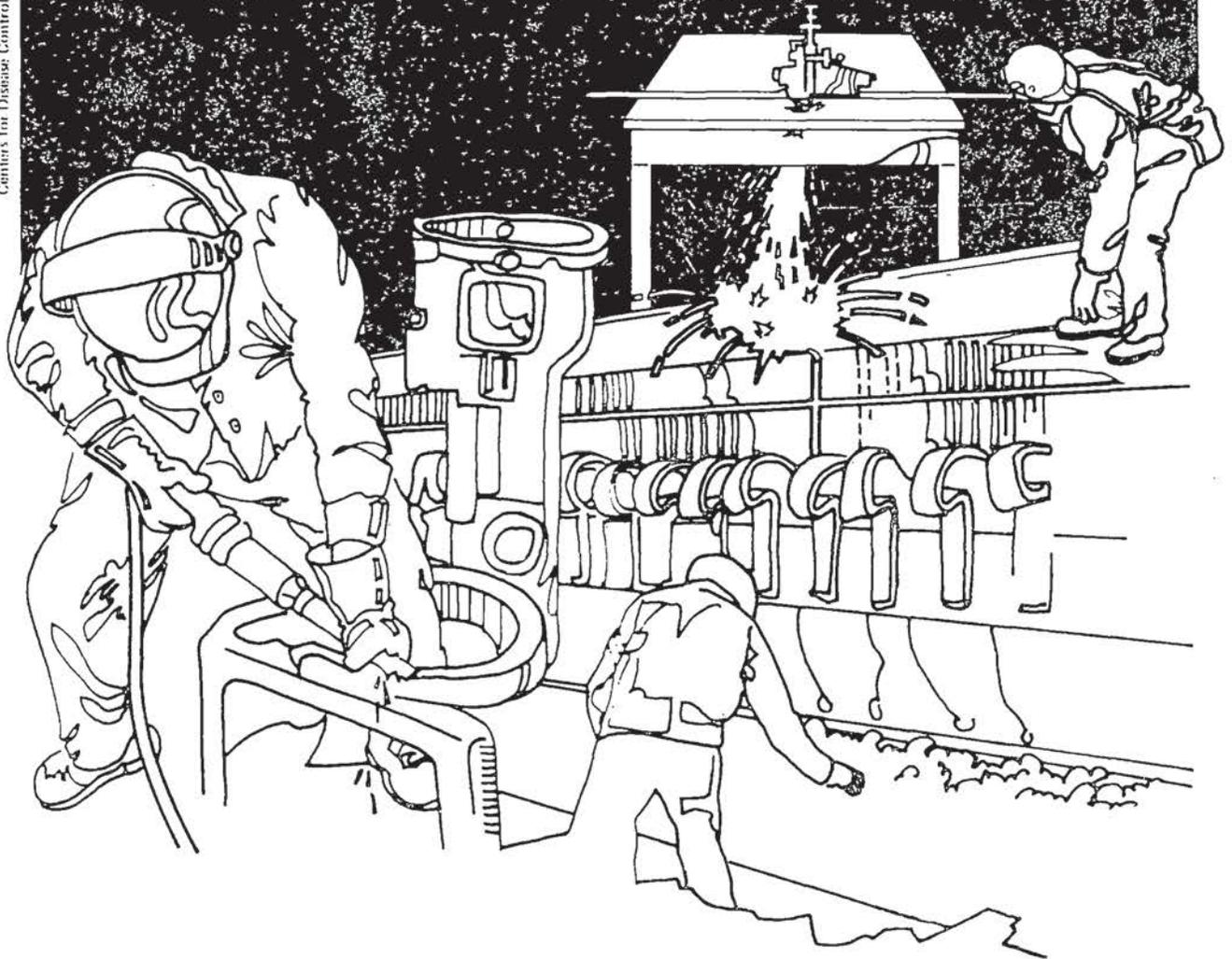


NIOSH



Health Hazard Evaluation Report

HETA 84-044-1441
RHINEHART TIRE FIRE
WINCHESTER, VIRGINIA

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 84-044-1441
MARCH 1984
RHINEHART TIRE FIRE
WINCHESTER, VIRGINIA

NIOSH INVESTIGATOR:
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I. SUMMARY

On November 2, 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Environmental Protection Agency to provide immediate technical assistance in evaluating site safety and worker exposure to unknown and potentially hazardous substances emanating from an automobile and truck tire fire in Winchester, Virginia.

