U.S. Department
of Transportation

Federal Aviation
Administration

Advisory Circular

Subject: SPECIFICATION FOR DISCHARGE-TYPE FLASHING LIGHT EQUIPMENT

Date: 09/19/05 **Initiated by:** AAS-100

AC No.: 150/5345-51A **Change:**

1. PURPOSE. This advisory circular (AC) contains the specifications for discharge-type flashing light equipment to be used for runway end identification lights (REIL) and for an omni-directional approach lighting system (ODALS).

2. EFFECTIVE DATES. Effective six months after the issue date of this advisory circular, only equipment certified per the specifications herein will be listed per AC 150/5345-53, *Airport Lighting Equipment Certification Program.*

3. CANCELLATIONS. Advisory Circular 150/5345-51, Change 1, *Specification for Discharge-Type Flashing Light Equipment*, dated 01/04/82, is cancelled.

4. APPLICATION. The specifications contained in this AC are recommended by the Federal Aviation Administration (FAA) in all applications involving development of this nature. For airport projects receiving Federal funds under the airport grant assistance program, the use of these standards is mandatory.

5. PRINCIPAL CHANGES.

a. Added L-849V and L-859V to designate systems that can be operated from an airport 120/240 volt AC voltage source.

b. Added L-849I, and L-859I to designate systems that can be operated from a 6.6A constant current series circuit.

c. Expanded the criteria for control voltages.

d. Revised the lightning protection criteria.

e. Added a requirement for radiated and conducted emissions.

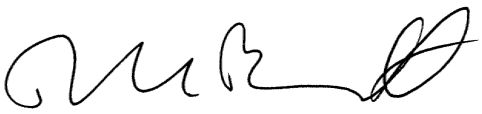
f. Upgraded environmental tests.

g. Due to availability problems associated with military temperature range components, changed the low temperature requirement to accommodate more commonly available industrial temperature range commercial integrated circuits and semiconductors.

h. Added a table to correlate equipment brightness levels with constant current regulator current steps.

i. Deleted the requirement for Sand and Dust environmental testing.

6. METRICS. To promote an orderly transition to metric units, this AC contains both English and metric dimensions. The metric conversions may not be exact metric equivalents, and, until there is an official changeover to the metric system, the English dimensions will govern.



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Director of Airport Safety and Standards

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1. SCOPE AND CLASSIFICATION.

1.1 Scope.

The flashing light equipment in this specification is used for runway end identification lights (REIL) and for an omni-directional approach lighting system (ODALS).

1.2 Classification.

Four types and six styles of flashing light equipment are in this specification.

1.2.1 Types.

L-849V – REIL powered by airport voltage power source

L-849I – REIL powered by constant current 6.6 A power supply

L-859V – ODALS powered by airport voltage power source

L-859I – ODALS powered by constant current 6.6 A power supply

1.2.2 Styles.

A - Unidirectional, high intensity, one brightness step.

B - Omni-directional, high intensity, one brightness step.

C - Unidirectional, low intensity, one brightness step.

D - Omni-directional, low intensity, one brightness step.

E - Unidirectional, three brightness steps.

F - Omni-directional, three brightness steps.

All styles apply to Type L-849, only Style F applies to Type L-859.

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2. REFERENCED DOCUMENTS.

2.1 General.

The following is a listing of documents referenced in this document.

2.1.1 Federal Aviation Administration (FAA) Publications.

2.1.1.1 FAA Advisory Circulars.

AC 150/5345-10	*Specification for Constant Current Regulators Regulator Monitors*
AC 150/5345-43	*Specification for Obstruction Lighting Equipment*
AC 150-5345-47	*Specification for Series to Series Isolation Transformers for Airport Lighting Systems*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*

2.1.1.2 FAA Drawing.

C-6046	*Frangible Coupling, Type 1 and 1A, Details*

2.1.1.3 FAA Specifications.

FAA-G-2100	*Electronic Equipment, General Requirements*
FAA-E-1100	*Photometric Test Procedures for Condenser Discharge Lamps*

2.1.2 Military and Federal Publications.

2.1.2.1 Military Specification and Standard.

MIL-C-7989	*General Specification for Light-transmitting Cover for Aeronautical Lights*
MIL-STD-810	*Environmental Engineering Considerations and Laboratory Tests*

2.1.2.2 Federal Standard.

FED-STD-595	*Colors Used in Government Procurement*

2.1.2.3 Code of Federal Regulations (CFR).

Code of Federal Regulations (CFR)	*Title 47*, *Telecommunications*, Part 15, *Radio Frequency Devices*

2.1.3 Institute of Electrical and Electronics Engineers IEEE)/American National Standards Institute (ANSI) Publications.

IEEE C37.90	*Relays and Relay System Associated with Electric Power Apparatus*
IEEE C62.41	*IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits*
IEEE C62.45	*IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits*

