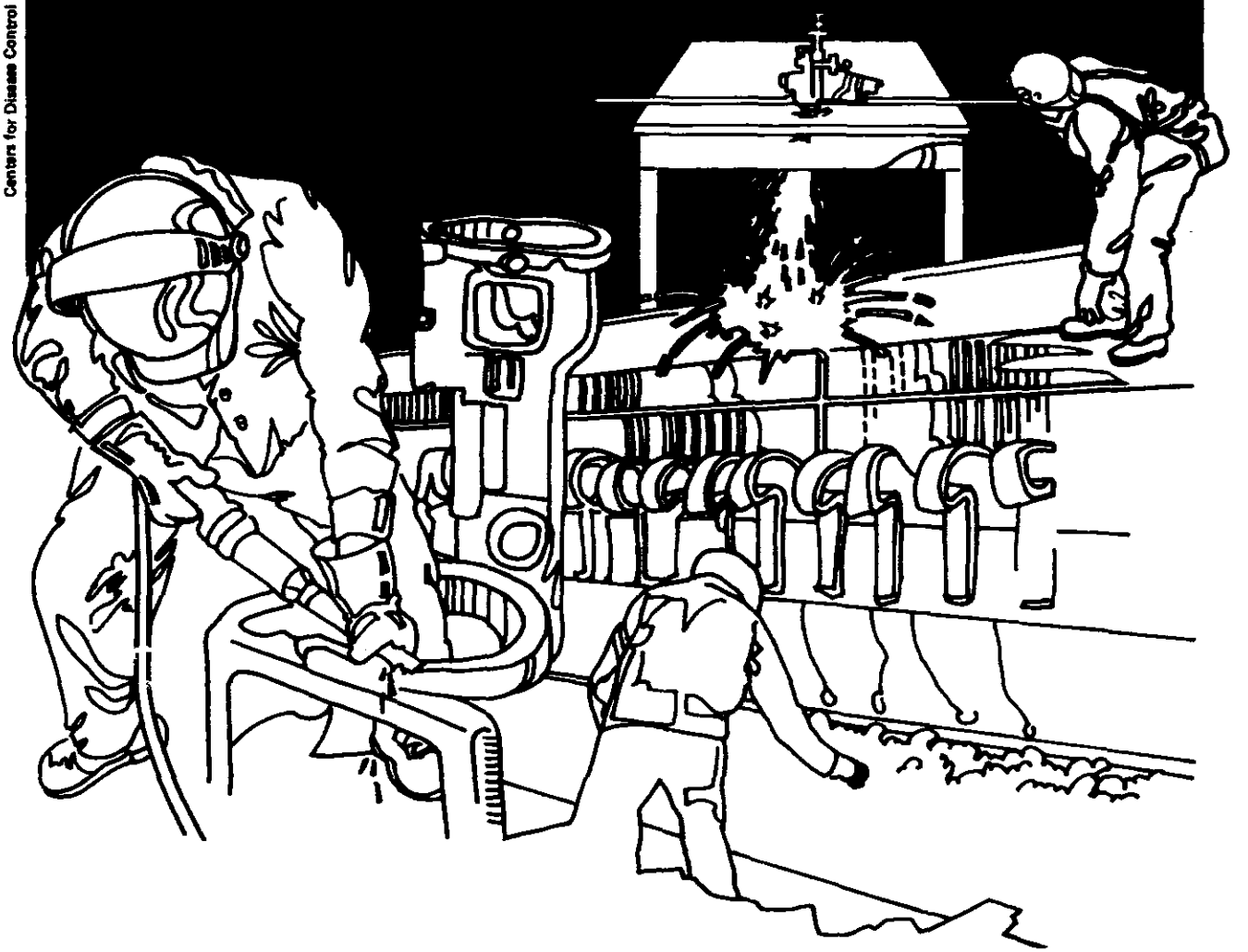
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 86-486-1799
NEW JERSEY EDUCATION ASSOCIATION
TRENTON, NEW JERSEY

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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NEW JERSEY EDUCATION ASSOCIATION
TRENTON, NEW JERSEY

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I. SUMMARY

On August 19, 1986 the National Institute for Occupational Safety and Health (NIOSH) received a request from the president of the General Staff Association of the New Jersey Education Association (NJEA) to evaluate reports of headache, sore throat, and eye irritation among employees in the NJEA building in Trenton, New Jersey. The request was assigned to the New Jersey State Department of Health (NJDOH) for follow-up under its Health Hazard Evaluation (HHE) cooperative agreement with NIOSH.

