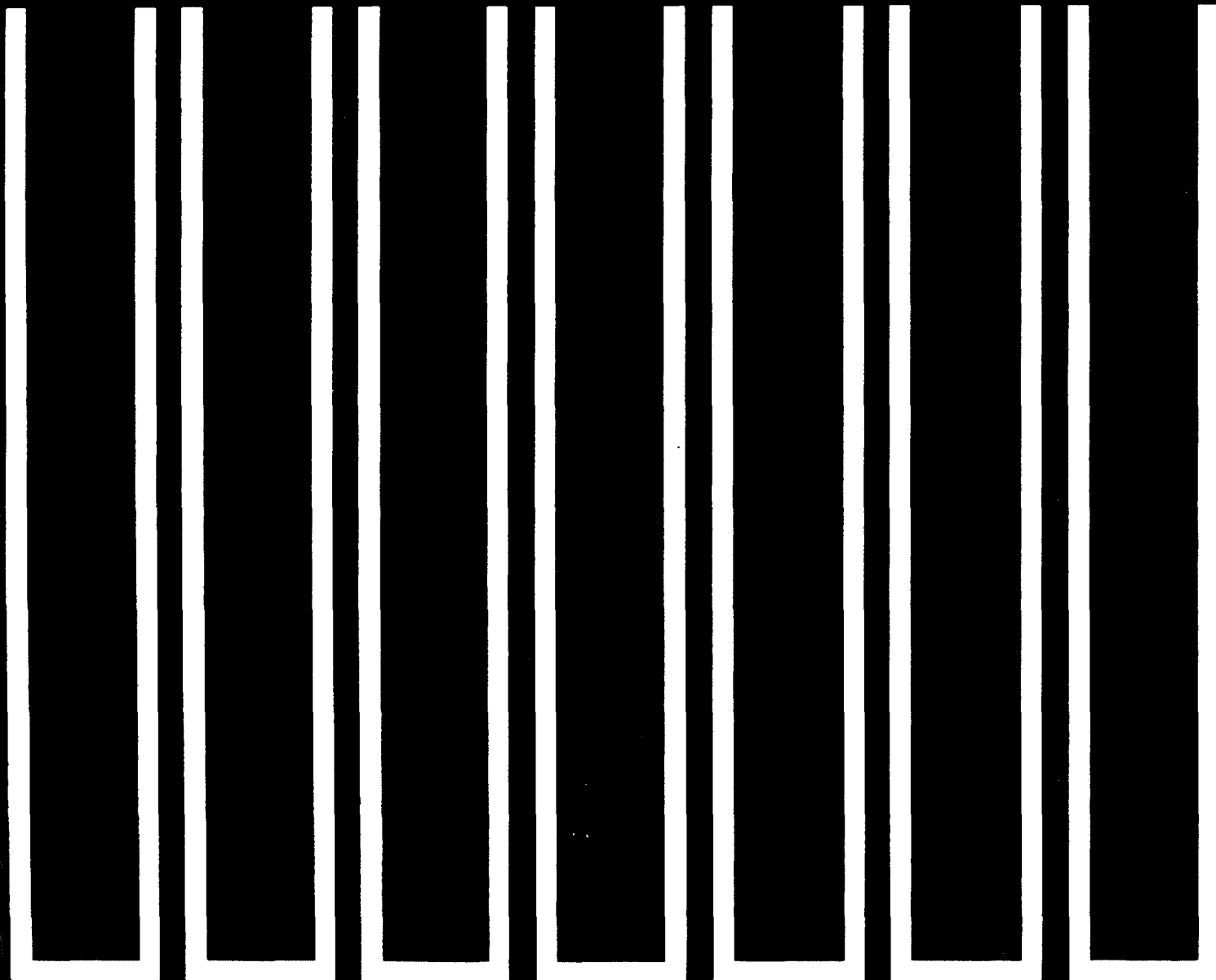


NIOSH

criteria for a recommended standard
occupational exposure to
ethylene dichloride (1,2-dichloroethane)



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
ETHYLENE DICHLORIDE
(1,2-DICHLOROETHANE)**



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

Public Health Service

Center for Disease Control

National Institute for Occupational Safety and Health

March 1976

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

HEW Publication No. (NIOSH) 76-139

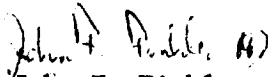
PREFACE

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 ethylene dichloride by members of my staff and the valuable, constructive comments by the Review Consultants on ethylene dichloride, by the ad hoc committees of the American Conference of Governmental Industrial Hygienists and the Society of Occupational and Environmental Health, 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 ethylene dichloride. 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 ethylene dichloride. Agatha Corporation developed the basic information for consideration by NIOSH staff and consultants under contract No. HSM-99-73-20. Jon R. May, Ph.D., had NIOSH program responsibility. Final preparation of the document was accomplished by Robert W. Mason, Ph.D.

