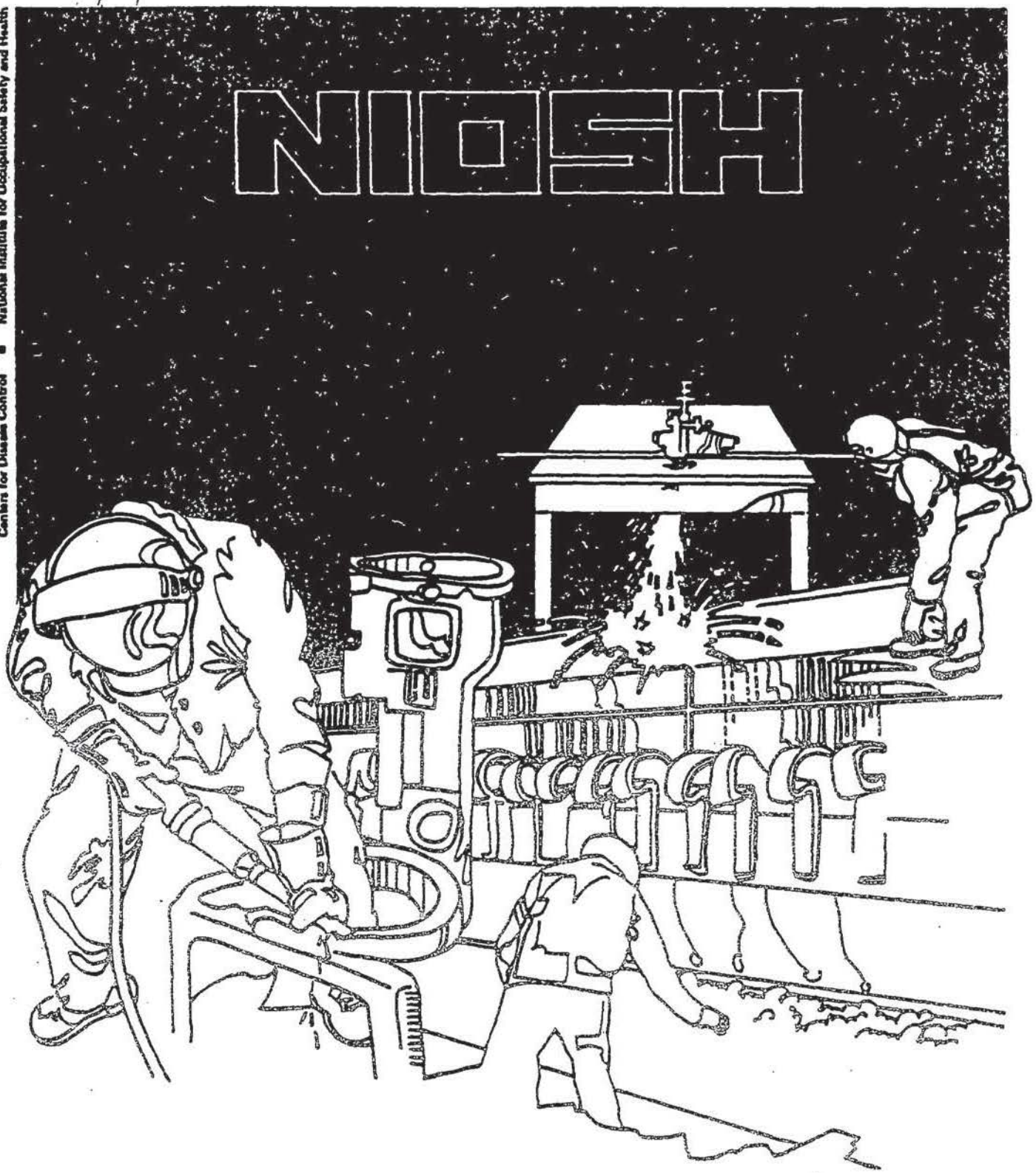
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-445-1487
DELORE INTERNATIONAL
CINCINNATI, OHIO

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 83-445-1487
JULY 1984
DELORE INTERNATIONAL
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
Michael S. Crandall, C.I.H.
Richard L. Ehrenberg, M.D.

