

# American National Standard

*American National Standard  
for Safe Use of Lasers  
in Educational Institutions*

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**American National Standard  
for Safe Use of Lasers  
in Educational Institutions**

Secretariat  
**Laser Institute of America**

Approved May 19, 2020  
**American National Standards Institute, Inc.**

**American  
National  
Standard**

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# American National Standard for Safe Use of Lasers in Educational Institutions

## 1. General

### 1.1 Scope.

This standard addresses laser safety concerns and situations that may occur in educational environments. This standard is not a substitute for ANSI Z136.1 (latest revision)<sup>1</sup> that is required for a full understanding of laser safety officer (LSO) duties and laser hazard evaluation. Environments characteristic of educational institutions, wherein lasers may be found, include teaching laboratories, classrooms, lecture halls, science fairs, museums, and student projects on-and-off campus. This standard is intended for faculty and students using lasers at primary, secondary, and college levels of education excluding graduate level research laboratories that are more comprehensively addressed by ANSI Z136.8 (latest revision) and Z136.1 (latest revision). The wavelength range of interest includes the ultraviolet (UV), visible, and infrared (IR) regions of the electromagnetic spectrum; specifically, the wavelength range from 180 nanometer (nm) to 1 millimeter (mm).

The LSO, or responsible person, for the educational institution shall assess if a specific laser safety standard, ANSI Z136.2, Z136.3, Z136.6, Z136.8 or Z136.9 (latest revisions), is to be consulted for additional safety control measures to complement the laser lesson plan.

### 1.2 Purpose and Application.

The purpose and application of this standard is to provide reasonable and adequate guidance for the safe use of lasers in educational environments by evaluating and minimizing hazards associated with laser radiation. The hazard evaluation procedure used in this standard is based on Class 1 through Class 4 classification of the laser or laser system that is related to the ability of the laser beam to cause physiological damage to the eye or skin and a fire hazard as an ignition source during intended use. The amount of laser radiation emitted from Class 1 lasers and laser systems is considered to be non-hazardous; Class 4 lasers and laser systems possess the highest potential hazard.

**1.2.1 Laser Classification.** Laser and laser system hazard potential are generally described using a scheme of Class 1 (inherently safe) through Class 4 (most hazardous). Laser equipment manufacturers are subject to laser product performance standards and regulations that include build safety features and safeguards. Where lasers are deployed such as in a place of work or educational setting, their safe use is addressed by the applicable consensus standards of ANSI Z136 (latest revision).

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<sup>1</sup> When a reference to a standard, regulation or order is followed by a date, e.g., Z136.1-2014, the reference is to that specific document. When a reference to a standard, regulation or order is not followed by a date, e.g., Z136.2, FAA order JO 7400.2, it means the latest revision of that document.



**Table 1. Laser Safety Officer (LSO) Requirements for Laser Classes**

Laser Class	Procedural & Administrative Controls	Training	Medical Surveillance	Laser Safety Officer	Laser Safety Program
1	Not Required	Not Required	Not Required	Not Required	Not Required
1M	Required	Application Dependent <sup>a</sup>	Application Dependent <sup>a</sup>	Application Dependent <sup>a</sup>	Application Dependent
2	Not Required <sup>b</sup>	Not Required <sup>b</sup>	Not Required	Not Required	Not Required
2M	Required	Application Dependent <sup>a</sup>	Application Dependent <sup>a</sup>	Application Dependent <sup>a</sup>	Application Dependent
3R	Not Required <sup>b</sup>	Not Required <sup>b</sup>	Not Required	Not Required <sup>b</sup>	Not Required
3B	Required	Required	Suggested	Required	Required
4	Required	Required	Suggested	Required	Required

NOTE—During maintenance and service, the classification associated with the maximum level of accessible laser radiation shall be used to determine the applicable control measures.

<sup>a</sup> Certain uses of Class 1M or 2M lasers or laser systems that exceed Class 1 or Class 2 because they do not satisfy Measurement Condition 1 may require hazard evaluation and/or manufacturer’s information (see 4.1).

<sup>b</sup> Not required except for conditions of intentional intrabeam exposure applications, which is prohibited in this standard.

<sup>c</sup> Should be considered if containing an embedded Class 3B or 4 lasers (see 1.3.1).

