Volume 1
Issue 4

Laser Lessons News Letter

This issue

"In order for the glasses to provide you with the proper protection, they must fit your face. Newer eyewear has the capability to be adjusted in many different ways, allowing a fit for all shapes and sizes of faces. Adjust the frame so the lens fits in a manner to be flush against the face. If you can see through gaps around your face and filter or frame, YOU ARE NOT FULLY PROTECTED!"

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Introduction

Welcome to the fourth and final edition for the first year of our quarterly Laser Safety Newsletter. As we are in the holiday season, it is ever so important that we remain vigilant, keep your eye on the ball, and keep safety first and foremost in our everyday work.

This issue will cover a couple of items on the radar recently that demand our attention: laser eyewear and work control.

Laser Eyewear

No matter how many controls we employ to protect us from beam hazards, there is always a situation or circumstance where a potential for exposure may exist. These situations necessitate the use of Laser Protective Eyewear (LPE) as the last line of defense.

As anyone who has worked with lasers for the past 15-20 years knows, this isn't your grandfather's or even father's LPE we are talking about. LPE has come a long way from the thick, heavy, and uncomfortably visionless glasses and goggles to the sleek, stylish, lightweight and "enlightening" eyewear of today. One thing that has remained the same is that LPE is designed to provide protection, i.e. Optical Density (OD), for the user from specified wavelengths.

Figure 1. LPE through the years

This can be accomplished in two ways, absorption and reflection. Most of the eyewear that we use utilizes the absorption method. This is accomplished by mixing dyes into polymeric or glass materials. The laser radiation is absorbed into the dye. The protective capability is dependent on the mixture of the dye and the thickness of the material. For reflective protection, a dielectric coating is applied to the lens. These two methods can be incorporated together to provide protection for multiple wavelengths.

How do you know which eyewear is correct for your specific activity? This can be found in several places. The Integrated Work Sheet (IWS), Work Permit, Laser Danger Sign, and even the Safe Plan of Action (SPA) should indicate the correct LPE to wear.

Each IWS has a Lasers Table attached listing all of the lasers "authorized" for use under that IWS. The Laser Safety Officer is responsible for calculating the OD required and compiling this information into the Lasers Table. The Laser Table is the pedigree from which all other documents listing required LPE is derived.

Laser Danger signs will list all of the "potential" wavelengths that may be present within the laboratory or space. This does not mean that all of the wavelengths are present at any one time. To determine which wavelengths are in use, consult the Work

From Start to Finish:

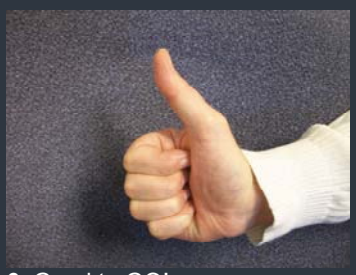
1. Check entry requirements

2. Verify Optical Density

3. Verify impact rating

4. Check physical integrity

5. Verify proper fit



6. Good to GO!

Figure 2. Prescription Inserts

Permit, SPA, Daily Work Team Leader (DWTL) or the Responsible Individual (RI).

Prior to using LPE, it is important to verify adequacy and functionality by performing a physical inspection of the eyewear. This is a task that is often overlooked the longer the eyewear is in service. In taking responsibility for your own safety, it is something not to be skipped.

When you pick up a pair of laser glasses, you will want to first make sure that it covers the wavelength that you will be using. In verifying adequacy, it is important to ensure that the LPE you intend to use is correct for the task at hand. After determining the required OD for the wavelength(s) in use, you should verify that the LPE you intend to use meets the required OD.

In many areas of laser operations there is also the potential for projectile hazards that will require the use of impact resistant glasses. If you have this requirement, verify that your glasses have the ANSI Z87 markings.

Next, perform a physical inspection. Check the frame integrity and also check the lenses. Are the frames and lenses solid and intact? Most of the eyewear we use has a lifetime warranty on the frames. If your frames are damaged or broken, report this to your LSO/DLSO and they may be replaced free of charge.

The lenses should be free of deep scratches, cracks, breaks, and discoloration. This is important because the thickness of the lens directly plays into the ability to provide the proper OD. For coated lenses, any scratch in the material means that there is no protection at that point. Make sure that the eyewear does not show any sign that it has been exposed to laser radiation. Any laser eyewear that shows degradation due to a laser exposure SHALL be removed from service.

One issue with laser eyewear is that it is generally considered "Community PPE". That is, the same pair is used by many different people. This is not the case as with most PPE, so there is a greater need to inspect prior to use.

If using "Community LPE", one thing that you will notice immediately is cleanliness/ hygiene. Are the glasses clean? In most cases, the answer is unfortunately NO. It is a requirement that all PPE be kept clean and sterilized prior to use. Chapter 11.1 Personal Protective Equipment, Section 2.4.2 Shared Equipment states, *"The RI for locations or groups where PPE is frequently shared shall ensure that the shared equipment is properly used, stored, cleaned, and maintained."*

There should be material kept with the glasses to ensure that this is completed and the eyewear is kept clean. At a minimum, it is good practice to have a supply of lens wipes with the glasses.

