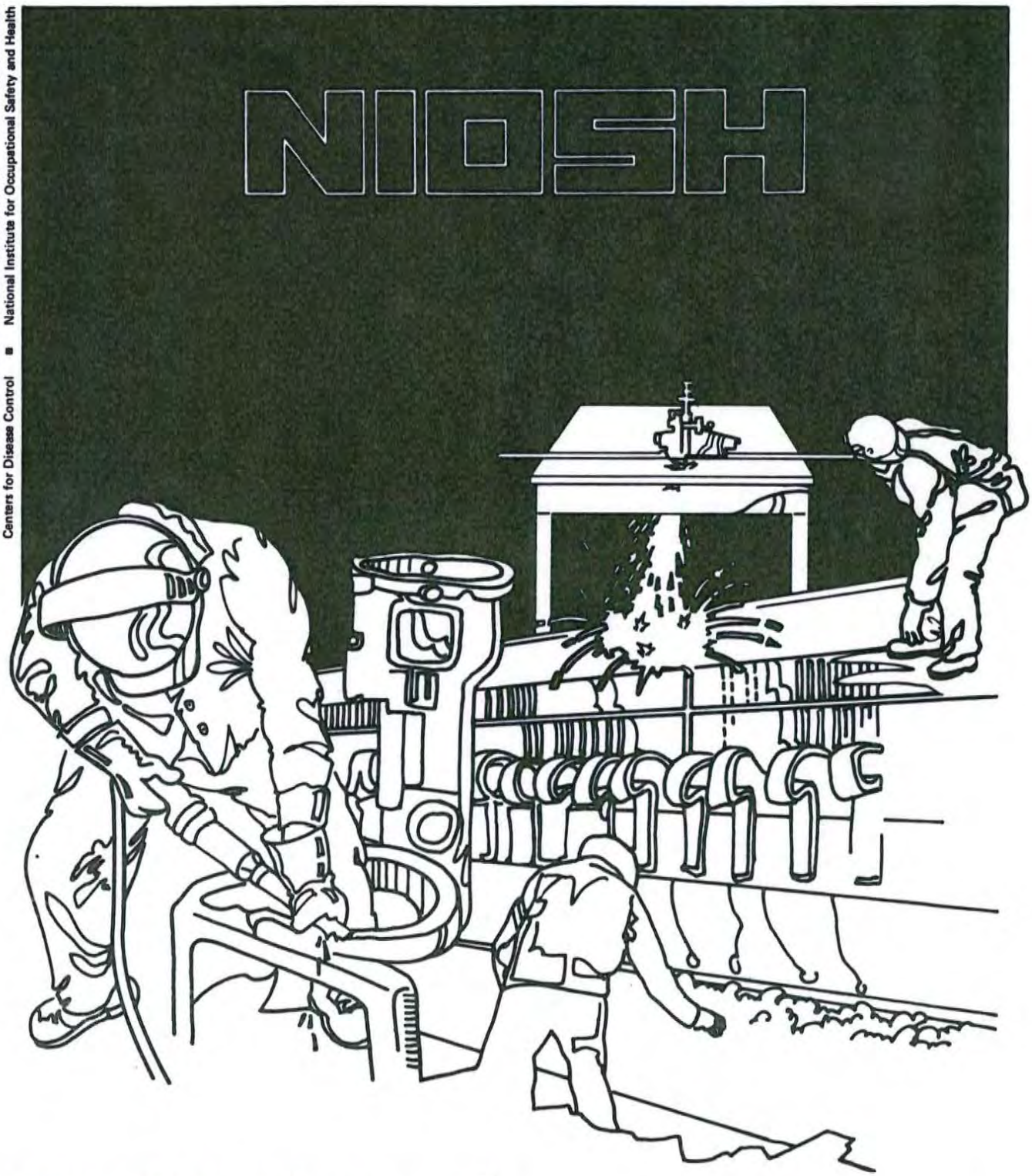
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HHE 79-104-838
A.O. SMITH-INLAND, INC.
LITTLE ROCK, ARKANSAS

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.

ERRATA SHEET

for

Health Hazard Evaluation 79-104-838

A. O. SMITH-INLAND, INC.
LITTLE ROCK, ARKANSAS

1. In order to recognize the "big thread" winder and "ceram core" operations/ products as trade marks of A. O. Smith-Inland, Incorporated, the following changes shall be made:

Page 2, Paragraph 2, Line 4
Page 2, Paragraph 3, Line 6
Page 3, Paragraph 4, Line 1-2
Page 7, Paragraph 3, Line 3
Page 9, Paragraph 2, Line 1
Tables 1, 2, 3, 5, 6

presently reads.....big thread™
should read.....BIG THREAD™

Page 2, Paragraph 2, Line 7-8
Page 3, Paragraph 4, Line 2
Page 7, Paragraph 3, Line 3
Tables 1, 2, 5, 6

presently reads.....ceram core™
should read.....Ceram Core™

2. Page 2, Paragraph 2, Line 5

presently reads.....isothalic
should read.....isophthalic

3. Page 4, EVALUATION CRITERIA, Environmental Table
Page 5, Paragraph 4, Line 7
Table 1, Page 3

OSHA standard for dimethylaniline
presently reads...18 milligrams per cubic meter ($18\ mg/M^3$)

should read.....25 milligrams per cubic meter ($25\ mg/M^3$)

HHE 79-104-838
DECEMBER 1981 (REVISED)
A. O. SMITH-INLAND, INC.
LITTLE ROCK, ARKANSAS

NIOSH INVESTIGATORS:
Harry L. Markel, Jr.
Thomas Wilcox, M.D.

I. SUMMARY

In May 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from A.O. Smith-Inland, Incorporated, Little Rock, Arkansas, to evaluate possible hazards to their Plant #2 employees from exposures to styrene, epichlorohydrin, dimethylaniline (DMA), benzoyl peroxide (BPO), and nuisance particulate matter. Approximately 25 employees work in the production area, where large-diameter fibrous glass reinforced plastic pipe is manufactured.

On December 3-5, 1979, an environmental/medical evaluation was conducted. Because of a need to: (a) confirm previously utilized NIOSH sampling/analytical methods, and (b) expand the scope of the original evaluation, additional environmental monitoring was conducted on June 2-3, 1981. Results of 145 personal breathing-zone/general area air samples were as follows: Styrene [38 air samples ranging from 4.2-123.0 milligrams per cubic meter of air sampled (mg/M^3)]; Epichlorohydrin [38 air samples, all of which were below the lower limit of detection (LOD) of the analytical method]; Dimethylaniline [38 air samples, all of which were below the lower LOD]; Benzoyl peroxide [12 air samples, 10 of which were below the lower LOD...the remaining 2 samples ranging from 0.01-0.10 mg/M^3]; Nuisance particulate matter [15 air samples ranging from 0.1-2.0 mg/M^3]; and Fibrous glass [4 air samples, all of which showed "non-detectable" concentrations]. An in-depth discussion of criteria used for evaluation of exposure to epichlorohydrin is contained in Section V of this report.

Seventeen production area employees and 8 sales division employees who worked within the pipe production building were interviewed regarding symptoms experienced while at work. In addition, blood specimens were drawn for complete blood counts (CBC)/liver enzyme tests as well as pre- and post- urine samples for determination of mandelic acid levels.

Mandelic acid levels for all production employees were of low magnitude compared to levels previously reported in workers with work-shift styrene exposures approaching styrene's threshold limit value concentration. The end-of-shift urine mandelic acid levels for the 11 employees whose breathing-zones were monitored for work-shift styrene exposure, were proportional to their airborne styrene exposure. No significant abnormalities were found in the CBC or liver enzyme tests performed.

Sixteen of the 25 employees interviewed reported having intermittently experienced possible work-associated symptoms such as mucous membrane irritation, headaches, somnolence, or nausea, but no specific cause for the symptoms could be determined.

Based on results of the environmental/medical evaluation, NIOSH found no evidence of styrene, epichlorohydrin, dimethylaniline benzoyl peroxide or nuisance particulate matter concentrations in excess of recommended levels. In light of a statistically significant increase in respiratory cancer, as seen in other studies involving workers exposed to epichlorohydrin, efforts to minimize the potential for employee exposure to this chemical should be continued.

It is probable that the symptoms reported by a majority of the employees interviewed are produced by a combination of exposures to styrene, nuisance particulate matter and other chemical vapors present in the work environment. Recommendations relating to this evaluation are presented in Section VIII of this report.

KEYWORDS: SIC 3079 (Miscellaneous Plastics Products); Styrene, Epichlorohydrin, Dimethylaniline, Benzoyl peroxide, Nuisance Particulate matter, Mucous membrane irritation.

II. INTRODUCTION

Under the Occupational Safety and Health Act (OSHA) of 1970, NIOSH is authorized to investigate the toxic effects of substances found in the workplace. On May 31, 1979, NIOSH received such a request from A.O. Smith - Inland, Inc., Little Rock, Arkansas, to evaluate possible hazards to their Plant #2 employees from exposures to styrene, epichlorohydrin, dimethylaniline (DMA), benzoyl peroxide (BPO), and nuisance particulate matter.

