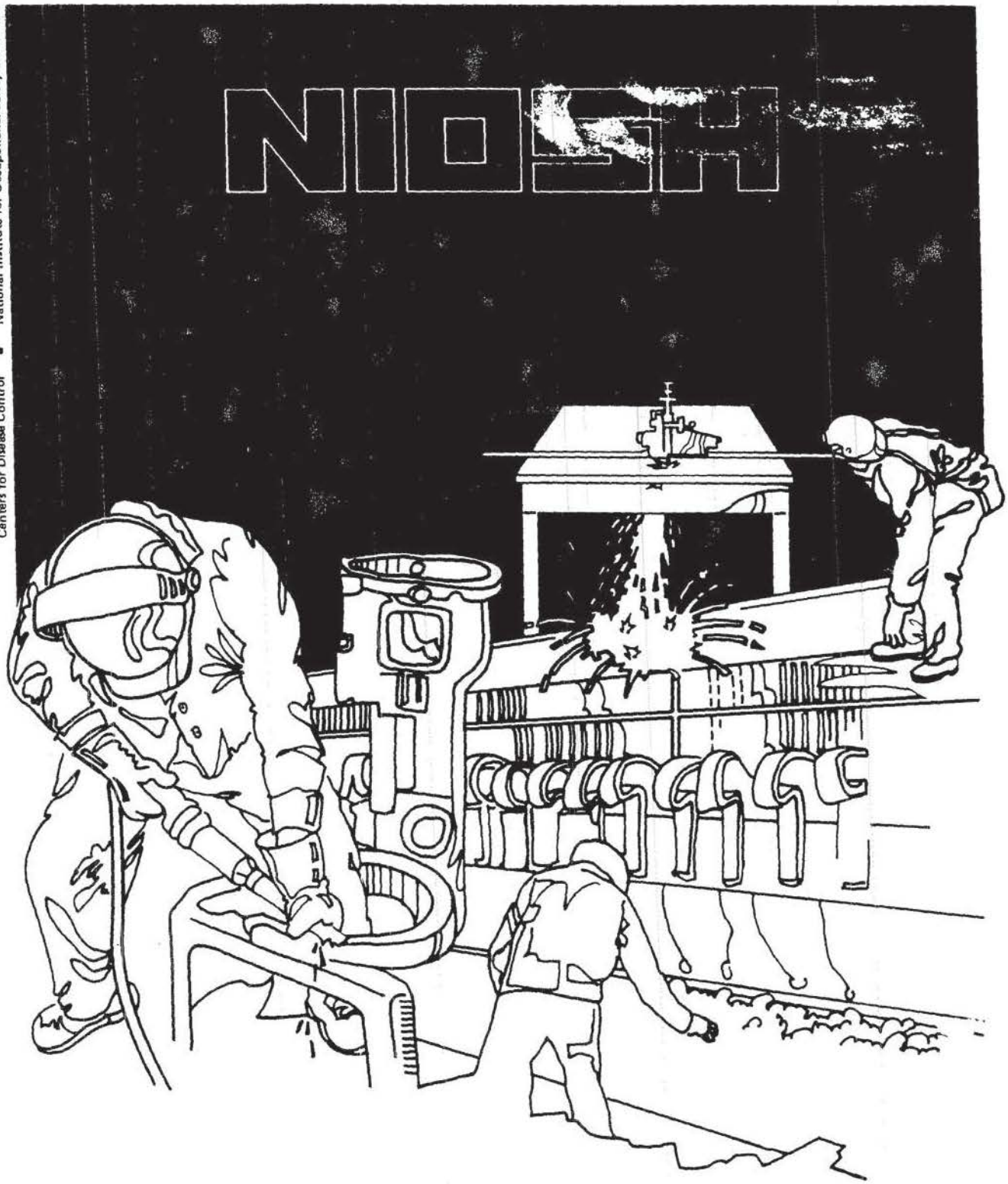
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-115-1101
FIRE DEPARTMENT
POUGHKEEPSIE, NEW YORK

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.

