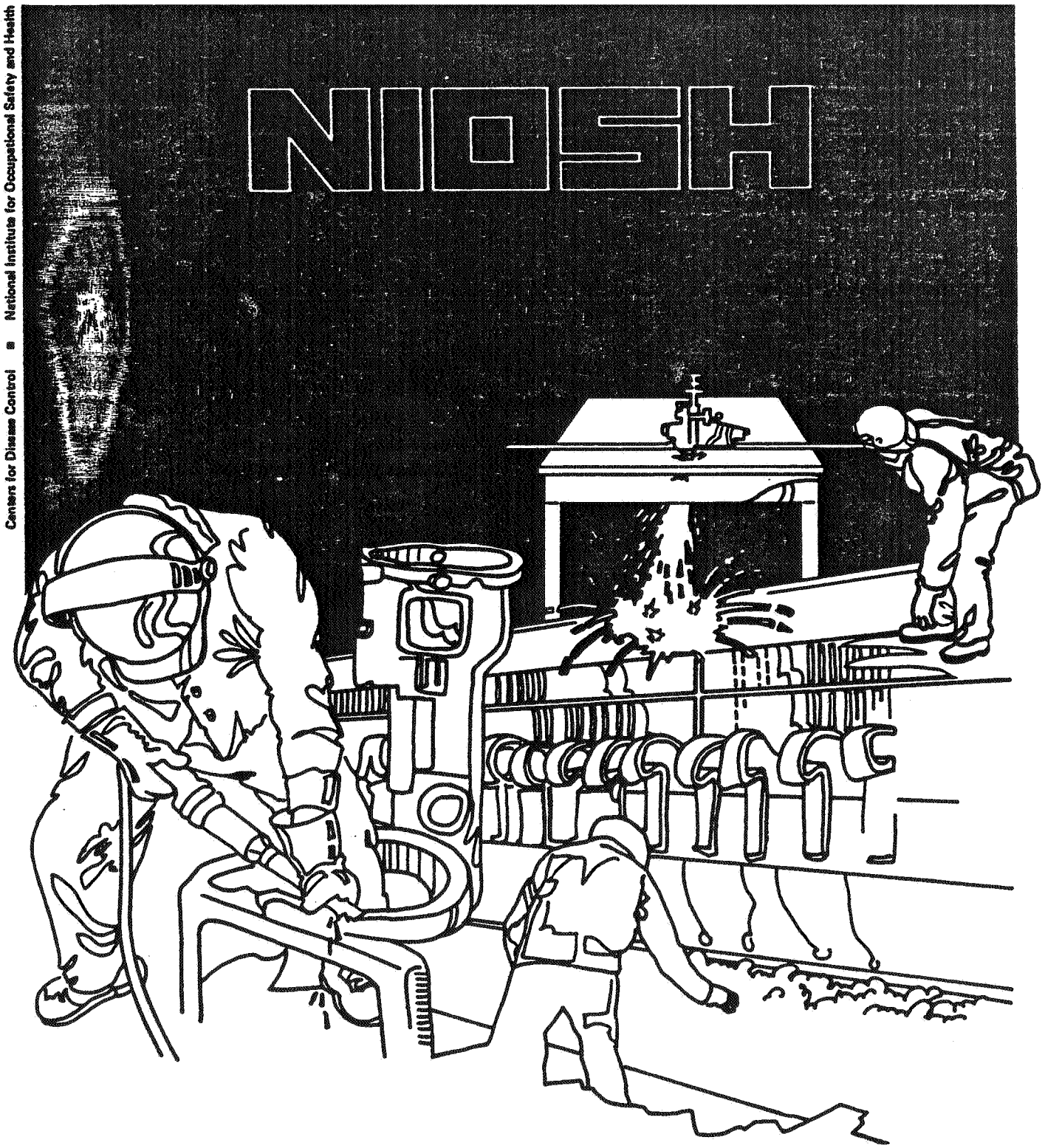
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public h. ervice
Centers for Disease Control • National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-020-1351
JOHNSON MUSEUM
CORNELL UNIVERSITY
ITHACA, 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.