One of the most commonly noted complaints about LPE is that it is uncomfortable. This is especially true for individuals wearing prescription glasses. Wearing goggles over glasses for an extended period of time can be difficult at best. This is no longer a problem as there are frames that will accommodate those with prescription eyewear (See Figure 2).

There are several different types of LPE frames available to you and the Laser Safety Officer has a selection of different models that you may want to try on to see which best suits your needs (See Figure 3).

In order for the glasses to provide you with the proper protection, they must fit your

Figure 3. Laser Safety Officer LPE Samples

face. Newer eyewear has the capability to be adjusted in many different ways, allowing a fit for all shapes and sizes of faces. Adjust the frame so the lens fits in a manner to be flush against the face. If you can see through gaps around your face and filter or frame, YOU ARE NOT FULLY PROTECTED!

Absorptive vs. Reflective

As discussed previously, the two methods used in LPE rely on absorptive or reflective material. Each has advantages and disadvantages. Both will be discussed here.

The absorptive method is the most commonly used filter in LPE. The positives are:

1. Inexpensive.
2. Can easily cover a large band of wavelengths.
3. Glass filters for IR protection are relatively clear.
4. Polycarbonate filters are lightweight and can be shaped into many styles.
5. Polycarbonate provides excellent impact resistance.

The negatives are:

1. Glass filters are fairly heavy, limited in shape, and impact resistant.
2. Higher OD means darker filter (lower visible light transmittance).

Visible light transmittance (VLT) is important because this is the amount of light that is transmitted through the filter. The higher the VLT means the more that you can see. The more that you can see means the safer that you can do your work.

The reflective method for LPE is used in situations where a high VLT is required, such as detailed inspections.

The positives are:

1. Light weight in certain applications.
2. Very good VLT.
3. Multi-wavelength applications when combined with absorptive glass.

Figure 4. Reflective Eyewear

The negatives are:

1. Very expensive when compared to absorptive LPE.
2. Limited in shapes.
3. Angle sensitive.
4. Dielectric coating is microns thick. A scratch removes protection.
5. Filter is limited in wavelength band

As you can see, depending on your specific application, one filter method, or even a combination of both, may be best for you. If you would like to review options available for your specific application, work with your Laser Safety Officer.

Incident #1

A worker, at a DOE Lab, was using a pair of dielectric coated (reflective) eyewear and viewed diffusely scattered 527nm laser light through the filter media. This specific model utilized a "notched" filter designed for OD7+@532nm. The spectral data sheet from the manufacturer indicated the OD@527nm is 3.1.

The worker stopped work and borrowed a similar pair of glasses from a co-worker. They could no longer see the scattered "green" light. The defective eyewear was taken out of service. No exposure to the worker was received from this event.

A quick check, using a laser pointer, was performed and it was discovered that there was a problem with a couple of centimeters in the center of both lenses. A transmittance check was performed and it was found that at the center of each lens, the OD was only 1.5@532nm.

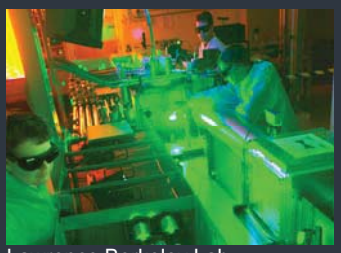
This event just recently occurred, so the investigation is still not complete. One big question to be answered is, was the dielectric coating indeed defective, or was it badly worn from improper use or storage? Stay tuned…

One of the negatives mentioned concerning reflective eyewear is that it is angle sensitive. These filters are rated for an incident beam striking perpendicular to the media up to an angle of about 30 degrees off axis. As the angle of incidence increases, the beam undergoes a shift in wavelength moving it away from the "notched" protected wavelength. Simply put, you are not getting full protection and laser light may pass through the filter into your eye.

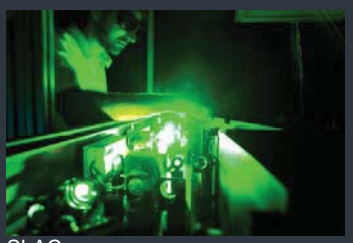
Also, if using a reflective "notched" filter that is rated for 532nm, it may not provide protection for a 527nm laser. Verify applicability either with the manufacturer or your Laser Safety Officer.

BE SAFE!

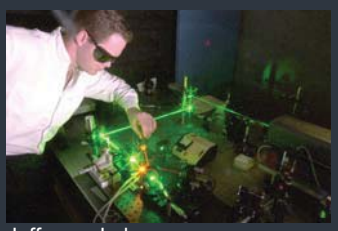
Note Similarities?