III. BACKGROUND

This plant produces large-diameter fibrous glass reinforced plastic pipe and employs nine production area employees on each of two shifts. The plastic pipe is produced on two separate production lines. One line, identified as the "big thread winder," produces large-diameter fibrous glass reinforced plastic pipe, utilizing either an isothalic acid or polyester-based resin dissolved in dimethyl phthalate), cobalt napthalate, and DMA are used to promote polymerization and hardening of the resin. The other production line is identified as the "ceram core" line, and utilizes an epoxy-based resin system (epichlorohydrin and bisphenol A) which contains no styrene. Small amounts of methylene dianiline (MDA) are used to enhance polymerization of the epoxy.

During each shift, three employees work on each production line. Each shift also utilizes a maintenance man and three employees who strip the plastic pipe from the mandrels. These six employees have contact with solvents (predominantly methylene chloride) used to clean the pipe producing machinery. The pipe strippers have some styrene exposure due to the background levels present throughout the production area. Because of the large amounts of styrene used in the resin for the big thread winder, and styrene's relatively high volatility, it is the major chemical exposure experienced by the production area employees.

IV. EVALUATION DESIGN AND PROCEDURES

A. Environmental

An initial walk-through survey was performed at the facility on June 29, 1979. The purpose of that visit was to gather information on the characterization of all substances used in the production area, as well as the conditions of their use. All areas within the plant where significant exposure to applicable chemicals might occur, were identified. Many employees reported having intermittently had mucous membrane irritation, headaches, somnolence, nervousness, or nausea while at work, but these same employees reported that symptoms were more commonly experienced during the winter months when doors and windows were closed to conserve energy.

To evaluate employee exposure to chemicals being used in the manufacture of the fibrous glass reinforced plastic pipe, environmental sampling/ medical evaluation(s) were performed during the period December 3-5, 1979. Because of a need to: (a) confirm previously utilized NIOSH sampling/ analytical methods, and (b) expand the scope of the original evaluation, additional environmental monitoring was conducted on June 2-3, 1981.

Personal breathing-zone air samples were collected to evaluate employee exposure to styrene, epichlorohydrin, DMA, BPO, and nuisance particulate matter. Samples were collected by using filters (0.8 and 5.0 micron pore size) and standard charcoal tubes, depending on the prescribed sampling/ analytical method. Analytical methods utilized were gas/liquid chromatography, gravimetric analysis, and phase contrast microscopy.

B. Medical

Seventeen production area employees (day shift - 9; evening shift - 8) and eight sales division employees working within the pipe production building, were interviewed with regard to work-associated symptoms of mucous membrane irritation, headaches, somnolence, nausea, and skin irritation, present on the day of the interview, or which had frequently been experienced in the past. The production area employees were interviewed during the second half of their first day of work (December 3), and the office employees were interviewed mid-shift of the second day of activity (December 4).

Participating production area employees performing duties on the big thread winder or ceram core line were individually monitored for their exposure to styrene during their work shifts on December 3-4. These employees also gave pre-and post-shift urine samples on December 3-4, as well as pre-shift samples on December 5, for determination of mandelic acid concentrations. (Note: It is thought that approximately seventy-five percent of the styrene absorbed by humans is excreted in the form of mandelic acid in the urine in excess of 700 milligrams per liter have been reported, and it is felt that, on the average, a worker with an eight hour exposure, at the TLV concentration of styrene, would produce a urine with approximately 2000 milligrams per liter of mandelic acid.[1]

All seventeen participating production area employees and six office employees had blood specimens drawn on December 4 for CBC and liver enzyme tests [alkaline phosphatase, serum glutamic oxaloacetic transaminase (SGOT), lactic dehydrogenase (LDH), serum glutamic pyruvic transaminose (SGPT)].

V. EVALUATION CRITERIA

A. Environmental

Environmental Standards and criteria considered applicable to this evaluation are shown below.

Substance	NIOSH, 8-10 hr. TWA Recommendation (mg/M^3)*	ACGIH, TLV Committee, 8-hr. TWA (mg/M^3)*	OSHA, 8-hr. TWA Standard (mg/M^3)*
Styrene	**	420	420
Epichlorohydrin	***	10	19
Dimethylaniline		25	18
Benzoyl Peroxide	5	5	5
Nuisance Particulate (Respirable)	**	5	5
Nuisance Particulate (Total)	**	10	10

*Eight or ten-hour, time-weighted-average (TWA) concentrations in milligrams of substance per cubic meter of air sampled.

**No recommendation available

***In September 1976, NIOSH recommended an occupational exposure limit of 2 mg/M^3 determined as a TWA concentration for up to a 10-hour work day in a 40-hour work week. After a comprehensive review of the literature, NIOSH concluded that risks from exposure to epichlorohydrin may include carcinogenesis, mutagenesis and sterility. Since most of the available evidence on adverse effects was obtained from animal experiments, which were inadequate to determine scientifically acceptable exposure limits, the 1976 recommendation was based on professional judgment which quantitatively considered the cumulative toxic effects. Pending further evaluation of its carcinogenic potential, NIOSH now believes it prudent to minimize occupational exposure to epichlorohydrin to as few employees as possible, while workplace exposure should be minimized with engineering and work practice controls.