On November 4 and 9, 1983, NIOSH industrial hygienists visited the Rhinehart Tire Farm, reviewed the site/safety protocol established by EPA's Office of Emergency and Remedial Response, and collected air samples to determine the types and magnitude of contaminants present during the fire containment and preliminary cleanup operations.

Analysis of samples collected in the fire smoke plume indicated potentially hazardous levels of carbon monoxide (CO) and polynuclear aromatic hydrocarbons (PAHs). Levels of CO were variable (due to windy conditions), but were measured at 50-100 ppm. The NIOSH recommended exposure limit for CO is 35 ppm 10-hour TWA. Polynuclear aromatic hydrocarbon analysis detected several PAH compounds, with the highest, naphthalene, present at a concentration of 461 $\mu\text{g}/\text{m}^3$. Others detected included benzo(a)pyrene (3 $\mu\text{g}/\text{m}^3$), pyrene (11 $\mu\text{g}/\text{m}^3$), chrysene (18 $\mu\text{g}/\text{m}^3$), fluorene (26 $\mu\text{g}/\text{m}^3$), anthracene (35 $\mu\text{g}/\text{m}^3$) and phenanthrene (54 $\mu\text{g}/\text{m}^3$).

Almost all job functions evaluated resulted in potential PAH exposure. Individual PAH exposures ranged from 12 nanograms/ m^3 benzo(a)pyrene to a dozer operator up to 3450 ng/m^3 fluorene to a pumper. Total PAH exposure ranged from 58 ng/m^3 to a dozer operator to 6802 ng/m^3 to a pumper.

Metals analysis of the plume showed 11 $\mu\text{g}/\text{m}^3$ lead, 14 $\mu\text{g}/\text{m}^3$ iron and 122 $\mu\text{g}/\text{m}^3$ zinc.

Analysis of the tire residue or "product" showed it to be extremely complex, likely containing thousands of individual compounds. Some of these organic chemicals, which also were detected in air samples, included benzene, styrene, toluene, xylenes, and PAHs. No nitrosamines were detected in either the product or the air samples.

Based on this limited set of environmental data, it was concluded that there was not an acute health hazard present from airborne contaminants relative to the containment and cleanup operations on those days sampled. It is unlikely that workers could be exposed to static CO concentrations in excess of 35 ppm. However, exposure to PAHs, from both skin contact and inhalation, is possible for all workers in the Contamination Reduction Area and the Exclusion Area, with potentially greater risk to those not using protective clothing. Considering the unknown exposure potential that existed in the beginning of the fire, level B protection (supplied air respirators and protective clothing) was appropriate.

Recommendations are presented in Section VI of this report concerning the use of personal protective equipment and work practices.

KEYWORDS: SIC 9999 (Non Classifiable Establishments), PAHs, personal protective equipment, carbon monoxide, petroleum combustion products.

II. INTRODUCTION

On November 2, 1983, NIOSH received a request for emergency technical assistance from the Environmental Protection Agency to evaluate personal protective equipment usage and potential exposures resulting from containment and cleanup of a major truck and automobile tire fire in Winchester, Virginia.

On October 31, 1983, a fire of unknown origin began in a dump containing approximately 5 million tires. This fire, which became known as the Rhinehart Tire Fire (named for the person who owned the dump), covered a 4-acre site and issued a black smoke plume approximately 3000 feet high and 30-50 miles long. Fallout from this plume was eventually reported in 3 states. The bed of tires, which were to be used in a recycling effort, were situated on a hillside (see Attachment 1 - Sketch of Rhinehart Tire Fire), at the bottom of which was a small creek. This creek led to Hogue Creek, and ultimately to the Potomac River which is the drinking water supply for Washington, D.C. Because of the intense heat of the fire, the tires beneath the surface were melting into a liquid which was running into the creek (estimated at peak to be 100 gallons/minute). Because of this potentially far-ranging environmental hazard, initial efforts were confined to fire and product (oily distillation and pyrolysis liquid from tires) containment rather than fire extinguishment. The terrain with its grades and wooded hillsides, and the possibility of fire spread, precluded measures such as bulldozing the tire pile into smaller, more manageable parts, and dynamiting the fire out. In addition, limited water supply prevented fire companies from dousing the fire.

