NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2005-0033-2984 and 2005-0234-2984
Liberty Central School District
Liberty, New York

November 2005

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) of the National Institute for Occupational Safety and Health (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 (OSH) Act of 1970, 29 U.S.C. 669(a)(6), or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorizes the Secretary of Health and Human Services, following a written request from any employers 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.

RDHETAP also provides, upon request, technical and consultative assistance 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. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Jeana M. Harrison and Terri A. Pearce, Ph.D. of the RDHETAP, Division of Respiratory Disease Studies (DRDS). Desktop publishing was performed by Amber Harton.

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HIGHLIGHTS OF THE NIOSH HEALTH HAZARD EVALUATION AT LIBERTY CENTRAL SCHOOL DISTRICT

NIOSH received a confidential Health Hazard Evaluation (HHE) request regarding indoor environmental quality at the Liberty Central School District Elementary School. Upon learning about the Elementary School request, the school administration submitted a second HHE request for the Middle and High Schools.

What NIOSH Did

- Conducted walkthroughs at each school
- Conducted observational assessments in all rooms at the Middle School (reported to be the school with the most known leaks and water incursion) and some rooms in the other two schools
- Combined the observational assessments with real-time monitoring of room air for temperature, relative humidity, and carbon dioxide concentration
- Discussed indoor air quality problems with teachers and staff in each school

What NIOSH Found

- Visible mold on the mural in the Middle School lobby and in the stairwell near exit 6
- Ongoing water leaks in the Middle School, particularly around windows on the south side of the building
- Water incursion in one boiler room in the Elementary School
- Rusty, and possibly moldy, window blinds in the High School library
- Some evidence of previous leaks and water damage in each school

What Managers Can Do

- Remove or remediate the mold in the Middle School following the Environmental Protection Agency or New York City Department of Health and Mental Hygiene guidelines
- Re-grade the Middle School grounds to prevent storm water run-off from entering the building
- Continue to assess schools for water damage and high humidity and correct these conditions upon discovery
- Develop procedures for discarding porous water-damaged items and for properly cleaning non-porous or semi-porous materials that can be reused
- Implement the Environmental Protection Agency's *Tools for Schools* program

What Employees Can Do

- Seek physician treatment of health symptoms related to the school environment
- Report health symptoms related to the school environment
- Immediately report water leaks or incursions to school facilities personnel

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2005-0033-2984 and 2005-0234-2984

Health Hazard Evaluation Report
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received Health Hazard Evaluation requests for the Elementary, Middle, and High Schools in Liberty, New York. The request from the Liberty Faculty Association for the Elementary School listed teacher health concerns including allergy, sinus problems, asthma, respiratory problems, rashes, numbness, and headaches. The exposure concern was "poor air quality" with mold and paint odors listed as specific concerns. The request for the Middle and High Schools was submitted by the Superintendent of Liberty Central School District upon learning about the Elementary School request. Health concerns listed for the Middle and High Schools were respiratory or allergic reactions to possible mold exposure. The exposure concerns were mold and indoor moisture.

We conducted walkthroughs of each school using our semi-quantitative assessment sheet, a worksheet for a standardized observational assessment of occupied rooms.[1] We modified our existing worksheet to allow us to record values from moisture meter measurements of building components and real-time measurements of room temperature, relative humidity, and carbon dioxide concentration. The semi-quantitative assessment approach allowed us to document areas of water damage, humidity, or other problems in each school as a means to provide a focus for recommendations made to the school administration. We also compared our observational findings to the equipment measurements and found that at least for some rooms, higher observational scores did relate to elevated temperature or relative humidity.

Water damage and possible mold was found in each school, although the Middle School had more visible water damage than the Elementary or High Schools. Some window caulking had failed in the Middle and High Schools, allowing water to enter the classrooms through the window. There was an on-going water infiltration problem in the Middle School library and some classrooms, as evidenced by the containers on the windowsills used to capture rainwater. We found two areas of visible mold in the Middle School: on a mural in the lobby and in a stairwell near exit 6 (next to the cafeteria). We recommended removal of the mural and cleaning of the stairwell using the Environmental Protection Agency (EPA) or New York City Department of Health and Mental Hygiene guidance for mold remediation.[2,3]

The Elementary School has no mechanical ventilation in the main portions of the building. The windows are the only means of ventilation. The modular units had unit ventilators. Teachers report that they open

windows during the winter due to the heat and odors in the classrooms. Teachers also report that diesel exhaust enters the classrooms on the side of the building where buses load and unload the students. Some water stains and possible mold were found in the third floor hallway. Steam pipe leaks were reported to have occurred in several areas of the building. The modular units, especially the corridor, had odors while we were there. The corridor outside the restrooms smelled of urine. Frozen pipes under the modular units have burst according to teachers, leading to water incursion in the building.

The High School had stained ceiling tiles in many classrooms, condensation on many of the curtain wall windows, and some leaky windows. Some of the Plexiglas storm windows were failing as the plastic holding the Plexiglas in place was becoming brittle and breaking on some windows. At least one room had Plexiglas that was hanging from the window. The library had rusty, and possibly moldy, window blinds. The rust appeared to be caused by the blinds sitting in water or staying wet for long periods. We noticed other blinds in various rooms with rust and possible mold, although not to the extent of the library's blinds.

