Chapter 3: Procurement and Use of Laser Systems

ORDER, RECEIPT AND TRANSFER OF LASERS AND LASER EQUIPMENT

A. Ordering

Prior to placing an order the Principal Authorized Laser Operator must approve all requisitions for laser systems, lenses and other components. To order lasers and laser components, follow the steps below:

STEPS	PROCEDURE
1	Prepare a USC Requisition form (Form LSP_C.1, Appendix C). Describe the laser or part to be ordered. It must include: • Class and mode of operation • Type and wavelength • Maximum power and beam divergence • Safety features and protective equipment
2	Print or type the PALO's name.
3	After approval from the PALO send Laser/Laser component Requisition to the USC Purchasing Department.
4	Notify the Laser Safety Officer.

B. Receipt

When the laser or laser component is delivered to the lab, the following action will be taken**:**

1. The laboratory staff will check the laser for damage.
2. The serial number, class, type and power of the laser will be recorded on a Laser Usage form that will be prepared for each system. (Form LSP_C.3, Appendix C).
3. All safety devices and controls must be checked and recorded in the Laser Hazard Evaluation Form (Form LSP_C.1, Appendix C).
4. Corrective action will be taken if there is a discrepancy between what was ordered and what was received.

5. A copy of the Laser Hazard Evaluation Form shall be sent to the Laser Safety Officer.

C. Laser Hazard Evaluation Form

The Laser Hazard Evaluation Form must be prepared when receiving or manufacturing a new laser/laser component and must be saved with all pertinent information related to that system. This form must be readily available when a City/State inspector or personnel from Laboratory Safety requests it.

D. Laser Usage Form

All Authorized Laser Operators shall complete this form every time the system is used. This form should have complete information about the system itself, together with all appropriate safety features and safety requirements for that particular laser. A usage-log book would be a suitable alternative. ALOs must indicate:

- Date of operation
- Length of operation (start and stop time)
- Wavelength (only if variable)
- Power output (only if variable)
- Operator's initials

E. Transfers of Equipment

Transfers of laser systems or components to anyone, either on or off campus, are not permitted without prior written approval by the Principal Authorized Laser Operators involved.

The recipient of the laser system should prepare a new Laser Hazard Evaluation Form and send a copy of it to Laboratory Safety.

Laboratory Safety shall maintain records of each transfer/shipment. The recipient Principal Authorized Laser Operator is required to maintain records of the transfer.

ROUTINE LABORATORY PROCEDURES

A. Introduction

A set of written procedures is required for each laboratory or area where lasers are used. These procedures must describe specific rules applicable to those areas. Every person who works in these areas must know these rules and where they are kept.

The following general rules apply to all personnel who use or work around lasers and should be incorporated into each laboratory's written procedures.

B. Signs and Notices

In all areas where lasers are used, post the following signs and replace if defaced.

- "Caution" signs on all doors to laboratories and storage areas where class 2 and 3a lasers are used.
- "Warning" signs on all doors to laboratories and storage areas where class 3b and 4 lasers are used.
- "In Case of Laser Emergency" emergency posting.
- "Standard Operating and Emergency Procedures".
- Laser classification.
- No eating, drinking, and smoking sign.

C. Personnel Protection

For the health and safety of all operators it is imperative to follow the rules concerning laser safety. If any questions arise about the following procedures, Laboratory Safety should be contacted.

- As required by the Laser Hazard Evaluation Form, wear personal protective equipment such as laser safety goggles.
- Keep the laboratory neat and clean.
- Do not smoke, eat, drink or apply cosmetics in designated work areas.
- Do not wear reflective jewelry.

- Before operating a laser, let all lab personnel and people in the vicinity know.
- Isolate all lasers from areas where uninformed persons may be present.
- If appropriate, keep illumination levels in the lab as bright as possible to constrict pupils of laser users.
- Set beam path either above or below normal eye level (below 4.5ft or above 6.5ft).
- Use shields to reduce the chance of unwanted reflections; remove shiny surfaces.
- Cover windows with appropriate shades and covers.
- Maintain proper electrical installations.
- Never leave operating lasers unattended. If equipped with a keyed power switch, lasers should be turned off and keys removed when lasers are left unattended.
- Keep a housekeeping checklist in order to ensure that tools and other items are not left in or around beams.
- Secure and lock laboratory doors or storage areas when lasers are left unattended.

D. Non-Beam Hazards

Certain lasers have hazards associated with them other than beam radiation. Specific SOPs should be devised for these special hazards.

- Chemicals: some dyes and solvents from certain dye lasers are toxic or carcinogenic. These chemicals are found with liquid and chemical lasers, saturated Q-switches, Raman and Brilloun scattering cells, etc. Toxic gases or fumes may result from high-energy beams, which ionize the air or vaporize target materials. Use fume hoods to fill up containers. Always provide appropriate ventilation.

- Electrical Hazards: Electrical shock is a common hazard associated with lasers. Energy sources should be labeled, controlled and maintained.
- Explosion Hazards: While lasers are in operation explosions may occur at capacitor banks or optical pump systems.
- X-rays: High voltage power supply tubes ($\geq$15kV) may emit X-rays.
- UV radiation: Direct or reflected UV radiation from flash lamps or from continuous wave (cw) laser discharge may cause eye and skin injuries.

