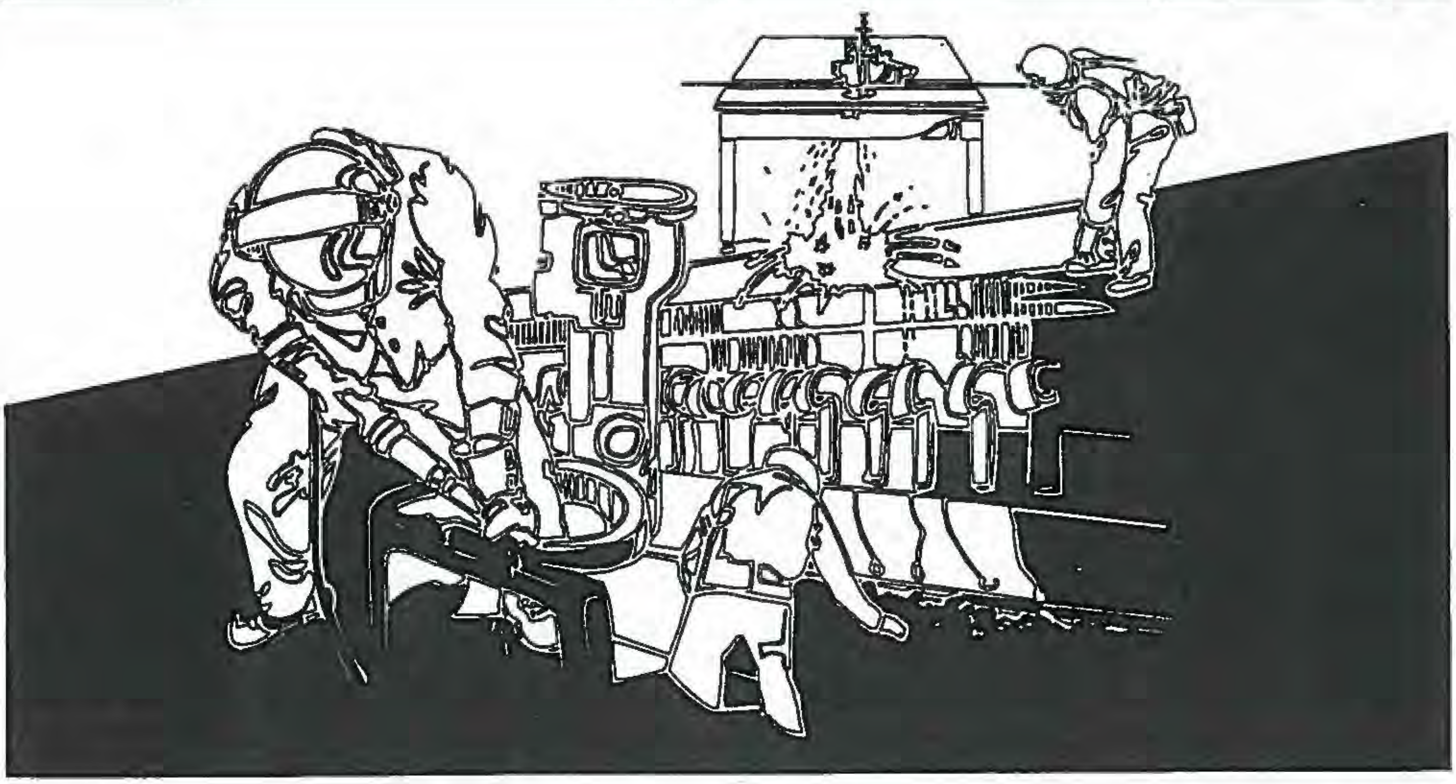
NIOSH

HEALTH HAZARD EVALUATION REPORT

HETA 90-300-2208
L-TEC WELDING AND CUTTING SYSTEMS CORPORATION
FLORENCE, SOUTH CAROLINA



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

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 and 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 90-300-2208
APRIL 1992
L-TEC WELDING AND CUTTING SYSTEMS CORPORATION
FLORENCE, SOUTH CAROLINA

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SUMMARY

A health hazard evaluation (HHE) was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Esab Group/L-Tec Welding and Cutting Systems Corporation (L-Tec) in Florence, South Carolina. This investigation was performed in response to a confidential request received from a group of employees on June 8, 1990. The health concerns included skin rashes, leukopenia (low levels of white blood cells), and eye, nose, and throat irritation among machine shop workers exposed to solvents and degreasers, especially methylene chloride and Safety-Kleen Solvent MS®.

