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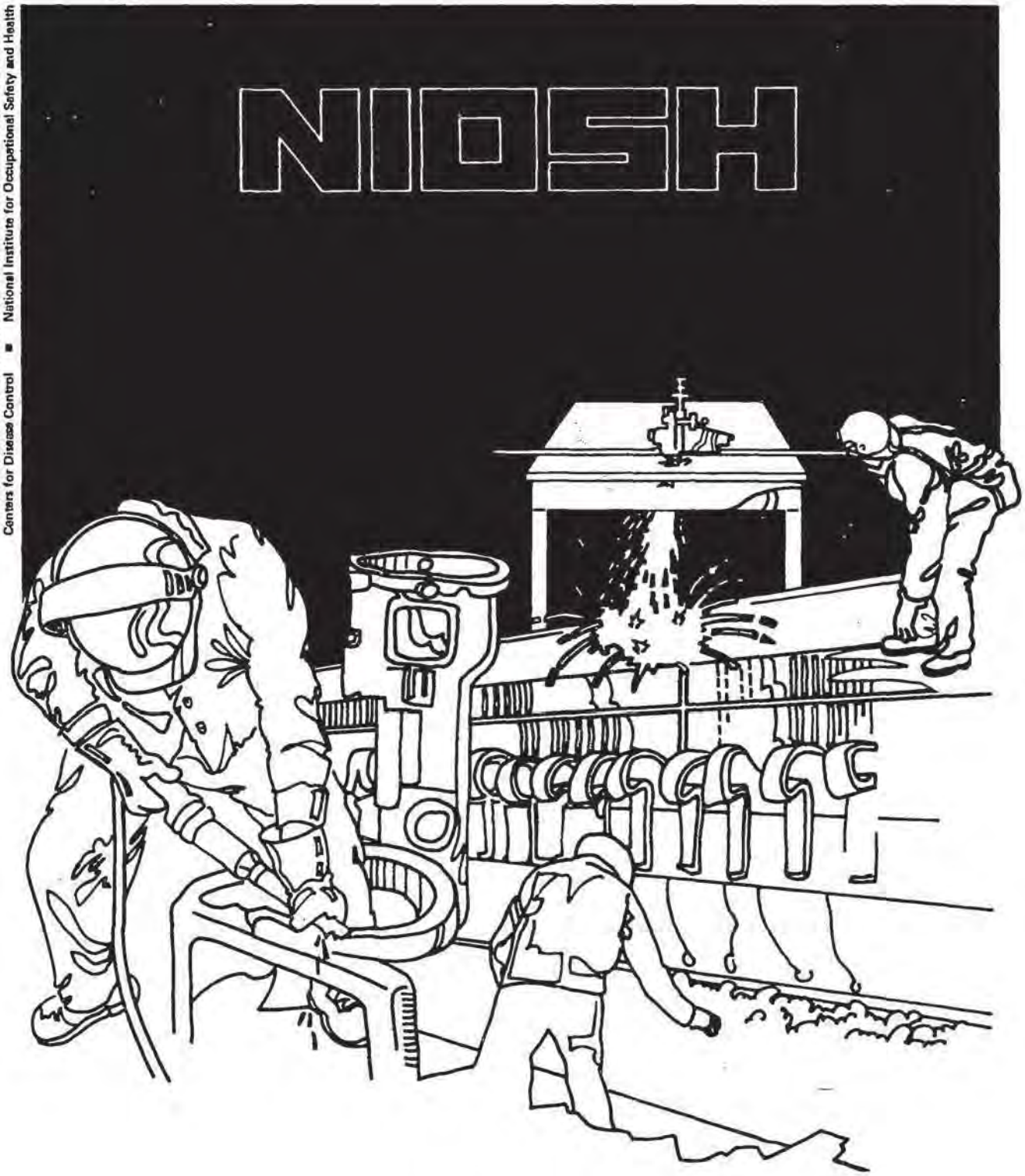

Health Hazard Evaluation Report

HETA 83-312-1400
CHAMPION TECHNOLOGY CENTER
HAMILTON, 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 83-312-1400
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CHAMPION TECHNOLOGY CENTER
HAMILTON, OHIO

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I. SUMMARY

On June 13, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the employees of the Champion Technology Center, Hamilton, Ohio to evaluate formaldehyde exposures among workers, following fumigation of the facility on June 14-15, 1983. The fumigation was necessitated by the possible presence of Histoplasma capsulatum fungi from contaminated bird droppings in the ventilation system. To decontaminate the building, formaldehyde gas (produced by thermal depolymerization of paraformaldehyde in household fry pans) was generated at concentrations up to 8000 parts per million (ppm) in the temporarily evacuated building.