HETA 83-020-1351
AUGUST 1983
JOHNSON MUSEUM
CORNELL UNIVERSITY
ITHACA, NEW YORK

NIOSH INVESTIGATORS:
Nicholas Fannick, I.H.
Jane Lipscomb, M.S.
Kevin McManus, I.H.

I. SUMMARY

In October 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from workers at the Herbert F. Johnson Museum of Art, Cornell University, Ithaca, New York, to investigate exposure to diethylaminmoethanol (DEAE), an additive to the water used to humidify the air in the museum. The request expressed concern that exposure to DEAE caused eye irritation and dermatitis in the workers.

On Januay 26 and 27, 1983, representatives of NIOSH visited the facility, interviewed affected employees and collected samples to determine exposure to airborne DEAE. Fourteen air samples were collected in the museum, 10 at a sampling rate of 0.2 liters per minute and 4 at a sampling rate of 1.5 liters per minute. DEAE was detected in two of the samples collected at the higher sampling rate. The concentrations of airborne DEAE were 0.05 and 0.04 milligrams per cubic meter of air (mg/M^3). The OSHA Permissible Exposure Limit for DEAE is 50 mg/M^3. DEAE also was identified on two samples of plastic material which had been exposed to the atmosphere in the museum for several years.

Thirty-one full-time and 4 part-time museum employees participated in medical interviews. Sixteen (46%) persons reported eye irritation during the past six months. Thirteen (37%) reported some type of skin problem since beginning work at the museum, but these were mostly transient and were dissimilar with respect to time of occurrence, bodily distribution, and appearance. Occasional headaches and throat irritation were each reported by approximately 25% of those interviewed. Although most employees reported experiencing these symptoms only while at work, there was no work area, or specific time period associated with the reported symptoms. As DEAE is a skin irritant and has a low vapor pressure, some of the dermatitis and irritation problems may have been caused by skin contact with DEAE which condensed on surfaces. The fact that little fresh air was added to the ventilation system during temperature extremes may be related to the recurrent, less specific complaints of headache, dizziness, and fatigue (closed building syndrome) experienced by a number of employees.

Based on the results presented in this report, NIOSH concludes that employees at the Johnson Museum were not exposed to excessive concentrations of airborne DEAE. However, sporadic contact with surfaces containing DEAE may have been associated with some of the irritant symptoms reported. NIOSH recommends that exposure to DEAE be eliminated. Until DEAE is eliminated, exposed surfaces which employees commonly touch should be cleaned with water and detergent, at least weekly. Protective gloves should be worn by the cleaning crew.

KEYWORDS:SIC 8411 (museums), dermatitis, eye irritation, diethylaminoethanol, closed building syndrome.

II. INTRODUCTION

In October 1982, the National Institute for Occupational Safety and Health received a request from the employees of the Herbert F. Johnson Museum, Cornell University, Ithaca, New York 14853 to investigate exposures to diethylaminoethanol (DEAE) at the museum. DEAE is a corrosion inhibitor which is added to the water that provides increased humidity to the museum. It was suspected as a cause of dermatitis and eye irritation among employees. On January 26 & 27, 1983, representatives of NIOSH visited the facility, interviewed affected employees and collected samples to determine exposure to airborne DEAE. An Interim report was issued in February 1983.

III. BACKGROUND

Approximately 40 people work at the museum as curators, guards, etc. Two of the employees are unionized. The building is about 12 years old. There are 10 floors (4 beneath ground level), 60,000 square feet of floor area and an internal displacement of 710,000 cubic feet. Floors 3, 4, 6 and the bottom basement are not open to the public, and most of the museum's staff work on these floors.

The windows of the building cannot be opened. During periods of temperature extremes, such as occurred during NIOSH's visit, the amount of fresh air added to the building is severly limited. The relative humidity of the facility is nominally maintained at 50% to aid in the preservation of the art works. To maintain this relative humidity, steam may be added to the atmosphere. Because of the climatic conditions of the locality, the steam is necessary mainly during colder weather--usually November through March. From 1971 to 1977, and from 1979 to 1983, an anti-corrosive agent (DEAE) was used in the steam lines, added at approximately 15 parts per million parts of water. During 1977-1979, morphaline was used as the anti-corrosive agent.

