HETA 86-236-1725
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SAN FRANCISCO OPERA
COSTUME SHOP
SAN FRANCISCO, CALIFORNIA

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I. SUMMARY

In March, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from an employer representative at the San Francisco Opera Costume Shop, San Francisco, California. The requestor was concerned that craftspersons and textile artists may be overexposed to chemical substances used in the shop.

On April 16, 1986 an initial walk-through survey was conducted. Several hydrogen sulfide air samples were collected while stripping cloth of its color, but no hydrogen sulfide was detected.

On April 29 and May 1, 1986 a follow-up environmental survey was conducted and five operations were evaluated including: boot deglazing, boot spray painting, hat lacquering, fabric painting and casting of pieces. Three environmental air samples were collected during boot deglazing and analyzed for xylenes (0.09-13 ppm parts of a vapor or gas per million parts of contaminated air), toluene (0.14-29.9 ppm), acetone (0.13-47.3 ppm), isopropyl alcohol (0.36-43.7 ppm) and ethyl alcohol (trace-17.4 ppm). All air concentrations were below the NIOSH evaluation criteria or CAL-OSHA standards.

Two personal air samples were collected during boot spray painting and analyzed for methylene chloride (11.9-25 ppm). These air concentrations exceed the most recent evaluation criteria for methylene chloride (lowest feasible limit based on potential for carcinogenicity) recommended by NIOSH.

Four personal air samples were collected during hat lacquering. Two air samples were analyzed for methyl ethyl ketone (MEK) (2.3 and 3.2 ppm), and two air samples were analyzed for toluene (9.6 and 11.5 ppm), xylenes (2.2 and 4 ppm), isobuyl acetate (2.7 and 5.5), and ethyl acetate (none detected). All air concentrations were below the NIOSH evaluation criteria or CAL-OSHA standards.

Five environmental air samples were collected during fabric painting. One air sample was analyzed for MEK (3.7 ppm), two air samples were analyzed for methyl alcohol (none detected and 0.42 ppm) and two air samples were analyzed for ethyl alcohol (trace, 108 ppm), isopropyl alcohol (trace, none detected), toluene (none detected), and acetone (trace). All air concentrations were well below the evaluation criteria.

Seven environmental air samples were collected during the casting operations and analyzed for methylene bisphenyl isocyanate (MDI) and toluene diisocyanate (TDI). One area air sample was detected MDI (36 ug/m^3) at a concentration below the NIOSH evaluation criteria, and no TDI was detected.

No exposures to hydrogen sulfide or TDI were measured, and no excessive exposures to xylenes, toluene, acetone, alcohols (methyl, isopropyl, or ethyl), MEK, isobutyl acetate, ethyl acetate, or MDI were measured during the environmental survey. Methylene chloride was detected at concentrations above the NIOSH recommended criteria. Recommendations are included in section VIII of this report to prevent unnecessary chemical exposures.

KEYWORDS: SIC 2389 (Apparel and Accessories, Not Elsewhere Classified) Boot spray painting, hat lacquering, fabric spray painting, and casting of medallions, helmet pieces and masks, methylene chloride

II. INTRODUCTION

On March 4, 1986 the National Institute for Occupational Safety and Health received a request for a health hazard evaluation from an employer representative at the San Francisco Opera Costume Shop, San Francisco, California. The requestor was concerned that craftspersons and textile artists may be overexposed to chemical substances used in the shop.

On April 16, 1986 an initial walk-through environmental survey was conducted, and on April 29 and May 1, 1986 follow-up environmental surveys were conducted. In May, 1986 a follow-up visit was conducted in order to discuss the environmental air sampling results with the requestor.

III. BACKGROUND

The San Francisco Opera Costume Shop has been at its current location for numerous years. The opera season runs from March through October where 7 or 8 crafts people work from 8:30 a.m. to 4:30 p.m. without much overtime. These employees are normally layed-off at the end of the season and re-hired at the beginning of the next season. No pre-employment medical exam is required of workers.

The craft area consists of two work areas. The smaller dye room is about 250 square feet in size. It includes a worktable, a washing machine and dryer, and a large vat where cloths are dyed and stripped of color.

