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NEW HAMPSHIRE BALL BEARING
LACONIA, NEW HAMPSHIRE

NIOSH

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I. SUMMARY

On May 30, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from management and employees for a Health Hazard Evaluation at New Hampshire Ball Bearing, Inc. in Laconia, New Hampshire. The request indicated that employees in the Teflon Room were experiencing adverse health effects, including headache, fever, and stomach upset, which seemed to coincide with a brief, unidentifiable odor in the area.

On May 31, 1991, an industrial hygienist conducted an initial site visit to gather background information and conduct a walkthrough of the Teflon Room. On July 10 and 11, 1991, environmental monitoring was conducted to characterize exposures in this area. Additional exposure monitoring and medical interviews were conducted on August 7 and 8, 1991. The industrial hygiene surveys consisted of personal breathing zone and area air sampling for formaldehyde, phenol, methylene dianiline, freon-113, dichloroethane, trichloroethane, ethanol, ethyl acetate, and other organic solvents, to characterize the exposures in the workplace.

Exposures to all chemicals sampled were below the applicable Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). However, NIOSH considers formaldehyde and dichloroethane to be potential human carcinogens and thus recommends that exposures be kept to the lowest feasible level.

Results of the bulk sample analyses indicated that Vydax (tetrafluorethylene telomer) is present throughout the Teflon Room. This finding is significant in that it could help explain some of the employees' symptoms. When this polymer is heated, it can cause polymer fume fever, a brief flu-like illness. It often occurs when workers smoke cigarettes that they have unintentionally contaminated with a polymer. All but one of the Teflon Department employees who reported these flu-like symptoms (fever, chills, aching, and sometimes nausea and vomiting) smoked cigarettes.

Other commonly reported symptoms among the Teflon Department employees included headache, lightheadedness and dizziness. Skin rashes were observed in ten workers. These rashes varied in appearance and location. Acute symptoms resulted in several hospital emergency room visits, but did not conclusively demonstrate any occupationally-associated illness.

Based on the results of this survey, NIOSH investigators have determined that a potential health hazard existed as a result of worker exposure to formaldehyde, dichloroethane and decomposition products of tetrafluoroethylene telomer. Symptoms of polymer fume fever (fever, chills, aching, and sometimes nausea and vomiting) were reported, and appeared to be related to smoking cigarettes that were contaminated with polymer. Recommendations are found in Section IX of this report to substitute less toxic materials where possible, and to prevent cross contamination of the Teflon Room with Vydax. Avoiding smoking, or careful storage of cigarettes and careful handwashing before touching the cigarettes or the pack, can prevent polymer fume fever.

KEYWORDS: SIC 3562 (Bearings), polymer fume fever, Vydax, Teflon, adhesives, lubrication, tetrafluoroethylene telomer.

II. INTRODUCTION

On May 30, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from management and employees for a Health Hazard Evaluation at New Hampshire Ball Bearing, Inc. in Laconia, New Hampshire. The request indicated that employees in the Teflon Room were experiencing adverse health effects including headache, fever, and sometimes stomach upset, which seemed to coincide with a brief, unidentifiable odor in the area.

On May 31, 1991, an industrial hygienist conducted an initial site visit to gather background information and conduct a walkthrough inspection of the Teflon Room. On July 10 and 11, 1991, environmental monitoring was conducted to characterize exposures in this area. Additional exposure monitoring and medical interviews were conducted on August 7 and 8, 1991.

III. BACKGROUND

New Hampshire Ball Bearing, Inc. employs approximately 490 workers in the manufacture of self-lubricating bearings, primarily for the aerospace industry. The majority of the workforce is employed in the machine shop. Approximately 40 employees work in the Teflon Department, where teflon cloth is adhered to the inside of bushings to provide lubrication of the bearings. Bearings range in size from under 1-inch in diameter, to over 1-foot in diameter. The plant operates 2 shifts: between 7 A.M. and Midnight, with staggering start and stop times. Many of the materials and chemicals used in this facility are specified in government contracts.

