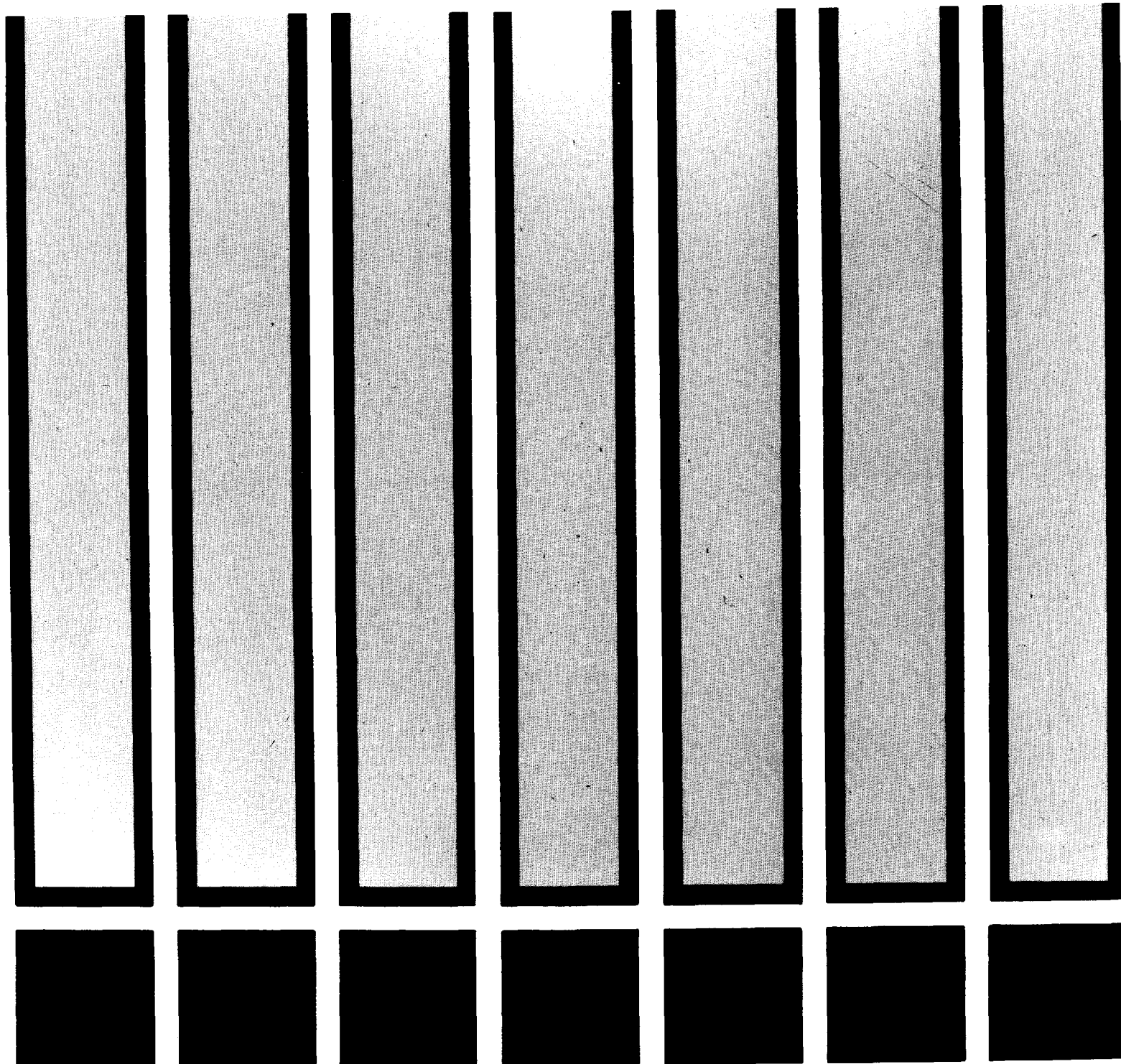


NIOSH

criteria for a recommended standard
occupational exposure to

ACRYLAMIDE



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
ACRYLAMIDE**



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

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CRITERIA DOCUMENT:
RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR ACRYLAMIDE

