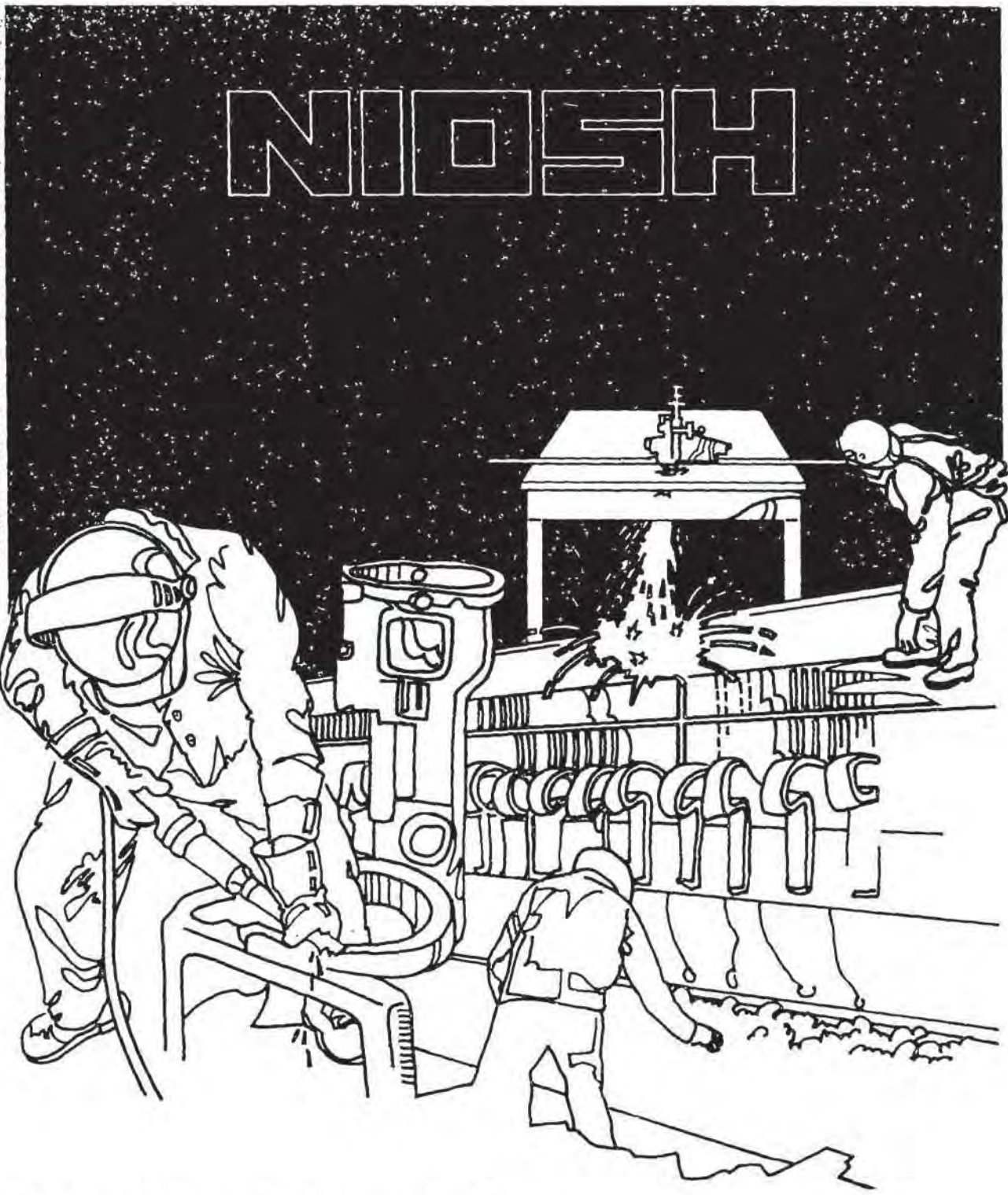
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-230-1093
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN

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 81-230-1093
APRIL 1982
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN

NIOSH INVESTIGATORS:
Kern Anderson

I. SUMMARY

On March 16, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate conditions in the Purchasing Department at Michigan State University in East Lansing, Michigan, where several employees have complained of eye, nose, throat, and skin irritation since October 1979.

On March 23-27, 1981, NIOSH conducted an initial survey including an industrial hygiene evaluation and medical evaluation . A follow-up survey was conducted May 4-8, 1981. Large volume air samples were obtained to determine airborne concentrations of fibrous glass and bulk samples were obtained for asbestos identification. A detailed health and occupational history questionnaire was administered to all 24 employees who work in the department. Routine clinical laboratory tests were conducted on all 24 employees, and medical examinations were performed on some of the employees.

No fibrous glass was detected in any of the air samples. Analyses of the bulk samples indicated no asbestos content.

