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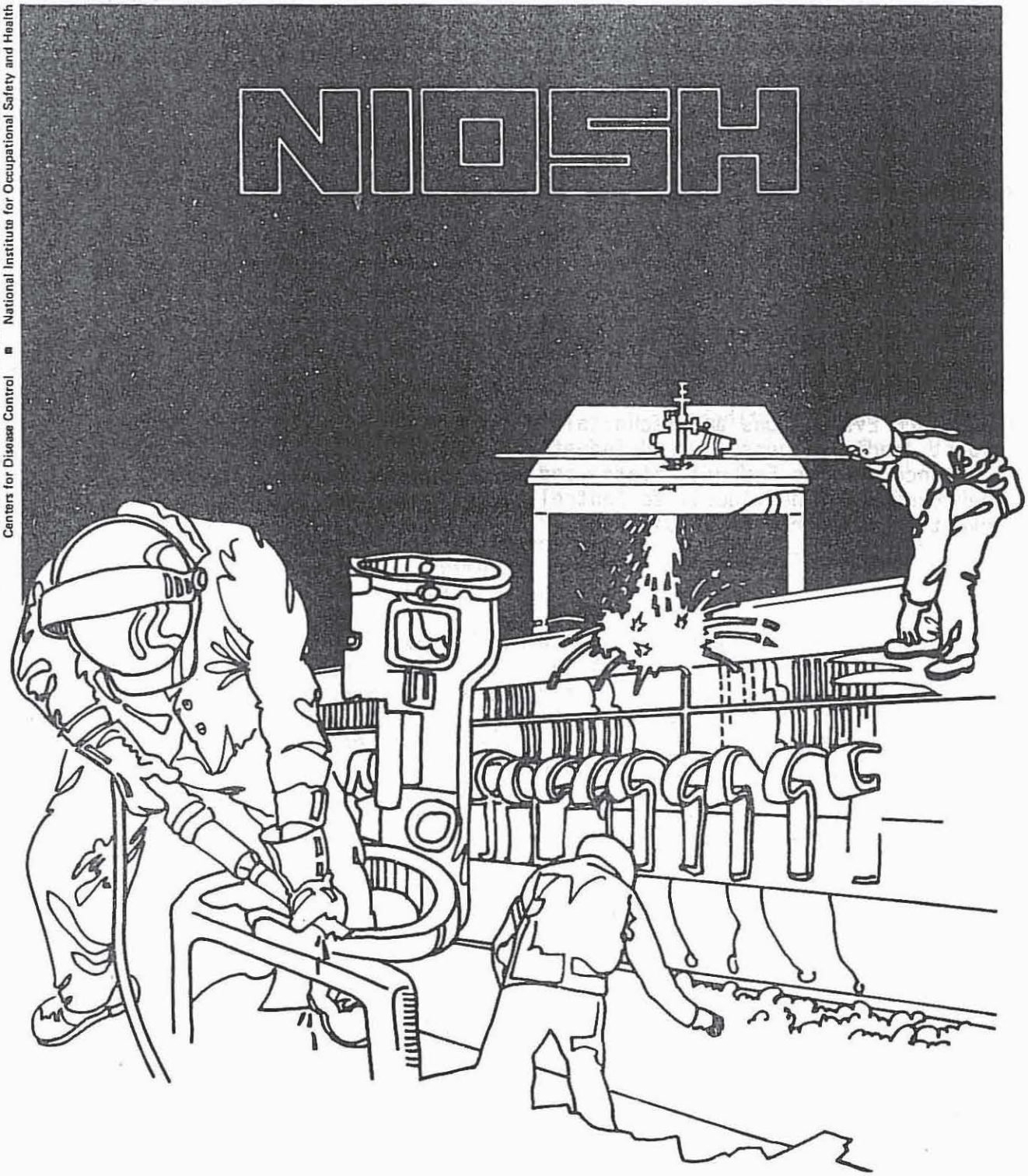

Health Hazard Evaluation Report

HETA 82-330-1252
DOWNING DISPLAYS, INCORPORATED
CINCINNATI, OHIO

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 82-330-1252
JANUARY 1983
DOWNING DISPLAYS, INCORPORATED
CINCINNATI, OHIO

NIOSH INVESTIGATOR:
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I. SUMMARY

In July 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from Downing Displays, Incorporated, Cincinnati, Ohio to evaluate worker exposure to two solvent-containing screen cleaners used in the silk screening process. Reported health complaints by employees included headaches and chest pain.

