

INDUSTRIAL HYGIENE REPORT
IN-DEPTH STUDY

OF

AMERICAN CYANAMID COMPANY
Warners Plant
Foot of Tremley Point Road
P.O. Box 31
Linden, New Jersey 07036

SURVEY CONDUCTED BY:

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DATE OF SURVEY:

February 1-3, 1984

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DISCLAIMER

Mention of company names or products does not constitute endorsement by NIOSH.

PURPOSE:

To conduct an in-depth survey of the acrylamide and polyacrylamide production facilities of the American Cyanamid Company, Warners Plant, as part of an industrywide assessment of extent and degree of worker exposure to these substances.

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STANDARD INDUSTRIAL
CLASSIFICATION OF PLANT:

2869 - Industrial Organic Chemicals,
Not Classified Elsewhere

2899 - Chemicals and Chemical
Preparations, Not Elsewhere
Classified

ABSTRACT

An in-depth industrial hygiene survey was conducted at American Cyanamid Company in Linden, New Jersey on February 1-3, 1984. A portion of this plant produces acrylamide, N-methylolacrylamide, and polyacrylamides. Acrylamide is manufactured by the hydration of acrylonitrile to yield a 50% acrylamide solution and further processed to form dry crystals and briquettes. The acrylamide solution is then polymerized to produce polyacrylamide products. Industrial hygiene monitoring for acrylamide was conducted in production areas and on potentially exposed workers. Personal eight hour time-weighted-averaged exposures to airborne acrylamide ranged from 0.01 to 0.39 mg/m³ with an arithmetic mean of 0.11 mg/m³. In the monomer production area, the mean eight hour time-weighted-averaged exposures by job category was: operators 0.17 mg/m³, utility operators 0.35 mg/m³, material handlers 0.14 mg/m³, and maintenance worker 0.03 mg/m³. The recommended NIOSH standard for airborne acrylamide is 0.3 mg/m³ as a 10 hour time-weighted average. The OSHA standard and ACGIH TLV for airborne acrylamide is 0.3 mg/m³ as a 8 hour time-weighted average.

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, exposure limits for airborne concentrations of acrylamide have been developed in which nearly all workers may be repeatedly exposed day after day without adverse effects.

These recommended levels or applicable standards 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.

| <u>NIOSH RECOMMENDED LEVEL</u> | <u>OSHA* PEL</u> | <u>ACGIH TLV</u> | <u>ACGIH TLV-STEL</u> |
|--------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|
| 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 m³ of air in 8 hours. It should be noted that the values 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 (14).

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/m³.), 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.

DESCRIPTION OF FACILITY

The Warners Plant is located in northeastern New Jersey along the Arthur Kill waterway which borders Staten Island. The site sits on 29 acres and is in an industrial zone with a number of near-by chemical and petroleum facilities. The plant was constructed in 1916 with commercial production of acrylamide beginning in 1954. In January, 1978 acrylamide production was begun in the new building by the metal catalytic method replacing the sulfuric acid hydrolysis process. This building, the "AMD Building", has 4 floors with approximately 6,000 square feet per floor. Employees generally remain on the lower 3 floors. The building can be divided into 3 areas: the "wet area" where a 50% acrylamide solution is produced; the "dry area" where acrylamide in crystal and briquette form is manufactured; and the warehouse for storage of bagged dry acrylamide. Polyacrylamide is manufactured in two buildings, the "PAM Building" and the "Job Shop". The building that houses the Job Shop is one large room with a mezzanine. Three products are manufactured here NMA (N-methylolacrylamide), MAGNIFLOC^R 2535 (polyacrylamide), and AR-86 (polyacrylamide). Besides manufacturing acrylamide and polyacrylamide, the company produces a wide range of other chemicals at this site.

DESCRIPTION OF WORKFORCE

The current workforce at the Warners Plant numbers 670. Administrative employees number 180, production employees 260, and other service employees, such as yard labor, maintenance, shipping, and laboratory personnel numbers 230. There are 80 employees involved in the production and use of acrylamide. The company estimates that as many as 246 employees are potentially exposed to acrylamide. The plant operates on three production shifts year round starting at 7:00 a.m.; 3:00 p.m.; 11:00 p.m. Production employees are nearly evenly assigned to each of the three shifts. Employees are represented by the United Steel Workers of America, AFL-CIO-CLC, Local 12426, which also has a worker health and safety committee.

The following list is a general description of employee job titles and duties in the acrylamide areas:

Reactor Operator or (Systems Operator) - Responsible for the first phase of production, the control of raw material to the reactor tank and completion of the reaction. Spends approximately 80% of his time in the control room and the remainder in the process area. In the Job Shop the reactor operator, NMA operator, and MAGNIFLOC^R operator have similar duties in that they are responsible for production up to the drying step.

Stripper Operator - is responsible for the second phase of acrylamide production, the stripping off or removal of unreacted acrylonitrile for recycling back into the reactor tank.

Evaporator Operator - converts the acrylamide solution to a slurry by operating the evaporator and crystallizer.

