

Radiation Guideline 4

Compliance requirements for x-ray protective clothing

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Introduction

Shielding of persons not behind a fixed radiation shield is important to ensure that doses to staff working with ionising radiation are kept as low as reasonably possible. Poor performance of x-ray protective clothing can cause an unnecessary increase in staff personal dose.

The need to minimise the radiation dose to staff is widely acknowledged. This document aims to contribute to dose reduction by:

- ensuring that adequate safety measures are provided to protect staff, occupationally exposed workers and the public from radiation exposure when not behind a fixed radiation shield
- improving the standard of x-ray safety clothing in use
- ensuring better monitoring of x-ray safety clothing performance.

This guideline for x-ray protective clothing is for the information of the person responsible and all wearers of x-ray protective clothing.

In the event of an amendment to the Act or Regulation, references to the legislation in this document must be deemed to refer to the current legislation. In the event of an inconsistency between the guideline and the legislation, the requirements of the legislation prevail to the extent of the inconsistency.

This document sets out the minimum requirements for x-ray protective clothing, which are stated as '**must**' statements. This guideline promotes industry best practice in radiation safety for x-ray protective clothing.

The guideline was developed by the Hazardous Materials Chemicals and Radiation Section of the NSW Environment Protection Authority (EPA) in consultation with the Radiation Advisory Council.

1. Conditions for use

1.1 General

- 1.1.1** The person responsible **must** ensure all staff in a radiographic room during x-ray exposures not standing behind protective screens wear protective clothing. A safety assessment **must** be undertaken to ensure all staff wear an appropriate lead equivalent apron giving consideration to the type of procedure, kVp and position of the person in relation to the x-ray source.
- 1.1.2** Protective gloves should also be worn if it is essential for the hands to be placed in the direct beam at any time, although there may be cases where this is impractical.
- 1.1.3** Aprons and gloves **must** have radiation attenuation of not less than 0.3 mm lead equivalence at 100 kVp.¹ Where a maximum tube potential exceeds 100 kVp the suitability of using non-lead garments at this kVp **must** be considered.
- 1.1.4** Aprons **must** cover the full width of the front of the body from the throat to within 10 cm of the knees, as well as the sides of the body. Wrap-around types of aprons **must** cover from the shoulder blades to below the buttocks. Fastenings **must** be provided to keep aprons closed. ¹ Refer to Part A3 for different types of x-ray protective clothing. Where aprons have two overlapping front panels the total of the two panels when correctly worn **must** not be less than 0.3 mm in lead equivalence at 100 kVp.
- 1.1.5** The person responsible **must** ensure all staff working in a room where fluoroscopy or cineangiography is being performed wear protective clothing.
- 1.1.6** If the operator's eyes or thyroid are likely to be exposed when working in the immediate vicinity of the patient, then it is advisable to wear additional protection for these organs. The patient's thyroid should be protected where appropriate.
- 1.1.7** Where appropriate, protection for the patient should also be provided in the form of protective clothing such as an apron or gonad shield.

¹ For the purpose of this policy Section 4.2 AS/NZS 4543.1 (1999) does not apply and lead equivalence is to be determined according to clause 6.3 of this Standard.

- 1.1.8** Personal dosimeters **must** be worn under the lead apron. A dosimeter **must** not be worn outside the apron unless it is additional to one worn underneath, and this fact is appropriately reported to the organisation issuing the dosimeter.
- 1.1.9** An appropriately qualified person, for example, a Consulting Radiation Expert, a Radiation Safety Officer, a Medical Physicist or a Senior Radiographer, **must** be consulted before the purchase of x-ray protective clothing.
- 1.1.10** The manufacturer's recommendations regarding the handling and storage of protective clothing **must** be strictly observed. Lead aprons **must** be stored either flat or on hangers to prevent the development of cracks in the protective material.
- 1.1.11** Inspection and testing of protective clothing **must** be performed as described in section 2 of this guideline when used in the course of diagnostic radiography, veterinary radiography, fluoroscopy and computed tomography procedures.

