Following are answers to questions from the viewing audience that were not answered during the broadcast due to time constraints:

1. **For typical low-rise commercial office buildings, what is typically the calculated ventilation CFM as a % of supply?**

   Jeff from New Jersey

   There will be no "typical" % of supply. It very much depends on the type of system you design. If you have VAV it will depend on the zones and box minimums. You may find that your specific designs fit a pattern, but there are too many variables to generalize.

   Hoy Bohanon

2. **Have any surveys been done to find out how design engineers feel about the ability of design fees to support the analysis required by the standard?**

   Jeff Grant, PE

   This question seems to imply that additional analysis is required by the newest version of Standard 62 (62.1-2004). The old standard and codes require(d) that one account for zone ventilation effectiveness (6.1.3.3 in 62-1989) and multi-zone efficiency (multiple spaces 6.1.3.1 in 62.1989). The calculation equation, and lookup tables provide information in a form that can be consistently followed by design engineers. This may result in a decrease in time because all of the assumptions that previously had to be researched, justified and documented for each job are now standardized. Hoy Bohanon

3. **Would you please address your feelings WRT {with regard to} reducing the prescribed ASHRAE/IMC ventilation rate allowing for high room volume and short-term occupancy?**

   Bill McNeal, P.E.
   Anchorage, AK

   My personal feelings are to use caution when applying the short-term occupancy adjustments. The standard allows for those adjustments and if you properly apply the adjustments you will meet the requirements of the standard. Hoy Bohanon

4. **We are designing a building with a heliport on top. How can we ensure good air quality inside to building and prevent the intake of smoke and odor inside the building?** Danilio – Brazil

   You must carefully locate the outdoor air intake. If it is on the roof with the heliport, you will have problems. You should perform an analysis of the effect of wind on the building. Such an analysis may help you to locate the outdoor air intake away from *potential helicopter exhaust (such as on a side of the building upwind in terms of the prevailing wind) and/or design adequate deflectors to direct the exhaust away from the intake. See chapter 16 of the Handbook of Fundamentals as a starting point.*

Hoy Bohanon

This is a common design challenge that we see in hospitals that have the "life flight" helicopters for transporting the seriously injured. Although the air cleaning technologies are readily available for both the particulate and gaseous components of jet helicopter exhaust, the customer often balks at the cost of what would be required for a truly effective system.

The main airborne contaminants in and around the terminal buildings at airports will be due to the expected large amount of vehicular and aircraft traffic. One can expect any number of different contaminants - gaseous and particulate - to be present at any one time in this environment. Therefore, any contaminant control system considered must be capable of addressing as many of these as possible.

My recommendation for a filtration system for an airport application would start with a 2-stage particulate prefilter section consisting of 30% "roughing" filters followed by a 90-95% "polishing" filter. Because a large part of the contaminant load to the systems would be particulate matter, a good prefilter section is needed. However, the removal of particulate matter is one part of the reason we recommend the 2-stage approach.

Much of what is considered as part of the particulate component of exhaust may be better described as semivolatile matter. This material is produced as a by-product of the incomplete combustion of fossil fuels. This semivolatile material is in the air as aerosol droplets which tend to plate out (or condense) on surfaces as a gummy or tarry substance. The size of these droplets is such that they can be removed with particulate filters. However, once this material has been collected on the filters, the movement of air causes chemicals to volatilize from this material and be released back into the airstream. (This is one of the reasons why you can tell that someone had been smoking in a room several days after the fact.) Therefore, the removal of this semi-volatile matter on particulate filters is only the first part of the solution.

The numbers and types of chemical constituents are such that (at least) two different dry-scrubbing media would be required for their control. Just as in the particulate filter section, the chemical filter section should also consist of two stages. The first stage would contain a virgin granular activated carbon (GAC) for the removal of the higher weight aldehydes, hydrocarbons, organic acids, and nitrogen. This stage would be analogous to a "chemical prefilter." The second stage would contain a permanganate-impregnated activated alumina (PIA) media for the control of the lower weight aldehydes (formaldehyde), hydrocarbons, organic acids, nitric oxide, and sulfur dioxide. This would be our chemical "polishing" filter.