The second larger room is about 800 square feet with 18-foot ceilings. There are four worktables which are used for casting, sewing etc. In one corner of the room is a plastic enclosure (64 square feet) which has an air supply and exhaust fan to remove any chemical vapors generated in the booth. The enclosure was installed by the supervisor to help contain any chemical odors which might be generated during the following operations: boot deglazing, boot spray painting, hat lacquering, cloth spraying, and casting. Prior to the installation of the enclosure, several workers reported, to their supervisor, headaches during or subsequent to the spray painting or casting operation. Employees are generally rotated every hour so that one or two workers don't have to spend 3 or 4 continuous hours inside the enclosure, or workers come out of the enclosure for 20 minutes for each hour spent inside the enclosure. It should be noted that no employee works at the same task for eight hours a day five days a week, but may work at several tasks during the course of the day.

Employees who work in the enclosure are required to wear a half-mask organic vapor cartridge respirator. Each person has an assigned respirator for which he/she is qualitatively fit tested using isoamyl acetate (banana oil). Also, the supervisor instructs the workers how to properly use, clean and store their respirator. Employees who handle epoxies, urethanes, glues, or shellac are required to wear a laytex glove, and a neoprene glove is worn during boot deglazing. The various operations observed during the survey are described below.

1. Cloth Stripping and Dyeing: A large vat which holds up to about 40 gallons of water can be heated to 250° Farenheit (F). A window exhaust fan is located about 2 to 3 feet above and adjacent to the vat to help exhaust the chemical vapors. Also, a fan is directed towards the window exhaust fan to help move the vapors emanating from the vat. A chemical stripper, either a powder or liquid depending on the material and color, is used to remove dyes from cloth. The vat is filled with water, the chemical stripper is added, and the water is heated to the desired temperature. The cloth is then placed in the vat and stirred in the vat until the fabric is stripped of its color. Three types of dyes, RIT*, Aljo* and Batik*, are available to the artist, but only two dyes, RIT* and Aljo*, are reportedly used. The artist wears coveralls, an apron, safety glasses, and protective gloves whenever working with these chemicals.

2. Boot Deglazing and Spray Painting: The boots and shoes are periodically cleaned of the waxy cover (polish) with a deglazing fluid called Dyo-Flex*. A small quantity of the solvent is poured into a plastic dish and a cloth is used to apply the cleaner to the shoes. Once the boots dry (about 3-5 minutes), another worker uses Majix* spray paint to spray the boots. The boots are sprayed directly in front of the exhaust fan to remove any of the paint overspray.

3. Hat lacquering (Sizing): A felt material is used to create hats. The felt is usually stretched and shaped over the form in the general work area. Afterwards, it is placed in the enclosure, and a shellac is brushed onto the felt to stiffen the material.

4. Fabric Painting: The dyes (water and alcohol soluble) are mixed in the dye room and poured into a small hand held air sprayer. The fabrics are hung up in the enclosure and sprayed.

5. Casting operation: Two types of chemicals are used for casting. Casting of medallions is done in the general work area using a two part component called PMC-744*. The hazardous ingredient associated with this product is toluene diisocyanate (TDI). A two part component called Hardcast*s used to cast helmet pieces and masks. Masks and helmet pieces are cast in the enclosure. The hazardous component associated with this product is methylene bisphenyl isocyanate (MDI).

IV. DESIGN AND METHODS

Workers were informally interviewed to determine if there were any health complaints regarding their work environment.