On October 16, 1990, NIOSH investigators performed a walk-through inspection of the degreasing and machining processes in the machine shop. Personal breathing zone and general area air samples were collected during first and second shifts to determine workers' exposure to methylene chloride and the hydrocarbons in the Safety-Kleen. Private medical interviews were conducted with 17 (94%) of the 18 employees in Department 011 (automatic machining), and 24 (28%) of the 86 employees in Department 012 (non-automatic machining). Medical records and OSHA 200 logs were reviewed for information pertinent to the hazard request. The on-site nurse was interviewed regarding the specific health concerns mentioned in the HHE request, periodic medical screening of employees, and medical protocols at the site.

The most commonly reported health concern was numbness. This symptom, and that of skin rashes, were reportedly related to direct skin contact with methylene chloride. Eye irritation was reported to occur if the eyes were exposed to methylene chloride vapor. Several workers also reported concern about Safety-Kleen and its possible contribution to a variety of symptoms, including joint pain, fatigue, dizziness and eye irritation.

Leukopenia (a low white blood cell count) was reported by five of the interviewed employees. Review of their medical records revealed one-time white blood cell (WBC) counts ranging from 2.41 to 4.42 $\times$ 10^6 cells/liter of blood. Except for the value of 2.41, these results were within the race-specific range. In addition, neither methylene chloride nor other substances used in this work place, have been associated with the development of leukopenia.

Most of the measured methylene chloride concentrations were well below the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) and the American Conference of Governmental Industrial

Hygienists (ACGIH) Threshold Limit Values (TLV) for this solvent. Levels of methylene chloride above 10 parts per million (ppm) were detected in only three of the samples. The levels in two of these samples were measured when the degreasing unit's ventilation system was deactivated.

Based on the data collected in this survey, the NIOSH investigators conclude that direct skin exposure to methylene chloride could cause some of the numbness and skin irritation described by the employees. The numbness not associated with direct methylene chloride exposure may be due to remaining in one position for an extended period of time, or repeating a group of movements during the course of work, causing the involved extremity to "fall asleep" due to temporary decreased blood flow or nerve compression. The measured methylene chloride concentrations were not in a range that would be expected to cause headaches and dizziness. Neither methylene chloride nor other substances used in this work place, have been associated with the development of leukopenia.

The industrial hygiene data generally showed low exposures to methylene chloride and to the chemicals in Safety-Kleen. However, a potential exists for exposure of the maintenance workers to elevated levels of methylene chloride when the degreaser and its controls are not operating.

Keywords: SIC 3548 (Electric and Gas Welding and Soldering Equipment), methylene chloride, leukopenia, Safety-Kleen, vapor degreasing, personal protective equipment.

INTRODUCTION

In June 1990, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for health hazard evaluation (HHE) at the Esab Group/L-Tec Welding and Cutting Systems Corporation (L-Tec) in Florence, South Carolina. The request concerned skin rashes, irritation of eyes, nose and throat, and leukopenia in machine shop workers who used solvents and degreasers in the course of their work. Specific materials of concern included methylene chloride and Safety-Kleen Solvent MS®. NIOSH representatives conducted an HHE during October 16-18, 1990.

BACKGROUND

Facility

The L-Tec Corporation, located in Florence, South Carolina, employs approximately 480 workers and is a manufacturer of welding machines. The 10 acre facility, built in 1966, includes a machine shop where brass, copper, and steel are handled. Approximately 100 employees work in the machine shop, which was the area of concern in the HHE request.

The machine shop is divided into two departments. Department No. 011, an area which surrounds the degreaser, contains automatic machining equipment. Eighteen employees work in this department. Department No. 012, which contains the non-automatic machining equipment, is located further away from the degreaser, but within the same large room. Eighty-six employees work in the No. 012 Department. The major concern in this HHE request was the workers in Department No. 011 because of their proximity to the degreaser.

Process Description

A vapor-lock degreaser is located in the center of the machine shop. Large parts are lowered into the degreaser using an overhead crane; smaller parts are placed in a basket and inserted into the degreaser via a small side door. When parts are in the degreaser, or when the degreaser is not operating, the unit can be closed using a metal lid. Above the top opening of the degreaser are two ventilation slots that run the length of the unit. The ventilation system is connected with the "on" switch so that the ventilation system is activated whenever the degreaser is turned "on".

The degreaser has a capacity of approximately 55 gallons of methylene chloride. When the unit is activated, this solvent is heated and agitated in order to clean the metal parts. Above the methylene chloride bath are refrigeration coils that cool the air above the solvent bath and parts. This causes the methylene chloride vapor to cool, condense, and drop back into the liquid pool. Parts are removed from the degreaser by hand and placed on drying racks and pallets located next to the unit. The operator of the vapor degreaser uses ungloved hands to move the methylene chloride-soaked parts.

