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

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-72-680

ENERGYLOC, INC.
PORTLAND, OREGON
APRIL, 1980

I. SUMMARY

On March 20, 1979 the National Institute for Occupational Safety and Health (NIOSH) received a request from the president of EnergyLoc, Inc., Portland, Oregon to evaluate the possible health hazards of worker exposure to fibrous glass particles during the installation of fibrous glass floor insulation. Specific employee complaints included sore throats, eye irritation, body welts, infections, coughing and bronchitis. Concern was expressed over possible long-term health effects of such exposure. Personal air samples were collected for determination of fibrous glass and total particulate concentrations, and area samples were collected for formaldehyde determination. The medical evaluation consisted of a respiratory questionnaire, a physical examination of the eyes, nose, throat, skin and lungs, and pulmonary function (breathing) tests before and after the work shift on Monday and Wednesday.

Formaldehyde concentration ranged from 0.007 to 0.033 ppm (NIOSH's recommended standard is 1.0 ppm); fibrous glass concentrations ranged from less than 0.016 to 0.035 fibers per cc of air (NIOSH's recommended standard is 3 fibers per cc of air). Total particulates ranged from 3.3 to 32 mg/cu m; 3 of the 5 samples were below 10 mg/cu m; one was 13.6 mg/cu m and the fifth was 32.0 mg/cu m. The latter two exceeded the State of Oregon standard for total particulates of 10 mg/cu m. Signs and symptoms of skin and respiratory tract irritation which either developed or worsened during the workshift were noted in workers exposed to fibrous glass insulation products. Results of the pulmonary function tests showed no abnormalities.

This investigation showed that employees are exposed to low levels of formaldehyde and fibrous glass and to intermediate to high concentrations of total particulates which are causing irritation in exposed workers. Recommendations on personal hygiene as well as respirator use are described on pages 9 and 10. It was not feasible to determine the possible effects of chronic exposure to fibrous glass in this work force because of the limited number of "exposed" employees and their relatively brief employment time.

II. INTRODUCTION

Under Section 20(a)6 of the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace.

The president of EnergyLoc, Inc. requested such an investigation from NIOSH to evaluate the health hazards presented by exposure to fibrous glass insulation materials. On April 10, 1979 an initial environmental evaluation was conducted and on June 25, 26, and 27th, 1979, a combined environmental/medical survey was done. Results of the environmental data survey were reported to the president of the company in October 1979. Individual pulmonary function test results were mailed to each participant.

III. BACKGROUND

Installation Process

EnergyLoc is a weatherization contractor which sells and installs insulation for homes. In this evaluation exposures were measured during the installation of fibrous glass mat insulation to the underside of the ground floors in houses that have crawl spaces rather than basements, and during the wrapping of the heating ducts and water pipes with fibrous glass insulation.

There were two crews at work during the evaluation. Each morning the crews reported to the office-warehouse building where they were given the work order for that day. Each crew of two or three then loaded the materials needed for that day in their truck and proceeded to the job site. Every house or job is different. Access to the crawl space may be from the outside or through the inside of the house. The crawl space usually varies between 15 to 48 inches in height with an average height of about 24 inches. Some of the spaces are dry and dusty; others are damp and may have standing water in places; spider webs are common. The installers enter the crawl space and, if needed, lay down a plastic vapor barrier. The fibrous glass rolls and/or batting are then passed into the crawl spaces where they are installed. Installation of the fibrous glass is accomplished by the worker lying on his back, inserting the fibrous glass between the floor joists and stapling the material to the joist. The fibrous glass insulation is also usually wrapped around the heating ducts and either taped or tied in place. The materials to which the installers are exposed to are fibrous glass fibers, formaldehyde (present in the insulation as a phenol-formaldehyde binder), cellulose dirt and dust.

During this evaluation, the installers wore coveralls taped at the wrists. Cartridge-type half-face respirators (for dust) were worn but not during the entire time the materials were being handled or the entire time spent in the crawl space.

