STUK

GUIDE **ST 9.4** / 30 April 2015

RADIATION SAFETY OF LASER DISPLAYS AND SHOWS

This Guide is valid as of 15 June 2015 until further notice.It replaces Guide ST 9.4, Radiation safety of high power display lasers, issued on 28 February 2007.

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Authorization

The Radiation Act stipulates that the party running a radiation practice is responsible for the safety of the operations. The responsible party is obliged to ensure that the level of safety specified in the ST Guides is attained and maintained.

Under section 70, paragraph 2, of the Radiation Act (592/1991), STUK – Radiation and Nuclear Safety Authority (Finland) issues general instructions, known as Radiation Safety Guides (ST Guides), concerning the use of radiation and operations involving radiation.

Translation. In the event of any differences in interpretation of this guide, the Finnish and Swedish versions shall take precedence over this translation.

1 General

Laser equipment used in public shows may cause a hazardous situation, particularly if a laser beam hits the eye directly or after reflection from a surface. A laser beam hitting the eye may damage the retina, and if the area of acute vision is damaged, vision will be impaired considerably. Even laser exposures lower than the exposure limits may cause temporary vision problems, such as dazzling, flash blindness and after-images. High-power laser beams may also burn the skin and cause a fire hazard. In addition, the use of laser beams in outdoor shows may affect air traffic safety and/or smoothness. Any activities that pose a risk to air traffic or disturb its smoothness are prohibited under the Aviation Act.

This Guide presents the requirements concerning laser shows at public events and the radiation safety of the audience facilities, environment and laser equipment. The Guide applies to both indoor and outdoor shows.

The definitions concerning this Guide are provided in Appendix A.

The bases for the regulatory control mandate of the Radiation and Nuclear Safety Authority (STUK) for laser radiation are regulated by the Radiation Act (592/1991) and the Ministry of Social Affairs and Health's Decree on the Supervision of Non-Ionizing Radiation (1306/1993).

STUK must inspect high-power laser equipment to be used in commercials, shows or other applications in which the public may be exposed to their radiation. This is regulated by the Decree on the Supervision of Non-Ionizing Radiation (1306/1993).

The maximum values of laser radiation for members of the public are regulated by the Ministry of Social Affairs and Health's Decree on the Limitation of Public Exposure to Non-Ionizing Radiation (294/2002).

The maximum values of laser radiation for employees are regulated by the Government Decree on the protection of workers from the risks of exposure to optical radiation (146/2010).

The requirements for battery-operated laser equipment are regulated by the Government Decree on laser equipment and its inspection (291/2008). The Decree also contains requirements concerning the use of laser equipment.

Activities that pose a risk to air traffic or affect its smoothness are regulated by the Aviation Act (864/2014).

2 The responsible party is liable for the safety of the laser show

The responsible party has the obligation to ensure that the laser show is organised safely and such that the level of safety meeting the requirements presented in this Guide is achieved.

The laser show must be planned and implemented such that the maximum permissible exposure values of laser radiation for members of the public and employees are not exceeded (item 4.1).

The responsible party must ensure, among other things, the following:

- the risks relating to the safety of the laser show have been identified and their significance has been assessed
- any abnormal events during both installation and the show itself have been identified in advance and the potential exposure caused by them has been assessed
- the possibility of abnormal events has been prevented as efficiently as possible, and the actions required by them have been planned in advance
- any abnormal events are reported to STUK (item 4.6)
- the equipment is used by persons who have received orientation in radiation safety and who have sufficient information for the safe installation and operation of the equipment (item 4.2)
- operating instructions and radiation safety instructions have been prepared for the equipment (item 4.5).

The responsible party is obliged to notify STUK of each laser show. For outdoor laser shows, the responsible party is also obliged under the Aviation Act to notify the air traffic service provider (Finavia Oyj) of the planned activities; refer to Chapter 5 for more information.

The radiation safety of the laser show is the responsibility of the responsible party referred to in the Radiation Act (592/1991).

3 Equipment safety

3.1 Laser equipment must meet the European requirements

The general requirements for the structure and accessories of laser equipment are based on the European Council's Low Voltage Directive (2006/95/EC) and the standards relating to its application.

