

Guidelines for shielding of x-ray installations

The utility can hence forth follow the standard layout plans as provided in AERB web-site or customize it as per guidelines given below:

Options in shielding materials

X-ray equipment must be installed in adequately shielded rooms to ensure that public in the vicinity of the x-ray installations are not unduly exposed to x-ray radiation. The adequacy of shielding depends on the material and thickness used for this purpose. Different materials can be used for shielding. However, brick or concrete are considered the best materials, as they are easily available, economical, and have good structural strength.

While lead is a suitable shielding option for energies encountered in diagnostic x-rays, it is a weak structural material with tendency to lose uniformity and needs periodic radiation survey to ensure its continued adequacy. Also, Lead poses a serious environmental hazard and the use of it is being discouraged the world over. Recently, many new materials are being used/ developed as potential shielding materials, as an alternate to Lead. AERB would like to promote use of these materials, on demonstration of shielding adequacy.

Step- by-step guidelines for submission of layout plan in diagnostic radiology facility

- 1) Decide a suitable room for housing an X-ray unit to facilitate the easy movement of staff and patient positioning.
- 2) Room should have preferably one entrance door and window if present, should be above 2m from the finished floor level outside the x-ray room.
- 3) Door should have a hydraulic mechanism to ensure that door is closed during procedure and should be provided with overlapping at the joints to avoid streaming.
- 4) Identify the walls as Wall A, Wall B, Wall C & Wall D (in any sequence)
- 5) Position the location of the equipment for each modality as follows:
 - a) *Radiography and Fluoroscopy equipment:* Couch, Control console and chest stand
 - In such a way that chest stand is on the opposite wall of the entrance door and the control console.
 - Mobile protective barrier with lead equivalent glass viewing window should be positioned in such a manner that the operator is completely shielded during the exposure.
 - Control console should be positioned as far away as possible from the x-ray tube.
 - b) *Computed Tomography and Interventional radiology equipment:* Gantry / C-Arm, Couch, Separate control console room, viewing window,
 - Position the gantry and couch such that the patient is completely visible from the control console, during the scanning
 - The entrance door to the gantry room from the control console shall have similar requirements as the patient entrance door.
 - c) *Mammography/ OPG/ CBCT:* Control console, Equipment and Protective barrier
Positioning of equipment should be as far as possible from the door and the control console.

- 6) Decide on the material and thickness of walls and door by referring to equipment specific table.
- 7) Measure the distances of all the walls, doors, windows from the centre of the couch
- 8) Tabulate the details of layout and shielding as given in Annexure-1
- 9) Note that the required shielding of any material shall be provided at least up to the height of 2m from external finished floor of x-ray room.

PLEASE NOTE:

The final assessment of the adequacy of the design and construction of structural shielding is based on the radiation survey of the completed installation to be carried out at the time of commissioning after installation by supplier of the equipment. If the assessment survey shows deficiencies, additional shielding or modification of equipment and procedures are required.

REFERENCE DATA ON SHIELDING OF X-RAY INSTALLATION ROOM

Radiography and Fluoroscopy

Shielding Material	Distance from centre of patient Table		
	1.5 m	2.0 m	Primary wall of dedicated chest x-ray installation at 2 m
Brick (cm)	23	20	20
Concrete (cm)	15	12	12
Steel (cm)	2.3	2.0	2.0
Lead (cm)	0.17	0.15	0.15
**Any other material	2.0TVT	1.8 TVT	1.8 TVT
Floor (if installation is not on ground floor) and ceiling thickness of 6-8 inch concrete is adequate.			

Computed Tomography

Shielding Material	Distance from iso- centre			
	1.5m	2.0 m	2.5 m	3.0
Brick (cm)	27	25	23	20
Concrete (cm)	18	15	13	12
Steel (cm)	2.7	2.5	2.0	1.8
Lead (cm)	0.21	0.18	0.15	0.14
**Any other material	3.0 TVT	2.8 TVT	2.6 TVT	2.5 TVT
Floor (if installation is not on ground floor) and ceiling thickness of 6-8 inch concrete is adequate.				

Interventional Radiology (Cardiac Angiography)

Shielding Material	Distance from centre of patient Table			
	1.5 m	2.0 m	2.5 m	3.0 m
Brick (cm)	25	23	20	18
Concrete(cm)	18	15	12	11
Steel (cm)	2.5	2.0	1.5	1.3
Lead (cm)	0.2	0.18	0.16	0.15
**Any other material	2.35 TVT	2.0 TVT	1.95 TVT	1.8 TVT
Floor (if installation is not on ground floor) and ceiling thickness of 6-8 inch concrete is adequate.				

