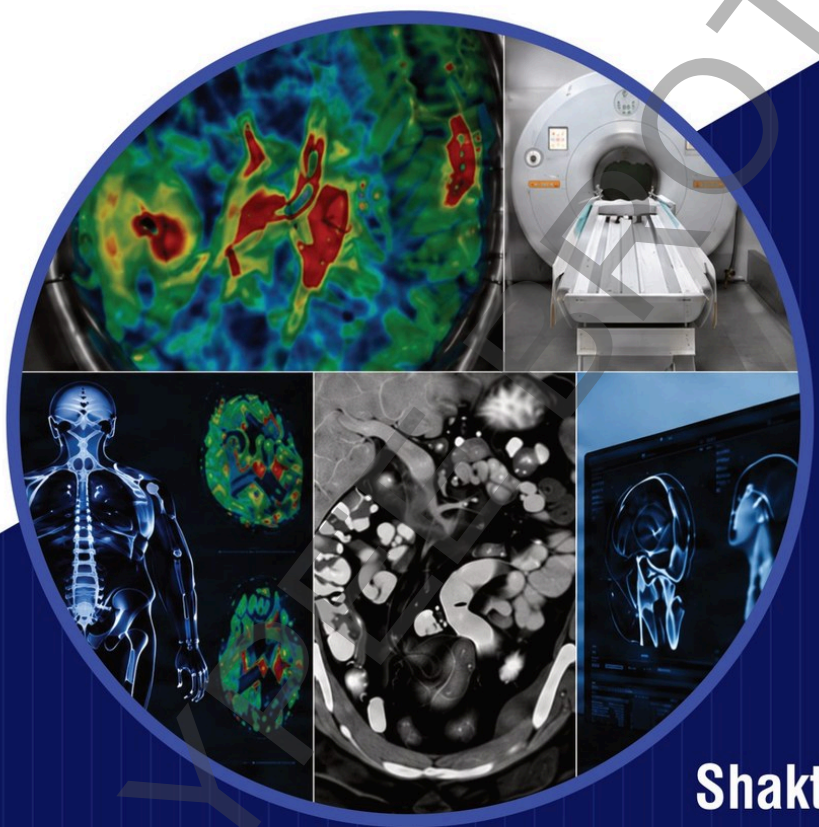
etailed information on radiology books, visit our website www.ejaypee.com, for detailed information on radiology books, visit our website www.ejaypee.com

Do's & Don'ts in RADIOLOGY

Best Practices and Operational Guidelines



Gita Devi
Sunil Kant
Shakti Kumar Gupta

JAYPEE BROTHERS

JAYPEE

CONTENTS

Section 1: Protocols and Standard Operating Procedures for the Diagnostic and Interventional Radiology Department

1. Protocols for X-Ray Imaging 3
2. Protocols for Computed Tomography Imaging 68
3. Protocols for Magnetic Resonance Imaging 96
4. Imaging with Dual-Energy X-Ray Absorptiometry 116
5. Checklists in Radiology 130

Section 2: Ready Reckoner for Developing Diagnostic and Interventional Radiology Department

6. Protocols for Optimal Service Utilization in Radiology Department: Lean and Six Sigma Technology 151
7. Standard Operating Procedures in the Radiology Department for Accreditation Preparedness 162
8. Equipment and Patient Safety in Radiology 194
9. Planning and Designing a Diagnostic and Interventional Radiology Department in a Newly Developing Institute 216
10. Hospital Equipment Utilization and Imported Medical Equipment: Procurement Considerations and Management 233

Index 243

JAYPEE BROTHERS

8 Equipment and Patient Safety in Radiology

JAYPEE BROTHERS

DO'S AND DON'TS

Do's

- Use appropriate radiation protection devices while performing procedures that involve radiation based equipment.
- Use accessible emergency stop buttons in computed tomography (CT) scan, X-ray, and fluoroscopy when required.
- Keep crash carts updated in the areas where they are required [CT scan, fluoroscopy, and digital subtraction angiography (DSA)].
- Replace the water trap in multiparameter monitors in a timely manner.
- Use metal detectors for proper screening before entry into the magnetic resonance imaging (MRI) gantry room.
- Use an intercommunicating system to communicate with the patient during MRI examination.
- Use mobile radiation shields when working near a radiation source, e.g., during fluoroscopy-guided procedures.
- Before entering the fluoroscopy room and DSA, check the warning light signs.

Don'ts

- Do not fail to notice the safety alarms, signage, and warning signs.
- Do not enter with metal objects in zone IV of MRI.
- Do not use metallic instruments inside the MRI gantry room.
- Do not cross the recommended distances for MRI conditional objects, e.g., MRI conditional objects like monitors, infusion pumps, and anesthesia workstations.
- Do not use damaged and untested lead aprons.
- Do not open the doors during radiation exposures.
- Do not fail to stand behind protective barriers or 6 feet away from the patient while performing portable X-ray in wards and ICUs.
- Do not fold lead aprons while in storage.

INTRODUCTION

Patient safety in the radiology department includes against both radiation and nonradiation-related concerns. Equipment design plays an important role when talking about patient safety in radiology because a particular design of the equipment influences not only the radiation safety but also the overall usability in the workplace. The safety against various issues such as workflow errors, radiation exposure, mechanical injuries in

radiology related to equipment design is a major concern. Well-designed equipment minimizes hazards for the patients, clinicians, and technical staff/nursing staff by reducing the above risks. The regulatory bodies, such as the Food and Drug Administration (FDA), ensure that the equipment has a premarket safety review, which guarantees both safe radiation exposure and high-quality imaging. To ensure such safety, in the devices used for clinical practice, in addition to complying with national regulations, imported equipment must also meet US regulatory standards.[1]

Beyond radiation safety and ergonomics considerations, the risks related to medications and contrast administration errors have to be reduced through the use of clear labeling systems and user-friendly interfaces.

So, it is essential to optimize the safety of equipment during its design process, incorporating human-friendly factors and usability principles to enhance quality patient care and overall safety in hospital settings. Feedback from the user to the manufacturers should be maintained as a continuous and coordinated process between the hospitals and the manufacturers. Such collaboration is important for improving the equipment design to enhance operational efficiency, safety, and the incorporation of user-friendly interfaces.

SAFETY FEATURES IN MAGNETIC RESONANCE IMAGING

Safety Feature Design and Safety Issues of Concern

Magnetic resonance imaging systems use strong magnetic fields. Although it is free from radiation hazards and is generally deemed safe, several other safety issues exist due to the powerful magnets used in the machine. It can attract ferromagnetic objects with great force and turn them into projectiles. Implants and medical devices can malfunction or become dysfunctional when brought close to the magnetic field. In addition, conductive materials such as electrodes and wires can form loops and can cause MRI burns.[2] During examination, the machine may be loud enough to cause hearing damage. Therefore, precautionary safeguards such as MRI-compatible headsets, earplugs, and earmuffs should be implemented whenever off-limit exposures are expected. Use of silent MRI sequences can also reduce the MRI noise.[3,4]

An enclosed space within the gantry can cause claustrophobia. For safety purposes, the American College of Radiology (ACR) has divided the MRI facility into four zones.[5] Zoning helps in maintaining a safe environment around the magnetic gantry by providing controlled access to the areas, systematic screening of patients, and staff for entry for MRI examination. The MRI zones are listed in **Box 1**.

Faraday Cage

The MRI room (zone 4) is surrounded by the Faraday cage enclosure. It is composed of copper mesh, copper panels, or stainless-steel sheets that line the surrounding walls, including the floor and the ceiling **(Figs. 1A and B)**. By creating a continuous conductive barrier, it prevents external electromagnetic fields and radiofrequency signals from interfering with the zone 4 (gantry room) magnetic field.[5,6] Shielding with the Faraday cage is necessary as highly sensitive radiofrequency signals are used to form an image in MRI. Even a minimal electromagnetic interference can compromise image clarity or may lead to artifacts.

Special doors: The scanner room is accessed through special doors that are sealed with a series of electrical contact strips to prevent radio-frequency leakage while closed.[5,7]

BOX 1: Classification of MRI facility areas according to ACR safety zoning.

- Zone 1 (patient holding area)
- Zone 2 (reception area of MRI)
- Zone 3 (console and patient preparation area)
- Zone 4 (gantry room)

(ACR: American College of Radiology)

JAYPEE BROTHERS



FIGS. 1A AND B: Faraday cage for 3 T MRI (A) and placement of MRI machine within the Faraday cage (B) for installation.

Courtesy: AIIMS, Vijaypur, Jammu.

Metal Detectors

Metal detectors are used in an MRI facility to scan metallic objects. They are used to identify metallic objects as part of the screening of a person before entry into zone 4. The main metal detectors used in an MRI facility are walk-through metal detectors, point-blank range metal detectors, and Ferroguard Assure metal scanners.

