Responses to Comments on draft 2010 GBSC
Post Construction IAQ Requirement for Flushout, BSC, Sec. 5.504
November 10, 2009

Comment

1. There are certain risks to the mechanical equipment if this procedure is mandated. First, damage may occur to ductwork in VAV systems during flushing because the fans are set to run at maximum capacity regardless of the need of the system. It is impossible to reach 60°F in warmer climates. Most of the cooling equipment is not designed to do it. If heating is done at the VAV zones and not at the AHU (no preheat coil), then freezing of the chilled water coil may be an issue in cold climates.
and
Please note that it is not a recommended practice to interfere with the control of the supply fans and outdoor air intake rates directly. To do this runs the risk of possible system damage by freezing, excessive downstream duct pressures and possible collapse of the air intake plenums. Controlling the equipment as a system is the recommended approach

Response

We have not seen or heard of reported HVAC damage in previous flush out cases in California and elsewhere. Maximum air flows should not produce pressure problems because HVAC systems should be designed to meet Title 24, which requires all nonresidential buildings, except smaller buildings, to have an economizer that delivers 100% outdoor air. Knowledgeable building designers and operators have been able to use modern HVAC control systems to automatically keep the HVAC system within safe operating parameters. Buildings in colder climates typically use "freeze stats" to prevent freezing of the chilled water coil.

The comment regarding reaching 60°F is puzzling, since 60 is the minimum, and it should be easy to reach higher temperatures and low humidities with outdoor air in warmer California climates.

Comment

2. Two of the criteria points seem to be mutually exclusive:
"… supplying continuous ventilation with all air handling units at their maximum outdoor air rate and all supply fans at their maximum position and rate for at least 14 days" and "…During this time, maintain an internal temperature of at least 60 °F, and relative humidity no higher than 60%"

Response

These dual criteria can be met in many California buildings. However, immediately following the sentence quoted by the commenter, Sec. 5.504.2 has language regarding "extenuating circumstances" that gives the building operator flexibility in adjusting the outdoor air (OA) flow rates and thermostat "as close as possible to these limits" for occupant comfort (for temperature and humidity). The operator must simply document in writing the reasons for using alternate flow rates or allowing alternate temperature or humidity. In our experience, during a spring-time flush out of ARB's previous headquarters building in

Sacramento, some nighttime condensation was observed. To solve this problem, the OA flows during the night were reduced to about 75%.

Comment

3. The cost of this testing done during the height of summer in Bakersfield or the dead of winter in Mammoth could be a burden on the construction budget or at minimum, a substantial energy consumer.

And

In some California climates there will be a large energy penalty for cooling to prevent the building from overheating, even if the tonnage is adequate, which it wouldn't be.

Response:

Energy costs have not been a major barrier for previous flush out cases. The cost can be minimized by flushing when heating or cooling needs are at their lowest, e.g., pre-occupancy and during the nights, weekends, and holidays. Flushing with hot air in the summer in Bakersfield, when the building is not occupied, should easily keep the building above 60 degrees and not cost much.

Comment

4. The control of humidity would be very difficult during this testing, especially during "occupied" hours. There is usually no provision in HVAC equipment for controlling humidity directly as the cooling coil accomplishes it indirectly. A better measure of this variable might be Dewpoint and not relative humidity…. To deal with it, the AC systems have to run with full refrigeration on to cool the air to the desired dewpoint temperature [because that is the only means of humidity control], so the AC systems have to have the capacity to accomplish this at weather extremes, and they usually do not.

Response:

This has not been a problem raised in previous flush out cases, but could occur in some high humidity locations or situations. If the building humidity exceeds the 60% limit. and the system lacks sufficient capacity for humidity control, then the thermal and/or RH limits can be exceeded under "extenuating circumstances", which must be documented in writing (see Sec. 5.504.2). Dew point is a useful metric, but RH meters or sensors can more easily be set up to track indoor conditions. Regarding full refrigeration mode, this should not be used because the temperature must be 60 degrees F or higher.

Comment

5. During this 14 day period, (especially if occupancy is begun on the 4th day) uniform T24 space temperatures cannot be achieved in all weather cases because the AC systems are not designed to operate with 100% Outside Air during peaked weather conditions. This requirement needs to be revised to be achievable.

