RenewAire
Energy Recovery Ventilation

ASHRAE 62.1: USING THE VENTILATION RATE PROCEDURE

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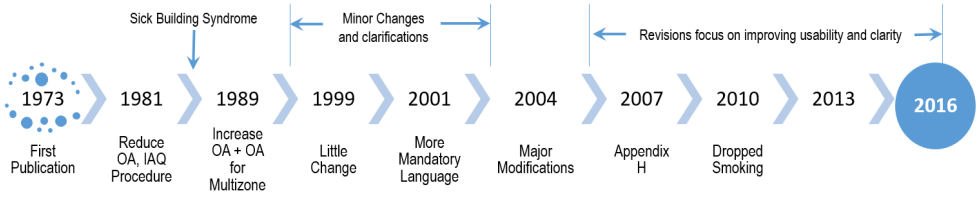
September 14, 2018 - Consulting-Specifying Engineer

ASHRAE 62.1 is best known for its regulation of the amount of ventilation air delivered to each space by HVAC systems through its Ventilation Rate Procedure for system design.

Figure 1



Learning Objectives:

- Understand the history, evolution, and organization of ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality.
- Recognize the equations for the Ventilation Rate Procedure and how to use them.
- Review example to enhance the understanding of equations in ASHRAE 62.1-2016.

While most mechanical design engineers are familiar with ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality (https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2), many are only familiar with the versions they've used through their careers-most use it to satisfy code or permit requirements or to achieve credit compliance for a high-performance building standard. The standard is best known for its Ventilation Rate Procedure (VRP), and its online spreadsheets and calculators have made achieving compliance (on paper) an "easy" step in HVAC design. What is missing, most times, is the understanding behind why ASHRAE 62 is necessary and how the standard evolves to optimize air quality.

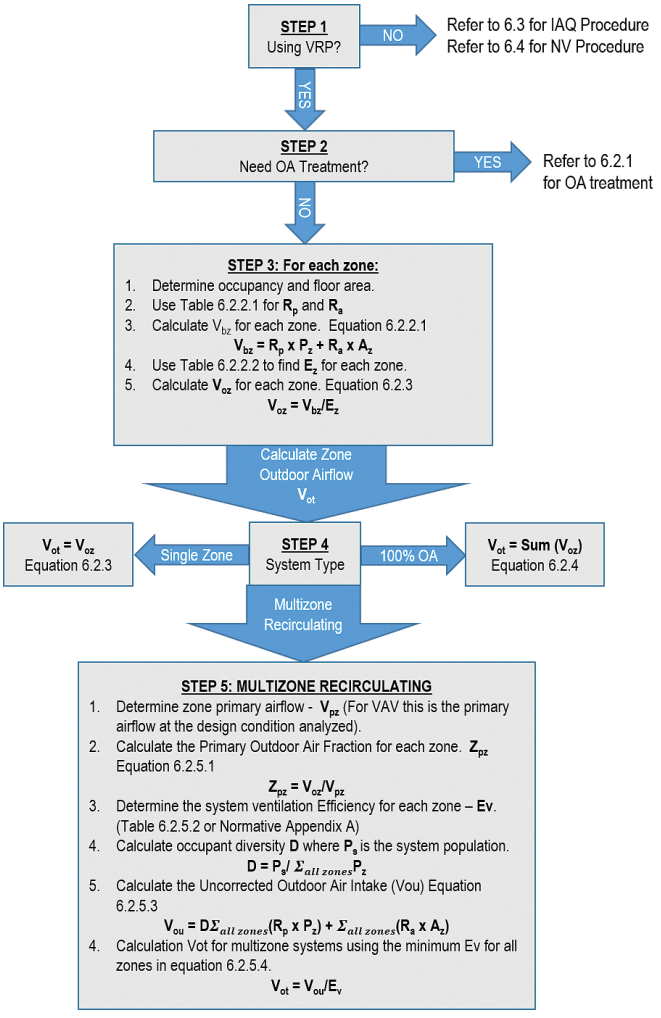
> "The intent [of ASHRAE 62] was to provide a comprehensive enforceable method of establishing ventilation rates centered around indoor air quality (IAQ). It provided prescriptive volumetric airflow rates per person and began looking at the concept of acceptable outdoor air quality."

