ASHRAE

ADDENDA

ASHRAE Addendum e to
ASHRAE Guideline 41-2020

Design, Installation and Commissioning of Variable Refrigerant Flow (VRF) Systems

Approved by ASHRAE on August 23, 2023.

This addendum was approved by a Standing Guideline Project Committee (SGPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the guideline. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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FOREWORD

Addendum e adds additional commentary to the proper methodology for complying with outdoor ventilation requirements when using VRF systems.

Informative Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum e to Guideline 41-2020

5.9 Ventilation Factors

a. ~~Ventilation is~~

> ~~the process of changing or replacing air in any space to control temperature or remove any combination of moisture, odors, smoke, heat, dust, airborne bacteria, or carbon dioxide, and to replenish oxygen. Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into mechanical/forced and natural types." ASHRAE Handbook—Fundamentals~~

~~Ventilation rates for buildings are prescribed in several ASHRAE standards and should be consulted to determine the proper quantity. ANSI/ASHRAE/IES Standard 90.1-11 provides specific ventilation rates for building and occupation types. ANSI/ASHRAE Standard 62.1 provides methods of ensuring indoor air quality.~~

~~VRF systems have multiple air handlers requiring a different perspective for providing ventilation air. For VRF systems, there are three primary methods of providing ventilation air:~~

~~1. Ventilation air introduced through the IDUs~~
~~2. Energy recovery ventilators~~
~~3. Dedicated outdoor air systems~~

~~b. In certain temperate areas of the U.S., economizers (free cooling by bringing in outdoor air that meets the criteria for providing cooling without mechanical assistance) are recommended or required by the building energy code. The designer should check the requirements in Standard 90.1 and local codes to determine requirements.~~

- Ventilation is the process of changing or replacing air in any space to control temperature or remove any combination of moisture, odors, smoke, heat, dust, airborne bacteria, or carbon dioxide, and to replenish oxygen. Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into *mechanical/forced* and *natural* types.
- Ventilation rates for buildings are prescribed in several ASHRAE standards and should be consulted to determine the proper quantity. ANSI/ASHRAE Standards 62.1 and 62.2 specify the minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects. Verify the local code requirements.
- VRF systems rely on the heat transfer to occur in/near the thermal zone it serves. While this advantage improves overall thermal comfort control and energy efficiency, the increased number and location of air-handlers create unique opportunities. This requires additional considerations to ensure that ventilation requirements are met.

There are three primary ventilation strategies for VRF systems.

a. Direct method—to the VRF IDU (Figure 4): In the direct method, unconditioned outdoor air is directed into the return air and conditioned by the VRF indoor unit.

Advantages

1. Reduces system complexity
2. Lower first cost

Considerations:

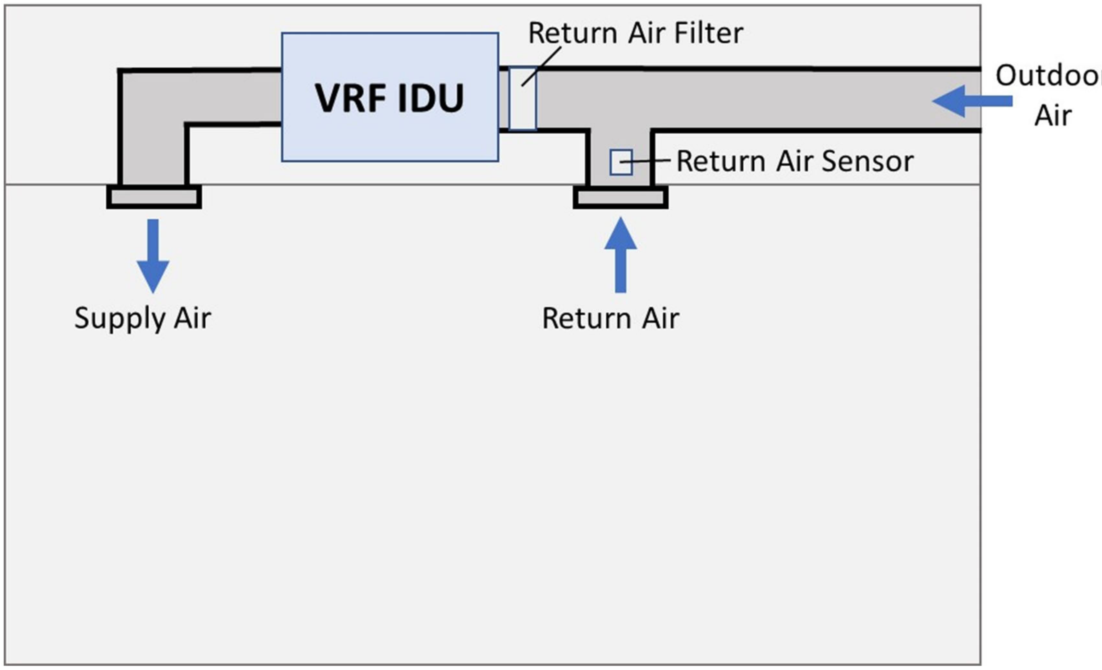

Figure 4 Direct method—to the VRF IDU.

1. Ensure that the summer and winter entering air wet-bulb and dry-bulb design conditions are within manufacturer-specified limits.
2. Ensure that the indoor unit can create the negative static pressure to distribute the ventilation air. This may require an interlocked inline fan.
3. Review the space required noise criterion (NC) levels with the resulting fan speed required to meet the design.
4. Requires continuous fan operation during occupancy.
5. Requires space temperature or return air temperature sensor. If temperature is read at the unit return, this could create a false reading from mixed-air temperature.
6. Outdoor air filtration requirements must be met.
7. Outdoor air is required to have a controlled isolation damper.
8. Ensure design meets local code compliance.
9. If the indoor unit serves more than one space type, ANSI/ASHRAE Standard 62.1 calculations may increase outdoor air.

b. Integrated method—pretreated and distributed by the IDU: In the integrated method, outdoor air is pretreated by mechanical means such as a 100% outdoor air unit, a dedicated outdoor air system (DOAS) or energy recovery ventilator (ERV) before being supplied to the VRF indoor unit through the return air or supply ductwork. Figure 5 shows ventilation air delivered to the return side of the ductwork. Figure 6 shows ventilation air delivered to the supply side of the ductwork.

Advantages:

1. Allows the indoor unit to process a reduced latent load versus the direct method
2. Allows for demand-control ventilation
3. Reduces variation in ventilation air temperature as compared to the direct method.
4. Dedicated outdoor air fans deliver ventilation air to the IDU without requiring additional negative static from the IDU fan.
5. Simplifies ventilation air filtration
6. Allows for energy recovery
7. Fewer building envelope penetrations
8. ERV may be a more cost effective than a DOAS for drier climates.
9. When ventilation air is integrated into the supply side of the ductwork, the IDU fan may cycle with load, as ventilation air delivery is not dependent on the IDU fan.
10. Allows for shared use of common ductwork for ventilation and supply airflow