During our walkthroughs, we spoke to teachers in the Elementary and Middle schools who reported migraines, watery eyes, sore throats, and cough that they attributed to being in their school. Damp buildings have been associated with risk of nose and throat symptoms, cough, wheeze, asthma symptoms in sensitized persons, and hypersensitivity pneumonitis for building occupants.[4] Some evidence suggests that exposures in damp indoor environments are associated with shortness of breath and development of asthma.[4]

We documented dampness in all schools of the Liberty Central School District with the Middle School having both water leaks and visible mold. The finding of dampness in the school buildings calls for action by the school administration to correct the water incursion and to remediate the impacted building materials or furnishings. Employees experiencing health symptoms that they feel are related to the building should seek the care of a physician and should report their concerns to the school administration. Implementing the EPA program, "Tools for Schools", is recommended as a means to protect and maintain indoor environmental quality.[5]

Teachers in Liberty Central School District reported health conditions that they attributed to the school. NIOSH conducted a walkthrough of the three schools in the Liberty Central School District. We found evidence of water leaks and dampness in all schools with the Middle School having both active leaks and visible mold. The finding of dampness in the Liberty Schools calls for action by the school administration. Employees with health concerns related to the building should seek the care of a physician and should report their concerns to the school administration.

Keywords: NAICS 611110 (SIC 8211), mold, observational assessment, school, water stains

Table of Contents

Preface ii
Acknowledgments and Availability of Report ii
Highlights of the NIOSH Health Hazard Evaluation iii
Summary iv
Introduction 1
Background 1
Methods 3
Results 4
Discussion and Conclusions 7
Recommendations 8
References 10
Appendix 17
Evaluation Criteria 18

INTRODUCTION

On November 8, 2004, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from the Liberty Faculty Association, a union representing teachers working at Liberty Elementary School, Liberty, New York (HETA #2005-0033). The requestor noted allergies, sinus problems, asthma, rashes, and headaches thought to be related to poor air quality in the school, specifically mold exposure and diesel fumes. The Liberty Central School District Superintendent subsequently requested a Health Hazard Evaluation for the Middle and High Schools, which was received by NIOSH on May 10, 2005 (HETA #2005-0234). The second request listed respiratory problems and allergic reactions due to possible mold and moisture in the buildings.

NIOSH conducted a walkthrough of all three schools on June 16th and 17th, 2005. During the walkthrough, we used our observational assessment tool to document areas of water incursion or visible mold in each school. We also spoke to teachers and staff about health concerns and building conditions.

BACKGROUND

The Liberty Central School District consists of three school buildings that are in current use. Liberty Elementary School is a pre-kindergarten to 4th grade school with approximately 80 employees and 500 students. The original portion of the building was built in 1911 and is a four-story brick classroom building with the first story partially below-grade (Figure 1). A three-story brick gymnasium and classroom addition with a full basement was added in 1938, and the cafeteria was added in the late 1940's. Both the original building and the addition have plaster walls. Some rooms have the original tin ceilings while drop ceilings have been installed in other rooms and some hallways. Due to the age of the school, lead paint may exist on painted pipes, radiators, tin ceilings, and other places. The operable windows were replaced in the early 1980's. Some classrooms have stand-alone powered air filtration units. Most of the classrooms have the original wood floors, although some have been covered with tile or carpet. The hallway floors are either tile or what appeared to be original linoleum. The rubber-membrane roof was replaced in sections in 1983 and 1988.

The school is heated by two boilers, which are fueled by No. 2 fuel oil. Boiler Room 1 is located on the first floor (partially below-grade) in the original portion of the building, and Boiler Room 2 is located in the basement of the 1938 addition, which also had a coal bin with a coal chute. The coal has been removed and the chute has been covered, but residue is noticeable on the block walls in this area. The "coal bin room" in the 1911 portion of the building has been converted to a guidance counselor office that is used by two employees and six students on average. This room is adjacent to the boiler room and is mostly below grade.

The school also has four modular classrooms that were added in 1987 (Figure 2). A single roof constructed above the individual modular roofs encloses the four units and allows for a central hallway connecting the modular units to one another and the 1938 portion of the building. Restrooms are located off the central hallway. Unit ventilators heat and cool the modular classrooms while electric baseboards heat the hallway. Windows were operable and each classroom has two exit doors, one to the hallway and one to outside.

Teachers reported a previous "stream" of storm water runoff from the parking lot that ran underneath the modulars. This was corrected by improving drainage and installing skirting beneath the modular units. Teachers also reported bowing ceilings, water stains, and water incursion in various classrooms and hallways. Fuel oil odors from the boiler rooms are reported during the filling of the boilers. Diesel exhaust odors are reported by many teachers, especially in the rooms near the bus loading area. Teachers also report musty odors that are worst in the

mornings and dissipate when windows are opened. We were provided with copies of questionnaires completed by teachers describing areas of the school where there were issues with water leaks and concerns about mold. Health effects reported on the questionnaires were similar to those listed in the HHE request: sinus infections, headaches, dry cough, and numbness.

We were also provided with a report containing results of an indoor air quality investigation conducted at the Elementary School by the Sullivan County Board of Cooperative Educational Services.[6] The investigation was conducted at the request of the Director of Facility Support Services and was a follow-up to work completed at the school by the facilities staff in response to recommendations made in a previous investigation report. The report provided results of air sampling for mold and found that indoor concentrations of mold were similar to those measured outdoors. A carbon dioxide measurement in the lower level of the Elementary School was reported as elevated. Recommendations were made regarding keeping windows open and not allowing vehicles to idle in the vicinity of the open windows.

