

LASER SAFETY CITATIONS

GENERAL

1. **Lasers are classified appropriately**
 - Classify lasers and laser systems according to their relative hazards
MSU Laser Safety Manual - Laser Classification, pg 22
2. **Beam attenuator present**
 - A beam attenuator is required on Class II, IIIa, IIIb, and IV laser systems. The beam attenuator is a mechanical or electrical device such as a shutter or attenuator that blocks emission. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10(f)(6)
3. **Beam is enclosed as much as possible**
 - Where practical, the laser system or beam should be enclosed to prevent accidental exposure to the beam. MSU Laser Safety Manual - Laser safety practices, pg 14
4. **Beam is not directed toward doors or windows**
 - Windows to hallways or other outside areas must be provided with adequate shades or covers when necessary to keep the Nominal Hazard Zone (NHZ) within the room.
MSU Laser Safety Manual - Laser safety practices, pg 14
5. **Beams are terminated with fire-resistant blocks or curtains**
 - The main beams and reflected beams should be terminated or dumped. This is required for any accessible laser for which the MPE limit could be exceeded. MSU Laser Safety Manual - Laser safety practices, pg 14
6. **Surfaces minimize specular reflections**
 - Do not wear bright, reflective jewelry or other objects. MSU Laser Safety - Laser safety practices, pg 14
7. **Laser may be fired remotely**
 - Each Class IIa, II, III, or IV laser product shall have operational and adjustment controls located so that human exposure to laser or collateral radiation in excess of the accessible emission limits of Class I and table VI is unnecessary for operation or adjustment of such controls. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10(f)(7)
8. **Lasers are included in the inventory**
 - The Laser Safety Officer will be responsible for maintaining inventory of all Class 3b and Class 4 lasers and verifying classification if necessary. MSU Laser Safety Manual – Introduction: Responsible Parties, pg 7

SAFETY PRECAUTIONS

9. Standard operating procedures are available

- A written SOP is required for certain lasers that are high powered or that emit invisible radiation. MSU Laser Safety Manual – Laser Safety Standard Operating Procedures, pg 17
- The LSO should require and approve written standard operating, maintenance and service procedures (SOPs) for Class 3B lasers or laser systems. The LSO shall require and approve written SOPs for Class 4 lasers or laser systems. These written SOPs shall be maintained with the laser equipment for reference by the operator, and maintenance or service personnel. Standard Operating Procedures (Class 3B or Class 4), ANSI Z136.1 2014, 4.4.3.1

10. Laser users have attended appropriate training EHS / Site Specific.

- All Class 3b or Class 4 laser users are required to take basic laser safety training. On-line training can be found at the [EHS Laser Safety webpage](http://www.ehs.msu.edu/laser/laser_toc.htm) (http://www.ehs.msu.edu/laser/laser_toc.htm).
- In addition, all laser operators must be trained on the usage of each specific laser to be used.
 - i. The Principal Investigator (PI), vendor, or other qualified individual may provide this training.
- Records of these trainings must be maintained for review by EHS and/or regulatory agencies. MSU Laser Safety Manual – Laser Safety Training, pg 17

11. Open laser is below/above eye level of a person sitting/standing

- The laser should be set up so that the beam path is above or below normal eye level of A seated or standing person. (In general, below 4.5 ft. or above 6.5 ft.). MSU Laser Safety - Laser Safety Practices, pg 14

12. Eye protection is appropriate for wavelength

- Each operator of a Class 3b or Class 4 laser must wear protective equipment (e.g., eye wear and clothing) as appropriate. MSU Laser Safety Manual – Laser Usage Requirements pg 15
- Eye protection devices that are specifically designed for protection against radiation from Class 3B and 4 laser or laser systems shall be administratively required within the NHZ and their use enforced when engineering or procedural and administrative controls are not practicable. Eye Protection (Class 3B or Class 4), ANSI Z136.1-2014, 4.4.4.2.1
- All laser protective eyewear shall be clearly labeled with the OD and wavelength for which protection is afforded. Labeling of Laser Protective Eyewear, ANSI Z136.1-2014, 4.4.4.2.6

