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ASHRAE'S RESIDENTIAL VENTILATION STANDARD: *EXEGESIS OF PROPOSED STANDARD 62.2*

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In January 1999 ASHRAE's Standard Project Committee on "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings", SPC 62.2P, approved ASHRAE's first complete standard on residential ventilation for public review and it was subsequently approved for release by ASHRAE. The standard is an attempt by the Society to address concerns over indoor air quality in dwellings and to set minimum standards that would allow for energy efficiency measures to be evaluated. The standard has requirements for whole-house ventilation, local exhaust ventilation, and source control. In addition to code-intended requirements, the standard also contains guidance information for the designer and/or user of the standard. This report summarizes the draft standard and attempts to address questions and concerns that those potentially affected by the standard might have. This report may also be of use to those considering public review comments on the draft standard.

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INTRODUCTION

Because of the effects it has on health, comfort, and serviceability, indoor air quality in our homes is becoming of increasing concern to many people. According to the American Lung Association elements within our homes have been increasingly recognized as threats to our respiratory health. The Environmental Protection Agency lists poor indoor air quality as the forth largest environmental threat to our country. Asthma is leading serious chronic illness of children in the U.S. Moisture-related construction defects and damage are on the increase in new houses. Minimum residential ventilation can improve many of these indoor air quality problems.

ASHRAE's Role

ASHRAE has long been in the business of ventilation, but most of the focus of that effort has been in the area of commercial and institutional buildings. Residential ventilation was traditionally not a major concern because it was felt that between operable windows and envelope leakage, people were getting enough air. In the quarter of a century since the first oil shock, houses have gotten much more energy efficient. At the same time, the kinds of materials and functions in houses were changing in character in response to peoples needs. People were also becoming more environmentally conscious not only about the resources they were consuming but about the environment in which they lived.

All of these factors contributed to an increasing level of public concern about residential indoor air quality and ventilation. Where once there was an easy feeling about the residential indoor environment, there is now a desire to define levels of acceptability and performance. Many institutions both public and private, have interests in Indoor Air Quality (IAQ), but ASHRAE, as the professional society that has had ventilation as part of its mission for over 100 years, was the logical place to develop a consensus standard. That standard is now ready for its first public review.

ASHRAE Standard 62.2P, "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings" defines the roles of and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality. It applies to spaces intended for human occupancy within single-family houses and low-rise multi-family structures and it generally excludes institutional buildings.

The standard appears to be principally about ventilation, but the purpose of ventilation is to provide acceptable indoor air quality. The most effective strategy for keeping exposure to undesirable pollutants low is to keep them from being released to the general indoor environment in the first place. Such "source control" measures actually make up the bulk of the pages in the standard, especially when you consider that local ventilation is intended to exhaust pollutants from specific rooms before they enter the general environment. Whole-house ventilation, is intended to bring fresh air into the general environment to dilute the pollutants that cannot be effectively controlled at the source.

BACKGROUND

Currently two of the most important and contentious areas that ASHRAE works in are energy efficiency and indoor air quality. Any reader of ASHRAE Journal will be familiar with standards numbered 62 and 90 as rarely an issue goes by without some significant mention of them. Standard 62, "Ventilation for Acceptable Indoor Air Quality" is the parent standard that our residential version came from.

Standard 62 has been around a long time and has changed considerable over that period. The last full revision of Standard 62 was approved by ASHRAE in 1989. While 62-89 claims to cover all spaces intended for human occupancy, it focuses on commercial and institutional occupancies; many occupancies are not explicitly covered at all. Residential occupancies get almost half a page.

The residential requirements in 62-89 include specific ventilation flow rates for kitchens, baths, toilets, garages and common areas, as well as air exchange rates for living areas. The air change rate of 0.35 air change per hour for living spaces can be provided using infiltration and natural ventilation, but the standard does not really describe how. Depending on one's interpretation, the residential requirements of 62-89 could either be quite onerous or mean virtually nothing.

In the early 1990s a new committee was formed to update 62-89. One of the recognized needs of the revision was to expand the residential section. The product of that committees work was a completely new document, known simply as "62R." (See Steve Taylor's article in the Feb 1996 ASHRAE Journal.) While that ill-fated document never got past its first public review, it did contain an entire chapter on residential ventilation and actually began to provide useful guidance to the builder.

Rather than attempt to resolve the large number of comments that 62R generated, ASHRAE decided, in the summer of 1997, that the better course of action was to change the structure of how it dealt with such High Profile Standards (HPS). At that meeting it was decided to split off the residential section from the "main" standard and let it follow a path of its own. Practicalities of standards processing aside, the key reason for the separation was that the users of and assumptions for a residential standard are qualitatively different from that of a commercial-institutional one.

In a commercial building, for example, the occupants who are subject to the indoor environment are often very different people from those controlling the HVAC system, from those paying the bills, from those controlling the sources of pollution, and from those responsible for operations and maintenance. Typically, in houses, most of these functions fall to the same group of people. Thus assumptions about the level of protection, knowledge and control are very different in the two cases.

OVERVIEW OF THE STANDARD

In developing this standard the committee recognized that there were many different kinds of houses, many different climates, and many different styles of constructions. To accommodate these difference, the major requirements were designed with several alternate paths to allow users flexibility. Some requirements are performance based, with specific prescriptive alternatives. The standard recognizes that there are several different ways to achieve a specified ventilation rate and allows both mechanical and natural methods.

There are three main primary sets of requirements in the standard and a host of secondary ones. The three primary sets involve whole-house ventilation, local exhaust, and source control. Whole-house ventilation is intended to dilute the unavoidable contaminant emissions from people, from materials and from background processes. Local exhaust is intended to remove contaminants from those specific rooms (e.g. kitchens) in which sources are expected to be produced by design. Other source control measures are included to deal with those sources that can reasonably be anticipated and dealt with.

