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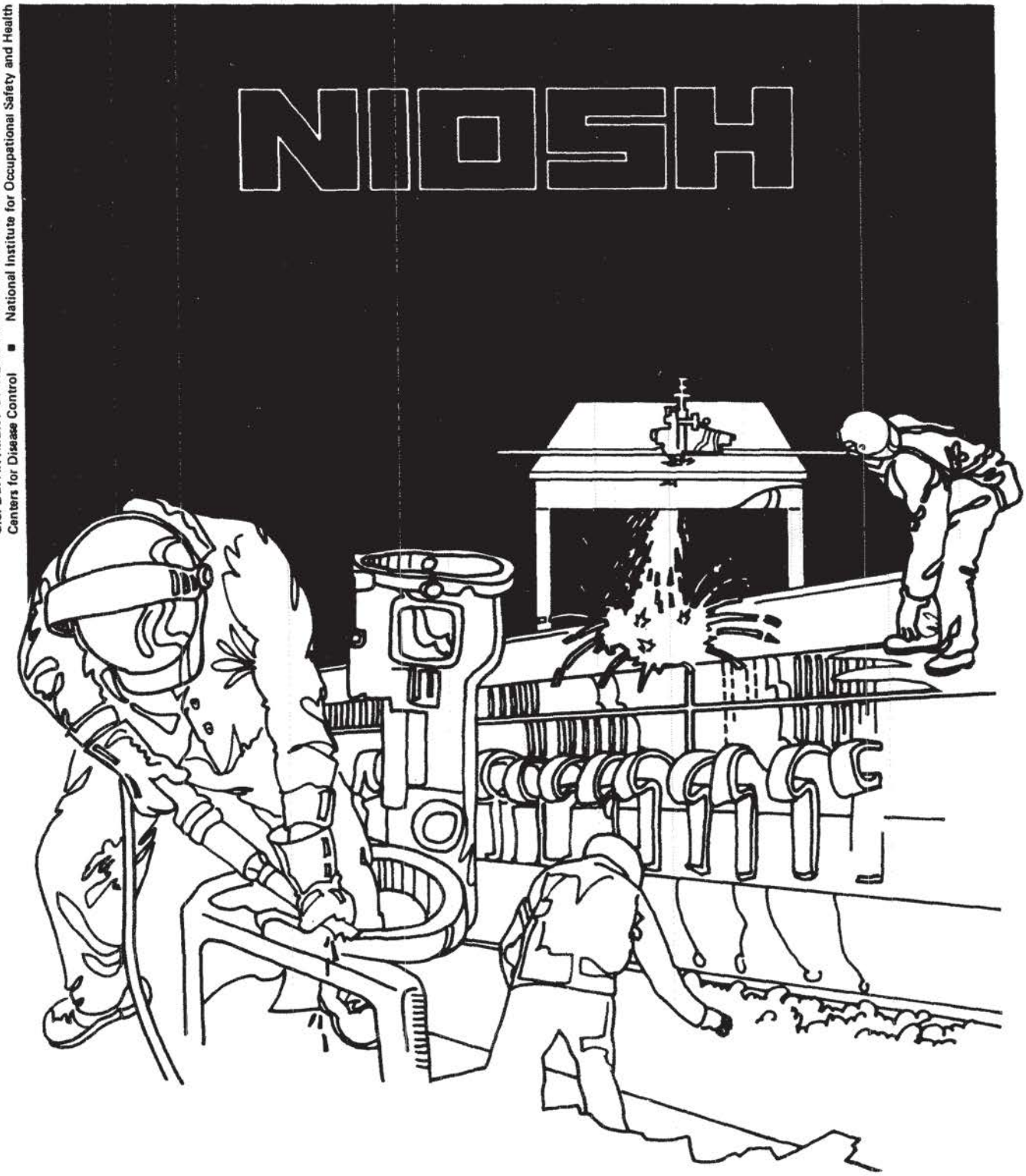

Health Hazard Evaluation Report

HETA 82-190-1156
METROPOLITAN OPERA
NEW YORK, 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 nygiene 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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Metropolitan Opera
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NIOSH INVESTIGATOR:
Nicholas Fannick, IH

I. SUMMARY

In February 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to perform a health hazard evaluation at the properties shop of the Metropolitan Opera Association, Lincoln Center, New York City. The properties shop makes and repairs props for opera stage productions. While most of the props are made by carpentry, an increasing number are now being made by fibrous glass lay-up molding. Several other products containing organic solvents also have been introduced into the properties shop. The workers in the properties department and the Opera's management became concerned about the extent of exposure to various organic chemicals used in the properties shop, and asked for NIOSH's assistance in identifying the organic solvents used and in evaluating the extent of exposure to these solvents.

