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Environmental and Medical Monitoring
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Expert Testimony
Hazard Communication

Preliminary

Indoor Air Quality Evaluation

at

Bethune Elementary School
Dania, Florida

prepared for

School Board of Broward County
Ft. Lauderdale, Florida

prepared by

Wil A. Spaul, CIH
PhD, MPH, MSCE
President

14 July 1994

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14 July 1994

Ms. Judith Hunt, Director
Risk Management and Safety Department
School Board of Broward County
1320 Southwest Fourth Street
Ft. Lauderdale, FL 33312

RE: Preliminary Indoor Air Quality (IAQ) Evaluation at Bethune Elementary School in Dania, Florida

Dear Ms. Hunt:

First, thank you for allowing me to provide these services to your school district. The enclosed report follows a standard scientific report format plus a recommendation section. Should you desire additional information, want clarification on any item, or have any questions about this report, please do not hesitate to contact me.

I would like to express my appreciation to the Principal for providing free access at this school and for assistance in identifying areas where concerns had been expressed.

Sincerely,

Wil A. Spaul

Wil A. Spaul, President
PhD, MPH, MSCE
Certified Industrial Hygienist

Adjunct Associate Professor of Indoor Air Quality
College of Public Health
University of South Florida - Tampa

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A PRELIMINARY INDOOR AIR QUALITY EVALUATION AT BETHUNE ELEMENTARY SCHOOL IN DANIA, FLORIDA

ABSTRACT:

On 2 June 1994, Dr. Wil A. Spaul (PhD, MPH, MSCE) conducted a preliminary indoor air quality (IAQ) evaluation at Bethune Elementary School in response to reported health concerns. Dr. Spaul's evaluation consisted of teacher interviews, inspections of the inside of the air handler units, and carbon dioxide measurements.

From the employee interviews, there appeared to be a pattern of allergy and "Tight Building Syndrome" complaints. The elevated carbon dioxide concentrations would support the hypothesis that "Tight Building Syndrome" complaints had been occurring. From the detailed inspection inside ten (10) air handler units, there are sufficient mold growths that could result in some of the reported allergic responses in those people who are sensitive to those molds. The enclosed report discusses these findings and their significance, and provides a punch-list of recommendations to correct these problems.

INTRODUCTION:

Dr. Wil A. Spaul (PhD, MPH, MSCE), a Certified Industrial Hygienist and an Adjunct Associate Professor of Indoor Air Quality (Department of Environmental and Occupational Health Sciences, College of Public Health, University of South Florida - Tampa Campus), was requested by the Risk Management and Safety Department of the School Board of Broward County, to conduct a preliminary indoor air quality evaluation at Bethune Elementary School.

METHODS AND MATERIALS:

It is Dr. Spaul's opinion that many building-related problems, if found to exist, can be tentatively identified from the reported complaint patterns of the occupants. For this reason, early in the evaluation, Dr. Spaul conducts interviews from a sampling of the employees who have expressed concerns. During this evaluation, several individuals were interviewed.

Dr. Spaul was assisted in his evaluation by Mr. Mark Commiskey, Chemical Manager of the Risk Management and Safety Department for the School Board.

The surrounding area was inspected to determine if likely outdoor sources could be identified that could contribute to any indoor air quality concerns.

Ten air handlers were shut down, locked out and tagged, opened up, and inspected. The return air plenum (at the air handler), the filters, both sides of the coils, the condensation pans, the insulation inside the fan chambers, and the fan blades and housing were inspected. The supply air duct, where the air leaves the air handler, was not inspected since no inspection hatches or ports existed in these supply ducts.

Between 11:10 and 11:15 hours, carbon dioxide concentrations were measured at two locations. The outdoor carbon dioxide concentration was also measured and recorded. All carbon dioxide measurements were performed with a direct reading carbon dioxide gas monitor (Gaztech International Corporation Telaire Model VEMS 1310) that was calibrated before and after sampling with two separate calibration gas mixtures.

RESULTS:

This portion of the report is divided into four sections. These sections are: a) summary of interview patterns; b) air handler unit inspection results; c) carbon dioxide concentration results; and d) photographic documentation.

a) Summary of Interview Patterns:

Two types of health-related complaint patterns that may be building-related appear to exist. "Tight Building" conditions, which are discussed in detail in the "Discussion" section of this report, were a fairly frequently reported problem. Allergic symptoms were reported in some people.

There have been several reports of re-occurring sinus infections, usually in those people who also reported allergic symptoms. This pattern is not uncommon since repeat sinus inflammation (due to an allergic reaction) can predispose a person to secondary infections.

In addition to the above types of reported problems, there were reports of viral colds and flu-like infections that had been diagnosed by physicians. This latter category of complaints, plus the usual childhood diseases, are not normally associated with building-related problems, but are more likely due to the shedding of viral particles or other infectious agents by people. Also, please be aware that last year there were two major upper respiratory infection epidemics in Florida and the Southeast, and so far this year there has been one. In the late fall we can usually anticipate another upper respiratory infection epidemic. The time and symptom patterns for these epidemics are slightly different from the types of health complaints that are usually building-related.

b) Air Handler Unit Inspection Results:

Air Handler Unit Over 500 Wing:

- McQuay unit; SN 34C01678;
- Outside air intake closed;
- Medium efficiency removal filters are used; filters are dirty but are properly installed;
- Access door (to coils) panel lock inoperable;
- Accumulation of mold growths in condensation pan;
- Insulation fairly clean of mold growths;
- Coils and fan blades are clean;
- No access to supply duct;
- New unit with old internally insulated supply ducts;
- Need to check chilled water valve; may not be working.

Air Handler Unit Due West Of 500 Wing:
- McQuay unit;
- Outside air intake closed;
- Medium removal efficiency filters are dirty;
- Sludge blanket in water in condensation pan;
- Insulation is clean;
- Fan blades are starting to accumulate debris;
- Coils are clean;
- No access to old internally insulated supply ducts.