The secondary requirements focus on properties of specific items that are needed to achieve the main objectives of the standard. Examples of this include sound and flow ratings for fans and labeling requirements. Some of the secondary requirements as well as the guidance in the appendices help keep the design of the building as a system from failing because ventilation systems were installed. For example, ventilation systems that push moist air into the building envelope can lead to material damage unless the design of the envelope is moisture tolerant.

WHOLE-HOUSE RATES

The first thing people tend to took at in an ventilation standard are the rates, specifically the whole-house ventilation rates. In standard 62-89 the whole-house rate was set at 0.35 air changes per hour, but no less than 15 cfm/person (7.5 l/s/person). The default number of people was assumed to be two for the first bedroom plus one for every additional bedroom.

In 62.2P the committee decided to make the target ventilation rate comprise a sum of the ventilation necessary to dilute background sources and sources attributable to occupancy. To find the total amount of outside air needed one needs to add 2 cfm/100 sq. ft. (10 l/s/100 sq. m.) to the 15 cfm/person (7.5 l/s/person). Thus the air change rate requirement will vary by the size of the house and the occupancy. Figure 1 shows the required air change for typical houses:

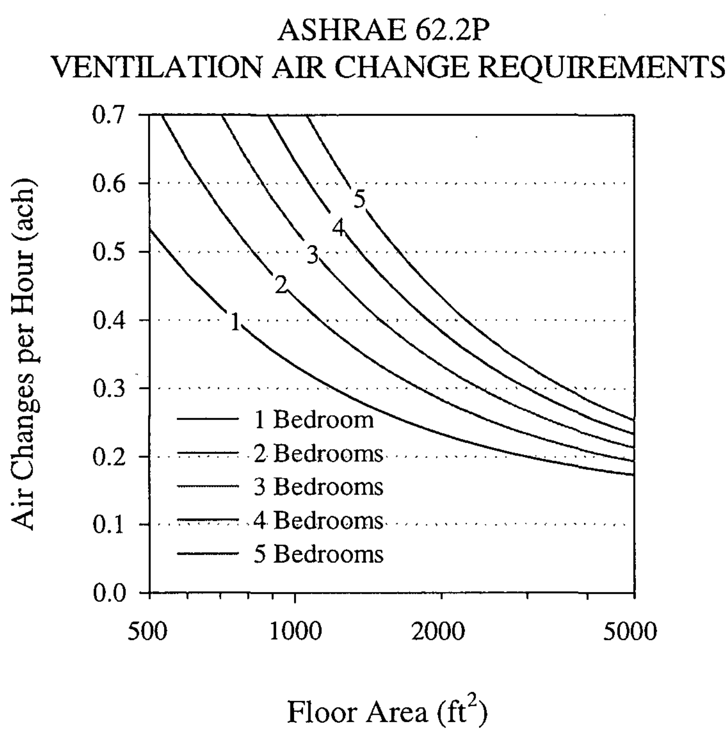

Figure 1: Required Ventilation for different size houses

For larger houses the 62.2P value comes out smaller than the 0.35 ACH of 62-89, but for small houses the 62.2P rates are higher.

Natural Ventilation

Figure 1 represents the required total air exchange, but there are a variety of methods to achieve that rate. The simplest route is that of natural ventilation (i.e. operable openings). A dwelling that has 5% of the floor area as operable openings would usually meet the requirements of a naturally ventilated structure, provided two key criteria were met. First, the openings should not present a hazard when used to provide ventilation. Such hazards need to be evaluated locally, but could include proximity to local sources of air or noise pollution (e.g. a freeway, an airport, industrial sites, etc.). Security and operability may be other reasons to exclude this as an option.

The second requirement to use the natural ventilation approach is that the climate not present a barrier to the occupants use of openings. The standard defines three climate classes and natural ventilation is only allowed in mild climates. Many of the pacific and sunbelt states contain mild climates, while the plains, and northern states do not. Natural ventilation during mild weather conditions is, however, considered in the calculation of infiltration credit for all climates.

Mechanical Ventilation

If one wanted to design a house to meet 62.2P regardless of local climate or siting issues, the easiest approach may be to design a simple, continuous mechanical ventilation system. To size the fan we can start with the values in Figure 1, but the standard allows credit to be taken for infiltration (including natural ventilation). The standard has a default infiltration credit (of 1 cfm/100 sq. ft. [5 l/s/100 sq. m.])that can be used in lieu of an air tightness measurement. Figure 2 shows the required continuous whole-house ventilation fan size using this default infiltration credit.

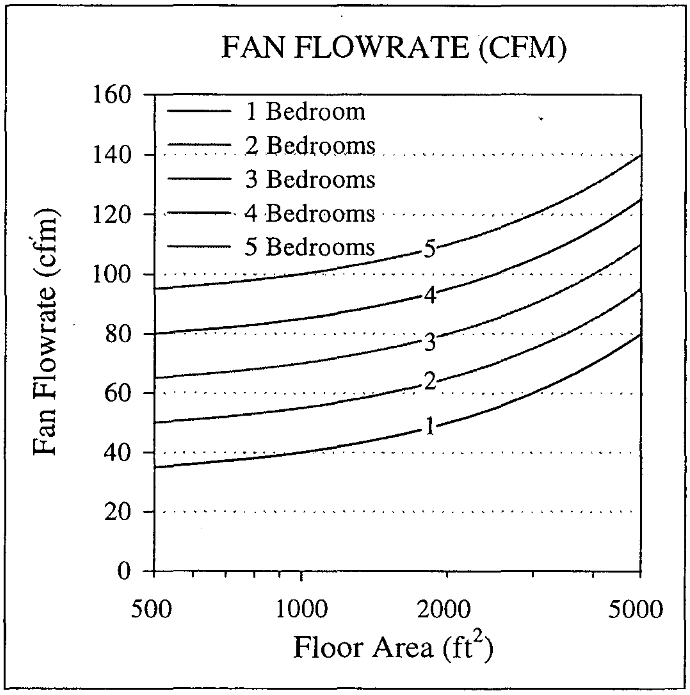

Figure 2: Minimum size of whole-house ventilation fan, assuming continuous operation and default infiltration credit.

