Rutgers Laboratory Laser Safety Program

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Laboratory Laser Safety Program

Program Purpose and Scope

This program establishes requirements to protect students and employees from the potential hazards associated with laser devices and systems used to conduct laboratory educational or research activities at Rutgers University. This program delineates the responsibilities for students and employees using lasers, describes the methods used to audit lasers, identifies laser hazard control strategies, describes required laser medical monitoring, and outlines the training requirements for this program.

Some Rutgers University employees, such as maintenance workers and REHS staff, may have incidental contact with lasers while completing their assigned job duties. However, compliance with the requirements contained in this document and Rutgers Laboratory Laser Safety Guide will limit these employees' exposure below the maximum permissible exposure limits established by ANSI Z136.1-2000.

This program incorporates the regulations outlined in the federal Food and Drug Administration, Center for Devices of Radiological Health (20 CFR Part 1040 and 21 CFR Part 1040), that requires labeling and engineering controls for lasers manufactured after 1976. This program also incorporates elements of the American National Standards Institute standard (ANSI Z136.1-2000) for the safe use of lasers, that establishes the minimum requirements for the control laser hazards based upon the actual conditions of use.

Laser Safety Program Personnel and Responsibilities

In order to implement an effective laser safety program that minimizes potential exposures and prevents accidents, the Rutgers Laboratory Laser Safety Program requires participation by *all* laser users, including students and employees. The overall responsibility for implementing and complying with this program is shared between the Authorized Laser Supervisors, the Authorized Laser Operators, the Laser Safety Officer (REHS), and the Occupational Health Department. The following defines the participants and their responsibilities:

A. Authorized Laser Supervisor: A faculty or staff member that has been approved by the Laser Safety Officer to operate specific laser devices or systems.

Responsibilities

- Ensures compliance with all elements of the Rutgers Laboratory Laser Safety Program and Guide,
- Provides adequate supervision and training to their operators of approved laser devices or systems,
- Initiates corrective actions to address potential hazards associated with equipment, experiments, and procedures proposed by their authorized laser operators,
- Requests hazard reassessments from the Laser Safety Officer prior to modifications or procedural changes proposed for approved laser devices or systems,
- Attends all required training sessions, ensures authorized laser operators attend all required training sessions, and implements elements of the training program in their laser operations,

- Implements appropriate engineering controls, writes and enforces laser standard operating procedures as directed by the Laser Safety Officer,
- Ensures appropriate personal protective equipment is available and worn when laser systems and devices are operating,
- Reports all laser accidents and incidents immediately to the Laser Safety Officer for appropriate investigation, and
- Ensures all laser injuries are evaluated and treated by either the Occupational Health Department or in the emergency room.

B. Authorized Laser Operator: A student, faculty, or staff member that operates laser devices or systems controlled by an authorized laser supervisor.

Responsibilities

- Complies with all elements of the Rutgers Laboratory Laser Safety Program and Guide,
- Attends all required training sessions specified in the Rutgers Laboratory Laser Guide and implements training elements in their laser operations,
- Requests prior approval and review of proposed experiments by their authorized laser supervisor to identify potential hazards and recommend corrective actions,
- Immediately reports any equipment malfunction or potentially hazardous condition to the authorized laser supervisor for corrective action,
- Immediately reports any incident and/or accident to the authorized laser supervisor and Laser Safety Officer for investigation and corrective action,
- Wears appropriate personal protective equipment for the lasers they operate as directed by the authorized laser supervisor or Laser Safety Officer.
- Seeks medical evaluation and treatment by either the Occupational Health Department or in the emergency room for all laser injuries.

C. Laser Safety Officer: A REHS employee that develops, implements, and enforces the Rutgers Laboratory Laser Safety Program.

