



AEROSPACE RECOMMENDED PRACTICE

ARP693™

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Superseding ARP693E

Landing and Taxiing Lights - Design Criteria for Installation

RATIONALE

This document covering older, established technology is stabilized. Refer to ARP6402 for updated guidance.

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FOREWORD

The recommendations set forth herein are the results of the combined efforts of engineers associated with the manufacture of lamps, equipment, and airframes, as well as engineers from the air transportation field and interested government agencies.

This SAE Aerospace Recommended Practice (ARP) does not include recommendations for the use of any specific equipment.

1. SCOPE

This document includes requirements of installations of adequate landing and taxiing lighting systems in aircraft of the following categories:

- a. Single engine personal and/or liaison type
- b. Light twin engine
- c. Large multiengine propeller
- d. Large multiengine turbojet/turbofan
- e. Military high-performance fighter and attack
- f. Helicopter

This document will cover general requirements and recommended practices for all types of landing and taxi lights. More specific recommendations for LED lights in particular can be found in ARP6402.

1.1 Purpose

The purpose of this document is to provide certain basic considerations and design criteria for installation of landing and taxiing light systems for night operation. These recommendations can be used to provide criteria for adequate lighting for the FAA or other certifying authority.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP881 Lamps for Aircraft Lighting

ARP6402 LED Landing, Taxiing, Runway Turnoff, and Recognition Lights

AS580 Pilot Visibility from the Flight Deck Design Objectives for Commercial Transport Aircraft

SAE J1330 Photometry Laboratory Accuracy Guidelines

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

14 CFR Part 23.1383, Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes

14 CFR Part 25.1383, Airworthiness Standards: Transport Category Airplanes

14 CFR Part 27.1383, Normal Category Rotorcraft

14 CFR Part 29.1383, Transport Category Rotorcraft

14 CFR Part 121, Certification and Operations: "Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft"

Aeronautical Information Manual 4-3-23. Use of Aircraft Lights section c.

Federal Aviation Administration Advisory Circular AC 25-7A Flight Test Guide for Certification of Transport Category Airplanes

Federal Aviation Administration Advisory Circular AC 150 Airport design

2.1.3 U. S. Government Publications

Copies of these documents are available online at <http://quicksearch.dla.mil>.

MIL-L-6503 Military Specification, Lighting Equipment, Aircraft, General Requirements For

2.1.4 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

Radio Technical Commission for Aeronautics (RTCA) Document No. 160, Environmental Conditions and Test Procedures for Airborne Equipment

2.2 Other Publications

Available from <https://books.google.com>.

Forward Vehicular Lighting and Inclement Weather Conditions, John D. Bullough and Mark S. Rea, Rensselaer Polytechnic Institute. (Progress in Automobile Lighting 2001: Proceedings of the Symposium)

Photometric Indicators of Headlamp Performance, John M. Sullivan and Michael J. Flannagan, University of Michigan Transportation Research Institute. (UMTRI-2009-18)

2.3 Related Research

Available from U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870
http://www.aphis.usda.gov/wildlife_damage/nwrc/

Efficacy of Aircraft Landing Lights in Stimulating Avoidance Behavior in Birds - B. F. Blackwell and G. E. Bernhardt

Avian Visual System Configuration and Behavioural Response to Object Approach - B. F. Blackwell, E. Fernandez-Juricic, T. W. Seamans, and T. Dolan

2.4 Definitions

GLARE: Light within the visual field that is brighter than the level to which the eyes are adapted, thus reducing visibility, reducing contrast, annoying, causing discomfort, or distracting the observer.

HALATION: Scattering of a light beam beyond its proper boundaries, causing a bright ring or halo surrounding an object or beam of light.

RATED AVERAGE LABORATORY LIFE: Rated average laboratory life is the average life obtained when 50% of a statistically large group of the same lamps still survive in closely controlled life testing at their design voltage. Lamps are typically tested using 60 Hz AC voltage. DC operation of lamps may reduce lamp life on some lower current lamps. Rated average laboratory life is not necessarily the same as service life. Conditions such as mechanical shock, vibration, voltage fluctuations, and environmental extremes may result in shorter average attained life. Does not apply to LED based lamps as they use different methods to determine life (refer to ARP881).

