



AEROSPACE RECOMMENDED PRACTICE

ARP4103™**REV. B**

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Superseding ARP4103A

Flight Deck Lighting for Aircraft

RATIONALE

SAE Five-Year Review. This SAE Aerospace Recommended Practice (ARP) is revised to update and improve specification of technical requirements. This document recommends flight deck lighting design and performance criteria to ensure prompt and accurate readability and visibility, color identification, and discrimination of needed information under all expected ambient lighting and electrical power conditions.

INTRODUCTION

This ARP provides recommended performance standards for air vehicle flight deck lighting. There were four documents covering this topic. The goal has been to streamline the guidance over time. AS264 has been cancelled. ARP1048 has been reaffirmed and is not recommended for new designs. ARP1161 has been stabilized and is not recommended for new designs. For new designs, use this document.

TABLE OF CONTENTS

1.	SCOPE.....	4
1.1	Purpose.....	4
1.2	Mandating and Recommending Phrases.....	4
1.3	Application.....	4
2.	REFERENCES.....	5
2.1	Applicable Documents.....	5
2.1.1	SAE Publications.....	6
2.1.2	ASTM Publications.....	7
2.1.3	CIE Publications.....	8
2.1.4	Code of Federal Regulations (CFR) Publications.....	8
2.1.5	FAA Publications.....	8
2.1.6	IES Publications.....	9
2.1.7	RTCA Publications.....	9
2.1.8	U.S. Government Publications.....	9
2.1.9	Other Publications.....	10
2.2	Definitions.....	10
3.	FLIGHT DECK LIGHTING SYSTEM and DISPLAY OPTICS REQUIREMENTS.....	13
3.1	Flight Deck Lighting Certification Regulations, Guidelines, Criteria.....	14
3.2	Visual Performance.....	14
3.2.1	Tasks.....	15
3.2.2	Viewing Angle.....	15

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Documents

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3.2.3	Finish Appearance	15
3.2.4	Font Characteristics	16
3.2.5	Luminance	17
3.2.6	Luminance Adjustment	18
3.2.7	Contrast, Contrast Ratio	18
3.2.8	Color and Spectral Considerations	18
3.2.9	Temporal Characteristics	18
3.2.10	Glare, Unwanted Reflection, Stray Light	18
3.2.11	Brightness and Color Uniformity	19
3.2.12	NVIS (Night Vision Imaging System)	19
3.3	Flight Deck Ambient Lighting Environment	19
3.3.1	Night, Dark	20
3.3.2	Twilight, Dawn, Dusk	20
3.3.3	Typical Day	20
3.3.4	Day, Bright Forward Field of View	20
3.3.5	Day, Transitional Dynamic	20
3.3.6	Day, Direct Sun on Instruments	20
3.3.7	Day, Direct Sun on Pilot's White Shirt	20
3.3.8	Ambient Light Spectrum	21
3.3.9	Laser Threats	21
3.4	Brightness Control	21
3.5	Non-Normal and Special Operation Lighting	21
3.6	Passenger Cabin Lighting Considerations	21
3.7	Exterior Lighting Considerations	21
4.	FLIGHT DECK LIGHTING SYSTEM COMPONENTS	22
4.1	Lightplate	22
4.1.1	Definition	22
4.1.2	Requirement	22
4.2	Switches, Knobs	22
4.2.1	Definition	22
4.2.2	Certification	22
4.2.3	Requirements	22
4.3	Annunciators (Indicators)	22
4.3.1	Definition	22
4.3.2	Certification	23
4.3.3	Requirements	23
4.4	Control Panel	28
4.5	Touchscreen	28
4.6	Electronic Displays	28
4.6.1	Definition	28
4.6.2	Visual Performance Certification Requirements	28
4.6.3	Design and Performance Criteria	30
4.6.4	Requirement Verification	30
4.7	Alphanumeric Electronic Displays	30
4.8	Head Up Display (HUD)	30
4.8.1	Definition	30
4.8.2	Certification Requirements	30
4.8.3	Requirement	31
4.8.4	Verification	31
4.9	Conventional Instruments	31
4.9.1	Visibility	31
4.9.2	Dial Configuration	32
4.9.3	Luminance	32
4.9.4	Light Source (Lamps)	32
4.9.5	Glass for Integrally Lighted Aerospace Instruments	32
4.10	Circuit Breakers	35
4.10.1	Integral Panels	35
4.10.2	Light Source	35
4.10.3	Floodlighted Panels	35