Eye irritation, fatigue, nasal congestion, headache, and skin irritation were the most commonly reported symptoms; the usual period of onset was September 1979 - January 1980. Symptoms occurred among employees throughout the building. Clinical laboratory results and medical evaluations revealed no consistent abnormalities.

On the basis of the data obtained in this investigation, a health hazard from exposure to fibrous glass particulate does not exist in the Michigan State University Purchasing Department. A high prevalence of eye, ear, throat, and skin irritation as well as headache and nasal congestion during the winter months may be due to the heated, unhumidified work environment. A contributing factor may be possible sensitization of some employees to dust particulate. Further evaluation of the heating unit will be required to rule out the intermittent presence of carbon monoxide in the building. Recommendations for ventilation, cleaning, and maintenance are presented in Section VIII of this report.

KEYWORDS: SIC 8221 (Universities), office environment, upper respiratory irritation, fibrous glass, asbestos

II. INTRODUCTION

On March 16, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Center for Environmental Toxicology (CET) at Michigan State University, East Lansing, Michigan, to assist in the evaluation of conditions in the University's Purchasing Department, where several staff members had complained of periodic symptoms of eye, nose, throat, and skin irritation since approximately October 1979. These symptoms were thought to be related to the building's heating/air-conditioning system since their occurrence had been reported most commonly during the "heating season" months. A preliminary site visit to the premises was conducted during the week of March 16-20, 1981. After information regarding past attempts to characterize the problem was reviewed, and strategies for this investigation were developed, on March 23, 1981, NIOSH began its initial survey in conjunction with the University's CET, Office of Radiation, Chemical, and Biological Hazards, and College of Osteopathic Medicine. The survey involved collection of general air samples to evaluate airborne concentrations of fibrous glass, bulk samples from the tops of desks, file cabinets, etc., to identify surface particulates, and administration of a health and occupational history questionnaire to characterize to what extent conditions in the Purchasing Department building were adversely affecting employees.

III. BACKGROUND

A. Chronology

The Michigan State University Purchasing Department is located in a single story, concrete block, brick faced building that was constructed in 1969. The structure is approximately 5400 square feet in size. The department has occupied the building since 1974. Previously, the space had been occupied by the Personnel Department. Twenty-three employees (7 males, 16 females) work in this building which includes 14 individual offices, a conference room, a lounge/coffee room, open floor space work areas and two restrooms. A corridor, with entrances at each end, divides the building in two sections. Other than creating an additional office and painting the building's interior just prior to the Purchasing Department's move into its new quarters, the building has not undergone any major renovations.

On September 20, 1979, the Physical Plant Department was asked to turn the heating unit on, as cooler fall weather had arrived. Between September 20 and October 5, the unit was malfunctioning, producing extreme conditions of hot and cold. One thermostat was replaced at this time. On October 9, 1979, the Physical Plant Department was notified that odors were circulating through the building. The Office of Radiation, Chemical and Biological Hazards

investigated the problem, but reported no unusual findings. At approximately the same time, several staff members began to complain of eye, nose, throat, and skin irritation, that became noticeable usually within one hour after entering the building. On October 29, 1979, Physical Plant inspected the rooftop heating unit and found the reheat coil both plugged with dust and with dust burned on it. Additionally, the insulation on the floor of the unit between the blower and reheat coil was sticky and odorous. The reheat coil was cleaned and reinstalled, and the compartment was sealed. The fibrous glass insulation was removed and discarded. Additionally, the end mounted horizontal discharge flue exhaust vent was removed, and replaced by a vertical exhaust flue extending 8 inches above the unit.

A departmental memorandum dated November 26, 1979, documented the continuing problem, describing episodes of several employees having to leave work after becoming ill in the building. One employee had to replace a set of contact lenses and was informed by the ophthalmologist that the lenses were discolored and ruined due to absorption of chemical fumes. Additional symptoms of severe headaches, nausea, disorientation, and extreme exhaustion were reported by employees over the next several weeks.

The Michigan Department of Public Health conducted environmental sampling on November 1, 1979, and again on December 10, 1979. Results indicated that no detectable levels of dust, solvents, or formaldehyde were present in the air. The rooftop heating unit was examined and samples of the fibrous glass insulation (removed from the base of the unit) were tested for formaldehyde. Laboratory analysis indicated that the material contained 0.002% (2 ppm), by weight formaldehyde. Since no formaldehyde was detected in the air sample, it was ruled out as a source of the problem.

On January 11, 1980, the Nalco Chemical Company, Chicago, Illinois, conducted microbiological sampling to rule out the presence of bacteria and fungi in the heating/ventilation system. A very small number of Aspergillus fusicarium and Bacillus subtilis organisms were isolated from insulation samples from the rooftop unit and one of the filters in a room vent; however, these findings were considered insufficient to be the source of the problem. The remaining samples tested were all negative for any microorganisms.

