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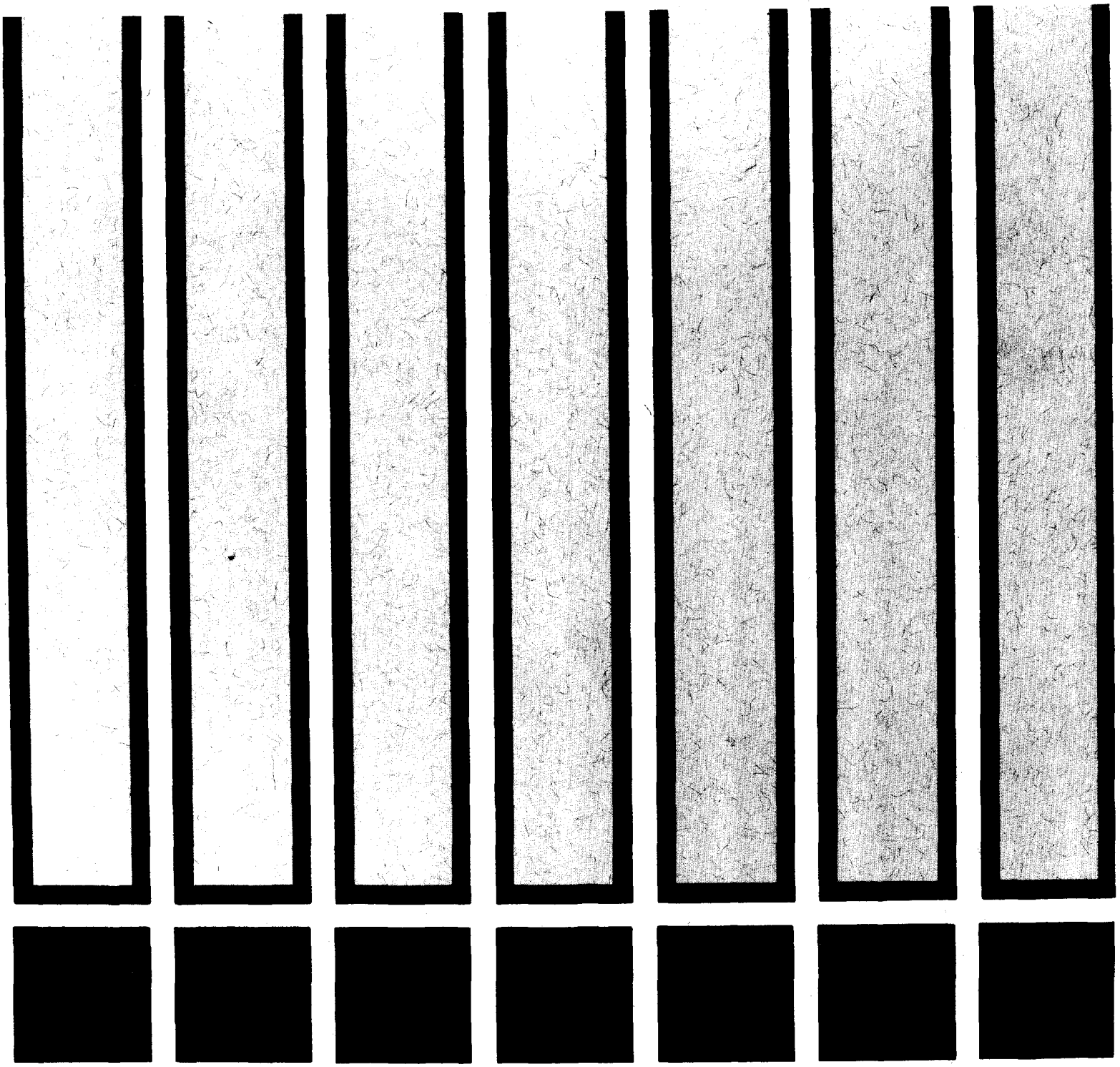

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service / Center for Disease Control

National Institute for Occupational Safety and Health

criteria for a recommended standard....