The structure, accessories, warning signs and operating instructions of laser equipment are covered by Harmonised European Standard EN 60825-1. The safety classes of laser products defined in the standard are presented in Appendix B, the key requirements for radiation safety in Appendix C and warning signs in Appendix D.

In order to meet the requirements of the Low Voltage Directive, laser equipment must carry the CE mark indicating conformity to requirements, and a written Declaration of Conformity, prepared by the manufacturer or its representative in the European Economic Area, must be available for the equipment.

If the laser equipment is not within the scope of the Low Voltage Directive, its conformity to requirements must be demonstrated with a type inspection certificate.

In Finland, the Low Voltage Directive (2006/95/EC) has been introduced into the national legislation by amendments to the Electrical Safety Act (410/1996) and Electrical Safety Decree (498/1996).

The type inspection procedure is presented in the Government Decree on laser equipment and its inspection (291/2008).

3.2 Laser equipment transferor's obligations

The transferor of the laser equipment must ensure that an appropriate Declaration of Conformity has been provided for the equipment and it carries the CE mark or its conformity to requirements has been demonstrated in some other way (item 3.1).

If laser equipment already transferred to the market is re-transferred, the re-transferor must ensure that the equipment conforms to the safety requirements in the same way as it did when originally transferred to the market. In addition, it must be ensured that the equipment is accompanied with up-to-date installation and operational safety instructions. Where applicable, this also applies to the sales, rental and other transfer of laser equipment already in use. If modifications are made to the laser equipment that substantially affect its radiation safety, it shall be treated as new laser equipment.

Laser equipment to be decommissioned shall be taken to appropriate separate collection points or to retailers when purchasing corresponding new equipment.

4 Laser installation and operational safety of equipment

When installing lasers, it must be taken into account that the maximum permissible exposure values of laser radiation for members of the public and employees must not be exceeded in the venue. The installation must be performed by the person appointed for the task, who must control the danger areas during the show.

4.1 Maximum permissible exposure values must not be exceeded

In a show with operator in control, the laser operator and any auxiliary personnel see the entire area in which the laser beams are present. In this case, the maximum permissible exposure values defined in the EN 60825-1 standard must not be exceeded in the audience facilities up to a height of 3 metres in the vertical direction and up to a distance of 2.5 metres in the horizontal direction in areas in which the audience may stay (figures a) and b) in Appendix E). The maximum values are determined for a stationary beam with an exposure time of 10 seconds (s). In practice, this usually means that no laser beams must be present in areas in which the audience stays.

A laser beam should not be directed at people. The beam must be prevented from hitting the eye or skin, and placing it at the eye level must

be avoided.

However, if laser beams are directed at the public on purpose, the responsible party must specifically ensure that the maximum permissible exposure values of laser radiation are not exceeded. In this case, the responsible party must demonstrate by measurements that the exposure does not exceed the maximum permissible exposure values for laser radiation with an exposure time of 10 seconds. The measurements must be made before the show and presented to STUK for inspection.

The radiation exposure of non-protected performers, laser operators and other employees during the show must not exceed the maximum permissible exposure values defined in the EN 60825-1 standard. If it is necessary to look in the direction of the radiation, the maximum values shall be determined with an exposure time of 100 seconds. In other cases, the maximum values of employee radiation exposure in the wavelength range of visible light are determined with an exposure time of 0.25 seconds, which corresponds to the eye protection reflex (closing the eyes, turning the head away).

In an unattended show, the laser equipment operating personnel do not see the entire course of the laser beams; for example, in an outdoor show with non-terminated beams. The use of laser equipment without constant monitoring is only allowed when the height of the beams from the audience facilities exceeds 6 metres and outsiders cannot change the direction of the beams (Figure c) in Appendix E). Even in this case, the safety of the installation must be ensured by technical means or safety reviews.

The maximum values of laser radiation for members of the public are regulated by the Ministry of Social Affairs and Health's Decree on the Limitation of Public Exposure to Non-Ionizing Radiation (294/2002).

The maximum values of laser radiation for employees are regulated by the Government Decree on the protection of workers from the risks of exposure to optical radiation (146/2010).

