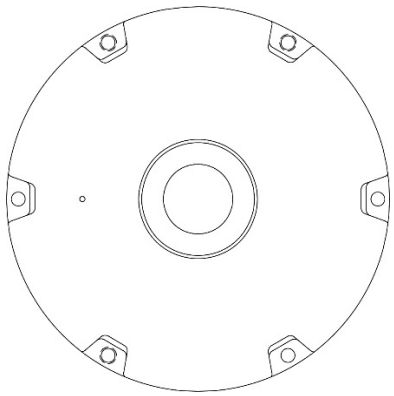


Figure 19
FAA L-852, In-Pavement, Bidirectional, Unidirectional (LED Shown)

1.12.2 Taxiway Centerline, Hold Point and High Speed Turnoff Lighting.

See UFC 3-535-01 paragraphs 5-2 and 5-4.

1.12.2.1 Fixtures.

Use fixtures meeting FAA AC 150/5345-46, Type L-852, Class I or II. These fixtures may be direct in-pavement, for mounting on special shallow bases, or for mounting on 10 or 12 inch (250 or 300 millimeter) base housings. Select fixtures by type depending on application.

1.12.2.1.1 Straight Centerline Sections.

For Category II and higher operations, use FAA AC 150/5345-46 Type L-852A with green/green filters except at hold bars where the filter facing the holding aircraft will be yellow. For Category III application, use FAA AC 150/5345-46 Type L-852C.

1.12.2.1.2 **Curved Centerline Sections.**

For Category II and higher operations, use FAA AC 150/5345-46 Type L-852. Where small radius turns require aiming along a chord for proper viewing, two fixtures may be used. For Category III applications, use FAA AC 150/5345-46 Type L-852D.

1.12.2.1.3 **Clearance Bar (Hold Point) In-Pavement.**

Use Type FAA AC 150/5345-46, L-852A with yellow filter for side lights at hold bar arrays for Category II and higher operations. For Category III applications, use FAA AC 150/5345-46, Type L-852C.

1.12.2.1.4 **Runway Guard Lights (RGL) Elevated.**

See UFC 3-535-01 paragraph 5-5. Use FAA-L-804 elevated fixture. For in-pavement, see paragraph 1.12.2.1.3 (see Figure 20).

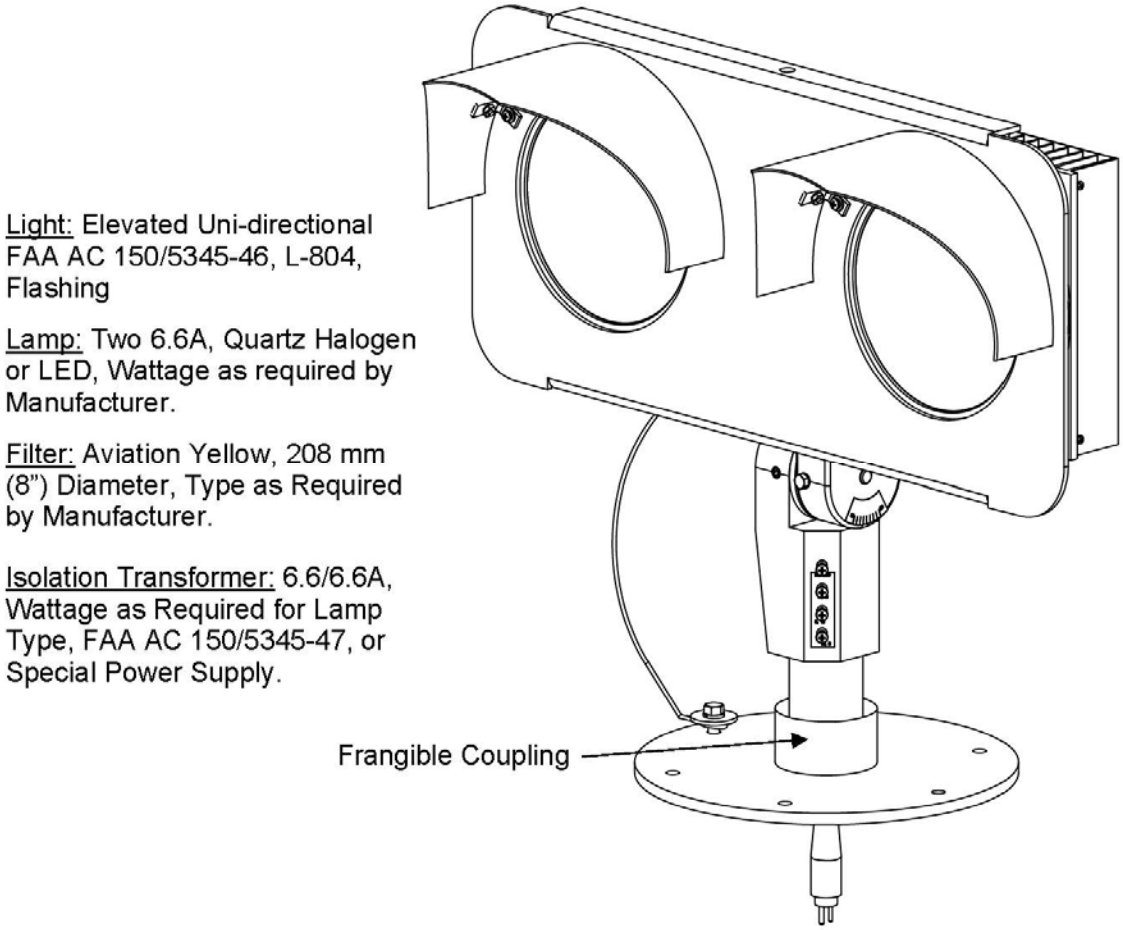


Figure 20
FAA L-804, Elevated, Unidirectional Fixture Runway Guard Lights

1.12.2.1.5 **High Speed Turnoff.**

For Category II and higher operations, FAA AC 150/5345-46, Type L-852 unidirectional with green filter may be used on straight sections and L-852B unidirectional on curved sections. Use Types L-852C and 852D for Category III applications.

