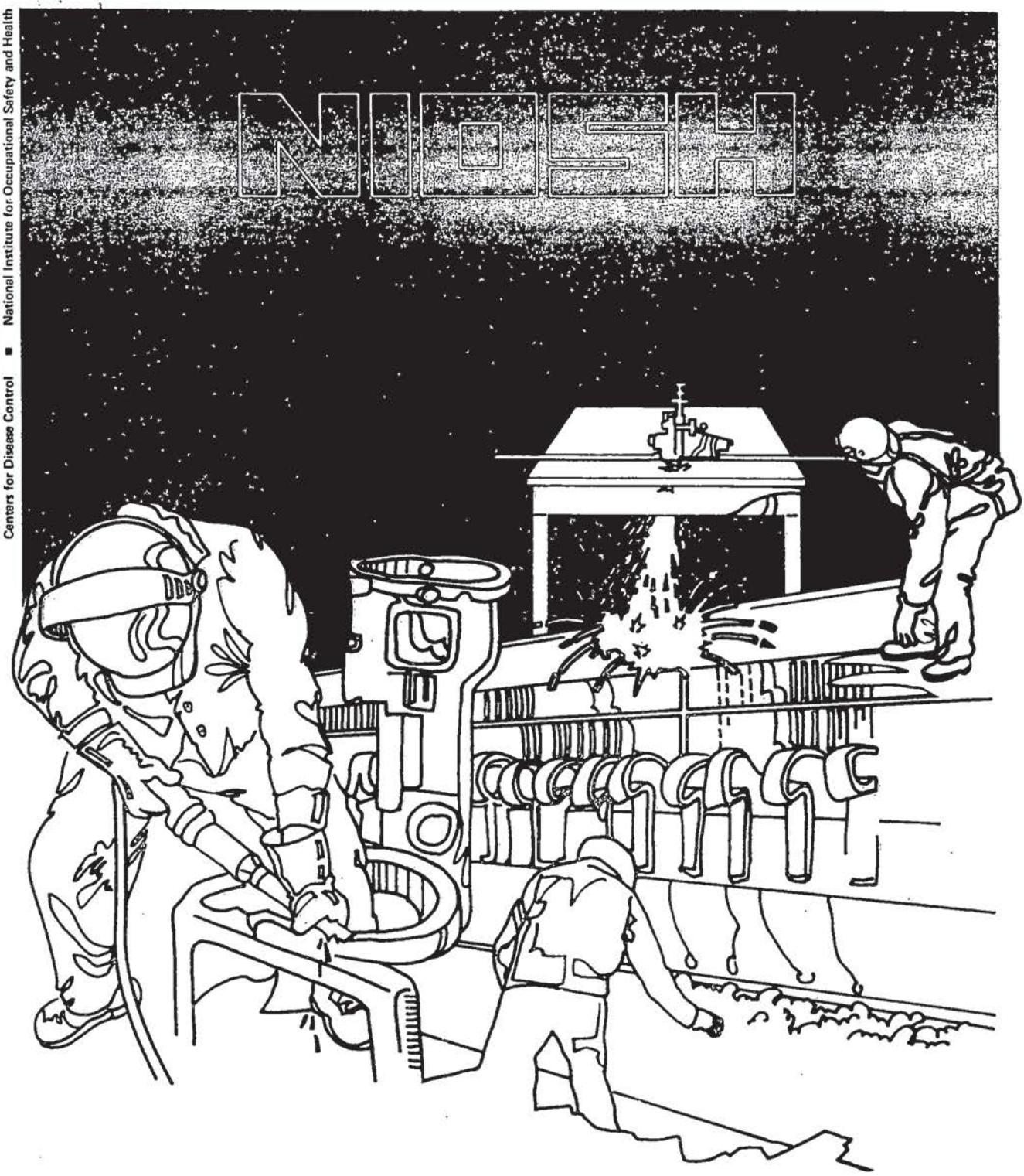
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ▫ Public Health Service
Centers for Disease Control ▪ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-276-1100
FIRE DEPARTMENT
CAMDEN, SOUTH CAROLINA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-276-1100
April 1982
Fire Department
Camden, South Carolina

NIOSH INVESTIGATOR:
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I. SUMMARY

In April, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the Health and Safety Department, International Association of Fire Fighters. The request concerned possible health problems resulting from exposures during a fire in Camden, South Carolina. NIOSH assistance was requested one week after the fire when fire fighters continued to complain of symptoms of chest discomfort, shortness of breath and headache.

Following multiple exposures to a burning stainless-steel tank containing a large amount of white powder, fire fighters reported symptoms of chest pain, shortness of breath, lightheadedness, headache, cough and hoarseness beginning several hours after the exposure and lasting several days in one fire fighter, and rhinitis and headache in a second fire fighter.

NIOSH performed telephone interviews with two of the three exposed fire fighters, suggested further screening tests be performed by the employer's physician, and analyzed a bulk sample of the chemical substance which was present at the fire.