Walk-through metal detector: It is usually placed in MRI control zone 2 to quickly screen individuals as they pass through it **(Figs. 2A and B)**. It detects ferrous as well as nonferrous metals. The presence of metallic objects gives an audio–visual alarm with colored lights and beeps.[8]

Metal scanner point-blank range: It is hand-held metal detector **(Fig. 3)**. It can detect ferrous and nonferrous materials. It easily detects small metal (ferrous and nonferrous) objects. It is light in weight. It is used to detect smaller metallic objects that might have been missed during initial scanning.



FIGS. 2A AND B: A walk-through metal detector, positioned in oblique (A), and shows a color alarm while crossing with metallic objects (B).

Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

Ferroguard Assure door frame scanner: These types of metal detectors are advanced systems **(Figs. 4A to D)**. These are designed to detect ferromagnetic objects containing iron, nickel, cobalt, or their alloys. It has two poles on either side of the door. It remains always ON so that it can detect objects crossing the doors. It detects objects by changing the color of light from green to orange to red and making a beep sound. Similar hand-held ferromagnetic detection systems (FMDS) also exist.[5] They help ensure that only persons free of unsafe metal objects enter zone 4, thus greatly increasing safety for patients and staff.

Multiparameter Patient Monitor

An MRI-compatible multiparameter monitor can be used inside the MRI gantry room; however, it is classified as an MRI conditional device.[9,10] The safety signage strip attached to the device clearly displays its MRI conditional status (arrow) and Gauss lines to be maintained from the MRI magnet **(Figs. 5A and B)**. When positioned at a distance of 1.5 m or more from the gantry, it functions safely and displays a green colored indicator. When the distance decreases from the MRI magnet, the color changes from yellow to orange and finally to red, which means the device has stopped functioning. It has the facility for wireless monitoring of SpO_2 and electrocardiogram (ECG), noninvasive measurement of blood pressure (NIBP), anesthesia gas module (AGM)/capnography, temperature recording, and invasive



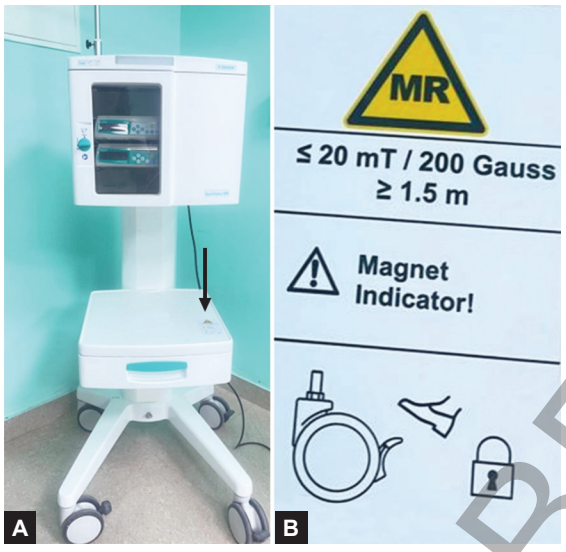
FIG. 3: A point-blank range metal detector.
Courtesy: AIIMS, Vijaypur, Jammu.



FIGS. 4A TO D: Ferroguard Assure metallic detector at the door of zone 4 MRI suite with two poles on either side of the door (A), normal green light (B), orange light when an unacceptable ferromagnetic object is around it (C), and red (D), when an unacceptable object is very close to it.
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

blood pressure measurement. It is equipped with fingertip adapters; the lighted point of which should be attached to the nail side of the fingertip. The fiber optic cable should be handled carefully, and bends should be avoided. It uses MRI-compatible electrodes made up of MRI-compatible materials such as carbon. Some models also integrate infusion pumps inside them[9,10] **(Figs. 6A and B)**.



FIGS. 5A AND B: Multiparameter monitor (A) and safety signage (MR conditional) strip (arrow) detailing safe distance and Gauss lines from the MRI magnet (B).
Courtesy: AIIMS, Vijaypur, Jammu.

Infusion Pump

It contains syringe pumps (5–50 mL) and the volumetric set. It is made up of fibers and electronic parts. When its door is opened, the pump does not remain MRI safe. When the door is closed, it remains compatible at a distance of ≥1.5 m from the MRI gantry.[11]

MRI-Compatible Electrodes

These are made up of carbon or silver alloy. Only MRI-compatible electrodes should be used inside the MRI scanner room **(Fig. 7)**. The metallic electrodes must be avoided inside the MRI scanner room.

Water Trap

It is a part of a multiparameter system, especially in systems using carbon dioxide sensors **(Fig. 8)**. It prevents moisture or condensed water from entering and damaging the sensors of the multiparameter. It should be replaced every 45 days to maintain equipment safety. It is important to write the date of its placement in the system so that its replacement can be tracked easily.[12]



FIGS. 6A AND B: Infusion pumps with box opened (MRI incompatible state) (A) and infusion pumps housed in a box (B) MRI-compatible state.
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS



FIG. 7: MRI-compatible electrodes.
Courtesy: AIIMS, Vijaypur, Jammu.



FIG. 8: WaterLock2 (water trap) for multiparameter monitor.
Courtesy: AIIMS, Vijaypur, Jammu.



FIG. 9: MRI-compatible laryngoscope set.
Courtesy: AIIMS, Vijaypur, Jammu.



FIGS. 10A AND B: MRI-compatible transport ventilator in different orientations.
Courtesy: AIIMS, Vijaypur, Jammu.

Magnetic Resonance Imaging-Compatible Laryngoscope Set (Fig. 9)

It is an MRI conditional device system and is used in an MRI gantry room with appropriate precautions. MRI-unsafe laryngoscopes should not be used inside the MRI room.[13]

Transport Ventilator

It is a small, portable, MRI conditional ventilator designed for use in pediatric and adult patients. Transport ventilators can be entirely pneumatically driven with no requirement of batteries or external electrical power for operation. Transition between noninvasive and invasive ventilation without interrupting respiratory support is possible. Additionally these are also designed to minimize the patient's work of breathening **(Fig. 10)**. It is used inside the gantry room, typically at the foot end of the patient, to minimize the magnetic effects of MRI. It is also useful for the shifting of critically ill patients between the MRI room and ICUs.[14]

JAYPEE BROTHERS

Oxygen Deficiency Monitor

It is a safety device fixed on the wall in the MRI facility to monitor the surrounding oxygen level in a nonstop manner **(Fig. 11)**. It beeps if there is a drop in the oxygen concentration below safer limits, e.g., during helium loss from the MRI magnet. In addition, it also detects gases such as nitrogen, CO_2, and argon if their concentrations rise above the safer limits.[15]



FIG. 11: The oxygen deficiency monitor in the MRI room.
Courtesy: AIIMS, Vijaypur, Jammu.

Intercom System and its Safety Features

It allows personnel and patients to communicate during the MRI examination **(Figs. 12A to C)**.

Open Magnetic Resonance Imaging

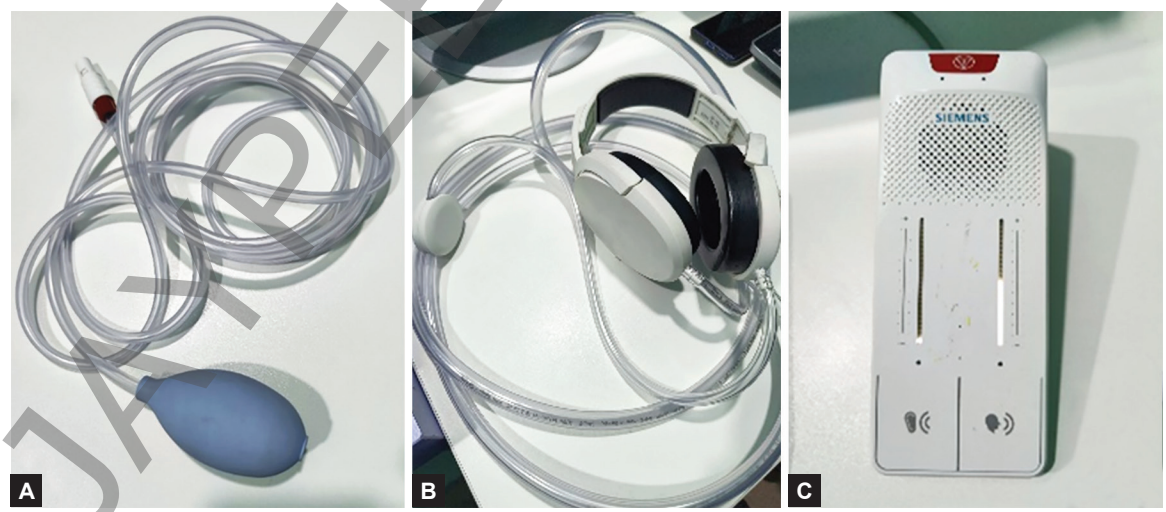
It is designed so that one of the sides of the gantry remains open **(Fig. 13)**. Open MRI uses low-strength permanent magnets instead of superconducting magnets. It is thus helpful for scanning claustrophobic patients.[16]

SAFETY FEATURES IN X-RAY-BASED EQUIPMENT

Safety Issues of Concern

Ionizing Radiation

Patients who undergo multiple imaging studies over time may lead to an increase in cumulative radiation dose from repeated radiation exposures. Therefore, long-term monitoring and careful management are essential to minimize the cumulative effects of radiation exposure. Alternative imaging tools such as MRI should be used whenever possible.[17]



FIGS. 12A TO C: Patient panic alarm system (A), noise reduction headphones (B), and intercom unit with table stop button shown in red (C).
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

Ergonomics in the design of equipment: As radiologists spend most of their time in front of the workstations and doing procedures using the equipment, the design of the equipment should be work-friendly. Additionally, the ergonomics of the workspace adds to the issues, such as acoustics caused by the abundance of equipment in a reporting room, such as printers, keyboards, and sounds from the abutting workstations and the doctors who come over to discuss their patients.