The standard allows intermittent whole-house mechanical ventilation to be used as an option to continuous ventilation. The size of the fan can be calculated from the Figure 2 values and the fractional run time. For designs when the total cycle time is over three hours, the fan size must be further increased to account for the poor efficiency associated with running the fan only rarely. (i.e. an infrequently operated fan needs to push through a larger total air volume than a continuously operating one to control the same pollutant.) The fan must run at least one hour out of every twelve.

The standard allows approaches in which air is drawn into the house through the forced air system, provided that there is a timer or other mechanism to assure a minimum amount of ventilation each day and such that some minimum cycle time can be estimated. Such systems currently exist in the market.

Infiltration

The default infiltration credit corresponds to a rather tight new house. A larger infiltration credit can be used if the air tightness is measured in accordance with ASHRAE Standard 119-1988 [RA 94], which requires a measurement such with a *blower door.* ASHRAE has another standard (136-1993) that could be used for this purpose, but is not. The credit given in the draft is conservative compared to that of Standard 136, but can, nevertheless be used to further reduce required fan size.

A house that is leaky enough could meet 62.2P without a mechanical ventilation system, regardless of climate. Figure 3 shows how leaky a house would have to be meet these requirements. The figure is labeled both in the Normalized Leakage of Standard 119 and the more common Air Changes at 50 Pa used in the field.

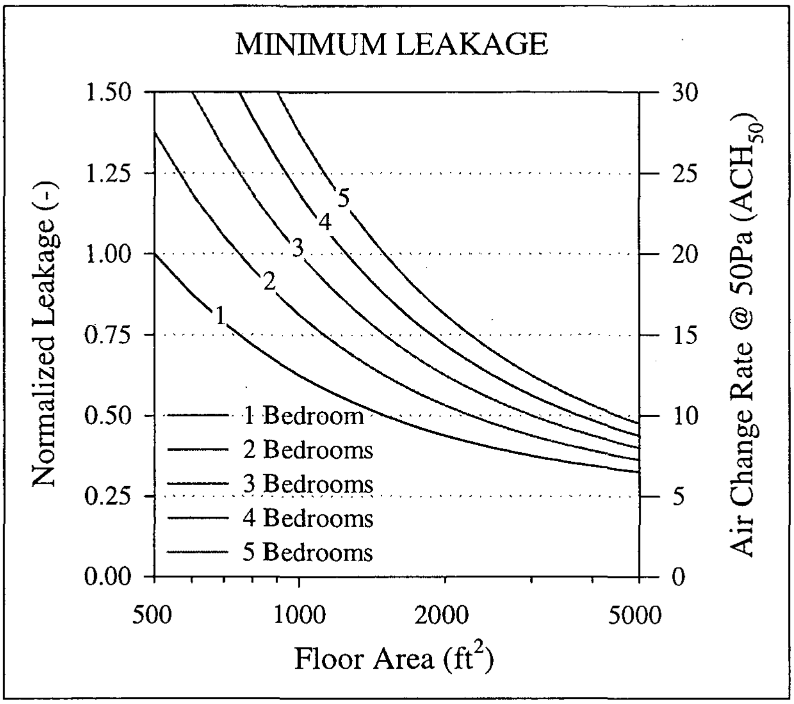

Figure 3: Minimum leakage levels needed to meet whole-house ventilation requirements by infiltration alone. Approximate conversion to air changes at 50Pa is included for convenience.

From a practical standpoint, it may be unreasonable to design a new house with the intent of making it leaky. The discomfort, energy impacts, and possible moisture problems of intentionally leaky houses make it an unattractive alternative.

Research has shown, however, that older houses are often quite leaky [Sherman & Matson, 1997] and are quite likely to meet the requirements of this standard on infiltration alone. Their estimate of the average air tightness of the stock is approximately an ACH_{50} of 24. Those wishing to apply 62.2 to existing houses in the context of Home Energy Rating Systems or utility programs, will make good use of the infiltration credit for measured air tightness.

OTHER REQUIREMENTS

The standard is more than just whole-house rates. It contains requirements to control local pollution either by direct source control or by local exhaust. It contains requirements to assure that any systems intended to meet the ventilation requirements can and do deliver ventilation without in themselves causing additional problems.

LOCAL EXHAUST

Houses are designed to have certain activities in certain rooms. Kitchens, bathrooms, laundries and toilets are all built to accommodate specific functions. These functions produce pollutants such as moisture, odors, volatile organic compounds, particles or combustion by-products. The purpose of local exhaust requirements is to control the concentration of these pollutants in the room they were emitted in and to minimize the spread of the pollutants into other parts of the house. Local exhaust ventilation is source control for the sources of pollution that are expected in certain rooms.

Unlike the whole-house rates, which are most effective when continuous, source control through exhaust is best operated when the source of pollution is active. The basic rates in the standard are for intermittently operated exhaust fans. For kitchens the basic rate is 100 cfm (50 l/s) and for the rest of the rooms requiring local exhaust the rate is half that. Because of the concern over capture efficiency, vented range hoods are required in kitchens if the required air flow rate yields less than five kitchen air changes per hour.

Continuous local exhaust is allowed as an alternative to give the designer the flexibility of making the local exhaust part of a larger ventilation system (e.g. a continuous, whole-house ventilation system). The rate is generally 20 cfm (10 l/s) for each room requiring it. Because of the concern about migration of pollutants out of the kitchen, continuous kitchen ventilation cannot be used unless the exhaust rate is at least five kitchen air changes per hour.

62-89 allowed operable windows as a substitute for exhaust ventilation requirement. 62.2P does not allow natural ventilation to meet the requirement in kitchens and bathrooms, because of the low pollutant removal efficiency of operable windows. (e.g. a window could just as easily blow moisture into the rest of the house as out of the bathroom.) 62.2P also does not allow operable windows to meet local exhaust requirements in severe climates, because it was felt that occupants could not or would not operate them for much of the year. Where odor or irritation is the key pollutant, such as in toilet compartments, operable windows are allowed in the less severe climates.