Small parts are also cleaned at numerous work-stations around the machine shop with Safety-Kleen 105 Solvent MS® (hereafter referred to as Safety-Kleen). These work-stations consist of sinks which are connected to a drum of Safety-Kleen. When the sink is activated, the solvent is pumped from the storage drum through a flexible hose in the sink. This hose is used to direct the solvent onto the part to be cleaned. The excess solvent drains back into the drum. The supplier of Safety-Kleen routinely removes the drums (containing used solvent) from the facility and replaces them with drums of fresh solvent. The material safety data sheet (MSDS) for Safety Kleen (manufacturer: Safety-Kleen Corporation, Elgin, Illinois) reports that the solvent contains 99.9% mineral spirits. Mineral spirits, a mixture which is also referred to as Stoddard solvent or petroleum distillates-naphtha, typically contains aliphatic and aromatic hydrocarbons in the C_9 to C_{12} range).

METHODS

General

The NIOSH evaluation began with an opening meeting with employee and management representatives to discuss the purpose and scope of the HHE. The visit included a walk-through survey of the degreasing and machining processes in the machine shop; personal breathing zone and area air sampling during first and second shifts to assess workers' exposures to methylene chloride and the hydrocarbons in the Safety-Kleen; private interviews with machine shop employees; review of U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) 200 logs; an interview with the on-site nurse; and a closing meeting during which the visit's findings were presented.

Medical

An attempt was made to interview all of the employees present in Department 011, since this was the primary area of concern, and a convenience sample of as many of Department 012 employees as time would allow. All interviews were done on a voluntary basis and no one refused to be interviewed. Medical records and OSHA 200 logs were reviewed for information pertinent to the hazard request. The on-site nurse was interviewed regarding the specific health concerns mentioned in the HHE request, periodic medical screening of employees, and medical protocols at the site.

Environmental

Personal breathing zone and area air sampling were performed to assess airborne exposure to the vapors of both methylene chloride from the degreaser and hydrocarbons from the Safety-Kleen solvent stations. Methylene chloride was sampled using NIOSH Method 1005.[1] In this method, air is drawn through two coconut shell charcoal tubes in series using a lightweight, battery-powered pump calibrated to a nominal flow-rate of 20 cubic centimeters per minute (cc/min). Personal breathing zone air samples were collected from the worker operating the degreaser and from other workers in adjacent areas. In addition, several area air samples were collected from locations at varying distances from the vapor-lock degreaser. Similar sampling protocols were used for both the October 17 (first shift) and October 18 (second shift) survey dates. After sampling, the A and B sections of individual tubes were separated and desorbed for 30 minutes with 1 milliliter (ml) of carbon disulfide. Aliquots of these samples were injected into a gas chromatograph mated with a flame ionization detector (GC-FID) for analysis. The weights of methylene chloride found on the two charcoal tubes in series were added, and the concentration was calculated by dividing this sum by the sample volume and converting to parts per million (ppm). The analytical limit of detection (LOD) for this method was 0.01 milligrams (mg) of methylene chloride per sample; the limit of quantitation (LOQ) was 0.03 mg/sample.

Area air sampling for hydrocarbon exposure at the Safety-Kleen stations was conducted using NIOSH Methods 1003, 1500, 1501, and 1550.[1] Sample air was drawn through coconut shell charcoal tubes using lightweight, battery-powered pumps calibrated to a flow rate of 200 cc/min. Area air samples were collected at several Safety-Kleen stations located throughout Departments 011 and 012 during first shift on October 17, and during second shift on October 18. To aid in the analysis of the air samples to be quantified, two bulk liquid samples of the Safety-Kleen and two area air samples taken at Safety-Kleen solvent stations were submitted for qualitative analysis. These samples were screened by GC-FID, and the peaks were identified by GC-mass spectroscopy (GC-MS). The remaining area air samples were quantitatively analyzed for the compounds identified by the GC-FID and GC-MS. Air concentration was determined by dividing the weight of these compounds identified in a given sample by the sampled volume of air. The LODs for these compounds ranged from 0.01 to 0.10 mg/sample; the LOQs ranged from 0.03 to 0.30 mg/sample.

