

USE OF CONTROL AND ANALYTICAL X-RAY APPARATUS

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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. Original text in Finnish.

1 General

Fixed and mobile X-ray appliances are used in industry, research and the security sector. Typical examples of these appliances include product control devices, analytical apparatus for teaching and research, and X-ray scanners used at security checkpoints. This ST Guide presents the radiation safety requirements governing the use of such X-ray appliances. It classifies the appliances under three categories: open, shielded and enclosed appliances. The radiation safety requirements governing use of the appliances comply with this classification.

The X-ray appliances referred to in this ST Guide are often used in the vicinity of permanently manned work areas. Workers do not generally need to be classified as radiation workers when the use of radiation is arranged in accordance with this ST Guide, nor is there any need for radiation exposure monitoring.

If the use of appliances that do not meet the requirements of this ST Guide is required, then the radiation safety requirements for its use shall be specified as necessary when issuing the safety licence.

This ST Guide does not apply to radiation appliances used in industrial radiography, which are governed separately by Guide ST 5.6.

The requirements for Installation, repair and servicing of radiation appliances are set out in Guide ST 5.8.

2 Safety licence

2.1 Safety licence, radiation safety officer and operating organization

The safety licence requirement when using X-ray appliances is based on section 16 of the Radiation Act (592/1991).

Applications for safety licences are governed by section 14 of the Radiation Decree (1512/1991). An application for a safety licence must include a description of the radiation operating organization (*description of organization*). Appointment of a Radiation Safety Officer responsible for the safe use of radiation generally suffices as a description of organization in the practices referred to in this ST Guide. If several appliances are used, or they are located in several districts and the Radiation

Safety Officer is unable to supervise the use of appliances actively and continuously in person, however, then other responsible persons must be appointed to assist the Radiation Safety Officer, and these persons must manage safety aspects in using the appliances at the place where radiation is used. The safety licence application must then include a more extensive description of organization in which, in addition to appointing a Radiation Safety Officer, the duties of these other responsible persons and the division of responsibilities between them are also explained. Further requirements on the description of organization are set out in Guide ST 1.4.

The typical duties of a Radiation Safety Officer are set out in Guide ST 1.4. The qualifications required for a Radiation Safety Officer are set out in Guide ST 1.8. The Radiation Safety Officer qualification required for practices referred to in this ST Guide is set out in Guide ST 1.8 as "Use of sealed sources and X-ray appliances in industry, research and education".

A responsible party engaged in servicing X-ray appliances must hold a special safety licence issued for servicing operations. Servicing of X-ray appliances must comply with the requirements of Guide ST 5.8. Staff engaged in servicing radiation appliances must be adequately trained for this function.

3 Requirements during operation

3.1 General requirements

The responsible party must plan the use of X-ray appliances, and the associated procedures, processes and resources, to ensure safety in the said use of radiation. Guidelines for radiation safety must be issued in writing.

Use of X-ray appliances must be arranged so that exposure to radiation that is hazardous to health is kept as low as is reasonably achievable. Pursuant to section 7 of the Radiation Decree, STUK may issue dose constraints with a view to implementing the principle of optimization in radiation shielding and allowing for exposure arising from various radiation sources. The effective annual dose constraint for X-ray appliances complying with this ST Guide is

0.3 mSv. The following precautions must be taken to ensure that this dose constraint is not exceeded:

- No person may remain for longer than one hour per day in an area where the dose rate arising from a radiation source is greater than 1.5 $\mu\text{Sv/h}$.
- If operating or servicing work must be done in an area where the dose rate arising from a radiation source is greater than 5 $\mu\text{Sv/h}$, then separate instructions must be prepared for the work in order to ensure that the annual dose sustained by the worker does not exceed the foregoing dose limit.

A practitioner must ensure that all X-ray appliances are serviced and the operation of safety devices is regularly inspected, and that records are kept of these precautionary measures. The correct operation of warning lights and other safety devices must be verified when servicing and repairing X-ray appliances.

In addition to workers, there may also be outsiders present when X-ray appliances are used in public places for scanning goods or items. Special attention must be paid in such cases to the technical arrangements for preventing unnecessary exposure to radiation that are set out in this ST Guide. Workers must also be capable of guiding and supervising outsiders to ensure the safety of scanning.

3.2 Requirements for use of appliances

The radiation exposure caused by X-ray appliances may be limited using radiation shields and safety mechanisms. Safety mechanisms can also play a substantial role in effectively preventing unwitting or unauthorized use of an appliance and unintentional exposure of workers or outsiders.

The following radiation safety requirements govern the use of all X-ray appliances covered by this ST Guide:

- The X-ray appliance shall have an interlock enabling the termination of radiation output.
- An ionizing radiation warning sign and a warning light indicating when the appliance is generating radiation must be placed on the appliance or in its immediate vicinity. Additional notices explaining the radiation

hazard warning may be used where necessary together with these warning signs and warning lights. Further details of warning signs are set out in Guide ST 1.3.

