UNIVERSITY OF NEW MEXICO
LASER SAFETY PROGRAM

Version 1

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REVIEWED AND APPROVED BY UNM CHEMICAL AND LABORATORY SAFETY COMMITTEE

Prepared By: UNM Safety & Risk Services Department

Table of Contents

Policy

The University of New Mexico is committed to:

- Providing a safe and healthy work and educational environment that is free from recognized hazards that could be responsible for injury or illness;
- Protecting the University's assets
- Ensuring the University's impact on the environment is positive.

To achieve these goals the University has an extensive loss control program administered by the University Safety & Risk Services Department. This program is described in "Risk Management" Policy 6100, UBP. The University Safety & Risk Services Department works with the Loss Prevention Control Committee to identify, evaluate, and control hazards and potential losses.

The ultimate responsibility for safety, however, cannot be delegated as a staff function, it must be assumed by every member of the University community. Faculty, staff, and students must comply with all University safety, health, and environmental programs, rules, regulations, and policies designed to prevent accidents and job related illnesses, and to protect the environment. A safe environment reduces the risk of accidents and associated costs, improves employee morale, and increases productivity.

PURPOSE

This program is designed to assure the safety of University of New Mexico (UNM) faculty, staff, students and visitors from potential health hazards associated with the use of lasers. To achieve this goal, the University has adopted the American National Standard for Safe Use of Lasers in Research, Development, or Testing, ANSI Z136.8-2012, and American National Standard for Safe Use of Lasers, ANSI Z136.1-2007. These documents are national consensus standards that are recognized laser safety standards. As allowed in Z136.1, guidance contained in Z136.8 can be used for Research and Development specific applications that may not have been fully addressed or are in conflict with Z136.1. It is up to the discretion of the UNM Laser Safety Officer to determine which standard(s) apply to a particular laser activity.

PROGRAM DESCRIPTION

This program addresses the following Laser Safety Program provisions required in ANSI Z136.1-2007.

- Designation of a Laser Safety Officer with the authority and responsibility to evaluate and control laser hazards, implement appropriate control measures, as well as monitor and enforce compliance with required standards and regulations.
- Education of authorized personnel in the safe use of lasers and laser systems and as applicable, the assessment and control of laser hazards.
- Application of adequate protective measures.
- Incident investigation and preparation of action plans for the prevention of future accidents.
- Medical examinations and surveillance program.

Scope

This program applies to all non-clinical lasers owned or operated in facilities under the control of University of New Mexico.

Regulatory and National Consensus References

OSHA 29 CFR 1910.132, Personal Protective Equipment
OSHA 29 CFR 1910.133, Eye and Face Protection
American National Standard for Safe Use of Lasers (ANSI Z136.1-2007)
American National Standard for Safe Use of Lasers Outdoors (ANSI Z136.6-2005)
American National Standard for Safe Use of Lasers in Research, Development, or Testing (ANSI Z136.8-2012)
Federal Laser Product Performance Standard (21 CFR Parts 1040.10 and 1040.11)

Definitions

Accessible emission limit (AEL) – The maximum accessible emission level permitted within a particular laser hazard class.

Continuous wave (CW) – A laser operating with a continuous output for a period ≥ 0.25 seconds is regarded as a CW laser.

Diffuse reflection – Change of the spatial distribution or "scattering" of a beam of radiation when it is reflected in many directions by a surface or by a medium.

Embedded laser – An enclosed laser that has a higher classification than the laser system in which it is incorporated, where the system's lower classification is appropriate due to the engineering features limiting accessible emission.

Infrared radiation (IR) – Electromagnetic radiation with wavelengths which lie within the range 700 nm to 1 mm. The region is subdivided into near infrared (700 nm to 1.4 μm) and far infrared (1.4 μm to 1 mm).

Laser – a device that producers radiant energy predominately by stimulated emission. Laser radiation may be highly coherent temporally, spatially, or both. The spectrum of electromagnetic radiation ranges from the ultraviolet region through the visible to the infrared region. An acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.

Laser controlled area (LCA) – Any area, permanent or temporary, that contains hazardous laser operations. Hazards associated with the laser operation must be evaluated and mitigated by the use of appropriate control measures at the boundaries of and within the LCA.

Laser safety officer (LSO) – One who has the authority and responsibility to monitor and enforce the control of laser hazards and effect the knowledgeable evaluation and control of laser hazards.

Laser system– An assembly of electrical, mechanical, and optical components which includes a laser.

Maximum permissible exposure (MPE) – The level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin.

Nominal hazard zone (NHZ) – The space within which the level of the direct, reflected, or scattered radiation may exceed the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the appropriate MPE level.

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 is not expected to exceed the applicable MPE.

Non-beam hazard – A class of hazards that result from factors other than direct human exposure to a laser beam.

