

IONIZING RADIATION

als were involved. The worst cases are now described by category.

External radiation exposure of personnel

Accidents occurring in atomic energy operations in this country during the 20-year period 1943-1962, which includes the AEC predecessor, the Manhattan Engineer District, may be divided into three groups: (1) those in no way unique to the use of atomic energy or its products, such as falls, electrocutions, and motor vehicle accidents; (2) those involving radioactive materials, such as fires, explosions, and environmental contaminations, and (3) those resulting in radiation exposure to workers.

During that period, there were a total of 239 fatalities resulting from the three groups of accidents, six of which were from accidents directly attributable to nuclear causes. The fatal injuries of three men at Los Alamos were attributed to the direct result of exposure in early experimental work to a massive dose of nuclear radiation.

The immediate cause of the three remaining fatalities was the effect of blast and flying missiles associated with the SL-1 nuclear accident on January 3, 1961, where the radiation levels associated with that accident were also extremely high and probably would have been fatal.

During this 20-year period in atomic energy operations, there were 7,081 lost time injuries of all kinds (as defined in American Standards Association *Method of Recording and Measuring Work Injury Experience*, ASA Z16.1) attributable to all accidental causes. This was the experience of 300,300,898 man-days of potential accident exposure, which produced over two billion man-hours of work. Only 35 of the 7,081 lost time injuries (approximately 0.6%) were caused by nuclear radiation which gives a 0.017 frequency rate (number of injuries per million man-hours). In some cases of no injury, time was lost for medical study.

It is interesting to note that the AEC's overall industrial accident experience has always been much lower than the all-industry rate reported by 42 industries in the United States to the National Safety Council. The annual average frequency rate for 1962 for NSC was 6.19 (for all disabilities,

11,998 units reporting) compared with 1.97 for AEC in 1962.

Such occurrences should even be less than the AEC figure for general industrial utilization of radioactive materials because they are possible only when critical quantities of fissionable materials are being processed. Therefore, they are more likely to occur in scientific investigations than in industrial operations with established production methods for work with radioactive materials.

Internal radiation exposure of personnel

A line must be drawn to distinguish trivial exposure values from significant exposure values. If the "permissible body burden" for an extended period of time is taken as the criterion, there have been perhaps a dozen or so cases so far reported. If the criterion is the appearance of the radioisotopes in the excreta of the exposed person at a level that may possibly lead to clinically observable health defects, the number of such cases is insignificant.

Some of the basic data on which all internal permissible levels depend is being further refined. Precise evaluation of internal body burdens from excretion data or from whole body counting is possible in many instances.

There have been some cases of inhalation of radioactive material and also cases of absorption of radioactive material through skin broken by an abrasion or cut. In some instances, materials contaminated with radioactivity have become imbedded in the body of the injured person at the time of an explosion from either chemical or nuclear origin, and here the serious injury was from the explosion rather than from the radioactivity.

Inhalation of contaminated air is a more serious cause of internal exposure than is the drinking or eating of material that has been radioactively contaminated on the job. Fortunately, such occurrences are relatively rare due to a high level of planning and close control of operations. In contrast to this experience, watch dial painters in foreign countries will probably continue to develop radium poisoning.

Contamination of personnel

The probability of contamination of both