13. Warning/indicator lights can be seen through protective filters

- The VLT of the protective filter that is needed to accomplish the task should be considered to allow adequate visibility without reducing the OD necessary for laser protection. Visible Luminous Transmission (VLT), ANSI Z136.1-2014, 4.4.4.2.4

14. Viewing cards are used for alignment with proper PPE and power levels

- Wear laser eye protection and protective clothing to the extent practicable
- When aligning invisible (and in some cases visible) laser beams, use beam display devices such as image converter viewers or phosphor cards to locate beams
- Perform alignment tasks that use high-power lasers at the lowest possible power level
Alignment procedures, ANSI Z136.1-2014, 4.4.3.8

15. **Controls are located so that the operator is not exposed to beam hazards**
 - Each Class IIa, II, III, or IV laser product shall have operational and adjustment controls located so that human exposure to laser or collateral radiation in excess of the accessible emission limits of Class I and table VI is unnecessary for operation or adjustment of such controls. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10(f)(7)
16. **Operators do not wear watches or reflective jewelry while laser is operating**
 - The potential for specular reflections should be minimized by shields and by removal of all unnecessary shiny surfaces. MSU Laser Safety Manual- Laser Safety Practices, pg 14
17. **Viewing portals present where MPE is exceeded**
 - All viewing optics, viewports, and display screens incorporated into a laser product, regardless of its class, shall limit the levels of laser and collateral radiation accessible to the human eye by means of such viewing optics, viewports, or display screens during operation or maintenance to less than the accessible emission limits of Class I. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10(f)(8)
18. **Protective housing present and in good condition**
 - A protective housing shall be provided for all classes of lasers or laser systems (except as noted in Service Access Panels (All Classes), 4.4.2.1.4). The protective housing may require interlocks (Interlocks on Removable Protective Housings, 4.4.2.1.3) and labels (Laser Equipment Labels, 4.6.6). Protective Housings (All Classes), ANSI Z136.1-2014, 4.4.2.1
19. **Interlocks on protective housing**
 - Each laser product, regardless of its class, shall be provided with at least one safety interlock for each portion of the protective housing which is designed to be removed or displaced during operation or maintenance. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (f)(2)(i)
 - For each laser product, labels shall be provided for each defeatably interlocked (as described in paragraph (f)(2)(iv) of this section) portion of the protective housing which is designed to be displaced or removed during operation, maintenance, or service, and which upon interlock defeat could permit human access to laser or collateral radiation in excess of the limits of Class I. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)(7)
20. **Service access panel present**
 - Portions of the protective housing that are only intended to be removed from any laser or laser system by service personnel, which then permit direct access to laser radiation associated with a Class 3B or Class 4 laser or laser system, shall either:
 - i. Be interlocked (fail-safe interlock not required), or
 - ii. Require a tool for removal and shall have an appropriate warning label (see Laser Equipment Labels, 4.6.6) on the panel. Service Access Panels (All Classes), ANSI Z136.1 2014, 4.4.2.1.4

21. Fire extinguisher present with a current tag

- Equipment malfunctions can lead to electrical fires. In addition, electrical sparks can serve as an ignition source in the presence of a flammable vapor. Fire extinguishers designed for electrical fires shall be located where laser systems are in use. Electric Spark Ignition of Flammable Materials, ANSI Z136.1-2014, 7.2.1.3

