The IAQ Procedure in Standard 62.1-2004

The IAQ Procedure offers a valid alternative to the Ventilation Rate Procedure, allowing designers to comply with Standard 62 while taking credit for air cleaning and material-emissions enhancements, for instance. However, compliance is neither easy nor risk-free.

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Past columns and countless trade journal articles that discuss Standard 62.1-2004 requirements almost seem to ignore the IAQ Procedure (IAQP) and to focus almost exclusively on the Ventilation Rate Procedure (VRP).

Why focus on the VRP?

The VRP provides a prescriptive path to Standard 62 compliance and avoids the somewhat controversial topic of concentrations. The idea is, if you ventilate at or above the minimum rates prescribed, space contaminants will be diluted and removed sufficiently to satisfy most people in most spaces in terms of odor-comfort and contaminant-related adverse health effects.

At the zone level, most designers understand how to use the minimum ventilation rates prescribed by this procedure and they feel comfortable making judgments about occupancy categories, expected population levels, and default zone air distribution effectiveness values.

At the system level, designers can determine the outdoor air intake flow needed for single-zone systems (by far the most common system) and for dedicated outdoor air systems using very simple math and without making any non-engineering judgments. More complicated multiple-zone recirculating systems (e.g., constant volume reheat and VAV systems) require correction for system ventilation efficiency, but the standard clearly spells out this process.

Designers must make some engineering judgments related to minimum expected zone airflow and system population at ventilation-design conditions, and they must choose either to look up a default value for system ventilation efficiency or calculate it using more accurate equations provided in Appendix A. Once established, design system ventilation efficiency can be used quite easily to calculate design outdoor air intake flow for the system. After some experience, and perhaps with the aid of the spreadsheet provided with *62.1-2004 User's Manual*, most designers are comfortable with the engineering judgments and straightforward calculations involved.

What about the IAQ Procedure?

The IAQ Procedure provides an alternative performance-based path to Standard 62 compliance. According to Section 6.1.2, it may be used to determine the outdoor airflow requirements for any project, and it is particularly useful for those projects where specific contaminant concentrations or specific levels of occupant perceived satisfaction are the design goal. (These projects might be expected to require more outdoor airflow than that prescribed by the VRP. The IAQP helps determine how much more.) Also, this procedure must be used to determine outdoor airflow requirements for those projects where the designer uses air cleaning or low-emitting materials, for instance, with the objective of requiring less outdoor airflow than that prescribed by the VRP.

In summary, the idea of the IAQP is to figure out:

- What contaminants pollute the indoor space;
- Where each contaminant originates (from indoor and/or outdoor sources);
- The net amount of each (added by sources, removed by air cleaning); and
- How much outdoor air is needed to dilute those contaminants to target concentration levels, all while satisfying a specific percentage of building occupants with respect to odor and irritant levels.

Sounds simple, right? Many designers would like to use this approach to take intake-airflow credit for increased air-cleaning capability. So, why don't more designers use it? I suspect that many designers are uncomfortable with the "loose" nature of the procedure and the perceived risks associated with the non-engineering judgments and knowledge it requires. Let's take a closer look at it.

Section 6.3.1.1

Section 6.3.1.1 (see *What 62.1 Says About Contaminants*) includes three requirements.

First, the designer must identify the contaminants of concern (CC) "for purposes of the design." In other words, the designer must decide upon a list of contaminants of concern for a given project. Such a list might be based on experience, analysis of similar buildings, documented indoor/outdoor contaminants, or perhaps, the advice or findings of others—the standard doesn't stipulate; it doesn't include a comprehensive list of indoor contaminants. And, it doesn't give any guidance as to what contaminants may be expected in various buildings. Designers must turn to other sources (as explained in more detail in the *62.1-2004 User's Manual*) to develop the required CC list. Designers must make some important non-engineering judgments to identify a reasonable and appropriately complete CC list. While not impossible, this task makes many designers uncomfortable and seems both daunting and risky.

Second, the designer must identify sources for each CC in the list. This requirement might actually precede or parallel the first requirement, since knowing potential contaminant sources can be helpful in establishing the CC list, and vice versa. For instance, if formaldehyde is a CC, how much does a specific chair, carpet or ceiling tile produce? Or, conversely, given that a space will include specific furniture, carpet and ceiling tiles, should the CC list include formaldehyde? Identification of sources requires close interaction between the HVAC system designer and the architect and material-emissions knowledge that most designers probably don't have.