EVALUATION CRITERIA

General Guidelines

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 which most workers may be exposed to 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 a specific worker to produce adverse health effects, even if the occupational exposures are controlled at the level set by the evaluation criteria. 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, potentially increasing 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, including Recommended Exposure Limits (RELs); 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs); and 3) the OSHA permissible exposure limits (PELs). The OSHA standards may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and this report's recommendations for reducing these levels, it should be noted that the Occupational Safety and Health Act of 1970 dictates that industry is legally required 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 (STEL) or ceiling values, which are intended to supplement the TWA when there are recognized toxic effects from elevated short-term exposures.

Methylene Chloride

Methylene chloride is a colorless, volatile, nonflammable liquid with a penetrating, ether-like odor that is detectable at about 200 ppm in air. The chemical and physical properties of methylene chloride are listed in Table 1.[2] The routes of entry of methylene chloride into the body include inhalation of vapors and absorption of liquid through the skin. The solvent is a mild central nervous system depressant, and an eye, skin, and respiratory tract irritant. If the liquid is held in contact with the skin for a prolonged period, it may cause skin burns. If methylene chloride is absorbed into the blood, effects may include headache, giddiness, irritability, and numbness and tingling in the limbs. In severe cases, toxic encephalopathy with hallucinations, pulmonary edema, coma, and even death are possible. Methylene chloride is metabolized to carbon monoxide, so exposure may cause elevated carboxyhemoglobin levels. This adds to the already elevated levels in smokers and those occupationally exposed to carbon monoxide, and may be particularly hazardous to workers with anemia or heart disease.[3]

Studies have been conducted which revealed an increase in cancers and tumors in both rats and mice exposed to methylene chloride. The ACGIH considers methylene chloride to be a category A2 suspected human carcinogen, meaning this chemical is suspected of inducing cancer, based on limited epidemiologic evidence, or demonstration of carcinogenesis in one or more animal species.[4] Although data from humans exposed to methylene chloride are inconclusive, the animal study results are sufficient for methylene chloride to meet the criteria established in the OSHA Cancer Policy for a "potential occupational carcinogen."[5] Therefore, NIOSH recommends that methylene chloride be considered as a potential human carcinogen, and that worker exposure to this compound be controlled to the lowest feasible concentration (LFC).[1] The OSHA PEL and ACGIH TLV for methylene chloride are 8-hour TWA values of 500 ppm and 50 ppm, respectively.[4,6] OSHA is in the process of rule making on methylene chloride which proposes to lower the PEL for this solvent.

RESULTS

Medical

Private medical interviews were conducted with 17 (94%) of the 18 employees in Department 011, and 24 (28%) of the 86 employees in Department 012. The results of the medical interviews are presented in Figure 1. All symptoms occurred in fewer than 25% of the individuals interviewed, and most (joint pain, fatigue, headaches, and dizziness) were not suggestive of a particular medical diagnosis. The most commonly reported health concern was numbness, described as occurring periodically in the feet and/or the hands of workers either when the hands were placed directly into methylene chloride, or after the worker remained in one position for a period of time or repeated a group of movements required to machine a specific part. Skin rashes were reportedly related to direct skin contact with methylene chloride, and eye irritation was reported to occur if the eyes were exposed to methylene chloride vapor. Several workers also reported concern about Safety-Kleen and its possible contribution to some of their symptoms.

Leukopenia (a low white blood cell count) was reported by five of the interviewed employees. Review of their medical records revealed one-time white blood cell (WBC) counts ranging from 2.41 to 4.42 $\times$ 10^6 cells/liter of blood. Except for the value of 2.41, these results values are within the race-specific normal range (all five affected employees are black). Most clinic and hospital laboratories would read these values as "low" because published references' ranges are based on WBC values from populations composed primarily of white persons. However, in black persons, the range of "normal" for WBC counts is significantly lower than in whites.[7]

Environmental

The data from the methylene chloride exposure assessments are found in Tables 2 and 3. Parts were degreased during the first shift survey (October 17), but no parts were degreased during the second shift survey (October 18) due to a faulty methylene chloride pump on the vapor-lock degreaser. The degreaser and its ventilation system were deactivated during the second shift for repairs. The lids were in-place on the top of the unit and the small parts door was open. Air sampling was done during both shifts despite the second shift problems.

Tables 2 and 3 show that most of the measured methylene chloride exposure concentrations were well below the OSHA PEL and ACGIH TLV. Levels of methylene chloride above 10 ppm were detected in only three of the samples. The levels in two of these samples, 132 and 11.8 ppm, were area samples obtained during second shift when the unit and its ventilation system were deactivated. The 132 ppm concentration was measured at the open small parts door, while the 11.8 ppm concentration was measured at a distance of 4 feet from the degreaser. These concentrations are not representative of routine operator exposures since the engineering controls that normally contain the methylene chloride vapors were not in operation.

