

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

A. Purpose

The purpose of this policy is to establish safe procedures for working with Class 3B and Class 4 lasers used in research, including procurement, registration, inventory, description of beam and non-beam hazards, selection of personal protection equipment (PPE) and other control measures. This policy requires that lasers and laser systems be operated in accordance with the American National Standards Institute (ANSI) Z136.1 2014, “The Safe Use of Lasers,” and other applicable federal and state regulations.

B. Applicability/Scope

This policy applies to Columbia University personnel working with Class 3B and Class 4 lasers at all University campuses (Medical Center, Morningside, Lamont-Doherty Earth Observatory and Nevis Laboratories). This policy does not cover lasers used in clinical applications at New York Presbyterian Hospital. This policy does not include Class 1, 1M, 2, 2M, and 3R lasers or systems with embedded lasers of a higher power where only a Class 1 beam is emitted.

C. Responsibilities

1. Principal Investigator

- a. Enforce the safe work practices outlined in the Laser Safety Program.
- b. Prepare Standard Operating Procedures (SOPs) for Class 3B and/or Class 4 lasers (See Appendix C for recommended SOP outline). The SOP will enable a total hazard evaluation in accordance with the manufacturer’s recommendations so that all safety measures are considered.
- c. Maintain and update, as needed, all operating, alignment and emergency procedures for the lasers and facility.
- d. Ensure registration of all Class 3B and 4 lasers.
- e. Ensure personnel using lasers have attended Laser Safety Training prior to operating a laser.
- f. Perform and document work area specific training for all laser users prior to initial operation.
- g. Comply with ANSI Standard Z136.1 in order to ensure that any exposure to lasers remains below the Maximum Permissible Exposure (MPE) values.
- h. Ensure that the PPE recommended by the manufacturer for safe operation of the laser is available and is used by all employees and visitors to the lab during laser operation.
- i. Restrict access to laser facility to only those individuals with authorization to work in (as well as authorized spectators and visitors to) the laser facility to ensure against accidental exposure to laser radiation.
- j. Act as or designate a knowledgeable person to:
 - i. Notify EH&S of any changes in operational status, such as location changes, new purchases, and/or modifications to any laser equipment that may change the classification.
 - ii. Change SOPs in accord with modifications made in the laser.
 - iii. Update all records to reflect changes in personnel or equipment.
 - iv. Re-register the laser with the EH&S Office indicating these changes.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

- k. Ensure that all users have reviewed manufacturer’s instructions for safe operation prior to use of the equipment and have also attended the Laser Safety Training provided by the EH&S Office.
 - l. Report all incidents involving safety violations to the EH&S Office at 212-854-8749 (MS) and at 212-305-6780 (CUMC)
 - m. Report all injuries to either Work Force Health and Safety (CUMC, LDEO, and NEVIS) or Student Health Services (CUMC and MS).
2. The Employee
- a. Wear all necessary PPE designated by the PI and/or LATCH (See Appendix H).
 - b. Inspect eyewear prior to use to ensure that it is in good condition.
 - c. Comply with all rules and requirements specified in this policy as well as any work area specific laser safe operating procedures (SOPs).
 - d. Report laser hazards, including potential exposures to the beam, to the PI and EH&S. Some exposure events also require the employee to have medical evaluation. These events include, but are not limited to:
 - i. Laser exposure to the eye or skin that are greater than the Maximum Permissible Exposure (MPE) for the actual exposure duration.
 - ii. Exposure that cause a burning sensation or a change in the condition of the skin, a visual after image, blurring or obstruction of vision, headaches or other pain.
 - iii. Any injury caused by laser support equipment, such as electric shock or exposure to a dye solution.
3. Environmental Health & Safety
- a. Oversee the Laser Safety Program.
 - b. Review and update this policy as necessary to ensure compliance with applicable regulations and change in technology.
 - c. Conduct inspections of laser areas to recommend action for compliance with requirements of ANSI Z136.1 and applicable state and federal regulations.
 - d. Assist with proper selection of PPE.
 - e. Upon request, assist PIs of their designated staff with writing SOPs to ensure a proper safety assessment is performed.
 - f. Develop a general laser safety training program and provide training to laser users.
 - g. Respond to inquiries on laser safety procedures and provide technical assistance.
 - h. Maintain records of laser inventories, audits, survey forms, and training attendance.

