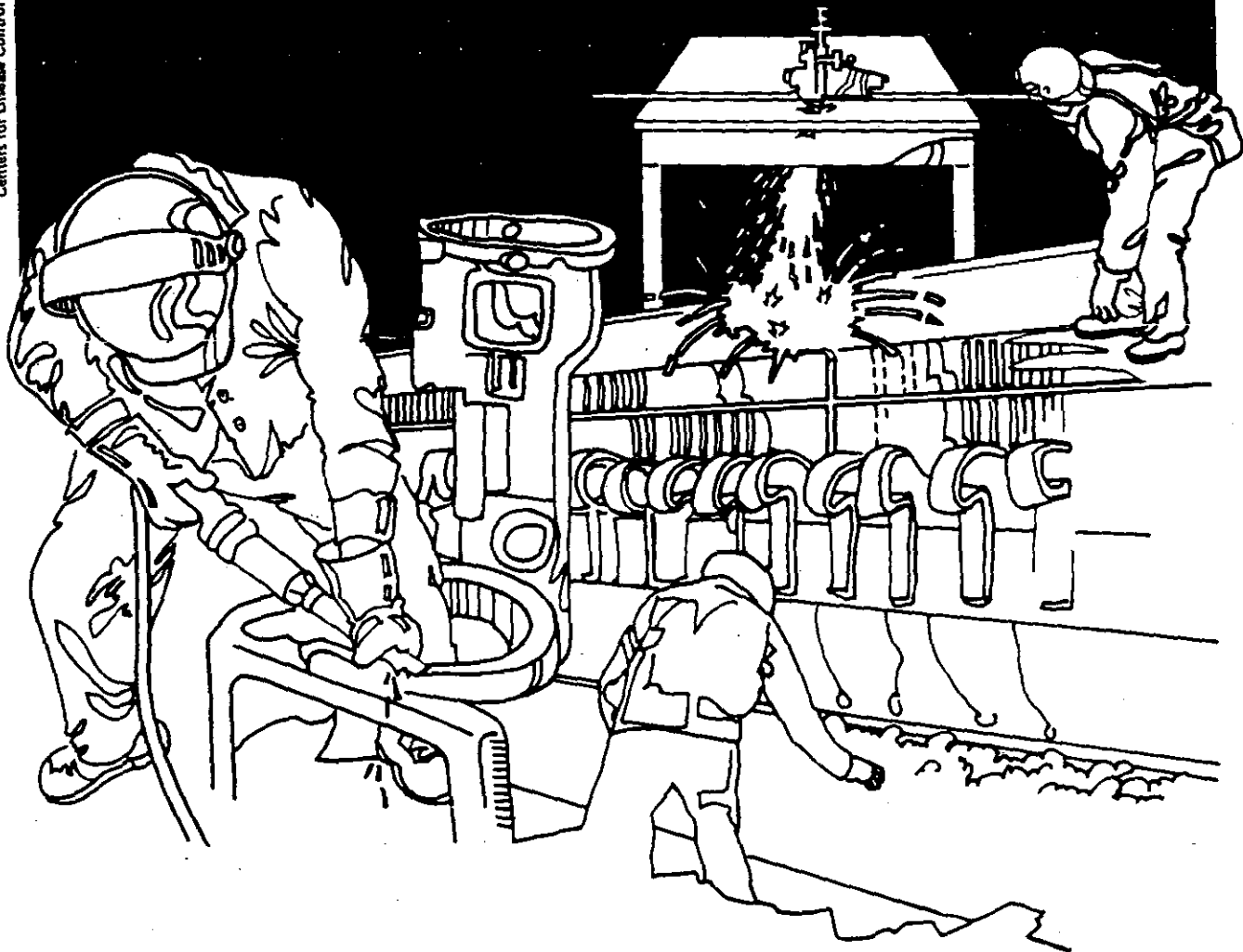


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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 88-335-1940
FORT STANWIX NATIONAL MONUMENT
ROME, NEW YORK

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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NIOSH INVESTIGATOR:
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I. SUMMARY

On August 3, 1988 the National Institute for Occupational Safety and Health (NIOSH) received a request for assistance in evaluating the air quality in the administrative offices and the Visitors Center at Fort Stanwix National Monument, Rome, New York. The request was a result of employee complaints of odors and allegations of ventilation system malfunctions which could not be substantiated by on-site maintenance staff.

On August 17, 1988, indoor air quality was assessed by collecting physical measurements of ventilation system parameters: ventilation rate through supply and return ducts, fresh air intake, and room occupancy and volume. Ventilation measurements were taken using a Kurz hot-wire anemometer. In addition, temperature and humidity was measured using a Cole-Palmer digital hygrometer, and carbon dioxide levels were measured using direct reading, Draeger detector tubes.

Results were compared to ASHRAE Standards 55-1981 "Thermal Environmental Conditions for Human Occupancy" and 62-1981 "Ventilation for Acceptable Indoor Air Quality".