1. Hydrogen sulfide gas detector tubes were used to sample the air concentration during the cloth stripping operation.

2. Environmental air samples were collected during boot deglazing on a charcoal tube. The tube was analyzed for xylenes, toluene, acetone, isopropyl alcohol and ethyl alcohol. The A and B sections of the charcoal tube were separated and analyzed by gas chromatography (G-C) according to NIOSH Methods 1501, 1300, and 1400 with modifications. The limit of detection (LOD) for isopropyl alcohol is 0.02 milligrams per sample (mg/sample). The LOD for the other chemicals was 0.01 mg/sample.(1)

3. Several air samples were collected during boot spray painting on two charcoal tubes connected in series. The tubes were analyzed for methylene chloride. The A and B sections of the charcoal tube were separated and analyzed by G-C according to NIOSH Method 1005 with modifications. The analytical LOD was 0.01 mg/sample.(1)

4. Several air samples were collected during the hat lacquering. Two of the air samples were collected on an ambersorb tube and analyzed for methyl ethyl ketone by G-C according to NIOSH Method 2500 with modifications. The analytical LOD was 0.01 mg/sample.(1) Two air samples were collected on a charcoal tube and analyzed for toluene, xylenes, isobutyl acetate, and ethyl acetate. The A and B sections of the charcoal tube were separated and analyzed by G-C according to NIOSH Methods 1501 and 1450 with modifications. The analytical LOD was 0.01 mg/sample.(1)

5. Five air samples were collected during fabric painting. One air sample was collected on an ambersorb tube and analyzed for methyl ethyl ketone by G-C according to NIOSH Method 2500 with modifications.(1) Two air samples were collected on silica gel tubes and analyzed for methyl alcohol. The A and B sections of the tube were separated and analyzed by G-C according to NIOSH Method 2000 with modifications.(1) Two air samples were collected on a charcoal tube and analyzed for ethyl alcohol, isopropyl alcohol, toluene, and acetone. The analytical LOD for isopropyl and methyl alcohol were 0.02 and 0.03 mg/sample, respectively. The LOD for the other chemicals was 0.01 mg/sample.(1)

6. Several air samples were collected during the casting of helmet pieces. The air samples were collected in an impinger solution of 1-(2-methoxyphenyl)-piperazine in toluene and analyzed for methylene bisphenyl isocyanate according to NIOSH Method 5505 with modifications. The analytical LOD was 0.3 microgram per sample (ug/sample).(1)

7. Four air samples were collected during the casting of medallions. The air samples were collected on a glass wool tube and analyzed for 2,4 and 2,6-Toluene Diisocyanate. The A and B sections of the tube were analyzed according to NIOSH Physical and Chemical Analytical Method 326. The analytical LOD was 0.3 ug/sample.(2)

V. 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), and 3) the U.S. Department of Labor (OSHA) occupational health standards. 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 those levels specified by an OSHA standard (Table A).

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.

TABLE A

SUBSTANCE	Permissible Exposure Limit 8-10 Hour Time-Weighted Exposure Basis	Source
Xylene	100 ppm(1)	NIOSH, CAL-OSHA, ACGIH
Toluene	100 ppm	NIOSH, CAL-OSHA, ACGIH
Acetone	250 ppm 750 ppm	NIOSH CAL-OSHA, ACGIH
Methyl Alcohol	200 ppm	NIOSH, CAL-OSHA, ACGIH
Isopropyl Alcohol	400 ppm	CAL-OSHA, ACGIH
Ethyl Alcohol	1000 ppm	CAL-OSHA, ACGIH
Methylene Chloride	LFL(2) 100 ppm	NIOSH CAL-OSHA, ACGIH
Methyl Ethyl Ketone (MEK)	200 ppm	NIOSH, CAL-OSHA, ACGIH
Isobutyl Acetate	150 ppm	CAL-OSHA, ACGIH
Ethyl Acetate	400 ppm	CAL-OSHA, ACGIH
Methylene Bisphenyl Isocyanate (MDI)	50 ug/m^3(3) 200 ug/m^3C(4)	NIOSH CAL-OSHA, ACGIH
2,4-Toluene Diisocyanate	35 ug/m^3 140 ug/m^3 40 ug/m^3	NIOSH CAL-OSHA ACGIH
Hydrogen Sulfide	10 ppm (C-10 min)(5) 10 ppm	NIOSH CAL-OSHA, ACGIH

1. ppm-Parts of a vapor or gas per million parts of contaminated air by volume
2. LFL (CA)-Lowest feasible limit due to suspect or confirmed carcinogen, use best control technology
3. ug/m^3-Micrograms of a substance per cubic meter of air
4. C-Ceiling level maximum air concentration which should never be exceeded
5. C-10 min-Maximum air concentration based on a 10 minute sample period.