Responsibilities

- Audits all laser devices and systems operated at the university to ensure compliance with appropriate government regulations and professional standards,
- Provides laser safety training to all university employees that work with class 3b and 4 laser systems,
- Provides technical expertise and recommendations to authorized laser supervisors, authorized laser operators, and the Occupational Health Department to protect employee health and safety, and to maintain compliance with applicable regulatory requirements and recognized professional standards,
- Maintains laser safety audit documentation and reports audit results to authorized laser supervisors for corrective action,
- Develops, implements, audits, and enforces the Rutgers Laboratory Laser Safety Program to ensure compliance with applicable regulations and recognized professional standards.

D. Occupational Health Department: Administers appropriate medical monitoring to university students, faculty, and staff as required by the Rutgers Laboratory Laser Safety Program.

Responsibilities

- Performs baseline eye examinations of all authorized laser supervisors, authorized laser operators, and other university employees identified by the Laser Safety Officer,
- Conducts or arranges for other appropriate medical examinations as required to evaluate laser exposures or injuries,
- Maintains all medical records as required by government regulations and recognized professional standards

Laser Safety Audits and Investigations

All authorized laser supervisors and operators are expected to review their open beam laser system(s) and experimental layout(s) before each use to verify all safety controls, components, and equipment operate properly, and to confirm the equipment and components have not been modified. All malfunctioning equipment shall be repaired and laser system modifications corrected before energizing the laser.

The Laser Safety Officer conducts formal laser safety audits with the authorized laser supervisor or one of their designated operators to assess compliance with hazard control strategies described in the Rutgers Laboratory Laser Safety Guide. The Laser Safety Officer issues a written report to the authorized laser supervisor and provides 30 days to correct deficiencies noted during the audit, unless the deficiency is serious enough to warrant immediate action. The following provides a brief overview of the formal laser safety audits conducted by the Laser Safety Officer; details for each audit are provided in the Rutgers Laboratory Laser Safety Guide.

Initial Audits

Initial audits are performed for all newly acquired lasers, new laser laboratories, or other lasers that have not been evaluated by the Laser Safety Officer. These initial laser safety audits collect information about the faculty supervisor and laser unit(s), evaluate administrative, engineering, and non-beam hazard controls, and assesses available and required personal protective equipment. The audit scope varies with the hazard class assigned to the laser. The audit scope for class 3b and 4 open beam systems, which have a greater potential for injury, is greater than an audit of an embedded laser device.

Periodic Audits

Periodic laser safety audits are performed annually to ensure compliance with the Rutgers Laboratory Laser Safety Guide requirements. These audits are specific to each laser, based upon the conditions of use observed during the previous audit, and limited to class 3b and 4 open beam systems.

Incident and Accident Investigations

Authorized laser supervisors and operators must report all laser incidents or accidents to the Laser Safety Officer immediately for a formal investigation. The purpose of these investigations is to identify the root cause and contributing factors to the incident or accident, to estimate employee exposures, and to identify corrective action(s) to prevent recurrence of the incident or accident. These investigations will be conducted immediately; the Laser Safety Officer, the authorized laser

supervisor, the employee involved in the incident, and any witnesses shall participate in the investigation. The Laser Safety Officer will send the authorized laser supervisor a written incident or accident summary that identifies necessary corrective action(s). The authorized laser supervisor shall initiate and complete all corrective action(s) identified by the Laser Safety Officer; when the Laser Safety Officer confirms successful completion of all corrective action(s), laser operations can resume.

All laser related injuries shall be evaluated immediately by the Occupational Health Department in Hurtado Health Center, or in the emergency room on weekends and evenings. Students, faculty, and staff shall report for all scheduled follow-up treatment and referral services as directed by the Occupational Physician.

Laser Hazard Control Strategies

Authorized laser supervisors shall provide and implement control measures to minimize the potential hazards associated with laser devices and systems. Laser hazards can be classified as either beam or non-beam hazards; the following briefly summarizes the control strategies for each.

Beam Hazards

Beam hazards are capable of causing personal injury to the eye and/or skin as a result of direct or indirect contact with the laser beam. The following laser safety controls, listed in order from most effective to less effective, are used to control beam hazards.