Numerous local, state, and federal agencies were involved in the operation, including the U.S. Coast Guard, and two private hazardous materials management firms contracted to contain and clean up the product. Two retention basins (indicated as primary and secondary containment) had been built to hold the product. The product would be pumped from the primary containment pond into tanker trucks and hauled away.

The level of worker protection required depended on the area in which he would be working. These areas were designated: Exclusion Area (EA) - area surrounding the tire pile and product containment ponds; Contamination Reduction Area (CRA) - from the Exclusion outward to the Support Area along the access road; and Support Area (SA) - the coordination area. These areas are shown as dotted lines in the sketch. Workers in the EA handling the product were required to wear impervious suits with head covering, three-layer glove protection with

taped wrists; boot coverings with taped ankles, and supplied air breathing apparatus (Level B). Others in the EA could downgrade to Level C (air-purifying). CRA workers were required to have Level C respiratory protection. The SA required no skin or respiratory protection. Workers leaving the EA must pass through the CRA, where CRA workers maintained a Contaminant Reduction (CR) or Decon line: suits and boots were scrubbed twice with detergent solution, then rinsed and removed. Some protective clothing articles were thrown away; reusable articles were recycled after decontamination and disinfection.

III. EVALUATION METHODOLOGY

On November 4, in order to learn what substances comprised the smoke and other emissions from the fire, area air samples were collected. However, fire conditions at the site were unstable and it was impossible to collect air samples close to the burning tires but not in the smoke. Therefore this latter idea was abandoned. Three area stations were selected: in the smoke plume, in an area along the access road away from smoke and fire, and at the CRA. Samples were collected for nitrosamines, metals, total particulates, PAHs, and other organic vapors. In order to determine if an acute health hazard was present in the smoke, several detector tube measurements were made. In addition, 7 personal samples were collected for the same substances mentioned above.

On November 9, 19 personal samples were collected. All air samples were collected with personal portable sampling pumps and specific collection media. The sampling and analytical parameters are listed in Table 1.

Also on November 9, bulk samples of the product were obtained. These samples would be used to support the air sample analysis (identification and confirmation), and for assay for mutagenic potential.

IV. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse

health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's)¹, and 3) the U.S. Department of Labor (OSHA) occupational health standards.² Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures. Refer to Table 2 for examples.

B. Specific Substances

The toxicity and recommended exposure limits for the two substances for which we believe potential excessive exposure exists - PAHs and CO - are presented below.

1. Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are a class of compounds consisting of various arrangements and substitutions of multiple benzene rings. PAHs result mainly from the combustion or high-temperature treatment of coal-derivatized materials. There are no published exposure limits to PAHs, per se. However, OSHA does have a standard for coal tar pitch volatiles (CTPV), described as a "benzene-soluble" fraction of total particulates, which is 200 micrograms/m³ 8-hour TWA. This benzene-soluble fraction of coal tar and related products generally contain substances which have carcinogenic potential for man. NIOSH has published a criteria document³ on coal tar products which recommends a 100 µg/m³ 10-hour TWA exposure limit for a "cyclohexane soluble fraction", which generally equates with the CTPV components. Epidemiological studies of the cancer mortality rates among steel workers, roofers, and gas workers indicate that high PAH exposure is associated with increased mortality from lung cancer.^(4,5,6,7) Consequently, NIOSH recommends that exposure to PAHs be reduced to the extent feasible by engineering control and personal protective equipment.

2. Carbon Monoxide⁸

Carbon monoxide is an odorless, colorless, and tasteless gas usually resulting from the incomplete combustion of carbon products such as wood and petroleum. The primary biological effect of CO is its combination with the hemoglobin of the blood to form carboxyhemoglobin (COHb). Hemoglobin is the oxygen - carrying component of the blood. Although CO reacts less rapidly with hemoglobin than O₂, the bonding in COHb is about 200 times stronger. The net result is that the tissues become O₂ starved (tissue hypoxia) and cardiovascular stress and central nervous system depression occurs. These effects are COHb-concentration dependent. COHb levels in excess of 5% have been shown to cause deleterious effects in persons with coronary heart disease (CHD), and adverse behavioral effects (e.g., task performance, vigilance).

