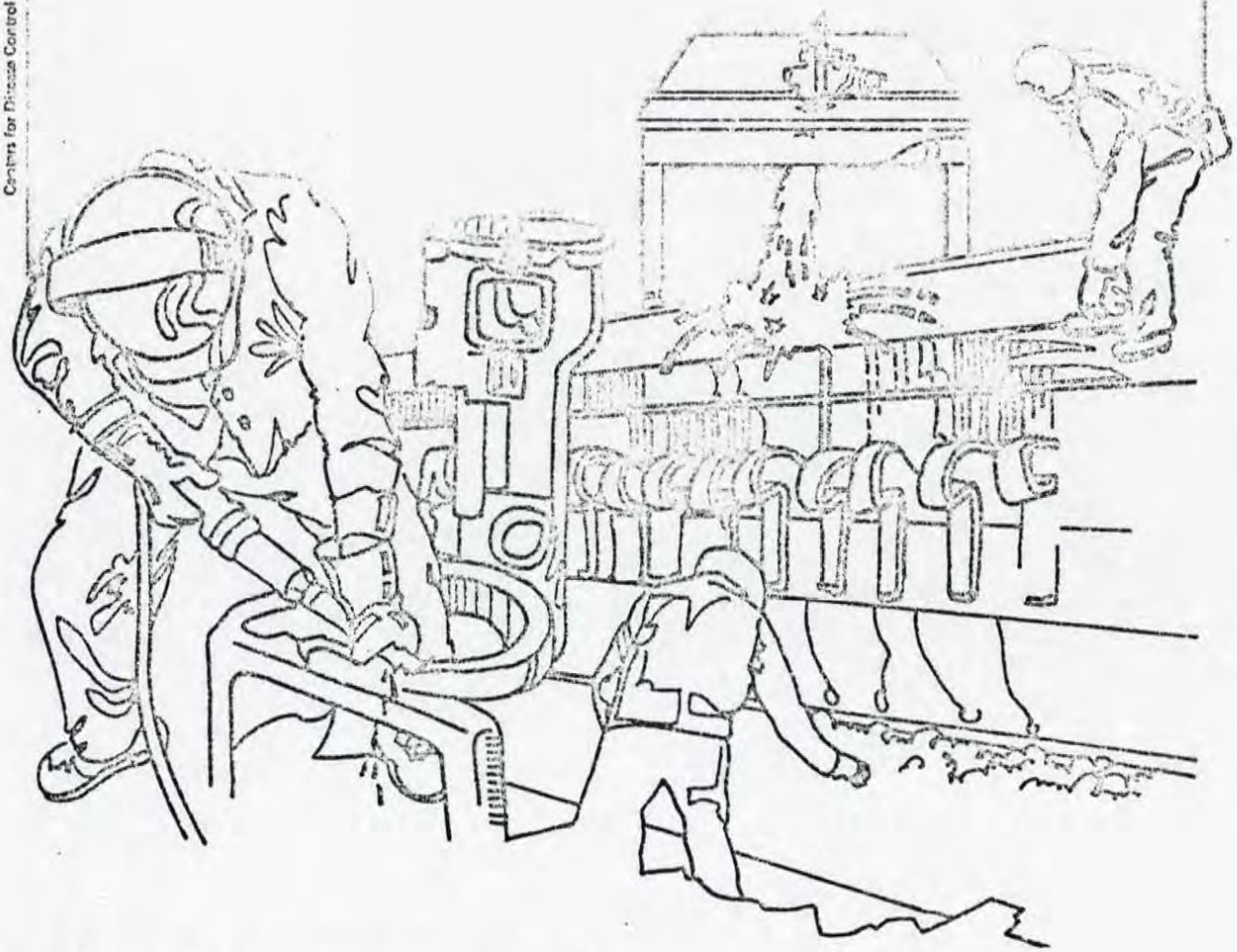
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 80-186-1149
TLB PLASTICS CORPORATION
MARION, INDIANA

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 80-186-1149
JULY, 1982
TLB PLASTICS CORPORATION
MARION, INDIANA

NIOSH INVESTIGATORS
RICHARD W. GORMAN, I.H.
JOANN R. SCHLOEMER, RN, M.Ed.

I. SUMMARY

On June 13, 1980, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Allied Industrial Workers of America (AIW), to conduct a health hazard evaluation at TLB Plastics Corporation, Marion, Indiana. The workers at the plant were concerned their health may have been adversely affected from past exposure to ethylene dichloride and that current exposure to ethyl acetate was causing acute adverse health effects, mucous membrane irritation, respiratory tract symptoms, headaches and dermatoses (rashes). The main production activity involves extruding cellulose acetate propionate into various plastic tubular forms used primarily for packaging. In 1979, ethylene dichloride, a bonding agent used for 25 years was replaced with ethyl acetate.

In response to the request, an initial survey was conducted in August 1980. Previous environmental exposure data was reviewed, and current exposures to ethyl acetate were monitored using an organic vapor analyzer. Fifty-nine workers were interviewed by questionnaire. Company employee medical and absenteeism records, OSHA occupational accident and illness forms, AIW union medical examination records and company death certificates were reviewed.

No previous ethylene dichloride exposure data was available except for three - 1 hour samples obtained in 1977 that ranged from 22-44 ppm. The OSHA standard is 50 ppm. NIOSH recommends a standard of 5 ppm with a 15 ppm ceiling level. Previous and current ethyl acetate data ranged from 2 to 14 ppm. The OSHA standard is 400 ppm.

Greater than 60% of the workers interviewed during the initial survey reported acute adverse health effects specifically mucous membrane irritation and respiratory discomfort. This finding was not consistent with the environmental results which documented ethyl acetate exposures at less than 1% of the current OSHA standard which is based on irritant effects. Due to these findings, a follow-up study was conducted to evaluate the plastic material as a possible source of irritating emission products.