OCCUPATIONAL EXPOSURE TO

EPICHLOROHYDRIN

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
SEPTEMBER 1976

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

HEW Publication No. (NIOSH) 76-206

PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. The National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices, to provide relevant data from which valid criteria for effective standards can be derived. Recommended standards for occupational exposure, which are the result of this work, are based on the health effects of exposure. The Secretary of Labor will weigh these recommendations along with other considerations such as feasibility and means of implementation in developing regulatory standards.

It is intended to present successive reports as research and epidemiologic studies are completed and as sampling and analytical methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on epichlorohydrin by members of my staff and the valuable constructive comments by the Review Consultants on Epichlorohydrin, by the ad hoc committees of the American Conference of Governmental Industrial Hygienists and the American Occupational Medicine Association, and by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine. The NIOSH

recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on epichlorohydrin. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.

John F. Finklea, M.D.
Director, National Institute for
Occupational Safety and Health

The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and recommended standard for epichlorohydrin. The Division review staff for this document consisted of J. Henry Wills, Ph.D., Howard Spencer, Ph.D., Seymour Silver, Ph.D., and Frank L. Mitchell, D.O.

Stanford Research Institute (SRI) developed the basic information for consideration by NIOSH staff and consultants under contract No. CDC-99-74-31. Jerry LR Chandler, Ph.D., had NIOSH program responsibility and served as criteria manager.

REVIEW COMMITTEE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Mark W. Jones
Division of Surveillance, Hazard
Evaluations, and Field Studies

Kenneth J. Kronoveter
Division of Surveillance, Hazard
Evaluations, and Field Studies

Charles Neumeister
Division of Physical Sciences
and Engineering

Harold Resnick, Ph.D.
Appalachian Laboratory for Occupational
Respiratory Diseases

Robert F. Rosensteel
Division of Surveillance, Hazard
Evaluations, and Field Studies

Robert Rostand, M.D.
Division of Surveillance, Hazard
Evaluations, and Field Studies

Herbert E. Stokinger, Ph.D.
Division of Biomedical and
Behavioral Sciences

NIOSH REVIEW CONSULTANTS ON EPICHLOROHYDRIN

Dennis I. Chamot, Ph.D.
Assistant to the Executive Secretary
Council for Professional Employees, AFL-CIO
Washington, D.C. 20005

D. Jack Kilian, M.D.
Director, Industrial Medicine
Texas Division U.S.A.
The Dow Chemical Company
Freeport, Texas 77541

Leonard D. Pagnotto, M.S.
Industrial Hygienist
Division of Occupational Hygiene
Massachusetts Department of
Labor and Industries
Boston, Massachusetts 02116

H. Elden Sutton, Ph.D.
Professor, Genetics
Vice President for Research
University of Texas
Austin, Texas 78712

Benjamin L. Van Duuren, Ph.D.
Professor, Environmental Medicine
Department of Environmental Medicine
New York University Medical Center
New York, New York 10016

Richard S. Waritz, Ph.D.
Senior Toxicologist
Hercules, Inc.
Wilmington, Delaware 19899

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL EXPOSURE STANDARD FOR EPICHLOROHYDRIN

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I. RECOMMENDATIONS FOR AN EPICHLOROHYDRIN STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to epichlorohydrin in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and safety of employees for up to a 10-hour workday, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent adverse effects produced by exposure of employees to epichlorohydrin. Although the workplace environmental limits are considered to be safe levels based on current information, they should be regarded as the upper boundary of exposure, and every effort should be made to maintain exposure as low as is technically feasible. The standard is measurable by techniques that are available and there is sufficient technology to permit compliance with the recommended standard. The standard will be subject to review and revision as necessary.