LABELING**22. Certification Label present**

- Every manufacturer of an electronic product for which an applicable standard is in effect under this subchapter shall furnish to the dealer or distributor, at the time of delivery of such product, the certification that such product conforms to all applicable standards under this subchapter. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1010.2
- The certification shall be in the form of a label or tag permanently affixed to or inscribed on such product so as to be legible and readily accessible to view when the product is fully assembled for use, unless the applicable standard prescribes some other manner of certification. All such labels or tags shall be in the English language. Food and Drugs Chapter I--Food and Drug Administration-Department of Health and Human Services-Subchapter J-Radiological Health part 1010-Performance Standards for Electronic Products: General- Laser Products: Certification, 21 CFR 1010.2
- Such certification shall be based upon a test, in accordance with the standard, of the individual article to which it is attached or upon a testing program which is in accordance with good manufacturing practices. The Director of the Center for Devices and Radiological Health may disapprove such a testing program on the grounds that it does not assure the adequacy of safeguards against hazardous electronic product radiation or that it does not assure that electronic products comply with the standards prescribed under this subchapter. Food and Drugs Chapter I--Food and Drug Administration-Department of Health and Human Services-Subchapter J-Radiological Health part 1010-Performance Standards for Electronic Products: General- Laser Products: Certification, 21 CFR 1010.2
- In the case of products for which it is not feasible to certify in accordance with paragraph (b) of this section, upon application by the manufacturer, the Director, Center for Devices and Radiological Health may approve an alternate means by which such certification may be provided. Food and Drugs Chapter I--Food and Drug Administration-Department of Health and Human Services-Subchapter J-Radiological Health part 1010-Performance Standards for Electronic Products: General- Laser Products: Certification, 21 CFR 1010.2
- The modification of a laser product, previously certified under § 1010.2, by any person engaged in the business of manufacturing, assembling, or modifying laser products shall be construed as manufacturing under the act if the modification affects any aspect of the product's performance or intended function(s) for which this section and § 1040.11 have an applicable requirement. The manufacturer who performs such modification shall recertify and reidentify the product in accordance with the provisions of §§ 1010.2 and 1010.3. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (h)(2)(i)(ii)(i)

23. Class designation and appropriate warning label present

- In addition to the requirements of §§ 1010.2 and 1010.3, each laser product shall be subject to the applicable labeling requirements of this paragraph. Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)

24. Radiation output information on label

- Each Class II, III, and IV laser product shall state in appropriate units, at position 2 on the required warning logotype, the maximum output of laser radiation, the pulse duration when appropriate, and the laser medium or emitted wavelength(s). Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)(4)

25. Aperture label present

- Each laser product, except medical laser products and Class IIa laser products, shall have affixed, in close proximity to each aperture through which is emitted accessible laser or collateral radiation in excess of the accessible emission limits of Class I... Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)(5)
- All labels affixed to a laser product shall be positioned so as to make unnecessary, during reading, human exposure to laser radiation in excess of the accessible emission limits of Class I radiation... Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)(9)
- All equipment warning labels shall be conspicuously displayed in locations on the equipment where they best will serve to warn onlookers (see Equipment Labeling, 4.4.2.1.5). Equipment Label Format, ANSI Z136.1 2014, 4.6.6.1

26. Appropriate warning/danger sign at entrance to laser area.

- The Class 3B and Class 4 laser controlled area shall be posted with the appropriate area warning sign(s) (see Laser Controlled Area Warning Signs and Equipment Labels, 4.6). An appropriate area warning sign shall be posted at the entryway(s) and, if deemed necessary by the Laser Safety Officer (LSO), should be posted within the laser-controlled area. Indoor Laser Controlled Area Minimum Requirements (Class 3B or Class 4), ANSI Z136.1 2014, 4.4.3.5.1
- All signs shall be conspicuously displayed in locations where they best will serve to warn onlookers (see Indoor Laser Controlled Area Minimum Requirements (Class 3B or Class 4), 4.4.3.5.1 and Outdoor Control Measures (All Classes):General, 4.4.3.6.1). Location of Laser Controlled Area Warning Signs. ANSI Z136.1 2014, 4.6.4
- Laser controlled area signs prepared in accordance with previous revisions of this standard are considered to fulfill the requirement of this standard. Existing Laser Controlled Area Signs, ANSI Z136.1 2014, 4.6.5

27. Warning posted for invisible radiation

- On the labels specified in this paragraph, if the laser or collateral radiation referred to is:
 - i. Invisible radiation, the word “invisible” shall appropriately precede the word “radiation”; or
 - ii. Visible and invisible radiation, the words “visible and invisible” or “visible and/or invisible” shall appropriately precede the word “radiation.”