Third, the designer must determine the source-strength for each CC from each identified source, both indoor and outdoor. This can become a significant spreadsheet exercise. The "strength" for outdoor sources is usually reported in terms of volumetric concentration (ppbv) or concentration density (g/m^3). The contaminant generation rate (cfm or g/s) can be determined based on concentration and outdoor air intake flow rate. The "strength" for indoor sources is usually reported in terms of mass-of-contaminant emitted per unit volume per unit time (mg/m^3-h), so contaminant generation rate (mg/h) can be determined based on the volume of each source. Source strengths have been established for many materials (the *62.1-2004 User's Manual* lists various papers and references) but not for all potential sources of each potential CC. So, compliance might require some (or a lot of) literature searching and/or materials-lab testing.

For each CC, the total generation rate from all sources (both indoor and outdoor) within a space must be determined as the sum of the generation rate from each source.

Section 6.3.1.2

Moving on to Section 6.3.1.2 (see *What 62.1 Says About Contaminants*), the designer must specify the target concentration limit (and corresponding exposure time) for each CC listed, and must specify (that is, include) an appropriate reference to a cognizant authority for the target concentration and exposure-time specified. Simple, right? But, what constitutes a cognizant authority? Standard 62 provides a definition (see *Definition*), but designers might still be a little unclear about which

What 62.1 Says About Contaminants

6.3.1.1. Contaminant Sources. Contaminants of concern for purposes of the design shall be identified. For each contaminant of concern, indoor and outdoor sources shall be identified and the strength of each source shall be determined.

6.3.1.2. Contaminant Concentration. For each contaminant of concern, a target concentration limit and its corresponding exposure period and an appropriate reference to a cognizant authority shall be specified.

6.3.1.3. Perceived Indoor Air Quality. The criteria to achieve the design level of acceptability shall be specified in terms of the percentage of building occupants and/or visitors expressing satisfaction with perceived indoor air quality.

6.3.1.4. Design Approaches. Select one or a combination of the following design approaches to determine minimum space and system outdoor airflow rates and all other design parameters deemed relevant (e.g., air cleaning efficiencies and supply airflow rates).

(a) Mass balance analysis. The steady-state equations in Appendix D, which describe the impact of air cleaning on outdoor air and recirculation rates, may be used as part of a mass balance analysis for ventilation systems serving a single space.

(b) Design approaches that have proved successful in similar buildings.

(c) Approaches validated by contaminant monitoring and subjective occupant evaluations in the completed building. An acceptable approach to subjective evaluation is presented in Appendix B, which may be used to validate the acceptability of perceived air quality in the completed building.

(d) Application of one of the preceding design approaches (a, b, or c) to specific contaminants and the use of the Ventilation Rate Procedure to address the general aspects of indoor air quality in the space being designed. In this situation, the Ventilation Rate Procedure would be used to determine the design ventilation rate of the space and the IAQ Procedure would be used to address the control of the specific contaminants through air cleaning or some other means.

authorities are actually expert enough or authoritative enough to be considered cognizant.

Wane Baker, P.E., CIH, Member ASHRAE, discussed cognizant authorities in a seminar at the 2004 ASHRAE Annual Meeting. Among his conclusions: no comprehensive list of such authorities exists; ASHRAE won't make a list; and, the inclusion of any authority in such a list depends on the specific issues and/or contaminants being considered. While the organizations listed in the tables in Appendix B (including EPA, OSHA, MAK, Health Canada, WHO, NIOSH, and ACGIH) may be cognizant for some contaminants, they may not be appropriate for all project-specific CC listed. Appendix B, with its limited list of contaminants, target limits and exposure times, and its limited list of "cognizant authorities" may be a good starting point for this requirement, but information from other sources is likely to be needed. Compliance seems to require non-engineering judgments related to both cognizant authorities and competing target limits.

