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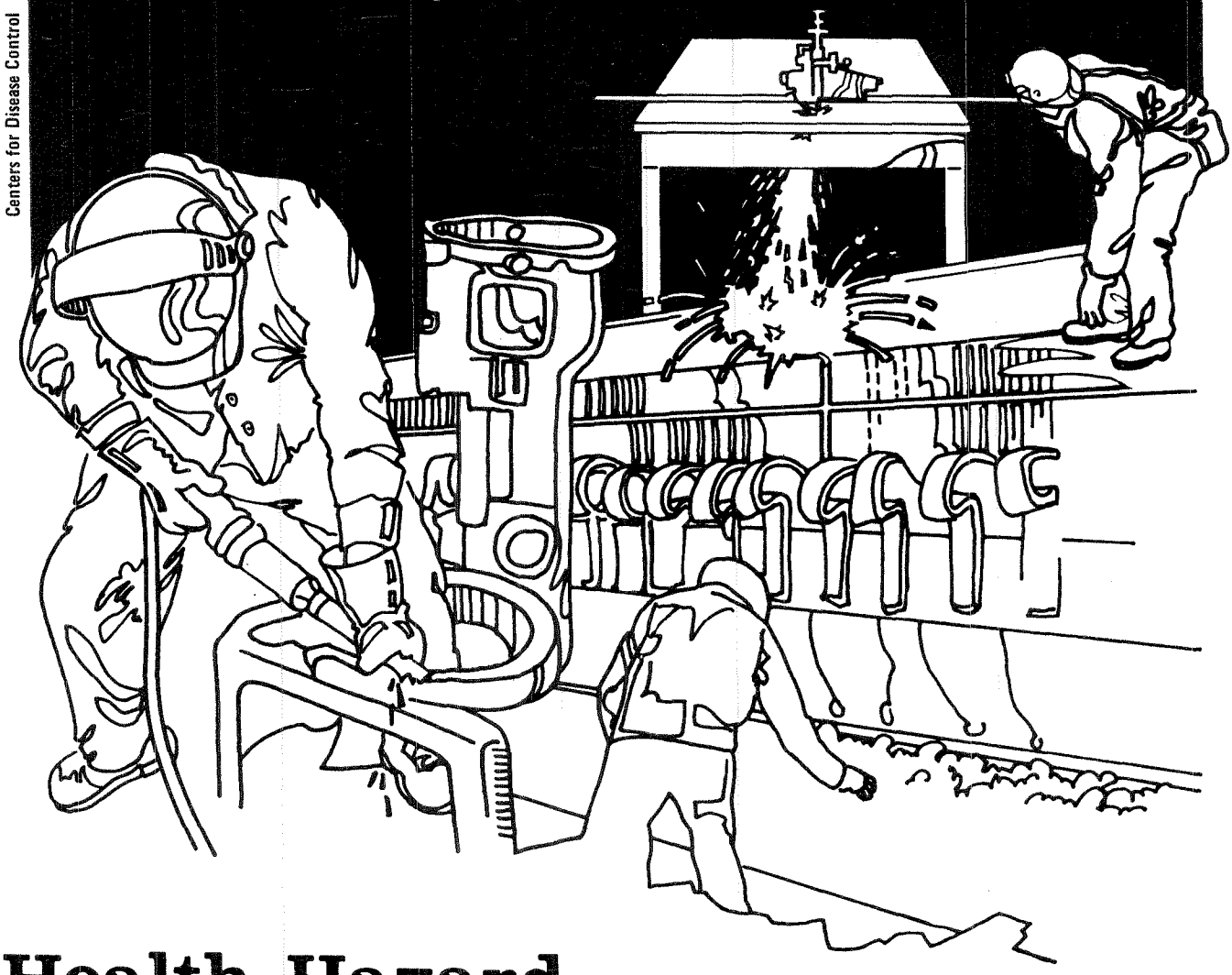
NIOSH



