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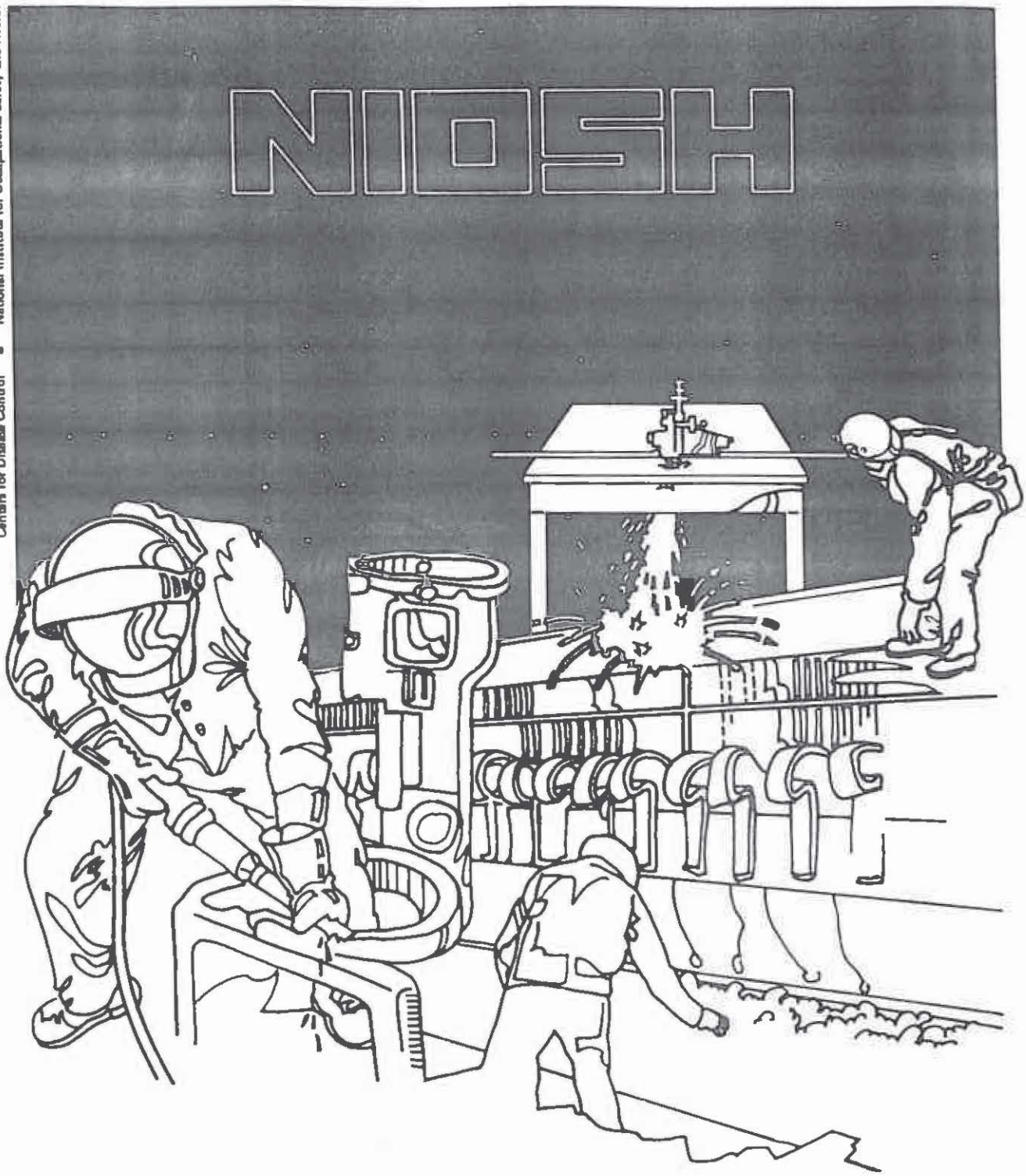

Health Hazard Evaluation Report

HETA 81-212-1169
N.P.C. SYSTEMS, INC.
MILFORD, NEW HAMPSHIRE

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.

HETA 81-212-1169
August 1982
N.P.C. Systems, Inc.
Milford, New Hampshire

NIOSH INVESTIGATOR
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I. SUMMARY

On March 2, 1981, the National Institute for Occupational Safety and Health received a request for a Health Hazard Evaluation at N.P.C. Systems, Inc., Milford, New Hampshire. The request stated that employee exposure to copper, tungsten, and zinc may have led to one case of heavy metal poisoning.

On January 6, 1982, a NIOSH industrial hygienist conducted a walkthrough survey of the plant. The operation evaluated during this investigation involved the manufacture of diamond impregnated segments for the core drills.

