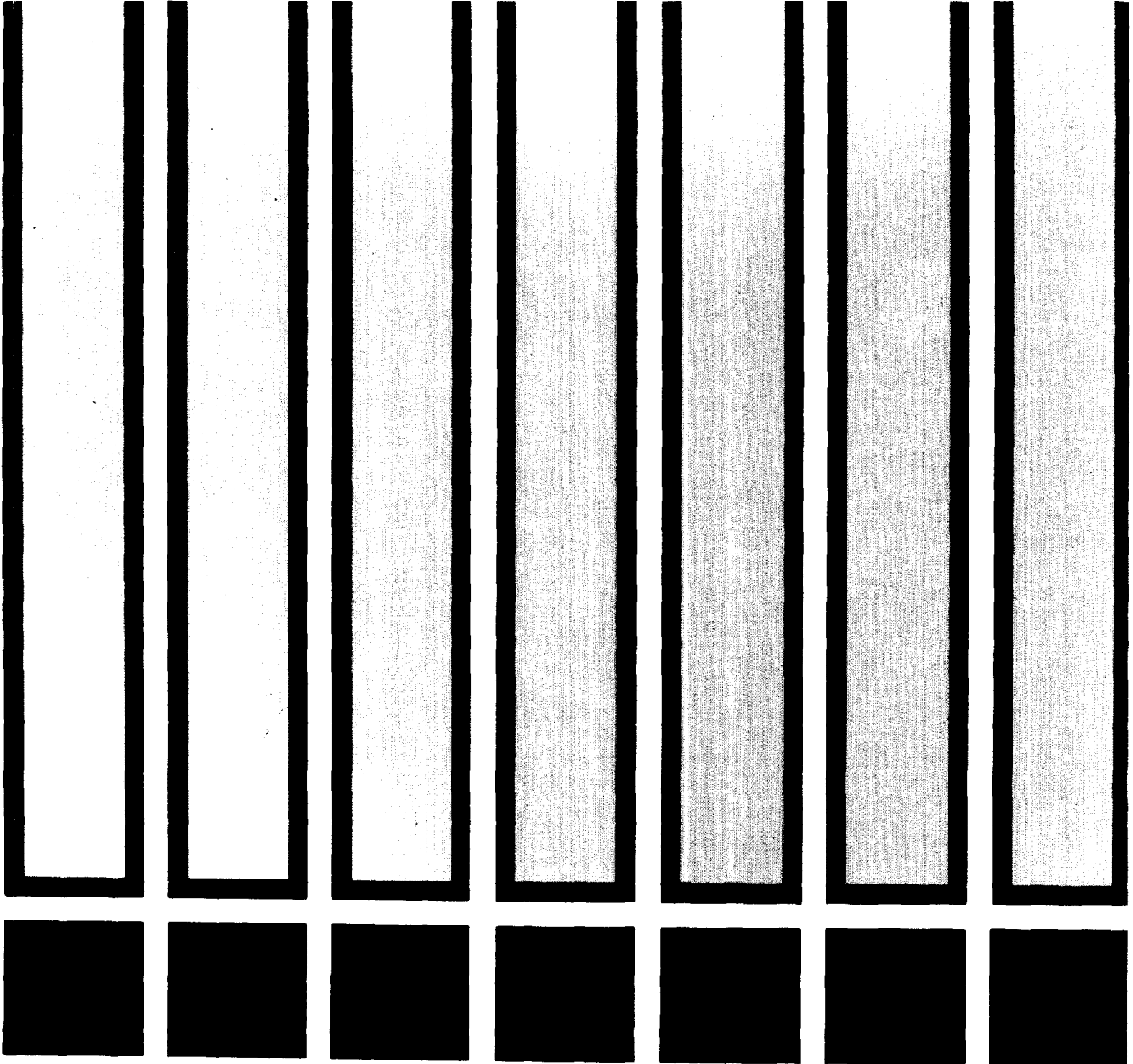


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criteria for a recommended standard
occupational exposure to

1,1,1-trichloroethane (METHYL CHLOROFORM)



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
1,1,1 - TRICHLOROETHANE
(Methyl Chloroform)**



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 1,1,1-trichloroethane by members of my staff and the valuable, constructive comments by the Review Consultants on 1,1,1-Trichloroethane, by the ad hoc committees of the American Industrial Hygiene Association and the American Academy of Occupational Medicine, 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 1,1,1-trichloroethane. Lists of the NIOSH Review Committee members and of the External Reviewers 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 1,1,1-trichloroethane. The Division Review staff for this document consisted of Keith H. Jacobson, Ph.D., Chairman; Richard A. Rhoden, Ph.D.; Paul E. Caplan; and special reviewers Hervey B. Elkins, Ph.D. and Charles C. Hassett, Ph.D.