Health Hazard Evaluation Report

HHE 80-191-829
UNIVERSITY OF CALIFORNIA/
MOFFITT HOSPITAL
SAN FRANCISCO, CALIFORNIA

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. 699(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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HE 80-191-829
March 1981
University of California - Moffitt Hospital
San Francisco, California

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I. SUMMARY

In August 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an authorized employee representative at the University of California (U.C.) - Moffitt Hospital, San Francisco, California. The requestor was concerned that several employees in the Materials Services Department (laundry and sterilizing) were experiencing coughs and/or headaches due to ethylene oxide exposure.

An initial environmental/medical survey was conducted August 20, 1980, and a follow-up survey on November 4, 1980. Ten environmental air samples (personal and general area) were collected for ethylene oxide and Freon 12. All the ethylene oxide samples were measured to be below the analytical limit of detection. All the Freon 12 samples were also well below the California-Occupational Safety and Health Administration (CAL-OSHA) standard of 1000 ppm (parts of a vapor or gas per million parts of contaminanted air by volume). Six general area air samples were collected to determine phenol concentrations. No airborne phenol (p-tert-amyl phenol, O-pheny-phenol, o-benzyl-p-chlorophenol) was measured on any of the samples.

On October 30-31, 1980, NIOSH conducted a follow-up medical survey. A brief questionnaire was administered to all workers on day and evening shifts, and procedures for materials handling and worker training were investigated. A majority of day shift, but far fewer swing shift workers complained of upper respiratory irritation and sinus problems. Both shifts complained of poor ventilation, excessive heat, and dryness of the nose and mouth. In light of higher past exposures to ethylene oxide reported by the hospital administration (also implying a concurrently greater exposure to the Freon which is a carrier gas for the ethylene oxide), it is possible that some workers have been sensitized to ethylene oxide. The effects currently reported may be the result either of heated and dry air in the work environment, or of a combination of that factor with sensitization to ethylene oxide and Freon irritation in low amounts.

On the basis of the evaluation, a health hazard of ethylene oxide, Freon or phenol exposure does not exist in the U.C. Moffitt Hospital Materials Services Department. A large number of reports of nose and throat irritation, particularly on the day shift, may be due to the heated and un-humidified work environment. A further factor is possible sensitization to ethylene oxide resulting from past exposures which are reported to have been significantly higher.

KEYWORDS: SIC 8062 (General Hospitals), ethylene oxide, Freon, phenols, laundry services, sterilizers, respiratory irritation.

II. INTRODUCTION

In August 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from an authorized employee representative at the University of California - Moffitt Hospital, pursuant to Section 20 (a)(6) of the Occupational Safety and Health Act of 1970. The request was to evaluate workers' exposure to ethylene oxide, liquid cleansers and liquid sterilizers. Three of the eleven workers in the Material Services Department complained of coughs while working swing shift and one worker complained of frequent headaches.

An initial environmental and medical survey was conducted August 20, 1980. A follow-up medical survey was conducted October 30-31, 1980 with workers on day and swing shift, and a follow-up environmental survey was conducted during the swing shift on November 4, 1980.

III. BACKGROUND

Materials Services at the Moffitt Hospital of the University of California employs approximately seven persons on each of three shifts to clean and package used medical instruments and equipment, and to load and unload two ethylene oxide/steam autoclaves and one 100% ethylene oxide autoclave. Three Technicians I employees are permanently assigned to washing instruments and equipment, and participate in packaging washed materials prior to sterilization, load and unload the three sterilizers, transfer materials into and out of aerators, and change connections to tanks of ethylene oxide. The supervisor of each shift may do all of these jobs. Materials are stored in an adjacent area until needed. Workers in the storage area (dispatchers) divide their time between the storage room and the hospital floors where they pick up and deliver materials. During the day shift, five clerical staff work in offices adjacent to the sterilizer vent rooms.

