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I. SUMMARY

On October 14, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steelworkers of America, Local 310, to investigate employees' exposures to metallic oxides or fumes, refactory (ceramic) fibers, mold coating compounds and fluxing agents at Hater Industries, Incorporated in Cincinnati, Ohio. Employees reported experiencing respiratory problems and metal fume fever as a result of exposure to these compounds.

NIOSH investigators conducted an initial environmental/medical survey at the aluminum foundry on December 10, 1986. A walk-through of the foundry was performed to observe work practices and conditions of exposures. Material Safety Data Sheets were also collected on the products used at the foundry. The NIOSH medical officer conducted private employee interviews. Follow-up medical surveys consisting of additional worker interviews were done on December 15, 1986 and February 10, 1987. Other activities included the review of previous air monitoring data which had been collected by OSHA.

Medical questionnaires were administered to sixteen randomly selected foundry workers. Those interviewed consisted of 10 molders, 3 sawmen and 3 hot inspectors.

None of the sawmen or hot inspectors interviewed reported current respiratory disability or recent history of respiratory illness. Seven of the 10 molders interviewed reported transient symptoms of upper respiratory irritation, which they related to the use of spray release compounds. Two of the molders also reported currently experiencing respiratory symptoms and, symptoms, of heat intolerance. Review of the employees medical records however showed no objective evidence of chronic respiratory illness. Both employees were also requested to record, over a one week period of time, their oral temperature whenever the symptoms of heat intolerance occurred. During these time periods, the sensation of heat intolerance was not accompanied by a measurable rise in oral temperature.

A review of previous air monitoring data of the grinding and abrasive blasting operation for total and respirable dusts indicated no overexposures. Observations of the processes also indicated that any agents likely to cause chronic pulmonary fibrosis or obstructive disease were not present in any appreciable amount or for any significant duration of time. Given these findings in combination with the fact that no chronic respiratory illness or metal fume fever was documented, no environmental monitoring was deemed necessary.

Based on the results of the survey, no evidence of chronic respiratory illness could be documented; however, acute respiratory irritation appeared to be common among workers. Recommendations made in this report to reduce exposures to irritant materials should be followed.

KEYWORDS: SIC 3341, aluminum, fluorides, sodium silicates, ceramic fibers.

II. INTRODUCTION

On October 14, 1986, NIOSH received a request from the United Steelworkers of America, Local 310, to investigate potential exposures to several substances used in the foundry, including metallic oxides or fumes, refractory (ceramic) fibers, mold coating compounds, and fluxing agents for cleaning the interior of the furnaces.

On December 10, 1986, NIOSH representatives conducted an initial environmental/medical survey at the foundry. Following the opening conference with representatives of management and union present, a walkthrough of the foundry was performed to observe work practices and conditions of exposure. Material Safety Data Sheets (MSDS) for several of the products used in the foundry were collected, and the NIOSH medical officer conducted a few private employee interviews. A follow-up medical survey consisting of additional worker interviews was done on December 15, 1986, and on February 10, 1987.

III. BACKGROUND

Hater Industries, an aluminum foundry situated on two acres of land on the western side of Cincinnati, has been in operation for approximately 25 years. There are currently 150 hourly personnel employed at the facility. Permanent iron molds (made from meehanite) are used to make a variety of aluminum automotive and commercial mold castings. The main products made are aluminum automotive brake pistons for brake master cylinders and master cylinders themselves.

Hater receives metal alloyed ingots which are made up of 90% aluminum, 2.0 to 7.5% silicon, up to 5.0% copper, and less than 1% zinc, manganese and magnesium. If the ingot meets the appropriate metal specification parameters it is then melted down by the hot inspectors (also called "molders' helpers") in one of four gas-fired reverberatory furnaces: two with capacities of 2,500 pounds and two with 6,000 pound capacities. These furnaces which are equipped with exhaust ventilation systems, melt metal at temperatures between 1600 and 1800°F. The metal bath or pouring well part of the furnace is held at 1300 to 1330°F. When the pouring well is full and reaches the desired temperature, molten aluminum is then manually ladled by the molders into the permanent molds. The process is similar to a die-casting operation in that no sand is employed and no knockout procedures are necessary. Prior to the metal pouring operation the molds are heated for about one hour and are then sprayed by the molders with two Foseco Company Inc. mold coating compounds (Dycote #34, which insulates the mold, and Dycote #36, which acts as a release agent). Once the molds are coated, they are reheated for thirty minutes before the aluminum pouring begins. Each molder usually pours two molds at a time and the mold process takes between two and three minutes. After removal from the molds the castings are inspected for defects and the risers/gates are removed at the saw tables. If necessary, the hot inspectors grind or file the parts to remove any metal surface defects. Further metal finishing work, most of which is conducted outside of the foundry area, includes sand blasting, heat treatment, electroplating, anodizing and machining.