2.1.4 National Electrical Manufacturers Association (NEMA) Publication.

NEMA 250	*Enclosures for Electrical Equipment (1,000 Volts Maximum)*

2.1.5 Powder Coating Institute (PCI) Publication.

PCI	*Powder Coating - The Complete Finisher's Handbook, 3rd edition.*

2.1.6 Illuminating Engineering Society of North America (IESNA) Publication.

IESNA *IESNA Handbook* (Document no. IESNA HB-9-2000)

2.1.7 International Standardization Organization (ISO) Publication.

ISO-10012 *Measurement Management Systems – Requirements for Measurement Processes*

Copies of FAA advisory circulars may be obtained from:

U.S. Department of Transportation
Subsequent Distribution
Office Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785

Tel: (301) 322-4961
FAX: (301) 386-5394
Website: www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars/

Copies of military standards and specifications publications may be obtained from:

DAPS/DODSSP
Building 4, Section D
700 Robbins Avenue
Philadelphia, PA 19111-5094

Tel: (215)697-2179
FAX: (215)697-1460
Website: dodssp.daps.dla.mil

Copies of Federal specifications and standards may be obtained from:

Federal Supply Services
Specification Section
470 L'Enfant Plaza East
SW Suite 8100
Washington, DC 20407

Tel: (202) 619-8925
FAX: (202) 619-8985
Website: www.dsp.dla.mil

Copies of Code of Federal Regulations (CFRs) may be obtained free of charge from:

Website: www.gpoaccess.gov

Copies of International Electrical and Electronics Engineers standards may be obtained from:

IEEE Customer Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331

Tel: (800) 678-4333
FAX: (732) 981-0060 *(Worldwide)*
FAX: (732) 981-9667
E-mail: storehelp@ieee.org
Website: shop.ieee.org/ieeestore

Information about obtaining National Electrical Manufacturers Association (NEMA) publications can be obtained from:

NEMA
1300 North 17th Street
Suite 1847
Rosslyn, VA 22209

Tel: (703) 841-3286
FAX: (703) 841 3386
Website: www.nema.org

Copies of Powder Coating Institute documents may be obtained from:

PCI Publications
2121 Eisenhower Avenue
Suite 401
Alexandria, VA 22314

Tel: (800) 988-COAT
FAX: (703) 684-1711
Website: www.powdercoating.org

Copies of Illuminating Engineering Society of North America documents may be obtained from:

IESNA
120 Wall Street, Floor 17
New York, NY 10005

Phone: (212) 248-5000
FAX: (212) 248-5017/18
Website: www.iesna.org

Copies of the International Standardization Organization document is available online from:

Website: www.iso.ch

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3. EQUIPMENT REQUIREMENTS.

3.1 Equipment to be Supplied by the Manufacturer.

Each system must include the following items:

a. Control Unit - one per system.

b. Optical Assembly:

(1) Two optical heads for Type L-849I/V systems.

(2) Seven optical heads for Type L-859I/V systems.

c. Power supply (as required for each system).

d. Instruction manual - one per system.

3.1.1 Connecting Cables.

Cables for connecting between the control unit and optical assemblies or between the optical head and power supply when installed remotely (paragraph 3.5.2) are not included in this specification. However, the instruction manual must provide sufficient information to guide the installer in selecting the proper cables.

3.2 System Description.

The REIL system is used to identify the threshold (approach end) of a visual or instrument non-precision runway and provides guidance to pilots during approach for landing. The REIL consists of two uni-directional or omni-directional simultaneous discharge-type flashing lights. A light is located at each side of the runway threshold.

The ODALS system uses seven omni-directional discharge-type flashing lights, five of which are installed on an extended runway centerline. The lights flash in sequence and appear as a ball of light traveling toward the runway threshold. This aids the pilot in determining which runway is in use. In addition to the five centerline lights, two lights are installed in a REIL configuration. The two REIL system lights flash simultaneously after the last flash of the centerline lights.

3.3 Environmental Requirements.

The equipment must be designed for outdoor operation in the following environmental conditions:

a. Temperature: The equipment must operate at temperatures from (–40 to +131 degrees Fahrenheit (F) (–40 to +55 degrees Celsius (C)).

b. Altitude: The equipment must operate at altitudes from sea level to 10,000 feet (3,000 meters).

c. Temperature Shock: The equipment must operate and not be damaged by the sudden application of cold water to the light emitting surface of an optical assembly at its normal operating temperature.

d. Humidity: The equipment must operate at a relative humidity of up to 100 percent, including conditions of dew or frost.

e. Salt spray: The equipment must operate when exposed to a salt laden atmosphere.

f. Rain: The equipment must operate when exposed to windblown rain.

g. Wind: The equipment must not be damaged when exposed to wind velocities of 150 knots (278 kilometers per hour).

h. Solar Radiation (Sunshine): If any non-metallic exterior components or plastic/thermoplastic lenses are used, they must be resistant to solar radiation.