The smallest 100% ethylene oxide sterilizer may be run once or twice daily during the day shift. It has a two-hour cycle. The two larger sterilizers are usually loaded at about 2:00 p.m., run for six hours, and then are unloaded approximately 8:00 p.m. each evening. Another load is usually run at approximately 8:00 p.m. to be unloaded by a Technician II on graveyard shift. After materials are unloaded from an ethylene oxide cycle of autoclave, they are placed into one of two aerators for at least twelve hours. At the end of this period, they are placed in the adjacent area for storage.

Dirty equipment reaches Materials Services by cart from the floors, or on one of the dumbwaiters that are located in the storage area of Materials Services. The Technicians I then hand wash these instruments in one of several washing solutions. These solutions include a blood solvent, Weck Instrument®, a combination of phenolic salts, Mayfair Superpolyphene®, and Wescodyne®, an iodophor and alcohol mix. The use of Cydex® (glutaraldehyde) was discontinued in August of this year. At the time of this study the day shift Technicians I were using only Weck solution, a nonbacteriocidal blood solvent, to wash all contaminated instruments. Hospital policy was to use Wescodyne to wash all instruments from isolation or suspected hepatitis patients. Superpolyphene was recommended for washing all other instruments, except that a pre-wash with Weck blood solvent was recommended for instruments heavily covered with blood. Swing shift technicians use Superpolyphene and Wescodyne as recommended. Vinyl examination gloves, surgical gloves, and rubber gloves are available for hand protection while washing.

Over the past several months numerous changes have been made in practices and organization of personnel in Materials Services. The former practice of pre-sterilizing contaminated materials before the washing procedure has been discontinued. In 1979 extensive study was made of the ethylene oxide venting system and ventilation changes were made to correct a probable long-standing problem of employee exposure to ethylene oxide and Freon 12 from the autoclaves. Cydex was discontinued and Mayfair Superpolyphene and Wescodyne washing solutions were introduced in August of this year. Additionally, the whole department will be moving to new quarters better designed for their purposes in June 1981. In August 1980 all workers were given a training program on microbiology and sterilization procedures, via a series of films on microbiology and antisepsis.

IV. HAZARD EVALUATION DESIGN

A. Evaluation Criteria and Health Effects

Occupational exposure criteria has been developed to evaluate a workers' exposure to chemical substances. Two sources of criteria were used to assess the workroom concentrations: (1) NIOSH criteria for a recommended standard, and (2) California-Occupational Safety and Health Administration (CAL-OSHA) standards. These values represent concentrations to which it is believed that nearly all workers may be exposed for an 8-hour day, 40-hour work week throughout a working lifetime without experiencing adverse health effects.

TABLE A
Evaluation Criteria (ppm)[1]

Substance	NIOSH (TWA)[2]	Ceiling	CAL-OSHA(TWA)	Ceiling
(1) Ethylene Oxide	50	75 (15 min)	50	-----
(2) Pheonl	5.2	15.6 (15 min)	5	-----
(3) Dichlorodifluor-ethane (Freon 12)	-----	--------	1000	10,000

(1) ppm - Parts of a vapor or gas per million parts of contaminated air by volume.
(2) TWA - Time Weighted Average.

B. Materials and Methods

1. Environmental

Ten personal breathing zone and general area air samples were collected for ethylene oxide using a specially impregnated charcoal tube and a MDA® pump operating at a flowrate of 50 cubic centimeters (cc) per minute. The samples were analyzed according to NIOSH Physical and Chemical Analytical Method (P&CAM) No. S286.

Ten personal breathing zone and general area air samples were collected for dichlorofluoromethane using a 150 milligram charcoal tube and a MDA pump operating at a flow rate of 50 cc per minute. The samples were analyzed according to NIOSH P&CAM No. S109.