A methylene chloride concentration of 21.6 ppm (Table 2) was measured in the personal breathing zone air sample from the worker operating the degreaser during first shift. Although this concentration is below the OSHA PEL and ACGIH TLV, it is not the lowest feasible concentration. Observation of the work activities of the degreaser operator suggested that a major part of this exposure is related to the handling of the parts upon their removal from the degreaser. The methylene chloride-soaked parts are removed from the degreaser by an overhead crane. After clearing the degreaser, the operator removes these wet parts from the crane using unprotected hands, and stacks them on pallets or racks in his/her work area. The parts are then allowed to dry by evaporation before being removed from the degreasing area. (See Section VI of this report for recommendations to reduce this worker's methylene chloride exposure.)

Several personal breathing zone and general area air samples were obtained during the NIOSH survey to determine the extent of worker exposure to methylene chloride in areas adjacent to the degreasing unit. These samples were collected from drill operators, set-up operators, and at various distances between 1 and 60 feet from the degreaser. As expected, the concentrations of methylene chloride measured in these samples were lower than the levels measured near the degreaser.

The data from the first and second shift area air sampling at the Safety-Kleen solvent stations are presented in Table 4. The qualitative analysis of the bulk samples of Safety-Kleen and the charcoal tube air samples yielded similar results: the major peaks identified were 1,1,1-trichloroethane (1,1,1-TCE), toluene, xylene, and a series of C_9-C_{12} aliphatic hydrocarbons and C_9-C_{10} alkyl-substituted benzene compounds, which are referred to as petroleum distillates or naphthas. The remaining charcoal tube samples were quantitatively analyzed for these four components. Table 4 shows that the concentration of these compounds at the Safety-Kleen stations were well below the NIOSH RELs, OSHA PELs, and ACGIH TLVs for 1,1,1-TCE, toluene, xylene, and naphthas. These concentrations are at levels that would not be expected to cause health effects in most workers.

It is important to note that the data contained in this report are only applicable to the work environment assessed during the dates of this survey. The concentrations and exposure data cannot be used to determine past exposures, since conditions, equipment, controls, and work practices may have been different prior to the NIOSH HHE.

CONCLUSIONS

Medical interviews revealed the primary health concerns of the workers to be numbness of the hands and feet and leukopenia. Some of the numbness described by the employees could be due to direct skin exposure to methylene chloride. The foot numbness (and hand numbness not associated with direct methylene chloride exposure) may be due to remaining in one position for an extended period of time, or repeating a group of movements during the course of work, causing the involved extremity to "fall asleep" due to temporary decreased blood flow or nerve compression.

The substances used in this work place, including methylene chloride, have not been associated with the development of leukopenia, either in animal or human studies. There are multiple known causes of leukopenia, including blood disease, certain medication use, nutritional deficiency, infection (including the common cold), and autoimmune disorders.

Other health concerns mentioned by some workers, such as headaches and dizziness, could be caused by exposure to methylene chloride vapor. However, the exposure levels found during this evaluation were not in a range that would be likely to cause these effects. Headaches and dizziness are also common enough occurrences that they could be caused by factors other than exposures at work, such as fatigue, muscle strain, sinus congestion, or arising from a sitting or reclining position too quickly.

The industrial hygiene data generally showed low exposures to methylene chloride and to the chemicals in Safety-Kleen. However, the degreasing operator's exposure to methylene chloride was appreciably higher than other workers'. Also, area air sampling during the second shift maintenance operation indicated that a potential exists for exposure of the maintenance workers to elevated levels of methylene chloride when the degreaser and its controls are not operating.

RECOMMENDATIONS

1. The best method for controlling exposure to any extremely toxic material is to use a less toxic material wherever possible. Less toxic solvents (for example, 1,1,2-trichloro-1,2,2-trifluorethane [Freon 113®] may be an effective degreaser for the parts manufactured at L-Tec, while at the same time reducing the overall hazard associated with using methylene chloride.

2. Physicians or other health care personnel should be provided with all toxicologic information, industrial hygiene sampling data, and a listing of protective devices or equipment the worker may be required to use when a potential for exposure to methylene chloride exists. If respiratory protective equipment is determined to be necessary, medical evaluations should be conducted to determine the worker's physical fitness for using this equipment. In addition, complete medical, chemical exposure, and occupational history information should be maintained for each worker.