About two years ago, the museum's employees began to complain of intermittent dermatitis and eye irritation, at first during the Winter months, but now the complaints are not seasonal. During the Winter of 1981-82, an oily film was noticed on the surfaces of display cases. This film was analyzed by the Mass Spectrometry Facility at Cornell University and was identified as DEAE. Concerned employees contacted NIOSH and obtained information on the health effects of exposure to DEAE, which corresponded to the symptoms experienced by the employees of the museum. The visit of NIOSH personnel to the museum was delayed until late January 1983 by the unusually warm weather which delayed the introduction of additional humidity into the museum's atmosphere until early January.

IV. EVALUATION DESIGNS AND METHODS

A. Environmental

NIOSH has developed two sampling and analytical methods for the determination of airborne DEAE--P&CAM 270 and S140. Both of these methods use acidified

silica gel as the collection media. A consultation firm employed by Cornell University had been unable to identify airborne DEAE, using Method S140 (limit of detection = 4 mg/M^3). NIOSH decided to modify the method somewhat by using citric acid-treated silica gel as the collection media and by varying the flow rates of the sampling pumps (some samples were collected at a flow rate of 0.2 liters per minute (lpm), some at 1.5 lpm).

B. Medical

The NIOSH medical investigator interviewed all museum employees present during the two day evaluation. Questions specifically addressed the symptoms reported in the hazard evaluation request (skin rashes; eye, nose, and throat irritation; headaches; and nausea). NIOSH also obtained and reviewed reports of medical evaluations of two employees who had consulted their private physicians. Finally, NIOSH interviewed a staff member from the University Health Service regarding the reported health problems.

V. EVALUATION CRITERIA

A. Environmental

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 conditions, 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 workers 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 Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational

health 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 solely 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 legally required to meet only 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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposure.

DEAE

The OSHA standard and the ACGIH TLV for exposure to DEAE are 50 milligrams per cubic meter of air (mg/M^3) or 10 parts per million parts of air (ppm)[1]. DEAE is an eye, skin and respiratory tract irritant. It can be absorbed through the respiratory tract and through the skin. Animals exposed to very high concentrations of DEAE developed bronchopneumonia. Histopathologic examination of animals exposed for 6 months to 200 parts per million (ppm) of DEAE revealed no significant physiological changes. Except for the previously noted irritation, there are no known long term effects of exposure to DEAE in humans.[2]

Animal toxicologic studies showed that rats exposed to 500 ppm, 6 hours daily, for 5 days exhibited marked eye and nasal irritation, and a number of rats had corneal opacity by end of the third day[3]. No information is currently available regarding the air concentration of DEAE which produces eye or respiratory tract irritation in humans. The odor threshold for DEAE has not been determined. A NIOSH Health Hazard Evaluation[4] conducted in September 1981 showed a primary chemical skin reaction (possibly phototoxic) among workers potentially exposed to several substances, including DEAE, although NIOSH was unable to detect DEAE with available sampling methods (limit of detection = 0.4 mg/M^3). The symptoms at that site abated after the use of DEAE was discontinued.

As of early July 1983, the employees of the Museum report to have had an increase in both the number and severity of their symptoms. In addition to the previously mentioned symptoms, intermittent nausea and menstrual irregularities have been reported. Nausea has been associated with short-term, human exposure to DEAE, at levels thought to be approximately 100 ppm[3]. There is no scientific evidence to suggest that there is an association between menstrual irregularities and any workplace exposure.

Closed Building Syndrome

Mention should be made of "closed building syndrome" or "building related illness episodes". Modern buildings are constructed primarily of steel, glass and concrete with large windows that usually connot be opened, thus making the building totally dependent on mechanical air handling systems for ventilation. Building related illness episodes have been reported more frequently in recent years as buildings have been made more air-tight in order to conserve energy and to reduce air conditioning and heating

expenses. The symptoms most often reported are eye, nose, and throat irritation, headache, fatigue and sinus congestion. Occasionally, skin rashes are reported. In some cases, the cause of the symptoms has been ascribed to an airborne contaminant, such as formaldehyde or insulation particles, but most commonly a single cause cannot be pinpointed.

