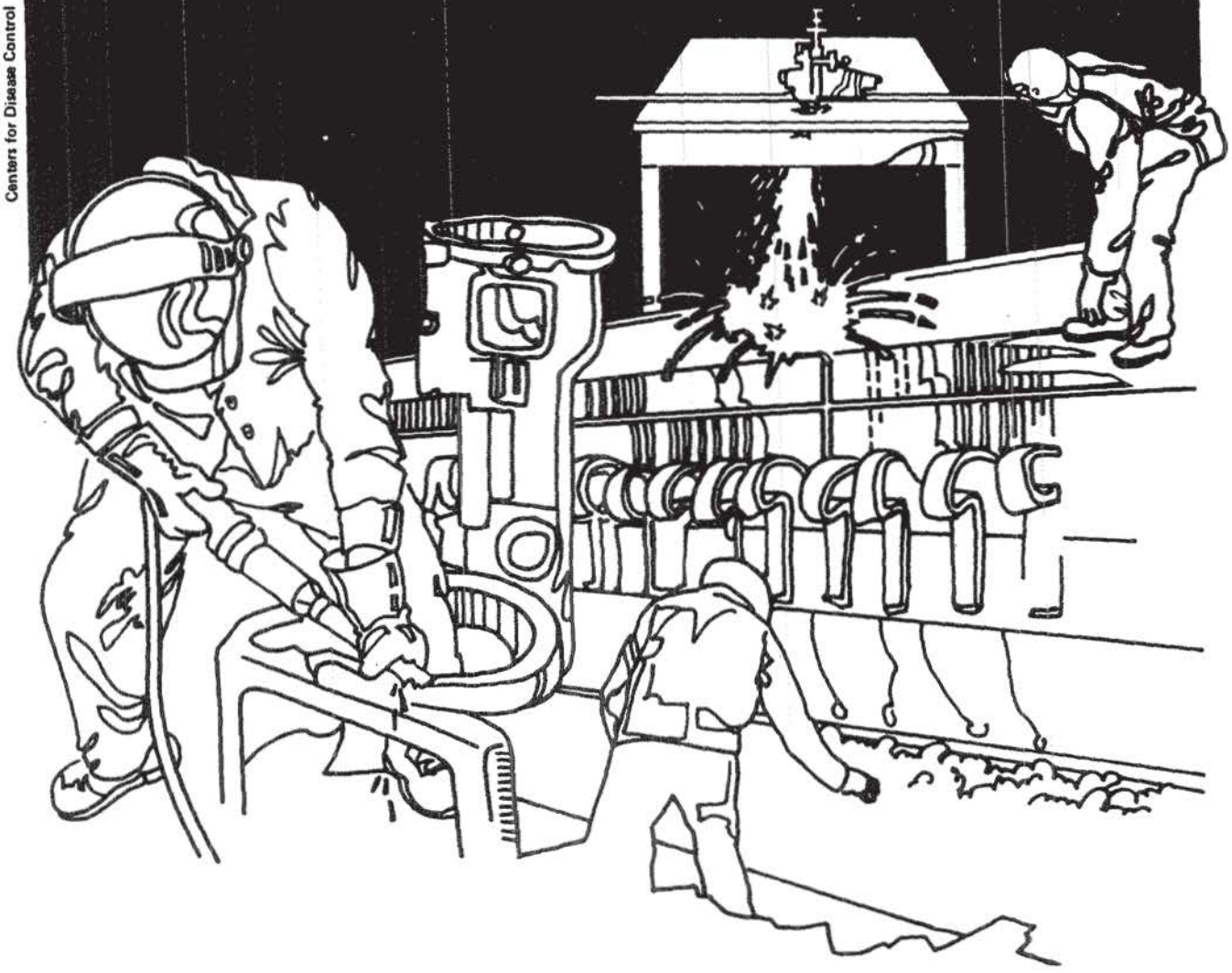
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 82-335-1289
EAST JACKSON
MIDDLE SCHOOL
JACKSON, 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 82-335-1289
APRIL 1983
EAST JACKSON MIDDLE SCHOOL
JACKSON, MICHIGAN

NIOSH INVESTIGATORS:
Kern Anderson, Epidemiologist
William J. Daniels, I.H.

I. SUMMARY

On July 12, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the East Jackson Middle School, Michigan, where several school staff members (estimated to be over 90%) have complained of a variety of non-specific irritating symptoms since the summer and early fall of 1979. The symptoms have included headache, fatigue, mucous membrane irritation of the eyes, nose and throat, and skin irritation. On September 28 - October 8, 1982, NIOSH conducted initial environmental and medical surveys, followed by an additional environmental survey (conducted unannounced), on January 21, 1983. Detector tube and long-term air samples were collected during the initial environmental survey and detailed medical questionnaires were administered to 43 of 44 current and former school staff members. (Two were returned by mail). Direct-reading detector tube samples were collected during the follow-up environmental survey.

NIOSH found no evidence of any chemical contamination in the school. Results of detector tube samples from the environmental surveys revealed no detectable concentrations of formaldehyde, carbon monoxide or nitrous fumes. Long-term air samples revealed no detectable concentrations of hydrogen sulfide, sulfur dioxide or carbon monoxide. Long-term air samples analyzed by gas-chromatography revealed no detectable concentrations of formaldehyde. Carbon dioxide levels were within normal ranges during both surveys.