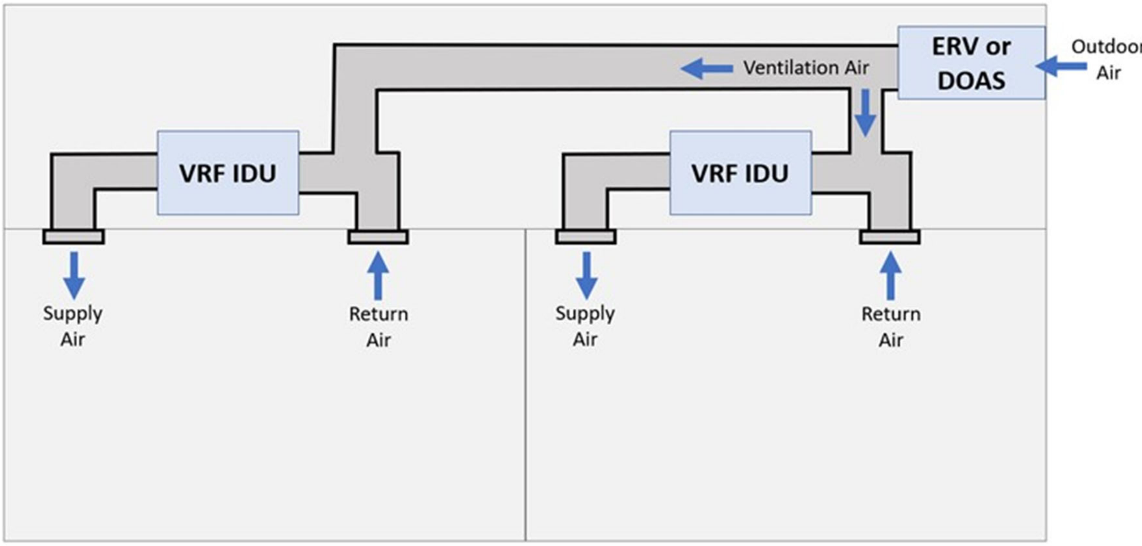

Figure 5 Integrated method—pretreated and distributed by the IDU. Ventilation air delivered to the return side of the ductwork.

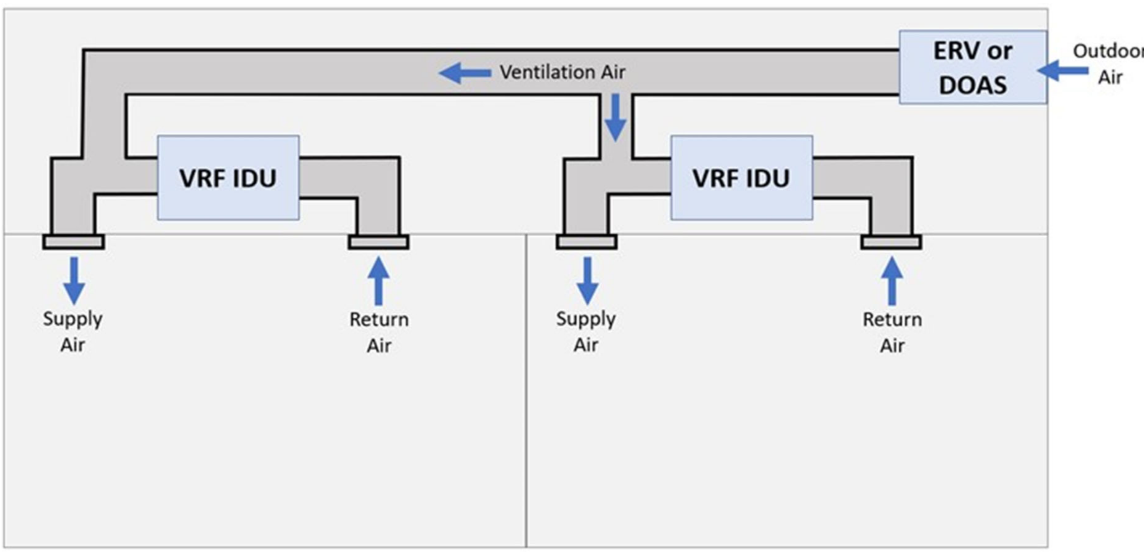

Figure 6 Integrated method—pretreated and distributed by the IDU. Ventilation air delivered to the supply side of the ductwork.

Considerations:

1. Ensure that the summer and winter entering air wet-bulb and dry-bulb design conditions are within manufacturer specified limits. Temperature and humidity control can become an issue, especially in warmer/moist climates.
2. If the ventilation air is delivered to the supply side of the ductwork, if the IDU fan is cycled off, care must be taken to ensure that the positive pressure of the ventilation air in the supply ductwork does not rotate the supply fan backwards.
3. Determine if the ventilation air is delivered to the return side of the ductwork.
4. Review the space required NC levels with the resulting fan speed required to meet the design.
5. May require space temperature or return air temperature sensor. If temperature is read at the unit return, this could create a false reading from mixed air temperature.
6. Ensure the DOAS or ERV meets outdoor air filtration requirements.
7. Ensure design meets local code compliance.