I. SUMMARY

On September 15, 1983, the National Institute for Occupational Safety and Health (NIOSH) was telephoned by the manager at DeLore© International, Cincinnati, Ohio. He requested that NIOSH determine the nature and air concentrations of odorous vapors infiltrating the DeLore® facility from a polystryrene foam production facility located adjacently in the same building. Twenty-five employees had been experiencing ill-health effects including headache, sore throat and dizziness since occupying new office space a few days prior to the request. DeLore® is a manufacturer of a fingernail care product which is essentially a mixture of organic oils.

On September 16, 1983, NIOSH investigators used Draeger® detector tube samples to determine that dangerous levels of the suspected contaminants pentane and styrene were not present. Informal medical interviews were conducted. On September 19, 1983, charcoal tube air sampling was conducted, and a self-administered health questionnaire was given to DeLore® employees. Results from four one-hour air samples indicated pentane concentrations ranging from 10 to 21 parts per million (ppm) and averaging 15 ppm (SD ± 4). The higher concentrations were in areas which were closer to the interface with the polystyrene foam facility. NIOSH recommends that exposure to pentane not exceed 120 ppm for up to a 10-hour time-weighted average (TWA) exposure, or 610 ppm for any 15-minute period. The OSHA permissible exposure limit is 1000 ppm as an 8-hour TWA. Styrene, toluene and xylene were quantitatively found at concentrations well below all applicable criteria, generally less than 1 ppm. Benzene was quantitated at concentrations less than 0.1 ppm. NIOSH recommends that exposures to benzene be kept to the lowest feasible level.

Follow-up air sampling and a health status survey were conducted on December 7, 1983 to evaluate the effect added controls had upon employee exposure and health. At that time pentane concentrations in DeLore® production and office areas had been reduced to a range of 1 to 5 ppm (average 2.4 ppm, SD ± 1.4), and other contaminants were generally not detected. Benzene was present at concentrations less than 0.003 ppm.

The symptoms most frequently reported in the September health questionnaire were dizziness, drowsiness or confusion, eye irritation, and nose irritation. The prevalence of symptoms in 10 of 12 categories decreased from September to December following improvements in control measures. The mean number of symptoms experienced by each employee also decreased after controls were instituted. When analyzed according to work-site, those working in production areas, which were closer to the interface between DeLore® and the polystyrene foam operation, experienced more symptoms per person than those in other areas (8.7 vs 4.0) in September. By the December survey the disparity attributable to work station was no longer present.

We found that the irritative symptoms experienced by the DeLore© personnel were associated with their exposure to pentane and other vapors and were alleviated by the control of this exposure. We have no reason to suggest any likely long-term health effects resulting from this incident.

KEYWORDS: SIC 2488, pentane, styrene, xylene, toluene, benzene

II. INTRODUCTION

On September 15, 1983 NIOSH received request for a health hazard evaluation at DeLore® International, Cincinnati, Ohio. The manager at DeLore telephoned the request to NIOSH. He was referred to NIOSH by the Cincinnati City Health Department. The requestor asked NIOSH to determine air concentration of odorous vapors infiltrating DeLore production and office areas from a polystyrene foam operation located in the same building (Foam Master). The suspected constituents of the vapor were pentane and styrene. Twenty-five of the employees at DeLore were experiencing ill-health symptoms including headache, sore throat and dizziness.

NIOSH initially visited the plant on September 16, 1983. On September 19, 1983 a medical questionnaire was administered to all employees and environmental monitoring was conducted throughout the plant. On December 7, 1983, after controls for reducing air vapor levels were instituted, a second survey with a questionnaire and environmental monitoring was conducted.

III. BACKGROUND

DeLore International was founded in Cincinnati in 1975 to manufacture a fingernail care product. This product is a non-allergenic mixture of organic oils. This is their only product. DeLore employs 20 workers, 15 of whom are in production. The process consists of blending and packaging the oils.

