U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-141-711

FISCHER & PORTER COMPANY
WARMINSTER, PENNSYLVANIA

JULY 1980

I. SUMMARY

On September 9, October 4, and October 26, 1979, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation of the Q-hut potting and coating operations at the Fischer & Porter Company in Warminster, Pennsylvania. A comprehensive walk-through survey and environmental sampling were conducted, ventilation measurements were taken and non-directed medical interviews were performed to determine possible employee exposures to asbestos fibers, 1,1,1-trichloroethane, epichlorohydrin, methylene chloride, methyl ethyl ketone, phenyl glycidyl ether, p,p-methylene dianiline, and methylene bis-4-cyclohexylisocyanate vapors.

Results of the eight-hour time-weighted average personal and area air samples were well within the environmental criteria/standards for asbestos fibers and the various organic vapors. They range from 8.1 to 35.7 mg/M^3 for trichloroethane; from non-detectable to 0.01 mg/M^3 for 4,4'methylene dianiline; from non-detectable to 0.1 fibers/cc for asbestos; and non-detectable for epichlorohydrin, phenyl glycidyl ether, methyl ethyl ketone, methylene chloride, and methylene bis-4-cyclohexylisocyanate. Employee interviews revealed occasional complaints of respiratory, skin, and eye irritation.

On the basis of data obtained in the investigation, NIOSH determined that concentrations of the above substances measured were within acceptable limits. Recommendations to further reduce exposures (personal protection, personal hygiene, medical surveillance and ventilation maintenance) are presented on pages 6 and 7.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. The Independent Union of Rotameter Workers requested such an investigation from NIOSH on September 4, 1979, to evaluate the possible health effects of asbestos fibers and the various organic vapors upon the operators in the Q-hut buildlings of the Fischer & Porter Company in Warminster, Pennsylvania.

*Section 20(a)(6) of the Occupational Safety and Health Act of 1970, U.S.C. 669(a)(6), authorizes the Secretary of Health and Human Services, following a written request by an employer or authorizes 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 NIOSH Regional Industrial Hygienist met with management and union representatives for the opening and closing conferences, walk-through survey and environmental sampling on September 9, October 4, and October 26, 1979.

III. BACKGROUND

The Q-hut potting and coating operations consist of a Quonset hut building, 75 feet wide, 150 feet long, and 25 feet high (at highest point). The company produces water pipe which has instrumentation and wiring for measuring water flow through it. The instrumentation is encapsulated with a water-proof protectant. These meters come in 4" diameter up to 54" diameter in size.

The building is divised basically into two area: (1) the General assembly area which contains an epoxy mixing area, polymer-flaring operation, assembly and wiring operations, and grinding and vitreous enamel spraying operations, and (2) the Potting Room for encapsulating the instrumentation. A total of twenty-one workers are employed in these various activities.

The epoxy mixing area contains two laboratory hoods for manually making up small quantities (5 oz.) of a two-part epoxy (Part A - epoxy resin + Part B - amine adduct). This mixture is used to coat and attach wires in the assembly and wiring area.

Assembly and wiring operations require the use of the two-part epoxy (epichlorohydrin; phenyl glycidyl ether and methylene chloride) for "palmering" (manual coating and attachment) of wires and instrumentation to the inside of water pipes.

The polymer-flaring operations consist of two flaring machines under a canopy hood. The heating tool for flaring the polymer is kept at 650°F continuously; the polymer parts are incorporated into the instrumentation packages.

The Potting Room operations typically involve three seaparate pourings into a rotating pipe assembly for the potting or encapsulation of instrumentation and wires; this offers protection against the "elements." Two rotators are used - one is for "large" pipes (> 24" diameter) and the other is for "small" pipes (< 24" diameter). Each unit has local exhaust ventilation located below and behind the rollers.

The first pouring involves the weigh-out of Part A (epichlorohydrin resin and 3% phenyl glycidyl ether) and Part B (poly-amide resin and phenyl glycidyl ether components) drawn from fifty-gallon drums into smaller metal containers. The A and B components are thoroughly mixed using an air-operated hand-held mixer. The mix is manually poured into the water pipe, which is rotating on a series of rollers and is resistance-heated; a local exhaust unit encloses (door on side and front) the rotating assembly. After pouring, 1,1,1-trichloroethane is sprayed onto the epoxy surface to get rid of air bubbles and to leave a smooth surface finish. Rotation and heating is continued for several hours to enhance the curing process.