Medical records of chest X-rays and physical examinations performed by the employer's physician several hours after the exposure, and screening laboratory tests, performed approximately 1 week after exposure revealed minor abnormalities in several laboratory values and an EKG with a sinus arrythmia in one firefighter. A follow-up EKG performed 3 weeks after the exposure showed possible ischemic effects. A stress EKG was performed showing occasional arrythmias. No sustained arrythmia or other abnormality was noted. These may have resulted from the acute exposure to pyrolysis products of polyacrylonitrile, but the lack of prior EKG's makes it impossible to assess the possible timing and cause of the EKG changes.

The analysis of the bulk sample by infrared techniques revealed that it was polyacrylonitrile.

Symptoms and EKG abnormalities found in fire fighters following exposure to smoke and fumes of a polyacrylonitrile fire were consistent with possible effects of pyrolysis products of polyacrylonitrile, including hydrogen cyanide. Recommendations are made in the body of the report to help prevent and alleviate these conditions.

Keywords: SIC 9224 ; fire fighters, polyacrylonitrile, electrocardiogram.

II. INTRODUCTION

On April 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the International Association of Fire Fighters. The request concerned possible health effects during exposure to a polyacrylonitrile fire in Camden, South Carolina.

On April 9, 1981, the NIOSH Medical Officer interviewed two of the three exposed fire fighters who were able to be reached by phone. The interviews consisted of questions concerning age, past medical history, past history of smoke inhalation exposures, history of symptoms and exposure to the polyacrylonitrile fire, and occupational history. On April 13, NIOSH received a sample of the white powder found at the site of the fire. This sample was subjected to infrared analysis to confirm its chemical composition.

NIOSH obtained releases of medical information from two of the three exposed fire fighters, and requested copies of medical records of physical examinations and chest x-rays performed on the day of the exposure by the City physician. In addition, NIOSH suggested that fire fighters be screened one week following the exposure to ensure that no adverse health effects persisted since the initial evaluation. The records of these evaluations were also requested from the employer's physician and other consulants.

III. BACKGROUND

On April 2, 1981, a fire occurred in a large scrap stainless steel drum stored in a residential area of Camden, South Carolina. The drum had reportedly been cut up with a torch for recovery of the metal on the day prior to the fire. Three volunteer fire fighters from the Camden Fire Department responded to the alarm. They reported finding a large unmarked stainless steel drum approximately 30 feet long, 7-8 feet in diameter with 2 large rectangular sections cut out of the sides. They reported a large amount of yellow acrid smoke emanating from inside the drum, with a small amount of flame visible. Water was used initially to put out the fire. The fire fighters used no personal protective equipment. They described putting their heads inside the drum for short periods of time to see the source of the flame. The fire restarted on two occasions over the next few hours, however, and the fire fighters were finally able to quench the fire with a dry chemical fire extinguisher and sand. A nearby DuPont Company plant manufaturing orlon, dacron and nylon was identified as the source of the scrap drum. The DuPont fire officials were called to the site, where they reportedly identified the drum, and the powder inside the drum as polyacrylonitrile.

The fire fighters reported symptoms of chest pain, lightheadedness, headache, nose running, and hoarseness beginning several hours after their exposure to the fire. They reported these to their supervisors and were sent to the local hospital where the employer's physician examined them. Chest X-rays were performed which were reportedly normal in all three cases.

One fire fighter reported experiencing continued chest pains, headache and lightheadedness for several days following the exposure. The local union office contacted the International office in Washington, who in turn contacted NIOSH for technical assistance.

IV. EVALUATION CRITERIA

Known pyrolysis products of polyacrylonitrile include hydrogen cyanide, an asphyxiant gas which may be inhaled or absorbed through the skin (1). A characteristic odor of bitter almonds can be smelled by 50-60% of people. Symptoms from exposure include vomiting, palpitations (irregular heart beat), confusion and dizziness. Blood pressure may be elevated initially, followed by an increasing heart rate and decreased blood pressure. Electrocardiograms may show ST elevation or depression. Severe exposure may lead to pulmonary edema.

V. EVALUATION DESIGN AND METHODS

A. Environmental:

A bulk sample of the chemical substance obtained during the fire was analyzed by NIOSH. The sample was prepared for infrared (IR) analysis by several techniques and a spectrum was taken of each preparation. The spectra were compared with the spectrum for polyacrylonitrile available in the Sadtler reference collection of IR spectra.

B. Medical:

Phone interviews were conducted with exposed fire fighters, the Camden fire chief, and the city's physician regarding the history of the fire, use of protective equipment, symptoms reported and occupational histories of the fire fighters involved.

Release of medical information was obtained for all three exposed fire fighters for medical tests and physical examinations performed by the city physician and other consultants. Medical records were requested from each physician involved in the evaluation of the fire fighters subsequent to the fire.

VI. RESULTS AND DISCUSSION

A. Environmental:

The analysis of the bulk sample by infrared showed good agreement between the reference and sample spectra for both the absorption peak frequencies and their relative intensities. Therefore, the major component of the sample was confirmed to be polyacrylonitrile.

