

DEPARTMENT OF HEALTH
DIRECTORATE: RADIATION CONTROL

**REQUIREMENTS FOR THE SAFE USE OF
LASERS FOR DEMONSTRATION PURPOSES**

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1. SCOPE

The laser power needed to produce effective theatrical or artistic displays in large spaces such as theaters, arenas or architectural sites may be large enough to pose a severe accidental exposure hazard even when the exposure is very brief. For this reason, special control measures are required.

2. OBJECTIVE

These requirements have to be met by those who operate lasers for display and entertainment purposes, by those who operate arenas, theatres, discotheques or other places where such lasers may be installed and operated, and by those who are responsible for reviewing the safety of such equipment, installations or displays.

The objective of these requirements is to prescribe safety measures for the protection of the public and persons in the vicinity of laser displays. **This document is a supplement to the document “*Requirements for the safe use of laser products*”.**

These requirements do not include the display or demonstration of scientific, medical or industrial laser products at trade shows, conferences, etc.

3. DEFINITIONS

For the purposes of this document, the following definitions apply:

Accessible radiation. The radiation that can reach the human eye or skin during normal use.

Ancillary personnel. Personnel who may be working at the venue or facility at which a laser display or light show is being set up or presented (including ushers, security guards, technicians, food and beverage suppliers, etc).

Barrier. Device to separate spectators from zones where potentially harmful laser radiation may occur. Barriers shall be constructed in such a way as to prevent being readily displaced or traversed by spectators.

Controlled area. An area where the occupancy and activity of those within it are subject to control and supervision for the purpose of protection from radiation hazards.

Demonstration laser product. Any laser product manufactured, designed, intended, or promoted for purposes of demonstration, entertainment, advertising display, or artistic composition.

Laser. A device which produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions. An acronym for Light Amplification by Stimulated Emission of Radiation.

Laser safety officer (LSO). A person who has authority to monitor and enforce the control of laser hazards and has the responsibility for oversight of the control of laser hazards.

Laser system. An assembly of electrical, mechanical, and optical components which includes a laser.

Mask (Baffle). Sheet of material (often with a small aperture in the center for the passage of the useful laser beam) designed to stop a laser beam travelling in unwanted directions. A mask shall be capable of withstanding the maximum anticipated level of laser radiation without penetration of the material occurring.

Operation. The performance of the laser system over the full range of its intended function (normal operation). It does not include maintenance or service.

Operator. Person who has direct operational control of the laser projection system.

Performers. Persons who entertain the public during a show. They may be dancers, singers, musicians, etc.

Reflection. Deviation of the direction of radiation following incidence on a surface.

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

Shall. The word "shall" is to be understood as mandatory.

Should. The word "should" is to be understood as a recommendation.

Spectator. An individual who wishes to observe or watch a laser system in operation, and who may lack the appropriate laser safety training.

Specular reflection. A mirrorlike reflection.

Ultraviolet radiation. Electromagnetic radiation with wavelengths smaller than those of visible radiation; for the purpose of this requirements, 180 to 400 nm.

Visible radiation (light). Electromagnetic radiation which can be detected by the human eye. The term is commonly used to describe wavelengths that lie in the range 400 to 700 nm.

Wavelength. The distance between two successive points on a periodic wave which have the same phase.

4. CONTROL MEASURES

The following control measures shall be employed for those situations where laser or laser systems are used for trade show demonstration, artistic light performances, planetarium laser shows, discotheque lighting, stage lighting effects and similar special lighting effects that uses lasers or laser systems emitting in the visible wavelength range (400 to 700 nm).

4.1 Operational Requirements

Only **Class 1** lasers or laser systems shall be used for general public demonstrations, display or entertainment in unsupervised areas **without any control measures**.

The use of **Class 2 and Class 3a** lasers or laser systems shall be limited to installations that prevent access to the direct or specularly reflected beams or where the accessible radiation is maintained at the **distance requirements** specified in 4.1.1.

The use of **Class 3b or Class 4** lasers or laser systems shall be permitted only when the LSO has assured that appropriate controls specified in the “**Requirements for the safe use of laser products**” are incorporated which provide for adequate protection to the general public, and subject to the following conditions:

- The laser installation shall be under the control of an experienced, trained operator as specified in 4.1.2.
- In the case of an unsupervised laser installation a designated person, present at all times during the show or display, shall be responsible for the immediate termination of the laser equipment in the event of equipment malfunction, audience unruliness, or any other potentially unsafe condition.

4.1.1 Unsupervised Laser Installations

If a laser demonstration using Class 2, Class 3a, Class 3b or Class 4 laser is not operated at all times under the direct supervision or control of an experienced, trained operator, the accessible laser radiation shall be limited by barriers, windows, or other means so as not to exceed the permissible exposure limit for Class 1 lasers. This limitation applies at any point less than 6 m above any surface upon which a person in the general public is permitted to stand and to any point less than 2,5 m in lateral separation from any point where a person in the general public is permitted to be present during the performance or display.

