

**criteria for a recommended standard . . . .**

# **OCCUPATIONAL EXPOSURE TO**



**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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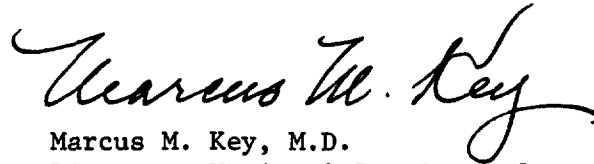
## PREFACE

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 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 chloroform by members of my staff and the valuable constructive comments by the Review Consultants on Chloroform, by the ad hoc committee of the American Conference of Governmental Industrial Hygienists, by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, and by Edwin C. Hyatt, NIOSH consultant on respiratory protection. The NIOSH recommendations for standards are not necessarily a consensus of all the

consultants and the professional society that reviewed this criteria document on chloroform. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.

A handwritten signature in black ink that reads "Marcus M. Key". The signature is written in a cursive style with a large, sweeping initial 'M' and a long, trailing flourish at the end.

Marcus M. Key, M.D.  
Director, National Institute for  
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The Office of Research and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and recommended standard for chloroform. Agatha Corporation developed the basic information for consideration by NIOSH staff and consultants under contract No HSM-99-73-20. Keith H. Jacobson, Ph.D., had program responsibility and Stanley C. Mazaleski, Ph.D., served as criteria manager.

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CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN  
OCCUPATIONAL EXPOSURE STANDARD TO CHLOROFORM

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## I. RECOMMENDATIONS FOR A CHLOROFORM STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to chloroform (CHCl<sub>3</sub>) 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 day, 40-hour week over a working lifetime; compliance with the standard should therefore prevent adverse effects of chloroform 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.

"Exposure to chloroform" is defined as exposure above half the time-weighted average (TWA) environmental limit. Exposures at lower environmental concentrations will not require adherence to the following sections, except for Sections 4 (b) and (c) and Section 6 (d).

### Section 1 - Environmental (Workplace Air)

#### (a) Concentration

Occupational exposure shall be controlled so that no worker will be exposed to chloroform in excess of 10 ppm (48.9 mg/cu m) determined as a time-weighted average exposure for up to a 10-hour workday, 40-hour workweek, or for any 10-minute period to more than 50 ppm (244 mg/cu m).

(b) Sampling and Analysis

The procedure for sampling and analysis of workroom air for compliance with the standard shall be as provided in Appendix I, or by any method shown to be equivalent or better in precision, sensitivity, accuracy, and specificity.

Section 2 - Medical

(a) Comprehensive preplacement medical examinations shall be made available to all workers subject to "exposure to chloroform" and yearly thereafter, unless a different frequency is indicated by professional medical judgment.

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

(1) A comprehensive or interim medical and work history giving special attention to gastrointestinal symptoms and mental status. The worker's alcohol consumption should be reviewed.

(2) A comprehensive medical examination, giving particular attention to cardiac rhythm, liver and kidney function. Liver function tests and urinalysis shall be performed.

(3) An evaluation of the advisability of the worker's using negative- or positive-pressure respirators.

(4) Proper medical management shall be provided for workers adversely affected by chloroform.

(c) The medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employee or

former employee, and of the employer shall have access to all medical records.

(d) Medical records shall be maintained for persons employed one or more years in work involving exposure to chloroform. All medical records with pertinent supporting documents shall be maintained at least 5 years after the individual's employment is terminated.

### Section 3 - Labeling (Posting)

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

#### CHLOROFORM

DANGER: INHALATION MAY BE

HAZARDOUS TO HEALTH.

Keep containers closed when not in use.

Use only with adequate ventilation.

Avoid breathing vapor.

Avoid contact with skin.

May generate toxic phosgene gas on contact

with flame or very hot metal surface.

This warning sign shall be printed both in English and in the predominant language of non-English-speaking workers, if any, unless they are

otherwise trained and informed of the hazardous conditions. All illiterate workers shall receive such training.

If exposures to chloroform in the workroom exceed the recommended standard, and a variance permitting the use of respiratory controls has been granted, the following shall be added to the sign: No worker allowed to enter area without proper respiratory protection.

#### Section 4 - Personal Protective Equipment and Clothing

When the limit of exposure to chloroform prescribed in subsection (a) of Section 1 cannot be met through application of available engineering controls in the design of equipment, systems, or operating procedures, an employer must utilize, as provided in subsection (a) of this Section, a program of respiratory protection to effect the required protection of every worker exposed.

