TITLE 32: ENERGY
CHAPTER II: ILLINOIS EMERGENCY MANAGEMENT AGENCY
SUBCHAPTER b: RADIATION PROTECTION

PART 315
STANDARDS FOR PROTECTION AGAINST LASER RADIATION

Section

AUTHORITY: Implementing and authorized by the Laser System Act of 1997 [420 ILCS 56].

SOURCE: Adopted at 25 Ill. Reg. 6920, effective May 17, 2001; recodified from the Department of Nuclear Safety to the Illinois Emergency Management Agency at 27 Ill. Reg. 13641; amended at 37 Ill. Reg. 20200, effective December 9, 2013.

Section 315.10 Purpose

This Part establishes standards for protection against laser radiation and is issued pursuant to the Laser System Act of 1997 [420 ILCS 56].

Section 315.20 Scope

a) Except as otherwise specifically exempted, this Part applies to *any location or facility where laser systems are produced, stored, disposed of, or used for any purpose* [420 ILCS 56/15].

b) This Part is not intended to restrict or limit in any way the use of laser radiation, of any type, that may be intentionally administered to an individual for diagnostic, therapeutic, or medical or dental research purposes by or under the direction of a practitioner licensed to practice a treatment of human ailments by virtue of the Medical Practice Act of 1987 [225 ILCS 60], the Illinois Dental Practice Act [225 ILCS 25], the Podiatric Medical Practice Act of 1987 [225 ILCS 100] or the non-human use of lasers by veterinarians by virtue of the Veterinary Medicine and Surgery Practice Act of 1994 [225 ILCS 115].

Section 315.30 Incorporations by Reference

All rules, standards and guidelines of agencies of the United States or nationally recognized organizations or associations that are incorporated by reference in this Part are incorporated as of the date specified in the reference and do not include any later amendments or editions. Copies of these rules, standards and guidelines that have been incorporated by reference are available for public inspection at the Illinois Emergency Management Agency, 1035 Outer Park Drive, Springfield, Illinois.

AGENCY NOTE: In this Part, the Agency has incorporated by reference Title 21 of the Code of Federal Regulations, 21 CFR 1040, 2000 edition, published April 1, 2000; the American National Standard for Safe Use of Lasers, ANSI Z136.1-2000, effective June 28, 2000; the American National Standard for the Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources, ANSI Z136.2, effective August 12, 1997; and the American National Standard for Safe Use of Lasers in Health Care Facilities, ANSI Z136.3, effective February 7, 1996.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.40 Definitions

As used in this Part, the following definitions apply:

"Act" means the Laser System Act of 1997 [420 ILCS 56].

"Agency" means the Illinois Emergency Management Agency.

"ANSI" means the American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

"Aperture" means any opening in a protective housing through which laser radiation can pass.

"Attenuation" means the decrease in the radiant power of any optical beam as it passes through an absorbing and/or scattering medium.

"Certified laser system" means that the system is certified by a manufacturer pursuant to the requirements of 21 CFR 1010.2.

"Class 1 laser" means any laser that meets the criteria of a Class 1 laser, as defined in 21 CFR 1040.

"Class 2 laser" means any laser that meets the criteria of a Class 2 laser, as defined in 21 CFR 1040.

"Class 2a laser" means any laser that meets the criteria of a Class 2a laser, as defined in 21 CFR 1040.

"Class 3 laser" means any laser that meets the criteria of a Class 3 laser, as defined in 21 CFR 1040. Class 3 lasers are separately designated as Class 3a or Class 3b.

"Class 4 laser" means any laser that meets the criteria of a Class 4 laser, as defined in 21 CFR 1040.

"Controlled area" means any area where the occupancy and access of those within is subject to control and supervision by the registrant for the purpose of protection from laser radiation hazards.

"Director" means the Director of the Illinois Emergency Management Agency.

"Embedded laser" means an enclosed laser with an assigned class number higher than the inherent capability of the laser system in which it is incorporated, where the system's lower classification (Class 1, 2, 3a or 3b) is appropriate due to the engineering features limiting accessible emission.

"Enclosed laser" means a laser that is contained within a protective housing of itself or of the laser or laser system in which it is incorporated.

"Energy" means the capacity for doing work. Energy content is commonly used to characterize the output from pulsed lasers and is generally expressed in joules (J).

"Facility" means a laser installation.

"FDA" means the Food and Drug Administration of the United States Department of Health and Human Services.

"Fire-resistant material" means a material that is not combustible when used for its intended purpose in conjunction with a laser system.

"Incident" means an event or occurrence that results in a real or suspected intentional or accidental exposure to laser radiation that caused or has the potential to cause biological damage.

"Irradiance" means the radiant power incident on an element of a surface divided by the area of that element, expressed in watts per square centimeter (W cm^{-2}).

"Joule" or "J" means a unit of energy: 1 joule = 1 watt second.

"Laser" means any device that can produce or amplify electromagnetic radiation at wavelengths greater than 180 nanometers but less than 1 millimeter, primarily by the process of controlled stimulated emission.

"Laser installation" means a location or facility where laser systems are produced, stored, disposed of or used for any purpose [420 ILCS 56/15].

"Laser radiation" means an electromagnetic radiation emitted from a laser system and includes all reflected radiation, any secondary radiation or other forms of energy resulting from the primary laser beam [420 ILCS 56/15].

"Laser safety officer" means any individual, qualified by training and experience in the evaluation and control of laser hazards, who is designated by the registrant to have the authority and responsibility to establish and administer the laser radiation protection program for a particular laser installation.

"Laser system" means a device, machine, equipment or other apparatus that applies a source of energy to a gas, liquid, crystal, or other solid substances or combination thereof in a manner that electromagnetic radiations of a relatively uniform wave length are amplified and emitted in a cohesive beam capable of transmitting the energy developed in a manner that may be harmful to living tissues, including but not limited to electromagnetic waves in the range of visible, infrared or ultraviolet light. Such systems in schools, colleges, occupational schools, and State colleges and other State institutions are also included in the definition of "laser systems". [420 ILCS 56/15]

"Maintenance" means the performance of those adjustments or procedures by the user to keep equipment in its intended operating condition. Maintenance does not include operation or service as defined in this Section.

"Maximum permissible exposure" or "MPE" means that level of laser radiation to

which persons may be exposed without adverse biological change in the eye or skin.

"Medical laser" means a laser system that is a medical device, as defined in 21 USC 321(h), and is manufactured, designed or intended for laser irradiation of any part of the human body for the purpose of diagnosis, surgery or therapy (see 21 CFR 1040.10(b)).

"Operation" means the performance of tasks required for the equipment to perform its intended functions. It does not include maintenance or service tasks as defined in this Section.

"Operator" is an individual, group of individuals, partnership, firm, corporation, or association conducting the business or activities carried on within a laser installation [420 ILCS 56/15].

"Optical density" or "OD" means a logarithmic expression of the optical attenuation afforded by a material.

$$OD = \log_{10} \frac{\text{incident power}}{\text{transmitted power}}$$

"Optical fiber communications system" or "OFCS" means a system consisting of one or more laser transmitters, each of which is coupled to an individual optical fiber and is used for the transmission of information, e.g., voice or data.

"Person" means any individual, corporation, limited liability company, partnership, firm, association, trust, estate, public or private institution, group, agency, political subdivision of this State, any other state or political subdivision or agency thereof and any legal successor, representative, agent or agency of the foregoing.

