***Instructions:***

* The purpose of this SOP is to identify the steps/control measures that must be implemented to protect individuals from the hazardous conditions that could occur during the alignment/setup and operation of the laser(s) in a given setup.
* Use this template to create a standard operating procedure for each setup involving Class 3B or Class 4 lasers. Use it for activities outside of normal operation for embedded laser systems as well. If you are designing/building a new setup, reach out to the LSO to file and get approval on a Temporary Work Authorization (Form TWA-1). Once that new setup is in place, this SOP template must be used moving forward. The TWA and SOP are required even if the Laser Supervisor is the only user at the time. The SOP will document the alignment/setup and operational laser safety procedures developed during the design phase that was governed by the TWA.
* The Laser Supervisor shall ensure that each Laser User that will use the setup is trained on this procedure and ensure it is followed each time the laser is used. This SOP is a vital component of the hands-on operational training that is required in addition to the online laser safety course.
* Each Laser User that has been trained on this procedure shall sign on the first page under “Laser User/Trainer/Supervisor Review.” The person that provided the operational training shall also sign along with the Laser Supervisor.
* Keep a hard copy of this SOP in a readily viewable area near the setup to which it applies. The LSO provides laboratory laser safety binders with the Laser Supervisors name. If you can’t locate the binder for your location, contact the LSO.
* This SOP shall be available for review upon request of the Laser Safety Officer.
* For specifications or operating conditions that frequently change, list anticipated ranges of specifications or operational settings.
* Email a completed version of each of your SOP(s) to the Laser Safety Officer at laser@ehs.gatech.edu.

***NOTE****: If your SOP(s) is already documented in another form and it includes all the information indicated in this template, you may use your current document(s). The manufacturer’s operating manual is not a suitable substitute for an SOP.*

***Alignment/Setup Guidelines:***

The items below are guidelines/helpful suggestions for things to consider during alignment/setup activities. Many of the items can be used/modified by you to include in your stepwise instructions for alignment/setup in Section 4.A. Remember, laser alignments are where the majority of laser injuries occur. Unexpected stray beams or reflections from unexpected angles cause most of these injuries.

* DO NOT perform alignment activities unless you have been specifically trained to do so by the Laser Supervisor.
* DO NOT rush through beam alignment activities in particular; give yourself plenty of time. Alignment is the laser activity that poses the greatest potential for hazardous exposure.
* DO NOT hold and align an optic with your hands. All optics must be attached to the bench reliably with mounting screws/mounting clamps and tightened appropriately, and only one optical part at a time should be loosened slightly to be adjusted. Minimize the degree of freedom and range of motion to what is necessary for alignment. Immediately re-tighten the optic when alignment of this part is done.
* Plan the beam path and sketch it out on paper before beginning alignment/setup
	+ ANTICIPATE UNWANTED REFLECTIONS FROM EVERY SURFACE IN THE BEAM PATH
* Ask another trained individual to provide assistance with alignment activities. At a minimum, the person conducting alignment activities should ensure another trained user is at least in a nearby lab or office so they can quickly provide assistance.
* Especially when aligning invisible beams, consider whether a low-power visible laser can be used to do the initial optics alignment.
* Color-blindness can cause the visibility of the beam spot on beam alignment cards to be diminished. Determine whether anyone in your group that will be involved in beam alignment/setup activities is color-blind so that alternative alignment methods can be considered.
* Use only beam alignment cards that are undamaged.
* When possible use a holder for beam alignment cards instead of propping them against optics on the table to prevent them falling over. There may be cases where propping the card is a better option, but the user must exercise extra caution so as not to be distracted by these cards if they fall over.
* Prior to enabling emission of the beam, ensure all users in the laser-controlled area are wearing appropriate laser goggles or remove them from the lab. Ideally, only individuals involved in the alignment should be present.
* Ensure laser warning sign at entry includes the laser type, wavelength, and OD for the laser(s) getting ready to be used. For labs with multiple wavelengths available, it is strongly recommended that the lab determine a way to communicate the current wavelength in use adjacent to the laser warning sign. This may be a small whiteboard that can be written on or a sign holder in which a paper indicating the wavelength in use can be easily swapped.
* Turn on the entryway laser in use warning light.
* Close the laser curtain at the entryway.
* Ensure unnecessary equipment, tools, and other miscellaneous reflective objects are removed from the optical bench to minimize the possibility of stray reflections.
* Remove any watches, jewelry, objects in shirt pockets, or lanyards that are reflective.
* Place beam blocks/dumps at locations on the optical bench to prevent the beam from leaving the bench.
* Wear laser eye protection at all times during the alignment. Make sure that the OD is appropriate to the wavelength for the alignment of the laser. Refer to the table in Section 5. Laser Eye Protection (LEP) for the correct alignment eyewear.
* Ensure that the laser eyewear fits properly with no large gaps present between the lenses and the face.
* No laser eyewear is required for alignment if there is only a visible beam < 5 mW present.
* Use the back of a white business card to make dim visible beams appear brighter.
* Use phosphor cards or image converter viewers to see invisible UV and IR wavelengths. For some UV wavelengths, the back of a white business card will fluoresce and render the beam location visible.
* Ensure laser emission shutter is closed until beam is needed.
* Indicate the laser settings for alignment.
* Proceed with laser settings and steps to turn on the laser according to the manufacturer’s user manual.
* Adjust optics.
* Routinely check for stray reflections terminate them with a laser barrier. Ensure all stray reflections and direct beams are properly terminated before high power operations.
* Turn off laser.
* Remove laser eyewear. Place it back in the eyewear storage location.
* Turn off laser in use warning light.