1.12.2.1.6 **Lamps.**

Use lamps recommended by the manufacturer. Different manufacturers may meet the requirement using different lamps. In the interest of energy conservation, lower wattage lamps are preferred.

1.12.2.2 **In-Pavement Fixtures.**

Use light fixtures meeting FAA AC 150/5345-46, Type L-852E or L-852T, class I or II with blue filters.

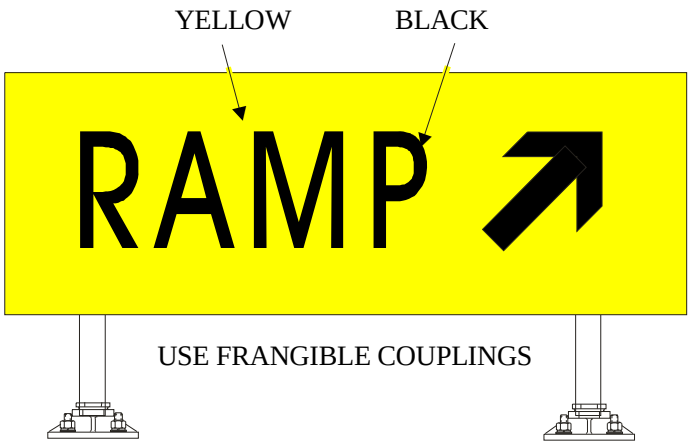
1.12.3 Taxiway Guidance Signs and Mandatory Signs.

See UFC 3-535-01 paragraphs 9-2, 9-3, and 9-4. Use signs meeting the requirements of FAA AC 150/5345-44, Type L-858Y for informational signs, Type L-858L for location signs, and Type L 858R for mandatory signs. The style and the class of sign are dictated by the power source and the operational climate (see Figure 21, Figure 22, and Figure 23). See FAA Advisory Circulars 150/5340-18 and 150/5345-44 for additional information on taxiway guidance signs. See 150/5345-44 Appendix H for additional information on figures.

SIGNS: INFORMATIONAL
FAA AC 150/5345-44
TYPE L-858Y, SIZE 1, 2 OR 3,
STYLE 2 OR 3, CLASS 1 OR 2,
LEGENDS AS REQUIRED.

LAMPS: RATING AND TYPE
PER MANUFACTURER.

ISOLATION TRANSFORMERS:
6.6/6.6A OR 20/6.6A DEPENDING
ON CIRCUIT, WATTS AND
NUMBER PER MANUFACTURER.



INFORMATIONAL (DIRECTION OR DESTINATION) SIGN

Figure 21
FAA L-858Y, Sign, Taxiway

Informational Note: These signs represent the bulk of existing signs and comply with previous edition of FAA AC 150/5345-44. These signs do not require replacement until the end of their economic lives or with a major renovation to the airfield. See current edition of FAA AC for new sign message elements.

Sign: Mandatory FAA AC 150/5340-44, Type L-858R, size 1, 2 or 3 as appropriate, Style 2 or 3, Class 1 or 2, Legend as Required.

Wind Load Rating: Mode 2, 322 KPH (200 MPH). For C-17 Operation Areas Use Mode 3, 483 KPH (300 MPH).

Lamps: Rating and Type per Manufacturer.

Isolation Transformer: 6.6/6.6A or 20/6.6A Depending on Circuit. Wattage as Required By Manufacturer.

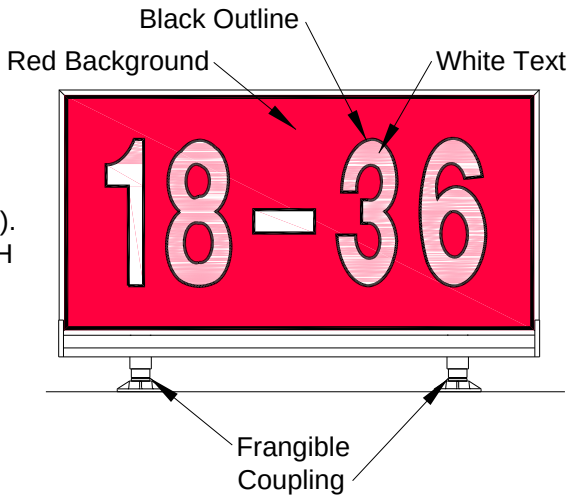


Figure 22
FAA L-858R, Sign, Mandatory

Informational Note: These signs represent the bulk of existing signs and comply with previous edition of FAA AC 150/5345-44. These signs do not require replacement until the end of their economic lives or with a major renovation to the airfield. See current edition of FAA AC for new sign message elements.

NOTE: New FAA L-858R signs use a black outline around the white legend. Use all current signs in inventory before ordering the black outline signs. See FAA AC 150/5345-44 for additional information.