Optical Density (OD) - Ability of a filter to attenuate optical radiation at a particular wavelength. To adequately protect laser users, the OD of the protective eyewear should attenuate the beam to a level below the MPE. For eyewear labeled in accordance with the European Laser Protective Eyewear Standard EN207:2010 the "L" attenuation number indicates the OD of the eyewear.

Standard operating procedure (SOP) – Formal written description of the safety and administrative procedures to be followed in performing a specific task.

Ultraviolet radiation (UV) – Electromagnetic radiation with wavelengths which lie within the range 180 nm to 400 nm.

Visible radiation (UV) – Electromagnetic radiation with wavelengths which lie within the range 400 nm to 700 nm.

Responsibilities

Deans, Directors, and Department Heads

- Ensure departmental compliance with the UNM Laser Safety Program
- Assign a Deputy Laser Safety Officer (DLSO) for his/her work area(s)
- Providing the DLSO with the training and support necessary to implement and maintain the Laser Safety Program
- Ensure that safety audit findings are resolved in a timely manner

Principal Investigator (PI) or Deputy Laser Safety Officer (DLSO)

- Ensure that laser users comply with the UNM Laser Safety Program and do not operate laser systems without proper training and authorization
- Provide site-specific training on the operation and safe use of Lasers and maintain training records
- Develop Standard Operating Procedures
- Reviewing procedures for potential safety problems before assigning to other personnel
- Ensure that required engineering controls are maintained and functioning properly
- Ensure that the proper administrative controls are in place
- Ensure that personal protective equipment is available, maintained properly, and used
- Ensure that required signage and equipment labels are in place and legible
- Conduct regular, formal laser safety and housekeeping inspections, including routine inspections of emergency equipment.
- Report incidents of actual or suspected exposure to harmful laser radiation to the University LSO.
- Report the acquisition of new Lasers to SRS and ensure that Lasers are properly registered, using the Laser Registration Form (see Appendix A).

Laser Users

- Plan and conduct laser operations in accordance with the UNM Laser Safety Program, applicable laboratory-specific SOPs, and any other further safety recommendations made by the PI, DLSO, or University LSO
- Consult with the PI, DLSO, or University LSO whenever there are any questions regarding laser use.
- Use all required engineering controls and personal protective equipment
- Only operate lasers and associated equipment for which they have been formally trained
- Report any questions on health and safety, or any unsafe or unhealthy working conditions to the PI, DLSO, or University LSO.
- Report incidents of actual or suspected exposure to harmful laser radiation

to the PI and LSO

Safety and Risk Services

- Develop and maintain a University-wide laser safety program
- Maintain a current University-wide inventory of Class 3B and Class 4 laser systems
- Develop and provide Laser Safety training and training materials.
- Provide printed laser area signs and equipment labels to laser users
- Assist departments and laboratories with site-specific training
- Assist departments and laboratories in developing SOPs
- Ensure that periodic audits of Class 3B and Class 4 laser systems are conducted and documented
- Oversee the investigation of incidents of actual or suspected exposure to harmful laser radiation
- Maintain current copies of applicable standards and regulations that are available to University departments and individual laser personnel
- Assign a Laser Safety Officer.

Laser Safety Officer

- Establish and maintain the policies and procedures for the laser safety program
- Classify or verify hazard classification of lasers and laser systems
- Conduct hazard evaluation of laser work areas
- Specify and assure that control measures are implemented and maintained
- Review and approve Class 3B and Class 4 standard operating procedures (SOPs)
- Recommend or approve personal protective equipment (PPE)
- Review and approve area signs and equipment labels
- Review and approve Class 3B and Class 4 laser installations, facilities and laser equipment prior to use, including modification of existing facilities or equipment
- Assure adequate training of laser personnel
- Determine personnel categories for medical surveillance
- Maintain required records such as training records, audits, laser inventories, and SOP approvals
- Perform periodic audits or surveys of each Class 3B and Class 4 laser or laser system
- Investigate and document incidents of actual or suspected exposure to harmful laser radiation
- Approve Class 3B and Class 4 laser system operations
- Obtain and maintain the appropriate training and certifications for Laser Safety Officer.

Personnel Training and Qualifications

Only qualified personnel are permitted to operate laser systems. The Principal Investigator, Deputy Laser Safety Officer (DLSO), or Laser Safety Officer (LSO) will identify and qualify personnel.

All persons operating laser systems are required to complete initial laser safety training to include _____ [insert course information], and a laser safety refresher training within every twelve month period thereafter. The initial training must be completed before initial assignment to operate a laser system. In addition, all personnel using Class 3B or Class 4 laser systems must:

- Review the UNM Laser Safety Program
- Review the operating and safety instructions provided by the manufacturer
- Complete laboratory-specific training from the Principal Investigator, or a designee, covering safe operation of the laser(s) to be used, applicable SOPs and alignment procedures.