The second pouring is similar except that the mix contains Part A and Part B with glass beads; and the third pouring is a polyurethane mix of Part A (methylene bis-4-cyclohexylisocyanate - $\sim$ 7.5%) and Part B (4,4'methylene dianiline)

plus a gray pigment for coloring. These Part A and Part B components are heated in ovens at 190°F and 215°F, respectively, using seamless and seamed cans; each oven utilizes a local exhaust set up.

The grinding and vitreous enamel spray operations are done outside or partially inside a large spray booth. Grinding of the polyurethane coating, created in the Potting Room, is done with a portable grinder and an air hose is used to blow away any loose material. Finally, a fixing or bonding agent (contains methyl ethyl ketone, 83% by weight) is painted onto the ground-down coating.

"Asbestos-type" insulation coats the ceilings and walls of the Q-hut interior structure. Through structural vibration employee work movement, disturbing air currents, and natural aging/drying out of the insulation, asbestos material can fall out into the work environment.

IV. EVALUATION DESIGN AND METHODS[1]

Discussions with management involved the collection of information concerning process description, engineering controls, personal protective equipment and clothing, work practices, training programs, monitoring, recordkeeping and medical surveillance for the areas in question. Employee interviews focused on the job description, work practices, training programs, and associated health problems.

The personal air samples for 1,1,1-trichloroethane, epichlorohydrin, methyl ethyl ketone, phenyl glycidyl ether and methylene chloride vapors were collected on activated charcoal tubes using portable pumps at a flow rate of 50 cc/minute. These samples were analyzed by gas chromatography according to NIOSH Method P&CAM #127 using a flame ionization detector.

Area air samples for p,p-methylene dianiline (MDA) vapors were collected in 10 ml of Marcalis solution using an impinger with a portable air sampling pump at a flow rate of 1.0 liter per minute. These samples using NIOSH Method P&CAM #142.

Area air samples for methylene bis-4-cyclohexylisocyanate were collected in 10 ml of nitro reagent using an impinger with a portable air sampling pump at a flow rate of 1.0 liter per minute. These samples were analyzed by high pressure liquid chromatography following NIOSH Method N240 (modified).

Area air samples for asbestos fibers were collected on a 0.8 M AA filters using a three-piece cassette and a portable air sampling pump at a flow rate of 1.5 liters per minute. The air samples were analyzed for asbestos according to NIOSH Method P&CAM #239 utilizing phase contrast microscopy, and the bulk samples were analyzed using prolonged light microscopy and dispersion staining techniques.

A bulk sample was taken of the interior insulation to identify type and composition of asbestos.

All samples were taken over an eight-hour work day.

Air velocity measurements were taken in and around the operator's work area and of the local exhaust units and laboratory hood using a velometer and smoke tube kit.

V. EVALUATION CRITERIA[2 - 11]

1,1,1-Trichloroethane (Refer to Table I for Environmental Standards)
Local - Liquid and vapor are irritating to eyes on contact. This effect is usually noted first in acute exposure cases. Mild conjunctivitis may develop but recovery is usually rapid. Repeated skin contact may produce a dry, scaly, and fissured dermatitis, due to the solvent's defatting properties.

Systemic - 1,1,1-trichloroethane acts as a narcotic and depresses the central nervous system. Acute exposure symptoms include dizziness, incoordination, drowsiness, increased reaction time, unconsciousness, and death.

Epichlorohydrin
Local - Epichlorohydrin is highly irritating to eyes, skin, and respiratory tract. Skin contact may result in delayed blistering and deep-seated pain. Allergic eczematous contact dermatitis occurs occasionally.

Systemic - The earliest symptoms of intoxication may be referable to the gastrointestinal tract (nausea, vomiting, abdominal discomfort) or pain in the region of the liver. Labored breathing, cough, and cyanoses may be evident and the onset of chemical pneumonitis may occur several hours after exposure. Animals exposed repeatedly to this chemical have developed lung, kidney, and liver injury.

