Laser Pointer Safety

INTRODUCTION

The use of laser diode pointers that operate in the visible radiation region (400 to 760 nanometers [nm]) is becoming widespread. These pointers are intended for use by educators while presenting talks in the classroom or at conventions and meetings. A high-tech alternative to the retractable, metal pointer, the laser pointer beam will produce a small dot of light on whatever object at which it is aimed. It can draw an audience¹s attention to a particular key point in a slide show.

Laser pointers are not regulated at Oklahoma State University although the university has a Laser Safety Committee. Only Class IIIb and Class IV lasers are covered under OSU's Laser Safety Program. The power emitted by these laser pointers ranges from **1 to 5 milliwatts (mW).** Laser Pointers are similar to devices used for other purposes such as the aligning of other lasers, laying pipes in construction, and as aiming devices for firearms.

They are widely available at electronic stores, novelty shops, through mail order catalogs and by numerous other sources. At $20 or even less, laser pointers are in the price range of other electronic toys and have been treated as such by many parents and children. **Laser Pointers are not toys!** Although most of these devices contain warning labels, as required by FDA regulations, many have been erroneously advertised as "safe".

The potential for hazard with laser pointers is generally considered to be limited to the unprotected eyes of individuals who might be exposed by a direct beam (intrabeam viewing). No skin hazard usually exists. The natural aversion response or blink reflex of the eye to a bright light (t=0.25 s) would usually limit the intrabeam exposure to a safe level for devices emitting at Class II levels (*ANSI Z136.1 Standard "For the Safe Use of Lasers"* [1] would, however, suggest that an intentional intrabeam exposure with a 5mW visible diode laser could require an eye filter of Optical Density (OD) of 0.7 for exposures in the order of 0.25 s. Longer exposure would require higher OD's. Diffuse viewing conditions would need no eye protection.

LASER POINTERS: CLASSES, DEFINITIONS AND CONCERNS

Laser pointers are today, usually Class IIIA (1-5 mW) devices as defined by the ANSI Z136.1 standards. Class IIIA lasers are moderate power lasers which could be hazardous even if viewed for a very short time. Until about 1993, most pointers were Class II (The FDA would include laser pointers under the definition of a demonstration laser product which is included in the U.S. Federal Laser Product Performance Standard: 21 CFR Part 1040.11 in the definitions for a Specific Purpose Laser Products [3]. That section indicates:
"Demonstration Laser Products: Each demonstration laser product shall comply with all of the applicable requirements of 1040.10 for a Class I, IIa, II, or IIIa laser product and shall not permit human access to laser radiation in excess of the accessible emission limits of Class I and, if applicable, Class IIa, Class II, or Class IIIa." Hence, by this definition, laser pointers are technically limited to a Class IIIa (5 mW) outputs.

SAFETY ISSUES AND LASER BIOEFFECTS:
Concerns for the eye: The endpoint of various research studies determined the lowest laser eye exposure level needed to cause a "minimal" retinal lesion ("burn") using an ophthalmoscope to view the damage effects. Maximum Permissible Exposures (MPEs) were established in the late 1970's by the Z136 Committee of the American National Standards Institute (ANSI) "about a factor of ten" below the eye damage threshold level. It should be stressed that a retinal burn is unlikely result from a laser pointer exposure. Recently, a group of distinguished scientists and physicians warned that light induced damage was often mistakenly blamed for a patient's visual problems when, in reality, other causes were frequently a more likely cause.

The major potential hazard from pointers is limited to the unprotected eyes of individuals who look at the direct beam emitted from the laser since no skin hazard usually exists. The natural aversion response or blink reflex (~0.25 sec.) of the eye from the bright laser light normally limits exposure to a safe level for those devices.

The ANSI Z136.1 Standard bases the "blink reflex" MPE on an exposure on 0.25 second exposure. This yields an MPE of 2.5 mW/cm^2. When this irradiance is spread over a "worst case" 7mm pupil opening (0.4 cm2), the total power entering the eye can be then computed as follows: Power = (2.5 mW/cm2) x (0.4 cm2) = 1.0 mW. **This suggests that laser pointer type devices might be limited to an output of 1 mW (Class II).**