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Fire Department
Poughkeepsie, New York

NIOSH INVESTIGATORS:
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I. SUMMARY

In January 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the International Association of Fire Fighters. The request concerned possible health effects to fire fighters who participated in rescue and fire suppression activities following an explosion and chemical fire at the Bern Color Company, Poughkeepsie, New York. The request also asked for advice concerning disposition of the fire fighters' protective clothing which was contaminated by chemicals during the fire. In addition, NIOSH received a verbal request for technical assistance concerning the incident from the Office of the City Manager, City of Poughkeepsie.

On January 14, 1982, an explosion and fire demolished the Bern Color Company. The company stores and uses a large number of chemicals in the manufacture of dyes. Approximately 150 fire fighters from Poughkeepsie and two neighboring communities were involved in extinguishing the blaze. Fourteen fire fighters were injured and required treatment at a hospital. The fire was exceptionally smoky and consumed large amounts of chemicals which had been stored on site. Many of the fire fighters' uniforms were perforated by acid burns and became contaminated by contact with the chemicals. Immediately after the fire, the uniforms were removed and stored in steel drums.

Because of concern over exposure to p-nitroaniline, the fire fighters were tested for methemoglobinemia 24 hours after the fire and again the following day. The latter blood samples also were analyzed by the SMA-24, which is a broad spectrum analysis that can detect damage to internal organs. No methemoglobinemia or other effects attributable to contaminant exposure were detected.

The Environmental Protection Agency (EPA) arrived on site on the evening of the fire and began testing for oxides of nitrogen and airborne organic contaminants. On-site monitoring was continued for about 2 weeks. No contaminants were detected. Analysis of samples collected from pools of water on site revealed minor contamination with organic chemicals. A contracting firm was engaged to package and remove the debris resulting from the fire. This was accomplished within 6 weeks.

Based on a review of the results of the medical tests performed on the fire fighters, NIOSH concludes that there were no apparent systemic health effects due to exposure to chemicals at the fire. NIOSH believes that decontaminating the fire fighters' uniforms is impractical with existing technology and recommends that they be disposed of properly.

KEYWORDS: SIC 9224 (Fire Departments); dyes and related chemicals, decontamination.

II. INTRODUCTION

In January 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to perform a health hazard evaluation from the Washington headquarters of the International Association of Fire Fighters (IAFF). The request concerned possible health effects to fire fighters who participated in rescue and fire suppression activities at an explosion and subsequent fire at the Bern Color Company, 75 North Water Street, Poughkeepsie, New York. The request also asked for NIOSH's advise in the disposition of the fire fighters' protective clothing which may have become contaminated during the incident. NIOSH also received a verbal request for technical assistance concerning the same problems from the Office of the City Manager, City of Poughkeepsie.

III. BACKGROUND

On January 14, 1982, beginning at 8:30 AM, an explosion and fire demolished the Bern Color Company plant on the East bank of the Hudson River in Poughkeepsie, New York. The plant was a four story brick building used for producing and storing dyes. A large amount of dyes stock, acids and bases were stored on-site. A 40 feet by 85 feet section of the building was destroyed by the initial explosion, while another 40 feet by 40 feet section was split open and substantially damaged. The dye materials and their combustion products were released in smoke and in run-off water during the fire suppression activities. Approximately 150 fire fighters from Poughkeepsie and the neighboring communities of Arlington and Dutchess/Fairview, New York, were involved in the rescue and fire suppression activities. Two employees of Bern Color were killed in the incident. Fourteen fire fighters were injured at the site and required emergency treatment. No one was hospitalized. The fire released substantial amounts of chemicals which had been stored at the site, both in smoke and in run-off water. Many of the fire fighters' uniforms were perforated by acid burns and were discolored by exposure to the smoke and contaminated water. The fire was extinguished by noon.

After returning to their fire houses, the fire fighters were instructed to shower for at least 15 minutes and to deposit their uniforms, boots, etc. in plastic bags. The equipment then was sealed in 55 gallon steel drums, which are currently stored in the Poughkeepsie Fire Department Headquarters.