ACGIH - American Conference of Governmental Industrial Hygienists, Threshold Limit Value Committee; OSHA - Occupational Safety and Health Administration.

B. Toxic Effects

Styrene[2,3,4,5,6,7]

Styrene is commonly used in the plastics and rubber industries. Below the eight-hour TLV (420 mg/M^3), subjective symptoms are usually not observed when exposure time is short. Mild eye and throat irritation may, however, develop if exposure continues. At higher concentrations, nasal, eye, and throat irritation are more noticeable. In addition, symptoms of headache and nausea, extreme fatigue, and a feeling of somnolence or drunkeness have also been reported.

Studies of workers with long-term (mean, 5 years) occupational exposure to high concentrations of styrene (over 210 mg/M^3), have shown an increased prevalence of employees with abnormal electro-encephalograms. These highly exposed styrene workers also demonstrated slightly impaired visual motor accuracy and psychomotor performance. Thus, long-term high styrene exposure may have chronic adverse central nervous system effects, but further evidence is needed to firmly establish this theory.

Another concern of styrene exposure is that styrene oxide, a probable metabolite of styrene in man, has been shown to be mutagenic in microbial systems and possibly carcinogenic in rats. There is no evidence linking human styrene exposure to mutagenic effects in man, but any human exposure to a potentially mutagenic substance is cause for concern.

Epichlorohydrin[8,9]

Epichlorohydrin is a reactive chemical whose vapor is irritating to the mucous membranes and respiratory tract. Acute high exposure may cause nausea and headache. Skin contact with liquid epichlorohydrin can result in severe chemical burns. In epoxy resin systems, at room temperature, epichlorohydrin has a low vapor pressure, and, thus, the air concentration of epichlorohydrin is generally low when measured near epoxy resin systems. Because of reports suggesting that epichlorohydrin exposure may increase the chance of developing respiratory cancer, NIOSH recommends that, as a prudent measure, epichlorohydrin be handled as if it were a carcinogen, and employee exposure should be maintained at the lowest feasible level.

Dimethylaniline[10]

Dimethylaniline (DMA) is moderately irritating and shares the ability of many aniline derivatives to change the blood's hemoglobin to methemoglobin and, thus, alter the ability of the blood of sufficiently exposed workers to transport oxygen. Although DMA is readily absorbed through the skin, or by inhalation, there have been few reports of adverse effects of occupational exposure, and it is felt that the OSHA exposure standard of 18 milligrams per cubic meter (8-hour TWA) provides adequate protection for workers.

Benzoyl Peroxide[11]

Benzoyl peroxide (BPO) may cause nose, eye and throat irritation at concentrations above the TLV of 5 milligrams per cubic meter. Its main hazard is its explosive potential and it must, therefore, be handled with care in occupational settings.

Nuisance Particulate Matter[12]

Nuisance dusts have little adverse effects on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called "inert" (biologically) dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics: the architecture of the air spaces remains intact; scar tissue is not formed to a significant extent; and the tissue reaction is potentially reversible.

Methyl Ethyl Ketone Peroxide[13]

Methyl ethyl ketone peroxide (MEKP) is irritating to the skin. There have been several anecdotal reports of severe eye damage caused by the splashing of MEKP into the eye. Adequate eye protection should, therefore, be used when handling this chemical.

VI. RESULTS AND DISCUSSION

A. Environmental

Results appearing in Tables 1, 2 and 3 show that airborne concentrations of 38 styrene; 38 epichlorohydrin; 38 dimethylanaline; 12 benzoyl peroxide, and 15 nuisance particulate matter breathing-zone personal/general area air samples were either below; (a) applicable NIOSH, 8-10 hour recommended levels; (b) ACGIH, TLV Committee 8-hour TWA recommended levels; (c) OSHA, 8-hour TWA standards; or (d) the lower detection limit of the analytical method. In addition, 4 fibrous glass air samples showed "non-detectable" concentrations.

In light of the statistically significant increase in respiratory cancer, as seen in other studies involving exposed workers, NIOSH recommends that epichlorohydrin be treated in the workplace as if it were a human carcinogen. Additional comments may be found in Section VII of this report.

B. Medical

On December 3, the pre- and post-shift mean urine mandelic acid concentrations were 15 and 102 milligrams per liter, respectively, and on December 4, the pre- and post-shift values were 20 and 74 milligrams per liter, respectively. On both days, the pre- and post-shift values were significantly different ($P = 0.001$ by paired T Test). There was no significant change in mandelic acid concentrations from the December 3, pre-shift samples (mean concentration, 15 milligrams per liter) to the December 5, pre-shift samples (mean concentration, 12 milligrams per liter).

