Title: Laser eye injury during alignment/optics work with a beam-splitting polarizer and an 800nm-wavelength beam

Date: January 29, 2010

Identifier: 2010-SLAC-01

Lessons Learned Statement:

Lessons learned for lab-wide programs (beyond just laser safety). There is a need to

- enhance expectations and requirements for on-the-job training (OJT);
- enhance expectations and requirements for both line management supervisors (person the worker reports to), **and** functional supervisors (person with safety responsibilities in a lab or for certain activities);
- verify that OJT and supervision are executed in accordance with management expectations,
- enhance message to workers and supervisors the importance of adhering to safety requirements;
- make clear to workers and supervisors that they have a responsibility to identify inadequate procedures and requirements, and to change or improve them as appropriate;
- assure that the above 5 bullets are adequately addressed for non-employees working at SLAC, including users and students, as well as for employees.

Lessons learned for laser personnel and SLAC's laser safety program:

- need to improve how (OJT) is done;
- for personnel with laser supervision responsibilities, need to improve how effective and well executed their supervision is;
- deficiencies in OJT and supervision led to inadequate work planning without proper review and discussion, such as a pre-job briefing, of the tasks related to the incident;
- there was a failure to i) abide by established safety requirements and to ii) work to improve procedures for difficult tasks;
- inadequate appreciation of the deceptive hazard of a dimly visible 800nm beam that is outside the normal 400-700nm visible wavelength range; (A number of DOE laser accidents have involved 750-800nm laser beams, which laser operators are sometimes tempted to view directly on a white card while not wearing protective eyewear.)
- inadequate appreciation of the hazards associated with a beam-splitting polarizer and controls needed to prevent an out-of-plane beam;
- prior safety violations involving removal of laser eyewear protection were inadequately addressed.

Discussion of Activities:

On September 24, 2009 a graduate student removed his protective eyewear during alignment and optics work with an 800nm laser beam. The beam hit his eye causing a small blind spot in his peripheral vision. While the eye damage was relatively minor the incident could have resulted in significant vision impairment.

The laser activity involved aligning a beam-splitting polarizer used in an 800nm-wavelength beam path. The laser operator wanted to align the polarizer normal to the beam path and removed his laser eyewear protection to allow direct viewing of the back-reflected beam from the polarizer on a white card. The laser operator also wanted to align the polarizer axis with a 0-degree marking on the rotation mount holding it; this task did not require the laser beam to be present. To get the rotation angle matched, he loosened the polarizer and an associated beam tube from the rotation mount to allow adjusting the angle of the polarizer. In doing so, the worker inadvertently uncovered a reflected laser beam that would normally be blocked by the beam tube; the uncovered laser beam came out of the horizontal plane of the optical table into his left eye. Although the SOP and a posted sign at the facility's entry door specified that laser eyewear protection PPE was required for this activity, the laser operator was not wearing this PPE at the time of the incident. The laser operator was working alone when the incident occurred.

Analysis:

Direct causes for accident:

- Inadequate administrative alignment procedures: i) failure to block or disable laser beam, which was not needed for the polarizer adjustment task; ii) failure to utilize alignment procedures that include use of laser eye protection PPE;
- Failure to wear the required laser eye protection PPE as required by the facility Standard Operating Procedure (SOP) document and posted warning signs;
- Deficiencies in engineering controls: poor selection of optics hardware configuration to block stray beam from polarizer.

Root causes for accident:

i. Inadequate laser operator training; in particular, the on-the-job training (OJT) given for laser alignment tasks was inadequate;
ii. Inadequate supervision of laser operator by both the laser safety supervisor for the facility and by the worker's administrative supervisor that he reported to;
iii. Inadequate work planning: related to inadequate training and supervision mentioned above; also inadequate pre-job briefing or review of optics configuration and tasks for worker, who had limited laser alignment experience relevant for the tasks to be performed;
iv. Inadequate adherence to laboratory rules for laser alignment;
v. Deceptive hazard of dimly visible beams outside 400-700nm wavelength range;
vi. Inadequate intervention following (prior) laser eyewear safety violations by other laser operators in the facility.

Recommended Actions:

External investigation and corrective actions for lab-wide programs at SLAC:

- The lab initiated a (DOE) Type-B like investigation for the laser incident, which was externally led by an accident investigation specialist. The Investigation Board submitted a final report at the end of October 2009, which stated its findings and judgments of need (JONs). The JONs have broad applicability to many safety and operations programs at the lab.
- In response to the JONs from the Investigation Board's report, the lab put together a Corrective Action Plan (CAP) Team to determine needed CAs to properly address the JONs. A report from the CAP Team is due in February 2010.

Corrective Actions for SLAC's laser safety program:

An internal assessment, conducted by the Lab's Laser Safety Officer (LSO) with assistance from the Laser Safety Committee, of causal factors and associated corrective actions (CAs) for SLAC's laser safety program was completed. This is described in LSO Memo 2010-1, which lists 20 CAs to be done. Ten of these were completed by the end of 2009 and the other 10 will be completed in 2010. The 20 CA items were entered into the Corrective Action Tracking System (CATS). Two of the CAs completed in 2009 were to i) create a new laser alignment practical course; and ii) create a new Laser Accidents + Lessons Learned classroom course. The CAs also include 2 review committees, whose work is in progress, to review SLAC policies and practices for i) Standard Operating Procedures and other safety documents, and ii) laser eyewear PPE policy.

Estimated Savings/Cost Avoidance: -

Priority Descriptor: Yellow/Caution

Hazard(s): laser

ISM Core Function(s): Hazard Controls

Originator: SLAC

Contact: Michael Woods, SLAC; email: mwoods@slac.stanford.edu; phone: 650-926-3609

Authorized Derivative Classifier: Not required

Keywords: Laser, OJT, supervision, SOP, PPE

References: References such as DOE Orders, Programs (e.g., Standards/ Requirements Identification Document program), Standards, Occurrence Report numbers, etc.