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Unauthorized Laser Illuminations: Pilot Operational Procedures		

RATIONALE

The G-10 Operational Laser committee has agreed to stabilize this document as the content has been determined to be basic and stable information not dynamic in nature.

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INTRODUCTION

The SAE G-10T, the Laser Safety Hazards Subcommittee, was established in 1994 in response to a request from the FAA Administrator, David Henson. The SAE G-10 was tasked to provide input for the revision of the FAA's 7400.2 Procedures for Handling Airspace Matters, and to produce new guidance in the form of an Advisory Circulars (AC) and other technical material for the aviation industry.

As part of our efforts to improve operational safety, the SAE G-10 Committee has worked with 17 different agencies to identify the issues, technologies, and operational considerations of outdoor laser illuminations in navigable airspace. Products of the SAE G-10T subcommittee have been used for major revisions to FAA Order 7400.2 and the more recently issued FAA Advisory Circulars 70-1, "Laser Operations in the National Airspace System" and 70-2, "Reporting of Laser Illumination of Aircraft." Together, these three documents, along with ANZI Z 136.6, "Standards for the Safe Use of Lasers Outdoors," interface with AS4970, "Human Factors Consideration for Laser Operations in Navigable Airspace" to provide in-depth reference materials for outdoor laser operations.

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1. SCOPE

This document addresses the operational safety and human factors aspects of unauthorized laser illumination events in navigable airspace. The topics addressed include operational procedures, training, and protocols that flight crew members should follow in the event of a laser exposure. Of particular emphasis, this document outlines coping strategies for use during critical phases of flight. Although lasers are capable of causing retinal damage, most laser cockpit illuminations, to date, has been relatively low in irradiance causing primarily startle reactions, visual glare, flashblindness and afterimages. Permanent eye injuries from unauthorized laser exposures have been extremely rare. This document describes pilot operational procedures in response to the visual disruptions associated with low to moderate laser exposures that pilots are most likely to encounter during flight operations. With education and training, pilots can take actions that safeguard both their vision and the safety of their passengers.

2. REFERENCES

- 2.1 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 the 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. FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov. FAA Order 7400.2E Procedures for Handling Airspace Matters

AC No: 70-1 Outdoor laser operations. December 30, 2004

AC No: 70-2 Reporting of laser illumination of aircraft. January 11, 2005

2.2 SAE Publications

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

AS4970 Human Factors Considerations for Outdoor Laser Operations in the Navigable Airspace

ARP5535 Observers for Laser Safety in the Navigable Airspace

ARP5572 Control Measures for Laser Safety in the Navigable Airspace

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI Z136.1 American National Standard for the Safe Use of Lasers (June 2000)

ANSI Z136.6 American National Standard for the Safe Use of Lasers Outdoors (August 2000)

3. DEFINITIONS

The terms defined in this section are limited to those actually used in this standard and its appendices and are not intended to constitute a dictionary of terms used in the laser field as a whole.

AFTERIMAGE: A reverse contrast shadow image left in the visual field after an exposure to a bright light, similar to the effects of a camera flash.

BEAM: A directed stream of optical energy emitted from a source that may be parallel, convergent, or divergent.

CONTINUOUS WAVE (CW): The output of a laser that is operated in a continuous rather than a pulsed mode. In this standard, a laser operating with a continuous output for a period >0.25 s is regarded as a CW laser.

CORNEA: The transparent outer coating of the human eye that covers the iris and the crystalline lens. The cornea is the main refracting element of the eye.

DISORIENTATION: Losing perspective in the spatial relationship between the direction of travel and surroundings.

DISRUPTION: Interference or interruption of critical tasks.

DISTRACTION: Momentary attention shift from primary tasks.

FLASHBLINDNESS: A loss of visual sensitivity from a bright light exposure, which persists after the source of illumination has been removed.

GLARE: Obscuration of an object in a person's field of vision due to a bright light source located near the object.

ILLUMINANCE: A measure of the irradiance on a surface multiplied by a factor to adjust for human visual sensitivity. Measurement units are foot-candle (lumens per square foot) or lux (lumens per square meter).

INCAPACITATION: Loss of spatial orientation and loss of spatial awareness in reference to the outside world. Incapacitated flight crew members should immediately transfer control of the aircraft because they can no longer reliably sense the attitude, altitude, or direction of the aircraft.

IRRADIANCE: Radiant power incident per unit area upon a surface. Unit: watt per square centimeter ($\text{W}\cdot\text{cm}^{-2}$).

LASER: A device that produces an intense, coherent, directional beam of light, either visible or invisible, by stimulating electronic or molecular transitions to lower energy levels. LASER is an acronym for "Light Amplification by Stimulated Emission of Radiation."

LASER LIGHT SHOW SYSTEM: A demonstration laser product for producing and redirecting laser beams to create a visual effect.

MAXIMUM PERMISSIBLE EXPOSURE (MPE): The level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin. In general, MPE is expressed as mW/cm^2 or mJ/cm^2 . Selected MPEs for the eye are listed in Tables A1, A2, and A3.

NOMINAL OCULAR HAZARD DISTANCE (NOHD): The distance from the laser system beyond which the beam irradiance of the laser does not exceed the MPE for that laser.

PILOT FLYING: (PF) The PF will monitor/control the aircraft, regardless of the level of automation employed.

PILOT MONITORING (PM): The PM will monitor the aircraft and actions of the PF.

POWER. The rate at which energy is emitted, transferred, or received. Unit: watts (joules per second).

PULSED LASER: A laser that delivers its energy in individual pulses, lasting less than 0.25 s. See repetitively pulsed laser.

SOURCE: A point of origin of laser light or a surface that reflects laser illumination.

STARTLE: Startle is the involuntary reaction to an unexpected event that alters mental, physical, and visual activities and diverts selected attention away from the normal primary tasks of the flight crew.

TRANSMITTANCE: The ratio of total transmitted radiant power through a medium to total incident radiant power.

VISIBLE LASER: For the purposes of this standard, a laser producing light in the wavelength range between 380 and 780 nanometers—that capable of detection by the human eye