All visitors and spectators of laser system operations are required to complete laser safety training _____ [insert course information].

Laser Classification

Lasers and laser systems are classified according to their ability to produce eye or skin injury to personnel. Commercially available lasers manufactured after August 1, 1976 are required to be classified and labeled by the manufacturer. Information on the label must include the laser class, maximum output power, pulse duration (if pulsed), and the laser medium or emitted wavelengths. When an existing commercial laser is modified, a custom laser is constructed or an unclassified laser is found in the laboratory, it is the responsibility of the Principal Investigator to ensure that the laser system is classified and labeled in accordance with the most recent version of ANSI Z136.1. The classification and labeling must then be verified by the LSO.

The laser hazard classification is based on the hazard level of the accessible laser beam during normal operation of the laser and is represented by a number or a numbered capital letter. The current laser classifications in ANSI Z136.1 – 2007 are Class 1, Class 1M, Class 2, Class 2M, Class 3R, Class 3B and Class 4. In general, the potential beam hazard increases in the same order with Class 1 being the least hazardous and Class 4 being the most hazardous.

Class 1 – Considered to be incapable of producing damaging radiation levels during operation, and exempt from any control measures or other forms of surveillance.

Class 1M – Considered to be incapable of producing hazardous exposure conditions unless viewed with collecting optics such as an eye-loupe or a telescope. Exempt from any control measures other than to prevent potentially hazardous optically aided viewing, and is exempt from other forms of surveillance.

Class 2 – Visible lasers (400 nm to 700 nm) considered incapable of emitting laser radiation at levels that are known to cause skin or eye injury within the time period of the human eye aversion response (0.25 seconds).

Class 2M – Class 2 lasers that are potentially hazardous if viewed with collecting optics.

Class 3R – A laser system that is potentially hazardous under some direct and specular reflection viewing condition if the eye is appropriately focused and stable. Class 3R lasers will not pose either a fire hazard or diffuse-reflection hazard.

Class 3B – A laser system that may be hazardous under direct and specular reflection viewing conditions, but is normally not a diffuse reflection or fire hazard.

Class 4 - A laser system that is a hazard to eye and skin from the direct beam, specular reflection, and may pose a diffuse reflection and fire hazard. Class 4 laser systems may also produce laser generated air contaminants (LGAC) and hazardous plasma radiation.

Laser Products Classified Under Previous Standards

Earlier laser standards prior to ANSI Z136.1-2007 differed slightly from current laser classification criteria. Products most likely affected are 1-5 mW laser pointers, expanded beam laser products (e.g. used in optical communication systems) and those with highly diverging beams (e.g. certain diode laser products).

For the purposes of this document, laser products classified as Class IIa under the Federal Laser Product Performance Standard (FLPPS) are to be treated the same as Class 1. Laser products that have been previously classified as Class 3a can be safely treated as Class 3R if the beam diameter is less than 7 mm. If the emergent beam diameter exceeds 7 mm, they could be Class 1M or 2M, if reassessed. There is no requirement to reassess lasers that were previously classified. However, a laser product with a highly diverging or greatly expanded beam that may have been "over-classified" by the previous classification system can be reclassified with the updated classification system in ANSI Z136.1-2007.

Laser Registration

All Class 2M, Class 3R, Class 3B, Class 4 lasers and laser systems and Class 1 laser systems with embedded Class 3R, Class 3B or Class 4 lasers must be registered with Safety and Risk Services prior to operation. Registration information must be updated when lasers are modified or disposed of. The Laser Registration Form is included as Appendix A.

Medical Surveillance

Medical Laser surveillance is not required for persons using Class 1, Class 1M, Class 2, Class 2M or Class 3R lasers and laser systems. Persons using Class 3B, Class 4, and Class 1 laser systems with an embedded Class 3B or Class 4 laser are required to have a baseline eye examination prior to performing laser work. ANSI Z136.1, Appendix E contains suggested medical surveillance guidelines. Contact UNM Employee Occupational Health Services (UNM employees only) or UNM Student Health and Counseling (UNM Students) or other qualified health care provider for baseline eye examinations.

A post-employment/post- assignment eye examination specific to laser use is also recommended. Following any actual or suspected laser injury, persons involved must seek medical attention.

Laser Accidents

Persons with an actual or suspected laser-induced injury should be evaluated by a qualified medical professional immediately after the exposure. University employees should contact Employee Occupational Health Services (EOHS) at 505-272-8034. Students should contact Student Health Services at 505-277-7810. If the exposure occurs after hours, employees and students should seek treatment at a hospital emergency room. The supervisor of the injured person and Safety and Risk Services must be notified as soon as possible after the exposure. A UNM Incident Report Form must be completed and submitted to SRS as soon as possible.