This two-stage approach would provide a longer service life and higher removal efficiencies than a single-stage system. Removal efficiencies of 97+% would not be uncommon over the useful life of the media. Due to the higher contaminant loads expected, make-up air units should use bulk media contained in either disposable or refillable modules. Adsorbent-loaded nonwoven filters should not be used. These filters may, however, be considered for use in the recirculation air units if they are separate systems from the make-up air units.

The final section of the filtration system would be a 30% final filter to catch any dust that may be generated during maintenance of the system.

To summarize, the preferred system for airport applications would consist of (in the direction of airflow) a 30% particulate filter, a 90-95% particulate filter, a chemical filter section containing GAC, a chemical filter section containing PIA media, and a 30% final particulate filter. Other system configurations may be discussed if there are physical or mechanical considerations.

One final comment about the two-stage prefilter section. Because the semi-volatile material tends to plate out on surfaces, and the dry-scrubbing media we would have in the system presents an extremely high surface area, the removal of this material is imperative for the optimum performance of the chemical filter section. If adequate particulate control was not employed, this material would literally "coat" the media, rendering it essentially useless. Also, the off-gassing from the material collected on the particulate prefilters would be yet another source of chemical contaminants which would negatively impact the service life of the media. Therefore, the most important maintenance item for the optimum performance of the system is the 30% prefilter section. These filters should be changed as often as necessary. This not only protects the chemical filters, but also the more expensive 90-95% filters.

Chris Muller

5. ASHRAE in the past specified 400 CFM per ton of refrigeration and 400 BTU per person. How does this relate to 20 CFM per person?

20 cfm per person was contained in a former ventilation standard. Ventilation standards are separate and unrelated to thermal comfort standards.

Hoy Bohanon

I'm not sure that ASHRAE has ever specified 400 cfm/ton or 400 btu/person. I believe they are more in the nature of industry "rules of thumb" than specified values. For example, 400 cfm/ton is indeed typical for estimating the air handling capacity of light commercial rooftop air conditioning units. But that value is not appropriate with respect to the cooling capacity needed to properly dehumidify mixed return and ventilation air during hot and humid weather. 300 cfm/ton or lower would probably be a better estimate, but manufacturers are the best source of this type of information regarding equipment.

According to the ASHRAE Handbook—Fundamentals 2005, Chapter 30, Table 1, 450 btu/hr/person is a reasonable estimate of the heat generated by a seated person, *doing moderately active work at a desk. If that person were walking or standing doing the same work, the estimate would rise to 550 Btu/hr/person. Of that value, about 250 Btu/h would be sensible heat, and 200 Btu/h would be moisture (about 0.21 lb/hr/person). A brisk walk through a factory, or light work at a machine is likely to release 1,000 Btu/h/person, or about the same heat release as a person who is dancing. Athletics like running or playing basketball releases about 2,000 Btu/h/person. Perhaps the most useful point shown by that table is that the amount of heat generated by people depends on their level of physical activity.*

20 cfm/person is the value formerly suggested by ASHRAE Standard 62.1 (Ventilation for acceptable indoor air quality) as the appropriate amount of outdoor air per person in an office occupancy. The current recommendations of Standard 62.1 are a bit more complex, because they separate the ventilation requirement for diluting contaminants from people from the requirement to dilute pollutants from the building. For example, in offices, Standard 62.1-2004 currently recommends 5 cfm/person, plus 0.06 cfm/ft2 of floor space. If one assumes an occupant density of 5 people per 1,000 ft2, the total outdoor air recommendation per person is now 17 cfm rather than 20 cfm/person. But as you can see, different occupant densities now affect that recommendation.

Lew Harriman

The 400 CFM per ton was not an "ASHRAE specified" value. It was a rule-of-thumb that's been around for at least 50 years! The way to determine the CFM is with the heat capacity equation; being careful to use as the load (q), the space sensible cooling load only! I've never heard of the 400 BTU per person. The 20 CFM per person is not an expression of load, it is the ventilation rate of outdoor air to dilute the air contaminants generated by the person. The actual currently recommended ventilation rates can be found in Table 6.1 of ASHRAE Standard 62.1, 2004.