Dryer Operator - works in the "dry end" of acrylamide production by converting the slurry to a dry powder or briquettes. Responsible for the centrifuge, dryer, and bagger. On occasions he will help the Material Handler with the bagging. Spends approximately 70% of his time in the control room. The Dryer Operator in the Job Shop controls the drying of the polyacrylamide.

Material Handler or (Bag Packer) performs the bagging of dry acrylamide, loads trucks with acrylamide solution, and is responsible for the cleaning up of acrylamide spills. Generally does not spend time in the control room. Material Handlers in the Job Shop have similar duties.

Maintenance or (Pipe Fitters and Instrument Mechanics) - Assigned to specific maintenance tasks involving cleaning and repairing equipment.

Utility Operator - is responsible for supplying water, electric power, and steam to the plant. Duties vary depending on current needs but most of their time is spent outside of the AMD Building.

DESCRIPTION OF PROCESS

Acrylamide is produced within a closed reactor system by the catalytic hydration of acrylonitrile. Liquid acrylonitrile is passed through an ion exchanger then deaerated before entering the reactor vessel. The reaction

takes place with water aided by a metal catalysis. The acrylamide solution and unreacted acrylonitrile is then sent to a stripper where acrylonitrile is removed, condensed, and recycled back into the reactor, Diagram 1. The liquid acrylamide contains approximately 50% monomer by weight and may be sold as is or used on site to manufacture polyacrylamide or copolymers.

The monomer solution is kept in temperature controlled storage tanks. Air is bubbled through the tank to prevent polymerization. Monomer is shipped outside the plant via truck or rail car. Small quantities may be drummed and sent to customers.

A portion of the acrylamide solution is evaporated, crystallized, centrifuged, dried, then bagged as either a dry crystal or as briquettes. The bagging is performed in an enclosed room under negative pressure. The process is mostly automated with sealed 50 pound bags leaving the bagging room by conveyor belt to the warehouse. The bags are then weighed and manually stacked on pallets.

As of January, 1985 the company has suspended all production of dry acrylamide. There are no plans for future production of dry acrylamide at this facility.

Acrylamide monomer which is not shipped from the plant is used to manufacture N-methylolacrylamide, copolymers, and polyacrylamides. The polymerization can occur in an aqueous solution or in an oil emulsion. In solution acrylamide is readily polymerized in the presence of free radicals. A typical formula for producing a low molecular weight polymer is the following:

| | |
|----------------------|-------------|
| acrylamide | 100 parts |
| demineralized water | 800 parts |
| isopropyl alcohol | 15.0 parts |
| potassium persulfate | 0.185 parts |

The polymerization reaction is normally 98% complete. Residual acrylamide is minimized by the use of the catalyst. The polymer is soluble in water, but can be made insoluble by lowering the pH during the reaction (15).

A typical preparation of high molecular weight polyacrylamide is:

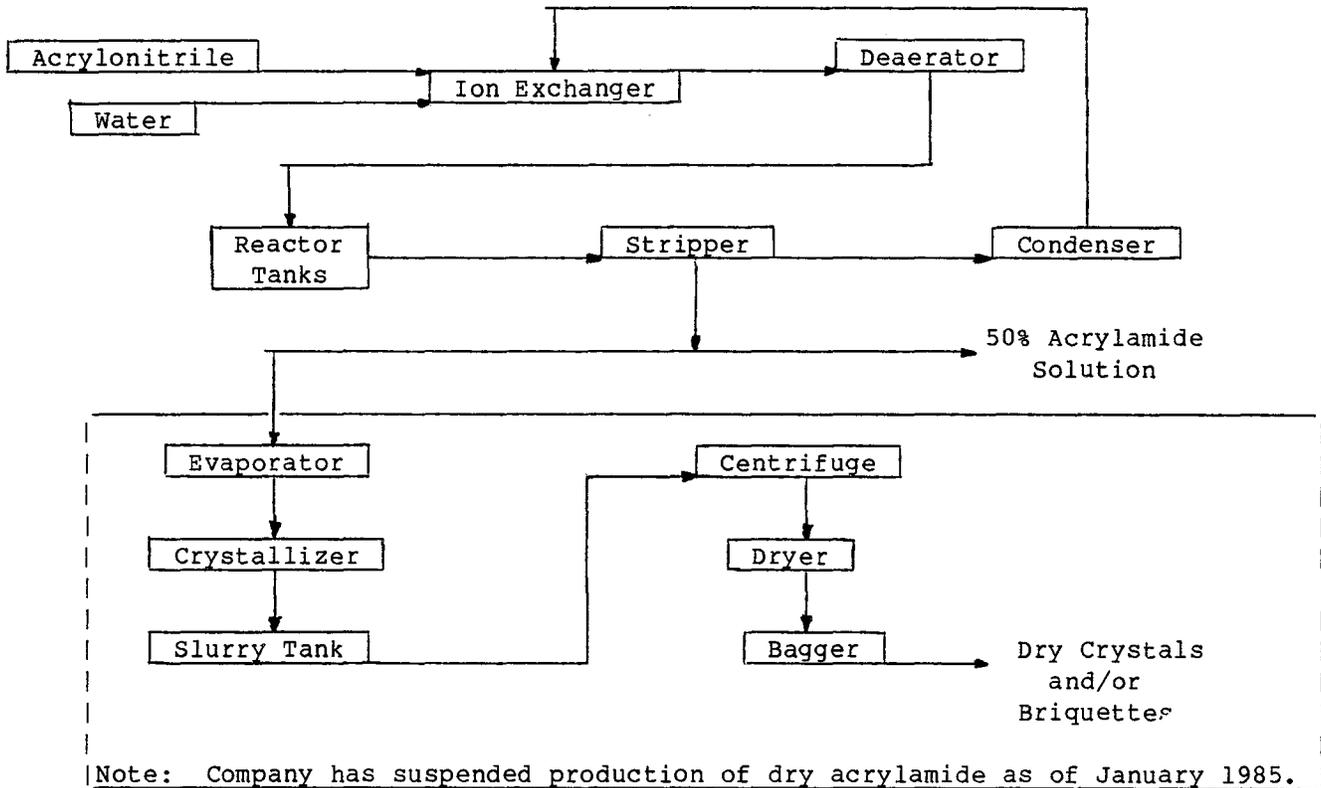
| | |
|----------------------------------|------------|
| acrylamide | 100 parts |
| demineralized, oxygen-free water | 900 parts |
| ammonium persulfate | 0.04 parts |
| 3,3,3'-nitrilotrispropionamide | 0.06 parts |

