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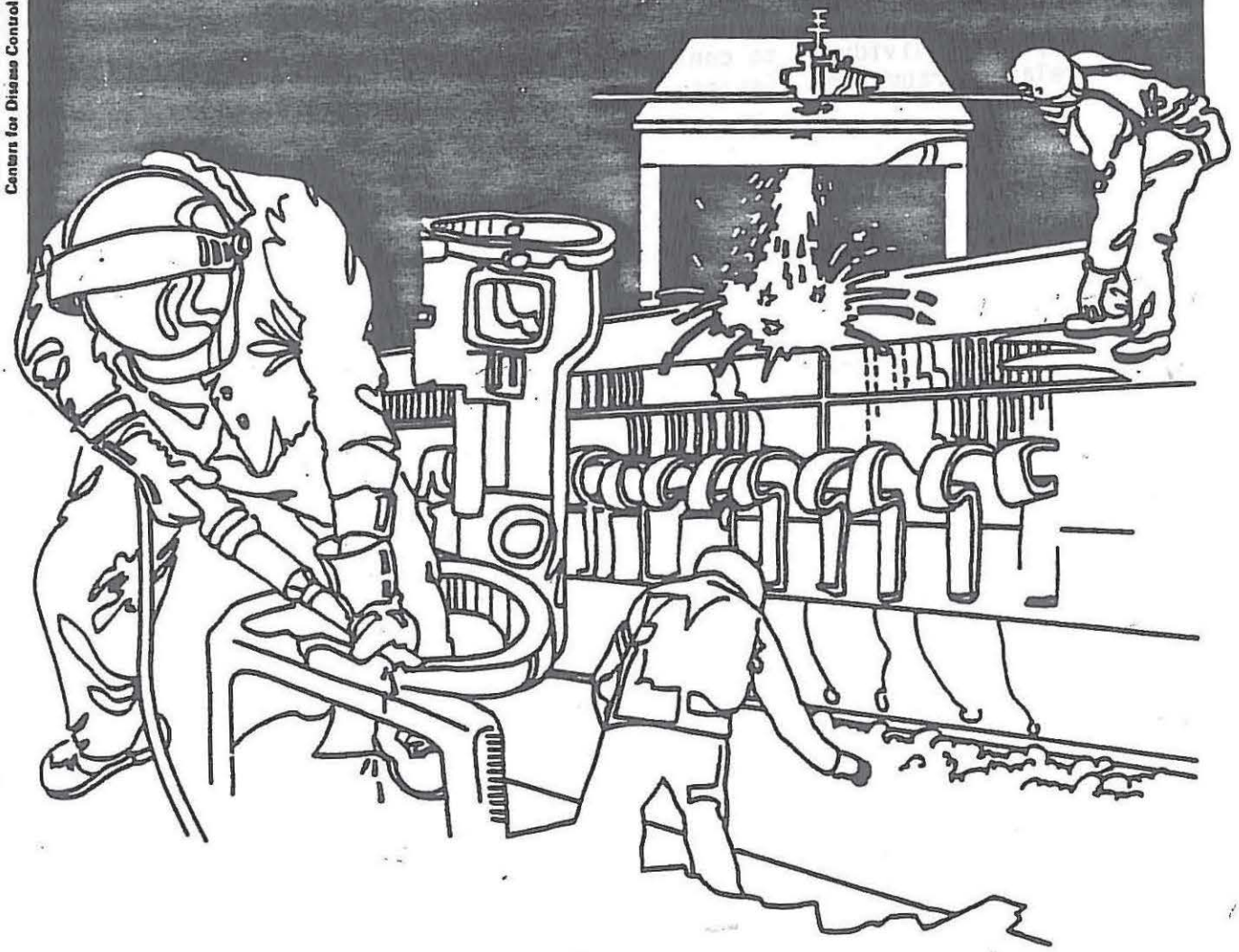

Health Hazard Evaluation Report

HETA 84-102-1653
LADISH COMPANY
CUDAHY, WISCONSIN

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 or 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.

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LADISH COMPANY
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I. SUMMARY

On December 19, 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate exposures to crystalline silica, metal dust and fumes, solvents, machine coolants, and lead at a metal forging plant owned by the Ladish Company, Cudahy, Wisconsin.

In January 1984, NIOSH investigators conducted an initial survey visit to the facility. In June 1984, medical and environmental surveys were conducted. Confidential employee interviews were administered, and air samples were collected to assess employee exposures to crystalline silica, trace metals, and total particulate at grinding operations.

