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HETA 91-378-2242
AUGUST 1992
NEW YORK STATE DEPARTMENT OF TAXATION AND FINANCE
ALBANY, NEW YORK

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SUMMARY

On September 5, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees working at Building 8 (New York State Department of Taxation and Finance), Albany, New York. The request concerned health effects perceived by employees to be associated with some environmental exposure while working at Building 8. Parts of the building have required evacuation at different times due to acute outbreaks of illness.

On March 4, 5, and 6, 1992, NIOSH investigators toured the site and reviewed extensive environmental sampling that had been done previously by a private consultant and by New York State. A medical evaluation, consisting of interviews of affected employees and consultations with employee physicians, was also conducted.

Medical symptoms consisted of headache, fatigue, eye irritation, sinus problems, dizziness, tightness in the chest, nausea and sore throat. There were also 11 employees who reported experiencing neurologic symptoms including numbness in the face, hands or tongue; tremors; losing one's voice; and muscle spasms. Physician interviews did not yield any information that identified any workplace exposure as a cause of the employees' symptoms. Environmental measurements taken by the State of New York as well as a private consultant were all within acceptable levels.

Neither the environmental review nor the medical evaluation could identify any one specific agent responsible for the reported symptoms. However, employees at Building 8 reported working conditions that contain many factors that have been reported in other studies as being significant predictors of health complaints in office environments. These include poor temperature control, open plan office design, lack of proper attention to ergonomics, perceived overcrowding and lack of cleanliness of the work areas. In addition, the building has had extensive spraying of insecticides in the past and had a leak of water containing 2-diethylaminoethanol (DEAE) that resulted in employees going to local hospital emergency rooms for treatment. NIOSH investigators recommend that building management address these risk factors for building related illness and improve office working conditions.

Keywords: SIC 9311 (Public Finance, Taxation and Monetary Policy), indoor environmental quality, diethylaminoethanol (DEAE), Bell's palsy, chlorpyrifos, carbon dioxide, temperature, relative humidity, ventilation.

INTRODUCTION

On September 5, 1991 the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees working at Building 8,

(New York State Department of Taxation and Finance) at the State Office Campus in Albany, New York. The request stated that employees were increasingly concerned about the health effects felt to be associated with working at Building 8. These included nausea, tightness of the chest, eye irritation, dizziness, forgetfulness, metallic tastes, losing one's voice, tremors, numbness in the face, and memory problems. On December 21, 1991, NIOSH also received a similar request from the New York State Office of General Services to evaluate problems in the building.

Because of the reported health problems, Building 8 has been the subject of investigations by State agencies and private consultants. NIOSH environmental and medical investigators visited Building 8 on March 4, 5, and 6, 1992, with the stated purpose of interviewing affected employees, touring and evaluating the physical plant, and reviewing existing environmental data. A preliminary NIOSH report was released on March 24, 1992 that reviewed the contents of the site visit and reported preliminary recommendations .

BACKGROUND

1. **Buildings 8 and 8A**

Building 8, part of the State Office Campus in Albany, New York, is the largest structure on the campus and is the worksite for 2940 permanent employees (see Table 1) and an additional 450 temporary workers who are hired to process tax returns between January and June. This 9 story building has glass exterior walls on all 4 sides and a forced air heating system. Heating coils, supplied with steam from a central heating plant located on the campus, provide heat for the building. Adjacent to Building 8 is Building 8A, a smaller annex consisting of only a basement and ground floor. During peak periods, 750 people work in Building 8A, only 90 of whom are permanent employees. The fresh air intakes for Buildings 8 and 8A are located on the roof and at ground level, respectively.

TABLE 1
DISTRIBUTION OF EMPLOYEES AND COMPUTER EQUIPMENT--BY FLOOR
New York State Department of Taxation and Finance
Buildings 8 and 8A
State Office Campus, Albany, New York

FLOOR	PERMANENT EMPLOYEES	PEAK PERIOD-TEMP EMPLOYEES	TOTAL AT PEAK
Basement	10	90	100
Ground Fl.	170	0	170
1	60	0	60
2	260	280	540
3	350	20	370
4	330	0	330
5	300	0	300
6	310	10	320
7	330	0	330
8	410	0	410
9	410	50	460

2. **Previous Symptoms and Environmental Concerns**

Employees of both buildings have reported symptoms that have been attributed, by the employees, to various indoor environmental conditions. In May and June of 1990, workers at Building 8 reported "bug bites", primarily on the upper and lower extremities and occasionally on the face. Clinically, these were described in a New York State Department of Health (DOH) report as "discreet raised papules with central redness, although (occasionally)...a more confluent erythematous dermatitis." The skin lesions were thought to be mite bites by an Albany dermatologist, and the presumed insect infestations were treated with three pesticide applications of Dursban® (chlorpyrifos, a type of organophosphate insecticide) between May 23 and June 18, 1990. Despite the treatments, the "bug bites" continued and Building 8 was treated with Tempo® (cyfluthrin, a type of pyrethroid) over the weekends of June 30 and July 7, 1990. The use of Dursban® and the subsequent increase in reported health problems at the building lead to employee concerns about the health effects of pesticide spraying in the building.

