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Bruce E. Stuck, TSC-1 Chair Introduction The ANSI Z136 series of documents provide practical guidance for the safe use of lasers and laser systems in many diverse configurations and environments. Classification of laser systems on a scale from Class 1 to Class 4 offers the purchaser, recipient or new user a rapid assessment of the relative hazard or risk to personnel. The laser Class scale is hierarchical and range from Class 1 systems that pose little or no risk to personnel to Class 4 systems that are hazardous with significant risk to personnel. General physical and administrative control measures are associated with each Class to mitigate or minimize the associated risk. Physical control measures include labels and signage, warning lights, room entry and laser cabinet interlocks and key systems, eye protection and protective barriers, rapid shut-off switches and fail-safe procedures. Administrative control measures outline operator, user, and ancillary personnel training requirements, use standard operating procedures (SOPs), medical surveillance recommendations, reporting procedures and laser safety officer (LSO) requirements and responsibilities. The higher the laser Class, the greater the number of both administrative and physical control measures. Laser or laser system classification is very essential to an effective laser safety program to minimize radiation hazards (or risk) by providing indicators of the relative risk (Classification) and mitigating procedures (Control Measures). Laser/Laser System Classification, Maximum Permissible Exposures and Laser Bioeffects There are seven levels of laser classification that include Class 1, Class 1M, Class 2, Class 2M, Class 3R, Class 3B, and Class 4. The details for classification are given in Section 3 and the associated tables in Z136.1-2014 (Ref 1). The Classification is based on the emission characteristics of the laser system, the configuration, and conditions of use. For classification, the emission characteristics are compared to selected maximum permissible exposures (MPE) to assess the relative hazard or risk (Section 8). The MPEs are promulgated by ANSI Z136.1-2014 (Ref 1) and expressed in terms of the exposure dose (radiant exposure in J×cm-2) or exposure dose rate (irradiance in W×cm-2) incident on the eye and skin. These exposure limits (MPEs) are a function of the exposure conditions that include wavelength, exposure duration, the irradiance diameter or “spot” size, and include assessment methods to evaluate repetitive or repeated exposures. The MPEs are anchored to a laser bioeffects data describing dose-response relationships and/or threshold laser-induced injury (Ref 2, 3, 4). In general, the MPE is defined as the “level of laser radiation to which an unprotected person may be exposed without adverse biological change in the eye or skin” (Ref 1). Biological thresholds (Ref. 2, 3, 4) for agreed-upon response criteria coupled with understanding of the light-tissue interaction mechanisms are used to determine the MPEs. The biological response criteria or threshold can include endpoints that range from visual observations to cellular effects by histo- or cyto-chemical assays. The eye is an imaging system with a large dynamic range to support vision from bright daylight to dark night. Because of its sensitivity and ability to focus collimated radiation to a small retinal image, the eye is susceptible to laser-induced injury at relatively low doses. In addition, laser-induced veiling and disability glare or dazzle may cause temporary visual performance dysfunction in the absence of a permanent effect on the retina. Although these effects may be considered “adverse” if performing a visual demanding task, the dose and required conditions to produce disturbing glare sensations may be below the MPE. If only the skin is exposed, a minimally visible erythema may be used as the endpoint to establish the exposure limit. Induction of an aversion (i.e. “look” away or movement “out” of the beam) may minimize the localized beam dwell time on a given tissue area and therefore reduce the dose below injury threshold or exposure limit. Both acute and chronic effects are assessed to determine if the exposure dose results in an “adverse” effect. If the biological effect is measured in a cellular or animal model, the relative susceptibility of human exposure must be considered. Delayed effects are observed by assessing the endpoint at extended observation times (i.e. time after exposure). The dose requirements for different endpoints are compared (e.g., an ophthalmoscopically visible lesion threshold dose may be compared with a threshold cellular response by histopathological methods). Recovery, repair rates, the slope the dose-response curve for a given exposure condition, and the ability of the dose to induce an aversion response are considered