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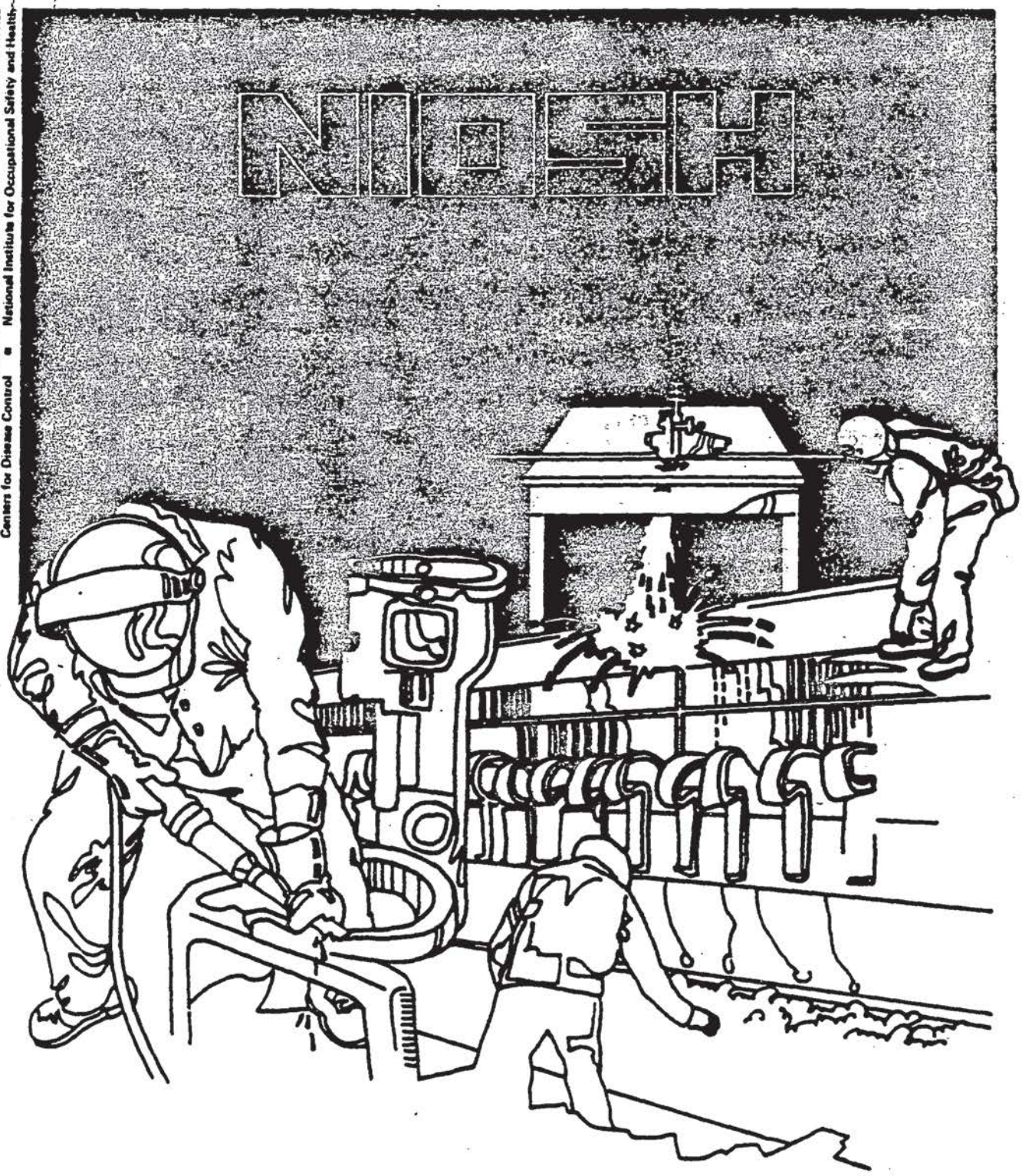


