



RADIATION SAFETY ACT

Shielding Requirements For Diagnostic X-Ray Facilities Regulatory Guide

All premises and x-ray equipment **must** be registered under the Radiation Safety Act. The possession and use of x-ray equipment without a current registration is an offence under the Radiation Safety Act.

The registrant is responsible for ensuring the appropriate plans (for structural shielding assessment) and other relevant details relating to the registration of x-ray equipment are provided to the Radiological Council. They are also responsible for ensuring that x-ray equipment and premises conform to the requirements for both design and use.

The Radiological Council is not able to approve the installation of x-ray equipment unless satisfied that there is sufficient structural radiation protection for both users of the equipment and any persons who may be in the vicinity during its operation. Appropriately experienced private consultants may advise the owner on radiation protection requirements. However, the Radiological Council **must** approve the plans for the premises and confirm any advice given by consultants before the x-ray equipment can be registered for use.

Registrants modifying premises (e.g. new equipment, relocation of existing equipment, structural shielding changes) must provide **prior notice** in writing to the Radiological Council of their plans and obtain the necessary approval.

Dose Constraints

The structural radiation protection of rooms containing x-ray equipment is assessed in accordance with the dose limits based on guidelines accepted by the Radiological Council. These are 10% of the occupational and 50% of the public annual effective dose limits respectively.

These conservative guidelines acknowledge that the dose limits have been consistently reduced over time and apply the ALARA principle recommended by the International Commission on Radiological Protection. Occupationally exposed persons who fail to utilise the protection provided or otherwise ignore recognised safe working practices may exceed the guideline limit.

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STRUCTURAL INFORMATION REQUIRED FOR ASSESSMENT

To conduct an appropriate structural protection assessment, the Radiological Council requires the information specified below for each type of x-ray installation.

Appropriately experienced private consultants may advise the owner on radiation protection requirements. However, the Radiological Council must approve the plans for the premises and confirm any advice given by consultants before the x-ray equipment can be registered for use.

Dental

For dental intraoral, panoramic or cephalometric, please refer to the Council's Radiation Shielding Guideline for Low Risk X-ray Facilities.

Veterinary

Please provide the information specified below as for Fixed Medical X-ray installations.

Fixed Medical X-ray (including Chiropractic)

A detailed scale plan of the installations must be submitted for assessment along with appropriate workload information (see appendix). The plan needs to include the following details for each x-ray unit:

- the location of the x-ray unit;
- the purposes of all areas surrounding the room, including floors above and below;
- the locations of tables, buckys, exposure controls, protective screens, warning signs/lights, doors, windows and other access ways into the room;
- types and thicknesses of wall construction materials; and
- a scale by which the room dimensions may be ascertained.

Mobile Medical X-ray

For mobile medical x-ray equipment that is used in a particular room, a structural protection assessment is also required. In this instance, please provide the information specified above as for Fixed Medical X-ray installations.

GENERAL STRUCTURAL PROTECTION REQUIREMENTS

Layout and Use

Distance is an important means of protection and the floor area allocated to any examination or treatment area should be considered. In general, a minimum distance of 2 metres between the patient and the operator should be achieved.

No one other than the patient is to be exposed to the useful x-ray beam. The simultaneous examination or treatment of patients in the one x-ray room should not be conducted unless approved protection is provided between the examination areas.

No unnecessary persons are to be in the room during any examination or procedure. All necessary personnel are to be shielded unless advised otherwise by the Radiological Council.

Protective Screens

Consideration should be given to the location of x-ray equipment within a room as shielding must provide line of sight protection from all sources of radiation. This includes leakage and scattered radiation from the x-ray tube(s) and scattered radiation from the patient. All locations and orientations of the x-ray tube(s) and patient need to be considered.

Medical X-ray – Radiographic (Incl. Chiropractic), Fluoroscopic & CT

Typically, 15 kg/m² (1.3 mm) sheet lead or its shielding equivalent is specified. This may need to be higher or lower depending on distance from the x-ray tube and patient, and workload. Other requirements include:

- Sheet lead must be supported on both sides to prevent creeping under gravity. Sheets must be overlapped to ensure continuous shielding or butt jointed with an overlapping lead strip. A permanent label must indicate the thickness of lead in the protective screen.
- The screen must extend from the floor to a height not less than 2000 mm and be wide enough (> 900 mm) to protect the operator from leakage radiation from the tube housing and scattered radiation from the patient. Where side protective shields are required, the junction with the main body of the screen must overlap to ensure the protection is continuous.
- The screen must contain a protective window which has a lead equivalence equal to or greater than that of the rest of the screen. The viewing window is required to be of a suitable size (typically no less than 300 mm x 300 mm) to view the patient and entrance/s to the room during all exposures and must be durably labelled with its lead equivalence at a nominal kVp. Generally the protective window is either lead glass (nominal thickness 6 mm; 1.5 mm lead equivalence) or H-22 lead acrylic (1.0 mm lead equivalence at 100 kVp).
- Mirrors or closed-circuit television can be used for observation of the patient in place of lead equivalent glass or acrylic protective window.
- The screen is to be secured to either the floor or wall so that the location of the protective screen is fixed. Although fixed in position for everyday use, the screen

may be hinged for service access to controls. A small gap (< 5 cm) between the floor and screen for castors is permitted.