Laboratory analysis of the cellulose acetate propionate, heated to the extrusion temperature revealed that emission products included propionic acid, acetic acid and plasticizers [suspected but not confirmed to be di(2-ethylbutyl)azelate]. A follow-up field visit consisting of environmental monitoring for these substances and questionaire interviews of 30 workers, documented propionic and acetic acid mean exposure levels of 0.2 and 0.1 milligram/cubic meter (mg/m^3) respectively, and an association between prevalence of mucous membrane irritation and increasing exposure. Concentration of the plasticizers was estimated to be less than 1 mg/m^3 above the extruder, but was not measured elsewhere in the plant.

There was no chronic disease pattern that could be associated with past ethylene dichloride exposure. Plastic emission products, rather than solvent exposures, may have been responsible for the mucous membrane irritation even though they are well below current exposure criteria. Recommendations are provided in Section XIII to further minimize solvent exposure, eliminate exposure to extrusion emissions and increase worker comfort.

KEYWORDS: SIC 3070 (plastic molding), Ethylene Dichloride, Ethyl Acetate, Propionic Acid, Acetic Acid, Di(2-ethylbutyl)azelate, Cellulose Acetate Propionate.

II. INTRODUCTION

On June 13, 1980, the Safety and Health Project Director, International Union, Allied Industrial Workers of America, requested a health hazard evaluation at TLB Plastics Corporation, Marion, Indiana. Workers were concerned that their health may have been adversely affected from past exposure to ethylene dichloride, a chemical no longer in use, and that acute health effects were resulting from current exposure to ethyl acetate, a chemical that replaced the ethylene dichloride in the sealer operation in 1979. An industrial hygienist and two medical investigators from NIOSH visited the plant in August 1980. Results of the air sampling conducted during this visit were forwarded to TLB and the requester in November, 1980.

Since ethyl acetate exposures were found to be very low and inconsistent with the employee reported acute adverse health effects data, a follow-up evaluation was conducted at TLB Plastics Corporation on September 9-11, 1981 to evaluate the possibility of other agents causing the acute adverse health effects. Two industrial hygienists and a medical investigator evaluated the possible acute adverse health effects of exposure to plastic emission products (propionic acid, acetic acid, plasticizer) in an effort to determine if these substances were responsible for the employees reported current adverse health effects. Environmental results and recommendations were forwarded to TLB and the requester in February, 1982.

III. BACKGROUND

TLB Plastics Corporation manufactures plastic tubing and shapes used primarily for packaging. They employ 112 labor and 12 management personnel. The process of interest during this evaluation consisted of extruding cellulose acetate propionate pellets into a tubular form which is cut to specified lengths and sealed on one end. The basic chemical, ethyl acetate, is used as a bonding agent in the automated sealing process. Ethylene dichloride was the bonding agent for approximately 25 years until 1979, when it was replaced with ethyl acetate. The sealing operation is the last step of the process except for inspection and packing.

At the time of the August, 1980 survey, there were four base production lines housed in a 4600 square foot area. Seven gas-fired and two electric heating units, suspended from the ceiling, heated the area. Except for one central duct, which supplied 5000 cubic feet per minute (cfm) of conditioned air, there was no mechanical ventilation. Open windows (in warmer months) and several pedestal fans allowed for ventilation and circulation of air. There were two additional production lines in an area called the "clean room" and a separate "P&G" production area that were temperature and humidity controlled. The ethyl acetate was used on the four base production lines and one of the two clean room lines. The P&G area was changed to a base production area in 1981. There were 3 lines using ethyl acetate in this area during the NIOSH survey in September, 1981.

IV. INITIAL SURVEY EVALUATION MATERIALS AND METHODS

An initial survey was conducted on August 20, 1980 with special attention given to the lines using ethyl acetate (formerly ethylene dichloride) in the production process.

A. Environmental

Results of previous environmental surveys were reviewed.

A bulk sample of the ethyl acetate was analyzed for purity.

An organic vapor analyzer, calibrated with the ethyl acetate used at the plant, was used to evaluate airborne concentrations of ethyl acetate during the day shift on August 21, 1980.

B. Medical

The medical evaluation included administration of a directed questionnaire; review of all company death certificates, of AIW Union physical examination medical records of workers having health problems identified in the health hazard evaluation request who were present at the time of the NIOSH medical investigation, review of October 1978 through June 1980 company employee medical and absenteeism records and of OSHA 200 Occupational Accident and Illness Forms.

All previous ethylene dichloride and/or current ethyl acetate exposed workers (59) working at the plant on August 21-22, 1980 (the dates of the investigation) were interviewed. Questionnaires were administered to all 59 workers to ascertain work exposure and health habit histories and the prevalence of: 1) specific chronic diseases known to be associated with ethylene dichloride exposure, and 2) specific acute adverse health effects associated with ethyl acetate exposure.

The 59 workers interviewed were placed into one of three exposure groups: 1) previous ethylene dichloride exposure only; 2) previous ethylene dichloride plus present ethyl acetate exposure; and 3) present ethyl acetate exposure only. Exposures were graduated by job title from most exposed to least exposed to the ethyl acetate (formerly ethylene dichloride).

The 49 ethylene dichloride exposed workers (Group 1 and 2) were evaluated for excess prevalence patterns of chronic diseases known to be associated with ethylene dichloride exposure. In addition, the 10 workers exposed to ethyl acetate only were used as a comparison group to the 12 workers exposed to ethylene dichloride only, because ethyl acetate is not known to have chronic effects. The 47 workers exposed to ethyl acetate (Group 2 and 3) were assessed for excess prevalence of acute adverse health effects associated with over exposure to ethyl acetate.

Death certificates and AIW Union Medical Physical Examination Records were reviewed and compared for adverse health effects known to be associated with ethylene dichloride and ethyl acetate exposure. The 1978-79 and 1979-80 TLB Plastics Corporation Medical and Absenteeism Reports and OSHA 200 Occupational Accident and Illness Forms were reviewed and evaluated for acute adverse health effects and chronic disease prevalence patterns.

V. INITIAL SURVEY EVALUATION CRITERIA

Remarks on ethylene dichloride are included since long-term health effects from past exposure were of concern.

