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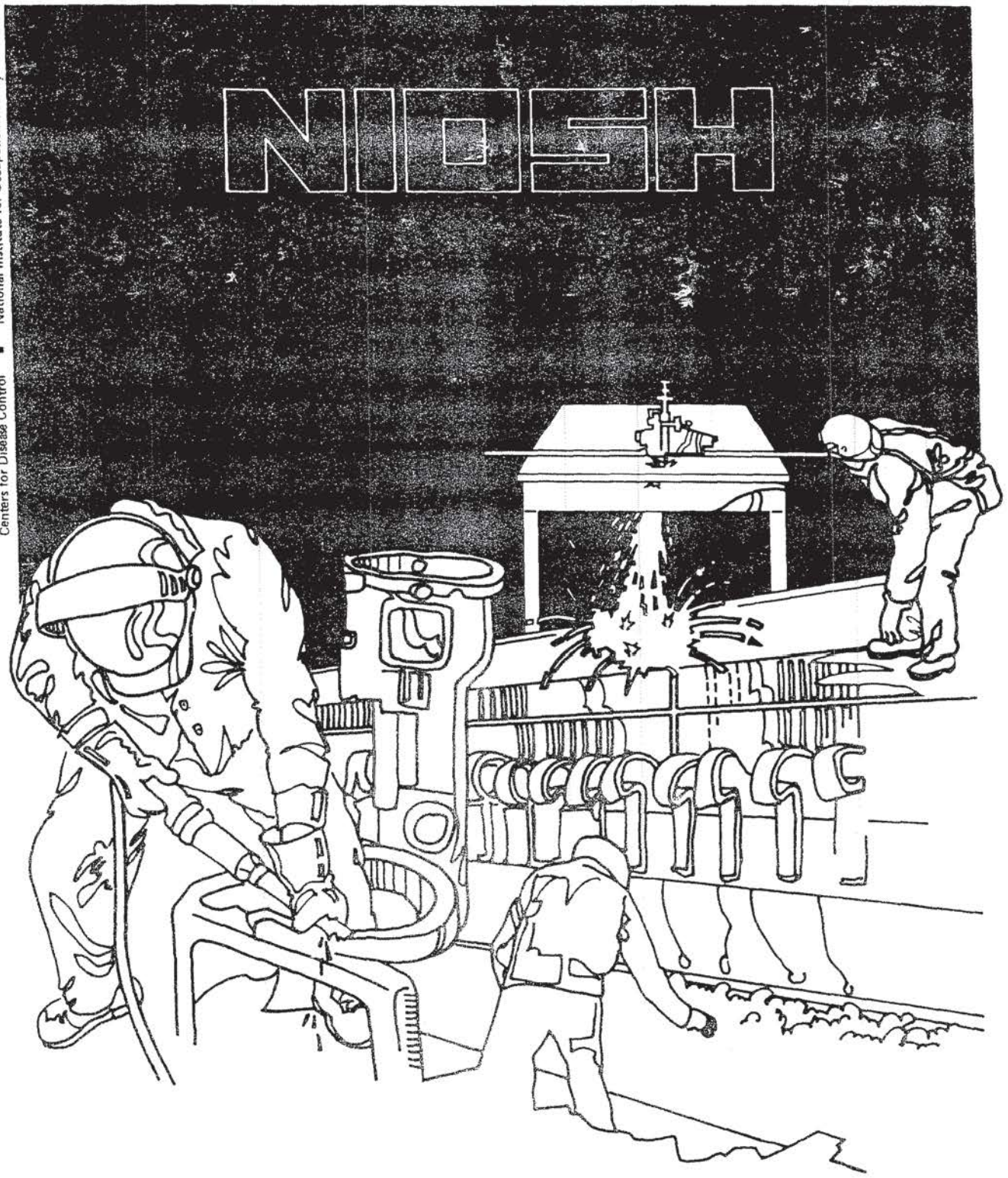

Health Hazard Evaluation Report

HETA 81-242-1019
UNIVERSITY OF MIAMI
CORAL GABLES, FLORIDA

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.