The dew point for all of the areas was between 55-60°F, which is within the established criterion. Temperature measurements ranged from 71-75°F, and humidity was between 60-65%. Although two of the temperature readings were below the operative temperatures of the cited criteria, it must be understood that the criteria is based on 50% relative humidity. The increased humidity will, in effect, allow the cooler temperatures to feel warmer.

Carbon dioxide measurements in the office and Visitors Center (400 ppm) indicate adequate fresh air supply to these areas. This measurement may not be a true indicator of ventilation rate since only one employee occupies each administrative office. In addition, one employee is allowed to smoke in the office area.

The ventilation system contained specific design flaws which are addressed in the body of this report, pertaining to the source of make-up air.

Based on the results of this investigation it was determined that the indoor air quality in the administrative offices and Visitors Center was acceptable according to the evaluation criteria in terms of temperature, humidity, dew point, ventilation rate and carbon dioxide level. However, the ventilation design which allows make-up air to be drawn from the tunnel area was deemed not prudent, and the most likely source of employee complaints of odors. Recommendations are made to improve the operation of the ventilation system.

Keywords: SIC 6512 (Non-residential Buildings) Indoor Air Quality, Offices, Ventilation

II. INTRODUCTION

On August 3, 1988 the National Institute for Occupational Safety and Health (NIOSH) received a request from the National Park Service for assistance in evaluating the air quality in the administrative offices and the Visitors Center at Fort Stanwix National Monument. The request was a result of employee complaints of odors and allegations of ventilation system malfunction which could not be substantiated by on-site maintenance staff.

NIOSH conducted a site visit on August 17, 1988.

III. BACKGROUND

Fort Stanwix was reconstructed and opened to the public in May 1976 for bicentennial celebrations. The administrative office area consists of three contiguous rooms built partially below ground level, all of which have interior wood paneling covering pressure treated stacked logs. The Visitors Center consists of an information/reception area and a theater, with finished wallboard covering the logs of the Fort exterior. Two previous NIOSH evaluations addressed the potential hazard associated with pentachlorophenol (PCP) exposure (1978 and 1982) from the treated logs. Based on the results of those studies, NIOSH determined that any PCP hazard had been eliminated.

The year round administrative office work force consists of three employees: a superintendent, a clerk typist, and an administrative technician who each occupy an administrative office. The Visitors Center is occupied primarily by the public. In addition, three maintenance employees move throughout the Fort during a typical work day.

The ventilation of these two areas is accomplished by both mechanical and natural means. The administrative offices have openable windows, which are not relied upon for ventilation, but may be used. Ventilation design plans indicate mechanical ventilation is by means of ducted supply and return to a Trane Model SVA-50 HVAC unit which delivers ventilation air at a rate of 2,000 cubic feet per minute (cfm) to the offices. A damper in the air return duct exhausts return air at minimum rate of 350 cfm. The Visitors Center is serviced by a 6,000 cfm unit, with a minimum of 700 cfm outside air. However, the door to this area is opened frequently and sometimes remains open throughout the day, providing additional outside air ventilation.

Engineering assessments of the ventilation system in 1985 and 1986 by Department of Interior engineers recommended revamping of the system, but the justification for their recommendations was based on design and energy efficiency, rather than operational deficiencies.

IV. EVALUATION DESIGN AND METHODS

Indoor air quality was assessed by collecting physical measurements of ventilation system parameters: ventilation rate through supply and return ducts, fresh air intake, and room occupancy and volume. Ventilation measurements were taken using a Kurz hot-wire anemometer. The air handlers were visually inspected to determine overall condition and check for potential contaminant sources. In addition, temperature and humidity was measured using a Cole-Palmer digital hygrometer, and carbon dioxide levels were measured using direct reading, Draeger detector tubes.

V. EVALUATION CRITERIA

A. Thermal Environmental Conditions

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published guidelines describing thermal environmental conditions that at least 80% of the occupants will find acceptable (ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy). The operative temperature for thermal acceptability (comfort zone) of sedentary or slightly active persons in the summer season at 50% relative humidity is 73 to 79°F. If the operative temperature is outside of this range, more than 20% of the healthy people will experience discomfort.

ASHRAE 55-1981, Section 5.1.2, also recommends that the dew point temperature in occupied space not be greater than 62°F or less than 35°F. This recommendation is based partially on structural preservation of the building itself, i.e., prevention of moisture condensation on building materials.

B. Provision of Adequate Amounts of Outside Air

ASHRAE Standard 62-1981 (Ventilation for Acceptable Indoor Air Quality) provides ventilation requirement guidelines for a wide variety of commercial, institutional, and industrial facilities, including office buildings. For general offices where smoking is not permitted, indoor air quality is considered adequate if outside air is provided at the rate of 5 cfm per occupant. Higher ventilation rates are recommended by the ASHRAE Standard for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control. Thus, where smoking is allowed, a minimum of 20 cfm of outdoor air per occupant should be provided (ASHRAE 62-1981, Table 3, Section 3.1).

