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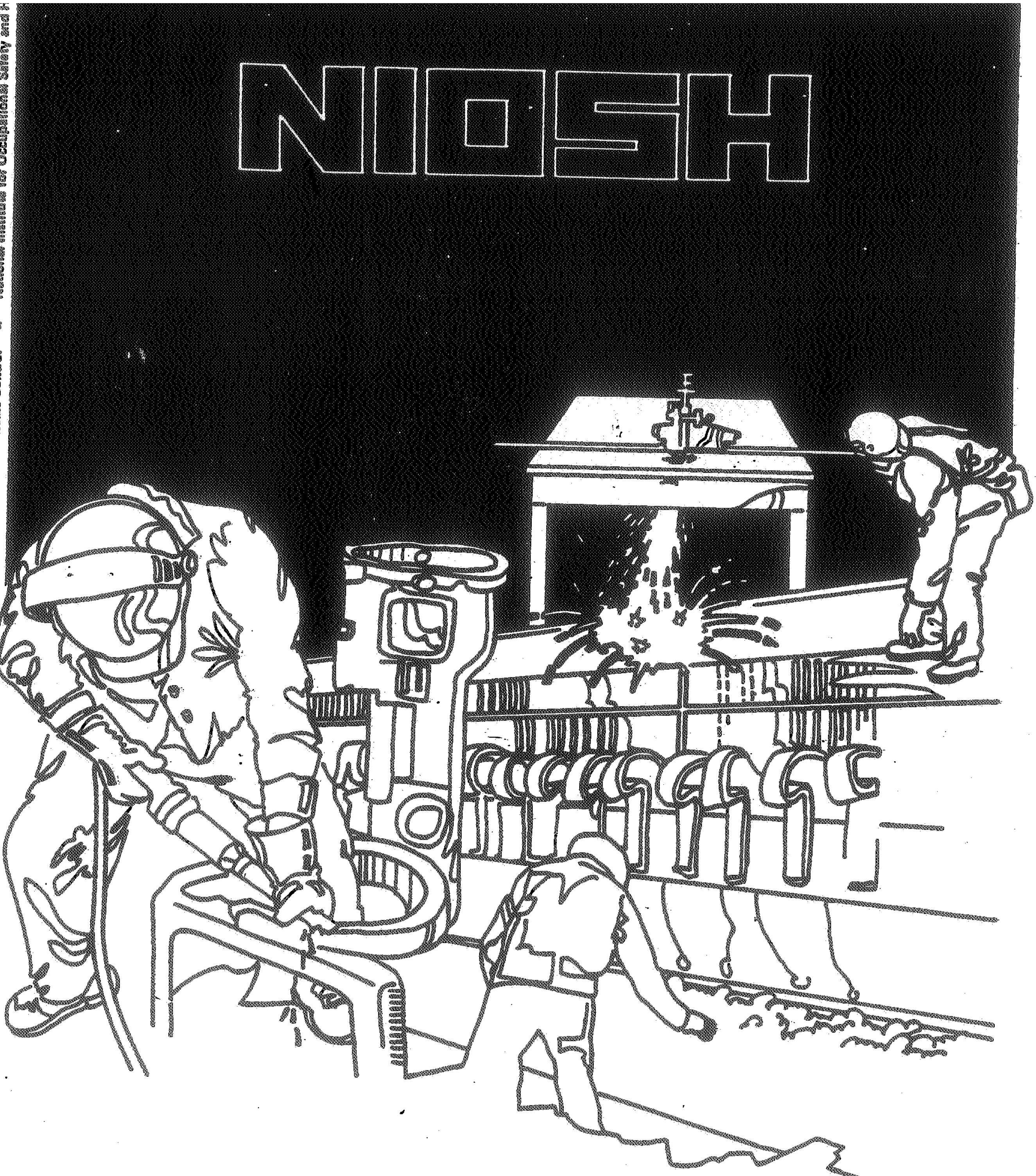


# Health Hazard Evaluation Report

HETA 84-132-1703
PUREX INDUSTRIAL DIVISION
MARION, OHIO

## 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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PUREX INDUSTRIAL DIVISION
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## I. SUMMARY

On January 18, 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate exposures during the manufacturing and packaging of various institutional and janitorial maintenance chemicals and allied products at the Purex Industrial Division Plant in Marion, Ohio. The request was prompted by the employees' reporting symptoms of headache, nasal irritation, muscular weakness and respiratory problems.

