CDC
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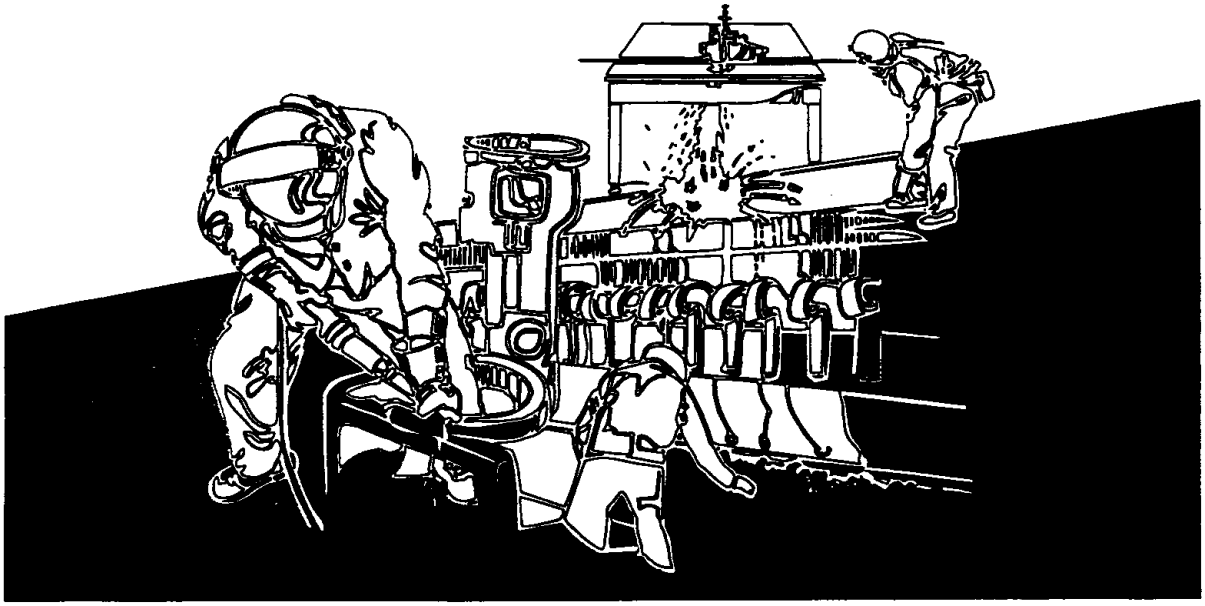
NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 92-287-2294
FEDERAL RECORDS CENTER
DAYTON, OHIO



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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 and 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.

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SUMMARY

On June 16, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a written request for a Health Hazard Evaluation from a management representative of the Federal Records Center in Dayton, Ohio. The facility has been in operation since the mid-1980s to archive federal records on paper and film media. A number of employees in the archives area complained of an overpowering odor originating from x-ray films stored adjacent to their work areas. An initial visit was conducted on July 8, 1992, to assess general working conditions. A follow-up visit was conducted on September 9, 1992, to conduct air sampling for suspected air contaminants.

Air sampling was conducted for several chemical compounds including formaldehyde, acetic acid and cyclohexane. Area air samples were collected in five locations which included the archives area, the vault area, the administrative area, bay area D and outside of the Federal Records Center.

Formaldehyde concentrations in the vault area, archives area, and bay area D were 0.023, 0.024 and 0.034 milligrams per cubic meter (mg/m^3), respectively. These concentrations exceed the NIOSH Recommended Exposure Limit (REL) of 0.02 mg/m^3 for formaldehyde. All other area air sample results for formaldehyde, acetic acid and cyclohexane were below NIOSH RELs. The highest acetic acid concentration measured was 29% of the NIOSH REL of 25 mg/m^3. The highest cyclohexane concentration measured was 0.1% of the NIOSH REL of 1050 mg/m^3.