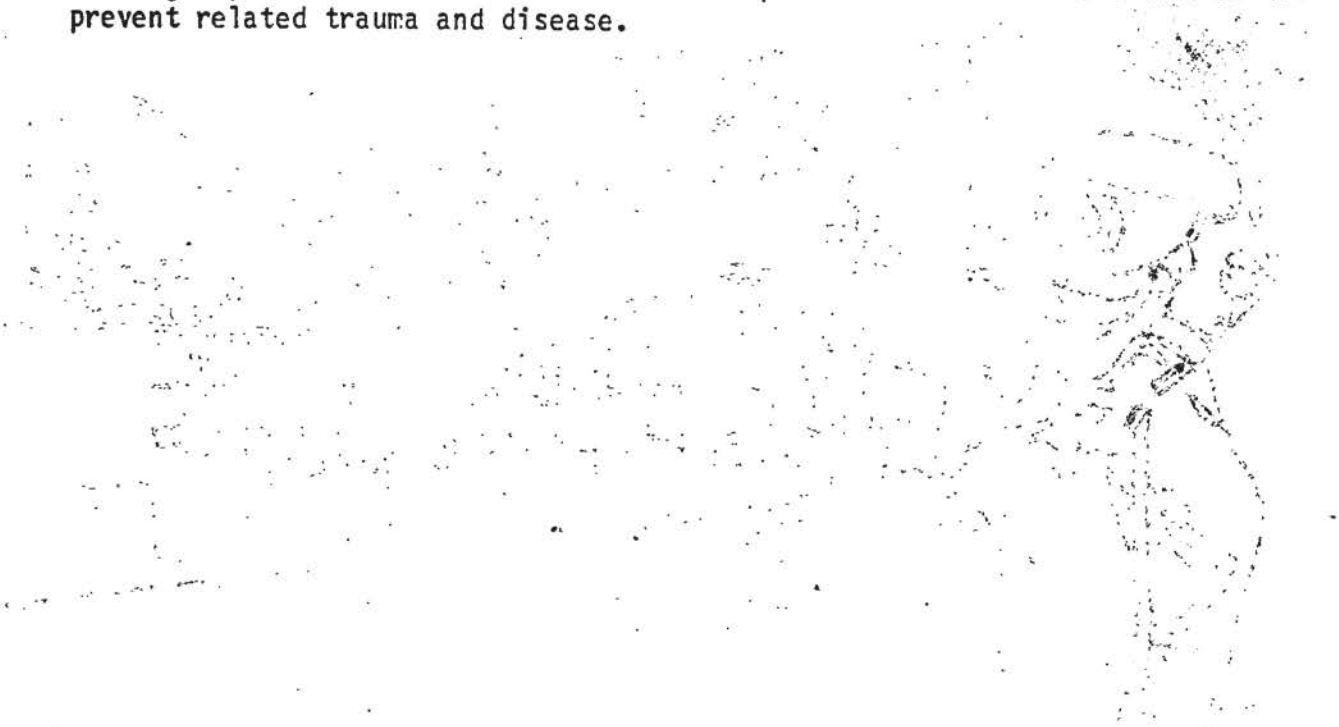
Health Hazard Evaluation Report

HETA 84-239-1588
ASHLAND SUPER VALU
ASHLAND, WISCONSIN

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.



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HETA 84-239-1586
MAY 1985
ASHLAND SUPER VALU
ASHLAND, WISCONSIN

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I. SUMMARY

On March 14, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate the respiratory complaints among meat wrappers at Ashland Super Valu, Ashland, Wisconsin.

In April 1984, NIOSH investigators conducted an initial survey of the facility during which confidential medical interviews were conducted with employees in the meat cutting and wrapping department. Following this survey, the medical records of one employee were obtained. In June 1984, personal and area samples were collected to assess airborne exposures to thermal degredation emissions from the meat wrap (total particulate, di-2-ethylhexyl adipate, and hydrochloric acid) and label adhesive (total particulate, cyclohexanol, dicylohexyl phthalate, and phthalic anhydride).

Hydrogen chloride (HCl) was not found above the limit of quantitation of 2.57 micrograms (ug) in a personal sample, but was found at a time-weighted average (TWA) concentration of 0.11 ppm in one of two process samples collected near the cool rod cutter. [OSHA ceiling standard for HCl - 5 parts per million (ppm)]. TWA concentrations of total particulate were 0.11 and 0.21 milligrams per cubic meter of air (mg/M^3) in process samples collected above the labeler and cool rod respectively, and 0.10 mg/M^3 in a general area sample. [ACGIH TLV for nuisance dust - 10 mg/M^3]. None of the following contaminants were found above their corresponding limits of detection; dicyclohexyl phthalate (20 ug/sample), di-2-ethylhexyl adipate (20 ug/sample) or cyclohexanol (0.01 mg/sample) in either the process or personal samples. Phthalic anhydride was detected (18.4 ug/g) in a bulk sample of the labeling stock, but was not detected in the process or personal samples above the limit of detection (1.54 ug/sample).