"Protective housing" means those portions of a laser system that are designed to prevent human access to laser radiation above the applicable MPE level.

"Pulse duration" means the time increment measured between the half-peak power points at the leading and trailing edges of a pulse.

"Radiant energy" means energy emitted, transferred or received in the form of laser radiation, expressed in joules (J).

"Radiant exposure" means the radiant energy incident on an element of a surface divided by the area of that element, expressed in joules per square centimeter (J cm^{-2}).

"Radiant power" means power emitted, transferred or received in the form of laser

radiation expressed in watts (W). Radiant power also means output power.

"Registrant" means any person who registers a laser installation with the Agency pursuant to this Part.

"Scanning laser" means a laser having a time-varying direction, origin or pattern of propagation with respect to a stationary frame of reference.

"Service" means the performance of adjustments, repairs or procedures required to return equipment to its intended state. These adjustments and procedures usually require specialized training and/or tools. Service does not include operation or maintenance as defined in this Section.

"Watt" or "W" means the unit of radiant power, 1 watt = 1 joule per second (J sec^{1})

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.50 Exemptions

The following are exempt from the requirements of this Part:

a) All certified Class 1, Class 2, Class 2a and Class 3a lasers or laser systems, provided that the laser is maintained as a certified Class 1, Class 2, Class 2a or Class 3a laser system throughout its useful life.

b) Laser systems containing embedded Class 3b or Class 4 lasers, where the laser system's lower classification is appropriate due to engineering features limiting accessible emission.

c) A *laser system being transported on railroad cars, motor vehicles, aircraft, or vessels in conformity with rules adopted by an agency having jurisdiction over safety during transportation, or laser systems that have been installed on aircraft, munitions, or other equipment that is subject to the regulations of, and approved by an appropriate agency of, the federal government* [420 ILCS 56/25(2)].

d) Laser systems that are inoperable due to the absence or failure of components necessary for operation. Laser systems that are not in operation due to disconnection from an electrical supply shall be considered operable.

Section 315.60 Registration

a) Installation Registration

1) Any operator of a laser installation shall register the laser installation with the Agency. The operator shall register the installation before the

installation is placed in operation on a form prescribed by the Agency, which shall include, but not be limited to:

A) The operator's name;

B) The location of the laser installation;

C) The classification number and room location of laser systems possessed; and

D) The name of the individual designated as the laser safety officer.

AGENCY NOTE: Prior to designation of the laser safety officer, the registrant should carefully review the requirements of Section 315.90.

2) Installation registration, as specified in subsection (a), shall be required only at the time the laser installation is placed in operation.

3) Laser systems that are located in a single building or in a group of buildings that are contiguous to one another, and used by the same operator, shall be treated as a single laser installation unless requested otherwise in writing by the operator and approved by the Agency.

b) Laser System Registration

1) Any operator of a laser installation where laser systems are located shall register the systems annually on a form prescribed by the Agency.

2) The form shall include, but not be limited to, the manufacturer, model serial number, output power, wavelength and class of each laser system.

3) Any operator of a laser installation that possesses multiple laser systems of the same manufacturer and model may register those laser systems on a single form, provided that the operator includes a listing of serial numbers for each laser system.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.70 Amendments and Changes in Status

a) Operators of laser installations that have been registered pursuant to Section 315.60 shall notify the Agency within 30 days after the installation of new, used, relocated or reactivated laser systems.

b) If any operator discontinues using a laser system, the operator shall notify the Agency within 30 days after the discontinuance. The notification shall include

the date of discontinuance, including the name, address and telephone number of the person who received the laser and the disposition of the laser system.

c) Within 30 days after changing the operator of a laser installation, the new operator shall notify the Agency in writing or by telephone or other electronic means.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.80 Registration Requirements for Out-of-State Laser Facilities

a) Whenever any Class 3b or Class 4 laser system is to be brought into this State, for any temporary use, the person proposing to bring the laser system into this State shall:

1) Register the installation and laser systems in accordance with Section 315.60.

2) Give written notice to the Agency at least 10 working days before the laser system is to be used in this State. The notice shall:

A) Include the nature, duration and scope of use;

B) Include the exact locations where the laser system is to be used; and

C) Comply with all applicable requirements of this Part.

b) A pre-operational inspection by the Agency of the out-of-state laser system may be required within 24 hours prior to the laser system being used in this State.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.90 Laser Safety Officer Qualifications, Duties and Responsibilities

a) Every operator of a laser installation shall ensure that the designated laser safety officer has qualifications that include training, experience and familiarity in the following areas:

1) Fundamentals of laser operation;

2) Familiarity with the type of laser equipment utilized at the facility;

3) Biological effects of laser radiation on the eye and skin;

4) Laser and laser system classification;

5) Control measures;

6) Nonradiation hazards of lasers;

7) Medical surveillance practices (if applicable);

8) Laser terminology; and

9) Maximum Permissible Exposure (MPE) levels for eye and skin for all lasers and for all conditions of use of laser systems at the facility.

b) Every operator of a laser installation shall ensure that the following specific duties are carried out by the laser safety officer:

1) Establish and implement a program of laser radiation safety for effective compliance with the requirements of this Part.

2) Ensure that instructions concerning hazards and safety practices are provided to individuals who may be exposed to laser radiation and to individuals who operate lasers.

3) Permit, on behalf of the registrant, operation of lasers only by individuals who have:

A) Been trained in the safe use of the laser in accordance with Section 315.100 of this Part; and

B) Received copies of and instruction in the registrant's operating and emergency procedures.

AGENCY NOTE: In facilities where more than one practitioner or operator may use lasers, a laser safety committee should be formed to oversee laser activity, establish use criteria and approve operating policies and procedures.

4) Ensure that all laser systems in operation meet the requirements of this Part, and that prescribed control measures are in effect. The laser safety officer may recommend and approve substitute or alternative control measures when the primary control measures are not feasible or practical. Accordingly, if alternative control measures are instituted, those personnel directly affected shall be provided appropriate training.

5) Periodically audit the functionality of control measures in use.

Section 315.100 General Operator Requirements

a) Administrative and Procedural Controls

1) The registrant shall provide personnel operating lasers written operating and safety procedures. These procedures shall include restrictions required for the safe operation of each laser and shall include the topics listed in the laser safety program of subsection (a)(2).

AGENCY NOTE: Sample standard operating procedures for the use of laser systems are contained in Appendix A. The Agency recommends these procedures be modified and adopted for each registrant's specific use of lasers.

2) The registrant shall provide for initial and annual in-service training in laser safety for individuals using laser systems to ensure their awareness of the registrant's laser safety practices and policies. The in-service training shall include the following topics:

A) Operating and emergency procedures for the lasers;

B) Use of laser protective devices, including selection and use of protective eyewear;

C) Clear warnings and precautions to avoid possible exposure to laser radiation in excess of the MPE; and

D) Requirements for safe operation of lasers as described in this Part.

3) Personnel operating lasers shall be instructed in and able to demonstrate competence with the registrant's operating and safety procedures.

4) Alignment of laser optical systems (e.g., mirrors, lenses and beam deflectors) shall be performed in a manner that assures that no one is exposed to laser radiation above the MPE.

5) A controlled area shall be established when exposure to laser radiation in excess of the MPE limit is possible. The controlled area shall meet the following requirements:

A) Be posted as required by Section 315.150.

B) Access shall be only by permission of the laser safety officer or a trained designated representative.

