CASE WESTERN RESERVE UNIVERSITY EST. 1826

Guidance for Laser Site Standard Operating Procedures

Section 1: Site Standard Operating Procedures

All Principal Investigators are required to write standard operating procedures (SOP) for all laser operations involving Class 3B and Class 4 lasers detailing alignment, operation and maintenance procedures. The SOP should be posted or attached to the inside of the lab door.

Class 3B and 4 lasers with enclosed or embedded laser beams, present no real hazard, as long as the enclosure or housing is intact. Other associated residual hazards must be addressed. These would include liquids, toxic plumes, use of gases and cylinders, electrical shock, to name a few.

For instances where the housing is removed allowing exposure of the embedded laser beam, then all the applicable safety requirements for that laser class must be thoroughly addressed.

Class 3B and 4 lasers with open beams, to include instances of housing removal, will require a more thorough site SOP that should address the applicable topics noted below:

All site SOP's should reference the CASE Laser Safety Manual, the CASE Laser Safety slide presentation, and each applicable manufacturer's laser manual.

A separate guidance sheet is available for addressing Controlled Entrance, Containment Curtains, Control Circuits for use of open Class 4 Laser Beams.

A. SOP's must include procedures to address when:

1. Use of eyewear, shields, and access control are necessary.
2. Two or more Class 3B or Class 4 lasers will be used in the same area by different operators without permanent, intervening barriers.
3. An interlock bypass is installed that does not conform to the conditions of the Laser Safety Manual.
4. A Class 3B or Class 4 laser will be used by non-University personnel;

(e.g., contract personnel or visiting colleagues).

5. A laser installation does not include all the required controls specified in this program (e.g., temporary operations).

6. Class 3B or Class 4 laser or laser system is operated off campus.

7. Other hazards may be involved that require an SOP (e.g.., acutely toxic gases, unattended laser operation).

B. A log must be maintained showing periods of use, service, maintenance and incidents.

C. Labels: A laser classification label must be conspicuously affixed to the laser housing.

D. Warning Signs: Each entrance must be posted with an appropriate danger, caution, or warning sign in accordance with ANSI Z136.1-2014.

E. Warnings Devices: Entrances to laboratories with a Class 3B or 4 laser shall have a lighted indicator that is fail-safe interlocked with the laser to activate when the laser is energized. The sign must be tested monthly. A written record must be kept of each test in the log book (see section 10.3).

F. Safety Interlocks

1. Access doors to a controlled laser area in which a Class 3B or a Class 4 laser is being operated must be equipped with safety interlocks to prevent laser operation when the interlock circuit is broken.

2. All protective enclosures that surround laser devices and high-voltage electrical sources must also be equipped with interlocks to prevent operation of the equipment.

3. Interlocks should be tested quarterly to ensure that they are operational . A written record must be kept of each test in the log book.

4. Interlocks must be designed so that after they are actuated, the capacitor banks, shutters, or power supplies cannot be re-energized except by manually resetting the system.

G. The responsible individual in a laser area controlled by a “warning light” is permitted to momentarily override (bypass) door interlocks to allow access of authorized persons if all of the following conditions are met:

1. There is no laser radiation hazard at the point of entry.

2. The necessary protective devices are worn by the personnel entering the area.

3. An interlock bypass circuit is designed into the interlock control system. This bypass circuit must only be operated from inside the interlocked area. It must delay no more than 15 seconds before shutting down the system.

4. If interlocks are not feasible, the Principal Investigator may consider the use of alarms or voice warnings.

H. Laser laboratories and controlled areas must be designed so that personnel can enter and leave under emergency conditions.

I. Lasers must have a master switch with a key or coded access that prevents use once the key has been removed or a code has been entered. The key must not be left in the control panel when the laser is not in use.

J. Laser Activation Warning Systems: An alarm, a warning light, or a verbal "countdown" command must be used during activation and start up.

K. Lasers must have a permanently attached beam stop or attenuator and emission delays.

L. Laser controlled areas shall be established which have limited access, covered windows and doors, and only diffuse reflective material. The facility must be a fully enclosed room or laboratory with floor-to-ceiling walls. Access to the area during laser operation requires the permission of the responsible operator.

M. Class 3B and 4 infrared laser beams with a wavelength greater than or equal to 710 nm must be terminated with fire resistant material.

N. Securely fasten all mirrors, prisms, beam stops, etc. in the beam path. Ensure that the laser is also securely fastened.

O. Circuit breakers must be identified for each laser.

P. Beam Enclosure : The entire beam path of Class 3 and Class 4 lasers, including the target area, should be surrounded by an enclosure equipped

with interlocks that prevents operation of the laser system unless the enclosure is properly secured. When total enclosure of the laser beam path is not practical, both the non-enclosed laser beam and any strong reflections must be terminated at the end of their useful path using such devices as backstops, shields or beam traps.

Q. Reflectance Control

1. Materials that diffusely reflect laser radiation must be used in place of specularly reflective surfaces wherever possible.

2. To minimize personnel exposure, specularly reflecting surfaces that are needed for beam-path control should be enclosed or shielded.

R. Invisible Beams

1. Ultraviolet (UV) and infrared (IR) lasers that emit invisible beams require several additional controls:

a. Visual or audible beam-warning devices must be installed in areas where personnel may be exposed to radiation in excess of the MPE. These warning devices must be clearly identified and visible from all areas of potential exposure.

b. Shielding must be installed that will attenuate UV radiation to levels below the MPE for the wavelength being used.

c. Hazardous concentrations of by-products formed by the reaction of intense UV radiation with materials in the area must be controlled.

d. IR beam enclosures and backstops must be fabricated of IR-absorbent material. For Class 4 lasers, the absorbent material must also be fire-resistant.