Responding to these concerns about pesticide spraying, the State Department of Labor conducted tests to measure the air levels of Dursban®. On November 1, 1991, a maximum level of 0.37 micrograms per cubic meter of air ($\mu g/m^3$) was measured, an airborne concentration much less than the present American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 200 $\mu g/m^3$ for Dursban®. The TLV is intended to protect most exposed workers from having measurable decreases in cholinesterase (ACGIH, 1986). However, pesticide spraying with Dursban® appeared to have stopped in mid- October 1991, and measurements were not made immediately following treatments.

Since spraying did not alleviate the "bug bite" problem, irritating fibers, particularly fiberglass, were proposed as the cause and the State Bureau of Toxic Substance Assessment tested the office environment for this possibility. Fibrous glass was recovered from different areas in the building but there was no apparent association between high fiber levels in the air and the number of employees reporting "bites" in the area.

There was a heating system leak of steam that contained 2-diethylaminoethanol (DEAE) on October 21, 1991. This resulted in an increase of reported symptoms that required the building to be evacuated. The health effects associated with the DEAE leak are discussed later in the report (see Medical Evaluation, page 11).

OPENING CONFERENCE

An opening conference was held on March 4 at Building 9. This meeting was attended by representatives from relevant state agencies (Taxation and Finance, Office of General Services [OGS], and DOH), labor unions (Public Employees Federation [PEF] and the Civil Service Employees Association [CSEA]), and affected employees. Each participant was asked to give a statement detailing his or her opinion concerning the extent of the health problem and possible etiologies.

1. **Union and Employee Comments**

Union officials agreed that the leak of 2-diethylaminoethanol (DEAE)[1] from a heating coil on October 21, 1991, brought the health and safety issues of Building 8 to a head. They stated that the building had deteriorated and was in disrepair, that communication between employees and management needed improvement, and that the overall cleanliness in the building was poor. Concerns were expressed about the long term effects of working in the building. Although the DOH had interviewed workers about health problems at the building, employees had told the unions that they had perceived the interviewers insensitive to their problems. Employees had also felt harassed by the State Insurance Fund when they tried to file claims for worker's compensation for building-related illness. Problems with the heating, ventilating, and air-conditioning (HVAC) systems were enumerated, including severe temperature fluctuations, stuffiness, low humidity and poor air distribution. Other employee concerns about the building included poor water quality, possible asbestos exposure, and ill defined odors. The employees felt they were entitled to "straight" answers about these problems. Concerns were expressed about the use of pesticides in the building and whether or not health problems could be related to excessive use of Dursban® during the past "bug bite" problem. In addition, employees felt that the building was overcrowded, particularly during the tax filing period from January to June, when temporary workers were hired to process income tax forms. The employees in attendance described the medical symptoms that they and other workers had experienced while working in the building (see Medical Evaluation, page 9).

2. **Management Comments**

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[1] 2-diethylaminoethanol (DEAE) is a commonly used corrosion inhibitor in heating water systems.

Management representatives agreed that there was a problem of temperature control in the building but disputed the wide temperature fluctuations that were noted by union officials and employees. They stated that due to State budgetary restrictions, maintenance staff had decreased from approximately 60 to 14 workers. Because of the problems occurring in the building, State officials reported that they had recently increased the maintenance staff to 22 and had increased the frequency and extent of cleanings of the building. Building managers suggested that, due to heightened awareness of building deficiencies, every employee ailment was being improperly blamed on the building.

Management representatives were aware that their employees believed there was a problem in Building 8, and they were concerned about decreased productivity due to increased employee sick days. Their stated goals were greater recognition of employee health concerns and increased communication of the steps being taken to ameliorate building problems. Building management had started a program of capital improvements for Building 8, including balancing the ventilation system, replacing the air diffusers, inspecting and repairing the reheat coils (including installing temperature controls for the reheat coils) and ordering equipment needed for restoration of the humidification system.

Reasons for the perceptions of poor temperature control in the building were informally discussed. Management was aware of the problem but felt hampered by poor design of the system and insufficient funds to correct the problem. In brief, building managers felt that the restoration of the reheat coils in the system should help to alleviate the temperature control problems. However, solar absorption in the building appeared to be significant at present, since the glass exterior walls were not tinted and building managers chose not to increase cooling on the side of the building exposed to the sun (to avoid over-cooling other office areas).

EVALUATION CRITERIA

A number of published studies have reported high prevalence of symptoms among occupants of office buildings (Kreiss, 1984; Gammage, 1985; Burge, 1987). NIOSH investigators have completed over 700 investigations of the indoor environment in a wide variety of settings. The majority of these investigations have been conducted since 1979.

The symptoms reported by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints (Kreiss, 1989; Norback, 1990). Among these factors are imprecisely defined characteristics of heating, ventilating, and air-conditioning (HVAC) systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and

noise (Morey, 1989; Molhave, 1986; Burge, 1989; Nagda, 1991). Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts (≥15 cubic feet per minute per person) are beneficial (Nagda, 1991). However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies (Jaakkola, 1991). Design, maintenance, and operation of HVAC systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments. Indoor environmental pollutants can arise from either outdoor sources or indoor sources (Levin, 1989).