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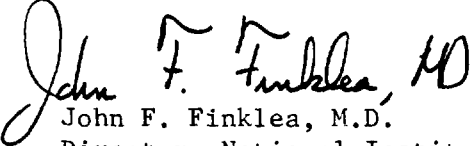
PREFACE

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 acrylamide by members of the NIOSH staff and the valuable constructive comments by the Review Consultants on acrylamide, by the ad hoc committees of the American Conference of Governmental Industrial Hygienists, American Academy of Occupational Medicine, American Academy of Industrial Hygiene, and American Occupational 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 acrylamide. The use of trademarks in this criteria document does not imply endorsement by the Health, Education, and Welfare Department. A list of Review Consultants appears on page vi.


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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 acrylamide. The Division review staff for this document consisted of Keith H. Jacobson, Ph.D. (Chairman), Howard L. McMartin, M.D., Richard A. Rhoden, Ph.D., with Seymour D. Silver, Ph.D., Charles S. McCammon, Jr. (Division of Physical Sciences and Engineering) and Jack O. Geissert (Division of Surveillance, Hazard Evaluations, and Field Studies).

Stanford Research Institute (SRI) developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31. Craig R. McCormack had NIOSH program responsibility and served as criteria manager.

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I. RECOMMENDATIONS FOR AN ACRYLAMIDE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to acrylamide in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and safety of employees for up to a 10-hour work shift, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent adverse effects of acrylamide on the health and safety of employees. Sufficient technology exists to permit compliance with the recommended standard. Although the workplace environmental limit is considered to be a safe level based on current information, it should be regarded as the upper boundary of exposure and every effort should be made to maintain the exposure at levels as low as is technically feasible. The criteria and standard will be subject to review and revision as necessary.

Synonyms for acrylamide include propenamide, acrylic amide, and akrylamid. The terms "acrylamide" or "acrylamide monomer" are used in this document interchangeably. "Action level" is defined as a time-weighted average (TWA) concentration of one-half the environmental limit. "Occupational exposure to acrylamide," because of systemic effects and dermal irritation produced by contact of acrylamide with the skin, is defined as work in an area where acrylamide is stored, produced, processed, or otherwise used, except as an unintentional contaminant in other materials at a concentration of less than 1% by weight. If an employee is occupationally exposed to airborne concentrations of acrylamide in excess of the action level, then all sections of the recommended standard shall be

complied with; if the employee is occupationally exposed at or below the action level, then all sections of the recommended standard shall be complied with except Section 8.

Section 1 - Environmental (Workplace Air)

(a) Concentration

The employer shall control workplace concentrations of acrylamide so that no employee is exposed at a concentration greater than 0.3 milligram per cubic meter of air determined as a TWA concentration for up to a 10-hour work shift, 40-hour workweek.

(b) Sampling and Analysis

Procedures for the collection and analysis of environmental samples shall be as provided in Appendices I and II, or by any method shown to be at least equivalent in accuracy, precision, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available to all persons subject to occupational exposure to acrylamide as described below.

(a) Preplacement medical examinations shall include:

(1) Comprehensive medical and work histories with special emphasis to such areas as weight loss and neurologic disturbances.

(2) Complete physical examination giving particular attention to the skin, eyes, and nervous system.

(3) Judgment of the worker's ability to use positive- or negative-pressure respirators.

(b) Periodic examinations shall be made available on an annual basis, or as otherwise determined by the responsible physician. These examinations shall include at least:

(1) Interim medical and work histories.

(2) Weekly examination by trained personnel of the fingertips of hands and other portions of the body exposed to acrylamide for evidence of skin peeling.

(3) Physical examination as outlined in paragraph (a)(2) of this section.

(c) In an emergency involving exposure to acrylamide, all affected personnel shall be provided immediate first-aid assistance and prompt medical attention, especially with respect to the skin and eyes. Medical attendants shall be informed of the need of observation and followup for any delayed neurologic effects.

(d) In the event of skin contact with acrylamide, grossly contaminated clothing and shoes shall be removed. Any exposed body area shall be immediately and thoroughly washed with soap and water. In the case of eye contact with acrylamide, eyes shall be flushed with copious amounts of water and a physician shall be consulted promptly.