Liberty Middle School is a 90,000-square foot school built in 1991 with approximately 82 employees and 450 students in grades 5-8. This school is located in a residential neighborhood and consists of two buildings – one building contains classrooms and the cafeteria (Figure 3), the other building houses the gymnasium, band rooms, and boiler room. The buildings are constructed of concrete block with a brick veneer. The rubber-membrane and gravel roof is original to the building. The two-story, semi-circular portion of the building extends beyond the classroom building and houses the administrative offices and library. The greenhouse is located on the roof above the library. The buildings are connected to each other and Liberty High School by an enclosed hallway (Figure 4). The classroom building was built into a hill with three floors above grade in the front and two above grade in the back. The gymnasium building is above grade. The school grounds behind the classroom building flood during heavy or long rains. The wall adjacent to the hallway in every classroom has slotted block walls with an interior felt lining for soundproofing. All rooms and hallways have drop ceilings with acoustical tiles. The two-story lobby is the main entrance to the building and is occupied by a receptionist.

The school has a closed, heating/cooling single-pipe system with boilers that use No. 2 fuel oil. The pipes run through unit ventilators in each room that provide fresh air from the outside. The louvers on the unit ventilators are set at 15% outdoor air intake and are closed at night. This is the only school in the District with cooling capabilities, although the chillers were not operable during our visit. The administrative and student services offices are heated and cooled by residential-type heating, ventilating, and air-conditioning units (HVAC). Filters in the unit ventilators and the HVAC units are scheduled to be changed every two months. All rooms and hallways are vinyl tile with cement block walls.

This school has a history of water incursion since it opened in 1991. Rainwater from the adjacent street and from the school grounds has been reported to cause flooding in the student services office. The storm water drain pipe in this area was reportedly clogged and therefore did not allow drainage away from the building. Water enters through the fresh air vent for the lower floor which is located below grade in a window well that is approximately 6-feet deep. The window well reportedly fills with water, allowing the water to transit directly into the office through the ventilation system. The library, administrative offices, student services, and teachers' lounge were areas of concern according to staff, who noted previous and on-going water damage.

We were provided with an architectural assessment (dated November 16, 2004) commissioned by the school administration to document the water infiltration in the Middle School.[7] The architectural report documented areas of water damage including identifying drainage issues on the school grounds and structural issues for the school building. The report provided methods for correcting the

problems identified and provided recommendations for areas of the Middle School requiring further evaluation.

Liberty High School was built in 1963 with an addition built in 1986 and has approximately 97 employees and 775 students. The school consists of two buildings, both constructed with concrete block with brick veneer and curtain walls (Figure 5). Curtain walls are panels made of metal and glass that are suspended from metal supports and comprise the sides of buildings. The two buildings are connected by two bridges of curtain wall construction. Windows are operable with Plexiglas storm windows retrofitted to the interior in 1990 or 1991. The building is heated by three hot-water boilers fueled with No. 2 fuel oil that supply a closed-loop pipe system supplying unit ventilators in each classroom. These units also provide fresh air from the outdoors. The louvers on the unit ventilators are set to bring in a minimum amount of fresh air during the day and are closed at night. An outside contractor services the units in the Middle and High Schools once each year. The rubber-membrane and gravel roof was replaced in 1986. This school had no history of on-going water incursion, other than minor pipe and window leaks.

METHODS

We conducted the walkthrough using our semi-quantitative assessment sheet, a worksheet used to document water damage and visible mold. A previous NIOSH HHE showed that respiratory symptoms reported by survey participants were associated with the indices of the semi-quantitative assessment sheet.[1] We modified the semi-quantitative assessment sheet to include air monitoring for temperature measured in degrees Fahrenheit (°F), relative humidity in percent (%RH), and carbon dioxide (CO_2) measured as parts of CO_2 per million parts of air (ppm). The assessment sheet was also modified to record moisture measurements of suspected wet building components. We used a Q-Trak™ Plus Model 8554 indoor air quality monitor (TSI Inc., St. Paul, MN) for real-time measurements of temperature, relative humidity, and CO_2. We used the worksheet to record our visual findings related to dampness and mold on the walls; ceiling; floor; windows; heating, ventilating, and air-conditioning units; pipes; and furniture of each room. Measurement results for classrooms and other common-use areas such as the cafeteria and the teacher's lounge were also recorded. We did not conduct air sampling for mold in any of the schools but relied upon visual assessment for determining whether mold or dampness was present.

In the Elementary School, we visually inspected every room that was accessible, including classrooms, boiler rooms, the modular classrooms, the gymnasium, and the roof. Signs of water damage or other items that might impact indoor air quality were noted on the semi-quantitative assessment sheet. We checked temperature, relative humidity, and carbon dioxide concentration in some of the occupied rooms. We also spoke to teachers regarding their impressions and experiences regarding the indoor air quality.

Due to the Middle School's history of water damage, we systematically assessed each room in the school, including the cafeteria and teachers' lounge to document the extensive water stains. Water stains, visible mold density, visible mold area, mold odor, and the presence of wet building materials were graded on a scale of 0-3 (see Table 1 for scoring values). Scores were totaled for the walls, floor, ceiling, window/window frame, ventilation units, pipes, and furniture to achieve a total room score. Rooms with scores greater than the median (one) were considered to have more signs of water damage than most other rooms. For example, room 211 had water staining less than 2 square feet (ft^2) (1 point), possible mold growth less than 2 ft^2 (1 point), and a moderate density of possible mold (2 points) for a total of 4 points (The appendix contains the observational sheet for room 211.) A tape-lift sample of possible mold growth in the stairwell near exit 6 was collected for microscopic examination. We informally discussed health concerns with teachers during the first afternoon of the site

visit and made certain to include the problem areas identified by teachers in our walkthrough.