REVIEW COMMITTEE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

John F. Bester, Ph.D.
Office of Extramural Programs

Robert H. Hill, Jr., Ph.D.
Division of Physical Sciences and
Engineering

Trent R. Lewis, Ph.D.
Division of Biomedical and
Behavioral Sciences

Theodore W. Thoburn, M.D.
Division of Surveillance, Hazard
Evaluations, and Field Studies

Robert Vandervort
Western Area Laboratory for
Occupational Safety and Health

NIOSH REVIEW CONSULTANTS ON ETHYLENE DICHLORIDE

Louis S. Beliczky
Director, Industrial Hygiene
United Rubber, Cork, Linoleum and
Plastic Workers of America
Akron, Ohio 44308

Hervey B. Elkins, Ph.D.
Consultant in Industrial Toxicology
and Industrial Hygiene Chemistry
Belmont, Massachusetts 02178

Maurice N. Johnson, M.D.
Director, Department of Environmental Health
The B. F. Goodrich Company
Akron, Ohio 44318

Kingsley K. Kay, Ph.D.
Department of Community Medicine
Mount Sinai School of Medicine
New York, New York 10029

Laurance G. Silverstein
Dow Chemical Company
Midland, Michigan 48640

Russell A. Van Dyke, Ph.D.
Mayo Clinic
Rochester, Minnesota 55901

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR ETHYLENE DICHLORIDE (1,2-DICHLOROETHANE)

Contents

	<u>Page</u>
PREFACE	iii
REVIEW COMMITTEES	vi
I. RECOMMENDATIONS FOR AN ETHYLENE DICHLORIDE STANDARD	
Section 1 - Environmental (Workplace Air)	1
Section 2 - Medical	2
Section 3 - Labeling (Posting)	3
Section 4 - Personal Protective Equipment and Clothing	3
Section 5 - Informing Employees of Hazards from Ethylene Dichloride	7
Section 6 - Work Practices	8
Section 7 - Monitoring and Recordkeeping	11
II. INTRODUCTION	14
III. BIOLOGIC EFFECTS OF EXPOSURE	
Extent of Exposure	16
Historical Reports	18
Effects on Humans	21
Epidemiologic Studies	46
Animal Toxicity	58
Correlation of Exposure and Effects	72
IV. ENVIRONMENTAL DATA AND ANALYTICAL METHODS	
Environmental Concentrations	83
Environmental Sampling and Analytical Methods	85
V. DEVELOPMENT OF STANDARD	
Basis for Previous Standards	92
Basis for Recommended Environmental Standard	96
VI. WORK PRACTICES	103
VII. RESEARCH NEEDS	109
VIII. REFERENCES	111

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR ETHYLENE DICHLORIDE (1,2-DICHLOROETHANE)

Contents

	<u>Page</u>
IX. APPENDIX I - Sampling Procedure for Collection of Ethylene Dichloride	124
X. APPENDIX II - Analytical Procedure for Determination of Ethylene Dichloride	127
XI. APPENDIX III - Material Safety Data Sheet	135
XII. TABLES AND FIGURES	145

I. RECOMMENDATIONS FOR AN ETHYLENE DICHLORIDE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to ethylene dichloride (1,2-dichloroethane) in the workplace be controlled by adherence to the following sections. Based on present information available to NIOSH the standard is designed to protect the health and safety of workers for up to a 10-hour workday, 40-hour workweek over a working lifetime; compliance with the standard should therefore prevent adverse effects of ethylene dichloride on the health and safety of workers. The standard is measurable by techniques that are valid, reproducible, and available to industry and governmental agencies. Sufficient technology exists to permit compliance with the recommended standard. The standard will be subject to review and revision as necessary.

"Occupational exposure to ethylene dichloride" is defined as exposure above half the time-weighted average (TWA) environmental limit.