The recommended exposure limit to CO in this report, and the current legal exposure limit, are:

<u>Substance</u>	<u>Recommended Exposure Limit</u>	<u>OSHA Standard</u>
CO	35 ppm, 8 hour TWA	50 ppm, 8 hour TWA

This recommended exposure limit does not take into account the smoking habits of the worker.

COHb levels in chronic cigarette smokers has generally been found to be in the 4-5% range prior to CO exposure. The recommended exposure limit is based on the utilization of the Coburn equation, which predicts the mean COHb level of a sedentary worker exposed to a known TWA concentration of CO for an eight hour day. More active workers will actually have higher COHb levels. It may be that very strenuous activities warrant a lower airborne exposure limit.

V. RESULTS AND DISCUSSION

A. Detector Tube Measurements

Detector tube measurement made at the site are presented in Table 2. Included is a list of substances reported to cause interferences (either positive or negative) in the measurement. For the most part, interferences are positive, meaning that, if the interfering substance was present, results should be considered high. No measurement exceeded any ceiling limit. However, the most important component of the smoke of those we looked for was carbon monoxide, which exceeded the NIOSH 10 hour exposure limit of 35 ppm. Under more static conditions (no wind) the concentrations probably would have been higher. However, workers are not likely to work directly above the fire or be in any position to be exposed to the smoke for 10 hours without supplied air respiratory protection.

B. Area Sampling

The only area sample set for which there is useful data is the plume sample set.

Metals analysis of the plume showed the presence of aluminum, calcium, iron, sodium, lead, and zinc in concentrations ranging from 2 to 122 ug/m³ (lead 11 ug/m³, iron 14 ug/m³ and zinc, 122 ug/m³). All other metals were less than 2 ug/m³.

PAH analysis of the plume was performed for the 16 PAHs listed (in order of increasing molecular weight) in Table 3. Also listed are the concentrations and the limits of detection for each PAH for all air samples. Problems with the sampling and analysis, such as far-ranging recoveries, significant break-through (substance on back-up section of sorbent tube), and the presence of low molecular weight or highly volatile PAHs (e.g., naphthalene) on the plume sample but not the personal samples, lead us to believe that the personal results, in general, represent low estimates of exposure.

C. Product Analysis

Analysis of the air space above a vial of the product by GC/MS indicated low concentrations of toluene, benzene, xylenes, and limonene (lemon extract). Numerous other peaks, many too small for absolute identification, included C₉H₁₂ and C₁₀H₁₄ alkyl benzenes, styrene, naphthalene, and several C₇-C₈ type unsaturated aliphatics such as dienes and cycloalkenes. Analysis of the charcoal tube sample taken in the plume revealed the same components as the product.

More extensive GC/MS data were provided by Southern Research Institute (SRI), Birmingham, Alabama, under contract for NIOSH. The product was an extremely complex mixture, likely containing thousands of individual compounds. Some of the classes of chemical compounds detected are: alkanes substituted benzenes, substituted hydrazines, ketones, halogenated hydrocarbons, substituted phenols, nitriles, benzoic acids, and substituted benzeneamines. In addition, several PAHs were detected: anthracene, pyrene, naphthalene, and fluoranthrene.

SRI also performed the Ames test for mutagenicity on the product. It was determined that the product exhibited a positive mutagenic response with Salmonella typhimurium strain TA98 in the presence of S9 rat liver metabolic activation system.

No nitrosamines were detected in the product (lower limit of detection for dimethylnitrosamine = 35 nanograms/mL sample).

D. Personal Monitoring

Personal air sampling results are listed in Tables 4 and 5. These data must be qualified as follows. Due to the restrictions imposed by personal protective equipment and access to the worksite, it was impossible in some cases to check the sampling pumps for flow rate or to collect them after 8 hours (work shift was 12 hours). When sampling was terminated, some pumps had discharged completely so the true endpoint could not be determined. Therefore, the time period "start of sampling" to "retrieval of sample" has been used for calculations of sampling duration. In those cases, this results in an underestimation of the concentration. This does not appreciably compromise the results relative to the recommended exposure limits. Further, any results should be considered maximum since all workers were wearing respiratory protection.