6) Unenclosed Beam Paths

A) An evaluation of the expected beam path and the potential hazards

from reflective surfaces that may be encountered shall be conducted before operating the laser. All reflective surfaces shall be excluded from the beam path at all points where the laser radiation exceeds the MPE.

B) If applicable, the stability of the laser platform shall be evaluated to determine the constraints that shall be placed upon the beam traverse and the extent of the range of control.

C) No laser shall be operated or made ready for operation until the area along all points of the beam path where the laser radiation will exceed the MPE is clear of individuals, unless the individuals are wearing appropriate protective devices.

b) Requirements for Safe Operation

1) Operator Supervision

A) The laser system shall be operated at all times under the direct supervision or control of an experienced, trained operator who shall maintain visual surveillance of conditions for safe use and terminate laser emission in the event of malfunction or any other condition of unsafe use.

B) Unattended use of the laser system shall be permitted only when the laser safety officer has implemented appropriate control measures that provide adequate protection and laser safety training to those who may enter the laser controlled area during times of unattended use.

2) Maximum Permissible Exposure (MPE)

A) No individual shall be exposed to levels of laser radiation higher than the MPE, as described in Tables A and B.

B) In those cases in which MPE is known for particular wavelengths and pulse durations, exposure to laser radiation shall be prohibited.

C) Measurements and calculations performed to determine MPE limits shall be made in a manner consistent with the criteria contained in ANSI Z136.1-2000.

3) The minimum laser radiant energy or laser power level required for the application shall be used.

4) All service procedures shall be performed by qualified personnel who are

trained in laser radiation protection.

5) Protective eyewear, when specified by the laser safety officer, when engineering or other procedural and administrative controls are inadequate to eliminate potential exposure in excess of the applicable MPE, shall be worn by all individuals with access to Class 3b and Class 4 levels of laser radiation. The protective eyewear devices shall meet the following requirements:

A) Provide a comfortable and appropriate fit all around the area of the eyes sufficient to protect the eyes from laser radiation.

B) Be in proper condition to ensure the optical filters and holder provide the required optical density or greater at the desired wavelengths, and retain all protective properties during use of the device.

C) Be suitable for the specific wavelength of the laser and be of optical density adequate for the energy of the laser.

D) Have the optical density or densities and associated wavelengths permanently labeled on the filters or otherwise permanently identified.

E) Be examined by the registrant's laser safety officer, or designee, at intervals not to exceed 6 months, to ensure the reliability of the protective filters and integrity of the protective filter frames.

F) Eyewear not meeting the requirements of this subsection (b)(5) shall not be utilized as protective eyewear.

6) When there is a possibility of exposure to laser radiation that exceeds the MPE limits for skin as specified in Table B, the registrant shall require the appropriate use of protective gloves, clothing and shields.

7) Laser products certified by a manufacturer to be compliant with the requirements of 21 CFR 1040 applicable at the date of manufacture shall be maintained in compliance with the requirements. Certified laser products that have been modified shall comply with this Part.

c) Engineering Controls

1) Each laser product shall have a protective housing that prevents, during operation, human access to laser radiation that exceeds the limits of a Class 1 laser (see 21 CFR 1040.10, Table I), wherever and whenever human access is not necessary in order for the laser system to perform its

intended function.

2) Safety Interlocks

A) A safety interlock, which ensures that laser radiation is not accessible above MPE limits, shall be provided for any portion of the protective housing that, by design, can be removed or displaced without the use of tools during normal operation or maintenance.

B) Adjustment during operation, service, testing or maintenance of a laser containing interlocks shall not cause the interlocks to become inoperative or the laser radiation to exceed MPE limits outside the protective housing except where a controlled area, as specified in subsection (a)(5), is established.

C) For pulsed lasers, interlocks shall prevent firing of the laser.

D) For continuous wave lasers, the interlocks shall turn off the power supply or interrupt the beam.

E) An interlock shall not allow access to laser radiation in excess of MPE limits when the interlock is closed.

F) Multiple safety interlocks, or a means to preclude removal or displacement of the interlocked portion of the protective housing upon failure, shall be provided if failure of a single interlock would allow human access to levels of Class 3b or Class 4 laser radiation.

3) Viewing Optics and Windows

A) All viewing ports, viewing optics or display screens included as an integral part of an enclosed laser or laser system shall incorporate suitable means to attenuate the laser radiation transmitted through the port to less than the MPE during maintenance or operation of the laser.

B) When optical systems such as lenses, telescopes and microscopes are used that were not supplied as part of a certified laser product, the laser safety officer shall determine the potential hazard and specify administrative procedures and the use of controls such as interlocks or filters.

4) Warning Systems

A) Each laser system shall provide visual or aural indication during the emission of accessible laser radiation.

B) Any visual indicator shall be clearly visible through protective eyewear designed specifically for the wavelengths of the emitted laser radiation.

C) Visual indicators shall be positioned so that viewing does not result in exposure to laser radiation in excess of the MPE.

D) An indication shall be provided prior to emission of the radiation to allow appropriate action to avoid exposure.

5) Additional Requirements for Indoor Class 4 Laser Controlled Areas

A) Latches, interlocks or other appropriate means shall be used to restrict access to controlled areas.

B) Measures shall be designed to allow both rapid exit by the laser personnel at all times and entrance to the controlled area in an emergency condition.

C) For emergency conditions, a control-disconnect switch or equivalent device (panic button) shall be available for deactivating the laser or closing the shutter.

D) During tests requiring continuous operation, the laser safety officer or a trained designated representative shall be permitted to momentarily override the safety interlocks to allow access to other authorized personnel if it is clearly evident that:

i) There is no optical radiation hazard at the point of entry; and

ii) The necessary protective devices are being worn by the entering personnel.

E) Optical paths (e.g., windows) from an indoor facility shall be controlled in such a manner as to reduce the transmitted values of the laser radiation to levels at or below the MPE. When the laser beam must exit the indoor controlled area (as in the case of exterior atmospheric beam paths), the operator shall be responsible for ensuring that the beam path is limited to controlled air space or controlled ground space when the beam irradiance or radiant exposure is above the appropriate MPE.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.110 Additional Requirements for Infrared Laser Systems

a) The beam from an infrared laser (wavelength greater than 710 nanometers) shall be terminated in fire-resistant material where necessary.

b) Periodic inspection of fire-resistant material shall be made to assure that the material has not degraded with use. Degraded material that could create a fire or reflection hazard shall be replaced prior to further operation of the laser.

Section 315.120 Additional Requirements for Optical Fiber Communications Systems

a) Laser communication systems that employ optical cables shall be considered enclosed systems with the optical cable forming part of the protective housing.

b) Disconnection of a connector resulting in access to radiation in excess of the applicable MPE shall take place only in a controlled area.

1) The use of a tool shall be required for the disconnection of a connector for service and maintenance purposes when the connector is not within a protective housing.

2) All connectors shall bear the appropriate label specified in Section 315.150 of this Part.

