Introduction to Fiber Optic Safety

Written by Larry Johnson and Glenn Rosin

In today’s workplace, the issue of job safety has never been more important to the success of an organization. Litigation, lost productivity and human costs can take an enormous toll if safety is not considered as “Job 1.”

Each year, approximately 6,000 employees in the US die from workplace injuries while another 50,000 die from illnesses caused by exposure to workplace hazards. In addition, 6 million workers suffer non-fatal workplace injuries at an annual cost to U.S. businesses of more than 125 billion dollars.

“Safety culture” is a term used to describe the way in which safety is managed in the workplace, and often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety. Unfortunately, worker overconfidence is often a potential safety problem.

When strong health and safety practices become part of the operational fabric of the organization, everyone wins. Although a positive safety culture begins at the top, it is still up to individual workers to obey all safety standards and practices and go beyond ‘the call of duty’ to identify unsafe conditions or behaviors.

In this introductory article we will address one of the basics safety concerns that fiber optic professionals can be exposed to, the power of lasers.

**Laser Safety**

Most fiber optic systems today use laser transmitters and the optical signals carried by the fibers can also pose eye hazards to the unwary. Even short distance multimode systems, which in the past used LEDs, have now migrated to low cost Vertical Cavity Surface Emitting Laser sources. For this reason, all cables must be handled as if they are carrying a laser signal unless it has been verified by an optical instrument that no laser energy exists.

It is the responsibility of the manufacturer to provide the correct classification of a laser, and to equip the product with appropriate warning labels and safety measures as prescribed by regulations.

In the United States, lasers are regulated by the Center for Devices and Radiological Health (CDRH). A branch of the FDA, the CDRH is responsible for overseeing the manufacturing, importation, performance and safety of all medical devices as well as devices that emit certain types of electromagnetic radiation, including cell phones, microwave ovens and lasers. With lasers, the CDRH is concerned that the devices are properly labeled as to their output power and are equipped with the appropriate safety equipment if necessary.
Safety measures used with the more powerful lasers include key-controlled operation, warning lights to indicate laser light emission, a beam stop or attenuator, and an electrical contact that the user can connect to an emergency stop or interlock.

A number of organizations have developed standards and guidelines for safely working with optical fiber, cables and optical transmission equipment. These include the ANSI Z136.2 American National Standard for the Safe use of Fiber optic and Free Space Optical Communication Systems Utilizing Laser Diode and LED Sources and the OSHA standard on laser safety STD-01-05-001. Another standard issued by the International Telecommunications Union is the ITU-T G.664 recommendation, which covers optical safety procedures and requirements for optical transport systems critical for DWDM and other high powered systems.

For construction, the Telcordia SR1421 Blue Book is a detailed manual of construction procedures which also contains numerous safety references for all types of physical plant construction. The ANSI Z117.1 standard covers safety requirements for confined spaces, and its provisions must be strictly adhered to when working in vaults, manholes or any other type of confined space.

Whereas the construction hazards of a fiber optic transmission system are temporary, the potential optical hazards will exist throughout the entire working lifetime of the system, and will affect not only the installation personnel, but future maintenance technicians and even end-users as well.

For the lasers used in fiber optic communication systems and test equipment the ANSI Z136.2 standard divides laser devices into a set of 4 general classes and several sub-classes based on their wavelength and optical power output. The first version of the standard was published in 1988 at a time when laser-based fiber optic communications systems were very simple. They used only two wavelengths, 1310 and 1550 nanometers, at maximum power levels well under 10 milliwatts. The standard was the first written specifically for fiber optic communications systems.

However through the 1990’s, laser and fiber optic technology developed rapidly. Erbium Doped Fiber Amplifiers (EDFA) along with Dense Wavelength Division Multiplexing (DWDM) installations and the use of high-density ribbon fibers began to fundamentally change the optical communication landscape. Higher laser powers at more wavelengths prompted the ANSI to revise the standard in 1997.

In today’s DWDM systems, it is not uncommon to find optical power levels in individual fibers exceeding several watts. High-density fiber ribbon structures are also common in fiber optic cables, with each fiber carrying high levels of laser energy.

These advancements have allowed modern optical communication systems to pose hazards significantly greater than in the past. This is why standards must continually evolve to meet current needs. In 2007, the IEC featured a re-organization of the laser classification system,
where a number of sub-classes have been added to better define the hazards posed by laser devices. This was further updated using the optical fiber communication systems.

Briefly, a Class 1 laser system is considered to be incapable of producing damaging radiation levels during operation, and is exempt from any control measures or other forms of surveillance.

A Class 1M laser is incapable of producing hazardous exposure conditions during normal operation unless the beam is directly viewed through an optical instrument such as an eye loupe or a fiber inspection scope. For this reason, the “M” stands for Magnifying Optics Caution. Class 1M lasers are also exempt from control measures other than to prevent direct viewing of the beam through optical instruments. Most fiber optic lasers are class 1 types.

Class 2 lasers emit in the visible part of the spectrum between 400 and 700 nanometers. Eye protection is generally provided by a person’s natural aversion response to bright lights. A common product is the 1 milliwatt red laser tracers used by technicians for troubleshooting.

Class 2M lasers emit in the visible part of the spectrum, and also rely on aversion responses for eye protection, but can be hazardous if viewed through optical instruments.

Class 3, or medium power lasers, is divided to two sub-classes 3R and 3B. While the “B” has no special meaning other than a means of dividing Class 3 lasers, the “R” stands for Reduced Requirements. Class 3R lasers have reduced product safety requirements and represent a transitional zone between safe and hazardous laser products. A Class 3 laser may be hazardous when directly viewed, and its specular reflection off a shiny surface may also be hazardous. The higher power 5 mW red lasers are class 3 types as are most EDFAs.

Class 4 lasers are high power lasers whose output is a hazard to eyes or skin from the direct beam, specular reflections, and in some cases even diffuse reflections. Class 4 lasers often have sufficient optical power to be a fire hazard as well. A few of the higher optically amplified fiber systems using Raman and EDFA amplifiers can be rated as class 4 types.

The classifications relate specifically to the laser itself and its potential hazard, based on operating characteristics. However, the conditions under which the laser is used, the level of safety training of the individuals using the laser, as well as environmental and other factors are important considerations in determining specific safety control measures.

These situations require the informed judgment of a responsible person, namely the Laser Safety Officer (LSO) who has the authority and the responsibility to monitor and enforce the control of...
laser hazards and effect the knowledgeable evaluation of Class 3 and Class 4 hazards. An LSO is required when the employees of an installation or maintenance organization routinely encounter optical power levels of Class 3B or Class 4.

Today, most optical signals are laser based; with low power and low speed LEDs now used only in the simplest and shortest links. Fiber systems that use LEDs emit non-coherent energy at wavelengths longer than 700 nanometers at power levels considerably less than laser diodes. Since the potential risk of eye injury is determined by the output characteristics of the optical fiber system including power, coherence-time, wavelength and beam divergence, it is less for an LED than a laser. However, for the purpose of uniformity, all control measures commensurate with a specific hazard level apply to laser diode and LED systems.

**Conclusion**

This article deals with only one of many important safety topics related to fiber optics. In subsequent articles we will be touching on other concerns, including: Optical fiber handling and safety, Chemicals and right-to-know documentation, Safety practices during installation and restoration, Safety in confined spaces, and Types of personal protective equipment.

All these topics and several more are covered in the Light Brigades latest Staff Training Video, “Fiber Optic Safety”, part number W-6D-221, which is available from the Light Brigade at [www.lightbrigade.com](http://www.lightbrigade.com).

**About the authors**

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