Medical interviews with four meat department employees revealed only one, a meat-wrapper, with work-related respiratory tract symptoms. Information in the medical records of the symptomatic individual neither refuted nor confirmed the emissions from the meat wrap or labels was the cause of the symptoms.

On the basis of the data obtained during this investigation, NIOSH was unable to determine whether the persistent symptoms experienced by one employee were due to exposure to emissions from meat wrap or label adhesive. Recommendations designed to futher reduce exposures are included in Section VIII of this report.

Key Words: SIC 5411 (Grocery Stores), heat-activated price labels, meat-wrapper's asthma, respiratory symptoms, cool rod, meat wrap

II. INTRODUCTION

On March 14, 1984, a representative of Ashland Super Valu, Ashland, Wisconsin, requested that NIOSH conduct a health hazard evaluation. The requestor was concerned about complaints of respiratory problems by one of the grocery store's meat wrappers. The Occupational Safety and Health Administration (OSHA) had previously conducted an inspection at the facility in September 1983, and finding no contaminant levels exceeding OSHA standards, had referred the requestor to NIOSH for a health hazard evaluation.

On April 5, 1984, NIOSH investigators conducted an initial survey of the facility. An opening conference was conducted with representatives of management and the local union, during which background information was obtained relating to the basis for the request, the workforce, and the meat wrapping procedures. Following a walk-through survey, medical questionnaires were administered confidentially to the employees in the meat cutting and wrapping department. Following the survey, the medical records of one employee were obtained for review.

On June 20 and September 6, 1984, environmental surveys were conducted, during which personal and general area air samples were collected to assess the potential emissions from the meat wrapping and labeling operations. The results of these samples were transmitted to the requestor by phone in August and December of 1984.

III. BACKGROUND

Ashland Super Valu, a retail supermarket, has been at its present location for approximately five years; however, the building itself has been occupied by other grocery businesses since 1941. The area of concern in this evaluation, the meat department, is located in the rear of the store. At the time of the survey, there were five employees working in this department; three full-time meat cutters, one full-time meat wrapper, and one part-time meat wrapper.

In the meat processing operations, bulk quantities of meat and meat products delivered to the store are placed in walk-in refrigerators/freezers within the meat department. When needed, the meat is retrieved from storage and brought into the preparation area, which is also refrigerated, where it is processed into retail sale portions by the meat cutters. The meat cutters place the meat on plastic-foam trays, and it is then stacked on a cart and moved to the packaging area in the front of the room.

The majority of the meat wrapping takes place on a semi-automated packaging line. The meat wrapper pulls out the desired length of transparent shrink wrap (R. J. Reynolds Filmco - MWSA Code 322), wraps it around the tray, cuts it using a "cool rod", and folds under the edges of the wrap. The tray is then placed on a U-shaped conveyor which passes it over and through an enclosed heater/hot-plate, shrinking the wrap around the tray and sealing the edges. The meat continues around the conveyor to an automated scale, located directly to the side of the

meat wrapper, where it is weighed and a label is printed. Next, a hot plate briefly comes into contact with the printed side of the label, thereby activating the adhesive, and it is then stamped onto the packaged meat item. On items having non-uniform shapes or sizes, the meat wrapper may apply the heated label directly by hand. The packaged and labeled meat is dispensed into a container from where it is either placed in the a meat counter for immediate sale or in a holding refrigerator until needed.

A hand wrapping machine is located to the side of the room. This machine uses a stretch wrap (Goodyear Prime Wrap II) which is pulled around the meat, cut with a "cool rod", and placed on a hot plate to seal the ends of the wrap. This machine is not frequently utilized, and was only in operation for short time periods during the survey visits.

