

amount of air that can be drawn through the hood is limited by the fact that the adhesives in the paints dry quickly in an air stream and are sometimes difficult to apply. Where hoods are used and additional ventilation also is required, it is essential to provide sufficient make-up air to the room at all times, and it is well to equip each hood with an air flow indicator. Ten changes of air per hour, combined with good housekeeping, have been found to produce satisfactory general ventilation in an average dial-painting room.

Hoods for painting dials should be enclosed on all sides except the face, which should have an entrance opening of about one square foot. The glass top should extend to the front edge of the worktable, and sufficient air should be exhausted to maintain an inward flow of 50 to 60 l.f.m. at the face of the hood. Enclosures for the compounding of radioactive paints, that is, mixing the dry powdered pigment with the radioactive constituent or mixing the compound with the adhesive, should be exhausted at a face velocity of not less than 100 l.f.m. Compounding should be done only by experienced technicians who are aware of the hazards involved in handling relatively large quantities of radioactive substances. All precautions required in the handling of millicuries of radioactivity should be observed.

It is obviously necessary that all ventilation described above should deliver the exhausted air to the outside atmosphere, preferably above the roof of the building. The air should not be recirculated or exhausted in a way in which it can be drawn back into the building, either by natural or by forced ventilation.

It must be pointed out that the real criterion in judging the performance of the ventilation system is the radon concentration in the workroom air at the breathing zone of the workers. Any system that keeps this concentration consistently below tolerance is adequate from the standpoint of injuries from radon. Since dial painting should never be permitted even remotely to resemble a dusty operation, the radon is the chief offender to be controlled.

In rooms where radium luminous compounds are manipulated it is necessary to see that ventilating systems are in operation at least a half hour before the employees start the day's work. This precaution is required to reduce the radon concentration in the air that results from an accumulation in stagnant air during the night. Radioactivity tests of room air samples taken at the start of work should be made occasionally to test the effectiveness of this procedure.

Repainting Dials. Repainting of radium luminous figures on dials must be done with caution. The old compound contains essentially all the radium that was originally, and it must be removed under the same precautions required for any similar radioactive material. Dust must be avoided, and the waste material must be disposed of as radioactive waste from other operations. Sometimes the old compound is soaked off; where this is done, the hands should not be permitted to come in contact with the solvent after dials have been immersed in it. The rubber gloves used for protecting the hands should be checked frequently for radioactive contamination.

Dressing Rooms and Protective Clothing. In plants manufacturing radioactive luminous dials there is absolute necessity for dressing rooms entirely separate from the workrooms. These dressing rooms are to be used by the employees to change from street clothes to working costume and for storage of personal effects, including purses and other valuables. Employees should be provided with coveralls, such as smocks, and caps, which they never take from the plant. Laundering and testing for radioactivity of these garments should be the responsibility of management. The coverall should be the external garment worn at all times in the plant. A double locker system should be installed, and street clothing should be kept entirely separate from work clothing. All personal effects of the employee should be kept in the locker for street clothing.

B. THORIUM POISONING

1. Industrial Use of Thorium

In addition to the former use of mesothorium in radioactive luminous compound, thorium itself is used in the manufacture of gas mantles, which are still in considerable demand in this country, mainly for use in portable gasoline lights and similar lighting devices. In the extraction of thorium from the ore, mesothorium is separated and, usually, refined. The supply of mesothorium is not sufficient in quantity, nor is the regularity of production adequate, to permit it to compete with radium for industrial use. Consequently, there is little demand for this radioactive substance, and the refining of mesothorium has been limited to one or two laboratories with a few employees under close supervision. The large demand for thorium now is as fuel for nuclear reactors, and refining operations are at present supervised by the Atomic Energy Commission. A summary of the hazards and precautions for a laboratory engaged in mesothorium refining has been published by Schlundt, McGavock, and Brown.¹⁸ These hazards are similar, though somewhat intensified in degree, to those described in this chapter in connection with the preparation and application of radioactive luminous compound.

In the thorium mantle industry the main hazards are probably from the inhalation of thoron in the mantle-soaking operations, where mantles are soaked in open bowls of thorium nitrate solution, and from the inhalation of dust in the mantle-cutting operation, where considerable thorium-bearing dust is generated. Both operations can be controlled by local exhaust ventilation. Concentrations up to 4×10^{-9} curie of thoron per liter of air have been found in this industry by Evans and Goodman,¹⁹ but none of the workers studied showed evidence of injury or of storage or excretion of thorium or its radioactive products. The chief difference between this situation and those where materials containing radium are manipulated, as far as measurements for control are concerned, lies in the

¹⁸ H. Schlundt, W. McGavock, Jr., and Mildred Brown, *J. Ind. Hyg.*, **13**, 117 (1931).

¹⁹ R. D. Evans and C. Goodman, *J. Ind. Hyg. Toxicol.*, **22**, 89 (1940).