Six general area air samples were collected for phenol using a midget bubbler containing 15 milliliter of 0.1 normal sodium hydroxide solution through which approximately 100 liters of air was passed. The samples were analyzed according to the NIOSH P&CAM No. S330. Also, a bulk sample of the disinfectant/detergent was submitted for analysis of phenol.

2. Biological Monitoring Design and Methods

An initial meeting and walk through of Materials Services was conducted on August 20, 1980. Medical interviews were conducted with all affected workers present on the day shift on October 30, and swing shift on October 31, 1980. All Technicians I and II who were present on the days of interview were questioned. In addition, three of the five day clerical workers were interviewed, along with approximately fifty percent of the dispatch clerks. On these visits workers health complaints were reviewed as a group. Individuals were then interviewed individually to elicit the following information: 1) Length of employment in Materials Services: Job category, and actual tasks performed; Health problems while on the job and their duration; Relation of health problems to specific work areas, tasks, time of day, or chemical contacts. 2) Presence of Symptoms: respiratory irritation, dermatitis, drowsiness, heart palpation, and gastrointestinal distress. 3) Whether they had sought medical attention for their complaints, or were taking any medications for these complaints. 4) Presence of other medical problems, especially food, drug or airborne allergies, childhood or adult-onset asthma or family history of asthma.

On October 30 and 31, physical layout, work process and flow of materials, job categories and actual tasks performed were explored both with workers and shift supervisors in an attempt to correlate facets of the workplace with health problems. Day and swing shift supervisors were questioned about their perceptions of problems in the workplace, the workers complaints, and their manner of dealing with these problems.

C. Toxicological Effects

1. Ethylene Oxide (ETO)

The major route of human exposure in the hospital sterilizing process is contact of eyes, skin and respiratory passages with ethylene oxide vapor. Systemic absorption is primarily by inhalation, and to a lesser extent via penetration of vapor and liquid through the skin. At relatively low levels ETO may cause irritation of eyes, nose, throat and a peculiar taste. Higher levels of exposure (more than 278 ppm for one hour) may also cause delayed effects of headache, nausea, vomiting, dyspnea, cyanosis, pulmonary edema, drowsiness, weakness, incoordination, electrocardiographic abnormalities, and urinary excretion of bile pigments. Chronic exposure to low levels over several years has been associated with an elevated absolute lymphocyte count, bone marrow cell abnormalities, including leukemia, and reduced hemoglobin levels. Ethylene oxide is a well established plant and bacterial mutagen. A few studies of animals and humans exposed for

short period of high concentrations of ETO have demonstrated a greater frequency of chromosomal aberrations than controls. Teratogencity has not been proven. However, ethylene chlorohydrin, a reaction product present in small amounts, has demonstrated pronounced teratogenic effects in developing chick embryos. A variety of malignant tumors and platelet dysfunction have been demonstrated in female and male mice, respectively, who were exposed to long term high doses of ethylene oxide.

Systemic response to prolonged high levels of ethylene oxide (greater than 556 ppm for one hour or 278 ppm for eight hours) has been associated with weight loss, diarrhea, dyspnea, pulmonary edema, pneumonia, impaired nervous function at the lumbar and sacral area, convulsions, and death associated with degenerative changes of lungs, liver, and kidneys.

Skin contact with 1% aqueous solutions of ethylene oxide have been associated with burns, vesiculation and desquamation. ETO has also been found to elicit delayed sensitivity reactions and "spontaneous flare up" reactions.

Chronic exposure to small amounts of ethylene oxide may diminish the sense of smell, cause excessive tearing of the eyes and nausea. Upper respiratory tract irritation may also occur.

Ethylene oxide is an epoxide which is capable of alkylating cellular proteins and nucleic acids. Ethylene oxide is metabolized by the body and is excreted through both liver and kidneys. (1,2,3,4,5,6)

2. Phenol

Phenol is a systemic toxin that enters the body through ingestion, inhalation, or skin absorption. Skin absorption efficiency equals that of inhalation. Phenol has not been found to be a carcinogen. It may create benign skin tumors with prolonged contact at high levels by acting as a nonspecific irritant. Chronic high levels of exposure may cause anorexia, weight loss, weakness, muscle aches and pains, dark urine, or onchronosis.

