AUBURN UNIVERSITY LASER SAFETY
STANDARD OPERATING PROCEDURES

PRINCIPAL INVESTIGATOR: _____

DEPARTMENT: _____

BUILDING/ROOMS CONTAINING LASERS: _____

LASER USERS: _____

DATE: _____

For your current laser inventory, fill out the attached Laser Registration Form for each laser.

A. LASER SAFETY TRAINING

There are two required components of laser safety training:

1. **General laser safety training:**

   This is conducted by Radiation Safety via an on-line Laser Safety Training (https://cws.auburn.edu/OHS/Training.aspx/Info/Laser%20Safety).

   All persons on campus who will be operating Class 3b and/or Class 4 lasers are required to complete the Radiation Safety laser safety training -- ideally before starting to operate lasers. General laser safety principles are covered including engineering, administrative and personal protective laser safety controls, biological effects of laser radiation, frequent causes of laser accidents, non-beam hazards, and human behavioral factors as they relate to laser safety.

   On-the-job/hands-on training:

   This is to be conducted by the Principal Investigator or an experienced senior researcher in the laboratory. All persons must be provided with adequate on-the-job training so that they are sufficiently competent to operate their lasers independently and safely, and feel comfortable doing so. All appropriate operational procedures (laser system startup, alignment, shut-down, etc.) need to be covered in this training, including the needed safety equipment and other safety-related considerations.

B. WARNING SIGNS AND ACCESS CONTROL

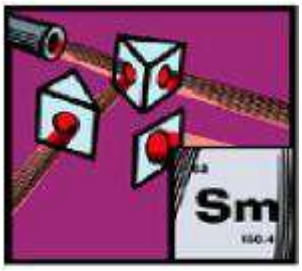
All rooms in which lasers are operated must be posted with permanent door-type laser warning signs that include the all information appropriate to the lasers operated within the rooms (e.g., laser types and classes, output characteristics). Doorknob-type warning signs ("Do not enter", "Alignment in progress", "Laser operating inside") should be temporarily posted in cases when persons intending to enter rooms or enter laser use areas need to be alerted regarding potentially enhanced hazards such as during beam alignments.

All types of laser warning signs are available at [Auburn University Door Sign Creator](https://cws.auburn.edu/rmsDoorSign/Login.aspx) (https://cws.auburn.edu/rmsDoorSign/Login.aspx)

In cases in which illuminated "laser-on" warning signs are present outside laser laboratories, these should only be turned on during laser operation. Otherwise, they become part of the landscape and are ignored. *{Note: Illuminated "laser-on" signs are not required at AU.}*

Only persons needed to perform the studies are permitted in laser use areas during laser operation. All others, especially *casual visitors*, must be excluded.

C. BEAM ALIGNMENT PROCEDURES



Pre-alignment procedures

- Make sure that only person who is authorized by the Principal Investigator or laser supervisor and who needs to be there during the alignment process are present.
- Post a temporary beam alignment warning sign on the doorknob to the laser laboratory and lock the door.
- Remove all unnecessary reflective items from the optical table and your person (shiny tools, extra mirrors, jewelry, watch, plastic ID card, etc.).
- Put on protective eyewear with adequate optical density. In some cases *(low power visible beam only)*, low optical density ***alignment eyewear*** can be worn. Contact Radiation Safety with any questions about protective eyewear. *M-rated eyewear is needed for lasers with pulses < 1 nsec*.
- Reduce the beam power as much as possible. Use a low-power (< 5 mW) visible beam laser like a He-Ne laser or a diode laser *(i.e., a laser pointer)* to align the optics, whenever possible.
- Make sure all materials needed for the alignment are readily available and that you have carefully thought through the alignment procedure in advance so there will be no surprises that could increase the likelihood of an accident.
- Isolate the beam from other areas of the laboratory using laser curtains, beam barriers, and beam stops. Enclose as much of the beam as you can to protect your eyes and skin.

