



AEROSPACE RECOMMENDED PRACTICE

ARP5674™**REV. A**

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Superseding ARP5674

(R) Safety Considerations for Aircraft-Mounted Lasers
Projected into the Navigable Airspace

RATIONALE

ARP5674 Revision A is updated to reflect current terminology, definitions, and applicable documents.

On March 26, 1999, the Federal Aviation Administration (FAA) submitted a written request to SAE for assistance in developing procedures for evaluating the effect of lasers in the navigable airspace on aircraft operations. To this end, SAE develops documents, such as Aerospace Standards (AS) and Aerospace Recommended Practices (ARPs). Also, the SAE G-10T committee has worked closely with the American National Standard Institute (ANSI) Z136 committee for the safe use of lasers, particularly the subcommittee for the safe use of lasers outdoors.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) is intended to be used for laser systems mounted on aircraft and propagated into navigable airspace. This does not include lasers onboard aircraft where the beam is contained within an enclosure so that the beam cannot enter into airspace, nor does it include lasers from satellites and spacecraft in outer space. It may be used in conjunction with AS4970, ARP5535, ARP5572, ARP5293, and the ANSI Z136 laser safety standards.

1.1 Purpose

The purpose of this document is to provide guidance to regulatory and approving authorities as well as proponents on issues specific to the use of aircraft-mounted laser systems designed to propagate into navigable airspace.

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: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

ARP5293	Safety Considerations for Lasers Projected in the Navigable Airspace
ARP5535	Observers for Laser Safety in the Navigable Airspace
ARP5572	Control Measures for Laser Safety in the Navigable Airspace
AS4970	Human Factor Considerations for Outdoor Laser Operations in the Navigable Airspace
AS6029	Criteria for Laser Control Measures for Aviation Safety

2.1.2 ANSI Publications

Copies of these documents are available online at <https://webstore.ansi.org>.

ANSI Z136.1	American National Standard for Safe Use of Lasers
ANSI Z136.6	American National Standard for Safe Use of Lasers Outdoors

2.1.3 FAA Publications

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

FAA Order 7400.2	Procedures for Handling Airspace Matters. [VI] Part 6 (Miscellaneous Procedures), Chapter 29 (Outdoor Laser Operations)
FAA AC 70-1	Outdoor Laser Operation(s)
FAA AC 70-2	Reporting of Laser Illumination of Aircraft

Title 14 CFR §91.11 Prohibition on Interference with Crewmembers

Title 21 CFR §1010 Performance Standards for Electronic Products: General

Title 21 CFR §1040.10 Laser Products

Title 21 CFR §1040.11 Specific Purpose Laser Products

FDA 86-8260 Compliance Guide for Laser Products - U.S. Department of Health and Human Services

2.2 Definitions

The definitions of the terms listed below are based on a pragmatic rather than an academic approach. The terms defined are therefore limited to those that are specific in the context of this manual. This list is not intended to constitute a dictionary of terms used in the laser field as a whole.

AERONAUTICAL REVIEW: A review of the potential effects on aircraft operations and/or aeronautical facilities from lasers projected into the National Airspace System (NAS).

AFTERIMAGE: A transient image that persists in one's vision after a bright source of illumination has been removed.

AIRCRAFT-MOUNTED LASER SYSTEM: A system designed to emit laser energy from an aircraft. This does not include lasers onboard aircraft where the beam is contained within an enclosure so that the beam cannot enter into airspace, nor does it include lasers from satellites and spacecraft. For the purpose of this document, aircraft-mounted laser systems can be categorized into three types:

- **Intrinsically Flight-Safe Laser Systems:** Aircraft-mounted laser systems that, during normal use and under any conditions of fault likely to occur in practice, that are incapable of producing accessible laser energy in excess of the applicable visual interference or MPE level.
- **Design-Mitigated Flight-Safe Laser Systems:** Aircraft-mounted laser systems that rely on verifiable design/engineering control measures to mitigate laser hazards.
- **Other Aircraft-Mounted Laser Systems:** Aircraft-mounted laser systems that rely on procedural control measures to mitigate laser hazards. These systems require an FAA aeronautical review due to their reliance on human interaction.