HIGH INTENSITY DISCHARGE (HID or XENON): A light source using an electrical gas-discharge source which produces light by means of an electrical arc between two electrodes. The arc is contained within a quartz tube filled with a noble gas such as Xenon and a mixture of metallic salts. The salts are turned into a plasma by the arc and the particular mix of salts determines the emission spectrum of the lamp. HID lamps require a high voltage to create the arc, typically provided by an electronic ballast.

LIGHT EMITTING DIODE: A solid state light source using a semiconductor which emits light when excited by an electric current. Different semiconductor materials have different band gaps and produce very pure monochromatic light of different colors. The most common way of creating white light with an LED uses a blue diode covered with a yellow phosphor, but white light can also be created by combining several LED dies of different colors (i.e., red, green, and blue). LEDs require low voltages and a controlled current, which can be provided by a remote power supply or built into the light.

PAR: Parabolic Aluminized Reflector. Incandescent and halogen sealed beam lamps are often called PAR lamps, with a number following the PAR to indicate the diameter of the lamp. The number corresponds to the diameter in eighths of an inch. Hence, a PAR 36 lamp is 4.5 inches in diameter, and a PAR 64 lamp is 8 inches in diameter.

3. DETAILED RECOMMENDATIONS

3.1 Landing Lights

3.1.1 General Provisions

3.1.1.1 Landing lights are used primarily to provide ground reference information during final approach, touchdown, ground roll, and takeoff, and to illuminate any major obstructions in the airplane's approach glide path or on the runway at night.

3.1.1.2 Landing lights may also be used for signaling purposes in flight. The landing lights may be turned "on" when:

- a. Operating within 10 miles of any airport, day or night
- b. Operating in conditions of reduced visibility (i.e., haze, dust, etc.)
- c. Operating under special visual flight rules (VFR) conditions
- d. Operating where flocks of birds may be expected (coastal area, swamp lands, migratory areas, etc.)

This requires that all or some of the landing lights have the ability to be activated when the Landing gear and slats/flaps are retracted.

3.1.1.3 The federal aviation regulations (CFR Parts 23.1383, 25.1383, 27.1383, and 29.1383) contain the following general requirements for landing and taxi lights:

Each landing light should be designed and be installed such that:

- a. No objectionable glare is visible to the pilot.
- b. The pilot is not adversely affected by halation.
- c. It provides enough light for night landing.

The traditional way to provide lights for landing and taxiing involves mounting high-intensity halogen sealed beam lamps in various locations on the aircraft. With the advent of High Intensity Discharge (HID) and Light Emitting Diode (LED) lighting, designers now have more freedom to design lighting with different beam patterns, emission spectra, lifetimes, and maintenance characteristics. Because sealed beams have been used successfully for many years, Tables 1 and 2 are provided as guidance for typical lighting installations. If newer technology lighting will be used on an aircraft, the light pattern produced by the halogen technology can be used as a basis of comparison.

Table 1 - Lamps for landing service

NOTE: The lamps listed below represent typical industry standards for this type of installation. The peak intensity and beam spread values in the table are derived from the manufacturer's data sheets. Actual measured values often vary significantly from the data sheet numbers.

Lamp No ¹ .	Watts	Volts	Bulb	Rated Ave. Lab. Life (hours)	Initial Peak Intensity on Centerline (cd) ²	Nominal Horizontal Beam Spread to 10% of Peak Intensity (deg) ³	Nominal Vertical Beam Spread to 10% of Peak Intensity (deg) ³	Category See Section 1
4509	100	13	PAR-36	25	110000	12	6	a
Q4509	100	13	PAR-36	100	140000	3	3	a
4591	100	28	PAR-36	25	90000	12	6	a
4537	100	13	PAR-46	25	200000	11	6	a
4313	250	13	PAR-36	25	140000	16	7	a,b
4522	250	13	PAR-46	25	290000	12	10	a,b
4553	250	28	PAR-46	25	300000	11	12	a
4552	250	28	PAR-46	25	500000	7	8	b
4581	450	28	PAR-46	10	400000	13	14	b,e,f,
4559	600	28	PAR-64	25	600000	11	12	c,d,f
Q4559	600	28	PAR-64	100	600000	12	8	c,d,f
Q4559X	600	28	PAR-64	100	765000	11	7-1/2	c,d,f,
4556	1000	28	PAR-64	25	700000	12	13	c,d
Q4681	450	28	PAR-46	50	310000	15	9	c,d
4557 Land.	1000	28	PAR-64	25	540000	11	15	c,d
Taxi.	400	28	PAR-64	100	100000	25	11	c,d