Laser Hazard Evaluation

Prior to the operation of new laser systems, or significantly modified systems where the hazard level may have changed, a hazard evaluation must be completed to identify all hazards associated with the laser or laser system and to determine the necessary control measures. The Laser Operations Safety Audit Form (Appendix B) can be used as a tool in the hazard evaluation process. Both beam and non-beam hazards must be evaluated. In addition to normal operation, maintenance and service activities must also be evaluated.

Factors to be considered in the hazard evaluation are:

- The laser or laser system's capability of injuring personnel or interfering with task performance
- The environment in which the laser is used
- The personnel who may use or be exposed to laser radiation

The PI with the assistance of the DLSO or LSO shall conduct this evaluation.

Engineering and Administrative Control Requirements

Engineering and administrative controls in accordance with ANSI Z136.1-2007standards are required for lasers and lasers systems used at UNM. Tables 1 and 2 show the ANSI Z136.1-2007 engineering and administrative control requirements and recommendations. At the discretion of the LSO and the UNM committee overseeing lasers, variances to these controls may be allowed when specified controls are not feasible or are inappropriate. However, any controls that deviate from those listed in any of the ANSI Z136 standards must provide an equivalent level of laser safety protection. Any such variances must be documented.

Table 1. ANSI Z136.1-2007 Engineering Control Measures

Engineering Control	Class 1/1M	Class 2/2M	Class 3R	Class 3B	Class 4
Protective Housing (4.3.1)	Required	Required	Required	Required	Required
Without Protective Housing (4.3.1.1)	LSO shall establish Alternative Controls				
Interlocks on Removable Protective Housings (4.3.2)	Required if enclosed 3B/4	Required if enclosed 3B/4	Required if enclosed 3B/4	Required	Required
Service Access Panel (4.3.3)	Required if enclosed 3B/4	Required if enclosed 3B/4	Required if enclosed 3B/4	Required	Required
Key Control (4.3.4)				Recommended	Required
Viewing Windows, Display Screens and Collecting Optics (4.3.5.1)	Assure viewing limited < MPE				
Fully Open Beam Path (4.3.6.1)				Required	Required
Limited Open Beam Path (4.3.6.2)				Required	Required
Enclosed Beam Path (4.3.6.3)	None is required if 4.3.1 and 4.3.2 fulfilled				
Remote Interlock Connector (4.3.7)				Recommended	Required
Beam Stop or Attenuator (4.3.8)				Recommended	Required
Activation Warning Systems (4.3.9.4)				Recommended	Required
Indoor Laser Controlled Area (4.3.10)	Recommended for 1M	Recommended for 2M		Required	Required
Class 3B Indoor Laser Controlled Area (4.3.10.1)				Required	
Class 4 Laser Controlled Area (4.3.10.2)					Required
Outdoor Control Measures (4.3.11)	Required	Required	Required	Required	Required
Laser in Navigable Airspace (4.3.11.2)	Required	Required	Required	Required	Required
Temporary Laser Controlled Area (4.3.12)	Required if enclosed 3B/4	Required if enclosed 3B/4	Required if enclosed 3B/4		
Controlled Operation (4.3.13)					Recommended
Equipment Labels (4.3.14 and 4.7)	Required	Required	Required	Required	Required
Laser Area Warning Signs and Activation Warnings (4.3.9)			Recommended	Required	Required

Table 2. ANSI Z136.1-2007 Administrative Control Measures

Administrative Control	Class 1/1M	Class 2/2M	Class 3R	Class 3B	Class 4
Standard Operating Procedures (4.4.1)				Recommended	Required
Output Emission Limitations (4.4.2)				LSO Determination	
Education and Training (4.4.3)	Recommended for 1M	Recommended	Recommended	Required	Required
Authorized Personnel (4.4.4)	Recommended for 1M	Recommended for 2M		Required	Required
Alignment Procedures (4.4.5)	Required if enclosed 3B/4	Required if enclosed 3B/4	Required if enclosed 3B/4	Required	Required
Protective Equipment (4.6)	Recommended for 1M	Recommended for 2M		Recommended	Required
Spectators (4.4.6)	Recommended for 1M	Recommended for 2M		Recommend	Required
Service Personnel (4.4.7)	Required if enclosed 3B/4	Required if enclosed 3B/4	Required if enclosed 3B/4	Required	Required
Demonstration with General Public (4.5.1)		Required	Required	Required	Required
Laser Optical Fiber Transmission Systems (4.5.2)	Required if > MPE	Required if > MPE	Required if > MPE	Required	Required
Laser Robotic Installations (4.5.3)				Required	Required
Protective Eyewear (4.6.2)				Recommend	Required
Window Protection (4.6.3)				Required	Required
Protective Barriers and Curtains (4.6.4)				Recommended	Recommended
Skin Protection (4.6.6)				Required	Required
Other Protective Equipment (4.6.7)	Use may be required				
Warning Signs and Labels (4.7)		Recommended	Recommended	Required	Required
Service Personnel (4.4.7)	LSO Determination				
Laser System Modifications (4.1.2)	LSO Determination				

Warning Signs and Labels

All laboratories where a Class 2, Class 2M, Class 3R, Class 3B or Class 4 laser is present shall have a laser warning sign posted at the entrances to the laboratory. Entrances to Class 3B or Class 4 laser laboratories shall have a lighted warning sign that is activated when the laser is energized. The outside boundary of a temporary laser controlled area shall be posted with a Notice sign.