In September 1983 DeLore moved from a location on Reading Road in Cincinnati to their current location on Reinhold Drive. The new office space is leased from and shares the same building with Foam Master, a maker of expanded polystyrene foam products. As soon as the new offices were occupied the employees of DeLore began to experience symptoms including headaches, sore throats, and dizziness. The symptoms were associated with the objectionable smell of vapors from the polystyrene foam process which infiltrated the production rooms, warehouse, and administrative offices. This was due to gaps in the walls above the suspended tile ceiling between the two production areas. It was reported that the odor was the strongest in the afternoon from 4:00 pm on. The work shift at DeLore ends at 5:30pm.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Draeger® direct reading detector tube samples for n-pentane and styrene were collected on September 16, 1983 to address concern that dangerous levels of contaminants were present.

On September 19 and December 7, 1983 air samples were collected using sorbent tubes containing 150 mg of activated charcoal. Air was drawn through the tubes at 0.2 liters per minute (lpm) or 1.0 lpm, depending on the sampling time, using callibrated battery operated sampling pumps. One of the samples collected on September 19 was used to identify components of the vapor. This sample was desorbed with carbon disulfide, injected into a gas chromatograph (GC) for separation with the analytes then being identified using a mass spectrometer (MS). All other samples were analyzed for the major constituents from the GC/MS scan using NIOSH method number P&CAM 127.[1] These analytes were pentane, styrene, xylene toluene and benzene. P&CAM 127 is a GC method using a flame ionization detector. The limit of detection for this method was 0.01 milligrams per sample (mg/sample) for pentane, styrene, xylene and toluene, and 0.001 mg/sample for benzene.

Area air samples during the follow-up on September 19 were collected in production room #3 the warehouse and administrative offices at DeLore. Concurrent area air samples were also collected in the Foam Master production area, and in an attic porch which was the ceiling for part of the DeLore production/warehouse area. Sampling during follow-up on December 7 was essentially the same but conducted only at DeLore to determine what effectiveness the controls added to the process of Foam Master and sealing the gaps between the two production areas had on exposures at DeLore.

B. Medical

During the initial site visit, we interviewed eight production area employees. On September 19, 1983, we distributed a self-administered questionnaire to all 23 DeLore employees and executives. The questionnaire probed for the presence of twelve irritative or constitutional symptoms* during the previous two weeks and during the previous day. On December 7, 1983, following the introduction of improved controls and isolation of the two facilities, we re-administered the questionnaire to 14 workers. In the analysis of the data, we used the number of symptoms

experienced by each individual as a surrogate for the severity of his/her reaction. This was done because virtually all personnel reported some symptoms. Because of the approximate tenfold decline in measured pentane levels (and comparable declines in the levels of other substances sampled) following the institution of the improved control and isolation procedures, we were able to contrast the results of the September medical survey with those of December, using the latter as an estimate for baseline symptom prevalence.

*Headache, itching or burning eyes, irritated or burning nose, painful or burning ears, dry or burning throat, cough, chest congestion, chest tightness, dizziness, drowsiness or confusion, nausea or vomiting, and any other unusual symptom.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage 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 evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department

of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Table 1 presents the exposure criteria and a summary of the effects of inhalation exposure to the contaminants found at DeLore.

Table 1
Exposure criteria and effects of overexposure
for contaminants found at DeLore® International

Substance	TWA (ceiling) Exposure Criteria, PPM NIOSH	ACGIH[2]	OSHA[3]	Effects of overexposure[4]
Pentane	120(610)[5]	600(750)	1000	Short-Term: drowsiness; irritation of eyes and nose; greater exposure leads to unconsciousness
Styrene	50(100)[6]	50(100)	100(200)	Short-Term: irritation of eyes, nose throat and skin; dizziness, headache, drowsiness.
Xylene	100(200)[7]	100(150)	100	Short-Term: irritation to eyes, nose and throat; at high concentrations dizziness, staggering, drowsiness and breathing difficulties.
Toluene	100(200)[8]	100(150)	200(300)	Short-term: irritation of eyes, respiratory tract and skin; fatigue, weakness, confusion, headache, dizziness and drowsiness.
Benzene	see below*	10(25)	10(25)	see below*

