



Internal Audit Report

Laser Safety

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I. EXECUTIVE SUMMARY

Audit & Management Advisory Services (AMAS) has completed an audit to evaluate the level of exposure and safety practices in place over the use of lasers in campus research.

In general, we did not observe any unsafe laser setups during our review. The newly established Laser Safety Program has gotten off to a good start. Laser users we spoke to were aware of the Program, most of them had taken the new online laser safety training, and were making use of the laser safety eyewear provided by EH&S.

However, opportunities were identified to improve safety in the majority of laser labs that we inspected. The new Laser Safety Manual identifies policies and procedures that enhance safety, and references standards for the safe use of lasers in general, and in research environments, such as universities. These opportunities should be addressed to the extent possible in order to achieve the goal of the Laser Safety Program, which is a positive laser safety culture established at UCSC, and the reduction of possible laser radiation exposure to levels below which eye or skin damage is possible.

The following observations requiring management corrective action were identified:

A. Compliance with the Laser Safety Program

There were opportunities for improvement to enhance laser safety in most laser labs inspected.

B. The Laser Safety Committee Charge

In its bylaws, the Laser Safety Committee is referred to as the Laser Safety Section of the Radiation Safety Committee. The Laser Safety Committee should be a stand-alone committee with its own charge from campus administration. There is no need to include it in the Radiation Safety Committee.

C. The Laser Inspection Form

The laser inspection form used during the audit-related inspections of laser labs did not include a conclusion on the safety of the laser(s) or laser system(s), and did not include recommendations for improving safety controls.

Management agreed to all corrective actions recommended to address risks identified in these areas. Observations and related management corrective actions are described in greater detail in section III. Of this report.

II. INTRODUCTION

Purpose

The purpose of the audit was to evaluate the level of exposure and safety practices in place over the use of lasers¹ in campus research.

Background

Lasers are used for research at UCSC, but they can potentially damage the eye or skin if they are not used safely. This is especially the case for those lasers with the hazard classification of Class 3B and Class 4. The University has a moral and legal responsibility to protect the health of its students and employees. It is the policy of the University that the principal investigator (PI), or faculty member in charge of a laboratory, is responsible for safety associated with laser use in his or her area. Environmental Health and Safety (EH&S) is the campus unit that provides assistance to these PIs or faculty members in fulfillment of its mission to effectively manage health, safety, and environmental risk to the UCSC community. The standard method of providing such assistance is to establish a laser safety program.

Until recently, UCSC has never had a functional laser safety program, and it is the last campus in the UC system to establish one. Creating a laser safety program in a university where laser use has been conducted for decades without it can be a challenge. Anticipating this, EH&S hired a highly respected senior laser safety consultant to review Class 3B & 4 laser use areas and provide recommendations. This review took place in spring 2015, which allowed the newly hired laser safety officer (LSO) to participate. No unsafe laser setups were encountered during that review, but it was common to find opportunities for improvement to enhance laser safety or deflect hazard perception issues. This review supported EH&S efforts to develop a laser safety program and as a direct result, EH&S was able to purchase laser safety glasses and provide them to laser labs.

The campus now has a formal Laser Safety Program. The Program includes a Laser Safety Committee (a subgroup of the Radiation Safety Committee) appointed by the University that is responsible for formulating policy for the safe use of lasers. The Committee is also charged with monitoring the University's compliance with federal and state regulations for the safe use of lasers. The LSO, an EH&S employee, is the overall manager of the Program, and is responsible for ensuring that the policies and guidelines established by the Committee are implemented. The LSO monitors laser safety practices through periodic inspections of laser laboratories and informs the Committee of any compliance issues. The LSO also provides basic laser safety awareness training, such as through online training, and provides supplies (signs, labels, etc.) to assist laser owners and operators.

The Program also includes a Laser Safety Manual that outlines the various responsibilities and procedures to comply with the Program. The Program in turn complies with the American National Standards Institute (ANSI) standards Z136.1 Safe Use of Lasers and Z136.8 Safe Use of Lasers in Research, Development or Testing. The goal, through an effective implementation of this Program, is a positive laser safety culture established at UCSC, and the reduction of possible laser radiation exposure to levels below which eye or skin damage is possible.

