LLNL Lessons Learned LLNL

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Laser Accidents Review

Laser accidents continue to occur across the DOE Complex. In the past four years, seven eye-exposure accidents resulting in six injuries have been reported to the Occurrence Reporting and Processing System (ORPS). The accidents were caused by failures to follow established procedures, failure to wear the eye protection that is essential when working with high-energy laser systems, and lack of management oversight. During this same period, four potential eye exposures have been reported at LLNL, although none resulted in injury.

LLNL conducted a review of laser operations at LLNL in 2005 and found situations similar to the eleven mentioned above and summarized on pages two and three. Several corrections have been made in individual laboratories and to the LLNL *ES&H Manual* document on laser safety. If you operate a laser or supervise students, it is important for you to know the lessons learned from these events and the changed LLNL requirements.

Laser eye exposures may initially go undetected when the beam is invisible. Visual disorientation from retinal damage may not be apparent to the individual until considerable thermal damage has already occurred.

Analysis

The three primary causes of the laser accidents from 2001–2005 are failure to wear personal protective equipment (PPE), inadequate training, and lack of internal oversight.

- All of the eye injuries would have been prevented if personnel had worn protective eyewear. Personnel either did not fully comprehend the need for the protective eyewear or thought that they had properly controlled the hazards so that protective eyewear was unnecessary.
- Lack of adequate training and an inadequate understanding of hazards and controls are factors in most of these accidents. An inadequate level of knowledge by those required to oversee laser operations and supervise laser users is also a factor.
- Infrequent or inadequate line management oversight of laser operations was a contributing factor to laser accidents. Some inspections or audits had not been conducted for several years. In addition, little documented evidence exists to show that line management followed up to ensure that deficiencies were corrected.

Recommended Actions

Supervisors or mentors of students:

1. Complete the new LTRAIN course HS0075-W "Student Safety Awareness for Supervisors." This course is required for payroll and work supervisors of students, and individuals who direct, guide or lead students or student guests for a specific period of time in an activity covered by an IWS or other formalized work control process.

Responsible Individual Actions:

1. Ensure each class 3B and 4 laser under his/her supervision has a detailed alignment procedure in the IWS.
2. Coordinate with the ES&H Team to perform the required annual self-assessment of all laser operations under his/her supervision.
3. Discuss with workers the ***mandatory*** use of protective laser eyewear.

Payroll Supervisor Actions:

1. Schedule a baseline eye exam for all new workers and students prior to assigning work in laser labs.
2. Verify that new workers and students who will be working around lasers have completed the required laser training courses.

Where to Get Help or More Information

- Mark Ludwig, Laser Safety Officer, 2-6964.
- The *newly* revised Document 20.8, "Lasers" in the *ES&H Manual.*
- The *new* LTRAIN Course, HS0075-W "Student Safety Awareness for Supervisors."

To search for other LLNL Lessons Learned, go to the "ES&H Program at LLNL" web page at esh. Select "Lessons Learned" near the middle of the page. Select a topic or select "Search" at the bottom of the page and enter a search term.

Search Categories: Radiation – Ionizing/Non-ionizing

The four LLNL near misses and seven DOE events and are summarized below.

LLNL Near Misses

August, 2002. A summer student entered a laser lab and realized she was not wearing eye protection while a laser was operating. The student subsequently felt an "odd sensation" in her eye and was examined by a Health Services employee and a retinologist. Both exams showed no eye exposure.

September, 2003. During an exercise, a Class 3a laser from a weapon crossed a Security Police Officer's eye path for a fraction of a second. The officer felt irritation and started to rub his eye. He was transported to Valley Memorial Hospital where an evaluation showed no damage from the laser.

April, 2005. While using a green laser pointer to initiate a chemical reaction, a worker peered around shielding that partially enclosed the experiment to get a different view. The worker later saw white spots and was examined, but there was no injury to the eye.

August, 2005. When a worker wearing laser goggles with a loose-fitting strap walked by an operating laser, scattered laser light penetrated the side of the goggles. An exam showed no eye injury.

DOE Reported Events:

Argonne National Laboratory, October 2001. A visiting scientist with 15 years of laser experience and a graduate student were working with a Class 4 multiple laser system at full power. The researchers were aligning a mirror element so that they could see a small amount of visible light from the laser.

The scientist, who was not wearing protective eyewear, was struck in the right eye by a specular reflection, resulting in a retinal burn and loss of visual acuity. The researchers had failed to consider the potential for eye exposure when repositioning optical elements, and the scientist was in violation of standard operating procedures requiring the use of protective eyewear.

Argonne National Laboratory, September 2004. A principal investigator, who was not wearing protective eyewear, suffered a non-permanent eye injury when he was struck by a Class 4 laser beam while adjusting an unguarded beam splitter. Because he had neglected to cover the lateral ports, a stray beam bounced off the optic table and struck his left eye. A laser subject matter expert had not conducted a safety review of the experiment and had not identified the potential hazard of the beam directing off the optics table.

Brookhaven National Laboratory, October 2002. A beam line technician unknowingly stepped into a beam path and was struck twice in the eye while measuring a beam angle. No injury occurred because the beam power was below harmful levels. A post-doctoral researcher and a science associate had changed the configuration of the light path, making it incompatible with the existing barrier and beam stop. The technician, who was not wearing eye protection, was unaware that the beam was now exposed and unprotected. Because the researchers knew that the beam's power was weak, they lacked concern for safety barriers and allowed work to proceed without communicating the altered configuration to co-workers.

Brookhaven National Laboratory, September 2003. An unsupervised graduate student received a retinal burns to both eyes when a beam from a Class 4 laser was reflected into his eyes by a mirror. The student was not wearing eye protection while attempting to repeat an alignment procedure he had observed only once. The student did not fully understand the procedure and decided to use a procedure of his own that was both unauthorized and inherently unsafe. In addition, the principal investigator had installed and operated the laser without registration and review by the Laser Safety Officer and without required postings and documentation.

Lawrence Berkeley National Laboratory, March 2003. A graduate student suffered a non-permanent eye injury when struck by the specular reflection of a stray beam from a Class 3b pulsed laser. Assuming that an alignment task was complete, the student had removed his protective eyewear. Then, while manipulating a power meter in the path of the invisible infrared laser beam, he was struck by a reflection. The student failed to follow safe work practices by not wearing eye protection and by not performing an adequate survey of the laser beam path.

Los Alamos National Laboratory, July 2004. A student suffered permanent loss of central vision in her left eye when she looked directly into the path of a Class 4 laser beam while performing an unauthorized experiment with a principal investigator. Following the principal investigator's example, the student looked into the target chamber directly in the beam's path. Both the student and principal investigator believed the laser was not producing laser light. The principal investigator routinely did not wear eye protection, and his failure to practice, model, and enforce safe behavior was transferred to the student and coworkers. The laser injury resulted from the lack of engineering controls and the lack of use of personal protective equipment.

National Renewable Energy Laboratory, January 2005. A researcher sustained a retinal burn to his right eye while operating a Class 4 Yttrium Aluminum Garnet laser. The researcher and his team leader were testing new sample instrumentation when a problem occurred with the instrumentation. When the team leader left to obtain a different test sample, the researcher, who was not wearing eye protection, removed the neutral density filters to obtain a response from the test sample using full beam power. When he manipulated the test sample using stainless steel tweezers, he saw a flash of light off the test sample.