##### (a) Respiratory Protection

Appropriate respirators shall be provided and used when a variance has been granted to allow respirators as a means of control of exposure to routine operations and while the application is pending. Administrative controls can be used to reduce exposure. Respirators shall also be provided and used for nonroutine operations (occasional brief exposures above the standard and for emergencies); however, for these instances a variance is not required but the requirements set forth below continue to apply. Appropriate respirators as described in Table I-1 shall only be used pursuant to the following requirements:

(1) For the purpose of determining the type of respirator to be used, the employer shall measure the atmospheric concentration of

chloroform in the workplace when the initial application for variance is made and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the chloroform concentration. This requirement shall not apply when only atmosphere-supplying positive pressure respirators are used.

(2) The respirator and cartridge or canister used shall be of the appropriate class, as determined on the basis of exposure to chloroform. The employer shall ensure that no worker is being exposed to chloroform in excess of the standard because of improper respirator selection, fit, use, or maintenance.

(3) A respiratory protective program meeting the general requirements outlined in Section 3.5 of American National Standard Practices for Respiratory Protection Z88.2-1969 shall be established and enforced by the employer. In addition, Sections 3.6 (Program Administration), 3.7 (Medical Limitations), and 3.8 (Approval) shall be adopted and enforced.

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

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

(6) Respirators specified for use in higher concentrations of chloroform are permitted in atmospheres of lower concentrations.

(7) Chemical cartridges and canisters shall not be used for periods of time in excess of those indicated in Table I-1.

(8) Employees shall be given instruction on the use of respirators assigned to them, cleaning of the respirators, and how to test for leakage.

(9) Wherever bulk chloroform is handled, emergency and escape-type respirators shall be made readily available for each worker. Continuous contact must be maintained with employees working in enclosed spaces where chloroform concentration may become excessive.

(b) Protective Clothing

In any operation where the worker may come into direct contact with liquid chloroform, protective clothing shall be worn. The clothing must be both impervious and resistant (such as neoprene or polyvinyl chloride) to chloroform. Bib-type aprons should be at least knee length, gloves should be lined to absorb perspiration, and boots or overshoes shall be provided when necessary. Impervious supplied air hoods or suits should be worn when entering areas with limited egress such as pits or tanks. All protective clothing should be well aired and inspected for physical defects prior to reuse.



TABLE I-1

REQUIREMENTS FOR RESPIRATOR USAGE

<u>Concentrations of Chloroform</u>	<u>Respirator Type</u>
Less than or equal to 100 ppm	<ol style="list-style-type: none"> <li>1) Chemical cartridge respirator with replaceable organic vapor cartridge with half or full facepiece. Maximum service life of 3 hours.</li> <li>2) Full face gas mask, chin type, with organic vapor canister. Maximum life of 4 hours.</li> <li>3) Type C supplied air respirator, demand type (negative pressure), with half mask facepiece.</li> </ol>
Less than or equal to 1000 ppm	<ol style="list-style-type: none"> <li>1) Full face gas mask, chest or back mounted type, with industrial size organic vapor canister. Maximum service life of 2 hours.</li> <li>2) Type C supplied air respirator, demand type (negative pressure), with full facepiece.</li> </ol>
Less than or equal to 2000 ppm	<ol style="list-style-type: none"> <li>1) Type C supplied air respirator, continuous flow or pressure-demand type (positive pressure) with full facepiece, hood or helmet.</li> </ol>
Greater than 2000 ppm	<ol style="list-style-type: none"> <li>1) Self-contained breathing apparatus with positive pressure in full facepiece.</li> <li>2) Combination supplied air respirator pressure-demand type, with auxiliary self-contained air supply.</li> </ol>
Emergency (no concentration limit)	<ol style="list-style-type: none"> <li>1) Self-contained breathing apparatus with positive pressure in facepiece.</li> <li>2) Combination supplied air respirator, pressure-demand type, with auxiliary self-contained air supply.</li> </ol>
Evacuation or Escape (no concentration limit)	<ol style="list-style-type: none"> <li>1) Self-contained breathing apparatus in demand or pressure-demand mode (negative or positive pressure).</li> <li>2) Full-face gas mask, front or back mount type with industrial size organic vapor canister.</li> <li>3) Mouthpiece respirator with escape type organic vapor canister (escape type gas mask).</li> </ol>

(c) Eye Protection

Eye protection shall be provided for any employee engaged in an operation where chloroform liquid or mist may enter the eye. Chemical-type goggles, safety glasses with splash shields, or plastic face shields made completely of chloroform resistant materials shall be used.

Suitable eye protection shall be provided in accordance with 29 CFR 1910.133.

Section 5 - Informing Employees of Hazards from Chloroform

At the beginning of employment in a chloroform area, each employee shall be informed of the hazards, relevant symptoms, effects of overexposure to and the proper conditions and precautions concerning safe use and handling of chloroform.

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

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.

Information on file and readily accessible to workers shall include that specified in Appendix II, on US Department of Labor Form OSHA-20 "Material Safety Data Sheet", or a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Handling and Storage

(1) Where employees are required to enter confined areas where containers of chloroform are stored, such as a delivery van, entry shall not be made until the space has been ventilated or checked for concentrations of chloroform.

