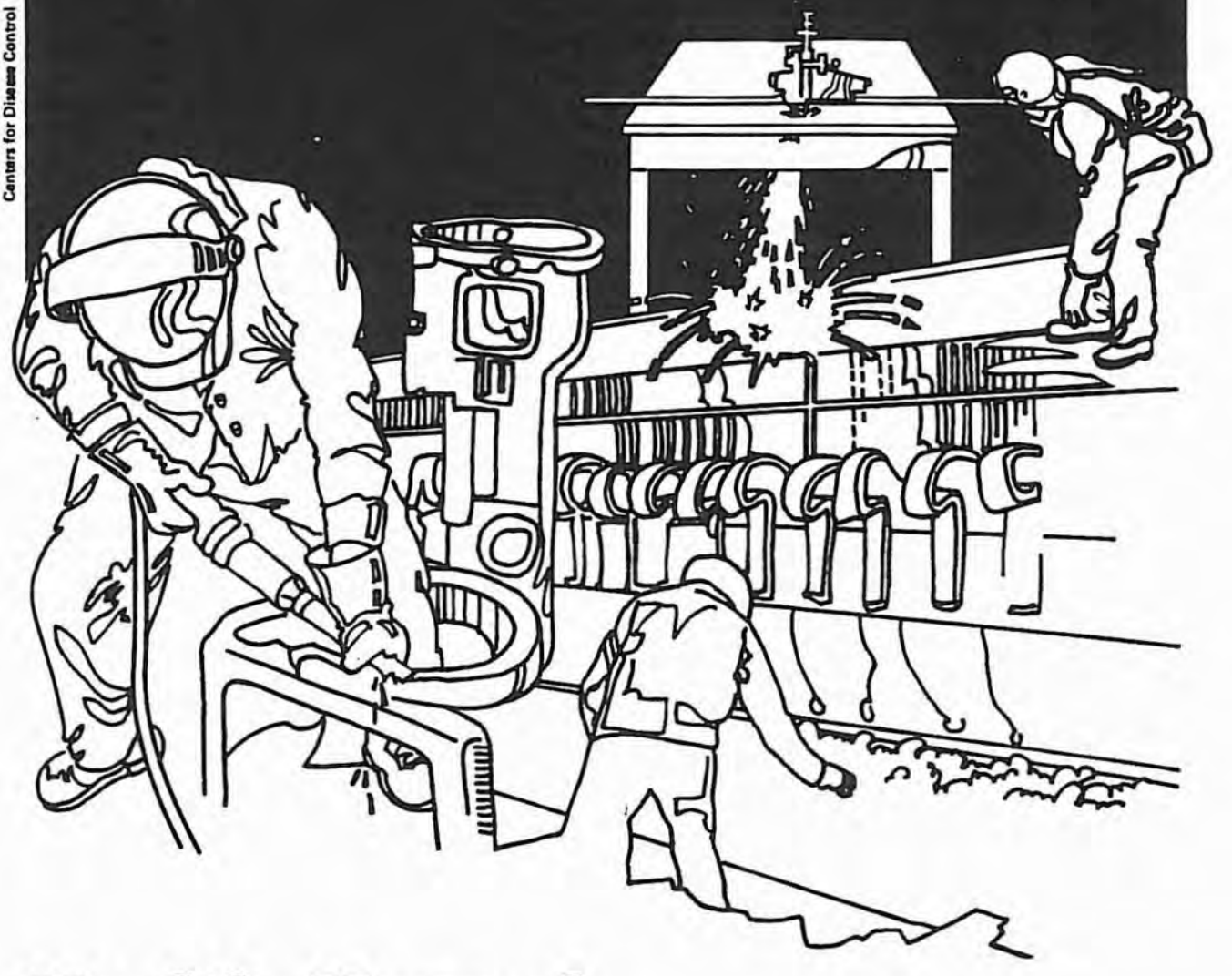
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-157-1373
FIRE DEPARTMENT
STAMFORD, CONNECTICUT

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 83-157-1373
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FIRE DEPARTMENT
STAMFORD, CONNECTICUT

NIOSH INVESTIGATOR:
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I. SUMMARY

In February 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Fire Fighters to evaluate potential health problems resulting from exposures during an industrial fire and explosion at United Organics, Inc., Stamford, Connecticut. NIOSH assistance was requested six weeks after the fire when fire fighters continued to complain of symptoms of chest discomfort, shortness of breath and headache.

