U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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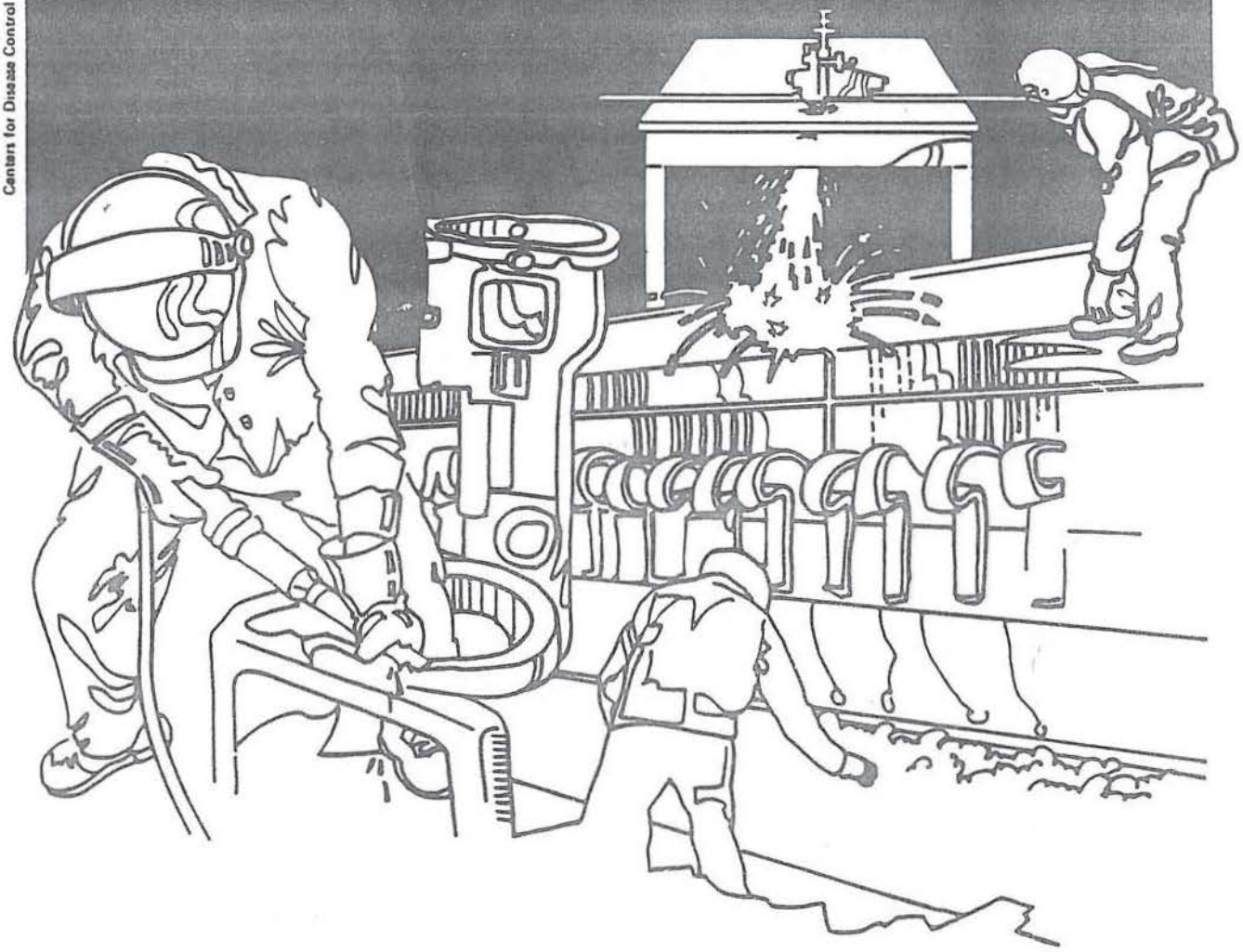
NIOSH



Health Hazard Evaluation Report

HETA 84-172-1573
PHILADELPHIA LIMERICK
POWER PLANT
POTTSTOWN, PENNSYLVANIA

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 84-172-1573
APRIL 1985
PHILADELPHIA LIMERICK
POWER PLANT
POTTSTOWN, PENNSYLVANIA

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I. SUMMARY

In February 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation at the Philadelphia Electric Limerick Power Plant construction site in Pottstown, Pennsylvania. NIOSH was requested to evaluate employees' exposure to Thermo-Lag 330-1. Thermo-Lag 330-1 is an insulation material composed of ammonium phosphate, fibrous glass, and a long-chain of hydrocarbons, not specifically identified. It contains no asbestos fibers. It is used in the fabrication of pipes and conduits at the nuclear power plant. The request noted respiratory irritation to employees working with Thermo-Lag 330-1.