According to another departmental memorandum, by February 5, 1980, conditions in the building had improved. The frequency of complaints was far less than in the prior four months, although there was some speculation whether there had been an actual improvement in the building or whether people had learned to cope with the situation better. In the same memorandum, there were questons raised and some confusion regarding the laboratory analysis for formaldehyde in samples taken from the insulation that

was removed from the rooftop heating unit. The Michigan Department of Public Health reported the concentrations of formaldehyde in the insulation to be 2 parts per million by weight; however, some individuals understood these results to have been 27 parts per million.

While the frequency of complaints dropped considerably in February 1980, the confusion created by the conflicting reports of formaldehyde concentrations fueled a search over the next several months for reference materials in efforts to obtain as much data as possible on formaldehyde, since many individuals still believed that formaldehyde had not been adequately ruled out as the problem source. The conditions apparently improved considerably, since the frequency and extent of problems experienced by Purchasing Department employees from February 1980 through September 1980 is not documented. However, the problems reappeared in late September (presumably when the heating unit was turned on) because the Michigan Department of Public Health was asked once again to evaluate the building.

On October 8, 1980, the Health Department conducted testing for airborne fibers to determine if fibrous glass was creating a hazard, analyzed samples of duct lining from three ceiling diffusers to analyze concentrations of formaldehyde, and measured the relative humidity inside the building. The air samples revealed 0.11 fibers per cubic centimeter (considered to be "nuisance" particulate) in one sample while in other samples there were no fibers detected. The duct lining samples contained 0.005%, 0.011%, and 0.005% formaldehyde - findings similar to previous tests conducted in November 1979. The relative humidity inside the building was recorded at 35%, within the normal range of 30% - 50%.

On November 24, 1980, the University's Department of Botany and Plant Pathology conducted testing for molds and spores. Although a few organisms were isolated, the colonies were considered to be below numbers that would be attributable to the source of the problem.

The building's temperature and relative humidity were monitored from January 30 - February 1, 1981. Temperature ranges were normal. However, the relative humidity was measured at 15% for most of the monitoring period.

B. Heating and Air-Conditioning System - Description

The building is equipped with a NESBITT rooftop, multi-zone heating and air-conditioning unit, consisting of a 7-1/2 horsepower (h.p.) 208 volt/60 cycle/3 phase supply fan and a 1 h.p. 208/60/3 exhaust fan. The unit's air movement capability is 8900 cubic feet per minute (CFM) at 3/4" (water) external (to unit) static pressure.

The system delivers filtered air to the building's 7 ventilating zones through sheet metal ducts, lined with fibrous glass. Air is diffused from ceiling diffusers, typically measuring 9" x 9" or 12" x 12". Air is returned to the system through baseboard, return-air diffusers and ducts running beneath the floor and behind the walls. Each ventilating zone has its own thermostat control. Additionally, there is one "night" thermostat that monitors the entire system during evenings and on weekends. There are 3 "power-roof-ventilators", located in the conference room, the coffee lounge, and the records room that exhaust room air directly up through the roof and outside at rates of: 762, 387, and 650 CFM respectively.

Four humidifiers are installed above the ceiling in ventilating zones 2, 4, 6, and 7. However, this system has reportedly been disconnected for some time, apparently due to corroded and clogged pipes.

The heating unit section has a two-position ("high-fire" and "low-fire") natural gas burner, with a heating input rated at 500,000 BTUs and output rated at 375,000 BTUs at "high-fire". The unit is set at 60°F for mixing air. The percentage of outside air (OA) introduced into the building varies, depending upon outside temperatures; however, the standard specifications for this unit are 15% (OA) at 10°F and 100% (OA) at 60°F. The actual percentage of outside air introduced into the building at any given time can be determined by the following formula:[1]

$$\%OA = \frac{TR - TM}{TR - TO} \times 100$$ where:

TR = Temperature of return air (room air)
TM = Temperature of mixed air (set at 60°F on this unit) and
TO = Temperature of outside air

If the outside temperature reaches 70°F, the unit has a heating "lock-out" override mechanism, that automatically shuts off the burner. The entire system is controlled by a 7-day clock. During weekends, the heating unit is set to turn on at 6:30 a.m. and shuts off at 5:30 p.m. On weekends, the system is shut down. A "night" thermostat, set at 55°F, controls the system during evenings and on weekends, and ensures that temperatures inside the building do not get below 55°F.

The air-conditioning unit section consists of: a 25 h.p. 208/60/3 compressor and (3) 1 h.p. 208/60/3 condensor fans, with a total unit cooling capacity of 253,000 BTUs.

IV. METHODS

A. Environmental

Large volume, general area air samples were obtained to evaluate airborne concentrations of fibrous glass, and bulk samples from desk tops, file cabinets, and ceiling diffusers were collected for fiber identification. Samples for fibrous glass were obtained with open-faced cassette filters attached to a large volume air pump. These samples were analyzed for fibrous glass according to a modification of NIOSH method P&CAM 239 utilizing phase contrast microscopy. Bulk samples were analyzed for asbestos and other fibrous constituents based upon a visual estimation of the percentage of these substances present under polarized light microscopy and dispersion staining techniques.