A walkthrough of the building was performed on September 17, 1986. During the walkthrough, employee interviews were conducted, and information and a questionnaire concerning indoor air quality were distributed by the union president. On September 17 and 22 and October 16, the NJDOH industrial hygienist performed air monitoring for formaldehyde, carbon dioxide, carbon monoxide, dry bulb temperature, wet bulb temperature, humidity, and velocity at air inlet and exhaust diffusers. On January 12, 1987 he performed additional carbon dioxide and humidity measurements inside and outside the NJEA building.

At employee work locations, very little air movement was observed with smoke tubes; no air velocity was detected with a Alnor Senior Velometer. Carbon dioxide concentrations inside the building were found to be 2 to 4 times higher than those outside the building. These findings indicate poor mixing of air within work areas. The main air inlet and exhaust of the Air Handling Unit (AHU), supplying and exhausting air to and from Floors #1, 2 and the basement were located side by side resulting in recirculation of part of the exhausted air. The controls that operate dampers to supply outdoor air in the AHU at the penthouse appeared faulty and needed inspection and adjustment in order to regularly supply 20 cubic feet per minute (cfm) of outdoor air per person. Relative humidity inside the building was found lower than the recommended levels in the measurements performed on January 12, 1987. Formaldehyde and carbon monoxide were not detected.

A self-administered questionnaire focusing on health symptoms putatively related to faulty indoor air quality was distributed to 96% of the employees. Eighty percent of the questionnaires were completed; all respondents perceived the quality of air in their work environment as poor. An additional, open-ended assessment of physical concerns showed repeated complaints of dryness of mucous membranes (nose, mouth, and throat), dryness of eyes, headache, and tiredness.

Based on the information obtained during this investigation several improvements are needed in the indoor air ventilation system to provide adequate quality and quantity of air in the NJEA building. Recommendations for the improvements are contained in Section VII.

KEYWORDS: SIC 9451 office building, indoor air pollution, carbon dioxide, temperature, relative humidity

II. INTRODUCTION

On August 19, 1986 the National Institute for Occupational Safety and Health (NIOSH) received a request from the president of the General Staff Association of the New Jersey Education Association (NJEA) reporting symptoms by the employees of headache, sore throat, and eye irritation allegedly due to poor indoor air quality in the NJEA building at 180 West State Street, Trenton. The request was assigned to the New Jersey State Department of Health (NJDOH) for follow-up under the NIOSH-NJDOH cooperative agreement.

III. BACKGROUND

NJEA employs approximately 140 people engaged mainly in office work in a building that was renovated in 1984-85. While renovations were being done, the employees moved floor-by-floor to an old building. Upon return to the renovated building, approximately 80% of the employees reported symptoms. The employees had not had health related complaints before renovation of the building nor while relocated in the old building.

IV. METHODS

A. Environmental

A walkthrough of the building was performed on September 17, 1986. During the walkthrough employee interviews were conducted and information and a questionnaire related to indoor air quality were distributed by the union president. The questionnaire was the American Lung Association's Office Indoor Quality Checklist (IAQC)

On September 22 NJDOH investigators attended a meeting with a ventilation engineer contracted by the company to study the NJEA building's ventilation system.

On September 17 and 22 and October 16, the NJDOH industrial hygienist performed air monitoring for carbon monoxide, carbon dioxide, dry bulb temperature, wet bulb temperature, humidity and velocity at air inlet and exhaust diffusers. Carbon dioxide, carbon monoxide and formaldehyde monitoring was performed with a MSA model 'A' pump and detector tubes. The minimum limits of detection for carbon dioxide, carbon monoxide and formaldehyde were 0.02% (200 ppm), 10 ppm and 0.5 ppm respectively. Velocity measurements were performed with a Alnor Senior Velometer; dry bulb and wet bulb temperatures were measured with a Sling Psychrometer. Humidity measurements were performed with Serdex Humidity Temperature Indicator Model 22-7056.

The NJDOH industrial hygienist reviewed the following documents:

- NJEA's smoking policy,
- A report on asbestos bulk sampling performed at NJEA by the United States Testing Company Inc. dated April 26, 1982,
- Reports on ventilation measurements performed by Eugene G. Freda, Co. dated September 5, 1984 and June 3, 1986,
- A report on an indoor air quality survey for organics and dust conducted at NJEA by Elson T. Killam Associates,
- A New Jersey Department of Environmental Protection (DEP) report on asbestos measurements performed at NJEA dated March 12, 1981.

