Comfort: A Classroom is Not an Office

by maury tiernan

The challenges involved in creating a comfortable learning environment in a classroom are different from those encountered creating a comfortable working environment in an office. They differ as much as an office is different from a home.

Let's compare the air conditioning needs of a 960sqft office with those of a 960sqft classroom, both with 8.2ft high ceilings.

The typical office with a B2 occupancy rating (UBC 100 sq ft/person) would occupy 9.6 people. The typical classroom with an A or E occupancy rating (UBC 30 sq ft/ person) would occupy 32 (31 students and a teacher.) While the chances of 9 or 10 people occupying a 14x67 office are slim, the chance that a 24x40 classroom would have 32 students or more, is not only possible, it's certain.

That's 100sqft of office floor space per person compared to 30sqft per person in the classroom. What size of air conditioning unit would be best?

Our typical office usually has a 3 or 3.5 ton air conditioning unit (providing 320-270sqft per ton of cooling capacity, depending on outdoor conditions). Our classroom example, with more people and a greater ventilation load, traditionally requires a 3.5 to 5 ton unit (conditioning 270-190sqft per ton, depending on outdoor conditions). In some circumstances, a classroom heat gain load calculation suggests a unit larger than 5 ton (examples: extremely hot Phoenix, or extremely humid Miami).

Let's take a look at what actually happens when we apply the air conditioning units in the examples above.

The office building provides 820 cubic feet of interior air space for each of the 9.6 occupants, while the classroom provides only 246 cubic feet of interior space for each of the 31 students and their teacher.

Experience tells us that everyone is a little different, but when the temperature is in the 72-75 degrees Fahrenheit range, and the relative humidity is held to around 50%, the human body generally feels comfortable with about 8 circulated air changes per hour. (That's one every 7.5 minutes.) Too much circulated air will feel drafty. Not enough circulated air can be stuffy.

For years the rule of thumb in the air conditioning industry has been to expect 400 cubic feet of conditioned air per minute per ton of cooling capacity. Therefore, we can expect that the office building's 3.5 ton air conditioner would give us 1,400 cubic feet of conditioned air per minute (400 cfm/ton x 3.5 ton unit capacity = 1400 cubic feet of conditioned air per minute) and the 5 ton classroom unit would provide us with 2,000 cubic feet of conditioned air per minute (400 cfm/ton x 5 ton unit capacity = 2000 cubic feet of conditioned air per minute).

If a 3 ton unit was selected for a 960sqft application, with its 1,200 cubic feet of air circulated every minute, it would produce the seven-minute circulated air change that feels most comfortable to us. (7872 cubic feet of office air space/1200 cubic feet of conditioned air per minute = 6.56 minutes per air change.)

For high occupancy circumstance in low ceiling applications such as classrooms, select an HVAC unit that is designed to deliver a higher cooling capacity at a lower cfm delivery per ton on a properly designed duct system.

A 4 ton unit, with 1,600 cubic feet of air per minute, pushes the air change rate to once every five minutes (7872 cubic feet of classroom air space / 1600 cubic feet of conditioned air per minute = 4.92 minutes per air change.) A 5 ton unit, with 2,000 cubic feet of air per minute, pushes the air change rate to once every four minutes. (7872 cubic feet of classroom air space / 2000 cubic feet of conditioned air per minute = 3.93 minutes per air change.) Air changes every 4.92 or 3.93 minutes will feel drafty and uncomfortable to occupants. An associated detriment is register noise.

A five-minute air change might feel good to our students temporarily, if they have been exercising, or when they first come into the classroom from a warmer environment, but as soon as they become acclimated to the indoor temperature and humidity, they will begin to feel uncomfortable.

To reduce this discomfort, don't make the mistake of reducing your HVAC unit's cooling capacity. Lower tonnage will reduce the amount of air circulating within the building, but reduced cooling capacity will not maintain the comfortable 72-75 degrees Fahrenheit temperature range under high outdoor ambient conditions.

In other words, a classroom benefits from an HVAC unit with a higher cooling capacity at a lower cfm/ton air delivery, because it can manage the heat load (cooling requirement) with noiseless, and draftless air movement within the classroom.

How can we get that noiseless and draftless air movement, if we don't want to lower cooling capacity to achieve a comfortable airflow?

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Circulated airflow is just half of the comfort equation. Ventilation (outside air) is the

other. Now let's consider the difference between the office and classroom ventilation requirements.

Most building codes require a minimum of 15 cubic feet of outside air per occupant per minute (continuous intake and exhaust during occupied times), so we will need 144 cubic feet per minute for our office (9.6 people x 15 cubit feet/person = 144 cubic feet of outside air required per minute) and 480 cubic feet per minute for our classroom (32 people x 15 cubic feet/person = 480 cubic feet of outside air required per minute)

Our classroom requires 3.3 times more outside air than our office. Bringing this much outside air into our classroom poses other problems: room pressurization and increased heat load. Let's focus on the room pressurization issue.

Have you ever noticed an HVAC unit's airflow holding the door open, or the sound of air whistling around the door and window cracks? The room's intake of outside air is beyond its exhaust capabilities.

With only 144 cubic feet per minute required ventilation, our office building could almost leak enough around the door, window, and building cracks to relieve the room pressure. Plus we will get some pressure relief through open doors as people come in and out of the building. It is doubtful that we will have much pressurization to worry about in an office building.

Our classroom is a different story. With 3.3 times the air coming into the building and today's tighter construction methods, internal air pressure builds up fast. We need to provide pressure relief. There are many possible ways to accomplish this. The HVAC unit may provide an integral intake and exhaust method, the building may have barometric relief, or a roof mount exhaust fan may be interconnected to the HVAC unit.

Whichever means of building ventilation (continuous intake and exhaust during occupied times) is selected initially, the ventilation method and measurements must be verified during commissioning and re-verified annually to insure "good" indoor air quality.

An HVAC system must provide a comfortable environment for the occupants. Comfort conditions for the occupants include a tempered, humidity controlled, noiseless, draftless, and filtered environment. Teachers and office workers will turn off a noisy or drafty HVAC unit to avoid uncomfortable conditions created by an HVAC unit's blower at full volume. Turn the HVAC unit off and there is no circulation or ventilation in the building. Good system design and proper HVAC equipment selection will prevent such problems.

Effective air conditioning design differs between an office and a classroom. Each application has its own unique challenges, but each challenge is easy to resolve once you understand the differences from one application to the next, and find the correct solutions.

Consult your mechanical engineer, or HVAC supplier for solutions to the comfort challenges encountered in your office or classroom applications.

Until we meet again, stay draftless and noiseless in . . . *The Comfort Zone*. ■

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