All exposure values (except for benzene) in Table 4 are well below any established exposure limits. Worker exposure to benzene ranged from nondetectable to 0.6 mg/m³ (exposure limit = lowest feasible level); toluene, nondetectable to 0.79 mg/m³ (exposure limit = 375 mg/m³); xylenes, nondetectable to 1.08 mg/m³ (exposure limit = 425 mg/m³); styrene, nondetectable to 0.63 mg/m³ (exposure limit = 215 mg/m³); aluminum, 0.01 to 0.02 mg/m³ (exposure limit = 10 mg/m³); calcium, 0.02 to 0.09 mg/m³ (exposure limit = 2 mg/m³); iron, 0.01 to 0.15 mg/m³ (exposure limit = 5 mg/m³); magnesium, nondetectable to 0.01 mg/m³; sodium, 0.01 to 0.03 mg/m³ (no published exposure limit); and zinc, nondetectable to 0.02 mg/m³ (exposure limit = 5 mg/m³). No nitrosamines were detected in any personal samples.

Table 5 contains data relating to PAH exposure to workers. The top row of numbers can be linked to the PAHs by referring to Table 3. Eleven different PAHs were quantitated. The blank spaces in the table indicate non-detectable (see Table 3 for individual LLOD). Exposures to individual PAHs ranged from 12 ng/m³ benzo(a)pyrene to a dozer operator to 3451 ng/m³ fluorene to a pumper. Total PAH exposures ranged from 58 ng/m³ to a dozer operator to 6802 ng/m³ to a pumper. The average number of parts to which these workers were exposed is 6. To put these values in perspective: exposures documented in petroleum refinery workers⁹, a situation somewhat analogous to this fire, were in the low microgram/m³ range with an average of 10-11 PAHs identified per sample.

Every job function evaluated, with the exception of a worker involved in creek cleanup (which would place him away from, and generally upwind of the fire, at the time of sampling, was potentially exposed to PAHs. However, the CR line worker was exposed to all eleven PAHs - he was the only worker to be measurably exposed to pyrene. A Decon line worker would be expected to have the least potential for exposure considering his remote location with respect to the fire. His only exposure should be from washing down and helping remove other workers' protective clothing.

There is an apparent difference in PAH exposure between dozer operators for which we have no good explanation. Diesel exhaust contains PAHs. Assuming that both bulldozers and all the heavy trucks used to haul away product were diesel-powered, the exhaust would be a potential positive contribution to the PAH exposure. The differences also could be associated with operator location relative to wind direction.

Hutcheon *et. al.*¹⁰ reported that the concentration of benzo(a)pyrene (BaP) in American cities ranged from 0.3-6.0 ng/m³ in summer and from 6.0-74 ng/m³ in winter. Therefore, one could consider some of this report's values to be comparable to background. Further, cigarette smoke contains PAHs and represents a significant source of exposure to both smokers and passive smokers. Observation showed that Decon workers did not wear their respiratory protection constantly, and, when not actually working, spent their time in a truck cab where it was warm. Presumably, they had ample opportunity to be exposed to cigarette smoke. The report Indoor Pollutants by the National Research Council¹¹, indicates that mainstream cigarette smoke contains many PAHs ranging in concentration from 11-270 nanograms per cigarette.

Particulate weight gains were slight (<0.1 mg).

Review of the types of protective clothing being used, the log in - log out procedure for entry beyond the support area, and the decontamination procedures showed all to be satisfactory. Initially there was a problem with respirators supplied by the Virginia National Guard which was remedied before they were put into use. Consultation with the Department of the Army revealed that the cartridges supplied with the full-face gas masks were training cartridges and not suitable for use in hazardous environments. Subsequently, their use was disallowed by the CDC.

VI. CONCLUSIONS AND RECOMMENDATIONS

Our conclusions and recommendations concerning worker protection are predicated on our belief that two different environmental conditions exist: conditions while the fire is burning, which have been characterized by NIOSH and EPA; and conditions when the fire is out which are unknown, but, considering the nature of the product, are expected to present less of an inhalation hazard.

