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CHEMETALS, INC
NEW JOHNSONVILLE, TENNESSEE

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SUMMARY

In response to a union request, the National Institute for Occupational Safety and Health (NIOSH) conducted an industrial hygiene evaluation at Chemetals, Inc. on June 14, 1994, and August 2, 1994. The request indicated some employees had nose bleeds, eye irritation, chest congestion, headaches, and dizziness, which they associated with potentially excessive exposures to sulfuric acid mist and manganese dust. Chemetals' New Johnsonville facility has a staff of approximately 137 employees.

Chemetals is a major producer of high purity manganese dioxide used to make alkaline and heavy duty zinc chloride batteries. Manganese dioxide production involves three primary processes: (1) ore preparation and reduction, (2) digestion and purification, and (3) electrolytic deposition and product preparation.

The NIOSH evaluation consisted of the following elements: a visual inspection to review employee work areas, work practices, and engineering controls; a literature search to review the health effects associated with exposure to manganese dust and sulfuric acid mist; and environmental monitoring to assess airborne levels of manganese dust, aluminum dust, and sulfuric acid mist. Sixteen personal breathing zone (PBZ) and nine area samples for manganese were collected. Three of the area samples for manganese were collected with 10-mm diameter Dorr-Oliver nylon cyclones to assess the respirable fraction of the generated dust; each cyclone sample was paired with a total dust sampler at the same location. Additionally, three PBZ samples for aluminum and seven PBZ samples for sulfuric acid were collected.

During the June 14, 1994, visit, exposures to manganese exceeded the NIOSH Recommended Exposure Limit (REL - 1 mg/m^3 [milligrams manganese per cubic meter air] as 10-hour time-weighted average [TWA]) for workers in the briquette bagging operation (TWA 7.62 mg/m^3), the briquette batch mixing (TWA 1.27 mg/m^3), and the manganese powder 4000-pound bagging operation (TWA 1.90 mg/m^3). During the August 2, 1994, visit, manganese exposures exceeded the TWA REL and short-term exposure limit (STEL - 3 mg/m^3) for workers in the briquette batch mixing area (TWA 1.24 mg/m^3 and STEL 3.2 mg/m^3). Additionally, the worker in the manganese powder 100-pound bagging operation had a TWA exposure of 1.19 mg/m^3. Approximately 18% of the particulate (by weight) was in the respirable range. All exposures to sulfuric acid were below the 1 mg/m^3 TWA REL (range 0.12 to 0.87 mg/m^3). The highest sulfuric acid exposure found (0.87 mg/m^3) was taken from an amperage checker in cell room #2. Since many employees work extended shifts (i.e., 12 hours), a reduced occupational limit should be considered (see discussion in Evaluation Criteria). No over-exposures to aluminum were found.

A potential health hazard from over-exposures to manganese dust was found during both NIOSH site visits. Although no over-exposures to sulfuric acid mist were found, notable eye and throat irritation in the cell rooms suggest the need to implement engineering controls. Recommendations for reducing exposures to manganese dust and sulfuric acid mist can be found in the Recommendations section of this report. Substitution of silica sand as an abrasive blasting agent and implementation of a respiratory protection program are also discussed.

KEYWORDS: SIC 2819 (Industrial Inorganic Chemicals, Not Elsewhere Classified) Manganese dioxide, aluminum pyro powder, sulfuric acid mist; eye, nose, throat irritation

INTRODUCTION

In response to a request from the International Union of Operating Engineers, the National Institute for Occupational Safety and Health (NIOSH) conducted an industrial hygiene evaluation at Chemetals, Inc. on June 14, 1994, and August 2, 1994. The request indicated some employees had nose bleeds, eye irritation, chest congestion, headaches, and dizziness, which they associated with potentially excessive exposures to sulfuric acid mist and manganese dust.

BACKGROUND

Chemetals is a major producer of high purity manganese dioxide used to make alkaline and heavy duty zinc chloride batteries. Chemetals' New Johnsonville facility operates 24 hours per day, 7 days per week, and has a staff of approximately 137 employees (about 25 are in management). Most employees work 12-hour schedules. The facility was originally constructed in 1967.

Manufacture of manganese dioxide involves three primary processes: (1) ore preparation and reduction, (2) digestion and purification, and (3) electrolytic deposition and product preparation. Ore preparation and reduction involve mixing the ore with coal, pulverizing the mixture, and reducing it to manganese oxide (MnO) in reduction furnaces (in the natural state, manganese is in various oxidation states). Manganese oxide can then be solubilized in a sulfuric acid/aqueous solution, whereas the other oxides cannot. The resulting manganese sulfate solution is subjected to various purification steps to remove other metals and impurities. The solution is then fed into electrolytic cells. The three cell rooms contain 156 cells, and each cell is about 6 feet wide and 16 feet long. The electroplating process utilizes steam heat that maintains the electrolyte solution slightly under the boiling point. A charge is applied, and the manganese dioxide is plated onto titanium anodes.