All Class 2, Class 2M, Class 3R, Class 3B or Class 4 lasers and laser systems shall have a label conspicuously affixed to the laser housing or control panel. Such labels should be placed on both the housing and control panel if they are separated by more than two meters.

All Classes of lasers or laser systems with removable protective housings that have no safety interlocks, and which can be removed or displaced during operation, maintenance, or service shall have a label conspicuously affixed to the laser housing

to indicate the hazard of the enclosed laser.

Laser manufacturers are required to label their equipment in accordance with the Federal Laser Product Performance Standard, which satisfies this requirement. Contact the LSO for labeling guidance if the laser was not labeled by the manufacturer, or was built or modified in the laboratory.

All warning signs and labels shall be in accordance with ANSI Z136.1-2007. Labeling of laser equipment in accordance with the Federal Laser Product Performance Standard or the IEC 60825-1 standard may be used to satisfy the labeling requirements of ANSI Z136.1. PowerPoint templates that can be used to create ANSI ANSI Z136.1-2007 compliant warning signs and labels are available on the SRS website.

Personal Protective Equipment

Personal protective equipment (PPE) is required whenever Maximum Permissible Exposure levels to laser radiation may be exceeded. All PPE must be properly stored and inspected before use to verify that it is not defective and is suitable for the laser systems in use.

Protective eyewear is required to be worn whenever Class 3B and Class 4 laser systems are in use. Protective eyewear may also be required for Class 2 and Class 3R laser systems where intentional long term (> 0.25 seconds) or direct viewing is required. Protective eyewear must be ANSI approved and clearly labeled with the wavelengths and optical densities for which the minimum level of protection is provided. Because laser eyewear may only offer protection over a narrow range of wavelengths, eyewear designed for use at one wavelength may provide little or no protection at another wavelength. This specificity can be a problem in situations where multiple wavelengths and/or unfiltered harmonics are present in addition to the primary beam (e.g. unfiltered frequency doubled Nd:YAG laser pointers that are frequency doubled from a 1064 nm infrared beam to a 532 nm visible green beam). Laser eyewear selection should be made in consultation with a reputable eyewear manufacturer and the LSO or a DLSO.

Recent studies have indicated that existing eye protective filters when exposed to very high irradiance pulsed lasers can cause induced transmittance in protective filter materials from picosecond, and femtosecond pulsed lasers. This loss of filter capability can place laser users at risk for eye injury. In response, the European Laser Protective Eyewear Standard EN207 has established additional eyewear testing and marking protocols to address this potential hazard. This Standard adds a pulse duration rating to the previously established “L” attenuation number (which corresponds to the OD of the eyewear) and wavelength. In EN207:2010, lasers are divided into 4 categories depending on whether they are continuous wave or pulsed:

Designation	Laser Type	Pulse Width
D	Continuous wave (cw)	> 250 ms
I	Long pulse length	1 us < I < 250 ms
R	Q-switched pulsed	1 ns < R < 1 us
M	Mode locked (ultrafast) pulsed	< 1 ns e.g. picosecond, femtosecond

In addition to meeting the wavelength and optical density requirements, laser protective eyewear for Class 3B and Class 4 picosecond and femtosecond laser systems must be "M-rated" in accordance with EN207:2010.

In addition to eye protection, unenclosed UV laser systems may require the use of protective clothing to guard against UV skin exposures above occupational exposure limits.

Non-Beam Hazards

Non-beam hazards are those hazards not related to actual exposure to laser radiation. These can include physical, chemical, and biological agents. These hazards must be reviewed and addressed in the SOP for the laser operation.

Electrical Hazards Some lasers use high-voltage power supplies, large capacitors, or capacitor banks that present a lethal shock hazard. Additional hazards of electrical equipment include resistive heating and electric spark ignition of flammable materials. All electrical equipment, electrical work, etc. must meet electrical safety, lockout tag out and other applicable requirements.