Section 315.130 Additional Requirements for Medical Laser Applications

a) Medical lasers used for human irradiation shall be calibrated in accordance with the manufacturer's specified calibration procedure at intervals not to exceed those specified by the manufacturer. Calibration records shall be maintained at the facility for inspection by the Agency.

b) Each medical laser shall incorporate a means for measurement of the level of laser radiation intended for human irradiation, with an error in measurement of no greater than plus or minus 20 percent, when calibrated in accordance with the laser manufacturer's calibration procedure.

c) Any footswitch that is used to control patient exposure to laser radiation shall have a guard mechanism to prevent inadvertent exposure.

d) The operator shall ensure that medical lasers shall not be used for human irradiation unless all applicable requirements of this Part are met.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.140 Additional Requirements for Entertainment Laser Light Show

a) The operator shall notify the Agency in writing or facsimile, at least 10 working days in advance of the proposed laser light show, and shall include the following information:

1) Name, address and telephone number of:

A) Laser registrant;

B) Laser safety officer;

C) Individual in charge of the laser light show;

2) The location, time and date of the show;

3) Documentation that a variance has been obtained in accordance with 21 CFR 1040.11;

4) For outdoor performances, a copy of the notification to the Federal Aviation Administration;

5) Manufacturer, class, wavelength and output power of the laser systems to be used; and

6) Sketches showing the location of the laser systems, operators, performers, laser beam paths, viewing screens, walls, mirror balls and other reflective or diffusive surfaces that may be struck by the laser beam.

b) The operator shall also supply additional information as may be required by the Agency for the evaluation of the safety of the proposed laser light show.

c) Requirements for Safe Operations

1) Laser radiation emissions outside the spectral range of 400 to 700 nanometers shall not exceed the limits of a Class 1 laser.

2) Levels of laser radiation where the audience is located, and where operators, performers and employees are located if the laser radiation is intended to be viewed by them, shall not exceed the limits of a Class 1 laser.

3) Operators, performers and employees shall be able to perform their functions without being exposed to laser radiation exceeding the limits of a Class 2 laser when the laser radiation is not intended to be viewed by them.

4) Areas where levels of laser radiation exceed the limits of a Class 2 laser

shall be identified by posting of warning signs and through use of barriers or guards to prevent individuals from entering these areas.

5) Scanning lasers shall not, as a result of scan failure or any other failure causing a change in either angular velocity or amplitude, permit audience exposure to laser radiation in excess of the limits of a Class 1 laser.

6) Where a mirror ball is used with a scanning laser, the conditions of subsections (c)(1) and (c)(2) shall be met with the mirror ball stationary or during any failure mode resulting in a change in rotational speed of the mirror ball.

7) Laser light shows shall be, at all times, under the direct and personal supervision of the laser operator, except:

   A) In cases in which the maximum laser output power level is less than 5 milliwatts (all spectral lines);

   B) When the laser beam path is located at least 6 meters above any surface upon which an individual in the audience is permitted to stand; or

   C) When the laser beam path is located at least 2.5 meters in lateral separation from any position where an individual in the audience is permitted during the performance.

8) Laser radiation levels shall not exceed the limits of a Class 2 laser at any point less than 3 meters above any surface upon which any individual in the audience is permitted to stand, and 2.5 meters in lateral separation from any position where an individual in the audience is permitted, unless physical barriers are present that prevent human access to these levels.

9) All safety devices and procedures necessary to comply with this Part shall be functionally tested and evaluated after setup and prior to the laser light show to ensure compliance.

10) The laser system, when not in use, shall be secured against unauthorized operation or tampering.

11) Laser alignment procedures shall be performed with the laser output power reduced to the lowest practicable level, and protective eyewear shall be worn where necessary to prevent exposure to laser radiation levels exceeding the MPE. Unless specifically authorized by the laser safety officer, only individuals required to perform the alignment shall be present during these procedures.

12) The operator shall ensure that no laser light show is conducted except as specifically authorized in a variance issued in accordance with 21 CFR 1040.11 and applicable requirements of this Part.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.150 Caution Signs, Labels and Postings

a) Except as otherwise authorized by the Agency, signs and labels prescribed by this Section shall use the design and colors specified in Illustration A or B of this Part.

b) Controlled areas shall be conspicuously posted with appropriate sign or signs as specified in subsection (c).

c) Labeling and Posting Laser Systems and Laser Facilities

1) Class 3b lasers shall have a label and facilities shall be posted with signs with the warning specified in Illustration A and that include the following wording:

(Position 1 on the logotype)

"LASER RADIATION − AVOID DIRECT EXPOSURE TO BEAM"

(Position 3 on the logotype)

"CLASS 3b LASER"

2) Class 4 lasers shall have a label and facilities shall be posted with signs with the warning specified in Illustration B and that include the following wording:

(Position 1 on the logotype)

"LASER RADIATION − AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION"

(Position 3 on the logotype)

"CLASS 4 LASER"

3) Each laser, except lasers used in the practice of medicine, shall have labels in close proximity to each aperture through which is emitted accessible laser radiation in excess of the MPE with the following wording as applicable:

A) "AVOID EXPOSURE − Laser radiation is emitted from this aperture", if the radiation emitted through the aperture is laser radiation.

B) "AVOID EXPOSURE − Hazardous electromagnetic radiation is emitted from this aperture", if the radiation emitted through the aperture is electromagnetic radiation.

C) "AVOID EXPOSURE − Hazardous x-rays are emitted from this aperture", if the radiation emitted through the aperture is x-ray radiation.

4) Each label specified in this subsection (c) shall state, at position 2 on the required warning logotype, the maximum output of laser radiation, the pulse duration when appropriate, and the laser medium or emitted wavelengths.

5) Each noninterlocked or defeatably interlocked portion of the protective housing or enclosure that is designed to be displaced or removed during normal operation, maintenance or servicing and that would permit human access to laser radiation shall have labels as follows:

A) For Class 3b laser radiation, the wording: "DANGER − Laser radiation when open, AVOID DIRECT EXPOSURE TO BEAM".

B) For Class 4 laser radiation, the wording: "DANGER − Laser radiation when open, AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION".

C) For protective housings or enclosures that provide a defeatable interlock, the phrase "and interlock defeated" shall be inserted after the word "open" on the labels specified in subsections (c)(5)(A) and (B) of this Section.

6) The word "invisible" shall precede the word "laser" on labels and signs required by this Part for wavelengths of laser radiation that are outside of the range of 400 to 710 nanometers.

7) The words "visible and invisible" shall precede the word "laser" on labels and signs required by this Part for wavelengths of laser radiation that are both within and outside the range of 400 to 710 nanometers. For laser products emitting only visible wavelengths, the phrase "laser light" may be used in lieu of "laser radiation".

8) All labels placed on lasers or signs posted in laser facilities shall be positioned so as to make unnecessary, during reading, human exposure to

laser radiation in excess of the MPE.

9) Labels and signs required by this Part shall be clearly visible, legible and permanently attached to the laser or facility.

AGENCY NOTE: With respect to laser systems only, the labeling requirements found in 21 CFR 1040, and labels otherwise approved by the FDA, may be used in lieu of subsection (c).

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.160 Notifications and Reports

a) Each registrant shall notify the Agency immediately of any incident involving exposure to laser radiation that has or may have caused *accidental injury to an individual in the course of use, handling, operation, manufacture or discharge of a laser system* [420 ILCS 56/40], including:

1) An exposure to an individual of greater than 100 times the MPE;

2) An exposure to an individual that involves the partial or total loss of sight in either eye; or

3) An exposure to an individual that involves perforation of the skin or other serious injury exclusive of eye injury.

b) Each registrant shall notify the Agency within 24 hours of any incident involving exposure to laser radiation that has or may have caused:

1) An exposure to an individual of greater than 5 times the MPE; or

2) An exposure to an individual that involves second or third degree burns to the skin.

c) Each registrant shall make a report in writing within 30 days to the Agency of any incident for which notification is required by subsection (a) or (b).

d) Each report filed with the Agency pursuant to this Section shall include the full name of each individual exposed to laser radiation, including estimates of each individual's exposure, levels of laser radiation involved, the cause of the exposure, a description of any injuries, and corrective steps taken or planned to be taken to assure against a recurrence.

e) When a registrant is required pursuant to this Section to report to the Agency any exposure of an individual to laser radiation, the registrant shall also provide to the individual a report on that exposure data. The report to the individual shall be

transmitted at a time not later than the date of transmittal to the Agency.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.170 Records/Information

a) Each registrant shall maintain, for a period of 5 years, records that shall be kept current and available for inspection by the Agency, showing:

1) A listing of all individuals who have been authorized by the registrant to operate lasers.