On the day of the fire, the IAFF contacted the NIOSH Region II office concerning potential health effects of exposure to various chemicals presumed to have been present at the fire site. NIOSH informed the representative of the IAFF of the potential toxicity of the chemicals which were identified at that time. The NIOSH Regional Program Consultant also discussed the medical evaluation of persons exposed to chemicals generated by the fire with the Medical Director of the local hospital nearest to the fire site. At the time of the fire, the greatest concern was caused by potential exposure to p-nitroaniline. Because p-nitroaniline can cause methemoglobinemia*, the

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* Methemoglobin is an altered form of hemoglobin, the oxygen-carrying substance in the blood. Once formed, methemoglobin is incapable of delivering oxygen to the cells of the body. The body can gradually change the methemoglobin back into hemoglobin.

hospital was advised to test the exposed persons - fire fighters, police, emergency medical personnel and residents in the immediate vicinity of the fire - for the methemoglobin content of their blood. Approximately 150 persons were tested on January 15, 24 hours after the fire. Most of the fire fighters were retested on January 16 and 17. These latter blood samples were also analyzed for a broad spectrum of substances normally found in the blood by the SMA-24 instrument. The levels of these substances in the blood can reflect damage to the body's organs, such as the heart, liver and/or kidneys.

A response team from the Environmental Protection Agency (EPA) arrived at the fire site on the afternoon of the fire and began monitoring the site that evening. Ambient air monitoring was performed two or three times a day until the removal operations were completed. The sampling instrument was a "H-Nu" photoionization instrument, which operates on the principal of broad band ultraviolet light analysis and is capable of detecting airborne vapors of many organic chemicals in the parts per million parts of air (ppm) range. Intermittent monitoring of airborne nitrogen dioxide (NO_2) concentrations also was performed using direct reading detector tubes. Neither NO_2 nor organic vapors were ever detected at the site.

Because the site is on the river bank and much of the (contaminated) water used to extinguish the fire ran into the river, the Coast Guard was called to the site to monitor the river for possible pollution. The Coast Guard further acted to coordinate on-site monitoring and clean-up activities. Table 1 lists the chemicals determined to be present on site at the time of the fire. Table 2 lists the concentrations of contaminants found in samples collected from pools of run-off water at the fire site. The contaminants found in the run-off water suggest that the fire fighters may have been exposed to a number of chemicals during fire suppression activities.

IV. EVALUATION DESIGN AND METHODS

A. Medical

When the Regional NIOSH Office was first contacted, the extent of potential exposure of the fire fighters to chemicals was unknown. At that time, the major concern was the potential health effects of exposure to p-nitroaniline, which was believed to have been present at the fire site. The local hospital was advised to perform analyses for methemoglobinemia as an indicator of the extent of exposure to p-nitroaniline. Since any methemoglobinemia resulting from exposure to p-nitroaniline would decrease following removal from exposure, it was advised that blood samples be collected from exposed persons as soon as possible. It was further advised that additional blood analyses be performed on samples collected a day or two later, because other physiological responses to exposure to the potential contaminants might best be detected after a short time lapse.

On February 2, 1982, representatives of NIOSH toured the fire site and met with representatives of the Poughkeepsie Fire Department, the IAFF, the Environmental Protection Agency and the staff of Vassar Brothers Hospital, Poughkeepsie, who were responsible for the medical evaluation of exposed persons. The medical evaluations, diagnoses and treatments of the 14 fire fighters seen in the Emergency Room were reviewed with the medical staff of the hospital. Individual identities were kept confidential by the medical staff.

NIOSH reviewed the results of the testing for methemoglobin levels of the 150 potentially exposed persons. Vassar Hospital provided SMA-24 test results for 67 fire fighters or police who had their blood sampled on January 16th or 17th. Representatives of the Poughkeepsie Fire Department classified each person at the fire by approximate exposure level - high, medium, or light to no exposure. NIOSH compared serum levels between the three exposure groups on the following tests: blood urea nitrogen (BUN), total protein, total bilirubin, alkaline phosphatase, creatine phosphokinase (CPK), lactic dehydrogenase (LDH), serum glutamic oxalacetic transaminase (SGOT), and serum glutamic pyruvic transaminase (SGPT). Mean levels of each group were compared using Student's t-test.