when assigning an exposure limit (or MPE). Some studies of biological effects have been reproduced in several laboratories. Exposure data are discussed, plotted, and analyzed (Ref 4) to define the MPEs based upon the functional relationships between a threshold biological effect and the exposure condition. In practice, the threshold dose is multiplied by a reduction factor to determine an MPE. Consensus is required to deem that the MPE for the given exposure conditions does not produce an adverse biological response. After discussions, reviews, and votes, exposure guidelines published. Although complex, MPEs are set at levels that are both protective but do not restrict safe, beneficial applications. Hence, elements of risk assessment have intrinsically been built into MPE or exposure limits. While the MPEs are important to determine relative risk, effective laser safety standards must include practical guidance to promote and assure safe practices. Classification and control measures are integral and critical to those practices. Control measures are detailed in Section 4 and are dependent upon the system classification. For Classification of lasers or laser systems, the accessible laser or laser system emission is given in terms of the Accessible Emission Limit (AEL) expressed in watts for continuous wave lasers and in joules for pulsed laser systems. The AEL is a readily measureable quantity provided the measurement aperture is defined for the exposure condition. For example, the AEL for a visible laser operating in the retinal hazard region is determined by multiplying the MPE given in terms or the corneal radiant exposure or corneal irradiance by the area defined by a 7 mm measurement (a large, near “worst case” pupillary) aperture. Measurement apertures for the purpose of classification are given in Table 9 in ANSI Z136.1-2014 (Ref 1) for other exposure conditions. While some consider laser classification to be complex, the guidelines accommodate many diverse situations with complex inclusion of relative risk. When the Class is determined, the simplified ordinal Class scale is a rapid indicator or relative risk. Several examples of laser or laser system classification are given in Appendix B of ANSI Z136.1-2014 (Ref 1). Section B4 specifically addresses Laser Classification and provides instructive classification examples. Section B4.1 provides classification examples for unaided viewing (Condition 2) and Section B4.2 for all viewing conditions that includes optical aided viewing (Condition 1). Example 20 in Section B4.1 explores the classification of an argon laser emitting 1 watt. As the example illustrates, classification is dependent on the configuration of the system and could range from Class 1 if the beam is totally enclosed in a “sealed pipe” or Class4 if the accessible beam exceeds 0.5 watts in a small beam. Instructive classification examples of more complex systems (e.g. repetitive pulsed systems) included in Section B4 are indicative of the inherent complexity of Classification. However, these examples also indicate the importance of Classification to indicate the actual hazard or risk based upon actual configuration or use. Classification determines the nature and number of control measures required. Control measures required for a Class 3B system far exceed those required for a Class 2 laser but are not as stringent as required for a Class 4 laser. Tables 10 and 11 in ANSI Z136.1-2014 (Ref 1) provide a helpful list of control measures required as a function of Class. The recently updated entitled Laser Safety Guide (Ref 5) booklet published by the Laser Institute of America r summarizes the degree of hazard or risk for the seven laser classes in accordance with the 2014 guidance and exposure limits provided in ANSI Z136.1-2014 (Ref 1). A verbatim excerpt from this booklet is included as Appendix A to emphasize the relationship between laser or laser system class and risk. Summary and Recommendation Laser and laser system classification indicates the relative hazard or risk of a system implementation. The laser or laser system Class is based upon the emission characteristics and the use circumstances. The Class is anchored to selected maximum permissible exposures (MPEs). Despite the complexity of the classification process, the laser class provides the user with an immediate assessment of relative risk in an ordinal scale (Class 1 to Class 4). Recommend ANSI Z136.1-2014 be consulted for comprehensive classification details. If further assistance in Classification is required, recommend a laser safety specialist or Certified Laser Safety Officer by consulted. Appendix A The following extracted from Ref 5 provides a description of the relative risk of each class of laser or laser system. Class 1 denotes lasers or laser systems that do not, under normal operating conditions, pose a hazard. Class 1 also includes those lasers