ADDENDA

ASHRAE Addendum f 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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ASHRAE Standing Guideline Project Committee 41
Cognizant TC: 8.7, Variable Refrigerant Flow
SPLS Liaison: Paul A. Lindahl, Jr.

SPECIAL NOTE

This Guideline was developed under the auspices of ASHRAE. ASHRAE Guidelines are developed under a review process, identifying a Guideline for the design, testing, application, or evaluation of a specific product, concept, or practice. As a Guideline it is not definitive but encompasses areas where there may be a variety of approaches, none of which must be precisely correct. ASHRAE Guidelines are written to assist professionals in the area of concern and expertise of ASHRAE's Technical Committees and Task Groups.

ASHRAE Guidelines are prepared by Project Committees appointed specifically for the purpose of writing Guidelines. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Guideline.

Development of ASHRAE Guidelines follows procedures similar to those for ASHRAE Standards except that (a) committee balance is desired but not required, (b) an effort is made to achieve consensus but consensus is not required, (c) Guidelines are not appealable, and (d) Guidelines are not submitted to ANSI for approval.

The Senior Manager of Standards of ASHRAE should be contacted for

a. interpretation of the contents of this Guideline,
b. participation in the next review of the Guideline,
c. offering constructive criticism for improving the Guideline, or
d. permission to reprint portions of the Guideline.

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

Addendum f moves normative references to new Section 9 and updates them. Informative Appendices B and C are deleted.

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 f to Guideline 41-2020

Modify existing Normative Appendix A as shown.

~~NORMATIVE APPENDIX A~~

9. NORMATIVE REFERENCES

References required for compliance with this standard are listed below. Informative references are listed in Annex C.

1. ASHRAE. ~~2019~~2022. ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*, ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
2. ASHRAE. ~~2019~~2022. ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*. ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
3. ASHRAE. ~~2019~~2022. ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*. ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
4. ASHRAE. ~~2016~~2020. *ASHRAE Handbook—HVAC Systems and Equipment.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
5. ASHRAE. ~~2018~~2021. ASHRAE Standard 202, *The Commissioning Process for Buildings and Systems.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
6. ASHRAE. 2019. ASHRAE Guideline 0, *The Commissioning Process.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
7. ASHRAE. 2015. ASHRAE Guideline 0.2, *Commissioning Process for Existing Systems and Assemblies*. ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
8. ASHRAE. 2007. ASHRAE Guideline 1.1, *HVAC&R Technical Requirements for the Commissioning Process.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
9. ASHRAE. 2018. ASHRAE Guideline 1.3, *Building Operation and Maintenance Training for the HVAC&R Commissioning Process.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
10. ASHRAE. 2019. ASHRAE Guideline 1.4, *Preparing Facility Systems Manuals.* Atlanta, GA: ASHRAE.
11. ASHRAE. ~~2018~~2022. ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings.* ~~Atlanta, GA~~Peachtree Corners, GA: ASHRAE.
12. IECC. ~~2019~~2021. *International Mechanical Code*. Country Club Hills, IL Washington, DC: International Code Council.
13. IAPMO. ~~2019~~2021. *Uniform Mechanical Code*. Ontario, CA: International Association of Plumbing and Mechanical Officials.

Delete Informative Appendix B and C as shown.

~~(This appendix is part of this guideline. It contains requirements necessary for conformance to the guideline.)~~

~~NORMATIVE APPENDIX B~~
~~REFRIGERANT MANAGEMENT~~

~~This appendix provides additional information about refrigerant management concepts from other sources, in particular ISO 5149, which was written with VRF systems in mind. ISO 5149 was revised in 1993 to include environmental safety aspects in addition to refrigeration system safety. Although the revision was initially based on ASHRAE Standard 15~~[2]~~, ultimately EN 378 was used as the basis for revision.~~

B1. ISO 5149-1[C1] AND ISO 5149-3[C2]

B1.1 ISO 5149, *Refrigerating Systems and Heat Pumps, Safety and Environmental Requirements*

- Part 1: Definitions, Classification, and Selection Criteria
- Part 2: Design, Construction, Testing, Marking, and Documentation
- Part 3: Installation Site
- Part 4: Operation, Maintenance, Repair, and Recovery

a. Part 1 includes a table listing refrigerant charge limitations, taking into consideration refrigerant toxicity and flammability classifications.
b. Class 2L quantity limitations were based on a reduced risk of combustion, determined in part by the burning velocity of the refrigerant, as compared with Class 2 and 3 refrigerants.
c. ISO 5149 permits higher refrigerant quantities of Class 2L refrigerant than of Class 2 or 3.
d. Risk management approach was included for calculating refrigerant charge under certain conditions for class A1 and A2L refrigerants.

Risk management is the systematic process of determining and implementing measures to reduce the risks associated with identified hazards for a particular installation or project site.

The risk management process involves the following basic steps:

a. Identify and characterize threats or hazards.
b. Assess the threat of a specific risk to critical resources.
c. Evaluate and determine the expected likelihood and consequences of specific types of threats on critical resources.
d. Determine whether the risk can be controlled.
e. Identify ways to control (avoid, mitigate, or transfer) those risks.
f. Implement the most effective control measures as are reasonably practical.
g. Monitor and review the control measures to ensure they are effective and reproducible.