A. Cloth Room

Two employees perform cloth preparation in a room adjacent to the Teflon Room. Teflon fabric pieces, measuring 18 x 24 inches, are roll coated with adhesive and allowed to cure in a drying room. Curing times vary from 7-14 days. One side of the fabric is roll coated with adhesive and allowed to cure before the other side is coated and allowed to cure. Sometimes a third coat is required to meet certain specifications. The adhesives used contain various resins, including phenol-formaldehyde, methylene dianiline, and styrene-butadiene. Several solvents are also used in the cloth room, as carriers for the adhesive and to clean the roll coating machine. Ethanol, dichloroethane, trichloroethane and freon-113 were identified. The cloth room has a dedicated ventilation system that provides 10 air changes per hour. The air is exhausted directly to the outside. Employees are provided air supplied respirators, which are only used when applying certain adhesives. However, the air supply was not monitored to warn against carbon monoxide or oil mist contamination. Additionally, there was no respirator program to indicate proper use, storage, cleaning and limitations of these respirators, nor were employees medically cleared to wear respirators. Employees indicated that the air supplied

respirators are used because adhesive "NH" is bad. Employees could not identify the chemical composition, nor the potential adverse health effects associated with "NH". The raw materials inventory indicates that "NH" has the trade name FE 7119 and contains ethylene dichloride, ethyl alcohol, methyl ethyl ketone, and phenol. During this evaluation, the cloth room was using adhesive "AD", which contains a phenolic resin, free phenol, ethyl alcohol, and free formaldehyde.

A manual of material safety data sheets for all of the adhesives is located in the cloth room but many of them do not list the chemical names of the adhesive components. There is also some confusion as a result of the trade name given by the supplier being different from the common name used by this company. There is no cross reference to identify the chemicals.

B. Oven Room

Prior to entering the Teflon Room for assembly, bushings are prepared in the Oven Room. Usually one employee works in this room. Bushings are sprayed with a lubricant and put in ovens for drying. Two types of lubricant are used: Vydax and Freekote. Vydax is a tetrafluoroethylene telomer suspended in freon-113. Freekote is a similar material suspended in trichloroethylene. Both materials leave a lubricating film on the bushing after the solvent is driven off.

C. Teflon Room

Cut strips of teflon cloth, already impregnated with adhesive, are glued to the inside diameter of the bushings. Twelve employees perform this operation in laboratory hoods. The types of hoods used in the Teflon Room are called "add air" hoods. This means that in addition to drawing air from the room, a blower is also forcing air through small slots located along the sides, top and bottom of the hood. This blower intake draws air from the machine shop. The hoods exhaust directly to the outside. The Teflon Room is maintained at a constant relative humidity between 20 and 40 percent. All air entering the room is preconditioned utilizing a 2-stage desiccant dehumidification process. Air is cooled first, and then heated for environmental control.

Just prior to this evaluation, gas heaters were replaced with electric heaters in the Teflon Room. Also, charcoal filters were installed before and after the air conditioning process. Since this modification, it was reported by management that odor complaints have decreased significantly. However, thermal comfort complaints seem to have increased, though the room temperature is maintained close to 70 degrees Fahrenheit. Perception of temperature is also affected by the amount of air movement in the work space. The teflon room is maintained under positive pressure with respect to the rest of the building, and there is considerable air movement.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

The industrial hygiene survey consisted of personal breathing zone and area air sampling for formaldehyde, phenol, methylene dianiline, freon-113, dichloroethylene, trichloroethane, ethanol, ethyl acetate, and other organic solvents,

to characterize the exposures in the workplace. Selected samples were analyzed by gas chromatography/mass spectrometry to identify which of the organic chemicals were present. All samples were collected using battery operated pumps, calibrated to the desired flow rate and attached to the desired sampling media.

1. Formaldehyde

Formaldehyde was collected in two sodium bisulfite-filled (20 ml) impingers in series and analyzed by visible spectroscopy according to NIOSH Method 3500.[1]

2. Phenol

Phenol was collected on XAD-7 sampling media and analyzed according to a recently developed NIOSH sampling and analytical method. Each XAD-7 sample tube was desorbed ultrasonically in 2 ml of methanol for 1 hour. Both front and back sections were desorbed separately. Sample analysis was achieved by GC/FID using an HP5890 GC. A Stabilwax-DA fused silica capillary column (NUKOL equivalent) was used for the analysis. Separation was achieved with a temperature program running from 180^{o} to 235^{o} @ 4^{o}C/min. All analyses were performed using 1 ul splitless injections.

