

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION

REPORT 72-53-70

SAFeway STORE
TUMWATER, WASHINGTON

SEPTEMBER 1973

I. TOXICITY DETERMINATION

In response to six requests for Health Hazard Evaluations from retail meat wrapping employees in and around Seattle, Washington, regarding exposure to the thermal decomposition products of polyvinyl chloride (PVC) meat packaging film, a limited study of retail meat wrappers was undertaken. Although the data presented in this report did not result from direct evaluation of the work environment at the Safeway Store in Tumwater, Washington, the findings of this study are generally applicable to retail meat wrapping operations using PVC meat packaging films.

It has been determined that air contaminants generated by the thermal cutting of polyvinyl chloride (PVC) packaging films in conjunction with the wrapping of meat are potentially toxic to some meat wrapping employees. This determination is based upon medical evidence compiled during a limited study of meat wrappers in the United States. This study involved a review of the pertinent scientific literature, consultation with researchers in this area of investigation, the collection of medical histories, clinical observations at the worksite, pulmonary function testing of meat wrappers, and consideration of wrapping procedures, equipment, and meat wrapping environmental conditions.

Evidence suggests that a sizeable percentage of meat wrappers suffer from mild symptoms to include eye, nose, and throat irritation. A portion of these affected meat wrappers who have an underlying predisposition to respiratory difficulties resulting from a variety of conditions (tobacco abuse, asthma, emphysema, and other serious respiratory diseases) experience more serious respiratory problems. These can include shortness of breath, difficulty in breathing, coughing, and general physical distress. This study has not established whether or not presently healthy meat wrappers may develop respiratory difficulties after prolonged exposures to contaminants from thermal decomposition of PVC packaging films.

Although substances in the meat wrapping environment other than those associated with PVC films may be responsible for the previously stated clinical manifestations, the available evidence strongly implies that the air contamination from thermal cutting of PVC packaging film is the causative agent. As yet, the pathophysiologic mechanism for this malady is not clearly understood.

Based on present experience with this particular problem, it is recommended that the following practices be instituted:

1. Pre-employment physical examinations, including chest x-rays and pulmonary function tests be performed on all individuals entering the meat wrapping industry. (Individuals who are found to have severely compromised pulmonary function or who exhibit strong predisposition to pulmonary disorders should not enter the meat wrapping profession.)
2. Meat wrapping machinery should be clean and well maintained. Machines with controlled low temperature cut-off wires are to be preferred. (There is need for further study with regard to controlling contamination at its source via new cutting mechanisms or local exhaust ventilation, etc.)
3. Meat wrapping should be conducted in well ventilated surroundings.

II. DISTRIBUTION AND AVAILABILITY OF THE DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

- a) Safeway Store - Tumwater, Washington
- b) Authorized representative of employees
- c) U. S. Department of Labor - Region X
- d) NIOSH - Region X
- e) Washington State Department of Labor and Industries

For the purposes of informing the 1-3 affected meat wrappers the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of the meat wrapping employees at the Safeway Store, Tumwater, Washington,

as well as from five other stores in Seattle, Washington area regarding employee exposures to the potentially toxic substances emitted from thermal decomposition of polyvinyl (PVC) packaging films in use in the meat department. One to three meat wrapping employees are employed in each of these stores and are subsequently exposed to the substances in question.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

Although several types of meat wrapping machines were observed during the course of this study, most machines incorporated the basic features of the "typical" hand wrapping machine shown in Figure 1.

Wrapping meat involves: (1) pulling out a desired length of film, (2) wrapping the film around a tray or cut of meat, (3) severing the film from the supply roll using the hot wire cut-off, (4) folding the film ends under the package, and (5) sealing the folded ends under the package by touching the package to the heated pad.

