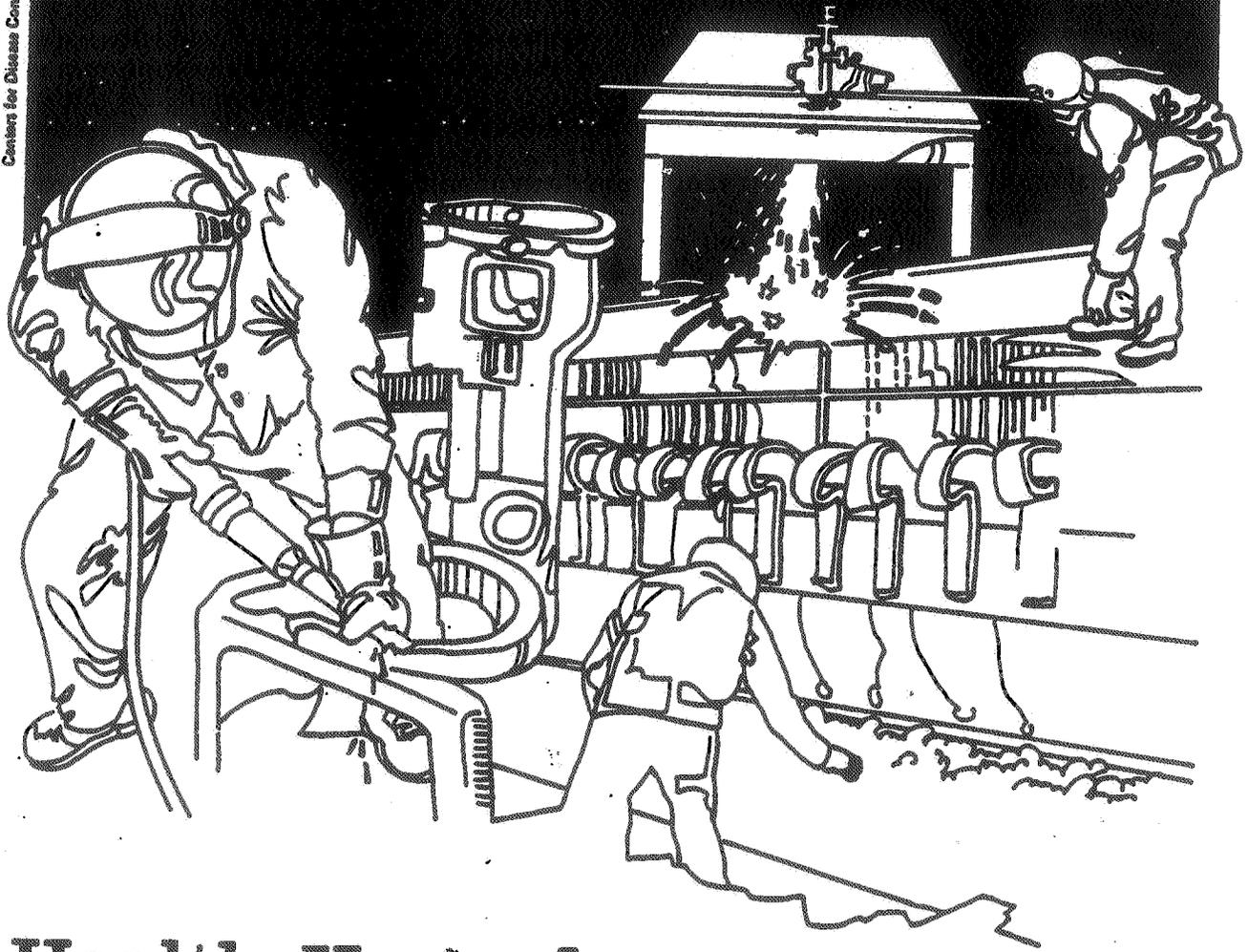


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service  
Center for Disease Control • National Institute for Occupational Safety and Health

# NIOSH



## Health Hazard Evaluation Report

HETA 84-478-1636  
PALACE THEATER  
NEW YORK, N.Y.

## 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 84-478-1636  
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Palace Theater  
1564 Broadway  
New York, N.Y. 10036

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New York City

## I. SUMMARY

In August, 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the American Federation of Musicians, Local 802 to investigate possible causes of intermittent episodes of headache and nausea associated with a sweet odor, among musicians playing during performances of the musical comedy "La Cage aux Folles". A request to the New York City Department of Health had also been made and NIOSH's participation in the investigation was delayed until the New York City Department of Health completed its investigation.