The following potential electrical problems have been frequently found during laser facility audits:

- Uncovered and improperly insulated electrical terminals
- Hidden "power-up" warning lights
- Lack of personnel trained in current cardiopulmonary resuscitation practices, or lack of refresher training

- “Buddy system” or equivalent safety measure not being practiced during maintenance and service
- Failure to properly discharge and ground capacitors
- Non-earth grounded or improperly grounded laser equipment
- Non-adherence to the OSHA lock-out standard (29 CFR 1910.147)
- Excessive wires and cables on floor that create fall or slip hazards

Compressed Gases Hazardous gases, such as fluorine and hydrogen chloride in excimer lasers, may be used in laser activities. All compressed gases having a hazardous material information system (HMIS) health, flammability, or reactivity rating of 3 or 4 shall be contained in an approved and appropriately exhausted gas cabinet that is alarmed with sensors to indicate potential leakage.

Laser Dyes and Solvents Dyes used in dye lasers are often highly toxic or carcinogenic organic chemicals that are dissolved flammable solvents. These materials require special handling to avoid potential personnel exposures above occupational exposure limits, fires, and chemical spills. These materials must be handled in a manner that complies with applicable local, state and federal regulations. They must be prepared inside a chemical fume hood and Safety Data Sheets must be available for all dyes and solvents in use. Contact SRS for guidance on how to handle hazardous chemicals.

Laser Generated Air Contaminants Air contaminants may be generated when certain Class 3B and Class 4 laser beams interact with materials. When target irradiance reaches approximately 10^7 W/cm^2, target materials including plastics, composites, metals and biological tissues may liberate carcinogenic, toxic and noxious airborne contaminants. Any laser operation that creates visible smoke or a plume must be evaluated by SRS to determine the need for local exhaust ventilation. In some cases, respiratory protection may also be required.

Plasma Radiation

Interactions between very high power (~1012 W/cm2) laser beams and target materials may produce a plasma, which in turn generates "blue light" and UV emissions that pose an eye and skin hazard. Similarly, targets heated to very high temperatures (e.g. in laser welding and cutting) emit an intense light. The PLU must ensure adequate control measures are in place and addressed in the SOP for such operations.

UV and Visible Radiation Laser discharge tubes and pump lamps may generate sufficient UV and visible radiation to pose an eye and skin hazard. Short wavelength UV radiation may also produce ozone that will need to be exhausted.

Ionizing Radiation (X-rays)

Electronic components of lasers systems such as X-rays could be produced from two main sources: high voltage vacuum tubes of laser power supplies such as rectifiers and thyratrons and electric discharge lasers. Any power supplies that require more than 15 kilovolts may produce enough x-rays to be a health concern. Consult HSC Radiation Safety for review and control of such hazards.

Operating Procedures

Written operating procedures are required for Class 3B and Class 4 lasers or laser systems. These written procedures must be reviewed and approved by the LSO. As applicable, the written procedures should address normal operations, alignment and service procedures. Written procedures must include the following sections.

- Identification of the laser and operating characteristics.
- Beam and non-beam hazards associated with the laser.
- Control measures including engineering controls, administrative controls, and personal protective equipment.
- Applicable alignment and service procedures.
- Training requirements.
- Emergency procedures.
- Approved personnel.

Outdoor Laser Operations

Laser experiments that will involve the use of lasers in navigable airspace shall/should be coordinated with the Federal Aviation Administration (FAA) and U.S. Space Command in the planning stages to ensure proper control of any hazard to airborne personnel and equipment. Refer to the latest versions of FAA Order JO 7400.2J and ANSI Z136.6 for additional information.

Only Class 1 lasers or laser systems shall be used for outdoor public demonstrations, displays, or light shows in unsupervised areas. Any outdoor use of Class 3B or Class 4 lasers in unsupervised areas involving the general public requires a written variance issued by the U.S. Food and Drug Administration, Center for Devices and Radiological Health.

Laser Disposal

There are four basic ways for the disposal of excess or unusable laser systems at UNM. In all cases, consult with UNM Surplus Property and Safety and Risk Services to determine current University requirements

- Donations. Ensure that the laser system complies with all applicable product safety standards such as the Federal Laser Product Performance Standard

and electrical codes. The donor is required to provide adequate safety instructions for the operation and maintenance of the laser system to the recipient. All donations must also comply with UNM policies regarding the donation of University equipment. Export controls may also apply to external donations.

- Trading in the laser system for credit towards the purchase of a new laser or re-selling the laser system to a recycler.
- Decommissioning followed by disposal. All means of activating the laser must be removed (e.g. cutting/removing of electrical connections or components) and the laser must be completely de-energized and drained of all fluids. Contact SRS for details.
- Destruction and disposal of the laser system.

The last two methods of disposal may be subject to waste disposal restrictions due to hazardous materials contained in the components of the laser system such as mercury switches, oils, and laser media containing hazardous chemicals. Contact SRS for guidance on disposal of hazardous materials.

