Safety Lesson Plan:

FTTP and LASER Safety

Summary

LASERs are used in an amazing range of products and technologies. Today, LASERs are used in practically every field - from medicine to manufacturing to telecommunications - and are even given cameos in Hollywood movies such as Austin Powers and Star Wars. You will find them in many products including CD players, dental drills, LASER pointers, distance measuring systems, and high-speed metal cutting machines. LASERS are being used to produce artwork such as fine wood carvings, etched glass and 3D images inside plastic cubes. In order to work with various products these LASERs vary in size and intensity. But what is a LASER and how is a LASER beam different from the beam of a flashlight? This lesson plan will provide an introduction and information needed to understand the risks associated with LASERs used in telecommunications.

What is a LASER?

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. A LASER is a device that controls the way that an energized atom (small particles of matter) releases photons (light energy). These emitted photons have a very specific wavelength (color). The type of radiation emitted is the same as light energy and does not cause ionization of matter like nuclear energy.

Types of LASERs

There are various types of LASERs. The LASER medium can be a solid, gas, liquid or semiconductor. LASERs are commonly designated by the type of material used to generate the beam. Listed below are some examples of various types of LASERs

- Semiconductor LASERs - Sometimes called diode LASERs. These are generally very small and use low power and are commonly referred to as Light Emitting Diodes or “LEDs”. The color depends on the type of diode used, and they may be built into larger arrays, such as the writing source in some LASER printers. This type of LASER is commonly used in CD players to reproduce digital music and in the slide presentation pointers. These are the LASERS used in Optical Fiber Communication Systems (OFCS) and are invisible since they are in the infrared range.
- Gas LASERs - Have a primary output of visible red light. CO_2 LASERs emit energy in the far-infrared range, and are used for cutting hard materials.

- Excimer LASERs - Produces light in the ultraviolet range. These LASERs are used for research and many medical procedures such as corrective optical surgery.
- Dye LASERs - Use complex organic dyes in liquid solution or suspension as lasing media. They are tunable over a broad range of wavelengths. These LASERs are used for specialized experimental, medical and research projects.

LASER Classification (American National Standards Institute – ANSI)

LASERs are classified into four broad areas depending on the potential for causing injury (tissue burns). When you see a LASER, it should be labeled with one of these four class designations:

- **Class 1** – Considered to be incapable of producing hazardous radiation levels during normal operation and maintenance, and is exempt from any control measure or other forms of surveillance.
- **Class 1A.** – This is a special designation that applies only to LASERs that are "not intended for viewing," such as a supermarket laser scanner.
- **Class 2** – (low power) These are low-power visible lasers that emit above Class I levels. Visible LASERs, which may be viewed directly only under carefully controlled exposure conditions.
- **Class 3A and 3B-**(medium power) Requires control measures to prevent exposure to the direct beam. This is a LASER that can emit dangerous optical radiation levels and cause eye damage when one looks at the output directly or with an optical instrument, such as a microscope, magnifying glass or eye loupe.
    - **Class 3a** – These are intermediate-power LASERs. Most pen-like pointing LASERs are in this class. Power level ranges from 0.01dBm (decibels per mill watt) to 7 dBM.
    - **Class 3b** – These are moderate-power LASERs. Power level ranges from 7dBm to 27 dBm.
- **Class 4**- (high power) Requires the use of controls, which prevent exposure to the eye and skin from the direct, secularly reflected, or diffusely reflected beam.

Characteristics of a LASER

A LASER is a fine point of light that has high intensity. A LASER beam does not spread, so the power remains in a small spot for significant distances. This is evident when using a low power LASER pointer to highlight a presentation projected many feet away. For higher power LASERs, this creates a potential hazard by concentrating significant energy in a very small area. When this high-power point of light comes in contact with the skin or eye tissue, this may cause heating. The extent of tissue injury from LASER exposure is determined by the intensity, duration and beam size. Depending on intensity, a LASER focused on a specific point for a sufficient duration may cause a tissue burn.

- **3 Characteristics of a LASER**

- LASER light contains one specific wavelength (color) of light. Some are visible and some are not, depending on the wavelength. Infrared and ultraviolet LASERS are not visible.
- The light beam created is coherent-meaning that unlike a flashlight that is dispersed randomly, LASER emissions are organized.
- LASER light has a tight beam that is projected in one direction versus a light bulb which emits light in many directions.

LASER Safety and the Eye

A concern associated with LASERs, is potential injury to our eyes. The major risk of LASER light is from the beam entering the eye and focusing on the retina. A retinal burn can occur when a sufficiently powerful LASER beam focuses on the retina for a significant duration. Depending on the power level and other characteristics, such as how much the LASER beam has spread apart (divergence), this injury can occur in less than a second or in several minutes.