E. Beam Hazards

High-powered laser beams are capable of shattering glass and other vitrified objects when they are subjected to thermal stress. These types of objects, whether they are targets or components of the laser optical system, should be enclosed.

F. Surveys

Laser surveys and monitoring should be performed routinely in the authorized laboratory and the results should be recorded. (See section entitled "Guidelines for Laser Surveys", in this Chapter).

G. Medical Surveillance

Be familiar with and comply with the Medical Surveillance Program requirements. See "Guidelines for Medical Surveillance", Chapter 4.

H. Chemical Waste

Any toxic dyes or chemicals used in the operation of laser systems shall be stored and disposed of according to the Environmental Health and Safety Office's chemical waste guidelines.

For further information on hazardous waste disposal, call 0-7310 (UPC) or 2-2200 (HSC).

I. Incident Reporting

Notify the Laser Safety Officer and your supervisor ***immediately*** of all incidents involving:

- Eye or skin injuries resulting from laser beam exposure to personnel or the general public.
- Fires or burns occurring in non-experimental materials resulting from laser beams.
- Explosions resulting from laser equipment.
- Irritation or injury resulting from exposure to toxic dyes.
- Any suspected injuries, which may have resulted from laser operation.
- Loss or damage to equipment.

If the injury results in lost work time, also contact Workers Compensation. Contact information is available at http://srm.usc.edu/workerscomp/.

EMERGENCY PROCEDURES

A. Introduction

During the course of routine operations, injury, fire, explosions or mechanical failure may occur calling for emergency action. Correct action taken during such an emergency can prevent further damage and injury.

B. Written Instructions

A set of written procedures describing the specific steps to be taken in the event of an injury, fire, explosion or mechanical failure must be posted in a prominent location in each laboratory or area where lasers are stored and operated. These procedures must be established on an individual basis applicable to the particular area, according to the type and class of laser used and in addition to those posted by Laboratory Safety.

C. Laser Burns

1. **To the eye:** Excessive infrared exposure (1.4 to 1000 μm) causes a loss of transparency or produces surface irregularity in the cornea. Damage results from heating of the cornea by absorption of the incident energy by tears and tissue water in the cornea. Excessive ultraviolet exposure (0.2 to 0.4 μm) causes photophobia

accompanied by redness, tearing, conjunctival discharge and stromal haze. The action of the UV radiation is photochemical rather than thermal. A retinal lesion (0.4 to 1.4 μm) starts with the smallest ophthlamoscopically visible change in the retina (a small white patch - apparently coagulation), which occurs within 24 hours of the time of exposure.

2. **To the skin:** The biological significance of irradiation of the skin in the visible and infrared regions is considerably less than exposure to the eye, as skin damage is usually reversible or reparable. Effects may vary from a mild reddening (erythema) to blisters and charring. Depigmentation, ulceration and scarring of the skin, and damage to underlying organs, may occur from extremely high-powered laser radiation. No data is available describing reaction of skin to laser radiation in the 0.2 to 0.4 μm range.

GUIDELINES FOR LASER SURVEYS

A. Frequency of Survey

The Laser User Permit requires that Laboratory Safety review Laser Safety Operation Procedures every year in conjunction with the Principal Authorized Laser Operator.

B. Laser Performance Standard

During the laser survey, the posted classes should be checked to ensure proper classification.

- **Class 1** lasers would permit exposure whereby no biological damage is detected.
- **Class 2** lasers generally emit light that could cause damage after long-term exposure.
- **Class 3** lasers emit radiation, which may cause damage to tissue from one short, direct exposure.
- **Class 4** lasers may cause biological damage after indirect as well as direct exposure.

Hazards by Laser Classification

Class 1	Exempt	Presents no hazard
Class 2	≤1 mW	Do not present a hazard but may if viewed for extended periods of time
Class 3a	1 - 5 mW	Do not usually produce a hazard if viewed only momentarily, but may present a hazard if viewed using collecting optics
Class 3b	5 – 500 mW	Can produce a hazard if viewed directly and except for high power Class 3b, will not produce hazardous diffuse reflections
Class 4	≥500 mW	Can produce a hazard not only from direct or specular reflections, but from a diffuse reflection as well

C. Signs and Labels

Rooms, areas, and equipment where lasers are used or stored must be clearly marked with appropriately worded signs and labels describing the hazard. (See Appendix B for illustrations).

LOCATION	**SIGN OR LABEL**
SIGNS Placed on doors and in rooms or areas where laser systems are used or stored.	CAUTION for Class 2 Position 1 - laser radiation - do not stare into beam Position 2 - radiation output information Position 3 - class 2 laser product CAUTION for Class 3a Position 1 - laser radiation - do not stare into beam or view directly with optical instruments Position 2 - radiation output information Position 3 - class 3a laser product DANGER for Class 3b Position 1 - laser radiation - avoid direct exposure to beam Position 2 - radiation output information Position 3 - class 3b laser product DANGER for Class 4 Position 1 - laser radiation - avoid eye or skin exposure to direct scattered radiation Position 2 - radiation output information

	Position 3 - class 4 laser product
LABELS Labels are to be affixed to all laser classes	Same as above

Note:

- Warning labels are required for Class 2, 3a, 3b, and 4 lasers. Class 1 lasers **do not require** warning signs.