The tests included in the SMA-24 are used to screen for evidence of injury to vital organs of the body. Each substance (BUN, etc.) primarily is related to the functions of one or a few organs. Abnormal levels of a substance can occur in the blood if there is injury to the organ(s). The tests evaluated by NIOSH reflect injury to the heart, muscles, lungs, liver or kidneys. Substantial injury to the liver or kidneys would result in an increase in the BUN, total bilirubin, alkaline phoshatase, LDH, SGOT and/or SGPT after a brief latent period. Blood tests obtained 48 to 72 hours after exposure would be abnormal, if injury had occurred.

B. Environmental

NIOSH was asked about the necessity for disposal or decontamination of the fire fighters' protective clothing. A decision on how to handle the contaminated uniforms must be based on 1) knowledge of the contaminants to which the clothing was exposed, 2) the extent of the contamination and/or damage to the clothing, 3) the efficacy of known decontamination practices, and 4) the cost and practicability of decontaminating the uniforms.

NIOSH obtained a list of chemicals known to be stored at the site at the time of the fire. NIOSH also obtained from the Coast Guard the list of chemicals found in the samples collected from pools of run-off water at the fire site. After these tables had been assembled, the NIOSH chemists were contacted as to the feasibility of analyzing some of the uniforms to determine the degree of contamination. They advised against the analysis of the uniforms because of the large number of chemicals potentially present (over 50). The uniforms show obvious signs of contamination with discoloration and burn holes throughout.

NIOSH reviewed the literature and contacted a professional decontamination company as to known decontamination procedures.

V. RESULTS AND DISCUSSION

A. Medical

In general, the fourteen fire fighters seen in the Emergency Room were treated for localized burns, trauma or eye irritation. Five persons had their methemoglobin levels tested; all were within normal limits (0 to 3% methemoglobin in the blood). None of the fire fighters had significant respiratory or systemic symptoms. No chest X-rays or arterial blood gas tests were done. No one required respiratory therapy and no one was hospitalized.

Blood samples for methemoglobin levels were obtained from the rest of the fire fighters on January 15, 16 and 17. All were within the normal limits established by the testing laboratory (3% or less). The greatest value obtained was 1.5% methemoglobin. It should be noted that methemoglobin generated in the blood is slowly reduced to normal levels after exposure to a methemoglobin-producing substance has ceased. Estimates of the reduction half-time for high (above 80%) levels of methemoglobin in human red cells range from 6 to about 24 hours(1). The rate of reduction tends to decrease with decreasing methemoglobin levels. Substantially elevated methemoglobin levels at the time of exposure would still be elevated above normal levels even 24 to 48 hours later. Thus there was no evidence of substantially increased levels of methemoglobin, indicating that there was no significant exposure to methemoglobin-causing substances such as p-nitroaniline at the time of the fire.

The 67 SMA-24 test results were divided into the following exposure groups: 21 high exposure, 22 medium exposure and 24 light to no exposure. The mean values and standard deviation for each test, stratified by exposure group, are listed in Table 3. The mean values for each test in each of the groups are all within the normal limits defined by the testing laboratory. There are no significant differences between the mean values of the three exposure groups on any of the tests. Since the mean values of all tests were within normal limits and there were no differences between the exposure groups, NIOSH concludes that there was no evidence of acute systemic health effects as a result of exposure to chemicals at the fire site.

B. Environmental

Table 1 lists chemicals which were known to be stored at the site at the time of the fire. This list is not complete in that the inventory list kept by the company was not completely current. Furthermore, it can be assumed that the heat of the fire altered some of the chemicals and that new chemicals were produced by the interreaction of chemicals liberated during the course of the fire. The incompleteness of the list is demonstrated by the fact that phenols, toluene, and xylene were found to be present in the pools of run-off water (Table 2), but do not appear on the list of chemicals stored at the site.