that were previously designated as Class 2a. Class 1M denotes Class 1 lasers or laser systems that do not normally pose a hazard for unaided viewing unless the beam is viewed with collecting optics, e.g., telescope. Class 2 denotes low power visible lasers or laser systems which, because of the normal human bright-light aversion response (i.e. blinking, eye movement, etc.), do not normally present a hazard, but may present some potential for hazard if viewed directly for extended periods (like many conventional light sources). The signal word “CAUTION” is used with all signs and labels associated with Class 2, Class 2M and some Class 3R lasers warning against staring into the beam (see Fig. 7). Class 2M denotes Class 2 lasers or laser systems that do not normally pose a hazard for unaided viewing; however, are potentially hazardous if viewed with collecting optics. Class 3R denotes lasers or laser systems that have a lower risk of producing eye injury than other Class 3 lasers, and therefore have reduced requirements from those lasers that have a higher associated risk. Most lasers or laser systems previously classified as Class 3a can be treated as Class 3R including many laser pointers. Note: Products can be classified as Class 1M and Class 2M even if their output exceeds the Class 3R level as long as the output does not exceed the Class 3B level. Class 3B denotes lasers or laser systems that can produce a hazard if viewed directly, including intrabeam viewing of specular reflections. Normally, Class 3B lasers will not produce a hazardous diffuse reflection from a matte (not shiny) target. The signal word “WARNING” (Fig. 8) is required for Class 3B and most Class 4 lasers and laser systems. Class 4 denotes lasers or laser systems that produce a hazard from not only direct or specular reflections, but may also produce hazardous diffuse reflections. Such lasers may produce significant skin hazards as well as fire hazards. The signal word “DANGER” (Fig. 9) is restricted to those Class 4 lasers with high (i.e., multi-kilowatt) output power or pulse energies with exposed beams. References 1. ANSI Z136.1-2014, American National Standard for the Safe Use of Lasers, Orlando, FL: Laser Institute of America (2014). 2. Wolbarsht ML and Sliney DH. Safety with Lasers and Other Optical Sources. New York: Plenum Publishing Corp (1980). 3. Henderson R and Schulmeister K. Laser Safety. Bristol and Philadelphia: Institute of Physics Publishing. (2004). ISBN 0-7503-0859-1 4. Lund DJ. The New Maximum Permissible Exposure: A Biophysical Basis. IN: Laser Safety: Tools and Training. K. Barat, Ed., Boca Raton: CRC Press, pp145-175 (2014). 5. Laser Institute of America. Laser Safety Guide. DH Sliney, Ed., Orlando: Laser Institute of America, pp9-10 (2015). ISBN 978-1-940168-03-6 How can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today’s most recent coverage.Discover The CollectionCurated, compelling, and worth your time. 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The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Class 3R (IIIa) laser safety information WHAT IS A CLASS 3R LASER?Class 3R lasers are considered safe when handled carefully. There is only a small hazard potential for accidental exposure. For visible-light lasers, Class 3R lasers' output power is between 1 and 4.99 milliwatts.In the United States, both Class 2 and 3R lasers can be sold as "pointers" or for pointing purposes. (In Australia, the U.K., and many other countries, laser pointers are restricted to Class 2 only.)Class 3R is essentially the same as the Roman numeral "Class IIIa" you may see on some lasers' labels. At this website, we primarily use the Arabic numerals, for convenience.SAFE USE GUIDANCE - GENERALA Class 3R laser is low powered. It normally would not harm eyes during a momentary exposure of less than ¼ second. This is within the aversion response, where a person turns away and/or blinks to avoid bright light.Do not deliberately look or stare into the laser beam. Laser protective eyewear is normally not necessary. A Class 3R laser is not a skin or materials burn hazard.However, a Class 3R laser can be a distraction, glare or flashblindness hazard for pilots and drivers. NEVER aim any laser towards an aircraft or vehicle that is in motion. This is unsafe and is illegal -- you could be arrested and jailed.ONLY ALLOW USE BY RESPONSIBLE PERSONSThis is not a toy. Children can safely use Class 3R lasers only with continuous adult supervision. SAFETY NOTICE: This website is intended for the educational, instructional and informational purposes of the user and is not to be considered a substitute for a knowledgeable and trained Laser Safety Officer (LSO) with the duties and responsibilities as defined in the ANSI Z136 standard published by the American National Standard Institute.The hazard distances listed below are intended only as general guidance. This is because 