Environmental monitoring identified the source of odors noted in employee complaints as acetic acid. Acetic acid concentrations were below the NIOSH REL. However, environmental monitoring did indicate formaldehyde concentrations above the NIOSH REL. The most likely source of formaldehyde emissions is the carbonless copy paper records located throughout the Federal Records Center. Recommendations include: (1) increasing the overall ventilation exchange rate between the building air and the outside air to reduce the formaldehyde concentrations and, (2) performing subsequent industrial hygiene monitoring to assure the formaldehyde concentrations are below the NIOSH REL.

KEYWORDS: SIC 9199 (general government, not elsewhere classified), formaldehyde, acetic acid, archives, x-ray film.

INTRODUCTION

On August 31, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a written request for a Health Hazard Evaluation from a management representative of the Federal Records Center in Dayton, Ohio. A number of employees in the archives area complained of an overpowering odor originating from archived x-ray films stored adjacent to their work areas. An initial visit was conducted on July 8, 1992, to assess general working conditions. A follow-up visit was conducted on September 9, 1992, to conduct air sampling for suspected air contaminants. Opening and closing conferences were held with management and employee representatives during each visit.

BACKGROUND

The complaint area is located within the Federal Records Center, a 200,000 square foot warehouse structure. The facility has been in operation since the mid-1980s to archive federal paper and film records. Approximately 70 personnel are employed throughout the facility. The facility is owned by the General Services Administration and maintained by Johnson Controls.

The odor complaints originated in May 1991, when six full-time employees were permanently stationed in the archives area. Federal tax records and approximately 54,000 x-ray films were stored in this area. The x-ray films were moved to the vault area in May 1992, as a result of odor complaints attributed to the x-ray films. Employees currently working in the archives area still report occasional x-ray film odors.

The heating, ventilation, and air-conditioning (HVAC) systems serving the complaint and adjacent areas can be broken down into three basic systems: (1) the archives and vault room areas which are served by the same HVAC system; (2) the general bay areas which are heated with space heaters in the winter and cooled with exhaust fans and supply dampers in the summer and; (3) the administrative area which is served by a dedicated HVAC system.

EVALUATION PROCEDURES

The NIOSH investigation consisted of the following: (1) a walk-through of the Federal Records Center on July 8, 1992, to observe work practices and facility operations and, (2) a follow-up visit on September 9, 1992, to conduct area air sampling for suspected air contaminants.

Initial Walk-through

During the initial survey, the archives area and adjacent sections were inspected to observe work practices and facility operations. Four full-time employees of the National Archives and Records Administration were working in the archives area. The vault area is a controlled access area where the x-ray films are stored. Employees periodically visit this area to conduct record searches; no individuals are permanently stationed in this area. Both the archives and vault areas were originally designed for strict climate controls. However, as a result of operational changes, the HVAC system is only used to recirculate air in the workspace. The air dampers supplying outside air to the HVAC system were closed at the time of the walk-through survey.

Environmental Sampling

Area air samples were collected in the archives area, the vault area and adjacent areas to evaluate representative airborne concentrations of suspected chemical contaminants (see figure 1). Area samples were collected within the Federal Records Center to compare