¹ A laser is a device that produces radiant energy predominantly by stimulated emission. Laser radiation may be highly coherent spatially, temporally, or both. The term "laser" is an acronym for light amplification by stimulated emission of radiation.

Scope

We conducted this review by means of the following

- Interviewed EH&S management and the laser safety officer
- Interviewed the chair of the Laser Safety Committee
- Reviewed elements of the Laser Safety Program, including the UCSC Laser Safety Manual and the basic online laser safety training, manuals at other UC campuses, and the Bylaws of the Laser Safety Committee
- Reviewed ANSI standards Z136.1 and Z136.8
- Reviewed related laser safety regulations, such as OSHA regulations, California Code of Regulations, and Code of Federal Regulations
- Reviewed the Laser Safety Report 5/15/2015 by the laser safety consultant
- Accompanied the LSO on inspection of laser laboratories involving 30 lasers or laser systems²

Our scope was restricted by the availability of laser labs for inspection during the summer months of our review schedule. Further, as the Laser Safety Program is newly established with the Laser Safety Manual dated 7/1/2016, our emphasis was obtaining a snapshot of the current state of the Program that can serve as a benchmark for future reviews.

² A laser system is an assembly of electrical, mechanical, and optical components that includes one or more lasers.

III. OBSERVATIONS REQUIRING MANAGEMENT CORRECTIVE ACTION

A. Compliance with the Laser Safety Program		
There were opportunities for improvement to enhance laser safety in most laser labs inspected.		
Risk Statement/Effect		
In order for the new Laser Safety Program to achieve its goal of reducing the potential for laser hazard occurrences, opportunities for improvement that are observed through inspections need to be addressed to the extent possible.		
Agreements		
A.1	The LSO will perform a hazard analysis of those observations made during the audit-related lab inspections to determine what actions should be taken to ensure that control measures appropriate to the class of maximum accessible emission level are applied to assure safe operation.	Implementation Date
		11/15/2016
		Responsible Manager
		Executive Director, EH&S
A.2	The Laser Safety Committee will prioritize the LSO’s recommendations for opportunities to enhance laser safety, and take appropriate action to ensure these are implemented.	Implementation Date
		1/02/2017
		Responsible Manager
		Chair, Laser Safety Committee

A. Compliance with the Laser Safety Program – Detailed Discussion

The Laser Safety Program is required to be compliant with ANSI Z136.1, which applies to all class 3B and 4 lasers, whether industrial or university research lasers. However, there are circumstances in the research environment when some of these standards do not apply. ANSI Z136.8 applies specifically to R&D, including universities. Those standards may rely on the LSO who is responsible to perform a hazard analysis and ensure that control measures appropriate to the class of maximum accessible emission level are applied for safe operation.

The LSO, accompanied by the auditor, inspected 30 lasers or laser systems for this audit to understand the level of compliance laser labs had with the Laser Safety Program. The following are examples of observations we made where conditions were less than requirements stated in the Laser Safety Manual or in ANSI standards. We referenced where possible statements in the Manual for brevity sake; all these are also included in ANSI standards. There were a couple of observations stated here that were not explicitly stated in the Manual; in those cases, we referenced ANSI standards. Keep in mind that these observations are not exhaustive of all observations made during the inspections.

Manual: Before being placed into service, all class 3B and class 4 lasers must be registered with EH&S.

- Nine of the lasers inspected had not submitted LURs (laser use registration form). Further, the LSO was concerned that he would not be notified before new lasers are placed into service, or when old lasers are taken out of service or relocated.

Manual: New laser operator must have documented EH&S training and on the job training from the Principal Investigator (PI) or the Responsible Individual (RI).

- Users of three of the 30 lasers inspected did not take the online training.

Manual: The PI must provide written operating and safety procedures to personnel who operate lasers.

- 11 of the 30 lasers inspected did not have standard operating procedures (SOP). Further, the LSO was concerned that SOPs might be written without sufficient thoroughness and clarity to safely guide users.

Although users may have received the general online laser safety training, this is not sufficient for them to understand safety procedures on the particular laser setup they are working on. This requires hands-on training by the PI and documented procedures. Further, there needs to be documented user signoffs to provide assurance that users understood the safety procedures on the laser setup they are working on.

