

# General Laser Safety

April 2013

- Only trained, authorized personnel may operate lasers. Training is to be documented for each employee.
- NEVER put yourself into any position where your eyes approach the axis of a laser beam (even with eye protection on).
- Keep beam paths below or above standing or sitting eye level. Do not direct them towards other people.
- Do not damage laser protective housings, or defeat the interlocks on these housings.
- Eliminate all reflective material from the vicinity of the beam paths.
- Never use viewing instruments to look directly into a laser beam or its specular reflection. If this is necessary, install an appropriate filter into the optical element assembly.
- Keep ambient light levels as high as operations will permit.
- Follow departmental rules when performing high power laser operations after normal working hours.
- Visitors should not be permitted to observe a laser experiment without first receiving a laser safety briefing and being issued laser eye protection. They will be escorted by knowledgeable personnel at all times.

## **Class 3b Requirements**

1. Doors must be closed and locked during laser operations.
2. Doors must be properly posted and the warning light energized during operations.
3. Door windows and labs windows must be covered to prevent the escape of a laser beam, unless an interlocked laser beam path enclosure is provided.
4. Do not aim the laser at an individual's eyes
5. Permit only properly trained and authorized personnel to operate the laser.
6. Enclose as much of the beam path as possible.
7. Place appropriate beam stops at the end(s) of the useful beam path(s).
8. Restrict the access of unauthorized personnel: control spectators.
9. Operate the laser in a controlled area in the SOP)
10. Employ a warning light or buzzer to indicated laser operation if appropriate, especially for invisible (UV or IR) lasers.
11. Locate the plane of the laser beam & associated optical devices well above or below the eye level of the observers whenever possible.
12. Firmly mount the laser to ensure the beam does not stray from the intended path.
13. Use proper eye protection if eye exposure to the direct beam or a specular reflection is possible.
14. Do not view the beam or its specular reflection with collecting optics without sufficient eye protection.

15. Remove all unnecessary reflective surfaces from the area of the beam path.
16. Should develop SOP for laser operation.

#### **Class 4 Requirements (includes all Class 3b requirements and the following)**

1. Develop SOP's for laser operation.
2. Incorporate key control of master switch that can terminate beam operations.
3. Establish entryway safety controls to allow both rapid egress by laser personnel at all times and admittance to the controlled area under emergency conditions.
4. Provide for and ensure use of proper eye protection for everyone within the controlled area.
5. Use appropriate shielding between personnel and any beam having sufficient irradiance to pose a serious skin or fire hazard.
6. Use remote viewing methods where feasible (e.g. video monitoring) to accomplish any necessary viewing of the beam.
7. Construct non-specular absorbent beam stops of fire resistant materials.
8. Use adequate ventilation and vented enclosures when dealing with excimer lasers due to the presence of toxic gases and fumes.
9. Use proper window coverings for exterior windows and door windows as needed.

#### **Shared Laser/Non-Laser Space**

*Class 3b and 4 Laser Labs.* Labs will be arranged so that non-laser personnel will not have to pass through laser areas to enter or leave the lab. This can be done through lab design, or the use of movable partitions or interlocked curtains.

#### **Use of Laser Eye and Skin Protection**

Laser protective eyewear must be worn whenever you are within the Nominal Hazard Zone (NHZ). The NHZ is defined as that area within which the laser beam power exceeds maximum permissible exposure levels. During maintenance or alignment operations, the NHZ extends to the entire lab or to the partitioned laser use area. Once the laser beam path is well defined and contained to a specific area, the NHZ may be reduced in size to the area where the experiment is taking place. Note that Class 4 lasers can produce hazardous diffuse reflections, and that the NHZ for laser experiments must be extended to account for diffuse reflection hazards from your experiment.

1. Eyewear must be of the correct optical density and offer protection at the wavelength(s) of the laser(s) being used.
2. Eyewear will only protect your eyes for short time periods, depending on the laser power. Therefore do not look directly into any laser beam, even with laser eye protection on.
3. Periodically inspect and replace damaged or defective eyewear.
4. Exposure to direct or diffuse reflections from ultraviolet lasers (particularly excimers) can result in short and long term skin hazards. Cover your exposed skin areas when working near these lasers (use long sleeve shirts or lab coats, cloth gloves , etc. as necessary).
5. Exceptions:
  - a. Lower optical density eyewear may be used when a laser beam must be seen. This eyewear is chosen to eliminate the diffuse reflection hazard.
  - b. If a diffuse reflection must be observed, do this after the beam path is well defined and away from the area that the diffuse reflection will be viewed from. During viewing, your eyes may not come within the diffuse reflection hazard distance.