Air Handler Unit On Southwest Corner Of Kindergarten Wing:
- Old unit; not operating;
- No provisions for lock-out;
- Access door blocked by bottom clamp; not able to access;
- Insulation missing off chilled water pipes at unit;
- Top of filter case of unit rusted out (see photographs);
- Other filter access area blocked by duct;
- Armorflex insulation on one panel;
- Slime in condensation pan;
- Fan hydraulic line hanging by fan blades; not connected;
- Bottom of fan chamber is rusted out and pulls unconditioned, unfiltered air into unit;
- Roof supply duct seals appear to be cracked in some locations.

Air Handler Unit Over Office Area:
- New McQuay unit;
- Outside air intake barely open;
- Clean filter properly in place;
- Insulation in good condition and free of mold growths;
- Slime in condensation pan;
- No access to old internally insulated supply ducts.

Portable 321 CX:
- West Unit:
  - No outside air provisions;
  - Extremely dirty filter;
  - Coils extremely dirty.
- East Unit:
  - Same conditions were observed as those in west unit.

Portable 122C:

- Two units; same conditions were observed as those in Portable 321 CX;
- Handicap ramp is deteriorated and is a safety hazard;
- Dry rot on roof edges.

Portable 247:

- East Unit:
  - Mold growths and dampness on insulation in supply duct;
  - Electric room deodorizers were present;
  - Moldy coils;
  - Dirty filters;
  - Outside air intake was closed; now open.
- West Unit:
  - No provisions for outside air;
  - Very dirty filters;
  - Very dirty coils;
  - Deteriorated and bent coil fins;
- White mouse was present in room; need to determine if it is a "pet" or present for short term "educational purposes"; it is desirable to keep rodents and other animal exposures in a classroom to a minimum amount of time.

Other Observations:

- There are three roof units on the 500 wing;
- Each room is supplied by a central supply vent; air then flows from room to hall where the return air registers are located;
- Three return registers are located in hall;
- Jalousie windows and louvers to hall;
- Old school design;
- Several rooms in the 500 wing are not occupied.

c) Carbon Dioxide Concentration Results:

Time (hrs)	Location	CO_2 (ppm)	Notes
11:10	Room 503	1148	23 students
11:15	Room 508	1140	26 students

NOTE: Several rooms in this wing are not occupied, which would most likely reduce the measured carbon dioxide concentration in this area. These measurements may be an underestimation of the actual conditions.

DISCUSSION:

From the complaint patterns that were reported, and which were supported by the visual inspections, two different types of building-related indoor air quality health problems have been occurring at this school.

One type of problem is often referred to as "Tight Building Syndrome", and is the result of inadequate outdoor air flows and inadequate air flushing of the occupied spaces. The types of complaints that are often associated with this condition include: frequent headaches; eye and nose burning or stinging; excessive tiredness; periodic bouts of dizziness; difficulty mentally focusing; and lightheadedness; with symptoms starting about mid-day or later, and usually subsiding or disappearing fairly soon after leaving the building. Not everyone may experience all of these symptoms, and they may experience several different ones at different times. At the same time, please be aware that it is improper to attempt to diagnose an individual's complaints from the building conditions. Only a physician can make a determination as to the cause of a person's medical problem after considering all other possible different diagnoses. The causes for this type of condition in a building can include: inadequate outdoor air flow due to plugged outdoor air intake screens, missing outdoor air intakes; not operating the fan continuously when the building is occupied; closed outdoor air intake dampers; or initial low outdoor air flow design. Inadequate air flow balance within the building can also produce these conditions for areas that are supplied by multi-area air handlers. The primary reasons for the low outdoor air flows in this school are closed outside air intakes, missing outside air intakes (portables) and initial low outdoor air flows.

In summary, inadequate outdoor air flows for the number of occupants were observed in some of the classrooms that were evaluated. There are probably other rooms with this same problem, but not all rooms were measured during this screening preliminary evaluation. If several rooms in a group are found to have a problem due to inadequate outdoor air flows, it can usually be assumed that other similarly designed rooms will very likely have the same problem with inadequate outdoor air flows.

d) Photographic Documentation:

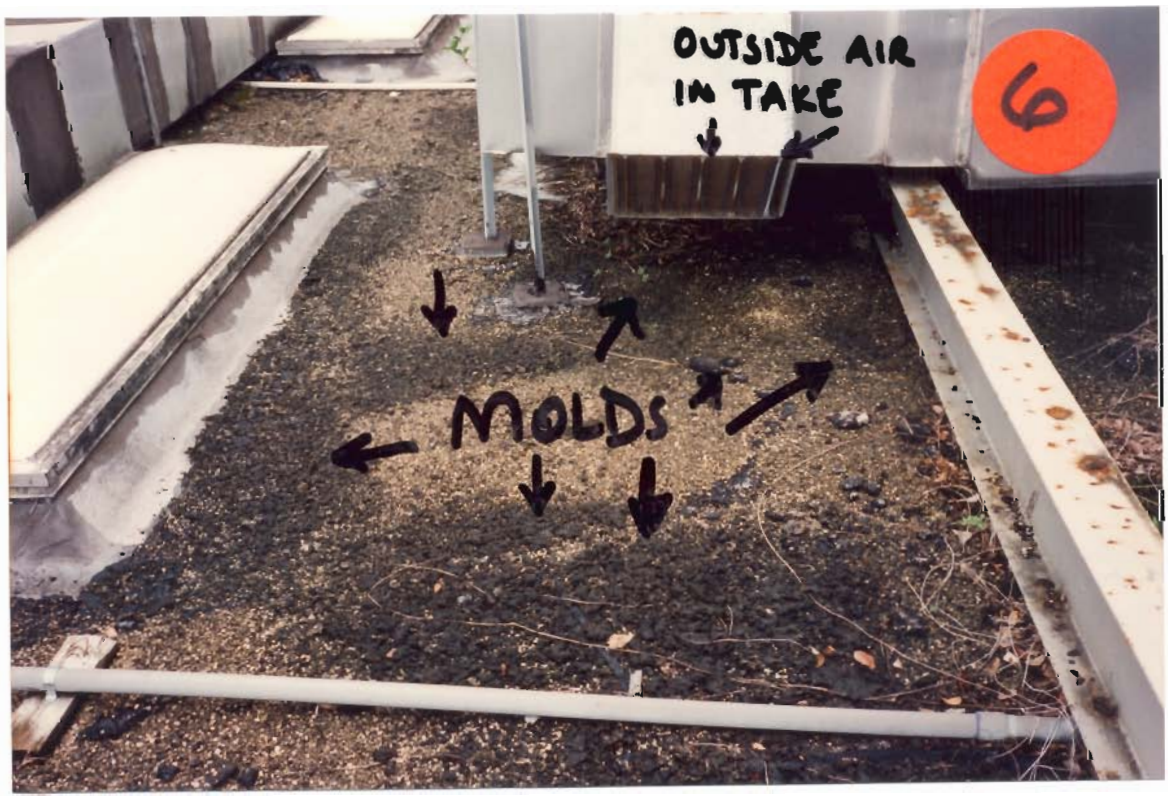
Photograph 1: Rodent Hole In Ceiling Tile. This Area Should Be Checked For Other Evidence Of A Current Infestation. This Tile Should Be Replaced

