DRI Policy on Laser Safety

1.0 INTRODUCTION AND REGULATORY REQUIREMENTS

1.1 The American National Standards Institute (ANSI) Z136 Standards have become accepted industry practice for the safe use of lasers. ANSIZ136.1, *Safe Use of Lasers*, is the guideline for all laser users. (A copy of Z136.1 is available for review in the DRI EH&S Office.) In addition, ANSI Z136.2 *American National Standard for the Safe Use of Fiber Optic Communication Systems Utilizing Laser Diode and LED Sources*" and ANSI Z136.6, *American National Standard for the Safe Use of Lasers Outdoors* may apply to certain DRI uses of lasers.

1.2 Regulatory oversight for laser safety falls under the Occupational Safety and Health Administration (OSHA) and the Food and Drug Administration (FDA)

1.2.1 OSHA addresses laser safety requirements in 29 CFR 1926.54, *Nonionizing Radiation*. When that particular standard does not apply to the situation, OSHA inspectors use Publication 8-1.7, *Guidelines for Laser Safety and Hazard Assessment*, as a reference document. (This guidance document is based on the ANSI Z136 Standards.) If a discrepancy is subsequently found, OSHA will use the 'General Duty Clause' as the basis for a citation.

1.2.2 The U.S. Federal Laser Product Standard 21 CFR Part 1040 (from the Center for Devices and Radiological Health (CDRH), a bureau within FDA) governs manufacturers of lasers. All laser products sold after 1976 must be certified by the manufacturer as meeting the safety standards of CDRH. All laser systems must bear a compliance label as well as denoting the hazard class of the laser enclosed. Please contact EH&S if any of your equipment is missing any of these labels.

1.3 Lasers are categorized into five hazard classes (listed from lowest to highest hazard): 1, 2, 3a, 3b, and 4. (There is also a hazard class 2a, which is not discussed by ANSI Z136 and there are some differences in class 3a between ANSI and CDRH. See the Chapter 3 of the UNR Laser Safety Manual for details. 0 Most of the hazards associated with lasers are caused by Class 3b and Class 4 lasers. Class 3b lasers are generally intermediate powers in the range of 5-500mW continuous wave, $10J/cm^2$ if a pulsed wave. A laser is considered Class 4; if greater than 5W continuous wave or greater than $10J/cm^2$ pulsed.

1.4 Both ionizing and non-ionizing radiation services are provided to DRI by the UNR Radiation Safety Office. In regards to laser usage, the UNR Laser Safety Officer (LSO) provides basic laser safety training and education; conducts hazard evaluations of laser operations and recommends signage, personal protective equipment, and other hazard mitigation steps; and provides other technical advice and assistance upon request.

2.0 PURPOSE:

2.2 To define responsibilities for the safe use of laser products and equipment.

3.0 SCOPE:

3.2 "Laser" will define any laser equipment or system utilizing wavelengths between 0.18 nm - 1mm.

3.3 This policy does not include Class 1 lasers or systems with imbedded lasers of a higher power where only a Class 1 beam is emitted. However, it does include alignment procedures for embedded Class 2 or higher laser beams.

3.4 Classification specifications and control measures are provided the UNR Laser Safety Manual Chapters 3 and 5 respectively.

4.0 RESPONSIBILITY OF DIVISION OR CENTER DIRECTORS:

4.2 Ensure all personnel operating a laser are following the applicable ANSI Z136 standards and safety requirements outlined in the UNR Laser Safety Manual.

4.3 Ensure the purchase of all personal protective equipment (PPE) necessary to comply with the safety requirements of ANSI Z136.1.

4.4 Ensure that all Principal Investigators (PIs) utilizing a Class 3B or 4 laser submit a laser registration form (Attachment A) to the UNR LSO, M/S 328.