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition (NIOSH, 1991). Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints (Boxer, 1990; Baker, 1989).

Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potential building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by *Legionella* bacteria. Sources of carbon monoxide include vehicle exhaust and inadequately ventilated kerosene heaters or other fuel-burning appliances. Exposure to boiler additives can occur if boiler steam is used for humidification or is released by accident.

Problems that NIOSH investigators have found in the non-industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and relative humidity conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, no cause of the reported health effects could be determined.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures (NIOSH, 1988; OSHA, 1989; ACGIH, 1991). With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines (ASHRAE, 1981 and 1989). The ACGIH has also developed a manual of guidelines for approaching investigations of building-related symptoms that might be caused by airborne living organisms or their effluents (ACGIH, 1989).

Measurement of indoor environmental contaminants has rarely proved to be helpful, in the general case, in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proved relationship between a contaminant and a building-related illness. However, measuring ventilation and comfort indicators such as

carbon dioxide (CO_2), temperature and relative humidity are useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

MEDICAL EVALUATION

The medical evaluation consisted of a review of data collected by the DOH, employee interviews, and discussions with physicians treating those employees.

1. **Employee Interviews**

   Nineteen employee interviews were conducted during the site visit, and three more were conducted on the telephone upon our return to Cincinnati. The sample of people we interviewed was not representative of all Building 8 or 8A employees. The employees were selected by both unions (PEF and CSEA) and by Tax and Finance management and probably represented a more severely affected group of Building 8 employees. Symptoms of the employees were, in most cases, non-specific and typical of what NIOSH investigators (NIOSH, 1988) and other researchers (Skov, 1990) have seen in evaluations of other office buildings and included burning eyes, dizziness, headache, tightness in the chest, fatigue, forgetfulness, sinus problems and a metallic taste in the mouth.

2. **Neurologic Symptoms**

   Eleven employees reported what appeared to be relatively severe neurologic symptoms. Employees reported their arms going limp upon detection of an odor, numbness in the face, hands or tongue, tremors affecting the entire body, losing one's voice and muscle spasms. There were also an additional 5 cases of Bell's palsy (one other case of facial paralysis was subsequently found to be secondary to herpes zoster). Symptoms were noted to increase in their severity with increased time in Building 8, and the severity of symptoms would be greater on Friday than the following Monday. Twelve employees were unable to continue working in Building 8 and were reassigned to Building 9. Even after reassignment, seven employees were unable to continue working and were reassigned to offices outside of the State Office Campus, on Wade Road (in Latham, New York), where they felt their condition improved. It was the observation by individual employees that their health improved away from Building 8 that lead to the conclusion that something in Building 8 is the cause of the problem. Employees who could not tolerate either Building 8 or 9 (and showed improvement after reassignment away from the State Office Campus), felt that something at the State Office Campus (not limited to Building 8) was making them sick.

   Bell's palsy is a paralysis of areas innervated by the seventh cranial nerve. Etiologies are speculative and have included viruses, diabetes and hypertension (Dyck, 1975). Facial paralysis may also be caused by Lyme disease (Lesser, 1990) and demyelinating disease (Jonsson, 1989). A literature search of Bell's palsy etiologies revealed no reports of Bell's Palsy due to chemical or environmental exposure, although it previously had been thought that cold air was responsible for its onset. Bell's palsy is relatively common, and incidence rates of 23 per 100,000 annually and 1 in 60 or 70 over a lifetime have been reported (Victor, 1987).

   We contacted the neurologists for nine Building 8 employees (some employees had been previously interviewed by the NIOSH investigator). Reported symptoms were not felt to be related to chemical exposure.

3. **Pesticide Usage**

Employees were questioned as to their proposed etiologies for the health problems among employees of Building 8. Responses tended to center around either the heating system or the spraying of insecticide in the building. Dursban® (chlorpyrifos) and Tempo® (cyfluthrin) have regularly been applied to the building as part of a regularly scheduled program of insect control. Dursban® is an organophosphate insecticide and Tempo® is a pyrethroid, a synthetic form of pyrethrum. The program consists of a weekly spraying of cafeterias, lunchroom and vending machine areas and a monthly spraying that adds restrooms, gondola (garbage) rooms, lounges, locker rooms and showers. However, as noted previously, in response to the "bug bite" outbreak of May and June, 1990, three applications of pesticide were made between May 23 and June 18. Employees stated that spraying had been done while employees were present in the building. Records that were made available by the state, however, indicated that most spraying was done between 4-7 P.M., when most employees had left the building. According to state personnel, spraying was once done along the baseboards around the perimeter of the building. However, records from the pesticide company that sprayed the building in 1990 were destroyed by fire, and the individual in charge of the spraying has left the firm with no forwarding address.