The foundry employees with the greatest potential for exposures to chemical substances include workers in three job categories: sawmen, molders and hot inspectors. A brief discussion of their job tasks, potential chemical exposures, and potential health effects of some of the materials with which workers in these three job classifications work are as follows:

Sawmen

A total of eight sawmen are employed on first and third shifts. Sawmen spend the majority of their time removing any excess metal from the finished castings. The sawmen's jobs also include cleaning the aluminum furnaces. The four gas-fired furnaces are "cleaned" weekly (one per day each week) by the sawmen using two Foseco Inc. drossing fluxes; Coveral #11 (a red colored powder) and Zendox #7 (a tan colored powder). The fluxes act to reduce formation of oxides and non-metallics in the furnace. The cleaning process consists of dumping two coffee cans (16 ounce size) full of the Coveral #11 powder and a half of a coffee can full of Zendox #7 powder into the furnace in the molten metal bath and on the furnace interior walls just prior to the start of first shift each morning. The fluxes are raked in or stirred with the surface of the dross layer and react to free the dross of aluminum. The dross is then raked off the surface of the molten aluminum and is sold to metal reclaimers.

According to Foseco's MSDS's for Zendox #7 and Coveral #11, both contain approximately 20 percent sodium aluminum fluoride, 30 percent sodium silico fluoride, and the balance "inert" materials.

Molders

A total of 26 molders are employed on first and second shifts. Their primary responsibility is setting up molds and pouring aluminum into molds. Potential exposures are mainly to mold releasing agents (Dycote Lubricants #34 and #36) and insulating materials. Sawmen mix both Dycote materials with water (one part or two parts Dycote to three parts water) initially in a 40-gallon drum equipped with an automated mixer. The Dycote lubricants are dispersed into the molds by the molders via a compressed air spray process. Dycote #36, which prevents the metal from sticking to the mold, is sprayed into each mold once in the morning at the start of the shift and again once after lunch break. Dycote #34 is sprayed on every mold before pouring the metal and acts to insulate the mold. Each molder uses approximately 12 ounces of Dycote #34 and 24 ounces of Dycote #36 per week. A mold spray additive, Sodium Silicate #40 Degree, an Ashland Company foundry product, is sometimes added to the Dycote lubricants for better adhesion of the metal to the mold.

The chief ingredient in both Dycote products and in the mold spray additive is sodium silicate. Currently, there are no established NIOSH Recommended Exposure Limits (RELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), or U.S. Department of Labor (OSHA) Permissible Exposure Levels (PELs) for occupational exposure to sodium silicate.

Two other materials that molders may use or have contact with are nitrogen gas and two furnace insulation products. The foundry receives liquid nitrogen in 25-liter dewar flasks from Air Products and Chemicals, Incorporated. Nitrogen is introduced into the molten aluminum in order to displace the high hydrogen gas levels. Aluminum with low hydrogen gas levels is desired since elevated hydrogen concentrations in the molten metal will result in finished castings with "pin-hole" type defects. Gassing of the aluminum with nitrogen occurs infrequently (once or twice a month and only on an as needed basis) and is done primarily on third shift when few foundry workers are present. Nitrogen is odorless and constitutes nearly 79% of the ambient air. If the cryogenic liquid form of nitrogen comes in contact with a worker's skin or eyes, tissue damage or burns with blistering can result.

CER-Wool Blanket made by Combustion Engineering Inc. and Inswool Blanket made by A. P. Green Refractories Co., are both synthetic refractory (ceramic) mineral fibers that have been used for the past 4-5 years at Hater around furnaces to reduce heat transmission through gaps/cracks in the furnace structures. Molders and sometimes foundry management personnel periodically place these insulation materials around some of the furnaces. Reportedly this work takes a relatively short period of time and occurs fairly infrequently, only on an as needed basis once per week or less.