4.5 Report any new uses for lasers/laser systems within their division/center to EH&S at the pre-planning stage.

5.0 RESPONSIBILITY OF THE PRINCIPAL INVESTIGATOR (PI):

5.2 Ensure the safe use of lasers in his/her laboratory/research project

5.1.1 By requiring adherence to the applicable ANSI Z136 standards and safety requirements outlined in the UNR Laser Safety Manual and

5.1.2 Appointing a laboratory/project laser safety officer (LLSO), who may be the P.I. or other appropriate person. If the LLSO is not the PI, he/she must be delegated the authority, in addition to the responsibility, to implement the lab/project laser safety program. (The name of the LLSO must be communicated to the DRI EH&S Office.)

6.0 RESPONSIBILITY OF THE LABORATORY/PROJECT LASER SAFETY OFFICER (LLSO)

6.1 Enforce the safety standards outlined in the UNR laser safety program.

6.2 Ensure the proper registration of all class 3b and 4 lasers (Attachment A).

6.3 Ensure that all personnel working with or around lasers or laser systems class 2 or higher have attended the appropriate laser safety training conducted by the UNR LSO. (Contact Mr. Jo, 775-784-4540 for scheduling.)

6.4 Prepare Standard Operating Procedures (SOPs) for Class 3b and/or Class 4 lasers and/or recurring alignment tasks with Class II or higher lasers. (See Attachment B for suggested SOP outline.) The SOP will enable a total hazard evaluation so that all safety measures are considered. (Contact Mr. Jo, 775-784-4540 for assistance.)

6.5 Maintain and update, as needed, all operating, alignment and emergency procedures for the lasers and the facility under LLSO's control.

6.6 Comply with ANSI Standard Z136.1 in order to ensure that any exposure to lasers remains below the Maximum Permissible Exposure (MPE) values.

6.7 Determine the PPE required for the safe operation of each laser, and require employees and visitors to don proper fitting PPE.

6.8 Ensure all new personnel obtain a baseline eye exam prior to the use or operation of a registered laser, when ANSI 136.1 has this exam as a requirement.

6.9 Supervise personnel with authorization to work in (as well as all spectators and visitors to) the laser facility to ensure against unauthorized entrance or accidental exposure to laser radiation.

6.10 Act as the contact for the DRI EH&S and UNR Radiation Safety Offices.

6.10.1 Report any changes in operational status, such as location changes, new purchases, and/or modifications to any laser equipment that may change the classification.

6.10.2 Update all records to reflect changes in personnel or equipment by contacting the DRI EH&S Office as these changes occur.

6.10.3 Report all incidents involving safety violations or injury to the DRI EH&S Office at 775-673-7329.

7.0 RESPONSIBILITY OF THE EMPLOYEE:

7.1 Obtain a baseline eye exam, when required, and attend general laser safety training before operating any class 3b or 4 laser/laser system.

7.2 Wear all necessary PPE designated by the PI/LLSO.

7.3 Inspect eyewear (prior to use) to ensure it is in good condition.

7.4 Comply with all rules and requirements specified in the laser safety program as well as any work area specific laser safe operating procedures (SOPs).

7.5 Report laser hazards, including potential exposures to the beam, to the LLSO. Some exposure events also require the employee report for medical evaluation at a NSHE approved (worker's compensation) clinic or hospital. These events include, but are not limited to

7.5.1 All laser exposures to the eye or skin that are greater than the MPE for the actual exposure duration.

7.5.2 Exposures that cause a burning sensation or a change in the condition of the skin; a visual afterimage; blurring or obstruction of vision; headaches or other pain.

7.5.3 Any injury caused by laser support equipment, such as electric shock or exposure to a dye solution.

8.0 RESPONSIBILITY OF DRI ENVIRONMENTAL HEALTH AND SAFETY (EH&S):

8.1 Act as a liaison between DRI laser users and the UNR Radiation Safety Office.

8.2 Review and update this policy so that it remains in compliance with all regulations and technologies.

8.3 Request inspections and/or hazard analysis and mitigation review of laser use areas to ensure compliance with ANSI Z136.1.