4.11	Marker	35
4.12	Flight Deck Area Lighting	35
4.12.1	Glare, Reflections, and Interference	36
4.12.2	Color Rendering	36
4.12.3	Task Surface Illuminance	37
4.13	Visors, Shades, Sunglasses, Transparencies, Windows	41
4.13.1	Windows, Visors, Sunshades, Transparencies, and Sunglasses	41
5.	LIGHTING CONTROLS	41
5.1	Lighting Controls Type	42
5.2	Lighting Controls Location	42
5.3	Panel Lighting - Integral	42
5.4	Lighting Controls Knobs	42
5.5	Ceiling (Dome) Light Controls	42
5.6	Standby Lighting Controls	42
5.7	Light Override Controls	42
5.8	Emergency Lighting	43
5.9	Special Circuitry Requirements	43
6.	LIGHT SOURCE CONSIDERATIONS	43
6.1	Life	43
6.2	Incandescent and Fluorescent Types	44
6.3	Replaceability	44
6.4	Placement or Location	44
6.5	Electrical Lighting Circuits	44
6.6	Interchangeable Lamps	44
6.7	Lamp Identification	44
6.8	Incandescent	44
7.	OPTICAL REQUIREMENT VERIFICATION	44
8.	ENVIRONMENTAL DESIGN CONSIDERATIONS AND QUALIFICATION TEST	45
8.1	Material and Electronics Design Considerations	45
8.2	Surface Temperature	46
8.3	Corrosion Prevention	46
8.4	Fog and Moisture Protection	46
8.5	Recommended Environmental Test Conditions	46
9.	NOTES	47
9.1	Revision Indicator	47
APPENDIX A	CERTIFICATION OF AIRCRAFT FLIGHT DECK LIGHTING and DISPLAY OPTICS SYSTEMS	48
Figure 1	ERP viewing angle	11
Figure 2	Viewing angle definition	12
Figure 3	Font example; Futura for control/displays	17
Figure 4	Annunciator diffuse contrast test setup	26
Figure 5	Specular contrast test arrangement	27
Figure 6	Dial marking and arrangement	33
Figure 7	Pointer and marker dimensions	34
Figure 8	Temperature limit for control surfaces	46
Table 1	Character symbology height	17
Table 2	Electronic display optical CFRs	29
Table 3	Instrument letter and numeral heights	31
Table 4	Example IES TM-30 values	37
Table 5	Recommended RTCA DO-160 environmental conditions	47

1. SCOPE

This document recommends design and performance criteria for aircraft lighting systems used to illuminate flight deck controls, luminous visual displays used for transfer of information, and flight deck background and instrument surfaces that form the flight deck visual environment. This document is for aircraft, except for applications requiring night vision compatibility.

1.1 Purpose

The criteria specified herein are intended to provide guidance to equipment manufacturers, flight deck designers, and certification personnel in managing such factors as brightness, contrast, and color selection to create a flight deck environment that supports effective human visual perception in all the expected ranges of ambient illumination conditions. The factors to be managed include those that are known to affect sensory coding, spatial organization, visual search time, and visual information processing; the goal is to optimize visual interface of the flight crew to promote safe operation of the airplane. The purpose is to satisfy the end user and obtain certification.

The desired system for aircraft flight deck lighting and display optics is one that will furnish light of adequate intensity and distribution under all conditions of internal and external lighting so that the crew may read instrumentation, placards, checklists, manuals, maps, instrument color coding, distinguish controls, etc., without undue interference with their vision outside of the aircraft.

1.2 Mandating and Recommending Phrases

“Shall” - The word “shall” indicates a mandatory criterion for compliance to this ARP.

“Should” - The word “should” indicates a criterion for which an alternative, including non-compliance, may be applied if it is documented and justified.

1.3 Application

This ARP should be used in conjunction with ARP4101 and ARP4102.

ARP4103 includes general lighting and display optics requirements for all expected lighting conditions and in all expected electrical power conditions and pilot tasks. This document defines the recommended design and performance requirements for component and system level lighting. The document is organized as follows.