After about two weeks, the manganese dioxide is stripped from the anode (mechanically or manually) for further processing. The manganese dioxide powder is then bagged into 100 or 4,000 pound bags and shipped to battery manufacturers.

During electroplating, sulfuric acid mist and hydrogen, along with water vapor, are released from the hot electrolyte solution. Polypropylene balls floating on the electrolyte surface are used to reduce water vapor and sulfuric vapor emissions. A few cells use a paraffin wax layer on the electrolyte surface, but this control method is being phased out because of the potential fire hazard created by the wax. Management indicated more frequent complaints about eye and throat irritation and nose bleeds with the polypropylene ball system compared to the wax method. However, a consultant found no significant increases in sulfuric acid mist exposures after implementation of the polypropylene balls, and all exposures to sulfuric acid were below all applicable criteria.

The briquetting operation involves production of small magnesium/aluminum bricks (75% manganese and 25% aluminum). The briquettes (Solumang® 75B) are used as a hardener for extruded aluminum (predominantly aluminum cans). Aluminum granules (50 1b bags), aluminum powder (600 lb drums), and manganese metal (2400 lb bags) are added to a large bin that is subsequently hoisted to an overhead mixer. An open 2½ gallon bucket of monoethyl ether glycol (carbitol) is carried up the stairwell and added by hand to the mixing bin. Mixing is accomplished in less than 30 minutes. The mixed contents are transferred to a 150-ton press, which produces the briquettes. The briquettes are conveyed through an oven to drive off the carbitol. The final step involves packaging the briquettes into 50 lb bags. The briquettes are bagged by hand, and each bag is individually weighed. The briquette packaging area and the mixing bin area are equipped with local exhaust systems. Signs are posted outside the brickquette area indicating sparking equipment should not be used in the area. Three employees normally work in the area. Several years ago, a fatality occurred during an accident involving ignition of airborne aluminum/manganese powder.

METHODS

The NIOSH evaluation consisted of the following elements:

(1) A visual inspection was conducted to review employee work areas, work practices, and engineering controls. Company information regarding work-shifts and administrative procedures were obtained.

(2) A literature search was conducted to review the health effects associated with exposure to manganese dust and sulfuric acid mist, to determine appropriate sampling methodologies, and to review the results of other industrial hygiene investigations involving the assessment of exposure to manganese dust and sulfuric acid.

(3) Environmental monitoring was conducted to assess airborne levels of manganese dust and sulfuric acid mist. Full-shift area and personal breathing zone (PBZ) sampling were conducted during the first shift on June 14, 1994. Eight PBZ and six area samples were collected for manganese. Three area samples were collected with 10-mm diameter Dorr-Oliver nylon cyclones to assess the respirable fraction of generated dust; each cyclone sampler was paired with a total dust sampler at the same location. Seven full-shift PBZ samples for sulfuric acid were collected. During the return visit on August 2, 1994, additional sampling for manganese and aluminum was conducted. Eight PBZ samples and one area sample were collected for manganese. One PBZ sample was collected for 15 minutes to assess a short-term exposure limit during the mixing and dumping operation in the Briquette area. The other manganese samples were full-shift. Three full-shift PBZ samples for aluminum were also collected.

Specific sampling and analytical methods used during the evaluation were as follows: PBZ and area air samples for manganese and aluminum (total dust) were collected according to NIOSH method 7300 by drawing air through 37-mm diameter 0.8 micron cellulose ester membrane filters at a nominal air flow rate of 2.0 liters per minute (L/min) using battery operated sampling pumps. Cyclone samples for respirable manganese dust were collected at a flow rate of 1.7 L/min, also using cellulose ester membrane filters. The cyclone is a centrifugal separator, which collects particulates less than 10 microns (μ) in diameter, with a median cut point of 3.5 μ.[1] Samples collected with the cyclone reflect a size range of particulate that can penetrate deeply into the lungs, rather than being deposited in the upper airways. All manganese and aluminum samples were chemically digested and analyzed according to NIOSH method 7300, modified for microwave digestion. Following digestion, the samples were analyzed using a inductively coupled plasma emission spectrometer.[1]

PBZ air samples for sulfuric acid were collected according to NIOSH method 7309 by drawing air through washed silica gel/glass fiber filter plug sorbent tubes (ORBO-53) at an air flow rate of approximately 200 milliliters per minute (mL/min). The samples were collected using SKC model 222 low-flow sampling pumps. The pumps are equipped with a pump stroke-counter and the number of strokes necessary to pull a known volume of air was determined. This information was used to calculate an air volume per pump stroke "K" factor. The pump-stroke count was recorded before and after sampling and the difference used to calculate the total volume of air sampled.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff use established environmental criteria for the assessment of a number of chemical and physical agents. These criteria suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It should be noted, however, that not all workers will be protected from adverse health effects if their exposures are below the applicable limit. A small percentage may experience adverse health effects due to individual susceptibility, pre-existing medical conditions, and/or hypersensitivity (allergy).

