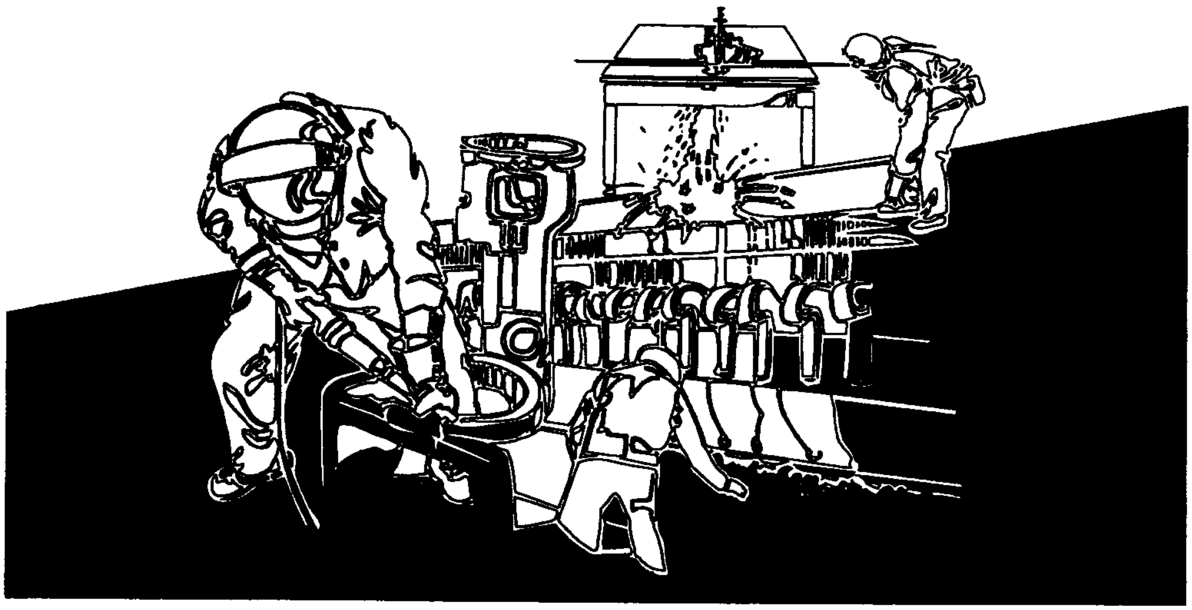
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 93-0492-2419
LTV STEEL-TUNDISH YARD
EAST CHICAGO, INDIANA



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 93-0492-2419
MAY 1994
LTV STEEL-TUNDISH YARD
EAST CHICAGO, INDIANA

NIOSH INVESTIGATOR:
NANCY CLARK BURTON, MS, CIH

I. SUMMARY

In January 1993, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation request from the United Steel Workers of America, Local 1011 Union to evaluate workers' exposures to refractory dust in the Steel Producing Tundish Repair Yard at the LTV Steel facility in East Chicago, Indiana. NIOSH investigators conducted industrial hygiene surveys in October and December 1993 to look at these exposures. Personal breathing zone (PBZ) and area air samples were collected for respirable dust and silica (quartz), and four bulk samples of refractory material were analyzed for silica (quartz) content. Work practices, engineering control measures, and material safety data sheets (MSDSs) were evaluated.

All of the PBZ (0.09-0.52 milligrams per cubic meter [mg/m^3]) and area (0.01 to 0.28 mg/m^3) sample concentrations measured for respirable dust for both sites visits were well below the evaluation criteria for occupational exposures of 5 mg/m^3. Silica (quartz) was not detected in any of the air or bulk samples (less than 0.02 mg/m^3). Smoking was allowed throughout the tundish yard, therefore, exposure to environmental tobacco smoke (ETS) was identified as a potential health hazard in this facility. During the walk-through survey, some potential safety and health hazards were identified, such as welding without protective screening, no eye hazard warning signs, and large dust clouds during hopper filling which filled a large portion of the tundish yard.

The industrial hygiene sampling data indicate that workers were not overexposed to respirable dust or silica at this facility. Environmental tobacco smoke was identified as a potential health hazard at this facility. Recommendations for engineering controls and improved safety practices can be found in Section VIII of this report.

KEYWORDS: SIC 3312 (Steel Works, Blast Furnaces [Including Coke Ovens], and Rolling Mills), tundish, refractory, magnesite, olivine, total respirable dust, environmental tobacco smoke, ETS.

II. INTRODUCTION

In January 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from representatives of the United Steel Workers of America, Local 1011 Union to evaluate worker exposures in the tundish repair area associated with the continual casting process at the LTV Steel Facility in East Chicago, Indiana. The request was prompted by union concerns over dust exposures to employees handling the refractory material. On October 14-15, and December 7, 1993, NIOSH investigators conducted industrial hygiene surveys to look at these exposures.