1) your laser may vary from the parameters (power, divergence) listed below, and 2) information on labels or marketing materials may not always be correct. For example, studies have shown that some laser pointers may be falsely labeled to avoid regulations -- the actual power may be 10 times or more what the label indicates.Always err on the side of safety. If your laser has not been measured by a knowledgeable and trained Laser Safety Officer, assume it is more hazardous than the label or marketing materials would indicate. EYE INJURY HAZARD -- DIRECT AND REFLECTED BEAMClass 3R visible-light lasers are considered safe for unintentional eye exposure, because a person will normally turn away or blink to avoid the bright light. Do NOT deliberately look into or stare into the beam -- this can cause injury to the retina in the back of the eye.Be aware of beam reflections off glass and shiny surfaces. Depending on the surface, the reflected beam could be about as strong and as focused as a direct beam.The Nominal Ocular Hazard Distance (NOHD) for the most powerful Class 3R visible-beam laser (4.99 mW) with a tight beam (0.5 milliradian divergence) is 104 ft (32 m). Color indicates the relative hazard: Red = potential injury, green = unlikely injury. Beyond the Nominal Ocular Hazard Distance, the chance of injury is “vanishingly small” according to safety experts.For a 4.99 mW Class 3R laser with a less-tight beam that spreads out faster (1 milliradian), the NOHD is 52 feet (16 m). This divergence is more typical of consumer lasers. If you are closer than the NOHD distance to the laser, there is a possibility of retinal damage if the direct or reflected beam enters your eye longer than about ¼ second. The closer you are to the laser and the longer the beam is in the eye, the greater the chance of injury.AIRCRAFT AND VEHICLE SAFETYLASERS CAN INTERFERE WITH PILOTS, DRIVERSNEVER aim any laser towards an aircraft or vehicle that is in motion. The bright light can flashblind, cause glare, or distract the pilot or driver. This is why aiming any laser towards an aircraft is illegal. A 4.99 mW Class 3R laser beam can temporarily flashblind a pilot or driver, causing afterimages, within 530 ft (160 m) of the laser.It can cause glare, blocking a pilot or driver's vision, within 2400 ft (730 m) of the laser.It can cause distraction, being brighter than surrounding lights, within 4.5 miles (7.3 km) of the laser.The above calculations are for a 555 nanometer green laser pointer with a tight beam (0.5 milliradian divergence). These parameters are very conservative and thus result in the longest visual interference distances for a Class 3R consumer laser.The more the beam spreads out, the shorter the hazard distances. For example, for a 4.99 mW 555 nm green laser pointer with a beam spread of 1 milliradian, divide the above numbers by 2 to find the visual interference distances.Green is the most visible color to the human eye. It will appear brighter and more distracting than other colors of equal power. For red, divide the above numbers by about 5 to get an approximation of the visual interference distances. For blue, divide the above numbers by about 20.Visual interference distances for other Class 3R lasers are listed in the Laser hazard distance chart.Never aim a laser at or near aircraft or vehicles, no matter what its color or power. LASING AIRCRAFT AND VEHICLES IS ILLEGALIn the U.S., aiming a laser at or near the flight path of an aircraft is a federal felony, punishable by up to 5 years in jail and a fine of up to $250,000. Other countries, and U.S. states have similar laws for interfering with safety; such laws may be used to arrest, fine or imprison a person for aiming at aircraft and vehicles.The power of the laser does not matter. Even if a laser's power is relatively weak, aiming ANY laser beam at an aircraft or vehicle is illegal.Persons aiming higher-powered beams are especially likely to be caught, because the beam is very visible from the air. It is easy for police helicopters to trace the beam back to the perpetrator's location.See this page for a selected list of the many persons who have been jailed and/or fined for aiming lasers at aircraft. General information about laser hazards and classes (Classes 1, 1M, 2, 2M, 3R, 3B and 4)A page with additional links and resources on consumer laser safety, what to do if you are injured, lasers and aviation safety, a laser pointer safety website, and laser industry groups. To inform those that may encounter lasers, they are classified according to their potential to cause biological damage. The pertinent parameters are: Laser output energy or power Radiation wavelengths Exposure duration Cross-sectional area of the laser beam at the point of interest. In addition to these general parameters, lasers are classified in accordance with the accessible emission limit (AEL), which is the maximum accessible level