*Since benzene causes progressive, malignant disease of the blood-forming organs, NIOSH recommends that benzene be considered carcinogenic in man. Because it is not possible at present to establish a safe exposure level for a carcinogen, the NIOSH recommendation is to restrict exposure to very low levels that can still be reliably measured in the workplace (lowest feasible level, LFL). The NIOSH recommendation can be expected, at a minimum, to materially reduce the risk of benzene-induced leukemia. In addition to possibly causing leukemia, exposure to benzene can result in central nervous system depression and skin irritation, however, not at the NIOSH recommended levels of exposure.[9]

VI. RESULTS

A. Environmental

Detector tube samples collected at 4:00-4:15 pm on September 16, 1983 indicated 50 parts per million (ppm) of n-pentane above the suspended ceiling of the DeLore warehouse, and in a gap at the top of the south wall in the warehouse. The concentration was less than 50 ppm in the general warehouse area. NIOSH recommends that concentrations of pentane be kept below 120 ppm for up to a 10-hour TWA and 610 ppm for a 15-minute ceiling exposure. The OSHA standard is 1000 ppm for an 8-hour TWA exposure.

On September 19 detector tubes for n-pentane collected at 4:00-4:30 pm indicated approximately 75 ppm over the DeLore warehouse ceiling and 50 ppm in the office/reception area, production room number 3 and general warehouse area. Charcoal tube samples collected on the same afternoon indicated concentrations of pentane ranging from 10 to 20 ppm (Table 3) and averaging 15 ppm (SD $\pm$ 4). The 20 ppm found over the warehouse ceiling using the charcoal tube sampling method is considered more accurate than the detector tube method. Low levels of styrene xylene, toluene and benzene were found with concentrations averaging 0.6, 0.2, 0.4 and 0.02 ppm respectively (Table 3). These levels are below all applicable criteria.

Concurrent air sampling on September 19, 1983 in the Foam Master production area (Table 4) showed concentrations of pentane ranging from 27 to 45 ppm (average 38 ppm, SD $\pm$ 8). The 45 ppm sample was located in a loft area, called an attic porch, which was the ceiling over part of the DeLore warehouse and production areas. There was no exhaust from this loft area so vapors tended to accumulate there. The concentration of pentane was 44 ppm next to the expander, a vessel which used steam to heat and expand polystyrene beads into foam. Pentane is an expanding agent in the beads. Again low levels of styrene, xylene, toluene and benzene were detected, averaging 0.8, 0.3, 0.5 and 0.08 ppm respectively.

Sampling conducted on December 7, 1983 reflected the control efforts by both DeLore and Foam Master. The pentane levels averaged 2.4 ppm (range 1 to 5 ppm) over the workday from 9 to 4:30 (Table 5). The highest exposure measured was in the mens restroom. The results from one-hour samples in Table 6 collected from 3:45 pm to 4:45 pm indicated no peak pentane exposure (average 2.8, range 1 to 5 ppm). Contaminants other than pentane were present at very low levels or not detected.

B. Medical

In September 1983, 23 individuals completed the questionnaire. They ranged in age from 18 to 61 years with a mean of 25 years (standard deviation = 11). Twelve (52 per cent) were female. Tenure at DeLore ranged from 1 to 98 months, with a mean of 26 months (s.d. = 35) and a median of seven months. Tenure in the current job ranged from 1 to 98 months, with a mean of 12 months (s.d. = 21) and a median of two months. In December, fourteen employees completed the questionnaire. On this occasion the mean age of respondents was 22 years (s.d. = 2). Eight (57 per cent) were female. The mean tenure at DeLore for this group was 22 months (s.d. = 28) with a median of nine months, and the mean tenure in the current job was 13 months (s.d. =20) with a median of six months.

The symptoms most frequently reported in September were: dizziness (86% of respondents), drowsiness or confusion (77%), eye irritation (77%), and nose irritation (77%) (Table A). For symptoms experienced during the two-week period prior to the survey, the prevalences in ten of the categories decreased from September to December following the improvements in the control measures. The prevalences increased in only two categories. This was a significant change ($p = 0.01$, two-tailed Wilcoxon matched pairs [signed rank] test). Similary, for symptoms experienced on the day preceeding our survey, prevalences again decreased in ten categories and increased in only two. This, too, was significant trend ($p < 0.01$, two-tailed Wilcoxon matched pairs [signed rank] test).