For the eleven employees who were personally monitored for work shift breathing-zone styrene exposure, the individual's urine mandelic acid concentration (milligrams per liter) increased over the work shifts on December 3 and 4, and showed a correlation of 0.81 with the corresponding individual's exposure to styrene during the work shift. This correlation indicates that inhalation was the major route of styrene absorption by these workers, and that they did not, therefore, absorb significant amounts of styrene through their skin during the testing period.

The work shift urine mandelic acid changes recorded in this study are small compared to the changes found in workers with higher occupational exposure. It is of note that the pre-shift mandelic acid excretions did not tend to become higher during the testing period, thus indicating that the employees did not accumulate styrene during the work shift that could not be excreted before their next work shift began.

The complete blood counts and liver enzyme tests for seventeen production area employees and six sales/office personnel showed no significant abnormalities in any of the participants. Thus, no adverse effects of the hematopoietic system or the liver were identified in those employees.

Office personnel and production area employees on each shift were interviewed with regard to symptoms of irritation frequently experienced while working at the plant. Table 4 shows the number of positive responses to each of the listed symptoms. A significant proportion of the production area employees reported experiencing headaches, somnolence, dizziness, gastrointestinal symptoms, respiratory symptoms, or mucous membrane irritation. Fifty percent of the office personnel reported frequently experiencing eye irritation or headaches while at work. Styrene environmental levels of 11-14 milligrams per cubic meter of air were found in the office/sales area on December 4. Considering that these levels were comparable to those found in the production area during the same period of time, it is probable that airborne chemical contaminants from the production area enter the office/sales area, and that the irritation experienced by the office personnel could be caused by substances originating in the production area.

Office personnel did not report currently experiencing any significant symptoms during their mid-shift interviews on December 4. However, on December 3, many production area employees reported currently experiencing symptoms, although frequently prefacing their responses with comments to the effect that they were not as severe as "usual". Table 5 summarizes the responses of production area employees regarding symptoms experienced on December 3.

Table 6 shows the mean months of employment for all production area employees and the styrene exposure (mean) -- as measured solely for the eleven employees who performed duties at the big thread winder/ceram core production lines on December 3 -- for the positive and negative respondents to each symptom. Employees reporting symptoms tended to be longer-term employees. Symptomatic employees performing duties at the two pipe production lines tended to have slightly higher styrene exposures -- although still quite low as compared to styrene's 8-hour TLV level (420 milligrams per cubic meter) -- than the non-symptomatic workers. However, the maintenance worker, as well as strippers and grinders, experienced symptoms with a frequency similar to that of the pipe production-line workers, thus suggesting that factors in addition to styrene exposure could be causing symptoms. It is probable that there is no one specific cause for the many symptoms experienced by the employees at this plant, and that the symptoms are, in fact, produced by a combination of exposures to styrene, epichlorohydrin, solvents, and other vapors in the work environment.

VII. CONCLUSIONS

A. Environmental

Results of environmental sampling indicate that employees were not exposed to levels of styrene, epichlorohydrin, dimethylaniline, benzoyl peroxide, and nuisance particulate matter which exceeded presently recommended limits. All measured exposures were well below the most stringent of existing OSHA/ACGIH/NIOSH criteria. After a comprehensive review of the literature, NIOSH has concluded

that risks from exposure to epichlorohydrin may include carcinogenesis, mutagenesis and sterility. Most of the available evidence on adverse effects was, however, obtained from animal experiments which were inadequate to determine scientifically acceptable exposure limits. A 1976 NIOSH recommended exposure level (2 mg/M^3, 8-10 hour TWA) was based on professional judgment which quantitatively considered the cumulative toxic effects. Until further evaluation of its carcinogenic potential is made, NIOSH now believes it prudent to minimize occupational exposure to epichlorohydrin to as few employees as possible.

B. Medical

No significant abnormalities were found in the complete blood counts or liver enzymes of the twenty-three tested employees. The urine mandelic acid levels of employees were found to be proportional to the individual's airborne styrene TWA exposure during the work shift, were of low magnitude, and indicated that the employees did not accumulate levels of styrene during the work day which could not be excreted prior to their beginning work the following day.

Both production and sales/office employees reported experiencing apparently work-related symptoms such as headaches, irritation of mucous membranes, and gastrointestinal discomfort. Environmental measurements indicated that chemical contaminants from the production area (e.g., styrene) could readily enter the sales/office area. Thus, it is plausible that symptoms experienced by office personnel could be related to substances emanating from the production area. No single specific cause of the multiple symptoms experienced by employees could be defined. It is likely that the irritative nature of styrene and the other constituents of fibrous glass resins -- even at the comparatively low concentrations found during this evaluation -- together with solvent vapors and nuisance particulate caused the subjective complaints reported by the study's participants.