2) The results of all inspections of protective eyewear required by Section 315.100.

3) The results of all instrument calibrations required by Section 315.130.

4) The reports of incidents as described under Section 315.160.

b) Each operator shall make records maintained pursuant to this Part available to the Agency for review and copying.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.180 Inspections and Investigations

a) The Agency is authorized *to enter upon, inspect, and investigate the premises and operations of all laser systems of this State, whether or not the systems are required to be registered by* the Act [420 ILCS 56/35].

b) Each operator of a laser installation shall afford the Agency the opportunity to enter upon, inspect and investigate the laser installation at all reasonable times.

(Source: Amended at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.190 Annual Registration Fee

a) Each laser installation required to be registered pursuant to the Act and this Part shall pay an annual registration fee of $50. Payment of this fee is required by those laser installations that possess a laser system capable of emitting laser or laser light.

b) The Agency shall bill each laser installation as soon as practicable after October 1 of each year.

c) The appropriate fees shall be paid within 60 days after the date on the invoice issued by the Agency. Failure to pay a properly assessed fee shall result in the Agency taking action as authorized in Section 30 of the Act.

d) All fees assessed in accordance with this Section are non-refundable.

(Source: Added at 37 Ill. Reg. 20200, effective December 9, 2013)

Section 315.APPENDIX A Sample Standard Operating Procedures

Standard Operating Procedures (SOPs) are governed by institutional policy and are developed, modified and maintained in accordance with the needs of individual facilities. Information relative to safety incorporated into these SOPs is gathered from a wide range of resources, including, but not limited to, the laser system manufacturer or distributor. This Appendix A contains examples of SOPs for issues associated with the use of laser systems. It is recognized that the safety needs of installations with multiple laser systems may be different from those facilities with a single laser system. The samples that follow cannot cover all situations or procedures; they are only intended as models that should be used to accommodate specific requirements. Typically, the Laser Safety Officer shall have the responsibility to see that SOPs are followed.

It is reasonable to expect that the manufacturer of the laser system shall supply safety information that can serve as the cornerstone for the generation of the SOPs. It is incumbent upon the operator to demand the information from the manufacturer. The availability of safety related information is facilitated by the FDA requirement that the manufacturer of laser products provide the user with adequate instructions for the safe operation and maintenance of all laser products.

SAMPLE 1: Controlled Access to the Laser Room

Purpose: To define the area in which control measures shall be applied and to describe the control measures necessary in order to maintain a safe environment for use of the laser system.

Policy: Class 3b and Class 4 lasers shall be operated in areas where traffic flow and compliance with all safety procedures can be monitored.

Procedure:

1) Appropriate warning signs shall be posted at eye level on all doors that access a room where a laser is to be operated. These signs shall state all required information and shall be removed when the laser is not in use.

2) Safety goggles labeled with the appropriate wavelength and optical density shall be available at the entry where each door sign is posted.

3) Glass windows shall be covered with shades or filters of appropriate optical density whenever a fiberoptic laser system is operational.

4) All safety procedures shall be followed during service, maintenance and demonstrations.

5) No one shall be allowed into a laser room unless properly authorized and protected.

6) The laser shall not be activated when it is necessary to open the door, if the controlled area extends to the doorway.

7) Laser keys shall be kept in a secured area and signed out only by those authorized to do so.

SAMPLE 2: Ocular Safety

Purpose: To prevent ocular injuries to personnel working with Class 3b and Class 4 lasers.

Policy: Within the controlled area, all personnel shall adhere to appropriate eye protection procedures during all laser applications.

NOTE: Under some conditions, the controlled area may include the entire room in which the laser procedure is performed. Under those conditions, the ocular safety procedures listed in this Sample 2 apply to the entire room. In health care facilities, ocular safety procedures shall also apply to the patient receiving laser treatment.

All personnel involved in maintenance and demonstrations of laser systems shall follow all ocular safety procedures whenever a laser is in operation in the facility.

Procedure:

1) Appropriate eyewear shall be worn by everyone in the controlled area while the laser is in operation. Appropriate eyewear consists of glasses or goggles of sufficient optical density to prevent ocular damage at the laser wavelength in use. Exception to this is the operator looking through an attached microscope with a lens that has the appropriate optical density for the laser in use.

2) Prior to use, the operator and ancillary personnel shall be responsible for selecting and examining eyewear for comfort, proper fit, and presence of labels describing both wavelength and proper optical density.

3) If eyewear is damaged, it shall not be worn and a report shall be made to the laser safety officer.

4) Contact lenses are not acceptable as protective eyewear. Prescription lens wearers shall use appropriate laser safety eyewear.

5) All goggles shall have side shields to protect from peripheral injury and impact.

6) Any articulated arm that is not shuttered shall be capped when not connected to the hand piece or the operating microscope.

7) The laser system shall be placed in standby mode when delivery optics are moved away from the target.

8) In health care facilities, patients shall be fitted with appropriately labeled eyewear, or have their eyes covered with wet cloth pads or towels. Metal or dry materials shall be placed on the patient's face or eyes only when indicated.

SAMPLE 3: Handling of Laser Fiber Delivery Systems in Health Care Facilities

Purpose: To promote safe and proper handling of laser fiber delivery systems and to limit the potential for fiber breakage, damage and reduced efficiency during clinical laser procedures.

Policy: Personnel handling laser fibers shall assure compliance with all safety procedures and shall consider the fiber an extension of the laser system, governed by applicable standards and regulations.

Procedure:

1) Appropriate eye safety filters shall be used with endo/microscopes.

2) Laser room windows shall be covered completely with appropriate filters, if necessary.

3) Fibers and associated equipment shall be positioned to allow for safe traffic patterns in the room.

4) The fiber shall be examined for breaks or damage of the distal tip, the proximal connector and the catheter sheath. Fiber shall be calibrated in accordance with manufacturer's directions. If deficiencies or damage are noted, another fiber shall be obtained.

5) Do not use clamps or other instruments to secure fiber in the operative site.

6) Always use coaxial cooling that is appropriate to the procedure. Never use gas to purge a fiber in the intrauterine cavity.

7) Never operate the laser unless the aiming beam (if used) and the tip of the fiber beyond the end of the endoscope are both visible.

8) Monitor the fiber for distortion of the beam, decreased power transmission and accumulation of debris on the tip.

9) Never reuse a disposable fiber without manufacturer's directions.

10) Always put the laser in standby when not aimed at a target.

SAMPLE 4: Non-Beam Hazards in Health Care Facilities

Purpose: To recognize and effectively deal with a variety of potential non-beam hazards that may be present during laser procedures.

Policy: Non-beam hazards are the purview of safety and industrial hygiene personnel, who will effect the appropriate hazard evaluation and control.