The results of the medical survey did not reveal an excess of dermatitis associated with exposure to coolants. Although there was no evidence of an excess of chronic respiratory disease, a high proportion (over 40%) of grinders in Bay 16 and Building 13 reported some symptoms of eye, nose, or throat irritation.

Eight-hour time-weighted average (TWA) concentrations of total particulate in 19 personal samples ranged from 0.4 to 14.8 milligrams per cubic meter of air (mg/M^3), with a mean of 3.8 mg/M^3. All sample results were below the Occupational Safety and Health Administration (OSHA) standard of 15 mg/M^3 as an 8-hour TWA, but two samples exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 10 mg/M^3 as an 8-hour TWA for nuisance dust. One of these samples was collected during a grinding operation where the local exhaust ventilation was ineffective due to the large size of the forging. Results of personal samples for trace metals did not indicate any exposures above the ACGIH-TLV's or the OSHA Permissible Exposure Limits (PEL's). However, nickel was detected in five of six personal samples at TWA concentrations ranging from 0.002 to 0.056 mg/M^3, with a mean of 0.021 mg/M^3. NIOSH has identified nickel as a suspect carcinogen and recommends reducing exposures to all inorganic nickel compounds to the lowest feasible level. Crystalline silica was not found above the limits of quantitation (1.5%) in either of the two bulk dust samples collected in the grinding area.

While no health hazard from airborne exposures was found in the majority of the grinding operations monitored during this survey, instances involving the grinding of large forgings and forgings containing nickel were determined to present a potential health hazard if not properly controlled. Recommendations designed to reduce employee exposures in these instances are contained in Section VIII of this report.

KEY WORDS: SIC 3462 (Iron and Steel Forgings) Grinding, Abrasives, Metals, Nickel, Nuisance Dust

II. INTRODUCTION

On December 19, 1983, an authorized representative of the employees at the Ladish Company, Cudahy, Wisconsin, requested that the National Institute for Occupational Safety and Health (NIOSH) conduct a health hazard evaluation at the facility. The requestor was concerned with employee exposures to crystalline silica, metal dust and fumes, machine coolants, solvents, and lead.

NIOSH investigators conducted an initial survey visit to the facility on January 17, 1984. An opening conference was held with representatives of plant management and the local union during which the nature of the request was discussed, followed by a walk-through inspection of the areas of concern. A medical survey was conducted on June 13-15, 1984, during which confidential employee interviews were administered. An environmental survey was conducted on June 25-26, 1984, during which airborne exposure to crystalline silica, metal dust and fumes, and total particulate at grinding operations were evaluated. The results of the environmental survey were transmitted by letter to the requestor and company on May 28, 1985.

III. BACKGROUND

The Ladish Company, founded in 1905, is engaged in the production of pipe fittings and industrial forgings. At the time of this survey, the plant employed approximately 850 administrative, 1200 production, and 300 maintenance employees. The request specified several different areas and substances of concern, each of which is discussed individually below.

A. Metal Dusts and Fumes

Abrasive grinding is conducted in order to remove excess material from the forgings produced by the company. This is usually accomplished by moving a portable abrasive grinding tool over the metal forgings. Commonly used abrasives include silicon carbide and aluminum oxide. Although the composition of the metal forgings is variable, titanium based metals were reported to be the forgings of major concern in the request. Grinding was primarily carried out in Bay 16 where approximately 40-60 grinders worked, and Building 13 where approximately 10 grinders worked. Grinding operations in both areas were conducted at individual grinding stations equipped with local exhaust ventilation hoods. Due to a potential for a noise hazard, hearing protection was required to be worn in each of these areas of the plant.

B. Crystalline Silica

The requestor was concerned with potential exposures to crystalline silica from the abrasive materials used during grinding operations carried out in the aforementioned areas.

C. Solvents

Solvents were used by maintenance employees to clean equipment in Buildings 29, 60, and 66. The solvent reported to be used most frequently was 1,1,1-trichloroethane. For maintenance work, this solvent was dispensed in small containers and applied to machinery or parts using rags or small brushes. In addition, 1,1,1-trichloroethane was also present as a component of a developer and penetrant used in dye penetrant inspections in various areas of the plant. Other solvents also reported to be occasionally used included acetone and amosol naptha - which was required for use in restricted operations reportedly occurring approximately 3 to 4 times a year.