The administration shall have the authority to require the power level of a laser or laser system reduced if it is determined to be excessive for the intended purpose. For example, a Class 2 or 3R laser or laser system may be used instead of a visible or invisible Class 3B laser or laser system. In all instances, the lowest power level required for the project should be used.

In recognition of the fact that an LSO may not be present in primary and secondary schools where Class 3B or 4 lasers are absent, all lesson plans or demonstrations involving lasers should be reviewed by a knowledgeable individual for laser safety controls. These controls are a required part of the laser plan and demonstration.

In addition to the above responsibilities, the LSO has the following specific responsibilities where Class 3B or 4 lasers or laser systems are to be used.

**1.3.1 Classification.** The LSO shall be responsible for effecting the classification or verification of the classification of Class 3B and 4 lasers and laser systems used under the LSO’s jurisdiction. Unmodified lasers or laser systems classified by the manufacturer in accordance with FLPPS may

**1.3.9 Training.** The LSO shall ensure that adequate safety training is provided to staff, students, and authorized personnel using Class 3B and 4 lasers and laser systems (see 4.6.3 and Section 5). The LSO shall maintain records for each of these persons, indicating that appropriate training has been provided (see Appendix F).

**1.3.10 Medical Examination.** When necessary, the LSO shall effect medical examinations of affected personnel (see Section 6 and Appendix G). These personnel shall include anyone who is suspected of having received a laser injury or eye exposure exceeding the applicable MPE, and shall include, but are not restricted to administration, faculty, staff, and students who work with Class 3B and 4 lasers or laser systems. If an injury or accidental exposure exceeding the applicable MPE is suspected, urgent medical attention shall be provided. The LSO shall ensure that applicable medical examinations are scheduled and performed and shall maintain records of these examinations (see Section 6 and Appendix G for further information on medical surveillance).

**1.3.11 Accidents.** Upon notification of a known or suspected accident resulting from the operation of a laser or laser system, the LSO or designate for those facilities with Class 1 through 3R lasers shall perform an investigation of the accident and initiate appropriate action. This may include preparation of reports for submission to appropriate agencies. Federal reporting requirements can be found in the US Code of Federal Regulations, 21 CFR Subchapter J, Part 1002.20.

**1.3.12 Additional Duties.** Additional recommended duties of the LSO are included in ANSI Z136.1-2014, Appendix A, a normative appendix.

## 2. Acronyms and Definitions

### 2.1 Abbreviations and Acronyms.

Refer to 2.2 for definitions of these acronyms

AEL – Accessible Emission Limit

ANSI – American National Standards Institute (USA)

ArF – Argon Fluoride (laser)

CDRH – Center for Devices and Radiological Health (USA)

CO<sub>2</sub> – Carbon Dioxide (laser)

CW – Continuous Wave

GaAs – Gallium Arsenide (laser), a family of solid-state semiconductor lasers

HeNe – Helium-Neon (laser)

Hz – Hertz

IEC – International Electrotechnical Commission

IR – Infrared

J – Joule

LASER – Light Amplification by Stimulated Emission of Radiation

LCA – Laser-controlled area

LGAC – Laser Generated Airborne Contaminants

LPE – Laser Protective Eyewear

LSO – Laser Safety Officer

While SOPs are not required for classroom use of Class 1, 1M, 2, 2M, or 3R lasers or laser systems, a laser lesson plan should be developed and is strongly recommended. Classroom demonstrations using Class 3B or 4 lasers or laser systems shall have a written SOP, approved by the LSO, specifying the necessary controls required during the demonstration.

**4.2.6 Lecture Halls.** Lasers used in lecture halls shall be limited to the lowest output power and lowest class needed for the demonstration. The beam or its specular reflections shall not extend beyond the demonstration area. The direct beam, as well as specular and diffuse reflections, from Class 4 open beam lasers can be hazardous and should only be used in lecture hall demonstrations if the increased power is absolutely necessary. In addition, direct or diffusely scattered ultraviolet, UV, radiation can create a skin hazard and the direct beam of a Class 4 laser can present a fire hazard. The instructor shall be familiar with Section 4 of this standard and the latest version of ANSI Z136.1, Section 4: Control Measures.

### **4.3 Multi-Use Laser Facility.**

The use of a variety of lasers, laser systems, or lasers of different wavelengths within a given area, including coaxial beam delivery systems, increases the potential risk for laser accidents. A systematic procedure shall be followed to characterize the NHZ of each laser or laser system.

