DRAFT

Florida Healthy School Design Initiative 2006

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Foreword by James Schaller, MD

Prepared for Rep. Franklin Sands
At NO Cost to the State

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Foreword by James Schaller, M.D.

Mold in Schools and Homes

What is the most important thing in your life? What is your deepest concern? What is the center of your life?

Every day adults prove to me their emotional center is the children in their lives. The “key” to their heart is the children they love.

Yet, sometimes love is not enough. In fact, sometimes it is irrelevant. Both my parents lost siblings to illnesses that would be easily cured with current medicine. They were loved, but the doctors did not have the knowledge to save them.

While I know that science can save lives and help children, I find that very few medical and science seminars radically help children.

Since I publish and create health solutions in sixteen areas of medicine, I am not easily impressed. However, **this very simple set of guidelines for improving new school design is very impressive**. Why? As a child and adolescent psychiatrist, I witness many youth with behavior and school difficulties. The solution for millions of struggling children is in improving the indoor air quality in homes and particularly in schools.

In my treatment of child and adolescent problems, I am increasingly finding one cause among hundreds. Want to be shocked? A common cause of child emotional, behavioral and school trouble is **indoor** mold contamination. Their trouble is linked to such things as water leaks and AC problems in homes or schools. Many adults do not realize the grave effects of these indoor mold chemicals. Routinely, sincere parents, teachers, schools, aunts, uncles, grandparents, clergy, pediatricians and counselors overlook mold as a cause for youth trouble. Blind people are often sincere, but still need a trained dog or a cane. *Florida Healthy School Design Initiative* is written to help you see.

Do You See Andrew's Problem?

Andrew transferred to a respected private school. Starting at the beginning of the school year, he was having trouble following directions and had an "ill mood" according to his teacher. His parents noticed that he seemed to be moodier. He was complaining that his classroom was "too loud," and he seemed to exaggerate physical contact with siblings and friends. His sleep was less settled, and he wanted to have more time with his mother, including coming into his parent's bed. He had stopped this behavior three years ago.

He was found to have a depressed alpha MSH, a critical hormone with over ten functions. He also showed increased blood inflammation (a high MMP-9 and C3a). DNA studies at our office showed that his genetic make-up included a vulnerability to mold toxins. His parents shared these and other results with his pediatrician and allergist who had no idea what the results meant, or that some children like Andrew could be completely cured in less than 3 weeks. They had not read *Mold Warriors,* which I co-authored, so they did not understand that these medical tests are now readily available.

Andrew is getting better. He was home-schooled for 6 weeks and now is in a new school. Leaving the school certainly was an extreme solution, and not always needed. But after his mother tested the school's vacuum dust, she found illness-promoting mold, not just the routine stuff one usually finds indoors. The parents again spoke with their pediatrician and allergist about these mold test results and they had no real reply. The spicy mother told both doctors to send "any children like Andrew" to me. She is funny but speaks honestly. But most importantly, her son is improving and acting like the son she had years ago. "I have my Andrew back!" his mother told me. And as she showed me a new picture of him, he was clearly happy in the photo. Good for him and his loving sacrificial parents!

Behavior, Emotional and Learning Challenges

In a mere 3 days mold growth starts. So any school or home that has ever been wet inside for only three days can make a child, teacher or parent ill. This is not a joke. We really do mean just three days. Toxin making molds flourish indoors because the temperature is generally constant and there is no destructive UV light. So mold spores from people's shoes sit and wait to become like popcorn as soon as the moisture gets to 65% humidity. So all they need is just a little water to explosively grow.

Do you think mold problems are rare? Just think about how often you hear of a roof leak in a home or a school. I routinely hear of homes or offices having a "small leak" or a "little water in the basement." People often mention in passing an annoying little leak, and talk about having a plumber come out to address this problem "in a few days." They often mention this "leak" casually. But indoor mold is **not** a casual topic. Every year one in ten homes has an indoor leak. And every year schools turn off their air conditioning during August and grow mold in the highly humid and stale air.

And once the leak is repaired or the home or school AC is turned back on … if the mold is not physically removed, it will be carried all over the structure by the duct work. And it will remain and continue to contaminate the home or school.