D. Definitions

See Appendix A

E. Procedures

- 1. Procurement, Inventory, Transfer and Disposal
 - a) Procurement

Before purchasing a Class 3B or Class 4 laser, the Principal Investigator (PI) shall complete a Laser Registration Form (LRF) ([Appendix D](#)) and send it to Columbia University Purchasing Office along with their purchasing requisition. The Purchasing office will download LRF into the ARC Portal System and notify

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

EH&S for approval. The PI must complete the LRF providing descriptions of the laser (class, lasing medium, wavelength, pulsed/continuous wave, power, etc.), a list of the laser users in the lab, and a description of various laser control measures required by the manufacturer. PI shall consult the manufacturer for unknown information. If the LRF is not attached or complete, the Purchasing office will not process the purchase order request, which could delay purchasing for several weeks. After review, EH&S shall approve LRF on the [ARC Portal System](#) for further processing by the Purchasing Office to proceed with the laser purchase.

b) Inventory

The PI shall complete the LRF for existing lasers as well as lasers transferred to CU that are to be included in the laser inventory. If a Class 3B or Class 4 laser is fabricated in the lab, the PI shall send an updated LRF describing the changes made. PIs shall also keep a copy of the LRF in their lab. EH&S maintains an inventory of lasers.

c) Transfer

The PI shall report to EH&S any lasers that are transferred to another laboratory at CU to update the EH&S database. The laser systems that are purchased (or those that are built in a R&D lab and transferred to other users out of the University) must meet the federal certification requirements and cleared by the University General Counsel Office. It is the responsibility of PIs to fulfill the certification requirements for laboratory built lasers.

Note: The transfer of a Class 3B or Class 4 laser on campus to a person who does not have appropriate training, who does not understand the hazards of the laser, and/or who does not have the proper PPE, could result in serious injury. Consult EH&S for information on laser hazards, proper safeguards and the necessary training.

d) Disposal

Before disposing of lasers off-campus, the PI shall consult with the University General Counsel to ensure that the University neither offers nor implies any warranty as to the safety of its use. All lasers shall be disposed in accordance with applicable regulations.

2. Written Safe Operating Procedures (SOP) (See [Appendix C](#))

The PI should prepare a written Standard Operating Procedures (SOP), including Service and Maintenance Procedure for each Class 3B and Class 4 laser present in their laboratory. Written alignment procedures are to be posted in the area or kept near the equipment. At a minimum, the most salient features of laser safety are to be posted in a clearly visible manner near each laser installation (Appendix F). General exposure guidelines, special precautions, or unusual conditions should be outlined in SOP. The Manufacturer's Manual should also be available to users.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

3. Laser Classification, Warning Signs and Labels (see [Appendix B](#))
Laser classification is determined by a formula that takes into account wavelength, power, and accessible emission limits, whether the laser is pulsed or continuous, among other factors. For manufactured (i.e., - *not* made in a lab) lasers, the manufacturer is responsible for providing the classification of the laser at the time it was purchased. The PI is responsible for the classification of lasers prepared or modified in their lab. Laser warning labels must be affixed on the instrument, close to the source of the laser light. In addition to information about laser parameters, labels should contain safety information.
4. Posting of Warning Signs (see [Appendix B](#))
Entrances to laser areas must be posted in accordance with [ANSI Standards](#). The areas must be secured against persons accidentally being exposed to beams, and be posted with a proper warning sign such as an illuminated warning sign outside of the area. Preferably the light should be flashing and lit only when the laser is on. (When a Class 3B or 4 laser is left on and personnel want to leave the room, the door should be locked.) All windows, doorways, and portals should be covered or restricted to reduce transmitted laser beam below the Maximum Permissible Exposure (MPE). The PI is responsible for posting signs and informing laboratory personnel.

For Class 4 lasers that have open beam lines, the [ANSI Standards](#) require interlocked doors (or sensors or pressure sensitive doormats), or devices that turn-off or attenuate the laser beam in the event of unexpected entry into the area. However, under special conditions where an interlocked door could interfere with the proposed research activity, and alternate method of protection, such as a curtain or a barrier, should be discussed with EH&S to provide a suitable barrier just inside the door or where ever most appropriate to intercept a beam or scatter it so that a person entering the room will not be exposed above the MPE limits.