SIGNS: LOCATION
FAA AC 150/5345-44
TYPE L-858L, SIZE 1, 2 OR 3,
STYLE 2 OR 3, CLASS 1 OR 2,
LEGENDS AS REQUIRED.

LAMPS: RATING AND TYPE
PER MANUFACTURER.

ISOLATION TRANSFORMERS:
6.6/6.6A OR 20/6.6A DEPENDING
ON CIRCUIT, WATTS AND
NUMBER PER MANUFACTURER.

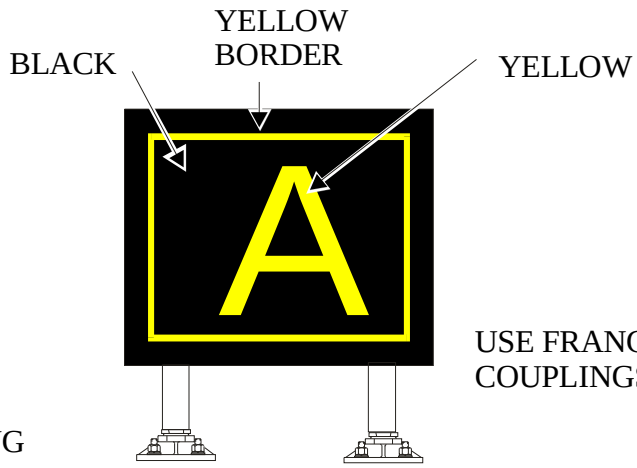


Figure 23
FAA L-858L, Sign, Taxiway, Location