of laser radiation permitted within a particular laser class. . Safety thresholds for lasers are expressed in terms of maximum permissible exposure (MPE). The higher the classification numbers the greater potential risk the laser or laser system presents. Two bodies are involved in laser hazard classification. The Center for Devices and Radiological Health (CDRH) a part of the Food & Drug Administration and The American National Standards Institute Z136.1 Safe Use of Laser Standard. Of these two it is the CDRH that laser manufacturers need to satisfy for there are minor differences between the two. Laser or laser system in use at LBNL are classified per CDRH criteria. The classifications are as follows: Class 1 This class is eye-safe under all operating conditions. A Class 1 laser is safe for use under all reasonably anticipated conditions of use; in other words, it is not expected that the MPE can be exceeded. Class 1 Product This is a laser product or device which may include lasers of a higher class whose beams are confined within a suitable enclosure so that access to laser radiation is physically prevented. Such products do not require a laser warning label on the exterior, think of a laser printer. Class 1M This class is safe for viewing directly with the naked eye, but may be hazardous to view with the aid of optical instruments. In general, the use of magnifying glasses increases the hazard from a widely diverging beam (e.g. LEDs and bare laser diodes), and binoculars or telescopes increase the hazard from a wide, collimated beam (such as those used in open-beam telecommunications systems). Class 1M lasers produce large-diameter beams, or beams that are divergent. The MPE for a Class 1M laser cannot normally be exceeded unless focusing or imaging optics are used to narrow down the beam. If the beam is refocused, the hazard of Class 1M lasers may be increased and the product class may be changed. Class 2 A Class 2 laser emits in the visible region (400-700nm). It is presumed that the natural aversion response to the very bright light will be sufficient to prevent damaging exposure, although prolonged viewing may be dangerous. Class 2M These are visible lasers. This class is safe for accidental viewing with the naked eye, as long as the natural aversion response is not overcome as with Class 2, but may be hazardous (even for accidental viewing) when viewed with the aid of optical instruments, as with class 1M. Classes 1M and 2M broadly replace the old class 3A under IEC and EN classification. Prior to the 2001 amendment there were also lasers, which were, Class 3B but were eye-safe when viewed without optical instruments. These lasers are Class 1M or 2M under the current Classification system. Class 3R (replacement for Class 3A) A Class 3R laser is a continuous wave laser, which may produce up to five times the emission limit for Class 1, or Class 2 lasers. Although the MPE can be exceeded, the risk of injury is low. The laser can produce no more than 5 mW in the visible region. Visible class 3R is similar to class IIIA in the US regulations. Class 3B A Class 3B laser produces light of intensity such that the MPE for eye exposure may be exceeded and direct viewing of the beam is potentially serious. Diffuse radiation (i.e., that which is scattered from a diffusing surface) should not be hazardous. CW emission from such lasers at wavelengths above 315nm must not exceed 0.5 watts. For pulse laser system to be Class 3B their output cannot exceed 125 mJ in less than 0.25 seconds. Class 4 This is the highest class of laser radiation. These are hazardous to view at all times, may cause devastating and permanent eye damage, may have sufficient energy to ignite materials, and may cause significant skin damage. Exposure of the eye or skin to both the direct laser beam and to scattered beams, even those produced by reflection from diffusing surfaces, must be avoided at all times. In addition, they may pose a fire risk and may generate hazardous fumes. Class 4 output levels for CW start at 500 mW and for pulse systems they CAN producer over 125mJ in less than 0.25 seconds. The origin of Class 1M, 2M, 3R In 2001 the standard governing the safety of laser products in Europe (EN) and Internationally (IEC), was substantially revised and the Classification system was overhauled. This resulted in the introduction of three new laser classes (1M, 2M and 3R) and the abolition of Class 3A. Below is a brief description of each of the current laser classes. The 60825-1 standards apply equally to lasers and LEDs. In most places we have used the word “laser”, but “LED” can replace it. Generally speaking LEDs would be in the lower Classes (1, 1M, 2, 2M, 3R), but very exceptionally may be Class 3B. At the time of writing we are not aware of any Class 4 LEDs*. The phrase “eye-safe” is used below. Please note that “eye-safe” is applicable to the whole optical spectrum