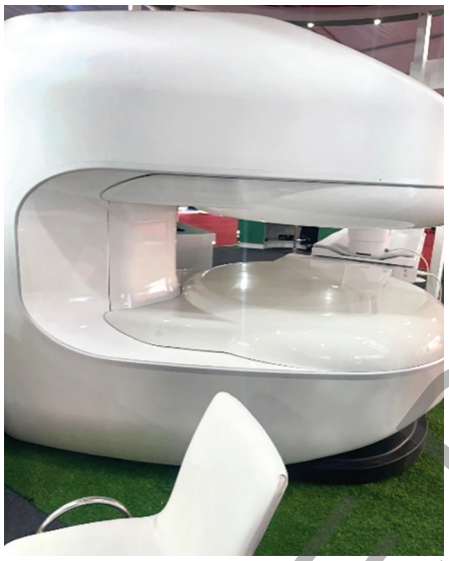


FIG. 13: Open MRI design.
Courtesy: Fujifilm.

A better choice of furniture, such as desks and chairs, is crucial since radiologists frequently perform repeated jobs and sit in the same positions for extended periods of time, which strains some muscles and joints more than others.[18]

X-Ray and Fluoroscopy

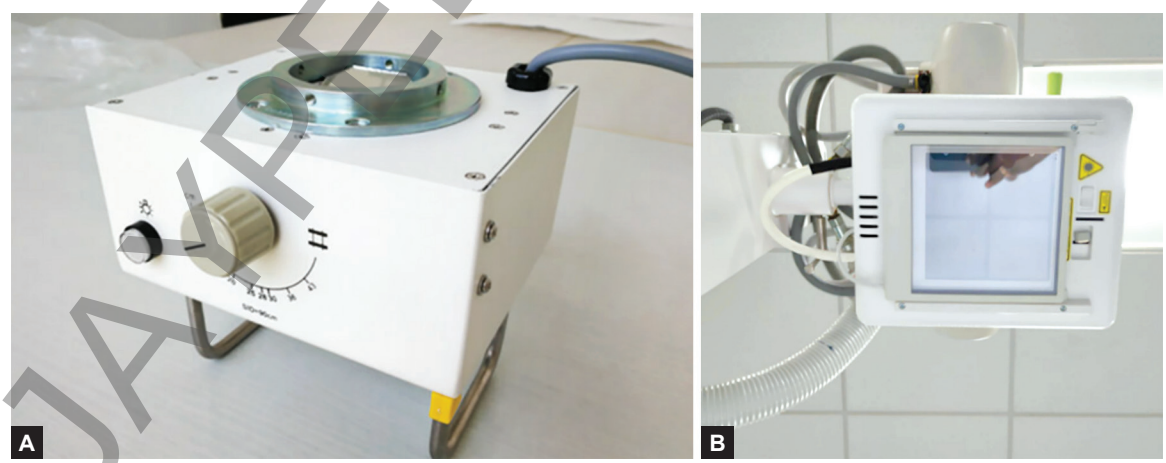
The designs of the parts of the X-ray/Fluoroscopy and CT equipment that help in radiation safety are:

Beam Limiting Devices (Collimator/Beam Shutter)[1,19,20]

Beam limiting devices **(Figs. 14A and B)** are designed to narrow the primary beam and confine it to the area of interest, therefore preventing unnecessary tissue irradiation. Positive beam limitation is also a safety feature designed into digital radiographic equipment **(Fig. 14A)**, which guarantees that the radiation field and image receptor are of the same size.

X-Ray Tube Housing (Fig. 15)

It is a safety design that helps in dissipating heat and restricts X-ray emission to the useful primary beam. It limits radiation leakage to some extent (approximately 100 mR/h at a distance of 1 m from the source, maximum voltage and current). Latest advancements in X-ray tube designs include better image quality, reduced radiation exposure, and longevity of the tube itself. They have enhanced



FIGS. 14A AND B: Beam limiting X-ray collimator device with a manual control knob to control the X ray beam field (A) and collimator housing mounted on an X-ray tube assembly meant for the restriction of X-ray beam to the region of interest (B).
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS



FIG. 15: The housing of the X-ray tube.
Courtesy: AIIMS, Vijaypur, Jammu.

cooling systems, lower power consumption, compact size, and provide the facility of dual-energy and spectral images, allowing the acquisition of two sets of images with different tissue contrasts to differentiate between materials of different densities, e.g., calcium, iodine, and soft tissues. Integration of sensors and artificial intelligence (AI) technology with X-ray tubes minimizes unexpected failures and ensures high-quality performance.[21]

Positive Beam Limitation

It is an X-ray equipment safety feature in digital X-ray machines that ensures the radiation field and image receptor are of the same size. This ensures that all the irradiated anatomy of diagnostic interest is recorded on the image receptor.

Beam stop: It is a shielding device, which absorbs the primary beam after it passes through the patient.

Interlock: It shuts down the beam if any switch in a series is open.

Fail-safe: When closed, it prevents the passage of the primary beam.

Filtration: The low-energy X-rays that do not contribute to image formation, the filters, absorb them and make the X-ray beam more penetrating (this is known as beam hardening).

Control console: The console system is one of the important X-ray equipment safety features, as it ensures all operations of the machine can be performed from an appropriate distance.

Automatic exposure control (AEC)—sign or button: This facility selects the appropriate exposure factors automatically based on the patient's body habitus. Additionally, it can be configured to stop exposure after a specific predetermined dosage. We select kV, and mA is selected automatically. The right or left, or middle chamber selection focuses the corresponding side for AEC exposure on that side and exposes the detector of that side **(Fig. 16)**.

Antiscatter Grid (Fig. 17)

The grid selectively uses primary radiations for image formation and removes the scattered radiations, hence improving the image contrast. Other shielding devices, such as ceiling suspended leaded glass shielding flaps, protect from scattered radiation. There are meters displaying cumulative air kerma, dose area product, and other parameters integrated in the X-ray equipment.

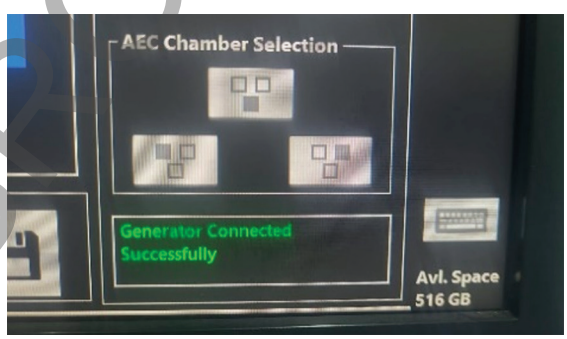


FIG. 16: A selection of AEC. (AEC: automatic exposure control)
Courtesy: AIIMS, Vijaypur, Jammu.

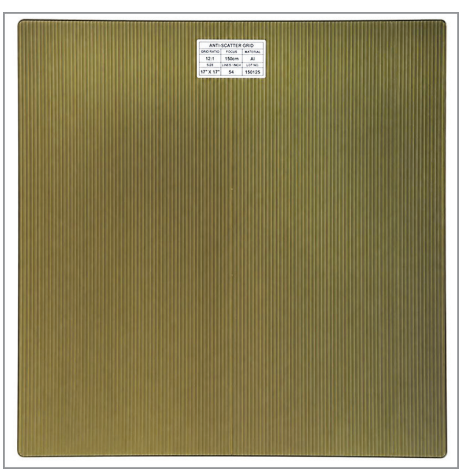


FIG. 17: Antiscatter grid.
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

Examination Table (Fig. 18)

The up and down movement of the table helps the patient to easily be positioned on the table during the examination.