A prior investigation of the facility had been conducted by the Occupational Safety and Health Administration (OSHA) in September 1983 in response to a formal employee complaint. Concentrations of di-2-ethylhexyl adipate and dioctyl phthalate in personal and area air samples were found to be below the limit of detection. Colorimetric indicator tube tests for vinyl chloride, formaldehyde and carbon monoxide did not reveal concentrations of these substances above the limits of quantitation. An area sample located approximately one foot from the meat wrapping machine showed a total particulate concentration of 0.086 milligrams per cubic meter of air (mg/M^3). No citations were issued by OSHA as a result of the investigation, and it was recommended that use of the "cool rod" wrap cutter be continued and that the use of local exhaust ventilation would be desirable. It was also recommended that the symptomatic employee contact an occupational physician or specialist, and if the symptoms persisted, that NIOSH be requested to further evaluate the workplace.

IV. MATERIALS AND METHODS

A. Environmental

1. Potential Emissions

a) PVC Packaging Film

Meat packaging film is usually composed of PVC resin and various additives. A primary ingredient of most wraps is the plasticizer di-2-ethylhexyl adipate (dioctyl adipate or DOA), which along with epoxidized soybean oil, can comprise up to 30 percent of the wrap.[1,2] Several studies conducted under both field and laboratory conditions have shown the major component of the particulate emissions from meat wrapping film to be the intact plasticizer, DOA (up to 100% of particulate emissions with wire temperatures below 200°C).[3,4] In addition, hydrogen chloride (HCl) has been shown to be the major gaseous component of the thermal decomposition emissions of PVC wraps.[4] HCl is emitted through the dehydrochlorination of the PVC polymeric material. Although the amount given off may vary with temperature, HCl has been shown to evolve during both hot-wire and "cool rod" cutting of PVC meat wraps.[4,5] While the HCl would generally be expected to be

emitted as a gas, laboratory tests have shown that it also may be attached to particulate emissions.[4] In addition, a number of other substances have been identified in film wrap emissions studies; however, the concentrations of all of the previously mentioned substances are generally low in actual applications, particularly with use of a cool rod at temperatures below 200°F.[4]

b) Label Adhesive

Pricing labels used in meat packaging generally utilize a paper stock coated on one side with a thermally activated adhesive, a major component being the plasticizer dicyclohexyl phthalate (DCHP).[1] Substances which have been reported to be present as major thermal decomposition products of the label adhesive include the intact plasticizer DCHP and cyclohexanol.[6], Other substances identified as components of the emissions include phthalic anhydride, cyclohexyl ether, cyclohexyl benzoate, and 2,5-di-tert-amyl quinone.[1,7,8]

2. Survey Design

Following the initial survey of April 5, 1984, the manufacturers of the wrapping and labeling materials used at the store were contacted regarding the composition of their products. Based on the information collected, we determined that the materials utilized in the store were of similar composition to those examined in previous studies. An environmental survey was then designed to assess process emissions and employee exposures during wrapping and labeling operations. The selection of substances for inclusion in the sampling protocol was based on the results of previous surveys, with particular attention given to substances either determined to be major emission components or identified as being potential respiratory irritants and/or sensistizers.

On June 20 and September 6, 1984, environmental surveys were conducted in the meat department of Ashland Super Valu during which samples were collected to assess airborne exposures to emissions from the meat wrapping and labeling operations. Four types of samples were obtained during the survey: 1) personal samples, designed to reflect employee exposure, collected near the breathing zone of the meat wrapper; 2) area samples, designed to reflect general ambient concentrations, collected at specific locations in the meat department; 3) process samples collected as close as possible to the labeler and the cool rod cutter, where the highest contaminant concentrations would be expected; and 4) a bulk material sample, for component analysis, of the adhesive labeling stock. Air samples were collected using battery-powered sampling pumps connected via Tygon® tubing to the collection media. Varying flow rates were used in order to collect both "high volume" samples for screening for the presence of individual substances, as well as lower sampling rates allowing for more quantitative exposure determinations. The numbers of samples, collection media, and method of analysis were as follows:

a) Three mixed cellulose ester membrane filters followed in-line by florisil sorbent tubes, for analysis of dicyclohexyl phthalate using a gas chromatograph equipped with a flame ionization detector (GC/FID).

b) Three mixed cellulose ester membrane filters followed in-line by Florisil sorbent tubes, for analysis of di-2-ethylhexyl adipate using GC/FID.

c) Three pre-weighed polyvinyl chloride PVC filters, for anlaysis of total particulate weight by gravimetric weighing.[9]

d) Three charcoal tubes, for analysis of cyclohexanol by by GC/FID.[9]

e) Five Supelco ORBO-53 silica gel tubes, for anlaysis of hydrogen chloride by NIOSH Method No. 7903.[9]

f) Four Zefluor Teflon membrane filters placed in vials containing three milliliters of methanol immediately following sampling, for analysis of phthalic anhydride using high pressure liquid chromatography and an ultraviolet detector (HPLC/UV).[10]

g) One bulk sample of the label stock, for analysis of phthalic anhydride by extracting approximately 0.4 grams of the material with 3 ml methanol and analyzing by HPLC/UV.