On January 12, 1987 the NJDOH industrial hygienist performed carbon dioxide and humidity measurements inside and outside the building. Carbon dioxide measurements were performed with a Draeger Pump, Model TUV 12 and Draeger detector tubes. The Draeger pump and tubes were used to measure carbon dioxide levels since the minimum limit of detection of the Draeger tubes (100 ppm) was lower than that of MSA detector tubes used previously. Humidity and dry bulb temperature measurements were performed with the Serdex Humidity Temperature Indicator.

B. Medical

A questionnaire on indoor air quality was distributed through the union president to 76 of the 79 secretarial staff employees. A total of 61 (80%) questionnaires were returned, of which 5 were from employees in the adjacent building which had not been renovated.

The questionnaire was the American Lung Association's Office Indoor Air Quality Checklist (IAQ). The IAQ checklist has a total of 25 "yes/no" questions regarding indoor air quality and 4 "yes/no" questions regarding efforts being made to provide clean indoor air. The 25 questions on indoor air quality are subdivided as follows:

* 14 questions on the employees' office work area;
* 4 questions on building operations;
* 7 questions on how the employee feels while in the office.

The questionnaire also includes an open-ended inquiry about symptoms.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employs 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 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 Hygienists' (ACGIH) Threshold Limit Values (TLV's) 3) the U.S. Department of Labor (OSHA) occupational health standards, and 4) the indoor air quality standards developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The first three sources provide environmental limits based on airborne concentrations of substances to which workers may be occupationally exposed in the workplace environment for 8 to 10 hours a day, 40 hours per week for a working lifetime without adverse health effects. The ASHRAE standards are general air quality standards for indoor environments, and are applicable for the general population exposed for up to a 24 hour day of continuous exposure without known toxic effects.

Often, the ASHRAE recommendations, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. They 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 exposure limits, by contrast, are based primarily 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 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 - 10 hour workday. Some substances have recommended short-term exposures. Indoor air should not contain concentrations of contaminants known to impair health, or to cause discomfort to a substantial majority of the occupants. Ambient air quality standards/guidelines available from federal, state, or local authorities should be consulted. If the air is thought to contain any other contaminants, reference to ASHRAE, OSHA, ACGIH, and NIOSH recommendations should be made; for application to the general population, the concentration of these contaminants should be well below the limits which are used in industry.

Several examples of common contaminants found in both industrial and non-industrial (indoor air) environments are shown below with their relevant environmental exposure criteria:

Contaminant	8 Hour TWA	STEL	Continuous	Source
Carbon monoxide (ppm)	50	400	____	OSHA/ACGIH
	35 (200c)		____	NIOSH
	____		9	ASHRAE
Formaldehyde (ppm)	3		---	OSHA
	CA		____	NIOSH
	____		0.1	ASHRAE
Total particulates (mg/m^3)	15		____	OSHA
	10		____	ACGIH
	____		0.26 (24 -hrc) or 0.075 (-yr mean)	ASHRAE
Asbestos (fibers/cc)	0.2		____	OSHA
	0.2--2.0		____	ACGIH
	0.1		____	NIOSH
Carbon dioxide (ppm)	5000		____	OSHA/ACGIH
	10,000		____	NIOSH

NOTE: ppm = parts of contaminant (gas or vapor) per million parts of air, by volume.
mg/m^3 = milligrams of contaminant per cubic meter of air
CA = lowest feasible level (suspect or confirmed carcinogen), use best control technology.
C = short-term (15-30 min.) or ceiling limit.

Other contaminants may be identified or suspect, dependent upon the particular situation and processes existing, and thus warrant further consideration.