On February 25, 1982, a survey was conducted to determine employees' exposure to the solvents used in the properties shop. Breathing zone and area samples were collected using appropriate sorbant tubes as the collecting medium. Results of the survey indicate that the workers in the properties shop are exposed to very low concentrations of methyl ethyl ketone, toluene, xylene, acetone, n-hexane or styrene during typical operations.

On the basis of this hazard evaluation, NIOSH concludes that the workers in the properties shop are exposed to minimal concentrations of various solvents during normal activities. However, during the construction of large props, the exposure levels may be much higher. For such periods, respiratory protective equipment is necessary and should be in proper working condition. The employees in the properties shop should receive training in the use of respiratory protective equipment and a program for the proper maintenance of the respirators and timely replacement of respirator cartridges should be established.

KEY WORDS: SIC 3999 (Manufacturing Industries, Not Elsewhere Classified), methyl ethyl ketone, toluene, xylene, acetone, n-hexane, styrene, respiratory protective equipment.

II. INTRODUCTION

In February 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of the Metropolitan Opera Association to investigate the exposure of workers in the opera's properties shop to several organic solvents. The official request followed several week's involvement of the Regional NIOSH Office with the management of the properties shop concerning matters such as the chemical ingredients of the various products used in the properties shop and the toxicological effects of exposure to those chemicals. A representative of the Regional NIOSH Office visited the properties shop in early February and the environmental monitoring was conducted on February 25, 1982.

III. BACKGROUND

The property department of the Metropolitan Opera Association (which includes the properties shop) supplies "props" to be used in opera productions. Many of these props are purchased, however the properties shop is called upon to manufacture (and repair) many unique objects such as life-sized mechanical dolls and swan boats. There is no production line and each piece is hand crafted. Because the work of the properties shop is so specialized, the adoption of the use of chemical solvents and adhesives has been slow and these products are less used than would be the norm in a shop of this size. The work force of the properties shop consists of 6 to 8 artisans. The activities of the shop vary from day to day and from (opera) season to season, depending on the number of new productions being staged and the wear and tear on the props. The staff estimates that lay-up molding averages less than 8 hours per day during normal production. Usually, only one employee is occupied with lay-up molding. However, during the construction of complicated or rush orders, two employees may work at lay-up operations, which may last for a week or longer. While much of the work of the shop is carpentry, an increasing number of the props are being made of fibrous glass and polyester resins. Also, the use of various adhesives and solvents has increased in the shop, and the employees and management began to be concerned about the consequences of exposure to the chemicals in these products. Respiratory protective equipment is available to the staff of the properties shop, and is generally worn during fibrous glass lay-up work. Discussions with the staff indicated that they have little knowledge of the use of different types of cartridges or filters for different kinds of contaminants, or of the need to replace cartridges on a regular basis.

In December 1981, the management of the properties department had contacted the Regional NIOSH Office for advice on obtaining the composition of the products they use and the toxicological effects of exposure to them. Once these facts were obtained, a health hazard evaluation to determine the extent of exposure to the chemicals was requested.

The properties shop is laid-out like a letter "P" (see Figure 1), with a large elevator in the "hole" of the "P". The fibrous glass lay-up work is performed behind and to the right of the elevator, and the carpentry shop occupies the stem of the "P". The carpentry shop is about 125 feet long and the two parts of the lay-up area are about 35 feet square. The ceiling is about 18 feet high. General dilution ventilation is supplied to the area but there is no exhaust ventilation for the lay-up operations. All major painting is performed in the Opera's painting shop, and only minor touch-up painting with a small brush is done in the properties shop.

IV. EVALUATION DESIGN AND METHODS

The components of the nine solvents and adhesives used in the properties shop are listed in Table I.

Methyl ethyl ketone (MEK) samples were collected on ambersorb tubes using a flow rate of about 200 cubic centimeters per minute for about 2 hours. The tubes were analyzed by gas chromatography using a modification of NIOSH method S-3.

Eight breathing zone and general area samples were collected for toluene, xylene (ortho, meta and para isomers), acetone, n-hexane and styrene with activated charcoal tubes as the collection media, using similar flow rates for similar time periods. The charcoal tubes were analyzed by gas chromatography using a modification of NIOSH method P&CAM 127.

