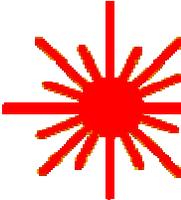


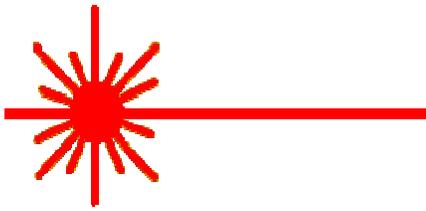
# Laser Safety



**We Put Science To Work**

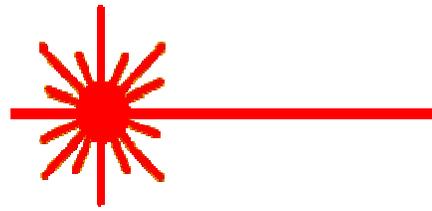
 LSGEN019-SBRF-0001-02  
SRNL Laser Safety Training





# Purpose

- The purpose of this overview briefing is to inform employees of the following:
  - Hazards associated with lasers
  - Control Measures: ways to prevent endangering themselves, others or equipment
  - Operational Safety Requirements



# References/Prerequisites

- References

- ANSI Z136.1 - American National Standard for the Safe Use of Lasers
- WSRC Manual 4Q, 601 – Laser Safety Program
- OSR 4-709 – Laser Safety Audit Form
- WSRC-IM-97-00024 – Conduct R&D – ISMS for the R&D Environment

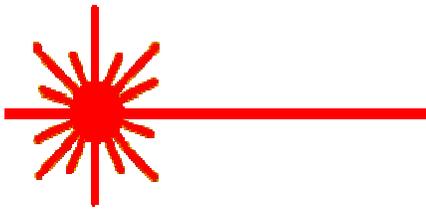
- Prerequisites

- QRIH3030 Laser Safety for Class 3b & 4
- Enrolled in SRS Medical Surveillance Program
- *NOTE: If work is being performed on or near exposed electrical conductors  $\geq 50$ volts (other than batteries), the following prerequisites are required:*

- Qualified Electrical Worker (QEW)

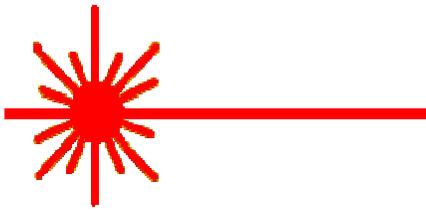
- SRQEW000 Supplemental Requirements for Elect Workers
- TMEE0300 Safe Practice on/or Near Electrical Conductors
- TMEE2800 Electrical Systems Safety
- TREG0013 Bloodborne Pathogens/First Aid/CPR\*
- TREG0014 Bloodborne Pathogens Alternate Year\*

\* Required to perform work as an electrical “buddy”; an electrical “buddy” is not required to have SRQEW000 unless the electrical “buddy” is also a QEW.



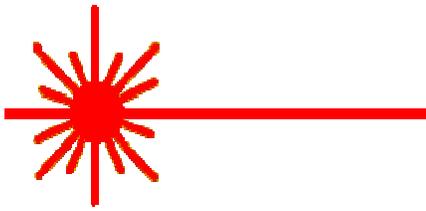
# Hazards

- Laser incident reports indicate that accidental eye and/or skin exposures to laser radiation can be most often attributed to one or more of the following:
  - Unanticipated eye exposure during alignment
  - Misaligned optics
  - Personal Protective Equipment not used
  - Equipment malfunction
  - Improper methods of handling high voltage
  - Intentional exposure of unprotected personnel
  - Operators unfamiliar with laser equipment
  - Lack of protection from ancillary hazards
  - Improper restoration of equipment following maintenance/service
  - Experimental set-up modification



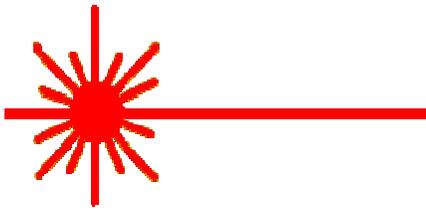
# Hazards

- Ancillary hazards associated with the use of lasers can be significant. For example, loss of life has occurred during electrical servicing and testing of laser equipment with high voltage power supplies.
- Toxic fumes, particulates and intense blackbody radiation (which can present additional eye hazards) may be released during the interaction of laser energy with materials.
- Chemical Hazards
  - Dyes containing hazardous chemicals - Laser dyes are complex fluorescent organic compounds which, when in solution with certain solvents, form a lasing medium for dye lasers. Certain dyes are highly toxic or carcinogenic.
  - Special care must be taken when handling, preparing solutions, and operating dye lasers.
  - A Material Safety Data Sheet (MSDS) for dye compounds must be available for worker review.
- Hazards of the eyewear - Some eyewear can cause dangerous reflections.