Neither NIOSH nor the Occupational Safety and Health Administration (OSHA) have developed ventilation criteria for general offices. Criteria often used by design engineers are the guidelines published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). ASHRAE Standard 62-1981(1) provides ventilation requirement guidelines for a wide variety of commercial, institutional, and industrial facilities, including office buildings. This standard is based on an occupant density of seven persons per 1000 square feet of floor area, and recommends higher ventilation rates for areas where smoking is permitted. The standard states that indoor air quality for general offices shall be considered acceptable if the supply of outdoor air is sufficient to reduce carbon dioxide to less than 2500 ppm and control contaminants, such as various gases, vapors, microorganisms, smoke, and other particulate matter, so that concentrations known to impair health or cause discomfort to occupants are not exceeded. However, the threshold levels for health effects from these exposures are poorly documented. For general

offices where smoking is not permitted, the rate recommended under the standard is 5 cfm of outdoor air per person. Higher ventilation rates are recommended for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control at the source. When smoking is allowed, the amount of outdoor air provided should at a minimum, be 20 cfm per person. Non-smoking areas may be supplied at the lower rate (5 cfm/person), provided the air is not recirculated from, or otherwise enters from, the smoking areas.

Occupant discomfort results from build-up of numerous contaminants, including cigarette smoke, hydrocarbons from copiers, etc., in the recirculated air within a building. The following evaluation criteria with regard to CO_2 in offices has been suggested by a Canadian investigator.[5]

CO_2 Level (ppm)	Comments
less than 600	Adequate outside air.
600-800	Occasional complaints, particularly if the air temperature rises.
800-1000	Complaints are more prevalent.
greater than 1000	Inadequate outdoor air in HVAC system; complaints are general.

Relative humidity (RH) has been shown to have a significant effect on the control of airborne infection. At 50 percent RH, the mortality rate of certain organisms is highest; the influenza virus loses much of its virulence.

Low relative humidity is undesirable for reasons other than those based on human comfort. Low levels will increase evaporation from the membranes of the nose and throat and drying of the skin and hair. Some medical opinion attributes the increased incidence of respiratory complaints to the drying out of mucous membranes due to low indoor humidities in winter.[6]

Studies of indoor areas show that high temperatures (greater than 78° F and low humidity (less than 30 percent) place employees in a "discomfort zone".[5]

The relative humidity range for minimizing as many adverse health effects as possible appears to lie between 40 and 60%.[12] An article describing the bases for this finding will be provided to NJEA management and employees' representative.

VI. RESULTS AND DISCUSSION

A. Environmental

1. Building Ventilation

The air for the NJEA Building is supplied and exhausted through a Heating Ventilation and Air Conditioning (HVAC) system. The air distribution on floors

4, 5 and 6 was from the Air Handling Unit (AHU) located in the penthouse and that of floors 1, 2, and the basement was from the AHU located in the basement. The air was distributed on each floor through diffusers located on the ceiling and exhausted through return air grills located on the side walls. Some of the air was distributed through grills provided on the periphery of each floor approximately 2 feet above floor level.

At the employee work locations very little air movement was observed with the smoke tubes. No air velocity was detected by the Alnor Senior Velometer on range 0 to 300 feet per minute (fpm).

Carbon dioxide concentrations inside the building were 2 to 4 times higher than those outside the building as indicated in Tables 1 and 2. The detector tubes used to measure the concentrations are plus or minus 20 to 25% accurate.

This lack of air movement and the CO_2 build up indicate that ventilation air is inadequate.

During the September 17 walkthrough of the building, the AHU at the penthouse was recirculating 100% exhausted air with the outdoor air inlet completely closed. In subsequent visits, NJDOH found that the outdoor air inlet was partially open. According to ASHRAE standard No. 62-1981-6.1.3, for acceptable air quality, at least 20 cfm/person of outdoor air should be continuously supplied in smoking areas. Information on the design capacity of the two AHUs viz. outdoor air in cfm was not available.

Diffusers for the air inlets were located on the ceiling, and diffusers for the air exhaust were located on side walls at the ceiling level. The incoming air appears to be exhausted without reaching down to employee level.

The main air inlet and exhaust for the AHU supplying and exhausting air to and from Floors 1, 2 and the basement were located side by side. This design flaw would result in recirculation of part of the exhausted air. This appears to be the reason for the relatively higher concentrations of CO_2 on Floors 1 and 2.

The clerical staff working at the core of the third floor do not benefit at all from the air supplied through grills located in the perimeter of the floor because the perimeter was covered with completely closed offices with ceiling-to-floor walls. On all other floors the offices located on the perimeter were provided with partitions which allowed some air movement in the clerical staff work area.