3. Methylene dianiline

Methylene dianiline was collected using acid treated filters, and analyzed according to OSHA Method #57.[2]

4. Organic Solvents

Freon-113, ethanol, trichloroethane, dichloroethane, and ethyl acetate were collected on activated charcoal media and analyzed by gas chromatography according to a combination of NIOSH Methods S49, 1003, 1300, 1400 and 1500.[1,2] These organic compounds were first identified by GC/MS.

Bulk samples of Vydax and surface dust were collected to determine if tetraflouroethylene telomer was dispersed throughout the work area. The Vydax sample was evaporated to dryness and heated in a tube furnace. A sample of the headspace air was injected into the gas chromatograph. The surface dust sample was also analyzed via the tube furnace. Chromatograms were compared to determine if cross contamination was taking place.

B. Medical

NIOSH medical investigators conducted confidential medical interviews with all thirty-nine employees of the Teflon Department, except for one employee who was on vacation. Records of work-related injuries and illnesses, and material safety data sheets for chemicals used in the Teflon area were reviewed.

V. EVALUATION 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 of workers may experience adverse health effects because of individual susceptibility, a pre-existing medical condition and/or by 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 considered for this study were: 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 (OSHA) federal occupational health standards. The OSHA standards 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 by the Occupational Safety and Health Act of 1970 to meet only 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 8-10 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.

A. Formaldehyde

The largest industrial use of formaldehyde today is in the manufacture of resins for plastic and synthetic fabric manufacturing processes. These resins are used to treat textiles to impart permanent-crease and permanent-press properties to garments. Finished fabrics purchased to produce garments, as well as the new garments themselves, contain some residual free formaldehyde which can cause skin irritation upon contact, as well as evaporate into the air in vapor form.

Irritation of the eyes, nose, mouth, and throat are the most common health effects from inhalation of formaldehyde gas. Formaldehyde has a very pungent, offensive odor that is noticeable even in very small concentrations, producing burning and tearing of the eyes. Eye and respiratory tract irritation have been reported in workers exposed to concentrations of less than 1 ppm.[3] Higher concentrations usually bring difficulty in breathing; intense burning of the eyes, nose and throat; profuse tearing; and severe coughing. Prolonged exposure to high concentrations may cause headache, heart palpitations, and serious inflammation of the bronchial tubes and lungs. In extreme cases, death may result due to swelling or spasm of the vocal cords. Asthmatic symptoms, such as wheezing, may occur, even at very low concentrations, in persons with an allergic sensitivity to formaldehyde.

Workers repeatedly exposed to low concentrations of formaldehyde during normal work periods seem to develop a physical tolerance to formaldehyde and can work in concentrations that are intolerable to many outsiders. Because of the physical tolerance that can develop, odor or irritation may not provide adequate warning to avoid exposure. Chronic symptoms that are associated with repeated exposure are itching eyes, dry and sore throat, disturbed sleep, and unusual thirst upon awakening.

Dermatitis may result from formaldehyde contact with the skin. Formaldehyde acts on the skin cells both as an irritant and as a tanning agent. The dermatitis usually appears first as a reddening of the skin, and then small blisters may form similar to those caused by poison ivy. Formaldehyde may also make the fingernails soft and brownish. Skin irritation seldom results from exposure to formaldehyde gas in the air, but individuals who have developed an allergic sensitivity show dermatitis symptoms from exposure to concentrations easily tolerated by nonallergic persons.

Formaldehyde vapor has been found to cause a rare form of nasal cancer in rats by two different research institutions.[4] These results have prompted

NIOSH to recommend that formaldehyde be handled as a potential occupational carcinogen.

B. 1,1,1-Trichloroethane

1,1,1-Trichloroethane is irritating to the eyes on contact. Exposure to the vapors depresses the central nervous system. Symptoms include dizziness, incoordination, drowsiness, and increased reaction time. Unconsciousness and death can occur from exposure to excessive concentrations.[5] The OSHA PEL and the ACGIH TLV are both 350 ppm. NIOSH recommends a 350 ppm ceiling.