CONTROL MEASURES: The means used to reduce or eliminate hazards from laser systems. Control measures can be categorized into three types:

- **Design/Engineering Control Measures:** Any hardware or design safety mechanism used to mitigate laser hazards. These control measures do not depend on operator intervention and cannot be overridden during normal operation but may be overridden during service or maintenance. Design/Engineering control measures are almost always the preferred type as they do not rely on human interaction.
- **Procedural Control Measures:** Any instruction, rule, or procedure designed to mitigate laser hazards. These control measures rely on human interaction and therefore are not as desirable as design/engineering control measures. These control measures can either control the actions of laser operators or limit the parameters of approved laser use (i.e., beam direction, times and dates, or flight paths).
- **Personnel Protective Equipment (PPE):** Any device used to attenuate the level of laser exposure to a safer level. Typically used as a last resort, PPE, such as laser eye protection, relies on human interaction to be effective in mitigating laser hazards. Under some circumstances, PPE may be the only feasible control measure to mitigate the hazards associated with laser illumination.

EFFECTIVE BEAM IRRADIANCE: The actual irradiance multiplied by the photopic luminous efficiency function to correct for visual perception. The effective irradiance is compared with the applicable visual interference level. When multiplied by 683, the effective irradiance is the illuminance.

FLASHBLINDNESS: A temporary loss of vision that persists after exposure to a bright light. Flashblindness can last from several seconds to several minutes.

FLIGHT HAZARD ZONES: Areas of airspace specifically designated to mitigate the potential hazardous effect of laser radiation. See Appendix A.

GLARE: A temporary disruption in an individual's field of vision caused by the presence of a bright light within an individual's field of vision (for example, an oncoming car's headlights). Glare is not associated with biological damage. Glare may only last as long as the light source exposure or may produce a lingering effect known as an afterimage.

NOTE 1: Glare can have disabling or discomforting effects on vision.

NOTE 2: The term "dazzle" has been used as a synonym for glare.

MAXIMUM PERMISSIBLE EXPOSURE (MPE): The highest level (irradiance or radiant exposure) of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.

NATIONAL AIRSPACE SYSTEM (NAS): The common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information, and services; rules, regulations, and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

NAVIGABLE AIRSPACE: Airspace above the minimum attitudes of flight prescribed by regulations including airspace needed for the takeoff and landing of aircraft. In semi-populated areas, navigable airspace is normally defined as airspace that exceeds 500 feet from any structure. In heavily populated areas, this distance may be greater. Near airports or heliports, navigable airspace extends to the runway. Helicopter operations may require additional considerations, since they are often flying below 500 feet AGL.

NOMINAL OCULAR HAZARD DISTANCE (NOHD): The distance along the axis of the laser beam beyond which the appropriate ocular MPE is not expected to be exceeded.

PHOTOPIC LUMINOUS EFFICIENCY FUNCTION: A factor applied to the beam irradiance to account for reduced visibility of some wavelengths. For a conservative assumption, a value of 1.0 can be used.

PROPONENT: A person or organization proposing to install or use aircraft-mounted laser systems; specifically, one who provides the FAA with information regarding the safety of a proposed system.

SAFETY OBSERVER: A person who has the responsibility for ensuring that people do not enter areas that contain hazardous laser beams, and has the authority and capability to terminate the laser beams when a potential hazard occurs.

VISUAL INTERFERENCE LEVEL: The minimum effective irradiance, or radiant exposure, of a visible laser beam that is less than the MPE, but can produce a visual response that interferes with the safe performance of sensitive or critical tasks by aircrew or other personnel. This level varies in accordance with the particular zone that the laser beam traverses.

NOTE: Visual interference level is a generic term for critical level, sensitive level, or laser free level. See Appendix A.