On March 20-21, 1984 and on February 6-7, 1985, NIOSH investigators conducted surveys at the plant. Due to the nearly 1600 active raw materials available for use at the plant and because of the extreme variability of the production operations, the potential exposures to the workers can change considerably from day to day. Thus the air samples collected during the NIOSH survey were only indicative of employees' exposures on the day of sampling. Long-term personal breathing-zone air sampling was performed to characterize exposures to acetone, ammonia, butyl cellosolve, ethanolamine, formaldehyde, methylene chloride, morpholine, sodium hydroxide, and styrene. Analysis of these samples revealed the following airborne concentration ranges which are compared to their respective environmental criteria (EC): acetone, one long-term sample, 104 $mg/m^3$ (EC-590 $mg/m^3$) and one short-term sample, 938 $mg/m^3$ (EC-2375 $mg/m^3$); ammonia, nondetectable (ND) - 68.8 $mg/m^3$ (EC-18 $mg/m^3$); ethanolamine, 1.5 $mg/m^3$ (EC-6 $mg/m^3$); methylene chloride, 171-561 $mg/m^3$ (EC-lowest feasible level (NIOSH), 1740 $mg/m^3$ (OSHA); sodium hydroxide, 0.4-1.3 $mg/m^3$ (EC-2 $mg/m^3$); and styrene, 6.0-66.9 $mg/m^3$(EC-215 $mg/m^3$). No detectable airborne concentrations of butyl cellosolve, formaldehyde, or morpholine were found.

Informal medical interviews conducted with nine workers indicated a wide variety of symptoms which varied greatly in severity and frequency. This would not be unexpected due to the batch-type nature of the manufacturing processes. Symptoms consistent with exposure to organic solvents and other contaminants were reported including weakness and irritation of the nose, throat, and respiratory tract . One worker reported experiencing hydrofluoric acid burns.

The results of this investigation indicated that in the operations sampled during the survey, employees were overexposed to ammonia and methylene chloride. Based on NIOSH's recommendation that methylene chloride be considered as a potential human carcinogen, employee exposures to methylene chloride should be reduced to the lowest feasible level. Medical interviews of employees revealed that some workers may be experiencing symptoms related to exposures to organic solvents and other materials used in the manufacturing processes. Recommendations to improve workers' safety and health are included in Section VIII of this report.

KEYWORDS: SIC 2842 (Sanitation Preparations), 2841 (Detergents), 2851 (Paint Removers), 2869 (Organic Solvents), 2819 (Industrial Inorganic Chemicals), methylene chloride, ammonia, acetone, ethanolamine, sodium hydroxide, styrene.

## II. INTRODUCTION

In January 1984, NIOSH received a request to evaluate employee exposures during liquid compounding, dry mixing and packaging of various institutional and janitorial maintenance chemicals and allied products at the Purex Industrial Division Plant in Marion, Ohio. The request was prompted by employee reports of a wide variety of symptoms including headache, nasal irritation, muscular weakness, and respiratory tract irritation.

NIOSH investigators conducted an initial environmental/medical survey at the plant on March 20-21, 1984. A response letter summarizing the activities conducted during the initial survey and outlining preliminary recommendations concerning work practices and personal protective equipment was distributed to plant management and the requestor in April 1984. On February 6-7, 1985, a comprehensive environmental follow-up survey was performed. Representatives of the plant management and workers received verbal notification in June 1985 concerning the results of the air samples collected on the follow-up survey.

## III. BACKGROUND

The Purex Industrial Division Plant, operational since 1980, contains over 200,000 $ft.^2$ of manufacturing, warehouse and office space on a 23-acre site in Marion, Ohio. The two production divisions at the plant, Turco and Purex Industrial, manufacture various products such as industrial, institutional, and household cleaning chemicals, laundry and washing compounds, carpet and upholstery cleaners, degreasers, disinfectants, floor finishes and waxes, paint strippers and soaps.

The total plant workforce (80 employees), consists of 50 production workers, 25 administrative and clerical staff and 5 maintenance employees. The five major production areas at the plant and the number of workers usually assigned to each area are as follows: Resin Reactor (1-2); Turco Dry Mix (4); Purex Industrial Packaging (12-14); and the Compound Room (10-12, includes Turco Liquid Compound and Purex Industrial Compound). The majority of the work is accomplished on one shift, 0730-1600.

The manufactured goods, mostly liquids or powders/flakes are made in quantities ranging from one quart to a semi-tractor trailer tank load containing several thousand gallons. Almost all of the products are made in a batch-type process. The basic manufacturing procedures involve manually or automatically metering or dispensing appropriate portions of the mixtures and then placing these ingredients into mixing containers of different sizes. The components are then usually blended using mixers of various capacities and speeds. Various quality control tests are performed throughout the production processes and just prior to shipment. If all specifications are met, the end-products are packaged for shipping.