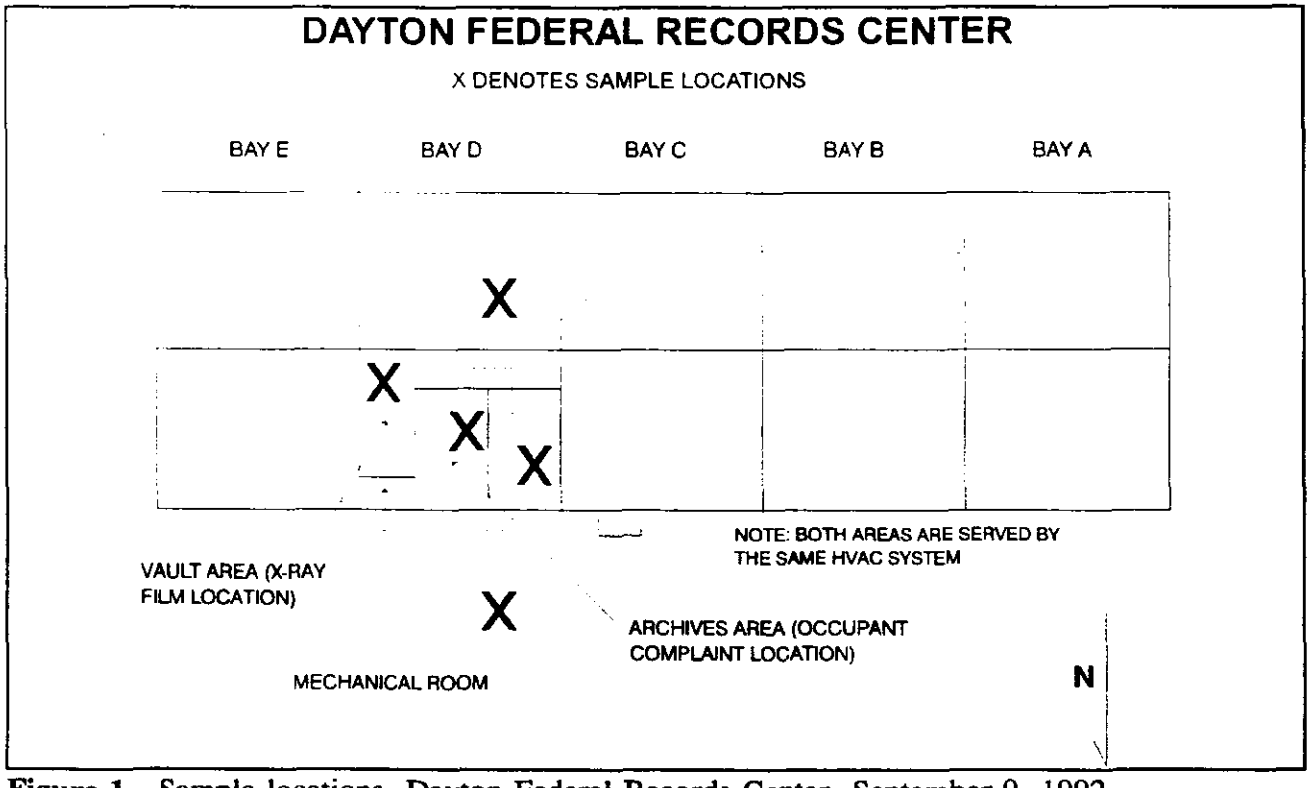

Figure 1. Sample locations, Dayton Federal Records Center, September 9, 1992

chemical concentrations in complaint and non-complaint areas. Area samples were collected outside of the building to evaluate background chemical concentrations.

Formaldehyde. Air samples for formaldehyde were collected and analyzed according to NIOSH analytical method 3500. Area samples were collected using a battery-operated sampling pump which was used to draw air through an impinger containing 20 milliliters (ml) of 1% sodium bisulfite solution at a flowrate of 0.9 liters per minute (lpm). The sampling pumps were calibrated before and after sampling. The impinger solutions were analyzed using visible absorption spectrometry.

Acetic Acid. Air samples for acetic acid were collected and analyzed according to NIOSH analytical method 1603 with modifications (modifications included slight alterations in the desorption process, column, and oven conditions). Area samples were collected using a battery-operated sampling pump which was used to draw air through a solid sorbent tube (coconut shell charcoal) at a flowrate of 0.2 lpm. The sampling pumps were calibrated before and after sampling. The sorbent tubes were analyzed using gas chromatography with flame ionization detection.

Volatile Organic Compounds. Volatile organic compounds (VOCs) were collected and analyzed according to NIOSH analytical method 1500. Area samples were taken using a battery-operated sampling pump which was used to draw air through a solid sorbent tube (coconut shell charcoal) at a flowrate of 0.2 lpm. This sampling technique was different from the sample techniques previously mentioned in that side-by-side samples were collected in the vault area next to the x-ray films. One sample was used to *qualitatively* access which VOCs were present. After determining which VOCs were present, the other samples collected in the vault area and adjacent areas were analyzed *quantitatively* to assess the concentrations of those VOCs. The sampling pumps were calibrated before and after sampling. The qualitative sorbent tubes were analyzed using gas chromatography combined with flame ionization and mass spectrometric detection. The quantitative sorbent tubes were analyzed using gas chromatography combined with flame ionization detection.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 ten hours a day, forty hours a week for a working lifetime without experiencing adverse health effects. It is important to note, however, 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 levels set by the evaluation criteria. Some substances are absorbed by direct contact with the skin and mucous membranes, or by ingestion, and thus the overall exposure may be increased above measured airborne concentrations. Evaluation criteria typically change over time as new information on the toxic effects of an agent becomes available.