One possible source of exposure was the cleaning solution used to clean the show's costumes. Environmental samples were collected and analyzed for 1,1,1-trichloroethane (TCE), which is the major spotting solution used to clean costumes backstage. Airborne concentrations were determined to be less than the Permissible Exposure Limit established by the Occupational Safety and Health Administration (OSHA) and the exposure limit recommended by NIOSH. Concentrations of the solvent vapor in the orchestra pit were less than 10 parts per million parts of air both during the spotting operation and during the performance of the musical, several hours following the use of the solvent.

Although no hazardous exposures to TCE were determined, conditions were observed which needlessly exposed individuals to airborne TCE, and the following recommendations are made to reduce exposures further.

1. Provide organic vapor cartridges for the respirator used during the spotting operation.
2. Discontinue the practice of using circulating fans to "dry" garments after cleaning.
3. Investigate the possibility of substituting a less harmful spotting compound and substituting a spotting table with downdraft exhaust and/or using an exhausted drying box.
4. Introduce dilution ventilation into the orchestra pit one hour before curtain time.

KEYWORDS: SIC 7922: Theatrical Productions, 1,1,1-Trichloroethane

## II. INTRODUCTION

In August, 1984, OSHA referred a request for investigation from the American Federation of Musicians, Local 802, to NIOSH. Several of the musicians who work in the pit have complained about intermittent episodes of headache and nausea, accompanied by the perception of a "sweet" odor. The New York City Department of Health, Bureau of Public Health Engineering had already started an investigation at the request of one of the pit musicians. NIOSH deferred to that organization and began its study in January, 1985, after the City agency finished its investigation. The City agency had investigated the exhaust system of the backstage area and performed a ventilation study by generating solvent vapors at the spotting table. No solvent odors were detected in the pit area during that study.

A NIOSH representative collected environmental samples in January and April, 1985 to evaluate exposure to solvent vapors in the pit and backstage areas. An interim report was issued in April, 1985, and a letter, outlining the recommendations contained in this report was sent to the manager of the La Cage Company in May, 1985.

## III. BACKGROUND

"La Cage aux Folles" has been playing at the Palace Theater on Broadway since August, 1983. Several of the musicians who work in the orchestra pit have complained of intermittent episodes of headache and nausea since the opening of the show. The musicians work eight performances per week for approximately 3 hours per performance, with two performances on Wednesdays and Saturdays. The incidents do not occur during every performance, but occur about 3 times per week.

The musicians' pit is about 40 feet wide, 12 feet deep, with the rear half of the pit under the stage. The height of the pit under the stage is about 5 feet. The doors to the pit are closed during performances to reduce infiltration of backstage noise. Circulation fans provide some movement of air in the pit. The musicians who are most affected perform in the rear of the pit and play wind or brass instruments. These musicians may inhale more air than other musicians while playing, thereby possibly increasing the effects of exposure to contaminants.

The musicians believe that the odor resembles cleaning compounds which are used in the production. La Cage aux Folles uses many elaborate, decorated costumes. Because decorations on the costumes would dissolve in dry cleaning chemicals, the costumes cannot be cleaned by commercial dry cleaners, and instead the costumes are carefully spot cleaned by the wardrobe staff. Various spotting

agents may be used, depending on the type of stain. The cleaning agent most often used is "Spray-A-Spot". This product is 1,1,1-Trichloroethane (TCE), also known as methyl chloroform, a common commercial organic solvent. The spotting table is about 20 to 30 feet from the orchestra pit and is fitted with an exhaust hood. The hood is of limited value because of its weak draft and because circulating fans are aimed at the cleaned garments to hasten drying. Another possible source of contamination with similar types of hydrocarbons is the beauty salon (hair room), which is about 50 feet from the orchestra pit. The production uses many wigs which must be cleaned and set before use. Other possible operations which produce minimal exposure to organic solvents are cleaning and dyeing of shoes and the repair of props. Both of these operations use products containing acetone as the solvent. The backstage area at the Palace Theater actually is under the stage and orchestra section of the theater. The doors to the orchestra pit are at the rear of the pit. A solid wall, an office and the wardrobe room are between the pit and the spotting table.