A complete listing of the locations and durations of sample collection is provided in Table 1.

B. Medical

During the initial survey of April 5, 1984, confidential interviews were held with all employees working in the meat cutting and wrapping department. Information was solicited regarding their work history and the presence of any general or work-related health problems. The medical records of the initially identified symptomatic employee were obtained for review.

V. EVALUATION CRITERIA

A. General

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 becomes 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, 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 required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) to meet 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.

B. Specific Substances

1. Thermal Emissions from PVC Packaging Films

a) Di-2-ethylhexyl adipate (DOA)

DOA is used in PVC films because of its low temperature performance characteristics and its very low acute toxicity when ingested. Alkyl and alkyloxy adipates generally possess low acute toxicities and only very slight irritant effects on the skin and eyes.[11] Very little information is available regarding inhalation of DOA, and there are presently no specific occupational health standards or criteria for this substance.

b) Hydrogen Chloride

Inhalation of HCl gas can cause irritation of the respiratory tract, with burning, choking, and coughing. At high enough concentrations, severe breathing difficulties may occur, which may be delayed in onset. Most people can detect HCl at concentrations ranging from 1 to 5 ppm, with exposures from 5 to 10 ppm found to be disagreeable.[12] While there is no NIOSH recommended standard, the current OSHA standard and ACGIH recommendation for HCl is a ceiling concentration of 5 ppm.[13]

2. Thermal Emissions from Label Adhesives

a) Dicyclohexyl Phthalate (DCHP)

Little data are available regarding the health effects from exposure to DCHP. Studies of other high-molecular weight phthalate esters, such as di-n-octyl and di-2-ethylhexyl phthalates show a very low order of acute toxicity, although the latter substance has shown to be carcinogenic in rodents.[14] Although inhalation challenge tests with thermoactivated price label fumes have been shown to produce airway obstruction and respiratory distress in some meat wrappers having a history of respiratory distress, DCHP did not show bronchospastic action when examined individually in clinical challenge tests.[15] There are currently no occupational health standards or criteria for DCHP.

b) Phthalic Anhydride

Vapor, fumes, or dust of phthalic anhydride may cause irritation of the eyes. In addition, it is both an irritant and sensitizer of the skin and respiratory tract and may cause asthma upon repeated exposure. Inhalation may also cause attacks of asthma in persons with pre-existing asthma.[12] While there is no NIOSH recommended standard, the current OSHA standard for phthalic anhydride is 2 ppm as an 8-hour TWA, and ACGIH recommends a TLV of 1 ppm.[13,16]

c) Cyclohexanol

Overexposure to cyclohexanol may cause headache and irritation of the eyes, nose, and throat. High concentrations (145 ppm) have shown only minimal changes in the liver and kidneys of rabbits, and no chronic systemic effects have been reported in humans.[12] While there is no NIOSH recommended standard, the current OSHA standard and ACGIH recommendation for cyclohexanol is 50 ppm as an 8-hour TWA.[13]

C. Meat Wrapper's Asthma

"Meat wrapper's asthma" is a misleading term used to describe respiratory symptoms, such as wheezing, shortness of breath, and chest tightness, occurring in workers exposed to emissions from (a) the cutting and sealing of polyvinyl chloride (PVC) film with a hot wire, and/or (b) the application of package labels utilizing a heat-activated adhesive. Attempts to document immunologic (allergic) hypersensitivity as the explanation for meat wrapper's asthma have been unsuccessful, as have attempts to demonstrate a characteristic spirometric change in pulmonary function. Meat wrapper's asthma is thus considered to be a non-specific pulmonary reaction to emissions from hot wire-heated PVC film and/or heated label adhesive. Like exercise, cold air, and other respiratory irritants, these emissions may precipitate an asthmatic reaction in people with hyperactive airways resulting from underlying asthma or other chronic obstructive lung disease. The PVC and adhesive emissions can also cause eye, nose, and throat irritation.[17,18]