The requirements for the use of laser equipment are regulated by the Government Decree on laser equipment and its inspection (291/2008).

4.2 Appointment and duties of the laser operator

The responsible party must appoint a laser operator under whose monitoring the laser equipment may be operated. The operator must be provided with appropriate orientation in the duties and laser safety.

Only the person appointed for the task is allowed to assemble the equipment and direct the laser beams. Only the persons necessary for the installation are allowed to be present at that time.

The laser operator's means of limiting exposure are presented in item 4.3, and the requirements for the marking and monitoring of danger areas are presented in item 4.4.

4.3 Means of limiting exposure

The laser operator must assess in advance the safety risks of the laser show (including installation and testing) and any related abnormal events. The assessments must be made according to instructions issued by the responsible party (also refer to Chapter 2 for the obligations of the responsible party).

The operation, direction and other control devices of the laser equipment must be located such that the maximum permissible exposure values for employees are not exceeded.

No radiation exceeding the radiation limits of Class 1M must be present at openings and screens intended for making observations. A description of laser classes is provided in Appendix B.

The intensity of the laser radiation must be adjusted such that it is as low as possible during the work. When the radiation from the equipment exceeds the maximum values set for classes 1M and 2M, safety goggles must be worn if possible.

Mirrors, mirror balls and other objects affecting the course of the beams must be fixed firmly and securely so that the direction of the beams does not change.

In indoor shows, and also in outdoor shows where applicable, the laser beams must be terminated by a non-reflective, fireproof material. Reflections to areas in which the audience stays

must be prevented.

Before the show, it must be ensured that the direction of the beams is correct and all safety equipment operates at the lowest possible power. In particular, the operation of the emergency stop switch must be checked.

When the equipment is not in operation, it must be locked or put in a locked state.

The maximum values of laser radiation for employees are regulated by the Government Decree on the protection of workers from the risks of exposure to optical radiation (146/2010).

4.4 Danger areas must be marked and controlled

The access routes to the location where the laser is used must be clearly marked with combination signs in accordance with the EN 60 825-1 standard, including the general laser radiation warning sign and a class-specific warning text. Appendix D shows the combination signs for lasers in safety classes 3B and 4.

Areas in which the maximum permissible exposure values for laser radiation may be exceeded must be determined and marked as clearly as possible. The danger areas must be in operator control, and the audience must be prevented from entering them.

The laser operator must control the equipment throughout the show, ensuring that it works safely and that the direction of the laser beams does not change during operation. If the operator cannot constantly see all laser effects personally, he/she must have assistants who are in direct contact with him/her.

General instructions on warning signs and their use are provided in Guide ST 1.3, Warning signs for radiation sources.

4.5 Operating instructions must be prepared for the equipment

The responsible party must prepare installation and operational safety instructions for the use of the equipment. The instructions must include the necessary information on the following:

- laser equipment installation
- maintenance
- technical protective devices
- operation-related precautions
- preparation for and reporting of abnormal events
- laser equipment radiation properties; needed to assess the safety of the equipment.

The installation and operational safety instructions must always be at hand during the operation of the equipment. The instructions must be prepared in a language understood by the persons installing and operating the equipment.

4.6 Abnormal events

Abnormal events, such as damage and hazards, must be prepared for (Chapter 2), and instructions for responding to them must be included in the operational safety instructions (item 4.5).

The show must be interrupted immediately in the event of an abnormal event in which the audience and/or an employee has or may have been exposed to laser radiation. In such cases, it must be assessed whether the maximum permissible exposure values for laser radiation have been exceeded.

Abnormal events must be reported to STUK without delay.

5 Supervision of safety

The responsible party must notify STUK of all public shows featuring laser equipment that may cause danger to the eyes. In practice, laser products in safety classes 3B and 4 (Appendix B) must always be inspected by STUK before commissioning. In addition, laser products in classes 2 and 3R must be inspected in the event that their laser beams may be directed at the audience (members of the public), possibly exceeding the maximum permissible exposure values.

If outdoor laser shows affect the safety and smoothness of air traffic, they are, as a rule, prohibited under the Aviation Act. All laser equipment whose beams are not terminated require an assessment of air traffic safety. According to the Aviation Act, the responsible party must contact the air traffic service provider (Finavia Oyj) to determine how the planned laser

show can be carried out without affecting the safety or smoothness of air traffic.