Neither NIOSH nor OSHA has developed ventilation criteria for general offices. Criteria often used by design engineers are the guidelines published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.[3] (ASHRAE). For "general offices" where smoking is not permitted, the rate recommended by ASHRAE is 5 cubic feet per minute (cfm) of fresh outdoor air per person. When smoking is allowed, the amount of outdoor air should be increased to 20 cfm per person. It should be emphasized that this recommendation is for fresh outdoor air. Thus if a ventilation system has 90 % recirculated air (or 10 % fresh air) the ventilation system must supply 200 cfm per person to the average office where smoking is permitted.

VI. RESULTS AND DISCUSSION

A. Environmental

Cornell University had estimated that the concentration of DEAE in the museum's atmosphere would be less than 1 mg/M^3. NIOSH estimates that the maximum concentration of DEAE in the atmosphere of the museum at the time of the survey would be 0.05 mg/M^3, assuming 15 ppm of DEAE added to the steam, 70°F room temperature, 50% relative humidity and that the steam would supply 50% of the moisture in the atmosphere.

DEAE was determined to be present in two of the 14 samples collected: 0.05 mg/M^3 in the Registrar's office in the bottom basement, and 0.04 mg/M^3 in a sample collected in the lounge on the 2nd floor (Table I). Both of these samples were collected using the high flow rate. The limit of detection at the high flow rate (with a nominal total sample volume of 200 liters) was about 0.04 mg/M^3. The limit of detection for the samples collected at the low sampling rate (with a nominal total sample volume of 20 liters) was about 0.4mg/M^3. No DEAE was detected on the other samples.

The environmental standard for exposure to airborne DEAE is 50 mg/M^3. Exposure to airborne DEAE presents minimal hazard to the museum staff. A more likely route of exposure may be through contact with condensed DEAE. DEAE had been identified on surfaces of art work, plastic display cases and windows by the University. NIOSH analyzed two "bulk" samples of plastic film that had been exposed to the atmosphere "for years". These samples contained about 30 milligrams of DEAE per square meter of exposed area. Interestingly, this is approximately the concentration that theoretically would condense from an airborne concentration of 0.05 mg/m^3 in four years, assuming that DEAE would be added to the atmosphere 150 days a year.

An indication that the route of exposure at the museum is through contact with condensate rather than by exposure to airborne DEAE is the fact that symptoms did not begin to develop until about two years after the introduction of DEAE into the museum. As the DEAE is added to the steam at a concentration of 15 ppm, it is doubtful that the airborne concentration of

DEAE would ever approach the PEL of 50 mg/M^3, and in reality is closer to 0.05 mg/M^3. As the vapor pressure of DEAE is minimal, almost all of the airborne DEAE would be expected to condense onto exposed surfaces, where, after sufficient time for the condensate to accumulate, skin contact would be a substantial route of exposure.

Millions of cfm are circulated in the building. The amount of fresh air added to the building's air supply is severely limited in periods of extreme cold or hot temperature. ASHRAE recommends that 5 cfm of fresh air be supplied per person in an office situation. While this amount probably is supplied through open doorways as visitors and supplies enter and leave the building, there may be some question about the distribution of "fresh" air to the relatively small areas which are used as offices and which are work stations for the curators, secretaries, etc. Some of these employees' symptoms may be related to "closed building syndrome" as discussed above in Section V.

B. Medical

All 31 full-time museum staff and four individuals who work either as student interns or part-time employees (less than 20 hours per week) participated in the medical interviews. The participants included 19 (54%) females and 16 (46%) males. Ages ranged from 21-67 years. The length of employment among employees ranged from one month to 10 years, with a median of four years.

Results of the medical interviews are summarized in Table II. Thirteen (37%) of those employees interviewed reported no symptoms, 13 (37%) complained of 1-2 symptoms, 7 (20%) complained of 3-5 symptoms, while 2 (6%) complained of 10-11 symptoms. Of those reporting at least one symptom, all except one person complained of some type of skin, eye or upper respiratory tract irritation.