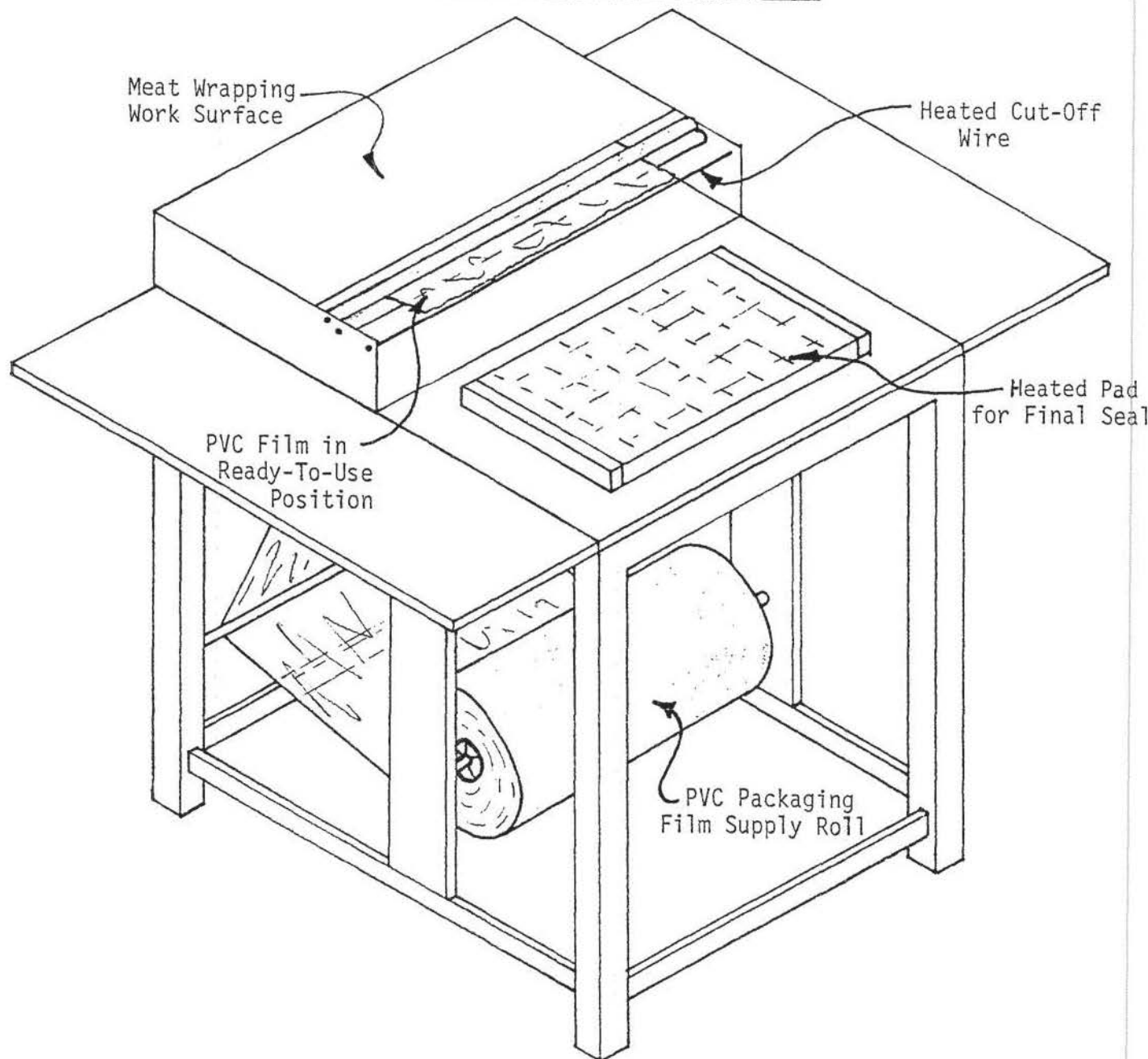
Air contaminants generated by the hot wire cutting of PVC packaging films and their alleged toxic effects on meat wrapping employees constitute the subject of this health hazard evaluation. There are approximately 75,000 meat wrapping employees in the United States, according to union and industry estimates.

B. Study Background and Design

Polyvinyl chloride and wrapping film is made from pure PVC resin and a variety of additives. All additives must be approved by the federal Food and Drug Administration for use in meat packaging materials. These additives include plasticizers, stabilizers, antifog agents, lubricants, and colorants. Plasticizers (dioctyl adipate - di-2-ethyl hexyl adipate, and epoxidized soya or soybean oil) can comprise up to 30% of the film. Stabilizers (calcium-zinc stearate) antifog agents (e.g., polyoxyethylene derivatives of sorbitan monooleate), lubricants (e.g., stearic acid), and colorants together makeup roughly 2-6% of the film.

Several investigators have attempted to identify and quantitate air contaminants generated by the hot wire cutting of PVC film in the meat wrapping environment. Early field measurements for hydrogen chloride (HCl) detected trace amounts (less than 1 ppm) in the vicinity of meat wrapping operations.² A later laboratory study of air contaminants from hot wire cutting of PVC film confirmed the presence of HCl and related its rate of generation together with the rate of generation of particulate to the operating temperature of the hot wire.³ As would be expected, the production of both HCl and airborne particulate increase with increasing wire temperature.

FIGURE 1: Typical Hand-Wrapping Machine



Manufacturers of Wrapping Equipment: Automatic, Semi-Automatic, and Hand Wrapping

Cleveland-Detroit Corporation, Clamco Division
J. B. Dove and Sons, Incorporated
Heat Sealing Equipment Manufacturing Company
The Hobart Manufacturing Company
Package Machinery Company
Reliance Electric Company, Toledo Scales and Systems

Page 5 - Health Hazard Evaluation Determination

To date, three researchers have found the film plasticizer to be the predominant contaminant generated by the thermal decomposition of PVC meat wrapping film.³⁻⁵ The oral toxicity of di-2-ethyl hexyl adipate, as determined by animal experimentation, is relatively low. However, no data are currently available regarding the inhalation toxicity of di-2-ethyl hexyl adipate. It is interesting to note that one researcher, Bovee, et al. identified the plasticizer to be diisooctyl adipate while the other two (Van Houten and Jaeger) found di-2-ethyl hexyl adipate. Diisooctyl adipate has exactly the same molecular weight as di-2-ethyl hexyl adipate and possesses very similar physical properties.

Hydrogen chloride is possibly the second most important degradation product. HCl can be detected at concentrations of 1-5 ppm and is disagreeable at concentrations of 5-10 ppm.

Other film degradation products have been identified, but are present in small quantities when compared to the film plasticizer. These other materials include chlorinated hydrocarbons and breakdown products of film additives.

Workplace concentrations of PVC film decomposition products are difficult to measure. As previously, stated, HCl has been found in very low concentrations in the meat wrapping environment. Laboratory experiments by Van Houten et al. suggest that airborne concentrations of HCl in the plume of "smoke" directly over the hot wire can reach 2 ppm. These measurements were made during "artificially severe operating conditions," which would rarely occur during actual meat wrapping. (It should also be noted that an employee's exposure would be to a significantly lower concentration than that found in the plume close to the wire. In the same study plasticizer concentrations in the plume were found as high as 13 mg/M³. Again, this value was found during artificially severe operating conditions.

Clinical complaints allegedly resulting from exposure to air contaminants from PVC meat wrapping film were first referenced in an unpublished study conducted by NIOSH's predecessor the Bureau of Occupational Safety and Health.² According to that investigation, state health officials in Virginia became involved with complaints from meat wrappers in the summer of 1969. Since that time complaints have come in by letter and telephone from several cities across the Nation. Due to the informal nature of most of the reports, it is difficult to accurately estimate the true number of individuals involved. However, a small group of medical investigators scattered throughout the Nation have reported approximately 50-75 cases of pronounced clinical symptoms.

Page 6 - Health Hazard Evaluation Determination

Subjective estimates from union officials, university investigators, medical professionals, and meat wrappers suggest that a large number of meat wrappers are less seriously affected.

To better delineate the clinical manifestations of exposure to contaminants from PVC film decomposition a preliminary survey of meat wrapping operations was made. Five retail stores in and around Seattle, Washington were visited during August 7-9, 1972. Meat wrapping operations were observed in each retail store and eighteen meat wrappers with varied work experience with PVC films were interviewed. Each worker was questioned in an attempt to elicit symptoms of upper respiratory tract irritation, irritation of the eyes, nose, and throat, and occupational dermatoses. Spirometric measurements were obtained from thirteen of the meat wrappers.

At the completion of this preliminary survey it was clear that a more detailed scientific study would be necessary to elucidate the full ramifications of the potential health problems associated with the use of PVC films. The assistance of the Amalgamated Meat Cutters and Butcher Workmen of North America was solicited to facilitate the location of metropolitan areas where sizeable numbers of meat wrappers were allegedly being adversely affected by air contaminants from PVC films. Following a nationwide search, the City of Louisville, Kentucky was selected as a site for further investigatory research.

A research protocol was developed under the guidance of pulmonary specialists from the NIOSH Appalachian Laboratory of Occupational Respiratory Diseases. The protocol called for the administration of a health questionnaire and the conduction of pulmonary function testing on meat wrappers and suitable controls. The orientation of the questionnaire and the subsequent interview with a NIOSH physician placed emphasis on occupationally related health problems, especially respiratory health problems.

On January 22, 1973, in Louisville, Kentucky, seventeen meat wrappers and twenty non-meat wrappers (office personnel serving as controls) completed medical questionnaires and participated in pre- and post-workshift pulmonary function testing. Technical problems regarding environmental sampling prevented evaluation of employee exposures on the day of testing. As observed in a number of retail establishments, meat wrappers' exposures to contaminants from hot wire cutting of PVC meat packaging film are intermittent and highly variable. To be useful in interpreting employee symptoms, breathing zone air samples would have to reflect both average and short term exposures. Although these contaminants have been measured in undiluted form near the source of generation³, there is at present no suitable method of sufficient sensitivity to measure variable breathing zone concentrations.

Page 7 - Health Hazard Evaluation Determination

C. Evaluation Methods

1. Medical Questionnaire

The medical questionnaire consisted of twenty-six sets of questions. Its purpose as to gather pertinent information concerning an individual's past medical history, smoking history, past occupational exposures, current respiratory status and adverse effects allegedly arising from exposure to air contaminants from PVC films.

2. Pulmonary Function Testing

Each pulmonary function test required the employee to make three forced expiratory volume practice maneuvers after which three forced expiratory volume maneuvers (reproducible within 5%) were recorded as flow volume loops. A waterless, high fidelity spirometer equipped with an air temperature probe was used. The flow volume loops were displayed on a storage oscilloscope and recorded on magnetic tape. A photograph of each oscilloscope display was taken for backup. Computer analysis of flow volume loops provided the following parameters forced expiratory volume in one second (FEV₁), and flow rates at 25,50,75 and 90 per cent of forced vital capacity (FVC).

D. Evaluation Results

1. Preliminary Survey (Seattle, Washington and vicinity)

Sixteen of the eighteen meat wrappers interviewed in the preliminary survey were known to have suffered ill effects from air contaminants from PVC films. Only two workers were free of any clinical symptomatology. Eight had similar case histories and admitted experiencing varying degrees of sneezing, rhinorrhea, and eye irritation. Most individuals gave a like story that the ill effects came on from one to three hours after the commencement of meat wrapping in the morning. The workers stated that as the workday progressed the prodromal manifestations increased in intensity. The sneezing, rhinorrhea, and throat and eye irritation would abate in the evening hours and would be non-existent during weekends and vacations.

Five workers experienced more severe clinical symptomatology necessitating physician intervention and, on occasion, hospitalization. These individuals seemed to suffer with "occupational bronchiolitis." They suffered at times with severe dyspnea, productive cough, and nasal congestion. Onset of these symptoms was from one-half to two and one-half hours after commencement of work. These ill effects led to increased absenteeism. All were on one form of medication or another. This group also stated that a period of several days away from the meat wrapping environment was required for them to feel like their normal selves.

Four of these workers had fifteen or more pack-years of cigarette smoking behind them.

Three meat wrappers had pre-existing susceptibility to upper respiratory symptomatology caused by severe disease processes (rheumatic fever, chronic obstructive pulmonary disease, and lung abscess).

2. Medical Questionnaires (Louisville Study)

Seventeen meat wrappers and a control population of twenty individuals completed the questionnaire. None of the controls reported any adverse clinical symptomatology associated with their particular form of employment. The majority of the controls worked as clerks in retail grocery stores.

As a group the seventeen meat wrappers averaged nine years and three months of experience in the meat wrapping profession. Forty-five per cent of these meat wrappers complained of irritation from film contaminants which resulted in watering and itching eyes. Thirty per cent of the wrappers complained of burning or dryness of the throat. Three wrappers (18%) stated that they experienced "painful breathing" and shortness of breath while working with PVC meat wrap. It is important to note that these same three individuals had a history of allergies, were on medication and were under physician care.

3. Pulmonary Function Testing (Louisville Study)

All pulmonary function data were analyzed by bio-statisticians at the NIOSH Appalachian Laboratory for Respiratory Diseases. The data can be summarized by examining the following statistical tests:

Note: df = degrees of freedom (number of employees tested minus one)

P = probability that a difference occurred by chance alone.

The "student t test" was used to determine whether there were significant differences between groups of individuals with respect to changes in FEV_1 's and FVC's. To be significant, a difference between groups would have a probability of occurring by chance of less than 5% or P less than 0.05.

Page 9 - Health Hazard Evaluation Determination

Test No. 1 - When all exposed (meat wrappers) were compared with all non-exposed (controls) with respect to any differences between pre- and post-workshift values of FEV₁ and FVC, there was no significant difference at the 95% confidence level (i.e. P less than 0.05).

$$\begin{array}{ll} T_{FEV_1} (35df) = -0.35 & P = 0.73 \\ T_{FVC} (35df) = -0.42 & P = 0.67 \end{array}$$

Test No. 2 - When exposed smokers were compared with non-exposed smokers, there was no significant difference.

$$\begin{array}{ll} T_{FEV_1} (11df) = 0.22 & P = 0.83 \\ T_{FVC} (11df) = 0.31 & P = 0.76 \end{array}$$

Test No. 3 - When exposed non-smokers were compared with non-exposed non-smokers there was no significant difference.

$$\begin{array}{ll} T_{FEV_1} (22df) = 0.55 & P = 0.59 \\ T_{FVC} (22df) = 0.11 & P = 0.90 \end{array}$$

Test No. 4 - Test No. 1 was repeated with respect to peak flow and flow at 25,50,75 and 90% of FVC. There was a significant difference for F90.

$$\begin{array}{ll} T_{PF} (35df) = 0.47 & P = 0.64 \\ T_{F25} (35df) = 0.38 & P = 0.71 \\ T_{F50} (35df) = 0.01 & P = 0.99 \\ T_{F75} (35df) = 0.11 & P = 0.91 \\ T_{F90} (35df) = 2.39 & P = 0.02 \end{array}$$

Test No. 5 - Test No. 2 was repeated with respect to the preceding parameters and there was a significant difference for F50.

$$\begin{array}{ll} T_{PF} (11df) = 0.08 & P = 0.94 \\ T_{F25} (11df) = 1.36 & P = 0.20 \\ T_{F50} (11df) = 2.31 & P = 0.04 \\ T_{F75} (11df) = 0.88 & P = 0.40 \\ T_{F90} (11df) = 0.54 & P = 0.60 \end{array}$$

Test No. 6 - Test No. 3 was repeated with respect to the preceding parameters and there were significant differences for F75 and F90.

$$\begin{array}{ll} T_{PF} (22df) = 1.14 & P = 0.27 \\ T_{F25} (22df) = 0.98 & P = 0.34 \\ T_{F50} (22df) = 1.61 & P = 0.12 \\ T_{F75} (22df) = 2.26 & P = 0.03 \\ T_{F90} (22df) = 2.87 & P = 0.01 \end{array}$$

In summary, pulmonary function tests of this small, randomly selected population of meat wrappers revealed no gross pulmonary effects in comparison to a control population after one workshift of meat wrapping. Furthermore, it must be stated that this exposed study group was of general good health and free of serious symptomatology.

E. Discussion

A study of meat wrapping employees is beset by various intrinsic problems from the onset. These include the following:

- a) Low density dispersal of meat wrappers in any geographic area.
- b) No more than two or three meat wrappers employed at any typical retail store.
- c) Meat wrapping work environments, although similar, are not strictly uniform. Differences can exist in packaging equipment (i.e., operating parameters), type of wrapping material ambient environmental conditions (temperature, humidity), general ventilation provisions, work practices, and volume of meat wrapping performed.
- d) Work shifts for meat wrapping employees are highly variable.
- e) There is a lack of suitable sampling and analytical methodology for the evaluation of employee exposures to PVC film decomposition products encountered in retail meat wrapping. At present, methods are not sensitive enough to characterize intermittent exposures or variable constant exposure via breathing zone sampling techniques.

The above problems interrupted the completion of this preliminary controlled scientific study. At this point, a limited amount of data have been compiled for a population of basically healthy meat wrappers. There remains the necessity to study a sizeable population of seriously affected meat wrappers. It is felt that such a population exists based upon scattered reports of clinical symptomatology from various medical investigators throughout the Nation.

V. REFERENCES

1. Vandervort, Robert - Personal Communication by Letter with Major Film Manufacturers, 1970.
2. Vandervort, R. "Polyvinyl Chloride Meat Wrapping Film Study," unpublished USPHS, BOSH, DOIDC, Technical Assistance Report, Cincinnati, Ohio (1971).

Page 11 - Health Hazard Evaluation Determination

3. Van Houten, R., A. L. Cudworth, C.H. Irvine. Evaluation and Reduction of Air Contaminants Produced by Thermo Cutting and Sealing of PVC Packaging Film. Liberty Mutual Insurance Company, Hopkinton, Mass. (Unpublished).
4. Bovee, H.H., L.E. Monteith, and R.M. Orheim. Thermal Decomposition of Meat Wrapping Film. Department of Environmental Health, School of Public Health and Community Medicine, University of Washington. (Unpublished).
5. Vandervort, Robert - Personal Communication by telephone with Dr. Rudolph Jaeger, Associate Professor of Toxicology at Harvard University School of Public Health.
6. Patty, F.A. Industrial Hygiene and Toxicology, Vol. II, John Wiley & Sons, 1963.

VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By: Phillip L. Polakoff, M.D.
Medical Officer

Robert Vandervort
Industrial Hygienist

Originating Office: Jerome P. Flesch, Chief
Hazard Evaluation Services Branch

Acknowledgements

N. Leroy Lapp, M.D., ALFORD, Morgantown, West Virginia

Arvin G. Apol, Regional Industrial Hygienist, Region X,
Seattle, Washington

Bobby J. Gunter, Ph.D., Regional Industrial Hygieniest, Region VIII,
Denver, Colorado

Richard Gais, Pulmonary Technician, ALFORD, Morgantown, West Virginia