



AEROSPACE RECOMMENDED PRACTICE

ARP5572™

REV. B

Issued 2004-01
Reaffirmed 2010-02
Revised 2026-06

Superseding ARP5572A

(R) Control Measures for Laser Safety in the Navigable Airspace

RATIONALE

Update to reflect current terminology, definitions, and applicable documents.

FOREWORD

This document applies to control measures designed to mitigate a laser beam's potential hazards to aircrews when projected from an outdoor laser system. Related SAE documents are AS4970, AS6029, and ARP5535. Additional control measures may be applicable and are discussed in ANSI Z136.6 regarding outdoor laser operations and control.

This document provides guidance to laser operators, proponents, and regulatory authorities (e.g., FAA) on the optimal use of control measures during propagation of a laser beam in the navigable airspace. It also discusses control measures for systems that generate these beams.

The SAE G-10T Committee includes representation from many different entities, including government, public, and private organizations, to identify the issues, technologies, and operational capabilities of outdoor laser use in navigable airspace.

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2026 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, or used for text and data mining, AI training, or similar technologies, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 1-877-606-7323 (U.S. and Canada only)
Tel: 1-724-776-4970 (outside U.S. and Canada)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: SAE ARP5572B

For more information on this standard, visit
<https://www.sae.org/standards/content/ARP5572B/>

Documents

Standard, visit Sharing Hub

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose	3
2.	REFERENCES.....	3
2.1	Applicable Documents	3
2.1.1	SAE Publications.....	3
2.1.2	ANSI Publications	3
2.1.3	IEC Publications.....	3
2.1.4	U.S. Government Publications	3
2.2	Definitions	4
3.	LASER CLASSIFICATION AND HAZARD IDENTIFICATION	6
4.	LASER CONTROL MEASURES	7
4.1	Engineering Controls.....	7
4.1.1	Aircraft Laser Protection Systems (ALPS).....	7
4.1.2	FAA Air Traffic Data	16
4.1.3	Radar Airspace Monitoring System (RAMS).....	17
4.1.4	Multilateration	19
4.1.5	Emergency Shutdown, Beam Stops and Attenuators.....	20
4.1.6	Beam Masking	20
4.2	Administrative Controls	20
4.2.1	Hazard Distance and Protective Distances.....	20
4.2.2	Safety Observers	20
4.2.3	Airspace Regulatory Coordination	21
4.3	Personal Protective Equipment (PPE)	21
5.	NOTES	21
5.1	Revision Indicator.....	21
Figure 1	Wavelengths of electromagnetic radiation.....	6
Figure 2	Boresight radar system showing overlap of RF beam with laser beam.....	9
Figure 3	Analog marine radar display	10
Figure 4	FAA digital radar antenna site.....	10
Figure 5	TCAS protection volume	14
Figure 6	Airspace where ADS-B is required.....	15
Figure 7	Display of ADS-B aircraft location, type, heading, and altitude range for Central Florida from Tampa/St. Petersburg (left), through Orlando (center) to Cape Canaveral (right). Aircraft colors correspond to altitude scale at lower right. Screenshot of Feb. 9, 2024, 1:14 pm local, from ADSBexchange.com.....	15
Figure 8	Close-up of Orlando International Airport area with Piper aircraft selected (orange prop plane in center). Past flight path of this aircraft is shown. Aircraft and flight details are in the info box at left. Screenshot of Feb. 9, 2024, 1:27 pm local, from ADSBexchange.com.....	16
Figure 9	Radar airspace monitoring system (RAMS).....	18

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides information and guidance for the control of hazardous laser exposure in the navigable airspace.

This ARP does not address techniques that pilots can apply to mitigate laser illuminations during a critical phase of flight. Such mitigation strategies are described in ARP6378.

1.1 Purpose

The purpose of this document is to provide recommended practices for operators of lasers to mitigate hazards related to laser beam propagation in the 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
ARP6378	Guidance on Mitigation Strategies Against Laser Illumination Effects
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 the Safe Use of Lasers
ANSI Z136.6	American National Standard for the Safe Use of Lasers Outdoors

2.1.3 IEC Publications

Available from IEC Secretariat, 3 rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 0211, www.iec.ch.

IEC 60825-1	Safety of laser products – Part 1: Equipment classification and requirements
-------------	--

2.1.4 U.S. Government Publications

21 CFR Chapter I, Subchapter J, Radiological Health (www.ecfr.gov)

FAA JO 7400.2	Procedures for Handling Airspace Matters. Part 6 (Miscellaneous Procedures), Chapter 29, Outdoor Laser Operations) (www.faa.gov)
---------------	---

2.2 Definitions

The definitions of the terms listed below are specific to this standard, and are in no way intended to constitute a general dictionary of terms. For some definitions, examples of typically used units are given; however, other units may also be used.

