



ADVISORY 19.1
LASER SAFETY PROGRAM

SCOPE

This program applies to all lasers and laser systems operated by University of Cincinnati. This program is based on guidance of ANSI Z136.1-2014, *American National Standard for Safe Use of Lasers*. The proper implementation of this program will assure that laser exposures are always below the maximum permissible exposure (MPE) limits.

LASER SAFETY OFFICER

An individual designated as the Laser Safety Officer (LSO) shall have the responsibility and authority to assure compliance with this program. The LSO shall:

- Assure the proper classification of all lasers
- Perform hazard evaluations for all class 3B and 4 lasers and laser work areas
- Specify control measures for all class 3B and 4 lasers and assure implementation
- Approve procedures, SOPs, protective equipment, signs and labels
- Assure that all laser personnel receive appropriate safety training
- Monitor the program and assure compliance
- Maintain program records

The LSO shall have final authority in determining laser control measures and may approve alternate controls when these are appropriate based on the judgment of the LSO. Class 3B and class 4 lasers shall be operated only with the written approval on the LSO. The LSO shall have the authority to terminate laser operations at any time.

The LSO may appoint a Deputy Laser Safety Officer (DLSO) and may delegate duties to the DLSO in accordance with ANSI Z136.1.

LASER CLASSES

Class 1 laser systems are incapable of producing damaging radiation levels during normal operation and are exempt from any control measures. Class 1 laser systems may contain higher class lasers and may produce laser hazards if operated with interlocks defeated. Only authorized personnel may operate class 1 laser systems with interlocks defeated. Operators of class 1 laser systems with embedded class 3B or class 4 lasers shall receive a laser safety briefing.

Class 1M laser systems are incapable of producing hazardous exposure conditions during normal operation unless the beam is viewed with optical instruments. Operators of class 1M laser systems shall receive a laser safety briefing.

Class 2 laser systems emit visible light only at a power level of 1 milliwatt or less. The normal aversion response to bright light is adequate protection. Staring into the beam of a class 2 laser is hazardous. Operators of class 2 laser systems shall receive a laser safety briefing.

Class 2M laser systems emit visible light only. The normal aversion response to bright light is adequate protection for unaided viewing. However, viewing the beam with optical aids is potentially hazardous. Operators of class 2M laser systems shall receive a laser safety briefing.

Class 3R laser systems are potentially hazardous under some viewing conditions, but the probability of an actual injury is small, and the control measures for safe use are straightforward. Most laser pointers fall in this class. Operators of class 3R laser systems shall receive a laser safety briefing. (Most lasers previously classified as class 3a fall in this category.)



Class 3B laser systems are eye hazards for intrabeam viewing and specular reflections, even for momentary exposures, but diffuse reflections are not usually hazardous. Class 3B laser systems shall be operated only in laser controlled areas by authorized operators. Operators of class 3B laser systems shall receive approved laser safety training.

Class 4 laser systems are eye hazards and skin hazards for intrabeam exposures, specular reflections, and diffuse reflections. They are also fire hazards and may produce laser generated air contaminants. Class 4 laser systems shall be operated only in laser controlled areas by authorized operators. Operators of class 4 laser systems shall receive approved laser safety training. A written Standard Operating Procedures (SOP) is required for class 4 laser operation.

TRAINING REQUIREMENTS

All operators of class 1, 1M, 2, 2M, and 3R lasers and laser systems and all incidental personnel or spectators who may be allowed to enter laser controlled areas shall receive a laser safety briefing before operating the laser or entering the controlled area.

All operators of class 3B and 4 lasers shall receive approved laser safety training before operating the laser.

MEDICAL SURVEILLANCE

Baseline eye exams are not required. An eye exam is required immediately following a suspected hazardous exposure. Laser personnel shall report any suspected hazardous exposure to the Laser Safety Officer immediately.

CONTROL MEASURES

All class 3B and 4 lasers shall be operated in a laser controlled area. The requirements for individual laser controlled areas shall be determined by the LSO. The minimum requirements for laser controlled areas are:

- Entryway controls to allow only authorized personnel or approved spectators to enter the laser control area. (Administrative controls are acceptable.)
- Laser safety eyewear available and used in accordance with the SOP for class 3B and 4 lasers.
- Beam control (barriers and beam blocks) to limit laser hazards within the controlled area and line of sight to entryway.
- Written SOP for class 4 lasers. (Recommended but not required for class 3B lasers)
- Training of operators of all class 3B and 4 lasers.