The flight deck lighting needs to be designed for the following top-level system considerations:

- a. Normal lighting systems
- b. Non-normal lighting, backup, standby, and battery systems
- c. Emergency evacuation
- d. Service and maintenance

System level design considerations discussed include:

- a. Human visual performance
- b. Ambient lighting environment
- c. The visual geometrical considerations include the pilot viewing angle and distance to the lighted components, window and display location for direct sun angles, and night reflections.
- d. The light source and display type technology affects reliability and visibility and must be considered for the following factors: luminance, illuminance, chromaticity, temporal characteristics, thermal characteristics, aging and end of life, luminous maintenance, contrast, and dimming.

- e. The format and layout affect visibility by font, type, size, luminance, color, and shape.
- f. Color appearance is a function of spectral characteristic, gloss, texture, and reflectance.
- g. Glare and reflection
- h. Regulation and certification

Section 4 provides component level requirements and guidance for flight deck lighting design. Each component and system visual factor subsection provides: a definition, certification regulations, visual performance guidance, and compliance verification methods. The Section 3 general system level requirements and guidance shall be considered for each component level or subsystem. The components discussed are:

- a. Lightplate, integrally lighted information panels
- b. Switches, knobs
- c. Annunciators, indicators
- d. Control panel, keypads, and keyboards
- e. Touchscreen
- f. Electronic displays
- g. Alphanumeric electronics displays
- h. Head up displays
- i. Integrally lighted instruments, painted white on black conventional instruments
- j. Circuit breaker panel lighting
- k. Markers, placards
- l. General area and localized task and flood lighting
- m. Windows, visors, shades, transparencies

Section 5 is about lighting control; Section 6 discusses light source considerations; Section 7 is on optical requirement compliance verification; and Section 8 provides the non-optical qualification and environmental requirements for flight deck lighting.

2. REFERENCES

2.1 Applicable Documents

This ARP should be used in conjunction with the ARP4101 and ARP4102 series of documents about flight deck design. In addition, 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.

AMS2521	Coating, Reflection-Reducing for Instrument Glasses
AMS-G-25871	Glass, Laminated, Aircraft Glazing
AMS-STD-595	Colors Used in Government Procurement
AIR1093	Numeral, Letter and Symbol Dimensions for Aircraft Instrument Displays
ARP378	Passenger Reading Lights
ARP493	Knobs, Control Aircraft, Recommended Design
ARP498	Design, Layout, Criteria - Plastic Integrally Lighted Panels
ARP503	Emergency Evacuation Illumination
ARP577	Emergency, Instruction, and Information Placards - Internal and External
ARP798	Design Criteria for White Incandescent Lighted Aerospace Instruments
ARP924	Specification and Inspection of Glass for Integrally Lighted Aerospace Instruments
ARP1048	Instrument and Cockpit Illumination for General Aviation Aircraft
ARP1088	Aircraft Indicating Systems Optical Performance
ARP1161	Crew Station Lighting - Commercial Aircraft
ARP1782	Photometric and Colorimetric Measurement Procedures for Airborne Direct View CRT Displays
ARP1798	Portable Emergency Lighting Systems for Flight Crew Members
ARP4032	Human Engineering Considerations in the Application of Color to Electronic Aircraft Displays
ARP4101	Flight Deck Layout and Facilities
ARP4101/2	Pilot Visibility from the Flight Deck
ARP4101/5	Aircraft Circuit Breaker and Fuse Arrangement
ARP4102	Flight Deck Panels, Controls, and Displays
ARP4102/4	Flight Deck Alerting System (FAS)
ARP4102/7	Electronic Displays
ARP4105	Abbreviations, Acronyms, and Terms for Use on the Flight Deck
ARP4155	Human Interface Design Methodology for Integrated Display Symbolology
ARP4168	Night Vision Goggle (NVG) Compatible Light Sources

