HETA 93–1082–2567
IMI Cash Valve, Inc.
Decatur, Illinois

Michael E. Barsan

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, technical and consultative assistance 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. Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Michael E. Barsan, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Dino Mattorano. Desktop publishing by Ellen E. Blythe.

Copies of this report have been sent to employee and management representatives at Cash Valve and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

NIOSH Publications Office
4676 Columbia Parkway
Cincinnati, Ohio 45226
800-356-4674

After this time, copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

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.

Health Hazard Evaluation Report 93–1082–2567
IMI Cash Valve, Inc.
Decatur, Illinois
March 1996

Michael E. Barsan

SUMMARY

During October 1993 and March 1994, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) investigation at IMI Cash Valve, Inc., in Decatur, Illinois. This HHE was performed in response to a management request which asked NIOSH to evaluate potential employee exposure to caprolactam in the powder coating room, paraffinic petroleum oil at the thermostat testing process, and welding fumes from an automatic welding machine in the assembly area.

Area and personal breathing zone (PBZ) air samples for caprolactam vapor and for total and respirable airborne particulates were collected at the powder coating process, area air samples were collected for paraffinic petroleum oil at the thermostat testing station, and area air samples were collected for welding fumes near the automatic welding operation. Some of these contaminants were detected in very low levels on many of the air samples that were collected, but all airborne concentrations for the samples that were collected were well below the established occupational exposure criteria.

NIOSH investigators determined that a health hazard did not exist during the testing, coating, or welding of water heater thermostat elements. Recommendations are provided for effective engineering controls.

Keywords: SIC 3822 [Automatic Controls for Regulating Residential and Commercial Environments and Appliances], caprolactam, petroleum paraffinic oil, welding fumes, thermostats, nylon coating.

TABLE OF CONTENTS

INTRODUCTION

On August 9, 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from a management representative of IMI Cash Valve, Inc., in Decatur, Illinois. IMI Cash Valve manufactures precision brass and stainless steel valves, as well as water heater thermostats. NIOSH was requested to evaluate potential worker exposures to airborne paraffinic petroleum oil, caprolactam, and welding fumes during the manufacturing, testing, and assembly of water heater thermostats.

On October 22, 1993, NIOSH investigators conducted a walk-through survey at IMI Cash Valve to determine a protocol for a subsequent air sampling survey. On March 2, 1994, NIOSH investigators returned to IMI Cash Valve to collect air samples in three operations that are involved with the manufacture of water heater thermostats: element testing, powder coating, and welding. Air samples were collected for total hydrocarbons at the element testing operation, for caprolactam at the powder coating operation, and for welding fumes at an automatic welder in the adjacent manufacturing room.

BACKGROUND

IMI Cash Valve Inc. is a manufacturer of precision brass and stainless steel valves, as well as thermostats for water heaters. Previous NIOSH investigations at Cash Valve (HETAs 88-242, 88-357, and 90-344) involved the valve manufacturing operation.[1,2,3] The current evaluation focused on the process where water heater thermostat elements were manufactured, tested, coated, and welded to the rest of the thermostat apparatus.

The element testing process consisted of two tanks of oil that were heated to different temperatures to determine if the thermostat elements worked properly. The operator placed a thermometer gauge on the elements and they were inserted into the tanks. There was a possibility for worker exposure to airborne hydrocarbons from the heavy paraffinic petroleum oil that had been vaporized during heating in the tanks. During the first site visit this operation had a poorly designed and maintained local exhaust ventilation system; by the time of the second NIOSH site visit, the company had greatly improved this local exhaust system.

Located in the same room as the element testing process was the powder coating operation. For this process, epoxy powder was sprayed onto a copper tube, which was then heated to melt the powder and form a nylon coating around the tube. The tubes, which were situated vertically on a mechanical conveyor, were sprayed with the powder in an enclosure equipped with local exhaust ventilation. The conveyor then moved the tubes through an oven to allow the powder coating to cure into a nylon coating. The material safety data sheet for the nylon coating powder indicated that caprolactam may be formed when this powder is melted in the curing ovens.

The assembly of the thermostat final product took place in a large area adjacent to the small room that was used for element testing and powder coating. This assembly area included an automated welding process. Although workers sometimes had the occasion to weld by hand, the automated welding process was most often used. There was no local exhaust ventilation for the automatic welder.