Rooms with unvented combustion appliances must meet the requirements for kitchens except that vented range hoods are not required. Examples might include unvented fireplaces or decorative gas appliances.

VENTILATION SYSTEM REQUIREMENTS

The ventilation system, whether it be natural or mechanical has to meet some basic requirements:

Capacity

Because there will be activities that in the normal course of use of a house produce pollutants in excess of what is handled by the basic rates, the standard requires that the system have more capacity. These kind of activities might include cleaning, smoking, parties, painting, etc. The requirement would usually be met by the code-required amount of window area, but a mechanical alternative is also provided.

Air Distribution

Outdoor air is not required to be delivered to every room, but there are requirements to help air get distributed from wherever it comes in to the rest of the house. A forced air system meets the requirements, but other options are available. Air handlers are also required to have particulate filters having a minimum efficiency of 60% for 3 micron particles.

Sound Ratings

In most cases noisy fans will not be used. Occupants are more likely to disable them than to run them. The standard requires that whole-house fans be very quiet (1 sone) and that bathroom and kitchen fans be reasonably quiet (1.5 sones) at their rated flows.

Flow Rating

To make sure that the fan actually delivers the amount of air intended, the standard requires either that the air flow rate be measured in the field or that certain prescriptive requirements be met. These prescriptive requirements are on the size and length of ducting as well as the manufacture's ratings.

SOURCE CONTROL

While many of the potential sources of pollution are beyond the control of a standard such as 62.2, there are various measures that can reasonably be taken to reduce pollutant sources at the design stage and thus reduce the need for excessive ventilation. Indeed, for some sources, ventilation may make them worse and not better. This section summarizes some of the source control measures in the standard. (Appendix A lists some of the impacts that the standard has on various sources either directly or indirectly.)

Outdoor Air

The outdoor air can be a source of pollution. The ventilation rates in the standard assume that the outdoor air is relatively clean and able, therefore, to improve indoor air quality by diluting indoor pollutants. When outdoor air quality excursions are foreseeable (e.g. excessive ozone) the standard requires that the occupants be able to reduce whole-house ventilation rates.

Ventilation Inlets

Even if the outdoor air is of good quality, pollution in the building's microclimate can make the air that comes in through windows or other intakes of low quality. The standard requires that there be adequate separation between inlets and exhausts or other known sources of pollution.

Garages

Attached workspaces can be a source of significant pollution. Carbon monoxide is of particular importance in attached garages. The standard requires weather-striped doors between the garage and the house and also does not allow air handlers or return ducting to be located in such spaces.

Clothes Dryers

62.2P requires that clothes dryers be vented directly to outdoors both to minimize moisture and laundry pollution, but also to help ventilate laundries.

Moisture Migration:

If moisture is forced into building cavities or the building envelope and allowed to condense molds and other microbiological contamination can become a threat to indoor air quality and material serviceability. The standard forbids the use of ventilation methods (e.g. supply ventilation in very cold climates) that would contribute to that effect unless the building envelope has been designed to accept it.

COMBUSTION SAFETY

Keeping combustion appliances from becoming indoor pollutant sources is a concern of the standard. The local exhaust section contains requirements for unvented combustion appliances, but vented combustion appliances can also become a problem if there is any significant backdrafting.

62.2P is not a standard about combustion safety, but indoor combustion sources can be a significant source of pollution and the requirements of 62.2P could have adverse impacts on those sources. The standard mostly considers the impact that envelope tightness and/or ventilation systems could have on the operation of a combustion appliance.

To minimize the potential for backdrafting the standard requires that naturally aspirated combustion appliances in the conditioned space have a spill switch, or pass a specific backdrafting test if the total of the largest two exhaust appliances exceed about 1 air change per hour of ventilation (not counting any summer cooling fans). The standard also allows the mitigation step of a compensating supply fan to be used. Many new houses would be exempt from these considerations because all their vented combustion appliances are outside the pressure boundary or are sealed combustion.

The draft standard also requires that a carbon monoxide alarm be installed in dwellings with attached garages or naturally aspirated combustion appliances inside the pressure boundary.

BEYOND REQUIREMENTS

The requirements in 62.2P are only a small fraction of the total number of pages. The committee felt it would be useful to users of the standard for it to contain information that goes beyond the requirements or to give some guidance in how to make choices to meet the standard.

Operations and Maintenance

The draft standard does not contain Operation and Maintenance (O&M) requirements, but it does contain labeling and information requirements. The committee felt that acceptable indoor air quality could not be achieved if the occupants did not operate and maintain the ventilation system consistent with its design. Building occupants need to be informed as to how to do that.

The philosophy behind this is that the building should be designed so it can be ventilated properly. The draft standard requires that whoever is designing it must supply appropriate documentation to the occupant, but is not responsible if the occupant fails to operate it correctly. The draft standard gives some guidance on the kind and format of information that could be given to the occupants.

Particulate Filtration

The standard requires 60% filtration efficiency of 3 micron particles in air handlers principally to keep the duct system, the air handler and the heat exchange components from becoming pollutant sources as dirt builds up on them. The filtration also benefits the thermal performance of the system as well as reducing airborne particles that the occupants are exposed to. Any other dedicated supply air system would also require filtration.

The minimum level of filtration can be achieved using a 1" pleated filter that costs a couple of dollars more than the most common furnace filters and is commonly available. Because there are many different kinds of filters available, having different efficiencies, capacities, costs, sizes and filter lives, the standard provides guidance on how to select a filter.

Source Control and Exposure

While the body of the draft standard does contain some specific source control requirements, the standard as a whole does not address all of the contaminants that could be present in a house. The standard addresses things like installed appliances, but does not really have requirements for the sources people may bring in the form of furniture, household goods, candles, pets, smoking, hobbies, or other activities.

In an appendix to the draft standard, there is some background information and guidance on potential pollutant sources, acceptable contaminant levels, and the role of building materials, building microclimate and construction details. The appendix provides guidance on control of some of these sources and references to literature on specific ones.