ARP4169	Night Vision Goggle (NVG) Filters
ARP4256	Design Objectives for Liquid Crystal Displays for Part 25 (Transport) Aircraft
ARP4260	Photometric and Colorimetric Measurement Procedures for Airborne Electronic Flat Panel Displays
ARP4822	Night Vision Imaging System (NVIS) Compatible Illuminated Pushbutton Switches and Indicators
ARP4967	Night Vision Imaging Systems (NVIS) Integrally Illuminated Information Panels
ARP5287	Optical Measurement Procedures for Airborne Head Up Display (HUD)
ARP5288	Transport Category Airplane Head Up Display (HUD) Systems
ARP5297	Recommended Qualification Tests for Halogen Miniature Lamps Less Than 35 Watts for Aircraft Applications
ARP5572	Control Measures for Laser Safety in the Navigable Airspace
ARP5873	LED Passenger Reading Light Assembly
ARP6161	Flight Compartment Glare
ARP6253	LEDs and Aircraft Applications
ARP6377	Human Engineering Considerations Associated with Design and Airborne Implementation of Head Worn Display (HWD) Systems
ARP6402	LED Landing, Taxiing, Runway Turnoff, and Recognition Lights
ARP60494	Touch Interactive Display Systems: Human Factors Considerations, System Design and Performance Guidelines
AS4970	Human Factor Considerations for Outdoor Laser Operations in the Navigable Airspace
AS5452	Night Vision Goggles (NVG) Compatible Lighting for Civil Aircraft
AS8034	Minimum Performance Standard for Airborne Multipurpose Electronic Displays
AS8055	Minimum Performance Standard for Airborne Head Up Display (HUD)
AS18012	Markings for Aircrew Station Displays, Design and Configuration of
AS25050	Colors, Aeronautical Lights and Lighting Equipment, General Requirements for

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D523 Standard Test Method for Specular Gloss

2.1.3 CIE Publications

Available from CIE Central Bureau, Babenbergerstrasse 9/9A, 1010 Vienna, Austria, Tel: +43 1 714 31 87, www.cie.co.at.

CIE S 014-1 Joint ISO/CIE Standard: Colorimetry - Part 1: CIE Standard Colorimetric Observers

CIE S 014-4 Joint ISO/CIE Standard: Colorimetry - Part 4: CIE 1976 L*a*b* Color Space

CIE S 014-5 Joint ISO/CIE Standard: Colorimetry - Part 5: CIE 1976 L*u*v* Colour Space and u', v' Uniform Chromaticity Scale Diagram

CIE TC 1-91 Methods for Evaluating the Colour Quality of White-Light Sources

2.1.4 Code of Federal Regulations (CFR) Publications

Available from United States Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

14 CFR Part 25 Airworthiness Standards

14 CFR Part 67 Medical Standards and Certification

14 CFR Part 91 General Operating and Flight Rules

14 CFR Part 121 Operating Requirements: Domestic, Flag, and Supplemental Operations

2.1.5 FAA Publications

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

AC 20-175 Controls for Flight Deck Systems

AC 23-19A Airframe Guide for Certification of Part 23 Aircraft

AC 25-7A Flight Test Guide for Certification of Transport Category Airplanes

AC 25-11A Electronic Flight Deck Displays

AC 25.1302-1 Installed Systems and Equipment for Use by the Flightcrew

AC 25.1322-1 Flightcrew Alerting

AC 25.812-1A Floor Proximity Emergency Escape Path Marking

AC 25.812-2 Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements

AC 27-1B Certification of Normal Category Rotorcraft

AC 29-2C Certification of Transport Category Rotorcraft

TSO-C113 Airborne Multipurpose Electronic Displays

TSO-C164 Night Vision Goggles

Notice 8110.98	Addressing human factors/pilot interface issues of complex, integrated avionics as part of the Technical Standard Order (TSO) process
Order 8110.4C	Type Certification
Order 8110.42	Parts Manufacturer Approval Procedures
Order 8110.48	How to Establish the Certification Basis for Changed Aeronautical Products
Pilot Safety Brochures	http://www.faa.gov/pilots/safety/pilotsafetybrochures/
Policy Memo ANM-99-2	Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks
Policy Memo ANM-0103	Factors to Consider When Reviewing an Applicant's Proposed Human Factors Methods of Compliance for Flight Deck Certification

Safety Brochure, "Laser Hazards in Navigable Airspace"

2.1.6 IES Publications

Available from Illuminating Engineering Society, 120 Wall Street, Floor 17, New York, NY 10005-4001, Tel: 212-248-5000, www.ies.org.