And, in light of the statistically significant increase in respiratory cancer seen in workers exposed to epichlorohydrin, and the statistically significant increase in nasal carcinomas seen in rat inhalation studies, as well as the chromosomal aberrations seen in the peripheral lymphocytes of exposed workers, NIOSH recommends that epichlorohydrin be treated in the workplace as if it were a human carcinogen. Pending further evaluation of its carcinogenic potential, NIOSH believes it would be prudent to minimize occupational exposure to epichlorohydrin. Exposures should be limited to as few employees as possible while workplace exposure should be minimized with engineering and work practice controls. In particular, skin epxosure should be avoided.

Methylene Chloride
Local - Repeated contact with methylene chloride may cause a dry, scaly, and fissured dermatitis. The liquid and vapor are irritating to the eyes and upper respiratory tract at higher concentrations. If the liquid is held in contact with the skin, it may cause skin burns.

Systemic - Methylene chloride is a mild narcotic. Effects from intoxication include headache, giddiness, stupor, irritability, numbness, and tingling in the limbs. Irritation to the eyes and upper respiratory passages occurs at higher dosages. In severe cases, observers have noted toxic encephalopathy with hallucinations, pulmonary edema, coma, and death. Cardiac arrythmias have been produced in animals but have not been common in human experiences. Exposure to this agent may cause elevated carboxyhemoglobin levels which may be significant in smokers, or workers with anemia or heart disease, and those exposed to carbon monoxide.

4,4'Methylene Dianiline (MDA)
Skin absorption, inhalation of dust or vapor, or ingestion of this substance can lead to toxic effects on the liver (jaundice, acute hepatitis) in human beings.

Also MDA is mildly irritating to the skin and eyes but is not a primary irritant or strong sensitizer. Reports of contact dermatitis from exposure to MDA has been reported in human beings.

Although being reviewed by OSHA, NIOSH and ACGIH as a candidate carcinogen, no cases of cancer in man has been reported; and evidence that MDA is an animal carcinogen is not adequate to reach a firm conclusion.

Methyl Ethyl Ketone
Local - This solvent may produce a dry, scaly, and fissured dermatitis after repeated exposure. High vapor concentrations may irritate the conjunctiva and mucous membranes of the nose and throat, producing eye and throat symptoms.

Systemic - In high concentrations, narcosis is produced, with symptoms of headache, nausea, light headedness, vomiting, dizziness, incoordination, and unconsciousness.

Phenyl Glycidyl Ether
This substance is slightly toxic following ingestion and practically non-toxic after percutaneous absorption. In man, no systemic effects have been reported. However, moderate skin irritation on prolonged or repeated contact and cases of skin sensitization have been reported.

Methylene bis-4-cyclohexylisocyanate
The only adverse industrial effects reported to date have been skin irritation and sensitization. It is a stronger skin irritant and sensitizer than TDI (toluene diisocyanate), but appears to be less toxic by inhalation.

VI. RESULTS AND DISCUSSION

Results of the eight-hour time-weighted average personal and area air samples were well within the environmental criteria/standards for asbestos fibers and the various organic vapors. The results of this air sampling are presented in Table II. They range from 8.1 to 35.7 mg/M^3 for trichloroethane; from non-detectable to 0.01 mg/M^3 for 4,4'methylene dianiline; from non-detectable to 0.1 fiber/cc for asbestos; and non-detectable for epichlorohydrin, phenyl glycidyl ether, methyl ethyl ketone, methylene chloride, and methylene bis-4-cyclohexylisocyanate.

Velometer and smoke tube measurements, for the most part, show less than optimum capture velocities for the particular operations involved.

Epoxy Mixing Area
The two laboratory hoods in the epoxy mixing area showed face velocities of 50 feet per minute at full open sash and 100 feet per minute at one-third open sash (normally used). Protective gloves are provided to prevent skin contact with epoxy materials. It was also noted that fan belts on the motors that service these hoods were worn; these belts were replaced soon after and increased the velocities by 25 feet per minute.

Polymer-Flaring Area
Air velocity measurements at the polymer-flaring canopy hood showed 25 feet per minute at the point of operation and 125 feet per minute at the hood face (approximately 18" above). It was observed that the exhaust tube connection to the hood was improperly attached; this was observed later to be remedied.

Polymer fumes usually present no problem at temperatures below 800°F; in this case the temperature of operation is 650°F.

Assembly and Wiring Area
Assembly and wiring operations require the use of protective gloves; it was observed that gloves are provided and used. No local exhaust ventilation is used during epoxy applications even though with large pipes it may require the employee to put his head into this confined area.