Mold growth is like a cancer in your home or local school. Once it starts growing, mold is not easy to stop. But unlike cancer, it is always easy to avoid. Just take care of water problems ***immediately*** … before mold has a chance to start. If you have a mold problem, make sure the problem is taken care of professionally. Often homes or schools are grossly contaminated because of improper removal of the toxic mold during the repair work. As a result, the sick often get sicker once the mold is removed, and remain sick while they are remain in this mold contaminated home or school. You do not use your local butcher to remove a cancer. You seek out the best surgeon you can afford. You want the diseased tissue to be removed completely, so no single cancer cell is left. If you understand this analogy, you are starting to understand mold removal.

One way indoor molds cause sickness is by making biotoxins that pass from cell to cell with great ease -- altering DNA, making dangerous inflammation chemicals and ultimately hurting your children in hundreds of possible ways.

Even low levels of ***indoor*** mold growth can adversely affect sensitive children.

Because of the way toxins work on a child's nervous system, they can make a child appear to have many different possible illnesses.

Mold can cause the following sample problems:

- ☐ Poor attention span
- ☐ Limited ability to focus
- ☐ Irritability
- ☐ Mood swings
- ☐ Disobedience
- ☐ Homework difficulty
- ☐ Difficulty in learning
- ☐ Anxiety
- ☐ Agitation
- ☐ Excess aggression
- ☐ Difficulty relating to peers

With these facts in mind, I am delighted to introduce a new weapon to protect the children you love: Florida Healthy School Design Initiative.

James Schaller, MD, MAR

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Clinical & Research Child & Adolescent Psychiatrist

www.personalconsult.com

www.usmoldphysician.com

Florida Healthy School Design Initiative

Goals:

There are three goals to this School Design Initiative:

1.) To provide background on several indoor air quality issues that concerns our schools.

2.) To propose a very simple, but effective guideline that will not only result in future schools being build to meet EPA recommended Indoor Air Quality but, along with quality of life improvements, to provide long term cost savings as well.

3.) To serve as a basis for a New School Construction bill in 2006.

Note from Dr. Rosen: All research, development and printing of this document has been paid for with personal funds. We expect to receive no personal gain. Our reward will come if no child in our state has to go thru the environmental illness that Dr. Rosen's daughter went thru as a result of mold contamination in her school. She is now happy and healthy after moving to another school and receiving suitable treatment for her illness.

Introduction:

The EPA has published guidelines for the design and construction of schools with good Indoor Air Quality (IAQ). The web address for the study is: URL: http://www.epa.gov/iaq/schooldesign/

We offer, in our initiative, specific recommendations on school design encompassing the new EPA specifications along with special considerations for the hot and humid Florida climate.

- ☑ The EPA recommendations do not include mention of controlling indoor humidity.
- ☑ The EPA spec therefore is not completely suited as it now stands for humid climates.

- ☑ The EPA spec does not properly deal with indoor air filtration and the control of indoor particulate pollutants particularly mold spores and dust mite and mite products.
- ☑ The EPA spec can be easily amended to include humidity control and indoor air filtration based on well accepted industry guidelines for these two additional items.

The Cost Dilemma:

Schools construction contracts in Florida are awarded based on competitive bids for their construction cost. The bidding and award process **must be improved** so that bid documents include projected energy costs to operate the school with good IAQ and control of:

- ☑ Fresh air
- ☑ Temperature
- ☑ Humidity
- ☑ Air Filtration

Without energy and IAQ related operating costs in the bid, school contractors **will always bid** rot gut AC systems that will meet building codes on Day One, but will be much too costly to operate on a day to day basis to meet fresh air, temperature and humidity requirements. Specialty energy efficient AC equipment designed for Florida's climate to control humidity must be sourced in the school bid package … just as such equipment **is always sourced** for new residential high rise and first-class commercial projects.

Not only will this equipment protect our investment in our kids, it will also greatly reduce the cost to maintain the school … *as school buildings and furnishings last much long when fresh air, temperature and humidity are properly controlled.*

Recurring costs estimates should be given based on a 7 to 10 year operating range and approved by a State Licensed P.E.

The yearly maintenance breakdown should include the cost to maintain/ clean the AC duct system as well as replace air filters (minimum of Merv 9 efficiency rating) on a regularly scheduled basis.

Concrete (permanent) overhangs, energy efficient windows and films, energy efficient lighting, shade trees are some examples of ways to lower the long term operating costs of schools and **must all** be

considered from on a return on investment point of view as part of the bidding package.