On April 25-27, 1984, a NIOSH team conducted an environmental/medical evaluation. Personal airborne samples were collected for total particulate and formaldehyde. The medical evaluation consisted of a questionnaire survey of 43 workers with various job descriptions and job locations at the construction site.

The survey demonstrated the 8-hour time-weighted average (TWA) exposures for total particulate concentrations ranged between 0.6 to 2.8 milligrams per cubic meter of air (mg/m^3) 8-hour TWA. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for total particulate is 10 mg/m^3. Concentrations of formaldehyde in six personal air samples ranged from 0.03 to 0.08 mg/m^3. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen and that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. The current OSHA standard is 3.7 mg/m^3.

The most frequently reported symptoms on the day of the site visit were chest congestion (30%) and throat irritation (30%) and the most frequent symptoms experienced at any time during the preceding two weeks were throat and nasal irritation (44% and 42%, respectively). There were no statistically significant differences in symptom prevalences in the workers when the results were analyzed according to exposure levels. Clinical interviews however, suggested that vapors from the substance do have some irritating qualities. The inability to document such effects may have been a result of other factors that affected the survey analysis. Since the use of this material at this site was terminated shortly after our survey, we cannot conclusively address these questions in this investigation.

Based on the environmental results, employee interviews, and available toxicological information, it is concluded a health hazard did not exist at the time of this survey. Recommendations to aid in providing a safe and healthful working environment are presented in Section VII of this report.

KEYWORDS: SIC 1629 (heavy construction) construction, Thermo-Lag 330-1 (insulation material), total particulate, formaldehyde.

II. INTRODUCTION

In February 1984, NIOSH received a request for a health hazard evaluation at the Philadelphia Electric Limerick Nuclear Power Plant Construction site in Pottstown, Pennsylvania. The request was submitted by the International Association of Heat and Frost Insulators and Asbestos Workers. NIOSH was requested to evaluate employees' exposure to Thermo-Lag 330-1. Thermo-Lag 330-1 is an insulation material composed of ammonium phosphate, fiber glass, and a long-chain hydrocarbon(s), not specifically identified. It contains no asbestos fibers. It is used in the fabrication of pipes and conduits at the nuclear power plant construction site. The request noted respiratory irritation to employees working with Thermo-Lag 330-1. On April 25-27, 1984, a NIOSH team conducted an environmental/medical evaluation. Personal airborne samples were collected for total particulate and formaldehyde. The medical evaluation consisted of a questionnaires survey of 43 workers with various job descriptions and job locations at the site.

III. BACKGROUND

Bechtel Power Corporation began construction of the Nuclear Power Plant in 1974. The company is constructing a two-unit nuclear station at Limerick, Pennsylvania. Each unit is designed to produce 1,055,000 kilowatts of electric power. Unit no. 1 is scheduled for operation in 1985 and unit no. 2 in 1988. The employees' concerns are job categories and work sites associated with the preparation or installation of the Thermo-Lag 330-1 (insulation material).

Thermo-Lag 330-1 is a white fire proofing insulation material used in the fabrication of pipes and conduits at the construction site. The insulation workers use a power saw to cut the cured insulation to the contour of the pipes and conduits. In this procedure the material becomes airborne. Joints are sealed with uncured Thermo-Lag 330-1 applied with a trowel.

In addition to the survey, an extensive industrial hygiene survey was conducted in December, 1983 by a consultant (Thermal Science, Inc.) for Bechtel Power Company to determine the chemical composition of Thermo-Lag 330-1. Analysis of Thermo-Lag 330-1 by dispersion staining, polarized light and phase contrast microscopy showed a small percentage of fiber-glass (less than 10%) and no asbestos fibers.

Analysis of Thermo-Lag 330-1 by gas chromatography and tandem mass spectroscopy indicated that no aromatic or aliphatic amines are present. Hydrocarbons in the same volatilty range as ethanol, glycols and glycol ethers were detected.