In January, 1985, because of the musicians' complaints, the company manager prohibited the use of the spotting table and other activities which would involve the use of solvents during performances, except for emergencies. The complaints persisted. The doors to the pit are closed during performances to reduce the infiltration of noise from the backstage area. The musicians are of the opinion that the spotting operations are still being done during performances. NIOSH was assured by the wardrobe mistress that routine spotting operations, shoe repair and wig preparation are now done before performances and never during performances. In February, 1985, a member of the wardrobe department complained to the Art Hazards Institute (a non-profit consultation service) about the solvent odor from the spotting operations. That person was interviewed and offered the information that the cleaning operations were restricted to non-performance times.

The production manager provided NIOSH with material safety data sheets (MSDS) for 61 products on hand at the theater, but not necessarily used in the production. A review of the MSDSSs did not reveal extensive use of any solvents other than TCE.

One additional possible source of contamination was thought to be the pesticides used to control rodent and insect infestation. Representatives of the service which provides pest control to the theater were contacted. They stated that pesticides are never used in the orchestra pit.

#### IV. EVALUATION METHODS AND MATERIALS

Environmental samples to determine the concentrations of solvent vapors were collected in the orchestra pit and in backstage areas during a performance when no spot cleaning was being done and prior

to a performance while spot cleaning was being done. Known volumes of air were drawn through glass tubes containing activated charcoal as the collection media. Vapors of organic solvents are adsorbed on the charcoal. The samples were analyzed by a standardized technique and the concentrations of solvent vapors were calculated.

#### V. EVALUATION CRITERIA

The Occupational Safety and Health Administration (OSHA) has established a Permissible Exposure Limit (PEL) of 1900 milligrams of 1,1,1-trichloroethane (TCE) per cubic meter of air ( $\text{mg}/\text{M}^3$ ) as a time weighted average for a 40 hour work week. The Threshold Limit Value (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH) also is 1900  $\text{mg}/\text{M}^3$ . NIOSH recommends that the 1900  $\text{mg}/\text{M}^3$  concentration not be exceeded for any 15 minute period.

TCE is irritating to the eyes on contact. Exposure to the vapors depresses the central nervous system. Symptoms include dizziness, incoordination, drowsiness, increased reaction time. Unconsciousness and death can occur from exposure to excessive concentrations. Although TCE has a relatively low systemic toxicology, at high concentrations it may cause cardiac sensitization. Some chloroethanes (not including TCE) have been associated with cancer in laboratory animals. NIOSH is unaware of any definitive evidence indicating that TCE is carcinogenic in humans. However, TCE should be treated with caution because of its close structural relationship to those chloroethanes that have been shown to be carcinogenic in laboratory animals.

#### VI. RESULTS AND DISCUSSION

The results of analyses of the environmental samples are listed in Table I. Airborne concentrations of TCE were far less than the PEL established by OSHA. In addition to TCE, trace amounts of Freon 12, isobutane, methylene chloride, toluene and ethanol were found to be present in the environmental samples. Freon is a propellant gas in many pressurized cans. The isobutane may result from leakage from pocket cigarette lighters. Methylene chloride, toluene and ethanol are common solvents.

At the spotting table, costumes are spot cleaned by a member of the wardrobe department who very carefully directs a stream of TCE from a pressurized container onto soiled areas of the costumes. Due to the nature of the production, many of the costumes have extensive padding. The padding absorbs the cleaning solution to a far greater extent than would costumes which did not have padding. During the survey, it required over a quart of TCE to clean a garment roughly the size of a one piece bathing suit with sleeves. This is considered to be a large amount of solvent for a relatively small

garment. The wardrobe department has been given a respirator to help control exposure to the person who does the cleaning. However, the respirator was fitted with a filter approved to provide protection against welding fumes. The welding fume filter provides no protection against the vapors of TCE, and even may increase exposure somewhat by absorbing the vapors and then desorbing the vapors at a later time.

The spotting table is fitted with a hood about 3 feet above the surface of the table. The rate of exhaust from the hood could not be measured at the surface of the table and was only about 50 linear feet per minute at the lip of the hood. The hood offers little benefit in removing vapors from the area of the spotting table. It is the practice of the wardrobe department to use a circulation fan to help dry a single cleaned garment. The little benefit of the hood is cancelled by the use of the fan. Larger amounts of cleaned garments are hung on a rack near the spotting table to dry. Again, the hood has little effect on removing TCE vapors from the area.

