

NIOSH



Health Hazard Evaluation Report

HETA 84-229-1543
IMPRESSIONS HANDPRINTERS
CHICAGO, ILLINOIS

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 84-229-1543
DECEMBER 1984
IMPRESSIONS HANDPRINTERS
CHICAGO, ILLINOIS

NIOSH INVESTIGATOR:
Daniel Almaguer, I.H.

I. SUMMARY

On March 14, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposure to solvents used in the production of custom silk screen printed vinyl wall coverings at Impressions Handprinters, Chicago, Illinois.

In May 1984, NIOSH investigators conducted an initial survey of the facility. In June 1984, an environmental survey was conducted during which personal breathing zone air samples were collected to assess airborne exposures to solvents used during screen printing and the washing of silk screens.

Short-term personal breathing zone air samples collected in the screen washing booth showed detectable levels of toluene and methyl isobutyl ketone (MIBK), both are components of the screen washing solution in use at the time of this survey. Toluene concentrations ranged from 144 ppm to 727 ppm, with concentrations in three of the five samples exceeding the NIOSH ceiling limit (200 ppm); two of the five samples exceeded the current Occupational Safety and Health Administration (OSHA) ceiling limit of 300 ppm. Methyl isobutyl ketone (MIBK) concentrations ranged from 24 ppm to 143 ppm, with one of the five samples exceeding the American Conference of Governmental Industrial Hygienists (ACGIH) Short Term Exposure Limit (STEL) of 75 ppm for MIBK. Neither OSHA, nor NIOSH have a ceiling limit for exposure to MIBK.

Air samples collected during screen printing showed no detectable levels of isophorone, a solvent contained in the retarder. Sampling for cyclohexanone, a component of the ink being used, showed detectable levels ranging from 4 ppm to 28 ppm, with total TWA concentrations of 9 ppm (8-hour TWA = 6.8 ppm) and 16.6 ppm (8-hour TWA = 12.8). The current OSHA-PEL for cyclohexanone is 50 ppm as an 8-hour TWA. NIOSH recommends 25 ppm as an 8-10 hour TWA. Further analysis of these samples showed the presence of toluene, TWA concentrations were 29.4 ppm and 80.4 ppm for the two employees working in the silk screen printing operation. The current OSHA-PEL for toluene is 200 ppm as a TWA with a 15-minute ceiling of 300 ppm. NIOSH recommends that exposure to toluene be limited to 100 ppm as a TWA concentration and a 10-minute ceiling concentration of 200 ppm. The combined 8-hour TWA concentration for exposure to toluene and cyclohexanone exceeded the criteria for substances having additive effects.

On the basis of the information obtained in this investigation, it has been determined that a hazard from short-term exposures to toluene and MIBK did exist at the time of this survey. Additionally, a potential hazard from combined exposure to toluene, MIBK, cyclohexanone, and isophorone could exist in silk screening operations. Recommendations for alleviating these hazards are included in the body of this report.

Keywords: SIC 7333, art hazards, silk screening, toluene, methyl isobutyl ketone, cyclohexanone

II. INTRODUCTION

On March 14, 1984, the president of Impression Handprinters, Chicago, Illinois requested that the National Institute for Occupational Safety and Health (NIOSH) conduct a health hazard evaluation at his facility. The requestor was concerned about the occurrence of headaches among employees while working with various solvents used in the production of custom silk screen printed vinyl wallcoverings.

On May 4, 1984, NIOSH investigators conducted an initial survey of the facility. An opening conference was conducted during which background information was obtained relating to the basis for the request, the plant workforce, and production operations, followed by a walk-through inspection of the facility. On June 8, 1984, an environmental survey was conducted during which short term personal breathing zone air samples were collected during the washing of silk screens and long term samples were collected on employees while silk screening. On October 31, 1984 an interim report was sent to the requestor detailing the results of environmental sampling.

III. BACKGROUND

A. Plant Production and Workforce

Impressions Handprinters produces custom designed silk screened wallcoverings. The company had originally operated at another location starting in May of 1983 and had moved to the present location in January 1984 due to an increased production rate. The facility produces approximately 30 to 60 rolls (15 feet/roll) of wallcoverings per day and provides employment for two full time production personnel, one part time maintenance worker, and one administrative/production worker. The normal work schedule for full time personnel is eight hours per day, five days a week.