Table 2
Prevalences of Complaints
DeLore International
September 1983 and December 1983

HETA 83-445

	Number and (percentage) with symptom during preceding day		Number and (percentage) with symptom over preceding 2 weeks	
Symptom	Sept.[a]	Dec.[b]	Sept.[c]	Dec.[b]
Dizziness	19 (86%)	1 (7%)	18 (78%)	2 (14%)
Drowsiness (confusion)	17 (77%)	1 (7%)	18 (78%)	1 (7%)
Eye irritation	17 (77%)	4 (29%)	18 (78%)	4 (29%)
Nose irritation	17 (77%)	3 (21%)	18 (78%)	3 (21%)
Headache	16 (73%	8 (57%)	19 (83%)	10 (71%)
Throat irritation	15 (68%)	5 (36%)	17 (74%)	6 (43%)
Nausea or vomiting	13 (57%)	1 (7%)	13 (59%)	1 (7%)
Chest congestion	12 (55%)	8 (57%)	12 (52%)	8 (57%)
Chest tightness	12 (55%)	2 (14%)	13 (57%)	2 (14%)
Cough	8 (36%)	9 (64%)	7 (30%)	10 (71%)
other complaint	8 (36%)	0 (-)	9 (39%)	0 (-)
Ear irritation	7 (32%)	0 (-)	7 (30%)	0 (-)

[a]N=22 (one respondent was absent from work on the previous day).

[b]N=14

[c]N=23

The mean number of symptoms per person experienced during the preceding two-week period decreased from 7.4 (s.d. = 2.9) to 3.4 (s.d. = 2.5) after controls were instituted, and the mean number of symptoms per person on the day prior to the survey fell from 7.4 (s.d. = 3.5) to 3.0 (s.d. = 2.7). In each instance this decrease was significant ($p < 0.01$ by t-test). In both September and December, females reported a slightly greater mean number of

symptoms than did males, but the difference was not statistically significant. The age of the workers did not seem to affect the prevalence of reported symptoms. In the September survey, however, there was some tendency for heavy smokers (more than 20 cigarettes (day) to report fewer complaints (mean = 5.2 symptoms (person) than did non-smokers (mean = 8.2), but this difference was not statistically significant ($t = 1.66$, 12 df; $p > 0.05$).

Finally, we analyzed symptom prevalence according to worksite. Employees who indicated that they worked primarily in one or more of the three production rooms reported a mean of 8.7 symptoms per sperson (s.d. = 2.6) for the day prior to the September survey, whereas those working elsewhere in the facility reported a mean of 4.0 (s.d. = 3.3) symptoms per person ($t = 3.52$, 20 df; $p < 0.01$). For symptoms experienced during the two-week period preceding the September survey, the production room staff reported a mean of 8.7 symptoms per person (s.d. = 2.0). Those working elsewhere reported a mean of only 3.8 (s.d. = 2.4) ($t = 4.89$, 21 df; $p < 0.01$). By contrast, in the December survey, for symptoms experienced the previous day, production room personnel reported a mean of 2.8 per person (s.d. = 2.3) compared to a mean of 3.4 (s.d. = 3.5) for those working elsewhere. The comparable values for symptoms experienced during the preceding two weeks, were 3.0 (s.d. = 2.4) and 4.0 (s.d. = 2.9) per person, respectively. Thus, the disparity attributable to work station was no longer present.

VII. DISCUSSION

The medical data are consistent with the hypothesis that the problems experienced by the employees at DeLore were attributable to the pentane and other vapors present in their new work quarters. Using the number of symptoms/person as a surrogate for the severity of a reaction, and comparing survey results before and after control measures reduced the exposure, we are able to demonstrate, by a variety of measures, a statistically significant decline in the prevalence of health effects.

The mean number of symptoms per person decreased significantly. Similarly, the general prevalence of symptoms fell in ten of the twelve categories queried. Age and sex did not appear to be significant factors. The location of the employee's worksite did seem to be a factor and, in fact, gave some evidence of a dose-response effect. In September, the production areas had levels of pentane (and other measured substances) approximately fifty per cent higher than the office areas. Correspondingly, workers in the production rooms had a statistically significant greater mean number of symptoms than did office personnel. Furthermore, following the institution of the

control measures, this difference in symptom prevalence completely disappeared. Finally, heavy cigarette smoking seemed to have been mildly protective, although not at a statistically significant level. This phenomenon might have been a result of the smokers' being accustomed to the inhalation of irritating vapors.