IES Illuminance Selector, <https://www.ies.org/standards/lighting-library/the-illuminance-selector/>

IESNA - The IESNA Lighting Handbook: Reference & Application

2.1.7 RTCA Publications

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

RTCA DO-160	Environmental Conditions and Test Procedures for Airborne
RTCA DO-178	Software Considerations in Airborne Systems and Equipment
RTCA DO-254	Design Assurance Guidance for Airborne Electronic Hardware
RTCA DO-268	Concept of Operations - Night Vision Imaging System for Civil Operators
RTCA DO-275	Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment

2.1.8 U.S. Government Publications

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

JSSG-2010/5	Crew Systems Aircraft Lighting Handbook
MIL-DTL-7788	Panels, Information, Integrally Illuminated
MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-L-85762	Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatibility

MIL-PRF-22885	Performance Specification Sheet; Switches, Pushbutton, Illuminated
MIL-STD-411	Aircrew Station Alerting Systems
MIL-STD-889	Galvanic Compatibility of Electrically Conductive Materials
MIL-STD-1472	Human Engineering
MIL-STD-3009	Interface, Lighting, Aircraft, Night Vision Imaging System

2.1.9 Other Publications

Common Displays Performance Requirements (Document D950-10620-1). The Boeing Company.

Davis, W. and Ohno, Y. (2010). Color quality scale. *Optical Engineering* 49(3).

Murdock, J.B. (1998). Step by Step. *LD+A*, 70.

2.2 Definitions

Additional definitions can be found in ARP4256, Section 5.

2.2.1 CHROMATICITY

The CIE defines chromaticity per International Lighting Vocabulary (ILV) term 17-144 chromaticity - property of a color stimulus defined by its chromaticity coordinates or by its dominant or complementary wavelength and purity taken together. In this document, u', v' (CIE 1976) coordinates will be used for emissive color per CIE S 014-5. "COLORIMETRY - PART 5: CIE 1976 $L^*U^*V^*$ COLOUR SPACE AND U', V' , UNIFORM CHROMATICITY SCALE DIAGRAM." It is recommended CIE $L^*a^*b^*$ be used for reflective color per CIE S 014-4. "COLORIMETRY - PART 4: CIE 1976 $L^*A^*B^*$ COLOUR SPACE."

2.2.2 COLOR

Measure of the chromaticity and luminance of an object.

The CIE defines perceptual color per E-ILV term 17-22-040 as the characteristics of visual perception that can be described by attributes of hue, brightness (or lightness), and colorfulness (or saturation or chroma).

The CIE defines psychophysical color per E-ILV term 17-23-001 as the specification of a color stimulus in terms of operationally defined values, such as three tristimulus values.

2.2.3 CONTRAST

The CIE defines contrast (in the perceptual sense) per E-ILV term 17-22-089 as the assessment of the difference in appearance of two or more parts of a field seen simultaneously or successively.

In this document, contrast is defined as follows:

$$C = \frac{L2 - L1}{L1} \quad (\text{Eq. 1})$$

where:

C = luminance contrast

L1 = average luminance of the background (or unlighted area) at specified ambient

L2 = average luminance of the information display (activated or lighted portion of the information display) at specified ambient

2.2.3.1 CONTRAST RATIO

$$L2/L1 \quad (\text{Eq. 2})$$

2.2.4 DESIGN EYE REFERENCE POINT (DERP)

A point fixed in relation to the aircraft structure (neutral seat reference point) at which the midpoint of the pilot's eyes should be located when seated at the normal position (see Figure 1). The ERP is the principal dimensional reference point for the location of flight deck panels, controls, displays, and external vision (refer to Figure 1 of ARP4101).

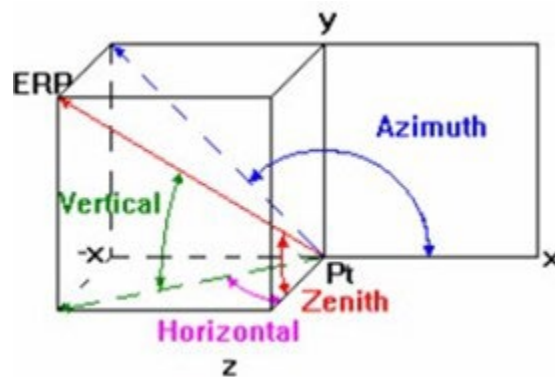


Figure 1 - ERP viewing angle

2.2.5 FINAL EYE POSITION (FEP)

The eye position obtained when the observer looks at the display by body movement from the design eye reference position.