Procedure:

I. Fire

1) Never use alcohol in the operative field. Fibers may be rinsed in hydrogen peroxide or saline intraoperatively.

2) Never place a hot fiber directly on paper drapes. Wait until tip is cool before contact is made with flammable material.

3) Use fire-retardant drapes, damp packs or pads. Fill pelvic cavity with Ringer's, saline or other appropriate solution during surgery.

4) Put laser system in standby mode when procedure is interrupted or terminated.

5) Avoid high levels of oxygen in the operative field.

6) Avoid laser beam exposure of the sheaths of flexible fiber endoscopes, since many of the sheaths are flammable.

II. Plume Management

1) Remove laser generated airborne contaminants from the laser target area to reduce the transmission of potentially hazardous particles.

2) Position smoke evacuator in the operating room whenever a plume is anticipated.

3) Check operation of the plume management system prior to the beginning of a procedure.

4) Check the plume filter monitor and, if needed, install a clean filter.

5) In-line filters with minimum 0.3 μm filtration shall be placed between wall suction and the fluid canister for:

a) Suction line not connected to evacuator

b) Procedures producing minimal plume

c) Failure of evacuator before or during operation

6) Distal collection port shall be no more than 2 cm from impact site when practical.

7) All tubing, connectors, adaptors and wands will be changed between patients and disposed of according to biohazard procedures.

III. Electrical Shock

1) During service or maintenance, precautions shall be taken against electrical shock that may be fatal.

2) Medical lasers shall be installed and operated in conformity with the National Electrical Code.

SAMPLE 5: Work Practices for Optical Fiber Communications Systems (OFCS)

Purpose: To recognize and effectively deal with a variety of potential hazards that may be present when working on an OFCS.

Policy: Engineering controls shall not take the place of good work practices. Good work practices are essential to operating, servicing and maintaining OFCS, especially with higher power systems that utilize Class 3b and Class 4 lasers.

Procedure: The following presents some basic guidelines when working on any OFCS.

1) Trained Personnel. Only authorized, trained personnel shall be permitted to install or perform service on OFCS containing Class 3b or Class 4 lasers.

2) Unterminated Fibers

a) Do not view the end of a fiber with unprotected eye. Fiber should only be viewed with an indirect image converter or with a filtered optical instrument or optical density (OD) sufficient to reduce the exposure to levels below the appropriate MPE.

b) Always cover the ends of unterminated fibers with a splice protector, tape or end caps.

3) Splicing. Splicing on ribbon cables, fixed array cables or OFCS containing Class 3b or Class 4 lasers shall be de-energized or viewing systems incorporating personal protection shall be employed.

4) Installation and Testing. The laser source shall be first to be disconnected and last

to be connected when installing and/or testing an OFCS.

5) Modifications. No modifications shall be made to the OFCS or associated equipment without management or supervision authorizations. Such modifications may alter the service group classification of the OFCS.

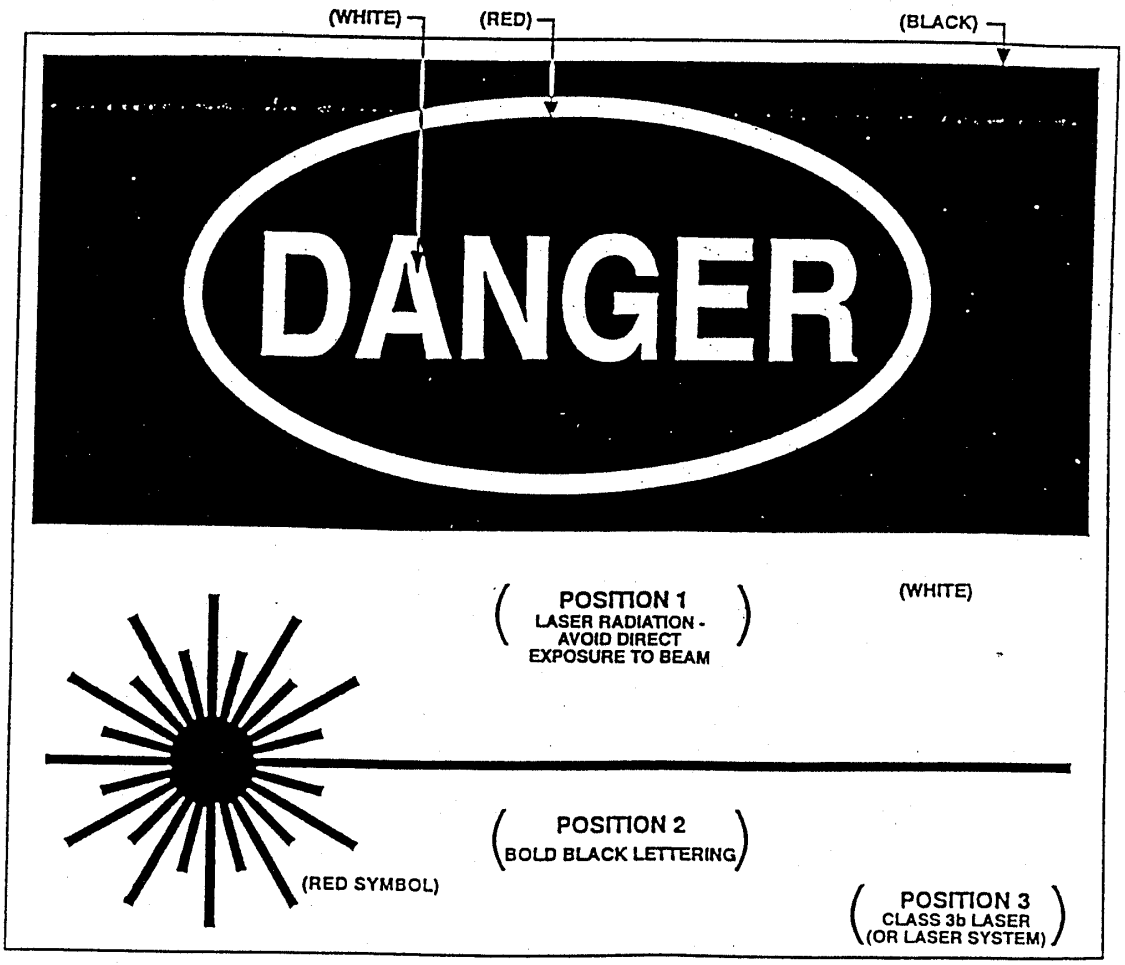
6) Labels. Any damaged or missing optical safety labels shall be reported immediately to the supervisor.