On July 14, 1982, NIOSH investigators conducted an initial industrial hygiene evaluation. Medical questionnaires were administered to four employees to identify any existing medical conditions. On August 18-19, 1982, personal breathing zone long-term and short-term air samples were collected for the solvent constituents contained in each of the screen cleaners. The silk screener using the image remover was monitored for exposure to cellosolve acetate and cyclohexanone. The silk screener using the paint remover was monitored for exposure to methylethyl benzenes, trimethyl benzenes, isopropyl benzene, butyl cellosolve, diacetone alcohol, cellosolve acetate, and xylenes.

Both silk screeners were exposed to airborne solvent vapors at levels below the Threshold Limit Value (TLV) for mixtures of 1.0 for both the long-term and short-term exposures. The silk screener using the image remover had an 8-hour time-weighted average (TWA) mixed solvent exposure up to about 20% of the TLV, with the short-term exposure ranging up to about 28% of the short-term exposure limit (STEL). The silk screener using the paint remover had an 8-hour TWA mixed solvent exposure up to 34% of the TLV with short-term exposures of up to 58% of the STEL, assuming a continuous 15 minute exposure. However, since the paint remover was used for 3 to 7 minutes in any given 15 minute period, the actual airborne short-term exposure would be somewhat lower.

In addition to exposure by inhalation, the silk screeners may also have been exposed to the solvents via skin absorption since personal protective equipment such as faceshields and gloves were not always worn.

The questionnaires revealed complaints of sinus problems, headache, lethargy and nausea possibly associated with solvent exposures. These symptoms were compatible with the chemical substances to which each silk screener was exposed.

On the basis of the data collected during this evaluation, NIOSH concluded that a health hazard from exposures to airborne solvent mixtures did not exist at Downing Displays, Incorporated. However, the solvents also may have been absorbed through the intact skin, contributing to the worker's overall exposure. Recommendations on work practices and the use of personal protective equipment are presented in Section VII of this report.

KEYWORDS: SIC 3993 (Signs and Advertising Displays), solvents, organic compounds

II. INTRODUCTION

On July 6, 1982, the National Institute for Occupational Safety and Health received a request from a representative of the employer at Downing Displays, Incorporated to conduct such a health hazard evaluation. The request asked NIOSH to evaluate worker exposure to two commercially available solvent-containing chemicals, an image remover and a paint remover, used to clean silk screens. Health complaints reported by the workers included headaches and chest pain.

An initial site visit was made to the facility on July 14, 1982, to discuss the request and ensuing evaluation with the company and to conduct a walk-through survey of the silk screening department. During the survey NIOSH investigators observed the silk screen printing process, in particular, the screen prepping and cleaning operations where the image remover and paint remover, respectively, were used. NIOSH investigators collected bulk samples of both screen cleaners for subsequent laboratory testing and made spot measurements for volatile organics. In addition, a non-directed medical questionnaire was administered to the workers. On August 6, 1982, a letter was sent to the company summarizing the findings of the survey and presenting preliminary recommendations.

On August 18-19, 1982 a follow-up environmental survey was conducted. Environmental samples were collected for the specific chemical constituents contained in each of the screen cleaners. The results of the follow-up survey were presented to the company in an interim report issued in November 1982.