Emergency Stop Button

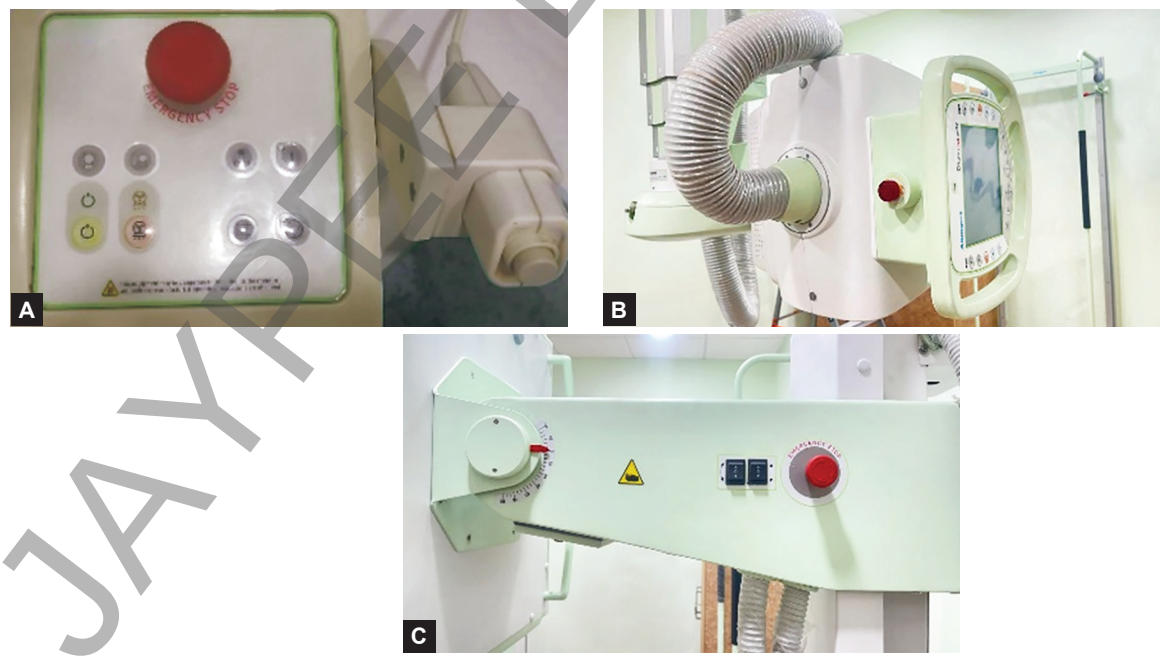
These help in the quick stoppage of electrical power during emergencies, such as accidental or unwanted machine movements. There are at least three emergency stop switches in the X-ray unit **(Figs. 19A to C)**. One in the control console, the second with an X-ray tube system, and the third one with a vertical bucky stand to ensure an easy approach.

Ultrasonic Anticollision Sensor (Fig. 20)

It automatically stops the movement of the vertical bucky system when someone comes close to it.



FIG. 18: X-ray examination table with safety features.
Courtesy: AIIMS, Vijaypur, Jammu.



FIGS. 19A TO C: Emergency stop button (red coloured button) in the X-ray machine attached with control console (A), X-ray tube system (B), and with vertical bucky stand (C).
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

Foot-Operated Pressure Switch

Helps in providing calculated exposures during the procedures done under fluoroscopic guidance. The cine switch records a series of X-ray images at a high frame rate and is used during real-time dynamic studies. The spot switch is used to capture a specific image (spot image) with high resolution using higher X-ray dose. The image can be used for documentation/analysis of the findings. Fluoroscopy (FLUORO) pedal switch uses continuous X-rays with lower doses as compared to the spot view **(Fig. 21)**.

High-Frequency X-Ray Control (Fig. 22)

All electronic components are placed in this control. It ensures a stable power supply, centralized control, and a more compact and lightweight system. Housing all components in a single system ensures the safety of operators and patients.

All-Stop Button

It stops the machine's movement functions without switching it OFF, while the machine remains switched ON **(Fig. 23)**. It is a safety feature in the fluoroscopy machine. The imaging activities can be stopped, including both fluoroscopy and radiography, in emergency situations, to stop the procedure to prevent unnecessary radiation exposure, and hence, it is a quick means to stop the imaging procedure.

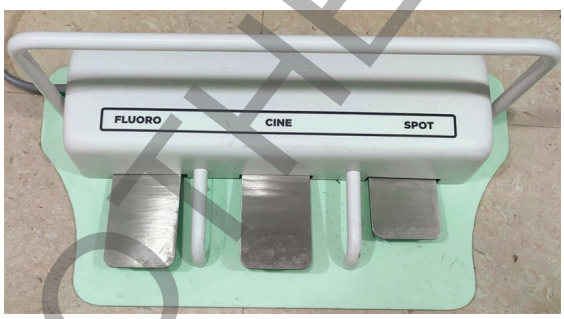


FIG. 21: Foot-operated switches in fluoroscopy unit.
Courtesy: AIIMS, Vijaypur, Jammu.

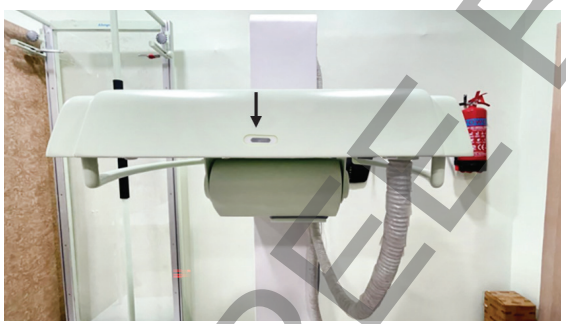
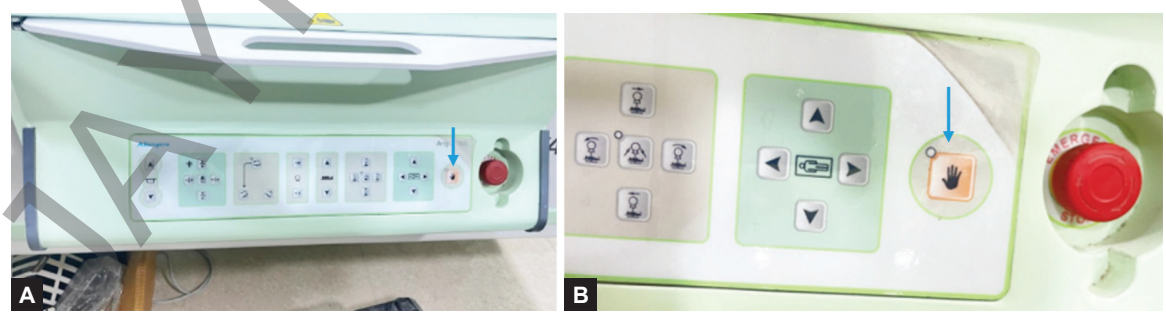


FIG. 20: Ultrasonic sensor over the vertical bucky system.
Courtesy: AIIMS, Vijaypur, Jammu.



FIG. 22: High-frequency X-ray control system.
Courtesy: AIIMS, Vijaypur, Jammu.



FIGS. 23A AND B: "All-stop button" on the fluoroscopic control table (arrow). The button adjacent to it is the emergency stop button (A) and the zoomed image (B).
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

Magnet Release Button (Fig. 24)

It is one of the safety features in X-ray machines. It is also called the magnetic brake release. Pressing the two buttons simultaneously keeps the machine in manual movement mode, allowing the user to safely reposition the equipment.



FIG. 24: Magnet release button (arrows) on X-ray tube monitor.emergency stop button.
Courtesy: AIIMS, Vijaypur, Jammu.

X-Ray Stitching Stand[22] *(Fig. 25)*

It has height-adjustable handles. It is lightweight and has 360° swivel casters for easy movement and positioning. It facilitates multiple X-ray acquisitions in a single sitting without changing the position of the patient. Thus, it saves time, decreases radiation dose, and increases comfort for the patient and staff.

Mammography Machine[23]

Modern mammography machines have highly developed ergonomics, and a movable X-ray tube enhances patient access and thus increases comfort to the user and to the patient.