Response

As discussed above, Sec. 5.504.2 provides for adjustments to be made under "extenuating circumstances". It gives the building operator flexibility in adjusting the OA flow rates to maintain occupant comfort.

Comment
6. Also, “the equivalent of 14 days of maximum outdoor air” needs a definition. What is equivalent?

Response

We recommend that the following text be added to no. 5 in Section 5.504.2: “The equivalent of 14 days of maximum outdoor air shall be calculated by multiplying the maximum feasible air flow rate (in ft^3/min) by the time in 14 days (20,160 min), to yield a target air volume for the flush-out (in ft^3). The air volumes for each period are then calculated and summed, and the flush out continues until the total equals the target air volume.”

Comment
7. VOCs off-gas slowly from new materials and the idea is to purge these gasses as they decay during the first few months of building occupancy.

Response

The goal of flushing with increased outdoor air flow rates is to accelerate off-gassing and pollutant removal prior to occupancy so that occupants are not exposed to elevated levels of contaminants. When occupancy must occur prior to completion, the goal is to reduce exposure within the first few days, or at most weeks, of occupancy, not months.

Comment
8. The LEED V3 flushing requirements are based upon total cubic feet of OSA per SF of building space and are intended to be performed over several weeks. This seems to be the more logical approach for determining the required purge rate or number of air changes required in a newly constructed space.

Response

The 14 day flush out with maximum OA will achieve the fastest feasible pollutant off-gassing and removal, whereas a set limit based on cfm/ft^2 will not. Furthermore, it is not clear what is the basis for the LEED IEQ Credit 3.2 requirement of 14,000 cubic feet/ft^2 of outdoor air; we have not been able to find the rationale but will consult LEED committee members who should be knowledgeable on this topic..

Comment
9. Testing the air for maximum concentration of contaminants is also a good option to include in the new code, since this allows a contractor some options to meet construction schedules and/or costs constraints.
And
IAQ Testing Alternative. The following programs all offer users an IAQ testing alternative:

- California CHPS (http://www.chps.net/content/032/CA_CHPS_Criteria_2009.pdf, page 125)
- LEED (LEED NC EQ 3.2)

- ASHRAE (Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings Fourth Public Review - ISC (September 2009). (The Standard Committee Chair is past ASHRAE President Kent W. Peterson, PE, FASHRAE, LEED AP, based in Long Beach).

Response

The LEED 3.2 option does not specify monitoring methods that are sensitive enough to allow comparison of results to health-based air quality standards, and its maximum allowable levels used for some pollutants are not adequately health protective. There are also many indoor air pollutants not included in the tests for new buildings, and not tested for in building product emissions tests. A flush out helps remove all pollutants that are present. Proper testing of indoor air quality, i.e., using the appropriate allowable levels and monitoring methods, is expensive and time-consuming

The ASHRAE Standard (189) has not been adopted yet. ASHRAE 189.1, Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings, requires both a building flush out and IAQ testing. 2009 CHPS allows limited IAQ testing and HVAC inspection as an alternative, but it is more protective in some respects than the LEED option. The CHPS and 189.1 options were considered for the Green Building Standards Code, but they were not included in the draft Green Building language because of the cost, time, and difficulty for proper implementation and enforcement by local building departments, and because flush outs assure removal of the breadth of pollutants that may be present.

Comment

10. Mechanical engineers will testify that to prevent thermal damage, condensation, mold or other unintended impacts caused by operating the building outside its design envelope the maximum outdoor air flow rate should be the design airflow rate for the system, not the maximum outside air flow rate, which is why both LEED and ASHRAE have rewritten their flush out procedures and included IAQ testing as an alternative to reflect this engineering reality. In other words, the flush out language used in this draft is obsolete.
And
The HVAC equipment and control systems will not have been designed to do this.

Response

Flush outs with maximum outdoor air were used for many years, and we have seen few reports in California or elsewhere of the problems indicated, although some moisture problems are expected in certain climates when air flows are not managed properly. Use of the design airflow rates would normally be inadequate to flush out or purge a new building of excess contaminants.