C. Ethyl Acetate

Ethyl acetate vapor is irritating to the eyes and respiratory passages at concentrations above 400 ppm - both the PEL and TLV value. In animals it has a narcotic effect at concentrations of over 5000 ppm. Due to its irritating properties, employees will not voluntarily remain in such high concentrations. Animals exposed to lethal concentrations died with pulmonary edema and hemorrhage. This substance is a defatting agent, and prolonged skin contact with the liquid may cause irritation of the skin. Painful conjunctival irritation may occur from splashes in the eye. No chronic systemic effects have been reported in humans. Most reported effects of ethyl acetate are caused by its irritant properties.[6] The ACGIH TLV was established to prevent systemic effects, but concentrations at this level may be mildly irritating for some workers unaccustomed to the exposure. The current OSHA permissible exposure limit is 400 ppm.[7]

D. Ethyl Alcohol (ethanol)

Ethyl alcohol irritates the eyes and mucous membranes of the upper respiratory tract and causes central nervous system depression. Exposure to 5000 to 10,000 ppm has caused transient eye and nose irritation and coughing. Human subjects exposed to 15,000 ppm experienced continuous eye watering and cough. At concentrations above 20,000 ppm the effect was described as intolerable and suffocating for even brief exposure. Long-term exposure to the vapor may result in mucous membrane irritation, headache, lack of concentration and drowsiness. Ethanol vapor concentrations typically found in industry are not likely to cause systemic effects such as central nervous system depression. The TLV of 1000 ppm was set at a level to prevent eye and upper respiratory irritation .[8] The current OSHA PEL is also 1000 ppm.

E. 1,2-Dichloroethane (ethylene dichloride)

Ethylene dichloride may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact. Short-term (acute) exposure to ethylene dichloride can cause headache, weakness, pain or irritation of the eyes and skin, bluish discoloration of skin and mucous membranes (cyanosis), nausea, vomiting, mental confusion, dizziness, incoordination, and unconsciousness.[9]

Long-term (chronic) exposure to ethylene dichloride can cause headache, fatigue, irritability, nervousness, cough, weakness, diarrhea, and muscle

tremor. Severe irritation of the skin, edema, and tissue destruction (necrosis) can also occur.[9]

Acute inhalation exposure to ethylene dichloride has caused respiratory tract irritation, congestion, edema and pneumonia, impaired functioning of the liver and kidneys, and myocardial hemorrhage. Chronic exposure has produced enlargement and fatty degeneration of the liver, impaired liver and kidney function, depression of nerve conduction, anemia. Ethylene dichloride has also been detected in the milk of exposed lactating mothers.[9]

In animal studies, chronic inhalation or ingestion of ethylene dichloride by rats caused pulmonary tissue irritation, congestion, edema and pneumonia, degeneration of liver and kidney tissue, adrenal gland hemorrhage and cell damage, fatty infiltration and hemorrhage of cardiac tissue, and death due to respiratory or cardiac arrest. Cancers of the stomach, circulatory system, mammary glands, uterus, lungs and skin were produced in similarly exposed rats and mice.[9]

The current OSHA PEL (effective until December 31, 1992) for ethylene dichloride is 50 ppm as an 8-hour time-weighted average concentration. OSHA also requires that no 15-minute ceiling concentration exceed 100 ppm, and no 5-minute peak concentration exceed 200 ppm. As of January 1, 1993, the OSHA PEL will be 1 ppm, with a 15-minute, short term exposure limit of 2 ppm. NIOSH recommends that ethylene dichloride be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit is 1 ppm, with a ceiling concentration of 2 ppm. The ACGIH TLV is 5 ppm.

F. Methylene dianiline

Methylene dianiline (MDA) can cause adverse health effects if inhaled or absorbed through the skin. Human studies have described the occurrence of jaundice, bile duct inflammation, suppression of bile excretion, and clinical hepatitis. Dermal exposure can cause allergic contact dermatitis, acute myocardial damage, jaundice, photosensitivity, hepatitis, and yellow staining of the skin. Animal studies indicate a potential for carcinogenicity from exposure to MDA. The liver, thyroid, adrenal glands, and lymphatic system are the primary sites identified with carcinogenic or tumorigenic responses. Tumors of the bile duct and urinary bladder have also been reported. Epidemiologic evidence suggests an association between MDA and bladder cancer, colon cancer, lymphosarcoma, and reticulosarcoma in workers with exposure to MDA and other chemical agents. Skin contact is considered the major route of occupational exposure.[11]

OSHA has not established a PEL for MDA. The ACGIH TLV for MDA is 0.1 ppm. ACGIH has also designated MDA as a potential human carcinogen. NIOSH considers MDA to be a potential human carcinogen in the workplace and recommends that exposure be reduced to the lowest feasible limit.