Acute exposure to high concentrations of phenols may cause shock, collapse, coma, convulsions, or cyanosis. Phenol is a by-product of natural body metabolism and is excreted through the kidneys.

Brief, intermittent industrial exposure to airborne or aqueous phenols can cause irritations of the eyes, nose and throat. Prolonged contact with the skin in even dillute aqueous solutions can cause ezcema, inflammation, discoloration, necrosis, sloughing, and gangrene. (7)

3. Freon

Freon 12 is a chlorinated fluorocarbon that is distributed systemically after inhalation of vapors and is retained by body tissues for short periods of time proportionate with tissue fat content. Whole body clearance has a half life of approximately forty minutes. A minimum threshold blood level is required (above 0.08 mg/100 mg) before adverse physiological effects are initiated; the current TLV for Freon 12 is 1000 ppm. Systemic reactions are rare, however, people with atherosclerotic heart disease, COPD, asthma, or

other conditions causing hypoxemia may be at greater risk of suffering adverse reaction to Freon inhalation. Adverse effects that have been reported have been reduced cardiac contractility, hypotension, reduced blood flow to the cerebral hemispheres, and central nervous system depression and premature ventricular contractions. Freons are thought to sensitize the myocardial muscle to epinephrine, and fatal arrhythmias have been reported in young people exposed to high levels of Freon who have subsequently become excited. (8, 9, 10, 11, 12)

V. RESULTS AND DISCUSSION

A. Environmental

All of the samples collected for ethylene oxide were below the limit of detection. The airborne concentrations of Freon 12 ranged from below the limits of detection to 1.66 ppm. All of the samples collected were well below the CAL-OSHA standard.

No airborne phenol (p-tert-amylphenol, O-phenylphenol, O-benzyl-p-chlorophenol) concentrations were measured on any of the six samples collected.

B. Medical

A majority of day-shift employees reported symptoms of nose irritation, sinusitis, or postnasal drip in the early morning. All of these people reported that their upper respiratory conditions had worsened since beginning work in Materials Services. Two workers had consulted otolaryngologists and were found to have allergies to dust and feathers. These individuals report no prior history of allergy, and are currently taking antihistimine/decongestant medication on a chronic basis. Two individuals reported occasional chest tightness and cough. One of these persons had a history of asthma. A few workers connected nasal stuffiness with use of Mayfair Superpolyphene. Several others associated their conditions with working in areas near where autoclaves are vented or near the aerators which give off small amounts of ethylene oxide. One day-shift technician also reported a rash and skin discoloration that had been attributed by her physician to nerves.

Interviews with day-shift Technicians I and II revealed a concern on their part that Superpolyphene causes hepatic cancer; the concern stemmed from information which had been provided by a supervisor. The problem seems to have been compounded by a general confusion about the process of sterilization, resulting from an education program given in August which apparently focused on the theory of microbiology and antisepsis and was not directed to the knowledge, background, or interest of the workers. In addition, the day-shift Technicians I and II appeared to have a poor communicative relationship with management, probably due to the recent problems in bringing ethylene oxide levels within acceptable limits. The protracted effort of workers of having this situation corrected appears to have created tension between day shift technicians and the day-shift supervisory staff.

Swing swift Technicians I and II reported fewer instances of nasal stuffiness, postnasal drip, cough, and respiratory allergies than did day shift workers. Three workers have had problems with a dry cough which began after starting work at Materials Services. One person tried antihistamines with no relief. No swing shift technicians had heard that phenols might be carcinogenic, swing shift workers routinely used Superpolyphene and Wescodyne as prescribed. A major complaint of swing shift employees was poor ventilation, excessive heat, and dry nose and mouth.