***Operation Guidelines:***

The items below are guidelines/helpful suggestions for things to consider during normal operation. Many of the items can be used/modified by you to include in your stepwise instructions in Section 4.B.

* Turn on the entryway laser in use warning light.
* Ensure laser warning sign at entry includes the laser type, wavelength, and OD for the laser(s) getting ready to be used. For labs with multiple wavelengths available, it is strongly recommended that the lab determine a way to communicate the current wavelength in use adjacent to the laser warning sign. This may be a small whiteboard that can be written on or a sign holder in which a paper indicating the wavelength in use can be easily swapped.
* Close the laser curtain at the entryway and/or place all necessary laser barriers in position.
* Prior to enabling emission of the beam, ensure all users in the laser-controlled area are wearing appropriate laser goggles or remove them from the lab.
* Ensure miscellaneous reflective objects are removed from the optical bench.
* Remove any watches, jewelry, objects in shirt pockets, or lanyards that are reflective.
* Place beam blocks/dumps at locations on the optical bench to prevent the beam from leaving the bench.
* Ensure laser warning sign at entry includes the laser type, wavelength, and OD for the laser(s) getting ready to be used. For labs with multiple wavelengths available, it is strongly recommended that the lab determine a way to communicate the current wavelength in use adjacent to the laser warning sign. This may be a small whiteboard that can be written on or a sign holder in which a paper indicating the wavelength in use can be easily swapped.
* Wear laser eye protection at all times during operation when line of sight to any part of the beam path is possible. Make sure that the OD is appropriate to the wavelength for the operation of the laser. Refer to the table in Section 5. Laser Eye Protection (LEP) for the correct operation eyewear.
* Ensure that the laser eyewear fits properly with no large gaps present between the lenses and the face.
* Ensure laser emission shutter is closed until beam is needed.
* Proceed with laser settings and steps to turn on the laser according to the manufacturer’s user manual.
* Acquire data.
* Turn off laser.
* Remove laser eyewear. Place it back in the eyewear storage location.
* Turn off laser in use warning light.

**Laser User/Trainer/Supervisor Review:**

**Operational Training Documentation**

This Laser Standard Operating Procedure has been written to aid with the safe setup/alignment and use of the laser setup that includes the identified lasers. Laser Supervisors and Laser Users must follow this procedure for each laser use.