At the time of the our survey some of the workers wore disposable or non-disposable half-face piece respirators with dust/mist filters, organic vapor, acid gas or combination organic vapor-acid gas chemical cartridges or cartridges for specific contaminants; for example ammonia, methyl amine or formaldehyde. More recently, however, (in September 1985), plant management provided several workers in the Compound Room with positive pressure hood-type supplied-air respirators.

Extensive changes were made in the ventilation system for the Compound Room in 1984 when local exhaust ventilation equipment was installed on most of the processing equipment. In January 1986, engineering control equipment was installed in the Compound Room to further enclose and automate the ammonia handling procedures and production operations utilizing liquid ammonia.

## IV. EVALUATION DESIGN AND METHODS

### A. Initial Survey

On March 20-21, 1984, an initial survey was conducted at the plant. Activities accomplished during the initial environmental/medical survey included a walk-through tour of the plant to obtain process information and observe work practices and conditions of exposure. Available data concerning previous in-plant environmental surveys and Material Safety Data Sheets were acquired from plant management. Finally, confidential medical interviews were conducted with a few employees and a personnel list of all production employees was obtained.

### B. Follow-Up Survey

At the plant the Turco and Purex Industrial Divisions combined have nearly 1600 active raw materials available for use, over 350 different active formulas and over 600 inactive formulas. The potential contaminant exposures to the production staff can often vary hourly, daily, monthly and yearly. Some chemicals may only be used once per year in quite small amounts (i.e. special custom order) and other substances may be used daily in large volumes to fill product inventory demands. Therefore, the NIOSH industrial hygiene air sampling protocol for the follow-up survey was designed with several factors in mind, including concerns about those materials contained in the goods produced on February 6-7, 1985 that would 1) make up the largest percentage of the product and most likely be in detectable concentrations in the air, and 2) have established air sampling and analytical methods and/or have promulgated occupational exposure standards.

Long-term personal breathing zone air samples were collected on February 6-7, 1985 to characterize employee exposures to methylene chloride in the Compound Room (Turco Liquid); ammonia in the Purex Industrial Packaging Department (Pail Line and Laub Line) and the Compound Room (Purex Industrial Liquid); acetone in the Resin Reactor Area (one short-term sample) and the Compound Room (Turco Liquid); ethanolamine in the Compound Room (Purex Industrial Liquid); sodium hydroxide in the Turco Dry Mix Area, and; styrene in the Resin Reactor Area. The sampling and analytical methodology[1] for these substances, including collection device, flow rate, and referenced analytical procedures, are presented in Table I.

## V. EVALUATION CRITERIA

### A. Environmental Standards

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 not usually considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and Recommendations, 2) The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's)®, and 3) The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's® are lower than the 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, by contrast, 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 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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

## B. Toxicological Effects

### Acetone

Acetone is considered to be a low hazard to health, since few adverse effects have been reported, despite widespread use for many years. Repeated skin contact with the liquid may cause dryness and redness. In one study, awareness of mild eye irritation occurred at concentrations above 2,375 mg/m$^3$. Much higher concentrations, 28,500 mg/m$^3$, depress the central nervous system, causing headache, drowsiness, weakness, and nausea.[2]

The NIOSH recommended standard for occupational exposure to acetone[3] is 590 mg/m$^3$ for up to a 10-hour workshift, 40-hour workweek. The current OSHA[4] permissible exposure limit is 2,400 mg/m$^3$ whereas the ACGIH[5] TLV® is 1,780 mg/m$^3$ both for 8-hour TWAs. The ACGIH short-term (15-minute) exposure limit[5] is 2,375 mg/m$^3$.

### Ammonia[6]

Ammonia vapor is a severe irritant of the eyes, especially the cornea, the respiratory tract, and skin. Inhalation of concentrations of 2500 to 6500 ppm (1738-4519 mg/m$^3$) causes dyspnea, bronchospasm, chest pain and pulmonary edema which may be fatal; production of pink frothy sputum often occurs. Consequences can include bronchitis or pneumonia; some residual reduction in pulmonary function has been reported. In a human experimental study which exposed 10 subjects to various vapor concentrations for five minutes, 134 ppm caused irritation of the eyes, nose, and throat in most subjects and one person complained of chest irritation; at 72 ppm, several reported the same symptoms; at 50 ppm, two reported nasal dryness and at 32 ppm only one reported nasal dryness. In a survey of eight workers in a blueprint shop, ammonia concentrations of 4 to 29 ppm caused "barely noticeable" to "moderate" eye irritation; no respiratory irritation was reported. Tolerance to usually irritating concentrations of ammonia may be acquired by adaptation, a phenomenon frequently observed among workers who were previously effected by exposure; no data are available on concentrations that are irritating to workers who are regularly exposed to ammonia and who presumably have a higher irritation threshold. Liquid anhydrous ammonia in contact with the eyes may cause serious eye injury or blindness; on the skin it causes first- and second-degree burns which are often severe, and if extensive, may be fatal. Vapor concentrations of 10,000 ppm are mildly irritating to the moist skin, while 30,000 ppm or greater causes a stinging sensation and may produce skin burns and vesiculation.