Two of three clerical workers in offices adjacent to the ethylene oxide venting room reported frequent colds, postnasal drip, nasal congestion, and nonproductive cough. When questioned directly they revealed occasional complaint of heart palpitations. Neither worker had any history of allergies or asthma. One person had worked in Materials Services for twenty-five years and expressed concern over her long-standing exposure to ethylene oxide.

Supervisors and dispatchers working the Materials Services storage area reported exacerbation of previous allergies in one case. The several swing shift dispatchers were interviewed, and reported no health problems.

A problem frequently mentioned by workers and supervisors was the movement of contaminated materials, and persons working with contaminated materials, through areas where cleaned and sterilized materials are stored. Also, management felt that the failure to use bacteriocidal agents during the prewash process may pose greater risk to the handlers of those instruments as well as impose a heavier biological burden on the sterilizer, possibly compromising the quality of the sterilization.

VI. CONCLUSIONS

The ethylene oxide exposures which were first identified by the hospital industrial hygiene staff in September 1979 were eliminated. This required the replacement of one door seal, retrofitting the sterilizers to allow internal purging prior to opening the doors and by installing exhaust ventilation above the sterilizer doors.

The addition of an exhaust ventilation system has perhaps created another problem. The relative humidity in the basement was reported by the hospital industrial hygienist to be 30 percent when measured October 7, 1980. Employees working both day and swing shifts have complaints of respiratory congestion and sinusitis, as well as a few complaints of dry cough, a common denominator may be low humidity and excessively warm breathing air. This may predispose workers to upper respiratory infections and greater irritation by trace amounts of ethylene oxide and other airborne irritants. Poor communication between day shift technicians and supervisory staff, as well as the unfortunate misinformation passed from supervisors to workers about the carcinogencity of Superpolyphene, may have contributed to a general dissatisfaction on the part of these workers. Although ethylene oxide and Freon 12 exposures have now been well controlled, it is possible that exposures to ethylene oxide and Freon 12 released from aerators during the day may continue to irritate the respiratory passages of day shift workers who work adjacent to these aerators.

The extremely low concentrations of phenolic derivatives in Mayfair Superpolyphene washing solution and the low air levels monitored, combined with the fact that the day shift technicians are not using this product, suggest that this product is not causing the respiratory irritation among Material Services workers.

VII. RECOMMENDATIONS

1. Complete physical examinations, with special attention to liver and kidney function, and the hematopoetic system should be performed on any of the clerical workers near the vent room who have worked in that area for four years or longer, all workers who have unloaded the sterilizer or loaded the aerators more than twice a week for four or more years, and anyone else who has had repeated exposure to high levels of ethylene oxide for four or more years.

2. Place hoods over the sterlizers to insure more adequate venting of ethylene oxide and Freon from the workroom air in case of inadvertent door seal leakage.

3. Pack materials to be sterilized loosely enough to insure that all materials are adequately penetrated by ethylene oxide, and adequately cleared of ethylene oxide before removal from the sterilizers.

4. Institute a program to train Technicians I and II about appropriate sterilization procedures, occupational risks, and correct precautionary measures at a level commensurate with their training and background.

5. Advise all Materials Services employees to wash their hands before eating and smoking, and provide an area away from the workroom for these purposes.

6. Advise all employees who unload sterilizers or load aerators that polyethylene gloves are to be worn during this procedure.

7. Advise all employees who work around the sterilizers to observe safe work practices as laid down in the work manual.

8. Periodically have valves, connections, and seals around sterilizers checked for leakage of ethylene oxide.

9. Institute more effective temporary measures to reduce traffic between sterilized materials storage room and contaminated materials workroom.

10. Reinstitute prescribed washing procedures with Mayfair Superpolyphene and Wescodyne solutions. All nonimmersible equipment should be washed off with Superpolyphene or Wescodyne, as appropriate. Gloves should be worn during all washing procedures.