3.4 Photometric Requirements.

3.4.1 Effective Intensity.

The optical assemblies must meet the effective intensity requirements listed in Table 1 with a tolerance of plus or minus 50 percent for the following beam patterns:

a. Styles A, C, and E: 10 degrees vertical by 30 degrees horizontal.

b. Styles B, D, and F: from 2 to 10 degrees vertical by 360 degrees horizontal.

The effective intensity must be maintained when the equipment is operated within plus or minus 10 percent of the design input voltage or when operated at the design input voltage and subjected to the temperature range per paragraph 3.3a. Light output below the vertical cutoff points must be minimized.

Table 1. Effective Intensity Requirements

Type	Style	Effective Intensity (candelas (cd)) Brightness Step		
		High	Medium	Low
L-849	A	15,000	--	--
L-849	B	5,000	--	--
L-849	C	--	--	700
L-849	D	--	--	700
L-849	E	15,000	1,500	300
L-849	F	5,000	1,500	300
L-859	F	5,000	1,500	300

NOTE: *For styles A, C, and E, corners may be rounded on a 5-degree radius to determine compliance.*

c. The effective intensity for flashing lights must be determined with the following formula by the methods described in the IESNA Handbook.

$$I_e = \left(\int_{t_1}^{t_2} Idt \right) / \left(0.2 + \left(t_2 - t_1 \right) \right)$$

Where:

I_e = Effective intensity (Candela)

I = Instantaneous intensity (Candela)

t_1, t_2 = Times in seconds of the beginning and end of that part of the flash when the value of I exceeds I_e. This choice of the times maximizes the value of I_e.

d. If multiple pulses are used to form what is apparent to an observer as a single flash, see AC 150/5345-43E, paragraph 3.4.1.1, for additional descriptions and effective intensity measurement methods.

3.4.2 Flash Rate, Type L-849.

a. For L-849V/I Style B, D, and F: the flash rate must be 60 flashes per minute (fpm) plus or minus 10 percent.

b. For L-849V/I Style A, C, and E: the flash rate must be 120 flashes per minute plus or minus 10 percent.

c. Both optical assemblies must flash simultaneously with no more than 20 milliseconds of difference between them.

3.4.3 Flash Rate, Type L-859.

a. The optical heads must flash at a rate of 60 fpm, 10 percent tolerance.

b. The flash sequence must start with optical assembly located farthest from the runway threshold. The remaining assemblies must flash in sequence toward the runway threshold.

(1) The interval between flashes of the projected runway centerline units must be 1/15 second.

(2) The interval between the flash of the last runway centerline optical assembly and the simultaneous flashes of the REIL configuration must be 4/15 second.

c. The interval between the REIL configuration flash and the start of a new cycle must be 7/15 second.

d. All flash intervals must be within 10 percent of the specified time.

3.4.4 Color of Light.

The color of light emitted by the optical head assemblies must be equivalent to that produced by an unfiltered xenon gas discharge lamp (approximately 4,000-8,000 degrees Kelvin).

3.5 Equipment Design Requirements.

3.5.1 General Operating Requirements.

a. The discharge-type flashing light systems must be capable of for continuous operation.

b. Style E and F equipment must have three intensity settings: high, medium, and low.

c. All systems must have provisions for remote control per paragraph 3.5.4.2

d. Lamp intensity changes must be completed within 1.50 seconds after initiating the command.

e. The power input to the optical assembly may be interrupted during intensity step changes.

f. The system design must prohibit the occurrence of flashes other than per paragraphs 3.4.2 and 3.4.3.

3.5.2 Optical Assembly.

a. The optical assembly consists of an optical head and a power supply.

b. The Type L-849 optical head must be attached to the power supply enclosure.

c. Type L-859 optical heads must be capable of being attached to the power supply enclosure or installed remotely up to 150 feet (45 m) from the power supply.

d. Brackets must be provided for mounting the optical head directly to the power supply enclosure or onto a single vertical 2-inch Electrical Metallic Tubing (EMT) conduit for remote locations.

e. The Type L-859 optical head must weigh no more than 12 pounds (5.5 kg).

f. When installed, the overall height of the Type L-849 optical assembly must not exceed 34 inches (0.85 m) above grade.

g. Frangible mounting hardware per FAA Drawing C-6046 (or equivalent) must be provided for Type L-849 optical assemblies and for Type L-859 optical heads mounted on 2-inch EMT conduit.

3.5.2.1 Flash Tube.

The flash tube must operate without failure or adjustment for a minimum of 1,000 hours while meeting the flash rates and high intensity requirements per paragraph 3.4.1. The effective intensity must not decrease more than 30 percent during this time period and flash skipping (misfiring) must be less than one percent with no skips occurring consecutively.