Section 6.3.1.3

Section 6.3.1.3 (see *Contaminants*) addresses odors and irritants, usually produced by low concentrations of one or more contaminants. The best sensor for the combined effect of low levels of odorous or irritating contaminants seems to be the human nose. With this in mind, the designer must specify "criteria" to be used in judging whether the design level of acceptability has been achieved. It's clear that one element of these criteria entails specifying design acceptability in terms of the percentage of occupants (or visitors) who perceive the indoor air quality as satisfactory. However, it isn't as clear what else must be included in the criteria. For instance, shouldn't the designer also specify either design analysis or field test criteria? Without a design-analysis or field-test method for determining perceived air quality, couldn't a designer merely specify that 60% (or 80% or 99%) of visitors must express satisfaction without making any changes to air cleaning or source-strengths or ventilation? In other words, shouldn't the designer also specify criteria for actually achieving the specified percentage-satisfied design target? It wouldn't be too surprising to find that these perceived air quality requirements confuse designers. Perhaps the committee should be asked to interpret this requirement or an interested user should propose a change to the standard to clarify this section.

Definition

Cognizant authority: An agency or organization that has the expertise and jurisdiction to establish and regulate concentration limits for airborne contaminants; or an agency or organization that is recognized as authoritative and has the scope and expertise to establish guidelines, limit values, or concentration levels for airborne contaminants.

Section 6.3.1.4

Section 6.3.1.4 (see *Contaminants*) addresses design approaches for determining outdoor airflow rates. It offers four acceptable approaches, one or more of which must be used to determine minimum space and system outdoor airflow rates, given target concentrations, net generation rate (i.e., contaminant gain from sources, less contaminant loss via air cleaning), supply airflow rate, and so on. Alternatively, a designer could use one or more of these approaches to find required air cleaning efficiency and supply airflow rate, given target concentrations, contaminant gain from sources, outdoor airflow rate, and so on.

The **first design approach** requires the use of mass balance equations to find required outdoor airflow (or air cleaner efficiency). Perhaps the most designer-friendly, this analytical approach uses mathematical models, such as the steady-state concentration equations for single-zone systems included in Appendix D. For multiple-zone systems, mass balance calculations could be carried out using modeling software, such as CONTAM.

The **second approach** allows designers to use any approach that works, based on its successful application in similar projects. For example, if the designer can show that using MERV 13 filters and reducing VRP-determined intake airflow by 15% has achieved contaminant and perceived air quality targets in ten (for example) similar buildings, using the same design approach would seem to comply with the IAQP requirement. This approach might be more difficult for specifying engineers to apply than, say, design-build contractors, since engineers don't always have good feedback mechanisms to evaluate previous designs in action.

The **third approach** requires contaminant monitoring and subjective evaluation after construction is complete to prove that the design targets for CC and for perceived IAQ have, indeed, been achieved. While straightforward, this approach carries with it the risk of failing the test. If outdoor air intake flow, particle filter efficiency or gaseous air cleaner operation prove to be inadequate, the installed mechanical system may need significant rework after occupancy, such as more coil or chiller capacity, more fan static pressure capability, more air handler space, and so on. These are risks that most designers probably want to avoid.

The **fourth approach** combines the IAQP and the VRP within a single system. That is, a designer could choose to find the minimum zone outdoor airflow for one or more zones using the IAQP, while using the VRP for all other zones in the system. This might be useful if the system includes one or more zones with an unusually high contaminant source-strength. For instance, if an office building includes a conference room used to display carpet or furniture samples, the designer could choose to apply the IAQP to find the outdoor airflow needed in the conference room, but use the VRP to find zone outdoor airflow requirements for the remaining "typical" zones. This approach would be expected to increase system outdoor air intake flow, compared to VRP-only design.

Section 6.3.2

Finally, Section 6.3.2 requires specific information in the design documents. This information includes, for each zone: the CC list, CC sources, CC source strengths, CC target concentration limits (along with exposure times and cognizant authority references), and the design approach used (along with justification for its use) to find the minimum outdoor airflow or minimum air cleaning efficiency. Of course, other relevant design information also should be documented, such as the target satisfaction percentage and the means to show that it will be achieved. In all, this procedure probably entails an increased documentation burden for the designer, compared with the VRP.

Summary

The IAQP offers a valid alternative to the VRP, allowing designers to comply with Standard 62 while taking credit for air cleaning and material-emissions enhancements, for instance. However, compliance is neither easy nor risk-free. As more and more designers use it, its strengths and weaknesses will become more apparent. Within the procedural confines of continuous maintenance of standards, Standing Standards Project Committee 62.1 stands ready and willing to refine it as necessary in response to requests for interpretation and/or change proposals.

Thank you for supporting ASHRAE standards.

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