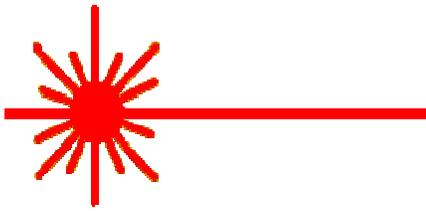
# Control Measures

- Comply with Conduct of Research & Development
- Control measures are implemented to reduce the possibility of eye and skin exposure to hazardous levels of laser radiation.
- Enclosure of the laser or beam path is the preferred method of control, since the enclosure will isolate or minimize the hazard.



# Control Measures

- Personal Protective Equipment (PPE)
  - Personnel protective equipment includes clothing, gloves, and laser eyewear. **Eyewear is the most important type of protective equipment available. It must be selected for the system with which it is being used. Selection of eyewear depends on several factors:**
    - Wavelength - The eyewear must be able to attenuate or filter all wavelengths associated with the laser.
    - Optical density - The optical density at the specific wavelength must be marked on the eyewear.
    - Luminous transmittance - The luminous transmittance is the degree to which you can see through the eyewear. Most eyewear has luminous transmittance values of 10% to 70%.



# Control Measures

- Damage to the eyewear - Eyewear damage can occur from melting, bleaching, or shattering and therefore the eyewear should be routinely inspected.
  - Comfort and wearability - This is one of the most important criteria when choosing eyewear. If the eyewear is not comfortable, chances are great that it will not be worn.
  - Ensure laser safety glasses are clean prior to using and properly stored when work is complete.
- **REMINDER:**
- Ensure the laser safety glasses being used are the correct type for laser system in use.



# Operational Safety Requirements

- Posting and Access Controls
  - Posted laser warning signs indicate one or more class 3b and 4 lasers in the laboratory are operational. The laser operator will confirm posted laser warning signs before operation.
  - Warning lights are required for Class 4 laser systems when in a permanent location. The laser operator will confirm lights are operational before energizing the laser.
  - Access to the lab must be controlled during the operation of the lasers by a combination lock on the door. Knowledge of the combination will be limited to authorized operators or those to be contacted in case of emergency as posted outside of the door.



# Operational Safety Requirements

- **Authorized Operators**
  - Authorized operators must meet the requirements for a laser operator as stated in procedure 4Q-601.
  - The authorized operator will determine that there is no optical radiation hazard at the entrance prior to permitting entry of personnel.
  - Only authorized operators may energize the lasers. Authorized laser system operators of class 3b and 4 shall be trained as follows:
    - Complete Initial Laser Safety Training for Class 3b and 4 Lasers (QRIH3030).
    - Complete biennial Laser Safety Refresher Training (QRIH3031).
    - Complete SRNL Laser Safety Training (LSGEN019).
      - Required for employees who complete QRIH3030 after 8/1/05. Employees who completed QRIH3030 prior to 8/1/05 are grandfathered for this training.
  - Authorized operators must also be enrolled in the WSRC Laser Medical Surveillance Program.



# Operational Safety Requirements

- **Unauthorized Personnel**
  - Entry of unauthorized personnel when a laser is energized is prohibited unless escorted by someone on the authorized laser operator list, which will be posted outside of the entry door.
- **Emergency Response Entrance**
  - Emergency Response Entrance to the laboratory during laser operations as indicated by the Laser Warning postings can be accomplished by turning off power to class 4 lasers in the appropriate electrical panels.
  - This action should be taken once personnel inside the laboratory do not respond to emergency personnel.



# Operational Safety Requirements

- **Non-Enclosed laser Beams**
  - All non-enclosed laser beams shall be compliant with and handled in accordance with SRS laser safety rules, Manual 4Q, Procedure 601 Laser Safety Program and ANSI Z-136.1 American National Standard for the Safe Use of Lasers.
  - Only the authorized operator using proper PPE may adjust or align open beams.
  - All alignment work is to be done at the lowest practical beam powers and/or pulse energies. Whenever practical, neutral density filters should be used for laser power reduction.
  - Trace all stray beams before increasing the laser power and/or pulse energies.



# Operational Safety Requirements

- Survey the optical setup for the following prior to use:
  - Dielectric mirrors may become transparent after laser damage.
  - Infrared (IR) and Ultraviolet (UV) light will pass through many transparent materials.
  - Curved optical elements may generate unexpected regions of intense light.
  - Reflections from any non-absorbing surfaces (i.e. watches, rings, etc.).
- Written procedures are required for:
  - Routine maintenance of Class 3b and 4 laser systems where the equipment is in the operation mode and the interlocks are defeated. See specific laser operation manuals.
  - Non-routine maintenance and service on or near exposed conductors, including troubleshooting and repair, shall be performed by the manufacturer or SRS personnel who are Qualified Electrical Workers. Access to the laser location must be controlled during these activities.