Some hazardous substances or physical agents may act in combination with other workplace exposures or the general environment to produce health effects even if occupational exposures are controlled at the applicable limit. Due to recognition of these factors, and as new information on toxic effects of an agent becomes available, evaluation criteria may change.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Criteria Documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and (3) the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards.[2-4] Often, NIOSH recommendations and ACGIH TLVs may be different than the corresponding OSHA standard. OSHA standards are required to consider the feasibility of controlling exposures in various industries where the hazardous agents are found; the NIOSH Recommended Exposure Limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

Manganese

Manganese metal is a silver-gray transition element that forms compounds in seven oxidation states. Airborne manganese consists primarily of insoluble oxides in particulate form.[5] The size of the particulates determines the location and amount of deposition in the pulmonary tract. Larger particles (greater than 2.5 μ diameter) generally deposit in the upper airways and are expelled by coughing or sneezing or are cleared to the gastrointestinal tract by mucocillary transport. Smaller particles (0.5 to 2.5 μ diameter) deposit in the pulmonary or alveolar region of the lung, where they are cleared to the gastrointestinal tract or absorbed.[5] The amount of manganese absorbed from the gastrointestinal tract is approximately 3 percent, but considerable variability has been reported depending on the manganese compound, age, and iron deficiency. Manganese deposited in the deep pulmonary region of the lung not transferred to the gastrointestinal tract is likely absorbed into the blood stream.[5]

Continual overexposure to manganese results in chronic manganese intoxication. The manifestations of overexposure are neurologic in nature and begin insidiously with headache, body weakness, irritability, and sometimes psychosis. Severe sleepiness, followed by insomnia is often found early in the disease. As the exposure continues, symptoms such as tremor, speech impairment, numbness, and incoordination may occur.[6] A characteristic sign of chronic manganese intoxication is the complete absence of facial expression.[5] Manganese intoxication resembles Parkinsonism, but these conditions are distinguishable both clinically and pathologically.[6]

The NIOSH REL for manganese and compounds (as Mn) is 1 mg/m^3 (milligrams manganese per cubic meter air) as a time-weighted average (TWA) up to 10 hours per day, with a short-term exposure limit (STEL - 15 minutes) of 3 mg/m^3. The OSHA Permissible Exposure Limit (PEL) for manganese is 5 mg/m^3, as a Ceiling concentration, which should not be exceeded at any time. The ACGIH TLV is 5 mg/m^3, as an 8-hour TWA.[2-4] The ACGIH has proposed lowering the TLV for manganese to 0.2 mg/m^3, and has placed it on the "Notice of Intended Changes" for 1994-1995. Epidemiological studies have found human effects at TWA exposures below 5 mg/m^3.[7-9] At an OSHA PEL hearing, NIOSH stated 5 mg/m^3 manganese as a TWA or Ceiling is questionably high.[10]

For unusual work schedules, the ACGIH refers to the Brief and Scala model to reduce the TLV proportionately for both increased exposure time and reduced recovery (nonexposure) time.[3,11,12] The model is intended to apply to work schedules greater than 8 hours per day or 40 hours per week. The TLV for manganese calculated by this method for a 12-hour work day is as follows:

$$\text{TLV Reduction Factor} = \frac{8}{\text{hours worked}} \times \frac{\text{hours off work}}{16}$$

$$\text{TLV Reduction Factor} = \frac{8}{12} \times \frac{12}{16} = 0.5$$

$$\text{TLV} = 5.0\ mg/m^3 \times 0.5 = 2.5\ mg/m^3$$

The ACGIH cautions that adjusted TLVs do not have the benefit of historical use and long-term observation. However, this method is one of the most conservative of the published methods.[12]

Aluminum

The inhalation of very fine aluminum powder (pyro powder) in massive concentrations may cause fibrosis and pneumothorax. Reported symptoms include difficulty breathing, cough, and weakness. According to *Patty's Industrial Hygiene and Toxicology*, 4th ed., "Past exposures in which serious lung changes occurred must have been extremely high."[5] Powder and flake aluminum are flammable and can form explosive mixtures in air.[3] The OSHA PEL and ACGIH TLV for pyro aluminum are 5 mg/m^3, expressed as 8-hour TWAs. The NIOSH REL for pyro aluminum is 5 mg/m^3, expressed as a 10-hour TWA.