Engineering Controls

Engineering controls are devices used to prevent or minimize beam exposures below the maximum permissible exposure limit. Typically, these controls are incorporated in both the laser and in the lab. Laser engineering controls consist of protective housings, interlocks, beam shutters, activation switches, and an emergency shut-off. The engineering controls required for a particular laser depends upon the assigned hazard class, and are established by the Food and Drug Administration as 20 CFR Part 1040 and 21 CFR Part 1040.

Laboratory engineering controls consist of devices, interlocks, and barriers installed to protect spectators or other authorized lab personnel from exposure to laser radiation above the maximum permissible exposure limit. Typically, these engineering controls are only required for open beam class 3b or 4 laser systems, but they may be required when protective housings or enclosures on embedded laser devices are opened for service or repair work.

Laser Eye and Skin Protection

Laser safety glasses and skin covering provide supplemental protection to laser operators when used in conjunction with engineering and administrative controls. However, for protective equipment to be effective, it must be properly selected to protect users from beam hazards, periodically inspected for damage that compromises its effectiveness, and worn by laser operators.

All laser eye protection is assigned an optical density (OD) value that refers to the attenuation provided at a specific wavelength or spectral range. Based upon the beam characteristics (diameter, output power, pulse width, frequency) and maximum permissible exposure value, an appropriate optical density is selected for the wavelength(s) used. Skin protection is required to minimize ultraviolet radiation exposure, which lowers the threshold for biological effects and may

cause photodermatitis in conjunction with certain medications. The laser safety officer shall assess and recommend appropriate eye and/or skin protection for each laser, and the authorized laser supervisor shall provide and ensure their operators wear this equipment whenever the laser is on.

Administrative Controls

Administrative controls consist of warning labels, signs, training, access restrictions, and work practices that inform laser operators of potential hazards associated with laser devices and systems. Administrative controls supplement engineering controls and personal protective equipment. The administrative controls required for a particular laser device or system depends upon the hazard classification as well as the intended use of the laser. Certain administrative controls are required for all laser devices and systems regardless of the hazard or condition of use; however, additional administrative controls are required for class 3b or 4 open beam systems.

Non-Beam Hazards

Non-beam hazards are capable of causing personal injury through contact with laser components or with materials used to support laser experiments and equipment. Some examples of non-beam hazards include electric shock, chemical contact and/or inhalation of laser dyes or compressed gases, air contaminants generated by beam-target interactions, and fire.

Non-beam hazard controls are achieved by following existing university programs such as Lockout/Tagout (for electrical energy), and by modifying the Rutgers Chemical Hygiene Guide to provide standard operating procedures to minimize chemical exposure issues associated with the laser. Specific non-beam hazards are identified during the initial laser safety audit, and recommended control measures are provided in the initial audit report to address the conditions of use in each lab. A detailed description of specific non-beam hazards and recommended control measures are contained in the Rutgers Laboratory Laser Safety Guide.

Employee Medical Monitoring

ANSI Z136.1-2000 requires eye examinations for all employees that use or may be exposed to class 3b and 4 laser radiation to:

- Establish a baseline for comparison in case of an accidental or chronic injury,
- Identify employees that may be at special risk from chronic exposure to selected continuous wave (CW) lasers,
- Assess the ability of an employee to safely perform their assigned duties, and
- Identify employees that may be at increased risk for eye injury.

ANSI Z136.1-2000 also recommends skin examinations for employees that use or may be exposed to class 3b and 4 laser ultraviolet radiation. These employees are at an increased risk of biological effects due to exposure to direct or diffuse beam reflections, and photodermatitis in conjunction with certain medications and diffuse beam exposures.