8.4 Assist with proper selection of PPE.

8.5 Identify clinics local to the DRI campuses that can perform baseline eye exams and any required subsequent exams for affected employees.

8.6 On request, assist PIs /LLSOs with writing SOPs to ensure a proper safety assessment is performed.

8.7 Develop training materials for a general laser safety training program and provide training tools to the LLSOs responsible for review training for their affected employees/temporary workers.

8.8 Maintain records of laser inventory, inspections, and training attendance.

8.9 Participate with the UNR LSO in laser accident investigations.

9.0 DEFINITIONS (see also Section 2 of ANSI 136.1 and Chapter 8 of the UNR Laser Safety Manual)

9.1 *Controlled Area*—An area where the occupancy and activity of those within is subject to control and supervision for the purposes of protection from radiation hazards.

9.2 *Laser*--A word for light amplification by stimulated emission of radiation. Lasers generate or amplify electromagnetic oscillations at wavelengths from the far infrared (submillimeter) to the ultraviolet. The laser oscillator needs two basic elements: an amplifying medium and a regeneration or feedback mechanism (resonant cavity). The amplifying medium can be a variety of substances, such as a gas, semiconductor, dye solution, etc. Feedback is generally created by two mirrors. The distinctive properties of the resulting electromagnetic oscillations include monochormaticity, extremely high intensity, very small bandwidth, very tight beam convergence and phase coherence.

9.3 *Laser Classification*--A ranking of comparative beam hazard, which is of great importance in setting the necessary control measures for reducing the radiation hazard. Four classifications exist.

9.3.1 *Class 1 Laser*--A laser or laser system which is not capable of (during normal operating conditions) causing any injury. Most lasers in this class are included by virtue of enclosure that prohibits or limits access to the laser radiation. A common example would be the laser printer.

9.3.2 *Class 2 Laser*--A laser or laser system that due to blink reflex (0.25 seconds) does not present a hazard. As with any bight light source it can be a hazard if one forces oneself to stare into the source too long. Class 2lasers are always in the visible spectrum and must be labeled warning the user to not stare into the beam. Power output is below 1 milliwatt.

9.3.3 *Class 3 Laser*--A laser or laser system whose laser radiation is potentially hazardous to the eye. There are two subclassifications of Class 3 lasers.

9.3.3.1 *Class 3a*--A laser or laser system that normally would not be a hazard is viewed for only momentary periods with the naked eye, but can be an acute viewing hazard if viewed directly with optical instruments. Construction and alignment lasers are common examples of this laser class. Power output is between 1 and 5 milliwatts.

9.3.3.2 *Class 3b*--A laser or laser system that can be a hazard if viewed directly. This includes intrabeam viewing of specular reflections. Power output is from 5-500 milliwatts.

9.3.4 *Class 4 Laser*-- A laser or laser system that can produce a hazard not only from the direct or specular reflection, but also from diffuse reflection. This class laser may present a serious eye, skin or fire hazard. Power output is above 0.5 watts.

9.4 *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. Refer to Section 8 of the ANSI Z136.1 Standard for more details.

9.5 *Nominal hazard zone (NHZ)*—The space within which the level of the 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.

10.0 REFERENCES

10.1 American National Standards Institute, ANSI Z136.1, "American National Standard for the Safe Use of Lasers."

10.2 American National Standards Institute, ANSI Z136.2 "American National Standard for the Safe Use of Fiber Optic Communication Systems Utilizing Laser Diode and LED Sources."

10.3 American National Standards Institute, ANSI Z136.6, "American National Standard for the Safe Use of Lasers Outdoors".

10.4 "Guidelines for Laser Safety and Hazard Assessment", OSHA Directive Pub 8-7.1.