Sulfuric Acid

Sulfuric acid is a dense, colorless liquid that is corrosive and nonflammable. Since the vapor pressure of sulfuric acid is low, it exists in the air only as a mist or spray. Sulfuric acid is an irritant of the respiratory tract, eyes, and skin. A dose-effect relationship for long-term exposure is difficult to determine because a number of factors affect the toxic effect, including the particle size of the mist, presence of particulates, synergistic and protective agents, and humidity.[3,5,6] The International Agency for Research on Cancer (IARC) has classified sulfuric acid as Group 1, carcinogenic to humans.[3] Some studies have associated sulfuric acid exposure to development of laryngeal cancer.[6] However, other organizations, such as NIOSH, OSHA, and ACGIH, have not yet designated sulfuric acid as a carcinogen. The TLV is based on minimization of pulmonary irritation, and a margin of safety is incorporated to prevent injury to the skin and teeth.[3]

The NIOSH REL for sulfuric acid is 1 mg/m^3 as a TWA for up to 10 hours per day. The OSHA PEL is also 1 mg/m^3, as an 8-hour TWA. The ACGIH TLV is 1 mg/m^3, as an 8-hour TWA, with a 15-minute STEL of 3 mg/m^3.[2-4] For a 12-hour workshift, the reduced sulfuric acid TLV is 0.5 mg/m^3 (calculated from the Brief and Scala formula described in the manganese section). On a case-by-case basis, OSHA may also apply reduction factors to PELs.

Although Brief and Scala's original paper suggested that reduction factors could be applied generally to TLVs expressed as TWAs,[13] the use of reduced TLVs are easier to justify for substances having long biological half-lives or chronic (long-term) health effects.[12] Application of a reduction factor for sulfuric acid, therefore, is more difficult if only the pulmonary irritant effects are considered. Other factors, such as abnormal physical factors in the workplace may also justify reduction factors for TLVs. According to ACGIH, physical factors such as heat and humidity may place added stress on the body so that the effects from exposure to a TLV may be altered. A cited example of a gross deviation is continuous work in temperatures above 90 ^{o}F. In such instances, ACGIH indicates "judgement must be exercised in the proper adjustments of the TLVs."[3]

RESULTS AND DISCUSSION

Manganese Results - June 14, 1994

The results of PBZ sampling for manganese can be found in Table 1. Three of eight PBZ samples exceeded the NIOSH REL of 1 mg/m^3 (10-hour TWA). A PBZ sample collected from the briquette bagger indicated a TWA exposure of 7.62 mg/m^3, which also exceeded the adjusted ACGIH TLV 12-hour TWA of 2.5 mg/m^3 and the unadjusted 8-hour TWA of 5 mg/m^3. It must be assumed that the OSHA Ceiling limit of 5 mg/m^3 was also exceeded. The worker indicated no unusual events throughout the day, but NIOSH investigators did not directly observe the worker's activities continually throughout the day. Because of time limitations, this job was not thoroughly evaluated by NIOSH investigators during the June visit. Additional evaluation and sampling of this job was conducted during the return NIOSH visit in August.

The sample collected from the batch mixer in the briquette area showed a TWA exposure of 1.27 mg/m^3, which exceeded the NIOSH REL, but not the ACGIH 8-hour or 12-hour adjusted TLV. However, this sampling started after the morning batch mixing was completed, thereby missing an important exposure event.

The sample collected from a bagger in the product preparation area (The sampled worker did various maintenance jobs in this area in addition to bagging product) showed a TWA exposure of 1.9 mg/m^3. It was not determined whether bagging or the other activities were the primary contributors to exposure. This sample also exceeded the NIOSH REL of 1 mg/m^3.

Table 2 shows the results of the area air sampling. None of the area samples exceeded the NIOSH REL. As indicated on the table, approximately 18% (by weight) of the particulate was in the respirable range (particulate less than 10 μ in diameter, with a median cut point of 3.5 μ.). These results indicate a significant amount of particulate can reach the lower portions of the lung, where it may be more readily absorbed into the body.

Manganese and Aluminum Results - August 2, 1994

Table 3 shows the sampling results from the August visit. Three full-shift samples for manganese (two PBZ and one area) exceeded the NIOSH REL (1 mg/m^3 TWA). The exposure of the B Operator in the briquette area was 1.24 mg/m^3, an employee in the Product Preparation area (100 lb bagging operation) was exposed to 1.19 mg/m^3, and an area sample located on the east side of Crane 2 in Cell Room 2 showed 1.47 mg/m^3. These samples, however, did not exceed the ACGIH criteria (5 mg/m^3) or the adjusted 12-hour ACGIH TLV (2.5 mg/m^3).

