



Radiation protection in x-ray facilities can be achieved by adequate shielding thickness, facility layout, and control of access to areas used for x-ray procedures. Facilities should also consider the need for shielding for floors and ceilings in multi-story structures.

Primary barriers intercept the useful beam emitting directly from the x-ray tube. Secondary barriers intercept leakage and scattered radiation. Primary barriers usually require more shielding than secondary barriers.

## Shield Thickness and Material

Shielding design is acceptable when the total air dose at a point approximately one foot beyond the barrier is equal to or less than 10 mrem/week for controlled areas (occupational workers) and 2 mrem/week for uncontrolled areas (public).

Controlled areas are areas where employees may be exposed to radiation during their work, or where employees are involved with the use and control of radiation. Examples of controlled areas are x-ray rooms and x-ray control rooms.

Uncontrolled areas are areas occupied by individuals such as patients, employees who do not work with radiation, and visitors. Examples of uncontrolled areas are patient exam rooms, hallways, employee lounges, public toilets, storage rooms, and waiting rooms. Areas adjacent to the facility are also uncontrolled areas, including sidewalks, parking lots, stairways, and elevators.

Some types of x-ray devices do not need shielding other than typical drywall. However, any assumption of the adequacy of conventional barriers can lead to a false sense of security and should be confirmed by an expert. Operators should be as far away as possible to minimize their dose during exposure.

Variables to consider when computing an appropriate shield thickness are:

- The type of material to be used for the shielding
- The maximum operating potential (kVp) of the x-ray machine
- The x-ray workload, determined by averaging the number of films per week
- The distance to the point of calculation (e.g., operator position, doorway)
- The weekly shielding design limit for a controlled area (10 mrem/week) or uncontrolled area (2 mrem/week)
- The fraction of the total “on” time of the x-ray tube during which a person is near the radiation source in an uncontrolled area (occupancy factor)

- The fraction of the total “on” time the x-ray tube is directed toward a barrier (use factor)
- The fraction of primary beam transmitted through the patient and image receptor
- The leakage radiation standard to which the tube was designed and the effective leakage current
- Any potential changes in the above variables

## Facility Layout for New Practices

In some cases, shielding costs can be reduced by placing exterior walls and low occupancy areas adjacent to the x-ray room. Corridors and other low occupancy spaces, such as rest rooms or utility rooms, may be used to separate radiation areas from occupied spaces such as offices and lounges. A shielded location allowing continuous observation of the patient is required for the x-ray machine operator. Facilities should consider future increases in workload when designing shielding.

Open space designs and operatories separated by modular cabinets or mobile partitions may present special problems. Patients in open space operatories shall be located such that they are not irradiated by the beam from an adjacent patient. All unnecessary individuals shall leave the area when the x-ray tube is activated.

Dental operators shall stand at least 6 feet away from the direction of the primary x-ray beam or behind a barrier.

Before purchasing a handheld dental x-ray device, facilities should contact the Vermont Department of Health to ensure that the device in question has been approved for use in the state. **Handheld dental x-ray devices (including veterinary) must be approved by the Vermont Department of Health before being used within the state.** Operators should use the unit exactly according to manufacturer’s instructions. If the operator is unable to follow the instructions, a lead apron shall be worn. The operator of a handheld device shall not use these devices in hallways, waiting rooms, or other uncontrolled areas.

Operators of veterinary x-ray machines shall wear lead aprons and gloves when holding animal patients during exposure. The personnel who hold the patients should rotate so that the same employees are not in the room during each exposure. Whenever possible, operators should stand at least 6 feet away or behind a shield.