Occupational exposure to ethylene dichloride requires adherence to all the following sections. Exposure at lower environmental concentrations will not require adherence to Sections 1, 2, 7(b), (c), and (d), and 4(a) except 4(a)(4).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure shall be controlled so that no worker will be exposed to ethylene dichloride in excess of 5 ppm (20 mg/cu m) determined as a TWA exposure for up to a 10-hour workday, 40-hour workweek, or to peak

concentrations above 15 ppm (60 mg/cu m) as determined by a 15-minute sample. Unless future research shows it to be unnecessary, nursing mothers shall not work with ethylene dichloride.

(b) Sampling and Analysis

Procedures for sampling and analysis of workroom air for compliance with the standard shall be as provided in Appendices I and II or by any equivalent methods.

Section 2 - Medical

(a) Comprehensive preplacement and annual medical examinations shall be made available to all workers exposed to ethylene dichloride unless a different frequency is indicated by professional medical judgment based on such factors as emergencies, variations in work periods, and preexisting health status of individual workers.

(b) These examinations shall include, but shall not be limited to:

(1) A comprehensive or interim medical and work history.

(2) A comprehensive medical examination giving particular attention to cardiovascular, pulmonary, neurological, liver, and kidney functions.

(3) An evaluation of the worker's physical ability to safely wear a respirator.

(c) Proper medical management shall be provided for workers exposed to ethylene dichloride.

(d) Medical records shall be maintained for all persons employed in work involving exposure to ethylene dichloride. All pertinent medical records with supporting documents shall be maintained for 20 years after

the individual's employment is terminated. The designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee shall have access to these records.

Section 3 - Labeling (Posting)

The following warning sign shall be affixed in a readily visible location on processing or other equipment, on ethylene dichloride storage tanks or containers, and at or near entrances to areas in which there is occupational exposure to ethylene dichloride:

ETHYLENE DICHLORIDE
DANGER: FLAMMABLE
May generate toxic gases on contact
with open flame, hot surfaces, or
other heat-producing conditions.
BREATHING VAPOR MAY BE
HAZARDOUS TO HEALTH.
Keep containers closed when not in use.
Use only with adequate ventilation.
Avoid breathing of vapor.
Avoid contact with skin.

This sign shall also be printed in the predominant language of non-English-speaking workers. All employees shall be trained and informed of the hazardous areas with special instructions given to illiterate workers.

Section 4 - Personal Protective Equipment and Clothing

(a) Respiratory Protection

(1) Engineering controls shall be used wherever necessary and feasible to maintain ethylene dichloride concentrations at or below the

prescribed limit. Compliance with the permissible exposure limits may be achieved by the use of respirators only:

(A) During the time period necessary to install or test the required engineering controls.

(B) For nonroutine operations such as brief exposure to concentrations in excess of the environmental limit for maintenance or repair activities.

(C) During emergencies when air concentrations of ethylene dichloride may exceed the permissible limit.

(2) When respirators are permitted by paragraph (1) of this section, a respirator program meeting the requirements of 29 CFR 1910.134 and 30 CFR 11.2-1 shall be established and enforced by the employer.

(3) Only appropriate respirators as described in Table I-1 shall be used pursuant to the following requirements:

(A) For the purpose of determining the class of respirator to be used, the employer shall measure, when possible, the atmospheric concentration of ethylene dichloride in the workplace initially and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the ethylene dichloride concentration. This requirement shall not apply when only supplied-air, positive pressure respirators are used.

(B) The employer shall ensure that no worker is being exposed to ethylene dichloride in excess of the exposure limit because of improper respirator selection, fit, use, or maintenance.

(C) The employer shall provide respirators in accordance with Table I-1 and shall ensure that the employee uses the

respirator provided.

(D) Respiratory protective devices described in Table I-1 shall be those approved under provisions of 30 CFR 11.

(E) Respirators specified for use in higher concentrations of ethylene dichloride are permitted in atmospheres of lower concentrations.

(F) Because of the poor warning properties of ethylene dichloride at the environmental limit, chemical cartridges and canisters shall not be used with ethylene dichloride except for evacuation or escape.

(G) The employer shall ensure that respirators are adequately cleaned, maintained, and stored, and that employees are instructed on the use of respirators and on testing for leakage.

