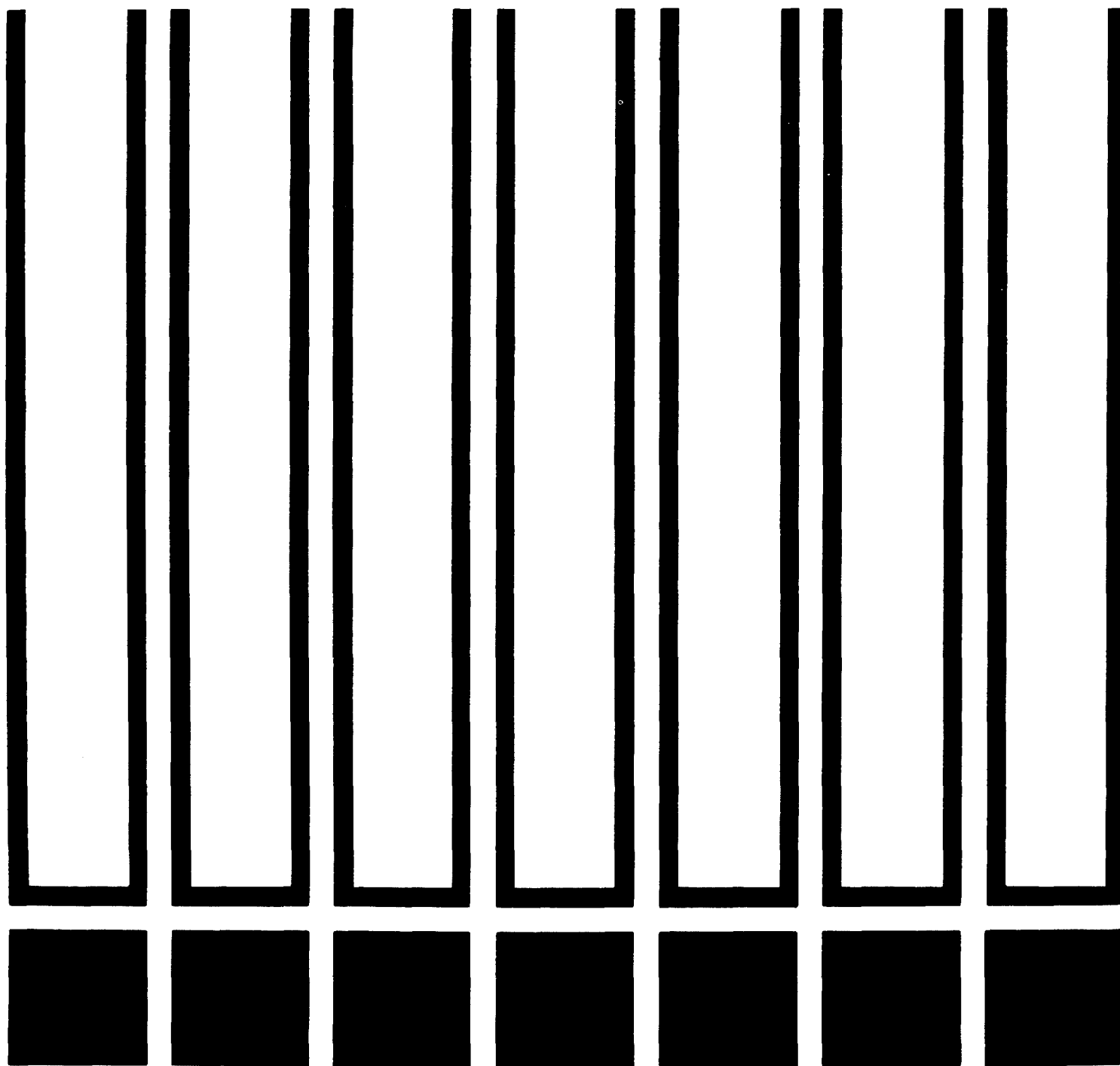


NIOSH

**criteria for a recommended standard
occupational exposure to**

**tetrachloroethylene
(PERCHLOROETHYLENE)**



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
TETRACHLOROETHYLENE
(Perchloroethylene)**



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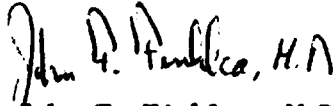
PREFACE

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 tetrachloroethylene by members of my staff and the valuable, constructive comments by the Review Consultants on tetrachloroethylene, by the ad hoc committees of the American Conference of Governmental Industrial Hygienists and the American Medical 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 tetrachloroethylene. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.