Bill Coad

6. **Why is there a difference between the procedure for the calculation of the minimum ventilation rates as per table 6-1 of ASHRAE Standard 62.1-2004 and the IMC-2003-Table 403.3?**

Hazem Al Saedi – Beirut Lebanon

The codes lag the standards. Standard 62 changed significantly in 2004. Future codes may adopt the new procedures that were first published in 2004.

Hoy Bohanon

The IMC usually uses the ventilation rates from Standard 62.1 so it's simply a matter of timing. The IMC 2003 was published prior to Standard 62.1-2004 so it used the values from the previous issue of 62.1 which, I believe, was 2001.

Bill Coad

7. **Is 65% relative humidity the design target?** Albert Peterson

No. the 65% RH requirement in 62.1-2004 is a limit. It should not be the target.

Hoy Bohanon

I may be reading more into your question than what you intended. But I think it's important to make a clear distinction between a design target and a design limit. ASHRAE standard 62.1-2004, paragraph 5.10.1 suggests 65%rh as a maximum limit rather than a design target. And the 65%rh limit applies to occupied spaces, and it's intended to provide the perception of "acceptable indoor air quality". That limit does not address the purpose of achieving acceptable comfort, nor does it ensure the health of the building. For those purposes, ASHRAE currently makes no recommendations as to either humidity maximums or humidity targets. Personally, I would suggest that the appropriate design target for indoor humidity should be specified in terms of dew point rather than relative humidity, because both the health of building health and human thermal comfort are affected more by dew point than by relative humidity. A design target of a 55°F dew point will be an excellent compromise between costs and benefits in most buildings during the cooling season. (Some others agree. For example, the Federal Facility Standard, P-100, requires drying of ventilation air to a 50°F dew point based on a target of 55°F dew point and a limit of a 58°F dew point.) For reference, a design limit of a 62°F dew point is the same absolute humidity level as 65%rh at 75°F. But I don't believe that any design should be targeted at the design limit. To me that would be like building the structural frame of a building at the limit of the tensile and compressive strengths of its materials. Structural engineers don't design that way, and I don't think that owners or occupants should expect mechanical engineers to do so either.

Lew Harriman

8. **We have pressure tested some houses recently which were incredibly air tight. They have mechanical ventilation, but we were concerned that if there was a power cut at night, occupants could asphyxiate. How many cfm/person is necessary to prevent asphyxiation or where can this information be found?**

Paul Overy – Tipperary, Ireland

There is a brief discussion of this topic in Standard 62.1-2004 appendix C.

Hoy Bohanon

9. **How can I reduce the outdoor ventilation air when using the IAQ procedure?**

The Indoor Air Quality Procedure (IAQP) allows credit to be taken – in the form of a reduction of the outside air intake rates – for controls that remove contaminants that can be reliably demonstrated to result in indoor contaminant concentrations equal to or lower than those achieved using the Ventilation Rate Procedure (VRP). As opposed to the VRP's indirect solution for the control of indoor contaminants, the IAQP can provide a direct solution by reducing and controlling the concentrations of contaminants, through air cleaning, to specified acceptable levels. Chris Muller

10. This question is concerned with the energy efficiency requirements in new buildings and limiting heat gains and losses. I am working on a new International Airport terminal which is at basic design stage now.

When designing chemical filtration for IAQ in the airport situation, we are asked to comply with UK Building Regulations Part L, this says we must not increase the HVAC power consumption by more than "Max 2 watts/litre/ second". This new requirement probably has strong similarities with U. S. codes What comments does the panel have on this form of energy limitation and the influence on good HVAC design?

George Colman – Birmingham, England

If there are restrictions on increased power consumption in order to apply chemical filtration, you would have to look at in much the same way people are looking to be "carbon neutral" with regards to their impact on the environment. By this I mean you have to be able to design an air cleaning system to be "energy neutral." The first thing that comes to mind for an HVAC system design is the application of the IAQ Procedure from Standard 62.1. For instance, using the mass balance model, one can show that the amount of energy consumed would be less than the original design – especially for a new construction application. The heating and cooling systems can be down-sized based on lower outdoor air intake rates which would produce an immediate capital savings along with an ongoing operational savings versus a design based on the VRP. Chris Muller

11. Water reduces level of ozone; a wet coil is therefore an ozone filter; by how much does a wet coil reduce ozone?

Barry Bloom
UGA Physical Plant

Many people are using "water washers" for the reduction of many atmospheric pollutants. Of course particulates and those gaseous pollutants that are highly soluble in water will be removed with the highest capacity.