A. While Still Burning

1. The smoke plume from the fire contains hazardous substances which should not be breathed (carbon monoxide, PAHs) or allowed to contact the skin (PAHs). If it is necessary for persons to work in the plume, then they should be provided with air-supplied respiratory protection and skin protection (Level B). While one could argue that there were other sources of PAHs, the actual contribution to the total PAH exposure is unknown. It is a conservative measure to assume that the fire is the sole source until more information is available.

2. Exposure to airborne metal fume and particulate and solvent vapors other than in the plume is slight and should not pose a health hazard.
3. The hot product releases volatile contaminants that pose a potential inhalation hazard to workers nearby. Hot product handlers should continue with level B protection.

B. When Fire is Out

1. Mild mutagenic activity is attributed to the product. Dermal contact should be prevented with the continued use of gloves, boot coverings, and suits.
2. It might be prudent to collect air samples over the cool and agitated product to determine if volatile organics are still being released. This could be done initially with an organic vapor analyzer or H-Nu photoionizer, with identification and quantification by more sophisticated procedures if vapor levels are above the EPA 5 ppm guideline. If acceptable vapor levels exist, then respiratory protection may be down graded to level C - respirators with organic vapor cartridges. Since eye protection is necessary, and half-face respirators and safety glasses are not compatible comfort-wise, full-face respirators will serve both functions, in addition to providing a better face seal. This recommendation is based on the belief that a situation immediately dangerous to life and health will not exist, there will be no oxygen - deficient atmosphere, and the product has a characteristic odor to serve as a breakthrough warning.

C. Other

1. The decontamination procedure, as conducted during the evaluation, was well executed. However, we noted workers, in the process of removing protective clothing, were sitting down on a bench where other workers, still fully clothed in contaminated protective gear, were sitting. This allows transfer of contamination to street clothing. A separate bench for those stripped down to street clothes should be provided.
2. A heated shelter should be provided for Decon line workers.
3. No eating, drinking, or smoking should be allowed in the EA or in the immediate vicinity of the CRA. Hand washing and latrine facilities should be provided adjacent to the CRA.

4. The problem with the respirators supplied by the National Guard should be brought to the attention of responsible parties within the Virginia National Guard. The issuance of inappropriate respirators (in this case, respirators containing non-functional training cartridges) could result in harmful consequences to the wearer.

VII. REFERENCES

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VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Center for Environmental Health, CDC
2. Office of Emergency and Remedial Response, EPA, Region III
3. NIOSH, Region III
4. OSHA, Region III

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.