Control of moisture is often a key to keeping microbiologicals from becoming either a health hazard or a serviceability problem. Depending on climate either indoor or outdoor moisture can be a problem if it is allowed to get in contact with certain materials. Design of the building envelope is a key part of moisture control and is discussed briefly. Detailed envelope design recommendations are beyond the scope of the standard, however.

HVAC System

The design of the HVAC system can affect the pressure in the living space, which can cause moisture, backdrafting, radon entry, or other kinds of IAQ problems. In general depressurization has more potential risks, but pressurizing a building in a cold climate can cause condensation in the building envelope.

62.2P has several compliance paths and allows a fair degree of flexibility in selecting the ventilation system. To help the designer along, the draft standard also contains some guidance on when to select certain kinds of systems and when to stay away from them. It also contains guidance on the energy impacts of different choices.

Guidance in selecting both the whole-house and local ventilation systems is provided. The pluses and minuses of the most common systems are summarized and can help the user of the standard make an informed choice of approach. Examples of such systems are given in Appendix B.

THE BIG QUESTIONS

It is often difficult to read a standard and understand what the purpose of a particular requirement is, let alone what the rationale for it is. Even those who have been close to the process may misstate or confuse particular issues. Articles in the press have mischaracterized aspects of the standard. The following Questions and Answers are intended to help explain the standard and give some of the justification and background of it.

Q **Why do we need 62.2? Isn't what is in 62-89 good enough?**

A The half page of residential requirements in 62-89 has many short comings. First and foremost it is not in code language and could not easily be adopted as a code. Secondly, it is very vague. Some have interpreted it to mean almost nothing, while others have interpreted its rate requirements to be rather severe. Finally, it leaves out many issues that were felt both by the 62R public review and by the current committee to be important in the residential environment. In short, it does not come close to meeting the charge that ASHRAE has laid out.

Q **Why could not the residential parts be handled in the Continuous Maintenance with the rest of 62?**

A ASHRAE felt that it was important to separate the residential parts from the commercial and institutional parts for several reasons. The target audiences were very different and users of the residential parts wanted a document that addressed their needs. The technical expertise for the committee resided in different people and thus there was not enough expertise on the old SSPC 62. Finally, the basic assumptions about who controlled the sources and the systems, who was responsible for design, operations and maintenance, and what kinds of excursions might be tolerable were very different in a home environment.

Q **How do the rates in 62.2P compare with 62-89?**

A The whole-house rate in 62.2P depends less on the floor area and ceiling height of the house than does that of 62-89. Expressed in air flow, the rates fall in a narrower band of flow. In general, the air flow requirements in 62.2P are lower for larger houses and higher for smaller houses than that of 62-89. The local exhaust rates are in the main the same as for 62-89. In both cases, however, 62.2P contains more detail and is more clear on how to apply the rates

Q **Does 62.2P credit occupant use of windows?**

A Yes, in several ways. There is a ventilation capacity requirement to allow for unusual events; this is generally satisfied by windows. There is an infiltration credit in the standard that takes into account the operation of windows during mild weather. The whole-house requirement may be met exclusively with windows in mild climates. The local exhaust requirements in toilets and utility rooms can met with windows in most climates

Q **Are there restrictions on the use of windows to meet ventilation requirements?**

A Yes. Because there are weather and local conditions under which people will not or cannot use their windows, the standard does not allow them to meet the ventilation requirements in less mild (i.e. temperate and severe) climates. Also, if there are known barriers to window operation, such as being in a noise abatement zone, they should not be used. Because of the poor pollutant removal efficiency of operable windows, they do not meet the local exhaust requirements in kitchens or baths.

Climatic Acceptability of Natural Ventilation

	Climate		
Application	**Mild**	**Temperate**	**Severe**
Toilet	Yes	Yes	No
Utility	Yes	Yes	No
Kitchen	No	No	No
Bathroom	No	No	No
Whole-House	***Yes***	***No***	***No***

Q **Does the standard give credit for infiltration?**

A Yes. The standard allows infiltration to provide some or all of the required ventilation. The default credit is based on a relatively tight house, but if an air tightness measurement is made, the actual tightness can be used.

Q **Is the infiltration credit larger in more severe climates?**

A No. The infiltration credit is based on the weather in a presumed critical week. This critical week is when the weather gets extreme enough that occupants decide to no longer open their windows for the season. The driving forces for this week and envelope tightness are used to calculate the infiltration credit. Where the critical week may be on the calendar will be different in different climates, but the credit size is independent of climate. The energy cost of infiltration, however, is climate dependent.

Q **Can there be a big enough infiltration credit to eliminate whole-house mechanical ventilation?**

A Yes. There is no maximum infiltration credit, but an envelope tightness measurement is required to get anything over the default credit. Such a strategy may not be the best choice for new construction, but much of the current stock of buildings is quite leaky and could meet the whole-house requirement through infiltration alone.

Q **Will 62.2 replace ASHRAE Standard 136?**

A Yes and No. Both standards address how infiltration can be used to meet ventilation requirements, but different assumptions are made. Standard 136 looks at long-term (i.e. seasonal or annual) exposures to pollutants and so tolerates periods of low ventilation. 62.2P uses the time base of a week rather than a year and is, less tolerant of periods of low ventilation. The net effect is that 62.2P gives less credit for infiltration than does Standard 136, especially in severe climates.

Q **How big a fan would I need to mechanically ventilate a house?**

A The calculation depends on the size of the house, but using the default infiltration credit the whole-house mechanical ventilation requirement typically falls in the 60-100 cfm range. A larger infiltration credit would reduce, or potentially eliminate, the fan requirements.

Q **What has changed for kitchen ventilation?**

A 62.2P requires that an exhaust fan be installed in the kitchen (and also the bathroom); windows are not deemed sufficient to control the moisture and cooking by-products. Because of the low capture efficiency at low air flows, vented range hoods are required if the installed exhaust capacity does not provide at least five kitchen air changes per hour.