A 15-minute PBZ sample, collected during the dumping and mixing operation in the Briquette area, showed an exposure of 3.20 mg/m^3, exceeding the NIOSH STEL criteria of 3 mg/m^3. However, the OSHA PEL Ceiling criteria of 5 mg/m^3, which is generally assessed by collecting a 15-minute sample, was not exceeded. None of the samples collected in the briquette area showed over-exposures to aluminum.

The sampling result from the briquette bagger (0.46 mg/m^3) was lower compared to that found on the June visit (7.62 mg/m^3). After the June visit, Chemetals' management inspected and repaired damage in the exhaust ventilation ductwork. Additionally, a new enclosure hood was installed at the briquette bagger work station shortly before the August NIOSH visit. The new hood, however, impeded the worker's ability to bag briquettes. Consequently, our manganese sampling with the new hood in place was not representative of a normal production day.

Sulfuric Acid Results - June 14, 1994

The PBZ sample results for sulfuric acid ranged from 0.12 to 0.87 mg/m^3 (see Table 4). All results were less than the 10-hour NIOSH REL, 8-hour OSHA, and 8-hour ACGIH TWA criteria of 1 mg/m^3. The highest samples (0.61 and 0.87 mg/m^3) were collected from a cell washer and an amp checker, respectively. These workers frequently work close to the cells and consequently may receive higher exposures. When compared to the reduced 12-hour TLV of 0.5 mg/m^3, these two results would be considered over-exposures to sulfuric acid. In the cell rooms, high humidities and temperatures exceeding 90°F also suggest that a reduced TLV may be appropriate (see discussion in Evaluation Criteria Section). One sample collected from a cell washer (uses a power sprayer) was saturated with fluid and was, therefore, invalid.

RECOMMENDATIONS

Cell Rooms - Sulfuric Acid Mist Exposures

Eye, nose, and throat irritation was noted by NIOSH investigators in all three cell rooms, although sampling results for sulfuric acid did not show over-exposures when compared to standard criteria. Much of the sulfuric acid mist appeared (visually) to be released from the spent liquor reservoirs. To address employee irritant symptoms, Chemetals' management designed several "mist eliminators," which consist of a series of baffles intended to condense sulfuric acid mist and water vapor over the spent liquor reservoirs. Reducing mist from these reservoirs should have first priority. At the time of the August NIOSH visit, the mist eliminators had not been fully evaluated. Chemetals management indicated that additional air sampling was planned to determine whether the eliminators are effective in reducing sulfuric acid mist exposures.

As an alternative, exhaust ventilation from each of the spent liquor reservoirs should be considered. However, potential problems such as corrosion or build-up of salts inside the ductwork will need to be resolved, and outside engineering advice may be required. Exhaust ventilation may also reduce the fog problem in the cell rooms during the winter months. According to management, a previous recommendation by the Meriwether Electric Cooperative to install large covers over each cell with exhaust ventilation would disrupt productivity and was not economically feasible.

In Cell Room 2, wall fans blow air over the cells into the building. Several employees thought the irritation was worse in this area, compared to Cell Rooms 1 and 3. This air movement may be stirring up sulfuric acid mist from the cell surfaces. The fan arrangement in Cell Room 3 may be preferable (exhausting air at roof level, thus taking advantage of convective air currents, with make-up air supplied through the sides of the building).

Briquette Area - Manganese Dust Exposures

In response to the high manganese air sampling results in June, Chemetals repaired damaged exhaust ductwork and installed a new exhaust hood for the briquette bagging operation. The new exhaust hood should provide better dust control, but the design was awkward for the employee to move briquettes into the bags. The hood will need further modifications. Because production was reduced, our August sampling results were not representative of normal conditions. Therefore, Chemetals should conduct additional sampling for this job after the hood is modified.

The briquette bagger exhaust and the batch mixer exhaust are connected to the same exhaust ductwork. This system needs further evaluation under all operational conditions. During batch mixing the operator opens a blast gate to start the exhaust ventilation, which subsequently reduces the exhaust ventilation for the briquette bagger, potentially increasing exposure to manganese dust. The ventilation system should have sufficient capacity to simultaneously ventilate both operations.