An example of how a LASER beam may injure the eye would be to use the analogy between a magnifying glass and the eye. The magnifying glass, like the lens of our eye, focuses light into a point. A magnifying glass can be used to focus sunlight onto a piece of paper or wood and cause it to burn. The lens of the eye will do the same thing if you view the sun directly. The intense light from a LASER would be focused in much the same way and could cause a retinal burn. The energy of a laser beam can be intensified up to 100,000 times by the focusing action of the eye. Even a low power laser in the milliwatt range has the potential to cause a burn if focused directly onto the retina. For this reason, directly viewing a LASER through a magnifying lens will increase the risk of a retinal burn.

In some situations the eye has a self defense mechanism, the blink or aversion response. When a bright light hits the eye we tend to blink or turn away from the light source (aversion). This may protect the eye from injury where very lower power lasers are involved but may not help with a higher power LASER. By the time the eye reacts, the damage is already done. In addition, some LASERs such as the type used in optical fiber communications systems are invisible since they are infrared, so the aversion reaction will not occur.

The very small diameter of an optical fiber makes it difficult to direct the beam into the eye. The unpolished or fractured end of an optical fiber also reduces the risk, since the beam will not be focused and will spread in many directions. Nonetheless you must be careful to prevent such an occurrence. Resist the temptation to view the end of the fiber directly or through a magnifying lens. The fiber can be viewed safely through a fiber scope while fusion splicing, since this is an indirect image.

Never look directly into a fiber end, a LASER source or point a LASER in your eyes or at others!

Precautions/Labels

Labels are required, as shown below, on the exterior surface of all class 2, 3, and 4 LASERS warning against viewing the beam with any type of optical instrument and warning against direct exposure to the beam.

Class 3a

Class 3b

Lasers and Optical Fiber Communications Systems (OFCS)

By the very nature of the fiber-optic cable, the optical radiation is confined to the cable core and therefore poses no hazard to the user. Thus, under normal operating conditions, the Optical Fiber Communications System (OFCS) is inherently a Class 1 LASER. However, when the OFCS is energized and opened up for servicing, communication fiber-optic systems LASERs are then designated a Class 3a or 3B LASERs depending on the power level. This requires specialized training and safety precautions for installation, maintenance and repair work to protect eyes from direct exposure to a beam. The potential risk of injury from an Light Emitting Diode (LED) system is slightly less than that from a similar system using a LASER transmitter.

Non-Beam Hazards of LASERs

There are three non-beam hazards related to working with LASERs:

- Glass Particles - Avoid contact with small pieces of glass fiber. While handling glass fiber you want to be careful with glass particles because they are so small the particles can easily become embedded into the skin, clothing or eye.
- Fusion Splicing - Refers to joining the fibers together at the ends by a heating process. Avoid contact with heated surfaces.
- Solvents/Chemicals - Solvents used while working with FTTP include isopropyl alcohol. Use the minimum amount of solvent necessary to clean fiber ends. Repeated or prolonged exposure to the skin may cause dry skin.

However, Class 3 LASERs when focused and Class 4 LASERs could ignite paper and solvents. Electrocution from high-voltage power supplies at the central office can be a hazard as well.

Safe Practices

Under normal operations, OFC systems are completely enclosed and are identified as Class 1. The plastic sheathing and optical connectors form the enclosure. The first box summarizes safety considerations for systems that are energized and fully enclosed (Class I). The second box summarizes considerations for systems that are energized, but are not fully enclosed (Class IIIa or IIIb)

If the System is fully enclosed the following safety considerations apply (Class I):

- ✓ Employee shall not disconnect fiber-optic cable and look directly into the optical connector terminating the cable.
  - Employees must not stare into the end of any broken, severed, or non-terminated optical fiber or cable.
  - Employees shall not view fiber-optic emission directly with an optical instrument (i.e. microscope, magnifying glass, eye loupe) other than an indirect image-converting device, such as a fiber inspection scope.
  - If a fusion splice is used, the appropriate safety procedures shall be followed.

Systems that are Not Enclosed and are Energized are Classified 3A or 3B

These safety considerations apply:

- ✓ During installation or servicing, or when an accidental break in the cable occurs the system can no longer be considered enclosed and is now classified as Class 3a or 3b due to the power levels.
  - Only Authorized and Trained Employees - may install, service, or maintain fiber-optic transmission systems that are not enclosed.
  - Repairs-can be made by authorized employees in the event of a fiber-optic cable breaks or is accidentally shifted from its' normal position.
  - All Unauthorized Personnel - shall be excluded from the immediate area of access to LASER radiation during service and installation when there is a possibility that the system may become energized.
  - Temporary LASER Controlled Area -the immediate area shall be considered a temporary LASER-controlled area when there is possibility that the system may become energized.
  - Unfiltered Optical Instruments - such as microscopes, magnifying glasses, eye loupe's etc. shall not be used to view the end of any broken, severed or non-terminated optical fiber.