2. Inspection and testing requirements

2.1 Identification

- 2.1.1 Each item of protective clothing **must** be identified by the purchaser (facility) with a locally unique identifier that is indelibly marked on the article.
- 2.1.2 A record **must** be kept that includes the identification number, usual location, date of purchase, lead equivalence, style, testing dates and test results.

2.2 Visual inspection

- 2.2.1 Each user **must** visually inspect each article of x-ray protective clothing at the time of each use and be confident of its integrity. Clothing **must not** be used if the surface appears cracked or damaged. (Note that most aprons have a non-shielding protective cover that may appear undamaged even if the shielding material underneath is faulty.)
- 2.2.2 If there is a suspicion that protective clothing is faulty, it **must** be tested by a licensed radiographer, medical physicist or other appropriate person such as a Radiation Safety Officer or a Consulting Radiation Expert. Persons undertaking screening **must** have an appropriate radiation licence issued by the Authority.

2.3 Shielding integrity testing procedures

- 2.3.1 All new protective clothing **must** be tested for shielding integrity before use.
- 2.3.2 Protective clothing **must** be tested at regular intervals of no more than 12 months, or more frequently if indicated.
- 2.3.3 A licensed radiographer or other appropriate person such as a licensed medical physicist, Radiation Safety Officer or Consulting Radiation Expert or **must** carry out the testing.

- 2.3.4** Testing may be performed using fluoroscopy at approximately 60 kVp (ideally with a floating-top table), which gives good radiographic contrast. Faults or inhomogeneities in shielding should be easily observed. (Note that the lead equivalence cannot be measured or verified by this method.)
- 2.3.5** If faults are found, an image of the region **must** be taken and **must** be kept and the apron marked as faulty. The article **must** be immediately removed from use and returned to the Radiation Safety Officer, Medical Physicist or Chief Radiographer or another appropriately qualified person. Refer to Part A4 for examples of aprons with shielding defects.
- 2.3.6** Based on the cost of replacing lead protective aprons and the estimated radiation dose received from a defect, it is suggested that lead aprons be replaced if a defect is greater than 15 mm² (Lambert *et al*). If the defect is clearly not over a critical organ then continued use of the lead apron may continue, provided the location of the defect is clearly marked on the lead apron and the size, location and date that the defect was identified logged in the accompanying documentation. Defects not in close proximity of critical organs, which are along the seam, or in overlapped areas, or on the back of the lead protective apron should be subject to a less conservative rejection criterion. In these cases, it is suggested that lead aprons be replaced if a defect is greater than 670 mm² (Lambert *et al*). Thyroid shields with defects greater than 11 mm² (Lambert *et al*) should be replaced. (Extract from Advisory Information on the testing of lead aprons, Department of Human Services, State Government of Victoria).
- 2.3.7** All protective garments **must** be marked in accordance with Standards Australia/Standards New Zealand. Protective Devices Against Diagnostic Medical X-Radiation. Part 3: Protective clothing and protective devices for gonads. AS/NZS 4543.3.2000.

3. Different Types of Protective Clothing



Standard apron

Straps cross the waist and tie securely in front and velcro shoulder strap prevents slippage.



Back view



Overlap skirt with vest



Wrap-around apron

Provides full protection of the back, front and vital areas.



Wrap-around apron

Full front and rear protection with the addition of wide belt which, when properly adjusted, removes the weight from the shoulders and transfers it to the hips.



Apron with integrated thyroid collar shield



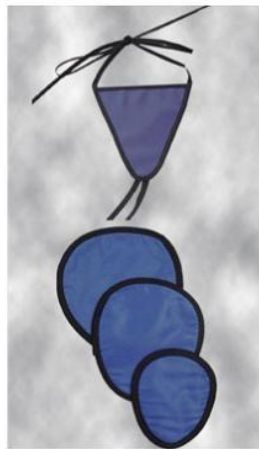
Apron with matching separate thyroid collar shield



Thyroid collar shield



Leg protectors



Gonad shields

Protect the reproductive organs.