B. Medical (Initial Survey)

A health and occupational history questionnaire was administered to all of the twenty-three employees who currently work in the Purchasing Department building and to one department employee who previously worked in the building but currently is assigned to the Purchasing Department's warehouse.

V. ENVIRONMENTAL EVALUATION CRITERIA

NIOSH has evaluated over one hundred office buildings in the past two years. These evaluations usually originate from complaints of poor air quality and the occurrence of irritative symptoms (eye irritation, dermatitis, etc.) among the employees working in these offices. In most of these investigations, no exposures to toxic chemicals are found, but rather the problems usually are due to inadequate ventilation in these office areas.

Fibrous glass has occasionally been found to be the cause of irritative symptoms among office workers. This material is very irritating to the skin and may be liberated from insulation and ceiling tiles in these buildings.

Asbestos was also a commonly used insulation material in buildings. Exposures to asbestos are associated with pulmonary disease and cancer.

Formaldehyde exposure can also cause irritative symptoms among exposed workers. More recently, formaldehyde has been found to cause cancer in animal experiments.

VI. RESULTS AND DISCUSSION

A. Environmental

Analysis of air samples collected revealed that no fibrous glass was detected. The limit of detection for the laboratory method was 4500 fibers/filter. The maximum concentration of fibrous glass on any of the samples was less than 4500 fibers/cc (Table I).

Results of bulk samples analyzed (ceiling diffuser, desk, and cabinet surfaces) indicated no asbestos content. One sample (taken from the ceiling diffuser in the typing room) contained approximately 10% cellulose fiber and less than 1% fibrous glass. The sample taken from desk and cabinet surfaces contained approximately 70% cellulose and synthetic fiber and less than 1% fibrous glass. The sample of the diffuser filter material was determined to be 100% "coated" with fibrous glass.

In order to investigate the conflicting reports regarding previous test results for formaldehyde in samples taken from the insulation from the rooftop heating and air-conditioning unit, the Division of Occupational Health at the Michigan Department of Public Health (MDPH) was contacted. MDPH records indicated that samples of the insulation were obtained on November 1, 1979, and again on November 14, 1979. The sample taken on November 1, 1979, contained 0.0047% (47 ppm) formaldehyde by weight while the sample taken on November 14, 1979, contained 0.002% (2 ppm) formaldehyde. Results from the sample taken on November 1, 1979, were inadvertently omitted from the MDPH report of the investigation dated January 7, 1980. Although the difference between the two results may appear startling, the absence of formaldehyde in all of the air samples taken on November 1, 1979, and on December 10, 1979, seemed to sufficiently rule out formaldehyde as a source of the problem. The difference in the two samples may be attributed to spilled paints, solvents, etc., resulting from cleaning, repairs, and adjustments performed on the unit. (Note: On November 19, 1980, Dr. Jerry B. Hook, Director of C.E.T., attended the Chemical Industry Institute of Toxicology's Conference on Formaldehyde, held in Raleigh, North Carolina. Details of the Purchasing Department investigation were reviewed with leading experts on the subject. Based on these discussions, Dr. Hook was satisfied that formaldehyde was <u>not</u> a source of the problem.)

B. Medical

Eye irritation (described as itching, burning, dry-sticking lids, gravel-like, bloodshot, or swollen) was spontaneously reported by 12 persons as the first noticeable symptom. Itching (described as a generalized body pruritis by some, and localized around the face,

ears, head, and neck by others) was spontaneously reported by 5 persons as the first noticeable symptom. Generally, these symptoms were described as occurring within 1-2 hours after entering the building with some individuals, and lasting anywhere from a few hours to persisting the entire workday, and disappearing within a few hours after leaving the building. When each employee was questioned about 24 specific irritating and other symptoms, a higher rate of response was obtained for eye irritation (19) and itching (12), with fatigue, nasal congestion, headache, skin irritation, irritability, and sneezing being reported at high frequencies as well. Two persons, who described their skin irritation as a burning, tingling sensation accompanied by a "glowing, rosy-red" coloration, especially noticeable on the cheeks, nose, ears, and neck, were observed with these symptoms on several occasions during the investigation by both the NIOSH investigator and the occupational medicine consultant. The one person who had just entered the building at the time of the interview, developed the symptoms within 45 minutes. The other person, who described similar symptoms, was observed at the beginning, during, and end of 2 workdays. In the morning, the person's face and nose appeared normal. At approximately the lunch hour on each day, the person's face and nose had started to develop the glowing-like redness which by the end of the working day had progressed to a very noticeable malar and nasal erythema. Of the 12 persons reporting itching as a symptom, 5 persons described severe and persistent itching, affecting the eyes, face, arms, and legs. Severe itching, aggravated by persistent scratching to the point of frequently drawing blood, was further reported by one of these persons. The complete distribution of symptom responses is presented in Table III.