Big Air = Bad Advice …. for the EPA:

Unfortunately the EPA has relied on the Big Air Conditioner Manufacturers for advice on the EPA school recommendations. Large, costly, energy-inefficient central air conditioners -- with their miles of costly and expensive duct work -- is all they recommend. The cost to maintain the large air ducts system required with centralized AC's is often prohibitive in the school environment. Whenever possible, small, high-efficiency low cost roof top units should be used in schools. Such local units have little to no ducting requirements. They are cheaper to purchase, cheaper to operate and cheaper to maintain than the large central units. Local units make it much easier to closely regulate IAQ on a per classroom basis in a cost effective basis.

Big units, unlike the small units, are often need to be shut down for long term repairs during the wet summer months, after which the school is full of mold and ready for the kids to return. Whose kids get sick the first week back?

The Outside Air Dilemma:

ASHRAE (American Society for Heating, Refrigeration & Air Conditioning Engineers) recommends bringing in 15 cubic feet of fresh outside air per student per minute (cfm). This guideline has been adopted by Building Codes throughout the country.

Unfortunately the introduction of high levels of outside air can sometimes cause as much harm as good since if the outside air that enters the building is humid, it will cause interior mold to grow and as a result contaminate the indoor environment. Mold is a problem in schools throughout many parts of the country, but our humid climate makes matters worse in Florida and in other humid areas.

The ASHRAE guideline for indoor air upon which the EPA Tools for Schools is based does not provide guidelines for control of indoor humidity.

In hot and humid climates, in order to avoid mold problems, outside air must be both cooled and dried. Cooling and drying the outside

air uses energy (costs money). Schools are under budget constraints and schools may look to save money by closing off outside air flow to students. Stale indoor air with an excess of C02 and other indoor pollutants may build up inside of the class rooms and as a result students will become tired or even ill. (Ever wonder why you get sick so often after flying? Airlines save money by re-circulating used air full of germs and low in oxygen rather than bringing in fresh air. This is happening in our schools as well!)

Compounding the problem, many schools have indoor mold problems. In such cases, cutting off the inflow of fresh outside air needed to flush out classrooms results in an accumulation of high levels of indoor mold spores and toxins. High levels of indoor mold spores cause allergic reactions in sensitive children and also cause complaints of malaise, lethargy, and headaches for many people. Note that government reports claim that nearly 1 in 13 school children suffer from Asthma and as such are sensitive to indoor air contaminated with mold spores.

Electron micrograph of mold spores in human lung.

Note: In certain industrial areas and farming areas the outside air may also need to be cleaned of certain chemicals, insecticides, fertilizer dusts, smells, or other offending pollutants. The AC equipment in humid environments that is installed to dry out the outside air may also be equipped to properly deal with cleaning the outside air using a combination of charcoal and particulate filters.

More on Asthma according to EPA

- An estimated 8,000 to 26,000 new asthma cases arise in children each year.

- Nearly 1 in 13 children of school age has asthma. The percentages are rising more rapidly in preschool age children than in any other group.
- Deaths related to asthma in children have nearly tripled over the last 15 years.
- African-American and Hispanic populations are more likely to have asthma

Following the building code without considering humidity

Bringing in outside air then is a double-edged sword: it brings in much needed fresh air but in our climate with it comes heat and humidity *both* of which need to be removed.

It is important that when bringing in the outside air into schools, a **high efficiency** Outside Air Ventilation unit be used that can dehumidify the outside air cost effectively ***before*** the outside air is mixed with the school indoor air. Selection and sizing of the Outside Air unit is a key aspect of providing good indoor air quality for schools in a cost effective way.

Point of reference: A resting adult breathes about .2 cu ft of air per minute… a child significantly less. 15 cu ft of air per minute per child is much more outside air than required to replenish the oxygen we need to breath. 15 cfm clearly then is a specification to allow outside air to wash away indoor pollutants rather than simply replenish oxygen.

Some groups such as HealthySchools.org recommend the use of CO2 monitors in the schools to measure the real time level of CO2 in the class rooms. However given that 15 cfm provides over 150 times the fresh air needed solely to replace oxygen used by children, we see no reason for this added expense. In addition, children can tamper with these monitors by blowing on them if the monitors are not placed in isolated areas.