Solid high molecular weight polymers are obtained by thermal sheet drying then grinding and packaging (15).

The largest application of polyacrylamide is in liquid-solid separation, where the polymer acts as a flocculant.

DIAGRAM 1

FLOW DIAGRAM OF ACRYLAMIDE PRODUCTION



Anionic polyacrylamide flocculant and polyacrylamide flocculant are produced at the Warners Plant. N-methylolacrylamide is also produced in the polyacrylamide area of the plant.

APPLICATION OF ACRYLAMIDE, POLYACRYLAMIDE, AND N-METHYLOLACRYLAMIDE

Nearly all of the liquid monomer is used on site to manufacture polyacrylamide and N-methylolacrylamide. The dry monomer and the remainder of the liquid is sold to companies in the chemical, coating-finishes, and adhesive industries. Polyacrylamides have application for enhanced oil recovery, water treatment, mineral ore and coal processing, pulp and paper manufacturing, and limited use in the food processing industry. N-methylolacrylamide is used in the textile industry for permanent press and in the production of auto tires.

DESCRIPTION OF PAST EXPOSURES

In 1953, a new method of acrylamide production began at the manufacturing site. About 5 months after the new process began, a "handful" of workers noticed numbness and tingling of their hands and weakness of their hands and legs. It was estimated that the maximum amount of acrylamide which could have been inhaled by one workers over the 5 month period was approximately 1.8 mg/kg (15). The manufacturing process was altered to reduce exposures (15). The details of these changes were not described.

In 1978, the closed system catalytic process began. Unreacted acrylonitrile is recycled back into the reaction resulting in a further reduction of acrylamide levels in the work area.

General ventilation has been installed in the dry bagging area which changes the air ten times per hour. The air is cleaned by cyclone-scrubbers. Likewise, local ventilation hoods collect the air at each of the quality control collection sites and send it to the scrubbers.

According to the company, 20 employees have been restricted from working in the acrylamide areas since production began. The decision to remove an employee from these areas is based on either skin peeling of the hands or elevated Tactile Test scores which are signs of possible acrylamide exposure. The methods for screening these symptoms is discussed in the Description of Medical Programs. The company reported 3 cases of possible acrylamide toxicity in instrument repair workers during February, 1982. In September, 1982, a material handler and a dryer operator also developed similar symptoms. Subsequent physical examination of these employees did not yield a diagnosis of acrylamide poisoning.

The following is a table of 1979-1984 acrylamide exposure levels provided by the company.

| <u>Process</u> | <u>Job Title</u> | <u>Current Number of Employees</u> | <u>Acrylamide Level TWA RANGE (mg/m3)</u> |
|----------------|----------------------|--|---|
| AMD | Evaporator | 3 | 0.034-0.285 |
| | Bagpacker | 6 | 0.07-2.2+ |
| | Drier Opr. | 3 | 0.07-1.47+ |
| | Stripper Opr. | 4 | 0.021-0.171 |
| | Reactor Opr. | 4 | 0.025-0.166 |
| Job Shop | MAGNIFLOC Operator | | 0.013-0.06 |
| | | | 0.364 (11 minutes) |
| | | | 0.155 (18 minutes) |
| | MAMD Operator | | 0.3 (39 minutes) |
| | MAMD Operator | | 0.014-0.047 |
| | AR86 Operator | | 0.014-0.116 |
| PAM | Dryer Opr. | 4 | 0.052-0.076 |
| | Bagger | 8 | 0.06-0.15 |
| | Utility or Asst R.O. | 4 | 0.15-0.257 |

+ Actual Exposure (not TWA)

Air sampling conducted by the company in January, 1985 at the monomer production building showed acrylamide air levels to be no higher than 0.08 mg/m³.