5. Laser Safety Training
Before working with lasers, all laser operators must receive safety training provided by EH&S or rascal (www.rascal.columbia.edu). The PI is responsible for ensuring the training of his/her staff before they are allowed to operate a laser. Refresher laser safety training may be done in-person or online through Rascal every two years. The training shall include basic instruction on:
 - a. The biological effects of laser radiation
 - b. Physical principles of lasers
 - c. Classification of lasers
 - d. Control of laser areas
 - e. Medical examination options
 - f. Basic safety rules
 - g. Use of personal protective equipment (PPE)
 - h. Control of non-beam hazards including electrical safety, fire safety, and chemical safety (handling and storage)

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

i. Emergency response procedures

On-the-job training for Class 3B and Class 4 laser users shall include a thorough review, by the PI or a designated senior or knowledgeable individual, of the hazards associated with each laser that a person may operate, the protection methods employed by the laboratory, and the emergency contacts.

6. Medical Surveillance (see [Appendix H](#))

Personnel using a modified/altered Class 3B and/or Class 4 laser system may be recommended to have a project specific baseline eye examination for visual acuity prior to beginning work. The PI should discuss it with EH&S for hazard assessment to determine risk. A follow-up examination should be provided to any personnel who have sustained eye injury during laser use.

7. Hazardous Waste Disposal

Certain types of research activities with lasers use organic solvents and toxic dyes. All waste mixtures must be collected and disposed of as hazardous waste through EH&S. Collect waste solvent/dyes in compatible containers (usually polypropylene) and label with a hazardous waste label as soon as the first material is added to the container. Do not attempt to evaporate waste in a fume hood to reduce the volume, or to drain dispose of the waste.

F. Emergency Contacts

PI must ensure that lab personnel have access to reach him/her during an emergency. Such information should be conveyed to all lab personnel.

G. Medical Surveillance

See Appendix H

H. Recordkeeping

All training records shall be maintained by EH&S office

I. Appendices

1. Appendix A: Definitions
2. Appendix B: Classes of Lasers
3. Appendix C: An Outline for Standard Operating Procedures (SOPs)
4. Appendix D: Laser Registration Form (LRF)
5. Appendix E: Laser System Inspection Checklist
6. Appendix F: Laser Safety Control Measures
7. Appendix G: List of Laser Protective Eyewear Manufacturers and Vendors
8. Appendix H: Medical Surveillance

J. Forms

See Appendix D, [Laser Registration Form](#)

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

K. References

1. American National Standard for Safe Use of Lasers, ANSI Z136.1-2007, The Laser Institute of America, 2007
2. OSHA Guidelines for Laser Safety and Hazard Assessment. STD 01-05-001 [Pub. 8-1.7] (1991, August 5)\
3. New York State Department of Labor. Part 50. Effective March 2, 1994.

L. Acknowledgements (optional)

Appendix A
Definitions

1. **Absorption:** transformation of radiant energy to a different form of energy by interaction with matter.
2. **Accessible emission limit (AEL):** the maximum accessible emission level permitted within a particular class.
3. **Attenuation:** the decrease in the radiant flux as it passes through an absorbing or scattering medium.
4. **Average power:** the total energy imparted during exposure divided by the exposure duration.
5. **Aversion response:** movement of the eyelid or the head to avoid an exposure to a noxious stimulant or bright light. It can occur within 0.25 seconds and can also be called the blink reflex time.
6. **Beam:** a collection of rays, which may be parallel, divergent, or convergent.
7. **Beam diameter:** the distance between diametrically opposed points in that cross-section of a beam where the power per unit area is $1/e$ (0.368) times that of the peak power per unit area.
8. **Beam Divergence:** The full angle of laser beam, usually measured at the half power points in radians or milliradians.
9. **Coherent:** a light beam is said to be coherent when the electric vector at any point in it is related to that at any other point by a definite, continuous function.
10. **Continuous wave (C.W. laser):** the output of a laser, which is operated in a continuous rather than a pulsed mode. In this program, a laser operating with a continuous output for a period of 0.25 sec is regarded as a CW laser.
11. **Controlled area:** an area where the presence and activity of those within it is subject to control and supervision for the purpose of protection from laser radiation hazards.
12. **Cornea:** the transparent outer coat of the human eye, which covers the iris and the crystalline lens. The cornea is the main refracting element of the eye.
13. **Designated Individual:** An individual selected and directed by a laser safety officer to supervise the operation of a laser
14. **Diffuse reflection:** change of the spatial distribution of a beam of radiation when it is reflected in many directions by a surface or by a medium.
15. **Divergence:** the increase in the diameter of the laser beam with distance from the exit aperture. The value gives the full angle at the point where the laser energy or irradiance is $1/e$ (36.8%) of the maximum value. For the purposes of this program, divergence is taken as the full angle, expressed in radians of the beam diameter measured between those points which include laser energy or irradiance equal to $1/e$ of the maximum value of the angular extend of a beam which contains all the radius vectors of the polar curve of radiant intensity that have length rated at 36.8% of the maximum. Sometimes this is also referred to as beam spread.
16. **Diffraction:** deviation of part of a beam determined by the wave nature of radiation and occurring when the radiation passes the edge of an opaque obstacle.
17. **Duty factor:** the product of the pulse duration and the pulse repetition rate.
18. **Electromagnetic radiation:** the flow of energy consisting of orthogonally vibrating electric and magnetic fields lying transverse to the direction of propagation. X-ray, ultraviolet, visible, infrared, and radio waves occupy various portions of the electromagnetic spectrum and differ