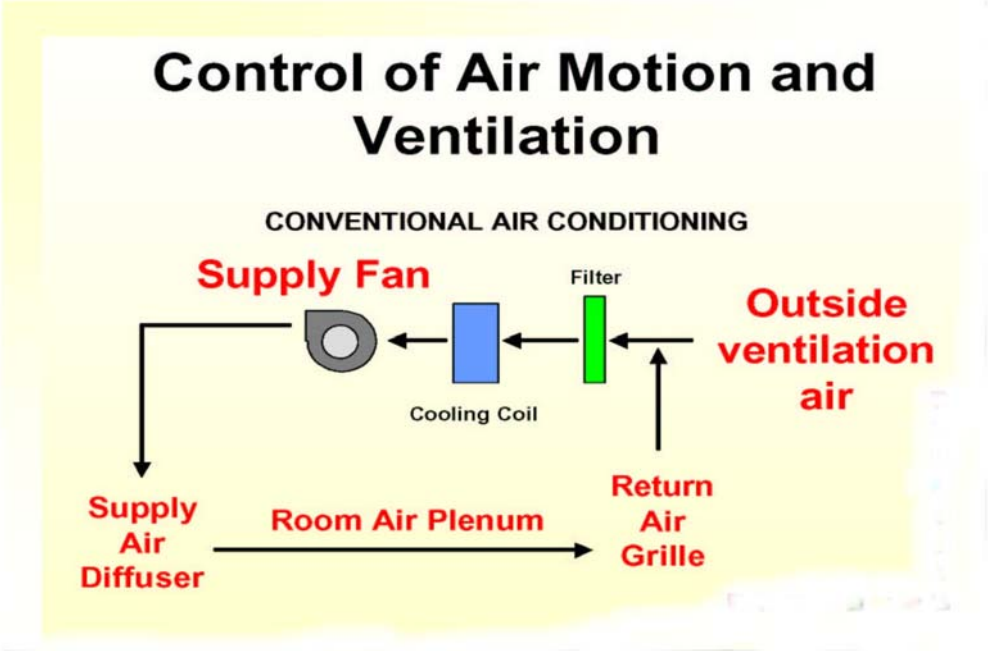
More on Outside Air Ventilation Units

Outside Air Ventilation (OA) units are specifically designed AC units that remove moisture from large volumes of entering air (see outside air ventilation diagram below) as cost effectively as possible using recovered energy for dehumidification. The energy normally

exhausted outside as waste heat is instead recovered and reused for the dehumidification process. Raw air entering via an Outside Air Ventilation unit is always dried *before* it is mixed with existing interior air.

With a *multi-stage* OA unit, on dryer days the Outside Air unit is not wasting unnecessary energy trying to dry air that is already dry. Only the OA drying stages that are needed are used at any one time. This saves energy.

By operating the Outside Air unit to produce a significant positive indoor air pressure, humid outside air leaking into the class rooms through the building structure (open doors, leaky windows etc.) will be significantly reduced (except on breezy days). Dry indoor air with positive pressure can actually dry out hidden moisture inside of the building or building walls creating a more resilient building that can be to some degree self-healing.



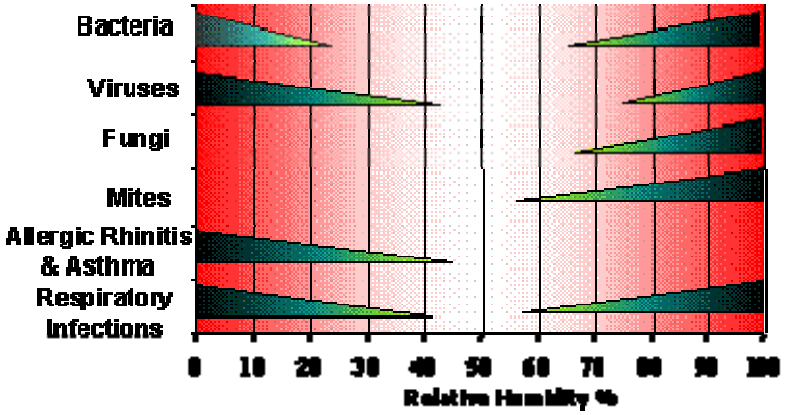
Indoor-AQ Healthy School AC Design Proposal

We are proposing design specifications for new schools that will provide a healthy indoor environment for school children. According to the recent information from the EPA on School IAQ, proper planning for Indoor AQ shows a payback of between 4 and 20

months. Therefore over time, designing for good school indoor air quality quite rapidly more than pays for itself in operating costs!

Proposed Design Guidelines

1.) Measure / monitor the level of indoor humidity in real time, making sure that it is 65% or below and as a result mold will not grow in classrooms. By controlling the indoor humidity, levels of indoor bacteria, viruses, respiratory infections and dust mites are also significantly reduced. In the graph below it shows that mold, dust mites, bacteria and viruses are all eliminated when the relative humidity is kept in the range between 40% and 60%.