STUK's regulatory control mandate is regulated by the Radiation Act (592/1991) and the Ministry of Social Affairs and Health's Decree on the Supervision of Non-Ionizing Radiation (1306/1993).

Activities that pose a risk to air traffic or affect its smoothness are regulated by the Aviation Act (864/2014). In questions relating to the Aviation Act, the competent authority is the Finnish Transport Safety Agency (Trafi).

5.1 STUK must be notified of any laser displays and shows

If non-terminated beams will be used in an outdoor laser show, STUK must be notified of this 10 weeks before the intended use of the laser equipment. For other laser shows requiring an inspection, STUK must be notified no later than 30 days before the intended use of the equipment.

If laser shows organised under the approval granted to the responsible party (item 5.2) do not require an inspection, STUK must be notified of them no later than 3 working days before the intended time of the show.

Requests for laser equipment commissioning inspections and installation-specific inspections (for example, outdoor shows) and notifications relating to STUK's approval (item 5.2) may be made by completing the form on the STUK website at www.stuk.fi and e-mailing it to STUK. The form requires more specific information concerning the equipment and its installation, which must be attached to the e-mail message as separate files. Alternatively, the form can be printed out and sent to the STUK registrar's office by post with the necessary enclosures.

If the public show requires a permit issued by the police authority or a notification made to the police, the police may also require that the use of laser equipment be mentioned.

5.2 Approval procedures for long-term use

Upon application, the responsible party may receive STUK's fixed-term approval for moving the same equipment repeatedly from one venue to another without presenting each transfer to STUK for inspection separately. However, this does not apply to outdoor shows requiring an air traffic safety assessment by the air traffic service provider (Finavia Oyj). A prerequisite for the approval is that STUK has inspected the equipment, the safety instructions for the installation and operation are in order and there are no remarks about the equipment (item 5.3).

STUK shall grant the approval to the responsible party for a fixed period, a maximum of three years at a time. The responsible party must separately apply for extension of the approval.

A list of responsible parties that have been granted an approval is maintained on the STUK website at www.stuk.fi.

STUK supervises the safety of approved laser equipment installations and operation by means of random checks at places of use. The inspection may be performed without advance notice.

5.3 Inspection at the place of use

If the laser equipment used at public shows is a high-power laser product belonging to Safety Class 3B or 4, the responsible party is always obliged to present the equipment and its installation to STUK for inspection.

In addition, the responsible party must present the laser equipment to STUK for inspection if the laser product belongs to Safety Class 2 or 3R and the maximum permissible exposures for members of the public during its use may be exceeded in the audience facilities below a height of 3 metres in the vertical direction and within a distance of 2.5 metres in the horizontal direction in areas in which the audience may stay (also refer to item 4.1 for limiting the exposure).

During the inspection, the safety class of the laser equipment is established, along with its general suitability for public shows. Special attention is paid to the operation and installation of the equipment and the clarity and sufficiency of the instructions.

If STUK has granted an approval for the long-term use of the laser equipment (item 5.2), a notification of the use of the equipment is sufficient for indoor shows.

A request for an initial inspection or installation-specific inspection may be submitted by completing the notification form on the STUK website at www.stuk.fi. The completed form may

be sent by e-mail or printed out and sent by post. Enclosures to the notification must be sent as e-mail attachments or by post (items 5.1 and 5.2).

The responsible party must ensure the following:

- the equipment has been installed and is fully ready for operation at the time of the inspection
- the persons responsible for the installation and operation are present
- the other conditions at the place of use make possible the appropriate assessment of the operational safety of the equipment.

STUK shall prepare for the responsible party an inspection protocol on the inspection of the laser equipment and its installation.

STUK must inspect high-power laser equipment to be used in commercials, shows or other applications in which the public may be exposed to their radiation. This is regulated by the Decree on the Supervision of Non-Ionizing Radiation (1306/1993).

The maximum values of laser radiation for members of the public are regulated by the Ministry of Social Affairs and Health's Decree on the Limitation of Public Exposure to Non-Ionizing Radiation (294/2002).