NOTES:

1. The Lamp numbers refer to ANSI specifications and are not specific to any one manufacturer.
2. Due to manufacturing variations, the peak intensity may not be precisely on the axis of the lamp.
3. This is the full width from 10% of the peak on one side to 10% of the peak on the other side of the beam center (see Figure 4).

Minimum recommended number of landing lights required for night flying are listed in Table 2.

Table 2 - Recommended number of landing lights for different category airplanes

Airplane Categories	Minimum Number of Landing Lights
Single engine personal and/or liaison type (category a)	2
Light twin engine (category b)	2
Large multiengine propeller (category c)	3
Large multiengine jet propulsion (category d)	4
Military high-performance fighter and attack (category e)	2
Helicopter (category f):	
Retractable landing light	1
Searchlight (may be used as landing light)	1

NOTE: The recommended quantities listed in Table 2 refer to equipment installation only and should not be misinterpreted as quantities required for aircraft dispatch.

- 3.1.1.4 The landing lights should provide sufficient illumination of the runway for night landings. As a design objective, 21.5 lux (2 ft-c) minimum at 122 m (400 feet) in front of the pilot at touchdown attitude and 5.4 lux (0.5 ft-c) minimum at 91 m (300 feet) in front of the pilot during ground roll should be provided (see Figures 1 and 2). Lux (ft-c) levels are measured normal to the light beam. Aircraft-specific details should be considered when designing a landing light system. Although only a single illuminance value is mentioned, the purpose of a landing light system is to provide sufficient illumination over the entire runway surface out to a sufficient distance in front of the aircraft. Calculating or measuring an average illuminance over a desired illuminated area is one way of comparing performance between landing light systems (see Appendix C).