Through the signatures below, the Laser Users attest that they have read and understand this procedure and have been trained on implementing its contents. The signing Trainer and Laser Supervisor attest that this operational training has been provided.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laser User Name (Printed) and Signature** | **Date** | **Trainer Name(Printed) andSignature** | **Date** | **Laser Supervisor Signature** | **Date** |
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1. **LASER SAFETY CONTACTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laser Supervisor:** |  | **Phone:** |  | **Mobile:** |  |
| **Primary Laser User:** |  | **Phone:** |  | **Mobile:** |  |
| **Laser Safety Officer:** | Gary Spichiger | **Phone:** | 404-894-8847 | **Mobile:** | 770-364-0824 |

1. **LASER DESCRIPTION(S)**

|  |
| --- |
| **Location** |
| **Department:** |  |
| **Building:** |  |
| **Room Number(s):** |  |

List all lasers used in this setup. If a given laser emits multiple wavelengths, list each wavelength on a separate line along with its corresponding specifications. Add rows as needed.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Laser Type*(Nd:YAG, Argon, etc.)*** | **Laser Model** | **Class(3B or 4)** | **Emission** | **Wavelength****(nm)** | **Max Average****Power or Energy/Pulse****(W or J)** | **Pulse****Duration****(sec)** | **Pulse****Frequency****(Hz)** |
|  |  |  | [ ] CW[ ] Pulsed |  |  |  |  |
|  |  |  | [ ] CW[ ] Pulsed |  |  |  |  |
|  |  |  | [ ] CW[ ] Pulsed |  |  |  |  |
|  |  |  | [ ] CW[ ] Pulsed |  |  |  |  |

Check the appropriate box and follow the listed instructions.

[ ]  The setup described in this SOP is permanent or semi-permanent. You must attach a diagram or diagrams showing laser location(s), emergency shutdown location(s) for Class 4 lasers, fire extinguisher(s) for Class 4 laser-controlled areas, laser eye protection storage locations, and barriers (laser curtains, bench top barriers, etc.). There may be benchtop barriers that need to be indicated for an alignment diagram that differ in location from the barriers indicated in the normal operation diagram. If applicable, indicate locations of doorway interlocks. You may also use labeled pictures of the setup as needed.

[ ]  The setup described in this SOP will be used on the order of a few days and will then be disassembled. Diagrams as described in the item above are encouraged but are OPTIONAL.

**LASER SAFETY PROGRAM**

Please refer to the Georgia Tech Laser Safety Policy Manual available at <http://ehs.gatech.edu/radiation/laser/documents> for the responsibilities of the Laser Supervisor and Laser User, a basic description of hazard control measures, warning sign requirements, laser safety training, and laser registration.

1. **BRIEF DESCRIPTION OF LASER SETUP**

Provide a brief abstract of the experiment, including its purpose/objectives

1. **SETUP/ALIGNMENT AND NORMAL OPERATING PROCEDURES**
2. Alignment/Setup
(List the sequential events that describe the setup and alignment of the laser beam path and optics. Include all safety steps including turning on warning lights, donning laser eye protection, use of alignment laser eyewear, use of beam visualization aids, beam output settings, placement of beam blocks, etc. The procedures shall be written for the benefit of a Laser User who must read and understand them to perform the operation safely.)
3. Normal Operation
(List the sequential events that describe normal operation of the setup. Include all safety steps including turning on warning lights, donning laser eye protection, beam output settings, etc. The procedures shall be written for the benefit of a Laser User who must read and understand them to perform the operation safely.)
4. Shutdown
(Describe the normal and emergency procedures for turning off the lasers in the setup.)
	1. Normal shutdown procedures
	(List proper sequence for safely powering down the laser)
	2. Emergency shutdown procedures
	(If any emergency occurs that requires the beam to be turned off immediately, turn off the laser at the location marked “Emergency Shutdown for Laser” or similar. Note: Only Class 4 lasers are required to have an emergency shutdown mechanism labeled. Also it is appropriate to have a shutter in place that simply blocks the beam at the emission port when an emergency stop button is pressed. Describe where and how to operate the emergency shutdown mechanism.)