The first four fire fighters at the scene received severe burns when they were engulfed in an explosion of burning acrytonitrile. Most of the burns were confined to exposed body parts, such as faces, hands and feet. One fire fighter was wearing only polyester uniform trousers, and suffered severe burns to the lower torso as well.

Following exposure to the burning chemicals in the building, fire fighters reported chest pain, shortness of breath, lightheadness, headache, cough, hoarseness and skin peeling from their lips and hands. These symptoms began several hours after the exposure and in one individual hoarseness persisted for four months.

NIOSH performed interviews with 54 exposed fire fighters, reviewed medical records generated by area hospitals and private physicians, and analyzed bulk samples of the burned men's turn out gear. In NIOSH interviews, the firefighters reported nausea and vomiting along with severe shortness of breath, chest pain, purulent cough and in one case blood tinged mucous lasting for three weeks after the fire. Emergency room records revealed evidence of acute respiratory distress in six of the fire fighters.

A Connecticut EPA report on the fire noted the presence of a 1200 gallon capacity acrylonitrile reactor on the main process floor.

The analysis of the turn out gear samples by infrared techniques revealed the presence of acrylonitrile as a major contaminant.

Symptoms and medical abnormalities found in these fire fighters following exposure to smoke and fumes from this chemical fire were consistent with the possible effects of pyrolysis products of polyacrylonitrile, including hydrogen cyanide. Recommendations are made in Section VIII of this report to help prevent future exposures.

KEYWORDS:SIC 9224; (fire fighters), acrylonitrile, chemical fire

II. INTRODUCTION

On February 17, 1983, NIOSH received a request for a health hazard evaluation from the International Association of Fire Fighters. The request concerned possible health effects resulting from exposure to acryonitrile and other chemical substances during a fire and explosion at United Organics, Inc., in Stamford, Connecticut.

On March 21, 1983, the NIOSH investigator conducted an opening conference at the Stamford Fire Department headquarters with management and labor representatives. This meeting was summarized and initial recommendations were made in a letter, sent to both parties, dated April 7, 1983.

During the week of June 27, 1983, the NIOSH investigator interviewed 54 exposed fire-fighters. NIOSH obtained releases of medical information from each fire fighter, who reported being seen in either the hospital emergency room or by their private physician, following this fire.

III. BACKGROUND

On January 4, a fire occurred at United Organics, Inc. A company engaged in chemical synthesis. The facility contained a wide variety of acids, solvents and metals (see Appendix 1 for listings provided by United Organics Corp.). Some of the chemicals and metals are known or suspected to cause cancer or to cause neurological damage. The three alarm fire burned fiercely, fueled by the volatile chemicals stored in the building. Fire supression was accomplished using master water streams and with the assistance of a Coast Guard fireboat and a Stamford police boat. The tremendous volume of water used carried buring chemical materials below the floor of the building, where the fire smoldered for the next three days, frustrating attempts to extinguish it with foam agents.

Four firefighters, responding to the first alarm, were seriously burned when they were engulfed in a fireball from the burning chemcial plant. Their burns were confined to exposed skin areas, which had not been afforded the protection of turn-out gear. One of these injured men has since returned to work, in light-duty status. Health complaints from other firefighters, following exposure to this fire included, respiratory complaints, nausea and vomiting, burns, and skin peeling from lips and hands.

Approximately 80 emergency personnel (fire, police, and ambulance) were seen in local hospital emergency rooms within 48 hours of the fire. No systematic special medical screening was conducted following the United Organics fire.