EYEWEAR POLICY

Laser safety eyewear is normally required for the operation of class 4 lasers with exposed beams. Laser safety eyewear is normally required for the operation of all class 3B invisible lasers and for class 3B visible lasers with powers greater than 15 mW. Eyewear is not required by policy for class 3B visible lasers with powers of 15 mW or less if other controls are adequate. The LSO will require eyewear or approve laser operation without eyewear on an individual basis based on a hazard evaluation performed by the LSO.

RESPONSIBILITIES OF EMPLOYEES WORKING WITH LASERS

Employees who work with class 3B or 4 lasers with the beam exposed shall:

- Energize or work with lasers only when authorized to do so.
- Comply with laser safety rules and work procedures.
- Notify their supervisor or the LSO in case of potential accident or injury or suspected unsafe condition.



AUDITS

An audit of all class 3B and 4 lasers and the Laser Safety Program shall be conducted annually by the LSO.

RECORDS

The LSO shall maintain records which document the Laser Safety Program. These records shall include:

- Laser hazard analysis reports for all class 3B and 4 lasers
- Training records for all operators of class 3B and 4 lasers
- Standard Operating Procedures for all class 4 lasers
- Approvals of alternate laser control measures
- Laser Safety Audit reports



LASER LAB PROCEDURES

Scope: These procedures apply to all activities in the Optical Lab where there is potential access to a class 3b or class 4 laser beam.

1. **Laser Description:**

Diode Laser: Wavelength: 850 nm; Maximum Average Power: 100 mW; Class 3b.
Argon Laser: Wavelength: 488 nm; Maximum Average Power: 5 W; Class 4.
Additional laser sources at other wavelengths may be added and will be described in the appendices.

2. **Hazards**

The primary hazard associated with the lasers is an eye hazard from direct or reflected beams. Invisible, open beams may be present and must be controlled by the laser operator. High power devices and collimated beams produce greater hazard distances. Class 4 lasers produce diffuse reflection hazardous.

3. **Eyewear**

Approved laser safety eyewear with an optical density of at least 2.2 at 850 nm must be worn by all persons inside the lab when the diode laser is energized. Approved laser safety eyewear with an optical density of at least 4 must be worn during argon laser alignment and if the beam and reflections are not terminated by beam blocks and barriers. Laser operators are cautioned to avoid direct observation of the output of laser diodes or optical fibers without approved laser safety eyewear.

4. **Additional Control Measures**

- A. Entryway controls consist of an automatic light warning panel. All lasers will be powered from a separate Laser Circuit. If this circuit is not energized, the green light will be on. Energizing the Laser Circuit will automatically turn on the red light.
Green indicates no laser hazard is present. The area may be entered safely by authorized personnel without eyewear.
Red indicates that a laser is in operation and an open beam hazard may be present. All personnel entering the laboratory must wear approved laser safety eyewear.
- B. **Authorized Operators** will have card key access and may enter the laboratory at any time. Operators are responsible for following all provisions of this SOP at all times
Observers may enter the laboratory upon approval of the laser operator after completing Laser Safety Awareness Training, reading and understanding this procedure, and signing a statement of understanding.
Visitors may enter the laboratory upon approval of the laser operator after reading and understanding this procedure and signing a statement of understanding.
- C. Laser beams will be initiated in a controlled manner with the beam terminated on a specific target or a diffusely reflecting surface. The laser operator will notify all personnel in the laboratory before a laser beam is initiated. When practical beam paths at sitting or standing eye level will be avoided.
- D. Only authorized personnel may align laser beams or move any lasers or optics while lasers are in operation.
- E. Safety curtains or other approved barriers will prevent a laser hazard at the entryway. The laboratory must be light tight with covered windows.

5. **Required Training:** Advanced Laser Safety training is required of all personnel before they will be authorized to operate the lasers with the beam accessible.

6. **Eye Examinations**

Eye examinations are required of all authorized operators in compliance with ANSI Z-136.1-2000.



7. **Emergency Procedures**
In case of emergency call Emergency Response at 911.
Also notify Environmental Health and Safety at 513-383-3242.

Report all incidents to EH&S Director at 513-556-4968.

8. **Authorization of the LSO is required for:**
Modification of any laser or laser system,
The initial operation of a new laser sources,
Changes to operation or safety procedures.

9. **Authorized Personnel**
The following personnel are authorized to operate class 3b lasers in this laboratory:



SOP for R&D Use of Class 3B Lasers

Scope: This SOP applies to the use of all class 3B lasers in R&D activities or in situations in which detailed written procedures have not yet been completed. (Note that class 4 lasers produce greater hazards and require individual detailed SOPs.)