ACGIH[5] has adopted an 8-hour TLV® of 18 $mg/m^3$ (25 ppm) for ammonia, whereas, the OSHA standard[4] of 35 $mg/m^3$ (50 ppm) is based on an 8-hour TWA and the NIOSH[7] recommended exposure level (REL) of 35 $mg/m^3$ is for a five minute ceiling level.

Ethanolamine

Ethanolamine is a colorless liquid with a mild ammonia-like odor. Ethanolamine vapor is a skin, eye, and respiratory irritant and has some narcotic properties. In one study liquid ethanolamine applied to the human skin for 1.5 hours caused marked redness.[6] No systemic effects from industrial exposure have been reported.[6]

The OSHA[4] standard and ACGIH[5] TLV® for ethanolamine are 6 $mg/m^3$ and 8 $mg/m^3$, respectively, for an 8-hour TWA.

Methylene Chloride

Methylene chloride $CH_2$ $Cl_2$, is a colorless volatile liquid that is widely used as a degreasing agent, as a blowing agent in foams and as a solvent for paints, lacquers, varnishes, enamels and adhesives.[6,8] It has a relatively high vapor pressure (350 mm Hg @ 20°C (68°F)) and substantial concentrations of vapor are readily achieved whenever methylene chloride is spilled or spread out over a large surface, even in a space that is not closely confined.[6,8] Various authors have reported odor thresholds for methylene chloride ranging from 25-320 ppm (87-111$^3$ mg/m$^3$). Since adaptation to the odor of methylene chloride can occur, the odor is not a good indicator of exposure and thus it cannot be considered an adequate warning property.[6]

Methylene chloride is readily absorbed through the lungs and across the skin.[9.10] Repeated skin contact with methylene chloride may cause a dry, scaly, and fissured dermatitis. It is an eye, skin and respiratory tract irritant and causes depression of the central nervous system.[2] Symptoms of methylene chloride intoxication may include headache, giddiness, stupor, irritability, numbness, tingling in the arms and legs, nausea and vomiting.[6,11] A metal degreaser briefly exposed to an undetermined but high concentration of methylene chloride vapor suffered from latent pulmonary edema.[12]

The toxicities of carbon monoxide and methylene chloride are additive.[13] The body has the capacity to metabolize methylene chloride to carbon monoxide and significant quantities of carbon monoxide and carboxyhemoglobin have been found in persons receiving single exposures to methylene chloride.[8] Carboxyhemoglobin, which is formed when carbon monoxide combines with hemoglobin, interferes with the oxygen carrying capacity of blood resulting in a state of tissue hypoxia. This may be significant in smokers or workers with anemia or heart disease, and those exposed to both carbon monoxide and methylene chloride.[11]

In its 1976 criteria document for methylene chloride[13] NIOSH recommended a 10-hour TWA occupational exposure limit of 261 mg/m$^3$ in order to prevent interference by methylene chloride with delivery of oxygen to tissues, and impairment in central nervous system functions.

Since 1976, several studies of chronic effects in animals have been reported documenting the carcinogenicity of methylene chloride[14]. Recently, the National Toxicology Program released a technical report[15] on the toxicology and carcinogenesis of methylene chloride. Under the conditions of this methylene chloride inhalation study mice developed cancers (alveolar/bronchiolar carcinomas) and tumors (alveolar/bronchiolar adenomas) of the lung, plus cancers (hepatocellular carcinomas) of the liver. Furthermore, rats exposed to methylene chloride in air developed tumors (fibromas and fibroadenomas) of the mammary glands and cancers (sarcomas) of the salivary glands. Although the potential for methylene chloride to induce cancer in humans has not been determined, the observation of cancers and tumors in both rats and mice treated with methylene chloride meets the criteria established in the OSHA Cancer Policy (29 CFR 1990) for considering methylene chloride a "potential occupational carcinogen."[14,16] Therefore, NIOSH recommends that occupational exposure to methylene chloride be controlled to the lowest feasible limit.[14]

The current OSHA Permissible Exposure Limit (PEL) for methylene chloride (29 CFR 1910.1000 Table Z-2) was adopted in 1971 without rulemaking under the authority of section 6(a) of the Occupational Safety and Health Act of 1970. The OSHA PEL was derived from a standard recommended by the American National Standards Institute (ANSI). The current OSHA[4] PEL is an 8-hour TWA concentration of 1,740 $mg/m^3$.