3. L-Tec should provide a worker education program designed to inform the worker about the potential health risks from exposure to methylene chloride, the proper use of personal protective equipment or clothing, smoking cessation programs, and proper work practice procedures. This should involve more than simply handing out literature for the employees to read. Health care personnel and/or others knowledgeable about these issues should discuss each of these topics with the employees, allowing adequate time for questions.

4. Any worker who handles parts wet with methylene chloride (or any other solvent), or who has skin contact with methylene chloride for any other reason, should be provided with and wear gloves that are impermeable to this solvent. Glove materials which resist permeation by methylene chloride include polyvinyl

alcohol (PVAL) and PE/ethylene vinyl alcohol (PE/EVAL). It should be noted that the physical demands by the wearer of these gloves (such as resistance to tearing, puncture resistance, etc.) must also be considered in the protective clothing selection process.

5. Upon leaving the degreasing unit, all solvent soaked parts should be transferred to a designated drying station. This station should be equipped with a local exhaust ventilation system that removes the solvent vapors from the drying station and workroom air. This exhaust air should not be recirculated.

6. All doors and openings to the degreaser should be sealed when it is not in operation, and the ventilation system should be operated at all times. In addition, whenever workers are performing maintenance on the degreaser, they should wear respirators if they are exposed to methylene chloride. Because NIOSH considers methylene chloride to be a potential human carcinogen and recommends that worker exposure to this compound be controlled to the lowest feasible concentration, respirators which offer the maximum level of protection for the wearer (such as a self-contained breathing apparatus or an air-supplied respirator equipped with an emergency escape bottle) should be worn.

7. Splash-proof goggles should be worn by any worker operating the hand-held spray gun used to spray solvents on parts. Goggles should be worn by any worker who is potentially exposed to a splash hazard from methylene chloride. This includes the worker operating the degreaser and anyone performing maintenance on the vapor-lock degreaser.

   In addition, L-Tec should develop and implement a written respiratory protection program. This program should be consistent with the NIOSH recommendations found in DHHS (NIOSH) Publication No. 87-116, "A Guide to Industrial Respiratory Protection", and the requirements set forth in the OSHA Safety and Health Standards, 29 CFR 1910.134. The degreasing operator should use respiratory protection (see Recommendation No. 6.) until a drying station is installed and air sampling documents a reduction in methylene chloride exposures to levels as low as are feasible.

8. All workers should be provided with gloves impermeable to mineral spirits whenever using the Safety Kleen® solvent to clean parts. Glove materials which offer good permeation resistance to mineral spirits include nitrile rubber (NBR) and Viton®. As with methylene chloride, both polyvinyl alcohol (PVAL) and PE/ethylene vinyl alcohol (PE/EVAL) gloves resist penetration by mineral spirits.

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4. NIOSH, Region

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Table 1
Some Chemical and Physical Properties of Methylene Chloride

Esab Group/L-Tec
HETA 90-300
Florence, South Carolina

Synonyms	DCM, dichloromethane, methane dichloride, methylene bichloride, methylene dichloride
Molecular weight	84.93
Empirical formula	CH_2Cl_2
Melting point	-96.7°C(-142°F)
Boiling point	40.1°C (104.2°F)
Vapor density (air=1)	2.93
Concentration in saturated air (25°C)	550,000 ppm
Specific Gravity (20°C)	1.326
Solubility:	
Water	Slight
Ethyl alcohol	Soluble
Ethyl ether	Soluble
Acetone	Soluble
Carbon disulfide	Soluble

Table 2
Results from Personal Breathing Zone and Area Air Sampling for Methylene Chloride According to NIOSH Method 1005

Esab Group/L-Tec
HETA 90-300
Florence, South Carolina
First Shift, October 17, 1990

Job Title or Location/Department	Sample Type[1]	Sample Time[2]	Sample Volume[3]	Concentration of Methylene Chloride[3]
Vapor Degreaser/012	PBZ	0708-1514	9.7	21.6
Parts Processer/012	PBZ	0713-1514	9.6	3.6
Drill Operator/012	PBZ	0717-1524	9.8	4.1
Drill Operator/012	PBZ	0720-1514	9.5	3.3
Drill Operator/012	PBZ	0723-1516	9.5	4.6
Drill Operator/012	PBZ	0740-1513	9.1	1.6
Set-up Operator/011	PBZ	0728-1522	9.5	3.3
Set-up Operator/011	PBZ	0730-1517	9.4	2.8
Set-up Operator/011	PBZ	0734-1515	9.2	2.8
Set-up Operator/015	PBZ	0745-1500	9.0	1.9
3 Feet From Degreaser	A	0752-1509	8.8	6.3
10 Feet From Degreaser	A	0802-1511	8.6	3.2
17 Feet From Degreaser	A	0812-1520	8.5	5.4
20 Feet From Degreaser	A	0809-1503	8.3	3.0
29 Feet From Degreaser	A	0808-1511	8.4	5.1
NIOSH REL				LFC[4]
OSHA PEL				500
ACGIH TLV				50

[1] PBZ = Personal Breathing Zone; A = Area.
[2] Sample volumes expressed in liters of air.
[3] Concentrations expressed in parts per million of methylene chloride.
[4] LFC = Lowest Feasible Concentration.