Since it is probable that there are several substances which produce symptoms of irritation and discomfort in the workforce, reduction in airborne concentrations of the other potentially irritating substances used within the plant should help to decrease the frequency with which discomfort is experienced by various employees.

Airborne levels of styrene and other measured chemicals were generally low as compared to "recommended permissible exposure limits". However, the fact that styrene oxide -- a possible human metabolite of styrene -- has been shown to be mutagenic in microbial systems, and that epichlorohydrin may have carcinogenic properties, are causes for concern. Justification exists, therefore, for a continuation of efforts by management to minimize employee exposure to these substances.

VIII. RECOMMENDATIONS

1. Modify the existing ventilation system to prevent production room air from entering the sales/office area, and ensure that periodic maintenance of the new system is performed to prevent future exposure of the office force to potentially irritating substances.

2. Periodic maintenance of the big-thread winder fume exhaust equipment, and the general production area ventilation equipment, as well as the employment of good work practices -- namely, the use of appropriate gloves/respiratory protective equipment when in prolonged close proximity to the pipe-winding machines -- are recommended to reduce employee chemical exposures, and to possibly decrease the frequency with which discomfort is experienced by the work force.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available, upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati, Ohio address.

Copies of this report have been sent to:

a) A.O. Smith-Inland, Inc., Little Rock, Arkansas
b) U.S. Department of Labor, Region VI
c) NIOSH, Region VI
d) Arkansas State Department of Health

For purposes of informing the approximately twenty-five affected employees, a copy of this report shall be posted in a prominent place, accessible to the employees, for a period of thirty (30) calendar days.

Table 1

Epichlorhydrin, Styrene, Dimethylaniline Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3-4, 1979
June 2-3, 1981

Sample Number	Date of Sample	(a) Type of Sample	Location	Sampling Period	(b) Concentrations (mg/M^3)		
					Epichlor-hydrin	Styrene	Dimethy-lanilene
S-1	12-3-79	P	Ceram Core-Wet winder	0733-1215	*	17.5	*
S-2	12-3-79	P	Ceram Core-Controls-computer	0735-1215	*	17.7	*
S-3	12-3-79	P	Ceram Core-Wet winder	0741-1216	*	18.8	*
S-4	12-3-79	P	Big Thread-Wet winder	0748-1216	*	81.3	*
S-5	12-3-79	P	Big Thread-Wet winder	0752-1217	*	123.0	*
S-6	12-3-79	P	Big Thread-Wet winder	0754-1217	*	47.1	*
S-7	12-3-79	GA	Ceram Core-Dispensing Station	0758-1219	*	23.0	*
S-8	12-3-79	P	Big Thread-Wet winder	1568-2020	*	30.0	*
S-9	12-3-79	P	Big Thread-Wet winder	1549-2021	*	18.3	*
S-10	12-3-79	P	Big Thread-Wet winder	1551-2015	*	30.0	*
S-11	12-3-79	P	Ceram Core-Controls-computer	1557-2017	*	9.1	*
S-12	12-3-79	P	Ceram Core-Wet winder	1558-2015	*	9.2	*
S-13	12-3-79	GA	Ceram Core-Dispensing Station	1559-2016	*	6.4	*
S-14	12-3-79	P	Ceram Core-Stripping Area	1701-2020	*	17.8	*
S-15	12-4-79	P	Big Thread Wet winder	0746-1300	*	40.0	*
S-16	12-4-79	P	Big Thread-Wet winder	0748-1300	*	38.7	*
S-17	12-4-79	P	Big Thread-Wet winder	0750-1301	*	31.7	*
S-18	12-4-79	GA	Ceram Core-Dispensing Station	0755-1301	*	4.2	*
S-19	12-4-79	P	Ceram Core-Wet winder	0754-1302	*	8.1	*
S-20	12-4-79	P	Ceram Core-Wet winder	0753-1302	*	8.2	*

Table 1 (Continued)

Epichlorhydrin, Styrene, Dimethylaniline Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3-4, 1979
June 2-3, 1981