These criteria and the recommended standard apply to exposure of employees to solid, liquid, or gaseous 3-chloro-1,2-epoxypropane, hereafter referred to as "epichlorohydrin," either alone or in combination with other substances. Synonyms for epichlorohydrin include 1-chloro-2,3-epoxypropane, (chloromethyl)ethylene oxide, chloromethyloxirane, chloropropylene oxide, gamma-chloropropylene oxide, 3-chloro-1,2-propylene oxide, 2-chloromethyl-oxirane, alpha-epichlorohydrin, epichlorhydrin, and epichlorophydrin.

"Occupational exposure to epichlorohydrin" is defined as exposure to airborne epichlorohydrin at concentrations exceeding the action level. The

"action level" is defined as one-half of the recommended time-weighted average (TWA) environmental concentration for epichlorohydrin. Exposure to airborne epichlorohydrin at concentrations equal to or less than one-half of the workplace environmental limit, as determined in accordance with Section 8, will not require adherence to the following sections except for 2, 3, 4(a), 5(a,b,c,d), 6, and 7. If exposure to other chemicals also occurs, provisions of any applicable standard for the other chemicals shall also be followed.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to epichlorohydrin shall be controlled so that employees are not exposed to epichlorohydrin at concentrations greater than 2 milligrams per cubic meter of air (approximately 0.5 parts per million parts of air by volume) determined as a TWA concentration for up to a 10-hour workday, 40-hour workweek, with a ceiling concentration of 19 milligrams per cubic meter of air (approximately 5 parts per million parts of air by volume) as determined by a sampling time of 15 minutes.

(b) Sampling and Analysis

Procedures for sampling and analysis of environmental samples and calibration of equipment shall be as provided in Appendices I and II, or by any methods shown to be at least equivalent, in accuracy, sensitivity, and precision to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available to all persons subject to occupational exposure to epichlorohydrin as described below:

(a) Preplacement medical examinations shall include:

(1) Comprehensive medical and work histories.

(2) Complete physical examination, giving particular attention to the kidneys, liver, respiratory tract, and hematopoietic system. Additionally, employees shall be evaluated for complaints and evidence of eye, mucous membrane, or skin irritation. Further tests, such as determinations of the concentrations of serum glutamic-pyruvic transaminase (SGPT), serum glutamic-oxaloacetic transaminase (SGOT), and lactic dehydrogenase (LDH), may be considered by the responsible physician.

(3) An evaluation of the ability of the worker to use respirators.

(b) Periodic examinations shall be made available on an annual basis. These examinations shall include, but shall not be limited to:

(1) Interim medical and work histories.

(2) Physical examination as outlined in paragraph (a) (2) of this section. The responsible physician shall consider administering appropriate organ function tests.

(c) Proper medical management shall be provided for employees overexposed to epichlorohydrin. When there is known or suspected overexposure to epichlorohydrin, immediate first-aid measures shall be followed by prompt medical evaluation and followup assistance. First aid shall include removal of the employee from the area of excessive epichlorohydrin exposure, restoration of, or assistance in, breathing by

trained personnel, and treatment of chemical burns.

(d) The responsible physician shall advise the worker that available information indicates that large doses of epichlorohydrin induce antifertility effects on rats; however, no effects on potency have been found. The relevance of this study to male or female workers has not yet been determined. It does, however, indicate that employers and workers should attempt to minimize exposures to epichlorohydrin whenever possible. If the physician becomes aware of any adverse effects on the reproductive systems of workers exposed to epichlorohydrin, the information shall be forwarded to the Director, National Institute for Occupational Safety and Health, as promptly as possible.

(e) Pertinent medical records shall be maintained and made available to the designated medical representatives of the employer, of the employee or former employee, of the Secretary of Labor, and of the Secretary of Health, Education, and Welfare. These records shall be retained for 20 years following the employee's last occupational exposure to epichlorohydrin.

Section 3 - Labeling and Posting

(a) Labeling

Containers of epichlorohydrin shall carry a label stating:

EPICHLOROHYDRIN

POISON! FLAMMABLE!

