

Title: Laser eyewear protection inadvertently not used

Date: February 27, 2013

Identifier: ORPS SC--SSO-SU-SLAC-2012-0008

Lessons Learned Statement: Robust barriers need to be implemented at entryways to nominal hazard zones. More generally, fault-tolerant systems need to be implemented such that a single mistake won't lead to a hazardous exposure.

Lab safety design and lab operation requirements need to account for variations in training and skills of personnel working in the lab. Additional On-the-Job Training and pre-job briefings may be required for some types of personnel.

Noteworthy practices:

- This lab has good barriers and enclosures for the laser beam paths. This simplified the determination that there was no plausible risk of accidental exposure to a primary beam or a secondary stray beam.
- This lab is well managed. There is a good syllabus for On-the-Job training and a comprehensive Standard Operating Procedures document that describes well the laser hazards and controls. Laser hazards and controls were well communicated and understood by the worker.

Incident Summary: A qualified laser operator (QLO) worked for a short time without required laser eyewear protection in a laser lab. This laser lab has a work area (computer workstation and optics preparation work bench) inside the laser controlled area (LCA), but separated from the nominal hazard zone (NHZ) by a laser curtain. In one instance the QLO forgot to put on eyewear when entering the NHZ and was in the NHZ for up to 5 minutes before exiting. Later that evening the QLO experienced some discomfort to both eyes and became concerned about possible laser exposure and eye injury. Follow-up exams show no eye injury and investigation shows no possibility for a direct exposure to a primary beam or a secondary stray beam; there would have been an exposure to diffusely scattered laser light but at a level below the maximum permissible exposure (MPE).

Incident Description and Analysis:

Description

On May 30, 2012 a worker was replacing laser mirror actuator motors and upgrading associated computer software in a Class 4 laser lab. The worker was a Qualified Laser Operator (QLO) for this laser lab, but in the capacity of a worker providing controls system support, rather than a worker who may perform laser alignment tasks. The laser lab is a Laser Controlled Area with access key-restricted to QLOs and personnel they may escort.

The job assignment required the worker to frequently move between two areas inside the laser lab that are separated by a laser curtain. One area is inside the laser curtain where the laser systems are located; this is the Nominal Hazard Zone (NHZ), where there may be accessible laser light above the MPE and where laser

eyewear protection (LEP) is required. The second area is an adjacent Work Area outside the laser curtain and NHZ where a computer workstation and optics workbench are located. In the Work Area outside the NHZ, personnel are not required to wear LEP because they are protected by a laser curtain separating the Work Area from the NHZ.

During one of these “back and forth” entries into the NHZ, the worker forgot to put on the required LEP before re-entering the NHZ. After approximately 5 minutes inside the NHZ without LEP the worker began walking back towards the NHZ exit and noticed light emitting from part of the laser system. The worker then realized they had forgot to put on the required LEP and left the NHZ.

Later that evening the QLO experienced some discomfort to both eyes and became concerned about possible laser exposure and eye injury. The worker had an eye exam performed which determined there was no injury to their eyes.

Analysis

The investigation evaluated potential exposure given the accessible laser beams at the time of the incident. Laser beam paths are typically fully enclosed in this laser lab, though not all are in credited Class 1 enclosures. At the time of the incident, a top access cover was removed from an enclosure where 760nm laser light is frequency tripled into the UV. This was the area where the worker observed unenclosed light from the laser. Given the beam enclosures present there was no possibility for a direct exposure to a primary beam or a secondary stray beam. There would have been an exposure to diffusely scattered laser light but at a level below the maximum permissible exposure (MPE).

A root cause analysis investigation was done. The report from that investigation summarized the following causal factors for the incident.

1. Direct causes of the incident were:
 - Human error. When entering the NHZ, the worker failed to don protective eyewear as required.
 - Unenclosed laser beam. Laser energy was accessible due to an open enclosure in the laser beam path.
2. Root cause of the incident was:
 - Inadequate controls/barriers. Controls to ensure donning of LEP were inadequate at the entry to the Nominal Hazard Zone.
3. Contributing causes to the incident were:
 - Work Planning & Control to discuss and coordinate parallel work activities in the lab could have further minimized open beam laser work when “Support QLOs” were present. (“Support QLOs” are those who do not perform laser alignment work. Their normal work tasks are typically not in laser labs and they may work infrequently in laser labs.)
 - Allowing workers to frequently don and doff LEP over an extended period of time at the NHZ entry increases the likelihood of forgetting to don LEP when needed. Less experienced QLOs who infrequently perform support tasks in laser areas may be more vulnerable to this risk.
 - The lab does not have a laser-enclosed Class 1 operation mode, in which

all potentially hazardous laser light is fully enclosed during support QLO work activities.

- The lab has a large number of QLOs, including some who are support personnel that are in the lab infrequently and thus may be more prone to making mistakes during time spent with exposed laser light.

Extent of Condition

1. Lab configuration. Currently this is the only SLAC laser lab that has a work area inside the LCA which is outside the NHZ, but similar configurations are expected in future labs.
2. Number of QLOs, including Support QLOs. This lab has 32 QLOs, including 8 that are Support QLOs. Approximately 5 additional SLAC laser labs involved in accelerator operations and user facilities have similar numbers of QLOs and Support QLOs.

Corrective Actions:

Actions for the affected laser lab:

1. An additional warning sign/barrier was added at the entry to the NHZ through the laser curtain chicane.



2. A pressure mat is being added in front of the laser curtain entryway. When someone is standing on the mat a red warning light will be lit and a two-tone audible alarm will sound. The warning light will have a sign next to it indicating that Laser Eyewear is required beyond that point (unless Laser Off conditions have been established).



3. On-the Job refresher training is being conducted for “Support QLOs.” This will be done annually for them.
4. This laser lab had plans prior to this incident to implement a Class 1 operation mode in which laser beams are fully enclosed. This requires an upgrade to the lab’s engineered laser safety system. Budget approval and scheduling for this are still pending. With a Class 1 operation mode, it would be possible to schedule most Support QLO work when laser beams are ensured to be fully enclosed.

Actions for SLAC’s laser safety policy:

The Laser Safety Officer, with input from the Laser Safety Committee, reviewed and evaluated policy for the lab’s laser safety program. The following updates are being implemented:

1. “Support QLO” requirements are being added. The requirements include the following statement: “Laser lab supervisors should implement the following controls for these personnel:
 - Limit their number to only those that are essential and may need unescorted laser lab access
 - Limit their scope of work, including to limit RFID authorization for the laser safety control panel
 - Conduct periodic refresher OJT
 - Conduct pre-job briefings prior to their laser lab work and determine if their work needs to be supervised by a regular QLO
 - Determine if any additional LCA or NHZ controls are needed to accommodate their work
 - Avoid scheduling their work during Class 4 laser operations, in particular if laser alignment will be taking place

2. LCA requirements are being updated to add the following item:
- For LCAs where there is a work area (ex. computer work station or optics preparation area) outside the NHZ, an additional barrier must be implemented at the NHZ entryway to remind entering personnel to don laser eyewear protection during Class 3B or Class 4 laser operation. Engineered barriers are to be given priority over administrative barriers, such as a sign. (An interlocked pressure mat with an audible/visual alarm is one way to implement this NHZ entryway control.)

Priority Descriptor: Yellow/Caution

Hazard(s): Laser

ISM Core Function(s): Hazard Assessment, Develop Hazard Controls, Perform Work within Controls.

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References: ANSI Z136.1 “Safe Use of Lasers”