We did not visit all classrooms in the High School as school was still in session and most rooms were being used for standardized testing. We did visit as many unoccupied rooms as possible using the semi-quantitative assessment sheet as needed and conducting temperature, relative humidity, and CO_2 measurements if room conditions warranted additional assessment.

RESULTS

Elementary School

The Elementary School is a very old school with many of its original fixtures, such as tin ceilings and exposed pipes. Given the age of the building, lead paint may exist on these original fixtures. Additionally, the ceilings were bowing in some areas of the building, particularly in the hallway outside of Room 33 (Figure 6).

The Elementary School is heated by radiators and does not have mechanical ventilation, except in the modular classrooms which have unit ventilators. Fresh air enters the building through open windows and doors. Teachers reported opening their windows in the winter due to excess heat from the radiators and stuffiness or musty odors in their rooms. However, the open windows were reported to be a source of odors for those rooms near the bus loading/unloading area due to exhaust from idling buses.

Some water stains and possible mold were found in the third floor hallway. Classrooms 33 and 37 had water stains greater than 2 ft^2. Many teachers reported musty odors in their classrooms especially when entering in the morning. Steam pipe leaks were reported to have occurred in several areas of the building. Additionally, water incursion was found in Boiler Room 2, in the former coal storage area (Figure 7).

The modular units, especially the corridor, had odors while we were there. The corridor outside the restrooms smelled of urine. The corridor is heated by electric baseboard heat, which, according to teachers, is not warm enough to prevent the water pipes below the building from freezing during the winter. Frozen pipes were reported to have burst, leading to water incursion in the building. There was no access door for the area below the modulars so we were not able to visually inspect the ground below the units or the insulation beneath the classroom floors. We were able to take pictures through a small opening in the skirting. These pictures did not show any water damage or mold.

The "coal bin room" in the original part of the building was an actual coal bin at one time that was converted to a guidance counselor's office. This room is next to the boiler room and reported to be very hot, especially during the winter. The electric baseboard heater is not used and the one operable window is open all year long. The other window, an escape window, is inoperable and inaccessible because a desk is located next to it. Odors from diesel-powered buses are reportedly very strong in this room because the windows are at grade level. A significant pile of dirt and debris had accumulated on the asphalt directly beneath the window.

Original construction of the gymnasium included large windows on either side. Windows on one side have been completely enclosed with brick and the windows on the other side have been partially enclosed with brick (Figure 8). Teachers report that opening the windows during assemblies does not allow adequate air to flow through the room. Teachers also report fuel oil odors from Boiler Room #2, which is located directly below the gymnasium. One pathway for the odors is the lighting on the stage, through which the boiler room can be seen. The previous locker room was reported to have been a source of odors due to drying out of unused sewer drains although this source had been corrected prior to the walkthrough.

During the Elementary School walk-through, teachers reported new-onset asthma, recurrent sinus infections, sore throats, dry or burning eyes, fatigue, and a "foggy feeling".

Middle School

The Middle School was very clean and well kept. It has experienced documented water damage since construction was completed in 1991, and we found active water leaks and signs of water damage during the walkthrough. The observational scores assigned using the semi-quantitative index ranged from zero to seven with a median of one. Twenty-two rooms or locations (e.g. hallway) had a score of zero; 17 had a score of one; 13 had a score of 2; seven had a score of 3; five had a score of 4; zero had a score of 5; the teachers' lounge had a score of 6; and the cafeteria had a score of 7. In fact, 28 of 67 rooms or locations had semi-quantitative assessment scores of 2 or greater (median = 1), including the cafeteria, teachers' lounge, the stairwell near exit 6, the combined computer lab and wood shop (room 107), administrative and student services offices, lobby, library, greenhouse, gymnasium, band room (room 116), and rooms 211, 218, 220, 319, and 313. Some room scores related to the quantitative measurements taken. For example, the teachers' lounge, which received an observational score of 6, had the highest humidity and the lowest temperature measurements in the school.

The Liberty Central School District has conducted many repairs to address the known water leaks. Improper roof flashing has been removed and re-installed. Caulking around the windows of the greenhouse was repaired on numerous occasions and sealer was applied to exterior brick in several areas to prevent leaks. Evidence of previous leaks was still in place above the drop ceiling in the library, including tarps and buckets that were used to channel and collect water from the leaking roof (Figure 9). Other signs of water incursion included a light fixture in the hallway outside the gymnasium with a hole drilled in the plastic cover to allow water to flow out of the fixture and containers on some windowsills to capture water coming in through the windows (Figure 10). Water incursion in this area may be from missing flashing above the rear entrance, near the gymnasium (Figure 11). The administrative offices in the front of the building showed extensive water damage, as indicated by peeling vinyl countertop material on the windowsills, water stains and rust on filing cabinets, water-stained carpet around desks and filing cabinets, and water-swollen particle board furnishings. Visible water damage was observed on the wall above the reception desk in the front lobby with visible mold on the canvas mural and musty odors also present (Figures 12 and 13). Visible mold was also found in the stairwell near exit 6. In-house microscopic analysis of the tape-lift sample taken in the stairwell identified the mold as *Alternaria*. Rust was observed on the metal ceilings of the gymnasium and band room, indicating previous or ongoing water incursion.

While the library has sustained major water damage in the past, we saw no current water leaks during our visit, which occurred during heavy rain, although water stains on the ceiling tiles indicated previous water incursion. The library and some classrooms with known window leaks had plastic containers on the windowsills to catch incoming water, although none had water in them during our visit. The humidity in the teachers' lounge was perceived to be high on June 16, 2005, when water was observed on the floor apparently due to condensation as no other obvious sources existed. Relative humidity was 61.1% on June 17th, and no condensation was observed. Water stains less than 2 ft^2 were noted on the walls and ceiling of the student services office, which has a historical account of water damage from stormwater runoff from the adjacent street and school grounds (Figure 14). Employees in this office also reported problems with temperature control and air supply vents were observed to have materials blocking the air outlet.