III. BACKGROUND

Downing Displays, Incorporated, Cincinnati, Ohio, manufactures a variety of portable displays for use in advertising and sales promotion. Approximately 60% of the artwork for the displays is reproduced by a silk screening process while the remainder is reproduced by a powdered ink process. This evaluation focused on the silk screening process and specifically on the screen prepping and cleaning operations, where the image remover, respectively, were used.

Three persons were assigned to the silk screening department - a supervisor and two silk screeners. The one silk screener only used the image remover in the screen prep room, while the other only used the paint remover in the washout room. Each silk screener, therefore, was exposed to a different combination of solvents.

IV. EVALUATION DESIGN AND METHODS

During the initial survey, spot measurements were taken with a calibrated direct-reading HNV Model PI 101 photoionization analyzer (10.2 eV ionization potential). Total hydrocarbon levels ranged up to 20 ppm during the use of image remover and up to 300 ppm during use of the paint remover. Based on these preliminary findings, NIOSH concluded that further air monitoring was necessary to qualitatively as well as quantitatively characterize the silk screeners' exposure.

Prior to the follow-up evaluation in August, the NIOSH project officer contacted the manufacturers of the image remover and the paint remover to obtain information concerning the specific chemicals contained in their product. Upon receipt of this information, NIOSH returned to Downing Displays on August 18-19 and collected air samples for the solvents contained in these products. According to the manufacturers the image remover contained a mixture of cellosolve acetate, cyclohexanone and caustic; the paint remover contained a mixture of cellosolve acetate, diacetone alcohol, butyl cellosolve, xylenes, isopropyl benzene, methylethyl benzenes and trimethyl benzenes.

To evaluate the silk screeners' exposure to the solvent mixtures, NIOSH investigators collected long-term and short-term breathing zone air samples on August 18 and 19, 1982. All samples were collected on charcoal tubes using battery-operated sampling pumps calibrated at a flow rate of 0.02 liters per minute (Lpm) for the long-term samples and 0.5 Lpm for the short-term samples. Two long-term samples were obtained from each silk screener. Sampling durations averaged 7 hours.

Different sampling techniques were used to evaluate the silk screeners' short-term exposure. The silk screener using the image remover had an air sample taken during each of the screen washing operations. Sampling durations ranged from 15 to 28 minutes. For the silk screener using the paint remover, one sampling tube was used to collect solvent vapors produced from three consecutive screen washings. Since the time required for one washing was relatively short (3 to 7 minutes), this procedure was used to ensure that the material collected on the tube was sufficient for subsequent quantitation by the lab and to provide an indication of the maximum level a silk screener would be exposed to if the washing operation lasted 15 minutes. Total sampling duration for each sampling tube ranged from 11 to 16 minutes.

All of the samples for the silk screener using image remover were analyzed for cellosolve acetate and cyclohexanone using NIOSH Method P&CAM 127.[1]

Because of the number of solvents contained in the paint remover, two charcoal tubes were used to collect the vapor mixture for subsequent analysis. Xylenes, isopropyl benzene, methylethyl benzenes, and trimethyl benzenes were analyzed from one tube by gas chromatography (GC) using NIOSH Method P&CAM 127.[1] Cellosolve acetate, diacetone alcohol, and butyl cellosolve were analyzed from the other tube by GC using NIOSH Method P&CAM S-55.[2]

Since the paint remover contained a number of substituted benzenes, a bulk sample was obtained and analyzed for benzene.

Non-directed medical questionnaires were administered to three current and one former silk screening department employee. The questionnaire was designed to elicit symptomatology possibly related to health problems arising from the use of the screen cleaners.

V. EVALUATION CRITERIA

The environmental criteria used to assess the silk screeners' exposure to the airborne contaminants evaluated are listed with the sampling results in Tables I and II. The criteria have been derived from existing human and animal data and from industrial experience. The criteria are designed to permit an occupational exposure over an 8-hour workday, 40-hour workweek throughout a normal working lifetime without adverse health effects.