Ethylene Dichloride:[4-7,9]

The current OSHA standard for this substance is 50 parts per million (ppm). Based on the results of animal studies, NIOSH recommends that ethylene dichloride be handled as a human carcinogen and that exposure to this substance be eliminated or minimized to the extent possible. Animal studies have also reported ethylene dichloride to have mutagenic as well as tertatogenic effects (abnormal development of the fetus.[6]

Acute human health effects related to over-exposure to ethylene dichloride airborne exposure include mucous membrane irritation (dry and/or sore throat, burning, itching, redness and tearing eyes, nasal irritation, discharge or nosebleeds), corneal injury, gastrointestinal tract upset (loss of appetite, nausea, vomiting, epigastric pain), dermatoses (severe skin irritation, edema, destruction), and central nervous system effects (dizziness, insomnia, headache). Ingestion of a few milliliters has caused headache, lethargy, somnolence, difficulty breathing, pulmonary edema, hypoglycemia, hypercalcemia, decrease in urine, liver and kidney damage and death within a week.

Chronic health effects associated with ethylene dichloride over-exposure include liver and kidney (renal tubule) damage, bile duct/gallbladder dysfunction, central nervous system effects (dizziness, weakness, coma), cardiopulmonary system effects (difficulty breathing, rapid heart rate, cyanosis) and recently, suspect reproductive effects.

Ethyl Acetate:[7,9]

The current OSHA standard for ethyl acetate is 400 ppm. NIOSH does not have a recommended exposure standard for this substance.

Acute health effects associated with over-exposure to ethyl acetate include irritation of the nose and throat, anemia, cardiopulmonary system effects (respiratory tract irritation, pulmonary edema, labored breathing), central nervous system depression and rashes. Ethyl acetate is not known to cause chronic effects.

VI. INITIAL SURVEY RESULTS AND DISCUSSION

A. Environmental

Ethylene Dichloride

The only data available that indicated the extent of past exposures to ethylene dichloride was a survey done by the company's insurance carrier in January 1977. Three 1-hour samples collected on charcoal tubes at a sampling rate of 500 cc/min. ranged from 22-44 ppm near the packer/inspector location.

Ethyl Acetate

1. NIOSH Results:

A bulk sample of the ethyl acetate was analyzed and found to be greater than 99% pure. No other significant peaks were present upon analysis using a flame ionization detector.

Table I presents the results of the air sampling conducted by NIOSH on August 21, 1980. Three sealer lines (2 in base production, 1 in clean room) were monitored using a direct reading, organic vapor analyzer that was calibrated with the ethyl acetate used at the plant. Operations were described as normal except that line 9 in base production was down and line 8 was only operating intermittently during the shift due to maintenance activities.

Twelve sampling locations (A through L, see sketch on Table I) were selected for each sealer line monitored. A reading was taken at each location from 2-5 times during the shift. The results appearing in Table I represent the average concentration of ethyl acetate at that location. Concentration ranges for each location are not given because readings were stable (within 5%) during the shift. Ethyl acetate concentrations ranged from 2-14 ppm except in two locations on each line where 40-75 ppm was detected within 6 inches of a liquid surface of ethyl acetate (dip tray and solvent reservoir). The 2-14 ppm concentrations represented the range of worker exposure for the day of this survey.

The inspector/packer location on each line was the only position manned continuously during the shift. This worker visually inspected the plastic tubes for defects, gathered the tubes by hand or on a conveyor, and packed them in a carton at arms' reach directly in front of him. The sources of the ethyl acetate vapors were the dip tray, solvent reservoir (previously uncovered, but covers were made the previous week and in place for this survey), and residual ethyl acetate on the plastic tubes. There were two activities that inspector/packers felt generated the highest exposures. One involved transferring ethyl acetate from a 55-gallon drum in the chemical storage area to the line reservoir. A 5-quart can is used for this purpose. Solvent vapors were generated as the ethyl acetate was poured into the

solvent reservoir. The other occurs during the packing stage as the initial rows of plastic tubes were stacked in the carton, the breathing-zone of the inspector/packer being very close to, and sometimes in the carton.

2. Past Survey Results:

The company's insurance carrier monitored for ethyl acetate using detector tubes in September 1979 and February 1980. All readings were reported as less than 5 ppm.

OSHA monitored this operation in February 1980 using charcoal tubes. Exposures for 4 of 5 workers ranged from 20-30 ppm (8-hour time-weighted average (TWA). The OSHA standard for ethyl acetate is 400 ppm. The fact that the OSHA results were higher than the concentrations found during the NIOSH survey was probably due to the following factors:

1. The OSHA study was done in the winter when overall ventilation of the base production area was less (windows not open).

2. One sealer line was totally down during the NIOSH study and another was down most of the day.

3. The solvent reservoirs on the sealer lines were covered during the NIOSH study and not during the OSHA survey.

The differences between the results of the OSHA survey and the insurance carrier survey, both done during the same month (February 1980), are unexplained except that the insurance carrier used detector tubes (non-certified), which are less accurate.

B. Medical

Fifty-nine employees who were potentially exposed to ethylene dichloride and/or ethyl acetate were interviewed using a directed questionaire. The 59 workers interviewed were placed into one of the following three exposure groups:

Group	Number Of Workers	Exposure
1	12	Previous ethylene dichloride exposure only(ED).
2	37	Previous ethylene dichloride exposure plus present ethyl acetate exposure (ED/EA).
3	10	Present ethyl acetate exposure only (EA).

Exposure was also graduated by job title; that is, those jobs which required the worker to be in areas closest to where the solvent was being used for the longest periods of time had the highest potential for exposure. Job titles, in descending order of exposure to the ethylene dichloride (which was later replaced by ethyl acetate), and number of workers in each job classification were:

Packer/Inspector - 28
Machine Operator - 18
Boxmaker -3
Maintenance Mechanic -8
Utility Attendant -2.

The demographic data and exposure histories of the three exposure groups are included in the following table.

Demographic and Exposure Data of Workers
Exposed to Ethylene Dichloride (ED) and/or Ethyl Acetate (EA)

Demographic Data	Number of Workers by Exposure Category		
	ED Only (12)	ED and EA (37)	EA Only (10)
Sex-Total Number			
Male	2	16	4
Female	10	21	6
Total	12	37	10
Mean Age in Years			
Male	34	32	23
Female	38	39	24
Total	35.5	35	23.5
Mean Years of Employment at TLB	7.2	7.5	1.04
Mean Years of Exposure	1.9	7.2	.34

Ethylene Dichloride

The reported chronic diseases of the three worker exposure groups and a combined fourth group consisting of all ethylene dichloride exposed workers are included in the following table.

Reported Chronic Diseases of Workers Exposed to Ethylene Dichloride (ED) and/or Ethyl Acetate (EA)*

Chronic Diseases	Number of Workers by Exposure Category			
	ED Only (12)	ED and EA (37)	All ED (49)	EA Only (10)
Respiratory Diseases:				
Bronchitis	1 (8%)	4 (11%)	5 (10%)	1 (10%)
Other	0	1 (3%)	1 (2%)	0
Asthma/Allergy	2 (17%)	1 (3%)	3 (6%)	1 (10%)
Gastrointestinal Disease:				
"Stomach" Ulcers	2 (17%)	3 (8%)	5 (10%)	0
Other	1 (8%)	3 (8%)	4 (8%)	0
Tumor or Cancer:	1 (8%)	4 (11%)	5 (10%)	0
Eye or Visual Problems:	1 (8%)	1 (3%)	2 (4%)	0
Skin Diseases:	0	1 (3%)	1 (2%)	0
Neurologic Diseases:	2 (17%)	3 (8%)	5 (10%)	0
Genitourinary Tract Dis.:	0	4 (11%)	4 (8%)	1 (10%)
Hypertension	0	3 (8%)	3 (6%)	0
Anemia	0	1 (3%)	4 (8%)	0
Other Diseases:	1 (8%)	3 (8%)	4 (8%)	0
Number of Workers Reporting 1 or More Chronic Diseases:	6 (50%)	17 (46%)	23 (46%)	2 (20%)

* Exclusive of chronic diseases acquired prior to employment at TLB Plastics Corporation or with a clear non-occupational etiology.

Analysis of the questionaire data from the 12 "ethylene dichloride only" exposed workers revealed that 8 of 11 workers reported chronic diseases in 6 different organ systems, while 32 chronic diseases were reported occurring in 11 different organ systems by the 37 "ethylene dichloride and ethyl acetate" exposed workers. Comparison of the "ethylene dichloride only" exposed group to the "ethyl acetate only" exposed group revealed not surprisingly, that the "ethyl acetate only" group was younger than the ethylene dichloride groups and had far less seniority and exposure time. Considering the difference in age between the "ethylene dichloride only" and the "ethyl acetate only" groups, the higher frequencies of chronic diseases in the former group is not unexpected. Analysis of questionaire data, therefore, revealed no apparent pattern of chronic diseases characteristic of the effects of ethylene dichloride. There were no reported emphysema, liver, cardiovascular or blood diseases nor adverse reproductive effects.

Review of the two company death certificates revealed one death from acute coronary thrombosis and the other from metastatic brain cancer. The findings from the four AIW Union workers examined by a union physician consultant, whose Medical Physical Examination records were reviewed, included two workers with normal physical examination findings, a third worker with an elevated cholesterol and triglycerides and the fourth with colon disease. Three of four workers reported headache at the time of their physical examinations, but there was no consistent pattern of time of initial onset, location, frequency, duration or severity which could be established.

Comparison of the October 1979 through June 1980 Absenteeism Report, (period of use of ethyl acetate) with the same period (October 1978 through June 1979) the previous year, revealed a 1-week 5% absenteeism rise in October 1979, otherwise a consistently similar absenteeism pattern for the two years. OSHA 200 Occupational Accident and Illness Records showed no one specific pattern of chronic disease or acute adverse health effects. Based on analysis of the questionnaire data, and review of company and union records, there were no prevalence of any one specific chronic or acute disease pattern present, including reproductive effects that could be associated with exposure to ethylene dichloride. None of the reported chronic diseases have been associated with ethylene dichloride exposure.

Ethyl Acetate

Current symptoms reported by worker participants are included in the following table.

Reported Symptoms of Workers
Exposed to Ethyl Acetate (EA) and Ethylene Dichloride ED

Reported Symptoms	Number of Workers by Exposure Category			
	EA Only (10)	EA and ED (37)	All EA (47)	NO. EA(ED ONLY) (12)
Mucous Membrane Irritation:				
Dry Throat	4 (40%)	7 (19%)	11 (23%)	4 (33%)
Sore Throat	1 (10%)	5 (14%)	6 (13%)	1 (8%)
Burning Eyes	4 (40%)	6 (16%)	10 (21%)	3 (25%)
Itching Eyes	5 (50%)	7 (19%)	12 (26%)	2 (17%)
Tearing Eyes	2 (20%)	5 (14%)	7 (15%)	2 (17%)
Nasal Irritation	3 (30%)	11 (30%)	14 (30%)	4 (33%)
Nasal Discharge	0	3 (8%)	3 (6%)	2 (17%)
Nose Bleeds	0	2 (5%)	2 (4%)	1 (8%)
Respiratory:				
Chest Discomfort	0	2 (5%)	2 (4%)	0
Cough up Phlegm-daily	0	9 (24%)	9 (19%)	2 (17%)
Cough up Blood in Phlegm	0	0	0	0
Wheezing in Chest	0	1 (3%)	1 (2%)	1 (8%)
Shortness of Breath	1 (10%)	4 (11%)	5 (11%)	2 (17%)
Difficulty Breathing	1 (10%)	4 (11%)	5 (11%)	2 (17%)
Gastrointestinal:				
Nausea & Vomiting	1 (10%)	3 (8%)	4 (9%)	0
Neurologic System:				
Headache	4 (40%)	10 (27%)	14 (30%)	2 (17%)
Stuporous State	1 (10%)	7 (19%)	8 (17%)	2 (17%)
Skin:				
Dry or Irritated	1 (10%)	7 (19%)	8 (17%)	2 (17%)
Skin Rash	1 10%)	2 (5%)	3 (6%)	1 (8%)
Number of Workers Reporting One or More Symptoms	7 (70%)	23 (62%)	30 (64%)	8 (67%)

Based on analysis of the current symptoms questionaire data all 47 ethyl acetate exposed workers and the 12 ethylene dichloride only exposed workers (workers with no ethyl acetate exposure) reported comparable rates of current symptoms. Both groups of workers reported a high prevalence of mucous membrane irritation; as well as comparable prevalences of skin irritation, respiratory, gastrointestinal and neurologic symptoms. Thus no specific symptom or group of symptoms could be associated with exposure to ethyl acetate.

The following correlation between job title and number of workers reporting current symptoms, however, suggested the need for a follow-up study to identify a common current exposure.

Correlation of Job Title with Number of Workers Reporting Current Symptoms By Exposure Category

Job Title	Number or Workers	Number of Workers by Exposure Category			
		EA Only	EA/ED	ED ONLY	Total
Packer/Inspector	28	7	10	5	22 (79%)
Boxmaker	3	-	2	-	2 (67%)
Machine Operator	18	0	8	3	11 (61%)
Maintenance Mechanic	8	0	3	-	3 (38%)
Utility Attendant	2	-	-	0	0 (0%)
Total	59	7	23	8	38 (64%)

EA - Ethyl Acetate
ED - Ethylene Dichloride

VII. PRELIMINARY CONCLUSIONS

Based on the information obtained in the initial survey:

1. There is no evidence that chronic (long-term) disease had occurred due to past ethylene dichloride exposure.

2. Ethyl acetate exposure had no apparent effect on symptom rates.

3. Ethyl acetate, furthermore, at the concentrations measured by NIOSH, OSHA and the company's insurance agency, would not be expected to cause the mucous membrane, respiratory tract and skin irritation, headaches and/or nausea experienced by more than 60% of the exposed employees who were interviewed for the following reasons-
    a. The 400 ppm OSHA standard for ethyl acetate is a well documented level supported by human exposure studies, intended to prevent such symptoms in most workers.

    b. The odor of ethyl acetate at low concentrations is not known to be irritating, as described by employees. It is usually described as a sweet, pleasant odor.

The above factors suggested that another agent (previously unidentified) may be responsible for the current adverse health effects. Therefore, a follow-up survey was conducted.

VIII. FOLLOW UP ACTIVITIES

A follow up study was undertaken in an attempt to explain why the majority of all workers (64%) were reporting acute adverse health effects associated with their work. Since cellulose acetate propionate, the plastic material which was used as a feed stock in the extrusion operation, was the only other major substance used, it was evaluated as the possible source.

Bulk samples of the plastic pellets were heated in the NIOSH laboratory to the extrusion temperature (400°F). Analysis of the air samples drawn from the head space above the hot plastic revealed that propionic acid, acetic acid, and a high-boiling compound suspected of being the plasticizer di(2-ethylbutyl)azelate, were present. Each of these substances could be responsible for the current adverse health effects, therefore, the next step was to visit the plant and evaluate these potential exposures.

IX. FOLLOW-UP SURVEY METHODS

Given the reported current adverse health effects and the results of the laboratory head space analysis of the plastic a follow-up field survey was conducted on September 9-11, 1981 to evaluate exposure to propionic acid, acetic acid and plasticizers. This survey included environmental sampling designed to measure airborne concentrations of these substances and a medical questionnaire to determine if there was any associated correlation with the current adverse health effects.

A. Environmental

Area and personal breathing zone sampling techniques were used to confirm the source of the emissions and estimate employee exposures to the emission products identified. Area samples were obtained above the extruder heads and in several locations in the production area. Personal breathing zone samples were obtained by attaching the sampling device to selected workers in such a manner so that the collection media was in the breathing zone (attached to lapel). The two sampling and analytical techniques used are described below.

1. Propionic and Acetic Acid

The acid vapors were quantitatively collected on a solid sorbent consisting of diatomaceous earth impregnated with sodium carbonate. Sorbent tubes were connected, via a piece of polyethylene tubing, to a battery-operated pump calibrated at 1.0 liter per minute (lpm). Each sample was desorbed with 10mg of deionized distilled water in a sonic mixer for 30 minutes. Each desorbed sample was filtered through a Millipore 0.45um HA filter and injected into an ion chromatograph equipped with a 10mm X 200mm anion separator column, a 7mm X150 mm suppressor column and a conductivity detector.

2. Plasticizer

Standard charcoal tubes were used to monitor for the plasticizer at the extruder heads. No personal breathing zone samples were obtained for this substance. Each charcoal tube was desorbed with carbon disulfide. High resolution gas chromatography/mass spectroscopy was used to identify the plasticizer.

B. Medical

The NIOSH medical investigator administered a directed medical questionnaire to employees to assess the prevalence and severity of possible worker exposures to propionic acid, acetic acid and plasticizer, and their subsequent potential work-related health problems. Thirty first-and second-shift employees, working lines 1, 3, 4, 5, 6 and 13 (the lines using the cellulose plastic), were interviewed. Questions were asked concerning each employee's occupational history at TLB Plastics Corportion, chronic disease history, smoking history, and current symptoms history associated with propionic acid, acetic acid and plasticizers in general. The current symptoms included irritation and other symptoms of the eyes, nose and throat; gastrointestinal tract upset; headache; rashes; and burns. The acute symptom history was divided into two sections: 1) symptoms present on the day of the interview, and 2) symptoms present the preceeding day or the last 8-hour shift worked. In each case time of onset was recorded.

X. FOLLOW-UP SURVEY EVALUATION CRITERIA

Propionic Acid (Methyl Acetic Acid):

Neither OSHA nor NIOSH has any exposure standard or criteria for propionic acid. ACGIH has established a Threshold Limit Value (TLV) of 10 ppm (30 mg/m^3), which is largely based on analogy with acetic acid and is intended to prevent undue irritation to the eyes and respiratory passages.