We noted rainwater coming in the bottom corners of some windows, possibly due to failed caulking on the outside of the windows. We also noted rusty headers above windows in many rooms, indicating water incursion. The computer lab and adjacent wood shop classroom had evidence of water incursion, indicated by the staining and darkening of the floor around the support column. This room also had no unit

ventilators, only three large exhaust vents in the ceiling.

Some classrooms had plants with standing water in their catch pans, another source of water for possible mold growth. We saw many water-stained ceiling tiles, some with possible mold on them. Most water-damaged ceiling tiles on the second floor were located above the middle window, which may be from leaking unit ventilators on the third floor.

The greenhouse, indicated by the District's architectural consultant as a source of some water incursion in the building, did have some condensation on the windows and a little water leaking through the windows. Because it is no longer in use, the unit ventilator was shut off. Also, the floor drain was dirty and possibly clogged.

The connecting hallway between the Middle and High Schools had indications of water damage. The landscaping outside this area was graded toward the building and had no French drains or other drainage systems, according to the head custodian (Figure 4). This may allow water to flow into the building, causing water damage.

Some weep holes inserted into the mortar between courses of bricks, particularly those above the windows of the administrative offices, were plugged and prevented water from draining. The head custodian knew of this problem and informed us that the plugs were plastic rope, which is used to keep the weep holes from filling with mortar during construction. The plastic rope is meant to be temporary and should have been removed upon completion of the brickwork, but improper installation of the weep holes and brick work prevented removal.

Most, but not all, unit ventilators were operating during our visit. Unless the windows are open, little to no fresh air enters the classroom if the unit ventilators are not operating. Inadequate fresh air can lead to occupant discomfort and a build-up of odors. The CO_2 concentrations ranged from 381 – 711 ppm, with an average of 478 ppm across all rooms (all measurements taken during low or no occupancy). The temperature ranged from 69.4 – 80.4°F, with an average of 77.4°F and the relative humidity ranged from 50.4 – 61.1% with an average of 54.6%.

During our walkthrough, teachers reported migraines, watery eyes, sore throats, and cough. We were told that a previous staff member had been awarded Worker's Compensation for new-onset asthma and other health problems experienced while working in the school.

Many of our observations agreed with an architectural assessment commissioned by the school administration to document the water infiltration in the Middle School.[6] The school administration was in the process of implementing the recommendations for improving drainage around the school as soon as funding could be obtained. Other items for repair and correction were under consideration by the school facilities committee. We met with the committee during our site visit to inform them about the methods we were using and the observations we had made at the Middle School.

<u>High School</u>

The High School had stained ceiling tiles in many classrooms, including at least three with more than two square feet of staining (Room 119, Room 120, and the library). Many of the curtain wall windows had condensation and some had observable leaks. Some of the Plexiglas storm windows were failing as the plastic holding the Plexiglas in place was becoming brittle and breaking on some windows. At least one room had Plexiglas that was hanging from the window.

The storm drain located near the bridge connecting the two High School buildings had a deep hole next to it and both the drain and the hole were clogged with leaves and grass cuttings. We brought this to the attention of the Facilities Director, who immediately notified the custodians to temporarily cover and eventually plug the hole.

The floor and supports of the covered walkway connecting the two High School buildings had some damage (Figure 15). The walls of the walkway were curtain walls. Pieces of the aluminum bottom cap were missing and the wood support had been exposed to the elements and was rotted. We observed a hole on the underside of the walkway floor and broken glass in one window. The Facilities Director was aware of the window, which had been broken the day before our site visit.

The library had rusty, and possibly moldy, window blinds (Figure 16). The rust appeared to be caused by the blinds sitting in water or staying wet for long periods. We noticed other blinds in various rooms with rust and possible mold, although not to the extent of the library's blinds.

DISCUSSION AND CONCLUSIONS

Damp buildings are associated with risk of nose and throat symptoms, cough, wheeze, asthma symptoms in sensitized persons, and hypersensitivity pneumonitis.[2] In addition, some evidence suggests that exposures in damp indoor environments are associated with shortness of breath and development of asthma.[2] Damp conditions also can allow for growth of mold on building materials and furnishings. Dampness can occur from existing leaks or new leaks from the windows, building façade, leaking pipes above the ceiling, or leaking unit ventilators from the floor above. We found some evidence of mold growth on materials in all three school buildings. Water damage that may have occurred in interior wall cavities or above ceilings should be evaluated to determine whether these areas may harbor mold. As described in the Middle School architectural report, this determination may require destructive investigation such as removing drywall or brick to determine whether mold is present.[7]

High indoor humidity can lead to dampness and low indoor humidity (less than 30%RH) can cause mucus membrane irritation, dry eyes, and sinus discomfort. Maintaining indoor humidity between 30-50% will control mold growth and alleviate the symptoms associated with low humidity.[4] The minimum relative humidity found in the Middle School was 50.4%, which may lead to mold and symptoms noted by staff working in the building. Room 120 in the High School had a relative humidity reading of 49.9%, which is essentially at the upper limit of the recommended range. In the Elementary School, the humidity readings fell within recommended limits with rooms 50 and 51 showing readings of 39.9% and 41.3%, respectively. The temperatures in the Middle School were generally at or below the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) recommendations for indoor summer temperatures. CO_2 concentrations in the Middle and Elementary Schools were well below ASHRAE recommendations; however, the rooms were generally unoccupied during sampling. Room 120 of the High School had the highest CO_2 concentration among the three schools (720 ppm in the middle of the room, 620 near the unit ventilator), although these concentrations are still considered low. This room had been occupied by students immediately prior to sampling, which is the likely cause of the "higher" concentration. (Please see the Evaluation Criteria at the end of this report for more information on relative humidity, temperature, and CO_2.)