Environmental samples, consisting of air and wipe samples, were collected during and after the decontamination effort. During fumigation on June 14-15, instantaneous formaldehyde measurements were made at various locations outside the Tech Center with airborne concentrations ranging from less than 0.3 ppm to 3.9 ppm. On June 16, the first day Tech Center employees returned to work, long-term area air samples were taken at six locations in the building to document residual formaldehyde levels. Air concentrations, equivalent to an 8-hour time weighted average (TWA), ranged from about 0.8 to 2.4 ppm. In most of these areas workers were not able to remain for prolonged periods because of irritative effects. The current OSHA standard for formaldehyde is 3 ppm as an 8-hour TWA and 10 ppm as a maximum ceiling level for 30 minutes. NIOSH, however, currently recommends that formaldehyde be treated as a potential human carcinogen and that exposures be reduced to the lowest feasible level.

Although NIOSH's field evaluation concluded on June 16th, subsequent air monitoring by the company indicated that formaldehyde levels continued to decline and were no longer detectable one week later.

Seventeen wipe samples were collected to evaluate interior surfaces for paraformaldehyde contamination. Six of the samples contained detectable quantities of paraformaldehyde (measured as formaldehyde) with surface concentrations ranging from 50 to 5600 micrograms per 100 square centimeters of surface area. These six samples were obtained from surfaces adjacent to the fry pans; the paraformaldehyde was probably associated with spillage of the paraformaldehyde during set up. Although paraformaldehyde gradually sublimes to formaldehyde at room temperature the overall contribution from this source to the already existing airborne formaldehyde levels is probably insignificant.

Although Histoplasma capsulatum fungus was present in all three wipe samples obtained from the ventilation system on May 25th, it was not present in any of the air or wipe samples collected by the fumigator before or after decontamination effort.

Based on the findings of this survey, workers reoccupying the Tech Center during the off-gassing period as well as those involved in the decontamination effort primarily had short-term exposures to formaldehyde gas, in some instances capable of producing irritative symptoms.

KEYWORDS: SIC 262 (Paper mill auxillary; research and development laboratory) formaldehyde, paraformaldehyde, decontamination, fumigation, Histoplasma capsulatum fungus.

II. INTRODUCTION

On June 13, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from employees at the Champion Paper Technology Center, Hamilton, Ohio. The requestors were concerned about potential worker exposure to formaldehyde gas following reoccupation of the building after it had been fumigated on June 14-15. The formaldehyde gas was used to eradicate Histoplasma capsulatum from the building's ventilation system.

On June 14-16 NIOSH conducted an environmental evaluation at the facility. The evaluation included the collection of air samples for formaldehyde gas and of wipe samples for paraformaldehyde.

A summary of survey activities and findings were presented to the company and requestors in a letter report dated September 2, 1983.

III. BACKGROUND

Champion Technology Center, Hamilton, Ohio, is a three story research and development laboratory which employs approximately 70 people. The lab is physically attached to the north end of the No. 1 paper mill building and occupies approximately 54,000 sq. ft.

In January 1983 the Company discovered pigeon remains and droppings in a false ceiling in one of the second floor labs (Lab 219). The birds had entered the building through an air intake duct servicing a relatively small air handling unit dedicated to this lab. Shortly afterward, the pigeons and soiled ceiling panels were removed, and the ductwork cleaned.

Over the next few months, several workers complained of throat infections and irritation, and felt that their symptoms stemmed from exposure to Histoplasma capsulatum fungus contained in the bird droppings.

On May 25th, during a routine safety inspection, bird droppings were once again found on the ventilation system servicing lab 219. This intensified concerns among the Technology Center staff. As a result, the company obtained three samples of settled dust, including pigeon droppings, from the ventilation system for identification of Histoplasma capsulatum. On June 9th the company was notified by a contract laboratory that the fungus was present in all three samples. Based on this finding, on June 10th Champion decided to close and decontaminate the Tech Center.