from 180nm to 1mm wavelength, not just in the retinal hazard range of 400nm to 1400nm. Outside the retinal hazard range there is potentially a hazard to the cornea. A wavelength outside the retinal hazard range is therefore not automatically eye-safe! Key Terms CW Continuous Wave – i.e. not pulsed Diffuse reflection The reflection of radiation from a matt surface such as a wall Extended source Having an apparent source size with angular subtense of greater than 1.5 mradian Optical instruments Binoculars, telescopes, microscopes, magnifying glasses (but not prescription glasses) Point source Having an apparent source size with angular subtense of less than 1.5 mradian Note: For a product to be classified correctly, it must be tested at the maximum output accessible under reasonably foreseeable single-fault conditions (e.g. in the drive circuitry). A non-M class product must pass both Condition 1 and Condition 2 of Table 10 in IEC/EN 60825-1, and an M-class product (which by definition has failed either Condition 1 or 2) must pass the irradiance condition in the same table. Lasers are classified for safety purposes based on their potential for causing injury to humans’ eyes and skin.Most laser products are required by law to have a label listing the Class. It will be listed either in Arabic numerals (1 2, 3R, 3B, 4) or in Roman numerals (I, II, IIIa, IIIb, IV). At this website, we primarily use the Arabic numerals, for convenience.For visible-beam consumer lasers, there are four main classes. Each is described in more detail here: Class 2, Class 3R, Class 3B and Class 4. The first two Classes are relatively safe for eye exposure; the last two are hazardous. The chart below shows how the eye injury hazard increases as the laser’s power increases.Click chart for larger viewClick chart for larger viewThe detailed information given below is for laser light that is visible -- between 400 and 700 nanometers -- and for an unintentional exposure of less than 1/4 second. Consult other sources for classifications of infrared and ultraviolet lasers, or other visible-light exposure durations. Lasers, producing an intense, highly-directional beam of monochromatic light found in various wavelengths on the electromagnetic spectrum, exist as remarkable phenomena while having the industrial ubiquity of a wrench. This is due to the fact that lasers—an acronym standing for Light Amplification by Stimulated Emission of Radiation—are relied upon in medicine, communication, and numerous other industries, in which they conduct bloodless surgery, send information over large distances with minimal loss through optical fiber communications, and cut a variety of materials, including metals, glass, and quartz.Of course, these beams enhance the outcomes of these processes, but, when following the path of the beam, humans can be exposed to severe hazards. At the basis of comprehending these hazards for the purpose of applying adequate mitigation techniques is the classification of the laser’s intensity.The international standard IEC 60825-1 Ed. 3.0 b:2014 – Safety of laser products – Part 1: Equipment classification and requirements addresses a great deal of information in relation to laser products, including the classification of their hazards. These laser classes have been incorporated into ANSI Z136.1-2022: American National Standard for Safe Use of Lasers, and they have been reiterated in other laser safety standards written and published by the Laser Institute of America (LIA), the ANSI-accredited standards organization that represents and safeguards the US laser industry.The laser classes for safety are as follows:Laser systems considered Class 1 are understood to be incapable of producing damaging radiation levels. Therefore, they are safe and are exempt from beam-hazard control measures.These laser products are designed explicitly for contact application to the skin or non-ocular tissue. During operation, any ocular hazards need to be prevented by engineering means (i.e. the laser should not be able to damage anyone’s eyes by design), and, during operation, exposure levels may exceed the skin MPE (maximum permissible exposure, the “level of laser radiation to which, under normal circumstances, persons may be exposed without suffering adverse effects”), if necessary for their intended treatment procedure.Furthermore, these laser products need to comply with applicable vertical standards, or stand-alone standard documents that address the necessary information specific to an application or product. Please note that Class 1C for lasers does not appear in ANSI Z136.1-2022, as the class was new to the recent edition of IEC 60825-1. Class 1C is included in more-recent LIA standards, however.Laser products considered Class 1M are, much like Class 1 lasers, safe and incapable of producing hazardous exposure. However, when viewed with collecting optics, such as a