All of the compounds sampled can cause varying degrees of anesthesia, with low level exposures causing headaches, and greater exposures causing lightheadedness, "drunkenness", and even unconsciousness. These compounds also may cause irritation to the eyes, mucous membranes, and respiratory tract. Skin contact, particularly on a prolonged or repeated basis, may cause dermatitis, and for those substances with a "skin" notation (see Tables I and II) significant absorption may occur via the dermal route.[3]

In assessing health hazards where workers are exposed to a mixture of organic solvents which produce similar health effects upon exposure, the overall effects are considered additive. The following formula was used to calculate exposure for contaminant mixtures:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n}$$

Where C_1 is the airborne concentration of contaminant 1 and T_1 is the evaluation criterion of the contaminant 1, and so on. If the sum of the fraction exceeds unity (1), then the evaluation criterion of the mixture is exceeded.

VI. RESULTS AND DISCUSSION

The airborne mixed solvent exposures for the two silk screeners were below the referenced long-term and short-term occupational health criteria (Tables I and II). The silk screener who used the image remover had an 8-hour TWA exposure ranging up to about 20% of the TLV for mixtures, with the short-term exposure limit (STEL) ranging up to about 28% of the TLV (Table I). Airborne mixed solvent exposures for the silk screener using the paint remover were somewhat higher with 8-hour TWA exposures ranging up to 34% of the TLV for mixtures (Table II). The short-term exposure ranged up to about 58% of the TLV. However, since the silk screener only used the paint remover for 3 to 7 minutes in any 15-minute period, the actual short-term TWA exposure would be somewhat lower than reported.

The bulk sample of paint remover did not contain benzene in an amount greater than the limit of detection for the analysis (0.1 mg/mL).

The silk screeners did not always use protective equipment (i.e., gloves, eye and face protection) provided to them. Consequently, it is likely that during the use of the screen cleaners solvents may be absorbed through the skin, thus contributing to the workers overall exposure.

Review of the medical questionnaire data indicated that all four workers were symptomatic and attributed their present symptoms, in part, to solvent exposures. Specific complaints were as follows: headaches (3), lethargy (2), sinus problems (3), nausea (1) and heart burn (1). Three workers mentioned that their symptoms improve when they are away from work.

Although the silk screeners' airborne exposures were below the referenced occupational health criteria the symptoms of headache, lethargy, and nausea may be attributed to the additive toxicological effects of these compounds.

VII. CONCLUSIONS

Based on the air sampling data and information obtained from the questionnaires, NIOSH concludes that both silk screeners were not overexposed to airborne solvent mixtures during the evaluation. However, solvent exposure may also occur via skin absorption and therefore may have contributed to the worker's overall exposure.

VIII. RECOMMENDATIONS

1. Since both screen cleaners contain chemical compounds which are readily absorbed through the skin, personal protective equipment including face shields, impervious gloves and coveralls should be worn during use of the screen cleaners to minimize skin contact.

2. Containers of solvents should be capped or sealed when not in use. This practice will minimize solvent evaporation and reduce the likelihood of exposure.

3. There should be an increased emphasis on housekeeping in the washout room.

4. An education program should be developed to assure that workers are made aware of the potential health hazards associated with and the precautions to be observed in the safe handling of solvents.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-A).

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3. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1982. Cincinnati, Ohio: ACGIH, 1982.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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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. Downing Displays, Inc., Cincinnati, Ohio
2. NIOSH, Region V
3. OSHA, Region V

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

Cellosolve Acetate and Cyclohexanone Exposures for the
Silk Screener Using Image Remover

