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DOWNING DISPLAYS, INC.
CINCINNATI, OHIO

NIOSH INVESTIGATOR:
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I. SUMMARY

On June 2, 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the management of Downing Displays, Inc., Cincinnati, Ohio. The requestor stated that on May 7, 1987, the Cincinnati Fire Department was called and asked to investigate employees complaints of irritation of the eyes, nose, and throat. On June 2, 1987, a second episode of irritation was experienced and NIOSH was requested to investigate.

On the afternoon of June 2, a NIOSH investigator conducted an initial walk-through evaluation of the Unlimited Department and collected general area air samples for organic vapors. A set of four air sampling pumps were placed near the sewer drain and a duplicate set of pumps were placed in the general work area. These samples were analyzed qualitatively via gas chromatography/mass spectrometry (GC/MS) for comparison and showed no differences between the two areas. Additionally, all four employees working in the Unlimited Department and two employees working in the Large Shelve Set (LSS) Department were interviewed.

On June 3, representatives of the Metropolitan Sewer District of Cincinnati and NIOSH walked through the plant and determined that the odor was not emanating from the sewer drain. Further investigation indicated that the adhesive being used in the Unlimited Department was the source of the irritating odor. The material safety data sheet (MSDS) for the adhesive indicated that the product contained "trace" quantities of formaldehyde. A bulk sample of the adhesive was collected in submitted to our lab for analysis via GC/MS.

On June 16, and June 22, 1987, environmental sampling was conducted to assess employee exposures to formaldehyde. Personal samples for formaldehyde were collected near the breathing zone of employees working in the Unlimited Department and general area air samples were collected at the display drying rack and at the production supervisors' desk. Personal samples ranged from 0.23 parts of formaldehyde per million parts of air (ppm) to 0.28 ppm and general area samples ranged from 0.23 ppm to 3.3 ppm. Additionally, bulk material samples of two new lots of adhesive were collected and submitted to our laboratory for analysis. These results indicated that the adhesive being used on June 2 contained 5 to 7 times the amount of formaldehyde of the two new lots.

The Occupational Safety and Health Administration (OSHA) standard for formaldehyde is set at 1.0 ppm as an 8-hour time weighted average. Because formaldehyde is a suspect carcinogen NIOSH recommends that occupational exposures be to the lowest feasible level (LFL).

On the basis of the data obtained during this investigation it has been determined that employees working in the Unlimited Department were exposed to concentrations of formaldehyde in excess of the NIOSH Recommended Exposure Limit (REL). Recommendations for reducing employee exposures are presented in Section VIII of this report.

KEYWORDS: SIC 3993 (Signs and Advertising Displays), adhesives, formaldehyde.

II. INTRODUCTION

On June 2, 1987, the National Institute for Occupational Safety and Health (NIOSH) received a phone call from the management at Downing Displays, Inc., Cincinnati, Ohio, requesting a NIOSH Health Hazard Evaluation (HHE). The requestor asked for an immediate response to what was perceived to be an emergency situation. The employees working in the Unlimited Department were experiencing irritation of the eyes, nose, and throat and were evacuated from the immediate work area.

Previously, on May 27, 1987, employees working in the Unlimited Department experienced irritation of the eyes, nose, and throat. The Cincinnati fire department was called to investigate the situation. The odor and source of odor was localized to an area in the northwest corner of the Unlimited Department near a sewer drain. The Unlimited Department is located in the basement of the facility.

On June 2, 1987, a second episode of irritation was experienced and NIOSH was called to investigate. On the afternoon of June 2, 1987, a NIOSH investigator visited the plant to initiate this HHE. During this visit general area air sampling for organic vapors was conducted in the area of the complaints. A set of four air sampling pumps were placed near the sewer drain and a duplicate set of pumps were placed in the general work area of the Unlimited Department. Afterwards each of the four employees working in the Unlimited Department and two employees working in the Large Shelve Set (LSS) Department were interviewed.