Figure 1

Rhinehart Tire Fire
Winchester, Virginia
November 9, 1983
HETA 84-44

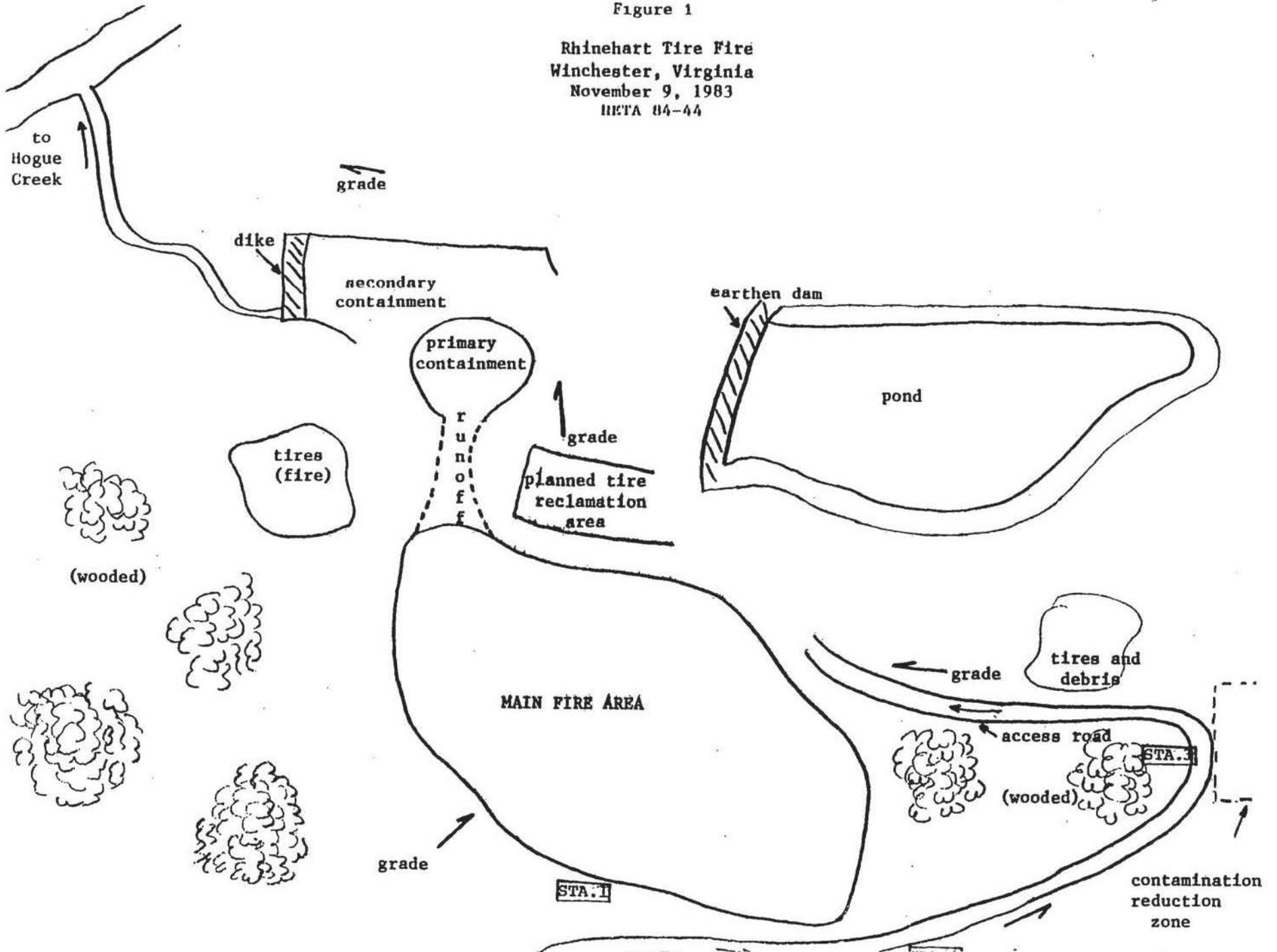


Table 1
Sampling and Analytical Methodology

Rhinehart Tire Fire
Winchester Virginia
HETA 84-44

Substance	Sampling Method	Analytical Method	Source
Metals	cellulose ester membrane filter flow rate 1.0 Lpm	low temperature ashing nitric acid digestion inductively coupled plasma, atomic emission spectroscopy	NIOSH
Organic Solvents	activated charcoal sorbent flow rate 0.2 Lpm	CS ₂ desorption GC-FID and GC/MS	NIOSH
Nitrosamines	thermosorb N sorbent flow rate 1.0 Lpm	methanol/methylene chloride desorption, thermo energy analyzer in nitrosamine mode	NIOSH
Total Particulate	preweighed filter flow rate 1.0 Lpm	gravimetric	NIOSH
PAHs	zefluor filter + ORBO 43 sorbent flow rate 1.0 Lpm	acetonitrile extraction 40/60 acetonitrile/water to acetonitrile linear gradient HPLC/UV detector	A.D. Little, Inc.

Table 2
 Detector Tube Measurements of Smoke Plume

Rhinehart Tire Fire
 Winchester Virginia
 HETA 84-44

November 4, 1983

Substance	Concentration, (ppm)	Interferences, (type)	Recommended Exposure Limit, ppm (source)
acrylonitrile	1.0	butadiene(-)	4 (NIOSH)
carbon dioxide	400		10,000 (NIOSH)
carbon disulfide	5-10	benzene(+), N-octane(+) H ₂ S(+), CO(+)	1 (NIOSH) *C10 (NIOSH)
carbon monoxide	50-100	acetylene(+)	35 (NIOSH) C200 (NIOSH)
formaldehyde	<0.5		no exposure (NIOSH)
hydrogen sulfide	<1.0		C10 (NIOSH)
mercaptan	<2.0		none published
nitrogen dioxide	<0.5	ozone(+), Cl ₂ (+)	C1
ozone	<0.05		0.1
phenol	<5.0		5 (NIOSH) C15 (NIOSH)
phosgene	<0.1		0.1 (NIOSH) C0.2 (NIOSH)
styrene	<50		100 (ACGIH) C200 (ACGIH)
sulfur dioxide	2.0	NO ₂ (+)	2 (NIOSH)
total hydrocarbons	<2000 mg/m ³		none published

*C = ceiling value, not to be exceeded.

