Follow Up Questions and Answers to Terry Brennan Presentation "Do Bath and Kitchen Fans Work"

Answers Provided by Terry Brennan, Camroden Associates

Question 1 – Tom Phillips Calif. Air Resources Board

a. How well do bath fans with humidistat controllers work, especially with several wet towels left in the shower area? Is this type of controller still required anywhere?
b. How well does the rated flow of an exhaust fan usually compare to the actual flow, especially over time? Is there an easy way for homeowners or facility managers to check these flows?
c. Does removing condensation from shower stall (via squeegee) cut moisture & window fogging way down? I've done it for years to reduce mold growth on grouting at wall/tub joint, and to reduce water corrosion on glass shower door. I also run the exhaust fan for a while, at least until the mirror clears or I don't smell any dampness when I enter.

One note on regional differences: the new California building energy efficiency standards (Title 24) incorporate ASHRAE 62.2, but do not allow the natural ventilation exception (reliance on windows) for certain climate zones. Our research confirmed earlier work indicating that windows in homes were not being opened often enough to provide the required air exchange rates for much of the year.

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Response to Question 1
Humidistats work pretty good for humidity control, but:

- won't help with someone who is in the bathroom without bathing
- have to be set high in cooling conditions or they run all summer because the outdoor humidity is high

Actual fan flows have gotten much better but if you don't measure you don't know. In the slide set there is a photo of an energy conservatory exhaust flow hood that is accurate at low flows and another photo of an iris ring measuring station that is also an accurate measuring device for low flows.

The water on the walls of the shower surround keeps the rh at the ceiling higher longer but has only small effect at the mirror level.

I agree with California on the 62.2 climate exception. I believe non-fan powered ventilation systems can be designed but they do not involve windows, they involve stacks, waste heat, variable dampers, wind catchers…

Question 2 - Ken Ruest, Canadian Home Mortgage Corporation
I wanted to ask Terry at what temperature was his house during the experiments. Houses that aren't heated to an adequate level may be more susceptible to condensation in bathrooms and elsewhere if the surfaces are too cold. During experiments at the Canadian Centre for Housing Technology to measure the impact of thermostat setback, it took seven hours for the drywall temperature on exterior walls to get back up to the temperature it was before the temperature was lowered. That means that people who do severe thermostat setbacks actually have very cold wall surfaces when they all take their showers in the morning--even if they have set the thermostat to re-set the temperature to their "comfort level" one hour before they get up.

The new house case with condensation problems that was discussed during the call may also be a case of not heating the house adequately, doing severe thermostat setbacks, or closing heavy drapes at night that prevent warm room air from warming the windows. I have seen cases where there were no excessive moisture sources present, and the condensation was strictly due to inadequately heating of the house. Some people have taken the advice to reduce the set temperature a little bit too far, and they have a daily condensation cycle that I call the daily mold sprinklering system.

Very interesting and practical experiment by the way Terry. I like simple tests like that, and I did lots type of work in houses for Don Fugler, and others when I was in private industry before I joined CMHC's Research Division. Keep up the good work!

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Response 2
Thanks for bringing up this important element of condensation dynamics. The easy answer is that the bathroom ventilation experiments I did were done with air temperature between 69 and 73 degrees F. The gypsum temperature in the bathroom was probably lower for the first experiment of the day. After the first experiment it was much warmer at the ceiling and as far down the walls as the "puddle" of warm, humid air came during the test. During the experiments condensation occurred in the "puddle" on painted gypsum surfaces (100% acrylic high gloss paints), all metal surfaces, the mirror and on varnished wood surfaces. It was hard to see on the wood and painted surfaces, but clear at 100x with shop microscope. How quickly and how much condensation occurs will be directly affected by the surface temperature of the materials. How visible the condensation is depends on how porous the surface is. Porous materials re-distribute the condensation very quickly.

The drapes and shades are problems. How low a setback and what were the indoor RH levels in the houses with condensation problems but no particularly big humidity sources? I'm wondering if we can develop some rules of thumb. I've had cases with seasonal buildings kept at 40 degrees during winter with condensation on everything in the spring.

Thanks for the compliment. I have found CMHC work to be very valuable tome over the years.

Question 3 – Eddie, Quad,-K Energy Conservation
Question Regarding tele-confrence,
On slide 15 we are discussing Range hood ventilation, is ir 40-100 cfm per *linear foot or square foot* of range top?

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Response 3
It's 40 – 100 cfm per linear foot of range front. So for a 3 foot wide range – 120 - 300 cfm.