Table 3
Results from Personal Breathing Zone and Area Air Sampling for Methylene Chloride According to NIOSH Method 1005

Esab Group/L-Tec
HETA 90-300
Florence, South Carolina
Second Shift, October 18, 1990

Job Title or Location/Department	Sample Type[1]	Sample Time	Sample Volume[3]	Concentration of Methylene Chlroide[3]
Set-up Operator/011	PBZ	1514-2331	8.7	3.6
Set-up Operator/011	PBZ	1606-2323	8.6	2.7
Drill Operator/012	PBZ	1544-2327	9.1	3.2
Drill Operator/012	PBZ	1601-2330	9.1	2.9
Gnutti Operator/012	PBZ	1515-2330	9.1	2.8
CNC Operator/015	PBZ	1622-2300	8.0	3.3
Degreaser Small Parts Door	A	1612-2312	8.4	131.8
1 Foot From Degreaser	A	1636-2318	8.0	6.1
4 Feet From Degreaser	A	1630-2326	8.3	11.8
15 Feet From Degreaser	A	1637-2324	8.2	6.0
20 Feet From Degreaser	A	1639-2324	8.1	5.3
25 Feet From Degreaser	A	1615-2323	8.6	3.4
30 Feet From Degreaser	A	1640-2319	8.0	5.1
60 Feet From Degreaser	A	1617-2319	8.4	3.4
NIOSH PEL				LFC[4]
OSHA PEL				500
ACGIH TLV				50

[1] PBZ = Personal Breathing Zone; A = Area.
[2] Sample volumes expressed in liters of air.
[3] Concentrations expressed in parts per million of methylene chloride.
[4] LFC = Lowest Feasible Concentration.

Table 4
Results from Area Air Sampling at Safety-Kleen Solvent Stations

Esab Group/L-Tec
HETA 90-300
Florence, South Carolina
October 17-18, 1990

Location of the Safety-Kleen Solvent Station	Sample Time	Sample Volume[1]	Concentrations[2] 1,1,1-TCE	Toluene	Xylene	Naphtha
First Shift, October 17, 1990						
Dept. 011, Near Lipe Bar Feed	0805-1505	84.0	(0.2)	(0.2)	(0.3)	5.7
Dept. 011, Set-up Area	0807-1506	83.8	(0.2)	(0.2)	0.6	16.7
Dept. 012, Near Beam K-4	0812-1528	87.2	(0.1)	(0.1)	(0.3)	7.2
Dept. 012, Near Seiki Machine	0814-1516	84.5	(0.2)	(0.2)	0.5	9.8
Dept. 012, Near Beam K-8	0815-1518	84.7	(0.3)	(0.3)	0.5	10.3
Dept. 011, Near Lipe Feed Bar	0859-1518	75.7	(0.2)	(0.2)	(0.3)	4.8
Dept. 012, Near Beam L-5	0902-1520	75.6	(0.2)	(0.2)	(0.2)	(2.8)
Second Shift, October 18, 1990						
Dept. 012, Near Seiki Machine	1600-1915	89.2	(0.1)	0.8	3.5	57.2
Dept. 012, Near Beam L-5	1610-1915	86.8	ND	0.5	(0.3)	5.3
Dept. 011, Near Lipe Bar Feed	1554-1915	89.6	(0.1)	0.6	0.9	21.2
Dept. 012, Kearny & Toecker Drill	1545-1915	92.3	(0.1)	0.7	0.5	10.4
Dept. 012, Near Beam K-4	1550-1915	88.9	ND	0.5	0.9	23.6
Dept. 011, Near Lipe Bar Feed	1554-1915	89.6	(0.1)	0.6	0.4	9.9
Dept. 012, Near Beam K-8	1542-1915	91.6	(0.1)	0.7	1.3	34.9
OSHA PEL			1900	375	435	1600
NIOSH REL			1900	375	435	350
ACGIH TLV			1910	377	434	525

[1] Sample volumes expressed in liters of air.
[2] Concentrations expressed in milligrams per cubic meter of air. Values in parentheses fall between the LOD and LOQ for the analytical method and are considered semi-quantitative. Values of "ND" are below the LOD.

