INDUSTRIAL HYGIENE WALKTHROUGH SURVEY REPORT

OF
NALCO CHEMICAL COMPANY
Garyville, Louisiana

SURVEY CONDUCTED BY:
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DISCLAIMER

Mention of company or product name in this report does not constitute endorsement by NIOSH.

PURPOSE OF SURVEY:	To conduct a walk-through survey of the acrylamide and polyacrylamide production facility at Nalco Chemical Company, Garyville, Louisiana, as part of an industrywide assessment of extent and degree of worker exposure to these substances, and to gather information needed to be used in a feasibility assessment for epidemiologic research.
EMPLOYER REPRESENTATIVES CONTACTED:	James R. Grapenthien Corporate Industrial Hygienist (312) 887-7500 Frank L. Sospenzi Plant Manager (504) 535-2221 Patrick L. Logue Industrial Hygienist (504) 535-2221 Dennis H. Patterson Technical Superintendent (504) 535-2221 John Dunn Acrylamide Engineer (504) 535-2221
EMPLOYEE REPRESENTATIVES CONTACTED:	No labor union at this facility
STANDARD INDUSTRIAL CLASSIFICATION (SIC):	2869 - Industrial Organic Chemicals, Not Elsewhere Classified 2899 - Chemicals and Chemical Preparations, Not Elsewhere Classified

ABSTRACT

A walk-through survey was conducted at Nalco Chemical Company, Garyville, Louisiana; a manufacturer of acrylamide and polyacrylamide. The purpose of the survey was to obtain information on the facility, workforce, processes, personal records, medical records, and industrial hygiene program for an acrylamide exposure study, being conducted by NIOSH researchers. Based on this preliminary survey, approximately 40 employees were identified as being potentially exposed to acrylamide. Since this plant is one of four acrylamide manufacturing sites in the United States, an in-depth industrial hygiene survey should be conducted to determine exposure levels.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), under Public Law 91-596, Section 20(a)7, has the responsibility to conduct and publish industrywide studies of the effects of chronic low level exposure to industry materials, processes, and stresses on the potential for illness, disease, or loss of functional capacity in the aging adult. Given this responsibility, NIOSH researchers have undertaken a study to assess acrylamide exposure in the work place based on the following background information on acrylamide.

Since commercial production of acrylamide began in 1954, there have been at least 48 reported cases of acrylamide poisoning in workers. All of these cases have involved occupational dermal or inhalation exposure to acrylamide monomer from either acrylamide and polyacrylamide manufacture or acrylamide monomer grouting (1-9). Acrylamide exposure can occur by ingestion, inhalation of vapors or aerosols, and dermal exposure. Since acrylamide is very soluble in water and is often used in a solution form, there is the likelihood of skin contact. In the above cases of acrylamide poisoning, dermal absorption appears to be the major route of exposure. The initial symptoms of skin exposure experienced by exposed workers are numbness, tingling, and coldness in the hands and feet followed by excessive sweating and erythema. Later, muscular weakness, peripheral neuropathy, absent deep tendon reflexes, severe atoxia, weight loss, fatigue, sleepiness, and lethargy are common symptoms (10,11).

Similar symptoms, effecting the nervous system, have been reported in animals dosed with acrylamide by all routes of administration - ingestion, inhalation, injection, skin contact or contact with the eye (12). Based on these animal studies, threshold limit values (TLVs) to airborne concentrations of acrylamide have been developed in which nearly all workers may be repeatedly exposed day after day without adverse effects.

The recommended levels or applicable standards used in this report as related to acrylamide are (1) NIOSH recommended levels, (2) Federal Occupational Standards as promulgated and enforced by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910, 1000) Permissible Exposure Limits (PEL) and, (3) American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and Short Term Exposure Limits (STELS). (10,12,13).

Listed below are the recommended levels or applicable standards for acrylamide.

NIOSH RECOMMENDED LEVEL	OSHA* PEL	ACGIH TLV	ACGIH TLV-STEL
0.3 mg/m^3 (10 hr TWA)	0.3 mg/m^3 (8 hr TWA)	0.3 mg/m^3 (8 hr TWA)	0.6 mg/m^3 (15 min TWA)

* Acrylamide has been given a "Skin Notation" because of its ability to penetrate cutaneous tissue including mucous membranes and eyes.

The OSHA standard corresponds to an approximated dose of 0.04 mg/kg/day of acrylamide in a 70 kg worker who is breathing 10 m^3 of air in 8 hours. It should be noted that the standards are based solely on acrylamide's neurotoxic properties and do not take into account possible carcinogenic effects.