4. **Diesel Exhaust and Other Odors**

Employees also reported diesel odors entering the ground floor of Building 8A, presumably from a loading dock where trucks idle during the course of their deliveries. The air intake for Building 8A, however, is on the opposite side of the building, adjacent to a walkway connecting Building 8 and 8A. It is possible, although unlikely, that diesel exhaust would enter through those intakes. A more probable source of the exhaust odors was through a door leading from the office area to the loading dock. While the door frame was equipped with a rubber gasket, this door was observed to be open during the walkthrough tour of Building 8A, apparently to provide some cooling to this section of the building. This situation creates a direct route for the diesel odors to enter the work area.

5. **Building Evacuations**

As noted previously, Building 8 has had a long history of medical symptoms felt, by employees, to be associated with the building. For the purposes of this Health Hazard Evaluation, we will concentrate on those problems that started with the release of 2-diethylaminoethanol (DEAE) in the building on October 21, 1991, and any health effects that might possibly be attributed to the use of DEAE. DEAE is a corrosion inhibitor that is added to steam to prevent deterioration of pipes. It is an irritant of the skin, mucous membranes and eyes and may cause permanent eye damage (Cornish, 1965). The leak was detected by its odor and, after investigation, it was determined that a leak in the steam heating system of the building had sprayed an undetermined amount of DEAE-containing steam into the ventilation system.

The DEAE leak was immediately followed by a number of employees reporting acute illness, necessitating the building's evacuation. Forty-nine employees were taken to area hospital emergency rooms complaining of dizziness, weakness, nausea, sore throat, and itching eyes. State DOH officials conducted an evaluation of the

outbreak, including all 49 individuals sent to the emergency room and 49 controls, who had been randomly selected from each of the floors. State DOH officials found that all but 2 of both the cases and controls had experienced some symptoms during the week following the leak and also found that symptoms lessened when employees left the building for the day. A review of emergency room records by DOH officials disclosed 9 employees with elevated temperature, 3 with visible eye and throat irritation and 2 known asthmatics who were wheezing. Although no further leaks were identified, between 25 and 50 employees per day continued to see the nurse for symptoms similar to those experienced immediately after the DEAE leak. Ill defined odors continued to be detected on the 4th, 5th and 9th floors on October 25 and 29, 1991.

The next major outbreak of health problems at Building 8 occurred on February 7, 1992. The nurse was called to the 2nd floor to evaluate an employee complaining of nausea and dizziness and, upon her arrival, was informed of another employee who had vomited. She called for paramedics to transport the employees to local emergency rooms. When the paramedics learned of a third employee who was not feeling well, they evacuated the 2nd floor. After the evacuation, 13 employees stated they did not feel well and were eventually transported to local hospital emergency rooms. The following Monday, February 10, an employee of the 2nd floor felt ill and directly contacted Albany police, who contacted the local paramedics. The paramedics treated 70 employees and transported 19 to local hospitals. A total of 32 people were transported to hospitals over these 2 days and all 32 were released by the hospitals, with some being given oxygen.

ENVIRONMENTAL EVALUATION

1. **New York State Environmental Assessments**

A. 2-diethylaminoethanol (DEAE)

It is unclear how much DEAE was actually released during the leak on October 21, 1991. On October 24 (3 days after the leak of DEAE in Building 8 was discovered), the New York State Department of Labor conducted air tests for DEAE. The highest air concentrations measured were 0.02 parts per million (ppm) in rooms 904 and 204B, levels at the limit of detection (LOD) for this analytical method. Tests run on October 25 and 27 could not detect any airborne DEAE (all samples were below the LOD of 0.02 ppm). Concentrations in the actual steam used in the heating system were found to be between 3 and 12 ppm DEAE. The 0.02 ppm detection level is slightly above the reported lowest odor threshold reported for DEAE of approximately 0.01 ppm (Ruth, 1965). This may explain why some employees reported that they smelled DEAE in areas where air testing could not measure it.

Ethylene glycol was initially reported to be present in the steam at levels of 308-672 ppm. On further examination, it was found that ethylene glycol was not routinely added to the heating system but only used to flush air conditioning coils. State officials attributed the original findings to laboratory error.

B. Carbon Dioxide and Other Possible Air Contaminants

Air sampling was performed on February 7, 1992, for carbon dioxide (CO_2), nitric oxide, carbon monoxide, sulfur dioxide and total hydrocarbons on the second and third floor of Building 8 by the New York State Department of Labor. None of these was detectable using direct reading colorimetric detector tubes with the exception of CO_2, which was present at levels of approximately 400 ppm, a level slightly higher than typical outdoor CO_2 concentrations.[2] Following this sampling, New York state officials then hired an environmental consultant to perform a thorough environmental analysis of the building.

2. **Environmental Assessment by Consultant**

Beginning in January 1992 a comprehensive environmental air quality and ventilation survey of Buildings 8 and 8A was conducted at the request of state officials by a consulting firm specializing in environmental services, engineering, architecture, and related specialties. The contents of the report, released in April 1992, are listed in Table 2.