Fifteen persons identified the period from September 1979 to January 1980 as the initial time of onset of symptoms. Persons most affected by symptoms, most commonly reported their symptoms as; occurring daily to several times a week from September 1979 to February 1980, occurring at a lower frequency of 1-2 times a week during February 1980, with virtually no symptoms reported by any person from the period of March 1980 to September 1980. In late September 1980, the heating system was turned on for the season and shortly thereafter, several persons became symptomatic once again. Although some symptoms have persisted through March 1981, people tend to agree that conditions have improved considerably, as complaints have been reported less frequently. At the time the questionnaires were administered, 7 persons reported experiencing symptoms at that moment. Four persons claim to have never been adversely affected by conditions in the building.

Generally, the affected employees tended to associate the occurrence of symptoms with being in the building and reported few episodes of symptoms occurring at home. However, with regard to the specific symptoms of eye and skin irritation, 13 people definitely associated relief, and subsequent disappearance of those symptoms, with leaving the building. Thirteen employees also associated the occurrence of symptoms in conjunction with the operation of the heating system. The absence of symptoms reported during the summer months when the air-conditioning system is used, seems to support a seasonal variation of the problem. There were no correlations of the occurrence of symptoms with regard to specific weather conditions, times of day, days of the week, or particular locations (ventilating zones) within the building. Additionally, the use of office equipment was not associated with the occurrence of symptoms. Because most individuals remain in the building the entire day, including lunchtime, comparisons of relief or disappearance of symptoms in persons who leave the building during lunch hours, to those who remain in the building for lunch, could not be considered. Finally, the number of years individuals have worked in the building was not an influencing factor with regard to the occurrence of frequency of symptoms.

In summary, the results of the initial survey seems to describe the presence of some unknown irritant that has caused varying degrees of eye irritation and fatigue in 19 of 24 employees and a high frequency of other associated irritating symptoms as well. The data suggests the period between September 1979 and January 1980 as the initial period of the onset of, and most severe symptoms. The occurrence of symptoms appears to be associated with the operation of the heating system, since the frequency of reported symptoms decreases as warmer weather approaches, ceases completely during the summer months, and increases as the "heating season" arrives once again. This pattern is documented for the periods between September 1979 through March 1980 and again from September 1980 through April 1981. Although symptoms persist in varying degrees in 19 persons, they are considerably less severe now than compared to 18 months ago. Although the distribution of responses to the list of symptoms seems to indicate some irritant that affects the eyes, skin, and nasal passages, closer examination of individual responses reveals a cluster of persons who have also experienced neurologic symptoms as well.

The questionnaire contained 5 symptoms addressing the nervous system: loss of coordination, irritability, dizziness or light-headedness, disorientation, and numbness or tingling. Nine persons indicated they had experienced 3 or more of these symptoms. Seven of these 9 persons had experienced loss of coordination, ranging from bumping into desks and doors, to losing balance or equilibrium. Unlike the specific irritating symptoms,

the neurological symptoms have had an insidious onset whose frequency has progressively increased over the past year. Further examination of individuals responses to the symptom of fatigue indicated that 13 persons described their fatigue as extreme exhaustion, or uncontrollable sleepiness that has resulted in behavioral changes (recognized by family members and others during the past year) ranging from: sleeping soundly but waking up tired, and inattention and lack of comprehension at work. Since most of the individuals associated with the neurological cluster of symptoms were also individuals who could be described as "most affected" by the irritant symptoms, further evaluation and follow-up of this group was deemed appropriate.

VII. FOLLOW-UP SURVEY

A. Methods

1. Environmental

The description of neurological symptoms experienced by the Purchasing Department employees suggests the intermittent presence of a gas such as Carbon Monoxide which led us to:

a. evaluate the rooftop heating unit burner for malfunctions and incomplete combustion,

b. monitor the air quality inside the building to rule out the presence of Carbon Monoxide,

c. rule out possible exhaust air "curling effect"; evaluate the relative position and height of the rooftop heating unit exhaust discharge flue in relation to the unit's air inlet.

2. Medical

In order to further characterize the problems experienced by department employees, employees categorized as "most affected" by symptoms were reinterviewed to obtain additional information regarding their major symptoms and to identify commonalities among this group of individuals. This included:

a. survey (including carboxyhemoglobin determinations) of all 24 department employees,

b. physical examinations selectively, within the group of "most affected" persons,

c. establishment of a personal-log recordkeeping system, for employees to document prospectively and more accurately, the occurrence of symptoms.