1. **Laser Descriptions:** Several visible class 3B lasers are used in class 1 laser products. These lasers include:

- 60 mW @ 405 nm (diode laser)
- 35 mW @ 658 nm (diode laser)
- 10 mW @ 670 nm (diode laser)
- 150 mW @ 532 nm (DPSS laser)

Other visible and invisible class 3B lasers may also be used in R&D areas.

2. **Hazards**

Laser hazards from class 3B lasers consist of eye hazards from direct or reflected laser beams. Diffuse reflections (scattered light) are not hazardous. Only laser beam hazards are considered in this document.

3. **Control Measures**

A. Class 3B lasers may be operated with the beam exposed only in laser controlled areas except for specific test procedures approved by the LSO.

B. Class 3B lasers may be operated only when mounted in a mount approved by the LSO and with the beam terminated in a manner approved by the LSO. Laser personnel must control the beam path to prevent misdirected or reflected beams and must not allow reflective or shiny objects in or near the beam path.

C. Laser safety eyewear is required for open beam invisible class 3B lasers. All laser safety eyewear must be approved by the LSO. Eyewear is recommended for visible class 3B lasers for procedures that are not part of the normal test sequence or are not well documented.

4. **Required Training:** Laser Safety training is required before personnel will be authorized to operate class 3B lasers with the beam exposed. All R&D laser use must be approved by the LSO.

5. **Emergency Procedures:** Report all incidents or safety concerns to the Laser Safety Officer or the Deputy LSO.

6. **Authorization of the LSO is required for:**

- Modification of any laser or laser system,
- The initial operation of a new laser sources,
- Changes to operation or safety procedures.

7. **Authorized Personnel**

The following personnel are authorized to operate class 3b lasers in this laboratory:



SOP for R&D Use of Class 4 Lasers

Scope: These procedures apply to all activities in the Laser Controlled Area when to a class 4 laser beam is accessible.

1. Laser Descriptions

Ti:Sapphire Laser (class 4):

Wavelength: 800 nm
Maximum Average Power: 1 W
Beam Diameter: 1.5 mm
Beam Divergence: 0.81 mrad

Nd:YAG Laser (class 4):

Fundamental Wavelength: 1064 nm	Double Wavelength: 532 nm
Maximum Average Power: 2.5 W	Maximum Average Power: 1 W
Beam Diameter: 1.2 mm	Beam Diameter: 1.0 mm
Beam Divergence: 1.24 mrad	Beam Divergence: 0.75 mrad

2. Hazards

The primary hazard associated with these lasers is an eye hazard from direct or reflected beams. Invisible, open beams may be present and must be controlled by the laser operator. Diffuse reflections may be a hazard, but the Diffuse Reflection NHZ is typically less than 20 cm.

3. Eyewear

Approved laser safety eyewear with the following optical densities is available in the laboratory:

Ti:Saph @ 800 nm	OD 7
Nd:YAG @ 1064 nm	OD >5.5
Nd:YAG @ 532 nm	OD >5.5

All personnel in the Laser Controlled Area are required to wear the appropriate eyewear during laser operation except in the following circumstances.

- During sample change eyewear may be removed if the laser shutter is closed.
- During work at the computer workstation eyewear may be removed for brief periods after authorization by the LSO if the person who will work without eyewear has performed a safety check to verify that there are no stray reflections in the area of the workstation immediately before removing eyewear. If IR beams are in use, a thorough safety check using an IR viewer is required.

4. Additional Laser Control Measures

- The Laser Controlled Area is bounded by a laser barrier curtain. Only **Authorized Laser Operators** and approved visitors are allowed inside the Laser Controlled Area during laser operation. **Visitors** may enter the Laser Controlled Area only upon approval of the laser operator after they have received a safety briefing.
- Laser beams will be initiated in a controlled manner with the beam terminated on a specific target or a diffuse reflecting surface. Safety checks will be performed regularly and following any optical path change to confirm that no stray reflections leave the laser tables.
- Only Authorized Laser Operators are allowed in the Laser Controlled Area during **laser and optical alignment**. Alignment will be accomplished using the lowest practical power. A safety check must be performed after beam alignment. All stray reflections will be blocked as near their source as possible with diffuse reflecting beam blocks.

- Required Training:** Laser Safety training is required of all personnel before they will be authorized to operate the lasers. Authorization by the LSO is required.



6. **Emergency Procedures**
In case of emergency turn off all lasers and notify the Laser Safety Officer.

7. **Authorization of the LSO is required for:**
Modification of any laser or laser system,
The initial operation of a new laser sources,
Changes to operation or safety procedures.

8. **Authorized Personnel**
The following personnel are authorized to operate class 4 lasers in this laboratory:
