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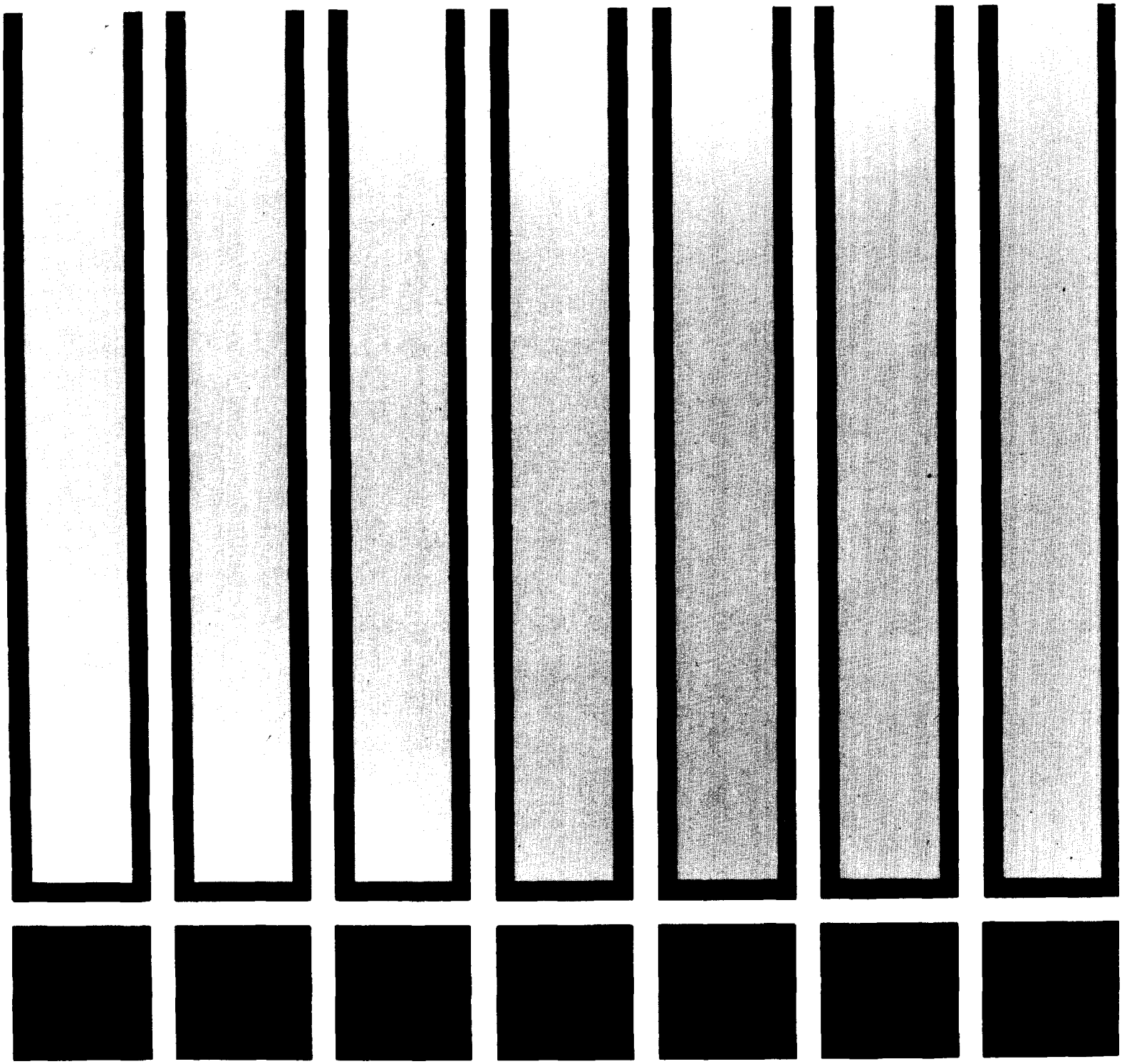

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service Center for Disease Control

National Institute for Occupational Safety and Health

criteria for a recommended standard....