Mammography

Shielding Material	Distance from centre of patient Table		<ul style="list-style-type: none"> Standard gypsum wallboard construction is usually adequate to shield the walls of mammography facility (as per thickness given below) Solid core wooden door (5 cm thick) leading to corridors outside a mammography room provide adequate shielding. Standard wooden doors may not be sufficient if the shielded area has significant occupancy. Standard concrete construction provides adequate barriers above and below mammographic facilities Lead lined walls and doors are usually not required
	1.0 m	1.5m	
Gypsum Wallboard (cm)	1.5	1.0	
Plate Glass (cm)	1.0	1.0	
Concrete (cm)	1.0	1.0	
Brick (cm)	1.5	1.0	
**Any other material	2 TVT	1.68 TVT	

Bone Mineral Densitometry

Dose rate at 1m is less than allowable dose limit for public hence no structural shielding is needed even with the smallest room.

Dental CBCT/OPG

(Ref: - Report of HPA working party on dental CBCT (HPA-RPD-065)

Shielding Material	Distance from centre of patient Table			
	0.5m*	1.0m	1.5 m	2.0m
Brick (cm)	22	17	15	12
Concrete (cm)	15	11	9.5	8
Baryte Plaster (cm)	1.5	1.0	--	--
Lead (cm)	0.22	0.17	0.15	0.12
**Any other material	2.6 TVT	2 TVT	1.72 TVT	1.4TVT

*Considered at this distance as the foot print of this equipment is small 100cm X 150cm
Floor (if installation is not on ground floor) and ceiling thickness of 6-8 inch concrete is adequate.

Dental -intra oral radiography (Recommendatory)

Shielding Material	Distance from centre of patient Table					
	1.0m		2 m		4.0m	
	Primary wall	Secondary wall	Primary wall	Secondary wall	Primary wall	Secondary wall
Brick (cm)	12	5	10	5	8	--
Concrete (cm)	9	4	7	2	5.0	--
Lead (cm)	0.1	0.04	0.08	0.02	0.06	--

C- Arm and Lithotripsy x-ray equipment:

Mobile C-arm and Lithotripsy equipment should be used in Operation Theater with normal wall thickness of 9" brick/ 6" concrete and should have 1.0 mm lead lined doors/windows.

****Note:** : Lead free shielding materials have been developed by Council of Scientific and Industrial Research (CSIR)- Advanced Materials & Process Research Institute (AMPRI), Bhopal. These materials may also be used as biological shielding material for construction of medical diagnostic x-ray installations (X-ray room). For further details of these materials you may visit the website www.ampri.res.in.

FORMAT FOR SUBMISSION OF LAYOUT DETAILS OF MEDICAL X-RAY INSTALLATION

Type of equipment:

Model name:

Wall Identification	Distance from exposure area (from centre of the couch)	Material used for shielding	Thickness of the shielding material (cm)
Wall A			
Wall B			
Wall C			
Wall D			
Entrance Door			
Any other door			
Window, if any, if at the height less than 2 m from outside finished floor of x-ray room			
Floor			
Ceiling			

	Check list to be filled by applicant	Status
1	All the walls are identified and distances of walls from the centre of the couch/equipment are indicated in the layout drawing	<input type="checkbox"/>
2	Layout drawing indicates the location of the mobile protective barrier	<input type="checkbox"/>
3	Layout drawing indicates x-ray machine, couch, control panel/ control room, chest stand, windows, doors, make and model of the x-ray equipment.	<input type="checkbox"/>
4	Layout drawing is signed and stamped by the applicant.	<input type="checkbox"/>
5	Layout drawing is authenticated by supplier.	<input type="checkbox"/>
6	The layout drawing is as per values filled in the above table.	<input type="checkbox"/>
7	Chest Stand is on the opposite wall of control console and entrance door	Yes/ No
8	If NO whether, a permanent protective barrier is placed between operator and chest stand	<input type="checkbox"/>
9	Height of the window from outside finished floor of x-ray room is > 2 m	Yes/ No
10	If No, whether shielding is provided on the window up to 2m	Yes/ No
11	No permanent occupancy behind chest stand is ensured	Yes/ No

Attach drawing authenticated by supplier in A4 size sheet (scale 1:50) indicating details given above.

Verified by:

Name:

Signature of applicant

Signature of the supplier

Name

Designation

Company