2.2.6 LUMINANCE

The CIE defines luminance per E-ILV term 17-21-050 as the density of luminous intensity with respect to projected area in a specified direction at a specified point on a real or imaginary surface. Photometric brightness, from IES, a measure of luminous intensity per unit area; units are candela per square meter (cd/m^2) or fL (footLamberts). $1.0000 \text{ fL} = 3.426 \text{ cd}/\text{m}^2$. This document uses the photopic response and the 2-degree CIE 1976 standard observer per CIE S 014-1.

$$1 \text{ fL} = 3.426 \text{ cd}/\text{m}^2$$

2.2.7 ILLUMINANCE

The CIE defines illuminance per E-ILV term 17-21-060 as the density of luminous flux with respect to area at a point on a real or imaginary surface.

A measure of power per unit area or flux density on a surface, lumens per unit area; units are lux (lx) or footcandle (fc).

$$1.00000 \text{ fc} = 10,7639 \text{ lx}$$

2.2.8 VIEWING ANGLE

Viewing angle is defined as the angle between the line of sight from the pilot (observer) to the information displayed in its installed location and the normal to the display (see Figure 2). Within the required viewing angle range, all display elements shall be clearly readable under all expected lighting and operating conditions.

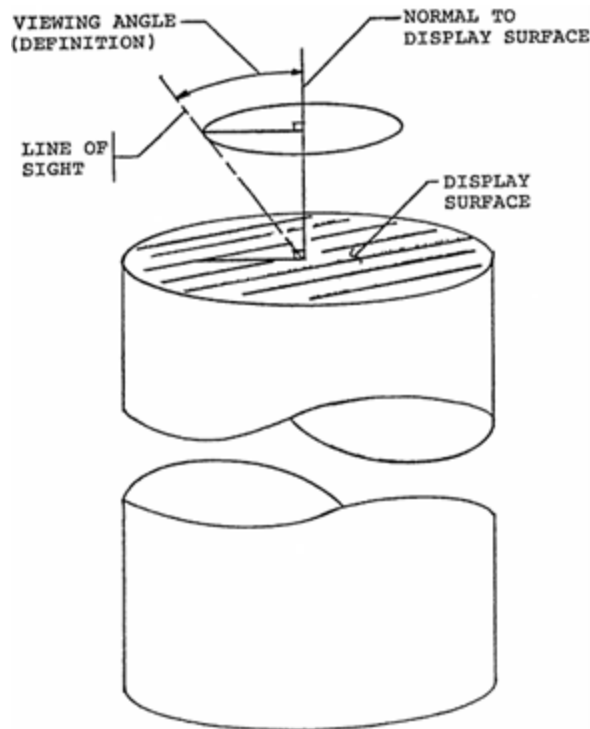


Figure 2 - Viewing angle definition

2.2.9 REFLECTANCE

The CIE defines reflectance per E-ILV term 17-24-064 as the quotient of reflected radiant flux and incident radiant flux.

In this document, reflectance will be defined as the ratio of the amount of light reflected from a surface to the amount of light incident on a surface. Usually, this is given as a percentage.

$$\% \text{ Reflectance} = \frac{\text{Light reflected from surface}}{\text{Light incident on a surface}}$$

2.2.10 GLARE

The CIE defines glare per E-ILV term 17-22-098 as the condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance or by extreme luminance contrasts.

2.2.11 GLOSS

The CIE defines specular gloss (perceived) per E-ILV term 17-22-122 as the perceived surface brightness associated with the luminous specular (regular) reflection of a surface.

The CIE defines specular gloss (physical) per E-ILV term 17-24-138 as the quotient of the flux reflected in the specular direction and the incident flux for a specified angle of incidence and specified source and specified angular apertures of the receptor.

2.2.12 VISUAL ACUITY

The CIE defines visual acuity (qualitatively) per E-ILV term 17-22-077 as the capacity for seeing distinctly fine details that have very small angular separation. The CIE defines visual acuity (quantitatively) per E-ILV term 17-22-078 as the measure of spatial discrimination such as the reciprocal of the value of the angular separation in minutes of arc of two neighboring objects (points or lines or other specified stimuli) which the observer can just perceive to be separate.