VI. RESULTS

A. Environmental

The results of the environmental surveys are presented in Table 1. Hydrogen chloride was not found above the limit of quantitation of 2.57 micrograms (ug) per sample in the personal sample, but was found at a TWA concentration of 0.11 ppm in one of two process samples collected near the cool rod cutter. Although this value does not reflect a personal exposure, it was well below the OSHA ceiling standard of 5 ppm. TWA concentrations of total particulate were 0.11 and 0.21 mg/M^3 in process samples collected above the labeler and cool rod, respectively, and 0.10 mg/M^3 in a general area sample. The general area sample, which would come closest to approximating a personal exposure, was well below the ACGIH TLV of 10 mg/M^3 for nuisance particulate. None of the remaining contaminants were found above their corresponding limits of detection - dicyclohexyl phthalate (20 ug/sample), di-2-ethylhexyl adipate (20 ug/sample) or cyclohexanol (0.01 mg/sample) - in either the process or personal samples. Phthalic anhydride was detected (18.4 ug/g) in a bulk sample of the labeling stock, but was not detected in the process or personal samples above the limit of detection (1.54 ug/sample).

B. Medical

The NIOSH medical investigator interviewed all four meat department employees working the day of the initial survey, none of whom were smokers. Their years of employment in the meat cutting/wrapping industry ranged from 1.5 to 32 years. One worker (a meat wrapper) believed that irritation of the eyes, nose, throat and lungs was work-related. During March 1983, the meat department of Ashland Super Valu reportedly underwent major remodeling. Meat cutting and wrapping continued during this reconstruction process in a plastic-enclosed environment. Three of the individuals interviewed stated that on some days during the construction smoke and fumes from the meat wrapping operation accumulated to such a degree that they had irritative symptoms affecting their respiratory system. It was after these "enclosure episodes" that the meat wrapper reported the occurrence of persistent irritative symptoms at work. The three other meat department workers, all meat-cutters, reported no work-related irritative symptoms themselves since the March episode, but each acknowledged seeing the affected meat wrapper in some respiratory distress during the months following the "enclosure episodes".

The affected workers's medical records documented several medical visits from April 1983 to January 1984 for work-associated respiratory symptomsthat were diagnosed as irritant (or acute) bronchitis. In February 1984, the worker was seen by a pulmonary specialist because of continued respiratory symptoms. Use of a disposable dust respirator at work reportedly resulted in a lessening of the respiratory symptoms. Physical examination revealed no signs of lung disease, and chest X-rays and pulmonary function tests were within normal limits. The specialist's impression of the case was "history of bronchial hyperactivity due to meat wrapping fume exposure". He recommended

avoidance of exposure to "fumes, aerosols, smoke and dust" because of the "risk for developing bronchial asthma".

VII. DISCUSSION AND CONCLUSIONS

A. Environmental

The environmental samples collected during this survey indicate very low or nondetectable levels of particulate and gaseous emissions from the meat wrapping and labeling operations. HCl was detected in a process sample, but the level was well below the evaluation criterion. Phthalic anhydride, a substance known to be a respiratory irritant and sensitizer, was detected in the bulk sample of the labeling material, but not in the air samples, a finding that has been reported in other studies of thermally-activated label adhesive emissions.[15]

The environmental sample results reflect "normal" meat wrapping operations, such as those encountered during the period of the survey. However, they do not reflect nonroutine conditions such as those that may have been encountered during the period of the meat department remodelling. It is probable that higher contaminant concentrations may have existed at this time; the exact magnitude of which cannot be determined. In addition, the above sample results do not reflect the magnitude of short-term exposures during periodic operator, procedure, or equipment problems. Such an occurrence was noted during an environmental survey when hand labeling of irregular-sized meat packages was taking place. On one occasion, the operator allowed a label to remain on the heated plate for a longer than usual amount of time and visible emissions were noted. A similar problem has been noted in another survey.[6] It is possible that incidents such as this may lead to a higher exposure for a very brief period of time that would not be reflected in the long-term samples which were collected.

B. Medical

On the basis of the data obtained during this investigation, NIOSH was unable to determine whether the persistent symptoms reported by one employee were due to exposure to emissions from heated meat wrap or label adhesive. The reason for the lessening of symptoms secondary to use of a disposable dust respirator is not clear, since this type of respiratory protection may not be effective against fumes or gasseous components of the emissions.