All of the members of an odor testing panel recognized an odor at concentrations as low as 0.03 ppm (0.09 mg/m^3). The odor was described as sour and unpleasant.[3] Symptoms of over-exposure from inhalation include sore throat, coughing and shortness of breath; from eye contact redness, pain and blurred vision; from skin absorption redness and pain; and from ingestion sore throat, abdominal pain and vomiting.[1]

Acetic Acid:[7,9]

The current OSHA standard is 10 ppm. (25 mg/m^3).

Acetic Acid vapor may produce irritation of the eyes, nose, throat and lungs; skin or eye burns from splashes and skin sensitization.

Repeated exposure will produce blackening and hyperkeratosis of the skin of the exposed area and erosion of the teeth.(9) Inhalation of concentrated vapors or repeated exposure of high concentrations may cause serious damage to the linings of the respiratory passages. The OSHA standard, which was adopted from the ACGIH TLV, is designed to prevent undue irritation.

Di(2-ethylbutyl)Azelate:

There are no exposure criteria for this substance. Several azelate esters are used as plasticizers. The available toxicity data indicates they are inert as far as any acute exposures are concerned (8).

XI. FOLLOW UP SURVEY RESULTS AND DISCUSSION

A. Environmental

Low concentrations of propionic and acetic acid were found in all air samples (see Table 2). The highest concentrations were found above the extruder heads, where the levels of propionic acid ranged from 0.34 to 1.10 mg/m^3 and the levels of a acetic acid ranged from 0.08 to 0.13 mg/m^3. Samples taken in other areas and via personal breathing zone sampling techniques indicated that employees were exposed to propionic and acetic acid at approximately 0.2 and 0.1 mg/m^3, respectively. The higher levels above the extruder head and the fact that no detectable quantities of emission products were found at 200°F during head space analysis of the bulk plastic indicate that the source of the acid vapors is the extruder head which operates at approximately 400°F.

The plasticizer could not be positively identified but was determined to be either dihexyl azelate or di(2-ethylbutyl) azelate. Both of these substances had the same GC retention time and identical mass spectra. Since di(2-ethylbutyl)azelate is a known plasticizer in cellulose plastics (2) it is more than likely the one used in this case.

The estimated concentration of the plasticizer above the extruder heads was 0.8 - 0.9 mg/m^3. Personal breathing zone samples were not obtained for the plasticizer; based on the acid vapor results, which indicate air concentrations out in the plant area are less than one-half the values above the extruder heads, employees exposures would probably be less than 0.5 mg/m^3. There are no exposure criteria for this compound.

B. Medical

All 30 employees working lines 1, 3, 4, 5, 6, 13 (the lines using the cellulose plastic) on day and evening shifts September 9-11, 1981 were interviewed. These thirty employees represented four

job titles: 1) packer/inspectors - 11, 2) machine operators - 11, 3) maintenance mechanics-6, and 4) set-up - 2. Maintenance mechanics and set-up have been combined into one group as each group had only intermittent exposure to extruder fumes during either set-up or repair of the lines; while packer/inspectors and machine operators had a continuous exposure. Twenty (67%) of the thirty employees were the same employees interviewed during the initial survey. The demographic data, occupational and exposure history, and current symptom history of the thirty employees by job title are included in the following table.

Demographic Data and Occupational History by Job Title

Demographic Data					Occupational History			
JOB TITLE	No. in Job Title	SEX M	F	Mean Age in Years	Mean No. of Years at TLB Plastics	Mean No. of Years in Current Job	Shift Worked 1st	2nd
Packer/ Inspector	11	1	10	32	3.7	3.1	6	5
Machine Operator	11	5	6	36	8.8	3.3	6	5
Maintenance Mechanic/ Set-up	8	8	0	37	7.0	3.9	6	2
TOTAL	30	14	16	34	6.5	3.5	18	12

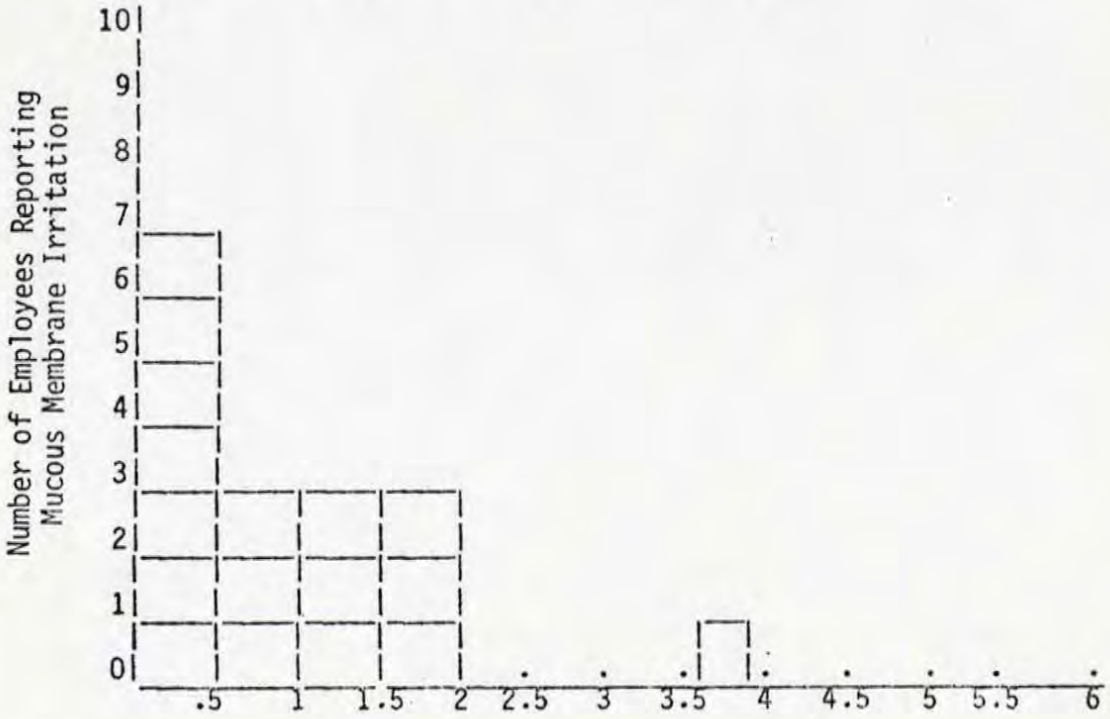
The mean age of the 16 women and 14 men was approximately the same 34.4 and 34.5 years respectively. The occupational history revealed that while the mean number of years at TLB Plastics ranged from 3.7 years to 8.8 years for the three groups; the mean number of years in the current job for all three groups were approximately the same, 3-4 years. Twenty of thirty employees interviewed (67%) reported exposures to fumes and vapors while 7 (23%) reported exposure to skin irritants.

Twenty-three (77%) employees reported current symptoms: all 11 packer/inspectors, 9 (82%) machine operators and 3 (38%) set-up/maintenance mechanics - as stratified in descending order of exposure (Following Table). Ten (91%) inspector/packers reported mucous membrane irritation compared to seven (64%) machine operators and three (38%) maintenance mechanics/set-up. Headache was reported by a comparable percentage of inspector/packers, machine operators and set-up/maintenance mechanics. Six (55%) inspector/packers reported rashes, as did one (9%) machine operator and one set-up/maintenance mechanic.

Reported Current Symptoms by Job Title

JOB Title	No. In Job Title	Number Reporting Current Symptoms	Current Symptoms History: Mucous Membrane Irritation	Resp. Tract Symptoms	Headaches	Dermotoses
Packer/ Inspector	11	11 (100%)	10 (91%)	3 (27%)	4 (36%)	6 (55%)
Machine Operator	11	9 (82%)	7 (64%)	4 (36%)	3 (27%)	1 (9%)
Maintenance Mechanic/ Set-up	8	3 (38%)	3 (38%)	1 (13%)	2 (25%)	1 (9%)
TOTAL	30	23 (77%)	20 (67%)	8 (27%)	9 (30%)	10 (27%)

As can be seen from the following histogram 14 of 16 employees reported their mucous membrane irritation as beginning within two hours from start of work. There were no differences found in time of onset of symptoms however, between employees with allergies and those without, or between smokers and non-smokers.



Time in one-half hour intervals of initial onset of mucous membrane irritation after start of shift.

Six (55%) of the inspector/packers reported skin problems, three reported red and irritated skin and six reported a macular or papular rash. The one (9%) machine operator who reported a rash stated that he had dry irritated skin which did not heal, and began when he mixed pellets. One (9%) set-up/maintenance mechanic reported skin irritation and a rash at the end of the shift.

The current symptom histories for the previous 8 hour shift worked were not analyzed because the lines using the cellulose plastic had changed from one day to the next, as well as from first to second shift. There was also some discrepency as to which lines employees had worked during the previous 8 hours, and whether they had been exposed to the propionic acid, acetic acid and plasticizers.

XII. CONCLUSIONS

1. There is no evidence of any specific chronic disease or disease patterns that can be associated with past exposures to ethylene dichloride.

2. There was evidence of current adverse health effects associated with normal production activities. Symptoms such as mucous membrane irritation and rashes were prevalent in the workforce, especially the packer/inspectors, before as well as after ethyl acetate was introduced into the work environment. This, along with the low levels measured in the plant, suggest that the ethyl acetate exposure was not solely responsible for the current adverse health effects.

3. The current symptoms survey results suggests that the low concentrations of plastic emission products (propionic acid, acetic acid and di(2-ethylbutyl)azelate) are judged to probably be responsible for the mucous membrane irritation. Whether one of these or a combination of them, along with low levels of the ethyl acetate, are causing the problem is uncertain.

4. It appears that the emissions caused by the plastic extrusion process are causing a significant amount of discomfort in the workforce.

XIII. RECOMMENDATIONS

A. To further minimize solvent exposure

1. Put a longer spout on the container used to transfer the ethyl acetate from the bulk storage drum to the line reservoirs.

2. Tilt the packing box back so that the packer/inspector do not have to lean into the box to stack the bottom layers

B. To eliminate exposure to plastic emission products

1. Implement engineering controls in the form of local exhaust to capture the smoke plume at the point of generation (short distance between the die head and water bath). This would also provide an added safety measure when experimenting with new plastic materials.

C. To increase worker comfort:

1. Those workers who handle the plastic products should wear protective gloves and/or use a moisturizing water resistant hand lotion or cream on their hands to prevent skin irritation.

2. Since extrusion operations can cause a dry environment, relative humidity (RH) levels should be monitored in the winter months and if RH is consistently less than 30% methods of humidification should be explored for use in the manufacturing area. Throat lozengers, hard candy or chewing gum may help to prevent throat irritation, especially during the winter months when the windows are closed and the ambient humidity levels are generally low.

XIV. REFERENCES

1. Handling Chemicals Safely 1980. Amsterdam, The Netherlands, Propionic Acid, p. 792.

2. Hawley, G.G., The Condensed Chemical Dictionary, Eighth Edition, Litton Educational Publishing, Inc., 1971.

3. Hellman, T.M., Characterization of the Odor Properties of 101 Petrochemicals Using Sensory Methods, Journal of the Air Pollution Control Association, Volume 24, No. 10, October, 1974.

4. NIOSH Criteria for a Recommended Standard... Occupational Exposure to Ethylene Dichloride, NIOSH Publication No. 76-139.

5. NIOSH Revised Recommended Standard... Occupational Exposure to Ethylene Dichloride, NIOSH Publication No. 78-211.

6. NIOSH Current intelligence Bulletin Reprints - Bulletins 19 thru 30 for 1978, No. 25, NIOSH Publication No. 79-146.

7. Occupational Disease: A Guild to Their Recognition, DHHS, PHS, CDC, NIOSH, Publication No. 77-181, Revised June 1977.

8. Patty F.A., Patty's Industrial Hygiene and Toxicology. Vol II -- Toxicology, 3rd Revised Ed. New York: John Wiley and Sons, 1978.