Sample Number	Date of Sample	(a) Type of Sample	Location	Sampling Period	(b) Concentrations (mg/M^3)		
					Epichlorhydrin	Styrene	Dimethylanilene
S-21	12-4-79	P	Ceram Core-Wet winder	0759-1302	*	8.2	*
S-22	12-4-79	GA	Office-General Reception Area	0830-1303	*	11.7	*
S-23	12-4-79	GA	Office-Sales/Service Area	0830-1303	*	13.9	*
(c)S-24	12-4-79	P	Polythread-Wet winder	0854-1500	*	25.9	*
(c)S-25	12-4-79	P	Polythread-Wet winder	0855-1500	*	27.3	*
(c)S-26	12-4-79	GA	Polythread-So. end of winder	0855-1500	*	12.0	*
(d)S-27	12-4-79	P	Big Thread-Wet winder	2221-2226	*	20.0	*
(d)S-28	12-4-79	P	Big Thread-Wet winder	2232-2252	*	122.5	*
S-29	6-2-81	P	Big Threadwinder, Operator "B"	0735-1445	*	86.9	*
S-30	6-2-81	P	Big Threadwinder, Operator "A"	0744-1446	*	68.0	*
S-31	6-2-81	P	Big Threadwinder, Operator "B"	0820-1459	*	56.5	*
S-32	6-2-81	P	Big Threadwinder, Operator "B"	0823-1459	*	110.7	*
S-33	6-2-81	GA	Big Thread-South End	0851-1510	*	23.8	*
S-34	6-3-81	P	Big Threadwinder, Operator "B"	0803-1233	*	57.5	*
S-35	6-3-81	P	Big Threadwinder, Operator "A"	0808-1225	*	64.7	*
S-36	6-3-81	P	Big Threadwinder, Operator "B"	0830-1233	*	50.8	*
S-37	6-3-81	P	Big Threadwinder, Operator "B"	0832-1234	*	76.9	*
S-38	6-3-81	GA	Big Thread-South End	0832-1245	*	18.2	*

Table 1 (Continued)

Epichlorhydrin, Styrene, Dimethylaniline Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3-4, 1979
June 2-3, 1981

	(b) Concentrations (mg/M^3)		
	Epichlorhydrin	Styrene	Dimethylanilene
U. S. Department of Labor (OSHA), Standard (8-hr. TWA).....	19	420	18
U. S. Department of Labor (OSHA), Standard (Ceiling).....	--	840	--
NIOSH, 8-10 hr. TWA, Recommendation.....	2	--	--
NIOSH, Ceiling, Recommendation.....	19	--	--
American Conference of Governmental Industrial Hygienists (ACGIH).. Recommendation (8-hr. TWA)	10	420	25

(a) P=Personal; GA=General Area
(b) mg/M^3 - milligrams of substance per cubic meter of air sampled
(c) Samples of #24, 25, 26 collected @ Plant #1; all other evaluations conducted at Plant #2
(d) Short-term (ceiling) samples

* Below lower limit of detection of analytical method for specific compound (0.01 milligram per sample)
-- No standard or recommendation available

Table 2

Benzoyl Peroxide Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3-4, 1979

Sample Number	Date of Sample	(a) Type of Sample	Location	Sampling Period	(b) Concentration (mg/M^3) Benzoyl Peroxide
BP-1	12-3-79	GA	Big Thread-South End	1340-1450	*
BP-2	12-3-79	P	Big Thread-Wet winder	1346-1450	*
BP-3	12-3-79	P	Big Thread-Wet winder	1347-1448	*
BP-4	12-3-79	P	Big Thread-Wet winder	1345-1449	*
BP-6	12-3-79	P	Big Thread-Wet winder	2028-2155	*
BP-7	12-3-79	P	Big Thread-Wet winder	2029-3156	*
BP-8	12-3-79	P	Big Thread-Wet winder	2033-2155	*
BP-9	12-3-79	GA	Big Thread-South End	2025-2156	*
BP-11	12-4-79	GA	Big Thread-South End	1317-1447	0.01
BP-12	12-4-79	P	Big Thread-Wet winder	1317-1447	*
BP-13	12-4-79	P	Big Thread-Wet winder	1316-1446	*
BP-14	12-4-79	P	Big Thread-Wet winder	1315-1445	0.10

U.S. Department of Labor (OSHA), Standard (8-hr. TWA)..... 5.0
NIOSH, 8-10 hr. TWA, Recommendation..... 5.0
American Conference of Governmental Industrial Hygienists (ACGIH)..... 5.0
Threshold Limit Committee, Recommendation (8-hr. TWA)

(a) P=Personal; GA=General Area
(b) mg/M^3 - milligrams of substance per cubic meter of air sampled

* Below lower limit of detection of analytical method for specific compound (0.8 microgram per sample)