Until recently, no completed studies existed that have evaluated the carcinogenicity of acrylamide in laboratory animals. In July, 1983, the Environmental Protection Agency (EPA) received a notice from several acrylamide manufacturers, under Section 8(e) of the Toxic Substance Control Act indicating that preliminary results from a two-year chronic toxicity and oncogenicity study on acrylamide were positive. The histopathologic data showed a statistically significant increase of neoplasms in exposed female rats at the 2.0 mg/kg/day dose level via drinking water for the following sites: central nervous system (brain and spinal cord), mammary gland, clitoral gland, uterous, oral cavity, pituitary gland, and thyroid gland.

Because of the greater concern about acrylamide's carcinogenic effect on laboratory animals, NIOSH developed this study to: (1) Gather information on the extent of worker's exposure to acrylamide by requesting air monitoring data from acrylamide manufacturing companies, and by conducting indepth industrial hygiene surveys at facilities that utilize acrylamide. (A minimal amount of published information is available regarding the concentrations of acrylamide to which workers are exposed. In 1976 NIOSH obtained limited air sampling data from one acrylamide manufacturing plant (10). The data, reported as eight-hour time-weighted averages (TWA), showed area airborne concentrations of acrylamide to range from 0.1 to 3.6 mg/m^3.) and (2) to provide current estimates on the number of workers exposed to acrylamide to aid in a risk assessment study to be performed by the United States Environmental Protection Agency, Office of Pesticides and Toxic Substances.

In addition, this project will determine the feasibility of conducting an epidemiological study to assess the carcinogenic potential of acrylamide.

DESCRIPTION OF THE FACILITY

The Nalco Chemical plant in Louisiana, lies in St. John the Baptist Parish and is located about 2 miles northwest of the village of Garyville. The site is in a rural area and borders the Mississippi River. The plant was constructed in 1974, the same year that acrylamide production was began. Beside manufacturing acrylamide and polyacrylamide, a wide range of other chemicals are produced at this facility which are used in water treatment. All buildings and storage tanks are located on approximately 250 acres. The monomer and polymer production is contained within one building separated by a wall. No other production activities are conducted in this building. Occasionally small amounts of acrylamide are used in another building to manufacture terpolymers.

DESCRIPTION OF PROCESS

Acrylamide is produced within a closed reactor system by the catalytic hydration of acrylonitrile. A water solution containing 40% acrylonitrile by weight reacts on a metal catalyst at an elevated temperature and

pressure. The solution of acrylamide is stripped of acrylonitrile and this is recycled to the reactor. The final product contains approximately 50% acrylamide with less than 100 ppm acrylonitrile. All acrylamide remains in solution; no acrylamide powder is manufactured at this facility. The production process typically begins on Monday mornings and ends on Friday evenings. This procedure is repeated throughout the year. Approximately 98% of the monomer is used to produce various polyacrylamides and copolymers at the Garyville plant and at Nalco's Chicago facility. The remaining 2% of monomer solutions is sold to chemical manufactures for other process reactions. Typical monomer applications are polymer and coploymer production as well as uses in adhesives, emulsifying agents, soil grouting, textiles, and thermosetting acrylic resins which are widely used as surface coatings.

The polymers are used in two broadly characterized types of applications in many industries. The first broad application is as a coagulant, flocculant, de-watering aid, thickening aid, retention aid, and dust binder. The major areas for this application are potable water and wastewater treatment processes for municipal, steel industry, refining, pulp and paper manufacture, automotive and other industries, enhanced oil recovery, mining and mineral processing, agriculture, paints and coatings.

The second broad area of application is as a dispensing agent, scale inhibitor and anti-foulant. The major applications involved are boiler and cooling water treatment for industrial facilities.

Liquid acrylamide is transported within the plant via pipe. The loading of trucks or rail cars is solely for shipping outside the facility. The bulk of the monomer is stored in tanks on the north side of the plant. Air is continuously bubbled through the tanks to prevent polymerization.

DESCRIPTION OF WORKFORCE

Currently, there are 90 production employees throughout the plant with 26 of these employees involved in either acrylamide or polyacrylamide production. In addition, there are approximately 14 maintenance employees, which include electricians, millwrights, pipe fitters and welders to service the acrylamide equipment on an as needed bases. The maintenance workers are not Nalco Chemical employees but are contracted by a company called Southern Maintenance Incorporated.