PBZ air sampling during batch mixing in the briquette area found some manganese exposures over the NIOSH REL (both full-shift and STEL), indicating the exhaust needs relocation and/or redesign. In general, local exhaust hood placement should be as close as possible to the point of contaminant generation. Since the dust generation portion of the mixing lasts less than 15 minutes, respirators may also be considered, but this option is less desirable than making changes to the exhaust system. Respirators should be used as an interim control until the exhaust is modified. Additional sampling should be conducted to verify that the control modifications effectively reduce exposures to acceptable levels.

The employees in the briquette area dry-sweep at the end of the work day. This activity undoubtedly contributes to manganese exposures. Vacuuming should be considered to reduce exposures. Explosion proof precautions will be necessary.

We observed employees carrying open buckets of glycol ether up a stairwell to the mixer. Additionally, a full bucket of glycol ether is frequently left unattended on the stairs. Spills and dermal exposure to the glycol ether are likely. A different method of transporting the glycol ether to the mixer should be considered (i.e., hose and pump, closed container, etc.).

Bagging Operation in Production Preparation - Manganese Exposures and Lifting

Exposures to manganese in the bagging operation exceeded the NIOSH REL of 1 mg/m^3 for both the 100 pound and 4,000 pound operations. Employees were using several comfort fans in the area, and the air movement may be disrupting the exhaust ventilation or resuspending dust from surfaces. The use of these fans should be restricted.

The 100 pound bagging operation involves lifting filled bags onto a skid. The manual lifting also involves twisting of the torso while lifting. This work practice could increase the risk of back injuries. Chemetals indicated the 100 pound bagging operation was scheduled to be phased out or reduced significantly. However, if this operation is continued, Chemetals should consider changing the operation so manual lifting is reduced or not required. The NIOSH *Revised Lifting Equation* may be consulted for additional lifting guidance.[14]

Abrasive Blasting Operations

Abrasive blasting in the cell rooms (June visit) and blasting building (August visit) were observed, but not evaluated. Silica sand was used as the abrasive, so respiratory protective equipment was required by employees. Abrasive blasting with sands containing crystalline silica can cause serious or fatal respiratory disease (silicosis). Chemetals should review the available abrasive blasting substitutes to determine whether the use of silica sand can be discontinued. Chemetals' management indicated a problem with many substitutes is that they contain substantial quantities of metals other than manganese, which contaminate their product. Copies of the NIOSH Alert *Preventing Silicosis and Deaths from Sandblasting* were distributed to company and union official during the August NIOSH visit.[15]

Because of the high risk of silicosis in sandblasters and the difficulty in controlling exposures, the use of crystalline silica for blast cleaning operations was prohibited in Great Britain in 1950 (Factories Act 1949) and in other European countries in 1966. In 1974, NIOSH recommended that silica sand (or other substances containing more than 1% free silica) be prohibited as abrasive blasting material and that less hazardous materials be used in blasting operations.[15]

Respirators

Respirators for manganese dust or sulfuric acid mist are not required by Chemetals. However, employees are provided respirators if requested. A respiratory protection program should be implemented by Chemetals, since respirators are being used. To be effective, any respiratory protection program must be supervised by a qualified individual who has sufficient knowledge of respiratory protection. All respiratory protection programs must contain at least the following eight elements: written standard operating procedures; medical surveillance; training; face-seal fit testing; respirator inspection, cleaning, maintenance, and storage; surveillance of exposures of workers; respirator selection; and periodic evaluation of the personal respiratory protection program. Regulatory requirements for a respirator program are specified in 29 Code of Federal Regulations 1910.134, OSHA General Industry Standards.

During the August visit, some employees were wearing disposable respirators that were not NIOSH-certified. The use of these respirators should be discontinued.

Heat Stress

Although not evaluated by NIOSH, heat stress was an issue for many workers at Chemetals, especially those workers in the cell rooms. A good heat stress management program should encompass the following items:

(a) Training of employees in safety and health procedures for work in hot environments, including the signs and symptoms of impending heat illness and initiation of first aid and/or corrective procedures. Additionally, the effects of non-occupational factors such as drugs, alcohol, obesity, etc., on tolerance to occupational heat stress should be covered. The need for fluid replenishment, and that reliance on the thirst mechanism is insufficient, are other important elements of worker heat stress training.

(b) Limiting exposure time to hot environments (e.g., scheduling hot jobs for the cooler parts of the day, altering the work-rest regimen, etc.).

(c) Ensuring all workers are fully acclimatized for working in hot environments. Acclimatization efforts should begin at the start of the hotter months of the year, and should include both new employees and employees returning from vacation or newly transferred to a hot area. Note that there is a wide difference in the ability of people to adapt to heat.

(d) Implementation of a Heat-Alert Program for predicted hot spells. This program should be used to alert workers of impending hot spells, and initiation of heat control efforts (e.g., additional breaks, increased ventilation, shorter work cycles).