A New York state law governs the idling of diesel vehicles, which applies to diesel-powered school buses.[8] The Liberty School District has a policy for minimizing the amount of diesel exhaust entering school buildings from idling school buses and other diesel vehicles. These policies should be reviewed and enforced at all schools.

Many repairs have been made to the Middle School since our site visit, according to the head custodian in a conversation on August 23, 2005. The mural, which contained mold, and stained

ceiling tiles in the lobby have been removed and the wall was cleaned, bleached, primed, and painted on August 19, 2005. Additionally, the mold found in the stairwell near exit 6 had been removed and the area has been cleaned. This area is reportedly prone to mold growth and should be monitored closely. A dehumidifier was purchased for the teachers' lounge, which will be emptied nightly and cleaned according to manufacturer's instructions. The head custodian also verified that the water stained ceiling tiles located next to the window in each room were likely due to leaking valves or condensation from pipes in the unit ventilators. Finally, a moldy or musty odor is still apparent in the assistant principal's office. The custodial staff was working to find the cause and is running the ventilation system in this area 24 hours a day.

Environmental findings and reports of health effects in staff dictate continued remediation efforts to improve the health of building occupants and to prevent additional health effects. Employees with health concerns should seek the advice of their physician and should report concerns relating to the school buildings to the Liberty Central School District administration.

RECOMMENDATIONS

General recommendations

- Develop a comprehensive program to immediately address and fix leaks as they occur. Consider redesigning known areas of on-going leaks, such as the greenhouse at the Middle School, to prevent future water incursions.

- Follow the Environmental Protection Agency or New York City Department of Health and Mental Hygiene guidelines when removing or cleaning mold or mold-damaged items.[2,3]

- Replace all water-stained ceiling tiles. Teachers and maintenance staff should be instructed to watch for new stains and to report them immediately.

- Check all unit ventilators located above water-stained ceiling tiles for leakage in the water supply piping or leaks due to condensation.

- Implement a preventative maintenance program to systematically check the caulking of windows in all schools. Reapply caulking where necessary. The curtain walls at the High School may be more prone to leaks if caulking is cracking or missing around windows or metal panes.

- Ensure that storm drains and pipes in all areas remain clear of leaves, grass cuttings, and other materials to allow water to drain away from the buildings.

- Operate unit ventilators at all times. Request that the Sullivan County Board of Cooperative Educational Services reassess the carbon dioxide concentrations in all schools during fall, winter, spring, and summer seasons.

- See a physician for treatment of health symptoms related to the school environment and report health concerns to the school administration.

- Implement a systematic way for the teachers and staff to report problems in their classrooms. A computer software package may help the custodial staff track problems so they can determine whether certain rooms are experiencing more problems than others. A database of health problems for the nurse may also provide information as to certain rooms having more health effects than others.

- Check all sinks in all schools regularly for leaking pipes, plugged drains, and dry traps.

- Implement an eye wash/shower inspection routine for the laboratories to make sure that the equipment is fully operational, clean, not leaking, and not growing mold. Consider adding a label to each station to track inspections.

- Implement an indoor air quality (IAQ) program at each school. A committee consisting of teachers, management, and custodial staff could routinely evaluate portions of the school at set intervals, looking for water incursion. We provided copies of our semi-quantitative index to various individuals while we were onsite and we have attached a revised blank worksheet with this report. We encourage your building management to use the EPA program "IAQ Tools for Schools", which contains information regarding the implementation of IAQ programs.[5]

- Consider using the Design Tools for Schools if you plan to build a new school or make major renovations to existing buildings.[9] This website also provides practical information for current maintenance of schools.

Recommendations for the Elementary School

- Prevent pipes from freezing and bursting under the Elementary School modulars.

- Replace damaged floor coverings and the sub-floor in the restrooms. Older floor tiles may contain asbestos and should be tested prior to removal.

- Inspect the insulation under the Elementary School modulars for water damage and mold growth. Previously wetted insulation should be replaced.

- Test the peeling paint in the Elementary School to determine whether a lead paint hazard exists. The New York State Department of Health provides information regarding lead hazards in schools on their website.[10]

- Re-purpose the guidance room and leave it unoccupied as it was reported to be too warm in all seasons. This required that windows be kept open which allowed diesel exhaust to enter the room.

- Fix the escape window in the guidance room in the Elementary School and move the furniture blocking it.

- Consider replacing at least one window on the back side of the Elementary School gymnasium to allow for better air flow through the room when occupied by students.

- Prevent fuel oil odors from entering the school during filling of tanks for the boilers by developing procedures that will exhaust the odors out of the building.

Recommendations for the Middle School

- Replace flashing that was missing between the gymnasium (two-story) and hallway (one-story).

- Remove and discard the mural in the Middle School lobby. Also, remove the mold found in the stairwell near exit 6. Follow the Environmental Protection Agency or New York City Department of Health and Mental Hygiene guidelines when removing or cleaning mold-contaminated building materials or furnishings.[2,3]

- Control humidity in the Middle school teacher's lounge. If dehumidifiers are used, they should be cleaned and maintained on a regular basis and according to manufacturer's recommendations.