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

- only in frequency and wavelength.
19. **Embedded laser:** an enclosed laser with an assigned class number higher than the inherent capability of the laser system in which it is incorporated, where the system's lower classification is appropriate due to the engineering features limiting accessible emission.
 20. **Enclosed laser:** a laser that is contained within a protective housing of itself or of the laser system in which it is incorporated. Opening or removal of the protective housing provides additional access to laser radiation above the applicable MPE than possible with the protective housing in place.
 21. **Hertz (Hz):** the unit, which expresses the frequency of a periodic oscillation in cycles per second.
 22. **Infrared radiation:** invisible, electromagnetic radiation beyond red light on the spectrum, with wavelengths greater than 0.7 microns.
 23. **Irradiance (E) at a point of a surface:** quotient of the radiant flux incident on an element of surface containing the point at which the area of that element measures irradiance. Units are watt per square centimeter (W-cm⁻²).
 24. **Joule (J):** a unit of energy. 1 joule = 1 watt-second = 10⁷ erg.
 25. **Laser:** a device which produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to lower energy levels. An acronym for Light Amplification Stimulated by Emission of Radiation.
 26. **Laser Safety Officer:** An individual, designated at a particular laser installation or for a particular mobile laser, who is qualified by training and experiences in the occupational and public health aspects of lasers to evaluate the radiation hazards of such laser installation or mobile laser and who is qualified to establish and administer a laser radiation protection program for such laser installation or mobile laser.
 27. **Limiting aperture:** the maximum diameter of a circle over which irradiance and radiant exposure can be averaged.
 28. **Maximum permissible exposure (MPE):** the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.
 29. **Nominal hazard zone (NHZ):** the space within which the level of direct, reflected, or scattered radiation during normal operation exceeds the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the appropriate MPE level.
 30. **Nominal ocular hazard distance (NOHD):** the distance along the axis of the unobstructed beam from a laser, fiber end, or connector to the human eye beyond which the irradiance or radiant exposure, during normal operation or service, is not expected to exceed the appropriate MPE.
 31. **Protective housing:** an enclosure that surrounds the laser or laser system that prevents access to laser radiation above the applicable MPE level. The aperture through which the useful beam is emitted is not part of the protective housing. The protective housing may enclose associated optics and a work station and shall limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals.
 32. **Pulse duration:** the duration of a laser pulse, usually measured as the time interval between the half- power points on the leading and trailing edges of the pulse.
 33. **Pupil:** the variable aperture in the iris through which light travels to the interior of the eye.
 34. **Q-switch:** a device that produces very short (~30 ns) intense laser pulses by means of

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

- enhancing the storage and dumping of electronic energy in and out of the lasing medium.
35. **Radian (rad):** a unit of angular measure equal to the angle subtended at the center of a circle by an arc whose length is equal to the radius of the circle. 1 radian = 57.3 degrees; 2 radians = 360 degrees.
 36. **Radiance (L):** radiant flux or power output per unit solid angle per unit area. Unit: Watts per centimeter squared per Steradian (W-cm⁻²-sr⁻¹).
 37. **Radiant energy (Q):** energy emitted, transferred or received in the form of radiation. Unit: joule (J).
 38. **Radiant exposure (H):** surface density of the radiant energy received. Unit: joules per centimeter squared (J-cm⁻²).
 39. **Radiant flux (W):** power emitted, transferred or received in the form of radiation. Unit: watt (W). Also called radiant power.
 40. **Specular reflection:** a mirror-like reflection of a laser beam.
 41. **Standard Operating Procedure (SOP):** formal written description of the safety- and administrative procedures to be followed in performing a specific task (e.g. beam alignment). Development of laser SOPs is the responsibility of the Principal Investigator (PI).
 42. **Transmission:** passage of radiation through a medium.
 43. **Transmittance:** the ratio of transmitted power to incident power.
 44. **Ultraviolet radiation:** an electromagnetic radiation having the wavelengths below 400 nm.
 45. **Uncontrolled area:** an area where the occupancy and activity of those within is not subject to control and supervision for the purpose of protection from laser radiation hazards.
 46. **Visible radiation (visible light):** light in wavelengths that can be seen by the human eye, 0.4 to 0.7 μ m.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

