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S-SA-M-028 Rev F

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S-SA-M-028 Rev F

Summary

- LLE Policy
- Lasers
- Potential laser hazards
- Laser classifications
- Control measures
- Engineering controls
- Administrative & procedural controls
- Administrative & procedural controls Warning signs
- Personal protective equipment
- Best Practices
- Instructions on satisfying laser-safety training requirements



Laser Policies and procedures are in accordance with:

- ANSI Z136.1-2014 American National Standard for Safe Use of Lasers
- Occupational Safety and Health Administration (OSHA)
 - This U.S. agency requires personnel to observe the ANSI recommendations for the safe use of lasers, and not following the ANSI recommendation can result in fines

• U. S. Food and Drug Administration (FDA)

- The FDA is responsible for radiation-emitting product safety

http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/ HomeBusinessandEntertainment/LaserProductsandInstruments/default.htm

- New York State Department of Labor
 - Labor Law Part 50. LASERS

http://www.labor.ny.gov/workerprotection/safetyhealth/sh50.shtm

- University of Rochester
 - Laser Safety Program for Research and Teaching Laboratories http://www.safety.rochester.edu/labsafety/lasers/researchlasersprogram.html







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Lasers and Intense Light Sources are regulated by LLE policy in Instruction 6200*

- No employee shall expose themselves or other employees to radiation energy that exceeds the Maximum Permissible Exposure to eyes or skin as determined by ANSI Z136.1
- All employees shall wear Laser Protective Eyewear (LPE) as specified at the entrance to the laboratory
- All suspected exposures above the MPE shall be reported to the Area Supervisor, the Laser Safety Officer, and the Chief Safety Officer
- Laser (or laser components) shall be introduced to the laboratory intentionally using the process detailed in Instruction 6200

*LLE Instruction 6200 (S-SA-M-064)



Laser Safety Training will be commensurate with job responsibilities



- All personnel who enter a laser environment with class 3B and 4 lasers shall complete General Laser Safety Training (this training) and require annual refresher training
- In addition to above, all personnel who will <u>operate/maintain</u> a laser or laser system shall complete a <u>laser operator qualification card</u>
 - Operation and maintenance must be performed per written and approved procedures
- Additional training (L_003: Laser Instrument Specialist Training) is required to integrate a new laser or modify an existing laser. This training shall be refreshed every three years.



This training is designed to educate workers who will enter laboratories where lasers may be present

You should know and understand the following:

- 1. The key characteristics of a laser
- 2. Types of hazards that can be presented by a laser beam and know that each laser presents unique hazards based upon it's characteristics
- 3. Associated hardware can have non beam hazards.
- 4. Each laser will require specific protocol for safety and that the area supervisor will oversee training for specific job responsibilities
- 5. How to read laser hazard door signs and select appropriate Laser Protective Eyewear
- 6. This training does not allow you to operate, perform maintenance, or repair Class 3B or 4 laser systems. Further training is required in the form of a operator qualification card



Lasers have three basic components





Active medium: This can be a solid (crystal), semiconductor (diode), liquid (dye), or gas, which contains atoms that can emit light by stimulated emission. Also known as lasing or gain medium

Excitation mechanism: this is the source of energy to excite the atoms to a proper energy state and can be optical, electrical, or chemical

Optical resonator: this reflects the laser beam through the active medium for amplification and consists of a high-reflectance mirror and an output coupler mirror

*Courtesy, laser-professionals.com



Laser Physics reference

Light Amplification by Stimulated Emission of Radiation

- LASER is an acronym
- Laser Light is characterized by the wavelength (λ) [and bandwidth (Δλ)]
- Light is
 - Reflected (e.g., mirror)
 - Refracted/transmitted (e.g., glass window)
 - Absorbed (e.g., sunglasses)
- Light absorption in a material can be characterized by the material's Optical Density (OD); OD is an important laser safety concept which is defined by the equation:
 - OD = log₁₀(1/T), where T=transmittance





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Subsystems that modify the laser beam are effectively a laser source.