G. Freon 113

Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane) can effect the body if inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it

is swallowed. Effects of short-term exposure include irritation of the eyes and throat, and drowsiness. Breathing high concentrations may cause the heart to beat irregularly or to stop. Prolonged or repeated contact with the skin may cause skin irritation.[9]

The current OSHA PEL for freon 113 is 1000 ppm. The ACGIH TLV is also set at 1000 ppm. NIOSH has not issued a recommendation regarding this chemical.

VI. RESULTS

Environmental

Qualitative analysis of two charcoal tube samples provided the basis for quantification of subsequent samples. GC/MS analysis identified the major organic contaminants of the workroom air to be ethanol, ethyl acetate, 1,2-dichloroethane, 1,1,1-trichloroethane, phenol and various C7-C12 alkanes. Other peaks identified, but in relatively lower concentrations included p-dioxane, methyl isobutyl ketone, toluene, butyl cellosolve, xylene and n-decane.

The results from the personal breathing zone and area air sampling are shown in Tables 1 through 7. Exposure to all chemicals sampled were below the applicable OSHA PELs. However, NIOSH considers formaldehyde, methylene dianiline and ethylene dichloride to be potential human carcinogens, and does not recommend exposure limits for these chemicals. Rather, NIOSH recommends that exposure to potential carcinogens be kept to the lowest feasible level.

Although methylene dianiline was not detected in any of the air samples, observation of the work practices indicated that skin contact with this and other chemicals is significant. Although cotton gloves and finger cots are worn by some of the employees in the Teflon Room, these are not considered sufficient protection. In fact, they can act as a wick and keep the chemicals in contact with the skin for prolonged periods.

The results of the bulk sample analyses indicated that Vydax (tetrafluorethylene telomer) is present throughout the teflon room on commonly contacted surfaces. This finding is significant in that it could help explain some of the employees symptoms. Hands can become contaminated with Vydax and without stringent personal hygiene measures can contaminate cigarettes, leading to "polymer fume fever."

Medical

Many of the employees in the Teflon Area reported irritant symptoms of the eyes, nose, and throat, that occurred during work and resolved away from work. Eye inflammation (redness and hordeolum [or sty]) was observed in two workers. There were four reports of hoarseness and loss of voice.

Thirteen of the thirty-nine (33%) interviewees reported similar gastrointestinal symptoms, including epigastric pain and bloating. Four of these employees had been diagnosed as having gastrointestinal ulcers since beginning work at this plant.

Six employees reported flu-like symptoms (fever, chills, aching, and sometimes vomiting) that continued into the evening, but resolved by the next morning. Four of

these employees recalled working with Vydax on the day that these symptoms occurred. Vydax is the trade name of a chemical compound used in the Teflon Department. This chemical compound contains a freon (trichlorotrifluoroethane) and a polymer (tetrafluoroethylene telomer). When workers smoke cigarettes that they have unintentionally contaminated with a polymer, the polymer becomes heated and decomposition products are formed. Inhaling the resulting fume can cause polymer fume fever. All but one of the Teflon Department employees who reported these flu-like symptoms smoked cigarettes. Avoiding smoking, or careful storage of cigarettes and careful handwashing before touching the cigarettes or the pack can prevent polymer fume fever.

Other commonly reported symptoms among the Teflon Department employees included headache, lightheadedness and dizziness. Skin rashes were observed in ten workers. These rashes varied in appearance and location. Acute symptoms (difficulty breathing, dizziness, lightheadedness, nausea, throat irritation, and difficulty swallowing) resulted in several hospital emergency room visits. These symptoms were the result of different illnesses and did not suggest a continuing occupational health problem.

VII. DISCUSSION

Although the individual chemical levels measured in the work environment during this evaluation were relatively low when compared to established standards, there is a potential for inadvertent exposure to these chemicals by insufficiently trained employees. There is a perception among the workforce that every chemical is "bad for you", and if one can smell an odor, then one can expect an adverse health effect. The odor threshold for the vast majority of chemicals in use at this facility is many times below the concentration known to produce any health effect. However, there are several potential occupational carcinogens in use (formaldehyde, dichloromethane, methylene dianiline), and the employees do not know which chemicals they are. This situation has led to a very anxious and apprehensive workforce.