    ***An exception to this is the use of indirect image converters such as infrared image converter, fiber inspection scope or closed circuit television system for verification that a fiber is energized**.
  - Safety Glasses/Goggles-are required during installation and servicing because of the risk of eye injury from small lengths or particles of glass.
  - Employees Removing or Replacing Fiber-Optic Regenerators - Do not look directly into the vacant regenerator slot with optical instruments because the FTTP system transmits in wavelengths that are not in the visible spectrum.
  - Eye Exposure - Emissions from non-terminated energized optical connectors must be avoided.
  - Suitable Container-shall be used for discarded pieces of glass fiber in order to avoid subsequent embedding in the eyes, skin or clothing.
  - Baseline eye exams are required for employees who work on equipment from the Central Office (CO) to the CO side of the Fiber Distribution Hub (FDH).

LASER Eye Protection

LASER eye protection is used to filter-out LASER light at specific frequencies, however does not provide full protection in all cases. LASER eye protection is not required for routine FTTP work. Avoid direct viewing of a focused beam at all times. By following the proper work procedures, the risk of inappropriate viewing the beam is greatly reduced.

Medical Surveillance – Baseline Eye Exam

The Central Office equipment and the fiber-optic feeder cable used in the Fiber To The Premise (FTTP) system from the Central Office (CO) to the CO side of the Fiber Distribution Hub (FDH) is considered a Class 3b LASER system when energized and opened-up for servicing.

Employees working on this section of the FTTP system shall receive a one-time baseline eye examination. Also Medical eye examinations shall be carried out immediately after a suspected abnormal exposure of the eye, or for specific eye complaints on an case-by-case basis.

From the FDH (on the customer side from the FDH to the ONT) the power drops-off due to the transmission loss associated with the FDH cabinet, the fiber-optic cable then becomes a Class 3a LASER system or lower. Hence, the risk of eye injury is reduced. Therefore, no baseline eye examination is required for employees working in this portion of the OFCS.

The Company is providing for a baseline eye exam conforming to the American National Standard for Safe Use of Optical Fiber Communication Systems Utilizing LASER Diode and LED Sources. ANSI Z136.2-1997. The employee's manager should contact Verizon's occupational health vendor, Health Resources, Inc. to schedule an appointment for a baseline eye examination for technicians who will be assigned to work on a Class 3b energized system. The telephone number is 1-800-219-7651. For questions and clarifications about this Safety Lesson Plan or baseline eye exam process, the Regional Safety Manager can be contacted by dialing 1-800-386-9639.

Supervisors will need to have the employee’s name, SS# and BAID available when calling Health Resources.

Because this is a baseline eye exam you may be requested to have an evaluation and follow up by your personal health care provider if there is the presence of a pre-existing ophthalmologic condition.

Documentation

Document this training on the Safety Training Roster (Form 20-1572) using TEDS course # YYJS0069.

Additional References

InfoPoint Document # 7516

Verizon's Safety Vision

All Verizon employees understand, accept and demonstrate accountability for their health, safe work processes and regulatory compliance.

Remember the Verizon Safety Creed

The demands of the service or urgency of the job are never so great that we cannot take the time to perform our work safely.

For help from a Safety Professional:

Visit the SH&E Contact Map

Call the SH&E Hotline, 1-800-386-9639, Option #5, or

Visit the SH&E Explore HR area

Answer Key

1T-, 2-F, 3-T, 4-T, 5-T, 6-F, 7-T, 8-F, 9-T, 10-T.

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Safety Meeting Lesson Plan Employee Quiz

FTTP and Eye Exams (LASERs)

Indicate True or False for each question.
Review your answers with your meeting facilitator.

1. Diode LASERS used in Optical Fiber Communications Systems (OFCS) -emit infrared light and is not visible.

   True / False

2. Staring into the end of any broken, severed, or non-terminated optical fiber or cable is safe.

   True / False

3. A completely enclosed Optical Fiber Communications System (OFCS) is classified as Class 1 LASER.

   True / False

4. Safety Glasses or Goggles are required during installation and servicing because of the risk of eye injury from small lengths or particles of glass.

   True / False

5. Glass Particles, Fusion Splicing, and Solvents/Chemicals are considered non-beam hazards related to LASERs.

   True / False

6. A LASER beam is most hazardous when the beam is not focused and it spreads over a large area.

   True / False

7. LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. This radiation is the same type as light energy.

   True / False

8. A specific LASER beam contains many wavelengths (colors) of light.

   True / False

9. Employees who work on FTTP equipment from the central office to the fiber distribution hub will receive a one-time baseline eye exam

   True / False

10. Only authorized and trained Employees may install, service, or maintain fiber-optic transmission systems that are not fully enclosed.

True / False