The 8-hour TWA, TLV® for methylene chloride recommended by ACGIH[5] is 350 $mg/m^3$ (100 ppm) with a 15-minute 1,740 $mg/m^3$ (500 ppm) Short Term Exposure Level (STEL). The documentation on the TLV® cautioned that: "concurrent exposures to other sources of carbon monoxide or physical activity will require assessment of the overall exposure and adjustment for the combined effect."[8,5]

Sodium Hydroxide

Sodium hydroxide or caustic soda is a strongly alkaline substance that is corrosive to any tissue with which it comes in contact. As a solid or in dusts, mists or solutions, sodium hydroxide may cause severe irritation of the eyes, mucous membranes and skin. Effects from dust/mist inhalation will vary from mild irritation to destructive burns and possibly severe pneumonitis depending on the severity of exposure.[6]

The current OSHA PEL[4] for sodium hydroxide is 2 $mg/m^3$ averaged over an 8-hour workshift. The ACGIH[5] TLV® and NIOSH REL[17] are both ceiling limits of 2 $mg/m^3$.

Styrene

Exposure to styrene may be irritating to the eyes, nose, throat, and skin. Respiratory tract irritation has been reported in persons exposed to vapor concentrations in excess of about 800 $mg/m^3$. Higher exposures depress the central nervous system. Prolonged or repeated skin contact may cause dermatitis due to defating action.[6]

The current ACGIH[5] 8-hour TWA/TLV® for styrene is 215 $mg/m^3$ (50 ppm) and the federal OSHA PEL[4] is 420 $mg/m^3$ (100 ppm) for an 8-hour TWA. The NIOSH REL for occupational exposure to styrene[18] is 215 $mg/m^3$ for up to a 10-hour TWA.

## VI. RESULTS

### A. Initial Survey

#### Medical

Informal medical interviews were conducted on March 20-21, 1984 with those identified by the workers and management as either being concerned about their health or concerned about their exposure to chemicals at work. Nine workers were interviewed: 6 males and 3 females. A wide variety of symptoms were reported. Symptoms consistent with exposure to organic solvents and other contaminants were reported including headache, muscular weakness and nose, throat, and respiratory tract irritation. One had experienced hydrofluoric acid burns. Four reported chemical splashes onto the skin.

#### Environmental

On the initial survey deficiencies in work practices and process controls were recognized. Some bearded employees wore respirators while working at their jobs. Also, during the walkaround, a large vat used to make liquid floor finishes in the Compound Room overflowed spilling excess solvents onto the floor.

### B. Follow-up Survey

Results of the personal breathing zone air samples obtained on February 6-7, 1985 to assess employee exposures to acetone, ammonia, ethanolamine, methylene chloride, sodium hydroxide and styrene are presented in Tables II - VII. The results of the air samples collected for butyl cellosolve, formaldehyde and morpholine are discussed later in this Section. All sample results were calculated as time-weighted averages for the time period sampled. The areas sampled included the Turco Dry Mix, Resin Reactor, Purex Industrial Packaging and the Compound Room (Turco Liquid and Purex Industrial).

Two air samples were collected for acetone (see Table II). Analysis of the short-term air sample obtained in the Resin Reactor Area (938 mg/m$^3$) and one long-term sample taken in the Compound Room (Turco-Liquid (104 mg/m$^3$)) revealed concentratons below the NIOSH recommended 10-hour exposure limit (590 mg/m$^3$), OSHA (2,400 mg/m$^3$) and ACGIH (1,780 mg/m$^3$) 8-hour criterion and the ACGIH short-term TLV® of 2,375 mg/m$^3$.

The analytical results for the eight ammonia air samples, three in the Compound Room (Purex Industrial Liquid) and five in the Packaging Department are presented in Table III. Ammonia levels were detected on only two of eight samples at 21.1 mg/m$^3$ and 68.8 mg/m$^3$. Both of these concentrations exceeded the ACGIH 8-hour TLV® of 18 mg/m$^3$ and one exceeded the federal OSHA ammonia standard of 35 mg/m$^3$ for an 8-hour TWA.