The fees of inspections and other regulatory measures are governed by the State Fees and Charges Act (150/1992) and the decree on STUK's charges and grounds for payment (580/1993). The regulatory service price list is available at www.stuk.fi.

Literature

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4. CEI IEC/TR3 60825-3. Safety of laser products – Part 3: Guidance for laser displays and shows.
5. ICAO International Civil Aviation Organization. Manual on laser emitters and flight safety. Doc 9815 AN/447. Montreal: ICAO; 2003.
6. Henderson AR. A guide to laser safety. London: Chapman & Hall; 1997.
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Appendix A

Terms and definitions

Laser radiation
Electromagnetic wave motion generated by stimulated emission.

Further information: The danger posed by laser radiation is due to the fact that its power can be collimated into a very narrow beam that is harmful to the eyes and skin.

Laser equipment (laser product)
Laser product belonging to a certain safety class as specified in standard EN 60825-1, Safety of laser products – Part 1: Equipment classification and requirements.

Abnormal event
An event resulting in a substantial safety hazard at a location where radiation is used or in its vicinity. An abnormal event may also consist of an exceptional observation or fact that is of substantial significance to the radiation safety of workers or the environment.

High-power laser equipment
Laser product belonging to Safety Class 3B or 4 as specified in the EN 60825-1 standard.

Responsible party
A business or a sole trader, company, corporation, foundation or institution that uses radiation sources in its operations or another employer or private trader engaged in radiation practices.

Further information: When the responsible party is a party other than a physical person (such as a limited company, foundation or municipality), the overall responsibility for the operations lies with the person with the highest decision-making power in the organisation.

Public show
An entertainment event, performance, commercial show, art performance or similar event. A public show may also be an event with limited admission or an event for invited guests only.

APPENDIX B

LASER SAFETY CLASSIFICATION ACCORDING TO THE EN 60825-1 STANDARD

Laser products are divided into different safety classes by numbering them, a higher number indicating a greater eye hazard. The numbering used in the laser product classification system is 1, 1M, 1C, 2, 2M, 3R, 3B and 4. Laser products in classes 1 and 1M are practically safe, and laser products in Class 4 may cause serious eye and skin injuries.

The radiation emitted by Class 1 laser product does not pose a risk in any conditions. The power and energy limits for Class 1 are derived directly from the exposure limits by multiplying the corresponding irradiance or radiant exposure value by the area of limiting aperture for the wavelength range in question. For the visible light and infrared radiation wavelength ranges, the aperture diameter for measurement equals the maximum diameter of the pupil (7 mm).

Class 1 often also includes enclosed laser product that contain a laser belonging to a higher class. However, if a procedure described in the operating instructions requires the opening of the laser's safety enclosure or part of it (which may result in a radiation hazard), the part in question must be equipped with a safety lock mechanism.

The beam of Class 1M laser product is strongly divergent, or parallel but fairly wide already at the output aperture. The letter M stands for "magnification". The eye closing reflex (reaction time approx. 0.25 s) usually protects against eye damage, unless the beam is viewed through optical instruments that collect and focus radiation, such as binoculars, a telescope or a magnifying glass.

Class 1C laser product may cause skin damage, since the radiation it emits may exceed the maximum permissible exposure values of the skin. The laser product has been designed to be safe for the eyes. The letter C stands for "contact". For example, Class 1C laser products may be used for cosmetic treatment of the skin in skin contact. Class 1C laser product may contain a high-power Class 3B or 4 laser, so more specific requirements for Class 1C laser's technical structure and accessories to ensure eye safety shall be specified in another technical standard in addition to the EN 60825-1 standard.

Class 2 laser products consist of low-risk lasers working in the visible light wavelength range (400–700 nm). The maximum allowable radiation power for continuously operating laser product is 1 mW. In this case, the average irradiance for a 7-mm aperture diameter is 25 W/m^2. This is the exposure limit corresponding to the time required by the eye closing reflex (approx. 0.25 s). The closing reflex protects the eye against damage, so the radiation may only cause damage if the person deliberately looks at the beam for a longer time.