On June 3, a meeting was held with representatives of the Metropolitan Sewer District of Cincinnati and an attempt was made to locate the source of the irritating odor. During the walk-through of the plant it was determined that the odor was not emanating from the sewer drain. Further investigation indicated that the adhesive being used in the Unlimited Department may have been the source of the irritating odor. A material safety data sheet (MSDS) for the adhesive product indicated that the product contained "trace" quantities of formaldehyde. A bulk material sample of the adhesive was collected and submitted to our laboratory for analysis via gas chromatography/mass spectrometry (GC/MS).

On June 16, environmental sampling was conducted to assess employee exposures to formaldehyde. Personal samples for formaldehyde were collected near the breathing zone of employees working in the Unlimited and LSS Departments, and general area air samples were collected at the display drying rack and at the production supervisors' desk. Due to a power outage normal work activities were suspended and therefore, sampling was suspended and the environmental sampling survey was rescheduled. All samples collected on this day were sent to our laboratory to be analyzed for formaldehyde.

On June 22, further environmental sampling was conducted. Again, personal samples for formaldehyde were collected near the breathing zone of employees working in the Unlimited Department and general area air samples were collected at the display drying rack and at the production supervisors' desk. Additionally, two bulk material samples of two new lots of adhesive were collected and submitted to our laboratory for analysis.

III. BACKGROUND

A. Plant Production and Workforce

Downing Displays, Incorporated, Cincinnati, Ohio, is a manufacturer of a variety of portable displays for use in advertising and sales promotion. In the Large Shelve Set (LSS) Department and the Unlimited Department, portable displays for use at conferences and exhibits are assembled. At the time of these surveys, four employees worked in the Unlimited Department and two employees worked in the adjacent Large Shelve Set (LSS) Department.

B. Process Description

In the Unlimited Department, display boards for sales promotions are assembled. Metal channeling is cut to size and metal slivers are cleaned from the surface with 1,1,1-trichloroethane while wearing protective gloves. Adhesive is purchased in 55 gallon drums and dispensed into paint roller pans as needed. The adhesive is applied to the cardboard backing using paint rollers. When the adhesive is not being used the paint roller pans are placed in a plexiglass cabinet to prevent the adhesive from drying out. The four employees working in the department do not use any type of respiratory protection and there are no engineering controls.

IV. EVALUATION DESIGN AND METHOD

During the initial survey of June 2, 1987, general area air samples were collected. Two sets of sampling media, consisting of four pumps each, were placed near the sewer drain in the northwest corner of the basement and in the center of the LSS Department on the glueing table. Each set of sampling media consisted of four solid sorbent tubes, two charcoal and two silica gel, connected via tygon tubing to battery powered pumps. One charcoal and one silica gel tube from each set were calibrated at 1 liter per minute (LPM) and 0.2 LPM. These samples were analyzed qualitatively via gas chromatography/mass spectrometry (GC/MS).
On June 16, and 22, general area air samples and personal breathing zone samples were collected to assess airborne concentrations of formaldehyde. General area air samples were collected at the production supervisor's desk, above the drying rack, and inside the clue cabinet. Personal breathing zone samples were collected for all employees working in the Unlimited Department and the LSS Department.

Air samples for formaldehyde were collected on solid sorbent XAD-2 tubes. Personal samples were collected by placing the sample media near the breathing-zone of the workers and general area air samples were placed in areas where the employees were likely to be present. The solid sorbent XAD-2 tubes were connected via tygon tubing to battery operated pumps operating at an air flow rate of 80 cubic centimeters per minute (cc/m) and were analyzed for formaldehyde via gas chromatography/flame ionization detection according to NIOSH Method No. 2502.[1]

V. EVALUATION CRITERIA

A. Environmental 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 Recommended Exposure Limits (RELs)[2], 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs)[3], and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards[4]. Often, the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH RELs and ACGIH TLVs 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 RELs, 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 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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

