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The Hot Issues in IAQ: Where Do We Go From Here?

On September 25th and 26th in Washington, D.C., ***IAQU*** will sponsor "IAQ Update '89." This will be a forum to discuss the most challenging issues facing researchers, consultants, policy-makers, and others responsible for indoor air quality. Leading IAQ authorities will assemble on panels moderated by ***IAQU*** editor Hal Levin. The panelists will address topics including radon, asbestos, the new ASHRAE ventilation standard, safe building materials, sick building syndrome, and the accreditation of indoor air investigators.

The forum caught the attention of Congressman James Scheuer (D., New York) whose Natural Resources Subcommittee has scheduled a hearing on the IAQ Act of 1989, the "Mitchell-Kennedy Bill," for the day following the forum. By doing so, Rep. Scheuer will take advantage of the presence in town of the many experts and industry leaders who will be participating in the forum. It is also likely that news coverage of the forum will generate more interest in IAQ, the legislation, and the hearing itself.

Levin conceived the forum as an opportunity for critical dialogue on important issues which do not get discussed directly in most scientific and professional meetings and papers. In this month's ***IAQU*** we consider some of the topics and issues which will be discussed at the forum. If you cannot attend in person, we hope the following articles will inspire you to send us comments or questions for inclusion in the discussion and in a post-forum publication. If you wish to register for the forum or submit comments, please see the information at the end of this issue.

In This Issue

ASHRAE STANDARD 62-1989 IMPLEMENTATION

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has revised Standard 62-1981, "Ventilation for Acceptable Indoor Air Quality," the most important guidance document for indoor air. Its replacement, Standard 62-1989, will be available any day now. This is perhaps the most important event regarding IAQ to occur in several years. ASHRAE established a committee in 1983 to revise the prior standard. Now, more than five years later, the revised standard is about to be published.

The standard-writing committee's membership included engineers, architects, chemists, physiologists, product manufacturers, and industry representatives. While it is certainly far from perfect, the final product represents an informed consensus and is the best available guidance on ventilation control of indoor air quality.

We believe that *full implementation of the standard would eliminate up to 90% of all indoor air quality problems.* The standard addresses most of the problems that cause poor indoor air quality in buildings where complaint or illness rates are elevated. These problems include HVAC system designs, installations, or operations inadequate for the loads; load changes without corresponding modifications of the HVAC system; poor HVAC system maintenance practices; microbial contamination in HVAC systems; insufficient outside air supply; and poor supply air distribution.

However, there is far more to the standard's "full implementation" than just its publication by ASHRAE. In order for it to be fully implemented, engineers, architects, and HVAC equipment manufacturers must use it to guide their designs, buildings, and products; code-writing organizations and jurisdictions charged with code adoption must choose to include or reference it as a mandatory element; and, building officials and building operators must enforce and follow it.

Because of its significance, we made implementation of Standard 62-1989 the focus of our first session at the forum. Following are some of the issues and problems critical to implementing the standard and developing more comprehensive control of indoor air quality.

Limited Health Protection

Can Standard 62-1989 protect the public from harmful constituents in indoor air, or is it just a comfort standard as many of its critics have alleged?

The standard defines acceptable indoor air quality by two criteria. The first criterion is that no more than 20% of the occupants express dissatisfaction with the indoor air. The second criterion is that there are no known contaminants at harmful concentrations as determined by cognizant authorities. Unfortunately, the standard fails to include provisions for fulfilling the second criterion.

Other than in its definition of "acceptable indoor air quality," Standard 62-1989 does not minimize the risks associated with long-term chronic exposure to low levels of indoor air pollutants. It can't; there simply are too many gaps in the current level of knowledge. It is primarily a comfort standard, providing more acceptable (to the occupants) indoor air quality. Complete protection of public health indoors through an ASHRAE standard is not likely in the foreseeable future.

How New Is the "New" Standard?