2.) When indoor humidity levels are low, indoor temperature may then be set higher at an equivalent comfort level. In the hotter months, school indoor temperature should be set no lower than 78 degrees. By reducing the cost to cool the school, you will more than compensate for the cost of dehumidification. Additionally, since in South Florida windows tend to be single pane low-cost windows that have minimal thermal insulation, keeping the indoor temperature at a higher level – closer to the outdoor temperature – has obvious cost advantages when it comes to energy efficiency. The closer the indoor temperature is to the outdoor temperature, the less heat loss there will be across the window panes.

3.) No carpets in school and no problematic (cellulose based) acoustical/ceiling tiles. Use only ceiling tiles certified to be resistant to mold growth. Eliminating carpet and problem ceiling tiles is a common and inexpensive way to minimize mold growth in schools.

4.) High efficiency (Merv 9 or better) air filters on return air ducts. These filters remove many indoor particulate based pollutants as well as keep the AC system coils clean. The return air ducts should be designed and placed to make it easy to replace the air filters. If the school is in a farming or industrial area or in a high traffic area such as near a Freeway or major intersection air filtration should include charcoal filters that include sensors that show when the charcoal filter is "used up".

5.) 4 air supply vents per classroom. These will provide good mixing of air, reduce whistling, and eliminate the need for costly ceiling fans that have been recommended by EPA and others in the past to circulate indoor air properly.

6.) West and South facing windows should be protected from sun by overhangs and/or window film or tinted windows in order to minimize cooling cost.

...gnin... ...do w... my think... ...my abil- Ligh... ...unaddressed," Giuliani said.

Grand jury probing school building woes

BY STEVE HARRISON
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A yearlong state attorney's investigation into mold, mildew and construction problems at Broward public schools is heading to a grand jury this month, with a report due by March.

About 100 school officials and parents were interviewed in the probe, which is a follow-up to a 1997 grand jury report that blasted the school district's construction department.

This year's look into mold and mildew troubles was spurred, in part, by shoddy construction highlighted in the first report. Bad designs and poor workmanship at schools built in the past 15 years allowed water to seep into buildings, and mold and mildew flourished in South Florida's muggy climate.

Numerous parents at various schools have complained about health problems in their children, caused by mold — and the slow pace of cleanup by school officials.

The investigation isn't necessarily designed to produce indictments but to examine an issue of public money that concerns the entire county.

Assistant State Attorney John Countryman said he won't present the case as one with criminal intent. He added that his boss, Broward State Attorney Michael Satz, had always intended a follow-up report to judge the school system's progress.

Countryman originally hoped to bring the case to the grand jury in the spring or summer of 2002 and wouldn't comment on the reason for the delay.

The grand jury report comes as Broward is moving forward with a long-range plan for its construction needs. A consultant has identified about $2.5 million in construction — much of it renovations — needed over the next 10 years. The consultant's final report is due in March, about the same time as the grand jury

PLEASE SEE GRAND JURY, 2B

TOUGH TALK | ALLEY FATALITY | SMASH-AND-GRAB | DEATHS

General specifications for school AC system:

1.) As recommended by Dept of Energy for 1-3 story schools (10 CFR Parts 434 and 435) we recommend small packaged roof top (low cost) commercial 12 SEER AC heat pump units for each class room; and larger packaged roof top units for public areas. By using off-the-shelf commercial roof top units rather than central units, we reduce overall up front cost; we reduce potential school down time due to AC problems; as well as reduce the amount of air duct that can

potentially become contaminated with mold; and we reduce energy/ operating costs.

2.) A central dedicated high efficiency multi-stage Outside Air Ventilation (OA) unit using energy recovery technology must be employed to control humidity in the fresh air brought into the building. The specification should be 60% or lower relative humidity (RH) 100% of the days. Such Energy Recovery ventilation technology for schools is recommended by the EPA (www.epa.gov/iaq/schooldesign/).

3.) Outside Air Unit – Hours of Operation: The OA unit should operate 24/7. The roof top units should be on a timer and turned off when classes are not in session in order to save on energy costs. The OA unit must be installed so that it may run in re-circulation mode using school air instead of outside air when the roof top units are turned off. Re-circulation mode will keep the indoor humidity under control and greatly reduce operating costs.

4.) Air Duct Installation: Air ducts should all be placed within the air conditioned space of the buildings. Ducting in such case will not have to be insulated and will provide for a much more energy efficient operation. Ducting is easily inspected and repaired when in the open. *The supply from the Outside Air unit should be piped directly into the supply from the roof top units.* In such a case neither the AC duct for the OA unit nor the AC ducting for the Roof Top units will need to be insulated. Note: A central OA unit will not create problems with mold in the OA air duct since the air from the OA unit is always dry.

