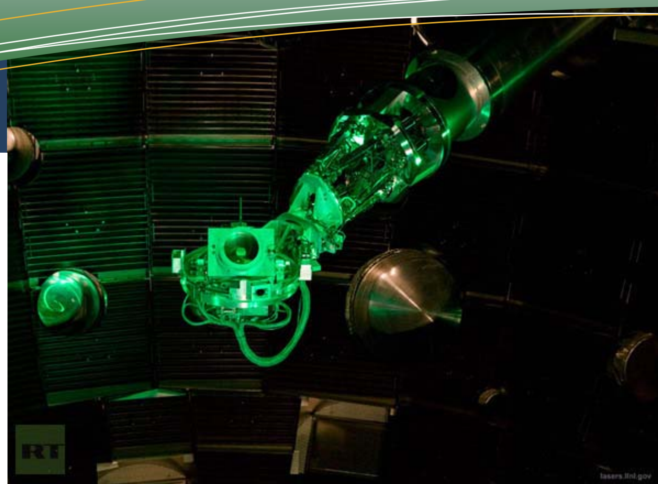
Volume 2
Issue 1

Laser Lessons News Letter



"Because UV lamps are not coherent/directional light sources, people do not treat them with as much respect as they do a laser. It may also be because they are generally not considered to be an acute hazard. Be very careful to protect yourself when working with high powered UV lights as you can attain very nasty erythema over a days-worth of work, and skin cancer over a lifetime."

Jamie J. King CLSO
Laser Safety Officer
Phone: 3-3077
King75@llnl.gov

Introduction

While we spend a considerable amount of time and resources trying to contain a laser beam, much less attention is paid to controlling non-beam related hazards. In certain situations, these hazards are a far greater risk to personnel than the beam itself.

This issue will discuss the non-beam related hazards that may exist with various laser operations.

Non-Beam Hazards

Electric Shock/Electrocution

This is the single greatest potential risk source for injury from a laser. The most common potential electrical problems noted are:

- uncovered electrical terminals
- improperly insulated terminals
- lack of CPR or refresher training
- not employing the "Buddy System"
- failure to properly discharge and ground capacitors
- improperly grounded equipment
- not utilizing Lock-Out Tag-Out (LOTO)

Capacitor Bank

Laser-Generated Air Contaminants

Laser Generated Air Contaminants (LGACs) are created when a high-powered laser interacts with matter. The ANSI Z136.1 states that "when the target irradiance reaches a threshold of approximately $10^7 W/cm^2$, target materials including plastics, composites, metals, and tissues, may liberate carcinogenic, toxic and noxious airborne contaminants."

If your laser operations involve or have the potential to create LGACs, this should be discussed with the Laser Safety Officer (LSO) and/or the Industrial Hygienist (IH) to ensure personnel are not exposed to potentially hazardous materials. Control measures can be employed to reduce the LGAC concentration to safe levels.

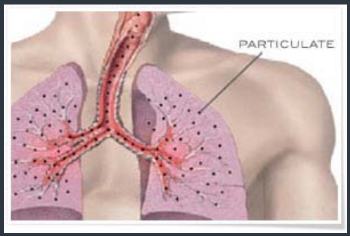
Laser Dyes and Solvents

Certain laser dyes are highly toxic and carcinogenic and special care must be taken when handling. Some laser dyes have been found to be mutagenic and particular solvents can cause absorption of the dyes through the skin directly into the bloodstream.

The Lambda Physik laser dye manual states, "In most cases the exact toxicity of laser dyes is not well known, but they should, like all chemicals, be considered dangerous until proven otherwise." All personnel should be intimately familiar with the material safety data sheet (MSDS) for each chemical that they are using and handle carefully, in designated areas, and with appropriate personal protective equipment (PPE).

Non-beam hazards:

Electrical



LGACs

Laser Dyes (and solvents)

Compressed Gasses

Explosive and Shock

Ionizing Radiation

Compressed Gasses

Inert compressed gasses like nitrogen and argon pose a serious concern for oxygen displacement and asphyxiation. There are also poisonous gasses used in some laser operations such as chlorine, fluorine, hydrogen chloride, and hydrogen fluoride that are immediately dangerous to life and health.