OCCUPATIONAL EXPOSURE TO BORON TRIFLUORIDE

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 boron trifluoride by members of the NIOSH staff and the valuable constructive comments by the Review Consultants on Boron Trifluoride, by the ad hoc committee of the American Academy of Industrial Hygiene, 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 boron trifluoride. 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 the recommended standard for boron trifluoride. The Division review staff for this document consisted of Keith H. Jacobson, Ph.D. (Chairman), and Richard A. Rhoden, Ph.D., with Robert L. Roudabush, Ph.D.

Stanford Research Institute developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31. Irwin P. Baumel, Ph.D., had NIOSH program responsibility and served as criteria manager.

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CRITERIA DOCUMENT:
RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR BORON TRIFLUORIDE

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I. RECOMMENDATIONS FOR A BORON TRIFLUORIDE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to boron trifluoride 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. Sufficient technology exists to prevent adverse effects in workers, but techniques to measure airborne levels of boron trifluoride for compliance with an environmental limit are not adequate. Therefore, an environmental limit is not recommended herein, in part because of the unavailability of adequate monitoring methods. Work practices and engineering controls are recommended for control of exposure since reliable environmental data will not be available. The standard will be subject to review and revision as more information is acquired.

Boron trifluoride is highly reactive in the presence of water vapor. A dense, white mist is formed when boron trifluoride reacts with the moisture present in the air. The hydration and hydrolysis of boron trifluoride appear to be rapid and extensive. The term "boron trifluoride" as used throughout this document refers to the unreacted gas, the products formed by the reaction of boron trifluoride gas upon release into the environment, or both. "Occupational exposure to boron trifluoride" is defined as working in areas where boron trifluoride is manufactured, used, or handled, or is evolved as a result of chemical processes.

Section 1 - Medical

Medical surveillance shall be made available to all workers occupationally exposed to boron trifluoride.

(a) Preplacement examinations shall include:

(1) Comprehensive medical and work histories.

(2) A physical examination giving particular attention to the respiratory system and using appropriate pulmonary function tests such as FEV_1 and FVC. Chest X-rays (14 x 17 inches, PA) should be considered by the responsible physician. Persons with respiratory difficulties should be advised of their possible additional risk from boron trifluoride exposures.

(b) Periodic examinations shall be made available on an annual basis. These examinations shall include at least:

(1) Interim medical and work histories.

(2) A physical examination as outlined in paragraph (a)(2) of this section.

(c) In an emergency involving boron trifluoride, all affected personnel shall be provided with immediate first aid, with emphasis on the respiratory tract, skin, and eyes. In the event of skin or eye contact with boron trifluoride, the contaminated areas shall be flushed with copious amounts of water.

(d) Pertinent medical records, including information on medical examinations with supporting documents, shall be maintained for 20 years after the last occupational exposure to boron trifluoride and shall be available to the designated medical representatives of the employer, of the employee or former employee, of the Secretary of Labor, and of the Secretary of Health, Education, and Welfare.

Section 2 - Labeling and Posting

The cylinder label and warning sign shall be printed both in English and in the predominant language of non-English-reading employees. All employees unable to read these languages shall be informed of the hazardous areas.

(a) Labeling

Cylinders of boron trifluoride gas shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances:

WARNING!

BORON TRIFLUORIDE GAS UNDER PRESSURE

HARMFUL IF INHALED

Avoid inhaling gas, mists, or vapor.
Do not get in eyes, on skin, or on clothing.
Use only with adequate ventilation.

First Aid: CALL A PHYSICIAN AS SOON AS POSSIBLE. If inhaled, remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush skin or eyes with copious amounts of water. Keep at rest.

(b) Posting

The following warning sign shall be affixed in a readily visible location at or near entrances to work areas in which boron trifluoride is present.

DANGER!

BORON TRIFLUORIDE

AUTHORIZED PERSONNEL ONLY!

IF ENTERING VISIBLE MIST, USE RESPIRATOR
HARMFUL IF INHALED
IRRITATING TO EYES AND SKIN

Observe precautions and follow safety procedures as instructed.

Section 3 - Personal Protective Clothing and Equipment

(a) Protective Clothing

Proper impervious protective clothing, including gloves, aprons, suits, boots, goggles, and face shields, shall be worn as needed to prevent skin and eye contact with boron trifluoride.

(b) Respiratory Protection

(1) Engineering controls shall be used to maintain boron trifluoride concentrations at the lowest feasible level. The use of respirators to limit exposure is permitted only:

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

(B) During operations such as nonroutine maintenance or repair activities which may cause exposures at elevated concentrations.