METHODS

Nine partial-shift air samples were collected (five area and four PBZ) at the powder coating operation to determine airborne concentrations of caprolactam vapor. Four PBZ samples were collected from the two operators that worked at this operation placing the copper tubes on the conveyor, and removing the nylon-plastic-coated tubes from the conveyor after the process was complete. A PBZ sample was collected from each worker in the morning and in the afternoon. Area air samples were collected just above each end of the curing oven in the morning and in the afternoon. An area sample was collected in the hallway just outside the powder coating room in the morning. To measure airborne caprolactam vapor concentrations, air was drawn through an OVS-2 solid sorbent tube connected to a battery-powered pump via Tygon™ tubing. The samples were analyzed in the laboratory for caprolactam using high performance liquid chromatography (HPLC) according to an OSHA stopgap method.[4]

To assess the amount of airborne particulates to which the workers in the powder coating room are potentially exposed, one respirable particulate and three total particulate air samples were collected in the powder coating room and in the adjacent hallway. These samples, which were all area samples, were collected on polyvinyl chloride filters and analyzed gravimetrically using NIOSH methods 0500 and 0600.[5,6]

Three area air samples were collected in the assembly area next to an automatic welding machine to determine airborne concentrations of welding fumes. Two of the samples were collected at different positions that were two feet from the welder, and another sample was collected about ten feet from the welder. Since this was an automatic process, workers were not usually in close proximity to the welder. These samples were collected on mixed cellulose ester filters and analyzed using inductively coupled plasma emission spectrometry for metal fumes using NIOSH method 7300.[7]

Ten area air samples were collected on charcoal sorbent tubes at the thermostat testing operation to determine airborne concentrations of volatile organic compounds (VOCs) from the paraffinic petroleum oil that was heated in the two testing tanks. The samples were collected side by side at five locations on both sides of both oil tanks and on a work table eight feet away from the tanks. One sample from each location was qualitatively analyzed for VOCs using gas chromatography and mass spectrometry (GC-MS).

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[8] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs™),[9] and (3) the U.S. Department of Labor, the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[10] In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the

1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Caprolactam

Caprolactam is an irritant of the eyes, mucous membranes, respiratory tract, and skin, and, rarely, a convulsant.[11] An investigation involving eight factory workers who were chronically exposed to fume condensed from caprolactam vapor at concentrations around 70 times the TLV showed that they suffered skin irritation in the form of peeling or fissuring, but there was no evidence of systemic toxicity.[12] Another study described a group of workers who were exposed to caprolactam vapor in concentrations as high as 450 parts per million (ppm) in brief periods over an 18-year span.[13] The ACGIH TLV for caprolactam is 5 ppm, while the NIOSH REL is 0.22 ppm (1 milligram per cubic meter [mg/m^3]).[8,9]

Particulates, not otherwise classified

Often the chemical composition of the airborne particulate does not have an established occupational health exposure criterion. It has been the convention to apply a generic exposure criterion in such cases. Formerly referred to as nuisance dust, the preferred terminology for the non-specific particulate ACGIH TLV criterion is now "particulates, not otherwise classified (n.o.c.)," [or "not otherwise regulated" (n.o.r.) for the OSHA PEL].

The OSHA PEL for total particulate, n.o.r., is 15.0 mg/m^3 and 5.0 mg/m^3 for the respirable fraction, determined as 8-hour averages. The ACGIH recommended TLV for exposure to a particulate, n.o.c., is 10.0 mg/m^3 (total dust, 8-hour TWA), and 3.0 mg/m^3 for the respirable fraction. These are generic criteria for airborne dusts which do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.[14]

Welding Fumes

The composition of welding fume will vary considerably depending on the alloy being welded, the process, and the electrodes used.[8,15] Many welding processes also produce other hazards, including toxic gases such as ozone or nitrogen oxides, and physical hazards such as intense ultraviolet radiation. Of particular concern are welding processes involving stainless steel, cadmium or lead coated steel, and metals such as nickel, chrome, zinc, and copper. Fumes from these metals are considerably more toxic than those encountered when welding iron or mild steel. Epidemiological studies and case reports of workers exposed to welding emissions have shown an excessive incidence of acute and chronic respiratory diseases.[15] These illnesses include metal fume fever, pneumonitis, and pulmonary edema. The major concern, however, is the excessive incidence of lung cancer among welders. Epidemiological evidence indicates that welders generally have a 40% increase in relative risk of developing lung cancer as a result of their work.[15] Because of the variable composition of welding emissions, and epidemiological evidence showing an increased risk of lung cancer, NIOSH recommends that exposures to all chemical and physical agents associated with welding or brazing be controlled to the lowest feasible concentration. Exposure limits for each chemical or physical agent should be considered upper boundaries of exposure. The ACGIH TLV and OSHA PEL for total welding fume, which applies only to manual metal-arc or oxy-acetylene welding of iron, mild steel, or aluminum, is 5 mg/m^3 as an 8-hour time-weighted average.[8,10]

Paraffinic petroleum oil

The material safety data sheet for the paraffinic petroleum oil that was used to test the thermostats stated that the oil was of low toxicity. However, prolonged or repeated contact with skin could cause some irritation.