The workforce appears to be very stable with a yearly turnover rate of less than 5 percent. There are no labor unions at this plant. In 10 years of operation, the company estimates that between 50-80 employees have worked in either the acrylamide or polyacrylamide areas. Production is continuous over 3 shifts starting at 8:00 a.m., 4:00 p.m., and 12:00 a.m. Employees have 30 minutes for lunch.

Employees have job titles and a description of duties, however, all employees may, at times, fill in or perform other duties on a temporary basis. This is especially true in the acrylamide building. Workers may rotate jobs or work in both the monomer and polymer areas. A total of 40 employees work in these areas, approximately 13 per shift. The following

list is a general description of the number of employees, job titles and duties per shift in the monomer and polymer building:

2 Process Operator - spends on an average 6 hours per shift in the control room. Starts up the process, monitors the reaction, shuts down the process. Also backs up the utility operator.

2 Utility Operator - collects production samples for analytical testing, occasionally may unload raw materials from rail cars or trucks. Does drumming of the final polymer products into 55 gallon and some 5 gallon drums.

1 Groups Leader - supervises the processes in both departments.

2 Loaders - fills tank cars or trucks with the liquid polyacrylamide and sometimes with acrylamide. They are also assigned to other parts of the plant when needed.

2 Engineers - supervise the processes in respective departments.

2 Chemists - conduct research and development on the monomer and polymer products.

2 Laboratory Technicians - analysis of the liquid production samples collected by the utility operators. Technicians and chemists remain in the laboratory which is not connected to the process building.

0-8 Maintenance - welding, electrical work, pipe fitting, equipment repair, and housecleaning accomplished mainly by washing the equipment with water.

DESCRIPTION OF PAST EXPOSURES

The company has performed acrylamide air sampling since 1980 at the Garyville facility. A summary of the results are listed below.

ACRYLAMIDE AIR SAMPLING DATA - NALCO GARYVILLE
BREATHING ZONE SAMPLES - JULY 1, 1982 TO PRESENT

JOB GROUPS	NO. OF SAMPLES	TOTAL DURATION (MIN.)	HIGHEST (mg/M^3)	AVERAGE (mg/M^3)
Maintenance	7	2864	0.13	0.076
Production Operators	30	12484	0.23	0.095
Q.C. Technician	4	1712	0.056	0.052
Utility & Loading Operators	13	5442	0.094	0.060
	54	22502	--	0.081
			Median Result	0.061

This table was reproduced from information provided by Nalco Chemical Company.

DESCRIPTION OF MEDICAL, INDUSTRIAL HYGIENE, AND SAFETY PROGRAMS

Nalco Chemical has a medical director but no company physician permanently assigned to the Garyville plant. Instead, a local physician is on call for medical emergencies. The plant does have a first aid room and all supervisors are trained in first aid, CPR, and fire fighting. All employees are given a preemployment physical which include: EKG, chest x-rays, pulmonary function test, audiometric test, visual test, occult-stool test, prostrate check, blood and urine test, and gynecological test for females. There is also a yearly neurological test given to all employees in the acrylamide areas. This test is a nerve conduction study which records the time the finger reacts to an electrical impulse. There is also a weekly check for skin peeling in the hands. Since 1974, there has been only one case of skin peeling on the hands which may be attributable to an acrylamide exposure.

All production employees are provided and required to wear safety glasses, hard hat, goggles on the hard hat, rubber sole work boots, and at all times carry a cartridge respirator. Quantitative fit testing is performed on these respirators. Also provided, and required according to activity, are neoprene gloves and cloth coveralls. A full body protective suit with a supplied air respirator are issued to employees for maintenance, repair activities or reactor cleaning. If gloves become contaminated at any time, the employee is instructed to dispose of the gloves. Coveralls and gloves are provided whenever needed. The plant has a locker room with showers. Time is provided at the end of each shift for showers and change of clothes. The company has a policy that all production employees have no facial hair that will reduce the effectiveness of respirators.

Safety meetings are held at least once a month. In these meetings there is a review of all toxic materials used in the plant and the proper handling of these chemicals. The company reports that there has been no lost work days due to accidents in 2 1/2 years. At the Garyville plant there is a full-time industrial hygienist and a safety specialist assigned. In addition, the corporation has 6 industrial hygienists and 6 safety specialists at other locations who are periodically available to the Garyville facility.

POTENTIAL EXPOSURES AND CONTROLS USED

The starting material in the manufacture of acrylamide is acrylonitrile. In 1978, OSHA enacted regulations to reduce worker exposure to acrylonitrile based on a suspected cancer hazard, by establishing a standard of 2 ppm (4.5 mg/m^3) as a time-weighted average. This standard requires personal protective equipment, training, medical surveillance, signs and labeling, and engineering controls. Nalco has installed a Bendix-GC continous acrylonitrile monitoring system with 20 sample points in the acrylamide production building. Any release of acrylonitrile may indicate an acrylamide release, thus efforts to control acrylonitrile exposure also reduce workers exposure to acrylamide. The company has also installed local exhaust hoods at the collecton sites for grab samples.