Agatha Corporation developed the basic information for consideration by NIOSH staff and consultants under contract HSM-99-73-20. Robert W. Mason, Ph.D., had NIOSH program responsibility and John A. Wass, Ph.D., served as criteria manager.

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CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR 1,1,1-TRICHLOROETHANE (METHYL CHLOROFORM)

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I. RECOMMENDATIONS FOR A 1,1,1-TRICHLOROETHANE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to 1,1,1-trichloroethane (CH₃CCl₃), also known as methyl chloroform, in the workplace be controlled by adherence to the following sections. 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 1,1,1-trichloroethane 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 1,1,1-trichloroethane" is defined as exposure above 200 ppm measured as a time-weighted average (TWA) for up to a 10-hour workday, 40-hour workweek.

Occupational exposure to 1,1,1-trichloroethane requires adherence to all the following sections. Exposure at lower environmental concentrations will not require adherence to Sections 1, 2, 7(b), and 4(a) except 4(a)(5).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure shall be controlled so that workers are not exposed to 1,1,1-trichloroethane at greater than a ceiling concentration of

350 ppm (1,910 mg/cu m) as determined by a 15-minute sample.

(b) **Sampling and Analysis**

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

Section 2 - Medical

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

(b) Preplacement physical examinations giving attention to at least the neurological, cardiovascular, and 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 1,1,1-trichloroethane.

(f) Initial medical examinations shall be made available to all workers within 60 days of the promulgation of the standard.

(g) Workers shall be advised that available scientific information from one experimental animal study has shown that the offspring of mice and rats exposed at high levels of 1,1,1-trichloroethane 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 1,1,1-trichloroethane whenever possible. If the physician becomes aware of any adverse reproductive effects including repeated spontaneous abortions in 1,1,1-trichloroethane 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 exposure to 1,1,1-trichloroethane. All pertinent medical records with supporting documents shall be maintained for 20 years after the individual's employment is terminated. These records shall be made available to 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.

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 1,1,1-trichloroethane storage tanks or containers:

1,1,1-TRICHLOROETHANE

BREATHING VAPOR MAY BE
HAZARDOUS TO HEALTH.

May generate toxic gases on contact
with open flame, hot surfaces, or
other heat-producing conditions.
Keep containers closed when not in use.
Use only with adequate ventilation.
Avoid breathing of vapor.
Avoid contact with skin.
Notice to physician: Sympathomimetic
amines are contraindicated.

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.

(b) This sign shall also be posted at or near entrances to areas in which there is occupational exposure to 1,1,1-trichloroethane.

Section 4 - Personal Protective Equipment and Clothing

(a) Respiratory Protection

(1) Engineering controls shall be used wherever necessary to maintain 1,1,1-trichloroethane concentrations at or below the recommended environmental exposure standard. Compliance with the permissible exposure limits may be achieved by the use of respirators only:

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

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

(C) During emergencies when air concentrations of 1,1,1-trichloroethane may exceed the recommended limits.

(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) To determine the class of respirator to be used, the employer shall measure the atmospheric concentration of 1,1,1-

trichloroethane in the workplace initially and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the 1,1,1-trichloroethane 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 1,1,1-trichloroethane 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.

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

(E) Respirators specified for use in higher concentrations of 1,1,1-trichloroethane 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) Chemical cartridges and canisters shall not be used for periods of time in excess of those indicated in Table I-1. In any case chemical cartridges and canisters should be replaced after each day of use.

(5) Where an emergency may develop that could result in employee injury from overexposure to 1,1,1-trichloroethane, 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 1,1,1-trichloroethane, protective clothing shall be worn. The clothing should be resistant to 1,1,1-trichloroethane. 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. Hands placed in liquid 1,1,1-trichloroethane shall be protected by impervious gloves. Any liquid 1,1,1-trichloroethane that contacts the skin should be promptly removed.