- Inspect water-damaged furnishings and carpet in the Middle School administrative offices and clean or discard as appropriate.[2,3]

- Add unit ventilators to the Middle School computer room and wood shop classroom to allow fresh air into the rooms and to control temperature.

- Re-grade the grounds north of the classroom building and the landscaping next to the corridor connecting the two portions of the Middle School and the High School.

Recommendations for the High School

- Set up a regular cleaning and maintenance schedule for the unit ventilators in the Middle and High Schools. The Middle School head custodian indicated that the units are very difficult to clean. If this is the case, determine whether modifications are necessary to ensure proper maintenance.

- Move the gravel on the Middle and High School roofs back into place so that the entire roof is covered to prevent sun damage to the rubber membranes.

- Replace or repair broken Plexiglas storm windows in the High School. Ensure that seal integrity is intact and prevents condensation between the glass window and the Plexiglas storm window.

- Inspect and repair the bridges connecting the two High School buildings. Replace rotted wood and other damaged materials.

- Clean or replace moldy window blinds.

- Fix the hole next to the storm drain between the two High School buildings. Monitor this area to see if another hole appears.

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Table 1. Scoring system for the observational worksheet.

Score	Water Stains	Visible Mold Density	Visible Mold Area	Mold Odor	Presence of Wet Building Materials
0	None	None	None	None	None
1	< 2 ft^2	Slight	< 2 ft^2	Mild	< 2 ft^2
2	2–33 ft^2	Moderate	2 – 33 ft^2	Moderate	2 – 33 ft^2
3	> 33 ft^2	Heavy	> 33 ft^2	Strong	> 33 ft^2

Table 2. Temperature, relative humidity, carbon dioxide, and room scores for each room in the Middle School

Room	Temp (ºF)	RH (%)	CO_2 (ppm)	Room Score	Room	Temp (ºF)	RH (%)	CO_2 (ppm)	Room Score
112	73.1	55.9	455	0	317	80	52.8	580	1
Guidance	73.7	53.8	391	0	Girls' Locker room	NS	NS	NS	1
209	78.4	53.5	490	0	Hallway Rm 212	NS	NS	NS	1
207	78.1	54.4	500	0	Stairs outside 301	NS	NS	NS	1
212	78	55	485	0	Boys' Restroom (3rd floor)	NS	NS	NS	1
213	79.4	51.5	434	0	Guidance	72.4	55.9	425	2
214	77.8	54	480	0	108 Main area	74.9	57.8	486	2
321 - Home Ec	79.4	52.6	512	0	108 BOCES	74.9	57.5	487	2
224	77.9	54.4	509	0	Principal's office	71.2	59.7	417	2
301	79.4	52.8	456	0	109	75.7	58.5	438	2
305	79.6	51.1	405	0	203	78.1	54.8	479	2
309	80	52	471	0	221	79.4	53	530	2
307	79.7	52.5	443	0	302	79	53.1	438	2
312	79.4	52.5	473	0	304	78.9	52.2	415	2
314	79.2	52.9	465	0	Boys' Lockeroom	NS	NS	NS	2
315	80	52.4	532	0	Ladies' Restroom (1st floor)	NS	NS	NS	2
318	78.9	53.7	530	0	202	NS	NS	NS	2
320	79	53.7	529	0	Band room	73.3	59.1	390	3
322	79	53.5	529	0	Entry/Reception	76.9	52.7	381	3
324	78.8	52.7	467	0	Office reception	70.8	59.8	450	3
Band practice	74.4	59	497	0	218	77	55.4	435	3
Choir room	74.1	57.6	478	0	220	77.3	57	599	3
Asst Principal's Secretary	71.6	59.2	458	1	313	80.3	51	440	3
110	73.5	55.3	441	1	Stairs Exit 6	NS	NS	NS	3
201	77.8	55.9	434	1	Gym	NS	NS	NS	3
205	78	54.7	485	1	107	75.5	60.5	460	4
204	78.3	56.1	413	1	211	79.1	51.4	489	4
206	78.4	55.1	414	1	217 - Third portion of library	79.7	50.9	580	4
216	77.1	54.8	461	1	219 - library	79.2	52.2	650	4
215 - Middle portion of library	80.3	50.4	515	1	319	79.3	51.8	435	4
222	77.5	56.2	497	1	Greenhouse	80.4	56.5	711	4
303	79.5	52.8	454	1	Teachers' lounge	69.4	61.1	520	6
306	79.4	51.9	415	1	Cafeteria	NS	NS	NS	7
311	80.3	51.8	515	1					

[1] NS – not sampled

Figure 1. Front view of Liberty Elementary School.

Figure 2. Liberty Elementary School modular classrooms.

Figure 3. Liberty Middle School classroom building.


Figure 4. Corridor connecting Liberty Middle and High Schools.

Figure 5. Liberty High School's curtain wall and brick veneer construction.

Figure 6. Bowed ceiling in Elementary School.

Figure 7. Water incursion in Liberty Elementary School's Boiler Room 2, old coal storage area.

Figure 8. Liberty Elementary School's partially bricked windows in the gymnasium.

Figure 9. Tarps and buckets above the Middle School library's ceiling.

Figure 10. Containers used to collect rainwater entering the Middle School library.

Figure 11. Missing flashing above corridor in Middle School.

Figure 12. Water-stained ceiling tiles in the Middle School lobby.

Figure 13. Likely mold growing on the mural in the Middle School lobby.

Figure 14. View of the grounds toward the back of the Middle School classroom building.

Figure 15. Rotten wood and rust on the bottom of the High School bridge.