VIII. CONCLUSION

We found that the irritative symptoms experienced by the DeLore personnel were associated with their exposure to the pentane (and other) vapors and were alleviated by the control of this exposure. While the acute symptoms were uncomfortable and annoying, we have no reason to suggest any likely long-term health effects resulting from this incident. Finally, it should also be emphasized that considerable discomfort was produced in this population by exposures well within currently accepted occupational exposure limits.

IX. RECOMMENDATIONS

Control measure taken by DeLore and Foam Master decreased exposures considerably. Efforts to isolate the two production areas by sealing gaps in walls and ceilings should continue until complete.

X. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-A).

2. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1982. Cincinnati, Ohio: ACGIH, 1982.

3. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised 1980.

4. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-123).

5. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to alkanes. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-151).

6 Leonardos G, Kendall D, Barnard N: Odor threshold determinations of 53 odorant chemicals. J Air Pollut Control Assoc 19(2):91-95, 1969.

7. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to toluene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1973. (DHEW publication no. (NIOSH) 73-11023).

8. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to xylene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1975. (DHEW publication no. (NIOSH) 75-168).

9. Askoy M, Erdem S, DincolGL Leukemia in shoe workers exposed chronically to benzene. Blood 44:837-41, 1974.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Michael S. Crandall, C.I.H.
Industrial Hygiene Engineer
Industrial Hygiene Section

Richard L. Ehrenberg, M.D.
Medical Officer
Medical Section

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By:

Connie L. Kidd
Clerk-Typist
Industrial Hygiene Section

XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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. Requestor, DeLore International, Cincinnati, Ohio
2. DeLore International, Cincinnati, Ohio
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Exposure Criteria and Effects of Overexposure
for Contaminants Found at DeLore® International

HETA 83-445

Substance	TWA (ceiling) Exposure Criteria, PPM NIOSH	ACGIH[2]	OSHA[3]	Effects of overexposure[4]
Pentane	120(610)[5]	600(750)	1000	Short-Term: drowsiness; irritation of eyes and nose; greater exposure leads to unconsciousness
Styrene	50(100)[6]	50(100)	100(200)	Short-Term: irritation of eyes, nose throat and skin; dizziness, headache, drowsiness.
Xylene	100(200)[7]	100(150)	100	Short-Term: irritation to eyes, nose and throat; at high concentrations dizziness, staggering, drowsiness and breathing difficulties.
Toluene	100(200)[8]	100(150)	200(300)	Short-term: irritation of eyes, respiratory tract and skin; fatigue, weakness, confusion, headache, dizziness and drowsiness.
Benzene	LFL	10(25)	10(25)	see below*

*Since benzene causes progressive, malignant disease of the blood-forming organs, NIOSH recommends that benzene be considered carcinogenic in man. Because it is not possible at present to establish a safe exposure level for a carcinogen, the NIOSH recommendation is to restrict exposure to very low levels that can still be reliably measured in the workplace (lowest feasible level, LFL). The NIOSH recommendation can be expected, at a minimum, to materially reduce the risk of benzene-induced leukemia. In addition to causing leukemia, exposure to benzene at levels above the OSHA Standard can result in central nervous system depression and skin irritation.[9]

Table 2
Sampling Results
DeLore International
HETA 83-445

September 19, 1983

Sample Location	Duration	Concentration, PPM				
		Pentane	Styrene	Xylene	Toluene	Benzene
Manager's office	1408-1556	10.0	0.3	0.1	0.1	0.01
Production room #3	1406-1555	14.5	0.6	0.2	0.1	0.01
South wall, warehouse	1453-1558	15.6	0.5	0.2	0.8	0.05
Above ceiling, warehouse	1410-1555	20.6	0.8	0.2	0.6	0.03
Average		15.2(±4.4)	0.6(±0.2)	0.2(±.05)	0.4(±0.4)	0.02(±0.02)
Criteria: (Short-term, PPM)						
	NIOSH	610	100	200	200	LFL*
	ACGIH	750	100	150	150	25
	OSHA	-	200	-	300	25