As this new standard goes into effect, what difference will it make? Will buildings be more comfortable, healthier, and safer?

The answer partly depends on the degree to which the standard is followed. This, in turn, depends in part on the engineering community's acceptance of the standard and in part on the rate and degree of its incorporation into mandatory codes and statutes. For most engineers, following the current standard simply means using the minimum outside air supply rates specified. Unfortunately, those trying to minimize equipment sizing and operational costs often dilute the prescribed rates by interpreting the standard contrary to its meaning or intent.

Can or should building owners be required to operate buildings according to the standard, or is it useful or practical only as a design standard? How should compliance with the standard be evaluated on an on-going basis? Can it be done in a practical and unobtrusive way?

Successfully implementing the standard also depends greatly on whether buildings will be required to operate according to the standards, or will just be required to meet design specifications. The foreword to the standard is unequivocal about this point: "It must be recognized, however, that the conditions specified in this standard must be achieved during the operation of buildings as well as in the design of the buildings if acceptable indoor air quality is to be achieved." If the standard is achieved in the design but the performance is not verified either upon completion or periodically after occupancy, the standard's purpose and promise will have been subverted.

Major changes in the standard:

There are two major changes in the new standard, according to John Janssen, chairman of the committee that developed it.

- The first major change is the increase in the minimum outdoor air flow rate in clean environments from 5 cfm/person to 15 cfm/person. A clean environment is one in which known sources of unusual contaminants or unusually strong sources of contaminants do not exist.
- The second major change is that the distinction in Standard 62-1981 between smoking-permitted and smoking-prohibited environments has been removed.

The old standard established a 5 cfm/p minimum in nonsmoking and a 20 cfm/p minimum in smoking-permitted areas. The new standard specifies a 15 cfm/p minimum for all spaces regardless of whether smoking occurs. The rationale is that people smoke less now than formerly, and that research has shown that 15 cfm/p is adequate to control environmental tobacco smoke to a level that will be found acceptable by at least 80% of the occupants.

Some critics of the standard argue that there has actually been a reduction in the protection afforded nonsmokers from ETS in the change from a 20 cfm/p minimum in smoking-permitted spaces to 15 cfm/p minimum in all spaces (whether or not smoking is permitted). However, outside air requirements for most occupied areas are 20 cfm/p or higher. Office spaces, dining rooms, and conference rooms must receive 20 cfm/p, bars and cocktail lounges must receive 30 cfm/p, and smoking lounges must receive 60 cfm/p. Nonetheless, it is still quite possible that significant concentrations of ETS can enter a non-smoker's "breathing zone" since smoke plumes do not mix perfectly. They tend to remain relatively concentrated until travelling some distance from the source.

We see some other significant changes in the standard — changes which can do more to improve indoor air quality in the future than the minimum outside air supply requirements.

- One is the requirement that design documentation be prepared in conjunction with the design of HVAC systems.
- Another is the requirement that HVAC systems be easily accessible for inspection, cleaning and maintenance.

Outside Air Supply Minimum Requirements

Do the outside air supply requirements mean delivery of specified quantities to the breathing zone of each individual occupant, or only an average for the space served by each supply air register? Is the total the quantity for each room or area or an average for the entire building? How do designers interpret the requirements in Standard 62-1981 and what will they do with the new standard?

These are serious and fundamental questions about how to interpret one of the standard's most important requirements. The standard is not sufficiently clear to answer these questions. Some of the provisions for averaging (described below) and identifying spaces according to the specific use suggest that the requirements are for particular spaces rather than for the whole building.

However, the standard provides no further guidance as to whether the air must actually be distributed within the space according to the distribution of occupants. It does not clarify whether the required quantities of outside air must actually be delivered to the breathing zone of each occupant, to a breathing zone somewhere within the space, or just introduced somewhere into the space.