X-ray tubes in modern mammography machines have molybdenum (Mo) anodes. Some mammography machines also have dual anode tubes [Mo–rhodium (Rh)]. Filters made up of Mo or Rh are used. The X-rays produced by the Mo anode and Mo filtration are optimal for imaging small to medium-sized breasts at 25–30 kV potential. Increasing kV decreases the mean absorbed dose but also decreases the contrast, as the attenuation differences also decrease. Similarly, the impact occurs when Rh filtration and Rh or tungsten anodes are selected on the mammography



FIGS. 25A TO C: X-ray stitching stand with patient positioning for long length X-ray of spine (A) and lower limbs, without and with the X-ray tube in front of the patient (B and C).
Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

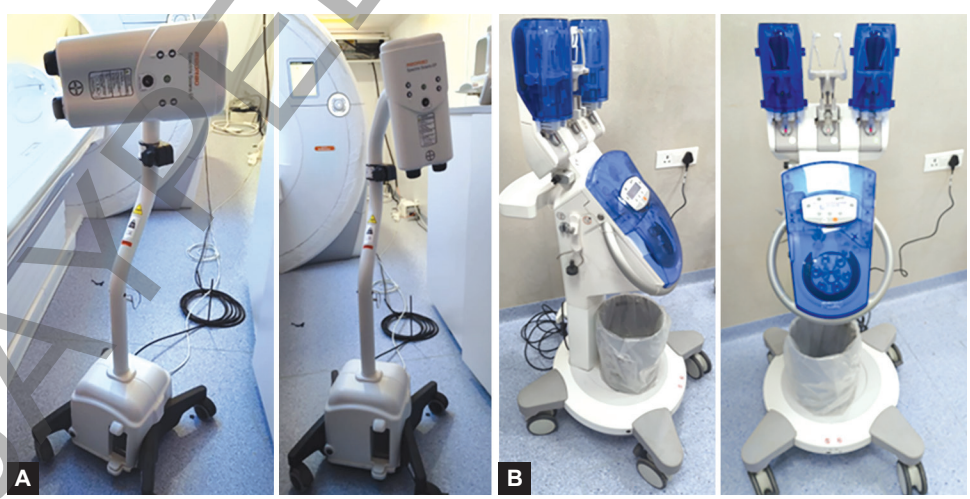
machine. The anode filter combination results in transmitting different energies at the same tube potential, e.g., tungsten/Rh produces higher mean energies than the Mo–Mo combination. Modern mammography equipment has a setting of automatic selection of tube potential and anode filter combination based on the breast thickness for examination. The compression unit and AEC provide input for breast thickness. There is an automatic control button for automatic switching OFF of the compression. Also, in modern machines, the compression unit provides bidirectional compression coordinated with the natural breast mobility, which helps to include more of the breast tissue into the examination field.[23]

Computed Tomography Scan[1]

- Emergency stop switch is located near the gantry and is an important X-ray equipment safety feature. It can be pressed to immediately terminate the emission of X-rays and the movement of the equipment.
- CTDI and DLP (CT dose index and dose-length product) display helps in the calculation of radiation dosage.
- *Focal spot display on the console (dual spots)*: Helps in the selection of focal spot, e.g., a smaller focal spot is chosen for the higher resolution of the smaller structures, whereas larger focal spot is used for faster, lower resolution scans.
- *Foot switch—CT fluoroscopy:* Helps in providing calculated exposures during interventions under CT scan guidance and thus reduces radiation dosage to the patient.
- *Table movements*: Similar to those in X-ray and fluoroscopy machines, as shown in **Figure 21**.
- *Control console*: Monitors in the console have features that control the equipment from a remote.
- AEC display: Similar to X-ray, as shown in **Figure 16**.
- *Multidetector/multislice CT scanners use*: Use of multiple rows of detectors reduces scanning time by capturing multiple data points simultaneously. Thus, decreases radiation exposure and improves image quality. It also allows the development of tailored scanning protocols and thus reduces radiation exposure.
- *Portable CT scanners*: The design supports the carrying of equipment to ICUs and OTs and hence increases safety.

Dual-Head Injectors (Figs. 26A and B)

This, as compared to single head injectors, helps in simultaneous injection of contrast and saline and



FIGS. 26A AND B: MRI-compatible dual head power injector, side view and front view respectively (A) and triple head CT contrast media injector, side view and front view respectively (B).

Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

hence increases optimal contrast enhancements, consistent contrast delivery, and reduced side effects. In the present scenario in the department of radiology, several imaging and interventional studies require pressure injectors, as in CT (CT angiography, three-phase abdominal organ studies, cardiac CT, pre- and poststent analysis, and perfusion CT) and MRI [contrast-enhanced MR angiography (MRA), cardiac MRI, and perfusion MRI].

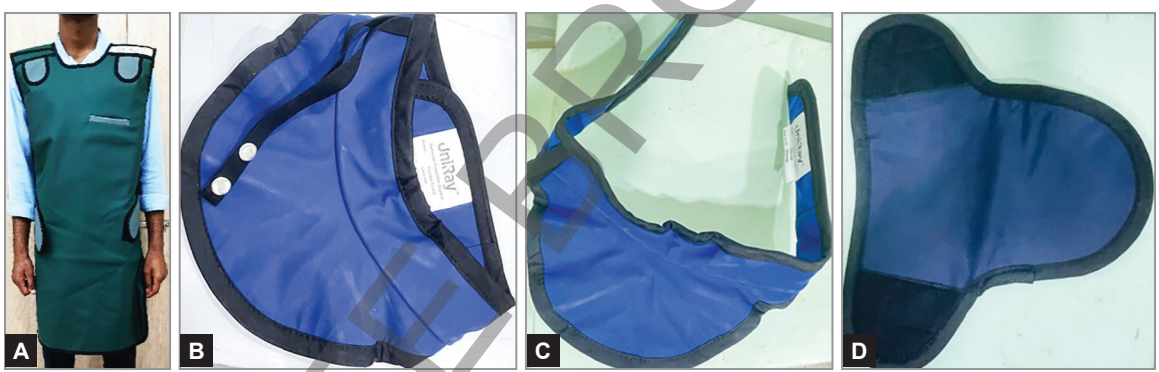
Medical gas pipeline system (MGPS): A color-coding system is used to identify the knobs present in critical areas in radiology department such as the CT scan room, DSA room, and fluoroscopy room.

Crash cart designs: Quick reference guides and checklists for various emergency protocols ensure quick actions during a crisis.

Shielding for Radiation Safety[24]

Equipment safety design involves radiation shielding, which is a critical aspect of ensuring safety in a radiology department, protecting both healthcare professionals and patients from unnecessary X-ray exposure. The devices of radiation shielding in radiology department include aprons, thyroid shied, gonadal shield **(Fig. 27A to D)**, lead gloves, lead glasses etc. and the recommended thickness of materials for X-ray, fluoroscopy and CT rooms at different distances from the isocentre[25] as depicted in **Tables 1 and 2.**

Lead-lined walls and Doors: To build up and construct the radiology examination rooms (X-ray, CT scan, and DSA rooms), it is imperative that the walls and doors be lined with lead or lead



FIGS. 27A TO D: Lead apron (A), thyroid shield (B and C), and gonadal shield (D).
Courtesy: AIIMS, Vijaypur, Jammu.

TABLE 1: Recommended shielding material thickness for X-ray and fluoroscopy rooms at different distances from the centre of the patient table.

Distance from the center of the patient table			
Shielding material	***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	2.0 TVT	1.8 TVT	1.8 TVT
Note: Floor (if installation is not on the ground floor) and ceiling thickness of 6–8-inch concrete is adequate			

(TVT: Tenth-Value Thickness)

JAYPEE BROTHERS

TABLE 2: Recommended shielding material thickness for computed tomography (CT) rooms at various distances from the isocenter.

	Distance from isocenter			
Shielding material	***1.5 m***	***2.0 m***	***2.5 m***	***3.0 m***
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 the installation is on the ground floor, the ceiling thickness is 6–8 inches of concrete. If installation is not on the ground floor, additional shielding may be required.			

equivalent materials to effectively absorb and attenuate ionizing radiation.[24,26]

Lead-Glass Windows

Install leaded glass in observation windows to maintain visibility while providing radiation protection for staff outside the examination room. The viewing glass window is 120 cm × 100 cm with a 2.0 mm lead equivalence in the DSA unit and 100 cm × 80 cm with a 2.0 mm lead equivalence in CT units.

Ceiling Suspensions

Use lead-lined ceiling suspensions to shield against scattered radiation, particularly in areas with fluoroscopy or interventional procedures. When positioned close to the patient's skin, ceiling-suspended shields can reduce scattered radiation to the operator's head, neck, and lens by 50–60% and as much as 90–98%, if the location of the X-ray source is further far away.[27]

Mobile Shields (Fig. 28)

Employ mobile radiation shields that can be moved to protect personnel during certain procedures or when working near radiation sources. Mobile shields of 0.5-mm lead equivalence can attenuate 95% of scatter radiation in the anteroposterior (AP) projection and 70% in the lateral projection. A mobile shield combined with a nondisposable 1-mm lead equivalent patient apron (outside the primary beam) attenuates 98% of the scatter. Mobile shields can protect stationary personnel, particularly nursing and anesthesia staff members.[28]



FIG. 28: Mobile shielding for X-rays.
Courtesy: AIIMS, Vijaypur, Jammu.

Protective Barriers

Use protective barriers, such as lead aprons and thyroid shields, for healthcare professionals involved in imaging procedures **(Table 3)**. Use lead curtains or drapes in areas where additional flexibility in shielding is needed, such as in mobile imaging units or temporary setups.