If these are recirculating-type systems, the treatment and disposal of this water may be a concern. If these are "once through" systems, water consumption would be high. In either case, the overall performance would need to be quantified as many of these systems use a gas-phase air filtration system downstream as a polishing filter.

Unfortunately, your question about the efficiency of a wet coil against ozone is one I cannot answer. I agree there would be some removal ozone, but whether you could claim it as an "ozone filter" would have to be verified. Residence time would be a deciding factor in how effective a wet coil would be for removing ozone.

Chris Muller

12. What filtering product(s) would you recommend for CO (Carbon Monoxide) control? Ron Braun, Earthtech, Canada

I do not know of any commercially-available products that claim an effectiveness for the control of CO at ambient conditions of temperature and humidity. There are some "room temperature catalyst" being sold that convert the CO to CO2, but they are very expensive and may require pretreatment of the air in order to work. The most common interferences come from water (vapor) when the relative humidity is above 20% and acid gases like SOx and NOx. These materials serve to "poison" the catalyst and render them ineffective.

Chris Muller

13. **What is the efficiency of UVPCO, UV and/or other filtration system/media at removing or reducing mold/mold spores?** Luc Chartrand, Saskatchewan , Canada

There is a lot a research going on right now to answer that question. Some who were looking to use these systems for gaseous contaminant control found that the cost per cfm of air treated was too high to be competitive against systems using granular absorbents / chemisorbents and started to look at other applications of this technology. The most logical of these was the application of UV-PCO for germicidal, fungicidal, sporicidal purposes.

The same issues that confront those selling the germicidal UV systems would be the same for UV-PCO systems – residence time versus kill rate. With mold and mold spores being the most difficult to "kill," certification of these systems for this application by someone other than the manufacturer would be a requirement. Claims of "one-pass" or "single-pass" kill rates can be highly exaggerated depending on which organisms were used in testing.

There currently are systems that claim to incorporate UV-PCO into their air cleaning system for the control of both chemical and biological contaminants, but their claims vary widely based on their understanding of the technology (or lack thereof). You can find many of these companies on the internet and I have not found one I would consider to be credible.

Chris Muller

14. **If I use 1.8 litres/second per square metre in Cold Air Distribution design and 8 degree Celsius temperature difference in heating, is this design acceptable from the perspective of air distribution effectiveness and thermal comfort?**

Translation to units I understand!
1.8 l/s= 3.8 cfm   1 sm = 11 sf   = 0.345cfm/sq.ft   8 C = 14.4 F Delta-T

This is a pretty low airflow rate for heating. But the Delta-T is within reason for overhead heating to avoid stratification. I'd be concerned about handling any significant heating demand, however, but maybe the climate is mild (guess it depends where in Australia one is). And assuming the diffuser is near a window, it's unlikely the 150 FPM (0.75 m/s) jet will penetrate into the occupied zone sufficiently to mix *with cold air falling down a cold window at that flow rate, but it wouold depend on the air distribution device. Again, this depends on the load. Our experience is that it takes upwards of 1 cfm/sq.ft (5.0 litres/second per square metre) to get effective distribution of heated air from the ceiling. I usually recommend that with CAD systems, the heating airflow will likely be greater than the cooling rate.*

Dan Int-Hout

15. Let's take a situation when HVAC fans are mounted very close to office rooms (short ductwork). Old ducts have been replaced with larger diameter round ducts with duct silencers inside. This eliminates the noise of turbulence and other noise from airflow. Because of poor location of the fans there is still some audible noise from fan blades. Can so called "active silencers" (electro-acoustically produced mirror-image of the disturbance) be used to eliminate this annoying sound? Or is there a better way to deal with it?

Raul Koosel – Estonia

My experience with active noise control (which may be dated) is that it takes a lot of energy to cancel low frequency noise (which means high power amplifiers, and relatively large speakers). It also usually requires a long, straight run of duct as well to get a good feedback system. New systems may be able to overcome these limitations, but I am not up to date on the latest developments in active noise control.