A related question concerns the following provision in the standard: outside air supply quantities may be reduced when multiple spaces are served by a common supply system. The purpose of this provision is to offer opportunities for energy conservation (read that "economy" if you like).

The standard allows for some averaging under a provision it borrowed from an Australian standard. This provision allows a reduction in the overall building total outside air to compensate for the ventilation requirements of the most demanding space. Where occupant density varies considerably in a building, this could result in significant differences among spaces. And, where room volumes vary significantly, differences could be rather large.

Shortfalls and excesses in outside air supply distributions can result from such an approach. But this is not the result of the "Australian" averaging procedure alone. It is the result of any approach which averages loads from different zones supplied by a common supply system. The problem has not been addressed by the standard. Averaging outdoor air requirements for all spaces served by a single system will result in these sorts of distortions of supply requirements unless we use some explicit approach to avoid them.

Variations on the types of systems used might result in some solutions. We could use induction systems with outside air and cooling coils (or, where required, heating coils) at the distribution terminal, or separate outside air supply and recirculation distribution networks. But where economizer cycles are employed for a significant part of the day or year, these approaches are less cost effective. Alternatively, we might use a variable outside air supply and constant volume space air distribution system or another system utilizing proportional control approaches.

Ventilation Effectiveness

How will ventilation effectiveness be measured? Can it be measured, and if so, when and by whom? What happens if it is less than what was specified?

How do we design for ventilation effectiveness? Will designers have to specify more than the minimums prescribed by the standard to compensate for ventilation effectiveness less than 100%?

What about very large spaces? Are outside air supply rates based on the number of occupants adequate? Shouldn't we consider a minimum outside air exchange rate for the space to remove stale air or contaminants emitted from sources not dependent upon occupants?

Ventilation effectiveness is a central part of the standard. Yet its quantification is relegated to an appendix in the standard. There is controversy in the indoor air research and consulting communities regarding the degree to which supply air actually reaches the occupants and how designers should deal with this consideration.

Poor air distribution within a space can adversely affect IAQ even though the outside air supply rate is at or above the required minimum. The standard says that the outside air supply rates in Table 2 are needed "for well-mixed conditions (ventilation effectiveness approaches 100%)." It defines ventilation effectiveness as the "fraction of outdoor air delivered to the space that reaches the occupied space."

This might be one of the more controversial provisions of the standard. It is not clear in the standard itself whether the outside air flow requirements pertain to each air handling unit, each space, or each individual occupant's immediate environment. There will be much controversy about how much and what kind of averaging is permitted by the standard.

Air exchange rates based solely on occupant density or number are inadequate because they ignore spatial volume. When volumes vary greatly from norms, for instance, in a very high ceiling space, a sparsely occupied space, or a very tiny space, per person outside air ventilation rates may provide insufficient air exchange or may result in unacceptable drafts.

The important question is whether required outside air must be delivered to each individual occupant's breathing zone. If not, where should it be delivered?

Several questions arise here.

- Should occupants receive some fraction based on the ventilation efficiency of the system?
- How and where will ventilation efficiency be measured? If the delivered outside air does not meet the design requirements, then who will be responsible to correct it?
- Will designers start to overdesign in order to protect themselves against liability?
- Will code officials question the inefficient use of energy and disapprove plan submittals for nonconformance to energy conservation requirements?

The engineer and architect are in a difficult position. We would expect them to protect themselves first, the owner and the occupants last. What else can they do?

Control of Unusual Sources or Contaminants

How can unusual or strong sources of contaminants be dealt with? Can and will ASHRAE provide guidelines? Is the standard's disclaimer with respect to the protection of occupant health an invitation for a parallel set of indoor air quality standards which do address health concerns comprehensively?

The standard requires the designer to consider any special or strong sources of indoor air contaminants, yet provides little to no guidance for assessing source strengths, calculating likely airborne concentrations, or controlling concentrations to acceptable levels. An appendix contains a collection of guidelines from various authoritative bodies, but engineers and architects are left on their own to interpret the information and apply it in their projects. This is certainly not a routine task.

