

**LASER CLASSIFICATION AND GENERAL
SAFETY CONTROL MEASURES**

(For assistance, please contact EHS at (402) 472-4925, or visit our web site at <http://ehs.unl.edu/>)

Lasers are classified as I, II, III, or IV based on the radiation intensity and the potential for producing injury. A Class I laser poses the least risk, while a Class IV laser poses considerable risk. Other hazards include electrical, chemical, and fire.

Class I Lasers cannot emit laser radiation that is known to be hazardous. They typically operate at 0.4 microwatts of continuous (cw) power. Class I lasers are exempt from control measures except during service.

Note that an embedded Class III or IV laser can be considered a Class I laser if it is totally enclosed, has engineering controls and interlocks, and is properly labeled. Such a laser requires Class IV controls during service and only qualified service personnel may service it.

Class II Lasers are low power visible wavelength lasers that emit at less than one milliwatt of power. These could cause eye damage, but the human aversion response to bright light normally prevents harm. There is a secondary class called Class IIa that is based on a 1000 second viewing exposure. Class IIa lasers should not be viewed. Some controls may be necessary for this class.

Class III Lasers are divided into Class IIIa and Class IIIb. Class IIIa lasers produce outputs of 1-5 milliwatts. These lasers should never be viewed directly. Limited controls are needed for this intermediate power class. Class IIIb lasers are moderate power lasers (cw-5-500 mW; pulsed to 10 joules/cm²). Some controls are needed, and they must not be viewed directly. Generally, they will not produce a diffuse reflection that is hazardous unless the viewer is quite close to the reflection. Class IIIb lasers are also considered an ignition/fire hazard.

Class IV Lasers are high power. They pose significant risk for eye and skin burns. Both direct viewing and scattered viewing are dangerous. Class IV laser facilities require significant control measures. Class IV lasers also have the potential to cause fire and chemical releases (such as fumes).

Controls (see attached table) may include but are not limited to:

The primary authoritative sources regarding hazard controls for the types of lasers commonly used at UNL are ANSI Z136.1: 2000, Safe Use of Lasers; ANSI Z136.3: 1998, Safe Use of Lasers in Health Care Facilities; ANSI Z136.5: 2000, Safe Use of

Lasers in Educational Institutions; and NFPA 115, Standard for Laser Fire Protection. A summary of ANSI standard requirements is provided in Table 1.

Training

All personnel working with Class III and IV open-beam lasers used for research and teaching must be trained on the safe use of the laser including the manufacturer's literature, operating manual, and control measures. All people that enter a room with an operating Class III and IV open beam laser used for research or teaching must be trained on how to prevent a personal injury and provided with the appropriate personal protective equipment. For additional guidance see Yale University's video titled [Introduction to Laser Safety](#).

Medical Evaluation

Medical surveillance and evaluations of laser workers may be necessary for chronic laser exposure or for accidental exposures. The primary concern is an accidental exposure to the eyes. Any suspected over-exposure from laser radiation to the eyes should immediately prompt an eye examination by a qualified physician. Subsequent re-examinations and follow-ups may be necessary. The EHS SOP, ***On-The-Job Injuries***, discusses medical treatment of occupational injuries.

Laser Program Administration

UNL does not support a centralized laser safety program. Principal Investigators and other persons with authority for laser operations are responsible to establish an effective and compliant program. This SOP serves as an awareness tool.

Table 1 – ANSI Control Measures for Laser Classes

Controls	Classification	I	IIA	II	IIIA	IIIB	IV
<u>Engineering</u>							
Protective housing		X	X	X	X	X	X
Without protective housing		Laser Safety Officer (LSO) shall establish alternate controls					
Interlocks on protective housing		1	1	1	X	X	X
Service access panel		2	2	2	2	2	X
Key switch master		-	-	-	-	3	X
Viewing portals		-	-	4	4	4	4
Collecting optics		-	-	4	4	4	4
Totally open beam path		-	-	-	-	X	X
Limited open beam path		-	-	-	-	X	X
Remote interlock connector		-	-	-	-	3	X
Beam stop or attenuator		-	-	-	3	3	X
Activation warning system		-	-	-	-	3	X
Emission delay		-	-	-	-	-	3
Class IIIB laser-controlled area		-	-	-	-	X	-
Class IV laser-controlled area		-	-	-	-	-	X
Laser outdoor controls		-	-	-	-	X	X
Temporary laser-controlled area, service only		2	2	2	2	-	-
Remote firing and monitoring		-	-	-	-	-	3
Labels		-	X	X	X	X	X
Area posting		-	-	3	3	X	X
<u>Administrative & procedural</u>							
Administrative & procedural controls		-	X	X	X	X	X
Standard operating procedures		-	-	-	-	3	X
Output emission limitations		-	-	-	5	5	5
Education and training		-	-	3	X	X	X
Authorized personnel		-	-	-	-	X	X
Alignment procedures		-	-	X	X	X	X
Eye protection		-	-	-	-	3	X
Spectator control		-	-	-	-	3	X
Service personnel		2	2	2	2	X	X
Laser demonstration		-	-	X	X	X	X
Laser fiber optics		-	-	X	X	X	X
Legend:							
X = shall		3 = should					
- = no requirement		4 = shall, if MPE is exceeded					
1 = shall, if embedded Class IIIA, Class IIIB, Class IV		5 = LSO determination					
2 = shall, if embedded Class IIIB, or Class IV		(4.X.X) = ANSI Z - 136.1 Section					

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Table 2 – Summary of Additional NFPA Class 3b and Class 4 Laser Requirements

Laser Equipment Employing Ignitable Liquids or Flammable Gases	Means to control or contain ignitable liquid spills using noncombustible materials
	Pumps, motors, and other electrical components in laser equipment that employ ignitable liquids or flammable gases shall be of intrinsically safe design or shall be appropriately rated for the application.
	Metal tubing is recommended for use with ignitable liquids or flammable gases. Where plastic tubing is used, it shall have a pressure rating of 1.5 times the maximum allowable working pressure, be of a material with the highest melting point and ignition temperature consistent with other necessary properties, and be of the shortest length possible.
Alarms and Controls	Shall incorporate circuitry that can be used for emergency shutdown by fire detection systems, manually, or by other means.
	Provisions shall be made for alarm and automatic shutdown should such conditions be detected.
Work Practices	Laser systems utilizing or containing flammable or reactive gas(es) shall be so labeled. Gas shutdown capability shall be provided both at the location of use and remotely.
	Appropriate combustible gas sensors shall be located near the area of use of the flammable gases except where demonstrated by calculation that 25 percent of the lower explosive limit (LEL) cannot be reached if the entire contents were to discharge.
	Reactive gas cylinders shall be located in an approved ventilated cabinet consistent with NFPA 55.
Facilities and Equipment	Indoor cylinder use shall be limited to lecture bottle size unless the cylinder(s) is kept in an approved ventilated cabinet or the room is provided with sufficient ventilation to keep the gas concentration below 25 percent of the LEL if the entire contents of the cylinder(s) in use were to discharge.
	Piping shall be pressure-tested and then leak-checked prior to initial use and after repair and modification.
Housekeeping	Laser equipment, systems, installation, and supporting materials and equipment shall be maintained in a clean, neat, and orderly condition.

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