DESCRIPTION OF MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

Medical

American Cyanamid Company maintains a full-time medical department on the corporate level and also provides medical services at the Warners Plant. The staff includes a full-time physician and one full-time and one part-time licensed nurse. The nearest hospital is located five miles from the plant. The department is equipped to handle all routine care and minor emergencies.

All new employees are required to take an initial physical examination. Then periodic examinations are offered on a two year bases up to age 40, and then a yearly examination is offered after age 40. To check employees for possible acrylamide toxicity the company has implemented a biological monitoring program. Appendix 1 is a description of this program provided by the company.

Industrial Hygiene and Safety

Industrial hygiene services are provided to the Warners Plant by the corporate office in Wayne, New Jersey, managed by Mr. Joseph Caporossi; and by the plant's own industrial hygiene and safety program, managed by Mr. John Carnall. The company performs air monitoring every 6 months for acrylamide, by the same method used in this survey, to insure that employee exposure is below the current PEL of 0.3 mg/m³ TWA-8 hour. The analytical and air sampling method was developed by the company at their Stamford Laboratory.

All employees in the acrylamide areas are trained in the hazards of acrylamide and instructed to present any symptoms of acrylamide exposure to their supervisor. The training program also emphasizes the proper handling and clean-up of acrylamide. Employees are provided and required to wear safety equipment such as, hard hats, neoprene gloves, non-leather soled work shoes, rubber boots, coveralls, and goggles to be worn on their hard hats. Full-face respirators are required in areas of elevated air concentrations of acrylamide. Employees are fit tested and are responsible for the care and cleaning of their respirators. Each employee is given a daily change of uniform. There are separate lockers for street cloths and protective equipment. There is also a lunchroom separated from the production area.

DESCRIPTION OF RECORD SYSTEMS

Personnel records of all present and terminated employees are kept on site at the personnel office. 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 kept for all employees. One standard personnel form was used from 1917. In 1949 the form was changed and is still in use today. There are approximately 10,000 records of active and inactive workers at the Warners Plant.

DESCRIPTION OF SAMPLING METHOD

This survey was designed to obtain typical environmental exposure data at this facility. Personal air monitoring samples were collected to assess employee's exposure to airborne acrylamide. Area samples were collected as an indication of air concentrations in various rooms in the production building. A few wipe samples were collected as an indication of general housecleaning and the potential for dermal exposure in workers.

General area samples and personal breathing zone samples were collected using SKC Universal Model 224-03 sampling pumps calibrated at a flow rate of 1 liter per minute. The collection media consisted of a mixed cellulose ester filter for aerosol collection followed by a silica gel tube to trap acrylamide vapors. The filters are 37 mm Millipore type AA with a pore size of 0.8 microns, placed in a cassette filter holder. The silica gel tubes are SKC No. 226-10. The filter cassette and tube were clipped to the front collar of the worker in order to sample air in the breathing zone. A flexible plastic tubing connects the collection media with the battery powered pump which is attached to the workers's belt.

Area samples were placed at various locations in the plant to collect workroom air samples. Most of the samples were collected for a period of approximately 8 hours. All samples were analyzed by high performance liquid chromatography using a modified method developed by the American Cyanamid Company (16). This method was validated over the range of 0.03-0.6 mg acrylamide/m³ air. The modification to this method was that after sampling, the filter and backup pad were removed from the cassette and placed in a glass vial with 5 ml of water then sealed and shaken. The sample vials and silica tubes were shipped to Utah Biological Testing Labs for analysis.

The wipe samples were collected from the inside surface of two respirators used in the dry acrylamide area. An additional wipe sample was collected from a table top in the lunchroom of the AMD building. To collect the sample, a mixed cellulose ester filter was dampened with water and gently used to wipe a surface area of approximately 10 cm³. The filter was then placed in a glass vial with 5 ml. of distilled water. These samples are analyzed by the same method as the air collection samples.

Acrylamide monitoring was performed in the "AMD Building" and the "Job Shop". A week before this survey the PAM building stopped production due to an accidental spill of acrylamide solution. Production in this building was suspended until a clean up crew had decontaminated the building. It was decided not to conduct monitoring in this area because the results would not be representative of normal operations.

Personal samples were collected from all employees, who were determined to be potentially exposed to acrylamide on the three work shifts covered by this survey. A total of 27 workers participated in the monitoring. Although as many as 80 employees may have had some contact with acrylamide in the past year, only 27 employees were working in the AMD building and Job Shop during this visit. This group of workers includes those employees who have the highest daily risk of exposure. A job category that may be at maximum risk of acrylamide exposure is maintenance. However, this is a difficult group in which to assess exposure because duties vary greatly and are often performed on an infrequent basis. During this survey 3 maintenance workers (pipe fitters) were monitored.

In nearly every case a single full period, or shift, sample was collected; the collection time being approximately 8 hours.