3.5.2.2 Power Supply.

The power supply provides power and triggering pulses to the optical head.

a. A power supply may power more than one optical head assembly.

b. The power supply must be designed to operate safely and reliably with the voltages and amperages required and with safety features consistent with those required for the control unit.

c. The power supply must be housed in a National Electrical Manufacturers Association (NEMA) type 4 (or equal) enclosure with a hinged access door and provision for padlocking.

d. Frangible points per FAA Drawing C-6046 (or equivalent) and associated hardware must be provided to mount the power supply enclosure on its foundation

3.5.2.3 Aiming and Leveling.

a. Style A, C, and E optical heads must be designed so the light beam may be aimed in a vertical and horizontal plane.

b. A positive locking device must be provided to prevent accidental movement of the optical head after aiming.

c. The optical head must be adjustable vertically from 0 to 15 degrees and horizontally 15 degrees each side of a zero reference point.

d. Aiming reference scales must be graduated in a maximum of one degree increments.

e. Style B, D, and F optical heads must have provisions to permit adjustment, after installation, of up to 6 degrees for leveling.

3.5.3 Control Unit.

The control unit powers and controls the individual optical assemblies.

NOTE: *At the manufacturer's option, the control unit may be integrated into a power supply enclosure; however, the following requirements must still be met with regard to any power supply/control unit.*

a. The control unit must be designed to operate from a 120/240 volt AC source or optionally from other standard commercial voltages.

b. The control unit must be housed in a NEMA type 4 enclosure (or equal) with a hinged door and have provisions for padlocking.

c. Terminal blocks with a suitable voltage rating must be located near the side or bottom of the enclosure for termination of external power and control wires feeding into the control unit. The terminal blocks must accommodate No. 8 through No. 20 American Wire Gauge (AWG) wires with an insulation rating up to 600V.

d. Mounting lugs or bolts must be provided on the back of the enclosure to allow vertical mounting.

e. If the control unit is not integrated with the power supply, frangible points per FAA Drawing C-6046 (or equivalent) and associated hardware must be provided to mount the control enclosure on its foundation.

f. A service entrance power disconnect switch must be furnished when utilizing either a voltage or constant current power source.

g. If the disconnect switch is mounted external to the control unit enclosure, it must be weatherproof and have provisions for locking.

h. A ground terminal must be provided on the outside of the control unit enclosure.

3.5.3.1 Elapsed Time Meter.

The manufacturer may optionally offer elapsed time meters in either L-849 or L-859 power supply assemblies.

a. The meter elapsed time must be in hours up to 999.

b. The meter must be a recycling type.

3.5.3.2 Series Circuit Adapter

An optional adapter may be provided to allow the discharge-type lighting system to be powered by an airport series lighting circuit (that may or may not have other types of lighting on the same circuit) which is energized by a constant current regulator as described in AC 150/5345-10, *Specification for Constant Current Regulators Regulator Monitor*. When the runway edge lights are on, the discharge-type lighting equipment must be on.

a. The circuit adapter must be compatible with series to series isolation transformer per AC 150/5345-47, *Specification for Series to Series Isolation Transformers for Airport Lighting Systems.* The input to the isolation transformer will be either from a 6.6 or 20 ampere series lighting circuit. The output of the transformer must be 6.6A to the series lighting circuit adapter. The manufacturer does not supply the isolation transformer or any associated cabling.

b. The discharge-type lighting system must operate and be compatible with all approved constant current regulators. A series circuit adapter must provide ON/OFF control of Type L-849I, Styles A,B,C, and D single intensity equipment depending on the current level in the runway lighting circuit. For Type L-849I Styles E and F and Type-L859 Style F three intensity level equipments, see Table 2 to correlate regulator current steps with discharge-type lighting equipment brightness levels.

c. The series circuit adapter circuitry may be incorporated into the control unit or housed in a separate enclosure. Any separate enclosure must pass all the environmental tests in this specification.

d. Approved regulator manufacturers (listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program*) will make available oscilloscope photographs or digital images (e.g., JPG, TIF, BMP) of the output waveforms of their regulators; the manufacturer of the flashing light equipment is responsible for any lack of compatibility.

Table 2. Constant Current Regulator (CCR) Settings and Discharge Lighting Equipment Intensity Levels

Runway Lighting Circuits	CCR Current	Discharge Lighting Equipment Intensity Level
Medium Intensity Runway Lighting	3 Step Regulator (6.6 Amps (A))	
	6.6 (A)	High Intensity
	5.5 A	Medium Intensity
	4.8 A	Low Intensity
High Intensity Runway Lighting (6.6A)	5 Step Regulator (6.6 A)	
	6.6 A	High Intensity
	5.2 A	High Intensity
	4.1 A	Medium Intensity
	3.4 A	Low Intensity
	2.8 A	Low Intensity
High Intensity Runway Lighting (20 A)	5 Step Regulator (20 A)	
	20.0 A	High Intensity
	15.8 A	High Intensity
	12.8 A	Medium Intensity
	10.3 A	Low Intensity
	8.5 A	Low Intensity

3.5.4 System Control.

3.5.4.1 Local Control.

All discharge-type lighting systems must have a local control capability located in the control unit for maintenance purposes. For equipment Styles A, B, C, and D, a three position switch must be per Table 3.