Question 4 – Trudy Smith, HomeAire
We're having really good results with sub-slab depressurization systems for remediating damp basements. You guys've done some on that too, right? It's a lot less expensive than dehumidification from an energy standpoint. I'd sure like to hear where you guys are on that.
Trudy Smith, HomeAire

Response 4
Good to hear from you. I've seen ASD systems have a pretty big impact on indoor humidity levels. Often it does not, sometimes it does. If you have any case studies to write up it would be a benefit to us all. Gene Fisher (EPA) and Brad Turk (building geek) did a very thorough study in three houses in PA. The results are very interesting. It sheds light on the moisture dynamics involved. Data from more buildings would be very helpful.

Question 5 – Stephanie Parent, Calif. Air Resources Board
If you open the bathroom door after showering, how, if at all, does the moisture and chemicals, such as chlorine in the water, affect the rest of the home? Maybe it doesn't affect the rest of the house at all, but it's something I was pondering.

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Response 5

A complex question. The short answer, as it so often is in this field, is sometimes.

In my house even a series of 4 experiments with very low ventilation rates did not have an appreciable effect on indoor humidity. Either during winter conditions or summer conditions. In a smaller house or apartment, with lower ventilation rates (my house has 70 cfm continuous ventilation) it may have a fairly big effect. During cooling conditions the operation of an air conditioner may help or make things worse depending on whether it is handling part-load conditions well or not. If it is oversized so the indoor surfaces are cool, but it does not run long enough to dehumidify then it is condensation on surfaces may cause problems.

In terms of the VOCs they will be distributed through the rest of the house. Whether they cause problems for folks or not depends on the specific contaminants and health endpoint mechanisms. If health endpoints are related to cumulative doses then the distribution through the house increases everyone risk. It probably has no impact if the health endpoints are acute effects that result from critical concentrations.

If the fan is large enough to keep the bathroom clear during the shower then there would be no impact on the rest of the house.

Question 6 - Linda

Assuming you have a high performance, low energy home that has or will have a fully ducted HRV or ERV, what is your recommendation for bath and kitchen ventilation? – - When does it make sense to have a separate point source exhaust for both the bath and kitchen and when is it redundant?

I assume that with an ERV it would be more critical to have point source exhaust to address moisture.

If you are installing new stuff, it doesn't seem like you should go with cheap, noisy inefficient equipment, even if there is built in redundancy. If you already have a functional, though inefficient exhaust fan in the bathroom or kitchen it would appear that you would have a harder time justifying an upgrade to a Panasonic, if your primary mechanical ventilation system was going to be a central ERV or HRV, and you could get the desired flow rate for the bathroom with the existing equipment.

Response 6

In the simplest systems I use continuous HRV exhaust in the bathrooms and the general kitchen area and provide outdoor air to the bedrooms. This is a good basic ventilation system with very simple controls. I exhaust the range hood and dryer separately.

A useful upgrade is to put controls in the bathrooms that will kick the HRV to high speed for a specified amount of time (e.g. timer switch, occupancy sensor).

Years ago I used separate bath exhaust fans as local boosts, ducting them to the HRV exhaust side. An idea I got from Memphremegog. It seemed to work but I have no real data. In those houses I have been back and replaced the original bath exhausts (which when new actually moved 40 cfm of air) with small Panasonics.

Marc Rosenbaum reports that Europeans provide general kitchen exhaust and use hoods that filter and recirculate kitchen air. Chris Benedict and Henry Gifford used recirc range hoods with general kitchen exhaust in their apartment buildings. I'd like to do some experiments to study vented and recirc performance. A kitchen range exhaust hood leads to a number of issues that have to be addressed. If the range is a commercial one that may kick hundreds of thousands of BTU and hour, I believe exhaust is important.

Question 7 – John Porterfield, eZing, Inc

A brilliant presentation & management of learning!
Question: are there terms for SBS Risk Factor, p. 4 of presentation?
Question Related: SBS risk appears to be linear to CO_2, and CO_2 would be related to occupant density & dilution rate. This SEEMS to imply that dilution is adequate to address SBS. I recall that source removal and point source exhaust are most effective (when possible), and that dilution is not effective in the same way as CO_2 for certain contaminants. I understand that todays talk focused on bath humidity control (an instance of point source removal), though I wonder whether (above us true) distinguishing contaminant management and ventilation strategies should accompany the presentation.