ANALYSIS AND DISCUSSION OF SAMPLING

Acrylamide air concentration data are listed in Tables 1 through 7. Tables 1-3 lists exposure data in the AMD building according to job title or location, sample number, sampling time, shift, amount of sample collected, the actual calculated air concentration, and the air concentration adjusted to an 8 hour time weighted average (TWA). When calculating the personal 8 hour TWA from samples collected for less than 8 hours, no exposure was assumed to have occurred for the time not sampled. In some cases this is an accurate assumption because the employee left the work site at the end of the sampling period. In other cases the employee remained at his work station after sampling. This method of calculating the data results in a conservative estimate of employee exposure.

Samples were collected over three consecutive shifts. Production of liquid acrylamide solution was constant during this period. Dry acrylamide crystals were produced during the first shift but not bagged. On the second shift there was no dry production or bagging. Full production and bagging began on the third shift but stopped within 20 minutes because of material blockage in a hopper.

Table 4 summarizes the exposures by job category. The utility operators had the highest mean exposure of 0.35 mg/m³. The source of their exposure is unknown because they worked on separate shifts and most of their time was

spent outside of the AMD building. There was no evidence to the NIOSH investigator that the utility operators wore a respirator during the shift, but it is possible that both employees did wear a respirator for at least part of the shift. Company policy requires respirator protection when working in areas of high air concentrations. Other Operators and the Material Handler had similar mean exposures ranging from 0.13-0.19 mg/m³ while the Maintenance workers had the lowest mean exposure of 0.03 mg/m³.

Table 5 summarizes the area samples from the AMD building. As expected the bag room and other enclosed locations in dry production had high levels of airborne acrylamide, 0.10-6.87 mg/m³ 8 hour TWA. These enclosed rooms were designed to contain acrylamide from migrating into other areas of the building. Employees enter these enclosed rooms on an infrequent basis and are required to wear a respirator. The warehouse which is adjacent to the bagging room had a mean air concentration of 0.08 mg/m³. The lunchroom which is part of the AMD building, but must be entered from the outside, had an air concentration of 0.13 mg/m³ 8 hour TWA.

The wipe samples collected from the inside of one respirator contained 2 ug of acrylamide, the other respirator was less than 0.5 ug (below the limit of detection). The wipe sample from the lunchroom table was also below the limit of detection.

In the Job Shop, production was constant for the three shifts that were sampled. Likewise, data (Table 6 and 7) obtained from personal air samples levels was fairly constant over this period ranging from 0.01 to 0.18 mg/m³ with a mean of 0.06 mg/m³ 8 hour TWA. Operators had the highest mean exposure of 0.09 mg/m³ where as Dryer Operators and Material Handlers had a mean exposure of 0.02 mg/m³.

CONCLUSIONS

Air monitoring detected acrylamide in both the monomer and polymer buildings on all samples. Air concentrations were highest in the vicinity of dry monomer manufacturing and lowest in the Job Shop. When production of dry monomer was suspended, air concentrations decreased but not greatly. The fact that acrylamide is present in the air in the lunchroom demonstrates that there is a low level background of acrylamide throughout the buildings.

In the Job Shop, the source of the collected monomer may be unreacted monomer in the polymer. Current polyacrylamide production methods limit the monomer content to levels below 1000 ppm. Another source of airborne acrylamide in both the Job Shop and AMD Department may be spilled acrylamide solution that dried and became airborne with nuisance dust. Acrylamide does have the property of subliming to a vapor, but the vapor pressure is very low. Nearly all of the acrylamide was collected on the membrane filters rather than on the silica gel tubes. The company reported that the vapor as well as dust aerosol are collected on the filters.

The two groups of workers that have the highest potential for exposure are the maintenance employees and employees working with dry acrylamide. Maintenance workers who open equipment for repair or cleaning may receive a high short term exposure. Dry end workers have a chronic exposure with the potential for peak short term exposures. Brief high exposures occur when

equipment fails to function and repair efforts lead to an unexpected exposure. This occurred when duct work in the bag room became clogged with acrylamide crystals. A material handler entered the bag room wearing gloves, blue coveralls and a respirator. Upon striking the duct with a stick to break the clog, acrylamide crystals fell on the employee. The white acrylamide dust was clearly visible in his hair and on his coveralls.

The personal air monitoring results from this survey demonstrated that mean exposure to acrylamide were approximately twice as high in the monomer production area 0.15 mg/m^3 as in the polymer production area 0.06 mg/m^3 . Utility Operators had the highest mean exposure of 0.35 mg/m^3 followed by Monomer Operators with means ranging from 0.13 to 0.19 mg/m^3 , Monomer Material Handlers at 0.14 mg/m^3 , Polymer Operators at 0.09 mg/m^3 , Maintenance at 0.03 mg/m^3 , and Polymer Dryer Operators and Polymer Material Handlers at 0.02 mg/m^3 .

It is not clear why there are differences in the mean exposures between job categories. This is especially true in the Polymer production area where all employees are working in the same room with closely similar duties and yet exposures range from 0.01 to 0.18 mg/m^3 .

This survey focused mainly on monitoring worker exposure to airborne acrylamide because a validated method of sample collection and analysis has been developed, however, of equal concern is worker exposure via the dermal route. It is well established from animal studies and case histories in workers that skin contact with acrylamide does result in absorption.