Eye irritation (burning, itching, or dryness) was the most frequently reported symptom. Sixteen (46%) persons complained of this symptom, with five of these employees also reporting increased lacrimation (eye watering). Thirteen (37%) of those interviewed stated they experienced some sort of skin irritation since beginning work at the museum.

At the time of the NIOSH evaluation, three employees reported currently having mild skin irritation. One employee had a small reddened area on her face; a second person had a patch of dry skin on his upper arm; and a third employee had a dry eczematous rash on her left hand (this person has a history of atopy). Among all employees reporting some skin irritation in the past two years, the onset of the symptoms ranged from 2 years ago to the present, with the majority of employees stating the symptoms began in January 1982 or between July 1982 and January 1983. Most skin problems were described as either "red with small rash-like blisters" or "dry and scaly skin". The part of the body affected varied between individuals (scalp, hands, face, legs, back, chest, and stomach) and did not resemble the phototoxic pattern seen in the previous NIOSH health hazard evaluation where DEAE was a potential exposure[4].

Employees reporting skin problems did not work in a single area of the building, nor was there one characteristic skin problem reported by employees. In addition, there were employees who worked in close proximity

to those with the more serious health complaints who experienced no symptoms. Although skin problems have been reported over the past two years, only five of the 13 employees reporting these symptoms have had more than a single occurrence. In addition, the dates on which these episodic problems occurred were not consistent from one employee to another.

Six female employees reported experiencing gynocological problems consistent with vaginal infections since beginning work at the museum. Vaginal infections and inflammatory processes are the most common and most frequently reported of gynecological problems. They are particularly common in women in the age group of the museum's employees[7]. There is no medical evidence to suggest an association between these reported problems and a work place exposure.

Although there is no clear pattern as to a particular area of the museum where employees experienced symptoms, employees who reported eye irritation, headaches, dizziness, and fatigue stated that these symptoms cleared up on weekends and during the three-week Christmas break. This is consistent with the building-related illness episodes described earlier in this report.

The two medical reports obtained from employees' private physicians provided no objective information suggesting an environmental etiology of their health problems.

VII. CONCLUSIONS

Airborne concentrations of DEAE found at the Johnson Museum were 1/1000 of the current OSHA and ACGIH standards. Therefore, it is unlikely that airborne DEAE was associated with health effects reported among museum employees. Since DEAE has a low vapor pressure and was detected on surfaces, skin contact with surfaces was a possible route of absorption .

Sporatic contact with surfaces containing DEAE may have been associated with some of the irritant effects reported. Elimination of DEAE from the humidification system is recommended by NIOSH. It is unlikely that exposure to DEAE is responsible for the less specific, non-irritant effects such as headaches, dizziness and nausea. These effects may be related to "closed building syndrome".

VIII. RECOMMENDATIONS

There are two methods of controlling exposure to condensed DEAE: 1) periodic cleaning of exposed surfaces to minimize the amount of DEAE, and therefore the amount of contact, and 2) elimination of the DEAE.

Although DEAE may be cleaned from surfaces with water, an aqueous solution of sodium bisulfate or an aqueous solution of alcohol[4], Method 1 is less desirable because it is less thorough and probably more expensive. This method also does not address the problem of possible damage to the art work. NIOSH is not qualified to address this problem

Cornell University has chosen to provide the museum with an independent humidification system, which, after cleaning the condensed DEAE, should provide a permanent, effective solution to exposure to condensed DEAE.

Since the survey was conducted, representatives of the United Auto Workers, Local 2300, indicated that five other buildings on campus are also humidified by steam treated with DEAE, and that employees in these buildings exhibit similar complaints. NIOSH recommends that Cornell University have wipe samples collected in these buildings to determine if contamination of DEAE has occurred, and that affected workers in these buildings be screened by the University health service to determine the extent of eye irritation and/or dermatitis. If problems associated with contact of DEAE appear to be widespread, the University should consider total elimination of DEAE from the humidification system and clean up of contaminated areas. Protective gloves should be worn by individuals performing the cleaning.