B. Toxic Effects of Formaldehyde

Formaldehyde gas is an irritant of the eyes and the respiratory tract; solutions cause both primary irritation and sensitization dermatitis.[5] The first signs or symptoms noticed upon exposure to formaldehyde, at concentrations ranging from 0.1 to 0.5 ppm, are burning of the eyes, tearing, and general irritation of the upper respiratory passages. Higher exposures (5 to 20 ppm) may produce coughing, tightening of the chest, a sense of pressure in the head, and palpitation (noticeable beats) of the heart. In 1976 NIOSH developed a REL for formaldehyde of 1 ppm to prevent the irritant effects

of exposures to this compound.[6] This recommendation predated animal carcinogenicity data implicating formaldehyde as a animal carcinogen and a potential occupational carcinogen. Formaldehyde has also produced positive results in mutagenicity testing, supporting the classification of this compound as a potential occupational carcinogen. NIOSH currently considers formaldehyde a human carcinogen and recommends that formaldehyde exposures be maintained at the lowest feasible level.[7,8]

On December 4, 1987, OSHA promulgated a new health standard for formaldehyde, which became effective on February 2, 1988.[9] In this revised standard, OSHA considers formaldehyde a probable human carcinogen. The PEL was reduced by two thirds, from 3 ppm to 1 ppm, as an 8-hour TWA, with an "action level" of 0.5 ppm. Exposures up to 2 ppm would be permitted for 15-minute periods, as long as the daily exposure does not exceed 1 ppm. The revised standard contains provisions for medical surveillance, recordkeeping, regulated areas, emergency procedures, control strategies, protective equipment, and hazard communication.

The ACGIH TLV for formaldehyde is 1 ppm, as an 8-hour TWA, but also classifies formaldehyde as a suspected human carcinogen necessitating that exposures be kept to a minimum.[3]

VI. RESULTS AND DISCUSSION

Qualitative analysis of the two sets of general area air samples collected on June 2, 1987, were analyzed via gas chromotography/mass spectrometry (GC/MS). Analysis of these samples showed no difference between the samples collected at the sewer drain and those collected in the general work area. Since the chromatograms of both sample sets were identical we are confident that the source of the irritating odor was not the sewer drain.

Results of the bulk sample, head space analyses, indicated that the adhesive being used on June 2, contained amounts of formaldehyde in excess of that indicated on the MSDS supplied by the manufacturer. The sample was analyzed via GC/MS. The two bulk material samples collected on June 16, 1987, were analyzed for formaldehyde along with the sample collected on June 2, and compared. These analyses indicated that the adhesive from Lot CUR-368 (adhesive used on June 2, 1987) contained five to seven times the amount of formaldehyde contained in Lots CFR-105 and CER-180 (adhesive used on June 16 and 22, 1987).

The manufacturer of the adhesive was informed of the results of our analyses and conducted an analyses of their own. Their results also indicated that the concentrations of formaldehyde in Lot CUR-368 contained excess amounts of formaldehyde. The manufacturer explained that the excess amount of formaldehyde in Lot CUR-368 was the result of a misformulation. The exact amount of the formaldehyde contained in the adhesive is considered proprietary information.

The results of the environmental sampling conducted on June 16, and 22, are presented in Tables I and II. One short term area air sample collected within the glue cabinet showed a concentration of 3.3 parts of formaldehyde per million parts of air (ppm). Two area samples collected above the drying rack and at the production supervisor's desk were below the analytical limit of detection. The results of five personal samples collected on June 16, 1987, were all below the

analytical limit of detection. It should be noted that because of a power outage normal work activities were discontinued and all samples collected were for a period of less than one and one-half hours. It is believed that the nondetectable levels on this day were due to the short sampling period and the fact that part of the sampling period was during the power outage when no work could be accomplished.

The results of sampling on June 22, 1987, are believed to be more accurate estimates of employee exposures. These results indicate that employees in the Unlimited Department and the LLS Department were exposed to airborne concentrations of formaldehyde in excess of the NIOSH REL. Airborne concentrations of formaldehyde ranged from 0.23 ppm to 0.68 ppm. Personal samples showed airborne concentrations of formaldehyde ranging from 0.23 ppm to 0.28 ppm for five workers. Two area samples collected above the drying rack and at the production supervisor's desk showed airborne concentrations of formaldehyde of 0.68 ppm and 0.23 ppm, respectively.