Appendix B CLASSES OF LASERS

The American National Standards Institute ([ANSI](#)) has established a laser hazard classification system in publication ANSI Z136.1-2014, Safe Use of Lasers. Certified laser manufactures are required to label their products as to the Class type as of September 19, 1985 (21 CFR Part 1040). Information regarding appropriate eyewear for a specific laser may be obtained from the manufacturer at time of purchase. The following table summarizes this laser classification scheme and the hazard capabilities associated with each class of laser.

Class of Laser	Hazards
1	Eye safe lasers; may not produce hazardous radiation
1M	Eye safe lasers except when viewed with an optical instrument.
2	Continuous intrabeam viewing can cause eye damage; momentary intrabeam exposure (< 0.25 sec) is not damaging to the eye; visible radiation only
2M	Continuous intrabeam viewing can cause eye damage when viewed with an optical aid; the accessible radiation shall not exceed Class 1 accessible emission limit (AEL) for an exposure duration of 1000 seconds
3R	Invisible lasers having an output power < 5x the Class 1 AEL or visible laser having an output power < 5 mW; capable of causing damage through intrabeam viewing, with optical instruments or through viewing a specular reflection for < 0.25 sec
3B	Invisible lasers having output power <500 mW; as with 3R lasers, 3B lasers can cause injury through intrabeam viewing, viewing with optical instruments, or through viewing a specular reflection
4	Beam power > 500 mW; intrabeam exposure, exposure to specular- and diffuse reflections capable of causing eye- and skin damage; fire hazard due to their power density

Appendix C

A Suggested Outline for Standard Operating Procedures (SOPs)

- A. Purpose:
- B. Applicability: state the name of lab for which these SOP is being developed and the type of employees covered by this SOP.
- C. Procedures:
 - i. **Registration** - who will complete registration form and send it to EH&S.
 - ii. **Manufacturers** - manual and other instructions location and notification of employees.
Material Safety Data Sheet (MSDS) – who will ensure their collection, where they will be located and how employees will be notified.
 - iii. **Emergency** - Who to contact -Supervisor- give telephone Home and Cell #; CU Public Safety phone numbers, what to do, what information to provide when calling, etc.
 - iv. **Equipment Tagging** - How to ensure that the equipment reported NOT working is properly tagged, method to notify other users of its unavailability, responsibility assigned for its repair, and notice to others after the equipment is operational.
 - v. **Repairs** - Who will coordinate any repairs with the vendor, who will ensure they are done, paper work is maintained and users are notified that it is working, etc.
 - vi. **Routine Maintenance** - How often, who will do it and who in the lab will coordinate them, who and where the paper work will be kept, etc.
 - vii. **Medical Evaluation** - where to get pre-employment medical examination, who will arrange it, who will ensure to receive documentation and who will keep it confidentially, etc.
 - viii. **Training** - who will ensure that all employees are trained before they use lasers
 - a. **EH&S training** – who will make arrangements to send employees for a live lecture given by the EH&S
 - b. **Hands-on Training** - Who will provide hands-on training and what it will cover
 - c. **Refresher** - rascal or lecture, etc.
 - ix. **Supplies** – What supplies are needed for routine operations and where they are located and who will check to ensure stocking and continuous availability?
 - x. **Accident** - what to do in case of an accident, who should be contacted, what medical facilities to contact and where to go for medical evaluation, what to carry with you when going to medical facility, who should accompany the victim, who will complete the accident form and send it workers compensation department, etc
 - xi. **Visitors** - who will coordinate with visitors entering the lab, what PPE visitors must have on before entering the lab, which will ensure that visitors have PPE on before entering the lab
 - xii. **Signs** - what signs need to be placed on the front door, on the instrument, etc. who will ensure their placements and replacement when needed.
 - xiii. **Audits** - who will do monthly or quarterly inspection /surveys of the laser using inspection form, where the forms will be maintained, who will ensure that deficiencies discovered during survey are corrected in a timely manner, etc.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

Appendix D Laser Registration Form (LRF)

The PI (Principle Investigator) **MUST** complete Appendix D when proposed research involves the use of Class 3b or Class 4 lasers, or if there is already an existing laser in the laboratory. A separate registration form must be submitted for each piece of equipment in this category. Please call EH&S with any questions or for assistance (212) 305-6780 or email to lasersafety@columbia.edu.