Analysis of the medical questionnaires did not reveal any time-place clusters of related illnesses that could be attributed to any chemical contaminants in the school's environment. Twenty-four (56%) of forty-three staff members reported several non-specific symptoms which they felt were associated with being in the school building. Eye irritation, fatigue, throat irritation and headache were the most commonly reported complaints. The fall of 1979 was identified by ten respondents as the period of symptom onset. Thirteen (30%) of the staff members reported no building-associated symptoms, while six (14%) of the staff members were "not sure" if their reported symptoms were building-associated. Claims (unsupported by data) that over 90% of the school's staff have suffered ill-effects seem to have been overstated.

On the basis of the data obtained in this investigation, a health hazard from exposures to chemical contaminants in the East Jackson Middle School could not be documented. The numerous complaints of irritant symptoms may be in part related to the school's heating, ventilating and air conditioning (HVAC) system. Recommendations pertaining to the HVAC system are presented in Secion VIII of this report.

KEYWORDS: SIC 8211 (Elementary and Secondary Schools), ventilation system, mucous membrane irritation, fatigue, headaches.

II. INTRODUCTION

On July 12, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the East Jackson Middle School in Jackson, Michigan. The request was filed jointly by the Michigan Department of Public Health (MDPH), the East Jackson School District, the Jackson County Health Department and the East Jackson Teachers Association. The request asked NIOSH to evaluate conditions in the middle school where several school staff members have complained of a variety of symptoms since the summer and early fall of 1979. The symptoms, including headache, fatigue, sinus and respiratory irritations, and eye and skin irritations, are believed, by the staff members, to be caused by the presence of airborne contaminants resulting from the ineffectiveness of the school's heating, ventilating and air conditioning (HVAC) system.

Although some staff members have taken extended sick-leave absences, most of the illnesses have been minor in nature, and of short duration. In the 3½ year history of the problem, no unusual time-place clustering of related illness in staff members or students has ever been identified. Previous environmental evaluation of the building has not identified any concentration of airborne substances sufficient to cause the health complaints.

A preliminary site visit and opening conference were held at the school on August 12, 1982. Information from previous investigations of the school was subsequently reviewed at the Michigan Department of Public Health and at the East Jackson School District. On September 28, 1982, NIOSH began its initial survey. The survey involved collection of long-term and "spot" air samples to evaluate airborne concentrations of formaldehyde, carbon monoxide, hydrogen sulfide, sulfur dioxide, nitrous fumes and carbon dioxide. Additionally, medical questionnaires were administered to school staff members to characterize the health problems staff have experienced.

A follow-up environmental survey of the building was conducted on January 21, 1983.

III. BACKGROUND

The East Jackson Middle School is a single story, double brick building constructed in 1973, and situated in very spacious and relatively rural surroundings, several miles from any heavy industry. The building is approximately 80,000 square feet in size and can house in excess of 500 students. Currently 362 students attend 6th, 7th and 8th grade classes at the school. Prior to the 1982-83 school year, 5th grade classes were also taught at the middle school.

Forty-four faculty and staff members (currently 13 males and 31 females) work in the school which is composed of 24 classrooms, 5 specialized instruction rooms (art, industrial arts, band, choral and home arts) a library, a kitchen and cafeteria, gymnasium, conference and school administration offices and a staff lounge. The majority of the classrooms and the library are located in the south wing of the school, typically called the

"academic" wing. The north or "activity" wing of the school houses the band, art room, etc., the cafeteria, kitchen, teachers' lounge and physical plant. The two wings are joined by a long corridor that has the gymnasium and the main entranceway to the school at its midpoint. The school structure, designed for energy efficiency, is virtually windowless, with the exception of the principal's office, the counselor's office, and the staff lounge. These rooms have functional windows. Typically, most of the rooms within the school are peripherally located, each with two doors, a main access door off a corridor and a fire exit door opening directly outside. With the exception of the science rooms, the academic wing of the building is carpeted. At the time of this investigation, five classrooms were unoccupied. There have been no renovations in the building since it was first occupied in 1973.

The building was originally equipped with ten Nesbitt rooftop, multi-zone heating, ventilating and air conditioning units. The system delivers filtered air to the building's ten ventilating zones through sheet metal ducts. Air is diffused from ceiling diffusers. Air is returned to the system also by ceiling return-air diffusers.

A single humidification system is installed to service the library. However, this system has been inoperable for some time. The remainder of the building has no provisions for humidifying the air.

The entire HVAC system has been a constant maintenance problem, with frequent malfunctions and breakdowns. At the time of this investigation, only one unit was being operated in the air conditioning mode. In September, 1982, a new TRANE rooftop HVAC unit was installed, replacing one of the original Nesbitt units that had worn out.

HISTORY OF THE PROBLEM

In July, 1979, the Michigan Department of Public Health (MDPH) and the Jackson County Health Department received complaints from a school staff member reporting that several school staff members were suffering from "building-related-illness," characterized by multiple symptoms and suggesting that carbon monoxide poisoning and Legionnaires Disease be investigated as possible causes of the problems. Results of these investigations revealed no unusual environmental findings. Carbon monoxide was not detected in any of the environmental samples and no violations of any Michigan occupational health standards were identified. Medical epidemiologists from MDPH investigated the health complaints and concluded that the symptoms experienced by the staff members were unrelated to Legionnaires Disease.