In general, the human eye has a visual acuity of 1 minute of arc (1/60 of a degree).

3. FLIGHT DECK LIGHTING SYSTEM AND DISPLAY OPTICS REQUIREMENTS

Section 3 provides system level requirements and guidance for flight deck lighting design and certification. These general requirements and guidance shall be applied to all subsystems and components in Section 4.

One of the first steps with the flight deck lighting design is to define the pilot's visual tasks with emphasis on what lighting or display is required for the tasks and the task surface. Flight deck lighting must be designed to function in all expected ambient lighting environments ranging from night to bright day. A failure hazard assessment (FHA) needs to be conducted to consider the effects of lighting failures on the design. Failure effects need to be considered for the flight deck lighting Master Minimum Equipment List (MMEL) and Dispatch Deviation Guide (DDG). A flight deck lighting system description should be created to include flight crew procedures for operating the system.

There are several basic considerations and determining factors that must be taken in account when selecting an optical design, including:

- a. The individual specifications of the instrument to be designed.
- b. Environmental conditions (ambient light, high temperature, low temperature, humidity, etc.).
- c. Power available (AC, DC, 5 V, 28 V, etc.).
- d. The amount of space and weight allowed for the lighting device.
- e. Cost.

3.1 Flight Deck Lighting Certification Regulations, Guidelines, Criteria

There are regulatory, customer, and company requirements to consider in the optical design of flight decks. The primary FAA Part 25 list is:

- 25.773(a)(2) Pilot compartment view
- 25.1301(a)(d) Function and installation
- 25.1302 Installed systems and equipment for use by the flight crew
- 25.1303(a) Flight and navigation instruments
- 25.1302-1 Installed systems and equipment for use by the flight crew
- 25.1309(a) Equipment, systems, and installations
- 25.1321(a)(c)(2)(e) Arrangement and visibility
- 25.1322 Flight crew alerting
- 25.1381 Instrument lights
- 25.1543(b) Instrument markings: General

FAA Part 121 rules include:

- 121.305(j)(6) Flight and navigational equipment
- 121.323(d) Instruments and equipment for operations at night
- 121.325(c) 121.325 Instruments and equipment for operations under IFR or over-the-top

See Appendix A for the CFR text and typical method of compliance. See Appendix B for the secondary list of CFRs to consider for flight deck lighting design. The amendment level of the CFRs must be noted to know what level is applicable at the time of the design.

Certifiable performance to the CFRs of flight deck lighting is demonstrated on the airplane to FAA pilots in a conformed installation. The main visual performance items to demonstrate are adequate readability, visibility, color identification, and color discrimination of needed controls and displayed information in all expected ambient lighting environments (see 3.3) and in all expected electrical power conditions. In addition, check that glare, stray light, and reflections do not interfere with crew duties during night and day flight. It is common to hold a simulated-night ground demonstration for high-risk electrical failure conditions. For night demonstrations, it is recommended the pilots dark adapt for at least 15 minutes. It is also recommended pilots wear white shirts that can be a source of reflection, because many airline pilots wear white shirts. AC 25-7A shall be used and “provides guidance for the flight test evaluation of transport category airplanes. These guidelines provide an acceptable means of demonstrating compliance with the pertinent regulations of 14 CFR part 25.”

3.2 Visual Performance

The visual interface is the most important pilot and airplane interface. Execution of flight crew visual performance tasks and procedures are measured in terms of accuracy, speed, and comfort. Visual performance factors include: task (who, what, when, where, task surface); visibility, readability, and legibility; font (visual size, viewing angle, distance, amount of lighted area); luminance, illuminance, polarization, and contrast; color, spectral; temporal; glare, stray light, and reflections; uniformity, balance, and dimming.

Lighting system level requirements for these factors are applied to the flight deck lighting components to ensure the system level requirements are met. It can be a difficult task to integrate various lighting components, media, and light source technologies.

A dimming curve, font, and color should be defined for all devices. Where possible, the same lighting and display technology should be used to help with color, appearance, luminance matching, and balance so all needed information is visible. For example, if LED and incandescent technology must be mixed, the LED appearance should be selected to match the incandescent or vice versa.