The decontamination was conducted by a private consultant specializing in microbial decontamination. Approximately 10 workers, employed by Champion, volunteered to assist in the decontamination effort.

The building was decontaminated in sections, starting with lab 219, as a trial run, on June 11th. The remaining labs/offices on the first and second floors (the third floor was not fumigated) were decontaminated in an around-the-clock effort on June 14-15. These areas were fumigated collectively, according to whether they were serviced by one of three large air handling units (see Table 1). During fumigation each of these areas were partitioned from each other with plastic sheeting. In addition, during the entire operation an area between the Tech Center and the mill was kept under negative pressure by a high volume fan positioned at a second floor fire door, to prevent fugitive gases from entering the mill.

Table 1

Fumigation Schedule

Date	Duration of Decontamination Effort	Air Handling Unit	Areas Serviced by Air Handling Unit
June 11	several hours	HVAC 219	Lab 219
June 14	10:30a-4:30p	No. 3	pulp lab 125, storage room 114
June 14-15	6:30p-12:30a	No. 2	1st floor labs, lab 207
June 15	5:00a-12:30p	No. 1	1st floor offices, lab 145, 2nd floor offices and labs

The procedure used to decontaminate the building was developed by the military for sterilization of infectious disease laboratories[1], and later modified to include neutralization of the fumigant.[2] For each of the areas fumigated, the total volume of office/lab space and the air handling system was calculated. Approximately 0.3 grams of paraformaldehyde was used for each cubic foot of space with the total amount for the entire decontamination effort estimated at 180 lbs. The paraformaldehyde was placed in household electric fry pans and positioned in strategic locations throughout the building. Following evacuation the fry pans were remotely activated. When completely depolymerized the resulting air concentration of formaldehyde was calculated to be about 8000 parts per million (ppm). During fumigation the air handling unit was operated at 100% recirculation to assure distribution and containment of the formaldehyde gas in the respective areas. Following a 3-hour contact period the formaldehyde gas was

neutralized by dissemination of an equal amount of ammonium bicarbonate, also placed in remotely controlled fry pans, next to the paraformaldehyde fry pans. After one hour contact period, fresh air was introduced into the fumigated areas to dilute residual formaldehyde gas. Following the aeration period workers cautiously entered the area while using direct-reading formaldehyde monitors. The company considered areas safe to enter if formaldehyde levels were below 3 ppm. Subsequently, all doors to the Tech Center were opened and pedestal fans were positioned throughout the building to help distribute fresh air throughout the building.

Self-contained breathing apparatus were available to workers during the decontamination effort in case of an emergency. Otherwise, workers did not wear respiratory protective equipment at any time during the decontamination effort.

Before and after fumigation air and surface wipe samples were obtained by the consultant for Histoplasma capsulatum identification. These samples were cultured by four different laboratories.

IV. METHODS AND MATERIALS

On June 14-16, NIOSH collected instantaneous and integrated air samples for formaldehyde. Wipe filter samples were collected on June 15 and 16 to determine whether interior surfaces of the building were contaminated with paraformaldehyde since this material was used to generate the formaldehyde gas.

The instantaneous formaldehyde measurements were made with a Lion direct-reading formaldemeter. Air measurements were taken at various locations outside the building and along the plastic containment curtain which separated the Tech Center from the mill during the time sections of the building serviced by Nos. 3 and 1 air handling units were being fumigated. This instrument, as discussed later in this section, was also used in conjuction with several integrated-type sampling devices to monitor formaldehyde levels in the building on the first day employees returned to work.

On June 15 and 16, seventeen (17) wipe filter samples were collected from various office and laboratory surfaces i.e., bench tops, desk tops, walls, etc., throughout the Tech Center. Most of the samples were collected from the first and second floors since the fumigation was confined to these two levels. Each sample was collected by wiping a 1% sodium bisulfite-soaked filter across an area of 100 square

centimeters (about four square inches). After the surface was wiped the filter was placed directly into a plastic bottle containing 20 milliliters of the bisulfite solution. Three sample blanks were prepared each day. These filters were handled in the same manner as the other samples but instead of being used for wiping surfaces they were placed directly into the plastic bottles. In order to minimize cross-contamination each filter was handled using a new pair of disposable gloves. All of the wipe samples were analyzed for formaldehyde (paraformaldehyde depolymerizes to formaldehyde in the analysis) by visible spectroscopy according to NIOSH Method P&CAM 125.[3] The limit of detection for the analysis was 5 micrograms per sample.