1.13 MISCELLANEOUS (SIGNS, BEACONS, WIND CONES).

1.13.1 Airfield Beacons.

See UFC 3-535-01 paragraph 10-1.

1.13.1.1 Station Rotating Beacon.

Use equipment meeting MIL-L-7158 (see Figure 24). Use equipment meeting FAA AC 150/5345-12 (see paragraph 1-2).

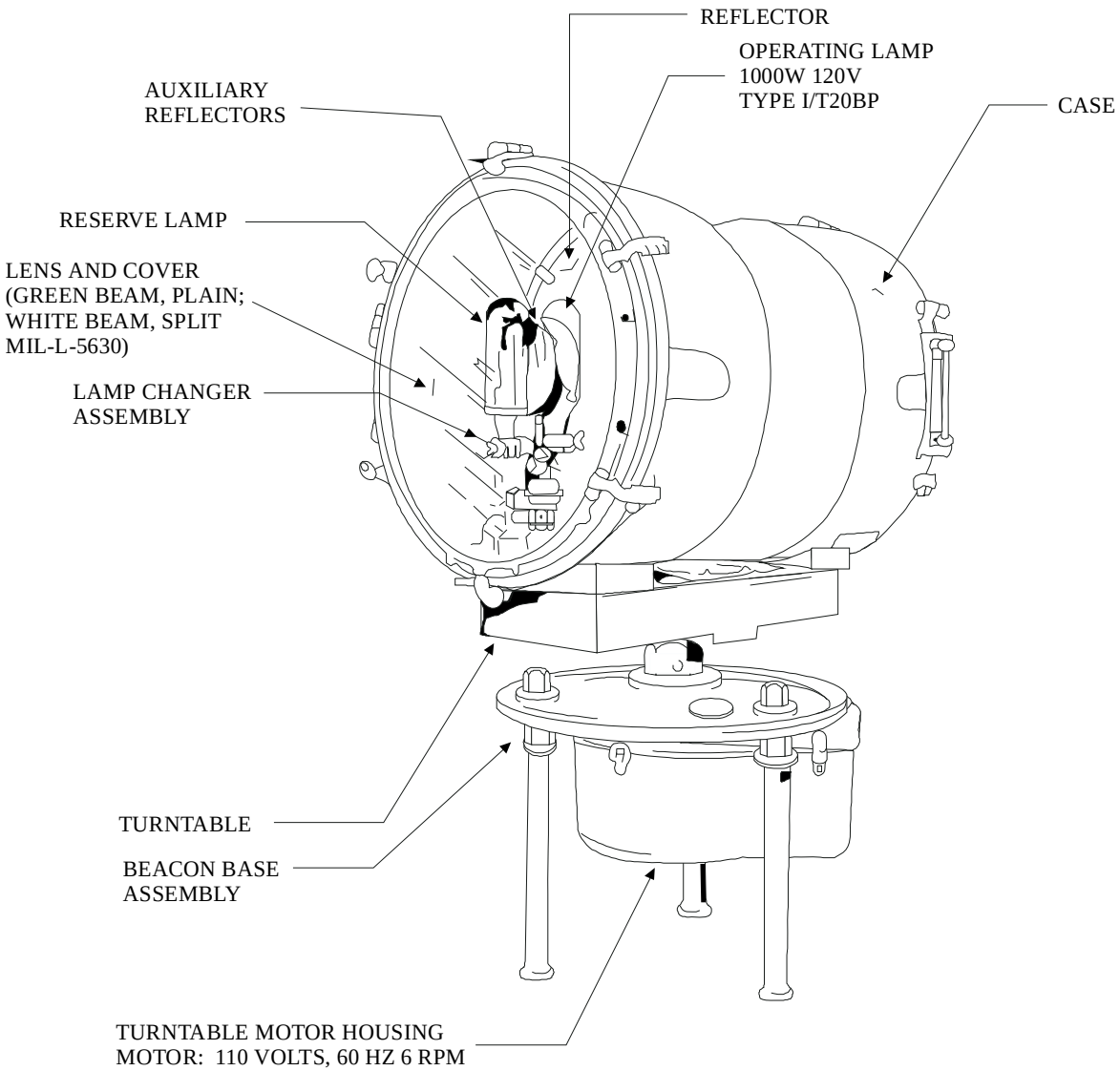
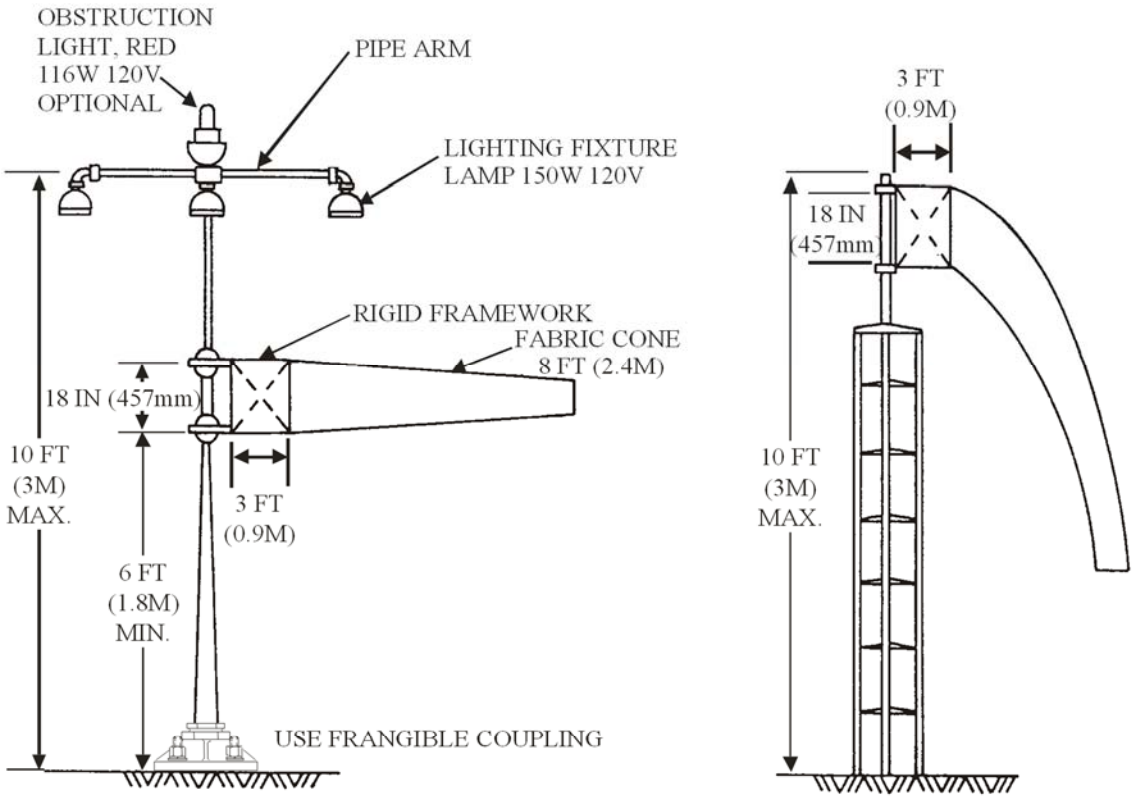