(e) Pertinent medical records shall be maintained by the employer for all employees occupationally exposed to acrylamide. Such records shall be retained for 20 years after termination of employment. These 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.

Section 3 - Labeling and Posting

All labels and warning signs shall be printed both in English and in the predominant language of non-English-reading employees. All employees shall be trained orally and informed of the hazardous areas, with specific instructions given to illiterate employees and employees reading only languages other than that used on labels and posted signs.

(a) Labeling

Containers of acrylamide shall carry in a readily visible location a label stating:

ACRYLAMIDE

(PROPENAMIDE)

IRRITATING TO SKIN AND EYES

REPEATED SKIN CONTACT, INHALATION, OR SWALLOWING

MAY CAUSE NERVE DAMAGE

Avoid contact with skin, eyes, and clothing.
Avoid prolonged or repeated breathing of dust, mist, or vapor.
Wash thoroughly after handling.
Use with adequate ventilation.
Keep away from heat.

First Aid: In case of skin or eye contact, flush with plenty of water; call a physician.

(b) Posting

Areas where acrylamide is present shall be posted with a sign reading:

ACRYLAMIDE
(PROPENAMIDE)

IRRITATING TO SKIN AND EYES

REPEATED SKIN CONTACT, INHALATION, OR SWALLOWING

MAY CAUSE NERVE DAMAGE

Avoid contact with skin, eyes, and clothing.
Avoid prolonged or repeated breathing of dust, mist, or vapor.
Do not enter areas where used, unless adequately ventilated.

Section 4 - Personal Protective Equipment

(a) Protective Clothing

(1) Appropriate protective clothing, including gloves, aprons, long-sleeved overalls, footwear, and face shields (8-inch minimum), shall be worn where needed to limit skin contact with acrylamide. Impervious clothing may be needed in specialized operations. Appropriate eye protection (chemical safety goggles or face shields and safety glasses with side shields) shall be worn in any operation in which acrylamide (solid, liquid, or spray) may come in contact with eyes.

(2) The employer shall provide the employee with the appropriate equipment specified in paragraph (a)(1) of this section.

(b) Respiratory Protection

(1) Engineering controls shall be used if needed to keep acrylamide concentrations at or below the TWA environmental limit.

Respiratory protective equipment may be used:

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

(B) During emergencies or during the performance of nonroutine maintenance or repair activities which may cause exposures at concentrations in excess of the TWA environmental limit.

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

(A) The employer shall establish and enforce a respiratory protective program meeting the requirements of 29 CFR 1910.134.

(B) The employer shall provide respirators in accordance with Table I-1 and shall ensure that the employee uses the respirator provided when necessary. The respiratory protective devices provided in conformance with Table I-1 shall comply with the standards jointly approved by NIOSH and the Mining Enforcement and Safety Administration (formerly Bureau of Mines) as specified under the provisions of 30 CFR 11.

(C) Respirators specified for use in higher concentrations of acrylamide may be used in atmospheres of lower concentrations.

(D) The employer shall ensure that respirators are adequately cleaned and maintained, and that employees are instructed in the proper use and testing for leakage of respirators assigned to them.

(E) Respirators shall be easily accessible, and employees shall be informed of their location.

TABLE I-1

RESPIRATOR SELECTION GUIDE

Concentration	Respirator Type
Less than or equal to 1 ppm (3 mg/cu m)	Supplied-air respirator, demand (negative pressure) mode, with half-mask facepiece
Less than or equal to 5 ppm (15 mg/cu m)	(1) Supplied-air respirator, demand mode, with full facepiece (2) Self-contained breathing apparatus, demand mode, with full facepiece
Less than or equal to 100 ppm (300 mg/cu m)	(1) Supplied-air respirator, continuous-flow type or pressure-demand (positive pressure) mode, with half-mask or full facepiece (2) Supplied-air respirator, continuous-flow type, with hood, helmet, or suit
Greater than 100 ppm (300 mg/cu m)	(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, with an auxiliary self-contained air supply
Emergency entry (into an area of unknown concentration)	(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, with an auxiliary self-contained air supply
Escape (from an area of unknown concentration)	(1) Gas mask, full facepiece, equipped with a combination organic vapor canister and a high-efficiency filter (2) Self-contained breathing apparatus operated in either demand or pressure-demand mode

(F) In case of an accident which could result in employee exposure to acrylamide in excess of the environmental limit, the employer shall provide respiratory protection as listed in Table I-1.