B. Process Description and Employee Duties

The owner prepares paints early in the day for application to the vinyl wallcoverings. This involves the mixing of various pigments, inks, and a retarder which serves to prolong the drying time of the ink and to prevent clogging of the silk screens. Employee duties include preparing the screening tables, positioning the silk screens, placing rolls of wallcoverings onto rollers, silk screening, placing finished rolls onto drying racks, washing screens, and clean up at the end of the day.

Silk screening requires two employees, the silk screen operator and a helper. After each run, these two employees trade jobs. The paint is poured from a can onto the silk screen by the helper. The silk screen operator then presses a large rubber-tipped spreader down the entire length of the screen, thus spreading the ink evenly through the stencil onto the vinyl wallcoverings which are positioned below the screen. The screen is then lifted up and the next section of vinyl wallcovering is positioned under the screen. The rolls of wallcovering are placed on drying racks as they are printed. If other colors are required on the same roll the process is repeated following drying.

Cleaning of screens takes place after application of each color or at the end of the entire run for single colored wallcoverings. The operator and the helper scrape the excess paint from the screen and the rubber-tipped spreader. Screens are then taken into an enclosed screen washing booth where they are cleaned. The screens are placed in a sink and sprayed with a solvent containing toluene and methyl isobutyl ketone (MIBK). This process takes about 10 to 15 minutes to complete and is done after every run or change of color.

C. Engineering, Administrative, and Personal Protective Controls

Washing of silk screens is done in a large sink contained within a booth which is local-exhaust ventilated to the outside of the building. Additionally, employees are required to wear a face shield and gloves when washing screens. The booth is approximately 10 feet by 10 feet with a ceiling height of 8 feet. All screen washing solvents are stored within the booth and are electrically grounded.

Screen printing is done in an area which is about 50 feet by 40 feet and is ventilated with two large window fans on the east side of the building. The printer and helper switch positions through out the day, when one prints the other washes screens.

IV. EVALUATION DESIGN AND METHOD

An environmental survey was conducted by NIOSH investigators in order to assess long-term time weighted average (TWA) concentrations of personnel working at the silk screening operation and short-term exposures during the washing of screens. All samples were collected using battery powered sampling pumps attached via tygon tubing to the collection media (charcoal tubes).

During silk screen printing, personal breathing zone air samples were collected for solvents contained in the ink and the retarder. These samples were collected at an operating volume of 50 cubic centimeters per minute (cc/min.) during the morning and afternoon and averaged over the entire workday.

Samples taken during washing of screens were collected at an operating volume of 200 cc/min. for the duration of each screen washing, which lasted about 10 to 15 minutes per screen.

All sorbent tubes were extracted with carbon disulfide (CS₂) and analyzed by gas chromatography with a flame ionization detector. Gas chromatography/mass spectrometry was used to identify an unknown peak which was observed in original samples submitted to the laboratory for analysis. The duration and location of sample collection is provided in Tables I thru IV.

V. EVALUATION 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/Occupational Safety and Health Administration (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 required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) 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.

A. Toluene¹

The current OSHA standard for toluene is 200 parts of toluene per millions parts of air (ppm) averaged over an eight-hour work shift, and during any such work shift, 300 ppm toluene may not be exceeded except that a peak of 500 ppm toluene is permitted for 10 minutes during the eight-hour work shift. NIOSH recommends that the permissible exposure limit be reduced to

100 ppm toluene averaged over an eight-hour work shift with a ceiling level of 200 ppm averaged over a ten-minute period. The ACGIH recommends a TLV of 100 ppm as an eight-hour TWA concentration and 150 ppm as a short term exposure limit (STEL).

Toluene can affect the body if inhaled, through skin absorption, if splashed in the eyes, or if ingested. Short-term exposures may cause irritation of the eyes, respiratory tract, and the skin. Repeated or prolonged skin contact has a defatting action, causing drying, fissuring, and dermatitis. Toluene can cause nervous system depression, the TLV was set at a level to prevent systemic effects.

B. Methyl Isobutyl Ketone^{2,3}

The current OSHA-PEL for MIBK is 100 ppm as an eight-hour TWA. NIOSH recommends that exposure to MIBK be limited to 50 ppm as an 8-10 hour TWA and the ACGIH recommends a TLV of 50 ppm and a Short-Term Exposure Limit (STEL) of 75 ppm.