Photograph 2: New Roof Top Units With Old Internally Insulated Duct Work

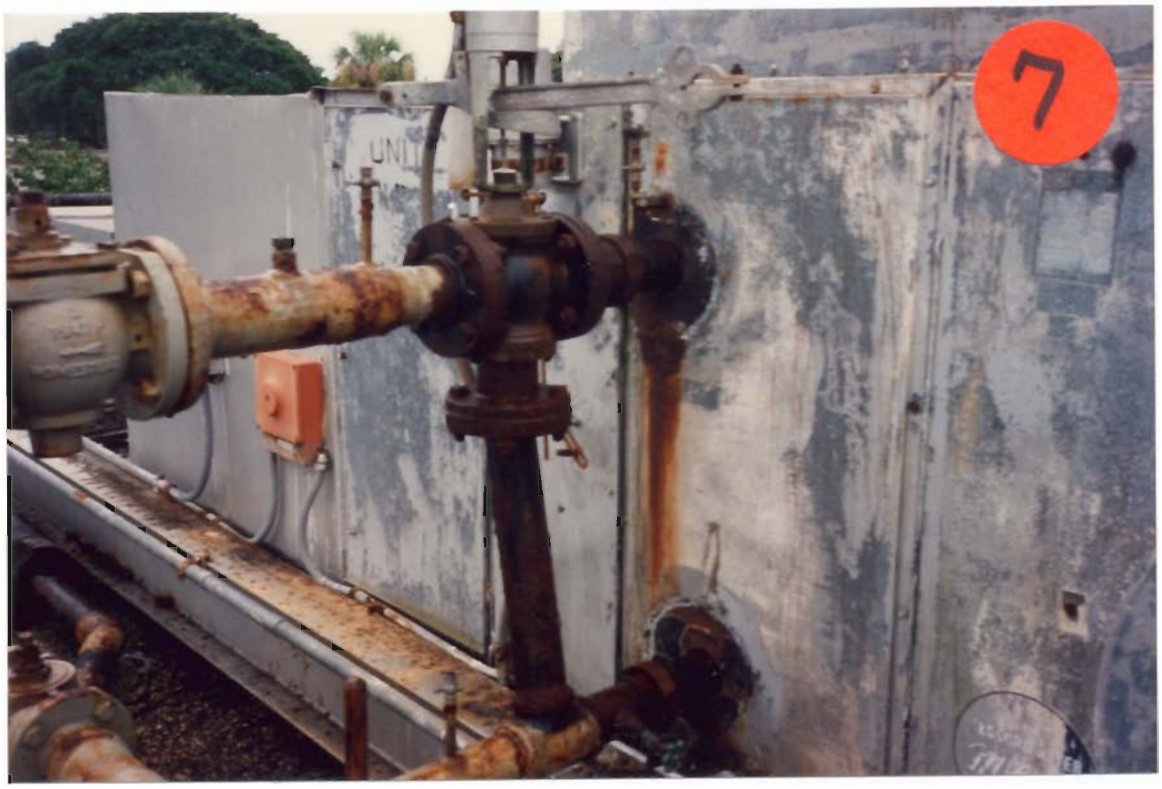
Photograph 3: Accumulation Of Debris And Microbial Growths In Condensation Pan Of New Roof Mounted Air Handler Unit

Photographs 4 & 5: Accumulated Debris And Plants On Roof Of School

Photograph 6: Large Amount Of Dried Black Mold In Area On Roof Around Outside Air Intake. These Areas Should Be Cleaned Periodically And, If Possible, The Reason For The Inadequate Drainage Corrected



Photograph 7: Chilled Water Pipes To Supply Coils That Are Not Insulated



Photograph 8: Clamp On Beam That Has Rusted Into Position Such That The Access Panel To Service This Roof Top Unit Cannot Be Serviced

Photograph 9: Very Dirty And Deteriorated Insulation Inside Return Air Duct That Should Be Replaced

Photograph 10: Rusted Out Top Layer Of Air Handler That Has Collapsed Onto Filter Rack

Photograph 11: Rusted Out Tops Of Air Handler Unit

Photograph 12: Very Dirty And Rusty Condensation Pan

Photograph 13: Fan Bearing Lubrication Line That Is Disconnected And Is Hanging Into Fan