Downing Displays Inc.
Cincinnati, Ohio
HETA 82-330

August 18-19, 1982

Date	Location	Sample Duration (min.)	Sample Volume (liters)	Environmental Concentration[1] (mg/M^3)		Percent of TLV for Mixture[2]
				Cellosolve Acetate	Cyclohexanone	
8/18/82	Screen Prep Room	428	6.3	6.3	17.3	0.20
8/18/82	Screen Prep Room	19*	8.9	8.9	80.6	0.22
8/18/82	Screen Prep Room	21*	9.9	14.2	100.3	0.28
8/18/82	Screen Prep Room	19*	8.9	20.1	59.3	0.18
8/18/82	Screen Prep Room	15*	7.0	9.9	39.7	0.12
8/19/82	Screen Prep Room	422	6.3	17.5	1.6	0.08
8/19/82	Screen Prep Room	28*	13.2	7.6	47.9	0.13
Evaluation Criteria:	8-hour TWA			270	100	1.0
	15-minute STEL			540 (skin)	400	1.0

1 Time-Weighted Average over sampling period.
2 ACGIH TLV's (1982) Threshold Limit Value for Mixtures.

* Although most of the sampling durations exceeded 15 minutes, these samples will be compared to the appropriate ACGIH 15-minute short-term exposure limits (STEL) as they are more applicable in this situation than the 8-hour time-weighted average (TWA) exposure limit.

NOTE:
ACGIH has published a Notice of Intended Change for Cellosolve Acetate (2-ethoxyethyl acetate) to 27 mg/M^3 as an 8-hour TWA with no STEL recommendation. This proposed reduction was based on (1) reported testicular and leukopenic changes in mice fed this compound and (2) an analogy to the proposed reduction for 2-ethoxyethanol from 270 to 27 mg/M^3 (see reference 4).

TABLE II

Multiple Solvent Exposures for the Silk Screener Using Paint Remover

Downing Displays Inc.
Cincinnati, Ohio
HETA 82-330

August 18-19, 1982

Date	Location	Sample Time (min.)	Sample Volume (liters)	Environmental Concentration[1] (mg/M^3) Cellosolve Acetate	Diacetone Alcohol	Butyl Cellosolve	Xylenes	Isopropyl Benzene	Methylethyl Benzenes	Trimethyl Benzenes	Percent of TLV for Mixture[2]
8/18/82	Washout Room	419	7.4	6.8	5.4	10.8					0.34
		419	5.6				ND	ND	12.6	21.5	
		16*	7.5	20.0	12.8	25.5					0.58
		16	7.5				7.1	2.8	36.9	59.6	
		14*	6.6	21.2	12.1	22.7					0.49
		14	6.6				6.1	1.5	35.0	47.1	
8/19/82	Washout Room	427	7.5	2.7	4.0	5.3					0.16
		427	5.6				ND	ND	ND	10.7	
		14*	6.6	15.2	7.6	19.7					0.42
		14	6.6				3.0	1.5	27.4	44.1	
		11*	5.2	17.3	9.6	15.4					0.56
		11	5.2				4.2	2.1	44.7	61.7	
Evaluation Criteria:	8-hour TWA			270	240	120	435	245	-**	125	1.00
	15-minute STEL			540 (skin)	360	360 (skin)	655 (skin)	365 (skin)	-**	170	

1 Time-Weighted Average (TWA) over sampling period.
2 ACGIH TLV's (1982) Threshold Limit Values for Mixtures (see Reference No. 3).

* These samples will be compared to the appropriate ACGIH 15-minute short-term exposure limits (STEL) as they are more applicable in this situation than the 8-hour time-weighted average (TWA) exposure limit.
** Currently, there are no established exposure limits for methylethyl benzenes. Available information suggests that the methylethyl benzenes produce similar health effects as ethyl benzene (see Reference No. 5). Therefore, for purposes of this evaluation, the criteria for ethyl benzene (435 TWA, 545 STEL) will be used.

NOTE:
ACGIH has published a Notice of Intended Change for Cellosolve Acetate (2-ethoxyethyl acetate) to 27 mg/M^3 as an 8-hour TWA with no STEL recommendation. This proposed reduction was based on (1) reported testicular and leukopenic changes in mice fed this compound and (2) an analogy to the proposed reduction for 2-ethoxyethanol from 270 to 27 mg/M^3 (see reference 4).

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