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University of Miami
Coral Gables, Florida

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I. SUMMARY

In March, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the University of Miami, Coral Gables, Florida. Of concern were reported respiratory distress and illness in University employees and mildew and mold growing on books and furniture in the Merrick building. The air conditioned building houses 237 employees and is used primarily for offices and classroom activities. There is a moldy smell in many of the enclosed areas of the building. Halls, elevators and breezeways were open to the elements.

On August 3 interviews were conducted with several University employees working in the building and others knowledgeable of the situation. These interviews and evaluation of the environmental conditions revealed occasions of damp, musty smells in the building, and records for July and August show high indoor humidity in the range of 65 to 75 percent.

Samples of air conditioner condensate were obtained for microbiological examination. All of the organisms isolated from the air conditioning unit's effluent are ubiquitous in nature and commonly found in water, air or soil. No known potential human pathogens were isolated. Air samples taken in the educational curriculum library were analyzed for 22 organic vapors and very low or zero concentrations of vapors were detected.

Data obtained in the investigation demonstrated that perhaps the high humidity gave rise to the mildew and molds accumulating on furnishings in the building. There is a potential for a biological hazard to exist due to this high humidity and accumulation of moisture in the air conditioning units that could promote the growth of and aerosolize microorganisms and carry them to offices and classrooms. Recommendations to reduce the humidity in the building and control condensate are contained in Section VIII of the report.

KEYWORDS: SIC 8221, Respiratory symptoms, mildew, mold, humidity.

II. INTRODUCTION

On March 16, 1981, the University of Miami requested a health hazard evaluation of the Merrick Building in Coral Gables, Florida. The request stated that relative humidity in the building is high and mildew and mold is growing on books and furniture. The condition is a suspected health hazard and is possibly associated with employees reportedly suffering respiratory distress.

A health hazard evaluation conducted by an industrial hygienist was postponed until August 3, 1981, a date which represented the occurrence of higher humidity in the Greater Miami area and a time in which the problem appears.

The goals of the evaluation were to evaluate the environmental conditions (particularly the ventilation system) for possible sources of work-associated respiratory problems and develop, based on findings, appropriate recommendations to the business affairs office to alleviate the situation.

III. BACKGROUND

The Merrick building has five stories, is used for classroom and office space, and is air conditioned by a multitude of units connected to the central chilled water system of the University. The building was completed in 1946. The latest renovation program for the Merrick classroom building was begun in June 1980 and construction was completed in August 1980. Change to the current air conditioning system was a part of this recent renovation program. The air conditioning installation was predicated to conserve energy and to improve comfort in the building. By September 1980 it became apparent that, although adjustments were complete, the system was not functioning as intended.

During the late summer months when the Greater Miami area experiences high humidity, even higher humidity was experienced in areas of the building. Mildew and mold appeared on the books and furniture in several offices and in the educational curriculum library, Room 315. Employees have reported suffering respiratory distress and, in some cases, illness. High humidity subsided with the fall season, but returned when air conditioning resumed in the summer of 1981.

IV. METHODS AND MATERIALS

A. Environmental

Environmental evaluation consisted of interviews with University personnel about environmental conditions, a walk-through industrial hygiene survey, collection of samples of material in the air conditioning system for microbiological analyses, and collection of air samples for organic vapor analyses.

Microbiological evaluation began with the collection of samples of air conditioning condensates from the educational curriculum library and an office area. The specific purpose of the field sampling was to make preliminary identification of resident bacteria and determine the numbers of viable microorganisms present.

Sterile apparatus was used for the collection of approximately 60 ml of condensate from an air conditioning unit for microbiological evaluation. The sample was kept cool during transport to the School of Public Health, Chapel Hill.

The specific methodology used for the isolation of L. pneumophila has been described (1). In addition, standard bacteriologic and mycotic media were used for the identification and enumeration of microorganisms.

Bacteriologic media utilized for assay included Feeley-Gorman (specific for Legionella pneumophila), Sheep Blood Agar, Trypticase Soy Agar, Eosin Methylene Blue, and MacConkey Agar. Prior to the streaking of media, each specimen was agitated in order to resuspend settled debris, and subsequently allowed to stand for 5 minutes for settlement of large particles. Aliquots of 0.1 ml were streaked onto all media used.