The ventilation rate procedure that prescribes a given quantity of outside air for each occupant is blind to the strength or nature of contaminant sources. This is one of the shortcomings of the standard. However, there is an exception statement under the ventilation rate procedure which requires that unusual contaminants or sources be controlled at the source or the air quality procedure must be used. Under that procedure, no specified quantity of outside air is required. Instead, contaminant levels are prescribed for ten contaminants, and guidance is offered for many others.

The standard requires that the designer determine what levels are acceptable under the indoor air quality procedure. This, too, is a shortcoming of the standard. If neither the cognizant authorities nor ASHRAE are able to establish acceptable levels, it is highly unlikely that any professional engineer is going to pretend to know what acceptable levels ought to be. By not providing guidance on this question, ASHRAE undermines the utility and value of the standard.

Air Cleaning Requirements

Is air cleaning required whenever outside air quality violates National Ambient Air Quality Standards (NAAQS)? What kind of filtration or other air cleaning will be required when outdoor air contaminants exceed NAAQS levels?

The outside air supply minimum requirements clearly state that outside air must meet federal air quality standards. The standard calls for reduced outside air flows when filtration of contaminants exceeding federal air quality standards is impractical. 100% recirculation would then occur.

Ozone, carbon monoxide, and particulate matter are the contaminants most frequently exceeding federal standards in urban areas of the United States. Filtration can remove ozone and particulate matter. But practical filtration for carbon monoxide (CO) is not currently available.

Many urban areas fail to meet federal standards for CO, especially during rush hour. So indoor air would be recirculated and indoor air levels of other contaminants will rise unless appropriate filtration is used.

When outside air supply is reduced to avoid using contaminated outdoor air, the standard and good engineering practice require filtration to remove contaminants known to be present in indoor air. Therefore, designers will be forced into the air quality procedure of the standard rather than simply supplying the required minimum quantities of outdoor air.

Thus, full implementation of the standard involves significant changes in current practice. Actually, the old standard, 62-1981, calls for cleaning outside air, but designers have not been complying with this requirement. The question now is will the new standard result in more complete compliance or will designers continue to ignore significant elements of the standard?

Design Documentation

Design documentation is a new requirement in the standard. However, it is not defined or described, and no direction or guidance is given for meeting the requirement. What does the requirement mean to practicing professionals? What does the standard require for design documentation? Will this requirement result in more responsibility for the design team? Who will receive the design documentation and what responsibilities will they have?

The design documentation requirement, if properly implemented, can result in far better communication between architect and engineer, between design team and building owner or operator, and between building management and building occupants. Architects, engineers, and facilities managers can focus contractual provisions on indoor air quality considerations. Interior designers and renovators will be able to determine the ability of the ventilation system to handle contemplated changes.

Unfortunately, ASHRAE has said practically nothing about what the design documentation should involve, who should prepare it, or what should be done with it. The standard only requires that the design documentation state design assumptions regarding ventilation rates and air distribution. There is no further guidance in the standard.

The only guidance we know of is in portions of papers presented at ASHRAE's 1989 winter meeting in Chicago by members of an ASHRAE committee preparing guidelines for HVAC system commissioning. See ***IAQU***, February 1989, for a summary of some of those papers and our own list of elements for design documentation. We incorporated relevant elements of those papers into that article and another one Levin presented last March at the American Society of Civil Engineers meeting in San Francisco.

What are the implications of documenting design assumptions when actual building conditions change? What will designers of tenant improvements do if the design assumptions for the base building do not provide adequate ventilation for the actual uses of the space? Who will be responsible?

The standard addresses this issue, indicating that building operators and designers of renovations should use the assumptions delineated in the design documentation. It says: "Design documentation shall clearly state which assumptions were used in the design so that the limits of the system in removing contaminants can be evaluated by others before the system is operated in a different mode, or before new sources are introduced into the space."