Problems with the HVAC system were documented by both the county and state health departments and recommendations for repair and maintenance were made.

Further examination of the building was requested by the school district in October, 1979, when one of the teachers filed a grievance. The grievance, supported by a physician's statement, concluded that the teacher was suffering from Legionnaires Disease and/or oxygen deprivation.. The East Jackson Teachers' Association also filed a complaint at the same time to the Division of Occupational Health, MDPH, outlining the multiple symptoms suffered by several teachers at the school. An epidemiologic investigation was initiated on November 1, 1979, by MDPH. Environmental sampling was conducted once again by the Division of Occupational Health, MDPH, on November 13-15, 1979.

In a report issued February 1, 1980, the State Epidemiologist at MDPH concluded that there was no apparent health hazard related to the building. Legionnnaires Disease had been satisfactorily ruled out in the case of the one teacher and no other unusual clustering of related illness was identified. Environmental findings indicated that oxygen and carbon dioxide levels were normal, recorded temperatures were within comfort ranges and no carbon monoxide was detected. Although some of the HVAC damper motors were not operating during this sampling period, supplied air volumes were determined to be adequate.

Subsequently, the school district contracted with the Jackson office of the engineering firm of Gilbert Commonwealth Associates to conduct an air quality study to evaluate the test data, reports, toxicology and epidemiology pertaining to the middle school and to make recommendations.

On March 31, 1980, Gilbert Commonwealth Associates reported their findings in Engineering Report R-2151 and made the following recommendations:

1. "Accept the Michigan Department of Public Health test data and conclusions as empirical evidence of presumed satisfactory air quality as of the dates and under the ambient conditions under which they were taken."
2. "Do not conduct additional bacteriological or toxic chemical testing unless evidence points to a single causative agent, or epidemiological investigation shows a relationship between reported illnesses."
3. "Should reported illnesses of unknown etiology and similar signs and symptoms occur, consider the efficacy of conducting specialized urine, blood, liver function, pulmonary function and other tests, as appropriate, since such tests are quite sensitive in detecting specific toxic agents or bodily dysfunction."

On May 12, 1980, Gilbert Commonwealth Associates issued a second report; Engineering Report R-2150 that assessed the school's heating, ventilating and air conditioning system. The report described four basic problems with the HVAC system:

1. "mechanical problems with the air conditioning units"
2. "air distribution problems in the classroom areas"
3. "undercapacity of the air conditioning units"
4. "high energy utilization of the system"

The report also presented the following recommendations:

1. "install perimeter heating"
2. "modify damper arrangements"
3. "replace air conditioning units fans"
4. "add makeup air to the system"

The school district did not implement the recommendations, citing a lack of funds to cover their cost-estimated to be in excess of $100,000.

In January, 1981, the building was examined once again for ambient temperature and oxygen and carbon dioxide concentrations, this time by a physiologist from Michigan State University, hired in conjunction with a law suit filed by one of the teachers. The results of these tests essentially confirmed the results of similar tests conducted by MDPH in November, 1979, and thus, revealed no significant new findings.

In January, 1982, teacher absenteeism began to increase and some teachers required extensive sick-leave for recuperation from problems they attributed to the building. During April and May, 1982, teacher absenteeism peaked to 25%. Several teachers, unconvinced by negative environmental findings, continued to seek medical attention to determine the cause of their illnesses. One physician suggested three chemicals, formaldehyde, phenol and ethanol, could be causing the problems. On April 7, 1982, and again on May 18, 1982, the Jackson County Health Department conducted tests to measure formaldehyde and phenol concentrations in the air. Results of those tests revealed no detectable levels of either chemical.

Although the school district has, to date, not implemented the specific recommendations for modifying the HVAC system, the system has not gone unattended. Repair of the frequent breakdowns has kept the system in operation, although in the spring of 1982, on the advice of Commonwealth Associates, the air conditioning component of the system was shut down. In an attempt to address the air stratification problems, reported by Commonwealth Associates, various floor fans were placed in four middle school classrooms on April 18, 1982. The fans were removed the following day because the teachers involved claimed that the air movement produced symptoms, rather than eliminate them. Increased public concern about the continuing problems in the school, prompted the formation of a "Concerned Parents" organization in the spring of 1982, public meetings, and at least two surveys, (one conducted by parents and one conducted by the Jackson County Health Department). On July 12, 1982, NIOSH received the request to conduct a health hazard evaluation.

IV. METHODS

A. Environmental

Initial Survey - September 28 - October 8, 1982

Sampling sites were selected, in part, to correspond with locations in the school, where complaints have been previously reported.

Long-term (4-8 hour) area samples were collected in the library and four classrooms to evaluate airborne concentrations of hydrogen sulfide (H_2S), carbon monoxide (CO) and sulfur dioxide (SO_2). These samples were collected using long-term, direct reading, Drager detector tubes attached via tygon tubing to calibrated, battery powered pumps operating at 20 cc per minute. Results of these tests were recorded at the end of the sampling period.