Figure 24
MIL-L-7158, Airfield Beacon, Rotating

1.13.2 **Lighted Wind Indicators (Cones).**

See UFC 3-535-01 paragraph 10-2. Use equipment meeting FAA AC 150/5345-12, Type L-806, size I or Type L-807 size 2 (see Figure 25 and Figure 26).



A. WIND INDICATOR
8 FT (2.4M) WIND CONE
LIGHTED
LOW-MASS DESIGN STRUCTURE
FAA AC 150/5345-27
TYPE L-806 STYLE I
SIZE 1

B. WIND INDICATOR
8 FT (2.4M) WIND CONE
UNLIGHTED
LIGHTWEIGHT STRUCTURE
FAA AC 150/5345-27
TYPE L-806 STYLE II
SIZE 1

(DIMENSIONS ARE FOR REFERENCE ONLY)

Figure 25
FAA L-806, Windcone, 8 Foot (2.4 Meter)

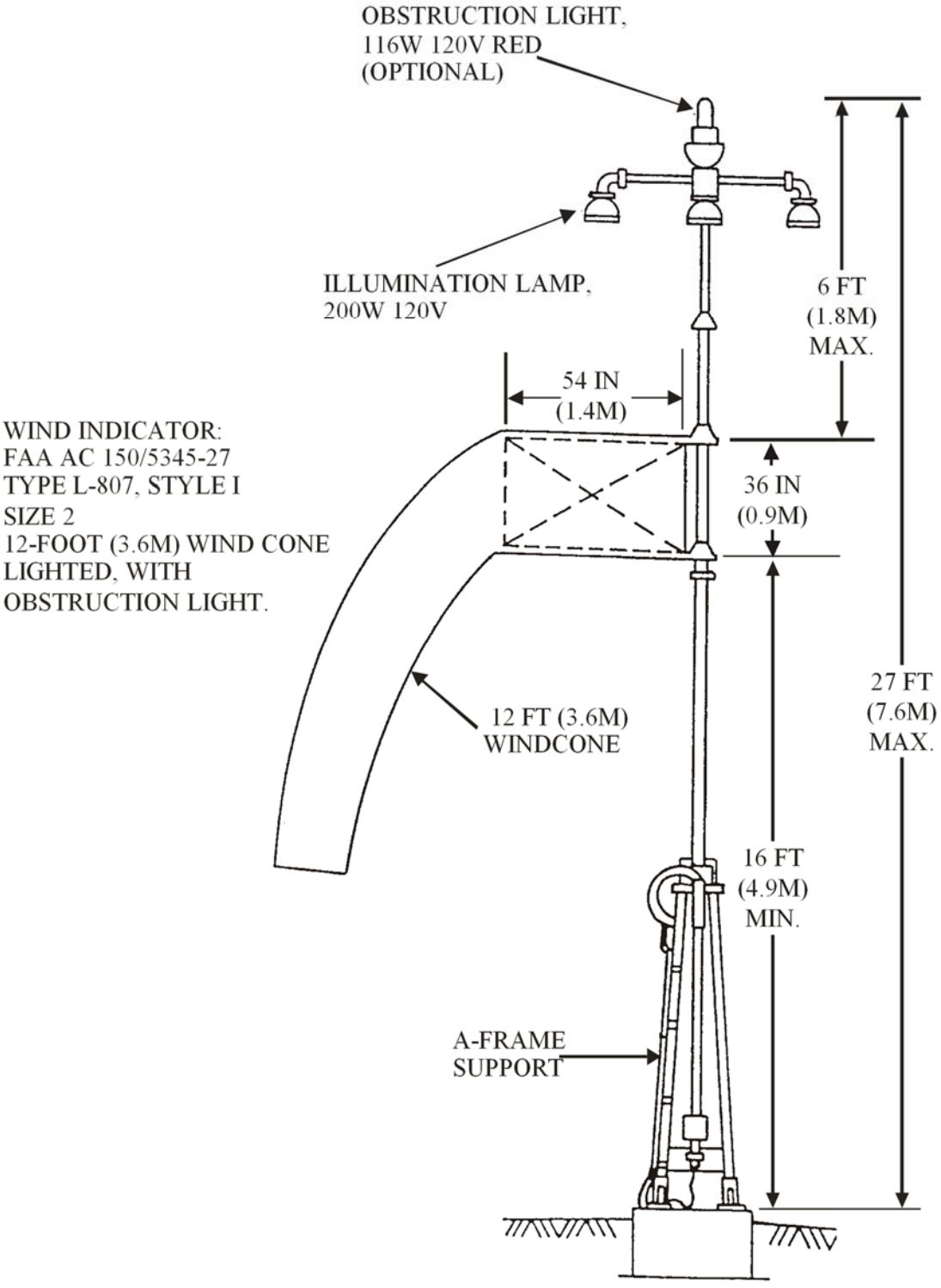


Figure 26
FAA L-807, Windcone, 12 Foot (3.6 Meter)

1.13.3 **Electrical Equipment.**

The equipment used depends on the power source. If required, use isolation transformers meeting FAA AC 150/5345-47, installed in bases meeting FAA AC 150/5345-42, Type L-867.

1.14 **OBSTRUCTION LIGHTING EQUIPMENT.**

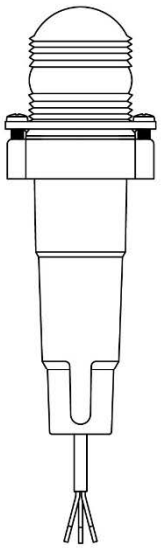
See UFC 3-535-01 paragraph 6-1.

1.14.1 **Flashing Beacons.**

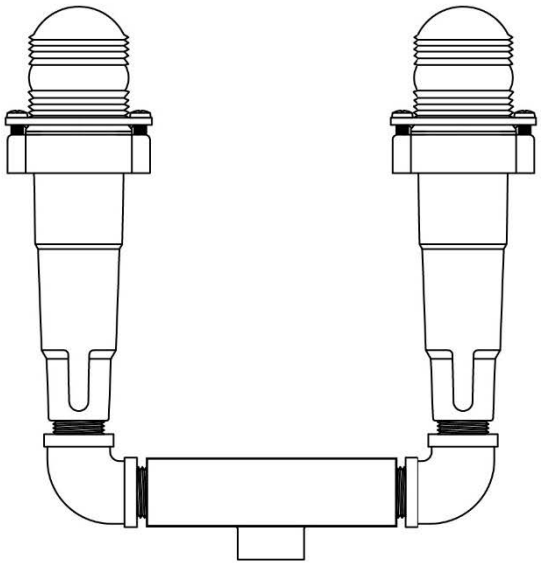
Use flashing beacon equipment in red light meeting MIL-L-6273 or FAA AC 150/5345-43, Type L-864.

1.14.2 **Steady Burning Lights.**

Use steady burning red lights meeting MIL-L-7830 or FAA AC 150/5345-43, Type L-810. These lights are supplied in single or duplex fixtures (see Figure 27).



SINGLE STEADY-BURNING LIGHTS,
FAA-AC 150/5345-43 TYPE L-810,
116W 120V TYPE 116A21/TS, OR
125W 120V TYPE 125A21/P LAMP.