This is unambiguous; design documentation must adequately describe the system capability and must be available to building operators and designers before making changes. However, who will be responsible to maintain the documentation and make it available to these parties in the future? This is not spelled out in the standard. We suggest that the designers (architect, engineer, interior designers) of the original construction and of all modifications retain copies of all relevant documentation in their files; that the building owner maintain a copy; and, that the operating engineer or building management company maintain a copy. When changes are made, the design should be documented, all changes specifically identified, and the updated design documentation should pass through the same custodial process.

The remaining question is whether performance verification reports should be similarly maintained. If laws or codes require operation of the building in conformance with the design standards, then some sort of field measurements will be made. That information is also needed to complete the design documentation.

Accessibility of HVAC System Components

What is a readily accessible HVAC system? Does it include every branch duct, plenum, and acoustic liner? Is it simply a design requirement, or is there an implicit assumption that maintenance of HVAC systems should be improved to achieve acceptable indoor air quality?

Another key provision requires that HVAC systems be readily accessible for maintenance. Air-handling units and cooling coils must be easily accessible for inspection and preventive maintenance. Periodic in-situ cleaning of cooling coils and condensate pans should be provided for in the design. These features and several others are intended to reduce the potential for microbial contamination, which has been implicated in many cases of sick building syndrome or building-related illness. While it seems logical that these features be part of every HVAC system, in many cases they are not.

Impacts on Professionals, Businesses, and Industry

How will 62-1989 affect owners, architects, engineers, interior designers, contractors, building occupants, building managers, building operators, and litigants?

It could change the way many of these professional and business interests relate. Currently, the vagueness in ventilation requirements and practices is at the core of many lawsuits, disputes, and indoor air quality problems. A clear set of rules could reduce ambiguity about what is required, who is responsible, and how to accomplish it. We do not think Standard 62-1989 as written has done that. However, it has articulated some requirements that, if taken seriously, could generate a dialogue leading to substantial clarification and problem avoidance.

Will buildings be more costly to design, build, and operate?

The answer is "most likely." The question is how much, who will arbitrate costs, and will it be worth it? Some critics of the new standard have argued that it will raise the cost of construction and operation. A pair of researchers at the University of California Lawrence Berkeley Laboratory have run simulations on a number of buildings in ten U.S. and three Canadian cities to see what differences in costs might occur. They used DOE 2.1C for the simulations. Their results showed that in a "worst case" Washington, D.C. or Miami, Fla. building situation, capital and operational costs might increase about three to five percent. Some authorities have questioned these results, but no further analyses have been published.

Must the new standard be incorporated into codes in order to impact the design professions and building owners and operators?

Currently, most designers and their clients tend to follow only those standards which are mandatory. There has been a proliferation of regulations and regulatory authorities affecting design and construction fields; naturally, no one seeks out any regulations they do not have to follow. There are exceptions, of course. Some clients or designers who have had indoor air quality problems in previous buildings are more inclined to protect themselves. This is especially true if they have already been sued.

The Future of Standard 62

Where is ASHRAE going with ventilation standards? This one took five years to develop, and there is already a revision under way. Will the revisions be completed soon? What will be the most important issues and changes? What will the next standard be like and when will it come out?

Many of the issues raised above have been identified by others. Many people felt the standard should be published now with its imperfections rather than delay by trying to refine it further. In the debate over adoption by ASHRAE, they prevailed. Will they now move to establish a new revision committee to address some of the most glaring problems?

We have heard that a new committee may be formed with only minimal carry-over membership. Some of the issues discussed above will surely be recognized as requiring attention. We would be surprised if ASHRAE does not begin to respond soon.