On January 29, 1982, environmental sampling was conducted for copper, nickel, tungsten, cobalt, cadmium and zinc. Two personal and three area samples were collected in the diamond room, at the furnace, and at the silver brazing operation.

Environmental sampling results for all materials sampled were well below established criteria on the day of the survey. Ni, Cd, Cu, and Co were below the limit of detection on the personal sample. Personal exposure to zinc was measured as 2.5 ug/m^3. Personal exposure to cadmium was measured as 20.8 ug/m^3. Area samples ranged from below the limit of detection for nickel and cobalt, to 2.5 ug/m^3 copper, 29.2 ug/m^3 cadmium and 31.25 ug/m^3 zinc.

Based on the results of the environmental evaluation, NIOSH determined that current employee exposure to cadmium, copper, cobalt, nickel, tungsten and zinc did not present a health hazard.

Keywords: SIC 3545, Copper, Cadmium, Nickel, Tungsten, Cobalt, Zinc, Cemented Tungsten-Carbide.

II. INTRODUCTION/STATEMENT OF REQUEST

On March 2, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from an employee of N.P.C. Systems, Inc., Milford, New Hampshire. The request stated that one employee was suffering from peripheral neuropathy/encephelomyelopathy, possibly related to heavy metal exposure in the diamond bit department at the plant. Chemicals mentioned as being present include; tungsten, tungsten carbide, nickel-silver, and trichloroethylene.

On September 29 and 30, 1981, NIOSH met privately with the employee and obtained an occupational history. Work process information was gathered as was a list of all raw materials used.

On January 6, 1982, a NIOSH industrial hygienist conducted a walkthrough survey of the plant. Additional process information was obtained and a sampling strategy was outlined for the employer.

On January 29, 1982, environmental sampling was conducted. Personal and area samples were collected in the diamond room, at the furnace, and at the silver brazing operation.

An Interim Report was released on January 18, 1982.

III. BACKGROUND

N.P.C. Systems manufactures core drills and gaskets for use in the cement pipe industry. The primary user of the "system" is the sewage treatment industry.

The operation involves the manufacture of diamond impregnated segments for the core drills. This operation involves an infiltration process in which diamond, tungsten, and tungsten carbide-cobalt powders are packed into graphite molds. Then a copper, zinc, nickel alloy is melted on top of the mold and infiltrates the packed powders. Upon cooling, a diamond impregnated composite body results which is used as a bit segment for concrete core drills. These segments are then silver brazed onto a steel drum, which results in a core drill. The core drills range in size from around one foot to four feet in diameter.

The particle size of the tungsten powder was reported by the manufacturer to be in the 4-16 micron range.

The silver solder is listed as containing cadmium. The nickel-silver alloy has a composition of approx. 50% copper, 40% zinc, and 10% nickel.

The weighing and mold loading process is conducted in an air conditioned 8'x11'x9' room. There is a fan located in the wall near the ceiling, which exhausts into the shop.

The furnace is equipped with a hood and ductwork leading to the roof. There is no exhaust fan attached to this system, but rather it relies on convection currents to carry the furnace exhaust out of the building. There was a white precipitate observed on the inside surface of the hood.

The silver soldering operation is presently equipped with local exhaust ventilation. However NIOSH was told by employees that this has not always been the case. This process utilizes a fluoride flux, that is applied to each segment prior to heating.

Environmental sampling, indicative of employee exposure levels, has never been conducted at this facility. The only attempt to quantitate potential exposure levels was set forth in a letter dated March 6, 1981, from a private consultant, who made some theoretical calculations based on first-hand knowledge of the operation aquired while consulting to N.P.C. Systems as a metallurgist. The potential exposure levels arrived at by the consultant, for the furnace operation, were reported as:

Copper.....2230 micrograms per cubic meter
Nickel.....173 micrograms per cubic meter
Zinc.....100 to 1000 times that of copper.

It must be noted that NIOSH does not accept these levels as exposure levels, but rather the potential concentrations generated at the source. These figures do, however, indicate the need for personal exposure monitoring.

IV. EVALUATION DESIGN AND METHODS

The purpose of this environmental evaluation was to determine the extent of current employee exposure to heavy metals as described in the request. Trichloroethylene exposure could not be evaluated since this material had been replaced with mineral oil prior to this investigation.

One high volume air samples was collected in the vicinity of the furnace using a General Electric 1/2 hp pump at a flow rate of 6 liters per minute. Total sampling time was 4 hours. Personal air samples were collected on the furnace operator and the silver solderer using MSA model G pumps at a flow rate of 2 lpm for 4 hours. An area sample was collected at the silver soldering operation, in the diamond room and at the furnace. All air samples were collected on AA filters. Wipe samples using Whatman filter paper were taken from the floor and machinery near the furnace, and inside the fume hood. The total area of the wipe samples was around 5 cm^2.