The complete NHZ is determined by first calculating the NHZ for each individual laser or laser system, reference Z136.1, Appendix B for NHZ calculations. The interactive hazard potential in these kinds of environments, coupled with the relative inexperience of the teachers and students involved, necessitates a thorough hazard evaluation by the LSO or effected by the LSO through a knowledgeable person.

### **4.4 Projects Containing a Laser Pointer.**

Laser pointers are appropriate for use at the primary and elementary grade levels. However, where a Class 3R or less laser pointer is used in the classroom for a demonstration or experiment, the following basic safety rules shall be observed with instructions given to the class:

- a) Do not point the laser at any individual.
- b) Do not directly view the beam or its specular, mirror-like, reflection.
- c) A laser pointer with the lowest possible power to accomplish the task should be used.
- d) Remove the batteries when the laser pointer is not in use.

### **4.5 Engineering Controls.**

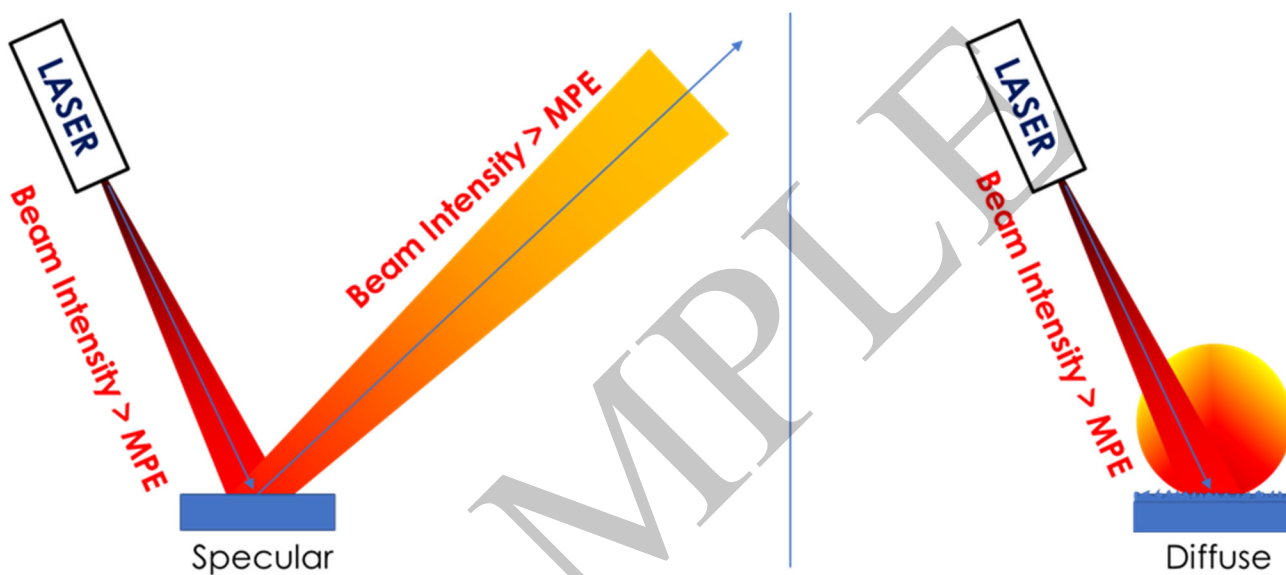
Commercial lasers are certified to comply with the FLPPS. Commercial laser systems that are certified to comply with the FLPPS can be expected to comply with the engineering requirements applicable to the laser system. Therefore, the LSO for the institution need only be concerned with those engineering controls that are applicable for emergent beams or for beams that become accessible as a result of modification or opening of the certified commercial laser system (see 21 CFR Part 1040.10).

The information contained in this appendix is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this appendix may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to this standard. It is intended for information only.