The sampling was performed during the lay-up of hand held articles such as mannequin heads and during the gluing and spraying of small articles by one employee. A second employee aided in the lay-up for about 1/2 hour and then returned to corpentry duties. While such activities are typical of the work usually done in the properties shop, exposure levels would be expected to be higher during periods when larger pieces are created or when additional workers are involved.

V. EVALUATION CRITERIA

Criteria recommended by NIOSH, Permissible Exposure Limits (PEL) established by the Occupational Safety and Health Administration (OSHA) and Threshold Limit Values (TLV) set by the American Conference of Governmental Industrial Hygienists (ACGIH) for exposure to airborne concentrations of the substances measured in this evaluation are listed in Table II. All concentrations are listed in parts per million parts of air (ppm). These limits are the maximum time weighted concentrations of each substance to which most individuals can be exposed for eight to ten hours per day or 40 hours per week without

adverse health effects. Some substances have been given ceiling, peak or short term exposure limits (STEL) which should not be exceeded. In those cases where there is a difference in the limits referenced, the most stringent value is the criteria used in this evaluation. In reference to Table I, aliphatic solvents, mineral spirits and kerosene are not individual substances, but rather are complex mixtures of various hydrocarbons (usually in the C5 to C10 range).

Almost all of the compounds used in the properties shop have related health effects, such as headache, nausea, dizziness and dermatitis. Propane and isobutane, which are used as propellants in two of the products, are usually considered to be simple asphyxiants (replace oxygen in the air) but may also produce some dizziness.

VI. RESULTS AND DISCUSSION

The results of environmental sampling are listed in Table III. In the analysis, minute concentrations of various other hydrocarbons were detected. As the exposure levels to these constituents were insignificant, they are not listed in the table.

The environmental criteria used in this report were not exceeded. The results of the environmental survey indicate that workers in the properties shop are not exposed to excessive concentrations of solvent vapors during periods of normal activities. Since the chemicals used in the properties shop have similar health effects, the results of exposure may be expected to be additive. However, the exposure levels are so low, that even considering additive health effects, the exposures present little opportunity for adverse health effects.

Although the results of this survey indicate that the employees of the properties shop are not exposed to excessive concentrations of organic vapors during normal lay-up operations, consideration should be given to exposures which might occur during the construction of large pieces. The total amount of material used in lay-up during the survey was not more than one cubic foot of fibrous glass/styrene. The amount of material used during the construction of large props (for example a 20 foot long gondola) would generate much more styrene vapor, not only during the lay-up operation but also during the curing period. While the amount of styrene which would be generated during the construction of a large prop is not known, it is probable that the concentration of styrene could exceed the OSHA PELs. The use of an organic vapor cartridge respirator is indicated unless the styrene concentration is 5000 ppm or greater.[4]

Because the organic vapor concentrations measured under normal operating conditions is so very low, the need for the installation of exhaust ventilation to control exposure to styrene vapor is not indicated, unless the use of styrene in the lay-up operation increases greatly.

While the use of organic vapor cartridge respirators offers adequate protection from exposure to chemical vapors generated during lay-up operations in the properties shop, the respirators must be used and maintained properly to be of any value. Discussions with the workers of the properties shop revealed that they had only a rudimentary knowledge of respirators. In addition, it was noted that the cartridges of the respirators used during lay-up had not been changed for weeks or months.

VII. RECOMMENDATIONS

NIOSH recommends that the employees of the properties shop be instructed in the proper use and care of their respirators, including the approximate "life" of the chemical cartridges used during lay-up and other operations involving the use of organic solvents.

Consideration should be given to providing fit testing (as described in the attachment to this report) to the employees who are exposed to organic solvents in the properties shop. Fit testing can be done by a quantitative test, where the amount of leakage of a contaminant into the user's breathing zone is measured or quantified. An alternative type of test is qualitative fit testing (in which the respirator wearer is asked to identify some odoriferous gas or vapor, such as banana oil). Qualitative fit testing is available through several companies in the New York City area, and the material to perform qualitative fit testing is available in kit form. Since the exposures in the properties shop are intermittent, and the organic solvents in use have good warning properties, qualitative fit testing would suffice, although quantitative fit testing is preferable.

VIII. REFERENCES

1. National Institute for Occupational Safety and Health . NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-123).

2. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values. 1981 suppliment. Cincinnati, Ohio: ACGIH, 1981.