IV. EVALUATION CRITERIA

General

The firefighter profession is characterized by periods of intense work interspersed with periods of relative inactivity. This, in combination with significant risk of bodily injury and death for both firefighter and fire victims, probably leads to high levels of stress and other untoward psychological effects among fire fighters. Due to the considerable prevalence of obvious physical health problems, their psychological effects may tend to be overlooked.

According to available statistics, firefighting is the most hazardous profession in the United States. As a cause of occupational morbidity and mortality it outranks other high-risk professions such as mining and construction. A considerable portion of these effects is due to the high incidence of trauma, including severe burns and smoke inhalation, which is a common cause of injury and death among fire fighters. Effective respiratory protection is available but usually not in sufficient quantities, especially during extended or large conflagrations.[6]

Apart from acute effects, there is an increasing body of evidence that repeated incidents of exposure to high levels of smoke and fumes can cause chronic disease and other lasting health problems. These effects occur mainly in the respiratory system and can result in debilitating conditions such as chronic bronchitis and/or emphysema. Even in fire fighters with no overt signs of respiratory disease, it is common to find decreased pulmonary function as measured by spirometry (breathing tests).[3]

The respiratory effects, both acute and chronic, are mainly caused by irritating gases, for example nitrogen dioxides. Although these gases are also produced by thermal decomposition of common organic substances, it is possible that the increased use of synthetic building materials has led to higher levels of previously uncommon, highly toxic gases, such as formaldehyde, phenol and hydrogen chloride.[5]

Acrylonitrile[1,4]

Known pyrolysis products of acrylonitrile include hydrogen cyanide, an asphixiant gas which may be inhaled or absorbed through the skin. A characteristic odor of bitter almonds can be smelled by 50-60% of people. The vapor is a severe eye irritant. 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. Recent epidemiologic evidence has suggested that occupational exposure to acrylonitrile may be associated with an excess of lung and colon cancer. The TLV is set by analogy to hydrogen cyanide. Because of the suspected cancer hazard. OSHA has proposed an Emergency Temporary Standard of 2 ppm with a ceiling of 10 ppm for any 15 minute period.

Cyanide inhibits cytochrome oxidase enzymes. Experimental studies have shown delayed toxicity, including ischemic anoxia. Irregular heart rythmns have been noted. Other symptoms reported include nausea, confusion, giddiness, lower jaw stiffness, coma, paralysis, and transitory failure. A few inhalations of high concentration 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 one hour of exposure. Levels of 18-36 ppm may result in some symptoms after an exposure of several hours.[7]

Carbon Monoxide[4]

An important cause of death in association with fires is the inhalation of carbon monoxide (CO), a colorless, odorless gas that results from the incomplete combustion of various carbonaceous compounds. The toxic effects of CO are due to its high affinity for hemoglobin, the oxygen transporting substance in the blood. Since this affinity is higher than for oxygen, CO replaces oxygen and thereby blocks the transport system for oxygen in the body. Prolonged inhalation of high concentrations of CO usually result in death or very severe brain damage. Intermediate concentrations may cause irreversible brain damage, whereas prolonged exposure to low concentrations has been associated with the development of atherosclerosis and heart disease.

V. EVALUATION DESIGN AND METHODS

A. Enviromental

NIOSH obtained a listing of chemicals and compounds used and produced by United Organics, Inc. from the company. Bulk samples of the four burned firefighters' turn out gear was analyzed by infrared (IR) spectrophotometry. The spectra were compared with the spectrum for polyacrylonitrile available in the Sadtler reference collection of IR spectra.

B. Medical

The NIOSH investigator interviewed 54 exposed fire fighters, using a questionnaire addressing demographic information, time of arrival and departure from the fire, use of protective equipment, reported symptoms and occupational histories of the firefighters.

NIOSH obtained medical records of those men seen in hospital emergency rooms or by private physicians subsequent to the fire.

VI. RESULTS AND DISCUSSIONS

A. Environmental

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

B. Medical

The 54 firefighters interviewed were all males, 44 of whom were white, seven black and three Hispanics. Their average age was 38 years (range, 20-62), and average years on the job was 12 (range 1-30). Twenty individuals were smokers (37%). Reported time at the fire scene ranged from 10 minutes to 70 hours over the course of several days. The use of self-contained breathing apparatus varied from none at all to three hours. On average, respirator usage was for 20 minutes duration per man.