Export Controls

Certain laser products are controlled for export purposes under the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR), and require U.S. Government authorization prior to the export or transfer to a non-U.S. Person. Visible laser products are subject to export controls imposed by the U.S. Department of Commerce. Contact UNM Export Control for details.

Appendices

Appendix A: UNM Laser Registration Form

(Required for Class 3B, Class 4, and any Class with embedded 3B or 4)

1. Principal Investigator Information

First Name:_____Last Name:_____ UNM ID:_____

College/Institution:_____Department: _____Position:_____

Physical mailing address:_____E-mail address: _____

Phone (Office):_____Phone (Cell):_____

2. Laser Location

Campus: _____ College/Institution:_____Department: _____

Building Name:_____ Room No.:_____

3. Laser Identification and Properties

New laser: _____ Alteration of an existing laser: _____Relocation of an existing laser: _____

Serial No.:_____ Manufacture:_____ Model No.:_____

Date Manufactured:_____ Use code: _____

Laser Class: _____ Embedded Class 3B:_____ Embedded Class 4:_____

Laser type (Ex. Argon, He-Ne, diode, Dye, Ti:Sapphire, Nd:YAG, Nd:YLF): _____

Operation mode: _____ Maximum output power if CW:_____

Repetition frequency if pulsed:_____ Maximum output pulse energy:_____

Pulse duration seconds:_____ Operational wavelength(s) (nm):_____

Beam diameter:_____ Beam delivery method: _____

Current laser status: _____ Divergence (mrad):_____

Hazards associated with this laser (check all that apply)

Eye: _____ Skin: _____ Electrical: _____ Chemical: _____ Laser generated air contaminants: _____Other: _____

Do you have adequate protective eyewear for this laser?

Yes: _____ No: _____ (if yes, list the wavelength(s) and Optical Density for each wavelength)

Is laser portable and used in more than one location? Yes: _____ No: _____

If portable list all other locations that is used:_____

Provide a brief description of the laser application:_____

_____

Note: For single laser system, this is the end of the registration. Please see back page for further instructions

If this laser is part of a laser system, please provide the following information of each component.

4. Component #1

Serial No.:_____ Manufacture:_____Model No.:_____

Operation mode: _____ Output power/energy:_____

Repetition Frequency:_____ Wavelength (s):_____

5. Component #2

Serial No.:_____ Manufacture:_____Model No.:_____

Operation mode: _____ Output power/energy:_____

Repetition Frequency:_____ Wavelength (s):_____

6. Component #3

Serial No.:_____ Manufacture:_____Model No.:_____

Operation mode: _____ Output power/energy:_____

Repetition Frequency:_____ Wavelength (s):_____

7. Component #4

Serial No.:_____ Manufacture:_____Model No.:_____

Operation mode: _____ Output power/energy:_____

Repetition Frequency:_____ Wavelength (s):_____

Form completed by:_____ Date:_____

Appendix B

Laser Operations Safety Audit Form

Audit Information:
Auditor:_____ SOP#:_____ Audit Date:_____
Type of Audit: ☐ Annual ☐ New ☐ Self-Assessment ☐ Other
Facility Name:_____ Building:_____ Rooms:_____
Responsible Individual:_____
Room Contact During Audit:_____
Comments:_____

Laser System Information
Class: ☐ Class 4 ☐ Class 3B ☐ Class 3R ☐ Class 2M ☐ Class 2 ☐ Class 1M
❑ Class 1 embedded Embedded Class:_____
❑ Commercial Laser System ☐ Modified Commercial System ☐ Homebuilt
Manufacturer:_____ Model:_____ Serial Number:_____
Laser Type (HeNe, etc.):_____ Wavelength (nm):_____
❑ Continuous Wave Beam Power (W):_____
❑ Single Pulsed ☐ Repetitively Pulsed
Energy per Pulse (J):_____ Pulse Duration (sec.):_____
Pulse Repetition Frequency (Hz):_____
Beam Diameter (mm):_____ Divergence (mrad):_____
Collecting optics used (microscopes, binoculars, telescopes): ☐ Y ☐ N ☐ NA
Comments:_____

Administrative and Procedural Controls
Written Standard Operating Procedures for operations and maintenance: ❑ Y ❑ N ❑ NA
Alignment procedures (Class 3B and 4): ❑ Y ❑ N ❑ NA
Laser safety training and authorization records available/current: ❑ Y ❑ N ❑ NA
Laser eye exams (Class 3B and 4): ❑ Y ❑ N ❑ NA
Written interlock procedures: ❑ Y ❑ N ❑ NA
Interlock check sheet available and current: ❑ Y ❑ N ❑ NA
Comments:_____