Class 2M laser products operate in the visible light wavelength range like Class 2 laser products, and shares the features of Class 1M lasers (a divergent, or parallel but fairly wide beam). A Class 2M laser beam may only pose a risk if viewed through optical instruments that collect and focus radiation, such as binoculars, a telescope or a magnifying glass. Otherwise the eye closing reflex will protect the eye from damage, as in Class 2.

The power limits and energy limits of Class 3R laser products are five-fold compared to the limits for Class 2 (visible light) and Class 1 (other wavelengths). The maximum allowable radiation power for continuously operating Class 3R laser product in the visible light wavelength range is 5 mW. Looking directly at the beam of Class 3R laser product may be dangerous.

The direct or mirror-reflected beam of Class 3B laser product is always dangerous to the eyes. The maximum allowable radiation power for continuously operating Class 3B laser product is 0.5 W.

Laser products whose radiation exceeds the emission limits of Class 3B belong to Class 4. If the beam hits the skin directly or by reflecting from a mirror, the skin may be damaged. Eye damage may result even from diffuse reflection. The beam may also cause a fire hazard.

Appendix C

Key requirements for radiation safety concerning the structure and accessories of laser equipment

The radiation safety requirements presented herein are based on standard EN 60825-1, Safety of laser products. Part 1: Equipment classification and requirements, and on technical report CEI IEC/TR3 60825-3, Safety of laser products. Part 3: Guidance for laser displays and shows.

Special requirements for laser products belonging to safety classes 3 and 4 are indicated below. The detailed requirements concerning all laser products are provided in the EN 60825-1 standard.

Laser product must carry the following markings:

- The warning sign for laser radiation in accordance with the EN 60825-1 standard, along with clearly visible warning signs that indicate the safety class of the laser product and the location of the laser aperture(s). The laser remote control or control unit must also be marked with a clearly visible warning sign for laser radiation. Appendix D shows examples of combination signs for laser products in safety classes 3B and 4, including the laser radiation warning sign and a class-specific warning text. Appendix D also provides examples of markings indicating the laser aperture.
- An explanatory sign containing the radiation information (the laserproduct's maximum output power, wavelength, continuous or pulse operation, pulse duration, laser medium, etc.).
- A sign warning about the opening of a protective housing.

Laser product must include the following accessories:

- a protective housing and any necessary safety switches or locking mechanisms
- a key – operated master control that prevents the use of the laser when the key is removed
- a remote control unit or cable connection for remote control
- a warning system (alarm) that gives an audible or visible warning signal when the equipment is ready for operation
- a beam stop switch or attenuator with which the radiation can be suppressed to the level allowed by Class 1M or 2M without cutting the electrical power needed to generate the radiation
- an easily accessible emergency stop switch with which the radiation can be cut immediately in the event of a problem causing danger
- a beam scanning sector limiter and a scanning protection mechanism that ensures that the radiation intensity remains at a safe level in the event of failure.

A fault, problem or adjustment of the laser product moving mechanism must not increase the radiation such that it would cause the need to classify the equipment to a higher safety class.

Any invisible radiation emitted outside the 400–700 nm wavelength range must not exceed the radiation limits of Class 1M.

Appendix D

The warning sign for laser radiation and examples of class 3B and 4 laser equipment combination signs and laser aperture markings

a) The warning sign for laser radiation.

b) Examples of alternative combination signs with the warning sign for laser radiation and a Safety Class 3B warning text. (lasersäteilyä = laser radiation, varo altistumista säteelle = avoid exposure to beam, luokan 3B laserlaite = class 3B laser product, varoitus = warning)

c) Examples of alternative combination signs with the warning sign for laser radiation and a Safety Class 4 warning text. (lasersäteilyä = laser radiation, varo silmien tai ihon altistumista suoralle tai hajaheijastuneelle säteilylle = avoid eye or skin exposure to direct or scattered radiaton, luokan 4 laserlaite = class 4 laser product, vaara = danger)

LASERSÄTEEN LÄHTÖAUKKO (LASER APERTURE) or LÄHTÖAUKKO LASERSÄTEELLE (APERTURE FOR LASER RADIATION) or VARO ALTISTUMISTA – LASERSÄTEILYÄ TULEE TÄSTÄ LÄHTÖAUKOSTA (AVOID EXPOSURE - LASER RADIATION IS EMITTED FROM THIS APERTURE)

d) Examples of alternative texts or signs indicating the laser aperture.