B. Results and Discussion

1. Environmental

A & B. Evaluation of the rooftop heating unit for malfunctions and incomplete combustion, along with plans to monitor the air inside the building for the presence of carbon monoxide, were not implemented and have been postponed since the "heating season" is over and the heating unit has been shut down.

C. The exhaust discharge flue has received some attention in the past. In October 1979, the end mounted horizontal flue was replaced by a vertical flue extending 8 inches above the unit. Although this modification probably improved the discharge of exhaust into the air, exhaust might still be occasionally capable of entering the building through the air inlet, as a result of a "curling effect", if the wind is from a southerly direction (the exhaust flue is mounted on the south side of the unit). In order to evaluate this possibility, meteorological data were obtained from the National Climatic Center in Asheville, North Carolina. Local Climatological Data Sheets were analyzed for the months of September 1979 through April 1980 and September 1980 through February 1981, to determine the number of days when winds from the south may have influenced the occurrence of a "curling effect". The Local Climatological Data Sheets record daily weather observations at three-hour intervals at 0100, 0400, 0700, 1000, 1300, 1600, 1900, and 2200 hours.

For this analysis, a "possible curling effect day" was defined as: a workday when wind direction was recorded from a southerly direction a minimum of two times, during the hours of 0700 to 1600. Winds from a southerly direction were defined as: any airflow from longitudinal azimuths ranging from $\geq 125°$ to $< 225°$ (Figure 1). During the months analyzed, there were a total number of 273 workdays. Of those days, 96 (35%) could be categorized as "possible curling effect days". While there appear to have been sufficient opportunities for wind to have influenced the movement of exhaust air, directing it towards the building's air inlet, conclusions cannot be drawn from these data, since accurate personal records of symptoms occurring on these days were not documented.

2. Medical

Reinterviews among "most affected" employees revealed no additional pertinent findings.

a. Medical Testing Survey: All 24 employees participated in the laboratory survey conducted during the week of May 4-8, 1981. This survey included RBC, Hb, Hct, WBC, differ differential, sed. rate, platelet, MCV, MCH, MCHC, triglyceride, cholesterol, alkaline phosphatase, calcium, phosphorus, total bilirubin, total protein, albumin, BUN, creatinine, globulin, uric acid, glucose, LDH, CPK, SGPT, SGOT, sodium, potassium, CO_2, chloride, and carboxyhemoglobin. Results of this survey revealed no consistent abnormalities. The carboxyhemoglobin determinations were within normal limits for most participants, with persons who smoke demonstrating significantly higher values.

b. Physical examinations were conducted on three persons. Results indicated no significant abnormalities and no findings referable to the presenting complaint.

c. Each employee has received a personal log to record future occurrences and descriptions of symptoms (see Appendix A).

VIII. CONCLUSIONS

Nineteen individuals have been affected in varying degrees by a persisting illness characterized by: eye irritation, headache, skin irritation, and fatigue. Additionally, a cluster of nine individuals have also experienced neurological abnormalities characterized by: loss of coordination, irritability, dizziness/light headedness, and disorientation. The association, if any, between these two groups of symptoms is not clear. The data seem to suggest a two-fold problem.

A. Irritating Symptoms

If the source of the irritating symptoms has a toxic etiology, then the offending agent was most likely introduced during the period of September 1979 through January of 1980. Exposure may have been constant, intermittent, or cumulative during this period, with chronic low level or residual effects persisting in certain individuals up to the present time. Skin contact would appear to have been the most likely route of entry. Clearly, there has been considerable improvement documented for most of the individuals affected, however, the problem does persist in varying degrees among the employees. Considering the environmental data from this and previous investigations of the building, the obvious environmental contaminants and biological agents seem to have been sufficiently ruled out as possible sources of the problem. However, these data may not accurately reflect cumulative or sensitizing effects of low level concentrations of the substances tested for. One can speculate about the continuing presence of

some unknown agent, whose limits of detection are beyond the capabilities applied to this investigation, however, it is difficult to imagine just what that agent could be.

A more reasonable explanation may be attributable to a combination of factors revolving around the malfunctions of the building's heating system, the extremely dry conditions that exist in the building during the winter months, and the presence of dust particulate in visibly excessive amounts. Correcting the frequent malfunctions in the heating system, that produced extreme conditions of hot and cold as well as energy conserving steps implemented during the fall of 1979, may have drastically affected the air quality in the building. The existing dry conditions may have become even drier, causing an acute sensitization or reaction to dust particulate, initially in 19 of 24 employees, followed by individual improvement or adjustment to the drier environment by February 1980. The persistance and varying degrees of symptoms to certain individuals, may be a result of a low-level, chronic sensitivity to dust particulate and extremely dry air. The virtual absence of symptoms during the warmer, more humid summer months seems to support this hypothesis.