On February 7,1985 a full shift air sample was collected in the Compound Room (Purex Industrial Liquid) to assess employee exposure to ethanolamine (see Table IV). The concentration of ethanolamine found, 1.5 mg/m$^3$, is within the OSHA standard of 6 mg/m$^3$ and the ACGIH TLV® of 8 mg/m$^3$.

The environmental air sample values for the methylene chloride obtained are shown in Table V. A total of 4 air samples were collected for methylene chloride in the Compound Room (Turco Liquid) and the results ranged from 171 mg/m$^3$ to 561 mg/m$^3$. Two of the sample concentrations, at 494 mg/m$^3$ and 561 mg/m$^3$, were more than the ACGIH TLV® of 350 mg/m$^3$ for an 8-hour TWA. NIOSH considers methylene chloride as a potential occupational carcinogen and as such concludes that an absolute safe level of exposure cannot be established. Furthermore, NIOSH recommends that occupational exposures to methylene chloride be reduced to the lowest feasible level.[14]

All four of the long-term air samples taken for sodium hydroxide in the Turco Dry Mix Area had measurable quantities ranging from 0.4 mg/m$^3$ to 1.3 mg/m$^3$ (see Table VI). However,none exceeded the OSHA standard of 2 mg/m$^3$ averaged over an 8-hour workshift.

Concentrations of styrene found on two air samples collected in the Resin Reactor Area (see Table VII) were as follows: 6.0 mg/m$^3$ and 66.9 mg/m$^3$. Both air samples collected for styrene were within the ACGIH and NIOSH 215 mg/m$^3$ criterion and the OSHA PEL of 420 mg/m$^3$.

No detectable butyl cellosolve, formaldehyde, or morpholine were found on the full shift samples collected on February 6-7, 1985. One sample for butyl cellosolve was obtained in the Compound Room - Purex Industrial Liquid (limit of detection (LOD) 0.01 mg/sample) and one morpholine sample was taken in the Compound Room - Turco Liquid (LOD 0.04 mg/sample). Five formaldehyde air samples were collected: four in the Purex Industrial Packaging Department (three on the Pail Line and one on the Laub line); and, one in the Compound Room - Purex Industrial Liquid (LOD 0.002 mg/sample).

## VII. DISCUSSION/CONCLUSIONS

The results of the environmental air samples obtained by NIOSH investigators revealed that workers in the Compound Room were exposed to methylene chloride. Methylene chloride has been shown to induce cancer in rats and mice.[15] Although humans and animals may differ in their suscepitibility to specific chemical compounds, any substance that produces cancer in experimental animals should be considered a cancer risk to humans. Based on the animal studies, NIOSH recommends that methylene chloride be handled in the workplace as a potential occupational carcinogen[14] and as a prudent public health measure suggests that effective engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. However, in the interim period, continued use of the recently acquired positive pressure supplied air respirators in the Compound Room is recommended. The use of air-purifying respirators for protection from excessive methylene chloride levels is not advised due to the 1) very short respirator sorbent breakthrough times of methylene chloride and 2) lack of adequate olfactory warning properties (no distinct odor threshold). The recently published carcinogenicity research findings on methylene chloride dictate the use of the best respiratory protection available; in this case, supplied air respirators.

Overexposures to ammonia were confirmed by the personal air sample results. Plant management's recent attempts (January 1986) to enclose and automate the ammonia handling procedures in the Compound Room may have helped to reduce these exposures.

The limitations of the air sampling conducted on the NIOSH survey must be acknowledged. Due to the frequent (daily) changes in a) the materials that may be used in the manufacturing processes, and b) the variety of final products made, not all potential exposure situations were monitored and other chemical exposures may (or probably do) occur.

## VIII. RECOMMENDATIONS

In view of the findings of this investigation, the following recommendations are made to ameliorate existing or potential hazards and to provide a better work environment for the employees covered by this determination.

1. Ideally, the reduction of employee overexposures should be accomplished by the implementation of improved engineering control of workplace contaminants such as substitution of less hazardous process materials, automation, redesign or replacement of existing mechanical ventilation systems, better work practices or a

combination of these measures. Industrial hygiene and engineering consultants (possibly from the company's corporate offices) should be retained by the plant management to provide additional methylene chloride and ammonia monitoring data to determine points of generation of these contaminants within the Compound Room and advice as to what specific improvements in work practices or in the existing local exhaust ventilation systems would be effective in controlling and reducing exposures to these contaminants.

2. Plant management should consider installing audible and visual warning systems on the large mixing vats in the Compound Room that would give notice to all employees in case the tubs are overfilled and an extensive spillage of organic solvents occurs.