Photographs 14-17: Unprotected Roof Penetrations. Old Rusty Tools And Equipment Were Left On Roof At Job Site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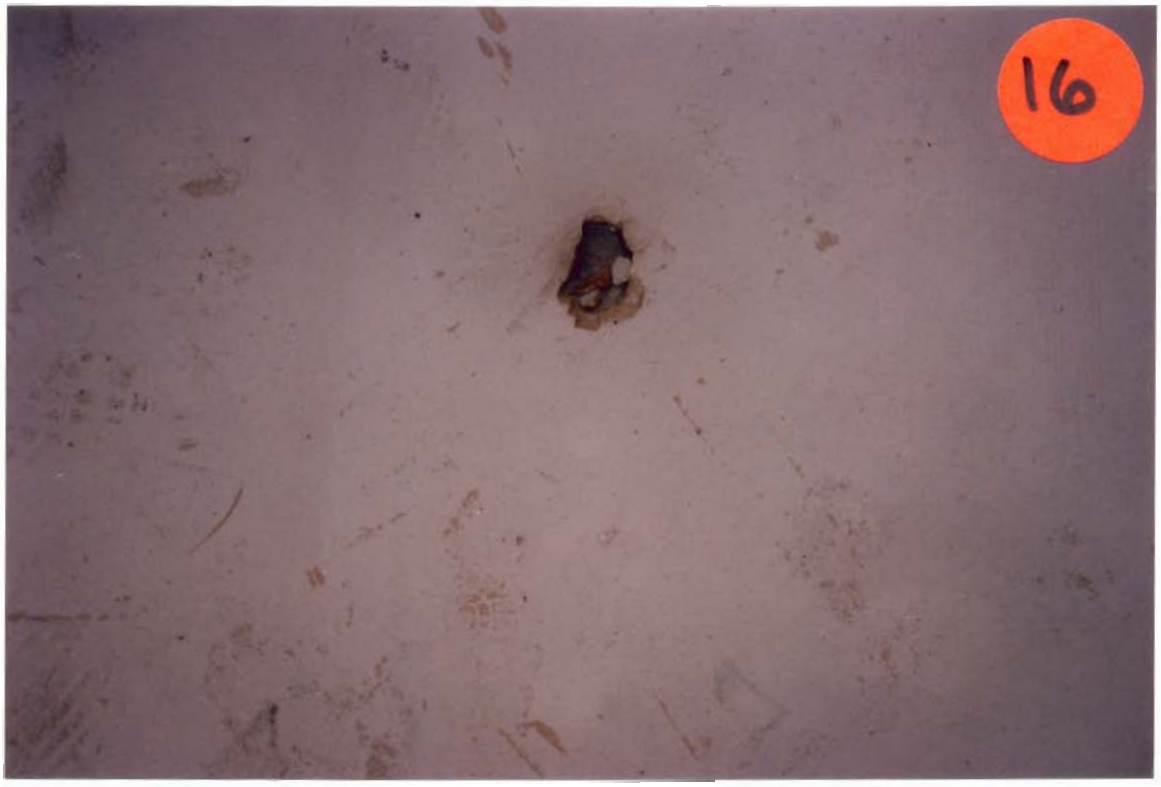
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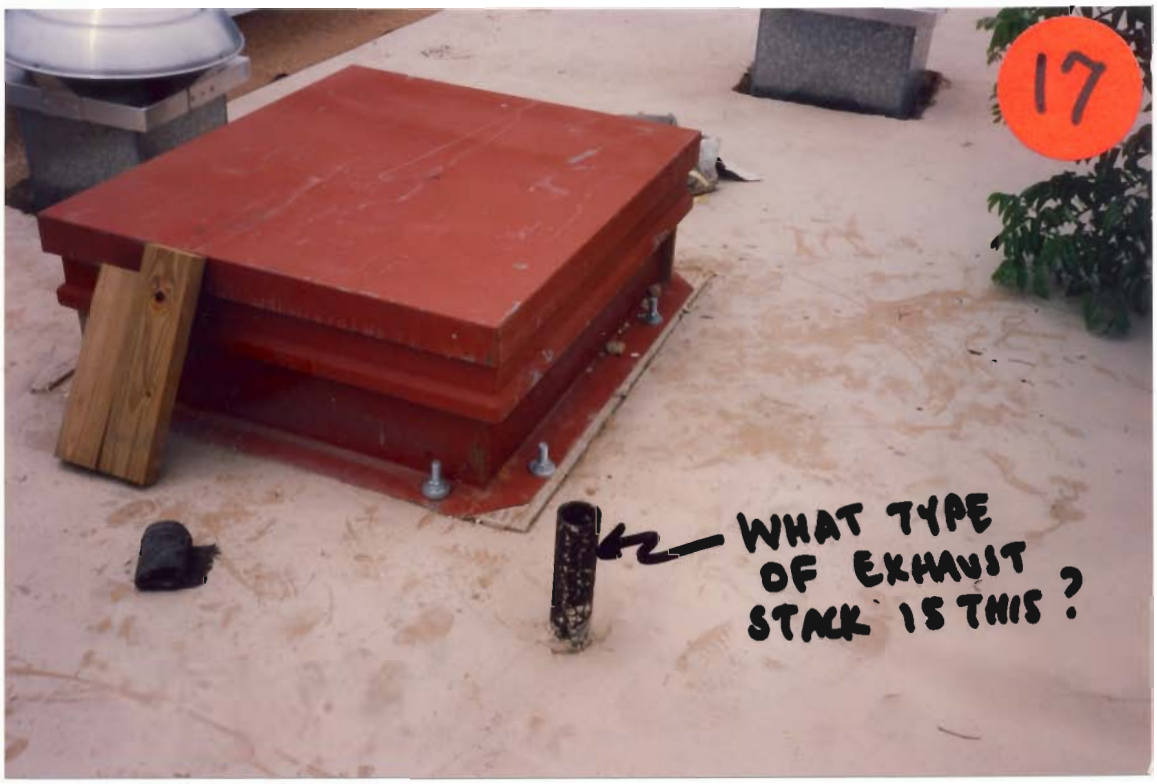