D. Machine Coolants

Four different machine coolants were used in a variety of machining operations throughout the facility. A straight soluble oil was used in Buildings 29 and 60, with the remaining 3 synthetic or semi-synthetic coolants being used in Building 66 and other areas of the plant.

E. Lead

The concern with exposure to lead centered around an operation where lead was melted and used to repair damaged pipe threads. Information obtained during the initial survey visit indicated that this operation was conducted approximately four times a year, usually lasted less than three hours, and involved only one or two employees.

IV. MATERIALS AND METHODS

A. Medical

The medical evaluation focussed on possible health effects from exposures to coolants (cutting fluids) and mixed metal dusts. During the walk-around on the initial survey visit, workers in each work area were privately interviewed by the NIOSH physicians. During the follow-up medical survey in June 1984, a NIOSH physician conducted confidential interviews with grinders in Bay 16 and Building 13. A medical questionnaire, designed to obtain information regarding the prevalence of acute symptoms, chronic respiratory symptoms and illnesses, and skin disorders, was administered to all 45 participants. Demographic data, work and smoking histories, medical history, and information regarding the use of personal protective equipment was also obtained. In addition, two plant nurses were interviewed and medical records from the first aid stations were reviewed.

B. Environmental

1. Evaluation Design

Following the initial survey, personal monitoring data related to each of the specific areas of concern were obtained from the company. Based on a review of this information, as well as the preliminary results of

the medical survey, an environmental survey was designed to assess employee exposures to solvents during maintenance activities and particulate emissions from grinding operations. Based on the lack of reported problems during the medical interviews, environmental samples for machine coolants were not collected. In addition, the infrequent use of lead in the pipe thread repair operation did not make environmental sampling of this operation feasible. Since the evaluation of abrasive grinding constituted a major portion of the environmental survey, a discussion of the potential contaminant sources during grinding is provided below.

In grinding operations, airborne contaminants may arise from the abrasive, its bonding material, the base metal being ground, or its surface coating if present.[1] Since the metals being ground during this survey were not coated, this was not considered as a source of contaminants. From the industrial hygiene standpoint, the abrasive material is generally considered to constitute a relatively small portion of the total grinding emissions, and the hazard from the bonding agent is also usually considered to be minor.[1,2] Studies have clearly shown that the majority of the particulate evolved during grinding is released from the workpiece.[2] The amount of particulate material given off is dependent on the specific type of metal being ground. During grinding, titanium metals are considered to be relatively dusty, steel alloys intermediate, and aluminum parts tend to release relatively little dust.[2]

While the total amount of particulate in the grinding emissions is of concern, due to a wide variation in toxicity, the particular type of metal(s) present in the particulate emissions also needs to be closely examined. Therefore, the NIOSH environmental survey was designed to assess both the total amount of particulate generated (total particulate), as well as the specific components of the base metal which might be present in the grinding emissions (trace metals).

While crystalline silica has often been cited as a hazard during the grinding of rough castings, this is due primarily to the fusing of silica from sand moldings onto the outer surfaces of the metal castings.[2] Since forging operations do not entail the use of sand moldings, this hazard would not be present. Furthermore, the silica present in the abrasive wheels is present in a chemically combined form and not as free silica. However, the possible presence of crystalline silica in the grinding dust was examined in order to address employee concerns.

2. Sample Collection Procedures

On June 25-26, 1984 an environmental survey was conducted by NIOSH investigators. Personal samples, designed to reflect employee exposures, were collected near the breathing zone of the workers to assess airborne concentrations of total particulate and trace metals. Samples were obtained using a battery-powered pump connected via tygon tubing to the collection media. A flow rate of 1.5 liters per minute was used for both the pre-weighed polyvinyl chloride (PVC) filters, and the mixed cellulose ester membrane filter collection media. The PVC

filters were later analyzed for total particulate by gravimetric weighing in accordance with NIOSH Method No. 0500.[3] The mixed cellulose ester membrane filters were analyzed for trace metal components by inductively coupled plasma emission spectroscopy (ICP-AES) in accordance with NIOSH Method No. 7300.[3] A complete listing of the location, duration and other information pertinent to sample collection is presented in Tables 1 & 2.

Bulk samples of settled particulate material were collected from the top surface of two grinding hoods in Bay 16. These samples were later analyzed for free crystalline silica by x-ray diffraction in accordance with NIOSH Method NO. 7500.[3]

Although the NIOSH investigators were prepared to collect samples for 1,1,1-trichloroethane and/or other organic solvents, no use of these materials in maintenance activities was reported to have taken place during the period of the environmental survey.