Important note about the outdoor air in the supply duct:
With a typical AC system the discharged air is at 100% RH (Relative Humidity) and below the dew point of the classroom air. The result is that the supply duct work becomes a prime area for mold. By mixing the conditioned outdoor air with the AC system's discharged air, the duct work is brought below 100% RH and usually above the dew point of the classroom significantly reducing the likelihood of mold.

5.) Filters on the OA unit should be cost effective and efficient in controlling indoor particulate contaminants such as pollen, dust and

mold spores as well as keeping the OA unit coils clean and running efficiently. They should be designed to be easily changed out.

6.) Detailed information on AC specification based on EPA guidelines in the Appendix pages 14-18 should be followed. We have included our comments based on optimizing the EPA guidelines for Florida's more humid climate.

Summary:

1.) By making the proper decisions on AC design and equipment as well as in selection of indoor furnishings, schools -- even in humid environments -- can be built that provide healthy environments without significant cost disadvantages. According to the recent information from the EPA on School IAQ, proper planning for Indoor AQ (called by them as IAQ Commissioning) shows a payback between 4 and 20 months. Therefore good IAQ over time it more than pays for itself in operating costs! See www.epa.gov/iaq/schooldesign

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2.) Good indoor air quality in the work place results in less sick time for teachers and administrators and lowers costs for furniture and structure maintenance.

3.) Proposed Federal legislation that requires government buildings to be mold free (or lose Federal funding) has the potential to cause grave damage to county and state budgets when public facilities are not properly designed.
http://www.iaqa.org/press_releases/Pr07122002.htm

4.) Asthma is a primary cause of school absenteeism, accounting for 10 million missed school days per year. Absenteeism directly affects school funding based on attendance. Better Indoor Air Quality can have a positive impact on school funding per student.

5.) Schools should be designed to maximize natural lighting both to reduce energy cost as well as well as improve student health and maximize student performance. Full Spectrum Lighting design should be used. Full spectrum, energy efficient, fluorescent lighting mimics natural light as recommended by the HealthySchools.org initiative.

Appendix A
Draft Specifications from the EPA School Design

Specify the following features for all air handling units:

✓	Double-sloped drain pan - A double-sloped pan prevents water from standing and stagnating in the pan. 1.5" drain outlet.
✓	Non-corroding drain pan and piping - Made from stainless steel or plastic. Prevents corrosion that would cause water to leak inside the AHU. Stainless steel recommended.
✓	Easy access doors - All access doors are hinged and use quick release latches that do not require tools to open. Easy access to filters, drain pans, and cooling coils is imperative. UL specifies that doors with dangers behind them, ie high voltage or moving parts must require a tool to be opened to prevent inadvertent opening by non designated personal, so kids can't get in easily. Filter access and drain pan access should not require a tool.
✓	Double wall cabinet - The inner wall protects the insulation from moisture and mechanical damage, increases sound dampening, and is easier to clean. Stainless steel wall recommended as they are really easy to clean. Urethane rather than fiberglass insulation is preferred as this can be cleaned with a pressure sprayer. In some units water would penetrate the seams in the double wall to wet the fiberglass.
✓	Tightly sealed cabinet - Small yet continuous air leaks in and out of the AHU cabinet can affect IAQ and energy. The greatest pressure differentials driving leaks occur at the AHU. Recommended: Unit is welded and then caulked with silicone, with automotive quality gaskets. This results in very tight system.
✓	Double wall doors with gaskets - Double wall doors provide better thermal and acoustic insulation, and will remain flatter, allowing a better seal against door frame gaskets
✓	Minimum 2 inch thick filter slots - For better protection of the indoor environment, as well as the equipment and ducts, the filters slots should be able to accommodate 2 in. or thicker filters. Minimum of 4" filter. We recommend 12". This will allow stacking of filters such as dust filter, HEPA, and/or charcoal should that be needed.
✓	Extended surface area filter bank - To reduce the frequency of filter maintenance and the cost of fan energy, the bank is designed to allow more filter area, such as the deep V approach or bags. Recommended: Pleated filters to extend the surface as opposed to a V bank.
✓	Low bypass filter bank - The filter bank should have gaskets and sealants at all points where air could easily bypass the air filters. Gaskets on filter are optional. On many systems there are no exposed points where air can bypass the filter so gaskets in these systems not required.
✓	Air filter monitor - A differential pressure gauge to indicate the static pressure drop across the filter bank. This feature could easily be installed as an option in the field. As a minimum unit should have a timed maintenance reminder based on run hours of the unit. Much like a car.
✓	Corrosion resistant dampers & links - All moving parts such as pivot pins, damper actuators, and linkages are able to withstand weather and moisture-induced corrosion for the full life of the system.