Photographs 18 & 19: Roof Covering And Plastic Sheets On Roof That Were Not Used To Cover Penetrations From Rain

Photograph 20: Unsafe Wiring Practice From One Room To Another Space

Photographs 21 & 22: Very Deteriorated Wood At Beginning Of Ramp To Portable

Photograph 23: Rotten Wood From Condensate Draining Onto Wall Under Air Conditioner Unit For A Portable

Carbon dioxide concentrations are used as a surrogate parameter for adequacy of outdoor make-up air flow into a space. It is assumed that if a space has an inadequate outdoor air flow for diluting and flushing normally encountered background contaminants from a room, then the carbon dioxide concentration, which is primarily released during exhalation by the building occupants, will also increase through the day. Since carbon dioxide concentration measurements are quick and inexpensive, and will often parallel other background concentrations in a building, this index was selected and is widely used by most indoor air quality professionals. In 1989, the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) released an indoor air quality standard (ASHRAE Standard 62-1989: Ventilation For Indoor Air Quality), which has subsequently been adopted by the American National Standards Institute (ANSI), and who also assigned it the same standard identification number (ASHRAE/ANSI Standard 62-1989). Although this standard is not a current legal statute, it has been generally accepted professionally. In a report by the Office of Educational Facilities in the Florida Department of Education on the "Study of Indoor Air Quality in Florida's Educational Facilities" (October 1993), of which Dr. Spaul was a project team member (pages 1-6 and 1-7), it was recommended that the Florida Administrative Code (FAC-6A-2) that specifies minimum outdoor air flows for classrooms also adopt this ASHRAE/ANSI standard. In discussions between Dr. Spaul and Mr. Kelly (the Department of Education person in Tallahassee, who is responsible for updating this section of the 6A-2 statutes) on 3 June 1994, Mr. Kelly reported that the revised 6A-2 rules can be expected this summer.

The carbon dioxide concentration (according to the ASHRAE Std) should not exceed 1000 parts per million (ppm), which is a peak-level measurement and not a time-weighted average measurement. The 1000 ppm guideline should not be interpreted as a definitive line for "safe or unsafe", but should be used simply as an evaluation tool for dilution ventilation. Federal OSHA has a recently proposed IAQ non-manufacturing workplace standard that is recommending that the carbon dioxide concentration not exceed 800 ppm. Although it has been shown by numerous studies that elevated carbon dioxide concentrations (>1000 ppm) have been associated with increased "Tight Building" types of complaints, there are many buildings with carbon dioxide concentrations above this level that have not reported any problems.

[Similarly, if a building has a high emission generator source (none were observed in these classrooms), then complaints can also occur at 800 ppm.] Again, this 1000 ppm guideline (or 800 ppm proposed OSHA standard) is not a fine line between well-being and ill-health, but is simply a professional guideline that is used as one piece of the puzzle by the indoor air quality expert.

So what does all this mean? At the time this school was designed, the Florida Administrative Code specified minimum outdoor air flow to a classroom was 5 cubic feet per minute per person (5 CFM/person). Although professionally outdated, the current Florida statute still currently requires only a minimum air flow of 5 CFM/person. If this school were operating as originally designed, then it would probably be in compliance with the current Florida Administrative Code (at least for several more months), but would not be in agreement with currently acceptable professional IAQ guidelines or the proposed OSHA standards that would regulate exposure limits for teachers and staff. From Dr. Spaul's inspection of a sampling of the air handlers, portions of this school are not operating, with respect to outdoor air flow, as the school was originally designed. In several of the air handler units, the controllers for the outdoor air intakes were not responsive, and some of the outdoor air intakes were almost closed. Given these observations, it is doubtful that those classrooms are being provided the originally designed outdoor make-up air flow of 5 CFM/person. Please also note that the student loading in classrooms in many schools is now considerably more than the original designer had planned, and this additional student load can exacerbate the inadequate outdoor air flow condition in a particular room. (As part of the long term remediation of this inadequate outdoor air flow problem, the mechanical engineer will need to design to the actual number or proposed number of students that will be using the room, and not to an outdated estimate of occupancy.)

In order to bring the air handler outdoor air flow back to the original design, the outdoor air intake damper controllers will need to be repaired or reset, and outdoor air intake provisions will need to be made for those units without outdoor air intakes. To increase the currently designed outdoor make-up air flow from 5 CFM/person to the recommended outdoor air flow of 15 CFM/person is not a simple task, and some major mechanical engineering and equipment changes will be required. The existing air handlers cannot handle the additional heat

and humidity loading from the increased outdoor air flow. The solution to the inadequate outdoor air flow should be viewed as a step process: first, get the outdoor make-up air flow back to the original design, which can be achieved fairly quickly; and second, initiate a mechanical engineering evaluation to determine the best option for increasing the outdoor air flow. Since there are several ways to achieve the increased outdoor air flow, some of which could be very expensive, it will be best to conduct a mechanical engineering review of this system and then have the mechanical engineer provide specific alternatives for the School District to consider. This second step to the ultimate solution will take time and money, and should be viewed as part of a master plan for all schools within the district.

Allergy-like Symptoms:

From the air handler inspections, there are a lot of mold growths in some of the units. Although many of these air handlers are fairly new, there are accumulated mold growths in the old internally insulated supply air ducts. Additionally, accumulations of mold growths and slime are present in some of the condensation pans. These molds could cause allergic reactions in people who are sensitive to those species of molds. Although exposures to airborne molds occur in all air in Florida, and can be extremely elevated outdoors between June and mid-October, these levels of exposures will generally only affect those people who are allergic to those organisms. The types of molds that are likely to grow inside an air handler are those same ones that are most frequently encountered outdoors in Florida, likely to become amplified inside an air handler unit, and are also frequently the cause of allergic reactions in people with mold allergies. Since these types of mold allergies are a very frequently encountered type of allergy in the general population, a thorough cleaning of these units should provide relief to these sensitized people. (As a note to staff and parents of children with these types of allergies, another major source of exposure that is often overlooked is the home air conditioner, which should also be cleaned annually - as specified in the recommendation section of this report.)