I have been told that double lagging ductwork with drywall, glued and screwed, will significantly reduce duct breakout near the exit of an air moving device. The ductwork must, of course, be lined with fiberglass duct liner. This is best accomplished as the ductwork is installed, rather than as a remediation. At least one acoustician has told me this is their standard practice.

Dan Int-Hout

16. Do you typically see mold in highly ventilated spaces? If you bring in outside air to a highly ventilated space, you should not have mold.

John – Chicago

Unfortunately, mold can be very common in highly-ventilated spaces. Mold will grow when cool materials absorb moisture from humid air. So when the ventilation air is humid and nutrient-laden surfaces are cool, mold grows well. Examples include:

- *The ventilated-but-not-dehumidified school discussed during the broadcast*
- *Manufactured homes and other houses with cool floors, open to the weather through a crawl space between the floor and the ground*
- *Building cavities in air conditioned buildings, through which humid air is being pulled by suction created by leaks in duct work.*

In summary, ventilation only helps avoid mold growth when the HVAC designer has taken the trouble to dry it, or when it happens to be dry enough by itself to remove rather than add moisture to materials.

Lew Harriman

17. Is there any good way to solve mold growth in buildings that have to operate under negative pressure? What is the spot where the air inflow (taken straight from outside) should be dehumidified? Is retrofitting possible?

Raul Koosel, Estonia

No simple answers to this question, I'm afraid. The solution will depend entirely on the nature of the building, it's geographic location, the volume of infiltrating air and it's exact location, and the temperature and composition of the interior surfaces over which the incoming humid air is drawn.

For example, swimming pool enclosures must operate under a constant negative pressure to avoid humid indoor air finding its way into cool parts of the building, where its moisture could condense. Any problem of infiltrating outdoor air is likely to be very minor compared to the importance of exhausting humid air from the pool area.

For another example, certain parts of hospitals and pharmaceutical manufacturing plants must operate under negative pressure to avoid cross-contamination of particulates between different parts of the building. But in general, those pressure differences are not great with respect to the outdoors, and the buildings tend to be built of very durable materials. So the risk of mold growth is not usually great, because the infiltrating air volumes are low and the materials are usually less supportive of mold growth.

But the real answer to your questions will depend on the exact circumstances you have in mind. The general rule is to keep the building under positive pressure with dry air. When that is not possible, there will be specific reasons for the negative pressure, and those reasons will dictate the means of reducing its inherent mold risk.

Whenever possible, the best location for placing the dehumidification equipment is certainly the inlet of the ventilation air stream. Removing the moisture before it blends with the return air will usually allow less expensive, smaller equipment which uses less energy to accomplish the necessary dehumidification. And certainly, the ventilation inlet is usually the most practical location for adding dehumidification to existing buildings.

Lew Harriman

18. When you have an unoccupied space in summer in a school environment, do you need cooling and dehumidification control to prevent mold?

J. K. Lawrence Tech – Southfield, MI

Dehumidification is the only tool needed to prevent mold in schools when they are unoccupied during the summer. High temperature is not a concern with respect to mold. (Unless there are also water leaks in addition to air leaks… then all bets are off!)

Not all schools have a high risk of mold during summer vacation. Many have no mold problems, even though they have no dedicated dehumidification equipment.

Higher risk comes during during humid weather, when the building might be partly—or periodically—cooled. Then the humid air which drifts into the building can condense its moisture onto cool surfaces, contributing to mold growth.

But the highest risk factor is ventilation without dehumidification during unoccupied periods. It's not wise to ventilate during the long summer vacation if there is no means of dehumidifying the building. Nor is there any real need to ventilate when the building is unoccupied.

In summary, dehumidification equipment is not always necessary when the building is unoccupied, but it's always useful. And when the building must be intermittently cooled for some reason during humid weather, dedicated dehumidification is definitely necessary, because when constant-volume cooling systems run for less than 40 minutes in each hour, they are not effective as dehumidifiers. In cases where short periods of cooling are necessary, dedicated dehumidifiers (controlled by humidistats and not by thermostats) are definitely a good idea.