The worker turnover rate for this work is extremely high, with most employees leaving within 6 months.

IV. EVALUATION DESIGN AND METHODS

1. Environmental

The environmental sampling and analytical methods are shown in Table 1.

2. Medical

Data were collected from all five currently employed insulation installers. The medical evaluation consisted of three parts: respiratory/occupational questionnaire, pulmonary function tests, and physical examination of the eyes, nose, throat, skin and lungs. Examinations were done before and after the work shift starting on Monday after a two-day weekend with no occupational exposure and were repeated on Wednesday. Informed consent was obtained from all participants prior to examination and testing.

a. Questionnaire

A modified version of the 1978 ATS-DLD* respiratory questionnaire was administered to each participant at the work site on Monday. This questionnaire was used to obtain basic information such as demographic data, previous and current occupational exposure, smoking habits, personal and family history of allergic, skin, and respiratory tract symptoms. An abbreviated respiratory questionnaire was also administered before each pulmonary function test to determine the presence of acute symptoms, particularly any which might have developed over the work shift, and to ascertain any factors which might acutely affect pulmonary function results, such as smoking.

b. Pulmonary Function Tests

Pulmonary function tests were done using a Vitalograph** single-breath, wedge-bellows spirometer. Spirometric tracings were corrected to BTPS (body temperature, standard pressure, saturated with water vapor).

Measurements of forced expiratory volume in one second (FEV_1), and forced vital capacity (FVC) were obtained from each participant. The largest of three spirometric tracings was used for calculation. The ratio of FEV_1 to the FVC, expressed as a percentage (FEV_1/FVC), was calculated. The predicted values of Morris et. al (1971)[2] were used for evaluation of observed volumes. A pulmonary fuction test was considered abnormal if FVC or FEV_1 was less than 80% of the predicted value and/or the FEV_1/FVC ratio was less than 70%. In serial evaluations (pre- and post- shift tests), a decline in FVC or FEV_1 greater than 10% and/or a decrease in FEV_1/FVC ratio greater than 6% was considered significant.

*American Thoracic Society - Division of Lung Diseases, National Heart, Lung and Blood Institute, Bethesda, Maryland.
**Mention of commercial names or products does not constitute endorsement by NIOSH

V. EVALUATION CRITERIA[1,3,4,5]

Formaldehyde The primary health effects of exposure to formaldehyde are irritation of the respiratory tract, eyes, and skin. Formaldehyde has been found to cause nasal cancer in rats exposed to high levels (15 ppm) of formaldehyde over a long period of time. An excess cancer risk in humans has not been noted; epidemiologic studies to investigate this possibility are planned.

Fibrous Glass The primary health effects of exposure to fibrous glass are irritation of the eyes, skin and respiratory tract. Concern over the carcinogenic potential of the very thin ($\leq$ 1.5u diameter), long fibers of fibrous glass has been expressed. There is presently no epidemiologic data on workers exposed to fibers of this size. The size fiber used for home insulation, however, is usually large, i.e., >3u in diameter. Epidemiologic studies of workers exposed to fibers of this size have not shown an excess cancer risk.

The environmental criteria and the primary health effects of the substances evaluated are summarized in Table I.

VI. RESULTS

1. Environmental

Thirteen time weighted average (TWA) samples were collected for fibrous glass particle counting. Only three of the 13 contained countable quantities of particles in the size range of $\leq$ 3.5 micron (u) in diameter and $\geq$ 10 u in length. Counts in the 3 samples were 0.021, 0.021 and 0.025 fibers per cubic centimeter of air (or 21,000 and 25,000 fibers per cubic meter). These concentrations are well below the evaluation criterion of three fibers per cc (3,000,000 fibers per cubic meter). This low count is not unexpected as the average diameter of the fibers in the glass used is 6-9 u. Fibers were visible in the air; however, most were larger than 3.5 u.