3. Patty FA. Patty's industrial hygiene and toxicology. Vol II-- toxicology, 3rd revised edition. New York: John Wiley & Sons, 1978.

4. NIOSH/OSHA draft technical standard for styrene. January 3, 1975.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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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.

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 Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. The Metropolitan Opera Association
2. International Alliance of Theatrical Stage Employees, Local 1
3. OSHA, Region II Office
4. New York State Department of Health
5. NIOSH, Region II Office

TABLE I

INGREDIENTS OF COMPOUNDS USED AT
PROPERTIES SHOP
METROPOLITAN OPERA

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COMPOUND	INGREDIENT	%
Spray Adhesive	Hexane	41
	Cyclohexane	14
	Styrene/butadiene elastomer, terpene resin, wood rosin, and an antioxidant	22
	Propane/isobutane propellant	23
Contact Cement	Aliphatic solvents	44
	Acetone	26
	Toluene	8
	Elastomer, resins, zinc oxide, magnesium oxide and water	22
Lacquer Thinner	Toluene	40
	Mineral spirits	20
	Butyl acetate	15
	iso Butyl alcohol	11
	Acetone	10
	Methanol	4
Mineral Spirits	Mineral Spirits	100
Acetone	Acetone	100
Quickset	Methyl ethyl ketone	60
	Dimethyl phthalate	40
Kerosene	Kerosene	100
Mold Release	Hexane	66
	Propane/isobutane propellant	29
	Silicone lubricant	5
Polyester Resin	Unsaturated resin	55
	Styrene	45

TABLE II

EXPOSURE LIMITS AND HEALTH EFFECTS OF
ORGANIC COMPOUNDS USED AT THE
PROPERTIES SHOP
METROPOLITAN OPERA

HETA 82-190

SUBSTANCE	NIOSH RECOMMENDATION	OSHA PEL	ACGIH TLV	HEALTH EFFECTS	REFERENCE
Hexane (n-hexane)	100 ppm 500 ppm/ 15 min ceiling	500 ppm	100 ppm 125 ppm STEL	nausea, headache, eye & nose irritation, dermatitis	1,2
Cyclohexane	--	300 ppm	300 ppm 375 ppm STEL	nausea, eye irritation, dizziness, dermatitis	1,2
Acetone	--	1000 ppm	1000 ppm 1250 ppm STEL	headache, nausea, dizziness, dermititis, eye irritation	1,2
Toluene	100 ppm 200 ppm/ 10 min ceiling	200 ppm 300 ppm ceiling 500 ppm peak	100 ppm 150 ppm STEL	headache, dizziness, weakness, euphoria, confusion, dermititis	1,2
Butyl acetate	--	150 ppm	150 ppm 200 ppm STEL	headache, eye irritation respiratory irritation	1,2
Styrene	--	100 ppm 200 ppm ceiling 600 ppm/5 min/3 hr peak	50 ppm 100 ppm STEL	eye & nose irritation, weakness narcosis, dermatitis	1,2
Propane	--	1000 ppm	--	simple asphyxiant dizziness, confusion	2,3
isoButane	--	--	800 ppm	narcosis, dizziness	2
Methyl ethyl ketone	--	200 ppm	200 ppm 300 ppm STEL	eye irritation, headache, dizziness	1,2
Mineral spirits, aliphatic solvents, kerosene	100-500 ppm	100-1000 ppm	100-500 ppm	dizziness, headache eye irritation, dermatitis	1,2,3

TABLE III

AIRBORNE CONCENTRATIONS OF
ORGANIC SOLVENTS

PROPERTIES SHOP
METROPOLITAN OPERA
HETA 82-190

FEBRUARY, 1982

OPERATION	TOLUENE ppm	XYLENE ppm	ACETONE ppm	HEXANE ppm	STYRENE ppm	MEK ppm
Lay-up	1.5	ND	9.5	2.2	5.3	ND
Lay-up Area(general air)	ND	ND	1.8	0.3	4.4	ND
Lay-up/Carpentry	0.4	ND	0.8	0.4	0.5	--
Carpentry 10 ft from lay-up	0.4	ND	0.6	0.4	0.6	--
Fiberglass Area(general air)	ND	ND	ND	ND	ND	ND

ppm = parts per million parts of air
ND = none detected
Limits of Detection (ppm): Toluene = 0.003
Xylene = 0.002
Acetone = 0.012
Hexane = 0.003
Styrene = 0.002
MEK = 0.003

FIGURE 1

Schematic of
Properties Shop
Metropolitan Opera

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