4.1.2 Supervised Laser Installations

Laser demonstrations which do not meet the criteria stated in 4.1.1 shall be operated at all times under the direct supervision or control of an experienced, trained operator who shall maintain constant surveillance of the laser display and terminate the laser emission in the event of equipment malfunction, audience unruliness or any other potentially unsafe condition.

The operator shall be able to see the entire area illuminated by the laser. If obstacles or size preclude visual access by the operator, then multiple observers shall be used, with a communication link to the operator. In the case of such supervised installations the accessible laser radiation shall be limited by barriers, windows or other means so as to not exceed the permissible exposure limit for Class 1 lasers at any point unless the following requirements are met:

- The accessible laser radiation is maintained a minimum distance of 3,0 m above any surface upon which the general public would be able to stand during a performance or demonstration.
- The accessible laser radiation is maintained a minimum distance of 2,5 m in lateral separation from any position where the general public is permitted to be present during the performance or demonstration.

As a general practice, the largest practical vertical and lateral separation distances should be employed wherever possible. However, if specific physical limitations of the space in which the lasers are to be used preclude compliance with the required minimum separation specified above, shorter separation distances may be utilised, provided that the LSO assures that alternative measures are established which assure an equivalent degree of protection to the general public.

4.2 Invisible Laser Emission Limitations

Ultraviolet projections are sometimes employed to excite fluorescence from screens or specially prepared targets. Particular care needs to be taken in such situations since the invisible radiation gives no forewarning of its presence. The general public shall not be exposed to laser radiation at wavelengths outside the visible range (400 to 700 nm) at levels exceeding the permissible exposure limit for Class 1 lasers under any possible conditions of operation.

4.3 Optical Radiation for the General Public

Laser radiation in the location where the general public is normally allowed shall not exceed the permissible exposure limit for Class 1 lasers during operation. Laser radiation to be considered shall include reflections from all possible surfaces and scattering materials.

4.4 Operator and Performers

All operators, performers and employees shall be able to perform their required functions without the need for exposure to laser radiation levels in excess of the permissible exposure limit for Class 1 lasers.

4.5 Scanning Devices

Scanning devices, including rotating mirrored balls, shall incorporate a means to prevent laser emission if scan failure or other failure resulting in a change in either scan velocity or amplitude could result in failure to fulfill the criteria in 4.3 and 4.4.

4.6 Beam Termination

All laser demonstration systems shall be provided with a readily accessible means to effect immediate termination of the laser radiation. If the demonstration does not require continuous supervision or operator control during its operation, a designated person, present at all times during the show or display, shall be responsible for the immediate termination of the laser radiation in the event of equipment malfunction, audience unruliness or any other potentially unsafe condition.

4.7 Maximum Power

The maximum output power of the laser shall be limited to the level required to produce the desired and intended effect within the requirements outlined in 4.1 through 4.6.

4.8 Posting of Warning Signs

If the laser installation fulfills all requirements as detailed in 4.1 through 4.7 then posting of area warning signs shall not be required except for Class 3b and Class 4 laser installations as described in the document "***Requirements for the safe use of laser products***".

4.9 Licensing

The LSO shall be responsible for complying with all the relevant licensing requirements of the Department of Health, Directorate: Radiation Control.

4.10 Other Outdoor Control Measures

Notification shall also be given, where applicable, to:

- aviation authorities for projections into navigable airspace ;
- maritime authorities for projections into navigable waterways or harbors;
- other relevant authorities for projections over rivers, lakes, shore or waterfront locations.

Notification to local aviation control authorities of planned projections into navigable airspace may also require the inclusion of geographical coordinates of the location and the azimuth and elevations of planned projections.

Note that directing a laser beam at motor vehicles, aircraft or other manned vehicles or structures is prohibited.

4.11 Engineering Control

Laser apertures shall be masked using material sufficiently robust to withstand direct exposure to the laser radiation for extended periods of time. The mask shall be positioned to confine the projections to the intended directions and to prevent errant laser radiation.

Targets shall be appropriately masked to prevent misdirection of the laser beam in the event that the laser becomes misaligned with the target.

Laser projectors, mirrors and targets shall be rigidly mounted to prevent movement as a result of vibration, jarring or the wind.

Each laser installation shall be provided with one or more clearly identifiable and easily operated emergency shut-off controls that immediately terminate the laser radiation when required.

4.12 Training

Designers, modifiers, installers and operators shall have received sufficient training in laser safety to be able to accurately assure that the permissible exposure level of laser radiation is not exceeded in spectator occupied areas and that required separation are maintained between spectators and projections that exceed this level.

Installers, performers and ancillary personnel shall be instructed in procedures to avoid exposure in areas in which laser radiation levels exceed the permissible exposure and in the proper use of safety equipment.

4.13 Set-up and alignment

Ample time should be provided for set-up and alignment. The area should be cleared of unnecessary personnel. Locations where the levels of laser radiation may exceed the permissible exposure shall be posted with appropriate warning signs and barriers erected to restrict entry.

Alignment should be made at the lowest possible emission levels. A check should also be made at full operating power at the conclusion of the alignment to identify any spurious beams so that corrective action may be taken.