Area "spot samples" were collected in four classrooms, the library, the teachers' lounge and the school's administration office, to evaluate airborne concentrations of carbon monoxide (CO), formaldehyde (HCHO), nitrous fumes (nitric oxide NO and nitrogen dioxide NO_2) and carbon dioxide (CO_2). These samples were collected according to the manufacturer's instructions using a Drager hand-pump and Drager direct reading detector

tubes. Results of these tests were recorded immediately after the conclusion of each test.

Long-term (8-hour) samples for formaldehyde were collected in the library and two classrooms using XAD-2 resin tubes attached via tygon tubing to calibrated, battery powered pumps operating at 50 cc per minute. These samples were analyzed by gas chromatography according to a modification of NIOSH Method P & CAM 354.

In addition, the entire building was examined three times using an HNU Photo-Ionizing detection instrument which is a general screening device used to determine the presence of a variety of organic and some inorganic constituents that have an ionizing potential (IP) of $\leq$ 11.70 units. Some of these include alcohols, aldehydes and other hydrocarbons. The HNU sensor consists of a sealed ultraviolet light source that emits photons that are energetic enough to ionize many trace constituents but do not ionize the major components of air. Constituents of a sample are ionized, producing an instrument response which is displayed on the readout unit.

Preliminary findings of the initial survey and recommendations were reported by letter on October 21, 1982.

Follow-up Survey - January 21, 1983 (Conducted Unannounced)

Drager direct-reading detector tube samples were obtained to evaluate airborne concentrations of methyl alcohol (methanol CH_3OH) and ethyl alcohol (ethanol CH_3CH_2OH), carbon dioxide (CO_2), formaldehyde (HCHO) and carbon monoxide (CO).

Results of this survey were reported by letter on January 25, 1983.

Medical

Confidential medical questionnaires were obtained for 43 of 44 current and former staff members of the middle school, who worked at the school during the 1981-82 school year.

The questionnaires solicited information on the incidence of and perceived building relatedness of several irritating and other kinds of symptoms, pre-existing medical conditions, use of medications, and other related personal characteristics. Additionally, the questionnaires addressed various other epidemiologic considerations; comparisons of affected and not affected individuals by age, sex, work location and length of employment at the school; variations of the reported problems with regard to season, times of day, week, and weather conditions; and other potential contributing factors. The following definitions were used to classify respondents: "Affected" - individuals who reported building-associated symptoms; "Not Affected"- individuals who reported no building-associated symptoms; and "Not Sure" - persons not sure if the symptoms they reported were building-associated.

V. RESULTS

A. Environmental - Initial Survey

Results of the indicator tube surveys conducted September 29 - October 8, 1982, revealed no detectable levels of any of the substances evaluated. Carbon dioxide measurements were within normal ranges. The results of these samples are presented in Tables 1, 2 and 3.

Table 1

Long-term (4-8 hours) direct reading indicator tube samples

Qty.	Location	Sample	Result	Limits of Detection
1	Library	Hydrogen sulfide	none detected	0.5 ppm
4	Rooms 104, 109 118, 202	Carbon monoxide	none detected	5 ppm
1	Library	Sulfur dioxide	none detected	1 ppm

Table 2

Direct reading indicator tubes -- "spot samples"

Qty.	Location	Sample	Result	Limits of Detection
1	Lounge	Carbon monoxide	none detected	5 ppm
4	Rooms 110, 118 201, Lounge	Formaldehyde	none detected	0.5 ppm
3	Library, Lounge "Office"	Nitrous fumes (nitric oxide, nitrogen dioxide)	none detected	2 ppm

Table 3

Direct reading indicator tube samples for carbon dioxide

Qty.	Location	Results % by Volume CO_2 (ppm)	Limits of Detection
1	Room 104	0.02% (200 ppm)	0.01% by Vol. CO_2 (100 ppm)
1	Room 110	0.06% (600 ppm)	"
1	Room 118	0.04% (400 ppm)	"
1	Room 201	0.08% (800 ppm)	"
1	8" from ceiling in Rm. 201 (approximately)	0.06% (600 ppm)	"
1	Outdoors by Room 201	0.02% (200 ppm)	"

(Differences in CO_2 measurements can be attributed to the size of the classrooms, the number of students present during the test and whether or not the doors were opened.)

Three XAD-2 resin tube samples for formaldehyde (and two blank control samples) were obtained in the library, room 109 and room 118, and analyzed by gas chromatography using a modification of NIOSH Method P & CAM 354. Formaldehyde was not detected in any of the samples. The limit of detection for these analyses was 5 micrograms (ug) per sample. Complete results for those samples are listed in Table 4.

Table 4

Location	Litres of Air Sampled (approx.)	Result ug/Sample (ppm)	Limits of Detection
Library	26	< 5 ug/sample (< .15 ppm)	5 ug
Room 109	23	< 5 ug/sample (< .21 ppm)	"
Room 118	25	< 5 ug/sample (< .20 ppm	"
Library	Blank	< 5 ug/sample	"
Library	Blank	< 5 ug/sample	"

Results of general scanning of the building, using the HNU photoioninzing detection instrument revealed no detectable constituents. The limits of detection for the HNU photoionizer were determined by the ionizing energy supplied by the instrument's ultraviolet (uv) lamp, which in this case was 11.7 electron volts (eV). Thus, only constituents whose ionizing potential was equal to or less an 11.7 eV would have been capable of producing an instrument response.