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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 tetrachloroethylene. The Division Review staff for this document consisted of Keith H. Jacobson, Ph.D.; Richard A. Rhoden, Ph.D.; and Paul E. Caplan. Hervey B. Elkins, Ph.D., and Charles C. Hassett, Ph.D., served as special reviewers.

Agatha Corporation developed the basic information for consideration by NIOSH staff and consultants under contract No. HSM-99-73-20. Robert W. Mason, Ph.D., had NIOSH program responsibility and Paul A. Schulte served as criteria manager.

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**CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR TETRACHLOROETHYLENE (PERCHLOROETHYLENE)**

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**CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR TETRACHLOROETHYLENE (PERCHLOROETHYLENE)**

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I. RECOMMENDATIONS FOR A TETRACHLOROETHYLENE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to tetrachloroethylene 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 prevent adverse effects of tetrachloroethylene 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 tetrachloroethylene" is defined as exposure at a concentration greater than the action level (TWA) environmental limit. An "action level" is defined as half the time-weighted average (TWA) environmental limit. Occupational exposure to tetrachloroethylene will require adherence to all the following sections. Exposure at lower environmental concentrations will not require adherence to the following Sections except for Sections 3(a), 4(a)(4), 4(b), 4(c), 5, 6, 7(a).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure shall be controlled so that no workers are exposed to tetrachloroethylene in excess of 50 ppm (339 mg/cu m) determined as a time-weighted average (TWA) concentration for up to a 10-hour workday,

40-hour workweek, or at greater than a ceiling concentration of 100 ppm (678 mg/cu m) determined by 15-minute samples, twice daily.

(b) Sampling and analysis

The procedures for sampling and analysis for workroom air shall be as provided in Appendices I and II or by any method shown to be at least equivalent.

Section 2 - Medical

Medical surveillance of workers occupationally exposed to tetrachloroethylene shall be made available as outlined below.

(a) Preplacement initial or interim medical and work history.

(b) Preplacement physical examinations giving attention to at least the neurological, cardiovascular, liver functions, and skin condition.

(c) A judgment should be made of the worker's ability to use positive or negative pressure respirators.

(d) Periodic examinations shall be made available on an annual basis or at some other frequency to be determined by the responsible physician.

(e) Proper medical management shall be made available to workers suffering from adverse effects of tetrachloroethylene.

(f) Initial medical examination shall be made available to all workers within 60 days of the promulgation of these standards.

(g) Workers shall be advised that available scientific information from one experimental animal study has shown that the offspring of mice

exposed at high levels of tetrachloroethylene were observed to have congenital abnormalities. The relevance of this study to male or female workers or their offspring has not yet been determined. It does, however, suggest that employers and workers attempt to minimize exposure to tetrachloroethylene whenever possible. If the physician becomes aware of any adverse reproductive effects including repeated spontaneous abortions in tetrachloroethylene exposed workers or congenital abnormalities in their children, this information should be forwarded to the Director, National Institute for Occupational Safety and Health.

(h) Medical records shall be maintained for all persons employed in work involving occupational exposure to tetrachloroethylene. 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 and Posting

(a) The following warning sign shall be affixed in a readily visible location on processing or other equipment, and on tetrachloroethylene storage tanks or containers:

**TETRACHLOROETHYLENE
(PERCHLOROETHYLENE)**

CAUTION

**BREATHING VAPOR MAY BE
HAZARDOUS TO HEALTH.**

**Keep containers closed when not in use.
Use only with adequate ventilation.**

AVOID CONTACT WITH SKIN.

**May generate toxic gases on contact
with ultraviolet light, open flame, hot
surfaces, or other heat producing conditions.**

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

(b) This sign shall also be posted at or near entrances to areas in which there is occupational exposure to tetrachloroethylene.