(e) Medical screening of workers to identify individuals with low heat tolerance. The capacity to tolerate heat has been shown to be related to physical fitness (the higher the degree of physical fitness, the greater the ability to tolerate heat) and physical work capacity (those with low physical work capacity are more likely to develop higher body temperatures than are individuals with high physical work capacity).

(f) Ensuring the worker break area is continually conditioned to maintain a cool environment.

NIOSH has publications that provide additional information on heat stress management programs.[16]

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2. International Union of Operating Engineers
3. OSHA Region IV Office
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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Sampling Results for Manganese
Personal Breathing Zone Samples
June 14, 1994
Chemetals, Inc.
New Johnsonville, Tennessee
HETA 94-0213

JOB	LOCATION	SAMPLE PERIOD[1]	MANGANESE[2,3] (mg/m^3)
Harvester	Cell Room 3	6:37 am - 1:35 pm (418 minutes)	0.35
Harvester	Cell Room 1	6:52 am - 4:52 pm (600 minutes)	0.51
Bagger	4-ton bags	7:18 am - 4:56 pm (578 minutes)	0.40
"A" Operator	Product Prep and Bagging Area	7:23 am - 5:03 pm (580 minutes)	0.20
Bagger, misc.	Product Prep	7:30 am - 4:55 pm (565 minutes)	**1.90**
"A" Operator	Ore Room, Ovens	8:30 am - 4:31 pm (481 minutes)	0.30
Briquette Bagger	Briquette Area	8:35 am - 2:02 pm (327 minutes)	**7.62**
Batch Mixer	Briquette Area	8:53 am - 2:00 pm (307 minutes)	**1.27**
NIOSH Recommended Exposure Limit		10-hour TWA[4]: 15-minute STEL[5]:	1 3
OSHA Permissible Exposure Limit		Ceiling Limit[6]:	5
ACGIH Threshold Limit Value		8-hour TWA: 12-hour TWA[7]:	5 2.5

1 Flow rate for all samples was 1.9-2.0 liters per minute.
2 Concentration of manganese (as metal dust) in milligrams per cubic meter air.
3 Approximate limit of detection is 0.001 mg/m^3, based on a sample volume of 800 liters.
4 TWA = time-weighted average
5 STEL = Short-term exposure limit
6 Ceiling Limit = Instantaneous concentration that must not be exceeded at any time. There are no TWA or STEL Permissible Exposure Limits for manganese dust.
7 TWA Limit calculation based on a 12-hour workday, using the Brief and Scala model

Table 2
Sampling Results for Manganese
Area Samples
June 14, 1994
Chemetals, Inc.
New Johnsonville, Tennessee
HETA 94-0213

LOCATION	SAMPLE PERIOD[1]	MANGANESE[2,3] (mg/m^3)
Near 4000-lb bag filling operation, total dust	8:07 am - 4:12 pm (485 minutes)	0.22 - total dust
Same as above, except sampling conducted with cyclone	8:07 am - 4:12 pm (485 minutes)	0.04 - respirable dust (18.2% of total)
Product preparation area, 2nd floor, central area, total dust	8:14 am - 5:06 pm (532 minutes)	0.16 - total dust
Same as above, except sampling conducted with cyclone	8:14 am - 5:06 pm (532 minutes)	0.03 - respirable dust (18.8% of total)
Ore room, near ovens, central area, total dust	8:24 am - 4:29 pm (485 minutes)	0.28 - total dust
Same as above, except sampling conducted with cyclone	8:24 am - 4:29 pm (485 minutes)	0.05 - respirable dust (17.9% of total)
NIOSH Recommended Exposure Limit	10-hour TWA[4]: 15-minute STEL[5]:	1 3
OSHA Permissible Exposure Limit	Ceiling Limit[6]:	5
ACGIH Threshold Limit Value	8-hour TWA: 12-hour TWA:[7]	5 2.5

[1] Flow rate was 1.9-2.0 liters per minute for total dust samples, and 1.7 liters per minute for samples collected with a cyclone.
[2] Concentration of manganese (as manganese metal dust) in milligrams per cubic meter air.
[3] Approximate limit of quantification is 0.003 mg/m^3, based on a sample volume of 800 liters.
[4] TWA = time-weighted average
[5] STEL = Short-term exposure limit
[6] Ceiling Limit = Instantaneous concentration that must not be exceeded at any time. There are no TWA or STEL Permissible Exposure Limits for manganese dust.
[7] TWA Limit calculation based on a 12-hour workday, using the Brief and Scala model (see text)

Table 3
Sampling Results for Manganese and Aluminum
Personal Breathing Zone and Area Samples
August 2, 1994
Chemetals, Inc.
New Johnsonville, Tennessee
HETA 94-0213