Follow-up Survey:

Results of the follow-up environmental survey conducted on January 21, 1983, revealed no detectable levels of any of the substances evaluated. Carbon dioxide measurements were within normal ranges. The results of these samples are presented in Table 5.

Table 5

Qty.	Location	Sample	Result	Limits of Detection
8	"Work Room", Library, Lounge, Rooms 104, 109, 110, 118, 201	Methanol and ethanol	None detected	200 ppm
1	Library	Formaldehyde	None detected	0.5 ppm
2	Library, Room 109	Carbon monoxide	None detected	5 ppm
1	Library	Carbon dioxide	.02% (200 ppm)	0.01% (100 ppm)
1	Room 109	Carbon dioxide	.06% (600 ppm)	0.01% (100 ppm)

Cleaning agents, pesticides and other chemicals used routinely at the middle school (and throughout the entire school district) were evaluated as possible causes of the problems - and satisfactorily ruled out. Significant exposures, in persons other than the school's custodial staff, could not be documented. Additionally, the absence of specific complaints from the custodial staff (and elsewhere in the school district), associated with these agents, seemed to sufficiently rule them out as problem sources.

B. Medical

Confidential medical questionnaires were completed on 43 (97%) of 44 individuals who comprised the middle school staff for the 1981-82 school year. This number included teachers, teacher aides, secretaries, cafeteria staff and custodians. (Selected characteristics of the school's staff members are presented in Table 6.)

Forty-one of the questionnaires were administered directly to participants by NIOSH personnel, while two were returned by mail.

Results of the medical questionnaire survey did not identify any time-place clusters of related illnesses occurring in the school that could be attributed to any significant exposures to chemical contaminants in the school's environment. Rather, the survey documented numerous, complaints of fatigue, eye and mucous membrane irritations, headaches and a variety of other irritant symptoms, commonly associated by respondents with being in the building, and commonly attributed by respondents to the school's HVAC system. Specific results were as follows:

Twenty-four (56%) of the school's 43 staff members reported ill effects associated with being in the building and characterized by some of the following symptoms; eye irritation, fatigue, headache, joint pains and stiffness, nasal and throat irritations and various skin irritations. Thirteen (30%) of the staff members reported no building-associated symptoms, while the six remaining staff members (14%) were "not sure" if the symptoms they reported were building related.

Responses to direct inquiry about 19 specific symptoms revealed the following results:

Among the 24 "affected" individuals, eye irritation (described as burning, itching, dry-sticking lids, swollen or gritty) along with fatigue, were equally reported by twenty persons. Throat irritation (described as dry and/or sore) and headache were reported by seventeen and sixteen individuals respectively. Joint pains and stiffness, nasal congestion, dizziness and lightheadedness, skin irritation (itching, burning, flushed face, dermatitis, etc.) and ringing in the ears were also reported at high frequencies. Typically, these symptoms were reported to occur insidiously, affecting persons in varying degrees of severity and duration. Some of the "affected" individuals reported sporadic episodes of symptoms during the past year, while others reported symptoms occurring almost daily, to three or more times per week. While six of the "affected" persons reported not having lost any work time due to their symptoms, at least ten people have consumed considerable amounts of sick-leave time. (At the time of this investigation, two staff members were still on extended sick leave, unable to work in the building.) Many of the individuals reporting ill effects, consider them annoying but not very serious. However, a few of the individuals who have been severely affected, expressed serious concern about their altered health status.

Among the thirteen "not affected" individuals, nine reported never having experienced any ill effects associated with the school building. Of the four persons who did report symptoms, joint pains and stiffness was the only consistent problem identified, and this, as well as the other scattered symptoms reported, was not attributed to conditions in the building.

Of the six persons "not sure" of building associated ill effects, fatigue and joint pains and stiffness were reported by five persons and three persons respectively, along with various other symptoms having fewer responses. The complete distribution of symptom responses is presented in Table 7.

Within the group of "affected" individuals, ten persons identified 1979 as the year of onset of their symptoms, with seven persons specifically pinpointing the fall season. This time was also identified by many individuals as the time when the HVAC system began to have frequent breakdowns. Six persons had onset during the fall of 1981. However, a specific event linked to this onset period, could not be identified.

Analysis of the "affected" and "not affected" individuals by age, sex and length of employment revealed no substantial findings. The attack rates in males (50%) and in females (58%) were not substantially different.

There were no correlations of the occurrence of symptoms with regard to season, specific weather conditions, times of day, days of the week, or particular locations within the building. Because few of the 43 staff members ever leave the building during lunch hours, comparisons of relief and/or disappearance of symptoms, in persons who leave the building, to those who stay, could not be considered.

The use of the spirit duplicating machines was directly associated with specific symptoms by four persons (rash in one person, metallic taste in a second person, eye irritation by the third and "allergy" described by the fourth).

Twenty-six persons reported difficulties getting to sleep at night or disturbed sleep. Twenty-four persons (fifteen in the affected group) reported various kinds of allergies (foods, hay fever, etc.)

