## General Information:

Your Safe Operating Procedure (SOP) outlines the requirements to be reviewed by authorized user(s) for the laser described herein, the normal operation of the laser and any hazards that may be encountered during normal operation. Finally, the SOP explains how to minimize any hazards and how to respond in the event of an emergency.

### Laser:

* You will need to provide specific laser information about the laser to be used in this SOP
* The location of the laser use and contact information at that location.
* What Is the laser(s) classification(s), output energy, beam diameter, emission frequency, etc. – usually identified in the manufacturer’s operations manual
* If you unable to find laser specifications contact the manufacturer for information and specifications.
* NCSU Laser Inventory Number.

### Beam Paths:

* Need to be described in full by either a diagram or in clear and concise English
* Open beam path – are the most hazardous and least desirable
* Partially enclosed beam path – are better than open beam paths
* Enclosed beam path – are the best option as beam access is prevented during operation.
* Beam termination – all beams must be terminated with the appropriate material for the energy and wavelength of the laser and specified in your SOP
* Remember that when protective enclosures (beam paths covers or laser housings) are removed for alignment, the laser class will change from a safer one to a more hazardous one. For example, a class 4 laser with a complete enclosure is a class 1 laser. However, when protective housings are removed, the laser is now a class 4 laser, requiring specific controls to be in place, these too must be described in your SOP.

### Protective Equipment:

* Must be included in your SOP:
* How the laser and the lab are interlocked, including where the important controls are located (Laser crash button, warning signs, etc.) and how and when they are to be used
* Any secondary interlocks (installed on barriers or beam path covers)
* What type of laser eyewear is available, where it is stored, and what laser(s) it is to be used for.
* Other protective equipment that maybe needed (lab coat, gloves, UV or IR shielding, venting of the laser, etc.)

### Beam Hazards:

* Must be included in your SOP examples are listed below:
* Fire hazards, beam height (at or below eye level), direct or indirect beam exposure to the skin or eyes, how to prevent these hazards and what to do if a beam causes a fire or injury to an individual (accident response).

### Non-Beam Hazards:

* Must also be included in your SOP examples are listed below:
* Electrical and fire hazards, reflective surfaces, laser-generated air contaminants, hazardous gas exposure, chemical, cryogenic, and explosion hazards, how to prevent these hazards and what to do if a one of these hazards causes an incident or injury to an individual (emergency response).

### Turn on/off Procedures:

* Must be included in your SOP
* What is the correct manner of starting the laser, what are the precautions or checks needed to be performed prior to turn on (Cooling water, beam path clear, etc)
* What is the correct manner of stopping the laser, what are the precautions or checks needed to be performed prior to turn off (Cooling water, shutters, etc)
* TIP: make a start-up check list and keep logs of them

### Alignment Procedures:

* Must be included in your SOP, things to consider including in your procedure:
* To reduce accidental reflections; watches, rings, dangling badges, and other reflective objects must be taken off before any alignment activity begins.
* Identify equipment and materials necessary to perform alignment prior to starting the procedure.
* TIP: this is another good place for a check list.
* Use of non-reflective tools should be considered.
* Limit access to the room/area to authorized personnel only.
* Alignments should be performed with a companion, not alone.
* Use LOW power alignment lasers (3R or less) for this procedure.
* Remove all unnecessary equipment, tools, and combustible materials to minimize the possibility of stray reflections and non-beam accidents.
* Persons conducting the alignment must be trained and authorized **by the PI**, to perform this type of work.
* A ‘Notice” sign is posted at the entrance when temporary laser control areas are set up or unusual conditions warrant additional hazard information.

### Maintenance

* You will need to describe all permitted maintenance procedures in your SOP
* Laser equipment shall be maintained in accordance with the manufacturer’s recommended procedures.
* You must descried all permitted maintenance activities (coolant water changes, lamp replacement, etc.) and what is NOT permitted (working with high voltage, etc.)
* How to disconnect the laser from electrical power.
* How to safely remove hazardous gases and the correct procedures for changing hazardous gas cylinders, and all safety requirements (respirator training, lock out and tag out training, etc.)
* All laser safety devices will be tested and documented after any maintenance.
* Accurate records will be kept of tests, calibrations, adjustments, and repairs done.
* The laser interlock system will be tested / checked quarterly and records kept.

### Emergency Procedures

* You must describe clearly ALL procedures to be done in the event of an emergency (how to shut down the laser, how to respond to an alarm, etc)
* Authorized laser users shall be familiar with the labs evacuation plan, location of emergency equipment, and emergency procedures for fires, and evacuations. Emergency shut-off procedures for lasers consist of shutting off the electrical power to the laser system. The main electrical shut-off switches to the laser shall be clearly labeled.