3. Adequate supplies of calcium gluconate gel should be stored on the plant premises for use as an effective first aid measure for liquid hydrofluoric acid splashes and hydrofluoric acid vapor burns.

4. Beards should be prohibited on employees who are required to use respirators. Respirators cannot provide sufficient protection if facial hair interferes with a proper facepiece to face seal.

5. Training of all employees in the potential health problems associated with exposure to the materials used at the plant and the methods of protection utilized should be offered on a regular basis. This could be a joint responsibility of the medical personnel assigned to the plant and the plant management/employee occupational safety and health committee.

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## XI. DISTRIBUTION AND AVAILBILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. The Purex Industrial Division, Marion, Ohio
2. Requestors
3. NIOSH, Region V
4. 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 I

Air Sampling and Analysis Methodology
PUREX CORPORATION
Marion, Ohio
HETA 84-132
February 6-7, 1985

| Substance | Collection Device | Flow Rate (liters per minute) | Analysis | References |
|---|---|---|---|---|
| Acetone | Charcoal Tube | 0.1 | Gas Chromatography | NIOSH Method S-1 with modifications* |
| Ammonia | $H_2SO_4$ Treated Silica Gel Tube | 0.05 | Ion Chromatography | |
| Butyl Cellosolve | Charcoal Tube | 0.1 | Gas Chromatography | NIOSH Method 1403 with modifications* |
| Ethanolamine | Silica Gel Tube | 0.2 | Gas Chromatography | NIOSH Method P & CAM 270 with modifications* |
| Formaldehyde | Orbo - 22 XAD Tube | 0.05 | Gas Chromatography | NIOSH Method 2502, with modifications* |
| Methylene Chloride | 2 Charcoal Tubes in Series | 0.05 | Gas Chromatography | NIOSH Method 1005 with modifications* |
| Morpholine | Silica Gel Tube | 0.2 | Gas Chromatography | NIOSH Method S-150 with modifications* |
| Sodium Hydroxide | Polytetrafluroethylene Filter | 1.5 | Atomic Emission Spectroscopy | Analytical METHOD: P & CAM 173 Collection Method: NIOSH Method 7401 |
| Styrene | Charcoal Tube | 0.05 | Gas Chromatography | NIOSH Method S-30 with modifications* |

*The modifications included sample preparation, instrument condition settings, and/or column selection.

TABLE II

Results of Personal Air Samples for Acetone[1]
PUREX CORPORATION
Marion, Ohio
HETA 84-132
February 6, 1985

| Sample Location | Time | Sample Volume (liters) | Acetone:STEL $(mg/m^3)$[2] | Acetone:Long-Term $(mg/m^3)$ |
|---|---|---|---|---|
| Resin Reactor Area<br>Compounder/Operator<br>End of Shift Clean-up | 1515-1546 | 3.2 | 938 | -- |
| Compound Room<br>Turco Liquid<br>Compounder | 0738-1531 | 46.1 | -- | 104 |
| Evaluation Criteria | | | | |
| (normal workday, 40-hour week for up to a 10-hour time-weighted average) | | | -- | 590 |
| 15-minute time-weighted average short-term exposure (STEL) | | | 2,375 | -- |
| Laboratory analytical limit of detection in milligrams/sample = 0.01 | | | | |

1. All samples are personal breathing-zone air samples.
   The concentrations are time-weighted averages for the period sampled.
2. $mg/m^3$ = milligrams per cubic meter of air.

TABLE III

Results of Personal Air Samples For Ammonia
PUREX CORPORATION
Marion, Ohio
HETA 84-132
February 6-7, 1985

| Sample Location | Date | Time | Sample Volume (liters) | Ammonia[1] ($mg/m^3$)[2] |
|---|---|---|---|---|
| Compound Room PI Liquid-Compounder | 2/06/85 | 0747-1541 | 24.7 | ND[3] |
| PI-Packaging Pail Line-Machine Operator | 2/06/85 | 0802-1545 | 28.2 | ND |
| PI Packaging Pail Line-Packer/Filler | 2/06/85 | 1330-1545 | 6.9 | ND |
| PI-Packaging Laub Line-Packer/Filler | 2/07/85 | 0802-1542 | 23.1 | ND |
| PI-Packaging Laub Line-Packer/Filler | 2/07/85 | 0803-1543 | 29.4 | ND |
| PI-Packaging Pail Line-Machine Operator | 2/07/85 | 0750-1528 | 24.7 | ND |
| Compound Room PI-Liquid-Compounder | 2/07/85 | 0753-1525 | 24.6 | 21.1 |
| Compound Room PI-Liquid-Compounder | 2/07/85 | 0744-1527 | 21.8 | 68.8 |
| Evaluation Criteria (normal workday, 40-hour week, 8-hour time-weighted average) | | | | 18.0 |

