



Laser Classification

UW-Madison Laser Safety Program follows the American National Standards Institute's (ANSI) Z136.1 standards classification for lasers. The standard defines the hazard and defines control measures for each class. The manufacturer provides the classification for most lasers. For custom-built and modified lasers, the LSO can assist with classification.

All lasers and laser systems are categorized into one of the hazard classes and subdivisions:

Class 1 and Class 1 M Lasers and Laser System

Class 1 lasers or laser systems are considered incapable of producing damaging laser exposure during operation and are, therefore, exempt from any control measures or other forms of surveillance. A Class 1 laser system may contain a more hazardous laser embedded in the enclosure, but no harmful levels of the laser radiation can escape the system enclosure. For Class 1 lasers containing an embedded higher class of laser, the enclosure must be interlocked.

Class 1M Lasers or laser systems are considered incapable of producing hazardous exposure conditions during normal operation unless the beam is viewed with an optical instrument such as an eye-loupe (diverging beam) or telescope (collimated beam). It is therefore, exempt from any control measures other than to prevent potentially hazardous optically aided viewing.

Class 1 Conditions: Class 1 conditions shall be considered as fulfilled for those limited open beam path lasers or laser systems where analysis, including measurements, when necessary, confirms that the accessible levels during operation are at or below applicable maximum permissible exposure, MPE, Levels.

Class 2 and Class 2 M Lasers and Laser System

Class 2 lasers or laser systems (low power) emit in the visible portion of the spectrum, from 400 nm to 700 nm, and eye protection is normally afforded by the aversion response, for example, blinking, pupillary contraction, and moving head. The Class 2 laser does not exceed 1 mW.

Class 2M lasers or laser systems emit in the visible portion of the spectrum, from 400 nm to 700 nm, and eye protection is normally afforded by the aversion response for unaided viewing but is potentially hazardous if viewed with certain optical aids such as an eye loupe or a telescope.

Class 2M lasers and laser systems pose the same ocular hazards to the unaided eyes as Class 2 but are potentially hazardous when viewed with optical aids.

Class 3R and Class 3B Lasers and Laser System

Class 3 lasers or laser systems (medium power) are divided into two subclasses, Class 3R and Class 3B. A Class 3 laser system may be hazardous to the eye under direct and specular reflection viewing conditions, but the diffuse reflection is usually not a hazard, it is not a hazard to the skin. A Class 3 laser system is normally not a fire hazard.

Class 3R lasers or laser systems produce moderate levels of visible or invisible laser radiation and require more stringent controls than Class 1 and 2 lasers. Under some direct and specular viewing conditions an individual can sustain an injury if the eye is focused and stable or if optical aids are used. The limit of a CW Class 3R visible laser is a factor of 5 greater than for Class 2, equating to 5 mW for visible CW laser. For invisible lasers, the accessible emission limit is a factor 5 greater than Class 1.

Class 3B laser or laser systems may be hazardous under direct and specular viewing conditions but is not normally a diffuse reflection or fire hazard. Power output 5-500 mW if CW, or less than 0.03 joule (J) per pulse for a pulsed system (i.e. pulse width less than 0.25 second).

Class 4 Lasers and Laser System

Class 4 lasers or laser systems (high power) are a hazard to the eye or skin from the direct beam, and sometimes from a diffuse reflection, and can also be a fire hazard. A Class 4 laser system may also produce laser generated air contaminants, LGACs, and hazardous plasma radiation. Includes all laser systems with power levels greater than 500 mW CW or greater than 0.03 J per pulse for a pulsed system.