Five TWA air samples were collected for measurement of total particulates. The total particulates included dust and all sizes of fibrous glass particles. Concentrations ranged from 3.3 to 32.0 mg per cubic meter of air. Two of the sample concentrations (13.6 and 32.0 mg/cu m) exceeded the evaluation criterion for total particulates of 10 mg per cubic meter. The crawl spaces were very dirty, and the material collected in the samples appeared to be mainly ordinary dust.

Five TWA area samples were collected for formaldehyde determination. Concentrations ranged from 0.007 to 0.033 ppm, which is less than 4% of the evaluation criterion of 1 ppm.

2. Medical Results

Four men and one woman, ages 18 to 30, were evaluated before and after the work shift on Monday and Wednesday (2 workers failed to return for testing after the shift on Wednesday). Four of the participants were present smokers, and one was a former smoker. Length of employment ranged from 0.5 to 8 months. The respiratory questionnaire revealed that each participant had at sometime experienced work-related symptoms such as nasal and eye irritation and/or scratchy throat. One individual reported chest tightness and difficulty breathing while running which had developed since beginning to work with fibrous glass. One worker complained of a stuffy nose associated with exposure to cellulose insulation. Three individuals noted development of mucous membrane irritation and/or cough during the workshift both on Monday and Wednesday.

Physical examination revealed that several individuals (4/5 on Monday and 2/3 on Wednesday) had developed a rash on the arms or face during the workshift. Mild to marked redness of the mucosa of the nose and throat was noted in all participants, but as this sign was present before (as well as after) the workshift on Monday (and Wednesday), it could not be determined if this finding was work-related. The redness of the throat appeared to increase somewhat during the shift. Auscultation of the lungs revealed no positive findings. Results of the pulmonary function testing revealed no abnormalities. The FVC and FEV_1 (expressed as percent of predicted) ranged from 97-124% for FVC and 99-120% for FEV_1 with the FEV_1/FVC ratio ranging from 76-84%. There were no significant changes in pulmonary function over the work shift.

VII. DISCUSSION AND CONCLUSIONS

The insulation installer's exposure to respirable fibrous glass particles and formaldehyde was very low. The total particulate levels were, however, elevated and are cause for concern. Most of the particulate material on the filters appeared to be ordinary dust. The airborne fibrous glass particles which were visible were larger than the particle size required for counting. The fibrous glass manufacturer stated that the diameter of the fibers in the product used is from 6-9u. Particle size is a concern because these workers either lie on their backs or sit and look up at their work. In this position large particles could enter the mouth and produce irritation of the throat. Installers wore cartridge respirators (for use with dusts) for only part of the time they were in the crawl space and not while loading and unloading the trucks. The workers indicated that they do not wear respirators on all jobs.

There was physical and/or historical evidence of respiratory tract irritation such as throat redness and cough which either developed or worsened during the workshift. Physical examination revealed that several workers developed a rash during the workshift. Although penetration of fibrous glass through the clothing cannot be prevented entirely, it can be reduced by changing coveralls daily.

Employees were exposed to low levels of formaldehyde and fibrous glass and to intermediate to high concentrations of total particulates. It was not feasible to determine the possible chronic effects of exposure to fibrous glass in the workforce because of the limited number of "exposed" workers and their relatively brief employment time.

VIII. RECOMMENDATIONS

The following recommendations are made to minimize exposure to irritating substances.

1. Workers should wear a NIOSH-approved respirator for use with fibrogenic dusts when working in crawl spaces and when loading and unloading materials in the truck. A respirator maintenance program that complies with the State of Oregon regulations must be implemented.

2. Workers should wear coveralls taped at the wrists and ankles and these coveralls should be laundered daily.

3. Personal cleanliness and hygiene of employees such as washing hands, changing personal clothing daily, and bathing daily as soon after work as possible, should be emphasized.