Mammographic

The protective screen needs to be at least 0.3 mm lead equivalence at 30 kVp.

Walls

Medical X-ray – Radiographic (Incl. Chiropractic), Fluoroscopic & CT

For installations other than CT, generally shielding equivalent to at least 1 mm lead at 100 kVp is required. For CT installations, shielding equivalent to 1.5 mm lead or more may be required. Shielding in both cases may need to be higher or lower depending on distance from the x-ray tube and patient, workload, and occupancy of adjoining rooms.

Protection needs to extend from the floor to a height of not less than 2000 mm and be continuous. Where recessed wall boxes such as GPOs and medical gas panels are installed, sufficient shielding must be added to maintain the level of shielding provided by the rest of the wall.

Doors

Shielding may not be required for doors for all types of x-ray installations. For major medical installations, generally 10 kg/m² sheet lead provides satisfactory shielding unless the area outside the door is likely to have high occupancy. For CT installations, the doors should generally not have less than 15 kg/m² lead.

Where radiation protection is requested for doors, the frames are excluded from this requirement. It is sufficient that the steel door frame be detailed to overlap the wall structure for the necessary protection to be achieved.

Warning signs which display the words 'CAUTION X-RAYS' or similar may be required at the entrances to a room containing mobile x-ray equipment. The signs must be installed at eye level adjacent to the doorway.

Warning lights which display the words 'CAUTION X-RAYS' or similar will be required, in lieu of warning signs, at the entrances to rooms containing fixed radiographic, fluoroscopic or CT equipment. Where required, the lights must be mounted alongside the entrance and connected into the x-ray generator circuit so that they automatically illuminate at 'prep' and remain illuminated for the duration of the exposure. These signs need not be large or obtrusive but should be sufficient to attract the attention of persons entering the room.

Floors / Ceilings

Consideration must be given to the potential exposure of persons on floors adjoining x-ray rooms. Precaution is needed if there are penetrations through concrete rafts beneath x-ray tables where either the attenuated primary beam or scattered radiation needs to be considered. The mounting of x-ray tubes close to the ceiling of x-ray rooms for long focal film distance radiography also needs special consideration

because persons occupying the floor may be very close to the x-ray tube housing.

Generally, 150 mm solid concrete provides sufficient shielding between floors of multiple storey buildings.

Vertical Bucky

Additional shielding may be required behind a vertical bucky, depending on the occupancy of the adjoining area. If required, the panel needs to extend from the floor (although up to 300 mm from the floor will be permitted) to a height of around 2000 mm and extend 300 mm either side of the vertical bucky. The protective panel may be attached to the wall with the vertical bucky supports provided its presence is obvious and there is no risk of physical injury to anyone dismantling the vertical bucky.

Bonding Methods for Sheet Lead

Sheet lead is incapable of supporting itself and will tear and creep under gravity if not bonded to a suitable substrate. Rigid glue (such as epoxy resin or wall bond adhesive) that does not permit creep under gravity is required. Rubber based contact cements are generally unsuitable. The best method of attaching sheet lead to a supportive substrate is to glue it under pressure in a press, similar to a door press. Sheet lead may be glued to chipboard, custom board, plywood, plastic laminate sheeting, galvanised steel sheet or aluminium sheet.

Sheet lead can be incorporated into a plasterboard framed (timber or stud) wall clad by gluing it to a suitable support material. Fastening holes such as those produced by screws through the sheet lead and wall board into the metal studs are permitted, provided the screws are in place. Sheet lead glued to a suitable substrate may be covered with a further material to provide a suitable finish.

Appendix 1 – Workload Information

The maximum projected radiation workload for each x-ray room must be considered in order to determine the required radiation shielding. It is prudent to make generous workload estimates, thereby reducing the probability of having to refit structural shielding at a later date.

Information relating to each of the following items must be supplied as part of an assessment:

- The most commonly performed examination types should be specified. In general, you need only include the examination types that collectively comprise the bulk (i.e. 80% or more) of your work. However, information must be supplied for *all* examinations in which the primary beam is directed towards an occupied area (e.g. cross-table radiography) even if performed infrequently.
- Specify the best estimate of the maximum projected number of patients per week for each examination type. This should be a long-term average based on maximum probable utilisation rates for the facility.

In addition, please specify the number of images per patient for each examination type. An average figure should be given if the exam type does not always require multiple views. For fluoroscopy and CT, please leave the “images per patient” field blank.

- Provide the mAs per image and the kVp for each examination type. For CT please also provide the manufacturers isodose curves for the model of equipment being installed.
- The beam direction needs to be specified for radiographic equipment; indicate either vertical, horizontal or oblique.

Workload template

A template for recording workload details is provided on the next page.

Please ensure that all above mentioned information is provided, incomplete submissions for assessment may not be assessed and may be returned with a request to provide the required information.

Workload details

Exam type			
Patients x-rayed per week			
Images per patient			
mAs per image			
kVp			
Beam direction			

Exam type			
Patients x-rayed per week			
Images per patient			
mAs per image			
kVp			
Beam direction			

Exam type			
Patients x-rayed per week			
Images per patient			
mAs per image			
kVp			
Beam direction			

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