Per the responses above, section 5.504.2 allows for adjustments under extenuating circumstances. So, if a particular building could only be operated at its design flow rate, adjustments could be made with written documentation. The regulation would not require abnormal operation of the HVAC system, i.e., modes

of operation that would damage the system or require extraordinary changes to the system equipment. Rather, it would require that the system operation be optimized to increase OA flow rates as much as possible, within the constraints of equipment limits.

Comment

11. Misuse of HVAC equipment outside its normal operating parameters will cause potential liability problems for building owners, equipment manufacturers, mechanical engineering firms and commissioning engineers.

Response

We have not seen or heard reports of such liability issues since the days when new buildings were "baked out" (heated up and flushed), and materials and equipment damage were a concern. Building designers and operators have been able to use modern HVAC control systems to keep the HVAC system within safe operating parameters while maximizing outdoor air flow rates.

Comment

12. The 14 day time period of abnormal HVAC operations will overlap the HVAC system commissioning timeframe, disrupting or disabling the ability of the building to be tuned for energy and comfort.

Response

The flush out should occur prior to occupancy, and preferably, prior to commissioning. However, the proposed standard does allow for occupancy after 4 days of a flushout, providing the flushout continues and provides the equivalent amount of air from 14 days of flushing.

Comment

13. If the outside air quality is particularly poor (not unheard of in California) mandating excess outside air could make IAQ worse for 14 days.

Response

The draft standard allows flexibility under the "exceptional circumstances" wording in Sec. 5.504.2. Similarly, ASHRAE 189.1 addresses this issue by allowing OA ventilation rates to be reduced temporarily.

Comment

14. There is no data to quantify any health or productivity benefit from flush out.

Response

See the previous email from Tom Phillips to Jane Taylor summarizing the scientific literature and ARB experience with building flush outs.
In addition, a study of long-term VOC trends recommends that new apartment buildings have a flush out period of 130 days before and during initial occupancy.[1] Other additional information is summarized below.

[1] Wolkoff P, et al., 2004. The Danish Twin Apartment Study; Part I: Formaldehyde and Long-Term VOC Measurements. Indoor Air 1(4): 478 - 490

Extended periods of ventilation have been shown to reduce indoor air pollutant levels in test chambers and test rooms and in the few buildings that have been studied. This reduction in indoor pollutant levels reduces the risk of health effects and productivity losses from pollutant exposure. In particular, it reduces the risk of cancer, and usually, irritant effects.

Quantifying such health benefits in an occupied building is very difficult because of the numerous confounding factors that can affect building conditions and human responses. The study of the Capitol East End building in Sacramento found that indoor pollutant levels were generally reduced after the pre-occupancy flushout.[2] In addition, a national survey of 430 buildings has found that the occupants' perception of indoor air quality was improved significantly in green buildings compared to other buildings.[3] However, the effects of flushouts, low-VOC materials, and other practices could not be isolated because of the study design and the various factors involved.

Comment

15. The expense of IAQ testing is in the same order of magnitude as flush out, or less, depending on the locale and season. However contractors and building owners who complete the IAQ testing at least have some documents for their money that document the indoor air quality status achieved at occupancy. The flush out gives no such assurances of acceptable IAQ.

Response

We are not aware of any data comparing the cost of <u>proper</u> IAQ testing to the cost of a flush out (see Response to item 9 above), or data on the cost of a flushout. Proper testing methods that have adequate sensitivity for comparison to health based standards and averaging times can be fairly expensive and take weeks to get the results.

Regarding an assurance of acceptable IAQ, by the time proper testing is done and occupants have already moved in, the occupants may have been exposed to high levels of air pollutants. Such exposure can result in acute health effects such as irritation of mucous membranes and chemical sensitization. Furthermore, IAQ testing can never totally assure acceptable IAQ, especially if the testing is only done once. Flushouts, combined with selection (and verification) of low-emission materials and HVAC commissioning, constitute best practice for reducing human exposures to pollutant emission in new nonresidential buildings.

[2] Alevantis L, et al. 2006. Lessons Learned from Product Testing, Source Evaluation, and Air Sampling from a Five-Building Sustainable Office Complex. Proceedings of Healthy Buildings 2006, Lisbon, Portugal.

[3] Abbaszadeh, S, et al. 2006. Occupant Satisfaction with Indoor Environmental Quality in Green Buildings. Proceedings of Healthy Buildings 2006, Lisbon, Vol. III, 365-370.