All the men who helped fight the United Organics fire were advised by their supervisors to report to local hospital emergency rooms.

The NIOSH questionnaire results underscore a preponderance of respiratory symptoms. Twenty-eight (52%) of the fire fighters reported two or more of the following symptoms: coughing, chest tightness, shortness of breath, lightheadedness, throat irritation, and hoarseness. Twelve individuals (22%) reported nausea and vomiting during their exposure to fumes and smoke at the fire scene. Six fire fighters (11%) reported skin vesicles and/or skin peeling from their lips or hands. Sixteen men (29%) reported "other" symptoms, (symptoms not specifically asked). These sympoms included intense headaches, metallic taste, memory lapse, nightmares and "shock". These symptoms are consistent with reported effects of known pyrolysis products of acrylonitrile, particularly hydrogen cyanide.

VII CONCLUSIONS

Four firefighters were seriously burned and approximately 60 firefighters were exposed to burning acrylonitrile and its pyrolysis products which include hydrogen cyanide. The NIOSH questionnaire survey found a high a prevalence of respiratory and cardiovascular symptoms following the fire. Review of the local hospitals emergency room records for six of these men detail probable acute hydrogen cyanide intoxication.

Review of the Stamford Fire Department respiratory protection program found no written standard operating procedure. At the time of the fire, polyester work clothes were standard department issue. This situation has since been remedied.

Accident and illness data was not available at the firehouse but was kept at Stamford City Hall in the personnel department. Review of these data detailed some 80 individual reports of health problems thought to be associated with fighting the United Organics fire.

VIII. RECOMMENDATIONS

1. Proper training in fighting fires involving unknown substances is needed. A fire with unknown substances or chemicals should be assumed to involve acutely toxic substances until proven otherwise. The firefighters would be afforded greater personal protection if a catalog of possible chemical fire sites was available to them. This catalog should include information, for potentially toxic substances, provided by material safety data sheets available from user companies.

2. The Stamford fire department should maintain a written standard operating procedure for their respirator program. It should be readily accessible to all firefighters. The development and institution of a written respiratory program must be in accord with 29 CFR 1910.134.

3. Prompt medical evaluation should be performed whenever potentially toxic exposures have occurred. Medical personnel involved in these evaluations should be made aware of the chemical nature of the exposure. Resources such as the NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards (DHHS [NIOSH] Pub. No. 81-123) should be available, perhaps via a regional poison control center, to medical personnel responsible for the health of firefighters to enable rapid identification and treatment of possible toxic effects.

4. Periodic physical examinations, as part of an overall fire department medical surveillance program should be implemented. These examinations should be primarily focused on both the respiratory and cardiovascular systems.

5. Individual accident and illness reports should be logged at each fire station in the city. Copies could then be provided to the city personnel department for summarization and eventual data analysis.

VIII. REFERENCES

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7. Smith, R.P., Toxic Responses of the Blood, in Doull J, et. al., eds., Casarett and Doull's Tocicology. New York: 1981, p. 328.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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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. Stamford Fire Department
3. NIOSH, Region II
4. OSHA, Region II

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

Appendix I

Substances generally in use in the United Organics plant:
(information provided by the company)

Toluene
Acetic anhydride
Antimony trioxide

Acrylonitrile
Triethylamine
Zinc chloride
Paraphenylphenol
"Molecualar Sieve"
Sulfuric acid
Sodium carbonate
Bromine
Sodium bicarbonate
Sodium bisulfite
Tween-60 (a soap)

Methyl methacrylate
Polymethyl methacrylate
N,N dimethyl-p-toluidine
Wax
2,6 di-tert-butyl-cresol
1,3 butylene glycol dimethacrylate
2 Hydroxy 4 methoxy Benzophenone
Butyl Benzyl Phthalate

Methacrylic acid
Acrylic Acid
Tributyltin oxide