APPENDIX E

LASER BEAM DISTANCES FROM AUDIENCE FACILITIES IN A SHOW WITH OPERATOR IN CONTROL

Figure a)

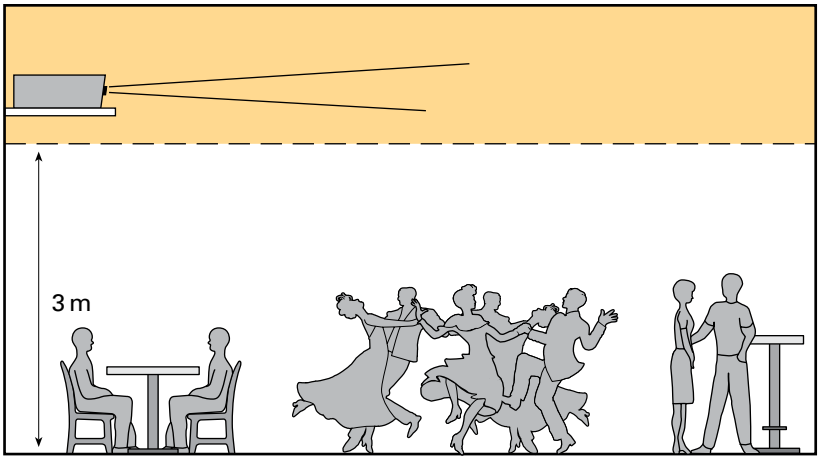
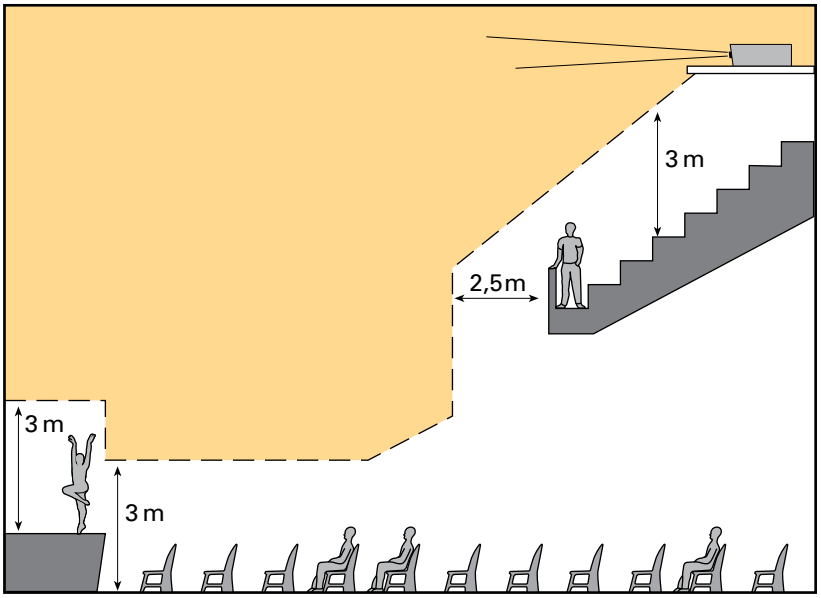


Figure b)



Figures a) and b). In a show with operator in control, no laser beams must be present in the area whose safety distances are 3 metres in the vertical direction and 2.5 metres in the horizontal direction (area shown in white in the figures).

LASER BEAM DISTANCES FROM AUDIENCE FACILITIES WHEN UNATTENDED BEAMS ARE USED

Figure c)