telescope, Class 1M lasers can potentially be hazardous. Otherwise, they are exempt from control measures.These lasers are visible, falling on the electromagnetic spectrum from 400 nm to 700 nm. These are usually safe for accidental exposure, but they are often handled with the aid of eye protection.Much like Class 2 products, these lasers are visible, between 400 nm and 700 nm, and are normally afforded eye protection for viewing. While they are generally safe for accidental exposure, Class 2M lasers are potentially hazardous if viewed with collecting optics.These laser products are potentially hazardous under certain viewing conditions and when the eye is properly focused and stable, but the probability of an actual injury is small, so they have reduced controls. Class 3R lasers will not pose either a fire hazard or diffuse reflection hazard, meaning that a change in the spatial distribution of a beam by scattering in various directions does not pose any sizeable threat.These laser products are considered more hazardous and relatively unsafe under direct and specular reflection viewing conditions. A Class 3B laser product, however, is normally not a fire hazard, diffuse reflection hazard, or a laser generated air contaminant (LGAC) production hazard.This type of laser is the most hazardous. Class 4 lasers care unsafe when a direct beam is exposed to the eye or skin. Furthermore, this laser can pose a fire hazard or diffuse reflection hazard, and it can also produce LGAC and even hazardous plasma radiation.Please note that the laser classes apply to almost all laser products and/or systems, whether they are in the form of laser pointers or industrial cutting machines, assuming that they operate at wavelengths between 180 nm and 1000 µm.IEC 60825-1 Ed. 3.0 b:2014 – Safety of laser products – Part 1: Equipment classification and requirements and LIA standards are available on the ANSI Webstore.You can learn more about the ANSI Z136 series of laser safety standards published by the Laser Institute of America (LIA) here: Lasers are classified according to their potential to cause biological damage. The pertinent parameters are: Laser output energy or power Radiation wavelengths Exposure duration Cross-sectional area of the laser beam a the point of interest In addition to these general parameters, lasers are classified in accordance with the accessible emission limit (AEL), which is the maximum accessible level of laser radiation permitted within a particular laser class. The ANSI standard laser hazard classifications are used to signify the level of hazard inherent in a laser system and the extent of safety controls required. These range from Class 1 lasers (which are inherently safe for direct beam viewing under most conditions) to Class 4 lasers (which require the most strict controls). The laser classifications are described below: Class 1-Exempt Lasers Class 1 laser cannot, under normal operating conditions, produce damaging radiation levels. These lasers must be labeled, but are exempt from the requirements of the Laser Safety Program. A laser printer is an example of a Class 1 laser. Class 1M lasers cannot, under normal operating conditions, produce damaging radiation levels unless the beam is viewed with an optical instrument such as an eye-loupe (diverging beam) or a telescope (collimated beam). This may be due to a large beam diameter or divergence of the beam. Such lasers must be labeled, but are exempt from the requirements of the Laser Safety Program other than to prevent potentially hazardous optically aided viewing. Class 2-Low Power Visible Lasers (top) Class 2 lasers are low power lasers or laser system in the visible range (400 - 700 nm wavelength) that may be viewed directly under carefully controlled exposure conditions. Because of the normal human aversion responses, these lasers do not normally present a hazard, but may present some potential for hazard if viewed directly for long periods of time. A continuous wave (cw) HeNe laser above Class 1, but not exceeding 1 mW radiant power is an example of a Class 2 laser. Class 2M lasers are low power lasers or laser system in the visible range (400 - 700 nm wavelength) that may be viewed directly under carefully controlled exposure conditions. Because of the normal human aversion responses, these lasers do not normally present a hazard, but may present some potential for hazard if viewed with certain optical aids. Class 3-Medium Power Lasers and Laser Systems (top) Class 3 lasers are medium power lasers or laser systems that require control measures to prevent viewing of the direct beam. Control measures emphasize preventing exposure of the eye to the primary or specularly reflected beam. Class 3R denotes lasers or laser systems potentially hazardous under some direct and specular reflection viewing condition if the eye is appropriately focused and stable, but the probability of an actual