VIII. REFERENCES

1. Proctor, N.S. and Hughes, J.P., Chemical Hazards of the Workplace, Philadelphia: Lippincott Co., 1978.

2. Van Ketel, W.G., "Allergic Contact Dermatitis from Propellants in Deodorant Sprays in Combination with Allergy to Ethyl Chloride", Contact Dermatitis, 1976: 2: pp. 115-119

3. Reich. A., "Ethylene Oxide Survey, Moffitt Hospital Central Service" Unpublished study, August, 1979.

4. Glaser, Z.R., "Ethylene Oxide: Toxicology Review and Field Study Results of Hospital Use", Proceedings of the First Annual NIOSH Scientific Symposium, 1978, Park Forrest South, 11: Pathotox , 1979, pp. 173-207.

5. Glaser, Z.R., Special Occupational Hazard Review with Control Recommendations for the Use of ETO as a Sterileant in Medical Facilities, August, 1977, DHEW (NIOSH) Publicatons No. 77-200.

6. Hogstedt, O., Malmquist, N., and Wadman, B., "Leukemia in Workers Exposed to Ethylene Oxide", Journal of American Medical Association, 1979, 241 (11) pp. 1132-1133.

7. Green, G.H., "Indoor Humidity and Respiratory Health", Respiratory Technology, Vol. 11, No. 3, 1975, pp. 18-22.

8. Speizer, F.E., Wegman, D.H., and Ramirez, A., "Palpitation Rates Associated With Fluorocarbon Exposure in a Hospital Setting", New England Journal of Medicine, 1975: 292(12): pp. 624-626.

9. Sandefer, J.C., "Death Associated with Fluorocarbon Inhalation: Report of a Case" Journal of Forensic Science, 1975: 20: pp. 548-551.

10. Bribord, K., et. al., "Exposure to Halogenated Hydrocarbons in the Indoor Environment", Environmental Health Perspectives, 1975: 11: pp. 215-220.

11. DuPont Corporation, "Freon Solvent Formulations", Solvent Formulation Data Bulletin, No 7ST-5.

12. Thomas, G., "Narcotic Effects of Acute Exposure to Trichlorofluormethane (Freon 11)", Transatlantic Association of Industrial Medicine Office, 1965: 15 (3), pp. 105-106.

13. NIOSH - Manual of Analyticial Methods, 2nd Ed., Vols 1-5, DHEW (NIOSH) Publication No. 77-157A (April 1977).

14. Special Occupational Hazard Review with Control Recommendations - Use of Ethylene Oxide as a Sterilant in Medical Facilities, DHEW (NIOSH) Publication No. 77-200 (August 1977).

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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Copies of this report have been sent to:

1. AFSCME Local 1650
2. U. C. - Moffitt Hospital
3. CAL-OSHA
4. U. S. Department of Labor - Region IX

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

TABLE I

ENVIRONMENTAL AIR SAMPLES COLLECTED

FOR DICHLORODIFLUOROMETHANE (FREON 12)

UNIVERSITY OF CALIFORNIA, MOFFITT HOSPITAL

SAN FRANCISCO, CALIFORNIA

NOVEMBER 4, 1980

HE 80-191

Sample Location	Sample Period	Sample Volume (Liters)	Concentrations (ppm)[1]
Technician II	1520 - 1720	6.4	0.63
Technician II	1720 - 1830 1950 - 2025	6.1	ND[2]
Technician II	2025 - 2155	4.9	1.66
Table Top-Across from Unit 5	1535 - 1730	6.2	0.34
Table Top-Across from Unit 5	1730 - 1935	6.7	ND
Table Top-Across from Unit 5	1935 - 2145	6.9	0.59
Above Unit 5	1535 - 1735	6.1	1.33
Above Unit 5	1735 - 1940	6.2	ND
Above Unit 5	1940 - 2145	6.2	0.98
Above Unit 5 (15 Min. Ceiling whole unloading sterilizer)	2130 - 2145	0.58	ND

(1) PPM - Parts of a vapor or gas per million parts of contaminated air by volume.