B. Toxicological

1. Solvents:

Xylene, toluene, acetone, methyl alcohol, isopropyl alcohol, ethyl alcohol, methylene chloride, methyl ethyl ketone, isobutyl acetate, and ethyl acetate are all solvents. They are primarily absorbed by inhalation or through the skin in workplace exposures. Excessive exposure to solvents may result in neurologic effects and dermatologic effects, including: eye and upper respiratory tract irritation, sleepiness, fatigue, headache, memory disturbance, difficulty concentrating, nausea, vomiting, abdominal cramps, loss of appetite, weight loss, flushed skin, skin defatting and irritation, and folliculitis (inflammation of hair follicles). The intoxicating effects of alcohol are frequently increased when alcohol is consumed after exposure to solvents.(3,4,5,6,7,8,9,10,11)

Extreme exposures may result in tremor, loss of coordination, mental confusion, loss of consciousness, coma and death. In addition, excessive or prolonged exposure to some of these solvents may result in chronic or delayed-onset effects including visual disturbances, loss of the sense of smell, impaired coordination and sense of touch, decreased nerve conduction velocity, neurobehavioral changes, and kidney and liver damage. Recent reports indicate that methylene chloride, in addition to hampering the delivery of oxygen to the tissues etc., has been documented in several studies to produce carcinogenic and tumorigenic responses in rats and mice.(9,11)

2. Toluene Diisocyanate (TDI):

TDI is a strong irritant of the eyes, mucous membranes and skin, and is also a potent sensitizer of the respiratory tract. In sufficient concentrations TDI causes irritation of the eyes, nose, ant throat, a choking sensation, and a productive cough. Depending on the length of exposure and level of concentration above 0.5 ppm (3.6 mg/m^3) respiratory symptoms will develop with a latent period of four to eight hours. Although the acute effects may be severe, a more important consideration is that respiratory sensitization can occur in susceptible individuals after repeated exposure to levels of TDI as low as 0.02 ppm (0.14 mg/m^3). Initial symptoms are often night time shortness of breath or cough with progression to asthmatic bronchitis. After symptoms subside a return to work can cause an acute and severe asthmatic attack almost immediately or within a few hours.(11) A person who has become sensitized to TDI must avoid future exposure completely. Some decrease in lung function in the absence of symptoms has been observed in some workers exposed to TDI for long periods of time, even at concentrations as low as 0.002 ppm (0.014 mg/m^3).(12) The ACGIH TLV (0.02 ppm) was set at a level which was believed to be low enough to prevent respiratory sensitization. After a thorough review of the literature available at the time, NIOSH, in 1978, recommended a workplace environmental standard of 0.005 ppm (0.035 mg/m^3).(13) More recent findings by Wegman et.al. indicates that even this low value may not protect sensitized workers.(14)

3. Methylene bisphenyl diisocyanate (MDI):

MDI is less volatile than TDI. Diisocyanates irritate the respiratory tract and can act as respiratory sensitizers, producing asthma-like symptoms in sensitized individuals with exposure at very low concentrations. Exposure to diisocyanates may also result in chronic impairment of pulmonary function.(10,13)

4. Hydrogen Sulfide (H_2S):

Hydrogen sulfide is a flammable, colorless gas with a characteristic rotten-egg odor and is soluble in water. The offensive odor is unreliable as a warning signal because of olfactory fatigue.(8) H_2S is an irritant of the eyes and respiratory tract at low concentrations, and at high concentrations causes respiratory paralysis. The TLV level of 10 ppm was established to prevent eye irritation.(10,15)

VI. RESULTS AND DISCUSSION

On April 16, 29 and May 1, 1986 NIOSH conducted environmental air monitoring during six different craft and textile operations to determine whether employees were being overexposed to any chemicals. All chemical exposures are compared to the NIOSH evaluation criteria or the CAL-OSHA standard listed in Table A, page 6.