Surface molds on items in a classroom can be another source for allergens, and in this school, surface molds have reportedly been an isolated problem in some classrooms. As long as the surface molds are

promptly removed from the surfaces, this type of exposure problem can be easily controlled. This type of problem is usually indicative of either excessive water leaks, negative building pressurization, or inadequate operation (too short a duty cycle, elevated chilled water temperatures in chilled water systems) and inadequate dehumidification by the air handler unit. The causes for the inadequate dehumidification or moisture intrusion should be further evaluated.

Electric room deodorizers were found in Portable 247. These deodorizers are a source of volatile organics, which can be an irritation source to some occupants, particularly those with sinus problems or asthma.

In summary, the most likely ongoing current source for the allergy-like symptoms in this school is from the dirty conditions and mold growths inside some of the air handler units and the old supply air ducts.

CONCLUSIONS:

1. Some of these classrooms meet the carbon dioxide concentration, air flow, and complaint criteria that defines "Tight Building" conditions. Although distracting and uncomfortable, long term health effects from these problems are not anticipated. Most people actually report symptom disappearance within minutes to a few hours away from the building.

2. There are sufficient mold growths in most of the air handlers to result in allergen releases, and allergic reactions in sensitized workers and students could be anticipated from the levels of mold growths that were observed in these units. Once these units have been cleaned, the allergic symptoms that would be related to this source would normally disappear within the following 10 to 14 days, with most complaints having subsided within about a week.

3. Some of the illness episodes that were reported do not fit the pattern that is usually associated with a building, and include the usual childhood illnesses (measles, chicken pox, etc.) and colds. Please be aware that last year, Florida experienced two major influenza (flu)

epidemics, and this year has so far experienced one. Some of the reported flu-like symptoms and upper respiratory infections are probably due to these viruses, and are not building-related.

4. If a person is seeing a physician about a suspect-building problem, or if the person's treating physician has questions about any aspect of this report, the physician is encouraged to call Dr. Spaul at his Tampa office: 813-986-6885. Dr. Spaul often works with treating physicians on indoor air quality issues, particularly when there is a question about the role of a building exposure. This professional service is provided by Dr. Spaul at no cost to the individual, physician, or school district.

5. Electric room deodorizers were found in Portable 247. These deodorizers are a source of volatile organics, which can be an irritation source to these occupants. All types of deodorizers should be removed from the school.

RECOMMENDATIONS:

As a synopsis of the following specific recommendations, the following four steps should be pursued:

First: Clean the air handler units, and repair all deteriorated fiberglass, rusted out metal housings, and condensation drain lines.

Second: Reconnect, repair, and reset any inoperable outdoor air intake dampers and clean the outdoor air intake screens to ensure that the originally designed outdoor air flows will be provided to these units and classrooms.

Third: Have a test and balance company conduct an evaluation of the air flows, and thermostat calibrations, and have them prepare a report that identifies any problems that may affect air flow and dehumidification.

Fourth: After correcting any deficiencies that may be noted by the test and balance company, contract with a Florida licensed mechanical engineer to provide alternatives on

ways to upgrade the outdoor air flows to the 15 CFM/person guideline.

Specific Recommendations:

1. In order to achieve a successful resolution of an indoor air quality problem, there are two major aspects that must be addressed. These two aspects are the "engineering solution" for the cause of the problems, and the "people aspect". Often the engineering aspect is much easier to solve than the "people aspect" of the solution. The "people aspect" involves a deconditioning of beliefs that there are on-going uncontrollable problems in the building, and is usually accomplished by keeping the employees and parents informed about the problems, the engineering solutions to be utilized, and the time frames for anticipated resolution of the diagnosed problem. It is recommended that the "people aspect" of this solution start promptly, and involve a meeting with employees and parents who have expressed a concern. It will be important to point out that the "building is not sick", just that some very specific maintenance activities and design changes need to be completed. Should you desire it, Dr. Spaul can be available during this meeting to assist you in this effort.

2. The coils and inside of all of the air handler units should be thoroughly cleaned at least once a year, and more often if needed. The coils should be inspected from both sides of the coils for evidence of discoloration (darker color) or accumulated debris. During the heating phases, this color change will not be as obvious as during the cooling phases, during which time condensation water will be on the coils. A thorough coil cleaning with a non-acidic, foaming coil cleaner (e.g., Trane Alkaline Foam Coil Cleaner or equivalent) should be performed, followed by a low pressure rinse from the filter side through the coil to the condensation pan. The cleaning process should continue until the foam remains clean and white. A self-rinsing coil solution is acceptable only as a periodic maintenance chemical, but should not be used exclusive of the annual foaming coil cleaner. Be sure to thoroughly rinse the coils and condensation pan at the end of the coil cleaning process and then put the air handler into operation for at least eight hours after the work has been completed to flush out any odors before the return of the building occupants. Any dented or bent coil

fins should be combed straight at this time. If any small black particles come out of the supply register after the coil cleaning, then the unit was not properly rinsed. If this is the case, then the coils, condensation pan, and fan should be thoroughly rinsed again. Be sure to remove all of the black residue from the pan since this dead organic matter can become a food source for future microbial growths in the condensation pan.