During the alignment

- Use an indirect means of viewing the beam (beam detector card, infrared viewer scope, Zap-it paper) except when aligning low power (< 15 mW) visible beam lasers.
- ***Keep the beam on the plane of the optical table and well below normal sitting eye level. Never direct a beam upwardly or across a walkway!***
- Do not leave a laser operating and unattended.
- Keep protective eyewear on during the entire process. Remember that special alignment eyewear is available for visible beam laser use *(only safe for output power up to about 100 mW)*. Contact Radiation Safety for information on this type of eyewear.
- Remember, about half of all laser accidents occur during alignment. Be careful!
- **The most dangerous lasers are the near-infrared mode-locked and Q-switched lasers** – invisible or barely visible beams, very short pulse durations, and thus very high peak powers. Use a high degree of caution when aligning these lasers. *[Note: As mentioned above, M-rated eyewear is needed to absorb picosecond and femtosecond-pulse laser radiation. Contact Radiation Safety Office for ordering information.]*

After the alignment

- Replace the enclosures or other safety barriers that were removed for the alignment.
- Remove temporary alignment doorknob warning sign.
- Always store your protective eyewear near the lasers for which it is worn such that it will not get scratched or broken.

D. PROTECTIVE EYEWEAR

Eyewear must be worn whenever there is a reasonable likelihood of exposure to a harmful level of laser radiation. Remember that protective eyewear is your last line of defense against laser hazards – engineering controls (beam enclosures, beam stops, beam tubes, beam barriers, beam dumps, laser curtains, etc.) and administrative controls (like laser safety training and these laser safety SOPs) are the best ways to control hazards.

Contact Radiation Safety if you need assistance in selecting eyewear, including calculating the **optical density (OD)** needed for adequate protection. Complete the attached *Laser Safety Eyewear Evaluation* form and return it to Radiation Safety for assistance in determining the needed OD.

The protective eyewear vendors below have good eyewear selections and excellent customer service. They supply standard laser eyewear and certified M-rated eyewear (for NoIR and Glendale only; Trinity M-rated*certification process underway), and they also give discounts on eyewear to educational institutions like Auburn University:

NoIR Laser Company
P.O. Box 159, South Lyon, MI 48178
Phone: 800-521-9746; Fax: 734-769-1708
Web: **www.noirlaser.com**

Laservision
595 Phalen Blvd., St. Paul, MN 55101
Phone: 800-393-5565; Fax 651-357-1830
Web: http://www.lasersafety.com/

Mallory/ California Safety & Supply Co.
44340 Osgood Road, Fremont, CA 94539
Phone: 408-727-8530
Web: www.calsafety.com

Kentek Corporation
1 Elm Street, Pittsfield, NH 03263
Phone: 800-432-2323
Web: www.kenteklaserstore.com

Newport Corporation
1791 Deere Avenue, Irvine, CA 92606
Phone: 949-863-3144
Web: www.newport.com

*** M-rated eyewear is needed for ultrafast lasers (pulse duration < 1 nanosecond).**

E. CONTROL OF NON-BEAM HAZARDS

1. **Electrical hazards**

   Only persons experienced in electrical maintenance and repair may perform these tasks. High voltage power supplies must only be serviced when personnel knowledgeable in performing cardiopulmonary resuscitation (CPR) are present.

2. **Fire hazards**

   Class 4 visible and infrared beams with irradiances above 10 W/cm^2 can ignite combustible beam enclosure materials. Keep combustible materials, including organic solvents, away from laser use areas. Never use cardboard or paper for high power visible or infrared beam containment.

3. **Chemical hazards**

   Fluorine and chlorine gases are used with excimer lasers. These need to be stored in approved ventilated gas cabinets. Dye solutions used with dye lasers need to be mixed in a properly functioning fume hood by personnel wearing a lab coat, impermeable gloves, and chemical safety eyewear. Material Safety Datasheets for toxic materials must be reviewed prior to using them. For MSDS Links and Other Sources for Chemical Hazard Information, please refer to https://cws.auburn.edu/rms/msds.aspx

4. **Laser-generated air contaminants**

   These are potentially-toxic substances generated when high power laser beams strike target materials (plastic, tissue, etc.). General/dilution ventilation and local exhaust ventilation are two means of controlling this hazard. In rare cases respirators need to be worn.

5. **Collateral radiation**

   Some laser systems can generate x-rays, ultraviolet radiation, intense non-coherent visible radiation or radiofrequency radiation. Contact Radiation Safety if you have any concerns regarding this.

6. **Noise**

   Some lasers can emit loud noise during pulsing.