The amount of visible dust in this building appears to be excessive when compared to other typical office settings. Dust virtually settles overnight on surfaces that are cleaned that day. The very nature of the forced air heating system contributes greatly to the presence and movement of dust within the building. However, there are other factors contributing to the dust problem as well. Traffic within the building is high, both from the movement of employees and a considerable number of outside business persons who visit the Department on a daily basis. Additionally, the building is situated within 150 feet of the main trunk-line of one of three freight railroad companies serving the Lansing area. The passing of 18-20 freight trains plus 2 passenger trains each day, subjects the building to vibration that can be detected by placing one's hand against a building wall as a train passes by. Although the building is cleaned routinely (although no longer on a daily basis due to University fiscal cut-backs), the activity of cleaning can, itself, contribute to the problem of dust. The exhaust air from a typical commercial-size upright or cannister model vacuum cleaner is sufficient to stir up dust as well as pick up dust.

Since the environmental survey identified no toxic exposures, and the clinical laboratory results and physical examination results indicated no consistent abnormalities, a specific cause of the illnesses could not be determined.

B. Neurological Symptoms

Further environmental testing and personal evaluation will be required to determine the cause of neurological symptoms experienced by a cluster of purchasing department employees. Although the carboxyhemoglobin determinations from the clinical laboratory survey were within normal expectations, this does not rule out the possibility that there may be occasions when carbon monoxide is present in the building. Additionally, there are other buildings in the Lansing area, equipped with similar heating units from the same manufacturer, that historically have had problems with carbon monoxide. Typically the problem was corrected by constructing a vertical exhaust flue extending several feet above the unit.

IX. RECOMMENDATIONS

The following recommendations were discussed with university officials at the conclusion of the investigation:

1. Install a central humidification system on the heating unit to increase the relative humidity within the building during colder months.

2. Install filters on all of the ceiling diffusers and establish routine maintenance procedures to ensure their cleaning/replacement.

3. Because of the excessive amounts of dust, it is recommended that the entire building be thoroughly cleaned, using a vacuum system with its exhaust and receptacle located outside of the building. It is further recommended that the building be cleaned on a daily basis to minimize the presence and accumulation of dust.

4. Since a specific cause of the illnesses has not been identified, it is recommended that each employee document future occurrences of symptoms if the problem persists.

5. When the fall "heating season" arrives, the rooftop heating unit should be thoroughly examined for incomplete combustion and the building should be monitored for the presence of carbon monoxide.

X. REFERENCES

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4. Occupational Disease, A Guide to their Recognition. National Institute for Occupational Safety and Health (NIOSH), Publication no. 77-181, June 1977.

XI. AUTHORSHIP AND ACKNOWLEDGMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Michigan State University, East Lansing, Michigan 48824
   Director, Purchasing Department
   Director, Physical Plant
   Director, Center for Environmental Toxicology
   Director, Office of Radiation, Chemical and Biological Safety
2. Michigan Department of Public Health
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing the employees in the Purchasing Department, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Air Samples for Analysis of Fibrous Glass

Results of Environmental Samples
Purchasing Department
Michigan State University
East Lansing, Michigan
HETA 81-230

March 1981

Sample Number	Description	Results Fibers/Filter
1	Director's office - diffuser closed	<4500
2	Director's office - diffuser closed	<4500
3	Director's office - diffuser open	<4500
4	Director's office - diffuser open	<4500
5	Typing room - diffuser open	<4500
6	Typing room - diffuser open	<4500
7	Buyer's office	<4500
8	Buyer's office	<4500
9	Buyer's work area	<4500
10	Buyer's work area	<4500

The above-numbered samples were analyzed for fibrous glass according to a modification of NIOSH method P&CAM 239 utilizing phase contrast microscopy. Fibrous glass fibers with a maximum width of 3.5 microns and a minimum length greater than 10 microns were counted. The samples are reported in total fibers per filter. The following calculation is performed to convert fibers/filter to fibers/cc:

$$\frac{\text{Fibers/Filter}}{(\text{Sample Vol. L.})(1000)} = \text{Fibers/cc}$$

The limit of detection (LOD) has been determined to be 0.03 fibers/field or 4500 fibers/filter. A detection limit is calculated by dividing the minimum observable fibers by the maximum number of fields specified by the method.

TABLE II

Bulk Samples for Analysis of Asbestos
and Other Fibrous Constituents

Sample Number	Description	RESULTS	
		Asbestos % and Type	Other Fibrous Constituents % and Type
11	Black substance from diffuser in typing room	No asbestos detected	Approx. 10% cellulose, <1% fibrous glass
12	Particulate from desk tops, file cabinets, etc.	No asbestos detected	Approx. 70% cellulose and synthetic fibers, <1% fibrous glass
13	Diffuser filter material	No asbestos detected	100% "coated" fibrous glass

A visual estimation of the percentage of asbestos and other fibrous constituents was made on the above-numbered samples utilizing polarized light microscopy and dispersion staining techniques.