When using any compressed gas, ensure that this hazard has been evaluated and appropriately mitigated. This includes the use of gas cabinets, securing of portable tanks, and pressure safety to name a few.

Explosive Hazard

An explosive hazard potential is created from high-pressure arc lamps, filament lamps, and capacitor banks in laser systems. These should be enclosed in housings that will withstand pressures created by component disintegration.

Fire Hazards

Fire hazards are a potential with the use of high-powered lasers with irradiances exceeding 10W/cm^2 or beam powers exceeding 500mW. The use of flame retardant materials is highly encouraged. No protection should be expected from the primary or reflected beam of a high-powered laser when using cotton or black photographic cloth.

When using curtains, as a barrier material for high-powered laser beams, the curtains shall be rated for the wavelength and beam energies that you are using.

Laser Welding (Fire Hazard)

Other Non-beam Related Hazards

Other hazards include noise from pulsed lasers, ergonomics, and limited work space created in smaller laboratories. It is very important to pay attention to these other hazards related to laser operations and not get lost in the forest while concentrating on the tree, i.e. the laser.

Other Optical Sources

Like non-beam hazards, little or no thought is given to the many other potentially hazardous optical sources that are all around. We will go over some of the "not so obvious sources" that exist both in and out of the workplace, including; fiber optics, ultraviolet light (UV) sources, and laser pointers.

Fiber Optics

Fiber optic cables are used everywhere, from carrying Class 4 laser light in high power laser welders and cutters to Class 1 lasers transmitting this newsletter to your computer. In most cases, little thought is given to their potential dangers.

Laser radiation exiting fibers diverge very rapidly. Because of this, most believe that there is little to no danger past a few inches. As there are fiber optics that transport laser beams from several watts to kilowatts, these can potentially present a nominal ocular hazard distance (NOHD) of several meters and farther.

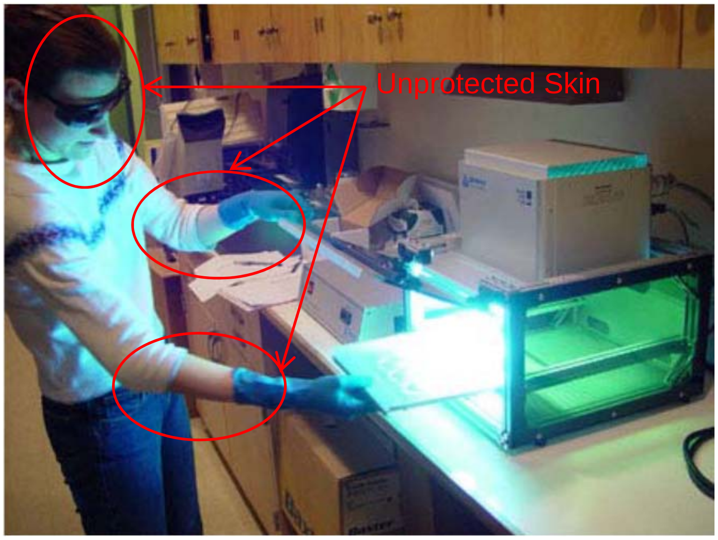
Micro-lenses can be attached to the fiber ends making their divergence literally the same as a laser. This can present an NOHD into the kilometers. Don't forget that with a laser of a watt or more you have a skin and fire hazard. Make sure that proper controls for these fiber ends are utilized.

In some of our fiber use areas we are confronted with a couple of challenges:

- Long fiber runs
- Racks requiring training for access

These can create areas that could be potentially hazardous if not well thought out. Below are seven rules of thumb to follow when dealing with fiber optics.

1. **Training:** Any person authorized to perform fiber optic work within racks at the NIF (B581) *shall* have completed NP0145-W "Fiber Optic Awareness." If you perform work in other areas, you may or may not need special



UV Oven

training. Check with your supervisor if unsure.