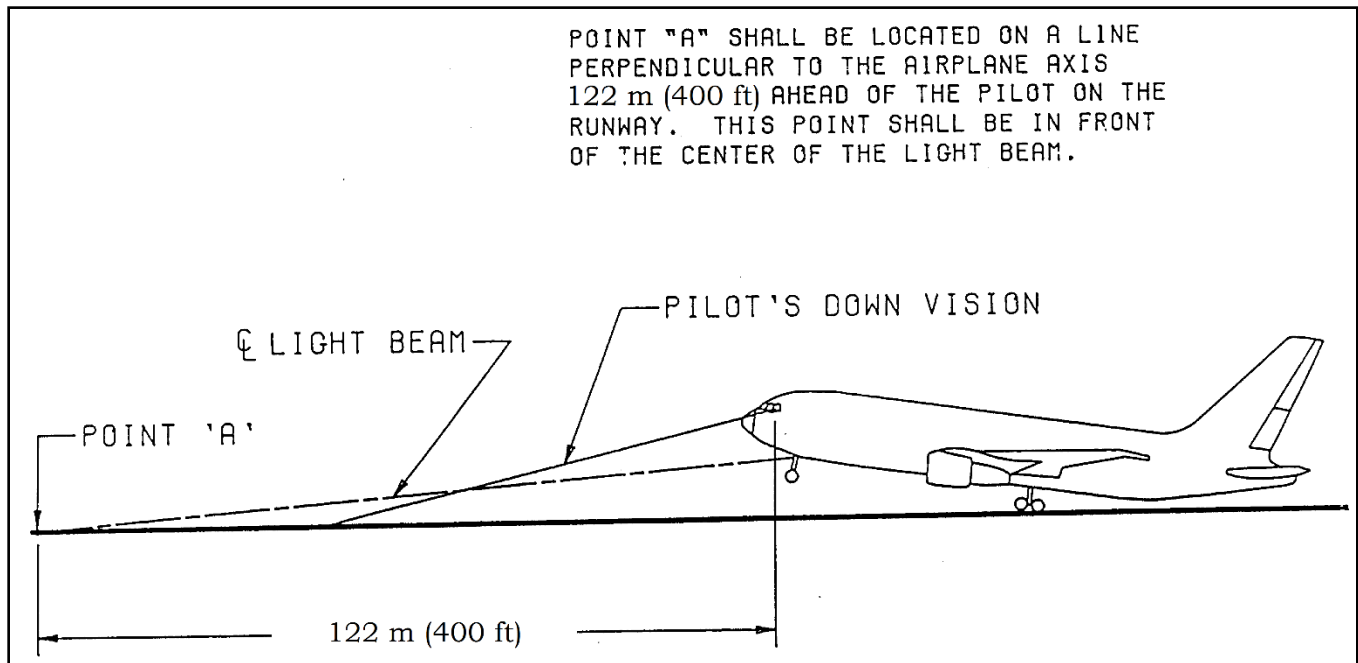


Figure 1 - Landing light at touch down attitude

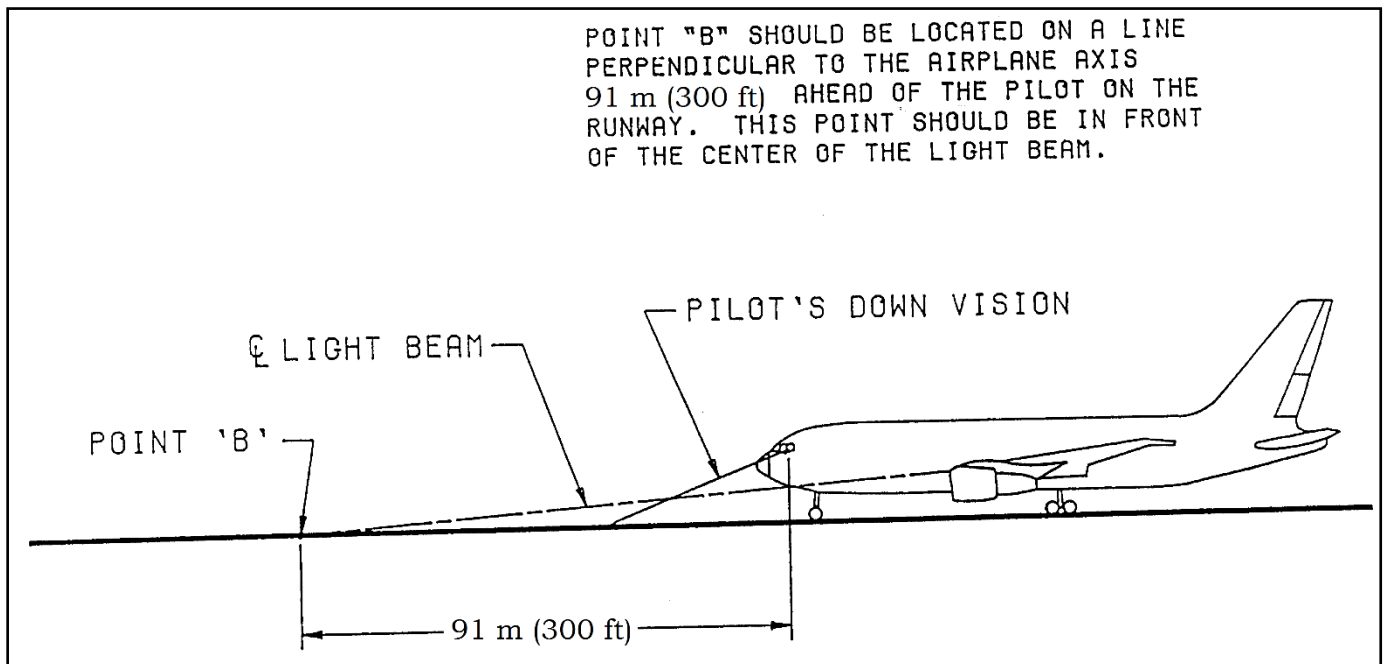


Figure 2 - Landing light at ground roll attitude