V. EVALUATION CRITERIA

A. General

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 becomes available.

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 (TLV's), and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are

lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's 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 required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) 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.

B. Specific Substances

Following is a brief discussion of the toxicity of the substances of concern in this evaluation. This listing includes those substances specified in the request, as well as others which were evaluated during the environmental survey. The environmental criteria for each of these materials are presented in Table 3.

1) "Nuisance" Particulate - Silicon carbide, an abrasive frequently used in grinding wheels, is an example of a material which is considered to be a "nuisance" particulate.[4] In contrast to fibrogenic dusts which cause scar tissue to be formed in the lungs when inhaled in excessive amounts, so-called "nuisance" dusts are stated to have little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount. However, the lung-tissue reaction caused by inhalation of nuisance dusts has the following characteristics: (1) The architecture of the air spaces remains intact, (2) Collagen (scar tissue) is not formed to a significant extent, and (3) The tissue reaction is potentially reversible.[4]

   Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages, or may cause injury to the skin or mucous membranes by chemical or mechanical action per se, or by the rigorous skin cleansing procedures necessary for their removal.[4]

2) Titanium - Titanium and titanium compounds are for the most part virtually inert and not highly toxic to man.[5] No specific criteria for titanium metal presently exists, but titanium dioxide is classified as a "nuisance" particulate by the ACGIH.[6]

3) Nickel - Skin sensitization is the most commonly seen toxic reaction to nickel and its compounds. Nickel is also an irritant to the eyes and mucous membranes of the respiratory tract.[5] Due to concern about the potential carcinogenicity of nickel compounds, NIOSH recommends that occupational exposure to nickel be reduced to the lowest feasible level.[7] Based on a review of data published since the 1977 NIOSH criteria for nickel, the ACGIH does not feel that nickel metal and insoluble nickel compounds are carcinogenic, and recommends a separate TLV for these materials.[4]

4) Chromium and its compounds - In some workers, chromium compounds act as allergens, causing dermatitis and pulmonary sensitization. In the hexavalent state Cr(VI), these compounds are irritating and corrosive to the skin and mucous membranes. Certain forms of hexavalent chromium have been found to cause respiratory cancer.[5,8]

5) Iron oxide - The inhalation of iron oxide fumes or dust may cause a benign pneumoconiosis known as siderosis. It is probable that the inhalation of pure iron oxide does not cause fibrotic pulmonary changes, whereas the inhalation of iron oxide plus certain other substances may cause pulmonary injury.[5]

6) Cobalt and its compounds - Repeated skin contact may cause irritation and an allergic type dermatitis, primarily at the elbow, knee, ankles and neck which are subject to friction. Inhalation may cause an irritation of the nose and throat, and may also cause symptoms ranging from cough, wheezing, and shortness of breath to permanent disability.[9]

7) Vanadium - Although the majority of vanadium produced is used in ferrovanadium for high speed and other alloy steels, there have been few studies which evaluate the reactions of humans to air concentrations of ferrovanadium and vanadium containing alloys.[5,10] Although these metallic compounds appear to be almost toxicologically inert, some slight acute respiratory irritation may occur if they are inhaled in sufficient quantity.[10] Some vanadium compounds, especially vanadium pentoxide, are irritants to the eyes, skin, and respiratory tract.[5] Inhalation of vanadium pentoxide may affect the respiratory passages, causing bronchitis, wheezing, and chest pain. Repeated exposure may cause more severe symptoms of the same nature.[9]

8) Aluminum - Aluminum metal and aluminum oxide dust are not considered to be highly toxic by inhalation, and both the ACGIH TLV and OSHA standard are set for that of "nuisance" particulates.[4]

9) Inorganic Lead - Ingestion or inhalation may cause damage to the kidneys, nervous system, and bone marrow. Long-term exposure is associated with infertility and with fetal damage in pregnant women.

10) Crystalline silica - Exposure may result in silicosis; a disease characterized by the development of scar tissue of the lungs with shortness of breath and cough. Crystalline silica may also produce upper airway irritation and chronic bronchitis.