- An X-ray appliance shall bear the serial or manufacturing number of the appliance and, where possible, the maximum operating voltage, maximum current and an indication of the X-ray tube filtration. If appliance data on the maximum operating voltage, maximum current and X-ray tube filtration are not marked on the appliance, then these details must be specified in the appliance operating instructions.
- An appliance that is not in service must be stored in a locked room, or its unauthorized use must be prevented by means of a lock or comparable arrangement.
- Mobile appliances must be kept in a locked transportation box while in transit to prevent unauthorized use. A record must also be kept of mobile appliances and of the places where they are used.
- On cessation of radiation practice the appliance must be surrendered to the appliance supplier or to another responsible party, or the X-ray appliances must be scrapped in an appropriate manner. All ionizing radiation and radiation hazard warning signs must be removed from decommissioned X-ray appliances that have been scrapped. Care must also be taken to ensure that any toxic or otherwise hazardous substances contained in the appliances are rendered harmless.

3.2.1 Enclosed appliances

In this ST Guide the expression *enclosed X-ray appliances* denotes appliances in which the X-ray tube, the radiation beam and the object to be examined or analyzed are protected by structural shielding in an enclosure to which no access is possible while the appliances is generating radiation. Typical enclosed appliances include enclosed X-ray diffraction and fluorescence appliances and inspection appliances for electronic components.

All doors, panels and hatches serving as structural shielding of enclosed X-ray appliances must be fitted with safety devices that shut off the radiation output when opening. This also

applies to all access routes to the radiation beam.

The radiation dose rate on the external surface of an appliance may not exceed 2.5 $\mu\text{Sv/h}$ when measured at a distance of 5 cm from any accessible surface of the appliance.

3.2.2 Shielded appliances

In this ST Guide the expression *shielded X-ray appliances* denotes appliances in which the X-ray tube and the radiation beam are protected by structural shielding and the object to be examined or analyzed is mounted in a housing that is accessible while the appliances is generating radiation. Typical shielded appliances include X-ray scanners used in security inspections and quality control, and shielded analytical appliances used in teaching and research.

All service hatches, detachable panels and corresponding access structures leading to the radiation beam area must be fitted with safety devices that shut off the radiation output when opened.

The radiation dose rate may not exceed 5 $\mu\text{Sv/h}$ when measured at a distance of 5 cm from any accessible surface of the appliance.

The object to be examined or analyzed must either be mounted in the housing before radiation output begins or the sample transfer mechanism must operate automatically.

The entry and exit openings of a shielded appliance used for inspecting products and goods must be fitted with additional shielding, such as a curtain of lead rubber strips, to attenuate radiation leakage arising near the opening. If the appliances are used in a place to which the public has access, and the radiation beam may be accessed at the entry and exit openings, then unwitting access to the radiation beam must be prevented. Installation of barriers is therefore recommended to impede access to the appliances and prevent unwitting exposure.

3.2.3 Open appliances

In this ST Guide the expression *open X-ray appliances* denotes appliances in which the radiation beam is directed outside of the appliance. Typical open appliances include portable fluorescence analyzers.

Open X-ray appliances must include a

mechanism to shut off or prevent radiation output. The mechanism must be secured to prevent unwitting exposure. If an open appliance has more than one radiation aperture, then it must be possible to fully close and secure all apertures that are not in use.

The protective jacket of the X-ray tube must ensure that the dose rate of leakage radiation does not exceed 25 $\mu\text{Sv/h}$ when measured outside of the radiation beam at a distance of 5 cm from any accessible surface of the appliance. The appliance control panel or operating panel must be located in a manner enabling supervision of appliance operation.

Open X-ray appliances must include a sign indicating the direction of the radiation beam and a separate warning if the X-ray tube does not have additional filtration.

The radiation shielding requirements and warning signs used in premises where open X-ray appliances are used must be separately assessed in each case. The requirements for radiation shielding and warning signs are set out in Guide ST 3.6.

Mobile open appliances must be fitted with a safety switch, key or code that prevents unwitting use of the appliance. All safety mechanisms must be fitted with a safety circuit which disables the appliance under fault conditions.

3.3 Training and guidance of staff

The users of X-ray appliances must be trained and given supplementary training in accordance with Guide ST 1.8. Workers must also have access to the operating and radiation safety instructions for the appliance written in the language of the place of use. Workers must also be given guidance in procedures to be followed in the event of abnormal incidents, and verifying radiation safety must become part of daily operations.

Task-specific instructions must also be formulated for users of shielded and open X-ray appliances, and these instructions must be observed when performing the said tasks. The instructions must also set out the precautionary measures to be considered when working in the vicinity of X-ray appliances. The task-specific instructions must be kept up to date at all times.