Conclusion

There are still many unresolved issues concerning both the protection of public health in indoor environments and the implementation of the standard as written. The standard is primarily a "comfort" standard rather than a "health" standard. It makes a meek attempt to address health considerations. Its foreword proclaims that its purpose is "to specify minimum ventilation rates and indoor air quality which will be acceptable to human occupants and are intended to avoid adverse health effects."

But the standard itself gives little guidance related to health. It relies primarily on a handful of standards developed by others. Its immediate usefulness is the provision of ventilation guidelines which are likely to eliminate most comfort-related indoor air quality complaints. By tripling the minimum quantity of outside air supplied to occupied spaces where smoking does not occur, the new standard is likely to reduce the airborne levels of most contaminants. However, a true health-protective standard has yet to be developed and will have to await an enormous increase in our understanding of the health effects of most indoor air contaminants.

Standard 62-1989 will be available from ASHRAE in mid-September. The cost is $42 for the general public and $28 for ASHRAE members. It is available from ASHRAE Publications, 1791 Tullie Circle, N.E., Atlanta, GA. 404/636-8400.

RADON: DOES THE RISK MERIT THE EXPENSE?

Radon is the "pollutant du jour" in indoor air. The scientific evidence is strong: the hazard posed by radon is considerable. Apparently, a large fraction of the population is exposed to significant levels of radon in their homes and other buildings. The popular media has published tremendous amounts of information concerning radon and its perils.

However, the scientific and policy questions about radon risk management are not without controversy. Some of the following questions identify important areas of uncertainty and disagreement.

Radon and Health: Do We Have All the Answers?

What is the verified health risk? What effects do changes in smoking prevalence rates have on projections of future health risks? What is the evidence that elevated radon levels in homes cause lung cancer in nonsmokers? Is there any epidemiologic evidence of radon risk at levels of four picocuries per liter of air (pCi/L) or even at 20 pCi/L?

Some epidemiological research has demonstrated the absence of excess lung cancer rates in areas where radon levels are elevated in nearly every home. Most lung cancers attributed to radon exposure are believed to occur in smokers. Some researchers have asserted that not a single case of lung cancer in a nonsmoker has been directly attributed to radon exposure. These facts would lead to a rather skeptical view of the need to mitigate radon, particularly where levels are less than 10 or 20 pCi/L.

Yet in many parts of the United States, a residential real estate transaction no longer occurs without considerable attention to radon. Individuals and families are worried. They spend time and money dealing with the radon problem. Can we hope for some resolution of these uncertainties in the foreseeable future? What needs to happen in order to develop a consensus opinion?

Federal Radon Policy

If EPA cannot regulate radon exposure, what can it regulate? What are the differences between protection of public health from radon versus protection from ambient air contaminants or VOC in indoor air?

What should government priorities be for answering unresolved technical questions about radon? What about the policy questions?

Some scientists, and most European governments, do not agree with the need for aggressive radon control at measured levels of four pCi/L of air. The Common Market countries have established safe levels approximately two and one-half times higher than EPA's.

While critics of EPA radon policy complain, EPA uses an approach which it has applied to regulate much smaller apparent risks. Should EPA develop a double standard: one for industrial emissions or contaminants, another for natural hazards? What sort of further evidence is needed for EPA to continue its aggressive radon program? Are there matters of fact that can be resolved through research, or are the issues strictly matters of opinion which must be resolved by policy-makers?

National Testing Program

Is a national testing program warranted in homes? Is the testing that is being done reliable? What hazard level warrants remediation? What risk level warrants the abandonment of a structure?

Is a national testing program warranted in schools? What is the risk for children exposed to four pCi/L in schools? If the exposure is for several hours a day, five days per week for up to 12 years, what is the increased risk? Does this merit a different action level than the residential environment?

In California, research has shown that radon levels are elevated in only a very small percentage of buildings. Should testing be done everywhere, or should the government identify high risk areas before all homes and public buildings are tested? How much will a reliable universal testing program cost? Is the problem urgent enough to warrant less-reliable universal testing?