- iii. Visible laser radiation only, the phrase “laser light” may replace the phrase “laser radiation.” Food and Drug Administration-Department of Health and Human Services-Subchapter J- Radiological Health. Part 1040 – Performance Standards for Light-Emitting Products: Laser Products, 21 CFR 1040.10 (g)(8)

LOCATION

28. Area restricted to authorized personnel

- The Class 3B and Class 4 laser controlled area shall be controlled to permit lasers and laser systems to be operated only by personnel who have been trained in laser safety and in the operation of the laser or laser system. (see User Training 5.5). Indoor Laser Controlled Area Minimum Requirements (Class 3B or Class 4), ANSI Z136.1 2014, 4.4.3.5.1.a

29. Limited access to spectators

- A Class 3B laser controlled area should and a Class 4 laser controlled area shall be located so that access to the area by spectators is limited and requires approval as detailed in Spectators and Laser Controlled Areas (Class 3B or Class 4), 4.4.3.7 and Laser Use Involving the General Public, 4.5.1. Indoor Laser Controlled Area Minimum Requirements (Class 3B or Class 4), ANSI Z136.1 2014, 4.4.3.5.1.f

30. Failsafe interlocks or equivalent at entry to controlled area

- All Class 4 laser controlled areas shall incorporate one of the following alternatives:
 - i. Non-defeatable (non-override) area or entryway safety controls.
 - ii. Defeatable area or entryway safety controls
 - iii. Procedural area or entryway safety controls.
 1. Where safety latches or interlocks are not feasible or are inappropriate (e.g., during medical procedures or service procedures) the following shall apply (see Figure 2b):
 - a. All authorized personnel shall be adequately trained and adequate personal protective equipment shall be provided upon entry.
 - b. A door, blocking barrier, screen, curtains, etc., shall be used to block, screen, or attenuate the laser radiation at the entryway. The level of laser radiation at the exterior of these devices shall not exceed the applicable MPE, nor shall personnel experience any exposure above the MPE immediately upon entry.
 - c. At the entryway there shall be an area warning device indicating that the laser is energized and operating at Class 4 levels (see Area Warning Device (Class 3B or Class 4), 4.4.2.8) Entryway Controls, ANSI Z136.1 2014, 4.4.2.10.3

31. Nominal hazard zone determined

- Where applicable (e.g., in the presence of unenclosed Class 3B and Class 4 beam paths), the LSO may specify the Nominal Hazard Zone (NHZ). If the beam of an unenclosed Class 3B or Class 4 laser or laser system is contained within a region having adequate control measures to protect personnel from exposure to levels of radiation above the appropriate MPE, that region may be considered to contain the NHZ. The NHZ may be determined by information supplied by the laser or laser system manufacturer, by measurement, or by using the appropriate laser range equation or other equivalent assessment methods as described in this section and Appendix B. Nominal Hazard Zones, ANSI Z136.1 2014, 3.4.1

- The LSO shall ensure that consideration is given to direct, reflected and scattered radiation in the establishment of boundaries for the laser controlled area. The LSO may declare the laser use area as the NHZ in lieu of calculating all possible NHZ distances, such as in the case of a dedicated laser use room. Control measures are required within the laser controlled area and may fully enclose the NHZ when this area is limited in size (see Laser Controlled Area (Class 4), 4.4.2.10, Indoor Laser Controlled Area (Class 3B or Class 4), 4.4.3.5, Outdoor Control Measures (All Classes), 4.4.3.6, and Spectators and Laser Controlled Areas (Class 3B or Class 4), 4.4.3.7). Nominal Hazard Zones, ANSI Z136.1 2014, 3.4.1