On June 16, the first day the Tech Center was reopened to employees following the fumigation, air samples were collected to determine the concentration of residual formaldehyde in the building. Six locations were selected, three each from the first and second floors. They included the receptionist's office, lab 119, office 132, lab 220, office 212, and lab 207A. In each location four integrated-type sampling devices were used since the levels of formaldehyde measured in the building (up to approximately 3 ppm) presented a good opportunity for NIOSH to field evaluate two diffusive-type formaldehyde monitors: the 3M and the DuPont formaldehyde badges. These devices were compared to two other formaldehyde sampling devices - the coated Chromosorb 102® tube and the impinger containing 1% sodium bisulfite solution. All four devices were placed in close proximity to each other during the sampling period. A brief description of each of these sampling devices, sampling parameters, and the analytical method associated with each sampling device are presented in Table 2. In addition, as mentioned earlier, NIOSH obtained spot formaldehyde measurements in each of the six areas. Measurements were made three times during the day in each area using both NIOSH's and Champion's formaldemeters. Measurements were taken simultaneously with the two meters held as close as possible to the stationary samples.

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 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 Hygienist's (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.

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 such as formaldehyde 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.

Formaldehyde

The health effects of formaldehyde can result from acute or chronic exposure. The effects of acute exposure are primarily mucous membrane irritation (burning, tearing eyes; nose and throat irritation). These symptoms can occur as low as about 0.1 part per million (ppm).[7] Dermatitis associated with formaldehyde vapor, solutions or formaldehyde-containing resins has been documented.[7,8] Formaldehyde is a primary skin irritant but may also cause allergic dermatitis in concentrations below those likely to cause primary irritant effects.

Allergic effects include skin sensitization and possibly, asthma or asthma-like symptoms.[9,10] There is considerable evidence that formaldehyde can produce skin sensitization in man, especially in persons occupationally exposed through skin contact.[11] Eczematous contact dermatitis, when acute, is characterized by redness, swelling, vesiculation and oozing with itching. In the chronic form, affected areas of the skin may become dry, thickened, and fissured.[12]

A recent study conducted by the Chemical Industry Institute of Toxicology (CIIT) in which rats and mice exposed to formaldehyde vapors developed nasal cancer has raised concerns about its carcinogenic potential in humans.

The current OSHA standard for formaldehyde exposure is 3 ppm as an 8-hour TWA, with a maximum ceiling concentration of 10 ppm for 30 minutes.[13] On the basis of the CIIT study findings ACGIH and NIOSH currently recommend that formaldehyde be treated as a potential human carcinogen. ACGIH currently proposes a TLV of 1 ppm as a ceiling limit.[14] NIOSH, however, recommends that exposures be reduced to the lowest feasible level.[7]

VI. RESULTS AND DISCUSSION

Spot formaldehyde measurements taken during the fumigation of areas serviced by Nos. 3 and 1 air handling units on June 14 and 15 are presented in Table 3. Airborne concentrations ranged from less than 0.3 ppm up to 3.9 ppm. At the main entrance to the Technology Center, an area where most of the volunteer staff convened during the decontamination effort, formaldehyde levels ranged from nondetectable (<0.3 ppm) to 1.6 ppm. The highest formaldehyde concentration (3.9 ppm) was measured at the second floor exit where the exhaust fan for the temporary containment area between the Technology Center and the mill was located. The fan was used to maintain this containment area under negative pressure so that any formaldehyde gas entering this area from the Tech Center would be exhausted outdoors before it would reach the mill. This procedure apparently worked very well since formaldehyde was not detected in the mill.