11) Cutting Fluids - Metalworking fluids as a whole are among the leading causes of industrial dermatitis, causing both follicular inflammation and irritative or hypersensitive skin reactions. These reactions may be stimulated by the fluid itself, metal parts or other impurities in dirty oil, or additives, such as biocides, used to prevent fluid decomposition and odor formation.[12]

There are conflicting reports in the literature regarding the pulmonary effects of the inhalation of mineral oil mist. In high concentrations it appears to cause pulmonary effects[9]; however, a report published in 1962 of oil mist exposures of all types found a lack of reported illness at concentrations below 15 mg/M^3.[13] While there is currently an OSHA standard and ACGIH TLV for "mineral oil" type mist, there is no specific standard for synthetic fluids. In assessing these compounds, it is important that the fluids' individual components or additives be examined for their specific toxicities.

12) 1,1,1-Trichloroethane (methyl chloroform) - Eye irritation can occur upon contact with the liquid and vapor of 1,1,1-trichloroethane. Due to the solvent's defatting properties, skin contact can cause the development of a dry, scaly, and fissured dermatitis. 1,1,1-Trichloroethane can also act as a narcotic and depress the central nervous system. Acute exposure symptoms include dizziness, drowsiness, increased reaction time, unconsciousness, and death.[5]

VI. RESULTS

A. Medical

During the walk-around inspection on the initial visit, workers in Buildings 13, 29, 42, and 66, and Bays 14, 15, and 16 were privately interviewed by the NIOSH physicians. None of the workers interviewed reported cases of skin or respiratory problems.

During the survey, the nurse supervisor in the main first aid office was interviewed and stated that dermatitis complaints were infrequent. One of the first aid station attendants was interviewed and also reported that she did not consider dermatitis to be a problem. A sample of the medical logs (two days per month for January-June 1984) were reviewed from the main first aid office and the stations in Buildings 29, 60, 66, and Bay 18. While lacerations, burns, abrasions, and contusions were recorded, no cases of dermatitis were noted.

During the follow-up survey in June 1984, 45 grinders were interviewed. Nine (90%) of the ten grinders from Building 13 were interviewed, and interviews were completed with 36 (75%) of the 48 grinders in Bay 16 (18 of the 23 first-shift grinders and 18 of 25 second-shift grinders). The employees who were not interviewed were on vacation, on sick leave, or assigned to other work areas during the interview days. One employee refused to be interviewed. One employee's interview was not completed because his responses were too confusing to code.

All the grinders were men. The racial distribution was as follows: 28 (62%) White; 14 (31%) Black; 2 (4%) Hispanic; one (2%) Indian. The mean age was 52.9 years (range 36 to 64, standard deviation (SD) 6.75). The mean total number of years employed at Ladish was 24.7 (range 18 to 36, SD 5.79). The mean number of years working at the present job was 4.58 (range 2 months to 26 years, SD 7.19 years). The mean total number of years working as a grinder at Ladish was 14.8 (range 6 months to 34 years, SD 11.6 years).

Twenty-three people (51%) were current cigarette smokers at the time of the interviews. Another nine people were ex-smokers and 13 people had never smoked.

Employees were asked about work-related acute symptoms (defined as symptoms experienced at work at least once a week) in the three months prior to the interview. Symptoms of mucous membrane (eye, nose, throat) irritation were reported as follows: dry or irritated throat, 21 people (47%); stuffy, runny nose, 20 people (44%); sinus congestion, 13 (29%); eye irritation, 13 (29%); frequent sneezing, 11 (25%). Acute respiratory symptoms reported included coughing (10 people - 22%) and difficulty breathing (8 people - 18%). However, only two people reported chest tightness and no one reported wheezing. Sixteen people reported skin problems, but the majority were referring to minor burns from sparks generated during grinding. Thirteen people reported headaches. Symptoms reported by only one or two people included nosebleeds, light-headedness, nausea, and abdominal pain.

Two people gave responses indicative of chronic bronchitis (coughing up phlegm for more than two consecutive months a year for two or more years). Four people reported they had had attacks of bronchitis confirmed by a doctor. Other illnesses confirmed by a physician were reported in the following frequencies: pneumonia, six people; heart disease, four; emphysema, two; asthma, none. Fourteen people (31%) reporting elevated blood pressure (hypertension).

Seven people reported shortness of breath when hurrying on level ground or walking up a slight hill; another three reported shortness of breath walking with other people their own age on level ground.

Twelve people (27%) reported hearing difficulty, 11 reported that they "always" had difficulty hearing and one reported that he "usually" had difficulty hearing.