Section 4 - Personal Protective Equipment and Clothing

(a) Respiratory Protection

(1) Engineering controls shall be used whenever necessary and feasible to maintain tetrachloroethylene concentrations at or below the recommended exposure limits. 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 at concentrations in excess of the environmental limit for maintenance or repair activities.

(C) During emergencies when air concentrations of tetrachloroethylene may exceed the recommended limit.

(2) When respirators are permitted, 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 the atmospheric concentration of tetrachloroethylene in the workplace initially and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the tetrachloroethylene concentration. This requirement shall not apply when only self-contained or combination supplied air and self-contained positive pressure respirators are used.

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

(C) When respirators are required the employer shall provide respirators in accordance with Table I-1 and shall ensure that the employee uses the respirator provided.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR PROTECTION
AGAINST TETRACHLOROETHYLENE

Concentrations of Tetrachloroethylene	Respirator Type
500 ppm or less	<ul style="list-style-type: none"> (1) A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) (2) A gas mask with chin-style or a front or back-mounted organic vapor canister. (3) A supplied-air respirator with a full facepiece, helmet or hood (4) A self-contained breathing apparatus with a full facepiece
>500 ppm or entry and escape from unknown concentrations	<ul style="list-style-type: none"> (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	<ul style="list-style-type: none"> (1) A gas mask providing protection against organic vapors (2) An escape self-contained breathing apparatus

(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 tetrachloroethylene are permitted in atmospheres of lower concentrations.

(F) 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 tetrachloroethylene, 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 tetrachloroethylene, protective clothing should be worn. The clothing should be resistant to tetrachloroethylene. In operations where repeated contact with tetrachloroethylene is necessary impervious gloves and other appropriate clothing should be worn. 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.

(c) Eye Protection

Eye protection shall be provided for, and worn by, any employee engaged in an operation where tetrachloroethylene liquid or mist may enter

the eye. Chemical-type goggles or safety glasses with splash shields made completely of tetrachloroethylene-resistant materials shall be used. Suitable eye protection shall be in accordance with 29 CFR 1910.133.

Section 5 - Informing Employees of Hazards from Tetrachloroethylene

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

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. It shall include a description of the general nature of the medical surveillance procedures and why it is advantageous to the worker to undergo these examinations.

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

Information on file and readily accessible to workers shall include that specified in Appendix III, 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) Materials Handling and Storage

(1) Containers delivered by closed truck or rail shall not be unloaded until the vehicle in which they arrived has been ventilated. The vehicle should not be entered if the odor of tetrachloroethylene is perceptible or if there is evidence of unsafe concentrations. Failure to perceive the odor of tetrachloroethylene does not ensure that concentrations in air are within a safe range. If there is liquid tetrachloroethylene on surfaces or if there is reason to believe there have been spills or leaks, respiratory protection shall be worn during unloading unless cleanup and ventilation is first accomplished. Protective clothing shall be worn to the extent needed to prevent skin contact with tetrachloroethylene.

(2) Storage containers, piping, and valves shall be periodically checked for leakage.

(3) Storage facilities shall be designed to:

(A) Contain spills.

(B) Prevent contamination of workroom air.

(b) Contaminant Controls

(1) Suitable engineering controls shall be used if needed to limit exposure to tetrachloroethylene to workplace environmental limits. Ventilation systems, if used, shall be designed to prevent the accumulation or recirculation of tetrachloroethylene in the workroom and to effectively remove it from the breathing zones of workers. Adequate, uncontaminated make-up air shall be provided. 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 nonroutine operations using tetrachloroethylene if needed to limit exposure to safe limits. Welding should not be started without adequate ventilation near open sources of tetrachloroethylene because the tetrachloroethylene may be decomposed to phosgene and hydrochloric acid.

(c) Equipment Maintenance and Emergency Procedures

(1) Tetrachloroethylene hazard areas

A hazard area, ie, an area and space with physical characteristics and sources of tetrachloroethylene that could result in concentrations of tetrachloroethylene in excess of the environmental limit, shall have exits that are plainly marked. Emergency exit doors shall be conveniently located and shall open to areas which will remain free of contamination in an emergency. At least two separate means of exit shall be provided from each separate room or building in which tetrachloroethylene is stored or handled in quantities that could create a hazard.