III. BACKGROUND

The tundish repair yard is located adjacent to the continual casting area in the Steel Producing Department. The yard operates 24 hours a day and the majority of employees in the area (up to 38) work on the first shift (6:00 a.m. to 2:30 p.m.). A tundish is shaped like a large trough with a gradual slope and is lined with a refractory material to help retain heat and avoid damage to the tundish itself. During the continual casting process, the tundish is placed between the ladle containing molten steel and the caster mold. It serves three functions: to help control the flow of steel, to remove additional slag, and to act as a reservoir for molten metal during ladle changes to keep the casting process constant.

After use on the continual casting line, the tundish is covered by a lid and returned to the tundish yard using a transfer car. Figure 1 is a diagram of the tundish yard (not to scale). The used tundish is placed in one of two deskulling pits, the covers removed, and the tundish is allowed to cool for approximately eight hours. The tundish at this stage contains a layer of steel and slag referred to as a "skull." After cooling, excess steel is burned out of the opening at the bottom of the tundish, using an oxygen lance, and the tundish is flipped. The skull and loose refractory material fall to the bottom of the deskulling pit and are then removed by an outside contractor, using a front-end loader.

After deskulling, the tundish is moved by overhead crane to the tundish repair area, where the inside surface of the refractory material is checked for damage. Wherever needed, the old refractory is chipped out using pneumatic chippers and the area patched.

From the repair area, the tundish is moved to one of two gunning pits for a final coat of refractory material. According to the material safety data sheets (MSDSs), the refractory material contains primarily magnesite and olivine. The refractory material is combined with mortar (aluminosilicate, clay, sodium silicate, quartz, fused glass, and water), water, and straw as a filler. One gunning pit uses a robot to spray the material and, in the other, the material is sprayed by hand. According to management, the robotic sprayer is used 95% of the time. This machine malfunctioned during the first site visit in October 1993, and the work was completed by hand. Three individuals work exclusively in this area: two employees of LTV Steel and one employee of the refractory contractor.

The dry refractory material comes in 3,000 pound bags. The bags are lifted, using the overhead crane, and added to one of two hoppers (one for each gunning station). Each hopper has a point in the center which breaks the bag. The hoppers are enclosed in plastic sheeting except at the top and there are wall exhaust fans behind each hopper to help control dust levels. There is no mechanical ventilation system for the tundish yard. Fresh air is provided by louvers in the top of the building which are always open and open bay doors.

This magnesite/olivine refractory material has reportedly been used since November 1992. There have been several company investigations in this area to address the issue of employee dust exposure. Three industrial hygiene surveys had been conducted between 1988 and 1991 to document exposures to other refractory materials. An additional study was conducted in November 1992 after the change to the magnesite/olivine refractory material. Two personal breathing zone (PBZ) and five area samples were collected and analyzed for respirable particulates. The two PBZ sample concentrations collected for the tundish gunners were 0.24 and 0.47 milligrams per cubic meter (mg/m^3) for total respirable dust. The area concentrations ranged from <0.023 to 0.52 mg/m^3 for total respirable dust.

IV. METHODS

The facility's MSDSs were reviewed and a walk-through survey of the area was conducted. Personal breathing zone and area air samples were collected for the following compounds.

A. Total Respirable Dust

Ten PBZ and 11 area air samples for respirable dust (aerodynamic diameter less than 10 micrometers [μm]) were collected at a flowrate of 1.7 liters per minute (l/min) using 10 millimeter (mm) nylon cyclones mounted in series with pre-weighed polyvinyl chloride (PVC) filters (37 mm diameter, 5 µm pore size). The samples were analyzed for particulate total weight by gravimetric analysis according to NIOSH Method 0600[1] with the following modifications: (1) the filters and back-up pads were stored in an environmentally controlled room for several days to obtain stabilization. The samples were weighed 5-10 minutes apart since the filters had been room stabilized for several days; (2) the back-up pads were not vacuum desiccated; and (3) the samples were not vacuum desiccated 15 minutes prior to final weighing. The analytical limit of detection (LOD) was 0.02 milligrams (mg), which is equivalent to a minimum detectable concentration (MDC) of 0.1 mg/m^3, assuming a sample volume of 192 liters.

B. Quartz

Five PBZ and six area respirable dust air samples from the first survey were analyzed for quartz using X-ray diffraction. Samples were analyzed according to NIOSH Method 7500[2] with the following modifications: (a) the filters were dissolved in tetrahydrofuran rather than being ashed in a furnace, and (b) standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than the suggested normalization procedure. The analytical LOD and limit of quantitation (LOQ) were 0.01 mg and 0.03 mg, respectively. The MDC and minimum quantifiable concentration (MQC) for respirable silica (quartz), assuming an average sample volume of 598 liters, were 0.02 mg/m^3 and 0.05 mg/m^3, respectively.