F. SUPERVISOR JUDGEMENT IN LASER SAFETY

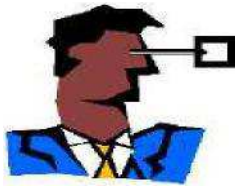
An intangible but critically important laser safety issue has to do with the mental readiness of laser operators to perform their studies. If a graduate student was awake the entire night studying for a final examination, that person would be a poor choice to operate a hazardous open-beam laser the following day. If a technician enters the laboratory very upset because another vehicle just sideswiped his new car, he would likely not be in a proper state of mind to perform operations in which a high level of concentration is needed. If a laser technician appears to have a health condition such that he/she may be on a drowsiness-inducing medication, then it would be best to have him/her do less hazardous work.

The common thread among these examples is that not all persons who show up at a laser laboratory are fit for duty. **It is up to the judgment of the Principal Investigator or laser supervisor to prevent those who are temporarily impaired from operating hazardous lasers and possibly injuring themselves.**

G. EMERGENCY PROCEDURES

In the event that you or somebody else in your laboratory suffers an eye or skin injury:

1. Turn off the laser involved in the accident immediately and unplug it. Post a “Do not use!” sign on the laser to ensure it is not used again until it can be determined that it is safe.
2. Keep the injured person calm. If an eye injury is suspected, keep the person in an upright position.
3. ***Make sure the injured person receives immediate medical treatment if the injury is serious – injured persons need to be seen by a doctor as soon as possible.***
4. Arrange for transportation of the seriously injured person to a medical facility. The victim might be in shock or have impaired vision so self-transportation is contraindicated.
5. If the injury is life-threatening (electrocution), ***call 911 immediately***.
6. Minor skin injuries can often be treated by rendering First Aid in the laboratory.
7. Call the AU Laser Safety Officer, Sevgi Kucuktas (334-844-6238) or contact her through the Auburn Police. If the Principal Investigator responsible for the laser involved is not present at the time of the injury, he/she must also be notified as soon as possible.



H. MOST COMMON CAUSES OF LASER EYE INJURIES

1. Unanticipated eye exposure during beam alignment.
2. Fatigue, carelessness, inappropriate shortcuts, or horseplay.
3. Upwardly-directed beam, beam at eye-level, or beam crossing walkways.
4. Eye protection not worn or the wrong eyewear worn.
   Overconfidence; feeling of complacency or invincibility.
5. Beam not sufficiently enclosed or isolated.
6. Laser operator not sufficiently trained.
7. Laser use area not optically isolated from other lab areas and entryways.
8. Failure to follow standard operating procedures due to hurrying, etc.
9. Manufacturer and laser user installed safety features removed or bypassed.

If you have any questions related to these laser safety SOPs or any other laser safety matter, contact Sevgi Kucuktas, AU Laser Safety Officer, at 334-844-6238 or kucukse@auburn.edu.

I. LAB-SPECIFIC LASER SAFETY PROCEDURES

Please add below any appropriate laser safety-related procedures specific to your laser operations that are not covered by the above general SOPs. This should include any special laser system startup, alignment, and shutdown procedures, including all safety-related steps:

AUBURN UNIVERSITY LASER SAFETY CHECKLIST

- ✓ **LASER OPERATOR RECEIVED AUBURN UNIVERSITY LASER SAFETY TRAINING ON-LINE AND ADEQUATE ON-THE-JOB/LAB-SPECIFIC TRAINING CONDUCTED BY PI**

- ✓ **PERMANENT DOOR-TYPE AND TEMPORARY DOORKNOB-TYPE WARNING SIGNS POSTED AND DOOR TO LAB LOCKED DURING LASER OPERATION**

