

## **Yellow Alert: Student Sustains Laser Eye Injury (Final)**

**Lesson ID:** LANL CHEMLASER 2004-0011 (*Source: User Submitted*)

**Originator:** Los Alamos National Laboratory; Clarence Lujan (505) 665-6976, Laser Injury Investigation Team

**Date:** 12/23/2004 **Contact:** Linda Collier, 505-667-0604, lcollier@lanl.gov

**Classifier:** Patricia Vardaro-Charles, 505-665-4644 **Reviewer:** Patricia Vardaro-Charles, 505-665-4644

**Statement:** LESSONS LEARNED: Organizations have a responsibility to monitor workers' performance to assure they work safely and comply with work management rules and procedures. Allowing work to be performed beyond the authorized scope deprives workers and those who work with them the protection afforded by safety barriers developed through thoughtful analysis and identification of hazards that are a part of the Integrated Safety Management process.

**Discussion:** DISCUSSION: The student came to Los Alamos National Laboratory as an employee of another government agency to work with a LANL scientist investigating the potential use of lasers in studying the composition of comets. The LANL scientist, who was the principal investigator (PI) for the LIBS project and served as a mentor for the student, was working with her on an experiment involving two Class IV, Nd:YAG lasers. One laser (L2) was aligned vertically to allow the laser beam to enter through the top of the target chamber to suspend particles. The other laser (L1) was aligned horizontally and, at the time of the incident, set in a configuration the PI believed only allowed viewing of suspended particles; meaning the PI believed only the laser flash lamps were operational to illuminate particles. Neither the PI nor the student was wearing laser eye protection (LEP) at the time. The PI energized both laser power supplies, fired and shut down L2, then removed the beam stop from behind the target chamber's rear window and viewed inside the chamber while L1's flash lamps continued to operate. He told the student he could see suspended particles and invited the student to take a look. 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 that was obscuring her vision. The student was taken to Occupational Medicine (HSR-2) and referred to several eye specialists. The injury was subsequently diagnosed as a laser-caused hole in the retina of the student's left eye that resulted in permanent loss of central vision.

The Accident Investigation Team conducted experiments after the accident and confirmed that the configuration of L1 at the time of the injury, as the PI described it, did not result in lasing. However, based on the evidence collected, the Team is confident that L1 did produce pulsed laser energy while the student was viewing the target chamber and that the laser energy caused the eye injury. The Team identified three possible lasing modes involving variations of the Q-switch and flash-lamp trigger configuration that would have produced a laser pulse and allowed the accident to happen. (See the Team's Investigation Report for more detail.)

**Analysis: CAUSAL ANALYSIS:** The Team's causal analysis revealed that the production of laser pulses and the lack of mitigation for the optical radiation hazard created by those pulses allowed the injury to occur. The team concluded that these conditions existed because the PI's work practices were unsafe, the performance of workers was poorly monitored, and work was inadequately planned and controlled. The Student Mentoring Program itself was also cited as a significant contributing cause of the accident because insufficient program quality assurance hinders adequate oversight of student safety.

**WORK PRACTICES:** The Team reported that the PI's failure to practice, model and enforce safe behavior directly influenced the student to practice unsafe behavior and resulted in the eye injury. The PI — a 23-year LANL employee with a record of technical accomplishment that included being the recipient of multiple R&D 100 awards — did not adhere to LANL requirements for Class IV laser operation, and violated industry laser safety standards. The Team said the PI did not consistently wear LEP during Class IV laser operations, and exposed himself and the student to significant laser beam hazards, including multiple stray beam reflections that he was unaware of but were detected by the team during the investigation. The Team noted that the PI did not consistently use laser interlocks and warning signs to control access to Room 106, therefore other personnel could have entered the room without knowing hazards were present. The PI failed to provide the student with proper pre-job training, and he asked the student to sign and predate the IWD after the accident. The investigation team also observed that housekeeping in Room 106 was poor, egress routes were obstructed, and gas cylinders were improperly stored.

**OVERSIGHT:** Although existing institutional policies and practices are adequate to have prevented the accident, they were not effectively implemented. The PI's line managers did not detect and correct unsafe working conditions, did not directly monitor the PI while he was performing laser operations, did not provide sufficient oversight of his work planning and execution to ensure compliance with and implementation of existing work requirements, and did not ensure the safety of students assigned to the PI. Team leaders and group leaders did not visit Room 106 during laser operations and inferred from the lack of prior reported mishaps and the PI's technical reputation that his safety practices were adequate. In addition, the Investigation Team discovered that safety-responsible line managers (SRLMs) and the laser safety officer signed the PI's IWD without identifying that hazards were poorly addressed, and that management did not ensure that the student completed all prerequisites for work. The Team noted that LANL's formal management walk-around process does not require that line managers systematically monitor every worker's safety performance.