7) Other Hazards

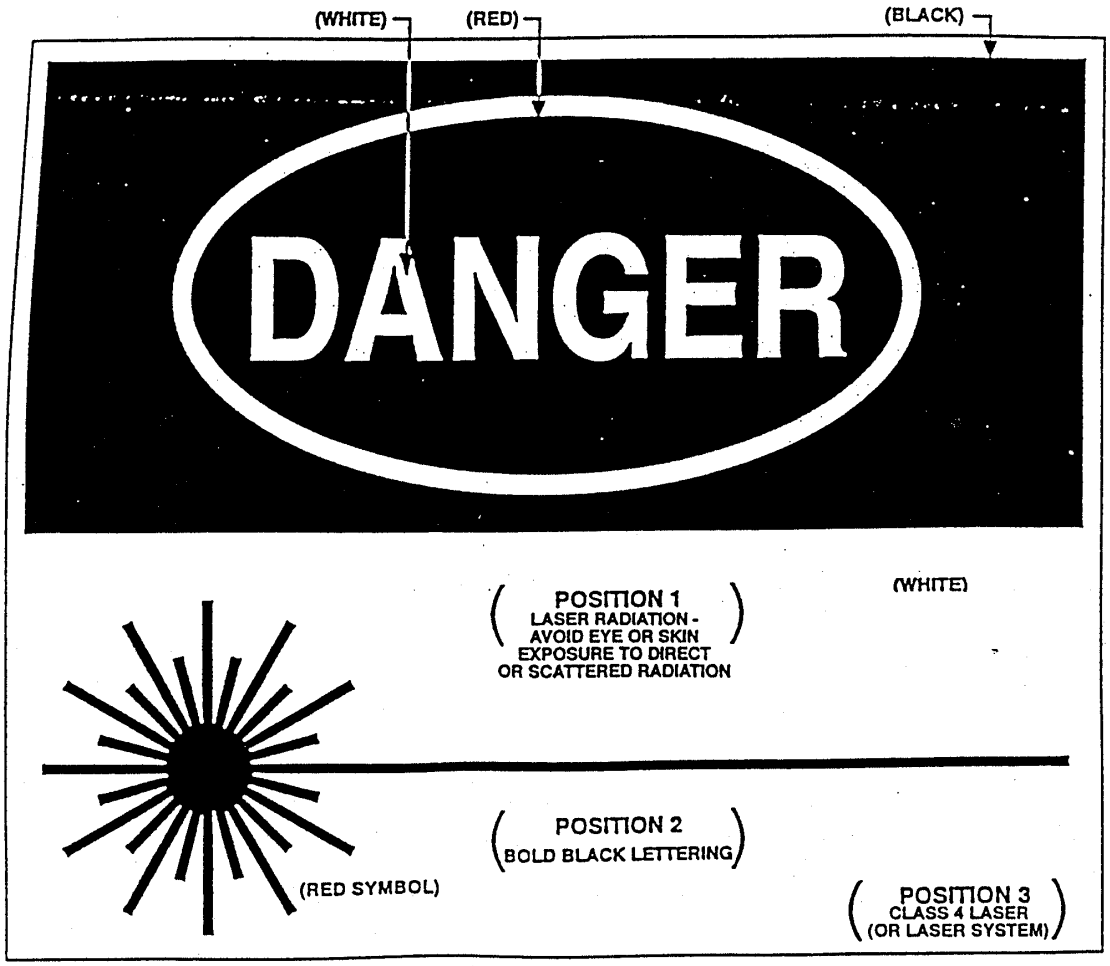
   a) Use of protective guards or shields shall be used during splicing and cleaving operation to prevent direct injury from small lengths or particles of fiber. Proper disposal of fiber pieces avoids subsequent embedding in clothing or skin.

   b) Optical photocuring may present a UV or light source hazard. Protective filter lenses of the appropriate optical density shall be worn if viewing of the light source is probable.

Section 315.ILLUSTRATION A Sample Warning Sign for Class 3b Laser Facilities



Section 315.ILLUSTRATION B Sample Warning Sign for Class 4 Laser Facilities



Section 315.TABLE A MPE for Ocular Exposure (Intrabeam Viewing)

Ultraviolet

Wavelength (μ m)	Exposure Duration, t^s	MPE ($J\ cm^{-2}$)	MPE ($W\ cm^{-2}$)
0.180 to 0.302	10^{-9} to 3×10^4	3×10^{-3}	
0.303	10^{-9} to 3×10^4	4×10^{-3}	
0.304	10^{-9} to 3×10^4	6×10^{-3}	
0.305	10^{-9} to 3×10^4	10×10^{-3}	
0.306	10^{-9} to 3×10^4	16×10^{-3}	
0.307	10^{-9} to 3×10^4	25×10^{-3}	
0.308	10^{-9} to 3×10^4	40×10^{-3}	
0.309	10^{-9} to 3×10^4	63×10^{-3}	
0.310	10^{-9} to 3×10^4	0.1	
0.311	10^{-9} to 3×10^4	0.16	
0.312	10^{-9} to 3×10^4	0.25	
0.313	10^{-9} to 3×10^4	0.40	
0.314	10^{-9} to 3×10^4	0.63	
0.315 to 0.400	10^{-9} to 10	$0.56\ t^{¼}$	
0.315 to 0.400	$10 \times 3 \times 10^4$	1.0	

NOTE: To calculate MPE, use the $J\ cm^{-2}$ value shown or $0.56\ t^{¼}$, whichever is lower.

Visible and Near Infrared

Wavelength (μ m)	Exposure Duration, t^s	MPE ($J\ cm^{-2}$)	($W\ cm^{-2}$)
0.400 to 0.700	10^{-9} to 18×10^{-6}	0.5×10^{-6}	
0.400 to 0.700	18×10^{-6} to 10	$1.8\ t^{¾} \times 10^{-3}$	
0.400 to 0.550	10 to 10^4	10×10^{-3}	
0.550 to 0.700	10 to T_1	$1.8\ t^{¾} \times 10^{-3}$	
0.550 to 0.700	T_1 to 10^4	$10C_B$ to 10^{-3}	
0.400 to 0.700	10^4 to 3×10^4		$C_B \times 10^{-6}$
0.700 to 1.050	10^{-9} to 18×10^{-6}	$0.5C_A \times 10^{-6}$	
0.700 to 1.050	18×10^{-6} to 10^3	$1.8C_A\ t^{¾} \times 10^{-3}$	
0.700 to 1.050	10^3 to 3×10^4		$320C_A \times 10^{-6}$
1.050 to 1.400	10^{-9} to 50×10^{-6}	$5C_c \times 10^{-6}$	
1.050 to 1.400	50×10^{-6} to 10^3	$9.0C_c\ t^{¾} \times 10^{-3}$	
1.050 to 1.400	10^3 to 3×10^4		$1.6C_c \times 10^{-3}$

NOTES:
1. See Section 315.Tables D & E for limiting apertures (see ANSI Z136.1 pg. 44).
2. For multiple pulses, apply correction factor C_p given in Section 315.Table C.
3. For information on correction factors T_1, C_B, C_A, C_p and C_c, see Section 315.Table C.

Far Infrared

Wavelength (μ m)	Exposure Duration, t^s	MPE ($J\ cm^{-2}$)	MPE ($W\ cm^{-2}$)
1.400 to 1.500	10^{-9} to 10^{-3}	0.1	
1.400 to 1.500	10^{-3} to 10	0.56 $t^{¼}$	
1.400 to 1.500	10 to 3 x 10^4		0.1
1.500 to 1.800	10^{-9} to 10	1.0	
1.500 to 1.800	10 to 3 x 10^4		0.1
1.800 to 2.600	10^{-9} to 10^{-3}	0.1	
1.800 to 2.600	10^{-3} to 10	0.56 $t^{¼}$	
1.800 to 2.600	10 to 3 x 10^4		0.1
2.600 to 10^3	10^{-9} to 10^{-7}	10 x 10^{-3}	
2.600 to 10^3	10^{-7} to 10	0.56 $t^{¼}$	
2.600 to 10^3	10 to 3 x 10^4		0.1

NOTES:
1. See Section 315.Tables D & E for limiting apertures (see ANSI Z136.1 pg. 44).
2. For multiple pulses, apply correction factor C_p given in Section 315.Table C.