The fire fighters' uniforms were potentially exposed to a great variety of toxic substances, including those listed in Tables 1 and 2, as well as any possible reaction product of the listed chemicals. The uniforms are splotched with blue, pink, yellow and green dyes. Many of the uniforms have numerous small acid burns (perforations) in them. The dye stains probably cannot be removed, and the presence of small holes would limit the use of the damaged garments to reserve status.

NIOSH searched the literature and consulted with a decontamination company as to known decontamination procedures. Most literature references dealt with decontamination of a single chemical or one type of contaminant (for example, aromatic hydrocarbon solvents). The representative of the decontamination company stated that it was common practice in the industry to discard and properly dispose of contaminated uniforms. It was suggested that the number of chemicals to which the uniforms potentially were exposed complicated decontamination procedures.

While it might be possible to decontaminate the uniforms by a combination of several decontamination procedures, the practicability of decontamination is doubtful because of the disposal requirements for the water and other solvents used in any decontamination procedure. One must assume that the water and other solvents cannot be released into Poughkeepsie's sewers and then into the Hudson River. Proper disposal of the contaminated water and solvents would be required. This cleaning and disposal of the cleaning solvents would likely be more difficult and costly than proper disposal of the uniforms. (Replacement cost of the uniforms is estimated to be $31,000). Furthermore, it would be difficult to analyze the "decontaminated" uniforms to assure that decontamination was complete.

VI. CONCLUSIONS AND RECOMMENDATIONS

Medical tests for methemoglobinemia indicate that there was no excessive exposure to contaminants capable of producing methemoglobinemia. Statistical analysis of the results of the SMA-24 tests indicate that there were no apparent acute systemic health effects based on exposure to chemicals at the fire site. No latent or chronic effects are likely to develop following a single exposure to chemicals which did not result in acute toxic effects. Thus no further medical testing is indicated.

While the mean values on each of the medical tests for each exposure group were normal, some individuals had abnormal values on particular tests. These abnormalities occurred in no pattern and are probably not related to the fire suppression activities. For example, some persons had elevated cholesterol or triglycerides levels. Because these test abnormalities may reflect individual health problems, NIOSH recommends that participants in the medical screening should review their test results with their personal physicians.

The fire fighters' uniforms exhibit evidence of contamination. It is not feasible to determine exactly the kind and degree of contamination. Because of the lack of established decontamination procedures and the expense and logistical problems for disposal of contaminated cleaning solutions, NIOSH recommends that the contaminated fire fighters' uniforms be disposed of properly.

VII. AUTHORSHIP AND AKNOWLEDGEMENT

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VIII. REFERENCE

1. Doull J., Klaassen C., and Amdur M., Eds. Casarett and Doull's Toxicology. 2nd Edition. Macmillan Publishing Co., Inc. New York, 1980.

IX. DISTRIBUTION AND AVAILABILITY OF REPORT

For the purposes of informing affected personnel, copies of this report should be posted in prominant places in the three fire departments involved in the Bern Color Company fire.

Copies of this report will be available form NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio, 45226, for 90 days. Thereafter, copies will be available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information concerning its availability through NTIS can be obtained from the NIOSH Publication Office at the above Cincinnati address.

Copies of this report have been sent to:

International Association of Fire Fighters, Washington, D.C.
Office of the City Manager, City of Poughkeepsie
Fire Department, Poughkeepsie, New York
Fire Department, Arlington, New York
Fire Department, Dutchess/Fairview, New York
International Association of Fire Fighters, Local 596
International Association of Fire Fighters, Local 2393
International Association of Fire Fighters, Local 2623
Centers for Disease Control, Atlanta, Georgia
U.S. Deptpartment of Labor, Occupational Safety and Health Administration, Region II
U.S. Department of Health And Human Services, Public Health Service, NIOSH, Region II
New York State Department of Health