Four bulk samples of loose material were collected from the robotic track, automatic hopper, wall of lockers, and the deskulling area for analysis of quartz (silica) content also using X-ray diffraction (NIOSH Method 7500[2]) with the same modifications. The analytical LOD and LOQ were 0.75% and 1.5%, respectively.

V. EVALUATION CRITERIA AND GUIDELINES

To assess the hazards posed by workplace exposures, industrial hygienists use a variety of environmental evaluation criteria. These criteria propose exposure levels to which most employees may be exposed for a normal working lifetime without adverse health effects. These levels do not take into consideration individual susceptibility, such as pre-exiting medical conditions, or possible interactions with other agents or environmental conditions. Evaluation criteria for chemical substances are usually based on the average personal breathing zone exposure to the airborne substance over an entire 8- to 10-hour workday, expressed as a time-weighted average (TWA).

The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),[3] the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[4] and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[5] Evaluation criteria change over time with the availability of new toxicologic data.

The OSHA PELs reflect the economic feasibility of controlling exposures in various industries, public notice and comment, and judicial review; whereas the NIOSH RELs are based primarily on concerns related to the prevention of occupational disease. An additional complication is due to the fact that a Court of Appeals decision vacated the OSHA 1989 Air Contaminants Standard in *AFL-CIO v OSHA,* 965F.2d 962 (11th cir., 1992); and OSHA is now enforcing the previous 1971 standards (listed as Transitional Limits in 29 CFR 1910.1000, Table Z-1-A).[5] However, some states which have OSHA-approved State Plans will continue to enforce the more protective 1989 limits. NIOSH encourages employers to use the 1989 limits or the RELs, whichever are lower.

A. Total Respirable Dust

Dusts, which have a long history of little adverse health effect on the lungs and do not produce significant organic disease or toxic effects when exposures are kept under reasonable control, are called particles not otherwise classified (PNOC), particles not otherwise regulated, or nuisance dusts.[4,5] The two major components of the refractory, magnesite and olivine, are considered to fall in this category. OSHA has established a PEL of 5 mg/m^3 for the respirable fraction of nuisance dust as an 8-hour TWA.[5]

Magnesite is a naturally occurring rock which is mined as a refractory material and as a source of the metal - magnesium. Exposures to high concentrations of dust have been associated with skin, mucous membrane, and other physical irritation.[3] One study has shown some cases of pneumoconiosis after exposures to high concentrations of dust from roasted magnesite.[6] NIOSH and OSHA have established a REL and a PEL of 5 mg/m^3 for the respirable fraction of magnesite, as 10- and 8-hour TWAs, respectively.[3,5] ACGIH has classified magnesite as a particulate not otherwise classified and has established a TLV of 10 mg/m^3 for total dust containing no asbestos and <1% crystalline silica.[4]

Olivine is a naturally occurring compound which is also mined. There are no known health effects associated with exposure to olivine, which has been used as a substitute for silica sand, therefore, it is classified as a nuisance dust.

B. Environmental Tobacco Smoke

Environmental tobacco smoke (ETS) consists of exhaled mainstream smoke from the smoker and sidestream smoke which is emitted from the smoldering tobacco. Environmental tobacco smoke consists of between 70 and 90% sidestream smoke. More than 4,000 compounds have been identified in laboratory-based studies, including many known human toxins and carcinogens such as carbon monoxide, ammonia, formaldehyde, nicotine, tobacco-specific nitrosamines, benzo(a)pyrene, benzene, cadmium, nickel, and aromatic amines.[7,8] Many of these toxic constituents are more concentrated in sidestream than in mainstream smoke.[9] In studies conducted in residences and office buildings with tobacco smoking, ETS was a substantial source of many gas and particulate polycyclic aromatic compounds.[10]

Environmental tobacco smoke has been shown to be causally associated with lung cancer and cardiovascular disease in adults, and respiratory infections, asthma, middle ear effusion, and low birth weight in children.[11-13] It is also a cause of annoying odor and sensory irritation. The U.S. Environmental Protection Agency has classified ETS as a known human (Group A) carcinogen.[14] NIOSH considers ETS to be a potential occupational carcinogen and believes that workers should not be involuntarily exposed to tobacco smoke.[15]

Worker exposure to ETS is most efficiently and completely controlled by simply eliminating tobacco use from the workplace. To facilitate elimination of tobacco use, employers should implement smoking cessation programs. Management and labor should work together to develop appropriate nonsmoking policies that include some or all of the following:

- Prohibit smoking at the workplace and provide sufficient disincentives for those who do not comply.