VIII. RECOMMENDATIONS

Although the symptomatic employee reportedly no longer works at the facility, the following recommendations are provided in order to reduce the possibility of future health problems among other meat department employees.

1. Use of the cool rod cutter should be continued, with the thermostatic temperature control set to maintain a temperature below 280°F, as

recommended by the meat wrap manufacturer.[19] Information obtained during the survey indicated that the cool rod was being operated at a thermostatic setting of 375°F, but equipment was not available to the investigators to accurately measure the temperature on this device. Since the amount and type of emissions is dependent on temperature, maintaining the cutting unit at the lowest effective temperature would be advisable.

2. Wrapping equipment should be checked to ensure that sufficient brake tension is applied to the film so that it pulls away from the cutter bar and does not lay on the cutting device.[19]

3. The addition of local exhaust ventilation would provide an efficient means of removing any emissions from the wrapping or labeling operations at their source. While contaminant levels appear to be low during normal operations, the addition of local exhaust ventilation would help reduce any exposure to sporadic high emission levels resulting from operator, procedural, or equipment problems. It is also possible that these intermittent exposures could be eliminated through more carefully designed work practices and procedures which would prevent their occurrence.

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IX. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH publications office at the Cincinnati, address. Copies of this report have been sent to the following:

A. Requestor
B. U. S. Department of Labor, OSHA - Region V
C. NIOSH Regional Offices/Divisions

TABLE 1
RESULTS OF ENVIRONMENTAL SAMPLES COLLECTED AT ASHLAND SUPER VALU
Ashland, Wisconson
June 20, and September 6, 1984.

Sample Date	Sample Type	Sample Location	Sample Time (minutes)	Sample Volume (liters)	Contaminant	TWA Concentration
6/20	Process	Above Labeler	270	270	Dicyclohexyl phthalate	< LOD
6/20	Process	Above Labeler	270	58	Dicyclohexyl phthalate	NA
6/20	Personal	Meat Wrapper	130	26	Dicyclohexyl phthalate	NA
6/20	Process	Near Cool Rod	240	240	Di-2-ethylhexyl adipate	< LOD
6/20	Process	Near Cool Rod	173	37	Di-2-ethylhexyl adipate	NA
6/20	Personal	Meat Wrapper	120	24	Di-2-ethylhexyl adipate	NA
6/20	Process	Above Labeler	210	13	Cyclohexanol	< LOD
6/20	Process	Above Labeler	60	4	Cyclohexanol	< LOD
6/20	Personal	Meat Wrapper	120	25	Cyclohexanol	< LOD
6/20	Process	Above Labeler	270	405	Total Particulate	0.11 mg/M^3
6/20	Process	Near Cool Rod	240	360	Total Particulate	0.21 mg/M^3
6/20	Area	Back of Room	227	340	Total Particulate	0.10 mg/M^3
6/20	Process	Near Cool Rod	155	31	Hydrogen Chloride	< LOQ
6/20	Process	Near Cool Rod	81	16	Hydrogen Chloride	0.11 ppm
6/20	Personal	Meat Wrapper	72	15	Hydrogen Chloride	< LOQ
9/05	Personal	Meat Wrapper	200	300	Phthalic Anhydride	< LOD
9/05	Process	Above Labeler	205	615	Phthalic Anhydride	< LOD
9/05	Process	Above Labeler	115	172	Phthalic Anhydride	< LOD
9/05	Process	Above Labeler	86	129	Phthalic Anhydride	< LOD

Evaluation Criteria - Refer to text of the report

Abbreviations:

TWA - Time weighted average (given for duration of sample collection).
mg/M^3 - milligrams of contaminant per cubic meter of air.
ppm - parts of contaminant per million parts of air.
NA - Not anlalyzed due to failure to detect the contaminant in a high volume sample.
< LOQ - Less than the limit of quantitation
Hydrogen Chloride: 2.57 micrograms/sample
< LOD - Less than the limit of detection
Phthalic anhydride: 1.54 micrograms/sample
Cyclohexanol: 0.01 milligrams/sample
Hydrogen chloride: 0.39 micrograms/sample
Di-2-ethylhexyl adipate: 20 micrograms/sample
Dicyclohexyl phthalate: 20 micrograms/sample

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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