2. **Procedure:** Follow Authorized Work Procedures (IWS, Work Permit, etc.) when performing fiber optic work activities.
3. **Verify:** Treat every fiber as if it were live unless you have verified otherwise. You should never directly view the end of a fiber unless you know and understand the status of the opposite end.
4. **Viewers:** Viewing of fiber optics with direct viewers should only be performed when you have absolute control of both ends of the fiber (i.e., both ends in your immediate vicinity or LOTO). Viewing of any other fiber end should be performed using an indirect (electronic) viewer.
5. **Labeling:** As policy, only fibers with a nominal ocular hazard zone past the fiber end are required to be labeled. Non-hazardous communication and timing fibers are not labeled. Do not rely solely on the lack of labeling to protect you since labels can and do fall off. If you are unsure of the status, ask the fiber owner.
6. **Access:** There are some fiber optics that may present a significant potential hazard. Equipment racks, containing these fibers, require LOTO and/or Work Permits for entry. Follow any and all postings prior to accessing a fiber rack.
7. **Injury:** If you suspect that you may have been exposed through a fiber end, please follow the off-normal response procedure, report this to your Work Control Officer/Supervisor and seek immediate medical attention.

Fibers also present another significant hazard not optically related. They can act as a "sharp," especially when cleaving or if one breaks. The small broken pieces can attach to your fingers, and if you touch your eye you may require an ophthalmologist to have the piece(s) surgically removed. The same goes for pieces finding their way under your skin. Sometimes the only way to remove them is by a visit to the doctor's office.

Always remember to follow good practices when working with fibers. Use a dark cloth or paper when cleaving fibers and place all scrap pieces into a properly labeled sharps container.

Ultraviolet Radiation

Ultraviolet Radiation (UV) sources are utilized around the Lab in various ways. They are used in semiconductor manufacturing and research, bio/medical research, nondestructive testing, and in general laboratory research. The source is usually either lasers, lamps or LEDs. UV radiation is a chronic, rather than an acute hazard. The effects from exposure are cumulative and show up over an extended period of time.

The susceptible organs are the skin, lens, and the corneal surface of the eyes. It is very important to wear proper PPE when working with these sources. You should also be aware that certain cosmetics and prescription drugs can dramatically increase the biological effects caused by UV radiation sources.

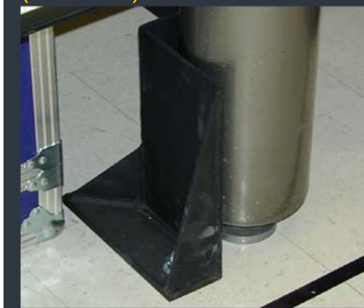
Because UV lamps are not coherent/directional light sources, people do not treat them with as much respect as they do a laser. It may also be because they are generally not considered to be an acute hazard. Be very careful to protect yourself when working with high powered UV lights as you can attain very nasty erythema over a days-worth of work, and skin cancer over a lifetime.

Laser Pointers

Why discuss laser pointers along with "other optical sources?" Laser Pointers can be found just about anywhere and though they are a laser device, they are often treated quite simply as toys. A laser pointer, intended to be used for presentations, is designed to certain specifications. It is compact, usually shaped like a pen, has <5mW output in the visible spectrum (Class 3a/3R), and has a "dead-man" switch. This means that the laser is only on when the on/off button is depressed.

Because of the low cost and difficulty in controlling the importation of these devices, for a

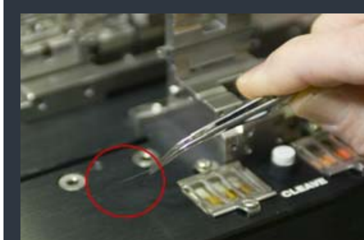
Non-beam hazards:
(continued)



Seismic

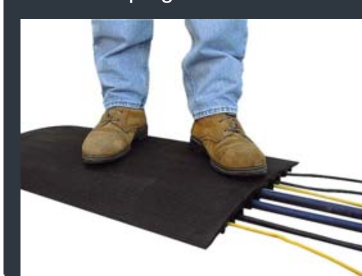
Cable Management

Magnetic Fields



Sharps

Housekeeping



Slips, Trips, Falls

little more than $10 you can purchase a Class 3B (50mW) laser advertised as a "laser pointer". Even laser pointers that are designed and manufactured as Class 3a/3R devices are being sold with visible outputs far exceeding the <5mW requirement.