10.5 Title 29 Code of Federal Regulations 1910.133, 1926.54, 1926.102.

10.6 University of Nevada Reno Laser Safety Manual.

11.0 ATTACHMENTS

Attachment A: University of Nevada-Reno Laser Registration Form

Attachment B: Suggested Outline for Standard Operating Procedure

DRI Policy on Laser Safety - Attachment A

University of Nevada-Reno Laser Registration Form

(Please complete a form for each Class 3b or 4 laser)

General Information:

Principal Investigator (PI): _____ Phone No. _____
Names of Laser Users: _____
Department of PI: _____
Building and Room Location of Laser: _____
Make/Model/Serial No. of Laser: _____
Type of Lasing Medium: _____

Laser Information

Laser Classification (circle one): 3b 4
Beam diameter at aperture (in mm): _____
Beam divergence (in mrad): _____

CW		**Pulsed**	
Wavelength(s), nm:	_____	Wavelength, nm:	_____
Maximum Output Power, W:	_____	Pulse duration, sec:	_____
Average Output Power, W:	_____	Pulse frequency, Hz:	_____
		Maximum Output Energy, J:	_____
		Average Output Energy, J:	_____

Laser Use (describe briefly)

_____
_____
_____

Others: please check all items that apply

Use of Cryogens:	_____	Use of pumping Laser:	_____
Use of Compressed gas:	_____	Beam focusing optics:	_____
High Voltage power supplies:	_____	High voltage >30 kVp:	_____
Dye Laser:	_____	Freq. Doubling Crystal:	_____
Exposed beam paths:	_____	Tunable laser:	_____
High Noise Levels:	_____	Invisible Beam:	_____
Laser cutting /welding:	_____	Others:	_____

Name of person completing this form: _____ Date: _____

If you have any questions regarding this form, contact Mr. M. Jo, Laser Safety Officer (LSO), at 4540. **Please return the completed form to:** LSO, EH&S, MS 328.

DRI Policy on Laser Safety - Attachment B

Suggested Outline for Standard Operating Procedure

PLEASE ADD ADDITONAL ITEMS THAT ARE MISSING OR THAT YOU WOULD FIND USEFUL IN USING THE COMPLETED SOP AS A TRAINING TOOL

1. Introduction

    a. Location of laser (building, room)

    b. Diagram of room layout

    c. Description of each laser (use part II of the laser registration form)

    d. Application of the beam

2. Hazards

    a. Identify beam hazards

    b. Identify any non-beam hazards (electrical, chemical)

    c. Analysis and Control (target area, absorbing material)

3. Controls Available[1]

    a. Access controls (door interlocks, signs, and signals)

    b. Beam controls (key-lock, enclosures, shutters, and stops)

    c. Electrical controls (High Voltage signs, "light on" power supply)

    d. Eye protection (Medical Surveillance, types of eyewear, optical density for each beam)

    e. Other (list)

4. Operating Procedures

    a. Initial preparation of laboratory for normal operation (key position, warning lights on, interlock (s) activated, and identification of all personnel present)

    b. Personnel protection (eyewear, isolation, barrier)

    c. Target preparations

    d. Countdown procedure

    e. Shutdown procedure

    f. Alignment procedure

[1] Please identify controls for each laser in your area.

DRI Policy on Laser Safety - Attachment B

5. Training required to operate laser or to work in area where lasers are in operation. (List for each category of employee. Include all training required, not just the laser safety courses required. Refer to the DRI Safety Training Decision Matrix.)

   a. Courses from commercial laser institutes or other Universities

   b. Department of Environmental Health and Safety Training

   c. Specific training, OJT on laser use

   d. Maintenance and repair training if applicable

6. Responsibilities

   a. Supervisor for normal operations

   b. Emergency coordinator

   c. Operators and other personnel

7. Emergency Procedures

   a. List potential emergencies and corresponding procedures

   b. Name and Numbers of pertinent help

8. Miscellaneous

   a. Visitor regulations at site

   b. Accident procedures

   c. Other as applicable