RESEARCH NEEDS FOR CONTROLLING HAZARDOUS SUBSTANCES AND TOXIC MATERIALS IN THE MINING INDUSTRY

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There has been a long and steady evolution of awareness regarding hazardous substances in our society. In the 1950's, attention was given to air pollution and the potential respiratory issues resulting from airborne contaminants. In the 1960's, attention was focused on water quality with the concern arising from unrestricted dumping of chemical substances into water resources. In the 1970's and 1980's, the interest became more focused. The issues of soil pollution, particularly from landfills, became prominent so that today there is scarcely an individual who has not heard the names PCB's and dioxin.

Along with this increasing concern of toxic substances and the environment, there has evolved the concern of contamination in the workplace. The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) was created in response to these concerns. The jurisdiction of OSHA essentially covers all nonmining-related occupations. The mining-related occupations are regulated by the U.S. Department of Labor, Mine Safety and Health Administration (MSHA). The American Conference of Governmental Industrial Hygienists (ACGIH) Handbook of Threshold Limit Values and Biological Exposure Indices is currently the recognized document used by MSHA for enforcement of personal exposure to harmful chemical agents.

Many physical and chemical substances are introduced into the mine environment to facilitate ore winning and processing. These substances are in addition to the dusts and gases generated from the extraction of ore that can also be hazardous if exposures are not controlled. Exposure to these substances can occur through inhalation, ingestion, and absorption. MSHA reports that complaints and inquiries concerning exposure to toxic substances have been increasing in recent years (1). It is speculated that

this trend has resulted from an increase in chemical usage in the mining industry, and a greater public awareness of the health hazards associated with exposure to toxic materials.

While the awareness of airborne contaminants continues to increase, there is also proposed Federal rulemaking regarding exposure standards and right-to-know legislation. Of the over 600 toxic materials identified by the ACGIH, little is known about the actual exposure levels of many of these substances in the mining environment. Only a few mining related Health Hazard Evaluations (HHE) have been performed by the National Institute of Occupational Safety and Health (NIOSH). The limited information obtained from these indicates several potential health risks in the mining environment. These HHE's include:

- o Potential Health Effects of Exposure to Coal Antifreeze Agents.
- o Worker Exposure to Organic Hydrocarbon Cleaners.
- o Adverse Health Effects Caused by Employee Exposure to Welding Fumes and Solvents.

A more detailed study of the sources of toxic materials and possible exposure levels in the mining industry is needed to identify what potential problems may exist. Control of the exposure to these substances remains the strategy for worker protection.

MSHA has recently published proposed changes to 30 CFR, Parts 56, 57, 58, 70, 71, 72, 75, and 90. These rule changes will establish new Air Quality, Chemical Substance, and Respiratory Protection Standards for the U.S. Mining Industry. These changes contain standards for over 140 substances that would be regulated for the first time in the mine environment.

The potential for exposure to these substances is unknown in many cases. The substances either exist in the mining and mineral processing environments or are introduced into these environments to aid in ore extraction or processing. They may be brought into the mine environment via supplies and materials, and into the ore processing environment as chemical reagents for use in flotation and other ore beneficiation processes. Many of the chemical reagents may have teratogenic and mutagenic effects which could persist for generations. Toxic substances such as amines, cyanides, and carbonyls are used to control mineral flotation processes. Smelting operations can generate toxic metal fumes including lead, mercury, beryllium, chromium, cadmium, and manganese. Toxic organic liquids such as gasoline, benzene, perchlorethylene, carbon tetrachloride, bromoform, acetylene tetrabromide, and pentachlorethane are used extensively for laboratory float-sink testing of mineral processing techniques. Toxic substances encountered in the underground mine environment include some ore dusts and gases, oil mists, epoxy resins, chemicals used to treat cribbing wood, surfactants, solvents, metal

fumes, and blasting and diesel fumes.

A sample listing of possible toxic substances released into the mine environment includes:

- Water sprays with surfactants for dust control.
- Substances resulting from outgassing of cribbing treatment for fire retardation or prevention of decay.
- Hydrocarbons in the diesel exhaust gases.
- Welding fumes.
- Blasting fumes, primary or residual, from conventional mining methods.
- Sulphur compounds present in coal deposits.
- Products of combustion from fire-fighting foams and roof bolt resins stored in the underground environment.
- Hydraulic fluids and oils.
- Solvents used in shop areas.

As a rule, mineral processing operations are not as confining as the underground mine environment and are more accessible, but do involve workers in closed areas. There are approximately 32,780 direct workers at 155 noncoal processing plants, refineries, and smelters operating in the United States. Many of these fall under the jurisdiction of MSHA by virtue of the fact that the operation resides on mine property or is owned by the mining company. The processing of these noncoal minerals usually involves a large number of chemicals, and in some cases, the mined material is hazardous.

With the changing economics of the mining industry, a continuing effort is being made to recover greater percentages of valuable minerals from ores of lower assay. This has resulted in the tailings of many mining facilities, previously considered uneconomical, being re-examined and reprocessed for the further extraction of mineral value. The introduction of solvent extraction allowed a copper company to treat 9.9 million tons per year of flotation tailings to produce 88,000 tons of finished copper from what was previously regarded as waste. There are many other plants where minerals are recovered in secondary circuits (treating tailings) and the feed grades are much lower than would be economic on a mined basis. For example, typical ore grades for tungsten ores are in the range 0.5 - 1.5% WO_3, but the Climax Molybdenum plant treated 49,500 tons per day of tailings, containing less than 0.1% WO_3.

The consistency of an ore may vary significantly throughout the life of the mine. The mineral processing techniques must keep pace with these changes, thus, many mine facilities are equipped with material testing and mineral processing control laboratories that fall under the jurisdiction of MSHA. These laboratories often use substances that MSHA does not allow in other mine facilities.

An initial thrust under the Occupational Health program of the Bureau of Mines to determine the hazards of physical and chemical agents

in the mining industry and to reduce potentially harmful exposures of workers to these agents would include the following objectives:

- o Identify potential exposure hazards of physical and chemical agents.
- o Rank exposure hazards based on degree of usage, toxicity, and expected worker dose.
- o Perform field evaluations to verify exposure levels of agents where suitable measurement and monitoring techniques exist.
- o Investigate design of measurement and monitoring techniques where no suitable technology exists.
- o Design and develop appropriate control technology.

The current emphasis of the Occupational Health program is in reducing worker exposure to the identified, long-term health hazards of exposure to respirable dust, diesel engine exhaust emissions, and noise levels. The control of respirable dust focuses on reducing the silica component of the dust by designing ventilation techniques to more effectively distribute ventilation air; investigating more effective dust suppression techniques; and developing more efficient coal extraction methods. Diesel exhaust emission research concentrates on the control of the most hazardous product of combustion--the particulate or soot--as well as on particulate sampling and monitoring techniques. The noise control program concentrates on the application of active noise cancellation techniques to reduce noise levels from fans, and the noise attenuation provided by hearing protectors in the mine environment. As the current health research projects are successfully completed and research thrusts in the health and safety program change, the increasing concerns of airborne toxic substances will be more actively pursued.

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