Manual: Each PI must ensure that appropriate eye protection is provided to individuals working with lasers and must ensure that protective eyewear is worn.

- Users of one laser did not have appropriate eyewear. Another laser lab had eyewear, but had not submitted their specifications to the LSO. We were pleased to see new eyewear supplied by EH&S at most of the laser labs we visited.

Manual: A controlled area, in which access is restricted for the purpose of protection from laser radiation, must be conspicuously posted with caution signs as prescribed for the class of laser.

- 11 of the 30 lasers inspected did not have proper signs on doors to their location. Seven had signs, but did not identify optical densities for the different wavelengths, which is supposed to be included on the signs.
- One lab's door signage misidentified the types of lasers it had. The sign should always indicate the highest hazard class of laser, which in this case was a Class 4.
- 11 of the 20 Class 4 lasers inspected did not have lighted indicator signs. One laser lab with three Class 4, open beam lasers had a laser indicator outside the entrance, but it was not operational.
- There needs to be warning lights inside the labs to notify personnel that a laser is on. A small LED light on a laser console is not sufficient warning.

Manual: No one shall be allowed into a laser room unless properly authorized and protected

- A lab with a laser may be entered without authorization or protection, as not all labs we entered were locked. However, these lasers usually are enclosed either by solid casing, optical fiber or a special curtain for this purpose. There are labs that have a separate room where lasers are located and entrance to these rooms is controlled. Other labs were locked.

Manual: Laser keys shall be kept in a secured area and signed out only by those authorized to do so.

- Laser keys are usually kept inserted in consoles in laser labs. Thus their security is as secure as the lab itself. As not all labs were kept locked, there is the possibility that a laser could be turned on without authorization and expose hazardous laser radiation to unprepared occupants in the lab.

Manual: Whenever possible, confine (enclose) the beam...

- Nine lasers were open beam or partially open beam. These should be fully enclosed unless there are circumstances that require the beam to remain open. In one lab we inspected, they had purchased optical table enclosures that restricted the area of the beam to the optical table³, while enabling access to the laser system for alignment changes.

ANSI Z136.8.4.2.8.1: Have any potentially hazardous beam terminated in a beamstop of an appropriate material

- Beam barrier⁴ material for seven lasers included combustible material. These should be replaced by noncombustible material.

ANSI Z136.8.4 General Controls has many references to interlock⁵ requirements

- Nine of the lasers did not have interlocks on protective housing or enclosures. Interlocks are often included in the manufacture of laser housing and enclosures. In one laser lab, an interlock was added to the laser enclosure by a staff specialist.

³ An optical table is a vibration control platform that is used to support systems used for laser and optics related experiments, engineering and manufacturing.

⁴ A beam barrier is a device used to block or attenuate to safe levels incident, direct or diffuse laser radiation. They are used to establish a boundary for a controlled laser area.

⁵ An interlock is a feature that makes the state of two mechanisms or functions mutually dependent. For example, if a cover or panel of a laser enclosure is removed, an interlock will either prevent the laser from being turned on or it will shut off the laser that is already turned on.

B. The Laser Safety Committee Charge		
In its bylaws, the Laser Safety Committee is referred to as the Laser Safety Section of the Radiation Safety Committee. The Laser Safety Committee should be a stand-alone committee with its own charge from campus administration. There is no need to include it in the Radiation Safety Committee.		
Risk Statement/Effect		
As the laser safety officer depends on the Laser Safety Committee to take action on safety issues observed during inspections, the Committee’s authority should not be in question.		
Agreement		
B.1	The Laser Safety Committee will be established as a stand-alone safety committee with a charge by the VC for Research.	Implementation Date
		01/31/2017
		Responsible Manager
		Executive Director, EH&S

B. Laser Safety Committee Charge – Detailed Discussion

According to the new Laser Safety Committee bylaws, the Committee is referred to as the Laser Safety Section of the Radiation Safety Committee. This was due to a previous radiation safety officer. However, the chair of the Laser Safety Committee believes the Committee should be a stand-alone committee with a charge from Campus administration, like the Department Chemistry and Biochemistry Safety Committee, and the Institutional Biosafety Committee that received their charge from the VC for Research.