• Amplifiers increase the energy or power of the beam.



• Frequency Conversion changes the wavelength of the beam





Laser Physics reference

Common laser wavelengths are shown. On OMEGA, frequency conversion generate harmonics of 1053nm_R



ASBO = Active Shock BreakOut diagnostic @ LLE **Omega** = Omega Laser Facility including OMEGA & OMEGA EP

Original, courtesy, laser-professionals.com

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Laser Physics reference

Wavelengths outside the Laser region are governed by other safety disciplines



ASBO = Active Shock BreakOut diagnostic @ LLE **Omega** = Omega Laser Facility including OMEGA & OMEGA EP

Original, courtesy, laser-professionals.com

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At LLE, lasers are used for a wide variety of purposes



Uses include

- Fusion research
- Damage Testing
- Electro-optic Sampling
- Alignment
- Optical Quality Control
- Interferometry

- Spectroscopy
- Metrology
- Non-linear Optics
- Holography
- Index Measurement
- Reflectometry

All of these uses have the potential for exposing personnel to dangerous levels of laser radiation



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Laser beams can cause serious eye and skin injuries

- Eye and skin injuries are the result of energy deposited and can be caused by:
 - Direct beam exposure
 - Specular (mirror) reflections (full or partial)
 - Diffuse (scattering) reflections
- High-power laser beams can burn exposed skin, ignite flammable materials, and heat materials to release hazardous fumes
- Many devices are used to modify the characteristics of the laser beam and can introduce additional laser hazards. These include
 - Amplifiers (increases energy of beam)
 - Frequency conversion (modifies the wavelength)



Potential laser hazards

There are many potential hazards associated with lasers that are non-beam related



- Electrical hazards from power supplies, capacitors (even after the power is turned off), discharge lamps, ultraviolet (UV), visible, infrared (IR), microwaves
- Radiological hazards from X-ray or Gamma production
- Fire hazards from beam contact with flammable materials
- Chemical hazards

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- Components in the laser (e.g., laser dye)
- Toxic fumes released from materials exposed to laser energy
- Component failures can be explosive (e.g., flash lamp)
- Noise levels can cause disorientation or hearing loss
- Mechanical components can create crush/pinch hazards

Many of these hazards are mitigated by interlocks. LLE chief Safety Officer must give authorization prior to defeating any interlock

The Maximum Permissible Exposure (MPE) is used to determine hazard level and appropriate mitigation

• Maximum Permissible Exposure (MPE): The level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin as defined by ANSI Z136.1

The MPE is a function of wavelength, pulse width and/or exposure duration. Think of the MPE as the damage threshold fluence for a person

Precautions must be taken to ensure that people are not exposed to hazardous levels of laser radiation. A dangerous exposure is to be investigated as an incident (in accordance with Instruction 6950)

> No employee is to expose themselves or others to laser light above the MPE



Reported incidents, nationwide, have shown that



Accidents and injuries related to lasers are most often associated with the following, specific conditions:

- 1. Available eye protection not used!
- 2. Misaligned optics and upwardly directed beams
- 3. Unanticipated eye exposure during alignment
- 4. Equipment malfunction
- 5. Improper methods of handling high voltage
- 6. Unintentional exposure of unprotected personnel
- 7. Operators unfamiliar with laser equipment
- 8. Lack of protection for ancillary hazards
- 9. Improper restoration of equipment following service
- 10. Failure to follow standard operating procedures (SOPs)

Laser injuries often result from someone who should have known better but who took a short cut, producing an unnecessary, but very costly risk

Laser radiation damage mechanisms differ



The principal cause of tissue damage is thermal in nature

- Thermal effects are caused by a rise in temperature following absorption of laser energy
- Blast damage can result when temperature rises rapidly (especially with water vaporization)