Section 5 - Informing Employees of Hazards from Acrylamide

(a) The employer shall ensure that each employee occupationally exposed to acrylamide is informed at the beginning of employment or on assignment to an acrylamide area of the hazards, relevant symptoms such as skin peeling, numbness ("pins and needles" in fingers), sleepiness, loss of weight, and weakness, appropriate emergency procedures, and proper conditions and precautions for the safe use of acrylamide. People engaged in maintenance and repair shall be included in these training programs. The employee shall be reformed at least once a year. Each employee shall be advised of the availability of such relevant information kept on file, including the material safety data sheet.

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

Section 6 - Work Practices

(a) Engineering Controls

(1) Ventilation systems if used shall be designed to prevent the accumulation or recirculation of acrylamide in the workplace, to maintain acrylamide concentrations at or below the recommended environmental limit, and to effectively remove acrylamide from the

breathing zones of employees. Ventilation systems shall be subject to regular preventive maintenance and cleaning to ensure effectiveness, which shall be verified by periodic performance measurements.

(2) A partially enclosed, ventilated, and automated system should be used to empty and transfer bags of solid acrylamide into a bin, so that dust are effectively removed. The bag should be cut open automatically and any dust should be removed by local exhaust ventilation.

(3) Concrete floors in operations areas shall be sealed in a manner that minimizes permeation of acrylamide into the concrete.

(b) Storage, Handling, and General Work Practices

(1) Containers of acrylamide shall be kept tightly closed when not in use. Only properly informed, trained, and equipped personnel shall be involved in storing, loading and unloading, or processing acrylamide.

(2) Acrylamide contact with skin and eyes of workers shall be prevented. Equipment, walls, and floors should be kept clean to limit worker exposure.

(3) Prior to maintenance work, sources of acrylamide and its vapor shall be eliminated to the extent feasible. If concentrations at or below the recommended workplace environmental limit cannot be ensured, respiratory protective equipment as specified in Table I-1 shall be used during such maintenance work.

(4) Employees whose skin becomes contaminated with acrylamide shall immediately wash or shower to remove all traces of acrylamide from the skin. Clothing contaminated with acrylamide shall be disposed of or cleaned before reuse.

(5) Any spills shall be either wet vacuumed or mopped up immediately and either decontaminated or disposed of appropriately in covered drums as contaminated waste; the spill area shall be decontaminated by washing.

(c) Waste Disposal

Solid acrylamide waste shall be disposed of either by burial in an environmentally acceptable manner or by burning in an approved manner. Liquid acrylamide waste shall be drained to a sump for subsequent treatment.

(d) Confined Spaces

(1) Confined spaces which previously contained acrylamide shall be thoroughly aerated, as well as inspected and tested for oxygen deficiency, acrylamide, and other known contaminant exposure concentrations prior to entry.

(2) Individuals entering confined spaces where they may be exposed to acrylamide shall wear respirators as outlined in Section 4.

(3) Confined spaces shall be ventilated while work is in progress to keep the concentration of acrylamide at or below the workplace environmental limit.

(4) When a person enters a confined space, another properly protected worker shall be on standby outside.

(e) Emergency Procedures

For all work areas where there is a reasonable potential for accidents involving acrylamide, the employer shall take all necessary steps to ensure that employees are instructed in and follow the procedures

specified below and any others appropriate for a specific operation or process.

(1) Procedures shall include prearranged plans for obtaining emergency medical care and for the necessary transportation of injured workers. Employees shall also be trained in administering immediate first aid and shall be prepared to render such assistance when necessary.

(2) Approved eye, skin, and respiratory protection as specified in Section 4 shall be used by persons involved in the cleaning procedure of the accident site.