(PLEASE TYPE OR PRINT)

PI NAME: _____ DEPARTMENT: _____

BLDG/ROOM: _____ OFFICE PHONE: _____ FAX _____

EMERGENCY PHONE: _____ EMAIL: _____

LASER SYSTEM LOCATION: BLDG: _____ FLOOR AND ROOM#: _____

USER'S NAME: _____ PHONE #: _____

Are safety signs posted on the door? (Y/N) Are Manufacturer's recommended safety glasses used? (Y/N)

Has a written SOP been developed? (Y/N) Are the users trained on laser safety? (Y/N)

Are appropriate engineering controls (Interlock, enclosure, curtains, etc.) in place? (Y/N)

LASER DESCRIPTION:

PLEASE DESCRIBE THE SPECIFICATIONS/CHARACTERISTICS OF THIS EQUIPMENT:

1. TYPE: _____ MANUFACTURER: _____

2. MODEL #: _____ SERIAL #: _____

5. LASER CLASS: _____ 3B _____ 4 _____

6. TYPES OF OPERATION:

(A) C.W _____ (B) PULSED _____

(C) MULTIPLE PULSED _____ (D) OTHER _____

7. RATED POWER OR ENERGY OUTPUT: _____

8. PULSE REPETITION FREQUENCY: _____

9. OPERATING WAVELENGTHS: _____

10. BEAM DIAMETER: _____

11. MAXIMUM EXPECTED EXPOSURE DURATION PER DAY: _____

12. OTHER PERTINENT INFORMATION: _____

13. WAS LASER SERVICE DONE IN HOUSE? (Y/N) CONTRACTED OUT? (Y/N)

IF CONTRACTED OUT, PLEASE LIST THE COMPANY _____

14. MOST RECENT DATE THIS EQUIPMENT WAS SERVICED: _____

MANUFACTURER'S RECOMMENDED FREQUENCY OF SERVICE: _____

REGISTRANT'S SIGNATURE: _____ DATE: _____

EH&S APPROVAL SIGNATURE: _____ DATE: _____ Approval No. _____

Columbia University Medical Center Radiation Safety - Laser Audit

Date of Audit: _____
Principal Investigator: _____
Building: _____
Floor/Room #: _____

Audit Performed by: _____
Reviewed by: _____
Date Reviewed: _____

Manufacturer	Model	Type	Serial Number

Laser Registration or Appendix D

P F NA

Personnel Qualifications

Personnel who will use laser system are appropriately trained

Name	C.U.ID #	STATUS (student/staff/faculty)	Training Received (Initial/Refresher)

Comments: _____

Laser Safety Control Measures

P F NA

Administrative and Procedural Controls

- Columbia University Laser Safety Policy available/posted
- Operating Manual available
- Appropriate laser classification
- Written Standard Operating Procedures (SOP) available
- Written operating, maintenance, and alignment procedures kept with laser equipment
- Laser is registered by EHS
- Laser is included in the EHS inventory
- Laser made or modified on Campus registered with EHS
- Access limited to authorized users only
- Viewing cards for non-visible beam available
- Image converter viewers or phosphor cards are used for alignment procedures
- Operators do not wear watches, jewelry, and ties during laser operation

Comments: _____

P	F	NA	Labeling-Posting-Warnings
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser sign posted on lab door (Danger/Warning/Caution)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser sign posted on lab door for invisible radiation (Danger/Warning/Caution)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Visible Warning Device when laser is energized
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Audible Warning Device when laser is energized
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser label on housing (Danger/Warning/Caution)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Label of laser classification on housing
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Label of laser characteristics on housing (power,wavelength)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Manufacturer's certification label on housing
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser controlled areas within the lab posted
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Label for the laser aperture on housing
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Posting to indicate that the use of PPE is required to operate the device
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	High voltage warning label on housing

Comments: _____

P	F	NA	Personal Protective Equipment (PPE)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Appropriate eye protection (goggles) available for laser use