3. The insulation, where there are small amounts of mold and debris that are visible, should be HEPA vacuumed, and then treated with Oxine. The supply air ducts should be accessed and inspected by the School Board's HVAC maintenance team when they start this project. If they find mold growths in the supply air ducts, then they should proceed with cleaning these ducts. Oxine is an EPA approved contact sanitizing agent that can be used inside air handlers. After HEPA vacuuming and disinfecting the insulation, the insulation should be coated with Portersept (Porter Paints) acrylic coating to inhibit future growths. About a 2-3 mil thick coating should be applied to the inside of the air handler (except the coils and condensation pan). White pigmented Portersept is useful in that it will be easy to check on the evenness of the coatings, and future dirt deposits are readily visible. This material has also been recently approved by the EPA, and can be used inside air handlers. The Oxine treatment may require several applications for some areas. Be sure to allow the Oxine to dry completely prior to applying the Portersept coating. It will not hurt to wait a few days between the Oxine and Portersept treatments. A HEPA-filtered vacuum cleaner can be purchased through most safety supply or asbestos abatement supply stores, and should not cost more than $600. The large, more expensive HEPA vacuums are not recommended since they are too bulky.

4. All air handler cleaning procedures should be performed at a time when the building occupants will be away from the building. Be sure to notify and remind the occupants prior to the cleaning and request that they keep away from the building during the times of the cleaning. All personnel who are involved in the cleaning should use appropriate personal protection during the cleaning and disinfecting process. Please refer to the manufacturer's MSDS for health and safety information about a particular chemical, and feel free to contact Dr. Spaul if you have any questions regarding the health and safety aspects of the cleaning procedures.

5. The condensation pans should be flushed but not treated with Portersept. The coils and condensation pan should be protected with plastic sheeting from Portersept overspray. Often it will help to increase the pitch slightly in the large units to encourage draining of the condensation pan.

6. After the decontamination of the air handlers has been completed, a very detailed follow-up inspection should be conducted to ensure that these units have been properly decontaminated.

7. As stated previously in this report, the *initial* goal for outdoor make-up air flow is to restore the school to the original design of 5 CFM/person. This will involve a review of all outdoor air controllers and damper positions, and making repairs where necessary. It should be understood that unless a school was built within the last year or so, it probably will not be able to handle the recommended outdoor air flow of 15 CFM/person as it is currently constructed. Since this problem is universal among most school districts in Florida, and no school district has the millions of dollars that will be required to immediately upgrade all of their schools, a master plan for achieving the currently recommended increased outdoor air flows throughout this school district should be initiated. This school should be put on a list of all schools within the district that will require upgrading the outdoor air flow, and then the list of schools should be prioritized according to the severity of problem.

8. The teachers and school custodian should be aware that the fans in these air handlers need to operate continuously when the school is occupied. If a teacher observes that the air handler fan is not operating during occupied times, then the teacher should notify the Principal so that the problem can be evaluated and corrected. During unoccupied times, particularly at night when there is minimal heat load on the building, the fans should not be operated since operating the fans under these conditions will load the building with excessive moisture, which could then put the building at risk for surface mold growths. During the late night and early morning hours, the outdoor air is nearly saturated with water vapor, and since the thermostats would not normally detect much of a heat load, the coils would not be sufficiently cold to provide dehumidification, especially for chilled water systems since the chiller plant is usually shut down at this time. Simply put, if the coils

are not cold, then there will not be dehumidification by the air handler unit.

9. Outdoor air intake dampers should be either interlocked with the air handlers (open only when the unit is operating) or put on timers. An advantage of the timer option is that during summer times or other extended periods of closed school, the outdoor air damper can be closed, and the air handlers can be operated for a few hours during the peak heat load period of the day. The air handler will then serve as a room dehumidifier. Outdoor air intake dampers need to be open when the building is occupied, and generally for about 1 to 1 1/2 hours prior to the start of school - to flush out odors. Opening the damper much earlier than 1 1/2 hours before the teachers arrive will load the building with unwanted moisture. With the timed outdoor air intake dampers, the damper could be shut when the students and staff leave, and the air handler can be operated for about an hour or two (depending on building heat load and time of year) to assist in dehumidification. During the humid times of the year, it is more detrimental to run only the air handler fan and pull in unconditioned outdoor air than it is to shut down the entire system.

10. The condensation pans should be frequently (monthly) inspected, and washed and flushed, if necessary. Much of the microbial slime growth in a condensation pan can be eliminated or greatly reduced by slightly pitching the units to encourage drainage. The condensation drain lines should be purged to ensure that the line drains freely. The use of condensation pan strips in the condensation pan can be an effective way to minimize microbial growth in the condensation pan. Biocidal tablets are not recommended since they can be corrosive, and as they dissolve, they may plug the condensation drain line and result in an overflowed pan. Large (12-15") condensation pan strips should be used instead of the small packages, and each of the larger air handler units should have at least two of the large strips. "Pan Guard" is a manufacturer of very effective strips that will also change color when exhausted. The housing to some units is extremely deteriorated and is leaking unconditioned air into the units. These deteriorated components should be replaced or repaired.

11. The supply air ducts should have inspection/access panels installed, which should be at least 24" x 24", or as close to this size as the space will allow. Small access panels are not worth their cost.

The HVAC worker should remove the panels to the air handlers and supply ducts to provide full access for inspecting and cleaning each unit. Thoroughness in cleaning the units and sealing any frayed fiberglass areas is extremely important.

12. Only a HEPA-filtered vacuum cleaner is recommended for cleaning these air handlers, ducts and fiberglass insulation. Any other type of vacuum cleaner will allow the fiberglass fibers and microorganisms to be discharged into the exhaust air, and breathed by the service worker and building occupants. Any areas where frayed, torn, or loose fiberglass insulation is observed should be either sealed or replaced. Even small amounts of fiberglass insulation can result in serious and ongoing health-related complaints - until the source is removed. As was noted in air handler unit #11, the fiberglass insulation has started to delaminate from the interior surfaces of the air handler units.