**Table A2. MPE for the Eye for Selected Single Pulse Lasers**

<b>Laser Type</b>	<b>Wavelength (nm)</b>	<b>Pulse Duration (s)</b>	<b>MPE (J cm<sup>-2</sup>)</b>
Excimer (ArF)	193	$2 \times 10^{-8}$	$3.0 \times 10^{-3}$
Excimer (XeCl)	308	$2 \times 10^{-8}$	$6.7 \times 10^{-3}$
Ruby	694	$1 \times 10^{-3}$	$1.0 \times 10^{-5}$
Yb:YAG (pulsed)	1030	$1 \times 10^{-3}$	$4.6 \times 10^{-5}$
Nd:YAG (pulsed)	1064	$1 \times 10^{-3}$	$5.1 \times 10^{-5}$
Yb:Fiber (pulsed)	1070	$1 \times 10^{-3}$	$5.1 \times 10^{-5}$
Yb:YAG (Q-switched)	1030	$5-100 \times 10^{-9}$	$9.1 \times 10^{-7}$
Nd:YAG (Q-Switched)	1064	$5-100 \times 10^{-9}$	$2.0 \times 10^{-6}$
Yb:Fiber (Q-switched)	1070	$5-100 \times 10^{-9}$	$2.0 \times 10^{-6}$
Carbon Dioxide (CO <sub>2</sub> )	10,600	$1 \times 10^{-3}$	0.1
NOTE—Table A2 is provided as a reference of MPEs for a selected set of single pulse lasers for the noted wavelengths and duration levels.			

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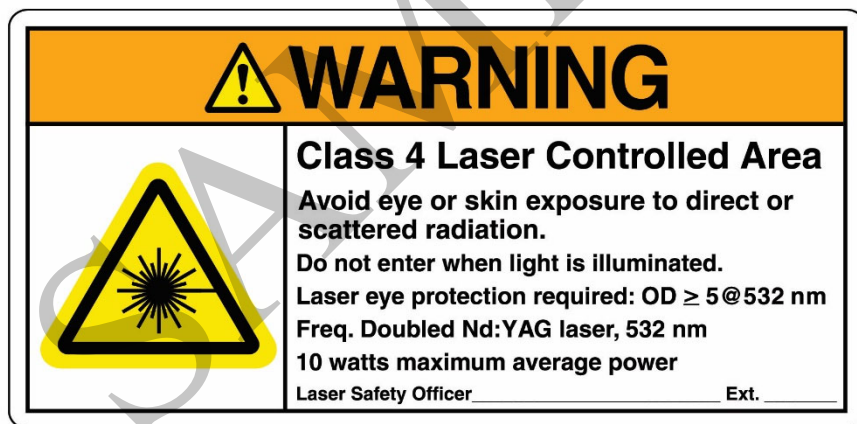
**Figure C7. Comparison of Laser Beam Dispersion Between Specular and Diffuse Reflections.**

The information contained in this appendix is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI’s requirements for an ANS. As such, this appendix may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to this standard. It is intended for information only.



**Figure D2. Sample ANSI Z535.2 & ISO 38642 Compliant Class 2, 2M, or 3R Laser-Controlled Area Warning Sign.**

NOTE—Use “CAUTION” with the safety alert symbol to denote a potential hazardous situation, which, if not avoided, may result in minor or moderate injury.



**Figure D3. Sample ANSI Z535.2 & ISO 3864-2 Compliant Class 3B or 4 Laser-Controlled Area Warning Sign.**

NOTE 1—Use “WARNING” with the safety alert symbol to denote a potentially hazardous situation which, if not avoided, could result in death or serious injury.

NOTE 2—The WARNING signal word is generally appropriate for Class 3B and most Class 4 laser operations. However, with some very high-power Class 4 laser operations the DANGER signal word may be more appropriate. The decision on Class 4 signal word is made by the responsible LSO.



Laser Institute of America (LIA), founded in 1968, is the professional society for laser applications and safety. Our mission is to foster lasers, laser applications and laser safety worldwide. Serving the industrial, medical, research and government communities, LIA offers technical information and networking opportunities to laser users around the globe.

The LIA is the secretariat to ASC Z136 and publisher of the American National Standards Institute approved Z136 series of laser safety standards. These documents provide a thorough set of guidelines for implementing a safe laser program. The ANSI Z136 series is recognized by OSHA, and is the authoritative series of laser safety documents in the United States. LIA also offers a wide array of products and services including safety and application publications, training videos, signs and labels, laser safety officer training and conferences. LIA members receive substantial discounts on all LIA courses, publications, and conferences. We invite you to become a member and be part of the LIA experience.

For more information, contact the LIA.

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# American National Standard

The standard in this booklet is one of more than 11,500 standards approved to date by the American National Standards Institute.

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