Twelve individuals, all in the affected group, reported having undergone chemical sensitivity testing for formaldehyde, phenol and ethanol, after a physician suggested that these substances might be present in the school building. Ten of these individuals reported that their test results indicated "sensitivity" to one or all three of the chemicals. These 10 individuals also reported that they had received and used, dilutions of those chemicals, applied as sub-lingual drops (typically 2-3 times per day) apparently as a "desensitizing" therapy. One person reported that the drops helped to relieve some symptoms, particularly ringing in the ears.

A list of reproductive outcomes, (collected by one of the teachers) indicating births and negative outcomes in some of the current and former staff members of the school, was submitted to NIOSH for comment.

During the investigation, a peculiar odor, best described as "green" or fresh concrete and slightly irritating to the nose of the NIOSH investigator, was present in one classroom and the teacher's lounge. Despite an extensive effort, a source of the odor could not be identified.

In summary, this survey documented numerous non-specific complaints of varying degrees of eye irritation, fatigue and headache, and a high frequency of other irritant symptoms in 56% of the school's staff members. Ten persons identified the fall of 1979 as the initial period of symptom onset while 6 others identified the fall of 1981. Symptoms were most commonly associated by staff members with the ineffectiveness and frequent breakdown of the school's HVAC system.

Since the environmental survey was unable to identify any airborne substance that would be responsible for the adverse health effects reported by staff members, and the epidemiologic findings could not identify any time-place clustering of related illnesses, a specific cause of the reported illnesses could not be determined.

VI. DISCUSSION

Air quality in the East Jackson Middle School has been the center of controversy for over 3½ years. Despite investigations from three independent health agencies, a specific building associated cause of the complaints has never been identified. Toxic agents and other contaminants appear to have been adequately ruled out as possible causes in this and previous investigations of the building. One can speculate about additive or synergistic effects from exposure to low levels of several chemicals, however, these effects would seem unlikely since rather extensive environmental testing has never identified measurable concentrations of any single suspect agent. One can also speculate about the continuing presence of some unknown agent that eludes all of the current detection capabilities, however, it is difficult to imagine just what that agent could be, and such a finding still would not explain the lack of any epidemiologic pattern for the reported health effects.

In the past three years NIOSH has conducted many health hazard evaluations in response to workers' complaints of building-associated illnesses or symptoms. In most of these investigations exposures to chemicals in concentrations sufficient to cause the symptoms are rarely found and in the absence of such findings, complaints have typically been attributed to inadequate heating, ventilation and humidification. While there are few similarities about the buildings themselves, symptoms present a strikingly similar pattern with fatigue, headache, mucous membrane irritation of the eyes, nose and throat and skin irritation as recurrent complaints.[1] However, the factors causing these irritations appear to be very complex and are not well understood.

We have also observed in reviewing these investigations that many of them have been charged situations in which feelings have run high, and frequently, resolution of the problem has been further complicated by misinformation and misconceptions. The East Jackson Middle School investigation has been no exception. In the absence of specific findings over the 3½ year duration of the problem, many persons, in the school and the community, have developed very definite opinions as to what the cause of the problem is and have gone to great lengths to gather reports, news and magazine articles and other "supporting data", to boost their opinions. When respected health care providers have suggested chemical contamination of the school and have implicated substances such as formaldehyde, investigators have been pressed to justify their sampling methods and the validity of their findings when none of the substances are found. Typically, out-gasing of chemicals, such as formaldehyde, from a building's fabric, are usually recognized when a building is newly constructed, newly renovated, or has had recent installation of foam insulation or new carpeting, etc. Additionally, as the age of the structure increases, out-gasing should decrease substantially and gases that remain (if any) should be diluted by the component of fresh air introduced into the ventilating system. In the middle school, it has been suggested that the frequent breakdowns of the HVAC system have altered the system's capability to effectively dilute any airborne pollutants. Although this is possible, environmental sampling should have identified some substance. In the case of formaldehyde, this ubiquitous substance is almost always a consideration in indoor air quality studies due to the great public awareness and concern about this chemical. In the middle school, where there has been a great deal of concern about this chemical, formaldehyde has never been found despite rather extensive and sensitive testing methods. Because formaldehyde can be normally present at low or "background" levels, it would be difficult, to associate complaints with trace amounts of formaldehyde and implicate this (or any other) building as the specific source of the problem.

However, in the 3½ year span of the problem, some of the staff members remain unconvinced that chemical contaminants are not the source of their numerous complaints and point to their positive results from the chemical sensitivity tests as conclusive evidence. NIOSH was subsequently asked to comment on these test results and accordingly, NIOSH medical staff were consulted.

With the disturbing number of individuals who continue to experience ill effects, it is understandably tempting to grasp any findings that might offer a plausible explanation. However, individuals should be aware that the effectiveness of chemical sensitivity testing has not been established. The undocumented information reported to NIOSH regarding individuals' chemical sensitivity test results is insufficient to comment upon. Assuming that sufficient information about these tests could be provided, since chemical exposures have not been documented at the school, it would be unclear what these test results mean.