Laboratory analytical limit of detection in micrograms (ug) per sample = 4.0

1. All samples are personal breathing-zone air samples. The concentrations are time-weighted averages for the period sampled.
2. $mg/m^3$ = milligrams per cubic meter of air
3. ND = nondetectable concentration

TABLE IV

Results of a Personal Air Sample for Ethanolamine

PURFX CORPORATION
Compound Room
Marion, Ohio
HETA 84-132
FEBRUARY 7, 1985

| Sample Location | Time | Sample Volume (liters) | Ethanolamine[1] ($mg/m^3$)[2] |
|---|---|---|---|
| Purex Industrial-Liquid Compounder | 0744-1527 | 81.2 | 1.5[3] |
| Evaluation Criteria (normal workday, 40-hour week 8-hour time-weighted average) | | | 6.0 |
| Laboratory analytical limit of detection in milligrams/sample = 0.02 | | | |

1. Personal breathing-zone air sample.
   The concentration reported is a time-weighted average for the period sampled.
2. $mg/m^3$ = milligrams per cubic meter of air.
3. The concentration should be considered as a minimum due to breakthrough (greater than 30% of the total concentration) occurring on the B section of the silica gel tube.

TABLE V

Results of Personal Air Samples For Methylene Chloride
PUREX CORPORATION
Compound Room: Turco Liquid
Marion, Ohio
HETA 84-132
February 6-7, 1985

| Sample Location | Date | Time | Sample Volume (liters) | Methylene Chloride[1] ($mg/m^3$)[2] |
|---|---|---|---|---|
| Machine Operator | 2/06/85 | 0733-1543 | 26.5 | 494 |
| Compounder | 2/07/85 | 0737-1549 | 25.3 | 561 |
| Compounder | 2/07/85 | 0734-1535 | 21.5 | 209 |
| Machine Operator | 2/07/85 | 0618-1420 | 25.8 | 171 |
| Evaluation Criteria (normal workday, 40-hour week for up to a 10-hour time-weighted average). | | | | Lowest Feasible Level[3] |

Laboratory analytical limit of detection in milligrams/sample = 0.01

1. All samples are personal breathing-zone air samples. The concentrations are time-weighted averages for the period sampled.
2. $mg/m^3$ = milligrams per cubic meter of air.
3. NIOSH recommends that occupational exposure to methylene chloride be controlled to the lowest feasible level.

TABLE VI

Results of Personal Air Samples For Sodium Hydroxide
PUREX CORPORATION
Turco Dry Mix Area
Marion, Ohio
HETA 84-132
February 6-7, 1985

| Sample Location | Date | Time | Sample Volume (liters) | Sodium Hydroxide[1] (mg/m$^3$)[2] |
|---|---|---|---|---|
| Compounder | 2/06/85 | 0742-1527 | 698 | 0.4 |
| Compounder | 2/06/85 | 0741-1527 | 699 | 0.7 |
| Compounder | 2/07/85 | 0743-1535 | 708 | 1.3 |
| Machine Operator | 2/07/85 | 0741-1535 | 711 | 0.6 |
| Evaluation Criteria (normal workday, 40-hour week 8-hour time-weighted average) | | | | 2.0 |
| Laboratory analytical limit of detection in milligrams/sample = 0.0005 (Sodium) | | | | |

1. All samples are personal breathing-zone air samples. The concentrations are time-weighted averages for the period sampled.
2. mg/m$^3$ = milligrams per cubic meter of air.

TABLE VII

Results of Personal Air Samples for Styrene
PUREX CORPORATION
Resin Reactor Area
Marion, Ohio
HETA 84-132
February 6-7, 1985

| Sample Location | Date/Time | Sample Volume (liters) | Styrene[1] ($mg/m^3$)[2] |
|---|---|---|---|
| Compounder | 2/6/85 0731-1546 | 26.7 | 6.0 |
| Compounder | 2/7/85 0734-1547 | 23.9 | 66.9 |
| Evaluation Criteria (normal workday, 40-hour week 8-hour time-weighted average) | | | 215 |
| Laboratory analytical limit of detection in milligrams/sample = 0.01 | | | |

1. All samples are personal breathing-zone air samples. The concentrations are time-weighted averages for the period sampled.
2. $mg/m^3$ = milligrams per cubic meter of air.