During set-up and alignment when laser beams may be projected in other than their final intended directions, laser controlled areas shall be established and warning notices posted in accordance with section 4.8.

Checks should be made of controls including any scan failure safeguards to ensure proper operation. Checks should also be made that warning signs and barriers are in place as appropriate. Checks should be made that all components are securely mounted and locked into position.

Equipment shall be secured and protected against misalignment or maladjustment between alignment completion and productions. Installation of the equipment in a secured projection booth or the employment of security personnel may be necessary.

Coordination with safety and security personnel shall be established and agreement reached on steps to be taken for notifying the operator in the event of an emergency. Spectators shall not be presumed to be cooperative with laser safety procedures or to be aware of proper procedures to follow to protect themselves from exposure or to avoid exposing others to hazards. Spectators shall not be permitted to bring items, such as reflective balloons, into the show site if overhead beam projections are to be used.

The operator should have copies of any official clearances, records of alignment and operational checks, and operating instructions in his or her possession at the show site.

4.14 Operation

The laser safety officer shall maintain a safety record at the show containing full and detailed information on laser safety. The record for each entertainment display should be kept up to date at all stages of implementation i.e. initial design, planning, set-up, alignment, modification and operation.

Prior to beginning high power operation, the operator shall, if at all possible, perform a final power alignment check to assure that components have not moved since completion of the set-up.

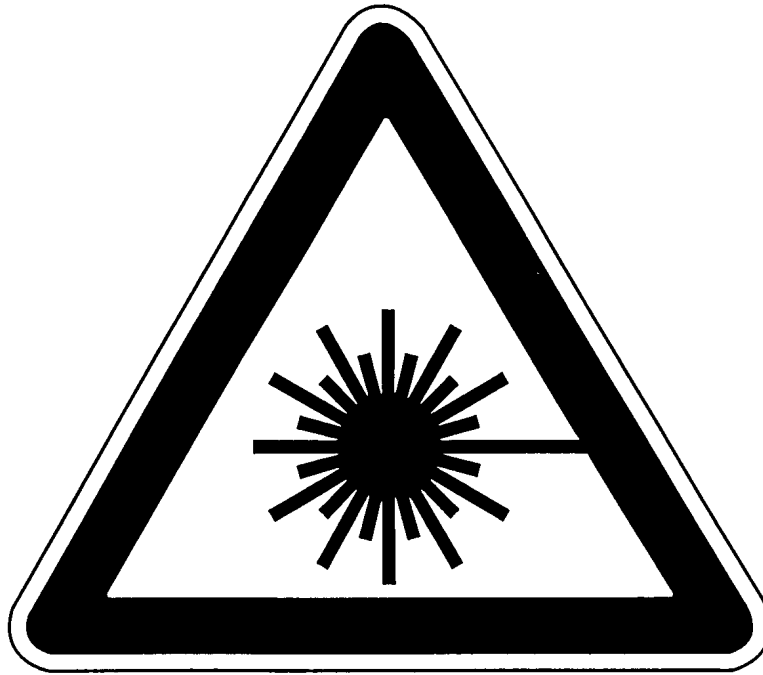
The operator shall make certain that there is visual control of all projections during the show or display operation. It is acceptable to employ observers who are in immediate communication with the operator if the operator cannot maintain personal visual control.

The operator shall be prepared to immediately terminate any projections that create a hazard as a result of any emergency such as unruly behavior of the spectators. An emergency is considered to be any situation that may result in possible exposure of spectators, performers or operators to laser radiation at levels exceeding the permissible exposure limit.

4.15 Special considerations

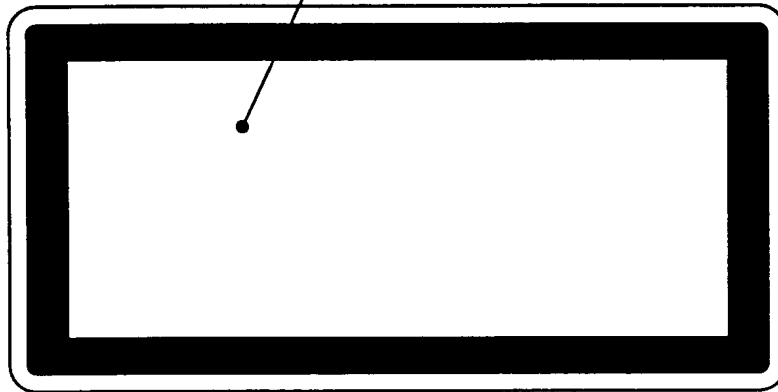
Holographic displays

Special consideration may be necessary for displays that are reconstructions of holographic images. Care shall be taken that laser beams used for reconstructions do not emerge in such a way that they can expose spectators or other persons to levels in excess of the permissible exposure limit for Class 1 lasers.



SYMBOL AND BORDER : BLACK
BACKGROUND : YELLOW

SPACE FOR LEGEND



LEGEND AND BORDER : BLACK
BACKGROUND : YELLOW