Ultraviolet and visible qualitative spectrophotometric analysis shows that ammonia is a constituent of the Thermo-Lag 330-1. Direct analysis of Thermo-Lag 330-1 for formaldehyde proved to be negative.

In June 1983 the International Association of Heat and Frost Insulators, Washington, D.C. submitted a sample of Thermo-Lag 330-1 to EMV Associates, Inc. (a consultant) in Rockville, Maryland to determine the amount of formaldehyde in Thermo-Lag 330-1. It was determined by EMV Associates, Inc. that Thermo-Lag 330-1 had a formaldehyde content of 344 parts per million.

Based on these findings, formaldehyde is clearly not a primary constituent of the substance analyzed. The low level of formaldehyde present in the material is probably a contaminant of one of the primary ingredients used in this product.

IV. EVALUATION METHODS

A. Environmental

Six personal air samples for total particulate were collected in the fabrication shop and the main building on preweighted FWSB filters using a battery-powered vacuum pump at a flow rate of 1.7 liters per minute (LPM). The total weight of each sample was determined by weighing the sample plus the filter on an electrobalance and subtracting the previously determined tare weight of the filter. The tare and gross weighings are done in duplicate.

Six personal air samples for formaldehyde were collected in the fabrication shop and the main building on "Supelco Orbo 22" sorbent tubes. The samples were drawn at a flow rate of 0.08 LPM. Analysis was by gas chromatography using NIOSH Method 354.[1]

Two charcoal tubes were collected in the fabrication shop for aliphatic and aromatic hydrocarbons using a vacuum pump operative at 0.2 LPM and submitted for qualitative gas chromatography/mass spectrometry analysis. The samples were desorbed with disulfide and then screened by gas chromatography.

One bulk sample of Thermo-Lag 330-1 was collected and submitted for latent formaldehyde analysis. The sample was analyzed according to Burlington Industries standard test method for determination of latent formaldehyde.

B. Medical

During the site visit, we administered a questionnaire to a random selection of day and evening shift workers (including groups exposed to and not exposed to the Thermo-Lag 330-1). The questionnaire elicited information concerning occupational history and exposures, underlying medical problems, and the presence of any symptoms from a list of constitutional and irritative symptoms. We completed questionnaires for 43 workers with various job descriptions and job locations and obtained additional clinical information from six to eight others (not included in the statistical analysis). Finally, we reviewed the site medical procedures and screened the onsite dispensary logs, giving special attention to any clinic visits by insulation workers for non-traumatic problems.

For the analysis, we stratified the workers according to whether they currently worked with the Thermo-Lag (current exposure) and also according to their degree of exposure (exposure level). Exposure levels were estimated based on a history of recent exposure and modified according to job description (e.g., foreman, applier, etc.); 17 workers (40%) were deemed unexposed, 4 (9%) lightly exposed, and 22 (51%) heavily exposed. Comparison according to exposure level was more sensitive than that according to current exposure, and was, therefore, used for most of the data analysis. Because of the small number (4) of lightly exposed individuals (mostly supervisory personnel) and the difficulty estimating their actual exposure, comparison was generally made between the non-exposed and the heavily exposed groups. Symptom prevalences were analyzed in terms of both the 24-hour period and the 2-week period preceding the survey. As measures of possible health effects of exposure to the Thermo-Lag, we considered mean number of symptoms/person and prevalences of specific symptoms. We also grouped symptoms into three general categories (upper airway and mucosal irritation, lower respiratory irritation, or constitutional/systemic) and considered various case definitions based on these groupings (Table 3). Statistical significance was defined as a p-value of less than 0.05; p-values were calculated by chi-square, Fisher's exact, or t-test, as appropriate.

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' of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations are 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 solely 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.

1. Formaldehyde

Formaldehyde gas may cause severe irritation to the mucous membranes of the respiratory tract and eyes. The aqueous solution splashed in the eyes may cause eye burns. Urticaria

has been reported following inhalation of gas. Repeated exposure to formaldehyde may cause dermatitis either from irritation or allergy. Systemic intoxication is unlikely to occur since intense irritation of upper respiratory passages compels workers to leave areas of exposure. If workers do inhale high concentrations of formaldehyde, coughing, difficulty in breathing, and pulmonary edema may occur. Formaldehyde has induced a rare form of nasal cancer in two test animals species as reported in a study by the Chemical Industry Institute of Toxicology. Formaldehyde has also been shown to be a mutagen in several systems.[2,3]

In 1976, NIOSH recommended that occupational exposure to formaldehyde be limited to a concentration of 1 ppm for any 30 minute sampling period.[4] This recommendation however, was based solely on the irritant effects of formaldehyde. In 1979, evidence for the carcinogenic potential of formaldehyde became known and in 1980 NIOSH issued a new criterion which considered formaldehyde as a potential occupational carcinogen and recommended that exposures be reduced to the lowest feasible level.[3]

ACGIH[5], in its notice of intended changes for 1983-84, has proposed that exposure to formaldehyde be limited to a ceiling level of 1 ppm (1.5 mg/m^3).