SKIN CONTACT CAUSES DELAYED BURNS

Avoid contact with eyes, skin, and clothing.
Avoid breathing vapor.
Use only with adequate ventilation.
Keep away from heat and open flame.
Keep container closed.
Do not take internally.

First Aid: In case of skin contact, immediately remove all contaminated clothing, including footwear, wash skin with plenty of water for at least 15 minutes and call a physician. In case of eye contact, flush eyes with water for 15 minutes and call a physician.

(b) Posting

Areas where epichlorohydrin is manufactured, stored, used, or handled shall be posted with a sign reading:

EPICHLOROHYDRIN

POISON! FLAMMABLE!

SKIN CONTACT CAUSES DELAYED BURNS
VAPOR IRRITATING TO EYES
HARMFUL IF INHALED OR SWALLOWED

The sign shall be printed both in English and in the predominant language of non-English-reading workers, if any; the employer shall use these or other equally effective means to ensure that all employees know the hazards associated with epichlorohydrin and the locations of areas in which there is likely to be occupational exposure to epichlorohydrin.

Section 4 - Personal Protective Equipment

(a) Protective Clothing

(1) Chemical safety goggles and face shields shall be

provided by the employer and shall be worn during any operation in which epichlorohydrin may splash into the eyes. Suitable eye protective devices shall conform to 29 CFR 1910.133.

(2) Aprons, suits, boots, or face shields shall be worn when needed to prevent skin contact with liquid epichlorohydrin. The protective clothing for this purpose shall be made of impervious material, such as polyethylene, polypropylene, or polyvinyl chloride (PVC). Use of protective clothing made of neoprene, rubber, or leather is unsuitable.

(b) Respiratory Protection

Engineering controls shall be used to maintain epichlorohydrin concentrations below the recommended environmental limits. Such control equipment shall be sparkproof. Compliance with the permissible exposure limit may not be achieved by the use of respirators except during the time necessary to install or test the required engineering controls, for nonroutine maintenance or repair activities in which brief exposures at concentrations in excess of the recommended limits may occur, and during emergencies when air concentrations of epichlorohydrin may exceed the recommended limits.

When a respirator is permitted by paragraph (b) of this section, it shall be selected and used pursuant to the following requirements:

(1) For the purpose of determining the type of respirator to be used, the employer shall measure, when possible, the concentration of airborne epichlorohydrin in the workplace initially and thereafter whenever process, worksite, or control changes occur which are likely to increase the epichlorohydrin concentrations; this requirement does not apply when only atmosphere-supplying, positive pressure respirators are used. The

employer shall ensure that no worker is exposed to epichlorohydrin in excess of the recommended workplace environmental limits because of improper respirator selection, fit, use, or maintenance.

(2) A respiratory protection program meeting the requirements of 29 CFR 1910.134 shall be established and enforced by the employer.

(3) The employer shall provide respirators in accordance with the provisions of both Table I-1 and 30 CFR 11 and shall ensure that the employee uses the respirator provided.

(4) Respirators specified for use in higher concentrations of epichlorohydrin may be used in atmospheres of lower concentrations.

(5) The employer shall ensure that respirators are adequately cleaned, and that employees are instructed in the use and the testing for leakage of respirators assigned to them.

(6) Where an emergency which could result in employee injury from overexposure to epichlorohydrin may develop, the employer shall provide respiratory protection as listed in Table I-1.