JAYPEE BROTHERS

TABLE 3: Lead equivalence of common protective barriers in radiology.

The lead equivalence of protective barriers	
Lead aprons	0.25 mm lead equivalent
Thyroid shield	0.25 mm lead equivalent
Gonads shield	0.25 mm lead equivalent
Eyewear (shield)	0.25 mm lead equivalent
Rubber hanging flaps [in digital subtraction angiography (DSA) laboratory]	0.5 mm lead equivalent
Hand gloves	0.25 mm lead equivalent
Lead glass window	1.5 mm lead equivalent
Door (lead lined)	1.7 mm lead equivalent
Mobile protective barrier (MPB)	1.5 mm lead equivalent

Recently developed lightweight lead free alternatives such as tungsten (W), Tin(Sn), antimony(Sb), bismuth(Bi) and barium(Ba), having comparable radiation protection performance are increasingly being adopted.[29]

In multidetector computed tomography scanner advanced detectors and computer algorithms for acquiring high-resolution, cross-sectional imaging is currently being utilized. This technology enables high-quality 3D reconstructions, increased diagnostic accuracy, and efficient imaging of moving organs such as the heart and lungs. The components inside CT scanner are shown in **Figure 29**.

Lead Apron Testing

When not in use, all lead aprons should be stored on hangers. They should never be folded for storage. Every apron should have its shielding integrity tested at approximately every 12–18-month intervals. Each apron should be given a permanent individual identification. If damage to an apron is seen or suspected, it should be reported to the chief radiographer immediately, and the apron should not be used until it has been tested and declared safe.[29]

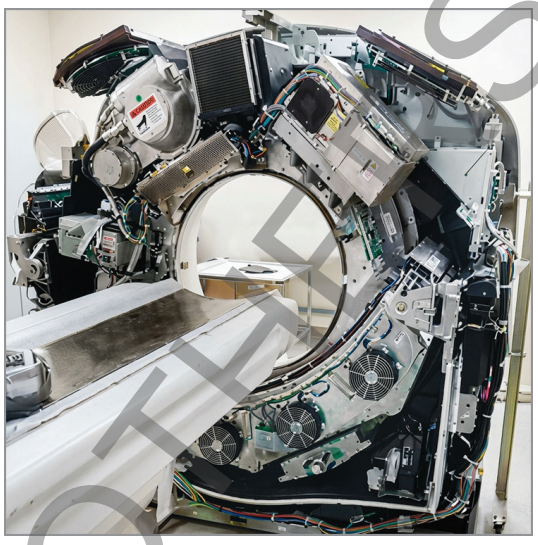


FIG. 29: Structural components of the CT gantry.
Courtesy: AIIMS, Vijaypur, Jammu.

TECHNOLOGY INTEGRATION[30]

Technology integration in radiology equipment plays a crucial role in improving diagnostic accuracy, efficiency, and patient care. For example, it includes integration of advanced technology such as AI with the equipment, integration of the hospital information system (HIS) with the radiology information system (RIS) and picture archiving and communication system (PACS).

Artificial Intelligence

Integration of AI Algorithms for Image Analysis and Interpretation

It assists in improving diagnostic accuracy and speeding up the interpretation process. AI can be used to automatically perform the CT angiography workflow, such as assessing coronary artery calcium scores, segmenting images, identifying arterial plaques, and calculating the severity of arterial luminal stenosis.[31,32]

Artificial intelligence is also applicable to evaluate the noncontrast computed tomography (NCCT) images in acute ischemic stroke. An automated imaging programmed software called RAPID AI

JAYPEE BROTHERS



FIG. 30: Portable X-ray machine unit.

configured with the NCCT is useful for the evaluation of ischemic stroke. The proposed ensemble model is able to detect the brain infarct area on the NCCT without using iodinated contrast media.[33]

Advanced Visualization Tools

Advanced visualization tools provide sophisticated tools for manipulating and analyzing images. Virtual reality (VR) and augmented reality (AR) are increasingly being integrated into radiology, offering innovative and immersive experiences for education, diagnosis, and clinical practice.[34]

Mobile Radiography (Fig. 30)

Portable and mobile radiography units are used for point-of-care imaging and are useful in emergency departments, operating rooms, and critical care settings. During the use of mobile X-ray equipment, stand at least 6 feet away from the patient and wear a lead apron.[35]

EQUIPMENT ERGONOMICS IN RADIOLOGY

Ergonomics in the design of radiology equipment is crucial to enhance user comfort, reduce the risk of musculoskeletal issues, and improve overall efficiency. The basis of equipment ergonomics is to understand the physical and cognitive constraints of human performance while working with machines. Such interface analysis is essential to create a secure, safe, practical, comfortable, and efficient system for the users.[36]

The role of ergonomics in radiology is to make sure that working circumstances are ideal in order to prevent injury and weariness. Sufficient ergonomics in the workplace can significantly boost output, effectiveness, and job satisfaction.[18]

Considerations for Ergonomic Design in Ultrasound Machines Include[37,38]

Adjustable controls: Ensure that controls are easily reachable and adjustable to accommodate users of varying heights and preferences.

Flexible monitor positioning: Allow for the adjustment of the monitor angle and height to reduce neck strain and provide optimal visibility during examinations.

Lighting: Provide adjustable ambient lighting in the examination room to reduce eye strain for both the operator and the patient.

Transducer design: Design transducers with ergonomic grips and lightweight materials to minimize strain during prolonged use.

Workflow optimization: Arrange controls and features in a logical and intuitive manner to support a smooth workflow and minimize unnecessary movements.

Portable options: If applicable, design portable ultrasound devices with ergonomic handles and lightweight construction to facilitate ease of use during point-of-care or mobile examinations.

Foot controls: Incorporate foot controls to enable hands-free operation, allowing the operator to focus on patient positioning and maintaining sterility during procedures.

Chair and seating arrangement: Provide comfortable seating for the operator with proper lumbar support to reduce the risk of back strain during longer scanning sessions.

Cable management: Implement effective cable management solutions to minimize clutter and tripping hazards in the examination room.

User training: Offer comprehensive training on proper scanning techniques and ergonomic practices to ultrasound operators to promote a healthy and efficient work environment.

JAYPEE BROTHERS

Ergonomics in Radiography, Computed Tomography Scans, and Magnetic Resonance Imaging[39]

It is crucial to ensure the well-being of both healthcare staff and patients. Proper ergonomic design contributes to increased efficiency, reduced risk of musculoskeletal issues, and an overall positive experience. Here are key considerations for ergonomics for staff and patients.

For Staff

Control console design: Arrange controls and displays in an ergonomic layout to minimize operator fatigue.

Provide adjustable workstations to accommodate different operators and promote proper posture.

Monitor placement: Optimize the placement and adjustability of monitors to reduce eye strain and neck discomfort. Use high-resolution displays for clear visualization of images.

Foot controls: Implement foot pedals for hands-free operation, allowing operators to focus on patient positioning and maintaining sterility during procedures.

Seating: Provide ergonomic seating with proper lumbar support for technologists who spend extended periods at the control console.

Workflow optimization: Arrange equipment and supplies to minimize unnecessary movements during examinations. Integrate features such as voice recognition and automation to reduce manual tasks.

For Patients

Patient table design: Ensure patient tables are easily adjustable to accommodate various body types and positions required for imaging. Provide comfortable padding and support to enhance patient comfort.

Communication: Clearly communicate instructions to patients to reduce anxiety and ensure cooperation during imaging procedures. Maintain open communication to address any concerns or questions.

Accessibility: Design equipment to accommodate patients with varying physical abilities, considering easy access to examination tables and other imaging devices.

Environment: Create a calming and comfortable environment in waiting areas and examination rooms to reduce patient stress and anxiety.

Clear instructions: Provide clear and concise instructions to patients regarding necessary movements or breath holds during imaging procedures.

Noise reduction: Implement measures to reduce noise during imaging, such as using ear protection or providing headphones to enhance patient comfort.

WARNING LIGHTS AND RADIATION SAFETY INTERLOCK SYSTEM (FIG. 31)

Implement warning lights and interlock systems that prevent the initiation of procedures unless all safety conditions are met. Examples include door interlocks and ensuring that the imaging room is properly sealed during radiation exposure.[40] The new radiation-warning symbol was launched in 2007 by the International Organization for Standardization (ISO) and the International Atomic Energy Agency (IAEA) and was entitled the "Ionizing-Radiation Warning-Supplementary Symbol," or ISO Standard number 21482:2007. According to that standard, the new symbol's purpose is to lessen the likelihood of major damage resulting from accidents or unintentional radiation exposure.[40]

Audible and visual alarms: Integrate audible and visual alarms to alert users to potential safety issues or errors.