### Authorized User(s)

* All users of the laser system described in this SOP will attest to having read and understood the SOP by signing the document.
* The PI will review with the users this SOP and initial that they have received this training.

### Initial and Annual Reviews:

* An initial review of this SOP will be conducted prior to commencing use of the laser describe herein, and will be signed off by the PI, NCSU Laser Safety Officer, Departmental Safety representative (if applicable) and any other Department or College representative (if applicable)
* A review of all laser operation shall be conducted annually or as conditions warrant whichever is the shorter time period.
* The introduction of any ‘NEW’ hazards into the existing SOP will require a full review of operations and potential hazards.
* If no changes, other than users have been made in the past twelve months, then the existing SOP will be considered valid and this will be documented.

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| **LASER SAFE OPERATING PROCEDURE** |

**General**

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| --- | --- | --- |
| Principal Investigator (Faculty or Supervisor of laser): | Department: | Phone: |
| E-mail: | |

**Location**

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| --- | --- | --- |
| Building: | Room(s) #: | Phone: |

**Equipment Information1**

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| --- | --- | --- | --- | --- | --- | --- |
| Manufacturer  of Laser Head: | | | Laser Head  Model #: | | | Serial #: |
| Manufacturer  of Power Supply: | | | Laser Power  Supply Model #: | | | Serial #: |
| NCSU EHS  Laser Inventory No: | | | Beam Diameter  (mm): | | | Beam Divergence  (mrad): |
| Type: | Wavelength(s)  (nm): | | | Class: | | Output  (J or W): |
| Pulse Duration  (sec): | | Max. Joules / pulse: | | | Repetition Rate  (Hz): | |
| Modifications  to the Laser: | | | | | | |

1. This information can be found in the manufacturer’s operations manual that was supplied with the laser.

**Laser Application Summary:**

(A brief description of the intended laser use, such as spectroscopy, chemical reaction work, wielding, etc.)

**Beam Path(s):**

(Describe in full by either by a diagram or in clear and concise English the intended path of the laser beam from the laser head to its finial target; SEE ‘Beam Paths’ on page 1, attach additional sheet(s) if needed)

**Protective Equipment:**

(Describe in full ALL safety equipment that is associated with this laser and its intended use SEE ‘Protective Equipment’ on page 1, attach additional sheet(s) if needed)

**Laser Protective Eyewear:**

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| **Wear this eyewear:** | | | |
| Eyewear Manufacturer | Protection Wavelength(s) | Optical Density (OD) | Notes |
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**Beam Hazards:**

(Describe in full ALL direct and indirect hazards that are associated with this laser beam and its intended use (Beam height, Reflections, Ultraviolet radiation/blue light exposure, etc.) SEE ‘Beam Hazards’ on page 1, attach additional sheet(s) if needed)

**Non-Beam Hazards:**

(Describe in full ALL direct and indirect hazards that are associated with this laser and its intended use (Electrical and fire hazards, reflective surfaces, laser-generated air contaminants, hazardous gas exposure, chemical, cryogenic, etc.) SEE ‘Non-Beam Hazards’ on page 1, attach additional sheet(s) if needed)

**Turn on/off Procedures:**

(Describe in full ALL steps necessary to the safe and proper manner of starting and stopping this laser SEE ‘Turn on/off Procedures’ on page 1, attach additional sheet(s) if needed)

**Alignment Procedures:**

(Describe in full ALL steps necessary to the safe and proper methods of aligning the internal and external beam for this laser SEE ‘Alignment Procedures’ on page 2, attach additional sheet(s) if needed)

**Maintenance Procedures:**

(Describe in full ALL steps necessary for maintaining this laser in a safe and proper manner. DO NOT forget to include what maintenance requires special training and what is NOT allowed SEE ‘Maintenance’ on page 2, attach additional sheet(s) if needed)

**Emergency Procedures:**

(Describe in full ALL procedures to be done in the event of an emergency (how to shut down the laser, how to respond to an alarm, etc) SEE ‘Emergency Procedures’ on page 2, attach additional sheet(s) if needed)

**Authorized Users:**

I have read this Safe Operating Procedure, understand its content, have been trained on implementing its contents and will utilize this procedure every time I use this laser system.

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| **NAME (print)** | **Signature** | **Date** | **PI Initial** |
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**Initial Review:**

The initial review of this SOP has been conducted and approved by the PI, NC State Laser Safety Officer, Departmental Safety representative (if applicable) and any other Department or College representative (if applicable) as indicated below.

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| **NAME (print)** | **Signature** | **Date** | **Affiliation** |
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**Annual Reviews:**

An annual review of this SOP has been conducted and approved by the PI and Departmental Safety representative (if applicable).They have found this Safe Operating Procedure, to still be correct and valid for the laser use that it herein describes.

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| **NAME (print)** | **Signature** | **Date** | **Affiliation** |
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