PERSONNEL RECORD SYSTEM

Personnel records of present employees and those terminated within 2 years are kept on-site, earlier employee's records are kept at the corporate office in Oak Brook, Illinois. These records contain name, social security number, date of birth, address, job title, starting and termination dates of employment. A record of work history is not kept. The current personnel form has been used since April, 1977.

CONCLUSIONS

All acrylonitrile and acrylamide is produced, transported by pipe, and stored in closed systems. Potential acrylamide exposure may occur from leaks in defective valves, during the collection and analysis of bulk samples for quality control, during the loading of trucks and rail cars, and from contact with polymers that contain a monomer residue. Exposure may occur from dermal contact or by inhalation of dust, mist, or vapors. Although powder acrylamide is not manufactured, spilled acrylamide solution will evaporate leaving a powder if not cleaned up. From observation during the walkthrough survey the plant has good housekeeping. Dried acrylamide powder was not apparent on equipment or floors. The company stated that no major acrylamide spills have occurred which would elevate acrylamide air concentrations.

A total of 40 current employees have some contact with acrylamide. Approximately 12-15 are assigned to the first shift. Since the process is continuous with little change between shifts and job descriptions are also the same, air monitoring during the first shift should be representative of the other shifts.

RECOMMENDATIONS

To profile employee exposure, all potentially exposed workers on the first shift should be asked to volunteer for personal air monitoring. In addition, 5-10 area air samples need to be collected inside and outside of the monomer and polymer building and at the perimeter of the plant. Several wipe samples from the inside of worker's personal protective equipment should also be collected as an indication of their effectiveness.

During this survey, 40 employees, which include maintenance employees, worked in the acrylamide areas. Since 1974, as many as, 80 employees have worked in the acrylamide and polyacrylamide production areas. The cohort is too small to conduct an epidemiological study at this facility, but may possibly be included in a larger industry-wide study.

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NIOSH

A Recommended Standard for Occupational Exposure to.....

Acrylamide

A complete criteria document for occupational exposure to monomeric acrylamide has been prepared by the National Institute for Occupational Safety and Health (NIOSH). NIOSH recommends adherence to the present Federal standard of 0.3 mg/cu m as a time-weighted average concentration for up to a 10-hour workday, 40-hour workweek.

The major application for monomeric acrylamide is in the production of polymers as polyacrylamides. Polyacrylamides are used for soil stabilization, gel chromatography, electrophoresis, papermaking strengtheners, clarification and treatment of potable water, and foods. Approximately 70 million pounds of acrylamide were produced in 1974 in the United States. NIOSH estimates that approximately 20,000 workers in the United States are potentially exposed to acrylamide. As applicable under the Occupational Safety and Health Act, the proposed standard would apply to the processing, manufacture, use, or other occupational exposure to acrylamide.

Toxic manifestations of exposure to acrylamide involve both localized and systemic effects. Localized effects include peeling and redness of the skin of the hands and less often of the feet, numbness of the lower limbs, and excessive sweating of the feet and hands. The systemic effects due to acrylamide intoxication involve central and peripheral nervous system damage manifested primarily as ataxia, weak or absent reflexes, positive Romberg's sign and loss of vibration and position senses.

Since skin contact with the substance may result in localized or systemic effects, NIOSH recommends that medical surveillance be made available to all employees working 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 percent by weight. Engineering controls should be used wherever feasible to maintain airborne acrylamide concentrations below the prescribed limit, and respirators should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. Personal protective clothing is recommended for all workers occupationally exposed to acrylamide to further reduce the likelihood of skin contact with the substance.

The recommended standard is part of a continuing series of criteria documents developed by NIOSH in accordance with the Occupational Safety and Health Act of 1970. The document was transmitted to the Department of Labor October 21,1976, for review and consideration in the standard setting process. The criteria document was reviewed by eight consultants, two professional societies, and Government agencies having interest and responsibility for occupational safety and health. The proposed standard is considered appropriate, and no additional information that would affect the recommended standard is available.

The following is the first chapter of the criteria document. It contains the NIOSH recommendations for controlling workers 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

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, 20-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 Appendixes 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.

(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.

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

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 reinformed 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, U.S. 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, contro 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.

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