Hot Inspectors

Eighteen hot inspectors are employed in the foundry with an average of six on each of the three shifts. These workers serve chiefly as molders' helpers. Their primary job reponsibilities include furnace maintenance and loading the furnaces. They periodically clean the dross from the walls of the furnace using fluxing agents. After fluxing, ashes and dross are raked out of the furnace into a hopper which is then emptied into a bin on the loading dock. Other job duties of note include inspecting and finishing castings (processing the castings through the enclosed sandblasting machine) after they have been separated from the metal stems by the sawmen.

IV. EVALUATION DESIGN AND METHODS

The NIOSH medical evaluation consisted of non-directed interviews with a representative sample of workers from all three job categories in the foundry. Interviews focused on 1) symptoms of shortness of breath, indicative of possible respiratory disability; and 2) current complaints of respiratory irritation possibly attributable to workplace exposures. To evaluate information on respiratory disability, the interviews also included a smoking history and history of previous respiratory illnesses of either occupational or non-occupational origin. Workers who had undergone recent medical evaluation for respiratory problems were questioned as to the results. Where possible, information obtained from employees was confirmed by interviewing the employees' personal physicians and reviewing copies of the relevant medical records.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to 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 is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available. The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the ACGIH TLVs, and 3) the OSHA occupational health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Sodium Aluminum Fluoride and sodium silico fluoride

Presently, there are no established NIOSH RELs, or ACGIH TLVs for occupational exposures to either of these two compounds. NIOSH, OSHA and ACGIH, however, do have existing exposure limits for fluorides of 2.5 milligrams per cubic meter of air (mg/m^3) (gaseous and particulate) for an eight-hour time-weighted average. Exposure to excessive levels of fluoride dusts/fume or gas may cause irritation of the eyes, skin, and respiratory tract.[1]

Sodium silicate

Currently, there are no established NIOSH RELs, OSHA PELs or ACGIH TLVs for occupational exposure to sodium silicate. Even though few experimental animal toxicity determinations have been completed with the soluble silicates, industrial experience has revealed that the liquid silicates are of quite low toxicity.[1] However, one should not overlook the fact that many of the liquid silicate solutions are alkaline (including the sodium silicate solutions in both Dycote products, with a pH in excess of 10) and can thus be corrosive to the eyes and skin and can cause irritation of the upper respiratory passages.

Synthetic mineral fibers

Synthetic, or "man-made" mineral fibers (MMMF), also referred to as man-made vitreous fibers (MMVF), generally refer to amorphous glassy fibers made from molten slag, rock or glass. Four general classifications of MMMF exist: slag wools, rock wools, glass, and ceramic wools and filaments. Unlike asbestos, MMMF are amorphous, generally have a larger diameter and fracture in a transverse plane. (Asbestos fibers fracture longitudinally producing a large number of fine fibrils). Advances in production have allowed manipulation of fiber length, diameter, physical form, and chemical composition to meet specialized needs and applications.[2]

Concern for the carcinogenic potential of MMMF increased in the 1970's, after a number of intra-pleural (placement of glass fibers inside the pleural cavity) and intra-peritoneal (in the abdominal cavity) injection studies compared the biological response of animals to glass fibers and asbestos, a naturally occurring fiberous mineral. Although glass fibers were much less carcinogenic than asbestos fibers, certain sized glass fibers were also capable of inducing mesothelioma. The authors hypothesized that fibrous shape and size rather than chemical composition may determine carcinogenic potential.[3,4] Other studies have indicated that fiber durability may also affect carcinogenic potential.[5,6]

Many epidemiological studies have been conducted on workers exposed to MMMF (fibrous glass and mineral wool production workers), although none of them have been conducted on ceramic fiber producer or user industry populations. Extrapolating from the health effects observed in the studies performed on fiberous glass and mineral wool to ceramic fiber exposures, may not be appropriate because parameters affecting fiber carcinogenic potential–fiber dimension and rate of dissolution, may not be comparable.[6] Ceramic fibers do not undergo dissolution as readily as glass fibers under laboratory conditions,[7] and are not as readily cleared from the lungs.[6] The need for further evaluation of the fibrogenic and carcinogenic potential of the ceramic fibers and glass fibers is clear.