(C) During emergencies when air concentrations of boron trifluoride are sufficient to form a visible mist in the employee's breathing zone.

(D) During the initial charging of a pressurized system with boron trifluoride gas when unsuspected leaks may become evident.

(2) When a respirator is permitted or required by paragraph (b)(1) of this section, it shall be selected and used pursuant to the following requirements:

(A) Only supplied-air positive-pressure respirators shall be provided for work in or entry into boron trifluoride contaminated areas. In addition, for escape purposes only, a full-facepiece gas mask with a combination acid-gas canister and high-efficiency (penetration less

than 0.03% against a 0.3-μm dioctyl phthalate aerosol) filter may be used. The employer shall ensure that no worker is exposed to elevated concentrations of boron trifluoride because of improper respirator selection, fit, use, or maintenance.

(B) The employer shall establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134 and of 30 CFR 11, which incorporates the American National Standard Practices for Respiratory Protection Z88.2-1969.

(C) The employer shall provide respirators and gas masks according to paragraph (b)(2)(A) of this section for all potentially exposed employees and shall ensure that the employees use these respirators.

(D) The employer shall ensure that respirators are clean and that employees are instructed on the location and proper use of respirators and on how to test for leakage.

Section 4 - Informing Employees of Hazards from Boron Trifluoride

(a) Each employee with potential occupational exposure to boron trifluoride shall be informed at the beginning of employment or assignment to a boron trifluoride work area, and at least yearly thereafter, of the hazards and relevant symptoms of overexposure and the proper conditions, emergency procedures, and precautions for the safe use of boron trifluoride. Records of such training shall be kept to verify the frequency of training. Each employee shall be instructed as to the availability of information which shall be kept on file and which shall

include that prescribed in paragraph (b) of this section.

(b) Information shall be recorded as required on a "Material Safety Data Sheet," as shown in Appendix I, or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 5 - Work Practices

(a) Emergency Procedures

For all work areas, procedures as specified below, as well as any other procedures appropriate for a specific operation or process, shall be formulated in advance and employees shall be instructed in their implementation.

(1) Procedures shall include prearranged plans for obtaining emergency medical care and for necessary transportation of injured workers. Employees trained in the administration of first-aid measures shall be available during each work shift and shall be prepared to render such assistance when necessary.

(2) Approved skin, eye, and respiratory protection as specified in Section 4 shall be used by personnel essential to emergency operations. Protective equipment shall be stored in a manner which will assure access by employees at all times.

(3) Nonessential employees shall be evacuated from exposure areas during emergencies. Perimeters of hazardous exposure areas shall be delineated, posted, and secured. Reentry into exposure areas shall be prohibited until the boron trifluoride mist has been removed.

(4) Only personnel properly trained in emergency procedures

and adequately protected against the attendant hazards shall shut off sources of boron trifluoride and repair leaks. Respirators shall be worn by all workers repairing leaks.

(b) Engineering Controls

Engineering controls shall be designed to prevent the accumulation of boron trifluoride in the workplace and to effectively remove it from the breathing zones of exposed workers. Primarily, closed systems should be used to maintain boron trifluoride concentrations at the lowest feasible level (within the recommended environmental limit when monitoring methods become available), but local exhaust ventilation may also be used. Permanent boron trifluoride storage areas shall also be equipped with adequate exhaust ventilation. Closed systems, exhaust hoods, and ductwork shall be kept in good repair so that design airflows and pressures are maintained. Airflow and pressure should be measured at least twice a year. Continuous airflow indicators (oil or water manometers) are recommended. A log showing design airflow or pressure and the results of periodic inspection shall be kept. Exhaust ventilation systems discharging to outside air must conform with applicable local, state, and federal air pollution regulations.

(c) Cylinder Handling

(1) Cylinders of boron trifluoride shall be equipped with safety relief devices conforming to 29 CFR 1910.167 and designed to release the gas safely in the event the cylinder is subjected to abnormal temperature or internal pressure. Cylinders shall be handled and stored in accordance with the applicable provisions of 29 CFR 1910.101 relating to

cylinder use, handling, and storage. Cylinders should be used on a first-in, first-out basis. Cylinder maintenance and inspection shall be in accord with applicable provisions of 29 CFR 1910.166.