Statistical analyses were performed to determine if there were associations between the prevalence of these illnesses and acute symptoms with (1) the number of years in present job (2) total number of years grinding, or (3) work area (e.g., Bay 16 or Building 13). The only statistically significant associations were:

1) Employees with less than 15 years experience as grinders were more likely to report the following symptoms than people who had been grinders for 15 years or longer: dry or irritated throat ($X^2=3.813$, $p<0.05$); headache ($X^2=6.133$, $p<0.01$); coughing ($X^2=4.294$, $p<0.04$).

2) The 11 grinders reporting frequent sneezing at work were all from Bay 16 ($X^2=4.091$, $p<0.04$).

B. Environmental

The results of the personal samples collected for total particulate in Bay 16 and Building 13 are presented in Table 1. Due to the physical separation of the two areas of the plant which were being sampled, samples could not be collected for the entire work-shift. Therefore, two separate TWA values are reported in Table 1. The first value is a TWA average for the duration of sample collection which is averaged only for the actual period of sampling. The second value given is an 8-hour TWA which is calculated based on an assumption of "zero" exposure for the unsampled work period, and this value is used for comparison to the environmental criteria which are expressed as 8-hour TWA's. However; it should be noted that, in actuality, some exposure was expected to have occurred during the unsampled work period. Therefore, the "actual" employee exposure would probably be somewhere between these two values.

As indicated by the data in Table 1, 8-hour TWA concentrations of total particulate in the 19 personal samples collected ranged from 0.4 to 14.8 mg/M^3, with a mean of 3.8 mg/M^3. Two of these samples exceeded the ACGIH-TLV of 10 mg/M^3 as an 8-hour TWA. All 8-hour TWA's were below the OSHA standard of 15 mg/M^3.

Table 2 shows the results of personal samples for trace metals at select grinding operations. Although exposures to the various metals were below the OSHA-PEL's and the ACGIH-TLV's (Table 3), nickel was detected in five of the six personal samples at TWA concentrations ranging from 0.002 to 0.056 mg/M^3, with a mean of 0.021 mg/M^3. While these values are below the OSHA standard and ACGIH-TLV of 1 mg/M^3 for nickel metal, NIOSH has identified nickel as a suspect carcinogen and recommends reducing exposures to all inorganic nickel compounds to the lowest feasible level. While chromium and vanadium might be expected to exist in a reduced state when present in the metal forgings, the possible presence of the carcinogenic forms of hexavalent chromium or the pulmonary irritant vanadium pentoxide in the grinding emissions can not be completely ruled out based on the analytical method used in the sample analysis.

Crystalline silica was not found above the limits of quantitation (1.5% based on a two milligram sample) in either of the two bulk dust samples collected in the grinding area in Bay 16.

While no monitoring for organic solvents could be conducted during the NIOSH survey visit, records of previous environmental monitoring conducted by the company were reviewed. These records included three instances during which the use of solvents in dye penetrant inspection operations were monitored. TWA concentrations of 1,1,1-trichloroethane in eight personal samples ranged from below the limit of quantitation of 0.1 mg/sample to 160.3 mg/M^3, and detector tube sampling indicated peak exposures to be less than 544 mg/M^3. In all instances, concentrations of 1,1,1-tricholoethylene were maintained below the OSHA standard of 1900 mg/M^3 as an 8-hour TWA, and the NIOSH recommended standard of 1910 mg/M^3 as a 15 minute ceiling concentration.

VII. DISCUSSION AND CONCLUSIONS

A. Medical

Of the 45 grinders interviewed, there was no evidence of excess respiratory disease, e.g., chronic bronchitis, emphysema, or recurrent pneumonia. In addition, only two people reported chest tightness and no one reported wheezing or asthma.

A substantial number of employees did complain of irritant symptoms. These symptoms may have been attributable to brief instances of exposure to high concentrations of the grinding dust. Such situations could occur when a forging is not positioned properly for the grinding hood to effectively capture the particulate emissions being generated.

Interviews with medical personnel and/or employees, and a review of medical records produced no evidence of an elevated incidence of skin problems related to coolant exposures.

While the evaluation of noise exposure was not a component of this survey, employee complaints of hearing related problems may merit further investigation by the company of the adequacy of the current hearing conservation program in these areas.