JOB	LOCATION	SAMPLE PERIOD[1]	Manganese (Mn) and Aluminum (Al)[2,3] (mg/m^3)
A Harvester	Cell Room 2	6:34 am - 2:02 pm (448 minutes)	0.90 Mn
Area	East Side Crane 2	6:40 am - 2:02 pm (442 minutes)	**1.47 Mn**
Briquette Bagger	Briquette Area	9:10 am - 1:44 pm (274 minutes)	0.46 Mn 0.78 Al
A Operator	Briquette Area	7:28 am - 1:47 pm (379 minutes)	0.91 Mn 1.28 Al
B Operator	Briquette Area	7:29 am - 1:48 pm (379-15 minutes)	**1.24 Mn** 1.04 Al
B Operator, Mixing, Dumping	Briquette Area	10:00 am - 10:15 am (15 minutes)	**3.20 Mn**
Bagging, Sealing 100 lb bags	Bagging Area	6:51 am - 1:54 pm (423 minutes)	0.75 Mn
Bagging, Sealing 100 lb bags	Bagging Area	6:54 am - 1:53 pm (419 minutes)	**1.19 Mn**
A Operator	Product Prep.	7:00 am - 1:57 pm (417 minutes)	0.43 Mn
NIOSH Recommended Exposure Limit		10-hour TWA for Mn[4]: 15-minute STEL for Mn[5]: 10-hour TWA for Al[6]:	1 3 5 (pyro powder)
OSHA Permissible Exposure Limit		Ceiling Limit for Mn[7]: 8-hour TWA for Al[6]	5 5 (pyro powder)
ACGIH Threshold Limit Value		8-hour TWA for Mn: 12-hour TWA for Mn[8]: 8-hour TWA for Al[6]	5 2.5 5 (pyro powder)

Footnotes are listed on next page.

Footnotes for Table 3

[1] Flow rate for all samples was 1.9-2.0 liters per minute.
[2] Concentration of manganese (Mn) or aluminum (Al), as metal dust, in milligrams per cubic meter air.
[3] Approximate limits of quantitation are 0.0004 mg/m^3 for Mn and 0.007 mg/m^3 for Al, based on a sample volume of 800 liters.
[4] TWA = time-weighted average
[5] STEL = Short-term exposure limit
[6] Exposure limit for Al pyro powders is listed. Toxicity is reported to be greater than that of Al metal dust.
[7] Ceiling Limit = Instantaneous concentration that must not be exceeded at any time. There are no TWA or STEL Permissible Exposure Limits for manganese dust.
[8] TWA Limit calculation based on a 12-hour workday, using the Brief and Scala model (see text).

Table 4
Sampling Results for Sulfuric Acid
Personal Breathing Zone Samples
June 14, 1994
Chemetals, Inc.
New Johnsonville, Tennessee
HETA 94-0213

JOB	LOCATION	SAMPLE PERIOD[1]	Sulfuric Acid[2,3] (mg/m^3)
"B" Harvester, Laborer	Cell Room 3	6:32 am - 1:16 pm Sample Volume: 88.87 L[4]	0.21
Amp Checker	Cell Room 2	6:43 am - 1:32 pm Sample Volume: 84.87 L	0.87
Harvester	Cell Room 1	6:50 am - 4:00 pm Sample Volume: 112.07 L	0.23
Cell Washer	Cell Room 2	7:02 am - 1:32 pm Sample Volume: 86.62 L	Invalid sample[5]
Plate Reconditioner	Reconditioning Area	7:06 am - 3:35 pm Sample Volume: 104.92 L	0.12
Cell Washer	Cell Room 1	7:15 am - 1:31 pm Sample Volume: 77.32 L	0.61
Amp Checker, Cell Washer	Cell Room 3	7:37 am - 1:17 pm Sample Volume: 73.22 L	0.30
NIOSH Recommended Exposure Limit		10-hour TWA[6]:	1
OSHA Permissible Exposure Limit		8-hour TWA:	1
ACGIH Threshold Limit Value		8-hour TWA: 12-hour TWA:[7] 15-minute STEL[8]:	1 0.5 3

[1] Flow rate for all samples was approximately 0.2 liters per minute.
[2] Concentration of sulfuric acid in milligrams per cubic meter air.
[3] Approximate limit of detection is 0.09 mg/m^3, based on a sample volume of 80 liters.
[4] L = liters of air
[5] Sample was saturated with fluid
[6] TWA = Time-weighted average
[7] TWA Limit calculation based on a 12-hour workday, using the Brief and Scala model (see text).
[8] STEL = Short-term exposure limit