Methyl isobutyl ketone is an irritant of the eyes, mucous membranes, and skin. The liquid splashed in the eyes may cause pain and irritation. Repeated or prolonged skin contact may cause defatting of the skin with primary irritation and peeling of the skin. The TLV was set at a level to prevent eye irritation.

C. Cyclohexanone^{2,4,5}

The current OSHA-PEL is 50 ppm as an eight-hour TWA. NIOSH recommends that exposure be limited to 25 ppm as an 8-10 hour TWA while the ACGIH recommends a TLV of 25 ppm and STEL of 100 ppm.

Cyclohexanone can cause eye, nose, and throat irritation. Eye contact with liquid may cause corneal injury. The liquid is a defatting agent, and prolonged or repeated skin contact may produce irritation or dermatitis.

D. Combined Exposures

Many of the aromatic and aliphatic hydrocarbon solvents exert similar toxicological actions, and can act "additively" to produce irritation, central nervous system depression, and other adverse effects. To assess the combined effect from exposure to more than one solvent, the following equation is used:

$$\frac{C_1}{E_1} + \frac{C_2}{E_2} + \frac{C_n}{E_n} > 1$$

where C_1 indicates the measured atmospheric concentration of compound 1, C_2 the concentration of compound 2, and so forth (C_n), and E_1 the evaluation criteria for compound 1, E_2 the criteria for compound 2, and so forth [$(C_n)/(E_n)$]. Therefore, if the sum of the above fraction exceeds the number 1 (unity), the overall criteria should be considered as being exceeded.

IV. RESULTS AND DISCUSSION

Short-term, personal, breathing zone air samples collected in the screen washing booth showed detectable levels of toluene and methyl isobutyl ketone (MIBK) both of which are components of the screen washing solution in use at the time of this survey. Three of the five short term samples collected for toluene during silk screen washing exceeded the NIOSH recommended standard of 200 ppm for a 10 minute ceiling period, levels ranged from 144 ppm to 727 ppm. See Table I for a complete listing of sample results. One of the five short-term personal breathing zone air samples collected for methyl isobutyl ketone (MIBK) exceeded the ACGIH-STEL of 75 ppm for a 15 minute period, levels ranged from 24 ppm to 143 ppm. See Table II for a complete listing of sample results. Neither OSHA, nor NIOSH have a standard for short-term exposures to MIBK. The calculated eight hour TWA concentration for exposure to MIBK is far below the current OSHA-PEL of 100 ppm and the NIOSH recommended standard of 50 ppm.

Sampling during screen printing operations showed no detectable levels of isophorone, a solvent contained in the retarder. Sampling for cyclohexanone, a component of the ink being used, showed detectable levels ranging from 4 ppm to 28 ppm with total TWA concentrations of 9 ppm (8-hour TWA = 6.8 ppm) and 16.6 ppm (8-hour TWA = 12.8). The current OSHA-PEL for cyclohexanone is 50 ppm as a TWA. NIOSH recommends 25 ppm as a TWA. See Table III for complete listing of sample results. Further analysis of these samples showed the presence of toluene. Total TWA concentrations for toluene were 29.4 ppm (calculated 8-hour TWA = 27.3 ppm) and 80.4 ppm (calculated 8-hour TWA = 62 ppm) for the two employees working in the silk screen printing operation. The current OSHA-PEL for toluene is 200 ppm as a TWA. NIOSH recommends that exposure to toluene be limited to 100 ppm as a TWA concentration. See Table IV for complete listing of sample results.

Although eight hour TWA concentrations for exposure to toluene and cyclohexanone would not exceed the specific criteria for either of these substances individually, the combined exposure for one of the two full time employees would equal 1.1; and therefore, would exceed the overall evaluation criteria. A complete listing of combined exposure calculations is provided in Table V.

The primary source of employee exposure was the cleaning solvent used to spray and clean screens. A significant amount of solvent vapors were generated during the 10 to 15 minute period required to clean screens. Skin contact with the solvent, especially when washing the screen and the hands, would provide an additional source of exposure since absorption of solvents can increase their systemic effects upon the body.