Table 3. Single Intensity Switch Functions

Switch position	Switch Function
REMOTE	System controlled by remote control (ON/OFF/Intensity)
ON	System ON
OFF	System OFF

For equipment Styles E and F, the switch must be a five position rotary switch with mechanical detents, labeled as follows to perform the indicated functions per Table 4.

Table 4. Three Intensity Switch Functions

Switch position	Switch Function
REMOTE	System controlled by remote control (ON/OFF/Intensity)
OFF	Power and control circuits de-energized
LOW	System operating at LOW intensity flash
MEDIUM	System operating at MEDIUM intensity flash
HIGH	System operating at HIGH intensity flash

3.5.4.2 Remote Control.

a. The Control Unit for Types L-849V and L-859V must have provisions for remote control by a switch or by a radio receiver/decoder unit. The operating voltage for the remote control system must not exceed 120 volts AC or plus 48 volts DC and is applied only when the local control is in the REMOTE position.

b. For single intensity discharge-type lighting systems (Styles A, B, C, and D), ON/OFF control is provided via 3 terminals (120 volts AC or plus 48 volts DC, ON, and Neutral).

c. For three intensity discharge-type lighting systems (Styles E and F), five terminals must be provided for control, as follows:

(1) Low Intensity

(2) Medium Intensity

(3) High Intensity

(4) 120 volts AC or plus 48 volts DC

(5) Neutral

3.5.4.2.1 Intensity-Step Switching.

a. A 120-volt AC or plus 48 volts DC source terminal fused for a 150-watt load shall be provided to activate the remote-control switching network.

b. For single-step style systems, the remote switch will close a circuit between the 120-volt or plus 48 volt DC source and an “on” terminal; the system will turn on when this terminal receives the 120-volt AC or plus 48 volt DC potential.

c. For multiple-step systems, the 120-volt AC or plus 48 volts DC potential (terminal (4)) is provided only when the local control switch is in the “remote” position.

d. The remote switching network will return the 120-volt AC or plus 48 volts DC potential to terminal (1), (2), or (3), and the system will turn on to the selected intensity.

e. If more than one intensity terminal is energized, the system shall operate at the highest intensity selected.

3.5.5 Circuit Design.

The circuit design and construction must be in accordance with highest standards, with emphasis on reliability and long life. The brightness control circuit must be designed such that it will revert to the lowest brightness setting in the event of failure.

3.5.6 Electrical Protection.

The system must be protected against electrical transients found in the airport environment as described below.

3.5.6.1 Transient Suppression.

To protect against input power line surges, the system must withstand without operational interruption or damage a 50-millisecond pulse with a peak value of 500 volts superimposed on the input power lines.

3.5.6.2 Dielectric Protection.

When installed in an operational environment per the manufacturer's instructions, the system must withstand repeated applications of a 5,000 volt potential between the equipment case (electrical ground) and any control or power conductor for 10 milliseconds.

3.5.6.3 Lightning Protection.

a. Lightning arresters must be installed on all ungrounded conductors as near as possible to their cabinet entry point.

b. The arrester's spark-over voltage must be less than the unit's dielectric withstand rating (paragraph 3.5.6.2). Telephone or gap-type arresters must not be used.

3.5.6.4 Radiated and Conducted Emissions.

a. The discharge light system must cause minimal conducted emissions (power lines/interface cables) and radiated RF emissions that may cause harmful interference to FAA or other airport equipment located on or near the airport (see paragraph 4.2.7 for measurements).

b. Discharge lighting equipment is classified as an incidental radiator (47 CFR § 15.13). This applies to equipment that does not intentionally generate any radio frequency energy, but may create such energy as an incidental part of its intended operations.

c. A discharge lighting system must employ sound engineering practices to minimize the risk of harmful interference. Since the equipment is operated in an environment where radiated RF and conducted emissions are a concern, both the conducted and radiated limits must be tested.

3.5.6.5 Electromagnetic Interference (EMI).

EMI sensitive components, such as timers or controllers, must be adequately shielded or otherwise protected.

3.5.6.6 Interlock Switches.

a. Interlock switches must be used in the control unit and power supplies so that opening the enclosure will:

(1) Disconnect the input power.

(2) Safely discharge all voltages over 150 volts to 50 volts within 30 seconds. This discharge must occur, even if components that normally draw current from the high voltage power supply are removed.

(3) Means must be provided to defeat the interlock with the door open for maintenance purposes.

b. The system design must include bleeder resistors to discharge the high voltage (>150V) power supply to 50 volts within 5 minutes after input power is disconnected. This feature must serve as a back-up to the interlock activated bleeder circuit.

c. If an interlock is not provided on an optical assembly, a warning label must be attached advising the maintainer not to open the optical assembly until the system power has been disconnected and the high voltage power supply is safely discharged.