Conversion of amorphous ceramic fibers to crystalline silica, cristobalite, has been reported to occur at or near 1000°C (1832°F)[8,9,10] and 1150°C (2102°F)[11]. Furthermore, some studies have indicated that this conversion process to cristobalite may require exposing the ceramic fibers to elevated temperatures for sustained periods. Removal of ceramic fiber insulation from high heat furnaces may present the greatest potential for exposure to fibers which have converted to cristobalite.

In summary, insufficient data are currently available to determine the toxicity of ceramic fibers. Current evidence on fibrous glass suggests that fiber size and durability in the lung may determine carcinogenic potential. Ceramic fibers are reported to be more durable than fibrous glass fibers. Since preliminary animal inhalation studies indicate that ceramic fibers may be carcinogenic, it would be prudent to minimize exposures to the extent feasible.

VI. RESULTS AND DISCUSSION

Sixteen foundry employees were interviewed during site visits conducted on December 15, 1986 and February 10, 1987. The group interviewed consisted of 10 molders, 3 sawmen and 3 hot inspectors.

None of the sawmen interviewed reported any current respiratory disability or recent history of respiratory illness. One of the three reported experiencing transient respiratory irritation while cleaning the furnaces each morning. This problem was particularly associated with the use of the flux, Coverall #11. By history, this problem seemed to be more severe in the winter months, when the large sliding doors which open to the outside of the building are kept closed. A second employee reported experiencing dryness in the throat while at work, but associated the symptom more with what was referred to as "dry heat" in the building rather than with a chemical exposure. A third employee interviewed reported no current symptoms, but had previously experienced symptoms of respiratory irritation when operating the sandblast booth during his employment as a hot inspector.

None of the hot inspectors interviewed reported any current respiratory disability or recent history of respiratory illness. Two of the three persons interviewed reported experiencing symptoms of respiratory irritation whenever they operated the grinding machine or the sandblast booth or were required to empty the hoppers filled with dross into the bins on the loading dock.

Two of the ten molders interviewed reported currently experiencing symptoms of respiratory disability. One of the individuals, a non-smoker with no history of asthma or sinus allergies, reported experiencing shortness of breath since 1984 and a decreased capacity for physical exertion. He also reported symptoms of heat intolerance or "hot flashes", but there was no change in the symptoms during an 18-day period in the summer of 1986 when he was off work. Pulmonary function tests recently conducted by his personal physician showed a normal vital capacity and forced expiratory volume. There was a decreased mid-expiratory flow rate, but no abnormalities on chest x-ray. Physical examination of the lungs conducted at the time of the NIOSH site visit revealed no abnormalities. Additionally, over a one week period this individual was requested by the NIOSH physician to record his oral temperature whenever the symptoms of hot flashes occurred. During this time period the sensations of heat intolerance were not accompanied by a measurable rise in the oral temperature.

A second individual reported experiencing symptoms of shortness of breath, and "inability to get a deep breath" since December 1986. An interview with his personal physician revealed that he had originally sought treatment during December 1986 for difficulty swallowing. Records reviewed indicated that no abnormalities were presesnt on chest x-rays taken in January 1987. A third molder reported a history of "scarring on x-ray" having been present in December 1984, following an episode of pneumonia. Originally x-ray reports from the hospital where he was treated showed changes consistent with pneumonia, but no evidence of dust-associated lung disease (pneumoconiosis). This same individual reported symptoms of heat intolerance (hot flashes) similar to those reported by another molder. Over a one week period this individual was requested by the NIOSH physician to record his oral temperature whenever these symptoms occurred. During this time period the sensations of heat intolerance were not accompanied by a measurable rise in the oral temperature.

Seven of the 10 molders interviewed reported transient symptoms of upper respiratory irritation associated with the spray release compounds used in the foundry. One worker also reported irritation associated with fluxes used to clean out the furnaces.

Previous air monitoring of the grinding and the abrasive blasting operations by an OSHA industrial hygienist for total and respirable dusts indicated no worker overexposures.

VII. CONCLUSIONS

No objective evidence of chronic respiratory illness or metal fume fever was documented in the population under investigation, and non of the interviewed workers had a symptom pattern suggestive of metal fume fever. Agents likely to cause chronic pulmonary fibrosis or obstructive pulmonary disease are not likely to be present in any appreciable amounts or for any significant duration of time. Likewise, aluminum oxide fume, unlike fumes of zinc, cadmium, copper, iron, magnesium, or manganese, is not known to cause metal fume fever.

