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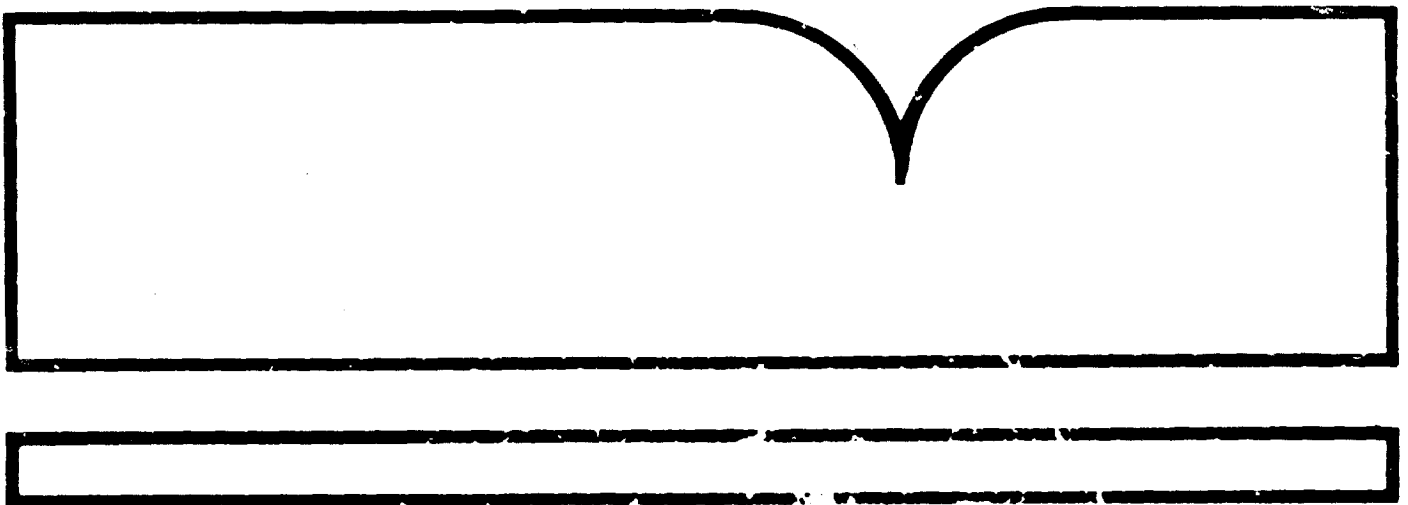
Criteria for a Recommended  
Standard - Occupational  
Exposure to Vinyl Halides

SRI International, Menlo Park, CA

Prepared for

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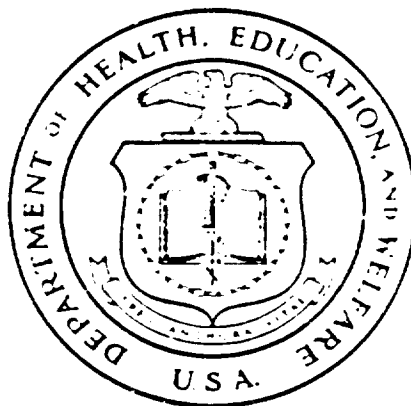
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<b>16. Abstract (Limit: 200 words)</b> NIOSH recommends that employee exposure to vinyl halides in the workplace be controlled by adherence to the provisions for vinyl chloride in 29 CFR 1910.1017, the contents of which are provided as Appendix I of this document, with the exception that the respirator provisions in 29 CFR 1910.1017 (c)(1)(i-iv) and also 29 CFR 1910.1017 (d)(1)(ii) shall be replaced with those given below. All provisions shall be adhered to for each of the vinyl halides as defined below. The recommended occupational exposure limits are measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. Employers should make every effort to limit employee exposure to the vinyl halides to concentrations that are as low as possible, with an eventual goal of zero exposure. Employee exposures shall be kept at or below the limits prescribed in 29 CFR 1910.1017. The criteria and standard will be subject to review and revision as necessary.		<b>14.</b>	
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criteria for a recommended standard....