2. Relative Humidity

Relative humidity (RH) as low as 28% was found on January 12, 1987 inside the building (Table 2). Forty to 60% RH is regarded as best for comfort. Half of the readings were below this range. Relative humidity inside the building was found higher on October 16, 1986 (Table 1) inside the building as compared to that found on January 12. This difference appears to be due to higher RH and temperature of outdoor air on October 16 as compared to that on January 12. During the winter cold outdoor air can hold relatively little moisture. When it is brought indoors and heated, the relative humidity of this outdoor air will be unacceptably low unless it is humidified. Similarly, humid outdoor air in summer requires dehumidification when brought indoors.

3. NJEA Smoking Policy

The NJEA smoking policy dated April 1, 1986 permits smoking in any work area unless a co-worker requests no smoking. This policy puts the burden on non-smokers for preventing smoking. In addition, it does not provide a practical mechanism to prevent smoking in individual offices with one smoking employee. The air from these offices and other smoking areas gets recirculated throughout the area serviced by the AHU. We conclude that the present policy is inadequate to prevent non-smoker exposure to primary and secondary smoke.

The provision of "smokeless" ashtrays is not an effective means of controlling smoke. These ashtrays have a very limited ability to capture gases and particulates from a cigarette placed in them. They have no ability to control exhaled smoke or smoke from a hand-held cigarette.

The New Jersey statute covering smoking in places of employment states that

> "All places affected by this act shall be identified by the signs posted by the supervisors thereof with letters at least one inch in height stating "Smoking Permitted' or 'Smoking Prohibited' or designated by the appropriate 'Smoking Permitted' or 'Smoking Prohibited' international symbol. The letters or symbols shall contrast in color with the sign. The sign may also indicate that violators are subject to a fine and that a person who smokes in a nonn-smoking area may be denied the services of the governmental department, division or agency. Every sign required by this section shall be located so as to be clearly visible to the public and employees."

The above-mentioned signs were not posted during the NJDOH visits to the NJEA building.

4. Formaldehyde - Carbon Monoxide

Formaldehyde and carbon monoxide were not detected in the air sampling performed on September 17 and 22, 1986.

5. Asbestos

The DEP report on asbestos sampling performed at NJEA dated March 12, 1981 indicates 9 - 13% asbestos in the bulk samples taken from the hidden ceiling. The hidden ceiling on each floor has a false ceiling below it. The space between the 2 ceilings is *not* used as a plenum for ventilation air; rather, the air is supplied and exhausted through closed ducts. Exposure of the employees to asbestos from the ceiling nevertheless will require assessment and possible remediation such as encapsulation or removal.

B. Medical

In scoring of the questionnaire, in general, more than 5 of a possible 25 "yes" answers may indicate poor indoor air quality in the work environment, and may indicate a need for professional assistance.[6]

Of the 56 questionnaires completed by employees in the renovated building, the lowest total of "yes" answers was 5, the highest was 22, and the average was 15.5. Thus, according to the IAQ checklist, 100% of the 56 employees perceived the quality of air in their workplace as poor.

Of the questions regarding efforts being made to improve the indoor air quality, the total possible "yes" answers is 4. Of the 56 questionnaires received from employees in the renovated building, the lowest total of "yes" answers was zero, the highest was 4, and the average was 1 total "yes" answers. Twenty-three (23) employees (41%) perceived that nothing was being done to improve the indoor air quality and thus answered "no" to all 4 questions in the "What is being done" section; 15 employees (27%) answered "yes" to only 1 of the 4 questions in this section; 13 employees (23%) answered "yes" to 2 of the 4 questions in this section.

The results of this questionnaire indicate that 100% of the respondents perceive the quality of air in their work environment as poor, and more than 90% feel that very little or nothing has been done to improve the air quality.

The most commonly reported symptoms reported in the open-ended questionnaire were dryness of mucous membranes (nose, mouth, and throat), dryness of eyes, headache, and tiredness. Table 4 shows the complete list of written complaints from the 44 people responding as well as the number of employees with each complaint.

VII. RECOMMENDATIONS

1. Increase the air flow to ensure an air velocity of 30 to 35 feet/min in the work areas of the building. This can be achieved either by increasing capacity of AHUs to supply total air or by changing the duct design to minimize friction and entry losses (static pressure).

2. The controls that operate outdoor air supply dampers in AHUs should be inspected for effective functioning and adjusted to supply a minimum of 20 cubic feet/min per person of outdoor air at all times.

3. The AHU located in the basement should be provided with an outdoor exhaust stack long enough to prevent mixing of exhausted air with fresh air entering the intake beside it.