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

(b) Protective Clothing

In any operation where the worker may come into direct contact with liquid ethylene dichloride, protective clothing shall be worn. The clothing shall be both impervious and resistant to ethylene dichloride. Gloves, boots, overshoes, and bib-type aprons that cover boot tops shall be provided when necessary. Impervious supplied-air hoods or suits shall be worn when entering confined spaces such as pits or tanks unless known to be safe. In situations where heat stress is likely to occur, air-supplied suits shall be used. All protective clothing shall be well-aired and inspected for defects prior to reuse.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR PROTECTION
AGAINST ETHYLENE DICHLORIDE

Concentrations of Ethylene Dichloride	Respirator Type
50 ppm or less	(1) Any supplied-air respirator. (2) Any self-contained breathing apparatus.
250 ppm or less	(1) Any supplied-air respirator with a full facepiece, helmet or hood. (2) Any self-contained breathing apparatus with a full facepiece.
>250 ppm or entry and escape from unknown concentrations	(1) Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. (2) A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure- demand or other positive pressure mode.
Firefighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	(1) Any gas mask providing protection against organic vapors. (2) Any escape self-contained breathing apparatus.

(c) Eye Protection

Eye protection shall be provided for, and worn by, any employee engaged in an operation where ethylene dichloride liquid or spray may enter the eye. Chemical-type goggles, safety glasses with splash shields, or plastic face shields made completely of ethylene dichloride-resistant materials shall be used. Suitable eye protection shall be in accordance with 29 CFR 1910.133.

Section 5 - Informing Employees of Hazards from Ethylene Dichloride

All new and present employees in any ethylene dichloride area shall be kept informed of the hazards, relevant symptoms, effects of overexposure, and proper conditions and precautions concerning safe use and handling of ethylene dichloride.

A continuing educational program shall be instituted to ensure that all workers have current knowledge of job hazards, proper maintenance procedures, and cleanup methods, and that they know how to correctly use respiratory protective equipment and protective clothing.

The information explaining the hazards of working with ethylene dichloride shall be kept on file and readily accessible to the worker at all places of employment where ethylene dichloride is manufactured, used, transported, or stored.

Information as required shall be recorded on US Department of Labor Form OSHA-20, "Material Safety Data Sheet," or similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Handling and Storage

(1) Storage containers, piping, and valves shall be periodically inspected for leakage.

(2) Storage facilities shall be designed to contain spills and prevent contamination of workroom air.

(3) Processes and storage facilities shall not be located near open flames or high-temperature operations, unless precautions are taken to prevent fire and explosion hazards and exposure to pyrolysis products.

(4) Where ethylene dichloride is transferred from one metal container to another, the 2 vessels shall be grounded or electrically interconnected by bonding. The use of mechanical equipment likely to give off sparks should be avoided.

(5) Where ethylene dichloride is used as a fumigant, strict adherence to label requirements for application and personal protection shall be followed. In addition, standards for pesticide use by agricultural workers can be found in 40 CFR 170.

(b) Contaminant Controls

(1) Suitable engineering controls designed to limit exposure to ethylene dichloride to that prescribed in subsection (a) of Section 1 shall be utilized. Ventilation systems shall be designed to prevent the accumulation or recirculation of ethylene dichloride in the workroom and to effectively remove ethylene dichloride from the breathing zones of workers. Ventilation systems shall be subjected to regular preventive maintenance and cleaning to ensure maximum effectiveness, which

shall be verified by periodic airflow measurements.

(2) Portable exhaust ventilation or suitable general ventilation shall be provided for operations that require the spray application of ethylene dichloride such as in fumigation operations.

(3) Buildings in which ethylene dichloride is used where it could form an explosive air mixture shall be explosion-proof. Explosion vents are available and effective on windows, roof and wall panels, and skylights as a safeguard against destruction of buildings and equipment in which flammable vapors may accumulate. Stair enclosures shall also be fire-resistant and shall have self-closing fire doors.

(4) Forced draft ventilation systems shall be equipped with remote manual controls and designed to turn off automatically in the event of a fire in the building.

(c) Equipment Maintenance and Emergency Procedures

(1) Ethylene dichloride hazard areas

A hazard area that workers may enter shall be considered as any space with physical characteristics and sources of ethylene dichloride that could result in concentrations of ethylene dichloride in excess of the environmental limit. Exits shall be plainly marked. Emergency exit doors shall be conveniently located and shall open into areas which will remain free of contamination in an emergency. At least 2 separate means of exit shall be provided from each room or building in which ethylene dichloride is stored or handled in quantities that could create a hazard.

(2) Confined spaces

(A) Entry into confined spaces or into other areas where there may be limited egress shall be controlled by a permit system.