Photochemical effects result when laser radiation breaks chemical bonds

- Continuous wave (CW) lasers: as defined by the ANSI standard are lasers that have a continuous output longer than ¼ second. CW lasers primarily cause thermal and photochemical effects
- Pulsed lasers: as defined by the ANSI standard are lasers that have a single or pulsed output shorter than 1/4 second. Pulsed lasers additionally can cause Blast Damage





Anatomy of the human eye*





Laser wavelength determines where the energy is deposited in the eye



- Ultraviolet (UV) radiation (180-400 nm) causes damage to the cornea
 - Excessive ultraviolet exposure produces photophobia, an intolerance to light
 - Adverse effects are usually delayed for several hours after the exposure but will occur within 24 hours
 - Cumulative exposure can contribute to cataracts (clouding of the lens)
- Visible (400-700 nm) and infrared (IR) radiation (700-1400 nm) can damage the retina

The eye is designed to intensify (focus) light making eye exposure the principal hazard associated with laser radiation



The sensitivity of your eye to laser light is not constant over the visible spectrum



- Visual sensitivity explains why green (~532nm) lasers appear bright when equal intensity red (650nm) or blue (400nm) lasers are dim
- We are careful about laser systems at the edge of sensitivity. They can appear dim (or invisible) even when capable of damaging your eye



Visual sensitivity at wavelength

Your large skin surface makes accidental exposures common



- UV, visible, and IR exposure can cause pigment darkening, photosensitive reactions, & skin burn
- Chronic exposure to UV wavelengths (200-400 nm) can have a carcinogenic effect
- Reducing the surface area of exposed skin decreases the risk of accidental exposure to laser radiation
- Pay particular attention to your hands while doing work around the laser beam



Laser radiation can cause *irreversible* damage to the eyes and skin







Top images depict laser damage caused by a <u>laser pointer</u>

Laser pointers should be designed with energy below the MPE, but users can overcome their reflexes to stare into the beam too long

Poorly designed/manufactured laser pointers may emit a laser beam that exceed the MPE

Lasers present a real hazard. Diligent use of safe operating practices and Laser Protective Eyewear (LPE) prevents injury



Lasers are classified according to their hazards



Laser Class	Hazard Level
1	Incapable of causing injury during normal operation
1M	Incapable of causing injury <u>unless optical system is used to</u> <u>collect light</u>
2	Visible light laser incapable of causing injury in 0.25 seconds
2M	Visible light laser incapable of causing injury in 0.25 seconds unless optical system is used to collect light
3R	Safe when handled <u>carefully</u> . Can cause flash blindness and disorientation. Extended viewing could cause damage. Less than 5 mW of visible light (400-700nm)
3B	Can cause eye injury
4	Can cause eye injury. Can cause skin injury or ignite a fire



Lasers are classified according to their hazards



Laser Class	Hazard Level	
1	Incapable of causing injury during normal operation	
1M	Incapable of causing injury <u>unless optical system is used to</u> collect light	
nowing the laser class allows you to know the relative		

hazards of a laser.

- Class 3B and 4 can cause eye or skin injury
- Other classes will not cause eye or skin injury when used according to manufacturer's instructions

3B	Can cause eye injury
4	Can cause eye injury. Can cause skin injury or ignite a fire



Before use, know the laser class and act accordingly

- Laser Class is determined by the entire device (including engineering controls)
 - A DVD player is labeled as Class 1, but has a Class 3B or 4 laser inside (Do not open the case!)
- Class 1, 1M, 2, 2M, and 3R systems are to be used carefully in accordance with manufacturers guidelines. <u>Additional protocol is not required</u>
 - These lasers are not to be modified without the express consent of the Laser Safety Officer (and it will not be granted without a design review process)
- When using lasers, if you experience discomfort, <u>STOP!</u> and consult with the Laser Safety Officer.