Incubation of bacteriologic media at 35°C for 48 hrs. did not produce visible colonies; reincubation for an additional 4 days did reveal the presence of bacteria. However, the streaking of additional media with incubation at room temperature was more conducive to microbial growth and subsequent colony development.

Air samples were collected using charcoal tubes and analyzed for organic vapor by means of gas chromatograph following elution by carbon disulfide.

B. General

A closing conference was held with University personnel to discuss the nature and scope of the evaluation, and to offer suggestions for improving conditions as observed during the one day of evaluation.

V. EVALUATION CRITERIA

There are no relevant standards or guides for microbial content of ventilation systems as an index to potential air transport and inhalation of pathogenic microorganisms. The concentration of microorganisms in the air was not assessed. The criteria for evaluating the microorganisms found were: 1) Generic and species identification; 2) their relative numbers; and 3) whether they are associated with respiratory disease, as indicated by literature review.

The criteria for evaluating the 22 organic vapors assayed are the current American Conference of Governmental Industrial Hygienists Threshold Limit Values (ACGIH-TLV), the U.S. Department of Labor, Occupational Health Standards (OSHA), NIOSH Criteria Documents, and the NIOSH Registry of Toxic Effects of Chemical Substances. Limits appearing below reflect the lowest found among these sources.

Substance	Ceiling Limit or STEL (ppm)	8-hour Time Weighted Average (ppm)	Source	OSHA 8-hour Limit (7)
Isopentane	610	120	NIOSH(2)	1,000
n-Pentane	610	120	NIOSH(2)	1,000
2,2-Dimethylbutane	510	100	NIOSH(2)	none
3-Methylpentane	510	100	NIOSH(2)	none
2-Methylpentane	510	100	NIOSH(2)	none
n-Hexane	125	100**	ACGIH(3)	500
Cyclopentane	900	600	ACGIH(3)	none
Methylcyclopentane	1,000*	500*	ACGIH(3)	none
n-Heptane	440	85	NIOSH(2)	500
Cyclohexane	375	300	ACGIH(3)	300
Methylcyclohexane	500	400	ACGIH(3)	500
n-Octane	385	75	NIOSH(2)	500
1,1,1-Trichloroethane	350	350	NIOSH(8)	350
Methyl ethyl ketone	300	200	ACGIH(3)	200
Isopropanol	500	400	ACGIH(3)	400
Benzene	1***	-	NIOSH(9)	10
Trichloroethylene	150	25	NIOSH(4)	100
Toluene	150	100	ACGIH(3)	200
Ethylene dichloride	15	5	NIOSH(8)	50
Xylenes; o,p,m	150	100	ACGIH(3)	100

* Proposed TLV
** TLV of 50 ppm proposed by ACGIH
*** 2-hr TWA Limit

The ventilation criteria used were the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) recommendations for ventilation and for maintaining comfortable temperature and humidity (5,6).

VI. RESULTS AND DISCUSSION

A. Environmental

The air conditioning systems throughout the building consist of multitudes of air conditioning units connected to the central chilled water system. The building was previously served by a series of individual systems. No spray humidifier or evaporative coolers are used in these systems so there is no source of artificially warmed water, the usual source of problems involving microorganisms in ventilation systems.

The air conditioning unit in the educational curriculum library was similar to those throughout the building. Total circulated flow was approximately 3,330 cfm. With a calculated space volume of 30,600 cubic feet, the total air circulation is about 6 air turnovers per hour. Fresh air make-up is an estimated 10 percent of air flow (330 cfm), or approximately 0.5 changes of fresh air per hour.

The moisture problem was reported to be associated with summertime operations; i.e., the cooling and high humidity season. It was reported by University personnel that damp feeling air (high humidity) disappeared soon after the ambient air humidity was reduced and less cooling was required, but returned in the summer of 1981. The day of the survey the temperature outside was 82°F, and the relative humidity was 80% (mid-morning). Inside Room 315, the education curriculum library, the temperature was 74°F with a relative humidity of 74%. It was easy to recognize a damp "musty" odor upon first entering the library. Mold-like materials were observed on books on several shelves.