Lawrence Berkeley Lab



SLAC



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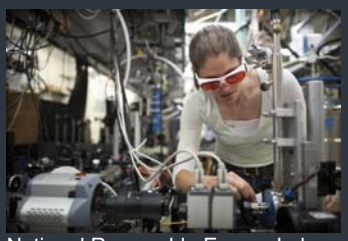
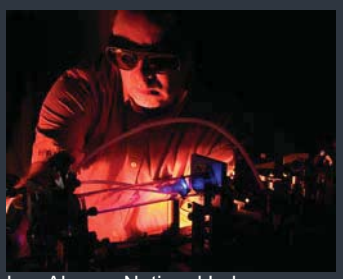


National Renewable Energy Lab



Los Alamos National Lab

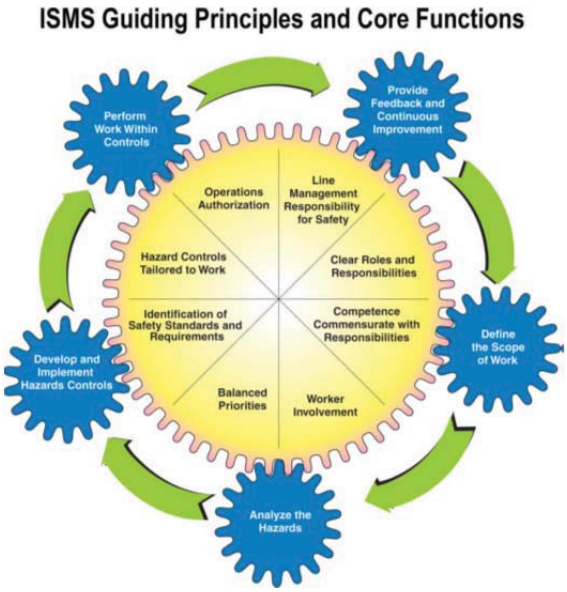
Lawrence Livermore National Lab

World Class Safety is NO Accident!

Work Control

Work Control is the single most important aspect of your job, including performing it safely. Work control defines the: what, where, when, and how you do your work. It is a standardized process by which we can ensure both our and our co-worker's safety. It also ensures safety to our infrastructure and the environment. This is very important because, as stewards of the Laboratory, we are accountable on many different levels. From the local community to the nation as a whole, what we do in our day-to-day business is under constant scrutiny. With this, the most important asset we have is our reputation. Gaining reputation as a World Class R&D Laboratory takes many years to attain, but on the flipside, can be destroyed in a fairly short amount of time.

We use the Integrated Systems Management System (ISMS) as a formalized work control process. There are five core functions to our ISMS process:



1. **Define Work**-This is where your scope of work is conceived. What will you be doing? Where will you be performing the work? What is the time-frame? What types of lasers will you be using? The specifications of each laser will be rolled into the Lasers Table so the hazard analysis can be performed.
2. **Analyze Hazard**- This is where your LSO will calculate the hazards from each laser, look at the limitations of the environment in which you wish to work, and look at the workers accessing the area. From this, the level of controls will be developed.
3. **Develop and Implement Hazards Control**- This is the point where a decision between implementing an Engineered or Administrative Control will be made. Also the choice of LPE can be made depending on how the laser hazards are controlled. Once all of this is in place, and a pre-startup review is completed, you are then ready to go to work.
4. **Perform Work**- Both Approval and Authorization must be completed before beginning the actual work. In doing the task, you will gain knowledge of how to do it better. This information is then provided for continuous improvement.
5. **Provide Feedback and Improvement**- This is where lessons learned and process improvement is used to make the task both safer and more efficient. If you determine that you need additional tools, i.e. different laser, or a significantly modified beam path, you should consult your LSO to determine if changes need to be made to your Work Control documents and if additional approval is required.

Documentation is critical in Work Control. Forms of documentation we use range from our Integrate Work Sheet (IWS) to Laser Alignment Procedures and Laser Tables to Safe Plan of Action (SPA) and Work Permits. Review your Work Control Documents and make sure that what you are doing is actually reflected in your authorized documents.

Incident #2

Recently there were two events dealing with procedural (administrative) control of lasers, specifically related to the Lasers Table. The Lasers Table is a quasi-laser inventory for each laser related Integrated Work Sheet (IWS). It contains important safety information, including the LPE OD that may be required for each laser used. It is included as part of the attachments to an IWS.

In one instance, two lasers were found in an operational mode by the Laser Safety Officer (LSO), but were not included on the IWS's Lasers Table. These lasers were of "like kind" currently in use where the output optical specifications were near that of other lasers in the lab. No previous approval had been given to allow the operation of these lasers. A hazard analysis was performed and the LPE in use was found to have adequate OD protection for the new lasers.

In the second instance, a Deputy Laser Safety Officer (DLSO) was performing the annual audit of laser operations and found that the Lasers Table attached to the IWS was not accurate for that IWS. The DLSO paused work while an investigation was conducted to determine what had happened to the misplaced Lasers Table. The DLSO, working with the RI, created a new table and attached it to the IWS. Because this was a static and mature operation, the controls and LPE were found to be correct for the operation.

In both of the events described above, we had a breakdown in our work control process. The IWS and all attached documents are a contract between the Responsible Individual and Lab Management to perform work safely. It is paramount that all workers understand the hazards related to their work and the controls that must be implemented in order to perform the work safely.

BE SAFE!