Particularly when working with an open appliance it must be ensured that all work with

the radiation appliance is optimised and complies with radiation safety requirements.

Task-specific instructions and worker training for use of open appliances must clearly stress that it is forbidden to bring the hands or other parts of the body into the radiation beam.

4 Abnormal incidents

An *abnormal incident* in the use of radiation denotes an incident resulting in a substantial safety hazard at the place where the radiation is used or in its environs. It may also be an exceptional observation or fact that is of substantial significance for the radiation safety of workers or other persons.

4.1 Instructions for responding to abnormal incidents

The responsible party must prepare instructions for responding to abnormal incidents. These instructions must provide a written description of reporting procedures and of measures to be taken in the event of an abnormal incident. The instructions must be made available to all workers and must be explained to them. They must also be kept together with mobile X-ray appliances, for example in the transportation package of an appliance.

4.2 Reporting of abnormal incidents

Under section 17 of the Radiation Decree, STUK must be notified without delay:

- of any abnormal event involving the use of radiation that is substantially detrimental to safety at the place where the radiation is used or in its environs
- of the disappearance, theft or other loss of a radiation source such that it ceases to be in the possession of the licensee
- of any other abnormal observation or information of essential significance for the radiation safety of workers or the environment.

The first notification of an abnormal incident (normally by telephone) must report the following details:

- the practitioner (safety licence holder) and the radiation safety officer
- the name and contact details of the person submitting the report
- the time and place of the incident
- a description of the incident
- details of any persons involved in the hazardous situation and of their possible radiation exposure
- the immediate measures taken.

This first notification must subsequently be confirmed in writing. In addition to the foregoing details, the written report must also give an account of the causes and consequences of the abnormal incident (particularly of possible radiation exposure) and of the measures taken to prevent future corresponding incidents.

ST GUIDES (17.12.2009)

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- ST 1.1 Safety Fundamentals in Radiation Practices, 23 May 2005 (in Finnish)
- ST 1.3 Warning Signs for Radiation Sources, 16 May 2006
- ST 1.4 Radiation User's Organization, 16 April 2004
- ST 1.5 Exemption of the Use of Radiation from the Safety Licence and Reporting Obligation, 1 July 1999
- ST 1.6 Operational Radiation Protection, 29 December 1999
- ST 1.7 Radiation Protection Training in Health Care, 17 February 2003
- ST 1.8 Qualifications of Persons Working in Radiation User's Organization and Radiation Protection Training Required for Competence, 16 April 2004
- ST 1.9 Radiation Practices and Radiation Measurements, 17 March 2008

Radiation Therapy

- ST 2.1 Quality Assurance in Radiotherapy, 22 May 2003
- ST 2.2 Radiation Safety of Radiotherapy Equipment and Treatment Rooms, 2 February 2001.

Diagnostic Radiology

- ST 3.1 Use and Regulatory Control of Dental X-ray Installations, 27 May 1999
- ST 3.2 Mammography Equipment and Their Use, 13 August 2001
- ST 3.3 X-ray Examinations in Health Care, 20 March 2006
- ST 3.6 Radiation Safety in X-ray Facilities, 24 September 2001.
- ST 3.7 Breast Cancer Screening Based on Mammography, 28 March 2001

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- ST 5.1 Radiation Safety of Sealed Sources and Devices Containing Them, 7 November 2007
- ST 5.2 The 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
- ST 5.4 Trade in Radiation Sources, 19 December 2008.
- ST 5.6 Radiation Safety in Industrial Radiography, 17 February 1999
- ST 5.8 Installation, Repair and Servicing of Radiation Appliances, 4 October 2007

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- 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 Use of Radiation in Nuclear Medicine, 18 March 2003

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- ST 7.1 Monitoring of Radiation Exposure, 2 August 2007
- ST 7.2 Application of Maximum Values for Radiation Exposure and Principles for the Calculation of Radiation Dose, 9 August 2007
- ST 7.3 Calculation of the Dose Caused by Internal Radiation, 23 September 2007
- ST 7.4 The Dose Register and Data Reporting, 9 September 2008.
- ST 7.5 Medical Surveillance of Occupationally Exposed Workers, 4 May 2007

Non-Ionizing Radiation

- ST 9.1 Radiation Safety Requirements and Regulatory Control of Tanning Appliances 1 December 2003 (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 High Power Display Lasers, 28 February 2007 (in Finnish)

Natural Radiation

- ST 12.1 Radiation Safety in Practices Causing Exposure to Natural Radiation, 6 April 2000
- ST 12.2 The Radioactivity of Building Materials and Ash, 8 October 2003
- ST 12.3 Radioactivity of Household Water, 9 August 1993
- ST 12.4 Radiation safety in aviation, 20 June 2005