Automated exposure control: Include automated exposure control mechanisms to adjust radiation doses based on patient size and anatomy. Optimize imaging parameters automatically to achieve diagnostic image quality with the lowest possible radiation dose **(Fig. 12)**.[41,42]

Dose monitoring and display: Provide real-time dose monitoring and display systems to allow healthcare

JAYPEE BROTHERS



FIG. 31: Warning lights. The X-ray machine is in operating mode when the green light indicator is ON. The X-ray machine is actively performing an X-ray examination on a case when the red light indicator is switched ON.
Courtesy: AIIMS, Vijaypur, Jammu.

professionals to track radiation exposure during imaging procedures. Ensure that dose information is easily accessible and comprehensible.[43]

Collision avoidance systems: Integrate collision avoidance systems, especially in mobile imaging equipment, to prevent collisions with obstacles or individuals. Use sensors and alarms to alert operators to potential collisions.

Remote control devices: Design remote control devices to allow healthcare professionals to operate imaging equipment from a safe distance during certain procedures. Useful in reducing radiation exposure to staff.

Maintenance alerts and diagnostics: Integration of maintenance alerts and diagnostic tools that notify operators when equipment requires servicing or calibration can help in scheduling timely maintenance to ensure optimal performance.

Emergency stop buttons (Fig. 32): Modern equipment has easily accessible emergency stop buttons that immediately halt the equipment's operation in case of emergencies. These should be clearly labeled and positioned for quick and intuitive use.



FIG. 32: Emergency stop button on CT scan gantry (arrow).
Courtesy: AIIMS, Vijaypur, Jammu.

AUTOMATIC CONTRAST INJECTION SYSTEMS

As shown in **Figure 26**, it delivers contrast agents and saline during contrast-enhanced studies. The implementation of automatic contrast injection systems has safety checks to ensure proper injection rates and volumes. These features prevent overdosing or underdosing of contrast agents.

Automatic power injectors reduce manual work and possible errors. Pressure injectors or power injectors in diagnostic and interventional radiology ensure optimized opacification and delineation of normal anatomy, including arterial and venous anatomy and abnormal lesions. In the present scenario in the department of radiology, several diagnostic and interventional studies require dual-head pressure injectors, e.g., CT angiographies, triple-phase studies, cardiac CT examinations, pre- and poststent analysis tests, and perfusion CT scans and MRI scans, such as contrast-enhanced MRA, cardiac MRI, and perfusion MRI.[44]

JAYPEE BROTHERS

MOBILE SCREENING UNITS

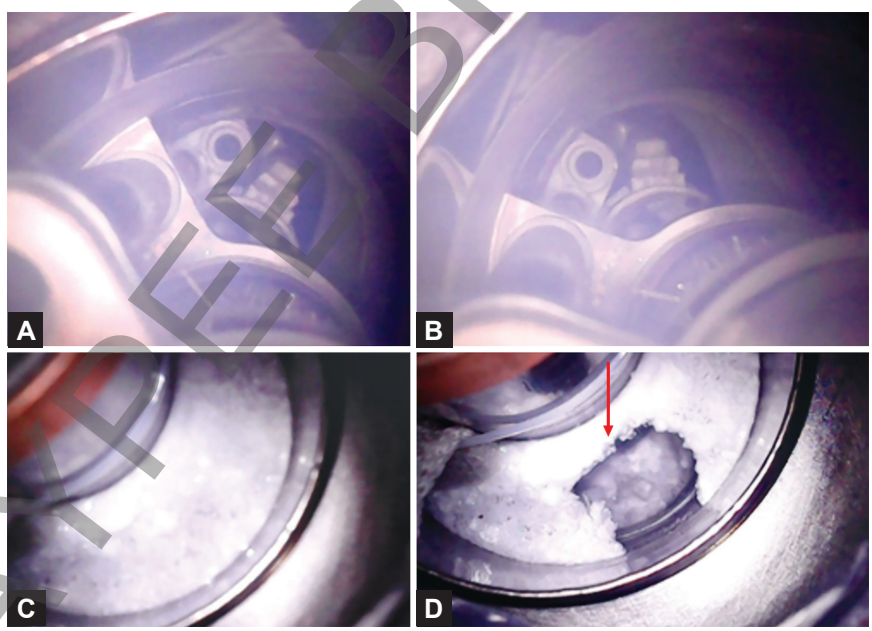
Mobile screening units equipped with advanced imaging technology are used to reach underserved or remote communities. They increase accessibility to screening services for populations with limited access to healthcare facilities.

For example, Asha Jyoti (Hindi meaning = Ray of Hope) is a women's healthcare outreach mobile program in Chandigarh, India. It started through a partnership between a government medical center, the Postgraduate Institute of Medical Education and Research (PGIMER), RAD-AID, and Philips Healthcare. It provides screening facilities for breast cancer, cervical cancer, and osteoporosis on a mobile van. It provides mammography, colposcopy, and bone density evaluation in a single visit, in outreach areas, and thus, offers a decentralized, sustainable, and cost-effective method of mass screening in females.[45]

VENTING SYSTEM IN QUENCH PIPE

The venting system in the MRI magnet, also called the turret, has to be regularly cleaned. It connects to the quench pipe. If it is blocked, the venting system of the magnet gets blocked. In MRI machines with liquid helium technology, if quenching occurs for any reason, helium cannot escape and poses a problem of oxygen deficiency to the individuals and patients present in the MRI facility.

Blockage of the turret system can occur due to hard ice formation, or leakages from washers, pipes, loose screws, etc. **(Figs. 33A to D)**. This may happen when external air enters the venting system. Deicing is the method of the breakdown of the hard ice formed in the venting system. It is performed with the help of pressurized helium gas after a controlled ramping down of the magnet of the MRI. The process takes around 2 days.



FIGS. 33A TO D: The picture shows a normal (A and B, in different orientations) and blocked [C and D, with icing and partial de-icing (red arrow), respectively] venting system of the MRI.

Courtesy: AIIMS, Vijaypur, Jammu.

JAYPEE BROTHERS

CONCLUSION

Design of imaging equipment plays an important role in the safety of the patients and the staff. In current times, there are rapid changes in the modifications in the radiology equipment design with comfortable ergonomics, radiation safety, and safety beyond radiation. Modern equipment has broader safety systems, including better control buttons and sensors, user-friendly interfaces, and better postprocessing technology.

REFERENCES

1. X-ray equipment safety features: essential information for radiologic technologists. [online] Available from https://ce4rt.com/rad-tech-talk/x-ray-equipment-safety-features-essential-information-for-radiologic-technologists/. [Last accessed June, 2026].
2. Tagell L, Alcheikh A, Jurevics R, Nair AP. Thigh burn—a magnetic resonance imaging (MRI) related adverse event. Radiol Case Rep. 2020;15(12):2569-71.
3. Mollasadeghi A, Mehrparvar AH, Atighechi S, Davari MH, Shokouh P, Mostaghaci M, et al. Sensorineural hearing loss after magnetic resonance imaging. Case Rep Radiol. 2013;2013:510258.
4. Motovilova E, Winkler SA. Overview of methods for noise and heat reduction in MRI gradient coils. Front Phys. 2022;10:907619.
5. Bijvoet GP, Holtackers RJ, Smink J, Lloyd T, van den Hombergh CLM, Debie LJBM, et al. Transforming a pre-existing MRI environment into an interventional cardiac MRI suite. J Cardiovasc Electrophysiol. 2021;32(8):2090-6.
6. da Silva JER, Pinheiro PFP, dos Reis MAL. Electrostatic shielding of Faraday's ring made of stainless steel 304 in the glass insulators. Mater Sci Eng Adv Res. 2018;2(3):15-8.
7. Kwok WE. Radiofrequency interference in magnetic resonance imaging: identification and rectification. J Clin Imaging Sci. 2024;14:33.
8. Costruzioni Elettroniche Industriali Automatismi (CEIA). Walk-Through Metal Detectors. [online] Available from https://www.ceia.net/security/sections.aspx?sec=a. [Last accessed June, 2026].
9. U.S. Food and Drug Administration. (2023). Testing and Labeling Medical Devices for Safety in the Magnetic Resonance (MR) Environment. [online] Available from https://www.fda.gov/media/74201/download. [Last accessed June, 2026].
10. GE HealthCare, service shop. IRadimed 3880Q Standard MRI Patient MonitorAvailable from https://services.gehealthcare.com/gehcstorefront/p/E8829TF.
11. MRI Infusion Workstation. BeneFusion MRI Station. [online] Available from https://www.mindray.com/en/products/infusion-system/benefusion-mri-station. [Last accessed June, 2026].
12. GE HealthCare. Water Traps Patient Monitoring System. Designed to protect medical equipment from moisture and contamination. [online] Available from https://www.gehealthcare.com.au/en-au/products/clinical-accessories/water-traps.
13. Anaesthetics MR Conditional Laryngoscope Set, for Hospital. [online] Available from https://www.indiamart.com/proddetail/mr-conditional-laryngoscope-set-21011618573.html?srsltid=AfmBOoorLgsEMEfGaT3SDTqnYfWAzF9Zt5ptEIKNT8mcySFFvY9QyYRB. [Last accessed June, 2026].
14. MRI Non-Magnetic Pneumatic Transport Ventilator. [online] Available from https://mriequip.com/mri-non-magnetic-pneumatic-transport-ventilator/?srsltid=AfmBOoqAU-JZtj6Xns7YtSdp0tiF4UVJsoGWmqhdm9OZHERS7PRyctZJ. [Last accessed June, 2026].
15. PureAire Monitoring Systems. (2024). MRI Room Oxygen Monitor. [online] Available from https://www.pureairemonitoring.com/oxygen-o2-monitor-for-mri-rooms-pureaire-sells-a-hassle-free-10-year-oxygen-monitor/?srsltid=AfmBOop2vuIX3H-COMxJTlmqQvVPsKJ4Ub8V_hqgzNtde8H4adCNIII4. [Last accessed June, 2026].
16. Metal Detectors. Should MRI facilities screen patients with metal detectors? [online] Available from https://www.mriquestions.com/metal-detectors.html. [Last accessed June, 2026].
17. Magnetic Resonance Imaging (MRI). [online] Available from https://www.nibib.nih.gov/science-education/science-topics/magnetic-resonance-imaging-mri. [Last accessed June, 2026].
18. Mohan SM C. Ergonomics in radiology—time to revisit. Indian J Radiol Imaging. 2018;28(3):271-2.
19. Moloney F, Fama D, Twomey M, O'Leary R, Houlihane C, Murphy KP, et al. Cumulative radiation exposure from diagnostic imaging in intensive care unit patients. World J Radiol. 2016;8(4):419-27.
20. Murphy A. (2023). Beam collimators. [online] Available from https://radiopaedia.org/articles/beam-collimators. [Last accessed June, 2026].
21. What are the latest innovations in X-ray tube technology for 2026?. Availavle from: https://www.vareximaging.