TABLE I-1

RESPIRATOR SELECTION GUIDE

Maximum Use Concentration	Respirator Type
Less than or equal to 25 ppm	(1) Gas mask with chin-style or front- or back-mounted organic vapor canister (2) Type C supplied-air respirator operated in the pressure-demand. (positive pressure) or continuous-flow mode
Less than or equal to 100 ppm	(1) Gas mask (full facepiece) with chin-style or front-mounted organic vapor canister with impervious plastic cover for head and neck (2) Type C supplied-air respirator operated in the pressure-demand (positive pressure) or continuous-flow mode with a full facepiece and impervious plastic cover for head and neck
Less than or equal to 1,000 ppm	Type C supplied-air respirator with hood, helmet, or suit operated in the continuous-flow mode
Greater than 1,000 ppm	(1) Self-contained breathing apparatus with full facepiece operating either in the demand (negative pressure) mode or in the pressure-demand (positive pressure) mode worn under an impervious plastic suit with headpiece (2) Combination Type C supplied-air respirator with full facepiece operated in the pressure-demand (positive pressure) mode and an auxiliary self-contained air supply worn under an impervious plastic suit with headpiece

TABLE I-1 (CONTINUED)

RESPIRATOR SELECTION GUIDE

Maximum Use Concentration	Respirator Type
Emergency (no concentration limit)	(1) Self-contained breathing apparatus in the pressure-demand (positive pressure) mode with full facepiece (2) Combination supplied-air respirator with an auxiliary self-contained air supply and full facepiece operated in the pressure-demand (positive pressure) mode
Escape (no concentration limit)	(1) Gas mask (full facepiece) with chin- or front-mounted organic vapor canister (2) Self-contained breathing apparatus with full facepiece operated either in the demand (negative pressure) mode or in the pressure-demand (positive pressure) mode

Section 5 - Informing Employees of Hazards from Epichlorohydrin

(a) Each employee working in an area where exposure to epichlorohydrin is likely, shall be informed of the signs and symptoms of overexposure, emergency and first-aid procedures, the hazards of chronic exposure, and precautions to ensure safe use of epichlorohydrin and to minimize exposure. All information shall be posted in the workplace and shall be readily accessible to the employee.

(b) Employers shall ensure that all such employees have current knowledge of job hazards, maintenance procedures, and cleanup methods, and

that they know how to use respiratory protective equipment and protective clothing.

(c) Employees and members of emergency teams who work near epichlorohydrin systems or containers where a potential for emergencies exists shall participate in periodic drills simulating emergencies appropriate to the work situation. Drills shall be held at intervals not greater than 6 months. Drills should include, but should not be limited to:

Evacuation procedures.
Handling of spills and leaks, including decontamination.
Location and use of emergency firefighting equipment, and handling of epichlorohydrin systems or containers in case of fire.
First-aid and rescue procedures, including prearranged procedures for obtaining emergency medical care.
Location, use, and care of protective clothing and respiratory protective equipment.
Location of shut-off valves or switches.
Location, purpose, and use of safety showers and eye-wash fountains.
Operating procedures including communication procedures.
Entry procedures into confined spaces.

Deficiencies noted during drills shall be included in the continuing educational program together with the required remedial actions. Records of drills and training sessions shall be kept and made available for inspection by authorized personnel upon request.

(d) Information as required shall be recorded on the "Material Safety Data Sheet" shown in Appendix III, or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Engineering controls, such as process enclosure or local

exhaust ventilation, shall be used to maintain epichlorohydrin concentrations at or within the recommended workplace environmental limits. Ventilation systems shall be designed to prevent the accumulation or recirculation of epichlorohydrin in the workplace and to remove epichlorohydrin from the breathing zones of exposed workers. When used, exhaust ventilation systems discharging to outside air must conform with applicable local, state, and federal air pollution regulations. Ventilation systems shall undergo regular preventive maintenance and cleaning to ensure maximum effectiveness, which shall be verified by periodic airflow measurements. Records of these measurements shall be maintained for at least 1 year.

(b) When an operation involves the use of epichlorohydrin in an open vessel, which is not part of an isolated system, continuous local exhaust ventilation shall be provided so that air movement is always from the work areas to the operation. Exhaust air shall not be discharged in the work areas and clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system. Containers of epichlorohydrin shall be labeled in accordance with Section 3 and shall be kept tightly closed at all times when not in use. Storage provisions are listed in 29 CFR 1910.106(a)19(iii). Containers shall be protected from heat, corrosion, mechanical damage, and sources of ignition.