Description	Wavelength - OD	S/N #	Condition (Free of damage/clean)	Date checked

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Warning lights can be seen through goggles
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Protection from diffuse UV radiation available (eyes/skin)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Appropriate skin protection available/used (lab coats, long sleeved garments)

Comments: _____

P	F	NA	Engineering Controls for Beam Hazards
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Protective housing and interlocks in good condition
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Access/entrance to laser use rooms, is controlled to prevent accidental exposure to the laser beam
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Door interlock in good condition
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Beam stops present at the end of all beam paths
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Barriers/screens/black out curtains if present, are in use
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser table level below eye level for standing or sitting position
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Beam is not directed towards doors or windows
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Windows and ports are covered or protected during laser operation
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Surfaces minimize specular reflections
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Optical bench free of unnecessary reflective items
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Beam path enclosed when possible
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Controls are located so that the operator is NOT exposed to beam hazards
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser may be fired remotely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All beams are traced

Comments: _____

P	F	NA	Non beam Hazards
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No exposed wiring or electrical circuits
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	High voltage equipment appropriately grounded
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser operation does not cause a fire hazard
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Barriers/screens/black out curtains are fire resistant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser is operated so that it does not cause an explosion hazard
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ventilation available to extract/scavenge metallic flumes, chemical vapors, and/or biological plumes
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser operation incorporates the safe use of compressed gases
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Laser operation incorporates the safe use of laser dyes

Comments: _____

Appendix F
LASER SAFETY CONTROL MEASURES

- A. Class 1 Controls
 - 1. No specific user safety rules are necessary but general precautions should be observed.
- B. Class 1M Controls
 - 1. To prevent injury, the beam should not be viewed with a magnification device.
- C. Class 2 Controls
 - 1. Never permit a person continuously to stare into the laser source.
 - 2. Never point the laser at an individual's eye unless a useful purpose exists and the exposure levels and duration will not exceed the permissible limit.
- D. Class 2M Controls
 - 1. To prevent injury, the beam should not be viewed with a magnification device.
- E. Class 3R Controls
 - 1.
- F. Class 3B Controls
 - 1. Do not aim the laser at an individual's eye.
 - 2. Permit only experienced personnel to operate the laser.
 - 3. Enclose as much of the beam path as possible. Even a transparent enclosure will prevent individuals from placing their head or reflecting objects within the beam path. Terminations should be used at the end of the useful paths of the direct beam and any secondary beams.
 - 4. Shutters, polarizers, and optical filters should be placed at the laser exit port to reduce the beam power to the minimal useful level.
 - 5. Control spectators.
 - 6. A warning light or buzzer should indicate laser operation. This is especially needed if the beam is not visible (i.e. - for infrared lasers).
 - 7. Do not permit laser tracking of non-target vehicles or aircrafts.
 - 8. Operate the laser only in a restricted area – for example, in a closed room without windows. A warning sign must be placed on the door.
 - 9. Place the laser beam path well above or well below the eye level of any sitting or standing observers whenever possible. The laser should be mounted firmly to assure that the beam travels only along its intended path.
 - 10. Always use proper laser eye protection if a potential eye hazard exists for the direct beam, or a specular reflection.
 - 11. A key switch should be installed to minimize tampering by unauthorized individuals.
 - 12. The beam or its specular reflection should never be directly viewed with optical instruments such as binoculars or telescopes without sufficient protective filters.
 - 13. Remove all unnecessary mirror-like surfaces from the vicinity of the laser beam path. Do not use reflective objects such as credit cards to check beam alignment.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

Note: The reflectivity of an object is a function of the wavelength of the laser beam.

G. Class 4 Controls

1. All controls listed for Class 3b laser system also apply to Class 4 lasers.
2. These lasers should only be operated within a localized enclosure, in a controlled workplace, or where the beam is directed into outer space. If a complete local enclosure is not possible, indoor laser operation should be in a light-tight room with interlocked entrances to assure that the laser cannot emit energy while the door is open. However, under special conditions where an interlocked door could interfere with proposed research activity, an alternate method of protection such as a curtain or a barrier should be discussed with EH&S to provide a suitable barrier just inside the door or where ever most appropriate to intercept a beam or scatter it so that a person entering the room could not be exposed above the MPE limits.
3. Appropriate eye protection is required for all individuals working within the controlled area.
4. If the laser beam irradiance is sufficient to be a serious skin or fire hazard, a suitable shielding should be used between the laser beam and any personnel or flammable surfaces.
5. Remote firing with video monitoring or other remote (safe) viewing techniques should be chosen when feasible.
6. Outdoor high-power laser devices such as a satellite laser transmission systems and laser radars should have positive stops on the azimuth and elevation traverse to assure that the beam cannot intercept occupied areas or non-target aircraft.
7. Beam shutters, beam polarizers, and beam filters should always be used to limit use to authorized personnel only. The flash lamps in optical pump systems should be shielded to eliminate any direct viewing.
8. Backstops should be diffusely reflecting fire resistant target materials where feasible. Safety enclosures should be used around microwelding and microdrilling work pieces to contain hazardous reflections from the work area. Microscopic viewing systems used to study the work piece should ensure against hazardous levels of reflected laser radiation back through the optics.