One area air sample and one wipe sample were analyzed for tungsten following NIOSH Method No. P&CAM 271.[23] Three air samples and three wipe samples were analyzed for zinc, nickel, copper, and cobalt following NIOSH Method No. P&CAM 173.[24] The two silver soldering air samples were analyzed for cadmium using NIOSH Method S-312.[22]

NIOSH conducted personal interviews with employees to ascertain prior working conditions and practices.

V. EVALUATION CRITERIA

Nickel:

NIOSH[2] has recommended an exposure standard of 15 micrograms of nickel per cubic meter of air (15 ug/m^3), expressed as time weighted average over an 8-10 hour workday. The recommended standard is based on the conclusion that inorganic nickel substances are carcinogenic. This standard will substantially reduce the risk of developing nickel-related cancers and minimize the risk of developing dermatitis.

Nickel has also been reported to cause sensitization in some individuals. Symptoms include: asthma, shortness of breath, tightness of the chest, wheezing, and a non-productive cough.

The current OSHA standard for employee exposure to nickel is 100 ug/m^3.

Tungsten:

Almost all reports of human exposure to tungsten and its compounds deal with the effects observed after exposure to mixtures of dusts encountered in the hard metal (cemented tungsten carbide) industry. The components of the hard metal include: tungsten carbide, cobalt, and sometimes tantalum, titanium, niobum, chromium, nickel, iron, or derivatives of these metals. Only two studies have been found which deal exclusively with tungsten without concurrent exposure to other toxic metals.[3] Thus NIOSH recommends that occupational exposure to dust of cemented tungsten carbide which contains more than 2% cobalt, be controlled via the federal cobalt standard, and dusts of cemented tungsten carbide which contains more than 0.3% nickel be controlled via the NIOSH recommended criteria for nickel.[3]

NIOSH also asserts that tungsten itself is more toxic than nuisance dust because of reported effects on the respiratory system, and recommends that exposure be controlled so that employees are not exposed to insoluble tungsten at a concentration greater than 5 mg/m^3, or soluble tungsten at a concentration of 1 mg/m^3, expressed as a time weighted average for up to a 10 hour workday, 40 hour work week.

Cobalt:

Cobalt metal fume and dust cause irritation of the nose and throat. They have also been reported to cause respiratory disease with symptoms ranging from cough and shortness of breath, to permanent disability and death. The symptoms frequently go away when exposure is stopped, but sometimes the symptoms progress after exposure has ceased. Exposure to cobalt may cause an allergic skin reaction[7].

Almost all reported cases of respiratory effects in workers concerned mixed exposures in the cemented tungsten carbide industry. Numerous case reports[6] demonstrate the presence of "hard metal disease" in the occupational environment, some in tool grinding operations.

A common pattern of the illness is described in these reports as: a worker develops a cough, followed by labored breathing on exertion. The person may experience weight loss, and develop interstitial pulmonary fibrosis; in the final stages leading to death.

Bronchitis, asthma, and allergic sensitization have also been reported as a result of exposure to cobalt. Two studies[20,21] suggest that hard metal workers can develop fibrosis or prefibrotic changes when exposure to cobalt is in the range of 0.1-0.2 mg/m^3. These studies suggest that the effects are reversible upon cessation of exposure.

Other studies[6] suggest possible chronic lung obstruction at average concentrations of 0.06 mg/m^3.

NIOSH has not recommended an exposure standard for cobalt at this time. The current OSHA standard for cobalt metal fume and dust is 0.1 milligram of cobalt per cubic meter of air averaged over an eight hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for cobalt metal fume and dust a Threshold Limit Value of 0.05 mg/m^3.

Cadmium:

Cadmium is an irritant to the respiratory tract. Prolonged exposure can cause anosmia (loss of sense of smell) and a yellow stain that gradually appears on the necks of the teeth. Cadmium compounds are poorly absorbed by the intestinal tract, but relatively well absorbed by inhalation. Skin absorption appears negligible. Once absorbed, cadmium has a very long half-life and is retained in the kidney and liver.[1]

Systemic effects have been reported as a result of cadmium exposure at concentrations which did not provide warning symptoms of irritation. If enough is inhaled, after a delay of several hours, a person may develop cough, shortness of breath (emphysema), chest pain, sweating, chills, headache, muscle aches, weakness, and nausea. Exposure to cadmium has also been reported to cause kidney damage and an increased incidence of prostate cancer in man.[7,17]

In animal studies, cadmium has produced damage to the liver and central nervous system, testicular atrophy, testicular neoplasms, hypertension, and teratogenic effects. None of these conditions have yet been reported resulting from occupational exposure to cadmium.