3.6 Material and Parts.

a. All materials and parts used in the discharge lighting system must be suitable for the intended purpose and adequately protected against corrosion.

b. All assembly hardware, including screws, bolts, nuts, washers, and latches must be 18-8 stainless steel.

c. All wiring and components must have adequate capacity and must not be operated in excess of the manufacturer's ratings.

3.6.1 Light Covers.

a. Light transmitting covers for the optical head assembly must be per MIL-C-7989B (8 March 1971), paragraph 1.2, Class A for glass and Class D for plastic. The light transmitted by the covers must not be noticeably different in chromaticity from the illuminant.

b. If plastic or thermoplastic light transmitting covers are used, they must withstand prolonged exposure to ozone and ultraviolet radiation with no degradation.

3.6.2 Gaskets.

a. Gasket material used must withstand temperatures from –40 to +131 degrees F (–40 to +55 degrees C).

b. Gasket materials used in the optical head assembly must withstand prolonged exposure to ultraviolet radiation and ozone with no degradation.

3.6.3 Special Component Requirements.

a. All materials and components (including the insulation on wiring) which are located in or near the optical head assembly must be resistant to ultraviolet radiation and ozone.

b. Flash capacitors must be suitable for the application and have a service life greater than 1 year in continuous operation at the working voltage.

3.7 Finish.

a. The exterior of all units must be painted with 3 coats of aviation orange paint, matching color No. 12197, FED-STD-595.

b. Interior surfaces must be painted white.

c. Painting must be done per FAA-STD-012.

d. Nonferrous enclosures will not require painting if the exterior material color matches aviation orange; otherwise the exterior surfaces must receive the 3 coats of paint.

e. Powder coatings with equivalent color, appearance, and corrosion protection properties may be substituted for paint. See Powder Coating Institute publication: *Powder Coating - The Complete Finisher's Handbook*, 3rd edition, for guidance about the selection, application, and corrosion resistance.

3.8 Assembly and Marking.

a. All components must be properly assembled and marked.

b. Each electrical component or part thereof must be identified by a reference designation marked adjacent to the physical location of the part of the equipment and readily visible to maintenance personnel.

c. Identification markings must be identical to reference designations used in instruction books for the equipment.

d. All wiring must, where possible, be grouped, color coded, laced into cables, neatly clamped, and properly marked.

e. Wire marking must be per FAA-G-2100g, paragraph 3.3.1.3.10.2

3.9 System Nameplates.

Identification data must be permanently affixed to each equipment unit (optical head, power supply, control unit, etc.) and must contain at least the following information:

a. Name of unit (optical head, power supply, etc.).

b. Type and style.

c. Manufacturer's name and address.

d. Manufacturer's part Number.

3.10 Instruction Manual.

An instruction manual must be supplied as part of each system and must contain the following information:

a. Safety precautions used while maintaining the equipment.

b. Theory of circuit and system operation.

c. Complete schematics and interconnecting wiring diagrams.

d. Complete parts list with each circuit component keyed to the designation assigned on schematics or wiring diagrams. Complete information shall be given for each part to permit ordering for replacement purposes. This information shall include the component's rating, name of the manufacturer, and the manufacturer's part number.

e. Recommended preventive maintenance.

f. Troubleshooting procedures.

g. Physical characteristics (weight, size, mounting dimensions).

h. Installation instructions.

i. Operating instructions.

4. EQUIPMENT QUALIFICATION REQUIREMENTS.

4.1 Qualification Requirements.

4.1.1 Qualification Request.

Procedures for qualifying equipment to be furnished under the Federal grant assistance program for airports are contained in AC 150/5345-53B, *Airport Lighting Equipment Certification Program*, Appendix 2.

4.2 Test Procedures.

The environmental tests specified in the following paragraphs must be conducted on a system (a control unit and at least one optical assembly). Operational tests required during or after environmental tests per the particular test methods must consist of a least one operational cycle per paragraph 4.2.14 with all test components connected together.

Where tests are conducted on an abbreviated system (a system without a complete complement of optical assemblies), the load imposed by the missing components and their interconnecting cables must be simulated by equivalent circuits.

A photometric test as described in this section must be performed before conducting any environmental tests. The same units must be used throughout the tests.

4.2.1 Altitude Test.

The equipment must be tested for low pressure (altitude) per MIL-STD-810F (1 January 2000), Method 500.4, Procedure II, Operation/Air Carriage.

a. The maximum altitude must be 10,000 feet (2,000 meters).

b. The maximum chamber ambient air temperature must be 131 degrees F (55 degrees C).

c. Allow the equipment to temperature stabilize.

d. Perform an operational test of the equipment after one hour of altitude and high temperature soak. Failure of the equipment to operate properly will be cause for rejection.

e. After the test chamber has depressurized and cooled, examine the equipment components for evidence of discoloration, cracking, or swelling. Any deterioration of materials will be cause for rejection.

4.2.2 Thermal Shock Test

The equipment must be installed as in normal use and operated at maximum intensity until the temperatures have stabilized. At a temperature between 32-41 degrees F (0-5 degrees C), water must be applied in droplets, having a diameter range between 0.5 and 4.5 millimeters, to the light face. There must be no cracking of glass, metal, or plastic as a result of this test.