Q **Are there new rooms that require local ventilation?**

A Yes, potentially. Laundry/utility rooms require local ventilation because of the materials that are normally stored there and the activities that normally take place there. In some climates a window can supply this ventilation. A clothes dryer may also supply this ventilation. Rooms with unvented combustion appliances also require local ventilation.

Q **Can recirculating fans meet any local ventilation requirements?**

A No. The local ventilation requirements specify that the air must be exhausted outside. Supplemental filtration, however, is not prohibited. The standard also requires that all clothes dryers be vented to the outside.

Q **Does this mean that houses have to have six fans to meet the standard?**

A No. A large house may have several rooms that require exhaust, but even in those situations in which mechanical whole-house and local ventilation is required, the standard can always be met with one or two fans, if remote-mounted, branched exhaust fans are used. Certainly, there will be cases in which one may choose to install six individual fans, but the standard allows flexibility of design. The designer will need to consider first cost, energy cost, and value to the customer in making that determination. (Appendix B provides some example solutions.)

Local Exhaust Air Flow Rates

Application	Continuous Flow	Intermittent Capacity
Kitchen	5 air changes per hour	100 cfm (50 l/s)
Utility	20 cfm (10 l/s)	50 cfm (25 l/s)
Bathroom	20 cfm (10 l/s)	50 cfm (25 l/s)
Toilet	20 cfm (10 l/s)	50 cfm (25 l/s)

Q **What specifications do the various fans have to meet?**

A Because people will disable noisy fans, most surface mounted fans must meet sound requirements of 1.0-1.5 sones. Because different fan and duct arrangements may not deliver the proper amounts of air, fans must either have their installed flow rate measured or must meet prescriptive requirements on sizing and rating. Finally ducted supply systems and the central air handler must meet minimum filtration efficiency of 60% for 3 micron particles.

Q **Can the central air handler be used to supply the whole-house ventilation?**

A Yes, but only if it has a timer control. Systems that pull in outdoor air through the air handler fall into the category of intermittent, whole-house ventilation. The standard allows various types of intermittent ventilation schemes to be used to meet the whole-house requirement. A key provision, however, is that they must be controlled to operated at least one hour in twelve and that the minimum daily on-time can be estimated. The standard describes how to increase the intermittent ventilation rate to make it equivalent to the continuous requirements.

Q **Can humidistats or other IAQ sensors be used to control the ventilation system?**

A Only as supplementary control methods. It is rare in a residential environment that the need for base ventilation is determined by a single pollutant or single class of pollutant. Control of the whole-house ventilation system with, for example, a humidistat can lead to inappropriate ventilation rates. Continuous whole-house ventilation is the preferred method.

Q **Are there special considerations in hot, humid climates?**

A Yes. Outdoor moisture is of particular concern in hot and humid climates. Ventilation often increases rather than decreases indoor humidity. Mechanical cooling (or dehumidification) is often the only way to reduce indoor moisture levels. Because of the risk of condensation in or on the building envelope, whole-house exhaust ventilation should not be used unless a moisture tolerant envelope design exists. In houses without mechanical cooling, whole-house mechanical exhaust is allowed as is natural ventilation.

Q **Can any required mechanical ventilation cause problems for vented combustion appliances?**

A Probably not. Depending on the tightness of the envelope, exhaust fans can depressurize the house and cause naturally aspirated combustion appliances in the conditioned space to backdraft. The problem less critical in a leaky house, but even in a tight house the minimum air flows required by the standard are unlikely to cause any problems. Clothes dryers alone, for example, normally exhaust more than is required to meet 62.2P. The real depressurization culprits are often large down-draft, or commercial size kitchen ventilation systems that are getting popular in upscale homes. These flows can be ten times higher than any requirements of 62.2P.

Q **What are the requirements for naturally-aspirated combustion appliances in the conditioned space?**

A First, there must be a carbon monoxide alarm. If the two largest exhaust devices are not too big, there are no other requirements. Otherwise, the appliance must either have a spill switch to stop operation in case of backdrafting or it must pass a house depressurization test, as described in an appendix. If all else fails 62.2P allows for a compensating supply fan to be installed. Sealed combustion appliances or appliances outside the pressure envelope are not affected by these requirements.

Q **What are the requirements relating to attached garages?**

A Because of the health hazards associated with carbon monoxide and other pollutants from the garage getting into the house, the committee has put in several requirements. The door to the house must have an automatic closing device to minimize the direct communication between house and garage. There may not be any return ducting or air handlers in the garage and the house must have a carbon monoxide alarm.

Q **Are there really as many new requirements as it seems?**

A Not really. Very few of the requirements in the standard are not directly related to requirements in relevant codes, standards, or guidelines currently in use. Many of the requirements in the draft standard are already code in parts of the U.S., but perhaps none of them is code everywhere. The standard is the committee's best estimate of the minimum set of requirements necessary to achieve the objective. For some jurisdictions, adopting it as a code would entail many new requirements, for others it may be almost none.

Q **Does the document contain more than just requirements?**

A Yes. There are more pages of guidance in the appendices than there are of requirements in the body of the standard. Users of the standard need some guidance in selecting among the alternative paths and in understanding what ramifications some choices may have. 62.2P has informative appendices on Operations and Maintenance; Air Filtration; Pollution Sources Exposures and Control; and on HVAC Systems.

Q **What data was used to develop this standard?**

A Like most all consensus standards, the primary data source is the assembled knowledge, experience, and expertise of the technical experts comprising the committee. Between the committee and other participants there are centuries of experience on relevant topics. A significant amount of the archival research work can be found in the proceedings of the 1999 Annual ASHRAE meeting in the reviews by Grimsrud and Hadlich.

Q **Does the draft standard address energy issues?**

A Not primarily. Conditioning ventilation air has, of course, an energy cost, which can be quite large in very cold, or hot, humid climates. The committee considered energy impacts in its debate, but acted only when it was clear that there was always a better way to do something. Many of the allowed ventilation systems (e.g. natural ventilation, infiltration, or intermittent whole-house ventilation) can be quite energy inefficient in some circumstance. Fans themselves have differing efficiencies. Heat recovery ventilation can be cost-effective in some circumstances. These issues are important in the overall design of a good house, but are beyond the scope of this standard.