Table 1: Overview of Laser Classification

Class	Type of lasers	Limits	Hazard
Class 1	Very low power lasers or encapsulated lasers	Visible lasers with wavelengths longer than 500 nm have a class 1 limit of 0.4 mW. The class 1 limit for visible lasers with wavelengths shorter than 450 nm is 40 μ W	Levels of laser radiation are not considered to be hazardous. Includes higher class lasers completely enclosed and interlocked to prevent beam access, allowing a Class 1 laser system designation
Class 1M	Very low power lasers; either collimated with large beam diameter or highly divergent	Same as Class 1	No hazard area for the naked eye, but hazard area for the use of optical instruments
Class 2	Visible low power lasers	1 mW visible light	No hazard area but can create eye damage through chronic exposure.
Class 2M	Visible low power lasers; either collimated with large beam diameter or highly divergent	Same as Class 2	Levels of laser radiation are considered a chronic viewing hazard.
Class 3R	Low power lasers	5 times the limit of Class 1 in UV and IR, and 5 times the limit of Class 2 in invisible (5 mW) Power output between 1-5 mW	Normally not hazardous when viewed momentarily with the unaided eye but may pose severe eye hazards when viewed through collecting optics (e.g., microscopes and binoculars).
Class 3B	Medium power lasers	500 mW	Hazard to the eye, no hazard to the skin, not mainly a diffuse hazard
Class 4	High power lasers	No Limit	Hazard to eye and skin, diffuse hazard, fire hazard

Requirements

Engineering Control Measures	Classification						
	1	1M	2	2M	3R	3B	4
Protective housing	X	X	X	X	X	X	X
Without Protective Housing	LSO shall establish Alternative Controls						
Interlocks on Removable Protective Housings	○	○	○	○	○	○	○
Service Access Panel	○	○	○	○	○	X	X
Key Control	○	○	○	○	○	X	X
Viewing Windows, Display Screens and Diffuse Display Screens	Ensure viewing limited < MPE						
Collecting Optics	X	X	X	X	X	X	X
Fully Open Beam Path	—	—	—	—	—	X NHZ	X NHZ
Limited Open Beam Path	—	—	—	—	—	X NHZ	X NHZ
Enclosed Beam Path	Further controls not required if requirements are met.						
Area Warning Device	—	—	—	—	—	X	X
Laser Radiation Emission Warning	—	—	—	—	—	●	X
Class 4 Laser Controlled Area	—	—	—	—	—	X	X
Entryway Controls	—	—	—	—	—	X	X
Protective Barriers and Curtains	—	—	—	—	—	●	X

Administrative & Procedural Controls	1	1M	2	2M	3R	3B	4
Standard Operating Procedure	—	—	—	—	—	X	X
Output Emission Limits	—	—	—	—	—	X	X
Education and Training	—	—	—	—	—	X	X
Authorized Personnel	—	—	—	—	—	X	X
Indoor Laser Controlled Area	—	—	—	—	—	X	X
Class 4 Laser Controlled Area	—	—	—	—	—	X	X
Temporary Laser Controlled Area	○ MPE	○ MPE	○ MPE	○ MPE	○ MPE	X	X
Controlled Operation	—	—	—	—	—	X	X
Outdoor Control Measures	X	□ NHZ	X NHZ	□ NHZ	X NHZ	X NHZ	X NHZ
Laser in Navigable Airspace	—	—	—	—	—	X	X
Alignment Procedures	—	—	—	—	—	X	X
Spectators	—	—	—	—	—	X	X
Services Personnel	—	—	—	—	—	X	X
Laser Controlled Area Warning Signs	—	—	—	—	●	X	X

Personal Protective Equipment	1	1M	2	2M	3R	3B	4
Laser Eye Protection	—	—	—	—	—	X	X
Skin Protection	—	—	—	—	—	●	●
Protective Clothing	—	—	—	—	—	●	●

Legend

- X Shall
- Should
- No Requirement
- Shall if enclosed Class 3B or Class 4
- With use of optical aid
- NHZ Nominal Hazard Zone
- MPE Shall if MPE is exceeded

Further Information Example

For further information please contact the Office of Radiation Safety (ORS) at RadiationSafety@wisc.edu

Please see the ORS website for more information. <https://ehs.wisc.edu/labs-research/radation-safety/>