At LLE, a Class 3R laser was found to output higher energy when in proximity with a radio transmitter. No injuries were sustained thanks largely to the engineer recognizing a problem and stopping work (Incident Report 265)

Mitigation

A standard mitigation strategy will be applied in the design process for laser systems

- 1. Selection: Select a Laser for use which has enough, but not excessive, energy. Procure an alignment laser (or laser with low power mode)
 - Elimination: remove unnecessary laser hardware
- 2. Engineering Controls: Design features that prevent hazard exposure including enclosures, interlocks, beam dumps, etc
- 3. Administrative Controls: All measures that inform the user how to behave safely including training, warning signs, procedures, reference material, incident investigation records, etc
- 4. Personal Protective Equipment: Laser Protective Eyewear, gloves, lab coat that prevents exposure when other controls have failed

Each laser must be evaluated to determine the hazard involved and the required safety measures



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Good Engineering controls start in design, but must be maintained through operation

- Door sign interlocks are required for Class 3B and 4 lasers.
- An enclosure can be used to prevent beam hazards. In some cases, the enclosure is used to change the hazard class
 - Enclosure can be interlocked to prevent laser propagation when panels are removed. <u>Do not defeat interlocks without the approval of</u> <u>the Chief Safety Officer</u>
 - Viewing ports with appropriate attenuation to provide protection
 - Remote controls so that enclosure does not need to be violated
- Avoid designs at eye level for standing/seated individual
 - Work stations should be protected by a barrier
- Terminate beams intentionally into beam dumps designed to handle the thermal load of the laser
 - Including partial reflections or mirror leakage from optics in beam path
- Type 3B and 4 laser are required to have key control

Know the engineering controls and <u>do not</u> defeat them

Engineering Controls

An example of engineering controls addressing the safety of the computer user in a laser environment





Any location where stray laser light could shine towards workers sitting at a computer requires barrier protection



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Optical Fiber Laser Systems are treated as a special case for engineering controls



- Laser transmission systems which employ optical fibers shall be considered <u>enclosed</u> systems with the optical fibers forming part of the enclosure.
- If disconnection of a connector results in radiation emission below the applicable MPE, then connection or disconnection may take place in an uncontrolled area and no other control measures are required
- If greater than above the applicable MPE via a connector, then the following will take place:
 - Deactivate the laser before making or breaking fiber connections ۰
 - Label devices and connectors where hazardous emissions can occur •
 - Label fibers carefully so that you are working on the right hardware (rather ۰ than for a source that is not disabled)
 - Lockout/Tagout must be applied at the laser source before breaking class 3B or Class 4 fiber connections. Verify (again) when connection is broken



Administrative Controls

Administrative and procedural controls supplement engineering controls and PPE

These controls include

- Laboratory Instructions, directives, and operating procedures
 - Including best practices while building or modifying laser systems
- Safety training orientations and annual refreshers
- On-the-job training & laser operator qualification ("Qual Card")
- "Buddy System"
- Laser safety signs
- Laser inventory and safety surveys
- Resources in the safety library with texts, standards, government regulations, and laser-hazard analysis software available to all
- Web-based resources
- Safety inspections (periodic, new installations, or following modifications, or following an inquiry)



Laser Protective Eyewear (LPE) is required to enter a laboratory where a Class 3B or 4 laser is in use

- Laser Eyewear can prevent injury when other controls fail
- LPE is characterized by wavelength of protection and OD of protection at that wavelength
 - No single LPE provides protection for all possible lasers. LPE requirements are based upon the laser characteristics.
 - The color of the lens is not adequate for determining protection
- The LSO will calculate the required OD during acquisition of a laser. This OD will be on the door sign.
- Users must verify that the OD on the eyewear exceeds the OD on the door for adequate protection



Warning signs address different environments



Although accident prevention signs are classified by ANSI Z535.2, the laser standard, ANSI Z136.1, along with the Center for Devices and Radiological Health, use the following signal words