Lew Harriman

19. When should dedicated outdoor air systems be used for humidity control?

David Miller – Rochester, NY

Three circumstances immediately come to mind:

1. *Federal buildings. Since 2003, the federal facility standard (P-100) has required dedicated ventilation systems which dry the incoming air to a 50°F dew point. There is no option for federal buildings covered by that standard—all the ventilation air must be dried, 24 hours a day, 7 days a week. (An excellent idea for all buildings, in my opinion.)*

2. *Buildings in which humidity must be controlled, rather than only moderated. If the building dew point must stay below a set level, as in the case of a museum, research lab or medical facilities, then using a dedicated outdoor air dehumidifier is probably the most economic choice as well as the most effective alternative.*

3. *Buildings in which there have been comfort complaints due to "cold and clammy" conditions. Drying the ventilation air will probably be the least expensive way to fix a problem of that type.*

Lew Harriman

20. Dew point control requires measuring humidity and temperature. How frequently do sensors need to be re-calibrated and/or replaced for state-of-the-art equipment today?

Barry – University of Georgia

The answer probably depends on the location of the sensor, the humidity level being measured, the probable contaminant level in the air and the consequences of inaccuracy.

For example, a high-quality sensor (±2% - a rather expensive device) when located indoors, in a stable environment without more than usual particulate contamination, measuring humidity in the 40° to 60°F dew point range at normal room temperatures, in an office building, should not need recalibration for many years.

On the other hand in that same office building, the same sensor located in the incoming ventilation air (which could vary from 10% rh to 95%rh in a single day, and which carries a high particulate load) will probably need recalibration every few months if the decisions based on that sensor input are economically significant.

Similarly, if a research laboratory will lose five years worth of results if the humidity goes out of specification (as can be the case with animal research), then quarterly recalibration would be prudent. And if the sensor is measuring humidity in a dry room held below a -10°F dew point, as is the case in lithium battery rooms, weekly checks would be wise, given the tendency of lithium metal to ignite when the surrounding air gets too humid.

Lew Harriman

21. Does the sealing of exhaust duct connections completely eliminate the risk of condensation and mold growth from continuous exhaust. I am thinking that the room itself may remain under negative pressure unless there is adequate makeup air therefore there will still be a draw of outdoor air, not directly through wall cavities or ceiling spaces, but through any building openings. While adjoining surfaces by some of these openings might have free air circulation, there may be other openings where mold growth may occur from outdoor entry and subsequent condensation. In conclusion, are we sure that the mold problem will be resolved through duct sealing when continuous exhaust is used?

Douglas, Spratt, P.E. – N. Vancouver, B.C.

A very good point. Sealing the exhaust ducts helps avoid mold behind walls because sealed ducts avoid humid air infiltration into building cavities… but sealed ducts are not the only concern. To avoid many other HVAC-dominated mold risks, the overall building air balance should be positive, using dry make-up air. I would further suggest a 50°F dew point as a working definition for the term: "dry" in this context.

Lew Harriman

22. How does the amount of grain in an occupied space affect the design?

I'm not certain I understand the question. But perhaps the question is: "How does the humidity control level inside the space (measured in grains per lb) affect the design?" If that's the question, the answer depends on the exact control level and the balance of humidity loads between outdoor and indoor sources. But typically, the control level will affect the best location for the dehumidification component within the system. For example, in industrial applications requiring low humidity levels and relatively high internal humidity loads, the dehumidifier is probably be best located after the point where the ventilation air and the return air blend. But for most commercial applications, drying the ventilation air before it blends with the return is often the most economical way to keep a space in a moderate humidity range. The best answer to this question is highly dependent on the specifics of the building, the exact control level in gr/lb, the location and magnitude of the loads and the owner's goals for the project. The ASHRAE Design Guide for Humidity Control is a 512-page book which contains extensive discussion of these issues, along with suggestions for both owners and designers.

Lew Harriman

I assume Mr. Nelson is referring to grains of moisture per pound of dry air (i.e., the humidity ratio). It's a key component of the design. The conditioned supply air or ventilation air must be dehumidified to a humidity ratio far enough below that desired in the space to absorb the vapor being generated in the space (otherwise, the latent load).

Bill Coad

23. What consideration in design must be considered for process cooling?

Horace Nelson – Kingston, Jamaica

I would need to have more specifics of the application and the project goal to provide any useful opinion.

