5. Screening Complete Rooms

In some situations it is desirable to line with lead, or equivalent materials, a complete room in which an x-ray tube is located to provide protection, in adjacent rooms, from the scattered radiation. Where this is done, the protective material should be joined in a lapped joint; and all perforations, such as nail holes, should be adequately covered with lead. Lap joints that leave no unobstructed path for x-rays also should be provided at the doors of such a room. The thickness of this material should conform approximately to the figures given in Table 6.

6. Ventilation

In x-ray installations where corona discharge may generate noxious gases such as oxides of nitrogen and ozone, forced ventilation is required. Such a condition exists where high voltage conductors are exposed in the air. Under usual conditions, the rate of change of air ordinarily recommended for general ventilation, four or five changes per hour, will be sufficient to reduce these gases below the level where any discomfort or harmful exposure will result.

7. Special Conditions

It is impossible to suggest, within a reasonable space, rules that will apply to all conditions. As conditions change, either regarding tolerance levels or type of generating equipment, the National Radiation Protection Committee issues handbooks that cover the more important cases. A list of these handbooks published by the National Bureau of Standards appears at the end of this chapter. Where unusually high voltages are used, or other exceptional features are present in a generating installation, safety can be assured only by careful measurements by specialists of exposure at stations occupied by personnel under actual operating conditions. Lead thicknesses given by Kaye[7] for x-ray voltages up to 5 Mev. are included in Table 6.

8. Unnecessary Hazards

Under this title should be considered those uses or misuses of x-radiation that serve no real purpose and unnecessarily expose individuals to possible injury. It is needless to say that all such procedures should be discouraged. Two examples may be cited to illustrate. In some shoe stores, x-ray machines, under no expert supervision, are occasionally used to permit customers to examine the bones of their feet by means of a fluoroscope after fitting new shoes. Since no limit is set on the duration of such exposures, it is surprising that numerous cases of injury have not come to light. Another illustration occurred during World War II in a large industrial plant where employees were permitted to use a medical x-ray installation to examine themselves for metal splinters, or make any other use of the machine that struck their fancy. This occasioned an outbreak of severe radiation dermatitis, and possibly other injuries that were not immediately identified by examining physicians. Considerable damage was done before a correct diagnosis led to the cause and the practice of self-examination was discontinued. The obvious conclusion from all such incidents is that no x-ray machine should be operated by other than a trained technician well aware of the limits of safe exposure and of the consequences of overexposure. Furthermore, the technician should be responsible for the enforcement of adequately safe procedures in all operations involving the use of x-ray equipment. In no other way can a certain degree of carelessness, either through ignorance or foolhardiness, be prevented.

[7] G. W. C. Kaye, *Nature*, **145**, 370 (1940).

III. Infrared Radiation

A. GENERAL EFFECT

The long wave lengths of infrared (heat) radiation can inflict no deep injuries in the human body, since they are readily absorbed by the surface tissues. Although the full effects on the surface tissues do not develop for several hours, there is almost immediately some discomfort associated with overexposure to this type of radiation. This discomfort gives adequate warning as far as general bodily injury is concerned. The eyes, however, may suffer from continual exposures to infrared radiation that is well below the level that causes general discomfort or injury. There is some evidence that this may result in a cataract.[8] Dunn,[9] however, found no cataract from infrared in the glass industry.

Although only a small portion of the energy is absorbed in the lens of the eye the lens cannot lose heat readily. An additional injury is a permanent necrosis of the retina, most likely to occur in unprotected eyes exposed over long periods at some distance from the source of radiation. Fortunately, in most situations where overexposure of eyes to infrared radiation may occur, visible radiation also is so intense as to require protective goggles. This may not always be true. Where sources of infrared are encountered in routine operations at such low temperature that little visible light is emitted, special attention must be given to the protection of the eyes.

B. PROTECTIVE MEASURES

The effects of excessive heat on bodily comfort and resistance can be reduced somewhat by taking salt tablets and drinking plenty of water to replace evaporational losses due to perspiration (see page 119).

[8] G. F. Kealing, J. Pearson, J. Simons, and E. E. White, *A.M.A. Arch. Ind. Health*, **11**, 505 (1955).

[9] K. L. Dunn, *Arch. Ind. Hyg. and Occupational Med.*, **1**, 166 (1950).