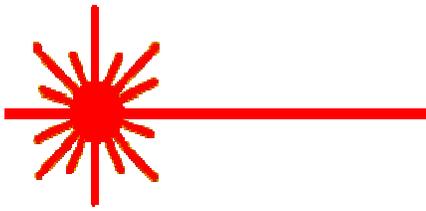
# Operational Safety Requirements

- **Laser Beam Alignment**
  - Alignment procedures include adjustments that may expose the laser beam or that could alter the course or state of the laser beam.
  - No person shall be allowed to sit or work within any containment area (i.e. lab area, etc.) for extended periods with his/her eyes in or near the plane of the laser during alignment procedures.
  - Extreme deviations from the height plane should be recorded in the Laboratory Notebook.
  - Whenever possible, all laser beams should be kept in the plane of the laser table.
  - In the event that the experiment requires a beam to be brought out of the plane of the laser table, the beam should be marked and shielded.



# Operational Safety Requirements

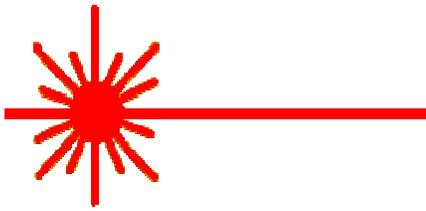
- Appropriate laser safety glasses shall be worn at all times by all persons in the containment area during the laser operation.
- In specific instances where invisible beams preclude the use of laser safety glasses, viewing aids, Infrared (IR) viewers and cameras can be used during alignment.
  - Work with an exposed beam without laser safety glasses should be avoided.
- Terminate any reflected or stray beams with non-reflective beam stops.
- Alignment of laser systems shall follow the available procedures described by the manufacturer of the laser systems.
- Alignment Procedures for Class 3b and 4 lasers can be found in Appendix C of the ANSI manual.



# Discussion Points

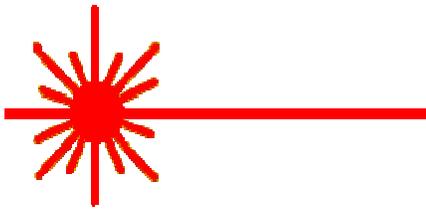
- **Awareness Note:**

- An administrative change to the operation of a laser facility and laser system cannot be made without the approval from the Laser System Supervisor and the Laser Safety Officer and the administrative change must comply with the Laser ANSI Standard.
- Discuss the following safety items and topics identified in this briefing. Items shall include but are not limited to the following:
  - **Associated Hazards**
    - Laser beams
    - High voltages
    - Dyes/solvents
    - Toxic fumes
    - Intense heat & explosions (very rare occurrences)



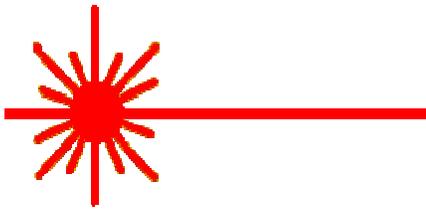
# Discussion Points

- Personal Protective Equipment (PPE)
  - Laser Safety Glasses
  - Gloves
- Purpose and use of OSR 4-709 Laser Safety Audit Form.
  - Provides important information related to specific lasers.
  - Laser operators must be familiar with information on this form for the specific laser being operated.



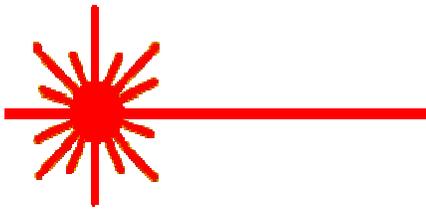
# Summary

- Ancillary hazards associated with the use of lasers can result in the loss of life during electrical servicing and testing of laser equipment with high voltage power supplies.
- Enclosure of the laser or beam path is the preferred method of control.
- Eyewear is the most important type of protective equipment available. It must be selected for the system with which it is being used. Use OSR 4-709 to obtain information for specific lasers.
- Posted laser warning signs indicates one or more of the class 3b and 4 lasers are in operation.
- The laser operator will confirm posted laser warnings are in place in accordance with the Laser ANSI Standard prior to energizing one or more of the lasers.



# Summary

- Laser warning lights are required for Class 4 laser systems.
- Only authorized operators may energize the lasers.
- Only the authorized operator may adjust or align open beams.
- Appropriate laser safety glasses shall be worn at all times by all persons in the containment area during the laser operation.
- Emergency Response
  - Entrance to the laboratory during laser operations as indicated by the Laser Warning postings can be accomplished by turning off power to class 4 lasers in the appropriate electrical panels.
  - This action should be taken once personnel inside of the laboratory do not respond to emergency personnel.



# Summary

- Personnel shall not be allowed to sit or work within any containment area (i.e. lab area) for extended periods with their eyes in or near the plane of the laser during alignment procedures.
- Written procedures are required for routine maintenance of Class 3b and 4 laser systems where the equipment is in the operation mode and the interlocks are defeated.
- Written procedures are required for non-routine maintenance and service on or near exposed conductors, including troubleshooting and repair.