Q **Is it a done deal?**

A No. The standard is undergoing public review, the purpose of which is to inform the committee about issues, concerns or problems that individuals may see in the standard. While the committee would be happy if everyone accepted it as is, there is a recognition that issues large and small may have been missed or not given enough thought. Thoughtful, constructive, and concise public review comments will be of great value to the committee.

Taken as a package, ASHRAE standard 62.2P represents a significant step forward for ASHRAE in applying professional consensus standards to the residential area. Houses meeting this standard will have improved indoor air quality, reduced moisture problems, and provide better value to the home owner and occupant than those that do not.

PUBLIC REVIEW PROCESS

The review period for the standard 62.2P is approximately summer of 1999. During this period any interested party can file comments. Instructions for filing comments on this or any other standard can be found in the standards section of the ASHRAE Home Page (http://www.ashrae.org)

Anticipated dates are that the standard will be available for public review in May 1999, and that the public review period will close in August. The committee will begin review of comments in the fall.

For those interested in asking questions of the committee, there will be a forum at the ASHRAE Annual meeting in Seattle during June 1999.

REFERENCES AND LITERATURE LIST

ASHRAE Standard 119, Air Leakage Performance for Detached Single-Family Residential Buildings, American Society of Heating, Refrigerating and Air conditioning Engineers, 1988.

ASHRAE Standard 136, A Method of Determining Air Change Rates in Detached Dwellings, American Society of Heating, Refrigerating and Air conditioning Engineers, 1993.

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APPENDIX A: SOURCE IMPACTS

In theory it is possible to have an indoor air quality standard that sets target concentrations for every major pollutant and does not explicitly deal with ventilation at all. The state of knowledge about targets emissions, and even the importance of some pollutants makes that a practical impossibility. Standard 62.2P, nevertheless, has requirements in it that limit emissions of pollutants from specific sources.

In this appendix we list the major sources common in dwellings and indicate how the standard does or does not address them. According to the American Lung Association the common pollutants are radon, combustion products, biologicals, volatile organic compounds (VOCs), lead dust, and asbestos. Although many sources are not addressed in the mandatory parts of the standard, Appendix D of 62.2P contains guidance and references for many indoor pollutants.

Radon and Other Soil Gasses

The base ventilation rates of 62.2P are sufficient to control the low level of these contaminants found in the majority of homes. Radon and other soil gasses can, however, be significant problems in certain kinds of contaminated soils. Ventilation itself is a very poor control strategy in these cases. Control of pressures and the pressure boundary, however, can be very effective. Other standards and mitigation approaches exist to deal with these problem cases. 62.2P does not attempt to.

Respirable Particulates

There are many sources of particulates including combustion, pollen, washing, inorganic compounds, mold spores, cooking, pet dander, etc. Respirable particulates are small enough to get into the lung and can cause health problems regardless of their chemical composition. The standard contains a filtration requirement for air handlers. While this requirement does reduce the level of airborne particles, it is primarily intended to keep the air handling system from becoming a source of contamination. When no unusual sources of particles are present, this requirement will also keep the level of respirable particulates to an acceptable level.

Inorganic Compounds

Airborne inorganic compounds such as lead dust or asbestos fibers are not well controlled by ventilation. Filtration is usually not a good control strategy either. The most effective control strategies are usually source removal or encapsulation. The requirements of Standard 62.2P do not address this class of pollutant.

Allergens

The best control method for most allergens is usually source removal. The standard's requirements address this issue for some kinds of allergens, but for other (such as pet dander) 62.2P does not. Filtration of outdoor air can be effective for some allergen sources, such as pollen. The filtration requirements of the standard will mitigate exposure to airborne allergens, but will often not be sufficient to control them.

Indoor biologicals can be a major source of allergens in houses. Asthma, for example, is exacerbated by the growth of dust mites in carpets and bedding. Biologicals require the proper mix of temperature, food, and moisture conditions for growth. Control of indoor moisture sources, which is addressed in the standard, can be a major factor in the control of allergen levels.

Moisture

Water vapor itself is not directly a pollutant in the normal sense, but high moisture content can lead to the growth of biologicals in the building envelope and on building surfaces. These biologicals can produces allergens and toxins and can also degrade building materials. Many of the requirements in the standard are focussed on controlling indoor moisture levels. The single most important requirement in this regard is that all rooms known to produce significant amounts of moisture (e.g. bathrooms) must have local ventilation to exhaust the moisture directly outdoors.

Ventilation alone cannot control moisture unless the outdoor air is relatively dry. Dehumidification (e.g. from an air conditioner) is necessary to remove moisture when the outdoor air has a high moisture content. The standard makes use of any dehumidification that is present, but does not require it. In the most extreme climates (hot and humid, or cold and dry), the standard has requirements to keep the ventilation system itself from drawing moist air into the building envelope where it might condense and cause decay.

Combustion Products

Carbon dioxide and usually water are produced by combustion, but other products may be produced depending on the fuel and the combustion efficiency. Such combustion products include carbon monoxide, oxides of nitrogen, soot, incompletely burned hydrocarbons and oxides of sulfur. Vented combustion appliances are designed to remove the combustion products through a flue.

Because naturally aspirated appliances in the conditioned space depend on using house air to make-up for the air going up the flue, interaction between the building, the ventilation system and appliance has the potential to cause combustion products to be released into the indoor environment. The standard, therefore, has requirements to mitigate this possibility, even though it is not a complete combustion safety standard.

Anytime the potential for combustion product release exists, 62.2P requires that a carbon monoxide sensor be installed. The standard also has requirements for combustion equipment in the conditioned space anytime there the installed capacity of uncompensated exhaust equipment is above a threshold.

Attached Garages

Stored inside attached garages are usually combustion sources (such as cars), VOCs and other hazardous compounds. To minimize the intrusion of these pollutants, especially carbon monoxide into the indoor environment, 62.2P requires that there be a door closer on the door to the conditioned space and that no air handlers or return ducting be placed in the garage.