4. Possible short circuiting of incoming air through the air inlet diffusers to the air exhaust grills should be prevented by redesigning the inlet diffusers to direct the air down further into the work areas and by baffling the return air diffusers to prevent supply air from entering them prematurely.

5. The clerical core of the third floor must be provided with fresh air either by installation of a core ventilation system or removing the walls between the offices and the core and replacing them with partitions which allow air movement above and below them.

6. Smoking areas should be designated in such locations that the non-smokers are not exposed to any second-hand smoke. Smoke-containing air must not be permitted to be recirculated by the ventilation system. Such air must be exhausted directly to the outdoors. There are commercially available air cleaners containing exhaust fans, filters, and, in some cases, ion generators. Consumer Reports[15] has reviewed the ability of these devices to remove cigarette particulates from the air and found several to be effective.

7. NJDOH recommends that NJEA revise its smoking policy to restrict smoking to designated areas. Smoking in private offices should be prohibited because of the inability of co-workers to exercise their right to request no smoking.

8. Appropriate signs or international symbols should be displayed conspicuously at the locations where smoking is permitted or prohibited and because of the possibility of cigarette smoke entering the HVAC system.

9. Humidity inside the building should be increased by winter humidification so that relative humidity remains between 40 and 60%. NJDOH considered the possibility of condensation at the recommended RH level on the glass panels located on the front and rear side of the building. According to Table 3, the condensation is a function of RH inside a building, the ambient temperature and the type of glass panels. The minimum average temperature in the Trenton area in February is 22° F. The front side of the building is covered partially with single glass panels and the rear side with double glass panels spaced 1/4 inch apart. At the minimum recommended RH level (40%), the condensation on the panels on the rear side appears unlikely. If occasional condensation takes place on the front side glass panels, it should be cleaned.

Humidifiers in HVAC systems should preferentially use steam as a moisture source. A dedicated "dry steam " system is preferable to systems that use raw steam from central boiler system. The latter may contain corrosion inhibitors that are meant to carry over into condensate return lines. For steam humidifiers, avoid steam sources that contain volatile amines. Humidifiers utilizing recirculated water are not recommended, as these can become rapidly contaminated with organic dust and microorganisms. Treatment of this type of humidifiers with biocides has been ineffective in controlling microbial contamination. If cold water type humidifiers are used, water should originate from a potable source and water after passing through the humidifier should be run into a drain line instead of being recirculated. The use of portable cold mist vaporizers is discouraged, since these devices are known to contaminate room air with microorganisms.

10. Temperature in work areas should be kept in the range of 68-72° F dry bulb temperature. Additional heating may be required in the winter since we found temperatures in the range of 60-66° F in January.

11. Asbestos-containing hidden ceiling should be assessed for their potential to generate airborne asbestos fibers. Any remediation shown necessary by an assessment should be implemented. For reference, a publication "Guidance for Controlling Asbestos-Containing Materials in Buildings" is provided.[14]

VIII. REFERENCES

1. American Conference of Governmental Industrial Hygienist, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1986-87

2. OSHA Safety and Health Standards 29 CFR 1910.1000, Table Z-2 Occupational Safety and Health Administration.

3. American Society of Heating, Refrigerating and Air-Conditioning Engineers: Standard 62-1981: Ventilation for Indoor Air Quality, Atlanta, GA (1981)

4. Bell S.J. and B. Khati: Indoor Air Quality in Office Buildings., Occupational Health in Ontario 4:103-118 (1983)

5. Rahhans G.: Indoor Air Quality and CO_2 Levels, Occupational Health in Ontario, 4:160-167 (1983)

6. HHE Report No. HETA 84-534-1721. Defense Industrial Supply Center. Philadelphia, Pa.

7. HHE Report No. HETA 84-248-1694. Wasson Elementary School. DuBois, Pa.

8. HHE Report No. HETA 86-045-1681. 101 Marietta Tower Building. Atlanta, Georgia.

9. Double Exposure: Women's Health Hazards On The Job And At Home. Edited by Wendy Chavkin, MD. Monthly Review Press. New York 1984.

10. Indoor Air Pollution In the Office. (Fact Sheet) American Lung Association.

11. Office Indoor Air Quality Checklist. American Lung Association.

12. Arundel A., et al. Indirect Health Effects of Relative Humidity in Indoor Environments, Environmental Health Perspectives, 65:351-361 (1986).