The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),[1] the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[2] and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] These values are usually based on a time-weighted average (TWA) exposure, which refers to the average airborne concentration of a substance over an entire 8-hour (PELs, TLVs) or up to 10-hour (RELs) workday. The concentrations measured during this survey will be expressed as milligrams of chemical per cubic meter of air (mg/m^3).

It is important to note that OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; in contrast, the NIOSH RELs are primarily based upon the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing those levels found in this report, it should be noted that employers are legally required to meet those levels specified by an OSHA PEL.

Formaldehyde: Formaldehyde is a colorless gas with a pungent and irritating odor at ambient temperatures.[4] The odor threshold (lowest concentration that is perceived by the sense of smell) is approximately 0.98 mg/m^3.[5] Formaldehyde may cause adverse health effects following exposure via inhalation, ingestion, dermal, or eye contact. Mild to unpleasant eye irritation occurs in acclimated workers at 2.5 to 12.3 mg/m^3, and intolerable irritation (tissue damage possible) occurs at levels above 30.7 mg/m^3.[4] Workers exposed to 0.37 mg/m^3 of formaldehyde have reported symptoms of upper respiratory and acute bronchial irritation during a work shift.[6]

Based upon the results of laboratory tests which have demonstrated the carcinogenic and mutagenic activity of formaldehyde in animals, NIOSH and OSHA recommend that formaldehyde be handled in the workplace as a potential occupational carcinogen.[7,8] NIOSH recommends that occupational exposures to formaldehyde be controlled to the lowest feasible level.[7] On December 4, 1987, OSHA issued a comprehensive regulation covering occupational

exposure to formaldehyde which was amended on May 27, 1992, to reduce the 8-hour PEL for formaldehyde from 1.2 mg/m^3 to an 8-hour TWA of 0.92 mg/m^3.[8,9] ACGIH classifies formaldehyde as a suspected human carcinogen and recommends that worker exposures by all routes be carefully controlled to levels as low as reasonably achievable below its TLV. On June 2, 1992, ACGIH adopted a ceiling limit TLV of 0.37 mg/m^3 to further reduce sensory irritation for workers handling formaldehyde or formaldehyde-containing products.[2]

Acetic Acid: Acetic acid is used in several processes including photographic chemicals, food additives, and the manufacturing of cellulose acetate films. According to the Kodak Information Center, x-ray films manufactured prior to 1960, were predominantly cellulose acetate based films. One study documented that workers exposed to acetic acid for 7 to 12 years at concentrations of 150 mg/m^3, plus one hour daily at 250 to 650 mg/m^3, had no injury except slight irritation of the respiratory tract, stomach, and skin.[10] The odor threshold for acetic acid is approximately 1.2 mg/m^3.[5] The NIOSH REL, ACGIH TLV, and OSHA PEL are all 25 mg/m^3 to prevent irritation to the skin, eyes and upper respiratory tract.[1,2,3]

Cyclohexane: Cyclohexane is used as a paint and varnish remover and as a solvent for lacquers and resins. The acute toxicity of cyclohexane is extremely low. In rabbit studies, concentrations of 44,100 mg/m^3 resulted in lethargy, narcosis, increased respiration rate, and convulsions; 11,660 mg/m^3 caused no visible effects. The odor threshold for humans is approximately 1050 mg/m^3 and at this concentration it is somewhat irritating to the eyes and mucous membranes.[10] The NIOSH REL, ACGIH TLV, and OSHA PEL are all at 1050 mg/m^3 which represents the borderline of irritation.[1,2,3]

RESULTS AND DISCUSSION

The results of the air samples collected on September 9, 1992, are presented in Table 1 and compared to the applicable evaluation criteria. Several qualifications need to be kept in mind when comparing the air sample results to the evaluation criteria: (1) the area air samples represent one day of samples and may not characterize weekly, monthly or yearly fluctuations; (2) area air samples were taken to represent environmental exposures to individuals working in the sampled areas and may not be representative of personal breathing zone samples (due to employee movement during the work-shift); and (3) the area air samples were extrapolated to represent an entire work-shift exposure although the air samples were only collected over approximately 70-80% of the work-shift (i.e., the concentrations obtained during the sample period were assumed to remain the same during the non-sampled period).