Lew Harriman

The question cannot be answered without knowing more about the "process". However, a generic response would be that it simply requires a fundamental first law balance of both the sensible and the latent components.

Bill Coad

24. Have you seen VAV dedicated ventilation systems?

Dave Humphrey - Boulder, CO

Yes. Dedicated VAV ventilation systems which dry ventilation air continuously are being used in schools and retail buildings, because both occupancies vary greatly over the day and year. So modulating the ventilation air in response to rising CO2 levels in the occupied spaces is a great way to keep operating costs to a minimum.

Lew Harriman

Yes, I've seen them and I've designed several of them. Properly designed and operated they can provide high quality building ventilation in a most energy efficient manner at little or no investment cost penalty.

Bill Coad

25. Re: SMACNA Seal Class A – what standards exist to test the quality of the installation and what is the budget impact? Jeff – New Jersey

According to sheet metal estimators I have contacted, the cost of sealing duct connections depends on how much work is done in the shop compared to how much sealing remains to be done on-site. In the shop, sealing joints and seams costs pennies per linear foot of seam, while job-site sealing of the connections to air handlers can be expensive when those connections must be accessed via man-lift—like rooftop AC units mounted on curbs, with duct connections on the bottom. But as a rule of thumb, for commercial duct sealing with mastic on all connections, one could estimate the installed cost as being between 5 and 12% of the sheet metal portion of the project. The lower figure reflects the majority of the work being done in the shop, and the higher figure represents working mostly in awkward locations on the job site. For residential projects, with simpler duct work and less obstructed access, the costs are lower, provided that the sealing is done before the insulation is added to the ducts. In both commercial and residential buildings, sealing duct connections in long-occupied existing buildings is more costly and difficult. So focusing on the supply and return connections to air handlers is probably the best return on investment when economics do not allow an entire existing system to be sealed. It's useful to note that in several states, the suggestion to seal all duct connections during new construction is no longer optional. Energy codes in (at least) California, Florida and Massachusetts require a standard of air tightness that effectively means that all connections must be sealed.

Regarding the actual testing procedures, probably the most practical guidance comes from the manufacturers of the actual equipment used for testing duct leaks. Regarding standards for such tests in large commercial buildings, SMACNA (the Sheet Metal and Air Conditioning Contractors National Association) has guidance. Also, ACCA (Air Conditioning Contractors of America) has standards for residential and light commercial duct testing.

Lew Harriman

The only one that I'm familiar with is the SMACNA "HVAC Air Duct Leakage Test Manual". It's probably available through the ASHRAE Book Store or from SMACNA at (703) 803-2980.

Bill Coad

26. When you have a 13-year old heat recovery system – glycol based – most of the time the outside air dampers open to 100% makeup air. What type of controls should be added now and where should they go? Health Departments only check for CO2 when testing schools in our area.

Rick Haskins – Holland, OH

It is difficult to answer your question without knowing more about the details of the building, the system and the equipment. I can suggest, however that if you have modulating control dampers in either stream, that on a quarterly basis (every 3 months) they should be serviced, cleaned, and adjusted to "balance" the ventilation *air system at the desired quantity and building pressurization. (That way, you will always be a step ahead of the health department and as an additional advantage, you will have a well ventilated building.)*

Bill Coad

27. **Due to IAQ and energy efficiency concerns, energy recovery equipment is becoming more specified. With its increasing use – is there an increasing probability of cross-contamination by outside VOCS, organisms, etc. into the supply air stream. Where can guidance be found to minimize this handicap?**

David Hills, Hamilton, Ontario

It depends upon the heat recovery device, any device that transfers latent heat poses the possibility of molecular transfer of other contaminants. You will have to check with the manufacturer of the specific device. Of course, in Hamilton, you may be more concerned about sensible heat transfer only, in which case, by proper design, there is no danger of cross-contamination.

Bill Coad

28. **Are sustainable buildings healthy buildings? Of particular concern are certified** buildings that have not addressed IEQ optional credits. Are we headed back to the future?

Elia Sterling, Vancouver, BC

If the building isn't "healthy" it couldn't be sustainable.

Bill Coad