

GENERAL SHIELDING REQUIREMENTS FOR DIAGNOSTIC X-RAY FACILITIES

1. PROTECTIVE SCREENS

(a) Major Medical (Radio/Fluoro/CT/Cardiac/Chiropractic)

Typically, 15 kg m^{-2} (1.3 mm) sheet lead or its shielding equivalent is specified. This may need to be higher if the protective screen is less than 2 m from either x-ray tube or patient. Other requirements include:

- sheet lead must be supported on both sides such as a ply-lead-ply sandwich or similar 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 of not less than 2 m and be wide enough ($> 90 \text{ cms}$) to protect the operator from leakage radiation from the tube housing and scattered radiation from the patient. Side protective shields may be required.
- the protective window needs to contain the same lead equivalence and have dimensions $> 30 \text{ cm} \times 30 \text{ cm}$ so that the radiographer can observe the patient during an x-ray exposure. 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). All shielding must overlap by a minimum 5 mm. A permanent label indicating the lead equivalence of the window at a nominal kVp is required.
- 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 ($< 5 \text{ cm}$) between the floor and screen for castors is permitted.

b) Mammography

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

2. WALLS

(a) Major Medical (Radio/Fluoro/CT/Cardiac/Chiropractic)

For installations other than CT, shielding equivalent to at least 1 mm lead at 100 kVp is required. A choice of building materials is available to achieve this degree of shielding, including a single layer of solid clay brick with fully mortared joints, two thicknesses of ordinary cored brick, 15 kg m^{-2} sheet lead (suitably supported and overlapped) or two layers (2 x 16 mm) of barium plaster x-ray

panels¹. For CT installations, shielding equivalent to 1.5 mm lead or more may be required.

Protection needs to extend from the floor to a height of not less than 2 m 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.

(b) **Mammographic**

Typically 0.3 mm lead equivalence protection at 30 kVp.

(c) **Dental Cephalometric**

Typically 0.5 mm lead equivalence protection at 100 kVp.

(d) **Dental (Intraoral/OPG)**

Typical building materials, including double gyprock walls, are generally sufficient provided all personnel maintain at least the minimum permitted distance of 2 m from the x-ray tube and the patient during exposures.

3. DOORS

Shielding may only be required for major medical installations. 10 kg m⁻² sheet lead is generally satisfactory unless the area outside the door is likely to have reasonably continuous occupancy, e.g. if the area is an office, film sorting / processing area. The doors to CT rooms should generally not have less than 15 kg m⁻² 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 lights at room entrances may be required for fixed general purpose, fluoroscopic or CT equipment where entry is not directly under the equipment user's control. Where required, warning lights ("Caution x-rays") should be mounted **alongside** the entrance and connected into the x-ray generator circuit so that they illuminate at 'prep' and for the duration of the exposure.

4. FLOORS / CEILINGS

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

¹ The **only** approved and tested barium plaster boards are those manufactured by Bradys Building Products. For 1 mm lead equivalence at 100 kVp, 2 x 16 mm R40 panels must be used, with joints offset.

5. VERTICAL BUCKY / CASSETTE HOLDERS

Except for walls equivalent to at least 1.4 mm lead, an additional protective panel may be specified for use behind the vertical bucky, depending on the occupancy of the adjoining area. This is generally 15 kg m⁻² sheet lead, suitably supported and overlapped. If required, the panel needs to extend from the floor (although up to 30 cm from the floor will be permitted) to a height of around 200 cm and extend 30 cm 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.

6. DARKROOM PASS HATCHES

Film pass hatch between the x-ray room and dark room must be lined with 15 kg m⁻² sheet lead, suitably supported and overlapped. The shielding must be on the x-ray room side of the pass hatch.

7. BONDING METHODS FOR SHEET LEAD

Sheet lead is incapable of supporting itself and will tear and fall under gravity if not bonded to a suitable substrate. A rigid glue (such as araldite 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 metal stud wall clad with gyprock wall board by gluing it to thin galvanised steel sheet, fastening to the metal studs and then covering with gyprock sheet. 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 chipboard or similar substrate may be covered with a glued layer of a laminate or similar which becomes the final wall finish or the lead side can be placed against the wall studs with laminate on the outside.

8. GENERAL

Each x-ray installation must be assessed for shielding requirements based on the:-

- dimensions of the room
- positions of the x-ray control, vertical bucky and operator
- proposed construction materials (protective screens, walls, floors, doors)
- areas adjacent to x-ray room (occupancy, future use)
- x-ray workload

Structural protection plans must be supplied to the Radiological Council prior to construction or for existing buildings prior to use of the x-ray equipment in the room.

9. RESPONSIBILITIES

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

The future registrant is responsible for ensuring appropriate plans (for structural shielding approval) and other relevant details are provided to the Radiological Council so that the application for registration can be properly assessed. Registration must be approved prior to any use of the equipment.

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.

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SHIELDING PROPERTIES OF COMMON BUILDING MATERIALS**BROAD BEAM CONDITIONS AT 100 kVp**

Material	Thickness (mm)	Pb equivalence (mm)	Transmission (%)
Concrete (solid)	100	1.5	0.20
Concrete (solid)	150	2.4	0.021
Concrete (aerated)	150	0.55	3.0
Brick (solid)	110	1.5	0.20
Brick (cored)	90	0.41	5.3
Brick (cored)	110	0.71	1.8
Brick (cored)	150	1.5	0.20
Lead sheet (15 kg m ⁻²)	1.3	1.3	0.30
Lead sheet (10 kg m ⁻²)	0.88	0.88	1.1
Plasterboard (2 sheets of 13 mm gyprock)	26	0.15	20
Plasterboard (2 sheets of R40 barium board)	32	1.1	0.50
Lead glass	5	1.7	0.11
Lead glass	7	2.3	0.024
Lead acrylic (H-22)	22	1.1	0.56
Plate glass	25	0.21	14
Plate glass	48	0.46	4.3
Steel	1	0.15	20
Steel	2	0.30	8.6
Steel	3	0.44	4.6

NOTES

1. This table is compiled from RHB studies, HPA's *Notes on Building Materials and References on Shielding Data for Use below 300 kVp*, and Sutton and Williams' *Radiation Shielding for Diagnostic X-rays*.

CONTACT

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