Permits shall be signed by an authorized representative of the employer certifying that preparation of the confined space, precautionary measures, personal protective equipment, and procedures to be used are all adequate.

(B) Tanks, pits, tank cars, process vessels, tunnels, sewers, grain storage bins, or other confined spaces which have contained ethylene dichloride shall be thoroughly ventilated to assure an adequate supply of oxygen, tested for ethylene dichloride and other contaminants, and inspected prior to each entry. Ventilation shall be maintained while workers are in the space.

(C) Inadvertent infiltration of ethylene dichloride into the confined space while work is in progress inside shall be prevented by disconnecting and blanking off ethylene dichloride supply lines.

(D) Personnel entering confined spaces shall be furnished with appropriate personal protective equipment and protected by a lifeline tended by another worker outside the space, who shall also be equipped for entry with approved respiratory, eye, and skin protection, lifeline, and have contact with a third party.

(E) Written operating instructions and emergency medical procedures shall be formulated and posted in conspicuous locations where accidental exposure to concentrations of ethylene dichloride which exceed the environmental limit may occur. These instructions and procedures shall be printed both in English and in the predominant language of non-English-speaking workers, if any. Special instructions shall be given to illiterate workers.

(d) Showers and Eye Wash Fountains

Showers and eye wash facilities shall be provided and so located as to be readily accessible to workers in all areas where skin or eye splash with ethylene dichloride is likely. If ethylene dichloride is splashed on the skin, contaminated clothing shall be promptly removed and the skin washed with soap and water. If liquid ethylene dichloride contacts the eyes, they shall be thoroughly irrigated with clean water, following which medical assistance shall be promptly provided. Such incidents shall be reported to the immediate supervisor by the affected employee or by a fellow worker.

Section 7 - Monitoring and Recordkeeping

(a) Where it has been determined that the environmental concentrations do not result in TWA workday exposures above one-half the TWA environmental limit, environmental monitoring shall not be required. However, records which form the basis for concluding that the exposures are at or below one-half the limit shall be maintained and exposure surveys shall be made when any process change indicates the need for reevaluation or at the discretion of the compliance officer.

(b) Where exposure concentrations have not been determined, they shall be determined within 6 months of the promulgation of a standard incorporating these recommendations.

(c) Where it has been determined that environmental concentrations result in TWA workday exposures above one-half the limit, employers shall maintain records of environmental exposures to ethylene dichloride based upon the following sampling and recording schedules:

(1) Samples shall be collected at least quarterly in accordance with Appendix I for the evaluation of the work environment with respect to the recommended limit.

(2) Environmental samples shall be taken when a new process is installed or when process changes are made which may cause an increase in environmental concentrations. Increased production, relocation of existing operations, or other functions which can increase concentrations shall require resampling.

(3) In all monitoring, samples shall be collected which are representative of breathing-zone exposures characteristic of each job or specific operation in each work area. Sufficient numbers of samples shall be collected to express the variability of exposure for the work situation and to estimate TWA workday exposures for every employee.

(4) The minimum number of representative TWA exposure determinations for an operation or process shall be based on variation in exposures and production schedules considering the number of workers exposed as suggested in Table I-2, or as otherwise indicated by a professional industrial hygienist.

TABLE I-2
SAMPLING SCHEDULE

Number of Employees Exposed	Number of fWA Determinations
1 - 20	50% of the number of workers
21 - 100	10 plus 25% of the excess over 20 workers
More than 100	30 plus 5% of the excess over 100 workers

(d) When exposure levels are found to be greater than those prescribed in Section 1(a), environmental concentrations shall be reduced by suitable engineering controls. Exposures shall be monitored at least weekly until the effectiveness of the controls is established.

(e) All records of sampling and of pertinent medical examinations shall be maintained for at least 20 years after the individual's employment is terminated. Records shall indicate the type of personal protective devices, if any, in use at the time of sampling. Each employee shall have access to information on his own environmental exposure.

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 ethylene dichloride. 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, after a review of data and consultations 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. It should be pointed out that any criteria and recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work environments and simply complying with the recommended standard should not be the final goal.

These criteria for a standard for ethylene dichloride are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of ethylene dichloride 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 workers against development of systemic effects, and against local effects on the skin and eyes, (2) be measurable by techniques that are valid, reproducible, and available to industry and governmental agencies, and (3) be attainable with existing technology.