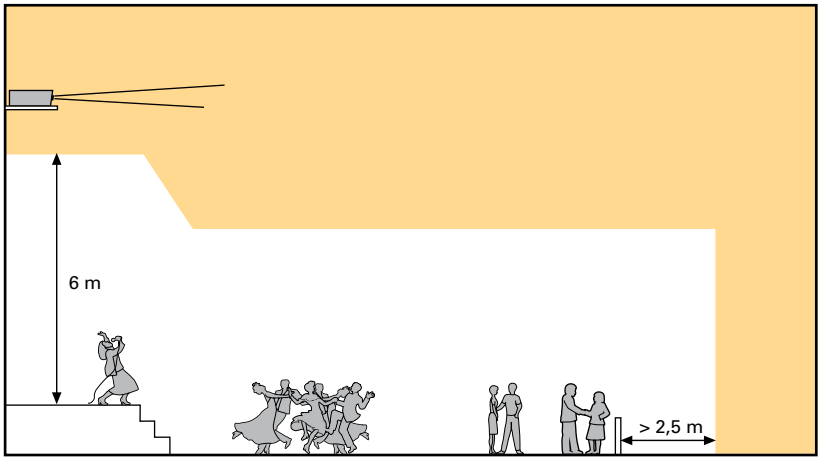


Figure c). When unattended beams are used, no laser beams must be present in the area whose safety distances are 6 metres in the vertical direction and 2.5 metres in the horizontal direction (area shown in white in the figure).

ST GUIDES (5.10.2015)

General guides

ST 1.1 Safety in radiation practices, 23 May 2013
ST 1.3 Warning signs for radiation sources, 9 December 2013 (in Finnish)
ST 1.4 Radiation user's organization, 2 November 2011
ST 1.5 Exemption of radiation use from safety licensing, 12 September 2013
ST 1.6 Operational radiation safety, 10 December 2009
ST 1.7 Radiation protection training in health care, 10 December 2012
ST 1.8 Qualifications and radiation protection training of persons working in a radiation user's organization, 17 February 2012
ST 1.9 Radiation practices and radiation measurements, 17 March 2008
ST 1.10 Design of rooms for radiation sources, 14 July 2011
ST 1.11 Security arrangements of radiation sources, 9 December 2013

Radiation therapy

ST 2.1 Safety in radiotherapy, 18 April 2011

Diagnostic radiology

ST 3.1 Dental X-ray examinations in health care, 13 June 2014
ST 3.3 X-ray examinations in health care, 20 March 2006
ST 3.8 Radiation safety in mammography examinations, 25 January 2013

Industry, research, education and commerce

ST 5.1 Radiation safety of sealed sources and devices containing them, 7 November 2007
ST 5.2 Use of control and analytical X-ray apparatus, 26 September 2008
ST 5.3 Use of ionising radiation in the teaching of physics and chemistry, 4 May 2007
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ST 5.6 Radiation safety in industrial radiography, 9 March 2012
ST 5.7 Shipments of radioactive waste and spent fuel, 6 June 2011
ST 5.8 Installation, repair and servicing of radiation appliances, 4 October 2007

Unsealed sources and radioactive wastes

ST 6.1 Radiation safety when using unsealed sources, 17 March 2008
ST 6.2 Radioactive wastes and discharges, 1 July 1999
ST 6.3 Radiation safety in nuclear medicine, 14 January 2013

Radiation doses and health surveillance

ST 7.1 Monitoring of radiation exposure, 14 August 2014
ST 7.2 Application of maximum values for radiation exposure and principles for the calculation of radiation doses, 8 August 2014
ST 7.3 Calculation of the dose caused by internal radiation, 13 June 2014
ST 7.4 The dose register and data reporting, 8 December 2014
ST 7.5 Medical surveillance of occupationally exposed workers, 13 June 2014

Veterinary medicine

ST 8.1 Radiation safety in veterinary X-ray examinations, 20 March 2012

Non-ionizing radiation

ST 9.1 Radiation safety requirements and regulatory control of tanning appliances, 1 July 2013 (in Finnish)
ST 9.2 Radiation safety of pulsed radars, 2 September 2003 (in Finnish)
ST 9.3 Radiation safety during work on masts at FM and TV stations, 2 September 2003 (in Finnish)
ST 9.4 Radiation safety of laser displays and shows, 30 April 2015

Natural radiation

ST 12.1 Radiation safety in practices causing exposure to natural radiation, 2 February 2011
ST 12.2 The radioactivity of building materials and ash, 17 December 2010
ST 12.3 Radioactivity of household water, 9 August 1993
ST 12.4 Radiation safety in aviation, 1 November 2013