B. Environmental

The information obtained during the environmental survey indicated that concentrations of total particulate were maintained below the evaluation criteria during the majority of the grinding operations monitored. The existing local exhaust ventilation appeared to effectively control total particulate exposures, with two exceptions. The first instance involved a sample collected during a grinding operation in Bay 16, Line 2; however, this result is not readily explainable in light of the lower values obtained in samples for other employees working in the same area on similar forgings. The second instance where the criteria was exceeded involved a sample which was collected in Building 13, during which a low alloy carbon steel part (CT293) was being ground. Due to the extremely large size of this forging, it extended beyond the effective range of the ventilation hood.

In general, the concentrations of the individual metals noted during this survey were found to be below their respective evaluation criteria. Nickel, however, was found above the limit of detection in some of the air samples collected. Based on the potential carcinogenicity of nickel compounds, NIOSH recommends reducing exposure to nickel to the lowest feasible level. Similar caution should be extended to work involving chromium and vanadium until sufficient data is collected to determine their exact form.

Based on the results of the bulk samples of grinding dust collected during the survey, crystalline silica exposure did not present a health hazard at the grinding operations.

A review of the environmental monitoring data supplied by the company indicated that for those situations monitored, exposures to 1,1,1-trichloroethane were maintained below the environmental criteria. However, since maintenance conditions can be variable, ongoing employee education regarding the proper use of solvents should be conducted. In addition, periodic monitoring should be continued with particular attention given to short-term (15-minute) exposures; especially when working in areas with poor or restricted ventilation.

Due to its infrequent use, exposure to lead during the pipe thread repair operation could not be evaluated during this survey. However, it is recommended that adequate attention be given to educating employees in safe work practices during these operations.

VIII. RECOMMENDATIONS

1. While local exhaust ventilation provides a means of controlling contaminants at their point of generation, its effectiveness depends on its proper use and maintenance. Continued attention should be given to instructing employees to properly position parts on the work table so that the dust generated is effectively captured by the grinding hood. Continued periodic measurements of the hood velocities should be made to ensure effective hood performance. The evaluations should include a determination of the maximum number of hoods which can be used on individual grinding lines while maintaining the hood velocities necessary for effective contaminant control. Dampers on ventilation hoods not in use should remain closed so that the efficiency of the remaining units is maximized. Any air moving fans used in the area should be positioned so as not to hinder the effectiveness of the local exhaust ventilation.

2. In situations where the grinding hood is not effective in controlling dust exposure (i.e., when grinding large workpieces) control could be achieved through the use of a movable hood, periodic repositioning of the part, or any other method which would help ensure that the grinding surface remains within the effective range of the local exhaust ventilation. In instances where engineering controls are not feasible, the use of a NIOSH/MSHA approved dust mask would help minimize exposures.

3. Since the majority of the particulate evolved during grinding is released from the workpiece, a consideration of the components of the base metal is particularly important in assessing the need for contaminant control in any grinding operation. While the hazards may be minor during the grinding of iron or steel, parts which contain the more highly toxic metals such as beryllium, chromium, cobalt, lead, nickel, and vanadium can present a greater potential hazard.[2] Work being performed on metals containing significant amounts of these materials should receive special attention to ensure that employee exposures are minimized through the proper use of engineering controls (i.e., local exhaust ventilation), work practices and personal protective equipment.

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH publications office at the Cincinnati, address. Copies of this report have been sent to the following:

A. Requestor
B. Ladish Company
C. U. S. Department of Labor, OSHA - Region V
D. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

Table 1
RESULTS OF PERSONAL AIR SAMPLES COLLECTED FOR TOTAL PARTICULATE
DURING GRINDING OPERATIONS
Ladish Company, Cudahy, Wisconsin - June 25 & 26, 1984

Sample Date	Sample Location	Sample Time (Minutes)	Sample Volume (Liters)	TWA Concentration for Sample Duration Total Particulate (mg/M^3)	8-Hour* TWA Concentration Total Particulate (mg/M^3)
6/25	Bay 16/ Line 2	401	602	8.4	7.0
6/25	Bay 16/ Line 2	399	598	2.6	2.2
6/25	Bay 16/ Line 2	399	598	15.2	12.6
6/25	Bay 16/ Line 1	399	598	4.0	3.3
6/25	Bay 16/ Line 1	399	598	2.6	2.2
6/25	Bay 16/ Line 4	394	591	3.2	2.6
6/25	Bay 16/ Line 3	394	591	1.5	1.2
6/25	Bldg. 13	410	615	2.5	2.1
6/25	Bldg. 13	419	628	16.9	14.8
6/25	Bldg. 13	415	622	1.4	1.2
6/26	Bay 16/ Line 2	386	579	3.2	2.6
6/26	Bay 16/ Line 2	379	568	1.3	1.0
6/26	Bay 16/ Line 2	387	580	8.4	6.8
6/26	Bay 16/ Line 4	387	580	0.9	0.7
6/26	Bay 16/ Line 1	387	580	1.6	1.3
6/26	Bay 16/ Line 1	385	578	3.8	3.0
6/26	Bay 16/ Line 3	379	568	0.5	0.4
6/26	Bldg. 13	386	579	1.2	1.0
6/26	Bldg. 13	385	578	6.8	5.5