However, determining the extent of worker exposure via the dermal route is difficult because quantitative monitoring techniques for dermal exposure are highly inaccurate. Because of this problem, there is a high degree of uncertainty as to the extent of skin contact and dermal absorption of acrylamide in workers. Only in cases where employees are observed to be in direct contact with acrylamide can an exposure be confirmed. When acrylamide is detected on workplace surfaces where workers are likely to have skin contact, then these workers are potentially exposed to acrylamide.

The company has substantially reduced the risk of skin exposure to the hands of employees by providing an ample supply of neoprene gloves. The gloves are lined with cloth for employee comfort and will absorb a small volume of liquid that enters from the cuff. Employees are instructed to dispose of any glove that they feel may be contaminated with acrylamide.

A few employees were observed to have the sleeves of their coveralls rolled up to the elbow. This practice exposes the lower arms to skin contact with acrylamide.

In general, the employee exposure levels found by the NIOSH investigators was lower than that reported by the company for 1984, with the exception of two utility operators. Based on the fewer cases of employees developing symptoms of possible acrylamide toxicity and the changes and improvements in process equipment, it can be assumed that employee exposure to acrylamide has decreased since production began in 1954. The fact that production of a dry acrylamide has been suspended in January 1985 should reduce exposure

levels even more, since the highest exposures occurred in the dry monomer department.

RECOMMENDATIONS

During this survey 2 utility operators may have been exposed to acrylamide levels above the Permissible Exposure Limit (PEL) (0.3 mg/m^3). Because the airborne levels were in excess of the PEL, it is recommended that utility workers be monitored more closely as to work practices and possible sources of acrylamide exposure.

Listed below are some additional recommendations.

1. A slight increase in the moisture content of the dry acrylamide may significantly reduce air concentration levels of acrylamide in the plant and during handling of the product by customers. However, increasing moisture content may not be feasible if this results in the clogging of the hopper and piping with acrylamide.
2. The stored bottles of drinking water should be removed from the warehouse containing dry acrylamide.
3. More frequent washing with water of equipment, walls, floors, and personal protective equipment will further reduce exposures.
4. A full body suit to protect the head and neck from dermal exposure is necessary during repairs or maintenance in the dry acrylamide area.

Note: The production of "dry" acrylamide was suspended in January, 1985.

Appendix 2 is a copy of Sections 1-8 of the NIOSH criteria for a Recommended Standard, Occupational Exposure to Acrylamide (10). The sections listed describe procedures on:

1. Environmental (workplace air)
2. Medical
3. Labeling and Posting
4. Personal Protective Equipment
5. Informing Employees of Hazards from Acrylamide
6. Work Practices
7. Sanitation
8. Monitoring and Recordkeeping Requirements

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TABLE 1
 Acrylamide Exposure Levels
 AMD BUILDING
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| <u>JOB TITLE</u> | <u>SAMPLE NO.</u> | <u>TIME MINUTES</u> | <u>SHIFT</u> | <u>ug/sample</u> | <u>ACTUAL AIR CONC mg/m3</u> | <u>ADJUSTED 8-hr TWA mg/m3</u> |
|------------------------------------|-------------------|-------------------------|--------------|------------------|----------------------------------|--|
| Utility Operator | F27/T40 | 476 | 1 | 147 | 0.31 | 0.31 |
| Maintenance Pipe Fitter | F67/T33 | 449 | 1 | 21 | 0.05 | 0.04 |
| Maintenance Pipe Fitter | F40/T32 | 433 | 1 | 4 | 0.01 | 0.01 |
| Maintenance Pipe Fitter | F55/T42 | 112 | 1 | 7 | 0.06 | 0.01 |
| Maintenance Instrument Mechanic | F64/T38 | 436 | 1 | 35 | 0.08 | 0.07 |
| Evaporator Operator | F33/T19 | 433 | 1 | 76 | 0.18 | 0.16 |
| Reactor Systems Operator | F20/T26 | 437 | 1 | 38 | 0.09 | 0.08 |
| Stripper Operator | F63/T16 | 436 | 1 | 75 | 0.17 | 0.16 |
| Material Handler | F10/T69 | 325 | 2 | 8 | 0.02 | 0.02 |
| Stripper Operator | F48/T68 | 461 | 2 | 109 | 0.24 | 0.23 |
| Chief Operator | F8/T74 | 447 | 2 | 93 | 0.21 | 0.19 |
| Utility Operator | F62/T70 | 459 | 2 | 188 | 0.41 | 0.39 |