H. General Safety Procedures

1. Do not work with or near a laser unless you have been authorized to do so.
2. Do not enter a room or area where a laser is being energized unless authorized to do so.
3. Before energizing a laser, verify that prescribed safety devices for the unit are being properly employed. These may include opaque shielding, non-reflecting and/or fire resistant surfaces, goggles and/or face shields, door interlocks, and ventilation for toxic material.
4. Make sure that a pulsed laser unit cannot be energized inadvertently. Discharge capacitors and turn off power before leaving the laser unit unattended.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

5. Do not stare directly into the laser beam. Use appropriate eyewear during beam alignment and laser operation. Beam alignment procedures should be performed at lowest practical power levels.
6. Control access to the laser facility. This can be done by clearly designating those who have access to the laser room. Implement access control by locking the door and installing warning lights and signs on the outside of the door.
7. Never leave the laser unattended when it is in operation.
8. Remove any jewelry to avoid inadvertent reflections.

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

Appendix G

LIST OF LASER PROTECTIVE EYEWEAR MANUFACTURERS AND VENDORS

Company Contact Information Products

5100 Patrick Henry Drive
Santa Clara, CA 95054
408-764-4000
www.cohr.com

Kentek Corp.

19 Depot Rd
Pittsfield, NH 03263
1-800-432-2323
www.kentek-laser.com

Laser Institute of America

1 800-34LASER
www.laserinstitute.org

Newark Electronics 65 Boston Post Rd. West

Marlborough, MA 01752-1854
508-229-2200
1-800-4-NEWARK
www.newark.com

U.S. Laser Corp. PO Box 609

825 Windham Ct. N.
Wychoff, NJ 07481
(201) 848-9200
www.uslasercorp.com

UVEX Safety, Inc. 10 Thurber Blvd.

Smithfield, RI 02917
(800) 343-3411
www.uvex.com [Laser Safety Eyewear](#)

Wilson Industries Laser Safety Products Division

123 Explorer St
Pomona, CA 91768-3278
1 800-423-4277

Rockwell Laser Industries

7754 Camargo Road
Cincinnati, OH 45243
1800-9LASER
www.rli.com

Laser Safety

Procedure: 6.15
Version: 2.0
Revised: 05/06/2015

Appendix H MEDICAL SURVEILLANCE FOR PERSONNEL WORKING WITH LASERS

Purpose: To establish a baseline eye examination for laser users.

Scope: Project specific baseline eye examination may be recommended for personnel working with class 3b and class 4 lasers.

Background: Lasers are used throughout Columbia University for clinical and research purposes. Use of class 3b and 4 lasers may cause damage to the eyes or skin (NIOSH-1976). Laser light in the visible to near infrared spectrum can damage the retina. Laser light in the ultraviolet or far infrared spectrum can damage the cornea or lenses. Project specific eye examinations are recommended based on the use of laser and/or modifications in the laser system.

Timing of the Examination: Examinations shall be performed as follow:

- a) Baseline based on the specific project - prior to assignment to work with class 3b or 4 lasers
- b) Post-incident (after exposure to laser)

Components of the Examination: The Medical Examination shall include:

1. Dermatologic history
2. Ocular history
3. Dermatologic exam as indicated by history
4. Ocular exam including:
 - a. Near/far vision
 - b. Color vision
 - c. Amsler grid
 - d. Corneal inspection (non-slit lamp)
 - e. Fundoscopic exam (non-dilated)

Responsibility: Medical personnel are responsible to provide appropriate medical examination.

Recordkeeping: All the records related to medical examination and or any treatment shall be maintained by the appropriate medical facility.

Reference: ANSI Standard Z136.1

Prepared by Marc Wilkenfeld, MD., July 2008, revised July 2013