Volatile Organic Compounds and Household Products

The base ventilation rate of 62.2P is sufficient to control the normal background of VOCs emitted from normal furnishings and other household components including formaldehyde emitting products meeting current standards. High emitting products or short-term emissions such as from cleaning, painting, refurbishing, etc, will not be adequately controlled, however, by these rates. The standard does specific that there be additional ventilation capacity to handle short-term excursions, but this may not be enough in all cases.

Smoking, Hobby and Business Activities

Occupants may choose to undertake a variety of optional activities in the home. Many of these activities have the potential to expose the participant and the other occupants to high levels of various pollutants. Smoking produces environmental tobacco smoke; particulates can be generated from a variety of activities; many hobbies produced volatile organic compounds; pets can be a constant source of dander and other biologicals; home office functions can produce VOCs and ozone; etc. Because Standard 62.2P is a minimum standard it is not intended to deal with all of these situations. It will be up to the occupants of dwelling to determine the acceptability of exposures and appropriate control strategies.

Outdoor Pollutant Sources

The outdoor air can be a source of pollution because of regional air quality problems such as ozone, because of local sources such as highways or stationery emission, because of homeowner activities such as pesticides, or because of unexpected events such as a toxic release. The standard does not require treatment of the outdoor air, but does recognize that indoor air quality cannot be achieved when the outdoor air is poor. Limits are placed on the use of windows for ventilation when outdoor conditions are unacceptable.

APPENDIX B: EXAMPLES

There are many options to choose from in the standard, especially for whole-house ventilation. The purpose of this section is to demonstrate some potential design solutions for common situations focussing on the whole-house ventilation requirements. These examples are not intended to be complete, only to provide a snapshot of what one might do.

Generic Mechanical Ventilation Design

The choice of whole-house ventilation system can depend strongly on the climate as well as the building envelope properties. The generic mechanical ventilation solution is a design that depends the least on these factors and is, therefore, broadly applicable. Most houses could use this design.

The basic design is a continuously operating exhaust fan sized to meet the rates in figure 2. Since the default leakage is assumed, neither blower door tests nor extra inlets are required.

These rates are normally less than the sum of the continuous rates required for bath, toilet, and utility room. Therefore, a single multiport fan can be used to exhaust from these rooms. Additionally, a kitchen fan is required. This becomes then a *two-fan design.*

Alternatively, the extra ducting could be eliminated at the cost of additional fans, if a bath fan is upsized to meet the whole-house requirement. This option is often called the *upgraded bath fan design.*

Because either of these design causes some depressurization, it will be important to make sure backdrafting is not an issue, following one of the methods in the standard. If these methods are used in humid climates in an air conditioned house, the standard requires that special care be taken to assure that the envelope will not suffer moisture problems

Natural Ventilation Design

Natural ventilation is allowed as an option for meeting the base whole-house rate only in mild climates. Climate is defined on the basis of typical weather for individual sites, but typically the mild climates can be found in the states of CA, HI, FL, GA, OR, SC, TN as well as parts of several others.

Rather than any specific rates, the natural ventilation design requires that there be about 5% of the floor area that can be operable and acceptable. Acceptability means that opening the window does not create a known hazard, so that the natural ventilation option would not, for example, be appropriate in a noise abatement area next to an airport.

Kitchens and bathrooms would need to have mechanical exhaust as they do in all of the designs, but any toilet compartments or utility rooms would not.

Central Exhaust Systems

In many multifamily buildings a central exhaust system can be used to provide all the necessary ventilation. In such a design the air is exhausted from the kitchen and bathroom continuously. The total rate must be at least that given by figure 2; any bathrooms must have at least 20 cfm. To be exhausted continuously the kitchen needs at least 5 room air changes per hour, which could raise the total above figure 2 values depending on the relative sizes.

In severe climates most utility rooms and separate toilet compartments would also need to be connected to the central exhaust, but in temperate climates an operable window will suffice.

Severe climates are generally cold climates. Most of the states of AK, IA, MT, MA, ND, NE, WI, WY as well as Canada are severe climates, for example.

Most of the states of CO, ID, MO, PA, WA and the District of Columbia are temperate climates. Many states have more than one kind of climate in them.

Supply System Design

The mechanical ventilation systems so far discussed have focussed on exhaust, usually to combine whole-house and local ventilation together. In some circumstances the depressurization caused by exhaust ventilation can be a problem and supply ventilation should be considered. Depressurization can potentially cause condensation in humid climates where air conditioning is used. Depressurization can potentially exacerbate back drafting of combustion appliances in the conditioned space. Depressurization can induce soil gas entry.

A continuously operating supply fan sized to figure 2 would be sufficient, but can cause comfort or moisture problems in some climates.

An alternative is to use an air inlet to the return side of the air handler to provide intermittent supply ventilation. To use the alternative the inlet should be sized to provide three times the flow in Figure 2 and controlled with a timer to make sure it runs at least 1/3 of the time in any 3 hour block. (e.g., 20 minutes each hour)

The Leaky House

As shown in Figure 3, infiltration alone can meet the whole-house requirements of the standard, even in the most severe climates. Exhaust ventilation will still be required in kitchens and baths. In order to get enough infiltration credit to pass the standard one is required to measure the air leakage using a blower door and calculate the credit from the formula in the standard. (Even when the infiltration is insufficient to meet the standard alone, it can reduce the size the mechanical ventilation substantially.)

A new house in Minnesota, for example, could meet 62.2P without whole-house mechanical ventilation, although it would not meet that state's new building code. It would normally be a poor choice, however, to design such a house. The energy and comfort penalties make it an unattractive option. The costs associated with making the leakage test, may make other design options more attractive.

The real value of a larger than default infiltration credit may not be when designing a new home, but when evaluating an existing house to determine if it meets the intent of the standard or when considering mitigation in a problem house. Much of the existing, leaky, building stock, may meet the standard through infiltration. Failure to account for the air leakage could lead to unnecessary mitigation and energy expense.

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