14. United States Environmental Protection Agency, Guidance for Controlling Asbestos-Containing Materials in Buildings, EPA 56015-85-024. Office of Pesticides and Toxic Substances, Washington, D.C. 20460, June 1985.

15. Consumer Reports, Air Cleaners, pp. 7-11, January, 1985.

16. Morton, B.W., Humidification Handbook - What, Why and How, Dri-Steem Humidifier Company, P.O. Box 128, Hopkins, MN 55343 (1986).

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DISTRIBUTION AND AVAILABILITY OF THIS REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through National Technical Information Service (NITS), Springfield, Virginia 22161.

Copies of this report have been sent to:

New Jersey Education Association, Trenton, New Jersey

For the purpose of informing the 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 1. RESULTS OF AIR MONITORING PERFORMED AT NJEA BUILDING BY NJDOH, September 17, 22 and October 16, 1986

Floor	Vin* fpm	Vex** fpm	CO_2@ ppm	Relative Humidity %
1	100	50	600	60
2	150	50	700	58
3	100	50	500	63
4	150	100	400	63
5	200	150	500	63

* Vin - Average velocity measured with Alnor Senior Velometer at the air inlet diffusers w/o application of K factor

** Vex - Average velocity measured with Alnor Senior Velometer at the air exhaust inlets w/o application of K factor

@ CO_2 - Average CO_2 concentration determined with MSA Model A pump and detector tubes. Minimum limit of detection was 0.02%

TABLE 2. RESULTS OF AIR MONITORING PERFORMED BY NJDOH OUTSIDE AND INSIDE NJEA BUILDING ON January 12, 1987

Location	CO_2 ppm	Relative Humidity %	Dry Bulb Temperature 0_F
OUTSIDE			
Terrace	150	52	51
East side of NJEA Building	150	52	51
INSIDE			
Floor 1, Executive Office	400	30	66
Govt. Relations	600	28	66
Floor 2,Research	500	30	66
Research Library	500	30	66
Floor 3,Uniserve	300	35	64
Training/ Instruction	300	30	65
Floor 4, Membership Process Center	400	40	60
Data Process Center	300	40	60
Floor 5, Communication Div.	200	40	60
Stair Exit	300	40	60

TABLE 3 - WINDOW CONDENSATION AT VARIOUS INDOOR HUMIDITY LEVELS
70°F ROOM TEMPERATURE

	OUTDOOR TEMPERATURE			
	F 30°	20°	10°	0°
Single Glass	29%	21%	15%	12%
Double Glass 1/4" Air Space	54%	48%	41%	36%

TABLE 4 - WRITTEN COMPLAINTS SUBMITTED BY 44 EMPLOYEES SCATTERED THROUGHOUT THE NJEA BUILDING

Complaint		Number of Employees	Percent of Employees
1.	dryness of mucous membranes (nose, mouth, throat)	21	48%
2.	dryness of eyes	19	43%
3.	headache	19	43%
4.	tiredness	14	32%
5.	itching/stinging/burning eyes	12	27%
6.	stuffy humid air	12	27%
7.	inadequate ventilation	12	27%
8.	too hot or too cold	9	21%
9.	shortness of breath and/or difficulty breathing	7	16%
10.	hair loss and/or hair breakage	7	16%
11.	dry skin	7	16%
12.	itching skin and/or rash	5	11%
13.	scalp irritations or "sores"	5	11%
14.	drowsiness	5	11%
15.	light-headedness	5	11%
16.	dry cough	4	9%
17.	sore throat or irritation	4	9%
18.	dry air	4	9%
19.	dusty air	3	7%
20.	sneezing	3	7%

TABLE 4 (Continued)

Complaint		Number of Employees	Percent of Employees
21.	inability to concentrate	2	5%
22.	change in bowel habits	2	5%
23.	nosebleeds	2	5%
24.	noise from nearby vents	2	5%
25.	lights too bright	2	5%
26.	no complaints	2	5%
27.	memory loss	1	2%
28.	nightmares	1	2%
29.	insomnia only on weekdays	1	2%
30.	anxiety	1	2%
31.	depression	1	2%
32.	stress	1	2%
33.	tired eyes	1	2%
34.	diarrhea	1	2%
35.	gastritis	1	2%
36.	aggravated irritable bowel syndrome	1	2%
37.	afternoon coarse tremors in hands	1	2%