Table 3

Nuisance Particulate Matter Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

June 2-3, 1981

Sample Number	Date of Sample	(a) Type of Sample	Location	Sampling Period	(b) Concentration (mg/M^3)
P-1(T)	6-2-81	GA	Finishing Dept.- Stripper/Cut-Off	0847-1455	0.2
P-2(T)	6-2-81	P	Finishing Dept.- Finisher	0739-1458	0.3
P-3(T)	6-2-81	P	Big Threadwinder, Operator "A"	0744-1446	0.3
*P-4(T)	6-2-81	P	Finishing Dept.- Finishing Inspector	0842-1452	2.0
P-5(T)	6-2-81	GA	Finishing Dept. Lathe Area	0842-1452	Lab Accident
P-6(T)	6-2-81	GA	Big Thread- Adjacent to Creel	0755-1454	0.1
P-7(T)	6-3-81	P	Finishing Dept.- Finisher	0840-1230	0.5
P-8(T)	6-3-81	P	Finishing Dept.- Finishing Inspector	0844-1227	0.6
*P-9(T)	6-3-81	P	Finishing Dept. Finisher	0849-1226	1.6
P-10(R)	6-3-81	P	Big Threadwinder, Operator "B"	0809-1225	0.1
P-11(R)	6-3-81	P	Finishing Dept.- Finisher	0840-1230	0.1
P-12(R)	6-3-81	P	Finishing Dept.- Finishing Inspector	0844-1227	0.1
P-13(R)	6-3-81	P	Finishing Dept. Finisher	0849-1226	0.2
P-14(R)	6-3-81	GA	Big Thread- Adjacent to Creel	0857-1351	0.1
P-15(R)	6-3-81	GA	Finishing Dept. Lathe	0900-1358	0.1
*P-16(R)	6-3-81	GA	Finishing Dept. Stripper/Cut-off	0903-1351	0.1
*P-17(X)	6-3-81	GA	Big Thread- Adjacent to Creel	0857-1351	(c)
P-18(Y)	6-3-81	GA	Finishing Dept.- Lathe Area	0900-1358	(c)

Table 3 (Continued)

Nuisance Particulate Matter Concentrations

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

June 2-3, 1981

	(b) Concentration (mg/M^3)
U. S. Department of Labor (OSHA), Standard (8-hr. TWA, Total).....	10.0
U. S. Department of Labor (OSHA), Standard (8-hr. TWA, Respirable).....	5.0
American Conference of Governmental Industrial Hygienists (ACGIH),..... Recommendation (8-hr. TWA, Total)	10.0
American Conference of Governmental Industrial Hygienists (ACGIH),..... Recommendation (8-hr. TWA, Respirable)	5.0

(a) P=Personal; GA=General Area
(b) mg/M^3 - milligrams of substance per cubic meter of air sampled
(c) no analysis for particulate matter performed

*Samples analyzed for presence of fibrous glass; none was detected in each instance

Table 4

Positive Responses to Symptoms Frequently Experienced at Work

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3, 1979

	---- Eye Irritation	---- Nasal Symptoms	---- Throat Irritation	---- Gastrointestinal Symptoms	---- Respiratory Symptoms	---- Headache	-----Lightheadedness or Somnolence
Day Shift (9 employees)	6	8	3	6	3	3	5
Evening Shift (8 employees)	3	3	2	3	1	4	3
Office Personnel (8 employees)	4	2	1	0	0	4	2

Table 5

Production Employees Reporting Presence of Symptoms on First Day of Testing

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3, 1979

Work Location	Big Thread Winder	Ceram Core Line	Stripper and Maintenance
Number of Employees	6	5	6
Eye Symptoms	2	2	1
Nasal Symptoms	2	3	4
Throat Irritation	3	2	2
Gastrointestinal Symptoms	2	2	2
Respiratory Symptoms	1	2	1
Excessive Nervousness	0	2	1
Headache	0	1	1
Lightheadedness or Somnolence	1	3	0
Skin	0	1	1

Table 6

Symptoms Reported by Production Employees on First Day of Testing

A. O. Smith-Inland, Inc.
Little Rock, Arkansas

December 3, 1979

Symptom	(a)Production-Area Employees		Months Employed (Mean)	(b)Styrene-Monitored Employees	(c)Styrene Concentrations, Mean (mg/M^3)
Eye Symptoms	Yes	5	34	4	40.9
	No	12	12*	7	16.8
Nasal Symptoms	Yes	9	25	5	36.5
	No	8	11	6	16.5
Throat Irritation	Yes	7	24	5	36.4
	No	10	14	6	16.6
Gastrointestinal Symptoms	Yes	6	28	4	40.9
	No	11	13	7	16.8
Respiratory Symptoms	Yes	4	34	3	38.8
	No	13	14	8	20.6
Excessive Nervousness	Yes	3	36	2	17.6
	No	14	14	9	27.3
Headache	Yes	2	3	1	17.0
	No	15	20	10	28.0
Lightheadedness or Somnolence	Yes	4	26	4	33.8
	No	13	16	7	20.8
Skin	Yes	2	2	1	9.0
	No	15	20	10	27.0

(a) All production-area employees
(b) Eleven big-thread winder or ceram core workers who were individually environmentally monitored for styrene exposure while performing duties on December 3, 1979
(c) Mean styrene concentrations in milligrams of substance per cubic meter of sir sampled

* Significant at p=0.05 level by T Test

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