4.2.3 Humidity.

The equipment must be tested for humidity tolerance per MIL-STD-810F (1 January 2000), Method 507.4, Humidity.

a. The chamber maximum temperature must be 131 degrees F (55 degrees C) maximum for this test.

b. Subject the equipment to five cycles (48 hours per cycle) at 95% relative humidity at a maximum temperature per paragraph 4.2.1.4a. See MIL-STD-810F (1 January 2000), Figure 507.4-1 for a graph of humidity cycles. Perform an equipment operational test at hour 24 of the test cycle.

c. At the conclusion of testing, inspect the equipment and components. Any evidence of water (condensation), corrosion, discoloration, swelling, or cracking will be cause for rejection.

4.2.4 Rain Test.

a. The rain test must be conducted per Method 506.4, Procedure I, paragraph 4.4.2 of MIL-STD-810F (1 January 2000).

(1) A simulated rainfall rate of 4 inches per hour or 1.7 millimeters per minute must be used.

(2) Wind velocity must be 40 miles per hour or 18 meters per second.

(3) The EUT must be at ambient temperature for this test.

b. Perform an operability test of the equipment under test (EUT) prior to the rain test.

CAUTION: *Perform a preliminary inspection before energizing the equipment to remove any accumulated water and prevent a potential shock hazard to test personnel*.

c. At the conclusion of rain testing and after a preliminary inspection for water intrusion, perform an operational test of the equipment.

d. If the EUT fails to operate or water has penetrated the equipment, it is a cause for rejection.

NOTE: *If the housing is ventilated, small amounts of water may penetrate the equipment during this test but must not be cause for rejection. Water penetration must not prevent proper operation of the equipment, and a path of egress for the water must be provided.*

4.2.5 Wind.

An optical head mounted to a power supply enclosure and one mounted to a 2-inch EMT conduit must be subjected to a 150-knot wind applied perpendicular to the optical head face. Distress or damage to any part of the assembly must be cause for rejection.

4.2.6 Salt Fog Test.

a. A salt fog test must be conducted to determine the discharge lighting equipment resistance to a salt laden atmosphere. Tests must be conducted per MIL-STD-810F (1 January 2000), Method 509.4, Salt Fog, Paragraph 4.5.2, Procedure I.

b. At the conclusion of salt fog testing, inspect the EUT for evidence of corrosion, flaking paint/powder coating, gasket failure, and in enclosed volumes for water damage where condensation may have occurred. Any evidence of the preceding will be cause for rejection.

c. Inspect circuit boards and components for evidence of corrosion, swelling, or discoloration. Any evidence of the preceding will be cause for rejection.

CAUTION: *Energize the EUT only after it has been determined there will be no shock hazard.*

d. Energize the EUT and perform an operational test. Failure of the equipment to operate properly will be cause for rejection.

4.2.7 Radiated and Conducted Emissions Tests.

a. The discharge lighting equipment must be in its normal operating configuration for the following tests.

b. The equipment tested must not exceed the conducted power line emissions per 47 CFR § 15.107b:

Table 5. Conducted Emission Limits

Frequency of Emission (MHz)	Quasi-peak Emissions Decibels per microvolt dB/μV	Average Emissions dB/μV
0.15 - 0.5	79	66
0.5 -30.0	73	60

c. The equipment tested must not exceed the radiated emission limits per 47 CFR § 15.109b for the following limits at 33 feet (10 meters):

Table 6. Radiated Emission Limits

Frequency of Emission (MHz)	Field Strength (microvolts per meter)
30-88	90
88-216	150
216-960	210
Above 960	300

d. If the equipment is not per the limits in paragraph 4.2.7b and c, the manufacturer must be advised that there is a potential for harmful interference with the operation of FAA or other airport equipment.

4.2.8 Transient Suppression Test.

The control unit and one optical assembly shall be tested for conformance to the requirements specified in 3.5.6.1. The test method shall be developed using IEEE C37.90 as a guide.

4.2.9 Solar Radiation (Sunshine) Test.

The equipment must be in its normal operational configuration for this test.

a. A sunshine test must be conducted in accordance with MIL-STD-810F (1 January 2000), Method 505.4, paragraph 4.4.3, Procedure II for all discharge lighting equipment with nonmetallic exterior parts or plastic/thermoplastic light covers.

b. The discharge lighting equipment must be subjected to a minimum of 56 cycles.

c. Perform an operational test of the equipment after 56 cycles.

d. Any evidence of deterioration of plastic parts: chalking, bleaching, cracking, hazing, or color changes (yellowing) to the thermoplastic lenses of the test unit must be causes for rejection.

e. For plastic/thermoplastic optical lenses or covers, the photometric performance must be measured after this test.

4.2.10 Visual Inspection.

The equipment must be visually inspected for workmanship, fabrication, finish, painting, and adequacy of selected parts.