In addition to the VRP, there are two additional methods for ventilation discussed in ASHRAE 62: natural ventilation and the indoor air quality procedure (IAQP). These will not be discussed here, but they are important to mention as options within the standard. The natural ventilation method is appropriate for buildings using natural ventilation in lieu of or in addition to mechanical ventilation. IAQP relies on numerical analysis of contaminant sources, contaminant concentration targets, and acceptability targets. For simplicity of a compliance analysis and because the VRP is the most common method for compliance, these methods are not discussed further in this article.

ASHRAE 62 was first published in 1973. It was the first ventilation standard published by ASHRAE and provided a prescriptive approach to minimum and recommended outdoor airflow rates for various indoor spaces. The intent was to provide a comprehensive enforceable method of establishing ventilation rates centered around indoor air quality (IAQ). It provided prescriptive volumetric airflow rates per person and began looking at the concept of acceptable outdoor air quality.

The intent was to provide a comprehensive and defensible method for establishing ventilation rates. The standard has had many revisions since

Figure 2



it was first published, each with the intent of improving ventilation in buildings. For existing buildings, it is important to understand the iterations and evolution of the standard to identify how existing buildings might be ventilated based on which version was used at the time of construction or retrofit.

The second version was published in 1981 and reduced minimum outdoor-air rates, included a VRP, as well as introduced the IAQP. It also included provisions for cigarette smoking, recognizing that "higher ventilation rates are specified for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control at the source." Additionally, recirculation air was addressed as well as provisions for "air cleaners and adequate temperature control" for recirculation air.

The next version, published in 1989, was influenced by a 1984 report from the World Health Organization (https://www.epa.gov/sites/production/files/2014-08/documents/sick_building_factsheet.pdf) (WHO) in which the WHO suggested that up to as much as 30% of buildings worldwide registered complaints related to IAQ. Through this, the term "sick building syndrome" was coined and is now synonymous with buildings in which building occupants experience health and comfort effects linked to spending time in a building.

These occupants have no other identifiable illness and report relief upon leaving the building. Common cited causes of sick building syndrome have been identified to be inadequate ventilation, chemical contaminants from outdoor sources, biological contaminants (mold, pollen, viruses), and chemical contaminants from indoor sources. Thus, the 1989 standard significantly increased minimum outdoor-air rates and introduced a requirement for multizone recirculating systems.

Minor changes and clarifications were made in the 1999 and 2001 editions, but these changes did not impact the minimum required outdoor-air rates. In those versions, the provision for thermal comfort was removed and it clarified the intent for 80% satisfaction. The satisfaction rate is achieved with 80% or more occupants expressing satisfaction with IAQ and spaces having no contaminants at harmful concentrations. Further, it recognized the harmful impacts of cigarette smoking and revised language around smoking.

A complete overhaul

Major changes came in the 2004 edition when the standard was revised in its entirety. The IAQP was modified to improve enforceability. More importantly, and with greatest impact to engineers, the VRP was modified. Minimum outdoor airflow rates and the procedures for calculating zone-level and system-level outdoor airflow rates were substantially modified. This version introduced both an area-related component and an occupant-density-related component for the breathing-zone ventilation rate. There also were revisions to the standard relating to indoor-air humidity, building envelope, pressurization, and filtration when outdoor-air particle levels are at harmful levels. The 2004 edition separated out residential ventilation in ASHRAE 62.2 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. The original version of the standard was renamed to ASHRAE 62.1 and included high-rise residential. It also removed all references to smoking.

Since 2004, there have been four additional editions of the standard. These editions have focused on providing clarity and improving usability. In the 2007 version, Appendix H was added to address outdoor-air quality. In 2010, the standard dropped all references to smoking, created Section 6.4 for the natural ventilation procedure, and added requirements for demand-control ventilation. The 2013 edition addressed the effectiveness of underfloor air systems, added additional space types, and made some changes to exhaust-air requirements.

The most recent edition is ASHRAE Standard 62.1-2016. The most significant change is the movement of all residential spaces to Standard 62.2 regardless of building height. Also significant is the allowance for ventilation to be reduced to zero when occupancy sensors are used for spaces of selected occupancy types.