Table 3

PAHs in Plume

Rhinehart Tire Fire
Winchester Virginia
HETA 84-44

November 4, 1983

ID Number	Concentration (ug/m ³)*	Limit of Detection (ug)
1 naphthalene	461	5
2 acenaphthylene	ND	7
3 acenaphthene	9	1
4 fluorene	26	0.5
5 phenanthrene	54	0.2
6 anthracene	35	0.3
7 fluoranthrene	16	0.005
8 pyrene	11	0.1
9 benz(a)anthracene	6	0.005
10 chrysene	18	0.10
11 benzo(b)fluoranthrene	1	0.003
12 benzo(k)fluoranthrene	1	0.005
13 benzo(a)pyrene	3	0.005
14 dibenz(a,h)anthracene	ND	0.05
15 benzo(g,h,i)perylene	ND	0.05
16 indenopyrene	3	0.02
Total PAHs	644	

* Sample duration, 405 minutes

Table 4
Personal Exposures to Tire Fire Contaminants

Rhinehart Tire Fire
Winchester Virginia
HETA 84-44

November 4 and 9, 1983

Job Description	Sampling Duration (min)	Nitrosamines (ng/m ³)	General Organics (mg/m ³)				Total Organic Compounds	Metals (mg/m ³)									
			Benzene	Toluene	Xylenes	Styrene		AL	Ca	Fe	Mg	Na	P	Pb	Zn		
pumper	410	ND															
pumper	724	ND															
pumper	596							0.01	0.02	0.01	<0.01	0.02	<0.01	<0.01	<0.01		
pumper	685		0.60	0.79	1.08	0.63											
dozer operator	640	ND															
dozer operator	550		0.05	0.08	0.11	ND											
foam truck operator	600							0.01	0.05	0.02	0.01	0.01	<0.01	<0.01	0.02		
foam truck operator	580	ND															
decon line worker	655		0.04	0.11	0.13	0.06											
decon line worker	90		ND	ND	ND	ND											
decon line worker	625	ND															
decon line worker	590							0.02	0.09	0.15	0.01	0.01	<0.01	<0.01	0.01		
creek cleanup	345		0.06	0.11	0.16	ND	0.81										
creek cleanup	320		ND	ND	ND	ND	ND										
creek cleanup	410																
creek cleanup	325		0.04	0.07	0.11	ND	0.73										
cleanup by 1 ^o containment pond	724							0.01	0.03	0.01	<0.01	0.03	<0.01	<0.01	<0.01		

Limit of Detection 70 nanograms/sample 1 ug/sample-----continued-----1 ug/sample 1 ug/sample-----continued-----1 ug/sample
 Recommended Exposure Limit LFL 375 425 215 10 2 5 10 0.1 0.05 5
 (NIOSH) (ACGIH) (ACGIH) (ACGIH) (ACGIH) (ACGIH) (ACGIH) (ACGIH) (ACGIH)(NIOSH)(ACGIH)

Table 5
 Personal Exposures to PAHs (nanograms/m³)

Rhinehart Tire Fire
 Winchester Virginia
 HETA 84-44

November 4 and 9, 1983

Job Description	Sampling Duration (min)	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total PAHs
dozer operator	565	**						58										58
dozer operator	583				19	1779	34	196		41	182	19	22	12			122	2304
pumper	585				3451	142	2651	84		55	335	19	15	50				6802
pumper	590				1035	97	276											1408
pumper	410																	
decon line worker	593				19	2497	34	297	211	66	322	44	29	24			83	3626
creek cleanup	410																	
cleanup by 1 ⁰ containment	645				1722	138	586											2446

* Numbers refer to the numbered list in Table 3.

** Blank spaces indicate non-detectable