### **Laser Alignment Practices**

1. Never look directly into a laser beam. Do not bring your eyes near the axis of any beam to perform an alignment (or any other operation).
2. Wear laser skin and eye protection.
3. Use a low power laser for alignments. If this is not possible, adjust your laser to minimum power levels and/or use a filter to bring down the power to safe levels.
4. Use viewers or viewing cards to sight where an invisible beam is. To sight where a visible beam is, use lower optical density laser protective eyewear (see below) or sight beams with a non-specular, dark colored viewing card.

### **Laser Beam Termination**

1. Terminate laser beams at the end of their useful path with immovable, non-specular, fire retardant beam stops or targets.
2. Do not allow open beams to cross aisle ways.
3. Choose target materials that partially absorb the laser beam.
4. Unused secondary beams emerging from alternate laser apertures will be terminated.
5. Terminate all unused beams.
6. Every time that a beam hits an optical element in your beam path, a portion of the beam will be reflected. This is of particular concern with an invisible beam and when a prism or angled optical element is used. Block all reflections and prevent them from leaving the experimental area. Even a 1% reflection from a high power YAG laser beam can cause instantaneous eye damage.

### **Non-Beam Hazards**

- a. *Electrical Safety*

- a. Practice Lock-Out/Tag-Out procedures where appropriate.
  - b. Do not defeat laser housing interlocks or come into contact with energized electrical circuits.
  - c. Do not wear jewelry or metallic objects when working near a high voltage source.
  - d. In case of emergency, press the Emergency Power Off button in your lab to turn off the electricity to your lab.
2. *Chemical Safety*
- a. Follow the precautions in your Lab Safety Plan when working with chemicals in your lab. Before working with chemicals you must have attended OSHA Laboratory Safety training.
  - b. Work shall be performed in hoods where required. Use appropriate personal protective equipment, including safety glasses/goggles, gloves, respirators, etc., as required.
  - c. Follow the precautions listed on the Material Safety Data Sheets for your chemicals.
  - d. Many dyes and dye solvents are either known or suspected carcinogens. In addition to the above, you must have a containment tray or system to contain any dye spill which may occur within your laser.
3. *Gas Safety*
- a. Store hazardous gases in vented gas cabinets. Provide laser housing ventilation for those lasers (e.g. excimers) that use hazardous gases.
4. *Airborne Contaminants*
- a. High power lasers interacting with a target or sample may cause airborne contaminants to be released to the air. Use a hood or other ventilation system to remove these contaminants from the ambient air.
5. *Noise Safety*
- a. Wear hearing protection when in the vicinity of a laser that generates noise levels exceeding 85 dB.
6. *Cryogenic Safety*
- a. Wear protective gloves, face shields, and clothing, as required when handling cryogenic materials.
7. *X-Ray Safety*
- a. Power supplies operating at potentials above 15 kV may produce X-rays. Leave interlocked power supply doors in place. Do not defeat the door interlocks and open these doors when the power supply is on.

## **Service and Maintenance Procedures**

1. Wear laser skin and eye protection.
2. Set up a temporary controlled area that restricts access to the nominal hazard zone. Post warning signs as required.
3. When access cannot be adequately restricted, use partitions or curtains to prevent the beam from leaving the area.
4. Work carefully. Take the time needed to service the laser properly.

5. Remove only the minimum number of protective housings required to do the work. Replace the housings promptly when done.
6. Use the lowest possible laser power.
7. Use indirect viewing instruments or targets to align the beam. Do not look directly at a potentially hazardous beam or specular reflection.
8. After servicing, reactivate all safety features.

### **Accident/Emergency Procedures**

1. In case of an emergency, dial 911 for assistance.
2. Emergency response personnel will be directed to you as necessary.
3. An Emergency Power Off button is located in the lab to shut down power to the lab.
4. Notify the lab manager and the Laser Safety Officer.