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

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

(b) Contaminant Controls

Suitable engineering controls designed to limit exposure to chloroform to that prescribed in subsection (a) of Section 1 shall be utilized where appropriate and feasible. Where ventilation systems are used to achieve such control, they shall be designed to prevent the accumulation or recirculation of chloroform in the workroom and to effectively remove chloroform 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. In addition, necessary measures shall be taken to ensure that discharge outdoors will be in conformance with all appropriate environmental regulations.

(c) Equipment Maintenance and Emergency Procedures

Air saturated with chloroform is immediately dangerous to life and if a limited egress situation exists, emergency procedures must be established and followed.

(1) Chloroform hazard areas

Exits shall be plainly marked. Emergency exit doors shall be conveniently located and shall open to areas which will remain free of contamination in an emergency.

(2) Confined spaces

(A) Entry into confined spaces or in 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, etc, which have contained chloroform, shall be thoroughly ventilated, tested for chloroform, and inspected prior to entry.

(C) Inadvertent entry of chloroform into the confined space while work is in process inside shall be prevented by disconnecting and blanking off chloroform supply lines.

(D) Confined spaces shall be ventilated or otherwise maintained to keep the chloroform concentration below the limit and to prevent oxygen deficiency.

(E) Personnel entering confined spaces shall be equipped with a lifeline tended by another worker outside the space who shall be equipped with approved respiratory, eye, and skin protection.

(F) Written operating instructions and emergency medical procedures shall be formulated and posted in conspicuous locations where accidental exposure to anesthetic concentrations of chloroform may occur. These instructions and procedures shall be printed both in English

and in the predominant language of non-English-speaking workers, if any, unless they are otherwise trained and informed of the hazardous areas. All illiterate workers shall receive such training.

(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 chloroform is likely. If chloroform is splashed on the skin, contaminated clothing shall be promptly removed and the skin washed with soap and water. If liquid chloroform contacts the eyes, they shall be thoroughly irrigated with clean water. Medical assistance shall be promptly provided in cases of eye splash. Such incidents shall be reported to the immediate supervisor by the affected employee or by a fellow worker.

Section 7 - Monitoring and Recordkeeping

Workroom areas where it has been determined, on the basis of a professional industrial hygiene survey or the judgment of a compliance officer, that the environmental concentrations do not result in TWA workday exposures above half the TWA environmental limit shall not be considered to have chloroform exposure. Records of these surveys, including the basis for concluding that the exposures are at or below half the limit, shall be maintained until a new survey is conducted. Surveys shall be repeated when any process change indicates a need for reevaluation or at the discretion of the compliance officer. Requirements set forth below apply to areas in which there is chloroform exposure.

Employers shall maintain records of environmental exposures to chloroform based upon the following sampling and recording schedules:

(a) In all monitoring, samples representative of the exposure in the breathing zone of employees shall be collected. An adequate number of samples shall be collected to permit construction of a TWA exposure for workers in each operation or process. The minimum number of representative TWA exposure determinations for an operation or process shall be based on the number of workers exposed as provided in Table I-2 or as otherwise indicated by a professional industrial hygiene survey.

(b) The first environmental sampling shall be completed within 6 months of the promulgation of a standard incorporating these recommendations.

(c) Environmental samples shall be taken as soon as feasible but at least within 30 days after installation of a new process or process changes likely to cause an increase in environmental concentrations.

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

(e) Where exposure levels are found to be greater than those prescribed in Section 1 (a), suitable control measures shall be initiated. Once controls are implemented, sampling should be resumed until it is established that the controls are effective.

(f) All records of sampling and of medical examinations shall be maintained for at least 5 years after the individual's employment is terminated. Records shall indicate the type of personal protection devices, if any, in use at the time of sampling. Each worker shall be able to obtain information on his own environmental exposure.

TABLE I-2  
SAMPLING SCHEDULE

<u>Number of Employees Exposed</u>	<u>Number of TWA Determinations</u>
1-20	50% of the number of workers
21-100	10 TWAs plus 25% of the excess over 20 workers
over 100	30 TWAs plus 5% of the excess over 100 workers

## 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 chloroform (CHCl<sub>3</sub>). 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 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. It should be pointed out that any recommended criteria for a standard should enable management and labor to develop better engineering controls resulting in more healthful work practices and should not be used as a final goal.

These criteria for a standard for chloroform are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of chloroform as applicable under the Occupational Safety and Health Act of 1970.



These criteria were developed to assure that the standard based thereon would (1) protect against development of acute and chronic effects from chloroform, (2) be measurable by techniques that are valid, reproducible, and available to industry and governmental agencies, and (3) be attainable with existing technology.