AIRPORT REFERENCE POINT: The designated geographical location of an airport.

AFTERIMAGE: An impairment in the form of a temporary perception of an image in the visual field after exposure to a bright source.

BEAM: A collection of rays characterized by direction, diameter (or dimensions), and divergence (or convergence).

BEAM DIVERGENCE: For purposes of this standard, the divergence is the increase in the diameter of the laser beam with distance from the beam waist.

BUFFER ZONE: A volume surrounding the beam which, when applied with appropriate control measures, provides sufficient margin to avoid inadvertent beam exposure.

COLLECTING OPTICS: Lenses or optical instruments (such as telescopes, binoculars, or microscopes) having magnification and may present an increased hazard.

CRITICAL ZONE: See flight zones.

FLASHBLINDNESS: A temporary biological visual impairment that reduces visual sensitivity after exposure to bright light.

FLIGHT ZONES: Airspace areas where laser light levels may be restricted to avoid visual interference effects (LFZ, CFZ, SFZ) or are unrestricted when aircraft are not present (NFZ). A given flight zone may not be continuous or concentric with other flight zones. Alternate term is Flight Hazard Zone.

[See LASER FREE ZONE, CRITICAL FLIGHT ZONE, SENSITIVE FLIGHT ZONE, and NORMAL FLIGHT ZONE for details.]

- a. **LASER FREE ZONE (LFZ):** Airspace in the immediate proximity of the airport, up to and including 2000 feet AGL, extending 2 nautical miles (NM) in all directions measured from the runway centerline. Additionally, the LFZ includes a 3 NM extension, 2500 feet each side of the extended runway centerline, of each usable runway surface, up to 2000 feet AGL of each useable runway surface. The effective irradiance of a visible laser beam is restricted to a level that should not cause any visual distraction or disruption ($\leq 50 \text{ nW/cm}^2$).
- b. **CRITICAL FLIGHT ZONE (CFZ):** Airspace within a 10 NM radius of the airport reference point, up to and including 10000 feet AGL. The effective irradiance of a visible laser beam is restricted to a level that should not cause transient visual effects (for example, glare, flashblindness, or afterimage) ($\leq 5 \mu\text{W/cm}^2$).
- c. **SENSITIVE FLIGHT ZONE (SFZ):** Airspace outside the critical flight zones that authorities (e.g., FAA, local departments of aviation, military) identify to be protected from the potential visual effects of laser beams ($\leq 100 \mu\text{W/cm}^2$).

NOTE: The SFZ may be established at the discretion of an authority, and need not necessarily be contiguous with the other zones.

- d. **NORMAL FLIGHT ZONES (NFZ):** Airspace not defined by the Laser Free, Critical, or Sensitive Flight Zones. As with all the flight zones, the NFZ must be protected from a visible or invisible laser beam that exceeds the MPE.

GLARE: A visual impairment due to a bright light source.

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

IRRADIANCE: Irradiance is the incident power per unit area, e.g., watts per square centimeters (W/cm^2).

INFRARED RADIATION: Electromagnetic radiation with wavelengths longer than visible radiation and up to 1 mm.

LASER: An acronym for light amplification by stimulated emission of radiation. A laser is a device that produces an intense, directional, coherent beam of visible or invisible light.

LASER-FREE ZONE: See FLIGHT ZONES.

LASER OPERATOR: The person in control of the operation of a laser system, who has been given authority to operate the laser system in compliance with applicable safety standards, subject to direction of the laser safety officer.

LASER SAFETY OFFICER (LSO): A designated person who has authority and responsibility to monitor and enforce the control of laser hazards and affect the knowledgeable evaluation and control of laser hazards.

LASER SYSTEM: An assembly of electrical, mechanical, and optical components that includes a laser.

LIGHT: See VISIBLE RADIATION.

MAXIMUM PERMISSIBLE EXPOSURE (MPE): The level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin.

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

NORMAL ZONE: See FLIGHT ZONES.

POINTING ACCURACY: The maximum angle of expected error in beam direction during all projected uses of the device. For automatic tracking systems, the pointing accuracy includes the maximum error that could occur during a loss of track scenario before the laser is disabled.

PROPONENT: Person or organization applying to conduct an outdoor laser operation at a specific time and location.

PULSED LASER: A laser that delivers its energy in individual pulses lasting less than 0.25 second.