Protective leaded eyewear

Lead glasses provide x-ray protection for the eyes.



Moulded gloves



Radiation Protection Gloves



Leaded protective mask

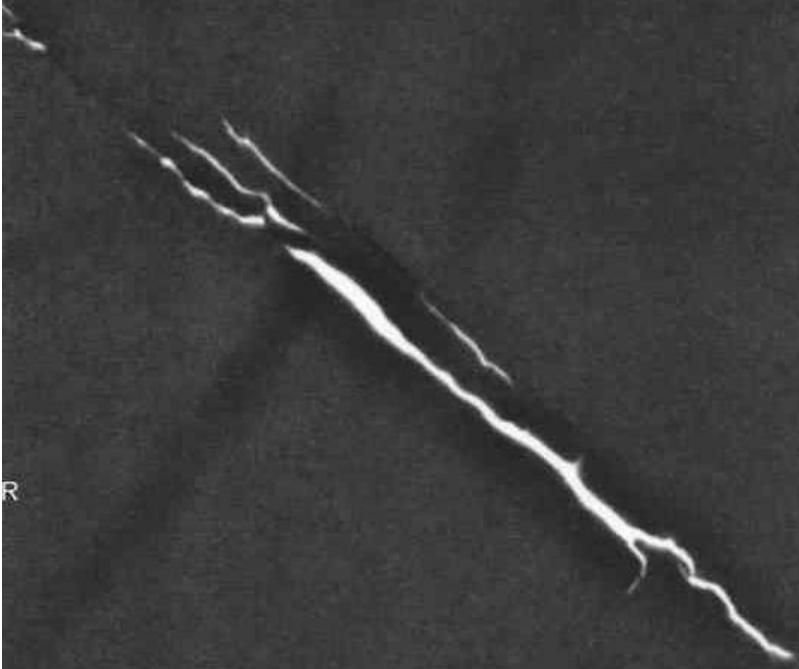
Providing eye protection against scatter radiation.

4. Examples of aprons with shielding defects (white sections)

These digital images are of light lead gowns which were captured from a fixed fluoroscopy unit.



06-Jan-09
2-47/47



R

EP / Pace
m 25
A
hA 15
RAO 2° / CAUD 2°

960 x 960
EE 10%
DDO 40%

WW 2600 [W 4096]
WC 2095 [C 2048]

For further information, the following Australian Standards should be consulted:

Standards Australia/Standards New Zealand (1999). Protective Devices Against Diagnostic Medical X-Radiation. Part 1: Determination of Attenuation Properties of Materials. AS/NZS 4543.1 Sydney/Wellington

Standards Australia/Standards New Zealand (2000). Protective Devices Against Diagnostic Medical X-Radiation. Part 3: Protective clothing and protective devices for gonads. AS/NZS 4543.3. Sydney/Wellington.

Radiation Advisory Council (March 2018)

Reference

Lambert, K and McKeon, T “Inspection of Lead Aprons: Criteria for Rejection”, Operational Radiation Safety, Supplement to Health Physics, 80, suppl 5, May 2001, S67-S69.

Definitions

In this guideline:

Act means the *Radiation Control Act 1990*.

Authority means the NSW Environment Protection Authority.

EPA means NSW Environment Protection Authority.

Lead equivalent means the thickness of lead causing the same attenuation of a beam of a specified radiation quality as the material under consideration.

Person responsible means as defined in section 6 of the Act.

Protective shield means a protective wall or barrier of radiation attenuation material(s) used to reduce the dose equivalent on the side beyond the radiation source.

Regulation means the Radiation Control Regulation.

Scattered radiation means ionising radiation produced from the interaction of electromagnetic ionising radiation with matter. It has a lower energy than, or different direction from, that of the original incident ionising radiation.

Staff means all people employed by an organization or person responsible.

X-ray protective clothing means clothing made of lead rubber or another material that attenuates ionising radiation with the intent to reduce the wearer’s radiation dose.

Unless otherwise defined, all words in this guideline have the same meaning as in the Act and the Regulation.