* Lowest Feasible Level

Table 3
Sampling Results
Foam Master
HETA 83-445

September 19, 1983

Sample Location	Duration	Concentration, PPM				
		Pentane	Styrene	Xylene	Toluene	Benzene
Near expander	1423-1545	43.8	0.6	0.2	0.2	0.06
Near foam mold	1424-1544	27.4	0.5	0.2	1.4	0.06
Attic porch	1447-1543	44.8	1.0	0.3	0.2	0.09
North wall	1455-1557	35.8	1.2	0.4	0.2	0.10
Average (SD)		37.8(± 8.2)	0.8(± 0.3)	0.3(± 0.1)	0.5(± 0.6)	0.08(± 0.02)
Criteria: (Short-term, PPM)						
	NIOSH	610	100	200	200	LFL*
	ACGIH	750	100	150	150	25
	OSHA	-	200	-	300	25

* Lowest Feasible Level

Table 4
Full-Shift Organic Vapor Sampling Results
DeLore International
HETA 83-445

December 7, 1983

Sample Location	Duration	Concentration, PPM				
		Pentane	Styrene	Xylene	Toluene	Benzene
Manager's office	0855-1641	1.0	ND	ND	ND	0.006
Production room #3	0902-1645	2.3	ND	ND	ND	0.003
South wall, warehouse	0904-1638	2.1	ND	ND	ND	0.003
Above ceiling warehouse	0909-1640	1.9	ND	ND	ND	0.003
Mens restroom	0905-1642	4.8	0.05	0.02	ND	0.006
Average (SD)		2.4(± 1.4)	-	-	-	0.004(± .002)
Criteria: (8-Hr TWA, PPM)						
NIOSH		120	50	100	100	LFL*
ACGIH		600	50	100	100	10
OSHA		1000	100	100	200	10

Lowest Feasible Level (no known safe exposure level for a carcinogen).

Table 5
One Hour Organic Vapor Sampling Results
DeLore International
HETA 83-445

December 7, 1983

Sample Location	Duration	Concentration, PPM				
		Pentane	Styrene	Xylene	Toluene	Benzene
Office area	1540-1641	1.0	ND	ND	ND	0.006
Production Room #3	1544-1645	2.5	ND	ND	ND	0.006
Mens restroom	1542-1642	4.8	0.05	0.05	ND	0.009
Average (SD)		2.8(± 1.9)	-	-	-	0.007(±.002)
Criteria: (Short-term, PPM)						
	NIOSH	610	100	200	200	LFL*
	ACGIH	750	100	150	150	25
	OSHA	-	200	-	300	25

* Lowest Feasible Level

Table 6
Prevalences of Symptoms
DeLore International
September 1983 and December 1983

HETA 83-445

	Number and (percentage) with symptom during preceding day		Number and (percentage) with symptom over preceding 2 weeks	
Symptom	Sept.[a]	Dec.[b]	Sept.[c]	Dec.[b]
Dizziness	19 (86%)	1 (7%)	18 (78%)	2 (14%)
Drowsiness (confusion)	17 (77%)	1 (7%)	18 (78%)	1 (7%)
Eye irritation	17 (77%)	4 (29%)	18 (78%)	4 (29%)
Nose irritation	17 (77%)	3 (21%)	18 (78%)	3 (21%)
Headache	16 (73%)	8 (57%)	19 (83%)	10 (71%)
Throat irritation	15 (68%)	5 (36%)	17 (74%)	6 (43%)
Nausea or vomiting	13 (57%)	1 (7%)	13 (59%)	1 (7%)
Chest congestion	12 (55%)	8 (57%)	12 (52%)	8 (57%)
Chest tightness	12 (55%)	2 (14%)	13 (57%)	2 (14%)
Cough	8 (36%)	9 (64%)	7 (30%)	10 (71%)
other complaint	8 (36%)	0 (-)	9 (39%)	0 (-)
Ear irritation	7 (32%)	0 (-)	7 (30%)	0 (-)

[a]N=22 (one respondent was absent from work on the previous day).

[b]N=14

[c]N=23