JAYPEE BROTHERS

com/blogs/what-are-the-latest-innovations-in-x-ray-tube-technology-for-2026/. [Last accessed July, 2026].
22. One Shot Long-Length imaging stand. [online] Available from https://www.xograph.com/one-shot/. [Last accessed June, 2026].
23. International Atomic Energy Agency (IAEA). (2002). Mammography—recent technical developments and their clinical potential. [online] Available from https://inis.iaea.org/records/qf9hd-vhs46. [Last accessed June, 2026].
24. Atomic Energy Regulatory Board. (2017). Radiation safety training module: Diagnostic Radiology Regulatory Requirements in Diagnostic Radiology Practice. https://www.aerb.gov.in/images/PDF/Diagnostic Radiology/REGULATORY-REQUIREMENTS-FOR-DIAGNOSTIC-RADIOLOGY-PRACTICE.pdf. [Last accessed June, 2026].
25. Guidelines for shielding of X-ray installations. Available at: https://aerb.gov.in/images/PDF/layout_guidelines.pdf. [Last accessed July 2016].
26. Atomic Energy Regulatory Board. Planning of diagnostic X-ray installations. Mumbai: AERB; 2017. Pages 1-38.
27. Meisinger QC, Stahl CM, Andre MP, Kinney TB, Newton IG. Radiation Protection for the Fluoroscopy Operator and Staff. AJR. 2016;207 (4):745-754. https://doi.org/10.2214/AJR.16.165.
28. Meisinger QC, Stahl CM, Andre MP, Kinney TB, Newton IG. Radiation protection for the fluoroscopy operator and staff. Am J Roentgenol. 2016;207(4):745-54.
29. Khorami MT, Salehi Z. Characterization of the light and flexible nonlead aprons as an alternative to Pb–PVC. J Appl Clin Med Phys. 2025; 26:e70398. https://doi.org/10.1002/acm2.70398.
30. International Atomic Energy Agency. (2006). Applying Radiation Safety Standards in Diagnostic Radiology and Interventional Procedures Using X Rays. [online] Available from https://www.iaea.org/publications/7115/applying-radiation-safety-standards-in-diagnostic-radiology-and-interventional-procedures-using-x-rays. [Last accessed June, 2026].
31. Jin D, Harrison AP, Zhang L, Yan K, Wang Y, Cai J, et al. Artificial intelligence in radiology. Artificial Intelligence in Medicine. Cambridge: Academic Press; 2021. pp. 265-89.
32. Liao J, Huang L, Qu M, Chen B, Wang G. Artificial intelligence in coronary CT angiography: current status and future prospects. Front Cardiovasc Med. 2022;9:896366.
33. Kaothanthong N, Atsavasirilert K, Sarampakhul S, Chantangphol P, Songsaeng D, Makhanov S. Artificial intelligence for localization of the acute ischemic stroke by non-contrast computed tomography. PLoS One. 2022;17(12):e0277573.
34. Diagnostic Imaging. (2020). Augmented and virtual reality—radiology at the center of medical technology. [online] Available from https://www.diagnosticimaging.com/view/augmented-and-virtual-reality-radiology-center-medical-technology. [Last accessed June, 2026].
35. Atomic Energy Regulatory Board. Radiation protection in diagnostic radiology. [online] Available from www.aerb.gov.in/images/PDF/DiagnosticRadiology/RADIATION-PROTECTION-IN-DIAGNOSTIC-RADIOLOGY.pdf. [Last accessed June, 2026].
36. Brusin JH. Ergonomics in radiology. Radiol Technol. 2011;83(2):141-57.
37. Goyal N, Jain N, Rachapalli V. Ergonomics in radiology. Clin Radiol. 2009;64(2):119-26.
38. Sweeney K, Ginn K, Spurway J, Clarke J, Mackey M. Does participatory ergonomics reduce musculoskeletal pain in sonographers? A mixed methods study. Ultrasound. 2022;30(2):105-16.
39. Roll SC, Selhorst L, Evans KD. Contribution of positioning to work-related musculoskeletal discomfort in diagnostic medical sonographers. Work. 2014;47(2):253-260.
40. Stanford University. (2025). Radiation safety manual. [online] Available from https://ehs.stanford.edu/wp-content/uploads/Radiation-Safety-Manual.pdf. [Last accessed June 2026].
41. IAEA. (2007). New Symbol Launched to Warn Public About Radiation Dangers. [online] Available from https://www.iaea.org/newscenter/news/new-symbol-launched-warn-public-about-radiation-dangers. [Last accessed June, 2026].
42. Doyle P, Gentle D, Martin CJ. Optimising automatic exposure control in computed radiography and the impact on patient dose. Radiat Prot Dosimetry. 2005;114(1-3):236-9.
43. Kim J, Yoon Y, Seo D, Kwon S, Shim J, Kim J. Real-time patient radiation dose monitoring system used in a large University Hospital. J Digit Imaging. 2016;29(5):627-34.
44. Indrajit IK, Sivasankar R, D'Souza J, Pant R, Negi RS, Sahu S, et al. Pressure injectors for radiologists: a review and what is new. Indian J Radiol Imaging. 2015;25(1):2-10.
45. Mango VL, Ha R, Nguyen B, Mema E, Kobeski J, Singh T, et al. RAD-AID Asha Jyoti Mammogram Quality Assessment in India: optimizing mobile radiology. J Am Coll Radiol. 2016;13(7):831-4.

JAYPEE BROTHERS

for detailed information on radiology books, visit our website www.ejaypee.com, for detailed information on radiology books, visit our website www.ejay

Do's & Don'ts in RADIOLOGY

Best Practices and Operational Guidelines

Salient Features

- A ready reckoner for residents, faculty of diagnostic and interventional radiology department, consultant radiologists, radiology technologists, and healthcare administrators
- Incorporates essentials of establishing a diagnostic and interventional imaging department
- Details the requirements of accreditation including standards for NABH and JCI and highlights excellence and patient-centric approach by adoption of best practices
- Enumerates safety features and measures for utilization of radiology equipment
- Recommends measures of quality improvement, for optimally utilizing equipment of radiology department/centers to reduce waiting times, unnecessary imaging, and cost
- Includes protocols and SOPs for radiology imaging investigations (X-ray, CT, MRI, and DEXA) and procedures (checklists for FNAC, biopsy, collection drainages, PTBD, upper GI studies, breast interventions, and sclerotherapy)
- Provides a blueprint for planning and designing the diagnostic and interventional imaging departments including model layouts and workflow according to the regulatory guidelines
- Highlights radiation protection, equipment ergonomics, and patient and staff safety
- Promotes a culture of continuous education, quality assurance, and excellence aligned with benchmarked standards

"Standardization Saves Time; Safety Saves Lives"

JAYPEE BROTHERS

Shelving Recommendation
RADIOLOGY

ISBN 978-81-6799-912-2

Buy from ejaypee

JAYPEE BROTHERS