The consultant's final report was reviewed and found to be comprehensive and well organized. While all of the air sampling and analytical methods used by the consultant were technically appropriate (as was their interpretation of these analytical results), the scope of the environmental sampling performed by the consultant in these buildings was excessive in comparison to the approach that NIOSH investigators would have taken in this situation. The extent of the sampling which was conducted was also surprising considering that the preliminary evaluations conducted by various state agencies had failed to detect any chemical contaminants. Because of the length of this consultant's report, our comments will be limited to the following areas.

TABLE 2
CONTENTS OF THE CONSULTANT'S FINAL REPORT
(Completed April, 1992)

Ventilation system inspection, including a review of the most recent ventilation system balancing report.	Ozone, arsenic and selenium from copier emissions
	Sewer gas (methane)
Air flow measurements	Drinking water for residual chlorine
Temperature and relative humidity levels	Carbon dioxide levels
Carbon dioxide levels	Mold in carpeting and ductwork
Mold in carpeting and ductwork	Dust (for mineral fiber content)
Polychlorinated biphenyls (PCBs)	Volatile hydrocarbons (copiers and other sources)

[2] Carbon dioxide levels are used as a measure for ventilation effectiveness with levels below 1000 ppm considered indicative of adequate ventilation.

A. Temperature and Relative Humidity (RH) Levels

Temperature and RH levels were measured during several visits to both buildings between January 14-31, 1992. On several days the temperature and RH levels were outside the winter comfort range recommended by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). In some instances the RH levels were below 20%, a dry condition which may contribute to employee-reported symptoms such as dry eyes, itching skin, sore throat, etc (IAQ Update, 1991). In several of these same locations the dry bulb temperatures ranged between 75 to 80^{o}F.

The temperature differences noted between floors (and occasionally on the same floor) in Building 8 during the January 1992 surveys were, in large measure, associated with the inability of the many ventilation systems supplying this building to reheat the supply air. To provide an example of this problem, envision that each floor in Building 8 is divided into 4 quadrants. Each of the air handlers servicing the building provides air to several quadrants located on separate floors. Heating (or cooling) demands on these floors, however, are not the same (due to occupancy density, use of heat-generating office equipment, etc.). Because of these differences in thermal demands, a reheat box (simply a device to warm up supply air to provide additional heat for an area) is used to avoid over-cooling an area. Since these reheat boxes were not functioning, one quadrant on a floor, for example, may be too cold while a quadrant supplied by the same air handling system may be adequately heated. Although reheat boxes were initially designed and installed in the ventilation systems, they have not been operational for several years. Repair of these reheat boxes which is underway should improve temperature control throughout the building.

B. Volatile Hydrocarbons

Concentrations of total volatile hydrocarbons were measured at higher levels in selected office areas where copiers or microfilm readers/printers (using a liquid toner) were used. All of the volatile hydrocarbon levels were well below their respective industrial exposure criteria. Health symptoms experienced by building occupants are often blamed on the presence of such chemicals in indoor air, but the effects of exposure to extremely low levels of mixtures of volatile hydrocarbons are not well understood. Following this initial finding by the consultant, the office equipment which used liquid toner was been replaced with dry processing equipment. An approximate five-fold reduction in volatile hydrocarbon levels in these same office areas was measured by the consultant in a follow-up survey following this equipment change.

C. Carbon Dioxide Levels

All of the CO_2 concentrations in Building 8 were below 1,000 ppm, which suggests that these office areas were being adequately ventilated with outside air. In Building 8A, however, CO_2 levels often approached, and occasionally exceeded, 1,000 ppm. These results are not unexpected considering the seasonal increase in employees working in this building during tax filing time.

D. Location of the Outside Air Intake for Building 8A

The ground level location of the air intakes for Building 8A increases the opportunity for vehicular exhaust to be drawn into the ventilation system. Repairs were underway by the State, however, to extend the height of this air intake shaft to reduce the chance that exhaust gases could enter the ventilation system. In a further effort to decrease the opportunity for exhaust odors to enter the building, the location where buses idled (while loading and unloading passengers) had been moved to a location more distant from Buildings 8 and 8A.

E. Odors

Although the consultant investigated several odor complaints, identification of the odor(s) was unsuccessful. We agree with their conclusion that the transient nature of the odors, along with the limitations of the sampling and analytical techniques, make identification of the type or source of these odors very difficult. The extensive changes underway in the ventilation systems (which should improve air distribution) may result in a diminishing of the reports of irritating or unusual odors by the employees.

DISCUSSION

Building 8 presents an unusual challenge for many reasons. It is a large building, contains several employees describing symptoms of unusual severity in addition to those with symptoms usually ascribed to indoor environmental quality problems, and has had a large amount of environmental testing performed in the building before the arrival of the NIOSH investigators. The employee hypotheses as to the cause of the health problems at Building 8, exposure to DEAE and pesticides, were reasonable and well thought out, and warranted further evaluation.

1. **DEAE**

The DEAE leak of October 21, 1991 appeared to have been responsible for an outbreak of symptoms in the building including headache, nausea, dizziness and eye irritation. These symptoms are consistent with DEAE exposures as reported in other NIOSH Health Hazard Evaluations, (NIOSH, 1983; NIOSH, 1989; and NIOSH, 1981), where steam-containing DEAE was used to humidify the buildings. In addition, two of these NIOSH reports described skin rashes, though these were not clearly due to the DEAE and, in any case, were unlike the papular lesions associated with the "bug bite" incident at Building 8 that occurred prior to the October 21 DEAE leak.

