fections from the inhalation of bacteria and fungi exists in several industries. Pulmonary anthrax from the inhalation of dust containing anthrax spores has occurred among employees engaged in the handling of wool and the crushing of bones from infected animals.

105. Fungi (molds) growing on grain has been found in the sputum of workmen shoveling the grain and are believed to be the cause of outbreaks of respiratory disorders. Fungi found in sugar cane residues (bagasse) are believed to be part of the cause of *bagassosis*. Fungal spores formed under the bark of some trees have been blamed for respiratory difficulties among employees who debark dry logs.

106. Although the incidence of occupationally related bacterial and fungal infections is found to be relatively low, the respiratory effects can be troublesome and, in the case of pulmonary anthrax, even fatal. The basic methods of control are the same as those for the pneumoconiosis producing dusts, but sterilization and disinfection must be added.

Radioactive Dusts*

107. A radioactive contaminant may offer a chemical toxicity hazard in addition to an ionizing radiation exposure, and it may be present as a gas, dust, fume, or mist.

108. Radioactive contaminants taken into the body may be deposited in various organs where they constitute sources of internal radiation. The chemical characteristics of the radioactive contaminant or isotope determine the organ in which it will be deposited. The excretion rate is also dependent upon the chemical nature of the isotope, because the radioactive isotopes of an element follow the same metabolic process as do the stable isotopes of that element.

109. If a radioisotope has been deposited in the body, the internal exposure is regarded as continuous until the isotope is lost by radiological or biological decay. In some cases, exposures may last a lifetime.

*For a detailed discussion of radioactivity and an extensive bibliography, see the chapter entitled "Ionizing Radiation" in the *Accident Prevention Manual for Industrial Operations*, published by the National Safety Council.

110. Since radioisotopes are selectively taken up in individual organs, they may cause only localized irradiation. The radiosensitivity of the organ dictates the extent of the hazard of a particular radioactive substance. Solubility and particle size determine how much of the active material will gain access to and remain in the blood stream and various organs.

111. If radioactive air-borne contamination is known to be present, control measures are mandatory. If the presence of contamination is unknown but suspected, sampling must be done to determine whether or not air-borne concentrations of the radioisotope are below the threshold limit value.

112. Good personal hygiene and good operating techniques are much more important in the handling of radioactive materials than in the handling of most other materials used in industry.

113. Engineering controls for radioactive dusts are similar to those for other dusts and depend primarily upon capture at the point of generation. The difference lies in the fact that controls for radioactive dusts must be extremely efficient. Threshold limit values for radioactive particulate matter are very low, and in some cases 100 per cent efficiency in capture and retention is required.

Permissible Dustiness

114. Threshold limit values of mineral dusts and toxic dusts—that is, time-weighted average concentrations considered permissible for exposures of eight hours per day, five days per week—have been published by the American Conference of Governmental Industrial Hygienists. These values have been obtained from the experience of many groups in industry and from laboratory studies on animals. They are reviewed annually and changed as necessary on the basis of experience.

115. These values are set only as guides for the best practice and are not to be considered absolute values. There is reasonable assurance that occupational disease will not occur if exposures are kept below these levels. On the other hand, occupational disease is likely to develop in some people if the recommended levels are exceeded consistently.

116. The currently recommended threshold limits of particular dusts can be found in the most recently published ACGIH list, or the ACGIH can be consulted directly. Information on threshold limits also can be obtained from the National Safety Council, state occupational health agencies, the American Industrial Hygiene Association, and compensation insurance carriers.

117. No one knows the exact concentration at which men will start to develop silicosis, asbestosis, or lead poisoning. With some toxic dusts, however, experience has been wide enough to establish the present threshold limits as fairly reliable.

118. For example, if the level of lead in a workroom is kept below 0.2 mg/cu m, experience has shown that cases of lead intoxication will not occur. Experience also has shown that many men can tolerate lead levels well above 0.2 mg/cu m without signs of trouble.

Mineral dusts

119. In the United States, the threshold limits for mineral dusts are expressed in millions of particles per cubic foot of air (mppcf). The concentration of a mineral dust is determined by counting dust particles that are less than 10 microns in size in an aliquot sample after sampling a known volume of air in a known volume of liquid. In some European countries, mineral dusts are weighed, and permissible levels are expressed as milligrams of dust per cubic meter of air (mg/cu m). In England and some other areas, the number of particles per cubic centimeter is the current basis of measurement.

120. In comparing United States and foreign dust counts, it is helpful to keep in mind that 100 particles per cubic centimeter is equivalent to approximately 3 million particles per cubic foot.