- DANGER Indicates an immediately hazardous situation which, if not avoided, will result in death or serious injury. Only Class 3B & Class 4 lasers require this signal word, "DANGER"
- CAUTION Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. "CAUTION" may also be used to alert against unsafe practices. The signal word "CAUTION" shall be used with Class 2, 2M, & Class 3R that do not exceed the applicable MPE



Administrative controls — Warning signs

Custom warning signs are made for each laboratory to address specific hazards



- Signs must be activated (flashing) before turning on the laser. Illuminated signs are not in force unless flashing
 - Tell other users in the room that a laser is being activated
 - Rooms are being fitted with interlock circuits so that warning signs are activated to enable the laser. This will take time to implement everywhere
- Some labs do not have illuminated signs. These signs are in force when visible. •

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Laser Safety Signs and LPE refer to the OD. Let's review OD



- Optical Density* (OD) characterizes the fraction of light blocked (absorbed) by laser protective eyewear
 - When OD=1 at a wavelength, 90% of the incoming light at that wavelength is blocked. 1/10th of the light transmits
 - When OD=5 at some wavelength, 99.999% of the incoming light *at that wavelength* is blocked. 1/100000th of the light transmits
- Make sure that the OD listed on the eyewear is <u>equal to or greater than</u> the OD required for every wavelength listed on the sign
 - The OD can be specified for a single wavelength or a range of wavelengths
- *OD = log₁₀(1/T), where T=transmittance

A higher OD value means the eyewear will provide greater protection at the specified wavelength(s)



Eye Protection Guidelines



- Verify proper OD protection for the wavelengths on the laser sign
- Put on laser protective eyewear before entering a laser hazard area
- Although our eyewear is designed to protect us, never look directly into the laser beam. Not all eyewear can sustain protection for full beam energy
- Wear eyewear to current prescription
- The color and/or darkness of your laser protective eyewear's lens does <u>not</u> unambiguously indicate the protection the lens provides, either in wavelength or optical density

<u>e.g., eyewear with green tinted "lenses" will not protect you from green</u>
 <u>laser light</u>



Care and maintenance of protective eyewear



- Check and clean the eyewear before every use
- Appropriate cleaners are provided; if you use a towelette, blow off any dust or dirt to avoid scratching the lens
- Immediately remove eyewear from service when lenses or frames are scratched, cracked, or broken. Return it to the Laser Safety Officer for disposal
- Laser protective eyewear that is provided in specific areas or for specific tasks must NOT be removed from that area (other labs generally have different requirements)
- Contact your supervisor to obtain replacement prescription safety eyewear, or the work area supervisor for non-prescription safety eyewear
- Store safety eyewear in a protective case or in designated storage locations when not in use



How to obtain prescription lenses for laser protective eyewear



LLE will reimburse you for prescription eyewear inserts

- 1. One vendor of laser protective eyewear with the prescription insert is the Honeywell Sperian XC series frames
 - These inserts (prescription lens holder) may be obtained from the Omega Facility Administrative Assistant
- 2. Take the insert to your eyewear vendor of choice, and pay for it
- 3. For reimbursement, take the receipt to your division's designee





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Laser protective eyewear comfort and fit are important during your selection



- Eyewear must fit to provide good protection
 - Gaps around the edges of the frames are locations with <u>no</u> laser protection
- Turn your head toward the object you want to see (do not look around your laser protective eyewear)
- Do not look around the eyewear for reading or computer work. If you can't see for functional tasks, talk to the work area supervisor and LSO for better options (increase lighting, better computer monitor, or better suited LPE)
- Safety eyewear having an elastic headband are easily adjustable for a secure fit (even in precarious situations)
 - Safety eyewear employing headbands should have the breakaway feature if used in an environment where a strangulation hazard is possible (i.e., wearing laser eyewear with a headband while operating a drill)

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Eyewear retainers should be properly secured





Retainers are available from the laser safety officer



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All LLE laser protective eyewear must comply with two ANSI standards