RADIANT EXPOSURE (H): Surface density of the radiant energy received. Radiant exposure is computed from the emitted energy divided by the area of the laser beam.

REACTION TIME: When implementing a laser hazard protection system, the reaction time is the maximum time from when a protected event occurs (e.g., an aircraft entering a protected zone, emergency stop) until the hazard mitigation (e.g., beam shuttered or laser deactivated) becomes fully effective. The reaction time for the overall aircraft protection includes all time needed to detect the aircraft, process the information, decide on mitigation, and fully implement any needed response.

REFLECTION: Propagation of radiation in different direction following an incidence on a surface. Reflection can be either a diffuse reflection or a specular reflection.

- a. **DIFFUSE REFLECTION:** Change in the spatial distribution of a beam of radiation when it is reflected in many directions by a surface or by a medium, e.g., reflections from flat finish paints or rough surfaces.
- b. **SPECULAR REFLECTION:** A mirror-like reflection.

SAFETY OBSERVER: A designated person who is responsible for monitoring the safe operation of a laser and who can immediately terminate the laser beam if necessary to ensure safety.

SENSITIVE ZONE: See FLIGHT ZONES.

ULTRAVIOLET RADIATION: Electromagnetic radiation with wavelengths shorter than those of visible radiation.

VISIBLE RADIATION: A form of electromagnetic radiation able to be detected by the human eye. Wavelengths between approximately 390 and 780 nm could produce visual interference. Wavelengths between 400 and 700 nm consider the natural aversion response to bright visual stimulus and are used for laser classification (e.g., Class 2). See Figure 1.

WAVELENGTH: The distance between two successive points on a periodic wave. For lasers, wavelength is commonly grouped into ultraviolet, visible, and infrared. For visible light, the numeric wavelength is associated with a color, e.g., 550 nm appears green.

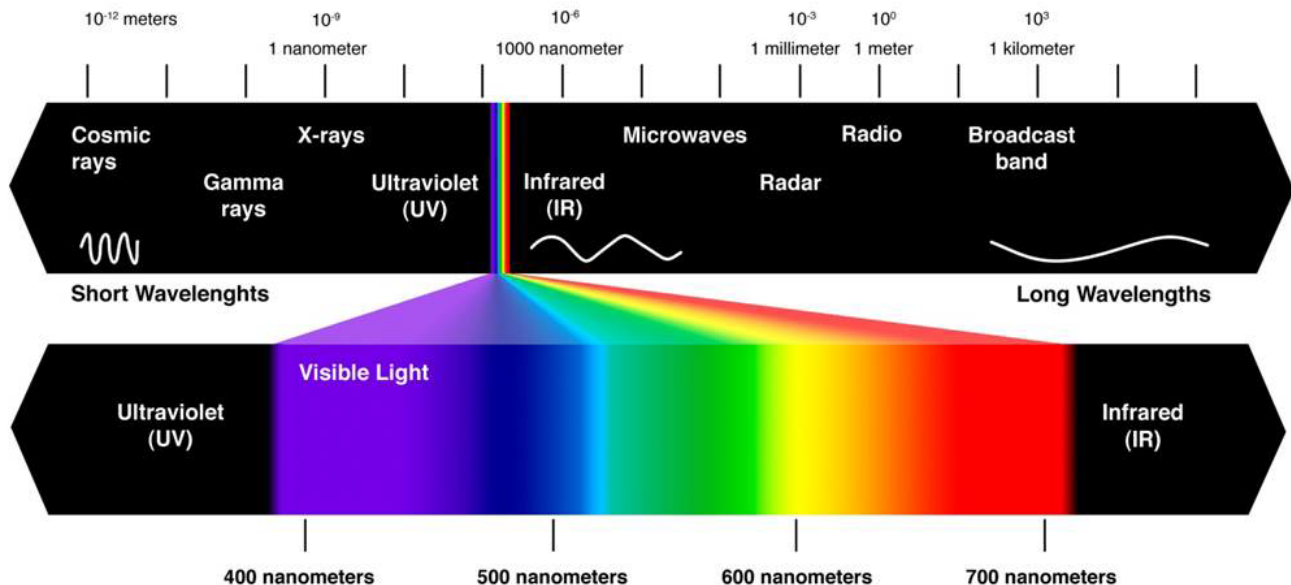


Figure 1 - Wavelengths of electromagnetic radiation
(Wikimedia user Xryaa. Licensed under CC BY-SA 4.0. <https://creativecommons.org/licenses/by-sa/4.0/>)

3. LASER CLASSIFICATION AND HAZARD IDENTIFICATION

Some lasers may pose hazards to people, equipment, or the environment. Laser users are responsible for evaluating their laser systems and identifying hazards. Some issues of concern include stability of the laser and platform, physical access to the laser, pointing accuracy of the laser beam, protective housings, undesired wavelengths, and laser intensity.

