

Measurements should be taken with the equipment being operated at normal operating maximum field size and at maximum current and voltage. Scattered radiation should be measured with the work to be radiographed in place.

Mobile X-ray equipment may be limited in use to a definite room. Under these circumstances the same control techniques as for a fixed installation may be used. If the unit is used in an unshielded room, *distance* is the primary control. Therefore, such installations should be located in areas remote from regions normally occupied. This type of installation is safe only if its operation is restricted by limitations set by a radiation survey. It is important, therefore, that the radiation levels be accurately determined for all operating positions of the X-ray tube and orientations of the useful beam. In this manner safe working distances can be determined.

A movable control booth or barrier may be provided to accommodate all necessary X-ray controls if it is necessary for the controls to be located in a high radiation zone. The booth of course should have sufficient X-ray shielding. Movable barriers should not be depended upon for protection above 100 kv.

The "danger" or high radiation zone should be fenced or roped off with sufficient posting of signs. Visible warning signals, such as flashing electric signs, should be conspicuously located at points where it is desirable to prevent trespassing by passers-by in uncontrolled areas.

Instructions regarding the safe use of equipment as well as any limitations that must be imposed should be conspicuously posted at the equipment controls.

Fluoroscopic installations. The hazards associated with fluoroscopic installations are similar to those of radiographic installations, except that they may be greater because the useful beam generally is directed toward the operator and the working distance from the tube is relatively shorter. Furthermore, in some respects industrial fluoroscopy presents greater hazards than medical fluoroscopy. Industrial installations frequently are operated 8 hours a day, and the object seldom covers the entire fluoroscopic screen. On the other hand, it is possible to protect the

operator completely against scattered radiation. In the design, use and maintenance of such installations the following should be considered:

- The movement of objects through the fluoroscopic installation should be by means of conveyor belts, turntables, or other remotely controlled means. It should be impossible for the worker to place his hands in the useful beam. Removal of foreign or defective objects from the conveyor, should preferably be done by remote control. Where this operation must be done normally through an access door in the enclosure, an interlock should be provided which would positively prevent the door from being opened when the tube is in operation.

- Transparent protective barriers, such as leaded glass, should be used for viewing the screen. When this barrier is removed periodically for heat treatment or for replacement the machines should not be used. Interlocking switches should be provided to prevent exposure while the barrier is not in place. If the screen is viewed indirectly by mirrors or closed circuit television the lead equivalent of the protective window can be less than that required for equivalent protection for a screen which is viewed directly.

A common source of radiation leakage is through and around the lead glass particularly after the glass has been replaced. Where no mirror is used, the useful beam is directed at the operator, and even a small crack in the shielding may cause serious injury. Such cracks can usually be detected with a Geiger counter.

X-ray diffraction units. The main hazard from X-ray diffraction units is accidental exposure of the hands or fingers to the intense useful beam while inserting or changing specimens. Owing to the low filtration and the short target distance, the dosage rate may be as high as 50,000 roentgens per minute to a localized area, permanent skin injuries may be caused by a few seconds exposure.

Where the equipment is used for production work, such as crystal orientation, each port or aperture should be provided with an automatic beam shutter which would make