1. Cloth Stripping and Dying: Two hydrogen sulfide gas detector tubes were used to sample the vapors emanating from the vat during the cloth stripping operation; however, no H_2S was measured. No cloths were dyed during the survey.

2. Boot Deglazing and Spray Painting: Three air samples were collected in the enclosure during boot deglazing (Table I) and analyzed for xylenes (0.09-13 ppm), toluene (0.14-29.9), acetone (0.13-47.3), isopropyl alcohol (0.36-43.7 ppm), and ethyl alcohol (Trace-17.4 ppm). All air concentrations were below the NIOSH evaluation criteria or CAL-OSHA standard. It should be noted that even in a worst case, the ACGIH-TLV for mixture of solvents was not exceeded.

Two air samples were collected during boot spray painting (Table II) and analyzed for methylene chloride. The air concentrations (11.9 and 25 ppm) were above the NIOSH recommended criteria for methylene chloride which are based on the evidence of carcinogenicity and tumorigenic response in rats and mice. Although the potential for methylene chloride-induced cancer in humans has not been determined, the probability of a population of exposed workers developing cancer could be decreased by reducing exposure. NIOSH recommends that either an air line supplied respirator with a full facepiece and operated in a pressure-demand mode, or a self contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive pressure mode be used for methylene chloride.(9)

3. Hat lacquering: Four personnel air samples were collected in the enclosure (Table III) during hat lacquering. Two air samples were analyzed for MEK (2.3 and 3.2 ppm) and measured to be below the NIOSH evaluation criteria. Two air samples were analyzed for toluene (9.6 and 11.5 ppm), xylenes (2.2 and 4 ppm), isobutyl acetate (2.7 and 5.5 ppm), and ethyl acetate (none detected). All air concentrations were well below the evaluation NIOSH criteria or CAL-OSHA standard.

4. Fabric Painting: Five environmental air samples were collected in the enclosure during fabric painting (Table IV). One air sample was analyzed for MEK (3.7 ppm), and two air samples were analyzed for methyl alcohol (none detected and 0.42 ppm). All the air samples were below the NIOSH evaluation criteria. Two air samples were analyzed for ethyl alcohol (trace & 108 ppm), isopropyl alcohol (trace & none detected), toluene (none detected), and acetone (trace). All air concentrations were well below the NIOSH evaluation criteria or the CAL-OSHA standard.

5. Casting Operation: Seven environmental air samples were collected during the casting operations. Helmet casting was done inside the enclosure and simultaneously medallions were being cast in the general work area. Three of the air samples were collected in the area near the medallion casting operation for TDI, but no TDI was detected. Four air samples were collected both inside the enclosure and in the general work area for MDI (Table V). One air sample, collected inside the enclosure, detected MDI at a concentration of 36 ug/m^3 which is below the NIOSH evaluation criteria.

It should be noted that chemical monitoring was never done prior to the installation of the plastic enclosure, thus it is not known what chemical air concentrations previously existed. As mentioned earlier, some workers reported, to the supervisor, headaches during the paint spraying and casting operation. This was the basis for the installation of the enclosure. Although each of the operations surveyed are not performed 8 hours a day, five days a week, the previously reported symptoms indicate an excessive chemical exposure.

The installation of the plastic enclosure with an exhaust and make-up air fan was a good attempt at trying to control workers' chemical exposures. In addition, employees were provided respiratory protection which is to be worn whenever working inside the booth. The installation of the booth appears to have resolved the workers health complaints; however, there are several potential problems which must be discussed.

The plastic enclosure, which is used as a paint spray booth and casting room, does not meet the flammability requirements of a "spray booth". Spray booths should be constructed of steel or some other substantial noncombustible material for intermittent or low volume spraying, and the floors, if combustible, should be covered with a noncombustible material which can be cleaned. The booth should be designed to guide the room air currents toward the exhaust duct. Given the types of chemical solvents used in the processes and the potential for exposure to diisocyanates during the casting operation, it is recommended that a more permanent non-flammable structure be utilized for this operation.