Refer to Table 3 for a complete listing of the environmental criteria

Abbreviations and Key:
TWA - Time-weighted average concentration
mg/M^3 - Milligrams of contaminant per cubic meter of air
* - Assumes zero exposure for unsampled period of time.

Table 2
RESULTS OF PERSONAL AIR SAMPLES COLLECTED FOR TRACE METALS DURING GRINDING OPERATIONS
Ladish Company, Cudahy, Wisconsin; June 25 & 26, 1984

Sample Date	Location & Part Number(s)	Sample Time (Minutes)	Sample Volume (Liters)	TWA Concentrations in Milligrams Per Cubic Meter of Air						
				Titanium	Nickel	Chromium	Iron	Cobalt	Vanadium	Aluminum
6/25	Bay 16/ Line 2 GE378, PX299	401	602	0.502	0.005	0.007	0.093	< LOQ	0.002	0.107
6/25	Bay 16/ Line 4 PX367	396	594	0.221	0.002	< LOQ	0.048	< LOQ	0.015	0.044
6/25	Bay 16/ Line 3 UA025, PX533	392	588	0.040	0.051	0.019	0.070	0.012	< LOQ	0.012
6/26	Bay 16/ Line 4 B0049	392	588	0.464	< LOQ	< LOQ	0.204	< LOQ	0.093	0.068
6/26	Bay 16/ Line 1 UZ011, PW635	388	582	0.577	0.056	0.020	0.166	0.013	0.004	0.128
6/26	Bay 16/ Line 1 UZ011, PW635	384	576	0.384	0.012	0.004	0.161	0.003	0.012	0.077

Refer to Table 3 for a complete listing of the environmental criteria

KEY:
< LOQ - Less than the limit of quantitation of 1 microgram/sample
TWA - Time-weighted average

Table 3

Summary of Environmental Criteria

Substance	OSHA Standard	NIOSH Recommended Standard	ACGIH Recommended TLV
Aluminum	15mg/M^3	NA	10 mg/M^3
Chromium (metal)	1 mg/M^3 NA	NA	0.5 mg/M^3
Chromium (VI)	1 mg/M^3§	LFL(carcinogenic forms) 25 ug/M^3(others)	0.05 mg/M^3
Cobalt (metal)	0.1 mg/M^3	NA	0.05 mg/M^3
Crystalline Silica (Quartz) (respirable)	$\frac{10 \text{ mg/M3}}{\%SiO_2+2}$	0.05 mg/M^3	$\frac{10 \text{ mg/M3}}{\%\text{quartz}+2}$
Inorganic Lead	0.05 mg/M^3	$\leq$ 0.1 mg/M^3	0.15 mg/M^3
Iron Oxide (fume)	10 mg/M^3	NA	5 mg/M^3
Nickel (metal)	1 mg/M^3	LFL	1 mg/M^3
Nuisance Dust	15 mg/M^3	NA	10 mg/M^3
Oil Mist	5 mg/M^3	NA	5 mg/M^3
1,1,1-Trichloroethane	1900 mg/M^3	1910 mg/M^3	1900 mg/M^3 2450 mg/M^3
Titanium	15 mg/M^3	NA	10 mg/M^3
Vanadium (metallic or vanadium carbide)	NA	1 mg/M^3	1 mg/M^3
Vanadium (pentoxide)	0.5 mg/M^3§(dust) 0.1 mg/M^3§(fume)	0.05 mg/M^3§	0.05 mg/M^3

Abbreviations: mg/M^3 - milligrams of contaminant per cubic meter of air
NA - No applicable environmental standard or recommendation
LFL - Lowest feasible level

§ - Indicates a short-term or ceiling limit. These concentrations generally should not be exceeded during any 15 minute period. All other concentrations are expressed as 8 or 10-hour TWA's.

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