TABLE 1

LIST OF CHEMICALS ON SITE AT THE TIME OF THE FIRE

BERN COLOR COMPANY FIRE, JANUARY 14, 1982

acetic acid
1,2,4-acid diazo
amino benzene
amino nitro phenol
aniline
anthranilic acid
b-naphthol
calcium
caustic soda
Cheelox
4-chlorometanilic acid
2-chloro-5-pyrazolic acid
1,2-chloro-5-sulfophenyl-3-methyl-5-pyrazalone
1,6-cleves acid
copper sulfate pentahydrate
diamino benzene sulfonic acid
dichloroaniline
enylperic acid
ferric sulfate
ferrous sulfate
H acid
hydrochloric acid
iron oxide
L acid
laurents acid
m-nitroaniline
metanilic acid
metanilic base
methyl pyrazalone
neville-withers acid
o-cresol
p-amino azo benzene
1,3 phenylene diamine-4-sulfonic-acid
phenyl diamine
phenyl methyl pyrazalone
phenlyperic acid
pyrazolone
resorcinol
salacylic acid
salt (sodium chloride)
schaeffer salt
soda ash
sodium nitrite
sodium picramate
sodium sulfide
sulfanilic acid
1,3-sulfophenyl-3-methyl-pyrazalone
sulfur
sulfuric acid
tanolin-R basic
tartrazine
teflon fluorocarbon resin
Twitchell oil

TABLE 2

ANALYSIS OF RUN-OFF WATER SAMPLES

BERN COLOR COMPANY, JANUARY 29, 1982

CONTAMINANT	CONCENTRATION (milligrams/liter)	PROPOSED EPA MAXIMUM TOXICITY CONCENTRATION (milligrams/liter)
Arsenic (1)	ND	5.0
Barium (2)	ND	100.0
Cadmium (3)	ND--0.09	1.0
Chromium	0.13-11.0	5.0
Lead (4)	ND--2.05	5.0
Mercury (5)	ND	0.02
Selenium (2)	ND	1.0
Silver (3)	ND	5.0
Cobalt (6)	ND--0.16	None Exists
Copper	0.54-20.5	"
Iron	9.8-194	"
Nickel	0.11--0.46	"
Zinc	0.36--4.0	"
Organic Carbon	64---946	"
Phenols	0.37--3.28	"
Ammonia	1.67--5.97	"
Sulfate	198--2010	"
Total Phosphorus	0.67--3.57	"
Toluene (7)	ND--7.38	"
Xylene (7)	ND-27.77	"
Acetone (7)	ND	"
Carbon Tetrachloride (7)	ND	"

ND = None Detected

1. Limit of Detection = 0.80 mg/L
2. Limit of Detection = 0.50 mg/L
3. Limit of Detection = 0.01 mg/L
4. Limit of Detection = 0.50 mg/L
5. Limit of Detection = 0.20 mg/L
6. Limit of Detection = 0.15 mg/L
7. Limit of Detection = 1.0 mg/L

TABLE 3

MEAN VALUES OF MEDICAL TEST RESULTS
STRATIFIED BY DEGREE OF EXPOSURE

BERN COLOR COMPANY FIRE, JANUARY 14, 1982

	MEDICAL TEST PERFORMED*							
	BUN	Total Prot.	Total Bili.	Alk. Phos.	CPK	LDH	SGOT	SGPT
HEAVY EXPOSURE (n=21)								
mean	15	6.9	0.56	78	168	214	29	33
S.D.**	2.8	0.35	0.28	19	93	36	6.7	14.6
MEDIUM EXPOSURE (n=22)								
mean	16	6.9	0.68	78	176	210	28	29
S.D.	3.7	0.31	0.38	24	138	48	9.8	14.2
LIGHT EXPOSURE (n=24)								
mean	15	7.0	0.62	77	157	217	28	35
S.D.	4.0	0.45	0.29	13	106	32	6.1	20.9
NORMAL RANGE								
lower	10	6.0	0.2	30	32	100	7	4
upper	26	8.5	1.2	115	225	225	40	45

* Test Name: BUN - blood urea nitrogen, Total Prot. - total protein, Total Bili. - total bilirubin, Alk. Phos. - alkaline phophatase, CPK - creatine phosphokinase, LDH - lactic dehydrogenase, SGOT - glutamic oxalacetic transaminase, and SGPT - glutamic pyruvic transaminase.

** S.D. - standard deviation