The International Fabric Care Institute (IFCI) was contacted for advice on the problems of cleaning the costumes used in this production. The IFCI suggested substitution of the TCE with a less hazardous solvent, such as trichlorotrifluoroethane, which may be more gentle to the costumes and substitution of the spotting table and hood with a spotting table with downdraft exhaust ventilation.

## VII. CONCLUSIONS

Although the concentrations of airborne TCE are less than the OSHA limit, operations that result in unnecessary and preventable exposure to TCE were observed during the health hazard evaluation. Therefore, recommendations to reduce exposures to the cleaning solvent are made.

## VIII. RECOMMENDATIONS

The following recommendations originally were made in a letter (May 2, 1985) to the Company Manager of the La Cage Company, with copies to the requestor and other interested parties.

1. Replace the fume filters currently used in the respirator provided for the spotting operation with cartridges approved for use with organic vapors. Approval is given to entire respirator assemblies, and cartridges of one manufacturer cannot be used with the facepiece of another manufacturer. The respirator currently used at the spotting table is a "Sellstrom" brand. Four Sellstrom respirators currently approved for use with organic vapors have been given the following approval numbers by NIOSH: TC-23C-107, TC-23C-124, TC-23C-163 and TC-23C-202.

2. The practice of using circulating fans to "dry" cleaned costumes should be discontinued. The weak exhaust provided by the hood of the spotting table is negated by the use of the circulating fans.

3. Consideration should be given to the suggestions of the IFCI, namely that the TCE be replaced by a cleaning solution which would be potentially less hazardous and more gentle to the costumes. Consideration also should be given to replacing the hood of the spotting table with a cold spotting table with downdraft exhaust ventilation. This type of table is fitted with numerous holes, through which air is drawn at a high rate. The costumes may remain on the table to dry. Another possible suggestion would be for the installation of an exhausted drying box, which would remove air contaminated with solvent vapors directly instead of diluting the vapors into the backstage area.

4. Although not indicated by this study, a possibility exists that solvent vapors may seep into the orchestra pit and remain in the relatively stagnant air in the pit until performance time. To negate this possibility, the circulation fans in the pit should be put into operation about one hour before curtain time to provide dilution ventilation to the orchestra pit.

#### IX. REFERENCES

1. National Institute for Occupational Safety and Health. Criteria for a recommended standard...occupational exposure to 1,1,1-trichloroethane (methyl chloroform). (DHEW publication no. (NIOSH) 76-184). Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976.
2. U. S. Department of Labor, Occupational Safety and Health Administration. occupational safety and health standards for general industry. 29 CFR 1910, Revised March 11, 1983.
3. National Institute for Occupational Safety and Health. current intelligence bulletin 27-chloroethanes: review of toxicity. (DHEW publication no. (NIOSH) 78-181. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978.

#### X. ACKNOWLEDGEMENT AND AUTHORSHIP

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report currently are available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, OH 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Port Royal Road, Springfield, VA 22161. Information concerning its availability can be obtained from the NIOSH Publications Office at the Cincinnati Address.

Copies of this report have been sent to:

American Federation of Musicians, Local 802, N.Y., NY  
The La Cage Company, N.Y., NY  
The Palace Theater Corp., N.Y., NY  
American League of Theaters and Producers, N.Y., NY  
Art Hazards Institute, N.Y., NY  
OSHA, Region II, N.Y., NY  
NIOSH, Region II, N.Y., NY  
The New York State Department of Health, Albany, NY  
The New York State Department of Law, N.Y., N.Y.

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

TABLE I

HETA 84-478

PALACE THEATER  
BROADWAY  
NEW YORK CITY

CONCENTRATIONS OF 1,1,1-TRICHLOROETHANE

Location	Sampling Times	Concentration (mg/M <sup>3</sup> )
January 28, 1985      7:45 - 11:00 PM		
No spotting activity.		
Orchestra Pit		2.5
Under Pit		4.2
Spotting Table		3.5
Office between Table and Pit		2.9
Fire Hose (beyond pit)		4.9
April 25, 1985      11:00 AM - 2:30 PM		
With spotting activity.		
Spotting table area		52.3
		51.7
		58.7
Orchestra Pit		7.7
		7.1
		10.0

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OSHA PEL for an 8 hour daily exposure = 1900 mg/m<sup>3</sup>  
 NIOSH recommended limit for a 15 minute exposure = 1900 mg/M<sup>3</sup>