GENERAL NOTES:
1. The MPE for diffuse reflections at wave lengths between 0.400 and 1.400 μm is obtained by multiplying the corresponding MPEs above by C_E (see Section 315.Table C for correction factors and T_1).
2. For repeated (pulsed) exposures, see ANSI Z136.1.
3. For purposes of this Section 315.Table A, the following abbreviations or symbols are used:

μm	=	micrometers
t^s	=	time in seconds
J	=	joules
W	=	watts
cm	=	centimeters

Section 315.TABLE B MPE for Skin Exposure

Ultraviolet

Wavelength (μm)	Exposure Duration, t^s	MPE (J cm^{-2})	MPE (W cm^{-2})
0.180 to 0.302	10^{-9} to 3×10^4	3×10^{-3}	
0.303	10^{-9} to 3×10^4	4×10^{-3}	
0.304	10^{-9} to 3×10^4	6×10^{-3}	
0.305	10^{-9} to 3×10^4	1.0×10^{-2}	
0.306	10^{-9} to 3×10^4	1.6×10^{-2}	
0.307	10^{-9} to 3×10^4	2.5×10^{-2}	
0.308	10^{-9} to 3×10^4	4.0×10^{-2}	
0.309	10^{-9} to 3×10^4	6.3×10^{-2}	
0.310	10^{-9} to 3×10^4	1.0×10^{-1}	
0.311	10^{-9} to 3×10^4	1.6×10^{-1}	
0.312	10^{-9} to 3×10^4	2.5×10^{-1}	
0.313	10^{-9} to 3×10^4	4.0×10^{-1}	
0.314	10^{-9} to 3×10^4	6.3×10^{-1}	
0.315 to 0.400	10^{-9} to 10	$0.56\ t^{¼}$	
0.315 to 0.400	10×10^3	1	
0.315 to 0.400	10^3 to 3×10^4		1×10^{-3}

NOTES: 1. To calculate MPE, use the J cm^{-2} value shown or $0.56\ t^{¼}$, whichever is lower.

2. 3.5 mm limiting aperture (see Section 315.Table D).

Visible and Near Infrared

Wavelength (μm)	Exposure Duration, t^s	MPE (J cm^{-2})	MPE (W cm^{-2})
0.400 to 1.400	10^{-9} to 10^{-7}	$2C_A \times 10^{-2}$	
	10^{-7} to 10	$1.1C_A\, t^{¼}$	
	10 to 3×10^4		$0.2C_A$

NOTE: 3.5 mm limiting aperture (see Section 315.Table D).

Far Infrared

Wavelength (μm)	Exposure Duration, t^s	MPE (J cm^{-2})	MPE (W cm^{-2})
1.400 to 10^3	10^{-9} to 10^{-7}	10^{-2}	
	10^{-7} to 10	0.56 $t^{¼}$	
	>10		0.1

NOTE: See Section 315.Table D for limiting apertures.

GENERAL

NOTE: 1. For purposes of this Table, the following abbreviations are used:

μm	=	micrometers
t^s	=	time in seconds
J	=	joules
W	=	watts
cm	=	centimeters
mm	=	millimeter

Section 315.TABLE C Parameters and Correction Factors

Correction Factor	Wavelength (μm)
$T_1 = 10 \times 10^{20\lambda-0.550}$	0.550 to 0.700
$C_B = 1.0$	0.400 to 0.500
$C_B = 10^{15\ \lambda-0.550}$	0.550 to 0.700
$C_A = 1.0$	0.400 to 0.700
$C_A = 10^{2\ \lambda-0.700}$	0.700 to 1.050
$C_A = 5.0$	1.050 to 1.400
$C_p = n^{-14}$	0.400 to 1000
$C_E = 1.0\ \alpha < \alpha_{min}$	0.400 to 1.400
$C_E = \alpha/\alpha_{min}$	0.400 to 1.400
Where: $\alpha_{min} < \alpha < \alpha_{max}$	
$C_E = \alpha^2/(\alpha_{max} \times \alpha_{min})$	0.400 to 1.400
Where: $\alpha > \alpha_{max}$	
$C_c = 1.0$	1.050 to 1.150
$C_c = 10^{18\ \lambda\ -1.150}$	1.150 to 1.200
$C_c = 8$	1.200 to 1.400

NOTES: 1. For pulse repetition frequencies below 55 kHz (0.4 to 1.05 μm) and below 20 kHz (1.05 to 1.4 μm) see ANSI A136.1.

2. For wavelengths between 0.400 and 1.400 μm:

α_{min} = 1.5 mrad for $t \leq 0.7$ s
α_{min} = $2\ t^{¾}$ mrad for 0.7 s < t <10 s
α_{min} = 11 mrad for t < 10 s
α_{max} = 100 mrad

3. For purposes of this Section 315.Table C, the following abbreviations or symbols are used:

λ	=	wavelength in μm
n	=	number of pulses
α	=	angular subtense (mrad)
t	=	time
t^s	=	time in seconds
s	=	seconds
μm	=	micrometers
Min	=	minimum
Max	=	maximum
mrads	=	milliradians
kHz	=	kilohertz

Section 315.TABLE D Limiting Apertures for Hazards Evaluation and AEL Determination

Spectral Region (μm)	Duration (s)	Aperture Diameter (mm) Eye	Skin
0.180 to 0.400	10^{-9} to 0.25	1.0	3.5
	0.25 to 3 x 10^{4}	3.5	3.5
0.400 to 1.400	10^{-9} to 3 x 10^{4}	7.0	3.5
1.400 to 10^{2}	10^{-9} to 0.3	1.0	3.5
	0.3 to 10	1.5 $t^{3/8}$	3.5
	10 to 3 x 10^{4}	3.5	3.5
10^{2} to 10^{3}	10^{-9} to 3 x 10^{4}	11.0	11.0

NOTES:

1. Under normal conditions these exposure durations would not be used for hazard evaluation (see ANSI Z136.1 (Table 8)).

2. For purposes of this Section 315.Table D, the following abbreviations or symbols are used:

   μm = micrometers
   s = seconds
   mm = millimeters
   t^{s} = time in seconds

Section 315.TABLE E Measurement Apertures for Classification

Spectral Region (μm)	Duration (s)	Aperture Diameter (mm)
0.180 to 0.302	10^{-9} to 0.25	1.0
	0.25 to 3 x 10^{4}	3.5
0.302 to 2.8	10^{-9} to 3 x 10^{4}	50.0
2.8 to 10^{2}	10^{-9} to 0.3	1.0
	0.3 to 10	1.5 $t^{3/8}$
	10 to 3 x 10^{4}	3.5
10^{2} to 10^{3}	10^{-9} to 3 x 10^{4}	11.0

NOTES: 1. These apertures are used for the measurement of optical power or energy for purposes of laser classification

2. When the laser output is intended to be viewed with optics (excluding ordinary eyeglasses) or the laser safety officer determines that there is reasonable probability of accidental viewing with optics, a 50 mm aperture is used if the following conditions are met.

   A) Viewing with optics presents a more severe hazard than unaided viewing.

   B) The viewing time is sufficient to constitute a hazard.

3. Under normal conditions these exposure durations would not be used for classification (see ANSI Z136.1 (Table 9)).

4. For purposes of this Section 315.Table E, the following abbreviations or symbols are used:

   μm = micrometers
   s = seconds
   mm = millimeters
   t^{s} = time in seconds