Laser Control Measures

Control measures are implemented to eliminate or greatly reduce the possibility of eye or skin exposure to hazardous levels of laser radiation and other ancillary hazards associated with the use of laser systems. The potential for injury from a laser is determined by its classification, and therefore the control measures are also determined by the laser classification. The environment where the laser will be used and application of the laser are also factors to consider when determining the appropriate control measures to be applied. The control measures reviewed in this section are adapted from ANSI Z136.1-2014 (Safe Use of Lasers) and can be found in section 4 of this standard.

Laser safety control measures include administrative controls, such as procedures, training, warning signs, and personal protection, and engineering controls, which may include protective housing, interlocks, beam stops, barriers, and curtains. The combined use of both engineering and administrative control methods is effective in controlling the hazards associated with laser use.

A. Engineering Controls

1. Protective Housing, Interlocks

A protective housing is a physical barrier sufficient to contain the beam and laser radiation from exiting the laser system so that the maximum permissible exposure (MPE) is not exceeded on the outside surface. Protective housings must be interlocked so that the laser cannot operate when the housing is opened or removed. When the requirements of a protective housing are fulfilled then the laser system is considered a Class 1 laser and no further control measures are required.

2. Laser Use without Protective Housing

In the research environment lasers are often used without a protective housing in place. Typically the use of optical tables and optical devices are employed in order to manipulate the laser beam. In this environment, the EH&S Radiation Safety Office (617-496-3797) will evaluate the hazards and ensure that control measures are in place for safe operation. These control measures may include, but are not limited to:

- Access Restriction
- Area Controls
- Barriers, Curtains, Beam Stops
- Eye Protection
- Procedural Controls
- Training

3. Access Restriction

For Class 3b and 4 laser laboratories, access controls are required to prevent unauthorized personnel from entering the area when the laser is in use. Doors need to be kept closed when the laser is in

operation and locked when the laser is left unattended. A door interlocked with the laser shutter may be required.

4. Area Controls

For Class 3b and 4 lasers, area control measures are used to minimize laser radiation hazards. The area must be posted with the appropriate signage and include a lighted sign at the doorways indicating the "on" status of a laser system. Only authorized personnel who have been appropriately trained will be allowed to operate the laser. For open beam installations, a nominal hazard zone (NHZ) analysis will be performed.

5. Barriers, Beam Stops, Enclosures

Beam barriers, stops and enclosures are used to prevent beam propagation outside of the controlled access area in excess of the MPE. It is always desirable to enclose as much of the beam path as possible. As with a protective housing, the proper enclosure of the entire beam path may change the laser system to a Class 1 laser. When the beam needs to be directed to another area, such as between optical tables, enclosure of the beam is recommended. Physical barriers are used to prevent laser radiation from exiting the controlled area. Laser curtains and partitions are routinely used as laser containment systems. Rail curtains can be used to completely enclose an optical table or part of the laser system. Due to the power density of Class 4 lasers, consideration of barrier material regarding combustion must be given. Use beam stops to prevent the beam from leaving the optical table and to terminate the beam path. Beam stops are used behind optical devices in the event that the beam becomes misaligned.

B. Administrative Controls

Administrative controls are methods and instructions that promote laser safety in the laboratory.

1. Standard Operating Procedures (SOPs)

A written SOP must be established for normal, maintenance, and alignment operations. The SOPs will be maintained with the laser equipment for reference by operators or service personnel and can be used for instructional material to train new laser users in the facility. All SOPs will be updated to reflect any changes in laboratory protocol and equipment usage.

2. Warning Signs and Labels

All signs and labels must comply with ANSI Z 136.1 (2014) and the FDA/CDRH standards. Signs indicating “Caution” will be posted in all entranceways into laboratories containing Class 2 and Class 3a lasers equal to or less than the MPE. For class 3a lasers exceeding the MPE for irradiance and all Class 3b and Class 4 lasers, laboratories must be posted with "Danger" signs. In accordance with ANSI Z 136.1, the signs will include the laser class, wavelength, and laser output. For laboratories containing Class 3b and 4 lasers, a warning light indicating the laser "On" status must be placed at all entranceways into the laser room. Lasers are marked with the manufacturers' label according to FDA/CDRH regulations. For laser systems developed in house, call the Radiation Protection Office to evaluate the laser for proper labeling.

3. Eye Protection

Eye protection is required for Class 3b and 4 lasers when engineering and administrative controls are inadequate to eliminate potential exposure in excess of the applicable MPE. The use of laser protective eyewear is especially important during alignment procedures since most laser accidents occur during this process. Protective eyewear must be labeled with the absorption wavelength and optical density (OD) rating at that wavelength. In addition to selecting the appropriate OD for safe viewing, one should consider the percent of visible light transmitted to the eye while wearing eye protection so that the beam can be adequately seen without the need to remove the protective eyewear. Comfort and fit are important factors when selecting protective eyewear.

4. Skin protection

Skin effects can be of significant importance with the use of lasers emitting in the ultraviolet spectral region. The potential for skin injury from the use of high power lasers can also present a severe hazard. For some laser systems using an open beam, skin protection may be necessary. Covering exposed skin by using lab coats, gloves and an UV face shield can protect against UV scattered radiation. Adequate skin protection may be required for certain applications using high power laser systems.

Email **radiation_safety@harvard.edu** to send comments and suggestions to the EH&S Radiation Protection Office.