The federal OSHA[6] standard for exposure to formaldehyde is an 8-hour TWA of 3 ppm, a ceiling level of 5 ppm, and an acceptable maximum peak above the ceiling level of 10 ppm for no more than a total 30 minutes during an 8-hour workshift. These criteria are based on the irritant effects of formaldehyde rather than its potential carcinogenicity.

2. Total Particulate

In contrast to fibrogenic dust which, when inhaled in excessive amounts, cause scar tissue to be formed in the lungs, so called "nuisance" dusts are stated to have little adverse effects on lungs and do not produce significant organic disease or toxic effects when exposures are kept under reasonable control. The "nuisance" dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lungs when inhaled in sufficient amount. However, the lung tissue reaction caused by inhalation of "nuisance dusts" has the following characteristics: 1) the architecture of the air sources remains intact; 2) collagen (scar tissue) is not formed to a significant extent; and 3) the tissue reaction is potentially reversible.

> Excessive concentrations of dusts in the work room air may seriously reduce visibility; may cause irritation of the eyes, ears, and nasal passages; or cause injury to the skin or mucous membranes by chemical or mechanical action per se, or by the rigorous skin cleansing procedures necessary for their removal.[7]

VI. RESULTS AND DISCUSSION

A. Environmental

Results of the six personal air samples collected on April 26, 1984, in the fabrication shop and the main building for total particulate are presented in Table I. The total concentrations ranged from 0.6 to 2.8 mg/m^3 8-hour TWA. The ACGIH (TLV) for total particulate is 10 mg/m^3 the OSHA (PEL) is 15 mg/m^3.

Results of the six personal air samples collected in the Fabrication Shop and the main building for formaldehyde are presented in Table II. Formaldehyde concentrations ranged from 0.03 to 0.08 mg/m^3 8-hour TWA. The analysis of the bulk sample of Thermo-Lag 300-1 for formaldehyde completed by NIOSH detected no formaldehyde in the sample, the limit of detection was 290 ppm. The bulk sample of Thermo-Lag 300-1 submitted to EMV Associates, Inc. had a formaldehyde content of 344 ppm. This clearly showed that formaldehyde is not a primary constituent of the substance analyzed. The low level present in the material is probably a contaminant of one of the primary ingredients used in this product. Nevertheless, NIOSH suspects that even the very low levels of formaldehyde evident in this product may cuase adverse health reactions in certain individuals. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen.

The major peaks of the two charcoal tubed area samples collected in the fabrication shop were identified as n-nonane and n-decane. Minor peaks identified were xylene, n-actane, n-undecane, n-dodecane, n-propylbenzene, aliphatic hydrocarbons ranging from C_9 to C_{12} and molecular weight 120 aromatic hydrocarbons such as trimethylbenzenes and methylethylbenzenes.

B. Medical

Forty-three insulation workers completed the questionnaire. The mean age of the respondents was 35 years (range, 23-54; standard deviation = 9.3). Their mean tenure on their current jobs was 3.2 months (range, 0-9; s.d. = 2.1) and their mean tenure with Bechtel was 7.3 months (range, 1-84; s.d. = 14.8). Thirty-three

respondents (77%) had been exposed to or worked with Thermo-Lag; 26 (61%) had done so within the preceding two weeks. The stratification of respondents according to exposure level was as described in the Methods Section.

We also compared the mean age, tenure on current job, and tenure at Bechtel for the workers in each exposure category (Table 4). The mean tenure on current job for the highly exposed group (3 months) was significantly shorter than that (4 months) for the unexposed group ($p < 0.05$, t-test). In all other respects, the various exposure categories were comparable according to these measures.