4. Workers should be informed that fibrous glass is a skin and mucous membrane irritant and that if signs of irritation of the eyes, nose, throat or skin, continue to occur, more care should be taken to reduce contact with fibrous glass materials. Implementation of such measures as outlined above should be helpful.

IX. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this complete 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 ninety days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. 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. EnergyLoc Inc., Portland, Oregon
2. Oregon State Accident Prevention Division, Salem, Oregon
3. U. S. Department of Labor, Occupational Safety and Health Administration, Region X, Seattle, Washington
4. Oregon State Health Department.

For the purpose of informing the approximately 15 - 20 "affected" employees, the employer shall promptly post this determination report for a period of 30 calendar days in a prominent place(s) near where exposed employees work.

X. REFERENCES

1. Chemical Industrial Institute of Toxicology, Progress Report on CIIT Formaldehyde Studies (January 16, 1980), Leon Goldberg, President, Research Triangle Park, N. C.
2. Morris, James L., Arthur Hoski and Lavar C. Johnson, Spirometric standards for healthy non-smoking adults, American Rev. Resp. Diseases, 103:57, 1971
3. NIOSH Criteria for a Recommended Standard...Occupational Exposure to Fibrous Glass, DHEW (NIOSH) Pub. No. 77-152
4. NIOSH Criteria for a Recommended Standard...Occupational Exposure to Formaldehyde, DHEW (NIOSH) Pub. No. 77-126
5. U.S. Dept. HEW (NIOSH), Occupational Exposure to Fibrous Glass, Proceedings of a Symposium, USGPO, Washington, D.C., 1976.

XI. ACKNOWLEDGEMENTS

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TABLE I
EVALUATION CRITERIA
ENERGYLOC INC.
PORTLAND, OREGON
HHE 79-72

SUBSTANCE	RECOMMENDED ENVIRONMENTAL LIMIT	SOURCE	STATE OF OREGON STANDARDS	PRIMARY HEALTH EFFECTS	SAMPLING MEDIUM	ANALYTICAL METHOD
Fibrous Glass	3 fibers/cc $\leq$3.5 um dia $\geq$10 um length	NIOSH(1,2)	None	Skin, eyes, and respiratory tract irritation	Filter (open face)	Fiber count NIOSH P & CAM #239
Formaldehyde	1.0 ppm	NIOSH (3)	2 ppm ceiling	Irritation of the skin, eyes, and respiratory tract	Impregnated charcoal tube	Ion chromatography
Total particulates (included fibrous glass and dirt dust)	10 mg/cu m	State of Oregon standards	10 mg/cu m	Health effects depend on the composition of the particulates	Filter	Total weight minus tare weight

TABLE 2

SUMMARY OF AIR CONCENTRATIONS FOR
FIBROUS GLASS, TOTAL PARTICULATES TO FORMALDEHYDE

ENERGYLOC INC.

PORTLAND, OREGON

HHE 79-72

CREW	INDIVIDUAL	DATE	FORMALDEHYDE PPM	FIBROUS GLASS FIBERS/cc	TOTAL PARTICULATES mg/cu m
1	Installer A	6/25/79	0.019	<0.024	-
	Installer A	6/26/79	-	-	32.6
	Installer A	6/27/79	0.007	<0.019	13.6
	Installer B	6/25/79	0.019	<0.035	-
	Installer B	6/26/79	-	-	3.3
	Foreman	6/25/79	0.019	<0.030	-
	Foreman	6/26/79	-	-	4.0
	Foreman	6/27/79	0.007	<0.018	5.1
2	Installer C	6/25/79	0.033	<0.031	-
	Installer C	6/26/79	0.029	0.025	-
	Installer C	6/27/79	0.016	<0.017	-
	Installer D	6/26/79	0.029	0.025	-
	Installer D	6/27/79	0.016	<0.016	-
	Foreman	6/25/79	0.033	<0.031	-
	Foreman	6/26/79	0.029	0.021	-
	Foreman	6/27/79	0.016	<0.037	-