While little evidence of chronic respiratory illness could be documented in the population, acute respiratory irritation associated with the use of mold coating agents appeared to be common among workers employed as molders, and similar health effects were noted by a few workers who handled the fluxing compounds. Similarly, amongst workers employed as hot inspectors, a high prevalence of complaints was associated with the grinding and sandblasting operations.

Many of the symptoms reported by the foundry workers, though episodic or transient in nature, were consistent with exposure to the fluxes and mold coating agents. These reported health effects should not be discounted, because with sufficient concentrations, exposures to some of the substances used in the foundry can cause irritation to the eyes, skin and mucous membranes of the respiratory tract.

VIII. RECOMMENDATIONS

In an attempt to reduce the number of foundry workers experiencing any acute work-related symptoms, plant management should ascertain that proper work practices are followed and all appropriate protective equipment is worn by employees with the objective of reducing workers' chemical exposures still further. In addition, periodic checks to make sure all existing ventilation controls are functioning effectively should be made. Workers handling the furnace insulating materials should use protective equipment in the form of Tyvek coveralls, gloves and boot covers, half-face dust, fume and mist respirators. If possible, the insulation materials should be wetted prior to any tear-out work. Lastly, MSDS's of the products used in the foundry should be made readily available to all employees, and training the workers of the potential health hazards associated with their jobs should be undertaken.

IX. REFERENCES

1. Patty FA. Patty's industrial hygiene and toxicology. Vol II–toxicology, 3rd revised ed. New York John Wiley & Sons, 1981.

2. National Research Council, Assessing non-occupational exposure to asbestiform fibers, in, Asbestiform fibers, non-occupational health risks (National Academy Press, Washington, D.C., 1984) p.74.

3. Pott F; Huth F; Friedrichs KH. Results of animal carcinogenic studies after application of fibrous glass and their implications regarding human exposure. In: US Department of Health Education and Welfare. Occupational exposure to fibrous glass: Proceedings of a symposium, College Park, Maryland, June 26-27, 1974. Washington, D.C.,1976, pp.183-193. (DHEW Publication no. (NIOSH) 76-151).

4. Stanton MF: Wrench C. Mechanisms of Mesothelioma induction with asbestos and fibrous glass. J Nat Cancer Inst 48: pp.797-821; 1972.

5. Morgan A; Holmes A. The depostition of MMMF in the respiratory tract of the rat, their subsequent clearance, solubility in vivo and protein coating. In: Guthe T, ed. Biological effects of man-made mineral fibers: Proceedings of a WHO/IARC conference in association with JEMRB and TIMA Copenhagen, April 20-22, 1982. World Health Organization, Regional Office for Europe, Copenhagen, 1984, pp. 1-17.

6. Hammad YY. Deposition and Elimination of MMMF. In: Guthe T., ed. Biological effects of man-made mineral fibers: Proceedings of a WHO/IARC conference in association with JEMRB and TIMA Copenhagen, April 20-22, 1982. Volume 2. World Health Organization, Regional Office for Europe, Copenhagen, 1984, pp. 126-141.

7. Leineweber, J.P. , Solubility of fibers in vitro and in vivo, In: Guthe T., ed. Biological effects of man-made mineral fibers: Proceedings of a WHO/IARC conference in association with JEMRB and TIMA Copenhagen, April 20-22, 1982. Volume 2. World Health Organization, Regional Office for Europe, Copenhagen, 1984, pp. 87-101.

8. Strubel G; Fraij B; Rodelsperger K. et al., Letter to the Editor, American Journal of Industrial Medicine, 10: 101-102; 1986.

9. Combustion Engineering, Inc., Material Safety Data Sheet for CER-Wool Blanket, prepared May 1985. C-E Refractories, Valley Forge, PA.

10. A. P. Green Refractories Co., Material Safety Data Sheet for Inswool Blanket, prepared August 12, 1985. A. P. Green Refractories Co., Mexico, Missouri.

11. Vine G; Young J; Nowell IW. Letter to the Editor, Health hazard associated with alumino-silicate fibre products. The Annals of Occupational Hygiene, 28: pp.356-359; 1984.

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1. Hater Industries, Inc.
2. Confidential Requestor(s)
3. OSHA, Region V

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