VERMONT
DEPARTMENT OF HEALTH

X-RAY FACILITY TIPS

Topic 2: Facility Shielding

Radiation protection in dental facilities is controlled by adequate radiation shield thickness, the layout of the overall facility, and controlling access to and flow through areas used for imaging procedures.

Shield Thickness and Material

*Conventional building materials in partitions, floors and ceilings may provide adequate radiation shielding for dental installations. However, any assumption of the adequacy of conventional barriers can lead to a false sense of security. A radiation survey is the only method to determine if the existing building materials are sufficient as shielding.

*Taking all these considerations into account, the Vermont Department of Health recommends that 1.5 inches of gypsum wallboard (or its equivalent using other types of material) be used for shielding purposes in all dental facilities.

The thickness of a shield is acceptable when the total air dose at a point approximately 1 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 those areas where employees may be potentially exposed to radiation in the course of their work, or where employees are directly responsible for, or involved with the use and control of radiation. Examples of controlled areas are: laboratories, pharmacies, x-ray rooms, x-ray control rooms and other work areas fully occupied by an employee. Other types of controlled areas include administrative or clerical offices, receptionist areas, attended waiting rooms, children's indoor play areas, adjacent x-ray rooms, film reading area, and nurse's stations.

Uncontrolled areas are those areas occupied by individuals such as patients and visitors to the facility. Examples of uncontrolled areas are: patient examination and treatment rooms, corridors, patient rooms, employee lounges, staff toilets, public toilets, unattended vending areas, storage rooms, outer areas with seating, unattended waiting rooms, and patient holding areas. Areas adjacent to, but not part of the x-ray facility, are also uncontrolled areas. These include outdoor areas with only transient pedestrian or vehicular traffic, unattended parking lots, vehicular drop off areas (unattended), attics, stairways, unattended elevators, and janitor's closets.

Variables requiring consideration in computing an appropriate shield thickness are:

* The type of material to be used for the shielding, for example, lead, concrete or gypsum wallboard.
* The maximum operating potential (kVp) of the x-ray machine.
* The workload of the x-ray tube. This is determined by counting the number of films exposed over several weeks and averaging the number for each week. The product of the average number of films per week and the average milliampere-seconds per film divided by 60 (to convert milliampere-seconds to milliampere-minutes) will yield the workload in milliampere-minutes per week.
* The distance to the point of calculation (e.g., operator position in the hall, open door to hall).
* 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 in the vicinity of the radiation source in an uncontrolled area (occupancy factor).
* The fraction of the total “on” time the x-ray tube is directed toward a wall, ceiling or floor (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.
* The potential changes in the above variables.

Facility Layout for New Practices

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 outside the radiography room allowing continuous visual observation of the patient is required for the x-ray machine operator.

Open space designs, operatories separated by modular cabinets or thin mobile partitions, door-less entries and windows on exterior walls may present radiation protection problems. For designs of this type, special consideration should be given to individuals occupying adjacent operatories and individuals passing by unshielded openings. For instance, patients in open space operatories should be located such that they are not irradiated by the primary beam from an adjacent patient.

In the absence of a shield, dental operators must stand at least 6 feet away from the direction of the primary x-ray beam, due to the scatter of radiation from the patient and walls of the operatory.

SOURCES:

National Council on Radiation Protection and Measurements, NCRP Report No. 49, Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 MeV

National Council on Radiation Protection and Measurements, NCRP Report 102, Medical X-Ray, Electron Beam and Gamma-Ray Protection for Energies up to 500 MeV

National Council on Radiation Protection and Measurements, NCRP Report No. 105, Radiation Protection for Medical and Allied Health Personnel

National Council on Radiation Protection and Measurements, NCRP Report No. 127, Operational Radiation Safety Program

National Council on Radiation Protection and Measurements, NCRP Report No. 133, Radiation Protection for Procedures Performed Outside the Radiology Department

National Council on Radiation Protection and Measurements, NCRP Report No. 145, Radiation Protection in Dentistry

National Council on Radiation Protection and Measurements, NCRP Report No. 147, Structural Shielding Design for Medical X-Ray Imaging Facilities

National Council on Radiation Protection and Measurements, NCRP Report No. 148, Radiation Protection in Veterinary Medicine