**OCCUPATIONAL EXPOSURE  
TO  
VINYL HALIDES**



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

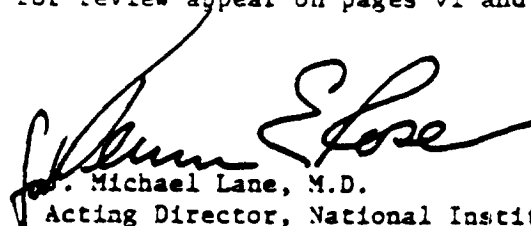
The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and provide for the safety of workers occupationally exposed to an ever-increasing number of potential hazards. The National Institute for Occupational Safety and Health (NIOSH) evaluates all available research data and criteria and recommends standards for occupational exposure. The Secretary of Labor will weigh these recommendations along with other considerations, such as feasibility and means of implementation, in promulgating regulatory standards.

NIOSH will periodically review the recommended standards to ensure continuing protection of workers and will make successive reports as new research and epidemiologic studies are completed and as sampling and analytical methods are developed.

A permanent Federal standard exists for worker exposure to vinyl chloride. This current standard was promulgated on October 4, 1974 (Federal Register 39:35896), became effective January 1, 1975, and was included in the Code of Federal Regulations (29 CFR 1910.1017) in January 1976. As part of NIOSH's efforts to ensure continuing protection of workers by periodically reviewing criteria and standards, this criteria document presents recently completed research and epidemiologic studies as well as revised sampling and analytical methods for vinyl chloride. In addition, this document presents complete criteria and a recommended standard for four additional vinyl halides.

The contributions to this document on vinyl halides by NIOSH staff, other Federal agencies or departments, the review consultants, the reviewers selected by the American Academy of Occupational Medicine, the American Academy of Industrial Hygiene, and the Society of the Plastics Industry, and Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, are gratefully acknowledged.

The views expressed and conclusions reached in this document, together with the recommendations for a standard, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. However, all comments, whether or not incorporated, were considered carefully and were sent with the criteria document to the Occupational Safety and Health Administration for consideration in setting the standard. The review consultants and the Federal agencies which received the document for review appear on pages vi and vii.

A handwritten signature in black ink, appearing to read "Michael Lane", is written over the typed name below.

Michael Lane, M.D.  
Acting 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 the development of the criteria and recommended standard for vinyl halides. Alfred N. Milbert, Ph.D., of this Division served as criteria manager. SRI International developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31.

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## I. RECOMMENDATIONS FOR A VINYL HALIDES STANDARD

NIOSH recommends that employee exposure to vinyl halides in the workplace be controlled by adherence to the provisions for vinyl chloride in 29 CFR 1910.1017, the contents of which are provided as Appendix I of this document, with the exception that the respirator provisions in 29 CFR 1910-1017 (g)(1)(i-iv) and also 29 CFR 1910 (g)(6)(ii) shall be replaced with those given below. All provisions shall be adhered to for each of the vinyl halides as defined below. The recommended occupational exposure limits are measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. Employers should make every effort to limit employee exposure to the vinyl halides to concentrations that are as low as possible, with an eventual goal of zero exposure. Employee exposures shall be kept at or below the limits prescribed in 29 CFR 1910.1017. The criteria and standard will be subject to review and revision as necessary.

These criteria and the recommended standard apply to workplace exposure of employees to the monomers vinyl chloride ( $\text{CH}_2=\text{CHCl}$ ), vinylidene chloride ( $\text{CH}_2=\text{CCl}_2$ ), vinyl bromide ( $\text{CH}_2=\text{CHBr}$ ), vinyl fluoride ( $\text{CH}_2=\text{CHF}$ ), and vinylidene fluoride ( $\text{CH}_2=\text{CF}_2$ ), including any unreacted monomer that may remain in polymers of these halides. As used in this document, "vinyls" and "vinyl halides" refer only to these five compounds unless the terms are otherwise qualified.