VII. CONCLUSION

On the basis of the information obtained during this investigation it has been determined that a health hazard did exist at this facility at the time of this survey. Employees were exposed to levels of toluene in excess of the NIOSH recommended standard of 200 ppm for a 10 minute ceiling period and above the ACGIH short term exposure limit of 75 ppm for a 15 minute period for methyl isobutyl ketone. Additionally, a combined 8-hour TWA concentration for exposure to toluene and cyclohexanone exceeded the criteria for substances having additive effects.

VIII. RECOMMENDATIONS

1. Substitution is the recommended method for controlling occupational exposures to toxic substances. The feasibility of substituting the screen washing solution with a less toxic solution should be investigated.
2. Application of engineering control methods (improvements in the present local exhaust ventilation system within the screen washing booth) should be used to control occupational exposures to solvents if a suitable substitute (for the solvent presently in use) does not exist.
3. The practice of wearing personal protective equipment (i.e. gloves and face shield) during the washing of screens should be continued. Additionally, an apron should be worn to prevent clothing, and thus skin from coming into contact with the solvents. Gloves and aprons should be made of an appropriate material to prevent solvent permeation and thus skin contamination.
4. During screen washing or other instances when a potential for high exposures exists, the proper respiratory protection should be utilized. NIOSH/MSHA approved respirators with organic vapor cartridges should provide protection against most solvents utilized in these operations.
5. Solvents should be kept in appropriately labeled containers and stored in fire resistant and well ventilated cabinets. Additionally, lids for all containers (trash containing solvent soaked rags etc.) should be kept closed when not in use, in order to prevent the escape of vapors into the general workroom environment.
6. Hands should be cleaned using a waterless hand cleanser, followed by soap and water when possible. Never use solvents for cleaning any part of the body.
7. Smoking, eating, and drinking should not be allowed in work areas in order to avoid the possibility of fire or inadvertant ingestion of the materials.

IX. 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. National Institute for Occupational Safety and Health. NIOSH/OSHA Pocket Guide to Chemical Hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978. (DHHS (NIOSH) publication No. 78-210).
3. Proctor, N.H. and Hughes, J.P. Chemical Hazards of the Workplace. Philadelphia: J.B. Lippencott Company, 1978.
4. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard - Occupational Exposure to Ketones. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978. (DHEW publication no. (NIOSH) 76-173).
5. American Conference of Governmental Industrial Hygienists. TLVs® Theshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices with Intended Changes for 1984-85. Cincinnati, Ohio: ACGIH, 1984.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by: Daniel Almaquer
Industrial Hygienist
NIOSH - Region V
Chicago, Illinois

Environmental Assistance: William J. Daniels, CIH
Industrial Hygienist
NIOSH - Region V
Chicago, Illinois

Originating Office: Division of Surveillance, Hazard
Evaluations & Field Studies
Hazard Evaluation and
Technical Assistance Branch
Cincinnati, Ohio

Laboratory Analysis: Utah Biomedical Laboratory
Salt Lake City, Utah

IX. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Port Royal Road, 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 the following:

- A. Impressions Handprinters
- B. U.S. Department of Labor, OSHA - Region V
- C. NIOSH, Region V

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

Table I

Personal Breathing Zone Air Concentrations of Toluene

Impressions Handprinters
Chicago, Illinois

June 8, 1984

Location	Sample Time (minutes)	mg/sample	sample volume (liters)	mg/M ³	PPM
Emp. #1, washing screen	11	1.5	2.2	682	181
" , "	12	1.3	2.4	542	144
" , "	15	3.5	3.0	1167	310
" , screen printing	16	<LOD	3.2	<LOD	---
Emp. #2, washing screen	12	2.6	2.4	1083	287
" , "	17	9.3	3.4	2735	727
Blank	-0-	<LOD	-0-	<LOD	---

Laboratory limit of detection: 0.01 milligrams/sample for toluene

Abbreviations:

<LOD - Less than laboratory limit of detection
 mg/M³ - milligrams of toluene per cubic meter of air
 ppm - parts of toluene per million parts of air

Environmental Criteria:

OSHA-PEL - 200 ppm TWA, 300 ppm (ceiling limit), 500 ppm (peak conc.)
 NIOSH - 100 ppm TWA, 200 ppm (10 min. ceiling)
 ACGIH-TLV - 100 ppm TWA, 150 ppm (15 min. ceiling)

Table II

Personal Breathing Zone Air Concentrations of Methyl Isobutyl Ketone (MIBK)