TABLE III

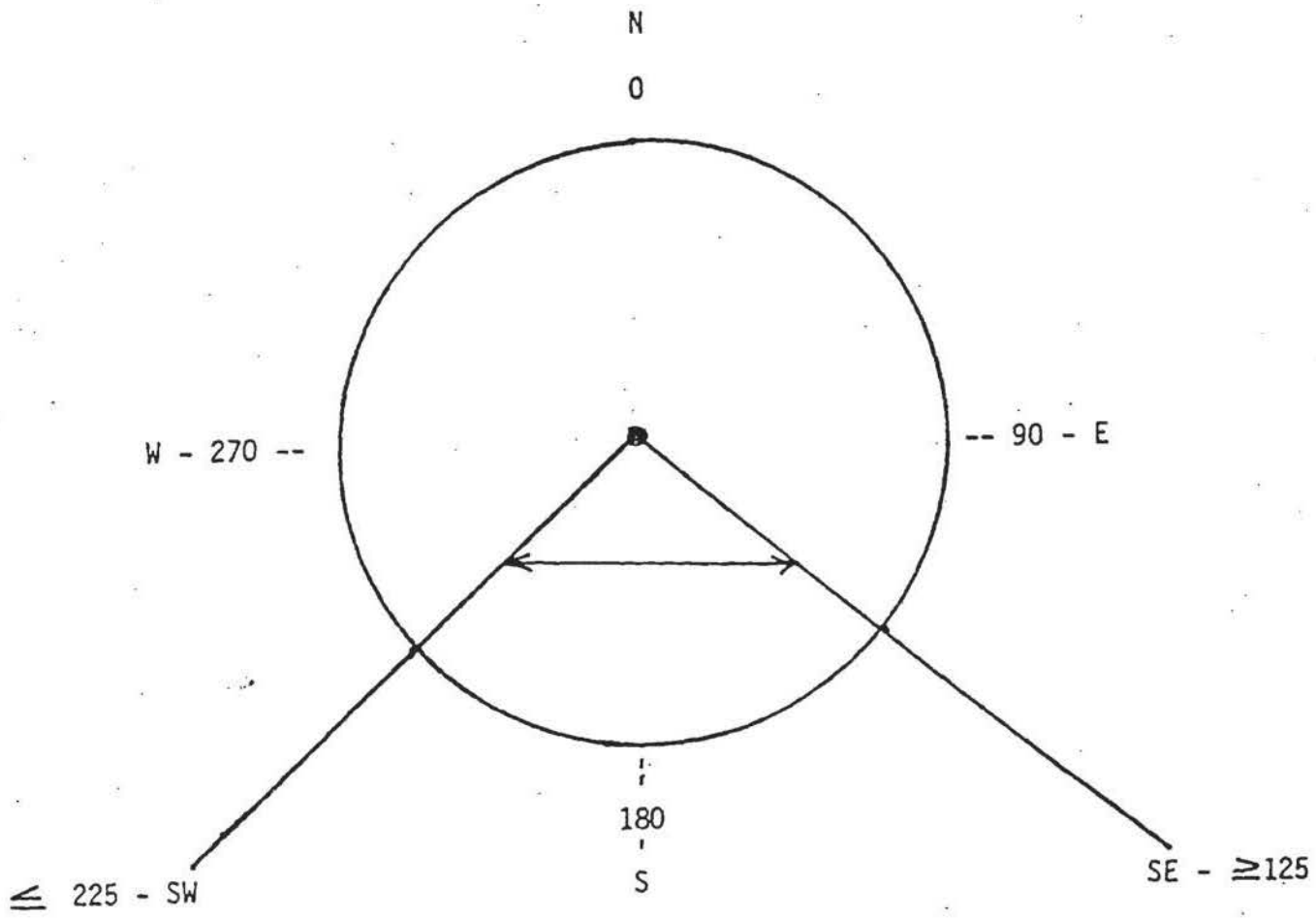
Responses by Purchasing Department Employees
To Direct Inquiry About Specific Symptoms

Michigan State University
East Lansing, Michigan

Symptom	No. Persons Affected	(%)
Eye irritation	19	(79)
Fatigue	19	(79)
Nasal congestion	15	(63)
Headache	15	(63)
Skin irritation	13	(54)
Pruritis (itching)	12	(50)
Irritability	11	(46)
Dry throat	11	(46)
Dizziness/light headedness	10	(42)
Sneezing	10	(42)
Sinus congestion	9	(38)
Nausea	8	(33)
Loss of coordination	7	(29)
Rash	6	(25)
Cough	6	(25)
Numbness or tingling	6	(25)
Sore throat	5	(21)
Disoriented	5	(21)
Metallic taste	4	(17)
Fever	4	(17)
Diarrhea	4	(17)
Wheezing	2	(8)
Chest pain	2	(8)
Shortness of breath	0	(0)

FIGURE I

COMPASS CARD



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