Results from the wipe samples are presented in Table 4. Of the 17 samples collected, 6 contained detectable quantities of paraformaldehyde (measured as formaldehyde) with surface concentrations ranging from about 50 to 5600 micrograms per 100 square centimeters (ug/100 cm^2). Three of the six samples were obtained from first floor surfaces while the other three were obtained from surfaces located on the second floor. Surfaces most contaminated with paraformaldehyde include those located on second floor labs 207A, 207 and 220. In these labs surface concentrations ranged from 1200 to 5600 ug/100 cm^2. Much lower levels were measured in samples obtained from the 1st floor, namely from surfaces along corridor 109 and inside lab 142. Most of the contamination appeared to be confined to the immediate location of the fry pans, probably associated with spillage of the paraformaldehyde during setup of the equipment.

Since paraformaldehyde sublimes at room temperature its presence on interior surfaces represents a "stored" source of formaldehyde gas. However, based on the relatively small amounts of paraformaldehyde on the surfaces, the localized nature of the contamination, and the fact that these surfaces were cleaned shortly after the decontamination effort, formaldehyde gas formation from these contaminated surfaces appears to be minimal compared to the formaldehyde gas levels already present in the building at that time.

The results of the integrated and instantaneous formaldehyde air measurements taken inside the Tech Center after employees returned on July 16 are presented in Tables 5 and 6, respectively. Airborne formaldehyde concentrations, equivalent to an 8-hour TWA, are presented by sampling method for each of the six locations (Table 5). Variations existed in the formaldehyde concentrations measured by the four sampling devices for each location, but such findings are not uncommon when conducting tests of this type in the field. Formaldehyde concentrations were within a fairly narrow range, ranging from about 0.8 ppm in the receptionist's office to about 2.4 ppm in Lab 207A. These concentrations, by comparison, were below the OSHA standard of 3 ppm, but were at or above the Threshold Limit Value of 1 ppm currently proposed by ACGIH. NIOSH recommends that exposures to formaldehyde be kept as low as feasible.

The levels of formaldehyde measured in the building on June 16, although below the OSHA standard of 3 ppm, were irritating to most of the Tech Center staff reporting to work on this day. Consequently, most of the employees, especially those with offices/labs on the second floor were not able to work in these areas. Those workers who decided to stay in the building did so voluntarily.

Throughout the day on June 16 formaldehyde levels generally decreased, particularly for those offices/labs on the first floor where outside dilution air was more readily available (Table 6). This trend was observed with both formaldemeters, but the NIOSH formaldemeter consistently measured air concentrations 2-3 times higher than the Champion formaldemeter. When comparing these results to the integrated (8-hour TWA) results, it appears that the measurements taken with the Champion formaldemeter underestimated actual concentrations to some extent.

Although NIOSH did not monitor airborne formaldehyde levels in the building after June 16, subsequent air monitoring by the company indicated that formaldehyde levels continued to decline and were no longer detectable one week later.

Based on the findings of this survey, workers reoccupying the building during the off-gassing period as well as those involved in the decontamination effort had short-term exposure to formaldehyde, which in some cases produced irritative effects. It is unlikely that the health of these workers was compromised to any extent, primarily because exposures were low and relatively brief in nature.

With respect to Histoplasma capsultum exposures, samples obtained by the consultant before and after the decontamination effort were all negative.

VII. REFERENCES

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VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. 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. Champion Technology Center, Hamilton, Ohio
2. Confidential requestors
3. NIOSH, Region V
4. 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 2

Air Sampling and Analysis Methods for Formaldehyde

Champion Technology Center
Hamilton, Ohio
June 16, 1983

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Collection Device	Description of Sampling Media	Sampling Flow Rate	Sampling Duration (min)	Analysis	Reference
ORBO-22 tube	benzoethanolamine-coated Chromosorb 102® resin	50 cc/min	455-490	gas chromatography	4
3M Badge	sodium bisulfite-treated sorbent	diffusion	455-490	spectrophotometry	5
Dupont Badge	1% sodium bisulfite solution	diffusion	455-490	spectrophotometry	6
Impinger	1% sodium bisulfite solution	200 cc/min	455-490	spectrophotometry	3

Table 3

Instantaneous Airborne Formaldehyde Concentrations Outside the Building During Fumigation of Areas Serviced by Nos. 3 and 1 Air Handling Units