4.2.11 Photometric Tests.

Photometric tests must be conducted on equipment to determine compliance with 3.4. Photometric tests must be conducted per FAA-E-1100, *Photometric Test Procedures for Condenser Discharge Lights.* Test results must include a graph showing the isocandela curve of effective intensity for each brightness

setting and oscilloscope photographs or digital image files (e.g., TIF, JPG, BMP) of the discharge pulse shape.

4.2.12 Dielectric Tests.

a. A dielectric test must be made on power and control wiring of the system.

b. The test must be made by applying both positive and negative 5kV pulses, 10 milliseconds minimum, between input power and control wires and ground (equipment case).

c. The test must continue until 10 pulses have been applied during a 10-second interval or until a 5kV DC voltage has been applied for 10 seconds.

d. The equipment must be capable of normal operation after this test.

e. After completion of the dielectric test, a 1,000-volt DC insulation tester must be used to check the same points.

f. The resistance to ground, as observed with the insulation tester, must not be less than 300 megohms.

g. Components not designed for the high voltage of the insulation tester such as capacitors, rectifiers, printed circuit boards, transient suppressors, etc., may be disconnected for this test.

h. Production units need only be checked with the insulation tester.

4.2.13 Lightning Protection Test.

NOTE: *The equipment might be damaged by the following tests, perform them only after all other testing is complete.*

a. Subject the equipment power line and control line inputs to 3 pulses at 15 second intervals to a standard 1.2/50 microsecond - 8/20 microsecond combination wave of 4,000 volts at 3,000 amps.

b. See IEEE C62.41-1991 Section 9.3 for test condition and test generator information.

c. See IEEE C62.41-1991 Section 9.4 for a detailed combination and ring wave generation and parameters discussion.

d. See also IEEE C62.45, *IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits* for guidance about equipment test methods.

4.2.14 Operational Test.

a. All components that will be part of a particular system must be connected together when undergoing operational tests.

b. For qualification testing, the components must be interconnected with the maximum length of interconnecting cable specified (paragraph 3.5.2c).

c. Proper operation of the interlock switches must be verified.

d. All operating requirements of the equipment must be checked over the full range of input voltage variations at the control unit power input terminal.

e. The brightness switching operation of the components must be verified through the remote control inputs provided in the control unit.

4.2.15 Eighty-hour Test.

An 80-hour continuous operation test must be performed on the system. All intensities must be checked using the remote control to cycle the system as described below, with a 10 percent tolerance on the time intervals specified.

a. Low Intensity - 5 minutes.

b. Off - 2 seconds.

c. Medium Intensity - 5 minutes.

d. Off - 2 seconds.

e. High Intensity - 5 minutes.

f. Off - 60 seconds.

g. Repeat Cycle, starting with a.

The local control switch must be manually cycled through the off, low, medium, and high intensity step positions a minimum of 20 times at the completion of the 80-hour test. Flashtubes used in the 80-hour test must not be shipped as part of the equipment but must be replaced with new flashtubes.

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5. PRODUCTION TESTS.

Production units must be subjected to the following tests:

5.1 Visual Inspection.

Per paragraph 4.2.10.

5.2 Photometric Tests.

a. Style A, C, and E production units shall be checked at the beam center, ± 15 degrees horizontally from the beam axis, and ± 5 degrees vertically from the beam axis.

b. Style B, D, and F production units shall be checked at 2, 6, and 10 degrees vertically for maximum and minimum points to determine compliance with 3.4.1.

5.3 Dielectric Test.

Per paragraph 4.2.12.

5.4 Operational Test.

Per paragraph 4.2.14.

5.5 Five-And-One-Half-Hour Test.

All production units must have a 5½-hour continuous operational test performed on them using the remote control inputs as follows:

a. High Intensity - 5 hours, minimum.

b. Per paragraph 4.2.15, cycle the equipment through steps a through g - one-half hour, minimum.

c. The local control switch must be manually cycled through the off, low, medium, and high intensity positions a minimum of 20 times at the completion of the 5½-hour test.

5.6 Failures.

Units failing any part of the production test must be repaired and undergo a complete retest per paragraphs 5.1 through 5.5.

5.7 Production Test Equipment.

All measuring and test equipment used in the production of discharge lighting equipment classified under paragraph 1.2 must have their accuracy and precision maintained by a calibration program with traceability to ISO-10012 *Measurement Management Systems – Requirements for Measurement Processes* or current industry accreditation criteria. The manufacturer must show that all production photometric testing equipment correlates to the certifying laboratory's equipment to within plus or minus 5 percent. Photometric testing must be performed in a properly designed photometric range using a calibrated photometer. All photometric measurements must be based on a minimum five flash average.

5.8 Production Test Records.

The manufacturer shall maintain records showing actual test results of all tests required by paragraphs 5.2 through 5.5 for a period of three years. These records shall be traceable to the units tested by serial number.

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