9. Proctor, N.H., Hughes, J.P. Chemical Hazards of the Workplace. Philadelphia: J.P. Lippicott Company, 1978.

XV. AUTHORSHIP/ACKNOWLEDGEMENTS

Evaluation Conducted and Report Prepared by:	Richard W. Gorman, M.S., CIH Industrial Hygienist Industrial Hygiene Section
	Joann R. Schloemer, R.N., M.Ed. Medical Investigator Medical Section
Field Assistance:	Marilyn Fingerhut, M.S, Ph.D. Medical Investigator Medical Section
	Mark Nutter Co-op Student Industrial Hygiene Section
Laboratory Analysis:	Ardith Grote, Chemist
Originating Office	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations and Field Studies Cincinnati, Ohio 45226
Report Typed by:	Terry R. O'Neal Clerk-Typist Medical Section

XVI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 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. Allied Industrial Workers of America, International
2. TLB Plastics Corporation, Plant Manager
3. TLB Plastics Corporation, Safety and Health Worker Representative
4. NIOSH, Region V
5. OSHA, Region V

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

Table 1

Ethyl Acetate Results[1]

HE 80-186
August 21, 1980

Sampling Location[2]	Sampling Location Description	Line #6 (ppm)	Line #7 (ppm)	Line #2 (ppm) (Clean Room)
(A)	Near front edge of Extruder	2	2	4
(B)	Midway down Line	2	2	4
(C)	At elbow leading into Cutter	2	3	4
(D)	Within 6 inches and above EA dip tray	45	75	68
(E)	Within 6 inches of EA resevoir (cover off)	40	40	----
(F)	Midway between turret and packer position	3	2	4
(G)	At elbow on exit side of turret	2	2	4
(H)	To immediate left of packer inspector	14	6	4
(I)	Three feet behind packer position	3	2	2
(J)	Breathing zone of inspector/packer	5	4	4
(K)	Face of box (near top)	13	10	----
(L)	Inside packing box	12	11	----

NOTE: (1) All readings were taken with an Organic Vapor Analyzer that was post-calibrated with the Ethyl Acetate being used at the plant. There were no other organic solvents in use.

(2) The sampling location is at the approximate breathing zone unless specified otherwise. Locations are depicted in sketch to the right.

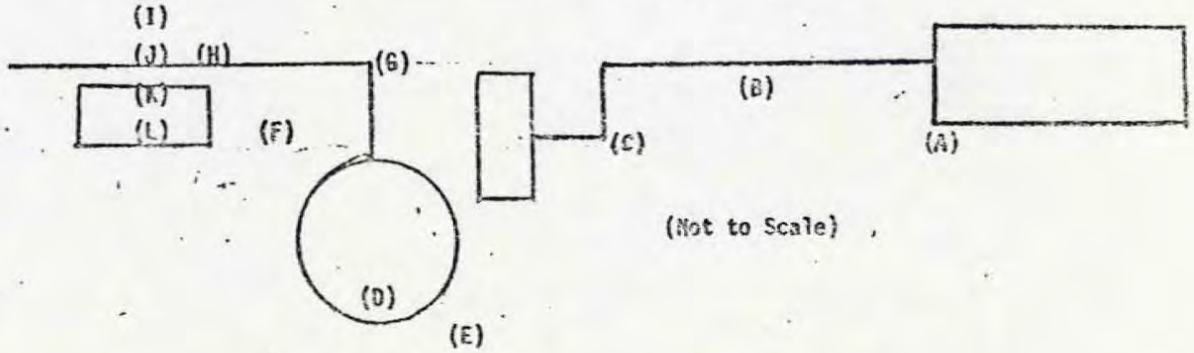


TABLE 2

Propionic and Acetic Acid

TLB Plastics
HETA 80-186

September 10, 1981

Job Description/Location	Sample Type (1)	Sampling Period	Sample Volume (liters)	Propionic Acid mg/m^3 (2)	Acetic Acid mg/m^3
Line #1, Above Extruder Head	A	0957-1623	390	0.34	0.08
Line #3, Above Extruder Head	A	1005-1601	360	0.39	0.09
Line #4, Above Extruder Head	A	1014-1608	350	0.53	0.13
Line #5, Above Extruder Head	A	1020-1558	360	1.10	0.10
Line #6, Above Extruder Head	A	1028-1620	350	0.59	0.12
Line #3, Above Packer Inspector	A	0939-1612	390	0.23	0.08
Line #5, Midpoint Down Line	A	0942-1615	390	0.21	0.07
Line #3, At Cutting Process	A	1040-1610	330	0.25	0.08
Line #4, At Cutting Process	A	1045-1610	330	0.24	0.09
Line #1, Packer Inspector	BZ	0900-1433	330	0.17	0.09
Line #1, Machine Operator	BZ	0905-1432	330	0.18	0.11
Line #3, Packer Inspector	BZ	0908-1435	330	0.22	0.09
Line #3, Machine Operator	BZ	0917-1430	310	0.15 (3)	0.07 (3)
Line #4, Packer Inspector	BZ	0910-1434	320	0.24	0.09
Line #4, Machine Operator	BZ	0912-1431	320	0.19	0.10
Line #6, Packer Inspector	BZ	0926-1432	310	0.15 (4)	0.08 (4)
Line #6, Machine Operator	BZ	0920-1434	310	0.10 (4)	0.08 (4)
Current Exposure Criteria, 8-hour TWA (Source)				30 (ACGIH)	25 (OSHA)

(1) Sample type; A - area sample, BZ - personal breathing zone sample.
(2) mg/m^3: milligram of substance per cubic meter of air.
(3) Sampling pump changed at 1115 due to low flow (150 cc/min instead of 1000 cc/min).
(4) Line #6 went down at 1000. Operators sent to Line #9 for portion of the rest of the shift.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396