**WORK MANAGEMENT:** The Team concluded the experiment was a new, unauthorized experiment that exceeded the scope of the HCP and the IWD. The work documentation did not address using two lasers or viewing particles in the chamber, and the non-standard use of L1's flash lamps for illumination was not described, evaluated, or authorized by the HCP. Consequently, the hazards associated with these activities were not analyzed. The Team's report noted that the student had not completed all the training required by the LIBS HCP or the required baseline laser eye examination, and she was not authorized through C-Division's online

worker authorization system to perform work under the LIBS HCP. In addition, the Team could not find a record of a laser registration (Form No. 1552) for L1.

**MENTORING PROGRAM:** The Team identified general deficiencies in LANL's volunteer mentoring program that include the lack of an established set of required safety elements for mentors, or mentor performance assessment. Mentors are not required to review key management and safety policies with students, and they are not required to ensure that students demonstrate their knowledge about equipment configuration, work hazards, required controls, work-scope recognition, or what it means to sign work/worker authorization documents. In support of this conclusion, the Team noted that students who worked with the PI were unsure of requirements for work/worker authorization and laser operation safety. Furthermore, the Team noted that the students' initial understanding about LEP, as obtained from LANL laser safety training, was replaced over time by the influence of the PI's ongoing practices and his reiteration that LEP was necessary only when the laser was lasing, contrary to LANL policy.

**Actions: ACTION:** The Investigation Team identified ISM deficiencies and made the following recommendations:

- LANL should implement a risk-based oversight program that systematically monitors the performance of every employee and work space. A team under the Associate Director for Technical Services (ADTS) will collect data and present it for consideration to the Director's Central Safety and Security Committee (DCSSC).
- LANL should establish non-punitive processes that emphasize peer-to-peer and worker-to-manager communication of unsafe acts and near misses. Such processes would create an environment of open communication, encouraging legitimate concerns for individual safety. A Health, Safety and Radiation Protection Division Office (HSR-DO) subject-matter expert (SME) will collect and evaluate data on multiple behavior based safety management tools, and present the data for evaluation by the DCSSC.
- LANL should assess the safety of laser operations at the Laboratory. HSR-DO and the LANL Laser Safety Committee will conduct the assessment and submit a report to the DCSSC.
- C-ADI should correct the safety issues inside Building 41, including the overall poor state of housekeeping. A C-ADI team will conduct an assessment and develop a plan of action.
- C-Division should implement a process that ensures the quality of IWDs and HCPs. Responsible Division Leaders (RDLs) will re-approve all IWDs prior to resumption of activities, and review all HCPs. A written, systematic IWD quality assessment process will also be implemented.
- LANL should conduct a continuing, periodic review of the quality of IWM implementation. HSR-DO will reconstitute the Integrated Work Management Committee (IWMC) to develop an assessment plan that includes measurable metrics.

- LANL should develop and implement a formalized Student Mentoring Program that establishes the following:

- Qualification and training requirements for mentors.
- A monitoring and performance-assessment program for mentors and students.
- Requirements that mentors teach their students safe work practices.
- Requirements that students demonstrate their ability to work safely.

The Science and Technology Base Programs Division will lead a team in developing a formal policy document governing LANL's Student Mentoring Program.

- Using existing institutional processes, C-Division should take actions to modify worker and manager behaviors. LANL took disciplinary and other personnel actions. C-Division will increase Management Walk-Around frequency. Worker safety training will be modified, safety issues will be addressed at nested safety meetings, and management will focus on balancing rewarding scientific achievement with operational excellence.

- LANL should use the institutional issues management system to address concerns involving processes, programs and procedures. The LANL Institutional Issues Coordinator will coordinate with division-level coordinators to resolve identified issues, and to track issue resolution through LANL's online tracking system.

**Savings:**

**Keywords:** LASER EYE PROTECTION, EYE INJURY

**Hazard(s):** Lasers

**ISM Code(s):** Analyze Hazards, Develop / Implement Controls

**Work Function(s):** Conduct of Operations - Work Control, Conduct of Operations - Work Planning, Occupational Safety & Health - Personnel Protective Equipment

**References:** Occurrence Report # ALO-LA-LANL-CHEMLASER-2004-0001

**Priority Descriptor:** Yellow / Caution