The Radiation Safety Committee was charged by the EVC to whom it reports, due to the fact that the Campus’s purchase of radioactive isotopes requires a state license; lasers however can be purchased without a license, like chemicals, laboratory animals, etc. Consequently, the Committee chair does not see the Radiation Safety Committee as a natural home for his committee. Further, when the Laser Safety Manual states, “The University has established a Laser Safety Committee...”, it should be clear what “University” means in this context. This will require a clear charge by senior management.

C. The Laser Inspection Form		
The laser inspection form used during the audit-related inspections of laser labs did not include a conclusion on the safety of the laser(s) or laser system(s), and did not include recommendations for improving safety controls.		
Risk Statement/Effect		
The LSO is responsible for monitoring laser safety practices, which is done by means of a laser safety inspection program. Although a checklist of points of compliance with the program is useful to gather information obtained during an inspection, there should also be a narrative of the LSO’s conclusions based on this information. Without the LSO’s documented judgement, it is difficult to understand the significance of the information gathered on the checklist.		
Agreement		
C.1	The LSO will include conclusions about the safety of lasers inspected and recommendations to improve safety on the Laser Inspection Form.	Implementation Date
		11/15/2016
		Responsible Manager
		Executive Director, EH&S

C. The Laser Inspection Form – Detailed Discussion

The Laser Inspection Form used during the audit-related inspections is a work in progress. It includes information identifying the inspector, date of inspection, location of the laser lab, identification of the laser, the PI, the lab contact person and contact information. In addition, it includes a check list of ANSI and campus controls, an additional comments section, and laser protective eyewear information. The check list is divided into the following sections, each with a list of controls (52 in all) that are to be assessed with a yes, no, or non-applicable, and a short space for comments:

- Laser Posting, Labeling and Security Measures: seven control points
- Laser Unit Safety Controls: 10 control points
- Engineering Safety Controls⁶: 16 control points
- Administrative Safety Controls⁷: seven control points
- Personal protective equipment: three control points
- Non-beam hazards⁸: nine control points

⁶ Engineering controls are methods of protecting others from exposure to laser radiation that requires no training on the part of those who may be exposed, such as interlocks and barriers.

⁷ Administrative controls are control measures incorporating administrative means, e.g. training, safety approvals, LSO designation, and standard operating procedures to mitigate the potential hazards associated with laser use.

⁸ Non-beam hazards are a class of hazards that results from factors other than the direct human exposure to a laser beam, e.g. compressed gas in use, high voltage power, fire, laser generated air contaminants, etc.

We did not observe the LSO's conclusion on the safety of the laser or laser system on these forms, or recommended actions to improve their safety profile. In speaking with the LSO, we understood that he had in mind recommendations for various labs that he intended to discuss with the Laser Safety Committee. We believe that these should be documented on the Laser Inspection Form to ensure they are not forgotten and to show how the conclusions and recommendations arose from information gathered during inspections and recorded on the forms.

APPENDIX A – Lasers Inspected

Laser/Laser Systems Inspected

Ben Abrams SINS 109C FLCPA and CBBS
Zuo SINS 118
Wilder 1064nm cutting (Class 3B)
Wilder Scanning-TCT
Schmidt JBE 16 Argon (3B) and HeNe (3B)
Schmidt JBE 16 diode x4 (3B)
Schmidt JBE 16 SuperContinuum
Schmidt JBE 46 Mira-900F Ti-saph
Schmidt JBE 46 Trestles Ti-saph
Franks ArF excimer
Zhang PSB 183 HeNe (3B)
Zhang PSB 183 Transient Absorption
Zhang PSB 183 TCSPC (2 lasers with 3 wavelengths in the system)
Ayzner PSB 186
Ayzner PSB 186 (3B)
Kliger PSB 195C DCR 2A & DCR 11
Kliger PSB 195D DCR 2
Kliger PSB 195E DCR 1
Kliger PSB 195F Pro-250-10
Bagshaw PSB 286E (3B)
Bagshaw PSB 179 Vortran Stradus (3B)
Yanik JBE 266
Yanik JBE 281 (3B)
Sher BioMed 345D
Nazario BioMed 445C FACS (3B)
Kubby JBE 57 diodes x2 (3B)
Kubby JBE 57 HeNe
Kubby JBE 62