Other findings of a controversial nature in this investigation were the reports by ten individuals who have taken, sub-lingual drops of diluted chemicals (formaldehyde and/or phenol and/or ethanol) apparently as a "desensitization" therapy. In a recent article appearing in the Journal of the American Medical Association (JAMA), Grieco[2] reviewed the literature describing sub-lingual provocative testing for diagnosis and desensitization of food allergy and reported; "There is no objective evidence to support the use of the sub-lingual method for diagnosis of food allergy." He further noted that, "controlled studies of sub-lingual desensitization have not been reported." Contact with the Food and Drug Administration (FDA) revealed no additional information about this form of therapy used for chemical desensitization. The FDA's Investigation of New Drugs (IND) registries reportedly contained no listing of controlled studies evaluating this therapy and a drug safety officer and two physicians at the FDA were unaware of the use of this type of therapy in conjunction with chemicals. It is clear that the efficacy and safety of sub-lingual therapy for formaldehyde, phenol and ethanol desensitization has not been established.

NIOSH was also asked to comment on the "seemingly high rate of birth problems" occurring among the school's staff. NIOSH was furnished a list of 14 birth outcomes occurring in seven families since approximately 1974. In two of the families the staff members were males. Eight negative birth outcomes were listed: 3 miscarriages, 1 still birth, 2 heart conditions (1 died) and 2 "serious" allergies. Of the five female staff members, three left the middle school in 1974, 1977 and 1978 -before complaints associated with the building were reported. The absence of documented exposures in this investigation to any substances known to cause reproductive abnormalities suggests that these birth problems were probably due to other causes and not associated with the school building. Additionally, epidemiologic investigations are contingent upon several observations of the same or similar events occurring in a defined group. Results of epidemiologic investigations involving such small numbers, typically are inconclusive and have very limited interpretive value.

Although students' complaints were not a focus of this investigation, some students have experienced a similar variety of non-specific symptoms as staff members have. Previous attempts to document students' complaints (absentee records, mail and telephone surveys, etc.) have been largely unsuccessful though, and may have been affected by reporting biases and other methodological constraints.

While a great deal of effort has been devoted to identifying a toxic etiology for the staff members' complaints, the absence of such findings suggests other causative factors. If epidemiologic considerations have any relevance to this investigation, then 1979 seems to be the time when problems with the HVAC system were linked with the onset of complaints. (This estimate may be affected by reporting bias, however, as a result of widespread and prolonged discussion of the problem over the past 3½ years.) Although there is no strong link, the problems documented in Commonwealth Associates Engineering Report No. 2150, regarding makeup air and air stratification, may be important factors pertinent to staff members' complaints. Unknown additive or synergistic effects of temperature and low humidity during colder months may be influencing factors as well. One can also speculate about the roles of noise, lighting, stress, anxiety and annoyance from body and other odors, as contributing factors, however, acceptable methods to investigate the association of these factors may not be easily available.

VII. CONCLUSIONS

Twenty-four (56%) of 43 staff members have been affected by a variety of non-specific, irritating symptoms including headache, fatigue, and mucous membrane irritations of the eyes, nose and throat. These symptoms were commonly associated with the school's HVAC system. Claims (unsupported by data) that over 90% of the school's staff have suffered ill effects, could not be substantiated. While some persons reported experiencing rather severe effects, there was no consistency of abnormalities in these reports and time-place clustering of related illnesses could not be identified.

Four individuals also reported singular effects attributed to spirit duplicating fluid, however, there is no evidence to suggest exposure to methyl alcohol as the cause of the complaints throughout the school.

Environmental sampling did not detect any measurable concentrations of formaldehyde, methyl alcohol, carbon monoxide or any of the other chemicals thought to be contaminating the building.

Based on the data obtained during this investigation, a specific cause of the illnesses could not be determined.

VIII. RECOMMENDATIONS

At the time of this investigation recommendations for venting the spirit duplicating machines were made and have since been implemented. Additionally, daily inspection of the rooftop HVAC units by the custodial staff and documentation of any problems found, were also recommendations that were implemented.

Ventilation System

Neither NIOSH nor OSHA has developed ventilation criteria for "general offices." Criteria typically used, are the guidelines recommended by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). Essentially, NIOSH feels that indoor air should not contain concentrations of contaminants known to impair health or to cause discomfort to a substantial majority of occupants. The difficulty is, threshold levels for health effects from exposures to contaminants such as gases, vapors, microorganisms, smoke and dusts, are poorly documented, and may vary significantly among individuals exposed.

The following recommendations are intended to provide a comfortable environment for students and staff at the East Jackson Middle School.

1. Ambient air quality should meet or exceed the new ASHRAE standard, 62-1981, "Ventilation for Acceptable Indoor Air Quality."[3] The intent of this standard is to provide "General Offices" with adequate outdoor or makeup air, to dilute carbon dioxide to less than 2500 ppm and to control airborne contaminants so that concentrations known to impair health or cause discomfort are not exceeded. Specifically, ASHRAE recommends a minimum of 5 cubic feet per minute (cfm) of outside air per person, for classrooms in academic buildings where smoking is not permitted (provided that the air is not recirculated from smoking areas). In rooms where smoking is permitted in these settings, (i.e. the staff lounge), ASHRAE recommends higher ventilation rates - 25 cfm of outside air per person.

2. NIOSH concurs with the findings and recommendations presented in Gilbert Commonwealth Associates Engineering Report No. R-2150 and recommends their implementation with the following additions;

   A. Repair and modification of the HVAC system should be performed so the equipment can provide ventilation in accordance with ASHRAE standard 62-1981.