Several brands (Rit*, Aljo*, and Batik*) of dyes are used to dye cloths. Some of the Rit* dyes eg. gold, golden yellow and jade green, are aniline based dyes. The containers have a warning that the dye contains a dispersant (0.1-1.4% yellow 3, 2832-40-8) which maybe a possible cancer hazard based on animal lab tests. The warning advises the user to prevent eye and skin contact and avoid inhalation. Also, it was learned that there are several benzidine based dyes which are still kept on the shelves; however, these are reportedly not used since there is no glove box to handle these dyes which are potentially carcinogenic.

VII. CONCLUSIONS

Based on the environmental air sampling results collected during this investigation, no overexposures to chemicals were found during the cloth stripping and dying operation, boot deglazing, hat lacquering, fabric painting and casting operation. Furthermore, employees currently do not have any health complaints regarding the work process. Employees who perform boot spraying with spray paints that contain methylene chloride are overexposed based on the recent findings discussed in the NIOSH Current Intelligence Bulletin (9).

VIII. RECOMMENDATIONS

1. A permanent spray booth should be constructed which meets the guidelines outlined in the California General Industry Safety Orders 5155, Register 85, No. 28 Section 5446 since employees will continue to perform most of the operations in the plastic enclosure.

2. It is recommended that the boot spray paint be substituted with a paint which does not contain methylene chloride. If this paint is to be used, then employees will need to wear the proper respirator i.e. a full-face positive pressure or pressure demand self-contained breathing apparatus, or a supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive pressure mode.

3. All casting should be performed in the spray booth.

4. It is recommended that a glove box be used to weigh out dyes in order to prevent unnecessary exposure to aniline and benzidine based dyes. If the benzidine based dyes are no longer going to be used, then these dyes should be disposed of properly.

5. The dyes and polishes (solvent base), which are stored in the general work area should be stored in a storage cabinet.

IX. REFERENCES

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XI. 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. San Francisco Opera Costume Shop
2. California-Occupational Safety and Health Administration
3. NIOSH, Region IX
4. U.S. Department of Labor, Region IX

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.

TABLE I

SUMMARY OF ENVIRONMENTAL
AIR SAMPLES COLLECTED FOR
SOLVENTS DURING BOOT DEGLAZING

San Francisco Opera Costume Shop
San Francisco, California
HETA 86-236
April 29, 1986

Sample Number	Type Sample	Description/Location	Exposure Period	Volume (Liters)	Solvent Concentration (ppm[1]) Xylene	Toluene	Acetone	Isopropyl Alcohol	Ethyl Alcohol
C-2	P[2]	Cleaning boots in booth with deglazing fluid	0927-1100	16.9	8.4	20.4	47.3	33.7	O.S.[3]
C-4	P	Cleaning boots in booth with deglazing fluid	1103-1230	5.5	13.	29.9	40.6	43.7	17.4
C-3	A[4]	On work table outside of booth where shoes are de-glazed	0935-1230	93.3	0.09	0.14	0.13	0.36	Trace[5]
Limit of Detection per sample (mg[6])					0.01	0.01	0.01	0.02	0.01
Limit of Quantitation per sample (mg)					0.01	0.01	0.03	0.02	0.02

1. ppm- Parts of a vapor or gas per million parts of contaminated air by volume.
2. P- Personnel air sample.
3. O.S.-Back-up section of tube was over saturated, i.e. contains greater than 30 % of contaminant.
4. 4.-Area air Sample.
5. Trace-Concentration is at the limit of detection.
6. mg-milligrams.

TABLE II

SUMMARY OF ENVIRONMENTAL AIR
SAMPLES COLLECTED FOR SOLVENTS
DURING BOOT SPRAY PAINTING

San Francisco Opera Costume Shop
San Francisco, California
HETA 86-236
April 29, 1986

Sample Number	Type Sample	Exposure Description/Location	Volume Period	Methylene (Liters)	Chloride Concentration (ppm[1])
M-1	P[2]	Spraying shoes in booth	0927-1105	11.6	11.9
M-2	P	Spraying shoes in booth	1109-1230	5.3	25

Limit of Detection per sample (mg[3])	0.01
Limit of Quantitation per sample (mg)	0.01

1. ppm-Parts of a vapor or gas per million parts of contaminated air by volume.