(2) ND - None Detected.

EVALUATION CRITERIA

(1) Cal-OSHA Standard - 1000 ppm.

FACT SHEET ON ETHYLENE OXIDE

What is ethylene oxide?

Ethylene oxide (ETO) is a protoplasmic (cell nucleus) poison which has a distinctive sweetish, ether-like odor. It is a colorless gas which becomes a liquid when the temperature drops to 12° Centigrade or approximately 55° Farenheit.

How is ethylene oxide used?

ETO was first developed for chemical warfare during World War I. Today it is used widely in hospitals to sterilize hospital equipment which cannot take the high temperatures of the autoclave. ETO is also used in agriculture as a fumigant and fungicide. It is commonly used to ripen fruit and vegetables.

How are people exposed?

People are primarily exposed to ETO by inhaling the gas. Exposure also occurs when moist skin comes into contact with ETO vapor, which often causes severe skin irritation including blisters and burns.

What are the short-term (acute) health effects?

The early health effects of low level ETO exposure are irritation of the eyes, nose, throat, and lungs. Effects which may develop later with higher exposure include: headache, nausea, vomiting, shortness of breath, cyanosis (bluish/purplish skin discoloration due to insufficient oxygen in the blood), pulmonary edema (fluid in the lungs), drowsiness, weakness, lack of coordination, and heart irregularities.

Contact with moderate to high levels of ETO or its residue can cause severe skin burns, rashes, sores or hemolysis (the breaking down of the red blood cells and decreased ability to supply oxygen to the body).

What are the long-term (chronic) effects?

We don't fully know what the long-term effects of exposure to ETO are, but there is reason to be quite concerned. ETO has been shown to be a mutagen in 13 of 14 species of animals tested. This means that ETO caused a change (or mutation) in the genetic material of the animals' living cells. Presently we don't know whether ETO is a mutagen in humans, but the fact that it is in animals means there is a good chance it is in humans as well.

ETO is also linked to cancer in animals and humans. It has been shown to cause cancer among female mice. And one study of workers at an ETO production unit showed a 200 percent increase in the leukemia (blood cancer) rate over what would be expected in the general population.

Whether you will develop any of these acute or chronic symptoms depends primarily on the amount and length of your exposure to ETO. Individual differences are also a factor, because people sometimes react differently to chemical exposures.

What is the OSHA standard?

The current standard for exposure to ETO is 50 parts per million (ppm), with a maximum exposure limit of 75 ppm for no longer than 15 minutes. In miligrams, the current standard is 90 miligrams per cubic meter of air (90 mg/m^3).

How can ethylene oxide be detected?

Most people can smell ETO at concentrations of 1 ppm. This means that you may smell ETO when your exposure is very low compared to the current standard. The ETO content in the air can be measured by use of two different kinds of equipment. One is a portable infrared analyzer. This can be used to measure the general workplace atmosphere as well as the breathing area of individual workers. The other method of air sampling is done by absorbing the ETO gas into activated charcoal tubes. This is a better method for figuring out the average worker exposure over the course of several hours.

What can workers do to reduce ethylene oxide exposure?

The best way to avoid potential problems for yourself and your co-workers is to insist that exposure to ETO be as little as possible, as infrequent as possible. You should also insist on regular monitoring of workplace exposures. Goggles should be worn since eye contact can be a serious problem. The skin should be washed thoroughly after any contact. Non-rubber gloves should be used when handling ETO treated items. Equipment which is wrapped in towels or similar material should be specially aerated for at least two hours, since ETO can become trapped in the towelling. Non-metal items should not be aerated for less than 12 hours total.

NIOSH - Region IX:

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September 1980

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