121. It is difficult to compare dust counts with results obtained on the basis of weight. However, with either type of measurement, a threshold limit can be set as an objective. Experience has shown that maintaining dust levels below the recommended threshold limits has resulted in a great decrease in the incidence of occupational diseases.

122. Threshold limits are based on the percentage of free silica where this substance is the important constituent of the dust. If silicosis is to be prevented, these limits must not be exceeded. Concentrations of dusts containing less than 5 per cent free silica should not exceed 50 million particles per cubic foot (mppcf). Concentrations of dusts containing from 5 per cent to 50 per cent free silica should not exceed 20 mppcf. Dusts containing more than 50 per cent free silica should be kept at concentrations below 5 mppcf.

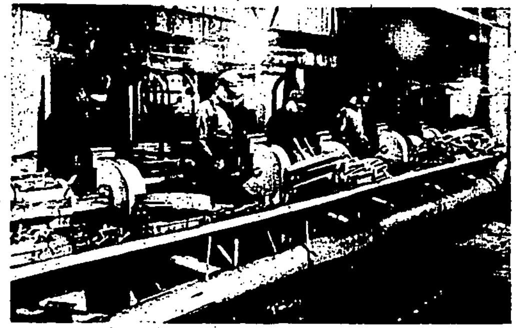

Figure 3. Each of these grinding wheels is partially enclosed by an exhaust hood. Efficient local exhaust is achieved by drawing the dust into the hoods, through branch ducts, and into a central duct which leads to the collection point. (Courtesy American Foundrymen's Society)

123. As more experience accumulates, original threshold limits sometimes can be modified. In some cases, it has been necessary to lower the limits, for the objective is to protect the more susceptible individuals. In a few cases, experience has shown that the limits were too stringent, and it has been possible to raise the limits to allow for more reasonable controls.

Toxic dusts

124. In all countries, threshold limits for toxic dusts are expressed in milligrams per cubic meter of air. With toxic dusts, the average levels must be kept below the suggested threshold limits. In fact, it is advisable to keep the levels of toxic dusts as low as practical in the specific circumstances. Little in the way of experience or data will be developed if the levels are kept unusually low, but few if any cases of occupational disease will occur from these dusts.

Nuisance dusts

125. Even though a dust may be considered generally innocuous and not be recognized as the direct cause of a serious pathological condition, its level should be kept as low as is practical. Dust levels well below the suggested threshold limits are desirable.

126. A concentration of 50 mppcf is suggested as the threshold limit for a number of nuisance dusts. With good engineering practice, there is no need for this level to be exceeded. Any reduction below this level will increase the comfort of employees and improve plant housekeeping.

Methods of Control

127. Various methods of controlling dusts, mists, and fumes are available. Basic engineering dictates where possible an operation should be made dustless through control at the source. This method is always the most effective, for it either completely prevents the contaminant from entering the workroom atmosphere or limits to safe levels the amounts that do escape. In addition, this method is generally the least expensive.

128. When control at the source is not possible, other methods may have to be considered. Any one or a combination of the following types of dust control may be needed to limit the exposure.

a. The dusty operation may be enclosed, with or without a local exhaust system. An enclosed operation generating large quantities of dust usually needs to be exhausted, or the dust will leak into the surrounding atmosphere. Examples are sandblast cabinets or sandblast rooms and the dry boxes used to handle radioactive materials.

b. The dusty work may be performed in a separate building or may be isolated by partitions to reduce the number of employees exposed to the dust. The employees who are still being exposed should be protected by respiratory protective equipment.

c. A less hazardous material may be substituted. For instance, steel shot may be used instead of silica sand in abrasive cleaning.

d. Keeping the materials moist may be a practical means of control. Examples are the careful and proper wetting down of aisles in a foundry and the use of water in drilling.

e. Local exhaust systems may be installed with virtually full or partial enclosure. Examples are an exhaust hood on a grinding wheel (Figure 3) and an exhaust hood at a bagging or filling operation.

f. General room ventilation can be used to dilute the dust by adding large quantities of air and thus preventing build-up of dust concentrations. Examples of this method are roof fans and roof monitor windows. But it generally is inefficient and expensive to attempt to control contaminants by dilution.

g. The dusty work may be performed at night or on week-ends to reduce the number of employees exposed. Cleaning dust accumulations from overhead beams, for instance, is preferably done during a weekend. The employees who are exposed should wear appropriate type of respiratory protective equipment.

h. The number of working hours at the particular exposure can be reduced. However, other methods of control are preferable.

i. Use of respiratory protective equipment approved for the exposure by the U.S. Bureau of Mines can give excellent protection against all types of dust, but in most cases should be considered as a temporary control measure. In a sandblast room, however, air-supplied helmets usually are required continuously during operations. Respiratory protective equipment,