Posted Documentation and Security Measures:
Access door interlocks and status panel functional: ❑ Key ❑ Code ❑ Badge ❑ Y ❑ N ❑ NA
Laser status indicator outside room: ❑ Y ❑ N ❑ NA
Access door signs current: ❑ Y ❑ N ❑ NA
Emergency contact information current: ❑ Y ❑ N ❑ NA
Unattended operation signs: ❑ Y ❑ N ❑ NA
Posting on ancillary doors: ❑ Y ❑ N ❑ NA
Eyewear requirements posted: ❑ Y ❑ N ❑ NA
Nominal Hazard Zone established and demarcated for unenclosed systems: ❑ Y ❑ N ❑ NA
Comments:_____

Laser Unit Safety Controls:

Laser classification labels present on commercial units: ❑ Y ❑ N ❑ NA
Protective housings in place: ❑ Y ❑ N ❑ NA
Housing interlock present and functioning: ❑ Y ❑ N ❑ NA
Beam shutters interlocked and functioning as per interlock check sheet: ❑ Y ❑ N ❑ NA
Interlock bypass functioning (=15 seconds): ❑ Y ❑ N ❑ NA
Key operation on operating console: ❑ Y ❑ N ❑ NA
Laser activation indicator on operating console: ❑ Y ❑ N ❑ NA
Emergency shutoff available: ❑ Y ❑ N ❑ NA
Comments:_____

_____

_____

Engineering and Administrative Laser Safety Controls:

Beam path: ☐ Totally open ☐ Completely enclosed ☐ Combination
Beams enclosed where available: ☐ Y ☐ N ☐ NA
Beam enclosure methods:
❑ Tubes ☐ Perimeter guards ☐ Panels/Curtains ☐ Fiber optics
Lasers and optics secured to table: ☐ Y ☐ N ☐ NA
Beam blocks secured to optical table: ☐ Y ☐ N ☐ NA
Fiber optics in use: ☐ Bare ☐ Enclosed
Fiber ends/connectors labeled: ☐ Y ☐ N ☐ NA
Fiber conduit labeled: ☐ Y ☐ N ☐ NA
Beam properly contained (Not a hazard to persons sitting or standing): ☐ Y ☐ N ☐ NA
Adequate controls where beams leave table or leave enclosure: ☐ Y ☐ N ☐ NA
Entry curtains on door(s): ☐ Y ☐ N ☐ NA
Windows/door openings covered: ☐ Y ☐ N ☐ NA
Beams blocked from open by-passed doors: ☐ Y ☐ N ☐ NA
Non-essential reflective materials out of beam paths and surroundings: ☐ Y ☐ N ☐ NA
Administrative controls employed, barriers, demarcates: ☐ Y ☐ N ☐ NA
Upward directed beams are labeled: ☐ Y ☐ N ☐ NA
Evidence of stray beams (Marks on walls, etc.): ☐ Y ☐ N ☐ NA
Housekeeping acceptable: ☐ Y ☐ N ☐ NA
Alignment lasers in use (specify type):_____ ☐ Y ☐ N ☐ NA
Comments:_____

_____

_____

Personal Protective Equipment:

Properly labeled eyewear available for all personnel: ☐ Y ☐ N ☐ NA
Wavelength(s):_____ OD(s):_____ General condition of laser eyewear: ☐ Very Good ☐ Good ☐ Fair ☐ Damaged
Observable cracks or scratches on lens: ☐ Y ☐ N ☐ NA
Properly stored (where):_____
Proper skin protection available and employed for UV hazards: ☐ Y ☐ N ☐ NA
Viewing cards available for non-visible beams: ☐ Y ☐ N ☐ NA
Comments:_____

_____

_____

Additional Class 4 Laser System Hazards

Class 4 Fire Hazard:	❑ Y	❑ N	❑ NA
Housekeeping fire hazards minimized:	❑ Y	❑ N	❑ NA
Class 4 Diffuse Reflection Hazard:	❑ Y	❑ N	❑ NA

Comments:_____

_____

_____

Non-beam Hazards:

Metal fumes, chemical vapors, gases, and biological plumes controlled:	❑ Y	❑ N	❑ NA
Exhaust ventilation adequate:	❑ Y	❑ N	❑ NA
High voltage hazards minimized:	❑ Y	❑ N	❑ NA
Optical tables bonded to building ground:	❑ Y	❑ N	❑ NA
Electrical equipment certified by Nationally Recognized Testing Laboratory (UL, CSA, etc.):	❑ Y	❑ N	❑ NA
Compressed gases stored and used safely:	❑ Y	❑ N	❑ NA
Ionizing radiation (x-rays):	❑ Y	❑ N	❑ NA
Good housekeeping on optical tables:	❑ Y	❑ N	❑ NA
Container for sharps:	❑ Y	❑ N	❑ NA
Proper disposal of chemical wastes:	❑ Y	❑ N	❑ NA

Comments:_____

_____

_____

Corrective actions required:_____