The OSHA Hazard Communication Standard was promulgated for this very reason. A properly trained workforce would be provided with a healthy respect for the chemicals used in the processes. At this facility there appears to be an unhealthy disrespect for all chemicals. The intent of the OSHA standard is to train employees as to the hazards of chemicals and the measures employed by the company to protect workers from harmful exposures. It is more than simply identifying the location of Material Safety Data Sheets.

This facility employs some of the most state-of-the-art engineering controls, and yet the employees are not aware of their function. The fume hoods in the Teflon Room are useless if employees conduct their work outside of the hood. The air supplied respirators in the cloth room are capable of protecting employees against exposure to chemicals, but at the same time they could cause a significant exposure because they are not properly maintained and serviced.

VIII. CONCLUSIONS

Based on the results of this investigation NIOSH researchers determined that a potential health hazard existed due to employee exposure to formaldehyde, ethylene dichloride, and decomposition products of tetrafluoroethylene telomer. Polymer fume fever symptoms appeared to be directly related to contamination of cigarettes

with Vydax. Irritant symptoms were likely due to workplace exposures. Methylene dianiline may also present a skin absorption hazard in the Teflon Room. Due to the absence of an effective hazard communication program, there exists the potential for employee exposure to a wide variety of chemicals, some of which are considered by NIOSH to be occupational carcinogens.

IX. RECOMMENDATIONS

Although it is recognized that many of the chemicals in use at this facility are mandated by government specification, the following recommendations are made.

1. Substitute adhesives should be investigated to eliminate the potential for exposure to formaldehyde and dichloroethylene. NIOSH considers both to be potential human carcinogens, and exposure should be minimized to the extent feasible.

2. A Hazard Communication program must be implemented that specifically addresses each chemical to which employees are potentially exposed. The program should be easy to understand so that every employee knows what he or she is working with, no matter what name is given to the substance. A general program, which identifies hazards according to a system of numbers and/or colors, is not appropriate at this facility. Employee training must be specific to the chemicals that employees work with.

3. A respirator program, consistent with the OSHA standard (1910.132), must be implemented. A written program must be developed and employees must be trained accordingly. Consistent with the OSHA requirement, only those employees determined to be medically qualified, should have job assignments that involve respirators.

4. The air supply to the respirators in the Cloth Room must be equipped with high temperature and carbon monoxide warning systems. Since carbon monoxide is odorless, a monitoring system is needed to alert the user of any problems.

5. Selection and use of appropriate personal protective equipment must be improved. Gloves made of the appropriate material to protect against exposure to specific chemicals in use need to be selected and provided.

X. REFERENCES

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies have been sent to:

1. Mr. Dan Petrini, Safety Officer, NHBB
2. United Steelworkers of America
3. OSHA, Region 1
4. Confidential requestor

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
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
July 10-11, 1991
August 7, 1991

PHENOL

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Drying Rm	AREA	7/10	2	340	36.0	0.26
Cloth Rm	AREA	7/10	2	340	37.4	N.D.*
Cloth Rm	PERS	7/11	1	450	47.7	0.42
Teflon Rm Cab	AREA	7/11	1	450	49.5	N.D.
Dipping	PERS	8/7	1	107	5.8	0.18
Dipping	PERS	8/7	1	163	8.9	0.12
Dipping	AREA	8/7	1	178	8.7	0.12
CRITERIA	**OSHA**					**5.0**
CRITERIA	**ACGIH**					**5.0**
CRITERIA	**NIOSH**					**5.0**

* N.D.= None Detected

TABLE 2
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
July 10-11, 1991

FORMALDEHYDE

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Drying Rm	AREA	7/10	2	340	207.0	0.08
Cloth Rm	AREA	7/10	2	340	245.0	0.03*
Teflon Rm Cab	AREA	7/11	1	450	274.0	N.D.
CRITERIA	**OSHA**					**1.0**
CRITERIA	**ACGIH**					**1.0**
CRITERIA	**NIOSH**					**0.02**

*Approximate value due to interference

TABLE 3
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
July 10-11, 1991
August 7, 1991