All authorized laser supervisors, operators, and other university employees that may be exposed to class 3b or 4 laser radiation shall receive appropriate baseline eye and/or skin examinations by the Occupational Health Department. The laser supervisor shall ensure that all their operators have received their examinations. The Laser Safety Officer will identify any other university employees with incidental exposure to class 3b and 4 lasers that require baseline eye examinations. The Laser Safety Officer shall report all laser eye and skin injuries to the Occupational Health

Department to ensure employees receive appropriate medical treatment. Injured employees shall report to the Occupational Health Department to ensure appropriate follow-up examinations, referrals, and assessments are performed and completed.

Training

All authorized laser supervisors and operators using class 3b and 4 open beam lasers are required to attend laser safety training sessions. The purpose of this training is to review laser safety concepts and topics, and to facilitate the safe use of laser devices and systems used in their laboratories. The Laser Safety Officer shall provide the authorized laser supervisors with appropriate training to comply with this requirement; the authorized laser supervisor shall ensure their operators attend the required training sessions. The following briefly summarizes the laser safety training provided by the Laser Safety Officer.

Initial Orientation

Initial orientation sessions cover laser safety concepts and requirements outlined in the Rutgers Laboratory Laser Safety Guide.

Refresher Training

Annual refresher laser safety training sessions review pertinent safety information and changes to applicable standards and university policies.

Site Specific Training

All authorized laser supervisors with open beam class 3b and 4 lasers must provide and document specific hands-on training to their operators for the lasers used in their labs:

- Prior to use by new students, technicians, or visiting faculty,
- Whenever modifications to a laser system results in changes to the output power, hazard controls, or existing standard operating procedures, or
- Immediately following an incident or accident that results or could have resulted in personal injury or property damage. In this case, the training shall review the incident, focus on the root cause and contributing factors, and identify the preventative measures implemented to prevent recurrence of that incident.

The scope and duration of site specific training will vary depending upon the lasers and their associated hazards; however, this training must review:

- The existing laser and laboratory engineering controls and their proper use,
- The administrative controls (standard operating procedures) developed for each laser system in use, that includes “normal” operations as well as alignment procedures, and
- The required personal protective equipment for each laser system present in the lab, as well as the proper storage, inspection, and use for each.

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Appendix 1: Laser Safety Program Definitions

Authorized Laser Supervisor	A faculty or staff member that has been approved by the Laser Safety Officer to operate specific laser devices or systems.
Authorized Laser Operator	A student, faculty, or staff member that operates laser devices or systems controlled by an authorized laser supervisor.
Controlled Area	An area where the occupancy and activity of those within is subject to control and supervision for the purpose of protection from laser radiation hazards.
Interlocks	An electrical or mechanical device designed to prevent access to laser radiation above the maximum permissible exposure level. Often, interlocks are connected to a shutter that interrupts the beam when the device is in the open position.
Laser	A device that produces an intense, coherent, directional beam of non-ionizing radiation by stimulating electronic or molecular transitions to lower energy levels. Also, an acronym for Light Amplification by the Stimulated Emission of Radiation.
Laser Device	An enclosed laser, assigned a higher hazard classification number than equipment in which it is incorporated, which uses engineering controls to limit accessible radiation emissions.
Laser Hazard Class	A classification scheme used to evaluate the laser system's capability of injuring people that ranges from class 1 (lowest) to class 4 (highest).
Laser Incident	An unplanned, undesired event or human activity that adversely effects or interrupts the completion of a specific activity or task. These include property damage or events that could have resulted in personal injury.
Laser Safety Officer	A REHS employee that develops, implements, and enforces the Rutgers Laser Safety Program.
Laser System	An assembly of electrical, mechanical, and optical components which includes a laser. For the purposes of this program document, this term refers to open beam laser systems.
Nominal Hazard Zone	The space within which the level of the direct, reflected, or scattered radiation during operation exceeds the applicable maximum permissible exposure level.
Protective Housing	An enclosure that surrounds the laser or laser system that prevents access to laser radiation above the applicable maximum permissible exposure level. A protective housing may also enclose associated optics and a workstation, and limit access to other associated energy emissions and to electrical hazards associated with components and terminals.