VII. CONCLUSION

Based on the information obtained during this investigation it can be concluded that employees working in the Unlimited Department were exposed to airborne concentrations of formaldehyde in excess of the NIOSH REL as a result of working with the adhesive. It can also be concluded that the adhesive from Lot CUR-368 contained five to seven times the amount of formaldehyde contained Lots CFR-105 and CER-180 and was the result of a misformulation. However, the adhesive used on the days we conducted formaldehyde sampling were from Lots CFR-105 and CER-180. This indicates that overexposure to formaldehyde can and did occur as a result of using normal batchs of the adhesive (i.e. Lots CFR- 105 and CER-180).

VIII. RECOMMENDATIONS

As a matter of good practice, emphasis should be placed on minimizing exposures through engineering controls, work practices, and personal protection where possible. The following recommendations are designed to reduce the airborne concentrations of formaldehyde.

1. The company should attempt to substitute the formaldehyde containing adhesive with an adhesive which contains a less toxic biocide.

2. If a suitable substitute is not feasible, the use of appropriate engineering controls should be implemented, such as those listed below.
3. The drying rack should be isolated from the general work area by enclosing this area and providing local exhaust ventilation.

4. The glue cabinet should be equipped with a local exhaust ventilation system to prevent high short term exposures to employees and to prevent the escape of concentrated formaldehyde vapors to the general work area.

5. Following the installation of ventilation, personal and general area air monitoring should be conducted to determine the effectiveness of the ventilation systems.

6. The manufacturer was informed of the misformulation. The manufacturer should evaluate how the misformulation occurred and should take all necessary precautions to prevent the reoccurrence of such misformulations.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods, 3rd Edition. Cincinnati, Ohio 1984. (DHHS (NIOSH) publication no. 84-100).

2. NIOSH Recommendations for Occupational Safety and Health Standard. Morbidity and Mortality Weekly Report Supplement. Vol. 35/No. 1S. September 26, 1985.

3. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment and biological exposure indices with intended changes for 1985-86. Cincinnati, Ohio: ACGIH, 1985.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. 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:

1. Downing Displays, Inc.

2. U.S. Department of Labor, OSHA - 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 and general area air samples for Formaldehyde

Downing Displays, Inc.
Cincinnati, Ohio
HETA 87-307

June 16, 1987

Job/Location	Sample Time (minutes)	Sample Volume (liters)	Formaldehyde (ppm)
Area - clue cabinet	32	2.7	3.3
Framer	69	5.4	ND
Gluer	69	5.5	ND
Framer	71	5.3	ND
Gluer	69	5.3	ND
Contact paper	53	4.2	ND
Area - drying rack	88	6.7	ND
Area - prod. supervisor's desk	92	7.7	ND
ENVIRONMENTAL CRITERIA		NIOSH REL	LFL
		ACGIH TLV	1.0
		OSHA PEL	1.0

Abbreviations:
ppm - parts of formaldehyde per million parts of air.
ND - nondetectable
LFL - lowest feasible level

Table II
Personal and general area air samples for Formaldehyde

Downing Displays, Inc.
Cincinnati, Ohio
HETA 87-307

June 22, 1987

Job/Location	Sample Time (minutes)	Sample Volume (liters)	Formaldehyde (ppm)
Gluer	267	20.7	0.28
Gluer	267	21	0.24
Gluer	267	21.8	0.26
Gluer	267	21.6	0.23
Transparencies	267	20.8	0.28
Area - drying rack	453	36.1	0.68
Area - prod. supervisor's desk	453	35.7	0.23
ENVIRONMENTAL CRITERIA		NIOSH REL	LFL
		ACGIH TLV	1.0
		OSHA PEL	1.0

Abbreviations:
ppm - parts of formaldehyde per million parts of air.
LFL - lowest feasible level