S. Beam Mapping : Controlled laser areas must be surveyed with appropriate measuring devices to locate and identify direct and reflected beams that exceed the MPE; shielding may be required to limit unwanted radiation.

T. Direct Viewing

1. Personnel must never look directly into any laser beam unless such action is specifically approved by EHS.

2. The primary beam and specular reflections of Class 3B or Class 4 lasers are particularly hazardous. In those cases where it is necessary to directly view a beam from a Class 3 or Class 4 laser, special provisions, such as filters, are mandatory.

3. An SOP must be prepared for operations where the beam of a Class 3B or Class 4 laser must be viewed directly or where it is necessary to work with optical viewers in close proximity to the laser beam.

U. Alignment

1. High-power laser optical systems must never be aligned by direct beam viewing if the radiant exposure or irradiance exceeds the MPE.

2. Use low-power lasers, diffuse reflectors, image-retaining screens, exposed Polaroid film, and other devices that will minimize eye exposure.

V. Optical Viewing Aids

Using optical systems such as cameras, telescopes, microscopes, etc., to view laser beams may increase the eye hazard. Therefore, all collecting optics must incorporate suitable means (such as interlocks, filters, or attenuators) to prevent eye exposures above the MPE.

W. Protective Equipment

1. Laser protective eye wear shall be worn whenever MPE levels may be exceeded.

2. However, it is good practice to always wear eye protection when lasers are in use.

3. In general, eye wear provides protection over a narrow range of the laser spectrum. Eye wear designed for protection at one wavelength may afford little or no protection at another wavelength.

4. Consult eye wear manufacturers and EHS for proper selection of protective eye wear (see section 9.1).

5. Laser protective eye wear must be approved by the American National Standards Institute (ANSI) and clearly labeled with optical densities and wavelengths for which protection is afforded. Eye wear

must be inspected periodically by the user for pitting and cracking of the attenuating material, and for mechanical integrity and light leaks in the frame.

6. Protection for the skin may be afforded through the use of clothing to cover normally exposed skin areas.

X. Unattended Equipment

1 . When lasers are to be left unattended, de-energize the power supplies or capacitor banks and remove the keys from power switches or master interlocks to prevent unauthorized activation of the equipment.

2. The operation of unattended lasers is only allowed when a specific SOP has been written and approved by the Principal Investigator.

Y. Temporary Installations

1. Occasionally, it may be necessary to remove protective enclosures or override equipment interlocks or other safety devices for service adjustments, maintenance, special training exercises, etc.

2. In these instances, a temporary controlled laser area must be set up. Specific methods for handling situations of this type must be described in the SOP.

3. Because the area will not have all the standard safety features, the SOP must describe provisions for protecting exposed personnel.

4. When the entire beam path is not fully enclosed, restrict access into the area to persons wearing proper protective equipment. Make sure that all optical paths from the restricted-access area are adequately covered to prevent escape of laser radiation greater than the MPE for the eye.

Z. Refer to the ANSI Z136.1-2014 for further guidance on control measures for various classifications of lasers.

Section 2: Converting to a Class l Enclosed Laser

A. Any laser or laser system can be converted to a Class 1 enclosed laser by including all of the following controls in the laser system design. These

controls will effectively enclose the laser, thus preventing personnel contact with the emitted radiation while permitting unrestricted access into the area.

1. Protective Housing

   a. House the laser system within a protective enclosure to prevent escape of laser radiation above the MPE.

   b. The protective housing must prevent personnel access to the laser system during normal operations.

   c. Personnel entering the enclosure to perform maintenance or adjustment tasks must be made aware of the higher risks and comply with the control measures for the higher risk laser class.

2. Safety Interlocks

   a. Install safety interlocks wherever the protective enclosure can be opened, removed or displaced.

   b. When activated, these interlocks must prevent a beam with a radiant energy above the MPE from leaving the laser or laser system .

   c. Service adjustments or maintenance work performed on the laser system must not render the interlocks inoperative or cause exposure levels outside the enclosure to exceed the MPE, unless the work is performed in a laser area with limited access and appropriate safeguards, supervision and control.

3. Fail-Safe Design: The protective enclosure and the laser system must be designed and fabricated so that if a failure occurs, the system will continue to meet the requirements for an enclosed laser operation.

4. Modifications: Modifications to commercial laser systems must be evaluated. Contact the LSO for an evaluation. If the modifications decrease the safety controls, an SOP will be required.

5. Attenuated Viewing Windows: Use viewing windows containing a suitable filter material that will attenuate the transmitted laser radiation to levels below the MPE under all conditions of operation.

6. Warning Signs and Labels

a. Label the enclosure with "CAUTION-ENCLOSED LASER" signs.

b. Attach a label directly to the laser which gives the laser classification in the absence of the enclosure. Make sure that the label can immediately be seen when the enclosure is opened.

B. Controlling Associated Hazards

1. Many chemical and physical hazards other than laser radiation can be found in the laser area that must also be adequately controlled.

2. Electrical Equipment and Systems - Always be aware of the high risk of injury and fire in laser operations because of the presence of electrical power sources.

3. The installation, operation, and maintenance of electrical equipment and systems must conform to the standards stated in the National Electric Code. Contact Physical Plant for assistance.

C. Lighting

1. Adequate lighting is necessary in controlled areas.

2. If lights are extinguished during laser operation, provide control switches in convenient locations or install a radio controlled switch.

3. Luminescent strips should be used to identify table and equipment corners, switch locations, aisles, etc.

4. When natural light is not sufficient for safe egress from a laser area during an electrical power failure, install emergency lighting.