ETHANOL

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Cloth Rm	AREA	7/10	2	340	33.2	11.3
Teflon Rm	AREA	7/10	2	340	10.5	1.2
Teflon Rm	AREA	7/10	2	340	17.7	1.6
Teflon Booth 9	AREA	7/11	1	450	23.4	1.1
Teflon Rm	AREA	7/11	1	450	21.6	0.8
Teflon Booth 8	AREA	7/11	1	450	22.0	2.6
Teflon Booth 4	AREA	7/11	1	450	24.3	2.8
Oven Room	AREA	8/7	1	40	1.92	0.3
Vydax Hood	PERS	8/7	1	10	1.0	0.5
Dipping	PERS	8/7	1	105	11.3	7.8
Vydax Ovens	AREA	8/7	1	190	7.3	0.1
Dipping	PERS	8/7	1	166	17.9	3.6
Freekote	AREA	8/7	1	35	3.8	0.7
Vydax	PERS	8/7	1	10	1.0	0.5
CRITERIA	**OSHA**					**1000**
CRITERIA	**ACGIH**					**1000**

TABLE 4
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
July 10-11, 1991

ETHYL ACETATE

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Cloth Rm	AREA	7/10	2	340	33.2	0.3
Teflon Rm	AREA	7/10	2	340	10.5	0.1
Teflon Rm	AREA	7/10	2	340	17.7	0.1
Teflon Booth 9	AREA	7/11	1	450	23.4	0.1
Teflon Rm	AREA	7/11	1	450	21.6	0.1
Teflon Booth 8	AREA	7/11	1	450	22.0	0.1
Teflon Booth 4	AREA	7/11	1	450	24.3	0.2
CRITERIA	**OSHA**					**400**
CRITERIA	**ACGIH**					**400**

TABLE 5
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
August 7, 1991

1,2,-DICHLOROETHANE

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Oven Room	AREA	8/7	1	40	1.92	0.1
Vydax Hood	PERS	8/7	1	10	1.0	0.3
Dipping	PERS	8/7	1	105	11.3	0.1
Vydax Ovens	AREA	8/7	1	190	7.3	0.1
Dipping	PERS	8/7	1	166	17.9	0.1
Freekote	AREA	8/7	1	35	3.8	1.3
Vydax	PERS	8/7	1	10	1.0	0.3
CRITERIA	**OSHA**					**1.0**
CRITERIA	**ACGIH**					**5.0**
CRITERIA	**NIOSH**					**LFL***

LFL = Lowest Feasible Level

TABLE 6
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
July 10-11, 1991
August 7, 1991

1,1,1-TRICHLOROETHANE

LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Cloth Rm	AREA	7/10	2	340	33.2	0.5
Teflon Rm	AREA	7/10	2	340	10.5	0.6
Teflon Rm	AREA	7/10	2	340	17.7	0.4
Teflon Booth 9	AREA	7/11	1	450	23.4	2.5
Teflon Rm	AREA	7/11	1	450	21.6	2.5
Teflon Booth 8	AREA	7/11	1	450	22.0	3.2
Teflon Booth 4	AREA	7/11	1	450	24.3	2.9
Oven Room	AREA	8/7	1	40	1.92	6.2
Vydax Hood	PERS	8/7	1	10	1.0	38.0
Dipping	PERS	8/7	1	105	11.3	2.2
Vydax Ovens	AREA	8/7	1	190	7.3	3.0
Dipping	PERS	8/7	1	166	17.9	3.6
Freekote	AREA	8/7	1	35	3.8	3.6
Vydax	PERS	8/7	1	10	1.0	14.9
CRITERIA	**OSHA**					**350**
CRITERIA	**ACGIH**					**350**
CRITERIA	**NIOSH**					**350 C**

TABLE 7
New Hampshire Ball Bearings, Inc.
Laconia, New Hampshire
August 7, 1991

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LOCATION	TYPE	DATE	SHFT	TIME (MIN)	VOL. (LITER)	CONC. (PPM)
Oven Room	AREA	8/7	1	40	1.92	1.0
Vydax Hood	PERS	8/7	1	10	1.0	6.5
Dipping	PERS	8/7	1	105	11.3	0.1
Vydax Ovens	AREA	8/7	1	190	7.3	0.1
Dipping	PERS	8/7	1	166	17.9	0.1
Freekote	AREA	8/7	1	35	3.8	0.1
Vydax	PERS	8/7	1	10	1.0	0.4
CRITERIA	**OSHA**					**1000**
CRITERIA	**ACGIH**					**1000**
CRITERIA	**NIOSH**					**N/A***

N/A = NOT APPLICABLE