Josh Hadler of the National Institute of Standards and Technology (NIST) presented a paper at the International Laser Safety Conference (ILSC) this past March, "Random testing reveals excessive power in commercial laser pointers." He tested 122 randomly selected commercial laser pointers. Nearly 90% of the green pointers and about 44% of the red pointers exceeded the output limitations established by the Code of Federal Regulations. It was also discovered that about 75% of those tested had infrared (IR) outputs that exceeded the allowed 2mW. This is because they were missing a simple and inexpensive IR blocker. This filter is meant to block out the 808nm pump light and the 1064 primary wavelength.

Laser Illumination of Cockpit

Should we panic and stop using all laser pointers? When comparing reported eye injuries related to the number of laser pointers in use, the statistics say no. When laser pointers are used as intended and not as a "toy," there is no potential for harm. Please see the related Safety News Flash on Laser Pointer Safety issued May 11, 2012 for more information. If you have a pointer or notice one in use that has a spot difficult to look at, contact your laser safety officer. The output can be measured to ensure that you have a compliant device.

Remember that laser pointers should be used as they are intended with a little common sense. Never point them at anyone and never direct them across your audience (from back of room). It is also important to remember that the human eye is more receptive to green than red, so the green laser pointers can present an even greater startle hazard than the same power output of red ones.

Use the following guidelines when purchasing or using laser pointers:

- Class 2 diode laser pointers are available and should be used instead of Class 3a/3R laser pointers whenever practical.
- ***Never*** purchase or use a Class 3b laser pointer. They are not authorized for use in any conference room at LLNL.
- Never purchase a laser pointer unless it has the FDA mandated CAUTION or DANGER safety warning label.

If you have a laser pointer or other laser "hand-held" device and you decide to take it outside and point it up into the night sky, remember that it is a federal offense (monetary fine and incarceration) to point a laser at any aircraft. A day doesn't go by where there is not a report of an aircraft being struck by a laser beam. Nearly every single one of these events results in the individual being criminally charged. In the State of California, one can be charged with a felony for maliciously directing a laser pointer at a person.

International Laser Safety Conference

The International Laser Safety Conference was held in Orlando, Florida from March 18-21. Besides the previously discussed talk on laser pointers, several DOE contractor site presentations were given:

- Jamie King, LLNL, presented "Is it time for a Class 5 Laser?" This paper discussed the possible need for a higher laser classification due to the mass proliferation of high energy and high average power lasers with a potential for injury beyond a simple skin burn or retinal lesion.
- Mike Woods, SLAC, presented two papers, "Performance Metrics for Safe Laser Operations at SLAC National Accelerator Laboratory;" and "UV Laser Radiation: Skin Hazards and Skin Protection Controls." The first discussed the two types of surveys that are conducted at SLAC to assess the Lab's laser safety program and practices. The second discussed the potential for hazardous skin exposures to ultraviolet radiation and provided guidance and safety controls to protect the skin.
- Tekla Staley, INL, presented "Lessons Learned from a Laser Injury Event." This presentation discussed a laser accident that occurred on August 30, 2011. The accident occurred while the laser was believed to be in a "safe mode." Results of the investigation showed weaknesses ranging from training to safety professionals' understanding of complex systems and reliance on maintenance technicians' training and experience to conduct an effective hazard analysis. This lesson learned was covered in this newsletter Volume 1, Issue 2.
- Joanna Casson and Connon Odom, LANL, presented "Historical Review of Laser Safety Accidents: Common Themes and Lessons Learned." This was a workshop where the first part discussed the number of laser incidents and accidents within the DOE laboratories before and after the DOE Special Operations Report (SOR). It also discussed the improvements made to DOE Laser Safety Programs after the SOR was published. The second part provided a historical review of incidents and accidents found in the Rockwell Laser Industries Accident/Incident Database.

BE SAFE!