2. P-Personnel air sample.

3. mg-milligrams.

Table III

SUMMARY OF ENVIRONMENTAL
AIR SAMPLES COLLECTED FOR
SOLVENTS DURING HAT LACQUERING

San Francisco Opera Costume Shop
San Francisco, California
HETA 86-236
April 29, 1986

Sample Number	Type Sample	Description/Location	Exposure Period	Volume (Liters)	Solvent Concentration (ppm[1]) Methyl ketone	Toluene	Ethyl Xylenes	Isobutyl Acetate	Ethyl Acetate
A-1	P[2]	Hat lacquering in booth	0927-1104	15.7	3.2	---	---	---	---
A-3	P	Hat lacquering in booth	1103-1230	4.4	2.3	---	---	---	---
C-1	P	Hat lacquering in booth	0927-1104	15.4	---	9.6	2.2	2.7	ND[3]
C-5	P	Hat lacquering in booth	1103-1230	4.6	---	11.5	4	5.5	ND
Limit of Detection per sample (mg[4])					0.01	0.01	0.01	0.01	0.01
Limit of Quantitation per sample (mg)					0.01	0.01	0.01	0.01	0.01

1. ppm-Parts of a vapor or gas per million parts of contaminated air by volume.
2. P-Personnel air sample.
3. ND-None Detected.
4. mg-milligrams.

TABLE IV

SUMMARY OF ENVIRONMENTAL AIR
SAMPLES COLLECTED FOR SOLVENTS
DURING FABRIC PAINTING

San Francisco Opera Costume Shop
San Francisco, California
HETA 86-236
May 1, 1986

Sample Number	Type Sample	Description/Location	Exposure Period	Volume (Liters)	Solvent Concentration (ppm[1]) Methyl ethyl Ketone	Methyl Alcohol	Ethyl Alcohol	Isopropyl Alcohol	Toluene	Acetone
A-11	A[2]	On table top in booth	1035-1134	6.9	3.7	---	---	---	---	---
S-1	P[3]	In booth during cloth spraying	0952-1141	71.5	---	0.42	---	---	---	---
S-2	A	In booth on table where shoes are de-glazed	0950-1159	200	---	ND[4]	---	---	---	---
C-21	P	In booth during cloth spraying	0950-1141	18.1	---	---	108	Trace[5]	ND	Trace
C-22	P	In booth on table where	0950-1141	28.7	---	---	Trace	ND	ND	Trace
Limit of Detection per sample (mg[6])					0.01	0.01	0.03	0.02	0.01	0.01
Limit of Quantitation per sample (mg)					0.01	0.01	0.09	0.05	0.02	0.01

1. ppm-Parts of a vapor or gas per million parts of contaminated air by volume.
2. A-Area air sample.
3. P-Personnel air sample.
4. ND-None detected.
5. Trace-This signifies that the concentration of contaminant was measured at the limit of detection.
6. mg-milligrams.

TABLE V

SUMMARY OF ENVIRONMENTAL AIR
SAMPLES COLLECTED FOR METHYLENE
BISPHENYL ISOCYANATE (MDI) DURING CASTING
OF HELMET PIECES INSIDE THE ENCLOSURE

San Francisco Opera Costume Shop
San Francisco, California
HETA 86-236
May 1, 1986

Sample Number	Type Sample	Description/Location	Exposure Period	Volume (Liters)	MDI Conc.(ug/m^3)[1]
I-1	P[2]	sample collected inside enclosure	0950-1210	210	ND[3]
I-2	A[4]	sample collected in general work area	0952-1215	215	ND
I-3	A	sample collected in general work area	1000-1215	203	ND
I-6	A	sample collected inside enclosure	1130-1220	75	36
Limit of Detection per sample (ug[5])					0.3
Limit of Quantitation per sample(ug)					0.6

1. ug/m^3-micrograms of a contaminant per cubic meter of air.
2. P-Personnel air sample.
3. ND-None detected.
4. A-Area air sample.
5. ug-micrograms.