We calculated the frequencies with which specific symptoms were reported by the respondents. The most frequently reported symptoms on the day of the survey were chest congestion (30% of respondents) and throat irritation (30%). The most frequently mentioned symptoms present at any time during the preceding two weeks were throat irritation (44%) and nasal irritation (42%) (Table 5). Whether analyzed according to current exposure or by exposure level, we found no significant differences in the prevalences of any specific symptom. This was the case both for symptoms reported at the time of the site visit and for symptoms over the preceding two weeks.

We also considered the mean number of symptoms per person (current or over the preceding two weeks) as a possible measure of reaction to the Thermo-Lag (Table 6). As part of this analysis, we also investigated the possible influence of smoking (defined as more than 5 cigarettes per day), history of allergies, use of a respirator, or exposure to fumes from a caulk substance used by some of insulation workers who didn't work with the Termo-Lag. Although there was a modest increase in the mean number of symptoms per person for each of these variables, none of these trends approached statistical significance (Table 6). The workers highly exposed to the Thermo-Lag had a mean of 2.1 (s.d. = 2.2) current symptoms per person and those not exposed had a mean of 1.8 (s.d. = 1.7). For symptoms during the preceding two weeks, the corresponding results were 3.0 (s.d. = 2.4) and 2.6 (s.d. = 2.2) symptoms per person. Neither comparison approached statistical significance.

When symptoms were combined into upper airway/mucosal irritation, lower respiratory irritation, and constitutional groups, there were modest increases in the proportions of positive responses when comparing non-exposed to highly exposed workers. Seven of 17 (41%) non-exposed workers reported a current symptom of upper airway/mucosal irritation compared to 9 of 22 (41%) highly exposed respondents. Corresponding figures for lower respiratory irritations and constitutional symptoms were 7/17 (41%) versus

12/22 (55%) for the former and 2/17 (12%) and 4/22 (18%) for the latter. Similar patterns were noted for symptoms over the preceding two weeks. None of these comparisons were statistically significant by Fisher's exact test. A similar analysis was done using a case definition combining constitutional symptoms and respiratory irritations; again there were no statistically significant increases of effects in the highly exposed group.

When the same analysis was done comparing the symptom groupings and case definition proportions according to smoking status, allergic status, respirator use, and caulk exposure, only smoking and a history of allergies showed statistically significant positive associations (Table 7). Smoking status was significantly associated with lower respiratory irritation symptoms both at the time of the survey and over the preceding two weeks ($p = 0.015$ and $p = 0.002$, respectively, 2-tailed Fisher's exact test). A positive history of allergies was significantly associated with current constitutional symptoms ($p = 0.027$, 2-tailed Fisher's exact test), and was associated with constitutional symptoms over the preceding two weeks at a level just short of statistical significance ($p = 0.095$).

Finally, it should be mentioned that we obtained from the interviews additional information that could not be analyzed statistically. There were several consistent, anecdotal/clinical descriptions of reactions to Thermo-Lag. Some of these descriptions were from individuals who were not part of the randomly selected cohort but who volunteered information. Other comparable descriptions were reported by questionnaire respondents who no longer worked with this material but claimed to have had such reactions during their previous exposure or who had had reactions before they started to use respirators. Generally, these descriptions were similar and involved symptoms such as a "raspy" sore throat and feeling sick or fatigued. Since these descriptions or situations had not been systematically queried, there was no valid way to analyze their occurrence statistically.

VII. DISCUSSION

Using a variety of measures or surrogates for health effects, we were unable to describe any statistically significant differences between those workers exposed to Thermo-Lag and those not so exposed. This is despite the fact that the consistent descriptions of reported symptoms obtained from the interviews suggested the clinical impression that the Thermo-Lag has an irritant effect. In addition, the questionnaire data demonstrate some tendency for symptom prevalences to increase with exposure to Thermo-Lag, although never to a statistically significant extent.

There are several factors which may explain some of this apparent discordance. We did demonstrate a statistically significant shorter job tenure in the Thermo-Lag group. This could well be a reflection of a rapid turnover in this group, which could be caused by those with reactions to the Thermo-Lag changing to other jobs. This would, in effect, leave a population of "survivors" in the Thermo-Lag jobs, i.e., the survey results might have been skewed by a self-selection process that left relatively unaffected workers in the study group. Another potential explanation for the above results lies in the fact that a number of the control group worked with a caulking material which they believed had irritating fumes. Since we did not specifically question all interviewees concerning this material, we could not analyze its effects, but it is quite possible that symptoms associated with exposure to this caulk among the control group might have blurred any potential intergroup prevalence differences that would otherwise have been attributable to the Thermo-Lag.