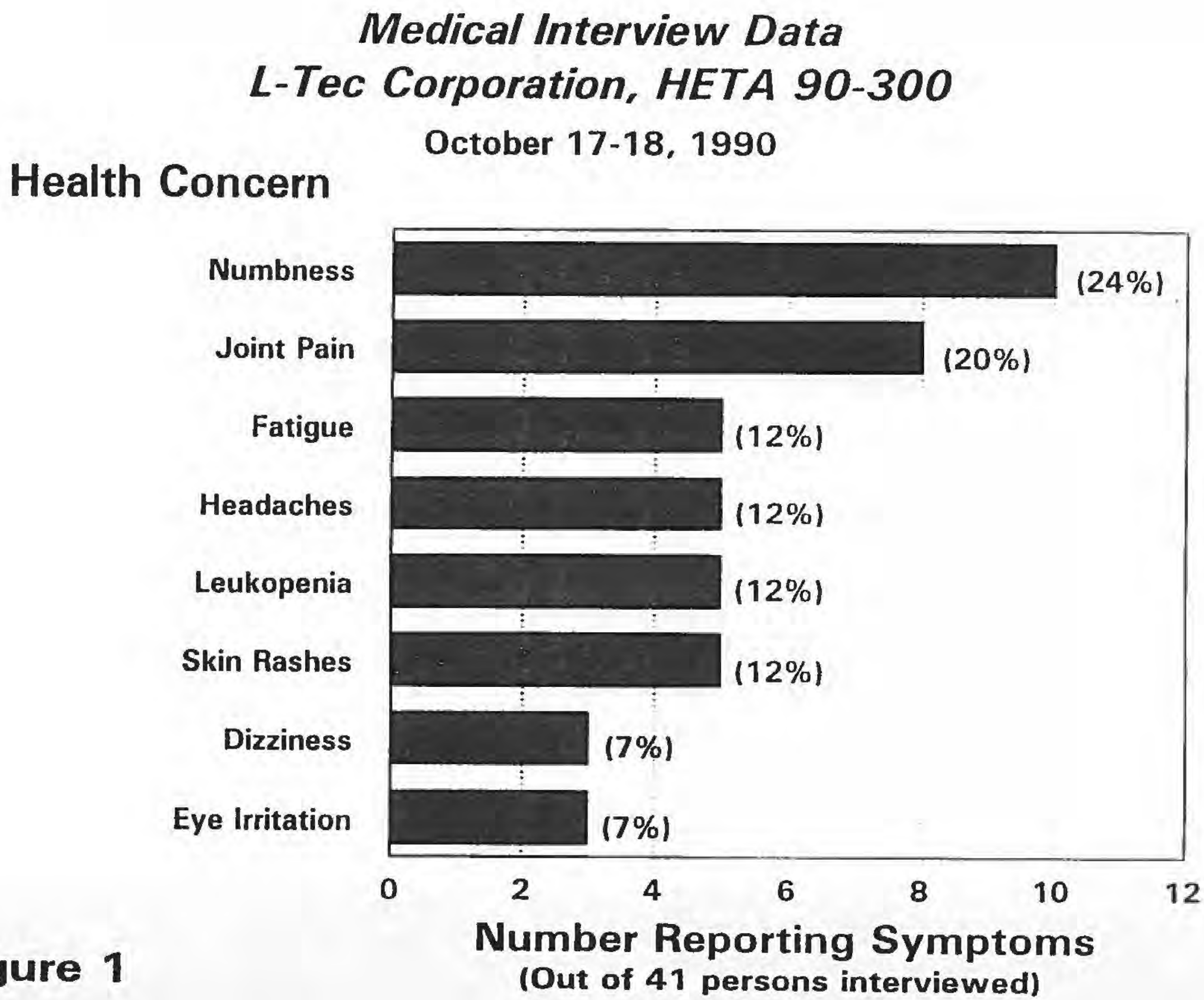
Medical Interview Data
L-Tec Corporation, HETA 90-300
October 17-18, 1990
Health Concern
Numbness
Joint Pain
Fatigue
Headaches
Leukopenia
Skin Rashes
Dizziness
Eye Irritation
(24%)
(20%)
(12%)
(12%)
(12%)
(12%)
(7%)
(7%)
0
2
4
6
8
10
12
Number Reporting Symptoms
(Out of 41 persons interviewed)

Figure 1