NIOSH investigators were unable to measure DEAE in the air during the previous studies but calculated that the exposure would be approximately 0.05 milligrams per cubic meter (mg/m^3) in one case (NIOSH, 1983). In that study, NIOSH investigators found DEAE in surface wipe samples of plastic film that had been exposed to the

environment for a number of years. Since DEAE possesses a minimal vapor pressure, it could have accumulated over time as condensate. NIOSH investigators did not detect DEAE on wipe samples taken during the other 2 investigations. At Building 8, wipe samples collected immediately after the leak contained trace amounts of DEAE. Subsequent wipe samples in these same areas of Building 8 following the clean-up contained no DEAE, although symptoms similar to those reported at the time of the DEAE exposure continued to be reported. This suggests that, although some symptoms could have been due to acute DEAE exposure on October 21 (and perhaps other times), the continuing symptoms probably had some other cause.

Employees were concerned that they had an undetected, long term exposure to DEAE. Heating Building 8 is accomplished by passing air over coils which contain steam, mixing that heated air with recirculated air, and then blowing this mixed air throughout the building. For the DEAE in the heating system to be a long term problem, one would have to assume a constant or recurrent leak of DEAE into the heating system that would be continually or repeatedly exposing employees to a small amount of DEAE. This exposure would have to be large enough to cause health effects. (Since DEAE containing steam is routinely used for humidification in some buildings without apparent problems, low levels are seemingly tolerable.) The consultant did locate a small leak from the heating system on January 16, 1992 during their inspection of the system, with condensed steam accumulating on a tray and not being blown into air ducts. Whether or not leaks regularly occurred in the past cannot be determined at this time. Inspections of the heating coils during routine maintenance, however, should be capable of detecting such a leak, should one occur in the future.

2. **Pesticides**

Pesticide spraying also has been a concern of the employees. Spraying, particularly baseboard spraying of an organophosphate insecticide in any building while employees are present increases the possibility of exposure. The perimeter heating system, located near the baseboards and containing a fan for circulation, may spread insecticide throughout the floor if the material is mistakenly applied on the vents. Employee exposure might be increased if droplets of pesticide were to be blown through the work area into employee breathing zones and chances for dermal absorption may be increased if insecticide is blown on employee work areas.

Up until October 1991, spraying had consisted of a weekly application in cafeterias, lunchrooms and vending machine areas and monthly application that adds restrooms, gondola (garbage) rooms, lounges, locker rooms and showers. According to the contracted pesticide company, Dursban® (chlorpyrifos) had been predominantly used with some application of Tempo® (a type of pyrethroid). This spraying was usually done after work, commencing at 5:30 pm. Spraying has been discontinued since October 17, 1991. The use of Dursban on a weekly basis appears excessive in that the residual should last at least two weeks (Doyle, 1992).

Employees had suggested that organophosphate insecticide may be responsible for some of the symptoms they have experienced in the building. Delayed polyneuropathies and behavioral changes have been suggested as effects of chronic low dose exposure to certain organophosphate insecticides including tri-ortho-cresyl phosphate (TOCP), mipafox, trichlorphon, tamaron, trichlornate and leptophos (Sharp, 1986). However, a study of workers exposed to chlorpyrifos during its manufacture found no cases of peripheral neuropathy; exposures ranged from 0.01 to 0.37 mg/m^3

(Brenner, 1989). The much lower levels of chlorpyrifos measured in Building 8 ranged up to 0.37 µg/m^3 (equivalent to 0.00037 mg/m^3).

All available records of spraying, both scheduled and unscheduled, were reviewed. Dursban® was sprayed in the workplace, although its use was usually restricted to the monthly and weekly treatments. Based on these records, it is unlikely that an employee would have become acutely poisoned by organophosphate insecticide. During interviews, employees wondered if it might be possible that they became sensitized to the insecticides as a result of repeated low dose exposure. This hypothesis was reinforced by the observation of employees who had been transferred off the state Office Campus to a facility in Latham, New York. They stated that they had been doing well at the facility until it received an announced insecticide treatment on April 1, 1992. Four employees who had neurologic symptoms at Building 8 had a return of their symptoms and had to leave the new facility as well. The insecticide that was applied at the Latham facility was chlorpyrifos, the same insecticide used at Building 8.

There are no published data about long term sensitivity developing to chlorpyrifos at the low levels which Building 8 employees were most likely exposed. We did not uncover employees describing symptoms of classic organophosphate poisoning at any time. There have been reports of neurologic sequelae, both sensory and behavioral, (Gershon, 1961; Savage, 1988) in individuals who had previously been acutely poisoned by organophosphate insecticides. However, peripheral neuropathy is considered a classic organophosphate effect that may appear without acute effects (Doyle, 1992). There are presently no data relating these symptoms specifically to chlorpyrifos.