(c) Any spilled epichlorohydrin shall be promptly cleaned up. During cleanup operations, complete skin and respiratory protective equipment shall be used. After a cleanup operation, the employee shall be required to shower upon removing the protective equipment. If epichlorohydrin is spilled on shoes made of leather, canvas, rubber, or of

any other permeable material, the shoes shall be rendered unusable and discarded. If clothing is contaminated with epichlorohydrin, it shall be removed promptly and laundered thoroughly before reuse.

(d) Appropriate regulations for Class IC flammable liquids are provided in 29 CFR 1910.106.

(e) Prior to maintenance work, sources of epichlorohydrin vapor shall be eliminated to the extent feasible. The employees shall be provided with appropriate skin and respiratory protective equipment.

(f) Confined Spaces

(1) Entry into confined spaces, such as tanks, pits, tank cars, barges, process vessels, and tunnels, shall be controlled by a permit system. Permits shall be signed by an authorized employer representative certifying that preparation of the confined space, precautionary measures, and personal protective equipment are adequate, and that precautions have been taken to ensure that the prescribed procedures will be followed.

(2) Confined spaces which have contained epichlorohydrin shall be inspected and tested for oxygen deficiency, epichlorohydrin, and other contaminants, and, prior to entry by the employee, they shall be thoroughly ventilated, cleaned, and washed.

(3) Inadvertent entry of epichlorohydrin into the confined space while work is in progress shall be prevented by disconnecting and blocking of epichlorohydrin supply lines or by other appropriate means.

(4) Confined spaces shall be ventilated appropriately while work is in progress to keep the concentration of epichlorohydrin at or below the recommended environmental limits and to ensure an adequate supply of oxygen.

(5) Individuals entering confined spaces where they may be exposed to epichlorohydrin shall wear either a combination Type C supplied-air respirator operated in the continuous-flow (positive pressure) mode or an auxiliary breathing air supply operated in the pressure-demand (positive pressure) mode equipped with a full facepiece, or a self-contained breathing apparatus operated in the pressure-demand (positive pressure) mode. Each individual shall also wear a suitable harness with lifelines tended by another employee outside the space who shall also be equipped with the necessary protective equipment, including a self-contained breathing apparatus which operates in the pressure-demand (positive pressure) mode and has a full facepiece. Communication (visual, voice, signal line, telephone, radio, or other suitable means) shall be maintained by the standby person with the employees inside the enclosed spaces.

(g) For all work areas where epichlorohydrin is used, procedures as specified in this section, as well as any other procedures appropriate for a specific operation or process, shall be formulated in advance. Employees shall be comprehensively instructed in the implementation of emergency procedures.

(1) Procedures shall include prearranged plans for obtaining emergency medical care and for transportation of injured workers to medical facilities.

(2) Firefighting procedures shall be established and drills conducted. These shall include procedures for emergencies involving fire and release of epichlorohydrin vapor. In case of fire, epichlorohydrin sources shall be shut off or removed as soon as feasible. Containers of epichlorohydrin shall be removed or cooled with water spray as soon as

feasible. Chemical foam, carbon dioxide, or dry chemicals shall be used for extinguishing epichlorohydrin fires. Proper respiratory protective devices and protective clothing shall be worn to protect against epichlorohydrin, acid gases, and other combustion products of epichlorohydrin.

(3) Approved eye, skin, and respiratory protective devices as specified in Section 4 shall be used by all personnel who are essential to emergency operations.

(4) During emergencies, employees not essential to the emergency operations shall be evacuated. A warning system informing the employees of the evacuation shall be established. Boundaries of areas where the emergency occurred shall be delineated, posted, and secured as soon as feasible. Entry into hazardous areas shall be prohibited to employees not essential to the emergency operations.

(5) Personnel trained and knowledgeable in the safety procedures and adequately protected against the attendant hazards shall shut off sources of epichlorohydrin, clean up spills, and immediately repair leaks.