TABLE 2
 Acrylamide Exposure Levels
 AMD BUILDING
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| <u>JOB TITLE</u> | <u>SAMPLE NO.</u> | <u>TIME MINUTES</u> | <u>SHIFT</u> | <u>ug/sample</u> | <u>ACTUAL AIR CONC mg/m3</u> | <u>ADJUSTED 8-hr TWA mg/m3</u> |
|--|-------------------|-------------------------|--------------|------------------|----------------------------------|--|
| Assistant Material Handler Operator | F34/T67 | 457 | 2 | 66 | 0.14 | 0.14 |
| Evaporator Operator | F29/T48 | 421 | 3 | 100 | 0.24 | 0.21 |
| Material Handler | F42/T61 | 420 | 3 | 125 | 0.30 | 0.26 |
| Area Bag Room | F45/T57 | 452 | 1 | 2170 | 4.80 | 4.52 |
| Area Bag Room | F72/T43 | 457 | 1 | 2569 | 5.62 | 5.35 |
| Area Warehouse | F57/T31 | 388 | 1 | 6.9 | 0.02 | 0.01 |
| Area Warehouse | F50/T34 | 454 | 1 | 71 | 0.16 | 0.15 |
| Area Warehouse | F24/T18 | 456 | 1 | 79 | 0.17 | 0.16 |
| Area 2nd Floor Feed and Centrifuge | F36/T24 | 415 | 1 | 175 | 0.42 | 0.36 |
| Area 1st Floor Dry Product Feeder | F54/T22 | 423 | 1 | 390 | 0.92 | 0.81 |
| Area Slurry Agitator Tank | F65/T29 | 410 | 1 | 186 | 0.45 | 0.39 |
| Area 2nd Floor | F46/T23 | 398 | 1 | 3300 | 8.29 | 6.87 |
| Area Lunch Room | F18/T28 | 425 | 1 | 72 | 0.17 | 0.15 |

TABLE 3
 Acrylamide Exposures Levels
 AMD BUILDING
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| JOB TITLE | SAMPLE NO. | TIME MINUTES | SHIFT | ug/sample | ACTUAL AIR CONC mg/m3 | ADJUSTED* 8-hr TWA mg/m3 |
|--|------------|-----------------|-------|-----------|--------------------------|--------------------------------|
| Area Bag Room | F12/T65 | 443 | 2 | 46 | 0.10 | 0.10 |
| Area Outside Bag Room on Control Board | F44/T72 | 443 | 2 | 35 | 0.08 | 0.07 |
| Area Bag Room | F19/T64 | 461 | 2 | 1550 | 3.36 | 3.23 |
| Area Bag Room | F30/T71 | 461 | 2 | 1190 | 2.58 | 2.48 |
| Area Warehouse | F21/T73 | 426 | 2 | 6 | 0.01 | 0.01 |
| Area Lunchroom | F7/T75 | 438 | 2 | 58 | 0.13 | 0.12 |
| Area Warehouse | F23/T56 | 388 | 3 | 42 | 0.11 | 0.09 |

Ambient Sampling Conditions, February 2, 1984, 1:00 p.m.
 Warehouse 23°C, 26% R.H.

Second Floor Next to Slurry Tank 24°C, 18% R.H.

Limit of Detection: 0.5 ug/sample

* A method of calculating average daily exposure by weighting the concentration of acrylamide (ug/sample) by 8 hours, assuming no exposure during the unsampled portion of the work shift.

TABLE 4
 Summary of Personal Acrylamide Exposure Levels
 AMD BUILDING
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| <u>JOB TITLE/LOCATION</u> | <u># SAMPLES</u> | <u>RANGE</u> <u>mg/m3</u> | <u>MEAN</u> <u>mg/m3</u> |
|---------------------------|------------------|------------------------------|-----------------------------|
| Reactor Operator | 2 | 0.08-0.19 | 0.13 |
| Stripper Operator | 2 | 0.16-0.23 | 0.19 |
| Evaporator Operator | 2 | 0.16-0.21 | 0.18 |
| Material Handler | 3 | 0.02-0.26 | 0.14 |
| Utility Operator | 2 | 0.31-0.39 | 0.35 |
| Maintenance | 4 | 0.01-0.07 | 0.03 |
| <hr/> | | | |
| Total | 15 | 0.01-0.39 | 0.15 |

TABLE 5
 Summary of Area Acrylamide Air Levels
 AREA SAMPLES AMD BUILDING
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| <u>LOCATION</u> | <u># SAMPLES</u> | <u>RANGE</u> <u>mg/m3</u> | <u>MEAN</u> <u>mg/m3</u> |
|--------------------|------------------|------------------------------|-----------------------------|
| Inside Bag Room | 5 | 0.10-5.35 | 3.14 |
| Warehouse | 6 | 0.01-0.16 | 0.08 |
| Lunchroom | 2 | 0.12-0.15 | 0.13 |
| Other Areas in AMD | 4 | 0.39-6.87 | 2.11 |
| <hr/> | | | |
| Total | 17 | 0.01-6.87 | 1.46 |