Finally, we should mention that bulk sampling demonstrated the presence of ammonia and a variety of glycols and glycol ethers in the Thermo-Lag specimens. As we did not conduct air sampling for these substances, we cannot comment on their possible role in this matter, although the symptoms of concern would be consistent with exposures to such substances.

In conclusion, we believe that the Thermo-Lag may be associated with symptoms of mucosal and airway irritation when used in confined spaces. We were unable, perhaps as a result of the factors outlined above, to confirm this unequivocally, but we believe there are good reasons to suspect that this is the case. We did not find any evidence to suggest that there are any chronic health effects likely to be associated with use of the Thermo-Lag. The presence of the glycol ethers in the bulk sampling warrants some concern, however, because these substances have been associated with adverse reproductive effects.[8] As we did not perform air sampling for these substances, we cannot comment on whether the workers were exposed to significant levels of these agents. Since the use of this material at this site was terminated shortly after our survey, we cannot address these questions in this investigation.

Based on the environmental results, employee interviews, and available toxicological information, it is concluded a health hazard did not exist at the time of this survey on April 25-27, 1984.

VII. RECOMMENDATIONS

1. Conventional engineering controls, such as local exhaust ventilation, would be difficult to employ in most construction projects. However, some of the portable local exhaust systems that are available should be investigated for their possible utility.

2. In the event a primer and/or accelerator material is used with Thermo-Lag 330-1 an environmental and medical evaluation should be conducted. The primer and/or accelerator was not used at the time of the survey on April 25-27, 1984, but it reportedly has been used with the Thermo-Lag 330-1 at other construction sites.

3. Joint management-union education programs should be development to address worker concerns and needs regarding materials used and effects of contaminants in the workplace.

VIII. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 7, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication No. 82-100).

2. National Institute for Occupational Safety and Health. Occupational Diseases: a guide to their recognition. Revised ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication No. 82-100).

3. National Institute for Occupational Safety and Health. Current Intelligence Bulletin #39. Formaldehyde: evidence of carcinogenicty. April 1981. (DHHS (NIOSH) Publication No. 81-111).

4. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard: occupational exposure to formaldehyde. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) Publication No. 77-126).

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

7. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values. 4th ed. Cincinnati, Ohio: ACGIH, 1980.

8. National Institute for Occupational Safety and Health. Current Intelligence Bulletin #39. The glycol ethers, with particular reference to 2-methoxyethanol and 2-ethoxyethanol: evidence of adverse reproductive effects, 1983. (DHHS (NIOSH) Publication No. 83-112).

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. 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. Bechtel Construction, Incorporated, Pottstown Pennsylvania
2. International Association of Heat & Frost Insulators & Asbestos Workers, Washington, D.C.
3. NIOSH, Region III
4. OSHA, Region III

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

Results of Personal Samples for Total Particulates

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 26, 1984

Job and/or Location	Sampling Period	Sample Volume (liters)	Total Particulate mg/m^3*
Insulation worker-fabrication shop	0644-1429	697	2.8
Insulation worker-fabrication shop	0645-1430	698	2.8
Insulation worker-fabrication shop	0646-1424	687	0.6
Insulation worker-control room A-217	0710-1510	720	1.6
Insulation worker-service building, area 3	0718-1515	715	0.9
Insulation worker-reactor area, area 11	0727-1525	717	1.2
Environmental Criteria mg/m^3			10
Limit of Detection			0.01mg

* mg/m^3 = milligrams of substance per cubic meter of air sampled.

TABLE 2

Results of Personal Samples for Formaldehyde

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 26, 1984

Job and/or Location	Sampling Period	Sample Volume (liters)	Total Formaldehyde mg/m^3*
Insulation worker-fabrication shop	0635-1431	36.4	0.06
Insulation worker-fabrication shop	0637-1432	24.3	0.08
Insulation worker-fabrication shop	0640-1430	29.3	0.03
Insulation worker-control room A-217	0709-1511	39.3	0.05
Insulation worker-service building, area 3	0719-1522	24.4	0.08
Insulation worker-reactor area, area 11	0725-1525	35.0	0.06

Environmental Criteria (NIOSH) **see below

Limit of Detection 2 ug

* mg/m^3 = milligrams of substance per cubic meter of air sampled.