Organizing ASHRAE 62.1

The organization of the standard has changed little over the years. It begins by outlining the purpose and scope and providing basic definitions. The next two sections address outdoor-air quality and systems and equipment. The predominant use of the standard is in Section 6: Procedures. Section 6 addresses the procedures and calculations for calculating minimum outdoor airflow rates as well as the requirements for exhaust ventilation.

> "The VRP is the most commonly used for compliance. Frequently overlooked in the VRP is the requirement for outdoor-air treatment. When using the VRP, it is important to verify if outdoor-air treatment is required. The requirements are outlined in Section 6.2.1 and are for ventilation systems that provide outdoor air through a supply fan."

The standard offers three options for calculation of minimum outdoor air. Section 6.1 gives a basic definition for each procedure. The VRP is the most commonly used procedure. It is a prescriptive design procedure in which outdoor-air rates are dependent on space type, occupancy, and floor area. The IAQP is a performance procedure in which minimum outdoor-air requirements are based on analysis of contaminant sources, contaminant concentration limits, and the level of perceived indoor-air acceptability (Standard Section 6.3). The third option is the natural ventilation procedure (Standard Section 6.4)), which is a prescriptive procedure where outdoor air is provided through outdoor openings.

Figure 3

A_z	=	zone floor area, the net occupiable floor area of the ventilation zone, ft^2 (m^2)
D	=	occupant diversity
E_v	=	system ventilation efficiency as determined from Table 6.2.5.2
E_z	=	zone air distribution effectiveness as determined from Table 6.2.2.2
P_s	=	total population in the area served by the system
P_z	=	zone population, the number of people in the ventilation zone during use
R_a	=	outdoor airflow rate required per unit area as determined from Table 6.2.2.1
R_p	=	outdoor airflow rate required per person as determined from Table 6.2.2.1
V_{bz}	=	outdoor airflow required in the breathing zone of the occupiable space or spaces in a ventilation zone
V_{ot}	=	system outdoor air intake flow
V_{ou}	=	uncorrected outdoor air intake flow
V_{oz}	=	zone outdoor airflow provided to the ventilation zone by the supply air distribution system
V_{pz}	=	zone primary airflow to the ventilation zone, including outdoor air and recirculated air
Z_{pz}	=	zone primary oudoor air fraction for multi-zone recirculating sytsems

The VRP is the most commonly used for compliance. Frequently overlooked in the VRP is the requirement for outdoor-air treatment. When using the VRP, it is important to verify if outdoor-air treatment is required. The requirements are outlined in Section 6.2.1 and are for ventilation systems that provide outdoor air through a supply fan. Verification of outdoor-air treatment is made on a local level and looks at particulates (PM10 and PM2.5) and ozone.

Special treatment is required for local conditions that exceed the national standards. When national standards are exceeded, HVAC systems are required to provide additional air filtration depending on noncompliance. Ozon-removal systems must be provided in areas with ozone noncompliance.

Calculations begin in Section 6.2.2. Each zone in a system must be looked at individually, and then systems can be analyzed. Figure 2 outlines the steps required when using the VRP, and Figure 3 provides the definitions of the symbols used in the calculations.

Understanding the formulas, symbols, and calculations for the VRP is best understood through example. An example calculation is provided in the sidebar, “Small-office HVAC calculations.” It is a single floor of an office building. The HVAC system is overhead VAV with predominantly office and conference room spaces.

If the Mortenson example in the sidebar is looked at retroactively, back to the initial standard, the variations in minimum outdoor-air requirements can be seen. Table 1 in the sidebar also looks at how taking occupant diversity into account impacts minimum outdoor-air requirements. And although there have been minor changes to the required minimums since 2004, the other changes surrounding the use of carbon dioxide control and allowing ventilation to go to zero when occupancy sensors are used can have larger impacts on energy consumption.

It is also good to analyze zone flows and calculation methods to iterate to the outdoor airflow the designer is most comfortable with. The minimum outdoor-air intake flowchart illustrates that for 2004-2016 there are four potential compliant minimum flows. It illustrates the impact that diversity can have as well as how the designer allows for minimum flows within each zone and if Appendix A is used.

View the original article and related content on Consulting Specifying Engineer: (https://www.csemag.com/articles/ashrae-62-1-using-the-ventilation-rate-procedure/)