13. A licensed mechanical engineer should conduct an evaluation of the exhaust air flows to ensure that the building is being properly "flushed", yet at the same time keeping the building under a positive pressure relative to the outdoors. With an increase in outdoor air flows, there will also need to be an increase in the exhaust air flows. The mechanical engineer should review the original heat load calculations and heat load capacity of the existing room air handlers. It was reported that some of these units were oversized, which could then be heat loaded with additional outside air flows. If this is the case, then additional outdoor air flows could be supplied to the classrooms, which would improve the "Tight Building" conditions and at the same time force the air handler units to have a longer duty cycle, which will further assist in dehumidification.

14. If the School District decides to bid the air handler cleaning to an outside contractor, a detailed set of project bid specifications should be prepared. The following list of key items is not inclusive of all items that should be included and should not be used as a specification. In your contract with the mechanical contractor, be sure to include, at a minimum, the following items. (If you do the work in-house, you should also ensure that the following OSHA requirements are met.) If you have any questions about any of these requirements, please call Dr. Spaul.

a) The contractor's employees shall wear at least a half-mask NIOSH-approved respirator that is equipped with a combination HEPA filter, chlorine, and charcoal canister during the decontamination process. The contractor shall comply with the OSHA respirator regulations (29 CFR 1910.134).

b) The air handler shall be "locked out of service and tagged" during the decontamination, and the contractor shall provide the lock. The contractor shall comply with OSHA "lockout regulations" (29 CFR 1910.147).

c) The contractor shall ensure that his employees have been trained on the potential health effects of biological agents that can be found inside an air handler, and on the effects of the chemicals to be used inside the air handler. The contractor shall provide documentation that he has complied with the OSHA Hazard Communication program with respect to training his employees about the hazards to which his employees may be exposed (29 CFR 1910.1200).

d) A copy of the MSDS for each chemical to be used during the decontamination process shall be supplied to you at least 5 working days prior to use on School District property. Any chemical substitutions should be reviewed by a Certified Industrial Hygienist.

e) The air handler units should be put into full and continuous operation for at least six to eight hours prior to people re-entering the space that is supplied by the air handler. This will require that the work be performed between Friday night and Sunday afternoon, over a holiday period, or in the evening until midnight. The outdoor air flow should be wide open during this building flushing period. During this flushing period, the unit should be operated in the heating mode for at least two hours. (The decontamination specifications will address these procedures in greater detail than is addressed in this report.)

f) Any damage to the air handler or building that is caused by the contractor shall be repaired by the contractor at his expense.

g) The contractor shall not put a Portersept treated insulation panel back onto the air handler unit until the panel has thoroughly dried. The contractor may use a hair dryer or heat gun to accelerate the

drying. These panels should be coated first to provide adequate drying time. Any panels that are put back on the unit and then stick to the unit will require the contractor to return to the school and replace all stuck or torn insulation panels at no additional cost to the School District. Additionally, should the school become contaminated with fiberglass fibers as a result of delaminated or torn insulation because the insulation panel stuck to the air handler, then the contractor shall be solely responsible for all decontamination costs, consultant's fees, damaged property, and legal costs associated with that event.

15. Portersept can be applied to clean blower wheels and fan shafts. It is recommended that the shaft be turned during application to evenly coat the clean shaft and blower wheel. Please note that a drain hole may need to be drilled into the bottom of the fan housing to allow debris and water to drain from the fan housing after it is cleaned. The contractor shall ensure that the coating on the fan and shaft is even and thorough, and that no excess amounts are deposited on any parts that could cause accelerated wear on a bearing.

16. All filters should be upgraded to at least medium removal efficiency filters for the air handler units, which are typically a pleated filter. At present low removal efficiency filters were observed in a few units. Since it is apparent that air has also been by-passing the filters in some units, the filter racks should be inspected for adequate spacers, and deteriorated (rusted out) air handler housing shall be repaired. Also, if the filters are taped together with duct tape when they are installed in the large air handler units, the likelihood of filter by-pass is greatly reduced.

17. All deteriorated insulation should be replaced. Please be aware that there are non-fiberglass replacement insulation materials available, but prior to installation inside an air handler, a school district engineer should ensure that flame spread and smoke generation requirements are met with the replacement material.

18. All air handler rooms should be kept free of chemicals, housecleaning equipment, or flammable materials. The Principal should instruct the custodial staff to promptly empty any mechanical rooms of these materials, and to keep these items out of these mechanical rooms. The problem with storing any cleaning equipment or chemicals in these rooms is that odors or vapors could be pulled into the air

handler and then be spread quickly through the building. The main air handler room for the administrative area was being used as a storage room for housecleaning equipment.

19. All air handler mechanical rooms should be provided a hose bib, drain, and 110-volt ground faulted circuit interrupter electrical source. Additionally, at least 30" should be specified all the way around the unit during any future renovations, so that the units can be properly accessed for cleaning and servicing. All fiberglass insulation for the unit and ducts should be specified in the future as an exterior insulation only (or between double metal walls) and should not be in contact with the air stream.

20. Electric room deodorizers should not be allowed anywhere on this campus. If any are found, they should be removed from the campus to ensure that they are not used.

21. If during the air handler cleaning process there are complaints about black debris coming from the air handler ducts, or any ill-health effects from the chemicals used in the process, the school is encouraged to promptly call the Risk Management and Safety Department at 765-6300.

Although this school has some indoor air quality problems, the problems that were observed are the same as those that are frequently found in most schools in Florida. As mentioned previously about the inadequate outdoor air flow, probably 97% of the schools in Florida fit this category due largely to recent changes in evaluation criteria since the schools were built. At the same time, some of the problems with reduced outdoor air flows can be significantly and quickly minimized by repairing broken damper controls and operating the units continuously during occupied times.

The mold growths on the coils and insulation are due to a lack of properly prescribed preventive maintenance on the units in the past. The School Board has recently hired about thirty new employees to assist in cleaning these units, which should help the preventive maintenance program in the future.

It has been a pleasure to have been able to assist you with this project. Please do not hesitate to contact me if you have any questions about this report.

Sincerely,

Wil A. Spaul, President
PhD, MPH, MSCE
Certified Industrial Hygienist

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