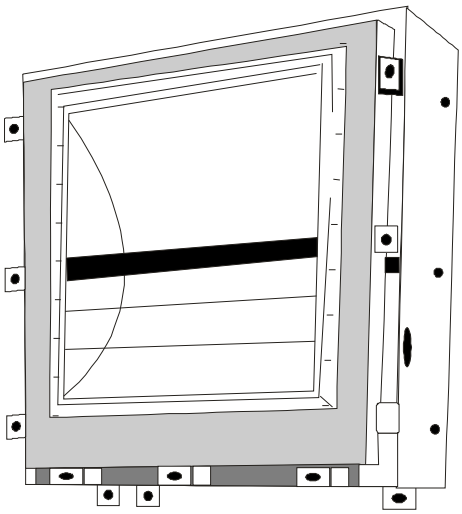


DOUBLE STEADY-BURNING LIGHTS
FAA AC 150/5345-43 TYPE L-810,
116W 120V TYPE 116A21/TS, OR
125W 120V TYPE 125A21/P LAMP

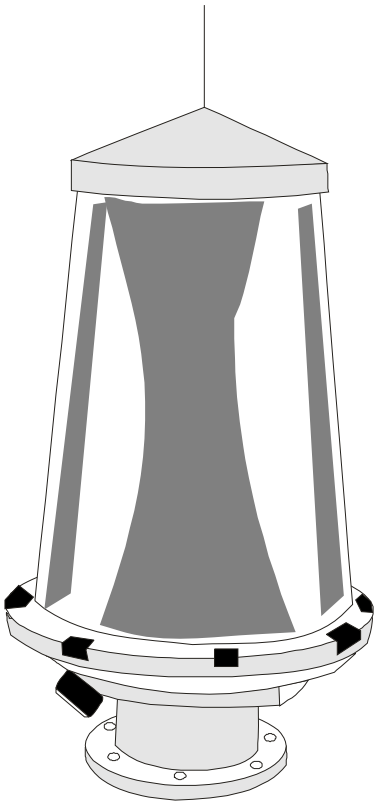
Figure 27
FAA L-810, Obstruction Light, Red, Single or Double Globe Steady Burning

1.14.3 **High Intensity Day Marking Light.**

Use equipment meeting FAA AC 150/5345-43, Type L-856 (see Figure 28).



HIGH-INTENSITY WHITE
OBSTRUCTION LIGHT,
FAA AC 150/5345-43,
TYPE L-856.



MEDIUM-INTENSITY WHITE
OBSTRUCTION LIGHT,
FAA AC 150/5345-43
TYPE L865, L866

Figure 28
FAA L-856, L-857, L-865, L-866, Obstruction Lights Flashing, High or Medium Intensity

1.15 **HELIPAD LIGHTING EQUIPMENT.**

See UFC 3-535-01 paragraph 7-1.

1.15.1 **Elevated Perimeter, Landing Direction and Approach Direction Lights.**

Use fixtures meeting FAA AC 150/5345-46, Type L-861 (see Figure 29). Use yellow filters except in approach direction lights that are white. For helipad IMC approach lights Category I configurations use fixtures meeting FAA-E-2325 (PAR 38, see Figure 5) or FAA-E-982 (PAR 56, see Figure 2).

1.15.2 **In-Pavement Perimeter, Landing Direction and Approach Direction Lights.**

Use fixtures meeting FAA AC 150/5345-46, Type L-852E (see Figure 29). Use yellow filters except in approach direction lights that are white.

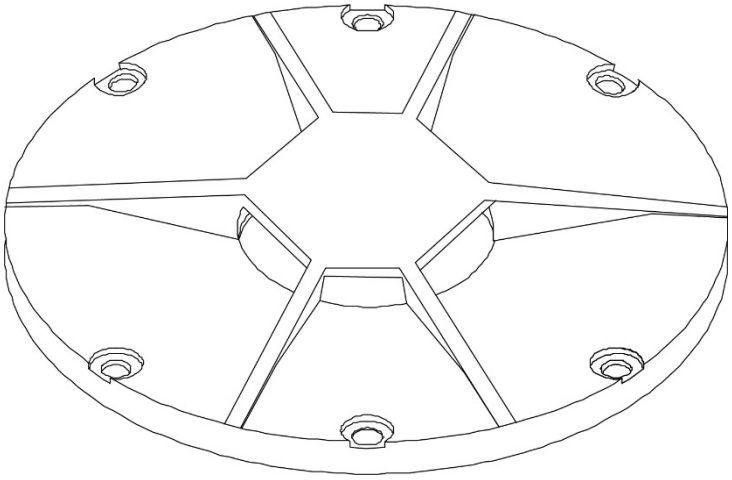


Figure 29
Type L-852E Landing Direction and Approach Direction Lights

1.15.3 **Heliport Beacons.**

Use beacon equipment meeting FAA AC 150/5345-12, Type L-801H (see Figure 30).

HELIPORT BEACON:
FAAAC 150/5345-12, TYPE L-801H
CLASS 2

LAMPS: 3, RATING AND TYPE AS DETERMINED BY THE MANUFACTURER

TRANSFORMER: VOLTAGE DISTRIBUTION, COMMERCIAL, RATING AS DETERMINED BY THE MANUFACTURER

COLORS: DOUBLE-PEAKED WHITE, GREEN, AND YELLOW or DOUBLE-PEAKED WHITE, GREEN, AND RED (as applicable)

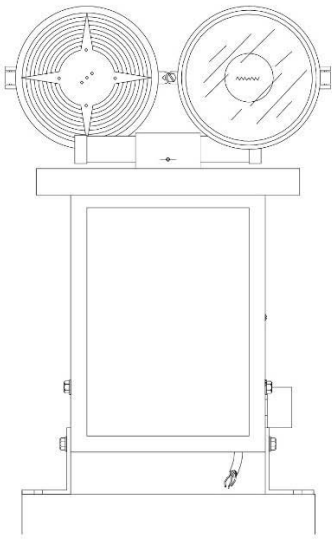


Figure 30
FAA L-801H, Beacon, Rotating, Helipad

1.15.4 **Helipad Floodlighting.**

No specific equipment has been identified to meet the standard.