There are inevitably trade-offs to make between these visual performance factors. However, beware that these factors are interrelated. Further complicating the design challenge is that current metrics for these human performance factors do not perfectly represent the human eye-brain visual system at this time. Therefore, subjective evaluations are almost always warranted to supplement the objective requirements and evaluations of the flight deck lighting system.

For more information on visual performance, refer to the FAA Pilot Safety Brochure “Pilot Vision” at <http://www.faa.gov/pilots/safety/pilotsafetybrochures/>. The FAA pilot eye standards for medical certification are found in 14 CFR Part 67 § 67.103, 67.203, and 67.303.

3.2.1 Tasks

All instruments, display and control information, and controls intended for use by the flight crew shall be readable and visible under all expected ambient lighting conditions in all expected electrical power states. Lighting can help ensure accurate, timely, and comfortable accomplishment of the task.

Some examples of pilot and user tasks that require flight deck lighting include:

- Read and verify checklists
- Write frequencies, passenger count
- Read aircraft situational awareness, flight regime, navigation, altitude, speed, attitude
- Read approach plates and en-route charts
- Ground service
- Set and adjust brightness controls

3.2.2 Viewing Angle

The needed information shall be visible with minimum head movement from the pilot's design eye reference position (DERP) per 14 CFR Part 25 § 25.1321. The airplane's DERP shall be defined as the recommended eye position to ensure proper external and internal viewing of forward instruments and displays. The viewing angles are determined from the DERP and from the eye position determined by the pilot's final eye position (FEP) based on head and body movement to view the displays and manipulate the controls. The FEP with head motion shall be used to determine viewing angles to equipment, which, due to its location, requires significant head deviations from DERP. Examples of FEPs that are significantly different from the ERPs are found in pedestal and overhead zones. It is important to know that the visibility of displayed information may change as a function of viewing angle. This is especially critical for some lighting media, such as LCDs, but is also fundamental for all media because the projected size of the font is reduced off-normal, reducing the perceived brightness.

3.2.3 Finish Appearance

Flight deck finish appearance is an important factor in the flight deck lighting system because it immediately surrounds the flight deck lighted information and affects the visibility and comfort of the pilot. Finish appearance is described as the color, gloss, and texture of the lining, window frames, top of glare shield, and instrument bezels. It generally deals with the reflective appearance, but the emissive media must also be considered.

The flight deck finish appearance should be low gloss and low reflectance to enhance visibility of information and to prevent distracting glare and reflections per 14 CFR Part 25 § 25.773(a)(2). Refer to ARP6161 for more guidance.

The finish color should be conducive to a good working environment, and it shall not interfere with the CFR alerting color selection criteria in 14 CFR Part 25 § 25.1322.

3.2.4 Font Characteristics

Font and markings should meet the guidelines given in:

- AS18012, “Markings for Aircrew Station Displays”
- AIR1093, “Covers Aircraft Instrument Dials and Panel Displays”
- ARP4102/7, “Electronic Displays” (see 6.1.4)
- AS18012, “Annunciator, Indicators”

There are a variety of fonts that are typical for aerospace applications, including Futura, Gorton, Helvetica, and DIN 1451, and variants of these are among the most common. All these fonts have their own design rules for stroke to height ratio and character spacing. Many fonts are copyrighted.

An example of a common font for instruments, controls, and displays is Futura Medium (see Figure 3). The font characteristics below should be considered for inclusion in the lighting specification because it has a significant impact on readability. The numbers below are examples for Futura Medium.

- a. Height to width ratio (8:5)
- b. Height to stroke width ratio (8:1)
- c. Spacing between characters (one stroke width)
- d. Spacing between words (one character width)
- e. Spacing between lines (one-half the character height)
- f. Character height and width tolerance (± 0.013 cm [0.005 inch])
- g. Character stroke width tolerance (± 0.005 cm [0.002 inch])
- h. Kerning

In addition, refer to Chapter 5 of AC 25-11A.

Figures, letters, and numbers shall subtend not less than the Table 1 vertical angles from the design eye position of the pilot (or crew) who normally utilizes the displayed information. The font stroke width, font height to stroke width ratio, and letter spacing shall be designed for readability at the maximum compound viewing angles for the equipment.