With regard to refrigeration system safety, some of the following control measures are commonly taken to eliminate or reduce risks associated with use of refrigerants:

a. Minimize the number of fittings and connections.
b. Provide a nonhazardous alternative to avoid the risk.
c. Contain the risk with appropriate enclosures.
d. Provide dilution ventilation and exhaust.
e. Install leak detection monitoring and alarm devices.
f. Reduce the system charge (e.g., multiple smaller systems).
g. Use valves, receivers, and automatic controls to reduce the consequences of leaks.
h. Remove potential ignition sources when using flammable refrigerants.
i. Provide emergency management procedures and personnel training.

B1.2 Alternative for Risk Management in Occupied Spaces

Part 1 includes a section (A.5) providing an alternative method of calculating the allowable refrigerant charge using a risk management approach.

Where the location and occupancy classifications allow the use of the alternative provisions, the designer can calculate the allowable refrigerant charge using the refrigerant concentration limit (RCL), quantity limit with minimum ventilation (QLMV), or quantity limit with additional ventilation (QLAV) values instead of the practical limit values (Table B-1).

B1.3 Conditions for Use of Alternative Risk Management Approach

a. The refrigerant is classified as A1 or A2L.
b. The refrigerant charge does not exceed 150 kg (A1) and does not exceed 195 m^3 × LFL (A2L).
c. The rated cooling/heating capacity of the indoor unit (IDU) is not more than 25% of the total cooling/heating capacity of the outdoor unit (ODU) (minimum 4 IDUs).
d. The equipment location is Class II.
e. The IDUs are protected against freezing.
f. The IDUs are protected against fan breakage.
g. Pipes in occupied spaces are sized correctly.

Table B-1 Allowable Refrigerant Concentration (ISO 5149-1 C1, Table A.3)

Refrigerant	Allowable Concentration (kg/m^3) RCL	QLMV [a], kg/m^3	QLAV [b], kg/m^3
R-22	0.21	0.28	0.50
R-134a	0.21	0.28	0.58
R-407C	0.27	0.46	0.50
R-410A	0.39	0.42	0.42
R-744 (CO_2)	0.072	0.074	0.18
R-32	0.061	0.063	0.16
R-1234yf	0.060	0.062	0.15

a. QLMV is based on 2.2 m room height and 0.0032 m^2 opening (0.8 m width door with 4 mm gap).
b. QLAV is based on oxygen concentration of 18.5 vol%, assuming perfect mixing.

h. Only permanent joints are used in the occupied space except for site-made joints directly connecting the IDU to the piping.
i. Pipes in the occupied space are protected against accidental damage.
j. Natural ventilation is provided.
k. Doors of the occupied space are not tight fitting.
l. Effect of flow down is considered.

Provided all these conditions are met, the risk of rapid release of refrigerant through a major leak is minimized, and leakage into the occupied space is considered to be no greater than that resulting from a pinhole leak (based on a leak rate of 2.78 g/s).

B1.4 Quantity Limit Definitions

refrigerant concentration limit (RCL): maximum refrigerant concentration in air, determined and established to reduce the risks of acute toxicity, asphyxiation, and flammability hazards (ISO 817 C3).

quantity limit with minimum ventilation (QLMV): charge of refrigerant that results in a concentration equal to the RCL in a room of nonairtight construction with a moderately severe refrigerant leak.

quantity limit with additional ventilation (QLAV): charge of refrigerant that results in a concentration equal to the oxygen deprivation limit (ODL) if the total charge leaked within the occupied space.

practical limit: concentration used for simplified calculation to determine the maximum acceptable amount of refrigerant in an occupied space.

B1.5 Allowable Charge. Alternate provisions included in ISO 5149-3, Clauses 6 and 8 provide the options of a gas-detection device and mechanical ventilation and safety alarms, or a gas-detection device with safety shut-off valves and safety alarms.

The total charge of the system divided by the room volume shall not exceed the QLMV or RCL unless appropriate measures are taken:

QLMV < ***charge/volume*** ≤ QLAV
At least one of specified measures shall be taken.

QLAV < ***charge/volume***
At least two of the specified measures shall be taken.

(This appendix is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE APPENDIX C
INFORMATIVE REFERENCES AND BIBLIOGRAPHY

C1. ISO. 2014. ISO 5149-1, *Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements – Part 1: Definitions, Classification and Selection Criteria*. Geneva, Switzerland: International Organization for Standardization.

C2. ISO. 2014. ISO 5149-3, *Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements – Part 3: Installation site*. Geneva, Switzerland: International Organization for Standardization.

C3. ISO 2014. ISO 817, *Refrigerants – Designation and Classification*. Geneva, Switzerland: International Organization for Standardization.

C4. ASHRAE. 2001. *Standard 15-2001 User's Manual*. Atlanta, GA: ASHRAE.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

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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As an industry leader in research, standards writing, publishing, certification, and continuing education, ASHRAE and its members are dedicated to promoting a healthy and sustainable built environment for all, through strategic partnerships with organizations in the HVAC&R community and across related industries.

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