Notes in blue are from Indoor-AQ

☐ **Where feasible, utilize central HVAC air handling units that serve multiple rooms in lieu of unit ventilators or heat pumps.**

Although there are many different types of air handling units, for general IAQ implications in schools, air handling units (AHUs) can be divided into two groups: unit ventilators and heat pump units that serve a single room; and central air handling units that serve several rooms. Unit ventilators and heat pumps do have the advantage of reduced floor space requirements, and they do not recirculate air between rooms.

We recommend roof top heat pump units and a central Outside Air unit for our humid climate rather than the EPA approach. Our approach reduces up front cost as well as operating costs. HVAC companies like big central units that are costly to install and maintain and have costly to install and maintain duct systems.

Advantages of central air handling units include:

✓	Quieter, and therefore more likely to be turned on or left on by teachers and staff
✓	Less drafty due to multiple supplies and a return that is away from occupants. Solved by central OA unit.
✓	Better at controlling humidity and drainage of condensed moisture. Solved by central OA unit.
✓	Easier to maintain due to reduced number of components and quicker access. Solved by central OA unit.
✓	Able to access without interfering with class activities, and more space around units. Roof top units easiest to maintain.
✓	Space for higher efficiency air filters, and more surface area
✓	Components are heavier duty. More costly and recommended by HVAC contractors. Quality roof top commercial units much more cost effective.
✓	Less likely to have quantity of outdoor air supply inadvertently reduced. Solved by central OA unit.

Notes in blue are from Indoor-AQ

Air Filtration

In addition to "atmospheric dust," airborne particulates can include pollen, mold fungal spores, cat dander, insect proteins, pesticides, lead, and infectious bacteria and virii. Designers can integrate features into the ventilation system that will provide benefits for the school occupants as well as the efficiency and longevity of the HVAC system. In addition, these features can reduce the need for expensive cleaning of the duct work and air handling units.

Filter Efficiency

☐ **Air filters should have a dust-spot rating between 35% and 80%.**

The higher the rating, the better the protection for the equipment and the occupants. It has been estimated that a 30% increase in static pressure across a coil results in a $200 per 10,000 cfm of air movement (at 7 cents per KWH). This does not include the added cost of cleaning dirty heating or cooling oils, drain pans, or air ducts. Designers should consider specifying low efficiency (~10%) pre-filter upstream of the main filters. The pre-filters are generally easy and inexpensive to change, and will capture a significant amount of the particulate mass in the air thereby extending the useful life of the more expensive main filters. Recommended: 12" pleated 60% dust spot with 2" prefilters and charcoal filter if required.

Pressure Drop

☐ **Design more filter surface area into ventilation systems.**

This has two advantages: the number of filter changes each year is reduced, thereby reducing the cost of labor to properly maintain the filters; and static pressure loss is lower, which saves money by reducing the amount of power needed to operate fans and blowers. Since different filter media are approximately proportional in their efficiency/pressure drop ratio, the most effective method for reducing pressure drop is to design more filter surface area into the filter system. This can be done by the specification of a filter with larger amounts of surface area, such as a pleated filter or bag filter. The next method is to increase the number and/or size of the filters in the airstream, for example, by mounting the filter slots in a "V" pattern, rather than a filter rack that is simply flat and perpendicular to the airstream. Recommended: 12" pleated 60% dust spot with 2" prefilters and charcoal filter if required.

Monitoring Pressure

☐ **Consider installing a simple pressure differential gauge across all filter banks.**

This will prevent school facilities personnel from having to guess whether the filter is ready for replacement. A gauge with a range of zero to 1.0 in. w.g. can save money and the environment by preventing premature disposal of filters that still have useful life, and can prevent health and maintenance problems caused by overloaded filters that have blown out. The gauge should be easily visible from a standing position in an easily accessed location near the air handling unit. Useful option but not required. Different manufacturers have different methods for solving this issue.

Exhaust Air

Quick removal of concentrated air contaminants and building pressurization are two ways that exhaust systems affect IAQ. Special use areas such as science labs, vocational/technical shops, and indoor pools already have well established regulatory codes regarding ventilation with outdoor air. Less well recognized areas in schools where special exhaust ventilation is desirable are janitor closets, copy/work rooms and arts/crafts preparation areas where off-gassing from significant quantities of material may occur.