Section 7 - Sanitation

(a) Food preparation, storage, dispensing, and eating shall be prohibited in posted work areas.

(b) Smoking shall be prohibited in posted work areas.

(c) Safety showers and eyewash fountains shall be installed in and adjacent to posted work areas.

(d) Shower facilities shall be made available to employees who may have occupational exposure to epichlorohydrin.

Section 8 - Monitoring and Recordkeeping Requirements

Workers will not be considered to have occupational exposure to epichlorohydrin if the environmental concentrations, as determined by an industrial hygiene survey conducted within 6 months of the promulgation of a standard, do not exceed one-half the recommended TWA environmental limit, ie, the action level. Surveys shall be repeated at least once every 3 months and within 30 days after any process change likely to result in increases of airborne concentrations of epichlorohydrin. Records of these surveys, including the basis for concluding that airborne concentrations of epichlorohydrin are at or below the action level, shall be maintained. If the survey indicates that airborne concentrations of epichlorohydrin exceed the action level, then the following requirements apply:

(a) Personal Monitoring

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of all employees who are occupationally exposed to epichlorohydrin. Interim monitoring of employee exposure to airborne concentrations of epichlorohydrin shall be conducted at least every 3 months. If monitoring of an employee's exposure to epichlorohydrin reveals that the employee is exposed at concentrations in excess of the recommended TWA environmental limit, the exposure of that employee shall be measured at least once every 30 days, control measures shall be initiated, and the employee shall be notified of the exposure and of the control measures being implemented to

correct the situation. Such monitoring shall continue until two consecutive samplings, at least 1 week apart, indicate that the employee's exposure no longer exceeds the TWA environmental limit recommended in Section 1(a). Quarterly monitoring may then be resumed.

(2) In all personal monitoring, samples of airborne epichlorohydrin that will provide upon analysis an accurate representation of the concentration of epichlorohydrin in the air the worker breathes shall be collected. Procedures for sampling, calibration of equipment, and analysis of epichlorohydrin in samples shall be as provided in Section 1(b).

(3) For each TWA determination, a sufficiently large number of samples shall be taken to characterize each employee's exposure during each workday. Variations in work and production schedules shall be considered in deciding when samples are to be collected. The number of representative TWA determinations for an operation or process shall be based on the variations in location and job functions of employees in relation to that operation or process.

(b) Recordkeeping Procedures

Records shall be maintained and shall include sampling and analytical methods, type of respiratory protective device used, and TWA and ceiling concentrations found. Each employee shall have access to data on personal environmental exposures and records of such data shall be included in his medical records. Pertinent records of required medical examinations, including records of occupational accidents, and environmental exposures within the workplace shall be maintained for 20 years after the worker's last occupational exposure to epichlorohydrin and shall be available to the

designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to epichlorohydrin. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health of workers from exposure to hazardous chemical and physical agents. These criteria for a standard for epichlorohydrin are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of, or other occupational exposure to, epichlorohydrin as applicable under the Occupational Safety and Health Act of 1970. The standard was not designed for the population-at-large, and any extrapolation beyond occupational exposures is not warranted. It is intended to (1) protect against the development of acute and chronic effects of epichlorohydrin exposure, (2) protect against local effects on the skin, (3) be measurable by techniques that are available to industry and government agencies, and (4) be

attainable with existing technology.

The development of the criteria for the recommended standard for occupational exposure to epichlorohydrin has elucidated the need for further research in the following areas: (1) further epidemiologic studies of employees exposed to epichlorohydrin, (2) animal studies designed to determine the cumulative effects from inhalation of airborne epichlorohydrin at concentrations below 5 ppm, (3) studies on the mutagenic effects of epichlorohydrin in mammals, and (4) animal studies to investigate the carcinogenic effects from epichlorohydrin inhalation. To fill these information gaps, a concerted effort is required by those people who are involved with the health and safety of employees exposed to epichlorohydrin.