RESULTS

The results of air sampling for airborne caprolactam vapor in the powder coating room are presented in Table 1. All of the area and personal breathing zone (PBZ) samples showed at least trace amounts of caprolactam vapor. Caprolactam was found in quantifiable amounts in three area samples that were collected directly above the curing oven. The highest airborne caprolactam concentration was 0.01 ppm, which is much less than the NIOSH REL (0.22 ppm) or the ACGIH TLV (5 ppm).

Presented in Table 2 are the results of airborne particulate samples that were collected in and around the powder coating room. The highest total dust concentration (0.4 mg/m^3) was collected next to the steps which are within the conveyor loop. A respirable dust sample, which was collected at the same location, showed an airborne concentration of 0.1 mg/m^3. The total dust sample collected next to the loading bin was 0.2 mg/m^3, and a total dust sample collected in the hallway just outside of the powder coating room showed an airborne concentration of 0.1 mg/m^3.

Table 3 shows the results of three air samples were collected next to an automatic welding machine in the assembly area. Neither cadmium, chromium, nickel, nor manganese were detected on any of these samples. Iron, zinc, and silver were detected in trace amounts on some or all of the samples. Copper was detected in low concentrations (2.0, 3.2, and 4.2 micrograms per cubic meter [µg/m^3]) on all three samples. All of these welding fume concentrations were well below the environmental evaluation criteria, which are also given in Table 3.

Of the five samples which were analyzed qualitatively for VOCs, only one sample contained trace amounts of various VOCs in concentrations adequate to be detected. The sample collected just above the top edge of the left tank revealed trace amounts of isopropanol, hexane, 1,1,1-trichloroethane, trichloroethylene, and toluene. Because of the very low yield of any VOCs on these samples, further quantitative analysis of the remaining samples was not performed.

DISCUSSION

The potential worker exposure to caprolactam fume in the powder coating room was shown to be very low. The curing oven, which melts the nylon powder and creates airborne caprolactam, was equipped with local exhaust ventilation. Based on the air samples collected, as well as visual inspection of the ventilation equipment, these engineering controls appeared to be effective in removing caprolactam fume from the workplace.

Airborne particulate concentrations in the powder coating room were well below the OSHA PEL and ACGIH TLV. Local exhaust ventilation appeared to maintain airborne particulate concentrations well within these environmental exposure limits.

Welding fumes created by the automatic welder in the assembly area were very low. Area air samples were collected as close to the point of welding as possible, indicating the highest likely potential exposure to welding fumes during the sampling period. The sample that was collected several feet from the welder showed even less metal fume. Since this is an automatic process, workers would not be likely to work in close proximity to the welder for extended periods of time.

The thermostat testing operation was equipped with local exhaust ventilation that removed vapor from the heated paraffinic oil and resulted in only trace amounts of airborne VOCs. This equipment appeared to be in good working order.

CONCLUSIONS

Air samples in the powder coating room, at the welding operation in the assembly area, and at the thermostat testing operation indicate that a health hazard does not exist in these operations. Airborne contaminant concentrations in these areas were either very low initially, or they were effectively reduced by local exhaust ventilation so that potential worker exposures were minimal.

RECOMMENDATIONS

The following recommendations are made to help reduce occupational exposures and to maintain effective engineering controls at IMI Cash Valve, Inc:

1. Because of the potential for skin irritation due to skin contact to paraffinic petroleum oil, the operator of the thermostat testing process should wear nitrile rubber gloves.

2. Although airborne particulate concentrations in the powder coating room were well below the exposure criteria, it would be a good housekeeping practice to periodically clean the accumulated powder from the floor of the room. A vacuum or wet-cleaning method would be preferable rather than a dry broom method in order to limit the amount of airborne powder.

3. The local exhaust equipment at the powder coating and thermostat testing operations should be inspected regularly, and cleaned or repaired as needed, to ensure their continued effectiveness.

REFERENCES

1. Kinnes GM [1988]. Close-out letter for health hazard evaluation 88-242 of September 26, 1988 from G.M. Kinnes, Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services, to Don Bright, A.W. Cash Valve Manufacturing Corporation, Decatur, Illinois.

2. NIOSH [1990]. Hazard evaluation and technical assistance report: A.W. Cash Valve Manufacturing Corporation, Decatur, IL. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 88-357-2042.

3. NIOSH [1991]. Hazard evaluation and technical assistance report: A.W. Cash Valve Manufacturing Corporation, Decatur, IL. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 90-344-2159.

4. OSHA [1988]. Occupational Safety and Health Administration stopgap method for caprolactam. Salt Lake City, Utah: OSHA Analytical Laboratory, Carcinogen and Pesticide Branch, January, 1988.

5. NIOSH [1994]. Particulates not otherwise regulated, total: method no. 0500. In: Eller PM, ed. NIOSH manual of analytical methods. 4th rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-113.