Figure 16. Rust, dirt, and possible mold on an aluminum blind in the High School library.

APPENDIX

This appendix contains an example observational worksheet.

Date: 6/16/05
Observer: _____

School name: Liberty Middle
Building: _____

Room/ Area ID	Floor	Room number (Area Type)	Location	Wall/ Floor/ Ceiling Type	Moisture Reading	Water Stains	Visible Mold		Mold Odor	Presence of wet building material	Temp (F)	RH (%)	CO_2 (ppm)	COMMENTS
							Density	Area						
		211	wall	black slot							79.1	51.4	489	crack in corners of walls above windows
			floor	tile										
			ceiling	drop		<2	Mod	<2						
			window											Rust on header
			HVAC											
			Pipes											
			Furn.											Fridg, microwave
			1											
			2											
			3											
			4											
			5											
			6											
			7											
		0 1 pen Cube Are 2 ivate office/roo 3 Cafeteria 4 Gym 5 ---------- 6 ---------- 7 ----------	---------- Wall Floor Ceiling window/frame HVAC units pipes furniture	---------- Carpet Tile Wood Concrete Gypsum	Instrument reading	none < 2 ft2 2-33 ft2 >33 ft2 -------- -------- -------- --------	none slight moderate heavy -------- -------- -------- --------	none < 2 ft2 2-33 ft2 >33 ft2 -------- -------- -------- --------	none mild moderate strong -------- -------- -------- --------	none < 2 ft2 2-33 ft2 >33 ft2 -------- -------- -------- --------	Instrument reading	Instrument reading	Instrument reading	

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increases the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Microbiologicals

Microorganisms are ubiquitous in the indoor environment. All microorganisms produce antigen–molecules (often proteins or polysaccharides) that stimulate the immune system. A single exposure to an antigen may result in sensitization. If the sensitized person is re-exposed to the same antigen, a hypersensitive or allergic response may occur to a level of antigen that would elicit little or no reaction from non-sensitized persons. Allergic reactions to inhaled antigens may be limited to the upper respiratory tract (e.g., allergic rhinitis), or they may affect the distal airways (e.g., allergic asthma) or the distal portions of the lung (e.g., hypersensitivity pneumonitis).

No standards or guidelines have been set by NIOSH, OSHA, or ACGIH® for culturable or countable bioaerosols.[4] The ACGIH policy[5] is that a general TLV® for culturable or countable bioaerosol is currently not scientifically supportable because:

1. Culturable microorganisms and countable biological particles do not comprise a single entity.
2. Human responses to bioaerosols range from innocuous effects to serious, even fatal, diseases depending on the specific material involved and employees' susceptibility to it.
3. It is not possible to collect and evaluate all bioaerosol components using a single sampling method (different methods of collection and analyses may result in different estimates of concentration).
4. At present, information relating culturable or countable bioaerosol concentrations to health effects is generally insufficient to describe exposure-response relationships.

"Specific TLVs® for individual culturable or countable bioaerosols have not been established to prevent hypersensitivity, irritant, or toxic responses. At present, information relating culturable or countable bioaerosol exposure to health effects consists largely of case reports and qualitative exposure assessments."[5] Therefore, results of airborne bacteria and fungi air sampling should not be used for compliance testing. Air sampling for microbials provides short-term "snapshot" which may not be representative of the fungal conditions over the whole work day or under different environmental conditions. Because of the limitations in air sampling for fungi and bacteria, air sampling results should not be used to prove a negative case. Microbes in air vary seasonally, diurnally, and with occupant activity level. These data should be used to help characterize the microbial environment rather than to evaluate levels as safe or hazardous.

Carbon Dioxide

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and a product of combustion. High concentrations of CO_2, a colorless, odorless gas that displaces oxygen, can cause death. Lower concentrations can cause symptoms such as headache, sweating, rapid breathing, and increased heart rate.

CO_2 measurements can be used to assess adequacy of air supply to indoor environments. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard recommends an indoor to outdoor differential concentration not greater than 700 ppm of CO_2.[6] The average outdoor (ambient) CO_2 concentration is assumed to be 300 ppm. When indoor CO_2 concentrations exceed 1000 ppm, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. It is important to note that CO_2 is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual level.

The OSHA PEL (8-hour time-weighted average (TWA)), ACGIH® TLV® (8-hour TWA), and NIOSH REL (10-hour TWA) is 5,000 ppm for carbon dioxide. These exposure limits apply to industrial, not indoor, work environments.

Relative Humidity and Temperature

ASHRAE recommends that relative humidity in indoor environments be maintained between 30% and 50% relative humidity[6] and that the indoor temperature range provide for occupant comfort (69.0°F to 76.5°F in the winter and 75.5°F to 81.0°F in the summer at 40% relative humidity).[7]

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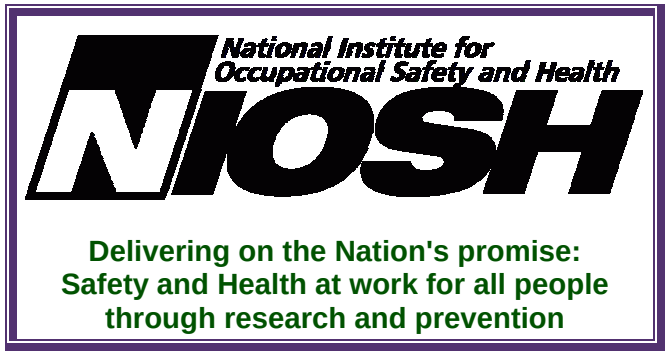

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