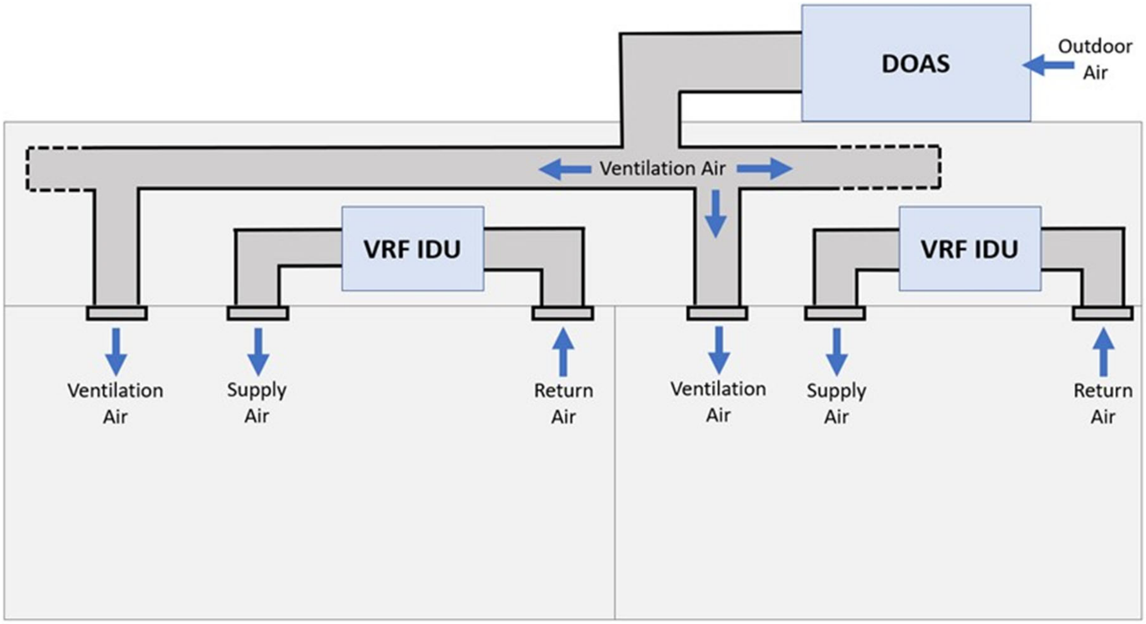

Figure 7 Decoupled method—DOAS delivers ventilation air.

8. Increased costs from additional equipment and ductwork
9. ERV option may not be as effective as a DOAS in warmer/moist climates.
10. If the indoor unit serves more than one space type, ANSI/ASHRAE Standard 62.1 calculations may increase outdoor air. This may result in a higher volume and mixed air calculation.

c. Decoupled method—DOAS delivers ventilation air (Figure 7): In the decoupled method, conditioned ventilation air is supplied directly to the space by a DOAS. The DOAS conditions the outdoor air based on dew-point control. The function of the VRF system is to maintain space comfort. Because no mixing is involved, ventilation rate delivery to the space/zone can easily be verified and continuously monitored.

Advantages:

1. More options to achieve optimum dehumidification
2. This method decouples dehumidification and temperature control sequences.
3. Indoor units are only sized for indoor space temperature control.
4. The indoor units may be downsized due to the reduced load if the DOAS delivers cold air instead of neutral air.
5. Decoupling ventilation heat load may decrease the required VRF heating capacity.
6. Simplifies ventilation air filtration at DOAS
7. Allows for energy recovery
8. Fewer building envelope penetrations
9. Space IDU fans can cycle with load.
10. Most versatile solution across all climate zones

Considerations

1. Higher first-cost equipment and duct design
2. Ensure ventilation air point of delivery does not affect space temperature controls.
3. Requires a separate centralized ductwork distribution
4. Ensure the DOAS or ERV meets outdoor air filtration requirements.
5. Ensure design meets local code compliance.
6. May require more mechanical space
7. More suitable for high-percentage ventilation requirements

d. Depending on the project climate zone, an economizer may be required by ANSI/ASHRAE/IES Standard 90.1.

e. Overall building pressurization shall be evaluated based on total building air balance as well as the selected ventilation strategy and building automation control strategy.