The toxicity of the pyrethroids appears to be much lower than that of the organophosphate insecticides. Reported poisonings of humans have been few, probably because toxicity through both inhalation and dermal absorption is low. Pyrethroids have been reported to cause paraesthesia when they contact the skin. These are temporary and usually disappear in 24 hours (U.S.EPA, 1989).

3. **Symptoms prevalence**

Many of the symptoms reported by employees we interviewed are common and could be due to a variety of causes. They are often attributed to so-called "sick building syndrome" and the World Health Organization has considered symptoms of this syndrome to include headache, nausea, mental fatigue, dizziness, irritation of the eyes, nose and throat, skin reactions and non-specific hypersensitivities (WHO, 1983). Mendell and Smith (1990) organized these symptoms into 4 groups: lower respiratory (tight chest, difficulty breathing, shortness of breath, wheeze and flu-like symptoms), upper respiratory/mucous membrane (nose, throat, and eye symptoms), central nervous system (headache and lethargy), and skin (dry skin, itching skin and skin rash). They then reanalyzed data, collected from 6 other studies of problem buildings, by the type of building ventilation system used. They found that buildings that were sealed and air conditioned (without humidification) had higher prevalence odds ratios than those with simple mechanical or natural ventilation. For air conditioned (not humidified) buildings (such as Building 8), the prevalence rates for central nervous symptoms ranged from 37-58% and prevalence rates for the upper respiratory/mucous membrane category ranged from 8.2-49% The exact prevalence rates of symptoms related to working in Building 8 are not known.

4. **Employee Comfort**

The poor comfort level in the building was repeatedly mentioned to the NIOSH investigators by employees during the visit to Albany. Employees were either too hot or too cold and periods of cold could be followed by periods of extreme heat. Employees reported wide variability in the ventilation of the building and unusual, unidentifiable odors. They also reported that the air was too "dry". However, one of the more consistent comments concerned the lack of cleanliness in the building. This was confirmed during our walkthrough examination. Floors had been swept but debris from the sweeping had been left on the floor. Garbage containers were not emptied, carpets did not appear to have been vacuumed, and floors did not appear to have been washed. A visible layer of dust was observed on many surfaces. Paper and cardboard debris was strewn throughout the building where, at times, it rested on electrical wires. Cooking using small electric ovens was being done near stacks of used paper.

Relative humidity (RH) levels below 20% were measured by the consultant on several occasions during their survey of Building 8 in January, 1992. This is outside the ASHRAE 62-1989 guideline of 30 to 60%. New York State plans to reinstall the humidification system in Building 8. However, a humidification system in a building must be carefully planned and properly maintained to assure that indoor environmental quality is not adversely affected (IAQ Update, 1991). From an indoor environmental quality perspective, steam humidifiers are the preferable method to humidify commercial spaces since the heated water kills nearly all of the organisms in the water (IAQ Update, 1991). While Building 8 was humidified using such a system, the steam was obtained from the boiler steam used to provide heat to the campus structures. This boiler steam, as has been explained, also contained additives (such as DEAE) to prevent mineral buildup and corrosion. Instead, steam humidifiers should have a separate water supply free from potentially irritating cleaning agents.

Skov et al. (1990) reported macromolecular organic dust in carpets (but not total dust) to be associated with sick building syndrome. They also felt that what they termed fleecy surfaces, such as carpeting or drapery, and paper and cardboard could accumulate those compounds and release them into the work environment due to changes in humidity or temperature.

We observed employees working in dimly lit areas because they were unable to see the computer screens because of glare from outside windows or overhead lighting. Most video displays were not provided with glare screens. In many areas work desks were not adjustable and no wrist rests were provided.

The issue of overcrowding in the building was a concern of employees. Recommendations regarding building occupancy exist, but they do not appear to be based on health related parameters. The American Society for Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has recommended occupancy levels for office workers of 7 employees per 1000 square feet of usable space (ASHRAE, 1989), based on the ability of building ventilation systems to supply sufficient fresh air to building occupants. The federal government (General Services Administration) sets guidelines for workspace area based on the pay grade of employee using the space. These work station space allowances are 60 $ft.^2$ for clerical personnel (GS 1-6), 75 $ft.^2$ for technical personnel (GS 7-11) and 100 $ft.^2$ and up for professional staff (GS-13 and higher) (41 CFR 101-17.3 [1991]). The federal Internal Revenue Service has a guideline of 125 $ft.^2$ of primary office space per employee as an average occupancy

level. This guideline does not include storage, lavatory or cafeteria space as part of that 125 $ft.^2$ total.

It appears that areas in Building 8 exceed the occupancy guidelines for federal buildings. Room 802 has a density of 10 employees per 1000 square feet; room 801, 13.8 workers per 1000 ft^2; and room 806, 16.8 workers per 1000 ft^2. Floors 8 and 9 have the highest density (410 employees each) of any of the floors in the building. The employee perception of overcrowding at Building 8, in conjunction with other factors detracting from the comfort and aesthetics associated with working there, is plausibly a factor relevant to the reporting of symptoms in the building but research relating overcrowding and symptoms is limited. Overcrowding has been shown to be significantly related to accidents, job satisfaction and infirmary visits in studies of sailors on U.S. Navy ships (Dean, 1975). However, Skov et al. (1990) found that although the number of workplaces in an office and the total size of the office significantly impacted on the number of reported symptoms, area per employee had no effect.