It is important to have a central system for reporting health problems among University employees so that trends in adverse health effects can be identified and a particular work situation or agent investigated. The Gannett Health Service is aware of health effects among university employees. Museum employees should report all symptoms and illnesses which they feel are work-related to the Gannett Health Service.

IX. REFERENCES

1. NIOSH/OSHA Occupational health guidelines for chemical hazards. DHHS (NIOSH) publication No. 81-123, January 1981.

2. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values. 4th ed. Cincinnati, Ohio; ACGIH, 1980.

3. Cornish, H., Oral and inhalation toxicity of 2-diethylaminoethanol, Am. Ind. Hyg. Asso. J. 26:479, 1965.

4. Mc Manus, K., Baker, D., Health hazard evaluation report no. 81-247-958: Boehringer Ingleheim, Ltd., Cincinnati, Ohio, NIOSH, 1981.

5. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE standard 62-1981, Ventilation for acceptable indoor air quality. Atlanta, Georgia: ASHRAE, 1981.

6. Manufacturing Chemists Association. Guide for safety in the chemical laboratory. New York: Van Nostrand Reinhold Company, 1972.

7. Green, T., Gyneocology: essentials of clinical practice, 3rd ed., Little, Brown and Co.: Boston, Mass., 1977.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report prepared by;

Nicholas Fannick
Industrial Hygienist
NIOSH/Region II

Jane Lipscomb
Medical Investigator
Medical Section

Kevin McManus
Industrial Hygienist
NIOSH/Region I

Originating office; Hazard Evaluations and
Technical Assistance Branch
Division of Surveillance,
Hazard Evaluations, and
Field Studies

XI. DISTRIBUTION AND AVAILABLILITY OF REPORT

Copies of this report and 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 Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati Address. Copies of this report have been sent to:

The requestors
Cornell University
United Auto Workers, Local 2300
NIOSH, Region II
OSHA, Region II
New York State Department of Health

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 I

DEAE Concentrations

Johnson Museum
Cornell University
Ithaca, N.Y.

HETA 83-020

January 27, 1983

LOCATION	SAMPLING TIMES (minutes)	SAMPLE VOLUME (liters)	DEAE (mg/M^3)
Registrar's Office	135	200	0.05
Gallery 9 (1st Floor)	155	230	N.D.
Gallery 8 (1st Floor)	200	295	N.D.
Gallery 14 (Lounge, 2nd Floor)	150	220	0.04
Study Storage (2nd Base)	236	24	N.D.
" " " "	200	20	N.D.
Print Room (4th Floor)	232	19	N.D.
" " " "	232	18	N.D.
Gallery 20 (5th Floor)	235	25	N.D.
" " " "	248	26	N.D.
North East Office (3rd Floor)	177	18	N.D.
Mechanical Room (2nd Base)	188	19	N.D.
Receptionist' Area (3rd Floor)	223	21	N.D.
Gallery 12 (2nd Floor)	224	23	N.D.

N.D. = None Detected

Limit of detection for the first four samples = 0.04 mg/M^3
limit of detection for the other samples = 0.4 mg?M^3

TABLE II

HEALTH EFFECTS REPORTED
DURING INTERVIEWS WITH
35 MUSEUM EMPLOYEES
January 1983

HERBERT F. J. MUSEUM
ITHACA, NEW YORK
HETA 83-020

Eye Irritation	16 (46%)
Skin Irritation	13 (37%)
Headaches	6 (17%)
Nose/Throat Irritation	6 (17%)
Dizziness/Loss of Balance	6 (17%)
Change in Vision	5 (14%)
Nausea/Vomiting	4 (11%)
Unusual Fatigue	4 (11%)
Breathing Difficulty	2 (6%)
Chest Tightness	2 (6%)
Cough	0
Wheezing	0
Other Problems:	
Problem Wearing Contact Lenses	2 (6%)
Gynecological Problems	6 (32% of females)
Weight Loss	1 (3%)

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396