(3) All persons who may be required to shut off sources of acrylamide, clean up spills, and repair leaks shall be properly trained in emergency procedures and shall be adequately protected against attendant hazards from exposure to acrylamide.

(4) Employees not essential to clean-up operations shall be evacuated from exposure areas during emergencies. Perimeters of hazardous exposure areas shall be delineated, posted, and secured.

(5) Eyewash fountains and showers shall be provided in accordance with 29 CFR 1910.151.

Section 7 - Sanitation

(a) Food preparation, dispensing (including vending machines), and eating shall be prohibited in work areas where acrylamide is present.

(b) Employees who handle any form of acrylamide shall be instructed to wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

(c) All contaminated gloves shall be washed before removal.

Section 8 - Monitoring and Recordkeeping Requirements

Within 6 months of the promulgation of a standard based on these recommendations, each employer who has a place of employment in which acrylamide is present shall determine by an industrial hygiene survey if exposures to airborne acrylamide at concentrations above the action level occur. Records of these surveys, including the basis for concluding that air levels are at or below the action level, shall be maintained. Surveys shall be repeated annually and within 30 days of any process change likely to result in an increase of airborne acrylamide concentrations. If it has been decided that the acrylamide environmental concentrations may exceed the action level, then the following requirements apply:

(a) Personal Monitoring

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of all employees occupationally exposed to airborne acrylamide.

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

(3) For each TWA determination, a sufficient number of samples shall be taken to characterize the employee exposures during each work shift. Variations in work and production schedules as well as employee locations and job functions shall be considered in deciding sampling times, locations, and frequencies.

(4) Each operation in each work area shall be sampled at least once every 3 months or as otherwise indicated by a professional industrial hygienist.

(5) If an employee is found to be exposed to acrylamide in excess of the recommended TWA environmental limit, the exposure of that employee shall be measured at least once a week, control measures shall be initiated, and the employee shall be notified of the exposure and of the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that the employee's exposure no longer exceeds the recommended environmental limit; routine monitoring may then be resumed.

(b) Recordkeeping

Records of environmental monitoring shall be kept by the employer for at least 20 years. These records shall include the dates of measurements, job function and location of the employees at the worksite, sampling and analytical methods used, number, duration, and results of the samples taken, TWA concentrations estimated from these samples, type of personal protective equipment used, and exposed employees' names. All employees shall have access to information on their own environmental exposures. Environmental records 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 be retained by the employer for 20 years after termination of employment. 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 that were prepared to meet the need for preventing occupational disease or injury arising from exposure to acrylamide. 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 from which standards can be established to protect the health and to provide for the safety of employees from exposure to hazardous chemical and physical agents. Criteria for any recommended 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.

Development of these criteria for a recommended standard for acrylamide is part of a continuing series of documents published by NIOSH. The proposed standard applies only to workplace exposure to acrylamide arising from the processing, manufacture, or use of the substance 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 environments is not warranted. It is

intended to (1) protect against development of systemic toxic effects and local effects on the skin and eyes and (2) be attainable with existing technology.

The major concern in occupational exposure to acrylamide is its potential for causing neurologic disorders. In addition, acrylamide can cause eye irritation and dermatitis in humans.

There are a number of areas that need further research with respect to acrylamide. Epidemiologic studies, carcinogenic, mutagenic, teratogenic, or other reproductive effects of acrylamide have not been found in the literature. Further, present toxicologic information on acrylamide is deficient in all physiologic systems other than the nervous system. Animal toxicity experiments of acrylamide on other organ systems such as the cardiovascular, pulmonary, hepatic, and renal systems have not been investigated. Pharmacokinetic (absorption, distribution, metabolism, and excretion) studies are also needed to understand the mechanism of action of acrylamide. Research in all these areas should be initiated. Improved sampling and analytical methods should also be developed.

Adherence to all provisions of the recommended standard is required in work areas in which acrylamide is used, regardless of the airborne acrylamide concentration, because the available evidence indicates that the greatest danger to employees exposed to acrylamide is from skin contact; however, inhalation hazards cannot be neglected.