- ANSI standard for laser safety, Z136.1, and
- ANSI standard for mechanical impact resistance, Z87.1





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This eyewear is labeled with the wavelengths for which they offer appropriate protection



There are two labeling standards used on protective laser eyewear:

- American National Standards Institute (ANSI), and
- European and labeled with "CE"

We have no control over labeling by a supplier nor is the labeling consistent, even with the same vendor. If you have a question on the labels, please ask your supervisor or contact the laser-safety officer



All LLE signs use the ANSI standard with wavelength called out in nanometers (nm)



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Eyewear identified with LLE added labels



- If it is necessary to use laser safety eyewear at wavelengths other than those listed on the lens by the manufacturer, contact the Laser Safety Officer or Chief Safety Officer BEFORE putting them into service. They MUST be measured and labeled with an LLE serial number to demonstrate they are suitable.
- A copy of the measurement shall be maintained in the laboratory







Eyewear storage units can have multiple types of eyewear with different protections



Remember to return safety eyewear to their original location



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Fluorescence — an eyewear response when struck by a laser beam



- Fluorescence is the re-emission ("glow") of absorbed (laser) light. Some materials used for laser protective eyewear exhibit fluorescence following exposure to laser light.
- Fluorescence is frequently at a different wavelength (color) than the (laser) source
- Eyewear fluorescence can startle the wearer, and cause the wearer to question its effectiveness
- If eyewear fluorescence is observed, it indicates unmanaged/stray laser beams are present that must be eliminated
- Individuals who observe eyewear fluorescence shall bring it to the attention of the work area supervisor and Laser Safety Officer
 - Eliminate the beam that caused the fluorescence



Laser protective eyewear deficiencies are cited in many incidents where injury occurs

- Around the Nation:
 - An undergraduate student was working at a national laboratory with a Class 4 laser to suspend particles. Neither the student nor the supervising scientist were wearing laser protective eyewear
 - As the student bent down to look into the chamber, she saw a flash and immediately noted a reddish brown substance floating in her left eye.
 The student had irreversible eye damage—a retinal traumatic hole caused by pulsed laser light.
- Here at LLE:
 - Incident Report 153. An operator was working in the lab wearing LPE.
 While leaning over the optical table and leaning head into a known laser beam path, the operator saw a flash and recognized a spot in vision.
 The employee had irreversible eye damage. Investigation concluded that gaps in the fit of the eyewear caused the beam to bypass the protection.



Before you can use a Class 3B or 4 laser, additional training is required



- Completion of a Laser Operator Qualification Card is required
 - Training sessions will be with the Work Area Supervisor, Laser Instrument Specialist, other Operators, and the Laser Safety Officer
- A Laser Operator is permitted to follow written procedures to operate the system
- A Laser Operator is <u>not</u> permitted to modify the laser system or perform repairs to the system

Laser Operator Qualification Card		
Name: Date	Date of Issue:	
Laser System: Laser	:1D#	
☐ erequisites: (To be determined by the Work Area Superv ☐ General Laboratory Safety Training ☐ Laser Safety Training	isor) □ Electrical Safety (or □N/A) □ Chemical Safety (or □N/A)	
Knowledge Requirements: Demonstrate knowledge of the oral examination by the designated individual:	following by satisfactorily completing an	
REQUIREMENT	QUALIFIED SIGNATURE / DATE	
1. Laboratory Orientation	//	
Describe Laser lasing medium and principle of operation	Laser Instrument Specialist	
 Describe wavelength(s) and mechanisms to adjust where applicable 	//	
 Describe energy (joules), pulse width, and rep rate or power (watts) 	/	
What is the laser class and the required OD for laser eye protection	//	
 Locate startup, shutdown, operations, and maintenance procedures 	e///////	
What should you do if you have a concern about the operation of this laser	Laser Instrument Specialist	
 Who is permitted to provide corrective service to this laser 	/	
Practical Factors: Satisfactorily complete the following pra qualified operator:	actical factors under the supervision of a	
REQUIREMENT	QUALIFIED SIGNATURE / DATE	
Startup & Shutdown laser/system according to procedure	//	
10. Operate laser/system according to procedure	/	
11. Identify all beam paths and respective hazards	/	
Qualification Certification: Satisfactorily complete a comp knowledge and practical requirements of this qualification:	prehensive oral examination covering all the	
//	//	