| **Laser Hazard Control Measures** |
| --- |
| **Check if used** | **Control** | **Comments** |
| [ ]  | Entryway (door) interlocks |  |
| [ ]  | Laser protective housing interlocks |  |
| [ ]  | Emergency stop/panic button |  |
| [ ]  | Master switch (operated by key or computer password) |  |
| [ ]  | Beam stops/attenuators |  |
| [ ]  | Beam path enclosure (e.g., light pipe) |  |
| [ ]  | Protective barriers |  |
| [ ]  | Warning signs |  |
| [ ]  | Warning lights |  |
| [ ]  | Other (specify):  |  |

1. **PERSONAL PROTECTIVE EQUIPMENT**

**Laser Eye Protection (LEP)**

|  |
| --- |
| **wear this eyewear** |
| **Eyewear Manufacturer**  | **Protected****Wavelength(s)** | **Optical Density****(OD)** | **Used for(Alignment or Normal Operation)** | **Eyewear Description** |
|  |  |  |  |  |
|  |  |  |  |  |
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**Other Protective Equipment**

Describe other protective equipment used. This might include the use of lab coats, face shields, etc. for UV laser use.

1. **Non-Beam Hazards of this System (check all that apply)**

Check all non-beam hazards that apply and provide a brief description of the control measure(s) implemented to control the hazard.

[ ]  Chemical (dyes, solvents, etc.); also indicate lab storage location for the Safety Data Sheets (SDS)

[ ]  Electrical (high voltage, large current, capacitors, etc.)

[ ]  Laser Generated Air Contaminants

[ ]  Compressed gases or cryogenic liquids

[ ]  Fire/ignition source

[ ]  Plasma/blue light exposure

[ ]  Other (specify):

|  |
| --- |
| **Emergency Procedures** |

**Emergency Procedures**

1. Stop all work in the lab.
2. Shut down laser (if it is safe to do so).
3. **Fire or life-threatening medical emergency**
	1. Call the Georgia Tech Police.
4. **Non-life-threatening medical emergency**
	1. Includes severe injuries from beam exposure such as suspected or known eye exposure, vision loss, bleeding from the eye and burns to areas around the eyes or on the face
	2. Call the Georgia Tech Police or ask a co-worker/Laser Supervisor to transport you to a hospital ER. DO NOT go to an urgent care clinic for these types of injuries. The Grady Hospital ER is recommended.
5. **Non-emergency injuries**
	1. For guidance on where to seek treatment for non-emergency injuries, contact the Laser Safety Officer at 404-894-8847 or laser@ehs.gatech.edu.
6. Do not alter the laser setup. Analysis of the setup as it existed at the time of injury can help to find the cause of the accident and in the development of corrective actions to prevent a recurrence.
7. Call the Laser Supervisor and the Laser Safety Officer.
8. Visit <https://ehs.gatech.edu/general/occupational-injury> for accident and injury reporting requirements.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laser Supervisor:** |  | **Phone:** |  | **Mobile:** |  |
| **Primary Laser User:** |  | **Phone:** |  | **Mobile:** |  |
| **Laser Safety Officer:** | Gary Spichiger | **Phone:** | 404-894-8847 | **Mobile:** | 770-364-0824 |
| **Medical and Fire Emergencies:** | Georgia Tech Police | **Phone:** | **911 or 404-894-2500** |
| ***Note:*** *If 911 is dialed from a cell phone, immediately mention Georgia Tech and you will be transferred to the Georgia Tech Police. Dialing 911 from a campus phone will directly connect you with the Georgia Tech Police.* |

**NOTE:** Ensure that the Laser Supervisor and Primary Laser User listed above are also posted on an emergency contact posting located at the entry to the lab. Please use the EHS “Pink Card” available at <http://ehs.gatech.edu/chemical/lab-signage>**.**