TABLE I-1
RESPIRATORY PROTECTION
FOR 1,1,1-TRICHLOROETHANE

Condition Vapor Concentration	Respirator Type
500 ppm or less	<p>A chemical cartridge respirator with organic vapor cartridge(s), maximum service life of 5 hours; chemical cartridges should be changed after each day of use.</p> <p>A self-contained breathing apparatus</p>
1000 ppm or less	<p>A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s), Maximum service life of 2 hours</p> <p>A gas mask with a chin-style or a front- or back-mounted organic vapor canister</p> <p>A supplied-air respirator with a full facepiece, helmet or hood</p> <p>A self-contained breathing apparatus with a full facepiece</p>
Greater than 1000 ppm or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode</p> <p>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</p>
Fire Fighting	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode</p>
Escape	<p>A gas mask providing protection against organic vapors</p> <p>An escape self-contained breathing apparatus</p>

(c) Eye Protection

Eye protection shall be provided for, and worn by, any employee engaged in an operation where 1,1,1-trichloroethane liquid or spray may enter the eye. Chemical-type goggles or safety glasses with splash shields made completely of 1,1,1-trichloroethane-resistant materials shall be used. Suitable eye protection shall be in accordance with 29 CFR 1910.133.

Section 5 - Informing Employees of Hazards from 1,1,1-Trichloroethane

(a) All new and present employees in any 1,1,1-trichloroethane area shall be kept informed of the hazards, relevant symptoms, effects of overexposure, and proper conditions and precautions concerning safe use and handling of 1,1,1-trichloroethane.

(b) 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 mechanical surveillance procedures and why it is advantageous to the worker to undergo these examinations.

The information explaining the hazards of working with 1,1,1-trichloroethane shall be kept on file and readily accessible to the worker at all places of employment where 1,1,1-trichloroethane is manufactured, used, transported, or stored.

(c) 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) Containers delivered by closed truck or rail shall not be unloaded until the vehicle in which they arrived has been ventilated. The absence of any odor of 1,1,1-trichloroethane should not be used as a criterion of adequate ventilation.

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

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

(4) 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.

(b) Contaminant Controls

(1) Suitable engineering controls designed to limit exposure to 1,1,1-trichloroethane shall be utilized if needed. Ventilation systems, if used, shall be designed to prevent the accumulation or recirculation of 1,1,1-trichloroethane in the workroom and to effectively remove 1,1,1-trichloroethane 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, if necessary, to limit environmental concentrations for nonroutine operations that require the application of 1,1,1-trichloroethane.

(c) Equipment Maintenance and Emergency Procedures

(1) 1,1,1-Trichloroethane hazard areas

A hazard area that workers may enter (any space with physical characteristics and sources of 1,1,1-trichloroethane that could result in concentrations of 1,1,1-trichloroethane in excess of the environmental limits) shall have exits that are 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 two separate means of exit shall be provided from each room or building in which 1,1,1-trichloroethane 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 1,1,1-trichloroethane shall be thoroughly ventilated to assure an adequate supply of oxygen and a safe concentration of 1,1,1-trichloroethane, tested for 1,1,1-trichloroethane and inspected prior to each entry. Ventilation shall be maintained while workers are in the space.

(C) Inadvertent infiltration of 1,1,1-trichloroethane into the confined space while work is in progress inside shall be prevented by disconnecting and blanking off 1,1,1-trichloroethane

(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 1,1,1-trichloroethane in excess of 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 1,1,1-trichloroethane is likely. If 1,1,1-trichloroethane is splashed on the worker, contaminated clothing shall be promptly removed and the skin washed with soap and water. If liquid 1,1,1-trichloroethane contacts the eyes, they shall be thoroughly irrigated with clean water, promptly followed by medical assistance. 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 1,1,1-trichloroethane if environmental concentrations, as determined on the basis of an industrial hygiene survey, do not exceed the action level, or if there is no operation, storage, or handling of 1,1,1-trichloroethane in any form, or contamination of workplace air by 1,1,1-trichloroethane 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 1,1,1-trichloroethane. Records of these surveys, including the basis for concluding that airborne concentrations of 1,1,1-trichloroethane 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 1,1,1-trichloroethane, 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 1,1,1-trichloroethane. 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 the 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 1,1,1-trichloroethane. 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 1,1,1-trichloroethane. 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 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. Simply complying with the recommended standard should not be the final goal.

These criteria for a standard for 1,1,1-trichloroethane are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of 1,1,1-trichloroethane 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, especially central nervous system (CNS) and hepatic insult, (2) be measurable by techniques that are valid, reproducible, and available to industry and governmental agencies, and (3) be attainable with existing technology.

Further research is needed to more completely characterize the effects of certain levels of 1,1,1-trichloroethane on workers, especially epidemiological, chronic and teratological studies. Animal studies are underway at the National Cancer Institute to determine if 1,1,1-trichloroethane is carcinogenic. Similar studies are being performed by the Dow Chemical Company.