- ✓ **BEAM NOT AT EYE LEVEL, NOT DIRECTED UPWARDLY, AND NOT CROSSING WALKWAYS TO AVOID EYE AND SKIN HAZARDS**

- ✓ **OTHER AREAS OF LAB ISOLATED FROM LASER USE AREA BY BEAM BARRIERS, LASERS SAFETY CURTAINS, BEAM TUBES, ETC.**

- ✓ **BEAM POWER REDUCED AS MUCH AS POSSIBLE**

- ✓ **BEAM ENCLOSED TO EXTENT POSSIBLE, BEAM STOPS USED TO BACK UP OPTICS, AND OPTICS TIGHTLY SECURED TO OPTICAL TABLE**

- ✓ **UNNEEDED REFLECTIVE ITEMS REMOVED FROM TABLE AND HANDS**

- ✓ **PROTECTIVE EYEWEAR AVAILABLE AND USED**

- ✓ **INDIRECT BEAM VIEWING SUPPLIES AVAILABLE AS NEEDED (VIEWER SCOPE, BEAM CARDS, ZAP-IT PAPER, ETC.)**

- ✓ **EXPERIMENT COMPLETELY THOUGHT THROUGH PRIOR TO ENERGIZING LASER TO PREVENT SURPRISES**

- ✓ **SUPERVISOR APPROVED PROCEDURE TO BE PERFORMED**

- ✓ **NON-BEAM HAZARDS PROPERLY CONTROLLED (ELECTRICAL, ETC.)**

- ✓ **OTHER LASER PROCEDURE-SPECIFIC SAFETY CONTROLS IN PLACE**

AUBURN UNIVERSITY LASER SAFETY GUIDELINES POSTER

WHEN WORKING WITH HAZARDOUS LASERS, ALWAYS FOLLOW THESE GUIDELINES:

- Make sure you have received Auburn University Laser Safety Training on-line (https://cws.auburn.edu/OHS/Training.aspx/Info/Laser%20Safety) and sufficient on-the-job/hands-on training in the lab.
- Never operate a laser without the permission of your PI or deviate from established standard operating procedures.
- **Always wear protective goggles or spectacles when operating an open-beam laser!**
- Remember that invisible-beam near-infrared lasers are the most dangerous.
- Make sure all reflective items are removed from your hands (jewelry, wristwatch) and keep unused optics and shiny tools well away from the beam.
- Always enclose as much of the beam as possible using beam barriers, beam stops, etc.
- Never direct beams upwards or across walkways.
- Keep beams below sitting eye level at all times -- do not sit at an optical table.
- Think through your laser procedure completely beforehand to avoid surprises. If you have questions, get answers before proceeding. Trust your intuition!
- Reduce the laser output power as much as possible, especially during beam alignments.
- Use indirect beam viewing techniques like beam cards, beam paper like Zap-it paper, and infrared viewer scopes.
- Do not operate a laser when tired, rushed, sick, angry, and preoccupied, etc.
- Remain vigilant regarding safety even if you are an experienced laser operator.
- Be a good example to others in your lab regarding laser safety (bad habits are contagious).

Contact the AU Laser Safety Officer (Sevgi Kucuktas; 334-844-6238; kucukse@auburn.edu) if you have any laser safety questions or concerns.

CLASS 3b AND CLASS 4 LASER REGISTRATION FORM

I- Principal Investigator:_____ Date:_____

Department: _____ School/College: _____

II- Personnel who use laser systems

Name	Status (Student or Staff)

III- Laser System Information

System location (Building/Room #)	
Laser warning sign on door (Y/N	
Wording on sign	
Do users wear safety goggles?	
Type/Manufacturer	
Are goggles available for visitors?	
Type/Manufacturer	
Service for laser: in-house (Y/N)	
Contract Service Company's name	
Is there a written SOP available?	

IV- Complete the table below:

Manufacturer	
Model	
Serial #	
Class (1, 2, 2a, 3a, 3b, 4)	
Type (CW, Pulsed)	
Description (i.e., He-Ne, ND:YAG)	
Wavelength (s)	
Maximum / Peak Power (Watts or Joules)	
Pulse Duration (repetition rate)	
Emerging Beam Dimensions (nm)	
Use (holography, alignment, etc.)	

Register all Class 3B and 4 lasers with the Laser Safety Officer. Complete this form for each laser to be registered and return it to Sevgi Kucuktas, AU Laser Safety Officer, at Radiation Safety, or call 334-844-6238 for more information.

LASER SAFETY EYEWEAR EVALUATION

Person Requesting Evaluation: _____ Date: _____

Principal Investigator:_____

Department: _____

LASER DATA	Laser 1	Laser 2
Type of Laser (Nd: YAG, Argon, HeNe, etc.)		
Class of Laser (3b or 4)		
Wavelength(s) Produced (nm)		
Operation: Continuous Wave, Single Pulsed, Repetitively-pulsed, Q-Switched, Mode-locked *(more than one might apply)*		
For Continuous Wave Laser: Maximum Power (mW or W)		
***For Pulsed Laser*:**		
Maximum Pulse Energy (mJ or J)		
Pulse Duration		
Pulse Repetition Frequency (Hz)		
Maximum Exposure Duration*		
Optical Density (OD) Needed*		

*** To be determined by Radiation Safety**

Return to Sevgi Kucuktas, Risk Management & Safety *(Or call 334-844-6238 if you have any related questions)*