- Distribute information about health promotion and the harmful effects of smoking.
- Offer smoking-cessation classes to all workers.
- Establish incentives to encourage workers to stop smoking.

The most direct and effective method of eliminating ETS from the workplace is to prohibit smoking in the workplace. Until this measure can be achieved, employers can designate separate, enclosed areas for smoking, with separate ventilation. Air from this area should be exhausted directly outside and not recirculated within the building or mixed with the general dilution ventilation for the building. The ventilation system of the smoking area should provide 60 cubic feet per minute of supply air per person, and the smoking area should have slight negative pressure to ensure airflow into the area rather than back into the airspace of the workplace.[15]

VI. RESULTS

A. *Total Respirable Dust*

The results of the PBZ and area air samples are presented in Tables 1 and 2. Table 1 and Table 2 show the concentrations from the first site visit in October when the manual spraying machine was used and from the second site visit when the robotic spraying machine was used, respectively.

All of the PBZ and area sample concentrations measured for respirable dust for both sites visits were well below the evaluation criteria for occupational exposures of 5 mg/m^3. The PBZ sample concentrations for the manual spraying operation ranged from 0.09 to 0.38 mg/m^3 and, for the robotic spraying operation, ranged from 0.16 to 0.52 mg/m^3. The tundish gunners, repairman, and deskuller had similar exposures. The area sample concentrations for the manual spraying operation ranged from 0.01 to 0.22 mg/m^3 and, for the robotic spraying operation, ranged from 0.06 to 0.28 mg/m^3.

B. *Quartz*

Quartz was not detected in the five PBZ and six area respirable dust air samples from the first survey at a MDC of 0.02 mg/m^3, using an average sample volume of 598 liters.

The four bulk samples collected from the robotic track, automatic hopper, wall of lockers, and the deskulling areas also did not contain detectable concentrations of quartz at the analytical LOD of 0.75%.

C. *Observations*

Employees were observed smoking throughout the tundish yard. The central walkways were cleaned using dry sweeping which created small dust clouds. When the hoppers were filled, large clouds of refractory dust were released which spread through a large portion of the surrounding area. Large piles of refractory material were located around each hopper. Refractory dust was present throughout the facility and had collected on all available surface areas. The MSDS for the refractory material recommends the use of a dustless system for handling the material to make sure levels do not exceed the OSHA PEL and that the material should not be permitted to accumulate on building surfaces. Welding, without any screening or other controls, was performed in the middle of the maintenance area. There were no eye hazard signs around oxygen lance in the deskulling area or the welding area in the maintenance section.

VII. DISCUSSION/CONCLUSIONS

The industrial hygiene sampling data indicate that respirable dust exposures in the tundish repair yard at this facility did not exceed the occupational exposure evaluation criteria. The exposures were similar to those found during an investigation conducted by the company in November 1992. Quartz was not detected in the PBZ, area air, or bulk samples.

During the walk-through survey, some potential safety and health hazards were identified, such as welding without protective screening and ETS exposure. Based on the observation of dust clouds in the facility, the addition of local exhaust ventilation during hopper loading should reduce employee exposures in that area.

VIII. RECOMMENDATIONS

The following recommendations are offered as prudent measures to further reduce workers' exposures to respirable dust during hopper loading and sweeping and to correct other safety and health hazards that were identified at this facility. NIOSH and OSHA recommend that engineering controls should be used to reduce exposures to the extent feasible, followed by work practices, and, if necessary, personal protective equipment.

1. To prevent accidental exposure to ultraviolet radiation from welding in adjacent areas, noncombustible or flameproof screens should be used in accordance with OSHA regulations (29 CFR 1910.252 Subpart Q - Welding, Cutting, and Brazing).[16] In accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200), labels and signs should be posted to warn other workers who normally do not work in that area of the need for eye protection around the welding and around the oxygen lance in the deskulling area.[17,18]

2. Based on the adverse health effects associated with ETS, smoking should not be allowed in the building. If that is not possible, a separate smoking area should be designed to meet the current guidelines of negative pressure with respect to the rest of the building, 60 cubic feet per minute of supply air per person, and direct exhaust to the outside to prevent smoke from entering the building.[19] Suggestions to eliminate or restrict smoking in the workplace are found in the references listed in the evaluation criteria.

3. To help capture dust during the loading of the hoppers, a booth with local exhaust ventilation should be installed as shown in Figure 2. The booth should enclose as much of the hopper and bag as possible.[20]

4. To reduce exposures to respirable dust, an industrial vacuum should be used on a regular basis to collect loose dust on the floor instead of dry sweeping.

IX. REFERENCES

1. NIOSH [1984]. Nuisance dust, respirable: method no. 0600. In: Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.