Open-plan office design has been found by some researchers to lead to increased symptoms of headache and increased symptoms of eye irritation and upper respiratory tract symptoms in buildings that both have an open plan and are air-conditioned (Hedge, 1984). Most of the work areas observed in Building 8 were of the open plan design.

CONCLUSIONS

In summary, employees of Building 8 reported workplace conditions that have been shown, by other researchers, to result in increased symptoms among building employees. Because of poor ergonomics, and perceptions that ventilation and temperature control were also poor, employees were uncomfortable. They were surrounded by a environment that was not clean, contributing to the image that management did not care about the building. Adding to their discomfort were impressions that they were also overcrowded in their workspace. In addition to all these factors, the building experienced a chemical leak from the heating system that lead to the development of new, acute symptoms and exacerbated symptoms that employees had previously experienced. Comfort has been shown in previous NIOSH studies to be an important predictor of increased symptoms among office workers (NIOSH, 1991). However, it is not known how perceived comfort levels interact with symptoms, nor is it known if improving comfort levels will result in decreased symptoms in the building. Still, it is our judgment that some of these problems with employee working conditions are of a serious enough nature that attempts to solve employee health issues must address these issues as well.

The reasons for the neurologic problems reported by employees were not determined. Although exposure to pesticides did occur, the actual levels of exposure could not be obtained. Based on review of records that were available of pesticide spraying, the level of pesticide was probably lower than that which is associated with known acute or chronic health problems. In addition, employee physicians did not feel that chemical exposures were a likely cause of most employee symptoms. Weekly applications of chlorpyrifos appear to have been excessive. However, due to the lack of data about actual pesticide exposure in the past, NIOSH investigators cannot completely characterize the extent of employees' pesticide exposure.

NIOSH investigators have not previously encountered these neurologic symptoms, attributed to DEAE, in buildings where DEAE has been used as an additive to steam used

for humidification, nor have such effects been reported in the medical literature. Bell's palsy has not been associated with chemical exposures, even in industries where exposures were much higher than those plausibly occurring in Building 8 so it is unlikely that the cases of Bell's palsy occurring among Building 8 employees are due to any exposure to chemicals at the building.

Some employees expressed concern about possible long term health effects of working in Building 8. The NIOSH investigators were not able to identify any current or past exposures that would cause such effects.

RECOMMENDATIONS

1. Building 8 should be thoroughly cleaned and the maintenance staff restored to a level that is appropriate for a building of its size. NIOSH is cognizant of the budgetary restraints existing at the present time in New York State, but the work of Skov et. al (1990) does indicate a possible relation between the accumulation of dirt on "fleecy" surfaces and paper and symptoms among building employees.

2. The concerns about scrap paper resting on electric wires is a safety issue that should be addressed immediately. The possibility of an electrical fire from this arrangement is one that should be taken seriously by management. The building has had a large increase in the number of electrical machines (computers, terminals, etc.) and the use these machines with their accompanying wiring should be carefully evaluated with regards to a possible fire hazard. Cooking should be restricted to appropriate areas that meet local fire and safety codes.

3. New York State management must make an effort to improve ergonomic conditions for employees at Building 8 and 8A. Wrist rests, glare screens, and adjustable desks and chairs, as a minimum, are essential components for worker health in the office environment.

4. The issue of perceived overcrowding by employees should be addressed by State management. ASHRAE guidelines, federal workspace allocations or other sources may be considered.

5. Pesticide spraying should be minimized. The use of organophosphates should be discontinued, unless absolutely necessary, and other less toxic procedures substituted, such as keeping cafeterias clean and sealing cracks in walls for cockroach control. Use of boric acid should be evaluated as a chemical means of cockroach control. (Conversations with the present pesticide contractor have revealed that these changes are already being implemented.)

6. Inspection and maintenance of the heating system should be increased. The use of DEAE or other steam conditioners may be necessary to prevent corrosion of the heating system, but proper care of the system should lessen the likelihood of a steam leak occurring.

7. Communication must be improved among all parties. Employees stated that they were unaware that building management was as concerned about the problems at Building 8 as was apparent to them during the NIOSH visit. State officials appeared very concerned about the building conditions and the health problems of the employees.

8. Trucks should minimize their idling time at the loading dock situated at Building 8 and 8A. The door leading to the loading dock should be kept closed.

9. To improve employee comfort, work on the repair and upgrade of the reheat boxes and the installation of the new humidification equipment should proceed as planned. Specifically, having operational reheat boxes for the ventilation system will improve the ability to provide heating and cooling to the various departments in Building 8 based on actual needs. This improvement will also reduce the temperature differences which existed between floors when these reheat boxes were not used. Since State officials plan to again humidify the building once the changes are complete, the new

humidification system should be designed to use only water which is free from any cleaning agents or other chemical additives. It was our understanding that this type of direct steam injection humidification system (which would not use boiler steam) would be installed in Building 8.

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