TABLE 6
 Acrylamide Exposure Levels
 JOB SHOP
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| JOB TITLE | SAMPLE NO. | TIME MINUTES | SHIFT | ug/sample | ACTUAL AIR CONC mg/m ³ | ADJUSTED* 8-hr TWA mg/m ³ |
|--------------------------------------|------------|-----------------|-------|-----------|--------------------------------------|--|
| Material Handler | F58/T30 | 390 | 1 | 8.6 | 0.02 | 0.02 |
| MAMD Operator | F66/T25 | 391 | 1 | 87 | 0.22 | 0.18 |
| Monafloc Operator | F60/T17 | 400 | 1 | 73 | 0.18 | 0.15 |
| MAMD Operator | F51/T21 | 389 | 1 | 22.8 | 0.06 | 0.05 |
| Dryer Operator | F53/T20 | 397 | 1 | 9 | 0.02 | 0.02 |
| Material Handler | F3/T60 | 450 | 2 | 12 | 0.03 | 0.02 |
| Dryer Operator | F31/T54 | 448 | 2 | 16 | 0.04 | 0.03 |
| System Reactor Operator | F16/T53 | 433 | 2 | 10 | 0.02 | 0.02 |
| System Reactor Operator | F41/T51 | 430 | 3 | 37 | 0.09 | 0.08 |
| Magnofloc Reactor System Operator | F5/T59 | 418 | 3 | 40 | 0.010 | 0.08 |
| Dryer Operator | F26/T62 | 426 | 3 | 5 | 0.01 | 0.01 |
| Material Handler | F49/T58 | 395 | 3 | 17 | 0.04 | 0.03 |
| Area Mezzanine between Dry 1 & 2 | F59/T27 | 384 | 1 | 27 | 0.07 | 0.06 |
| Area Mezzanine between Dry 1 & 2 | F43/T55 | 448 | 2 | 20 | 0.04 | 0.04 |

Ambient Sampling Conditions, February 2, 1984, 10:20 a.m., 14°C, 29% R.H.

* A method of calculating average daily exposure by weighting the concentration of acrylamide (ug/sample) by 8 hours, assuming no exposure during the unsampled portion of the work shift.

TABLE 7
 Summary of Acrylamide Exposure Levels
 JOB SHOP
 American Cyanamid Company
 Warners Plant
 FEBRUARY 2-3, 1984

| <u>JOB TITLE/LOCATION</u> | <u># SAMPLES</u> | <u>RANGE</u> <u>mg/m3</u> | <u>MEAN</u> <u>mg/m3</u> |
|---------------------------|------------------|------------------------------|-----------------------------|
| Operators | 6 | 0.02-0.18 | 0.09 |
| Dryer Operators | 3 | 0.01-0.03 | 0.02 |
| Material Handlers | 3 | 0.02-0.03 | 0.02 |
| Total | 12 | 0.01-0.18 | 0.06 |
| Area | 2 | 0.04-0.06 | 0.05 |
| Total for all employees | 27 | 0.01-0.39 | 0.11 |

APPENDIX 1

AMERICAN CYANAMID
CHEMICALS GROUP

Acrylamide Biological Monitoring Program

I. Scope

This standard applies to all employees who routinely or intermittently work with acrylamide monomer (dry or solution) or with materials containing acrylamide monomer. Included are supervisors, operators, helpers, track, tank car loaders and unloaders, maintenance and laboratory personnel as well as others whose activities may result in potential acrylamide exposure.

II. Medical Surveillance

1. Pre-employment physical examinations for all applicants shall include in addition to the requirements as outlined in the corporate medical manual, a tactile test using the Tactile Tester^R and the following minimum neurological tests:
 - a) Reflexes and reflex strength
 - b) Babinski
 - c) Romberg
 - d) Gait
 - e) Vibration sensitivity
2. Periodic examination shall follow the requirements of the corporate medical manual.
3. Periodic Screening
 - a) Finger Peeling - all persons included in the program shall be examined weekly for finger peeling by someone trained in identifying the characteristic pattern associated with such exposure. If typical acrylamide finger peeling is identified, the employee should be removed from exposure and given a Tactile Test.
 - b) Further decisions will be based on the use of the Tactile^(a) Tester^R and the neurological findings.
4. Tactile Testing^(a)
 - a) All persons included in this program shall have tactile testing according to the protocol Part B of this document.
 - b) Tactile testing will be conducted by a trained individual, nurses or designated technicians.
 - c) Tactile testing results will be reviewed by a physician and analyzed by a statistician.

III. Responsibilities

1. Plant Management shall:
 - a) Appoint an individual responsible for carrying out a finger peeling surveillance program. In larger plants, the plant Medical Department has this responsibility. For locations using contract physicians it is recommended that, to insure consistency, one individual be assigned the responsibility. A log must be maintained and follow up carried out to assure that all affected persons are examined on a weekly basis.
 - b) Maintain an up-to-date list of all jobs and persons included in this program. This list shall be made available to the plant/contract physician, CMD, and Chemicals Industrial Hygiene.
 - c) Take appropriate actions in response to cases of skin peeling and abnormal tactile test results.
 2. Industrial Hygiene and Health Information services will analyze tactile test data received from Central Medical Department and report to Central Medical if the data is abnormal by definition.
 3. The Central Medical Department shall:
 - a) Familiarize company and contract physicians with tactile testing, its application in screening for acrylamide exposure, interferences, limitations, "false positives", etc. and provide training to designated testers.
 - b) Discuss abnormal findings with plant or contract physicians and plant management as appropriate. Recommendations to restrict any individual from jobs having potential acrylamide exposure will be discussed with plant management.
 - c) Follow up on all cases involving abnormal tactile test results until the case is resolved, as provided for in the protocol.
- (a) New program in process of implementation.

APPENDIX 2



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.

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, in-

cluding 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 re-informed 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, 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.