(2) Cylinders containing boron trifluoride are at high pressure, up to 1,800 pounds per square inch gage (psig), and, therefore, shall never be used without an appropriate pressure regulator which is kept in good condition.

(d) Service Lines

Pressurized service lines connecting boron trifluoride cylinders with reaction vessels shall be constructed from material resistant to boron trifluoride corrosion. Gaskets in such lines shall not contain rubber. The potential for moisture to be introduced into the system shall be minimized, and open service lines shall be purged with dry air or inert gas before charging. These service lines shall be constructed to withstand up to 3,000 psig of pressure.

(e) General Work Practices

(1) In boron trifluoride manufacture and use there is the potential for the development of leaks. Such leaks will be visible since a white mist will be evolved. Adequately protected employees shall repair all leaks immediately.

(2) All boron trifluoride work areas shall be equipped with readily accessible eyewash fountains and safety showers.

Section 6 - Sanitation Practices

(a) Plant sanitation shall meet the requirements of 29 CFR 1910.141.

(b) Food preparation, dispensing (including vending machines), and eating shall be prohibited in boron trifluoride work areas.

(c) Smoking and uncovered smoking materials should be prohibited in boron trifluoride work areas because of the possibility of adsorption of the compound onto smoking materials.

Section 7 - Monitoring and Recordkeeping Requirements

(a) When an adequate sampling and analytical method is developed, the following shall apply:

(1) A program of personal monitoring shall be instituted to identify and measure or permit calculation of the exposure of all employees in boron trifluoride work areas.

(A) In all personal monitoring, samples representative of the exposure in the breathing zone of the employee shall be collected.

(B) For the determination of the exposure of each employee a sufficient number of samples shall be taken to characterize the employee's exposure during each work shift. Variations in work and production schedules shall be considered when samples are collected. The number of representative determinations for an operation or process shall be based on the variations in location and job functions of employees in relation to that operation or process.

(2) If monitoring reveals that an employee is exposed to more than the promulgated environmental limit, the exposure of that employee shall be measured at least once every 30 days, control measures shall be initiated, and the employee shall be notified of his or her

exposure and the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least a week apart, indicate that employee exposure no longer exceeds the promulgated environmental limit.

(3) When boron trifluoride is used and stored only in a proper exhaust hood, as described in Section 6, paragraph (b), monitoring is not required.

(b) Until adequate environmental monitoring methods are developed, environmental records shall consist of a description of job functions involving exposure to boron trifluoride and indicate any use of personal protective devices. These records shall be maintained for 20 years and shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare. Pertinent medical records shall also be retained for at least 20 years. Copies of the records of environmental exposures of each employee should be placed into the employee's medical record, and each employee shall be able to obtain information on his own environmental exposures. 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 boron trifluoride and resultant mists. 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 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. These criteria and recommendations for a standard should enable management and labor to develop better engineering controls resulting in more healthful work environments and mere compliance with the recommended standard should not be a final goal.

These criteria for a standard for boron trifluoride are part of a continuing series of criteria developed by NIOSH. The proposed occupational standard applies only to the processing, manufacture, or use of, or other occupational exposure to, boron trifluoride as applicable under the Occupational Safety and Health Act of 1970. The recommended standard was not designed for the population-at-large, and any

extrapolation beyond occupational exposures is not warranted. It is intended to protect against development of respiratory effects and against local effects on the skin and in the eyes.

Boron trifluoride, a highly reactive chemical, is used primarily as a catalyst in chemical syntheses. It is stored and transported as a gas but can be reacted with a variety of materials to form both liquid and solid compounds. The gas is very irritating to the skin and respiratory system; inhalation or contact should be avoided. Upon contact with air, the boron trifluoride gas immediately reacts with water vapor to form a mist which, if at a high enough concentration, provides a visible warning of its presence.

The toxicity of boron trifluoride has not been adequately studied. Additional work is needed to evaluate the chemical's potential for carcinogenicity, mutagenicity, and teratogenicity. Studies are needed to identify the composition and properties of the hydrolysis products. Because of present difficulties in the measurement of boron trifluoride in the workplace environment, evaluation for compliance cannot be based on the use of available monitoring methods but will depend primarily on the use of work practices and engineering controls until suitable environmental monitoring methods become available.