New laser equipment must be reviewed before use in the laboratory

- L_002 training is required to introduce a new laser at LLE or modify a laser system
 - All lasers shall have a Laser Instrument Specialist assigned
 - Laser Instrument Specialist responsibilities will be transferred as required
- A LLE designed laser must go through the Instruction 7700 process
 - Safety will be a key point for discussion at design reviews
- When you are purchasing a new laser, talk to the LSO and fill out a Laser Inventory Form (S-SA-M-066)
- When the laser arrives, the laser instrument specialist & LSO must verify that laser specifications and that safety measures are in place before activating. The checklist for this is (S-SA-M-067)

See the LSO early and whenever system changes occur to ensure that the safety protocol is in place when the laser arrives

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Follow these best practices, and call out your colleagues if they violate these guidelines



- 1. Securely mount the laser on a stable platform to maintain the beam in a fixed position during operation
- 2. Do not send a hazardous beam into a walkway or any space where someone might place their head. If necessary to do so, use a beam tube or chains
- 3. Minimize transient reflections: remove watches & jewelry, and be careful with tools
- 4. Terminate all beams intentionally. Investigate for stray beams regularly during work especially after installing a new optic
- 5. Use cameras to detect alignment. Avoid staring at alignment cards or targets when possible as they are diffuse reflectors capable of causing eye damage over long periods of time



More about beams in walkways

- If a beam exceeds the MPE for the eye, use a beam tube or chains to remind workers that a hazard exists
- If you are trained to access the area, then removing the tube or chains is permissible, but must be restored as soon as you pass through
- Do not linger in the beam path
- If you need to do work that will place you in the beam path, lock out the laser source before beginning the work
- There are exceptions where tubes would cause a trip hazard or where access is strictly controlled and training keeps workers cognizant of the beam







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Laser Information is tracked in Laser Safety Binders until the new database is fully populated

- Each individual laboratory's principal investigator is responsible for maintaining this binder
- LLE laser safety binders are reviewed during the safety inspections







EASY HAZ[™] is available so that you can verify the LSO calculations



http://lasersafetyu.kentek.com/easy-haz-laser-hazard-software-basic-web-version/



• It provides minimal hazard calculations; see restrictions online

EASY HAZ[™] Professional LSO Edition has extended capabilities and can be found, along with its instructions, at our internal online access

- Only one person at a time can access this software
- PC users, use the Remote Desktop Connection
- Login to the LLE computer easyhaz as *lleguest*; password is *lleguest*
- From the easyhaz desktop you can access the EASY HAZ[™] app or the folder in which its instructions reside

Software has limitations and can behave strangely to incorrect input. If you have questions, contact the Laser Safety Officer



Emergency Response

The response to a suspected exposure to laser radiation is well defined



- Stop work!!
 - If available use the red dump button to safe lasers and other hazards. If not available, leave the lab
- Get help
 - Eye injuries may cause significant disorientation and difficulty.
 Obtain help from people around you or call LLE receptionist (55101) and state "Medical Emergency"
 - Do not drive until you have had medical attention
- Get qualified medical attention
 - The individual with a suspected eye injury shall go to the Flaum Eye Institute Patient Care (585-273-3937, ask for Dr. David Maxwell Kleinman MD) or personal ophthalmologist
 - The individual with a suspected skin injury shall see a physician
- Inform management

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Work Area Supervisor, Supervisor, Laser Safety Officer, Chief Safety
 Officer, and Administrative Division

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Non-laser, intense sources can also be potential hazards

- Caution signs shall be prominently displayed
- If necessary, customized enclosures should be constructed
- If in doubt, the manufacturer's eyewear should be tested for proper protection
- UV lamps are a common example





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Custom-built UV enclosure





Notice: full-face protection used at this installation



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Potential retinal hazards from blue light-emitting diodes (LED)



Harmful effects. Severe headaches and nausea caused by blue light triggering the eye muscles to shut down. Intense blue light is also capable of causing permanent photochemical damage to the eye.