   B. The proposed repairs and modifications should be preceded by a complete ventilation study of the school by appropriate heating and ventilation professionals. (Ventilation rates throughout the school have not been measured since the new ASHRAE standard was published in 1981, thus NIOSH feels that the "current status" of the school's HVAC system should be determined before the proposed repairs and modifications are made. NIOSH also suggests that the school district contract with local professionals to conduct this study since the HVAC system may require frequent adjustments to achieve a comfortable building environment.)

3. Install a humidification system for the entire school and repair the humidification system in the library.

4. Establish a routine (prevention oriented) maintenance program for the HVAC system.

X. REFERENCES

1. Keenlyside, R.A. Personal Communication of Unpublished Data.
2. Grieco, M.H. "Controversial Practices in Allergy" JAMA, 1982:247: 3106-3111.
3. ASHRAE Standard 62-1981: Ventilation for Acceptable Indoor Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers, New York, 1981.
4. National Research Council Committee on Toxicology. "Formaldehyde: An Assessment of its Health Effects." National Academy of Sciences. Washington, D.C., 1980.
5. Occupational Disease: A Guide to Their Recognition. National Institute for Occupational Safety and Health. DHEW (NIOSH) Publication No. 77-181, June, 1977.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report Prepared By:

Kern E. Anderson
Public Health Advisor/Epidemiologist
Hazard Evaluations and Technical Assistance Branch

Field Assistance:

Michael T. Donahue
Physician's Assistant
Hazard Evaluations and Technical Assistance Branch

Environmental Survey Design:

William J. Daniels
Industrial Hygienist
NIOSH - Region V
Chicago, Illinois

Table 6

SELECTED CHARACTERISTICS OF STAFF MEMBERS SURVEYED AT THE EAST JACKSON MIDDLE SCHOOL, JACKSON, MICHIGAN: SEPTEMBER - 1982.

Females: N = 31 Males: N = 12 Total: N = 43

AGE PROFILE: All Staff

	Mean	Median
Females	46	46
Males	47	47
F & M	46	46

LENGTH OF EMPLOYMENT AT EJMS - All Staff

Years Employed	1-3	4-6	7-9+
Number of Staff	9	8	26

"AFFECTED PERSONS"

N=24; 18 Females; 6 Males
Attack rates - F (58%)
M (50%)

Age Profile

	Mean	Median
Females	45	45.5
Males	47	47
F & M	45	46

YEARS IN BUILDING

	Mean	Median
Females	6.2	8
Males	8	9
F & M	6.7	9

"NOT AFFECTED" PERSONS

N = 13; 9 Females; 4 Males

Age Profile

	Mean	Median
Females	46	46
Males	53	54
F & M	48	52

YEARS IN BUILDING

	Mean	Median
Females	5.1	5
Males	9.2	9
F & M	6.3	7

"NOT SURE" PERSONS

N = 6 4 = F 2 = M

Age Profile

	Mean	Median
Females	48.5	46.5
Males	36.5	36.5
F & M	44.5	42

Years in Building

	Mean	Median
Females	6.8	7
Males	8	8
F & M	7.1	8

Table 7

DISTRIBUTION OF RESPONSES TO DIRECT INQUIRY ABOUT SPECIFIC SYMPTOMS AMONG 43 SCHOOL EMPLOYEES AT THE EAST JACKSON MIDDLE SCHOOL, JACKSON, MICHIGAN - SEPTEMBER 1982

SYMPTOM	TOTAL RESPONSES	(%)	BUILDING ASSOCIATED	(%)	NOT BUILDING ASSOCIATED	(%)	NOT SURE	(%)
Fatigue	26	(60)	20	(47)	1	(2)	5	(12)
Eye Irritation	23	(53)	20	(47)	2	(5)	1	(2)
Joint Pain/Stiffness	22	(51)	15	(35)	4	(9)	3	(7)
Throat Irritation	19	(44)	17	(40)	1	(2)	1	(2)
Headache	19	(44)	16	(37)	1	(2)	2	(5)
Nasal Congestion	18	(42)	14	(33)	2	(5)	2	(5)
Dizziness/Lightheadedness	18	(42)	17	(40)	0	-	1	(2)
Shortness of Breath	14	(33)	12	(28)	0	-	2	(5)
Chest Tightness	14	(33)	12	(28)	0	-	2	(5)
Skin Irritation	13	(30)	12	(28)	1	(2)	0	0
Ringing in the Ears	12	(28)	11	(26)	0	-	1	(2)
Cough	11	(26)	9	(21)	1	(2)	1	(2)
Sneezing	10	(23)	9	(21)	1	(2)	0	-
Nausea	10	(23)	9	(21)	1	(2)	0	-
Metallic Taste	10	(23)	8	(19)	0	-	2	(5)
Numbness or Tingling	10	(23)	10	(23)	0	-	0	-
Loss of Coordination	9	(21)	7	(16)	1	(2)	1	(2)
Wheezing	5	(12)	4	(9)	0	-	1	(2)
Rash	4	(9)	3	(7)	0	-	1	(2)
Frequent Urination	3	(7)	3	(7)	0	-	0	-
Mental Confusion	2	(5)	2	(5)	0	-	0	-

No. of Persons in Category (%) T = 43 (100%) N = 24 (56%) N = 4 (9%) N = 6 (14%)

Persons reporting no symptoms: N = 9 (21%)