The biologic effects of exposure to the vinyl halides may include changes in behavior, cardiovascular abnormalities, degenerative changes in the liver and bones, and the induction of malignant neoplasms, especially angiosarcomas of the liver. A great deal of information is available concerning the effects of exposure of humans and animals to vinyl chloride, much of this is relatively new information having been developed since October 1974, when 29 CFR 1910.1017 was promulgated. As part of its effort to provide worker protection, NIOSH has extensively reviewed the newly completed studies as well as the older literature on vinyl chloride and has considered this information in its evaluation of the other vinyl halides. The data that are available from studies of carcinogenicity, mutagenicity, and metabolism, and predictions of biologic reactivity on the basis of physical and chemical properties of the vinyl halides suggest that the other vinyl halides have carcinogenic potentials similar to that of vinyl chloride. There is strong evidence from animal studies of carcinogenicity on the part of vinylidene chloride and vinyl bromide. Although there is a lack of toxicity data on vinyl fluoride and vinylidene fluoride, until some animal toxicity and/or metabolism data are available, there appears to be no reason to treat these two compounds differently from the other vinyl halides in considerations of worker protection.

Procedures for the collection and analysis of workroom air samples for compliance with this standard shall be as provided in Appendices II-VI or by any methods shown to be at least equivalent in precision, sensitivity, and accuracy to the methods specified for vinyl chloride in 29 CFR 1910.1017 (d)(4).

Continuous monitoring equipment with alarm capability has been developed for vinyl chloride and vinylidene chloride and should be used as specified for vinyl chloride in 29 CFR 1910.1017 (g)(6)(11).

TABLE 1-1

RESPIRATOR SELECTION GUIDE FOR VINYL HALIDES

Concentration	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 10 ppm	Chemical cartridge respirator with end-of-service-life indicator, if approved, for the specific vinyl halide
Less than or equal to 100 ppm	(1) Supplied-air respirator equipped with half-mask facepiece, operated in continuous-flow, pressure-demand, or other positive pressure mode (2) Supplied-air hood, helmet, or suit operated in continuous-flow mode
Less than or equal to 200 ppm	Supplied-air respirator equipped with full facepiece, operated in continuous-flow, pressure-demand, or other positive pressure mode
Greater than 200 ppm and Entry into area of unknown concentration for emergency purposes	(1) Self-contained breathing apparatus with full facepiece, operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece, operated in pressure-demand mode, and auxiliary self-contained air supply

## II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon that were prepared to meet the need for preventing impairment of health from occupational exposure to vinyl halides. 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."

After reviewing data and consulting with others, NIOSH formalized a system for the development of criteria on which standards can be established to protect the health and provide for the safety of employees exposed to hazardous chemical and physical agents. The criteria and recommended standards 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 recommended standard for vinyl halides are part of a continuing series of criteria developed by NIOSH. The recommended standard applies to the handling, processing, manufacture, use, or storage of the vinyl halides. The standard was not designed for the population-at-large, and its application to situations other than occupational exposure is not warranted. The standard is intended to: (1) protect against the development of short- and long-term systemic effects from exposure to vinyl halides; (2) protect against local effects on the skin and eyes; (3) minimize the risk of induction of cancer; (4) be measurable by techniques that are valid, reproducible, and available to industry and government agencies; and (5) be attainable with existing technology.

The diagnosis of a rare liver cancer, angiosarcoma, in employees involved in polymerization processes involving exposure to vinyl chloride has generated research on related compounds, including vinylidene chloride and vinyl bromide. The available data from studies with animals confirm the carcinogenic potential of vinyl chloride. The available information on vinylidene chloride and vinyl bromide suggests that these compounds also are carcinogenic and may induce the same type of characteristic tumor that is associated with exposure to vinyl chloride.

Although no reports of animal experiments have been located in which the effects of long-term exposure to vinyl fluoride or vinylidene fluoride were investigated, these compounds have been found to be mutagenic in bacteria, and they may have metabolic products and pathways similar to those of the other vinyl halides. Examination of the chemical and physical properties of the

vinyl halides indicates that all of them or their metabolites may have similar macromolecular binding potentials. The limited data on vinyl fluoride and vinylidene fluoride suggest that they probably exert nearly the same tumorigenic propensities as vinyl chloride, vinylidene chloride, and vinyl bromide.

To permit accurate assessment of the health hazards associated with the vinyl halides, additional research is necessary. This research should include attempts to: (1) develop less toxic substitutes; (2) develop improved control technology; (3) develop respiratory protective devices, especially those with end-of-service-life indicators, for the vinyl halides other than vinyl chloride; and (4) develop improved sampling and analytical methods and continuous monitoring equipment.