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Response 7

The SBS data is from Jan Sundel's work in Europe. The risk factor has to do with the probability that people in the building will experience the symptoms associated with sick building syndrome. Sick building syndrome usually occurs in buildings where there is no identifiable problem contaminant. Dilution ventilation appears to have an effect on the risk of SBS symptoms. The curve I fit to the data is similar in shape to the dilution curve we'd expect for any contaminant with a constant emission rate. CO_2 is one we know a lot about and have lots of data for.

I agree that the first choice for preventing or solving an indoor air contaminant problem is to keep or get the source out of the building. Failing that local exhaust with some degree of containment is a good option. When the sources are too spread out or the people and critters occupying the building are the contaminant source we come to dilution ventilation.

Question 8 – Marc Rosenbaum, Energysmiths

I'd love to understand Terry's last slides, if he cares to annotate them with the points he wants to make.

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For an excellent treatment of the economy, energy, and the environment, take The Crash Course at www.chrismartenson.com

Response 8
For the house slides – CONTAM model of ventilation flows and pressures in a house:

- slide 36 – stack powered ventilation 73 degrees inside, 10 degrees (F) outside (NPL Neutral Pressure Level) – total flow 53 cfm
- slide 37 – add 50 cfm exhaust fan, NPL rises towards ceiling 30 rather than 53 cfm leaves through the uper leaks – total flow 80 cfm, not 103 cfm
- slide 38 - blowing 50 cfm into the house has the opposite effect; neutral pressure level drops, 80 cfm leaves trough the upper leaks (50 cfm through exhaust 30 cfm from lower leaks)
- slide 38 – to actually double the natural ventilation rate we'd have to use 100 cfm exhaust fan, neutral pressure level rises higher, 12 cfm leaves through uppermost leaks, 100 cfm leaves through fan – 112 cfm total
- slide 39 – or we cold use two 500 cfm fans – one exhausts, one blows air in, the neutral pressure level stays at the same height and 53 cfm leaves through the upper leaks, total flow rate 1003 cfm 50 through fans, 53 through upper leaks.

Question 9
I enjoyed your presentation yesterday, as always.
I have a question and a couple of comments:
The question: On slide 6, the 'continuous exhaust statement seems incomplete, insofar as this would likely depressurize a tight house. Is the statement made with the assumption that the building is in compliance with 62.2, and that there is a ready supply of makeup air?
I'm always troubled by statements about exhaust that don't acknowledge the makeup aspect…

And the comments:
In slide 4, the flatline at high ventilation rates obviously reflects an asymptotic approach to outdoor CO_2 levels. It occurred to me that the few folks exhibiting SBS symptoms might likewise represent a baseline level of complaints perhaps having nothing to do with contaminants in a particular building.

Re the bathroom moisture: I think it was in the '80's that I needed to deal with a moldy bathroom ceiling (teenagers at home). On learning about the moisture permeability of drywall, I first applied a coat or two of Glidden's InsulAid (how do I remember this stuff, and forget so much of today's stuff?) reasoning that each shower provided a temporary loading of the wallboard with moisture, allowing mold to grow. This would have been a good experiment, except that I also

added a mildewicide to the paint. Nevertheless, we haven't seen any mold growth since. The kids started to leave for college in the mid '80's, and since then, we usually shower with the door open. There is no vent fan in this bathroom. I did recently add a nice Panasonic (0.8 sone) to the other bath. (My fussy daughter said: "But we WANT a noisy fan in the bathroom!')
Anyway, it was great to see some quantitative info on this!

Response 9

I agree that it always wise to consider the effect of fan powered exhaust on the proper venting of combustion equipment (e.g. atmospherically vented furnaces, boilers and ho water heaters). This is increasingly important as houses become more airtight and exhaust fans become larger.

The IRC and ASHRAE 62.2 are code and Standards documents. No discussion is allowed in them, only requirements to meet them. The IRC relies on the National Fuel Gas Code to deal with makeup air. My experience is that the National Fuel Gas Code does a better job of this than it used to but it is still not robust when dealing with houses that can be depressurized a few pascals by the exhaust fans in them. 62.2 has a simplified depressurization limit requirement – if the net flow of the two largest exhaust fans exceeds 15cfm/100 ft2 floor area the fans must be reduced in size or make-up air must be provided. This is better than the ICC, but not as good as a depressurization limit test as practiced by BPI, HERS rates or the Minnesota airport retrofit program.

I like the hypothesis of a baseline of building complaints being reflected in the SBS graph.

Thanks for your experience in dealing with a moldy bathroom ceiling. Teenagers are to humans as singularities are to stars. I do not know whether putting a capillary break on the ceiling or adding the milddewcide had the greatest benefit. I do know that I have had good luck with Zinsser permawhite mildew resistant paint on bathroom ceilings.