B. Medical:

The following are case reports based on the phone interviews with two of the three exposed fire fighters:

The first fire fighter interviewed was a volunteer with a more than 5 year history of fire fighting. He had a previous history of mild smoke inhalation several months prior to this incident. He reported spending approximately one-half hour at the site on April 2. He reported coughing and a feeling "like knots in the stomach" while at the site. Within several hours after exposure, he reported tightness in the chest ("like squeezing"), shortness of breath, lightheadedness, slight cough and hoarseness. He reported these symptoms to his supervisor, and was told to report to the local hospital where he received a physical examination and chest x-ray. He was told these were normal and sent home.

Following NIOSH's recommendation, he obtained screening laboratory tests approximately 1 week after the fire, including blood, urine and electrocardiogram (EKG). He was told that the EKG was abnormal, and was referred to a consulting cardiologist for follow-up. He had a repeat EKG and stress EKG performed by the consultant.

The second fire fighter interviewed had a more than 2 year history of fire fighting. He had no prior medical history or history of smoke inhalation severe enough to require medical evaluation or treatment. He reported being at the site for the three periods of exposure, but with highest exposure for about 12 minutes while leaning through the holes in the tank holding fire hose on the fire. He compained of symptoms of nasal irritation and dull headache for several hours after the fire, and reported to the local hospital for a similar evaluation. He was told his examination and chest x-ray were also normal and sent home.

His initial EKG showed sinus arrythmia. The medical record of the follow-up EKG three weeks following exposure showed possible ischemic changes. The stress EKG showed occasional arrythmia. No sustained arrythmia or other abnormality were seen. The medical record of the second firefighter showed entirely normal findings, including a normal EKG.

The symptoms reported were consistent with reported effects of known pyrolysis products of acrylonitrile, particularly hydrogen cyanide. (1) Cyanide inhibits cytochrome oxidase enzymes. (2) Experimental studies have shown delayed toxicity, including ischemic anoxia. (3) Cardiac arrythmias have been noted. Other symptoms reported include nausea, confusion, giddiness, lower jaw stiffness, coma, paralysis, and transitory respiratory stimulation followed by respiratory failure. (4) A few inhalations of high concentrations of hydrogen cyanide may be followed by instantaneous

respiratory collapse. Levels of 270 ppm may be immediately fatal, 181 ppm may be fatal after 10 minutes, 135 ppm after 30 minutes and 110 ppm after 1 hour of exposure. Levels of 18-36 ppm may result in some symptoms after an exposure of several hours. (5)

No baseline EKG's were available prior to the exposure, and no EKG's were performed immediately following the exposure, so the relationship between the symptoms and EKG changes observed on follow-up evaluations 2-3 weeks after expsoure is difficult to determine. The possiblity exists, however, that the inverted T-wave and arrythmias observed may have resulted from ischemia during the acute exposure. Alternative possiblities are that these were preexisting conditions which were exacerbated by the exposure, or were changes unrelated to this particular exposure.

VII. CONCLUSIONS AND RECOMMENDATIONS

Three volunteer fire fighters were exposed to a fire involving an initially unidentified chemical substance in a scrap metal drum in Camden, South Carolina. The substance was subsequently identified by chemical company officials as polyacrylonitrile, and confirmed by NIOSH infrared analysis to be polyacrylonitrile.

Episodes similar to this one should be prevented by proper disposal and handling of potentially flammable or toxic scrap materials.

Symptoms reported by fire fighters following exposure to the fire are consistent with reported effects of hydrogen cyanide exposure, a known pyrolysis product of polyacrylonitrile. At NIOSH's suggestion, screening tests including electrocardiograms, blood and urine tests were performed 1-3 weeks after the exposure. Electrocardiogram changes observed 2-3 weeks after the fire were also consistent with reported effects of hydrogen cyanide. No prior EKG was available for comparison.

This episode suggests the following changes in procedures during and following such fires:

1. Proper training in fighting fires with unknown substances is needed. A fire involving unknown substances or chemicals should be assumed to involve acutely toxic substances until proven otherwise. Adequate personal protective equipment should be provided and used to insure safe fire fighting conditions (7).

   Special emphasis should be placed on procedures for fighting fires in potentially enclosed spaces such as this fire.

2. Prompt medical evaluation should be performed whenever potential toxic exposures have occurred. Physicians involved in such evaluations should be made aware as soon as possible the chemical nature of the exposure. Resources such as the NIOSH/OSHA

Occupational Health Guidelines for Chemical Hazards (DHHS [NIOSH] Publication No. 81-123) should be available to physicians responsible for health of fire fighters to enable rapid identification of possible toxic effects reported and screening or treatment recommended.

For example, the close observed correlation between blood carboxyhemoglobin and blood cyanide levels in survivers of fires has led to the suggestion that blood carboxyhemoglobin might be used as a means of identifying those who might benefit from treatment with cyanide antidotes. (6) It is essential that these to be obtained as soon as possible after exposure.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENT

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. International Association of Fire Fighters
2. NIOSH, Region IV
3. OSHA, Region IV

For the purpose of informing affected employees, copies of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.