(2) Confined spaces

(A) Entry into confined spaces or to other situations of 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, or other confined spaces which have contained tetrachloroethylene shall be thoroughly ventilated to assure an adequate

supply of oxygen, as well as removing solvent vapor, and inspected prior to entry.

(C) Inadvertent infiltration of tetrachloroethylene into the confined space while work is in progress inside shall be prevented by disconnecting and blanking off tetrachloroethylene 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 at concentrations of tetrachloroethylene in excess of the recommended limits 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 fountains shall be provided and so located as to be readily accessible in all areas where skin or eye splash with tetrachloroethylene is likely. If tetrachloroethylene is splashed on the worker, contaminated clothing shall be promptly removed and the skin washed with soap and water. If liquid tetrachloroethylene contacts the eyes, they shall be irrigated for a minimum of 15 minutes with a directed flow of clean water. Medical assistance shall be promptly provided in cases of eye or skin splash. Such incidents shall be reported to the immediate supervisor by the affected employee or by a fellow worker.

Section 7 - Monitoring and Recordkeeping

(a) General

Workers are not considered to be occupationally exposed to tetrachloroethylene if environmental concentrations, as determined on the basis of an industrial hygiene survey, do not exceed the action level, ie, half the recommended TWA environmental limit, or if there is no operation, storage, or handling of tetrachloroethylene in any form or contamination of workplace air by tetrachloroethylene from other sources. These industrial hygiene surveys shall begin within 6 months after this standard is promulgated, and be repeated at least every 3 years and within 30 days after any process or operating change likely to result in increases of airborne concentrations of tetrachloroethylene. Records of these surveys, including the basis for concluding that airborne concentrations of tetrachloroethylene are at or below the action level, shall be maintained until the next survey has been completed.

The following requirements apply to occupational exposure to tetrachloroethylene, ie, to workplaces where the action level is exceeded.

(b) Personal Monitoring

A program of breathing zone or personal monitoring shall be instituted to identify and measure the exposure of all employees occupationally exposed to tetrachloroethylene. This sampling and analysis shall be conducted every 3 months on at least 25% of the workers so that each worker's exposure is measured at least every year; this frequency and percentage of employees sampled may be different if so directed by a professional industrial hygienist. Sufficient samples shall be taken and analyzed to permit construction of valid estimates of the TWA and ceiling

concentration exposures. If monitoring of any worker shows exposure in excess of either recommended environmental limit, additional monitoring shall be promptly initiated. If confirmed, control procedures shall be instituted as soon as possible; these may precede and obviate confirmatory monitoring if the employer desires. Affected employees shall be advised that exposures have been excessive and be notified of the control procedures being implemented. Monitoring of these employees shall be conducted at least as often as every 30 days and shall continue until 2 successive samplings at least a week apart confirm that exposure no longer exceeds recommended limits. Normal monitoring may then be resumed.

For each TWA concentration determination, a sufficient number of samples to characterize each worker's exposure during each workshift shall be taken and analyzed. The number of TWA and ceiling concentration determinations for an operation shall be based on such factors as the variations in location and job functions of workers in that operation.

(c) Recordkeeping

Environmental monitoring records shall be maintained for at least 20 years. These records shall include methods of sampling and analysis used, types of respiratory protection used, and TWA and ceiling concentrations found. Each employee shall be able to obtain information on his own environmental exposures.

Pertinent medical records shall be retained for 20 years after the last occupational exposure to tetrachloroethylene if the employee dies sooner. Records of environmental exposures applicable to an employee should be included in that employee's medical records. These medical records shall be made 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 tetrachloroethylene. 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. The criteria and recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work environments and should not be the final goal.

These criteria for a standard for tetrachloroethylene are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of tetrachloroethylene 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.

The development of the recommended standard for occupational exposure to tetrachloroethylene revealed a lack of information in certain areas of concern. These areas included: the neurologic and behavioral effects of chronic exposures at or below the recommended limit, the effects of tetrachloroethylene on animal fetuses of different species, and an understanding of the fate of absorbed tetrachloroethylene.