The OSHA standard for cadmium fume is 0.1 mg/m^3 as an 8 hour TWA with an acceptable 15 minute ceiling of 0.3 mg/m^3. NIOSH[4] has recommended a TWA limit of 40 ug/m^3 with a ceiling limit of 200 ug/m^3 in a 5 minute sampling period. The ACGIH recommends a TLV of 50 ug/m^3.

Zinc:

Zinc oxide fume causes a flu-like illness called metal fume fever. Symptoms of metal fume fever include headache, fever, chills, muscle aches, nausea, vomiting, weakness and tiredness. The symptoms usually start several hours after exposure. The attack may last 6 to 24 hours. Metal fume fever is most likely to occur after a period away from the job (after weekends or vacations). High levels of exposure may cause a metallic or sweet taste in the mouth, dryness and irritation of the throat, and coughing at the time of exposure. Recovery is usually complete.[7,18]

Chills have been reported in workers from exposures to concentrations of zinc oxide fume below 5 mg/m^3.

The current OSHA standard for zinc oxide fume is 5 mg/m^3 averaged over an 8 hour work shift. NIOSH has recommended that the permissible exposure limit be changed to 5 mg/m^3 averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 15 mg/m^3 averaged over a 15 minute period. The ACGIH recommends a TLV of 5 mg/m^3 TWA, and 10 mg/m^3 ceiling.

Copper:

Most reports of copper toxicity have consisted of gastrointestinal symptoms following ingestion of copper contaminated foods or beverages. In some cases, abnormal liver function tests and mild, transient jaundice have been seen following ingestion of large amounts of copper. Other systemic effects include episodes of hemolysis in persons chronically exposed to copper which may result in hemolytic crisis. Rare cases of renal failure have been seen in patients ingesting large amounts of copper.[14]

The current OSHA standard for copper fume is 0.1 mg/m^3 as a time weighted average. The ACGIH recommends a TLV of 0.2 mg/m^3.

VI. RESULTS AND DISCUSSION

NIOSH conducted the environmental survey of the process as it was performed on the day of the survey. However discussions with both current and past employees indicated that working conditions may have been different in the past. Although the process was described as essentially the same, an older furnace was used between November of 1977 and March, 1979. An old furnace was observed during the walkthrough located in the back corner of the building near the steel storage area. Employees described frequent small explosions (loud popping sounds) from the old furnace.

The sampling results from the present operation are presented in the following table.

Environmental Sampling Results
Collected 1/29/82

Air sample results in micrograms per cubic meter ug/m^3
Wipe sample results in micrograms per filter

Sample Description	Zinc	Nickel	Copper	Tungsten	Cobalt
Furnace Area 5' high				N.D.	
Furnace Area 5' high	31.25	N.D.	2.5		N.D.
Operator (personal)	2.5	N.D.	N.D.		N.D.
Diamond Room Area	N.D.	N.D.	N.D.		N.D.
Wipe samples of approximately 5 cm2 surface area.					
6' on machinery				N.D.	
3' on machinery	33	6	11		N.D.
Floor	210	57	220		5
In Fume Hood	8300	43	220		N.D.

*N.D.= Below the limit of detection which was 3.75 ug/m^3, Ni and Co. 2.5 ug/m^3 Cu and Zn.

Sample Description	Cadmium
Silver Soldering (personal)	20.8
Silver Soldering (area)	29.2

Occupational Exposure Criteria

Substance	OSHA	NIOSH	ACGIH
Cadmium	100ug/m^3 TWA	40ug/m^3 TWA	TWA
Cadmium	300ug/m^3 C	200ug/m^3 C	50ug/m^3
Cobalt	100ug/m^3 TWA		50ug/m^3
Copper	100ug/m^3 TWA		200ug/m^3
Nickel	1000ug/m^3 TWA	15ug/m^3 TWA	1000ug/m^3
Zinc	5mg/m^3 TWA	5mg/m^3 TWA	5mg/m^3
Tungsten(soluble)		1mg/m^3 TWA	1mg/m^3
Tungsten(insoluble)		5mg/m^3 TWA	5mg/m^3
Dust of Cemented Tungsten Carbide		Greater than 2% Cobalt, use Cobalt Criteria. Greater than 0.3% Nickel, use Nickel Criteria.	

*ug/m^3 = micrograms per cubic meter
mg/m^3 = milligrams per cubic meter
TWA = Time Weighted Average
C = 15 minute Ceiling (5 minutes for cadmium)

Current employees have not complained of any adverse health effects resulting from the work environment.

VII. CONCLUSION

Based on the results of the environmental evaluation, NIOSH determined that as of the date of air sampling, exposure to cadmium, cobalt, copper, nickel, tungsten, and zinc did not present a current health hazard to employees. However, a description of the previous process conditions suggest that exposures may have been greater in the past.

VIII. RECOMMENDATIONS

Since exposure to the heavy metals was controlled well within established criteria on the day of this survey, no recommendations are made at this time.

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