1.15.5 **Helipad Wind Indicators (Cones).**

Use indicator meeting FAA AC 150/5345-27, type L-806 (see Figure 25).

1.15.6 **Chase Helipad Approach Path Indicator (CHAPI).**

This system is a modified PAPI system with a green glide path indicator added (usually 2 degrees) use equipment meeting FAA AC 150/5345-27.

1.16 **SPECIFICATION AVAILABILITY.**

Various FAA specifications are cited in this document in the text and figures. The following is a title list of those that are cited.

1.16.1 **FAA Advisory Circulars.**

The FAA has available an Advisory Circular Checklist AC OO-2.X, that lists all of the documents, and how to obtain them (see Table 1). FAA Advisory Circulars are available for free download at: http://www.faa.gov/airports/resources/advisory_circulars/.

Table 1. List of FAA Advisory Circulars

Doc. No.	Title
AC 70/7460-1	Obstruction Marking and Lighting.
AC 120-57A	Surface Movement Guidance and Control System.
AC 150/5220-23	Frangible Connections
AC 150/5340-1	Standards for Airport Markings.
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities.
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821 Panels for Control of Airport Lighting.
AC 150/5345-5	Specification for Circuit Selector Switch.
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.
AC 150/5345-10	Specification for Constant Current Regulators and Monitors.
AC 150/5345-12	Specification for Airport and Heliport Beacons.
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.
AC 150/5345-26	FAA Specification for L-823 Plug and Receptacle, Cable Connectors.
AC 150/5345-27	Specification for Wind Cone Assemblies.
AC 150/5345-28	Precision Approach Path Indicators (PAPI) Systems.
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes and Accessories.
AC 150/5345-43	Specification for Obstruction Lighting Equipment.
AC 150/5345-44	Specification for Taxiway and Runway Signs.
AC 150/5345-45	Low Impact Resistant (LIR) Structures
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures.
AC 150/5345-47	Specification for Isolation Transformers for Airport Lighting Systems.
AC 150/5345-49	Specification L-854, Radio Control Equipment.
AC 150/5345-50	Specification for Portable Runway and Taxiway Lights.
AC 150/5345-51	Specification for Discharge-type Flasher Equipment.
AC 150/5345-53	Airfield Lighting Equipment Certification Program.
AC 150/5345-56	Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)

1.16.2 **Standards, Specifications, and Drawings.**

The following standards, specifications, and drawings, shown in Table 2. FAA E specifications are available for free download at: http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/index.cfm.

Table 2. List of Standards, Specifications, and Drawings

Doc. No.	Title
FAA-E-910	Structural Steel.
FAA-E-982	PAR 56 Lamp Holder.
FAA-E-2159	Runway End Identifier Lighting System (REIL).
FAA-E-2325	Medium Intensity Approach Light System with Alignment Indicator Lights.
FAA-E-2491	Approach Light, In-pavement, Steady Burning.
FAA-E-2628	Sequenced Flashing Lighting System Elevated and In-pavement with Dimming and Monitoring.
FAA-E-2689	Dual Mode High Intensity Approach Lighting System (ALSF-2/SSALR).
FAA-E-2702	Low Impact Resistant Structures.
FAA Drawing C-6046	Frangible Coupling Type I and Type IA, Details.
FAA Drawing D-6076	ALSF-2 Approach Lighting System 6'-0" to 128'-0" Low Impact Resistant (LIR) Structures.
FAA Drawing D-6155	ALSF-2, 6' to 128' and MALS, 40' to 128' LIR Structures.
MIL-L-7158	Light, Beacon, Rotating, 24-inch

1.17 **CONSIDERATIONS FOR ADDITIONAL EQUIPMENT REQUIREMENTS.**

This paragraph provides characteristics and features for some equipment or subsystems beyond the minimum required by FAA standards. These have been identified as improving system performance, or in the case of computerized control system, provide criteria for equipment not yet covered by FAA standards but for which components are commercially available and often used for newer installations.

1.17.1 **Constant Current Regulator.**

The constant current regulators (CCR) must meet the requirements of FAA AC 150/5345-10, L-828 regulator without monitoring or L-829 regulator with monitoring.

1.17.1.1 Provide monitoring when the activity requests that level of control.

1.17.1.2 Series circuit cutout (S1) may be integral to the CCR.

1.17.1.3 Use ferro-resonant CCRs for Army and Air Force projects. Navy requires ferro-resonant CCRs on circuits with varying loads; e.g., flashing or wig-wag circuits are a large part of the load.

1.17.1.4 Size the regulators rated 10KW and above to match the connected load and with a 25% growth factor minimum. Taps on regulators are recommended to help match connected load with rated load and provide a means to accommodate load changes in the system.

1.17.1.4.1 Resistive Loads. In the range of 50 percent to 100 percent of the nominal load at rated input voltage, with output current at 100 percent, the efficiency and power factor should not be less than the values specified by FAA AC 150/5345-10 (efficiency not less than 80 percent; power factor not less than 0.90).

1.17.1.4.2 Reactive Loading. The regulator is required to maintain the current within the permitted tolerance for all current steps when the load is connected via isolation transformers and the secondary of 30 percent of these transformers become open-circuited (lamps are burned out). The load before opening the isolation transformers may be of any value between 50 percent and 100 percent of the nominal load.