Spray Booth
The grinding of the polyurethane coating is done on the outside of a spray booth; this condition and the use of an air hose to blow away loose material on the coating renders irritant dust airborne. The application of the fixing agent (methyl ethyl ketone) is also done outside the spray booth using only protective gloves.

Potting Room
Cooled air is brought into the weigh-out/storage and rotating areas of the potting room area; this affords comfort ventilation as well as air replacement of approximately ten changes/hour. An eye-wash is located next to the chemical storage drums but had been shut off.

When the 1,1,1-trichloroethane is sprayed onto the epoxy surface of the rotating pipe, the resistance heated elements (over 900°C) are exposed to this spray. The two rotating units have local exhaust units located below the rollers with air velocities less than 100 feet per minute.

The polyurethane component heat-up ovens have local exhaust units with air velocities of approximately 25 feet per minute inside. Container leakage was observed inside the ovens and was attributed to the use of cans with "seams" that had opened up.

Q-Hut Interior
"Asbestos-type" insulation was observed on the ceilings and walls of the Q-hut interior structure and appeared to be in a "friable" condition.

Smoking, eating, and the consumption of beverages were also observed throughout the Q-hut work areas.

Non-directed interviews of seven employees in the Q-hut building revealed: tightness in chest - three cases; asthmatic reaction - one; dermatitis - four; dizziness - one; sore throat - one; eye irritation - one; stomach ache - one. Two of the seven employees reported no symptoms. All of the reported symptoms appear to be the result of transient high exposures which could not be detected by the environmental testing used.

VII. RECOMMENDATIONS[7,8,9,10]

The following recommendations are intended to minimize contact with the coating and potting materials, and in the case of asbestos insulation exposures to prevent chronic disease.

1. Protective gloves, coveralls, goggles, booties and head covering should be used during mixing, pouring, grinding, "palmering" and clean-up operations.

2. Hands, arms, neck and face should be washed before breaks and lunch, and a thorough wash-up or shower should be taken before leaving work.

3. Work clothes should be kept in a separate locker from street clothes; work clothes should not be brought home.

4. No smoking, eating or drinking should be allowed in any of the work areas.

5. Housekeeping needs improvement. Spills, leaks, and dust accumulations on floor and work surfaces should be cleaned up immediately using proper personal protective equipment; liquids should be swept up using an absorbing agent, and dusts either dry/wet vacuumed or wet-mopped.

6. When spraying 1,1,1-trichloroethane, resistance-heated elements should be shut off to prevent formation of toxic phosgene gas.

7. All ventilation units should be monitored and maintained on a regular scheduled basis, and although all contaminants were within the environmental criteria, consideration should be given to increasing the ventilation to over 100 feet per minute on the rotating units in the Potting Room. Grinding and spraying operations should be done with the "work" inside the spray booth.

8. Seamless containers or catch-pans would be useful in preventing spillage of the polyurethane components (MDA + isocyanate) onto the oven walls and heating elements.

9. Within the Q-hut, removal or containment of asbestos insulation should be considered where the insulation is in a friable state.

10. A comprehensive medical surveillance and respiratory protection program should be implemented with attention given to chest X-rays, and pulmonary function tests.

11. It is also recommended that a comprehensive audio-visual program be set up for a more effective safety and health training/education program.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Viriginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Fischer & Porter Company, Warminster, Pennsylvania
2. Independent Union of Rotameter Workers
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing the 21 employees of the results of the Fischer & Porter survey, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) for their perusal.

X. REFERENCES

1. NIOSH Manual of Sampling Data Sheets, 1977 Edition, DHEW, PHS, CDC, NIOSH, March 1977.

2. General Industry, OSHA Safety and Health Standards, 29 CFR OSHA 2206, Revised January 1976.

3. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1979, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

4. Occupational Diseases: A Guide to Their Recognition, U.S. DHEW, PHS, CDC, NIOSH, Publication No. 77-181, Revised June 1977.