6. NIOSH [1994]. Particulates not otherwise regulated, respirable: method no. 0600. In: Eller PM, ed. NIOSH manual of analytical methods. 4th rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-113.

7. NIOSH [1994]. Elements by ICP: method no. 7300. In: Eller PM, ed. NIOSH manual of analytical methods. 4th rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-113.

8. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

9. ACGIH [1995]. 1995-1996 threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

10. Code of Federal Regulations [1993]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

11. Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1991]. Chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold Company.

12. Kelman GR [1986]. Effects of human exposure to atmospheric ϵ-caprolactam. Human toxicology. 5:57.

13. Ferguson WS, Wheeler DD [1973]. Caprolactam vapor exposures. Am Ind Hyg Assoc J. 34:384.

14. ACGIH [1986]. Documentation of threshold limit values and biological exposure indices for chemical substances and physical agents. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

15. NIOSH [1988]. Criteria for a recommended standard: occupational exposure to welding, brazing and thermal cutting. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control; National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-110.

Table 1

Airborne Caprolactam Vapor Concentrations
IMI Cash Valve, Inc.
Decatur, Illinois
March 2, 1994
HETA 93-1082

Sample number	Sample type/location	µg per sample	Sample volume (liters)	Concentration (ppm)
CP-1	Area - above curing oven by door	2	100	trace
CP-2	Area - above curing oven away from door	4.2	100	0.009
CP-3	PBZ - Operator A	2	100	trace
CP-4	PBZ - Operator B	1	99	trace
CP-5	Area - hallway outside powder coat room	2	100	trace
CP-6	Area - above curing oven by door	3.6	110	0.007
CP-7	Area - above curing oven away from door	5.4	110	0.01
CP-8	PBZ - Operator A	2	96	trace
CP-9	PBZ - Operator B	2	94	trace
Minimum Detectable Concentration for a 100-liter sample				0.002
Minimum Quantifiable Concentration for a 100-liter sample				0.006

NIOSH REL **0.22 ppm**

ACGIH TLV **5 ppm**

ppm parts per million
trace these samples were between the analytical limits of detection and quantitation
PBZ personal breathing zone
REL recommended exposure limit
TLV threshold limit value

Table 2

Area Airborne Total and Respirable Dust Concentrations
Powder Coating Operation
IMI Cash Valve, Inc.
Decatur, Illinois
March 2, 1994
HETA 93-1082

Sample number	Sample location	Sample volume (liters)	Total Dust Concentration (mg/m^3)	Respirable Dust Concentration (mg/m^3)
TD-1	Side of loading bin	826	0.2	---
TD-2	Adjacent to the steps within the conveyor loop	816	0.4	0.1
TD-3	Hallway outside powder coat room	828	0.1	---
Minimum Detectable Concentration for an 823-liter sample			0.02	0.02
Minimum Quantifiable Concentration for an 823-liter sample			0.02	0.02
		OSHA PEL	**15**	**5**
		ACGIH TLV	**10**	**3**

mg/m^3 milligrams per cubic meter
PEL Permissible Exposure Limit
TLV Threshold Limit Value

Table 3

Airborne Concentrations of Welding Fumes
IMI Cash Valve, Inc.
Decatur, Illinois
March 2, 1994
HETA 93-1082

Sample number	Sample location	Sample volume (liters)	Cadmium µg/m³	Chromium µg/m³	Copper µg/m³	Iron µg/m³	Nickel µg/m³	Manganese µg/m³	Silver µg/m³	Zinc µg/m³
WF-1	2 feet from automatic welder	402	n.d.	n.d.	3.2	trace	n.d.	n.d.	n.d.	trace
WF-2	10 feet from automatic welder	402	n.d.	n.d.	4.2	trace	n.d.	n.d.	trace	trace
WF-3	2 feet from automatic welder	402	n.d.	n.d.	2.0	trace	n.d.	n.d.	n.d.	trace
Minimum Detectable Concentration (402-liter sample)			0.07	0.25	0.1	2.2	0.2	0.05	0.05	0.07
Minimum Quantifiable Concentration (402-liter sample)			0.2	0.8	0.3	7.2	0.6	0.2	0.1	0.2
NIOSH	Recommended Exposure Level		LFL	500	100	5000	15	1000	10	5000
OSHA	Permissible Exposure Limit		5	1000	100	10,000	1000	5000 C	10	5000
ACGIH	Threshold Limit Value		10	500	200	5000	1000	200	100	5000

µg/m³	micrograms per cubic meter
n.d.	not detected
LFL	Lowest Feasible Level
C	Ceiling Limit
trace	these concentrations are for samples that were between the analytical limits of detection and quantitation.

Delivering on the Nation's promise:
Safety and health at work for all people
Through research and prevention