☐ **Provide exhaust ventilation for janitor's closets.**

If housekeeping and maintenance supplies are properly stored in janitor closets, only enough air need be exhausted to place the closet under negative pressure relative to surrounding rooms. As long as air does not easily leak into or from the closet through openings such as plenums or utility chases, 10 CFM of air being exhausted for the room will typically make it negative, and prevent the buildup of air pollutants.

☐ **Provide exhaust ventilation for copy/work rooms.**

In addition to the code-required amount of outdoor air being supplied to this room for general ventilation, it is desirable to determine what types of equipment and activities the school plans for this room, and to supply special exhaust ventilation for concentrated pollutant sources. Two examples of sources are copy machines and work areas for adhesives. Most copier manufacturers can provide an optional vent kit, which is usually a simple plastic fitting, that allows a piece of 3 or 4- inch diameter flexible duct to be connected between the copier and an exhaust fan. This captures much of the heat, particles, ozone, and other pollutants and exhausts them outdoors before they can spread throughout the workroom. A small exhaust hood over a work surface, similar to a fume hood in a science lab, would also be helpful to reducing exposure when adhesives, sprays, paints, and solvents are being used in the workroom.

☐ **Provide exhaust ventilation for arts and crafts preparation areas where off-gassing from significant quantities of materials may occur.**

☐ **Consider specifying a differential pressure monitor to monitor building pressurization.**

Current practice is to design the ventilation systems in a building so that the indoor pressure is a maximum of 0.10 inches water gauge (w.g.) (15 Pascals) higher than outdoors. This will prevent air from whistling in through exterior doors, and allow the doors to close properly. IAQ problems are often traced to improper pressurization, causing unexpected airflow between indoors and outdoors, and between areas within the school. For IAQ purposes, the building should be designed to operate between zero and 0.03 in. w.g. (0 to 7 Pa) positive, relative to outdoors. In humid areas, much moisture can be come through the building envelope –via open does, lose windows etc. This is especially prevalent in warm climates where buildings are not as tight as in cold climates (like Canada for instance.) The Outside Air unit should be configured so that return air is vents are closed down to the extent that humid air intrusion through the envelope is minimized.

Designing for Efficient Operations and Maintenance

☐ **Ensure that all system components, including air handling units, controls, and exhaust fans are easily accessible.**

To help ensure that proper operation and maintenance of ventilation system components will be performed, it is critical that the designer makes the components easily accessible. AHUs, controls, and exhaust fans should not require a ladder, the removal of ceiling tiles, or crawling to gain access. Rooftop equipment should be accessible by way of stairs and a full-sized door, not a fixed ladder and a hatch.

☐ **Label system components to facilitate operations and maintenance.**

Labeling of ventilation components is an inexpensive and effective method for helping facilities personnel properly operate and maintain the ventilation systems. The labels should be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. At a minimum, the following components should be labeled in each ventilation zone of the school. "AHU" refers to any air handling unit that is associated with outdoor air supply.

✓	The number or name of the AHU (AHU ##, or AHU for West Wing)
✓	The outdoor air (OA), supply air (SA), return air (RA), and exhaust or relief air (EA) connections to the AHU, each with arrows noting proper airflow direction
✓	The access door(s) for the air filters and the minimum filter dust-spot efficiency (Air Filters, minimum xx% dust spot efficiency)
✓	The filter pressure gauge and the recommended filter change pressure (Filter Pressure, max 0.x in. w.g.)
✓	The access door(s) for the condensate drain pan (Drain Pan)
✓	Other pertinent access doors such as to energy recovery ventilation wheels or plates (Energy Recovery Ventilation Unit)
✓	The minimum amount of outdoor air for each AHU (#### CFM minimum during occupied times)
✓	The outdoor air damper (OA Damper), with special marks noting when the damper is in the fully closed (Closed), fully opened (open), and minimum designed position (Min)
✓	If a motorized relief damper is installed (EA Damper), note the same positions as above
✓	The access door to any outdoor air controls (OA Control(s)) such as damper position adjustments, outdoor airflow measuring stations, resets, fuses, and switches)
✓	Breakers for exhaust fans (Exhaust Fan ##)
✓	Access doors for inspection and maintenance of air duct liners (Duct Liner)
✓	Any dampers and controls for air side economizers (as appropriate)