In some darkly lit environments, and at some wavelengths, a 1 mW pointer power is perhaps an option, but in rooms with a high ambient light level and if operation is at the longer 670 nm wavelength, 1 mW is just marginal for visibility and, therefore, 3-5 mW is generally required for better visibility. Note that if the exposure is raised to a maximum of 5 mW (Class IIIA), then an eye filter with an optical density of 0.7 would be required for protection in the event of an intrabeam exposure of 0.25 seconds**. This suggests that caution is needed when the pointer emits near the 5 mW power level!**

Secondary Effects

Safety professionals are especially concerned about *secondary effects*, those experienced during critical activities such as driving down a busy highway. If the driver loses control due to either a split second visual effect or a psychological effect (startle or panic), the consequences could be dire. There are reports of pilots who have had to look away or hand control of a landing airplane over to a co-pilot after similar incidents from more powerful light show lasers.

Laser experts agree that transient visual effects are possible and should be addressed. These effects are called glare, flash-blindness, and afterimage. While there are slight differences in the definitions scientists use for these terms, they all refer to some vision disruption that lasts only a few seconds or minutes. The Laser Institute of America has received one report where exposure to a laser pointer startled a bus driver resulting in a traffic accident.

Afterimage: The perception of light, dark, or colored spots after exposure to a bright light that may be distracting or disruptive. Afterimages may persist for several minutes.

Flash-blindness: A temporary vision impairment that interferes with the ability to detect or resolve a visual target following exposure to a bright light. This is similar to the effect produced by flashbulbs, and can occur at exposure levels below those that cause eye damage. This impairment is transitory, lasting seconds to minutes depending upon the lasers light exposure level and time, the visual task, the ambient lighting, and the brightness of the visual target.

Glare: A reduction or total loss of visibility, such as that produced by an intense light source, such as oncoming headlights, in the central field of vision. These visual effect lasts only as long as the light is actually present affecting the individual's field of vision. Visible laser light can produce glare and can interfere with vision even at low energies well below those that produce eye damage.

People often *have strong psychological reactions to being illuminated with a laser beam.* One researcher found that at times people receive eye injuries, not from the beam itself, but by a strong response.

SAFETY PRACTICES

Generally speaking, the ANSI Z136.1 standard does not require the presence of a laser safety officer or medical surveillance when working with lasers classified less than Class IIIB. Moreover most laser safety officers (LSO's) or facility safety personnel would not consider devices such as a laser pointer as representing a significant hazard. However a few basic rules are indicated:

Suggested Safety Rules

The following safety rules are a few "common sense" rules recommended for laser pointers:

1. **NEVER point a laser pointer of any power at anybody**. Pointers should be used to point out or emphasize inanimate objects such as slide images, pipes, asbestos, laboratory apparatus, be used in non-human scientific experiments, etc.

2. **Avoid "mirror like" (specular) targets and NEVER - NEVER stare into a pointer!** Also, NEVER view a laser beam using an optical instrument (such as binoculars, microscope, etc.) unless the procedure has been technically reviewed and approved by appropriate safety personnel.

3. Always use LOWEST power rating possible and highest divergence where possible. **No laser pointer rated at a Class 3B should ever be used without special provisions- such as a Laser Safety Plan and approval of a LSO.**

4. These laser pointers are not toys and should not be used by juveniles. However they are attractive to children. **Therefore we recommend that the batteries be taken out of the pointer when not in use and that laser pointers are not to be taken home if children are present in the home.**

5. In the City of Stillwater it is a misdemeanor to point a laser pointer at another person. "Stillwater Code Sec. 16-85. Laser pointers. A laser beam directly or indirectly on another person or animal in such a manner as to harass or annoy said person or animal… shall be a Class A offense."
6. One should **NEVER** use (or purchase) a laser pointer above 5 mW or purchae a laser of any type without all required labels and warnings in place.

REFERENCES

1. American National Standards Institute, *American National Standard for the Safe Use of Lasers: ANSI Z-136.1 (2000)*, Publisher: Laser Institute of America, Orlando, FL, 2000.
2. Food and Drug Administration: Performance Standard for Laser Products, Center for Devices and Radiological Health, Food and Drug Administration (DHHS), Code of Federal Regulations (CFR), 50 (161): pp. 33682-33702, Tuesday, August 20, 1985.
3. FAA 74002D Outdoor Laser/High Intensity Light Demonstrations: From Chapter 34: Outdoor Laser/ High Intensity Light Demonstrations, Federal Aviation Administration
4. https://www.laserinstitute.org/publications/safety_bulletin/laser_pointer/