injury is small. This laser will not pose either a fire hazard or diffuse-reflection hazard. They may present a hazard if viewed using collecting optics. Visible CW HeNe lasers above 1 mW, but not exceeding 5 mW radiant power, are examples of this class. Class 3B denotes lasers or laser systems that can produce a hazard if viewed directly. This includes intrabeam viewing or specular reflections. Except for the higher power Class 3b lasers, this class laser will not produce diffuse reflections. Visible cw HeNe lasers above 5 mW, but not exceeding 500 mW radiant power, are examples of this class. Class 4-High Power Lasers and Laser Systems (top) A high power laser or laser system that can produce a hazard not only from direct or specular reflections, but also from a diffuse reflection. In addition, such lasers may produce fire and skin hazards. Class 4 lasers include all lasers in excess of Class 3 limitations. Classification (top) Commercial lasers are classified and certified by the manufacturer. When a commercial laser is modified or when a new laser is constructed in the laboratory, it is the responsibility of the principal investigator to classify and label the laser per the ANSI Standard. EHS can assist in determining the appropriate classification. See Table A for a summary of typical laser classifications. Contact us to learn more about how our advanced technology can help take your business to the next level. Contact Us Lasers are classified based on their potential for causing injury — especially eye damage, since the eye is most susceptible to excess laser light.There are four main classes for visible-beam lasers: Class 2, Class 3R, Class 3B and Class 4. The first two are relatively safe for eye exposure; the last two are hazardous. The chart below shows that the eye injury hazard increases as the laser’s power increases.Click chart for larger viewThe detailed information given below is for laser light that is visible -- between 400 and 700 nanometers -- and for an unintentional exposure of less than 1/4 second. Consult other sources for classifications of infrared and ultraviolet lasers, or other visible-light exposure durations.Click table for larger view. Thank you to Josh Hadler for info updated April 2023.For more information about a particular class, click here: __ Class 2 __ Class 3R __ Class 3B __ Class 4For information about laser classifications in general, see this page from Rockwell Laser Industries. Research studies, along with an understanding of the hazards of sunlight and conventional, man-made light sources have permitted scientists to establish safe exposure limits for nearly all types of laser radiation. These limits are generally referred to as Maximum Permissible Exposures (MPE's) by laser safety professionals. In many cases, it is unnecessary to make use of MPE's directly. The experience gained in millions of hours of laser use in the laboratory and industry has permitted the development of a system of laser hazard categories or classifications. The manufacturer of lasers and laser products is required to certify that the laser is designated as one of four general classes, or risk categories, and label it accordingly. This allows standardized safety measures to reduce or eliminate accidents depending on the class of the laser or laser system being used.The following is a brief description of the four primary categories of lasers:Class 1A Class 1 laser is considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser product. There may be a more hazardous laser embedded in the enclosure of a Class 1 product, but no harmful radiation can escape the enclosure.Class 2A Class 2 laser or laser system must emit a visible laser beam. Because of its brightness, Class 2 laser light will be too dazzling to stare into for extended periods. Momentary viewing is not considered hazardous since the upper radiant power limit on this type of device is less than the MPE (Maximum Permissible Exposure) for momentary exposure of 0.25 second or less. Intentional extended viewing, however, is considered hazardous.Class 3A Class 3 laser or laser system can emit any wavelength, but it cannot produce a diffuse (not mirror-like) reflection hazard unless focused or viewed for extended periods at close range. It is also not considered a fire hazard or serious skin hazard. Any continuous wave (CW) laser that is not Class 1 or Class 2 is a Class 3 device if its output power is 0.5 W or less. Since the output beam of such a laser is definitely hazardous for intrabeam viewing, control measures center on eliminating this possibility.Class 4A Class 4 laser or laser system is any that exceeds the output limits (Accessible Emission Limits, AEL's) of a Class 3 device. As would be expected, these lasers may be either a fire or skin hazard or a diffuse reflection hazard. Very stringent control measures are required for a Class 4 laser or laser system.