Several recent studies have suggested that in occupied spaces, a level of CO₂ in excess of 1000 ppm is an indicator of inadequate outdoor air supply (Rajhans, G.S., Occup. Health in Ontario 4, 160-67, 1983; Bell, S.J. and B. Khati, Occup. Health in Ontario 4, 103-108, 1983). Occupant discomfort results from the build-up of numerous air contaminants (not CO₂ itself) including cigarette smoke, hydrocarbons from copiers, odors, etc., in the recirculated air stream within a building. The following guidelines with regard to CO₂ in offices have been suggested by Canadian (above) investigators.

<u>CO₂ Level Measured in the Space</u>	<u>Comment on Outside Air and Occupant comfort</u>
< 600	Adequate outside air
600-800	Occasional complaints, especially if air temp rises
800-1000	Complaints more prevalent
> 1000	Complaints are general. Inadequate outdoor air

VI. RESULTS

The following table lists the operative temperature, humidity, carbon dioxide level, design cfm, and measured cfm in each of the office areas and the Visitors Center.

<u>Operative Temperature</u>	<u>Relative Humidity</u>	<u>CO₂ Level</u>	<u>Design cfm</u>	<u>Measured cfm</u>	<u>Location or Room</u>
71	64.5%	400	350	500	Adm. Left
71	64.5%	400	700	812	Adm. Center
75	60.0%	400	350	528	Supt. Office
73	60.0%	400	700 (O/A)	700 (O/A)	Visitor Ctr.
80	60.0%	350	N/A	N/A	Outside

(O/A) = Outside Air Intake

Visual inspection of the air handling units confirmed that the exhaust dampers were operating as designed, i.e., deflecting some of the recirculated air to the outside. It was not possible to measure the volume of fresh outside air intake to the administrative offices due to the location of the inlet. However, the measurements taken indicate that the system is operating as designed and thus, it was not necessary to physically measure the air inlet. The opposite was the case in the Visitors Center. The supply air ducts were out of reach, but the fresh air inlet was accessible. Measurement confirmed the proper operation of the unit.

The dew point for all of the areas was between 55-60°F, which is within the established criterion. Although two of the temperature readings appear below the operative temperatures of the cited criteria, it must be understood that the criteria is based on 50% relative humidity. The increased humidity will, in effect, allow the cooler temperatures to feel warmer.

Carbon dioxide measurements in the office and Visitors Center (400 ppm) indicate adequate fresh air supply to these areas. This measurement may not be a true indicator of ventilation rate in this instance since only one employee occupies each administrative office. In addition, one employee is allowed to smoke in the office area.

Although the ventilation system for the administrative offices appeared to be operating as designed, the design of the system was unique and innovative, with no component of the system visible from the outside Fort. Since the Fort is a replica of a Civil War era building, all ductwork and air handlers are located underground in a tunnel system. After visual inspection of the elaborate system of ductwork in the tunnel area, it became apparent that previous engineering recommendations to revamp the system were based on ventilation design principles to improve the efficiency of the system. In a span of ten linear feet, the ductwork from the air handler made no less than seven (7) right angle turns. There were no static pressure gauges built into the system to monitor performance. However, basic ventilation principles dictate that the more turns in the system, the larger the amount of energy that will be necessary to move the air through the system, i.e., larger fan.

In addition, the fresh air intake port for the system draws air from the tunnel area and not directly from the outside. The tunnels are poured concrete, with dirt floors. There is a musty odor in the tunnels, similar to a residential basement. There were no visible indications of mold or mildew in the tunnels. Employee complaints of odors could be attributable to the design of the ventilation system, drawing air from the tunnels and circulating it to the offices.

VII. CONCLUSIONS

Based on the results of this investigation it was determined that the indoor air quality in the administrative offices and Visitors Center was acceptable according to the evaluation criteria in terms of temperature, humidity, dew point, ventilation rate and carbon dioxide level. However, the ventilation design which allows make-up air to be drawn from the tunnel area was deemed not prudent, and the most likely source of employee complaints of odors.

VIII. RECOMMENDATIONS

1. The fresh air intake for the ventilation units should be ducted directly to the outside air. This recommendation should eliminate employee complaints of musty odors. Any changes or modifications to the existing ventilation system should also include provisions to supply fresh outside air to replace exhausted air.
2. As a Public Health Agency, NIOSH encourages the prohibition or restriction of smoking in the workplace. Elimination or reducing contamination of the air supply with cigarette smoke is a recognized method of improving the indoor environment. Restriction of smoking to designated areas (preferably that have their air supply exhausted rather than recirculated) is a means to attain this end.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Fort Stanwix National Monument
2. OSHA, Region II, New York

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