[. . .]

6.6 Ventilation Requirements. When determining the ventilation for VRF systems, the following should be considered.

~~**6.6.1 Distributed vs. Centralized.** VRF systems have multiple air handlers distributed throughout the building as opposed to unitary systems with central air handlers. There are many advantages to having multiple distributed air handlers with regard to ventilation, the primary advantage being that you can tailor the ventilation to each zone instead of having one solution for the whole building. Each zone may have different ventilation and filtration requirements that can be addressed specifically for that zone by the distributed air handler in that zone. Another advantage is that each zone only deals with the air in its zone, so the risk of cross contamination is significantly reduced.~~

6.6.1 When designing for ventilation, please reference national standards and building codes. The current industry standards for ventilation are ANSI/ASHRAE Standards 62.1 and 62.2. Standard 62.1 is specifically for commercial applications, whereas Standard 62.2 is for low-rise residential installations. A third important standard is ANSI/ASHRAE/IES Standard 90.1. Standard 90.1 details the energy-efficient strategies to treat and deliver ventilation air. Based on the type of installation, other standards may also apply.

~~**6.6.2 National Codes and Standards.** When designing for ventilation, please reference national standards and building codes. The current national standards for ventilation are ASHRAE Standards 62.1 and 62.2. Standard 62.1 is specifically for commercial applications, whereas Standard 62.2 is for residential installations. A third important standard is ASHRAE Standard 90.1. Standard 90.1 details the proper strategies to treat and deliver ventilation air. Based on the type of installation, other standards may also apply.~~

6.6.2 Where there is a conflict between the industry standards and the local or state building code, the accepted practice is to use the more stringent requirement. Local and state codes will vary by region.

~~**6.6.4 Economizer.** Assessments must be made based on the various sizes and configurations of VRF systems, along with national and local code requirements, if economizers are a requirement (Figure 7).~~

~~The IECC has specific requirements for economizers on VRF systems. Other codes that have economizer requirements include the 2012 IECC and ASHRAE/ICC/USGBC/IES Standard 189.1, which require economizers for IDUs „d33,000 Btu/h (9672 W), which is more stringent than the 2015 IECC, ASHRAE/IES Standard 90.1-2016, and the 2016 California Building Energy Efficiency Standards (all „d54,000 Btu/h [15,827 W]).~~

~~The 2012 and 2015 IECC provide equipment efficiency trade-offs for systems located in three climate zones (2B, 3B, 4B), whereas Standard 90.1-2016 and the 2016 California Building Energy Efficiency standards both provide trade-offs for all climate zones where economizers are required.~~

6.6.4 Economizers. Assessments must be made based on the various sizes and configurations of VRF systems, along with national and local code requirements, if economizers are a requirement.

Several factors will determine whether the system IDUs will require an economizer:

a. **Climate zone.** The applicable ASHRAE reference climate zone of the VRF system location is the first criteria to determine economizer requirements. The temperature and humidity conditions of cooler and drier climate zones offer acceptable opportunities for economizer operation.

b. **IDU capacity.** The cooling capacity of the IDU system is the second criteria to identify economizer requirements. The larger the system capacity, the larger the potential opportunity for energy savings through economizing.

c. **IDU location.** The location of the IDU, whether inside or outside the building envelope, is the third criteria dictating economizer requirements. Units on the exterior of the building have direct connectivity to the ambient air, simplifying the addition of economizer functionality to a system. Systems inside the envelope will need to have a direct connection to the outside.

d. **Minimum capacity requirements.** Per ASHRAE/IES Standard 90.1, systems achieving an exemplary energy performance may be exempt from economizer requirements. Standard 90.1 details the minimum system efficiency based on the installation location.

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ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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