Recent records (July 11 through August 4) from spot-checks at mid-morning in the library and outside the building on twelve different days show that the temperature varies between 70-78°F (Average 73.8°F) and the relative humidity between 60% and 75% (average 70%). The outside temperature varied between 80° and 86°F and the relative humidity between 64% and 89%. On five of the twelve days measurements were recorded, the relative humidity was higher in the educational curriculum library than outside the building. From observation of the air conditioning unit the cooling cycle appeared to be short term (approximately 5 minutes or less per hour). The fans in the unit operate continuously during office hours.

No specific internal "musty" odor source was located. The odors appear to be the result of high relative humidity through the building, which allows moisture on occasion to accumulate on room furnishings and encourages microbial growth.

Two 1-1/2 hour air samples for organic vapors were collected in the library. These were analyzed for 22 vapors listed in Section V. Concentrations in air of <0.05 ppm pentene, hexane, toluene, 0.19 ppm isopropanol, and 0.14 ppm benzene were found. None of the other chemicals were detected.

Total air circulation was calculated to be 1.0 cfm/sq. ft. of floor area, within the 0.75 to 2.0 cfm/sq. ft. range recommended by ASHRAE for office buildings. Fresh air supply was calculated to be 0.1 cfm/sq. ft. of floor area, below the ASHRAE recommended range of 0.25 to 0.4 cfm/sq. ft. (5).

The temperature and relative humidity records for July and August indicate usual daytime temperatures of 69-79°F in the building and relative humidities of 48-78 percent. ASHRAE recommends a temperature of 76°F and a desirable relative humidity of 40 percent (but no more than 60 percent in summer or no less than 20 percent in winter) for optimum comfort conditions (6).

The high humidity on occasions and the low fresh-air turnover are of concern and probably contribute both to employee discomfort and to the microbial growth mentioned above.

No evidence of L. pneumophila was found in any of the condensate fluids. Two types of pink colonies were found; further examination revealed the presence of small clear colonies as a background lawn. Preliminary quantitation indicates that the pink colonies were present at about 2×10^3 per ml condensate and the clear colonies at about 1×10^5 per ml condensate.

Gram stain morphology revealed the pigmented organisms to be gram-variable, pleomorphic, often club-shaped rods, with an internal granular appearance. The smaller colonies also stained gram-variable, and were thin, short rod forms. Based upon colonial and microscopic morphology, gram stain, and temperature requirements, all 3 isolates are presumptively identified as belonging to the Coryneform Group of bacteria, as outlines in the 8th edition of Bergey's Manual of Determinative Bacteriology. This group presently includes the genera Corynebacterium, Anthrobacter, Brevibacterium, Microbacterium, Cellulomonas, and Kurthia. Rare colonies of Micrococcus, Bacillus, and Staphylococcus were also isolated.

VII. CONCLUSIONS

All of the organisms isolated in the effluent from the air conditioning units are ubiquitous in nature and commonly found in water, air or soil. No known potential human pathogens were isolated. No chemical air contaminants or other obvious specific hazards were found which might explain the reported respiratory distress of several employees.

It is concluded that the excessive humidity in the building is the initiating cause of the "musty" odor detected in several rooms, and that the high humidity creates an environment in which microorganisms can multiply in the air conditioners and elsewhere, from where they may become air-borne and be redeposited on books and furniture or be inhaled.

VIII. RECOMMENDATIONS

1. Where condensate in the air cooling units has accumulated, efforts should be made to effectively drain the condensate pans. To prevent accumulating condensation, adjoining ducts should be insulated.

2. The relative humidity in the building should be lower. At the average normal temperature observed from the records (75°F), the summer relative humidity in the building should be between 40 and 60 percent, for continued comfort.

3. Periodic treatment of residual condensates with an effective disinfectant would further reduce the hazard of aerosolized microorganisms in the office and classroom air; a 1:100 dilution of household Chlorox appears suitable.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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