Impressions Handprinters
Chicago, Illinois

June 8, 1984

Location	Sample Time (minutes)	mg/sample	sample volume (liters)	mg/M ³	PPM
Emp. #1, washing screen	11	0.29	2.2	132	32
" , " "	12	0.24	2.4	100	24
" , " "	15	0.72	3.0	240	59
" , screen printing	16	<LOD	3.2	<LOD	---
Emp. #2, washing screen	12	0.48	2.4	240	58
" , " "	17	2.0	3.4	588	143
Blank	-0-	<LOD	-0-	<LOD	---

Laboratory limit of detection: 0.01 milligrams/sample for MIBK

Abbreviations:

<LOD - Less than laboratory limit of detection
 mg/M³ - milligrams of MIBK per cubic meter of air
 ppm - parts MIBK per million parts of air

Environmental Criteria:

OSHA-PEL - 100 ppm TWA
 NIOSH - 50 ppm TWA
 ACGIH-TLV - 50 ppm TWA, 75 ppm STEL

Table III

Personal Breathing Zone Air Concentrations of Cyclohexanone

Impressions Handprinters
Chicago, Illinois

June 8, 1984

Location	Sample Time (minutes)	mg/sample	sample volume (liters)	mg/M ³	PPM
Emp. #1	173	0.30	8.6	35	9
	191	0.34	9.6	35	9
				Total TWA =	9
				Calc. 8-hour TWA =	6.8
Emp. #2	176	0.14	8.8	16	4
	194	1.1	9.7	113	28
				Total TWA =	16.6
				Calc. 8-hour TWA =	12.8
Emp. #3	183	<LOD	9.2	<LOD	---
	156	<LOD	7.8	<LOD	---
Blank	-0-	<LOD	-0-	<LOD	---

Laboratory limit of detection: 0.01 milligrams/sample for cyclohexanone

Abbreviations:

<LOD - Less than laboratory limit of detection

mg/M³ - milligrams of methyl isobutyl ketone (MIBK) per cubic meter of air

ppm - parts MIBK per million parts of air

Environmental Criteria:

OSHA-PEL - 50 ppm TWA

NIOSH - 25 ppm TWA

ACGIH-TLV - 25 ppm TWA, 100 ppm STEL

Table IV
 Personal Breathing Zone Air Concentrations of Toluene
 Impressions Handprinters
 Chicago, Illinois
 June 8, 1984

Location	Sample Time (minutes)	mg/sample	sample volume (liters)	mg/M ³	PPM
Emp. #1	173	1.	8.6	116	31
"	191	1.	9.6	104	28
				Total TWA = 19.4	
				Calc. 8-hour TWA = 27.3	
Emp. #2	176	0.6	8.8	68	18
	194	5.	9.7	515	137
				Total TWA = 80.4	
				Calc. 8-hour TWA = 62	
Emp. #3	183	<LOD	9.2	<LOD	---
"	156	<LOD	7.8	<LOD	---
Blank	-0-	<LOD	-0-	<LOD	---

Laboratory limit of detection: 0.5 milligrams/sample for toluene

Abbreviations:

<LOD - Less than laboratory limit of detection
 mg/M³ - milligrams of toluene per cubic meter of air
 ppm - parts toluene per million parts of air

Environmental Criteria:

OSHA-PEL - 200 ppm TWA, 300 ppm (ceiling limit), 500 ppm (peak conc.)
 NIOSH - 100 ppm TWA, 200 ppm (10 min. ceiling)
 ACGIH-TLV - 100 ppm TWA, 150 ppm (15 min. ceiling)

Table V

CALCULATION OF COMBINED EXPOSURES

Formula: $\frac{\text{Measured - Toluene}}{\text{Criteria - Toluene}} + \frac{\text{Measured - Cyclohexanone}}{\text{Criteria - Cyclohexanone}}$

Calculations: Emp. #1 - Process Duration $\frac{27.3 \text{ ppm}}{100 \text{ ppm}} + \frac{6.8 \text{ ppm}}{25 \text{ ppm}} = 0.54$

Emp. #2 - " " $\frac{62 \text{ ppm}}{100 \text{ ppm}} + \frac{12.8 \text{ ppm}}{25 \text{ ppm}} = 1.1$

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. \$300

Third Class Mail



POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HEALTH
HHS 396