1.17.1.5 Isolation of high voltage equipment (1000V or greater) from the low voltage equipment, either by construction when in the same location, or by separation within the regulator.

1.17.1.6 The doors for access to high voltage components within the regulator should be equipped with safety door interlocks that de-energize the regulator before access is gained, and prevent energizing with the door opened. The door should be fitted with an appropriate label, such as: DANGER HIGH VOLTAGE, DE-ENERGIZE SWITCH BEFORE OPENING THIS DOOR.

1.17.1.7 Design regulator cabinets for easy movement to facilitate installation (e.g., rollers or lifting rings) and should also have an additional ground terminal to connect cable shielding.

1.17.1.8 Readable wiring diagram, indicating all customer connection points, permanently mounted unobstructed in regulator.

1.17.1.9 Alarms, to be indicated on front of the unit:

- Indicator that an open-circuit trip-out has occurred.
- Indicator that an over current trip-out has occurred.
- Warning indicator that the selected current step is not within ±3 percent of the set current values.

1.17.1.10 Nameplate securely attached to the exterior of the regulator. If on a readily removable surface (such as a cover) the serial number should be duplicated elsewhere on the regulator in a conspicuous place. The nameplate must contain as a minimum the following:

Constant Current Regulator
Manufacturer's Name and Part Number:
Number of Current Steps: _____
Input : Volts _____ Hertz _____
Input Current at Full Load: _____
Remote Control Voltage: _____ Volts DC (or Volts AC)
Output: _____ kVA and KW at 6.6 (or 20) Amperes
Maximum Full Load Output Voltage: _____ Volts
Serial Number: _____

1.17.2 **Series Circuit Cutout.**

Installation of series circuit cutouts (S1) meeting the requirements of FAA AC 150/5340-30 is required, either integral to the CCR or separate, to allow isolation of the airfield lighting circuit from the regulator.

1.17.3 **Circuit Selector Switch.**

Comply with FAA AC 150/5345-5, L-847. For use when multiple circuits are connected to a single constant current regulator, or for preventing interconnecting two regulators on some installations that provide switching to a spare regulator. Input and control voltages must be selected. Options typically include status indication and cabinet type.

1.17.4 **Isolation Transformer.**

The following characteristics for L-830 (60 Hz) and L-831 (50 Hz) isolation transformers represent current products and improve quality over the minimum FAA standards:

- Minimum thickness of encapsulation: 5/16" (6.5 mm).
- Minimum power factor: 0.95 (at nominal resistive load and rated primary current).
- Maximum dielectric strength (hot and cold): 2 microamperes, with primary tested at 15 KVdc and secondary tested at 5 KVdc.
- All internal connections to be permanent (e.g., high-pressure crimping or high-pressure soldering).

1.17.5 **Runway and Taxiway Guidance Signs.**

The following are recommended for L-858 signs to limit impact on the CCR, and provide performance and safety benefits.

1.17.5.1 Maximum volt-ampere (VA), as measured at input to isolation transformer (if no limits are set for VA, many signs on a circuit can have significant effect on the CCR):

1 module, or 3 - 5-foot (1 - 1.5 meter) length -	150 VA
2 modules, or 5 - 7-foot (1.5- 2 meter) length -	250 VA
3 modules, or 8 - 12-foot (2.5 - 3.5 meter) length -	300 VA
4 modules, or 13+ foot (4+ meter) length -	400 VA

1.17.5.2 Power Factor - minimum 0.85 at all intensity steps.

1.17.5.3 External disconnect switch that shorts secondary of isolation transformer when switch is turned off.

1.17.5.4 Tethers - minimum 2 per sign.

1.17.5.5 Average luminance:

1.17.5.5.1 For average sign luminance values and methods employed to determine the values, see FAA AC 150/5345-44. Types L-858Y, L & R Sign, white or yellow legend or background: 10-30 footlamberts (34-100 cd/$m^{2)}$, with 16-30 footlamberts (55-100 cd/$m^{2)}$ at two highest intensity steps. The ratio of any two measurements on any part of the sign (yellow or white portion) must not be greater than 6:1.

1.17.5.5.2 Type L-858R Sign (mandatory): Ratio between message (white) and background (red) will not be more than 10:1 or less than 5:1.

1.17.5.5.3 Type L-858B Sign (RDR): 30-88 footlamberts (100-300 cd/$m^{2)}$ (white).

1.17.5.6 Compatible with all L-828/L-829 regulators. Sign manufacturer must assure that pulsed demand of sign will synchronize with pulsed output of regulator. Unacceptable synchronization may be evidenced by sign flickering, abnormal noises from regulator, failure to stabilize by 1 second after change of intensity steps, or spikes on the output current or voltage waveforms. The sign should not require field adjustment for proper operation following changes in circuit loading or regulator type. The sign manufacturer should analyze the regulator output waveforms to verify that signs will perform satisfactorily and without adversely impacting the regulator, at all load conditions from no- to full-load capacity.

1.17.5.7 Operation to be at any incoming current value of a series lighting circuit. Rated operating lamp life: Minimum 2,500 hours (when operated at highest intensity step).

1.17.6 **Computerized Control Systems.**

See FAA AC 150/5345-56 for details on modern control systems.

1.17.6.1 **Software.**

Windows 7 has been vetted by the Air Force for industrial control system security and is the only operating system approved for use by the Chief Information Officer of the Air Force.