Table 1

Air Sample Results for Area Sampling
Conducted on September 9, 1992

Location	Sample times	Concentration, milligrams per cubic meter (mg/m^3)		
		acetic acid[A]	formaldehyde	cyclohexane[B]
Outside	8:50am-3:45pm	none detected	0.006	(0.01)
Admin area	8:55am-3:40pm	(0.1)	0.011	none detected
Archives area	9:00am-3:35pm	1.0	0.024	0.04
Bay area D	9:05am-3:20pm	(0.3)	0.034	(0.01)
Vault area	9:15am-3:15pm	7.0	0.023	1.0
NIOSH REL		25	0.02	1050
OSHA PEL		25	0.92	1050
ACGIH TLV		25	0.37[C]	1050

Comments:

[A] Values shown in brackets are between the minimum detectable concentration (0.1 mg/m^3) and the minimum quantifiable concentration (0.4 mg/m^3) based on an average air sample volume of 78 liters (0.078 cubic meters) for this sample set.

[B] Values shown in brackets are between the minimum detectable concentration (0.01 mg/m^3) and the minimum quantifiable concentration (0.04 mg/m^3) based on an average air sample volume of 78 liters (0.078 cubic meters) for this sample set.

[C] Ceiling limit which should not be exceeded at any time during the workday

The area air sample results were below all applicable evaluation criteria with the exception of the formaldehyde concentrations in the vault area, archives area, and bay area D. The concentrations in these areas exceeded the NIOSH REL, but not the ACGIH TLV or OSHA PEL. The highest acetic acid concentration measured was 29% of all applicable evaluation criteria. As previously stated, air samples were collected adjacent to the x-ray films stored in the vault area to qualitatively assess which volatile organic chemicals were present. According

to the analyses, measurable quantities of cyclohexane were present. Based on these results, cyclohexane was quantitatively determined in all sample locations. The highest cyclohexane concentration measured was 0.1 % of all applicable evaluation criteria.

CONCLUSIONS

Acetic acid is more than likely the chemical contaminant responsible for the odors identified by the employees working in the archives area. With an odor threshold of approximately 1.2 mg/m^3,[5] the concentrations of acetic acid found in the archives and vault room (1.0 and 7.0 mg/m^3, respectively) were within the range of concentrations that could be sensed by smell. However, these results are still well below all applicable evaluation criteria. The VOC samples yielded measurable concentrations of cyclohexane which were also well below all applicable evaluation criteria. It is interesting to note that a relationship can be seen between the location of the x-ray films and the acetic acid and cyclohexane concentrations in the areas sampled.

The formaldehyde results were above the NIOSH REL in the vault area, archives area, and bay area D. The most likely source of formaldehyde emissions is the carbonless copy paper records located throughout the Federal Records Center.[11] Because NIOSH considers formaldehyde to be a potential occupational carcinogen, it is recommended that exposures be reduced to the lowest feasible level. The NIOSH REL represents a target value for reduction efforts. A comparison between those areas which exceeded the NIOSH REL and the concentration measured outside the building suggests that an increase in the overall ventilation exchange rate between the building air and the outside air could decrease the formaldehyde concentrations.

RECOMMENDATIONS

The outside air intakes for the HVAC system serving the archives and vault areas (which at the time of the survey were closed) should be opened to increase the ventilation exchange rate. Additionally, the use of the exhaust fans serving the bay areas should be increased to improve the ventilation exchange rate.

Industrial hygiene sampling should be accomplished after the modifications are made to the HVAC systems serving the vault, archives and bay areas to determine whether an increase in the ventilation exchange rate lowered the formaldehyde concentrations below the NIOSH REL.

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