- The intensity of the blue light is often undetected because the sensitivity of the human eye falls drastically at 400 nm
- Normally, the viewer would blink or look away from an intense light source
- However, an intense blue light source is especially dangerous because it does not appear to be bright and a viewer's natural reaction to look away does not provide protection from long-term exposure
- The viewer may look at such a source for many seconds or minutes without their blink response ever kicking in
- Also known as high-energy visible light, 380-530 nm, and specifically a blue-light hazard, 400-500 nm

Laser pointers can be dangerous



- The safest laser pointers are those which do not exceed 1 mW output
- The FDA has issued warnings about the possibility of eye damage to children from hand-held pointers and has indicated that the light energy from a laser pointer aimed into the eye can be more damaging than staring directly into the sun
- The FDA and ANSI Z136.1-2014 restrict a laser pointer's emission limit to 5 mW in the visible spectrum (Class 3R); 2 mW in the infrared
- Recent tests by the National Institute of Standards and Technology (NIST) show that 90% of green pointers and 44% of red pointers tested were out of compliance with federal safety regulations*
 - Green laser pointers frequency-convert infrared laser light. Poorly designed devices may emit both green and potentially injurious invisible IR light

*www.nist.gov/pml/div686/pointer-032013.cfm



Public Service Announcement

Injuries & consequences associated with laser pointers



- Eye doctors at Iceland's Landspitali University Hospital treated a 13-yearold boy who was seriously injured in both eyes after playing with a 90milliwatt laser pointer purchased outside the country. He was said to have lost central vision in one eye.*
- Medical helicopter pilot blinded by a laser and has to make emergency landing; an arrest was made
- From the FBI: "If you point a laser and interfere with the operation of an aircraft, that's a felony. The crime carries a maximum of 20 years in federal prison and a quarter of a million dollars fine. In addition, the FAA can impose a civil penalty of up to \$11,000 for each violation." **

*http://www.laserpointersafety.com/news/news/nonaviation-incidents_files/383588a2c761851796992941a921673c-300.php#on **http://www.fbi.gov/news/videos/making-a-point-about-lasers



Public Service Announcement

FDA recommends that consumers be cautious when buying laser products over the internet*



- Consumers may unknowingly purchase an illegal laser product or may lose their money if the illegal product is refused entry into the U.S.
- The brightness of a laser beam does not always indicate its relative power or potential for injury in comparison to other color laser beams.
 Powerful blue or violet lasers will appear less bright in comparison to equally powerful red laser beams and much less bright in comparison to equally powerful green laser beams
- A blue or violet laser beam that appears as bright as a red or green laser is very likely to be a powerful laser that can cause immediate eye damage. Blinking or looking away when exposed directly to the beam may not provide sufficient protection to avoid injury to the eye

*http://www.fda.gov/Radiation-EmittingProducts/RadiationSafety/AlertsandNotices/ucm116534.htm



Instructions on satisfying the laser-safety training requirements



- 1. Visit the LLE Safety Zone "*Training*" tab http://safety.lle.rochester.edu/520_training/presentations.php
- 2. Read the L_001 Laser Safety Training presentation
- 3. Complete and submit the L_001 quiz
- New employees/students after receiving your graded quiz, contact the LSO for an orientation
- Any comments on this presentation and/or the on-line quiz can be recorded at the end of the quiz in the comment box and be submitted with your answers