**All concentrations are time-weighted averages for the period sampled. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen. An estimate of the extent of the cancer risk to workers exposed to various levels of formaldehyde at or below the current OSHA 3.7 mg/m^3 standard has not yet been determined. In the interim, NIOSH recommends that as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit.

TABLE 3

Symptom Groupings for Case Definitions

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 1984

Category	Constituent Symptoms (1 or more present)
Upper airway/mucosal irritation	Eye, nasal, or throat irritation
Lower respiratory irritation	Cough, wheezing, chest tightness or chest congestion
Constitutional/systemic effect	Headache, dizziness, or fatigue/faintness

TABLE 4

Demographic Results

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 1984

	Mean Age (s.d.)	Months on job (s.d.)	t (df)	p-value	Months at Bechtel (s.d.)	t (df)	p-value	N
All respondents	36 (9.3)	3 (2.1)			7 (14.8)			43
Not exposed	37 (9.4)	4 (2.1)	1.22 (41)	> 0.1	5 (2.3)	0.92 (41)	> 0.1	17
Currently exposed	35 (9.4)	3 (2.1)			9 (19.0)			26
Not exposed	37 (9.6)	4 (2.2)	2.13 (41)	< 0.05	5 (2.3)	0.95 (37)	> 0.1	17
High exposure	35 (9.4)	3 (1.9)			10 (20.6)			22

TABLE 5

Overall Prevalence of Symptoms

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 1984

Symptom (N=43)	Number and (Percentage) Day of Survey	Number and (Percentage) Preceding 2 weeks
Chest congestion	13 (30%)	13 (30%)
Throat irritation	13 (30%)	19 (44%)
Nasal irritation	11 (26%)	18 (42%)
Rash	11 (26%)	14 (33%)
Cough	9 (21%)	14 (33%)
Wheezing	7 (16%)	6 (14%)
Eye irritation	7 (16%)	14 (33%)
Other (miscellaneous)	7 (16%)	11 (26%)
Headache	5 (12%)	7 (16%)
Dizziness/lightheadedness	2 (5%)	3 (7%)
Fatigue/faintness	1 (2%)	2 (5%)
Chest tightness	4 (9%)	5 (12%)
Nosebleeds	0 (-)	4 (9%)
No symptoms	17 (40%)	9 (21%)

TABLE 6

Mean Number of Symptoms per Person

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 1984

	Current Symptoms			Symptoms Preceding 2 Weeks		
	Mean (s.d.)	t (df)	p-value	Mean (s.d.)	t (df)	p-value
Non-smokers	1.5 (2.0)	1.28 (41)	> 0.2	2.2 (2.6)	1.47 (41)	> 0.1
Smokers*	2.3 (1.8)			3.2 (1.7)		
No allergy	1.8 (1.9)	0.81 (41)	> 0.4	2.7 (2.2)	0.50 (41)	> 0.6
Allergies	2.5 (1.9)			3.2 (2.2)		
- Respirator	1.6 (1.6)	0.73 (40)	> 0.5	2.2 (2.1)	1.24 (40)	> 0.2
+ Respirator	2.1 (2.1)			3.1 (2.2)		
- Caulk	1.9 (2.0)	0.35 (41)	> 0.7	2.7 (2.3)	0.53 (41)	> 0.5
+ Caulk	2.1 (1.5)			3.1 (2.1)		
Thermo-Lag						
Non-exposed	1.8 (1.7)	0.46 (37)	> 0.5	2.6 (2.2)	0.57 (37)	> 0.1
High exposed	2.1 (2.2)			3.0 (2.4)		

* > 5 cigarettes/day

TABLE 7

Symptom Groupings Distributions

Bechtel Construction, Incorporated
Philadelphia Limerick Power Plant
Pottstown, Pennsylvania
HETA 84-172

April 1984

	Currently		Preceding 2 Weeks	
	Proportion (per cent)	p-value*	Proportion (per cent)	p-value*
		Lower respiratory irritation		
Non-smokers	6/21 (29%)	0.015	6/21 (29%)	0.002
Smokers**	15/22 (68%)		17/22 (77%)	
		Constitutional symptoms		
No allergy	3/37 (8%)	0.027	6/37 (16%)	0.095
Allergies	3/ 6 (50%)		3/ 6 (50%)	

* Fisher's exact (2-tailed)

** > 5 cigarettes/day