Due to operational/mission requirements, some laser beams exceed the maximum permissible exposure (MPE) limits in ANSI Z136.1 or visual interference levels in FAA Joint Order (JO) 7400.2 and ANSI Z136.6. Control measures intended to reduce or eliminate these risks to aircraft and crew member(s) are discussed in this document.

NOTE: Laser systems and laser products may have different applicable standards and regulatory requirements. A laser system is an assembly of electrical, mechanical, and optical components that includes a laser. ANSI Z136.1 provides guidance for the safe use of lasers, and for the classification and evaluation of laser systems in general. ANSI Z136.6, ARP5293, and this document provide guidance for laser usage and systems in navigable airspace. If the laser system is manufactured as a product, or is intended for use as the component of an electronic product, additional standards and/or regulations will apply. Specifically, in the U.S. laser products must be certified to FDA pursuant to 21 CFR Chapter I, Subchapter J, while IEC 60825-1 is an international standard intended for laser products.

4. LASER CONTROL MEASURES

Control measures mitigate risk by reducing the likelihood or severity (or both) of a hazard and are typically divided into three general categories (listed in order of preference): engineering controls, administrative/procedural controls, and personal protective equipment (PPE). Multiple control measures may be necessary to effectively control the hazard.

Engineering controls use physical means to minimize, contain, or eliminate the hazard. This is preferred, as it is understood that risk is best mitigated by controlling the hazard itself. The use of engineering controls simplifies overall risk mitigation by limiting the variability inherent in the reliance of people following administrative/procedural controls.

When the use of engineering controls to adequately mitigate risk is not practicable, risk mitigation can be done using administrative controls. Administrative controls are used to separate intrinsic hazards from people, material, or the environment to which they may cause harm. These types of control measure rely on rules, procedures, and their application, so they are subject to the inherent variability of human error. Additionally, administrative controls may have limited effectiveness against unanticipated hazardous eventualities.

Finally, when the use of both engineering and administrative controls cannot practicably be used to adequately reduce risk, PPE may be necessary. The need for PPE presumes that a person may be exposed to a hazard. This is the least desired means for mitigating risk and is considered the “last line of defense” against injury. Additionally, PPE requires both training and use, thus adding to the administrative controls necessary to mitigate risk.

4.1 Engineering Controls

The following are control measures that may be used to control laser hazards in the navigable airspace. Laser systems and control measures should be designed, installed, and operated in accordance with applicable federal, state, local regulations, and industry standards.

4.1.1 Aircraft Laser Protection Systems (ALPS)

The purpose of having an Aircraft Laser Protection System (ALPS) is to ensure that people (particularly in aircraft) are not exposed to laser levels above the MPE or any applicable visual interference limits. To achieve this, the ALPS shall detect all types of aircraft that may be reasonably expected to operate in the beam's potential path and shutter or attenuate the beam to safe levels before the aircraft enters the protected airspace.

The AS6029 standard requires a minimum safety buffer extending from the edge of the beam to twice the total ALPS reaction time. Note that this means that the system must be able to detect aircraft, and shutter or attenuate the beam to safe levels, before an aircraft enters the buffer zone (e.g., if the total ALPS reaction time is 20 ms, then the ALPS must shutter the beam at least 40 ms before an aircraft could enter the beam; this ensures that the beam is shuttered before the aircraft enters the protected airspace).

Non-boresighted radars, cameras, and transponders can use a computer to predict the future location of the aircraft relative to the laser beam, based on the aircraft's current location, heading, and speed. (For most boresighted radars, if an aircraft is detected no further analysis of its future location is needed; the protection system is simply activated.)

An ALPS can be totally automated. Control electronics are connected to the laser system to allow automatic termination or attenuation to safe levels upon aircraft detection. Otherwise, an operator would need to terminate or attenuate the laser manually. Once the aircraft has left the protected airspace, the system can either be reset automatically or manually to once again allow transmission of the laser beams through navigable airspace.

More details about ALPS are in the AS6029 standard.

Below is a list of technologies which may be considered for use in an ALPS system. These include various types of radar, cameras, and transponders. Laser control measure systems often rely on more than one of these technologies simultaneously, or in conjunction with other measures such as spotters. Determining what method or methods are used would be done on a case-by-case basis, depending on factors such as the reliability of the control measure, the laser site/location, an analysis of the air traffic in the area, and the nature of the laser hazard.