Champion Technology Center
Hamilton, Ohio
June 14-15, 1983

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Date	Sampling Location	Time	Formaldehyde Concentration (ppm)
6-14-83	Main Entrance	11:30 am	0.4
6-14-83	Main Entrance	11:32 am	<0.3
6-14-83	Main Entrance	11:35 am	0.7
6-14-83	Main Entrance	1:21 pm	<0.3
6-14-83	Main Entrance	1:22 pm	1.6
6-14-83	Main Entrance	1:40 pm	1.0
6-14-83	Ground Level, below exhaust fan	11:40 am	0.3
6-14-83	Ground Level, below exhaust fan	1:17 pm	<0.3
6-14-83	Ground Level, below exhaust fan	1:42 pm	<0.3
6-14-83	North end of building	11:45 am	<0.3
6-15-83	2nd floor exit where exhaust fan was located	11:10 am	3.9
6-15-83	2nd floor exit where exhaust fan was located	12:01 pm	1.6
6-14-83	At plastic partition, mill side	11:50 am	<0.3
6-14-83	At plastic partition, mill side	2:10 pm	<0.3
Detection Limit of formaldemeter			0.3
Evaluation Criteria: OSHA (maximum peak)			See Section V

Table 4

Paraformaldehyde Measured as Formaldehyde for Various Interior Building Surfaces

Champion Technology Center
Hamilton, Ohio
June 15-16, 1983

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Date	Sample Location	Formaldehyde Concentration ** (micrograms per 100 square centimeters of surface area, ug/l00cm^2)
6-16-83	Office 101, receptionists° desk top	ND
6-16-83	Lab 130, west bench top	ND
6-16-83	Office 132, desk top	ND
6-15-83	Corridor 109, outside wall of lab 138	53
6-15-84	Corridor 109, outside wall of lab 142	92
6-15-83	Lab 142, desk top	ND
6-15-83	Lab 142, north wall	83
6-15-83	Lab 207, center bench top	4400
6-16-83	Lab 207A, table top	5600
6-16-83	Office 212, desk top	ND
6-16-83	Office 213, desk top	ND
6-16-83	Lab 219, center bench top	ND
6-16-83	Lab 220, southeast bench top	ND
6-15-83	Lab 220, desk top	1200
6-15-83	Office 238, desk top	ND
6-15-83	Office 238, top of filing cabinet	ND
6-16-83	Office 302, table top	ND

ND - non detectable, less than 5 micrograms per sample
** Wipe samples were analyzed for formaldehyde although they indicate the presence of paraformaldehyde

Table 5

Residual Environmental Formaldehyde Concentrations at Selected Locations in the Building by Various Sampling Methods

Champion Technology Center
Hamilton, Ohio
June 16, 1983

HETA 83-312

Location	Formaldehyde Concentration (ppm)*			
	ORBO-22	3M Badge	DuPont Badge	Impinger
Lab 119, east bench top	1.49	1.22	1.93	2.00
Office 132, west table top	1.58	1.04	2.08	2.14
Receptionist office, south cabinet top	0.82	0.79	0.98	0.97
Lab 220, center bench top	1.18	1.15	1.53	1.61
Office 212, east table top	1.60	1.03	2.03	2.03
Lab 207A, east wall	1.71	0.87	2.25	2.36

Evaluation Criteria: ----------See Section V----------

* Formaldehyde concentrations determined by these methods are equivalent to an 8-hour time-weighted average

Table 6

Short-term Residual Formaldehyde Concentrations at Selected Locations in the Building

Champion Technology Center
Hamilton, Ohio
June 16, 1983

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	Formaldehyde Concentrations (ppm)		
Location	10:45am -- 11:40am	2:35pm -- 3:05 pm	5:10pm -- 5:50pm
Lab 119	2.2/0.8	2.3/0.8	1.3/0.4
Office 132	2.5/1.1	2.1/0.8	1.7/0.6
Recept. Office	1.0/<0.3	1.2/0.4	0.8/0.3
Lab 220	1.6/0.5	1.6/0.5	1.8/0.6
Office 212	2.2/0.8	2.0/0.8	2.2/0.8
Lab 207A	3.2/1.1	2.5/0.9	2.2/0.8

Evaluation Criteria ----------See Section V----------

The first value is the concentration measured by the NIOSH formaldemeter, the second that measured by the Champion formaldemeter.