5. Industrial Hygiene and Toxicology, Frank A. Patty, July 1967.

6. Industrial Toxicology, Hamilton and Hardy, 3rd Edition, Publishing Sciences Group Inc., Acton, Massachusetts, 1974.

7. Criteria for a Recommended Standard....Occupational Exposure to 1,1,1-Trichloroethane, NIOSH Publication No. 76-184.

8. Criteria for a Recommended Standard....Occupational Exposure to Epichlorohydrin, NIOSH Publication No. 76-206.

9. Criteria for a Recommended Standard....Occupational Exposure to Methylene Chloride, NIOSH Publication No. 76-138.

10. NIOSH Revised Recommended Asbestos Standard, December 1976, NIOSH Publication No. 77-169.

11. Documentation of the Threshold Limit Values for Substances in Workroom Air - with Supplements, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

TABLE I
Environmental Standards

Substance		OSHA	ACGIH	NIOSH
1,1,1-trichloroethane		1900 mg/M^3 8hr.TWA*	1900 mg/M^3 8hr.TWA 2380 mg/M^3 STEL**	1900 mg/M^3 (15 min. Ceiling)
Epichlorhydrin		20 mg/M^3 8hr.TWA	20 mg/M^3 8hr.TWA 42 mg/M^3 STEL	2 mg/M^3 8hr.TWA 19 mg/M^3 (15 min. Ceiling)
Phenyl Glycidyl Ether		60 mg/M^3 8hr.TWA	60 mg/M^3 8hr.TWA 15 mg/M^3 STEL	———
Methyl Ethyl Ketone		590 mg/M^3 TWA	590 mg/M^3 8hr.TWA 885 mg/M^3 STEL	———
Methylene Chloride		1740 mg/M^3 8hr.TWA 3448 mg/M^3 (Accept.C.***) 6897 mg/M^3 (max.-5 mins. in 2 hrs.)	700 mg/M^3 8hr.TWA 870 mg/M^3 STEL	261 mg/M^3 8hr.TWA 1740 mg/M^3 Ceiling
p,p'Methylene Dianiline		———	(Proposed) 0.8 mg/M^3 8hr.TWA 4.0 mg/M^3 STEL	———
Methylene bis-4-cyclohexylisocyanate		———	0.11 mg/M^3***	———
Asbestos Fibers (> 5 μ)	Current	2.0 fiber/cc 8hr.TWA 10.0 fibers/cc (Ceiling-15 mins.)	2.0 fibers/cc 8hr.TWA	0.1 fiber/cc 8hr.TWA 0.5 fibers/cc (15 min. Ceiling)
	Proposed	0.5 fibers/cc 8hr.TWA 5.0 fibers/cc (Ceiling-15 mins.)	———	———

*TWA = time-weight average
**STEL = short-term exposure limit
***Ceiling = for OSHA, 15 min. sampling time to be legally enforceable.
= for ACGIH, cannot be exceeded at any time.

Table II
Results of Air Sampling
Fischer & Porter Company
Warminster, Pennsylvania
October 4 and 26, 1979

Substance	Sample Type	Sampling Time (Mins.)	Job Operation or Location	Time-Weighted Average Concentration/Detection Limit*
1,1,1-Trichloroethane (Four samples taken. Time is total for all four and concentration is for time-weighted average)	FP 1-4 Personal	420	Potter	8.1 mg/M^3
	FP 5-8	418	Potter	26.2
	FP 9-12	414	Potter	35.7
	FP 13-16	410	"Palmering"	4.8
Epichlorohydrin	For all samples FP 1 - FP 16, none of these substances were detected; the detection limits are shown at the right:			<0.1 mg/sample*
Phenyl Glycidyl Ether				<0.04*
Methyl Ethyl Ketone				<0.2*
Methylene Chloride				<0.03*
4,4-Methylene Dianiline	FP 26 Area	273	Potting Room - Table Near Door	<0.2 µg/sample*
	FP 27	275	Potting Room - Table Near Ovens	0.01 mg/M^3
	FP 28	269	Mixing Room - On Shelf	<0.2 µg/sample*
Methylene bis-4-cyclohexylisocyanate	FP 22 Area	275	Potting Room - Table Near Door	<0.6 µg/sample*
	FP 23	273	Potting Room - Table Near Ovens	<0.6 µg/sample*
	FP 24	269	Mixing Room - On Shelf	<0.6 µg/sample*
Asbestos Fibers (>5µ)	FP 17 Area	390	Q-Hut Center Area	0.1 fibers/cc
	FP 18	390	Q-Hut Work Table	<0.1 fibers/cc
	FP 19	390	Potting Room/Oven Top	<0.1 fibers/cc
	FP 22;23	Bulk	Q-Hut;Potting Room	∿50% Asbestos by volume