**BSR/ASHRAE Addendum m**
**to ANSI/ASHRAE Standard 15-2019**

**First Public Review Draft**

# Proposed Addendum m to Standard 15-2019, Safety Standard for Refrigeration Systems

**First Public Review (November 2021)**
**(Draft shows Proposed Changes to Current Standard)**

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**ASHRAE, 180 Technology Parkway NW, Peachtree Corners, GA 30092**

**(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

*This proposed addendum to ANSI/ASHRAE Standard 15-2019 modifies allowances for the use of mechanical ventilation to expand this mitigation strategy for human comfort applications using A2L refrigerants. Presently, Section 7.6.4 restricts the use of mechanical ventilation solely to systems that have compressors and pressure vessels located indoors. This allowance, and requirements if the allowance is used, in ANSI/ASHRAE Standard 15-2019 matches the allowance/requirements in the current third edition of UL 60335-2-40/CSA C22.2 No. 60335-2-40 product safety standard (Refer to Annex GG.4). Notably, this same domestic product safety standard allows the use of mechanical ventilation in other human comfort applications – those with compressors and pressure vessels located outdoors (Refer to Annex GG.8). Further, the international version of the product safety standard (IEC 60335-2-40, 6th edition) has the same requirements/allowances as the North American version.*

*This proposed addendum rectifies the difference by largely harmonizing ANSI/ASHRAE Standard 15 with the allowance for broader application of ventilation, and requirements if the allowance is used, in UL 60335-2-40/CSA C22.2 No. 60335-2-40, 3rd edition. This proposal would allow for mechanical ventilation in ANSI/ASHRAE Standard 15 when meeting stringent requirements for either continuous operation or operation initiated by a refrigerant detector, using an approach similar to the product safety standard. This proposed approach begins with a "simplified table method" for determining required ventilation rates, but also has a detailed calculation method.*

***Note:*** This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.

## Addendum m to Standard 15-2019

***Modify Section 3 as follows. The remainder of Section 3 remains unchanged.***

## 3. DEFINITIONS

### 3.1 Defined Terms

[ … ]

***connected spaces:*** two or more spaces connected by natural ventilation, a ducted air distribution system, or mechanical ventilation.

***Note to Reviewers:*** *This definition is also proposed to be added by Addendum g to Standard 15-2019, which is not yet published. It has been duplicated here for reference only.*

[ … ]

***effective dispersal volume:*** the volume of a space or *connected spaces* into which leaked *refrigerant* will disperse.

***Note to Reviewers:*** *This definition is also proposed to be added by Addendum g to Standard 15-2019, which is not yet published. It has been duplicated here for reference only.*

[ … ]

***exhaust air:*** air removed from a space and discharged outside of the space by means of mechanical ventilation.

[ … ]

***makeup air:*** air added to a space from outside the building or from other indoor spaces by means of mechanical or natural ventilation.

[ … ]

***ventilated enclosure:*** a type of equipment enclosure that includes an integral ventilation system that will prevent *refrigerant* leaked inside the equipment enclosure from escaping into the space surrounding the equipment enclosure.

[ … ]

***Modify Section 7 as follows. The remainder of Section 7 remains unchanged.***

## 7. RESTRICTIONS ON REFRIGERANT USE

[ … ]

**7.2** ***Refrigerant Concentration Limits.*** The concentration of *refrigerant* in a complete discharge of each *independent circuit* of high-probability systems *shall not* exceed the amounts shown in ASHRAE Standard 34[2], Table 4-1 or 4-2, except as provided in Section 7.2.1, ~~and~~ 7.2.2, and 7.6.4. ~~of this standard.~~ The volume of *occupied space shall* be determined in accordance with Section 7.3.

[ … ]

**7.3 Volume Calculations…**

**7.3.1 Nonconnecting Spaces…**

[ … ]

~~**7.3.2 Ventilated Spaces.** Where a *refrigerating system*, or a part thereof, is located within an air handler, in an air distribution *duct* system, or in an *occupied space* served by a mechanical ventilation system, the entire air distribution systems *shall* be analyzed to determine the worst-case distribution of leaked *refrigerant*. The worst case or the smallest volume in which the leaked *refrigerant* disperses *shall* be used to determine the *refrigerant* quantity limit in the system, subject to the following criteria.~~

**7.3.2 *Spaces with Passive Dispersion.** For refrigeration systems not having a *refrigerant detector* in accordance with Section 7.6.5 nor having continuous air circulation, where leaked *refrigerant* from a refrigeration system can disperse into a space or *connected spaces* through an air distribution system or part thereof, the entire air distribution system *shall* be analyzed to determine the worst-case distribution of leaked *refrigerant*. The *effective dispersal volume* used in calculating the *refrigerant* charge limit *shall* be the worst case or the smallest volume in which the leaked *refrigerant* disperses, subject to the following criteria.

**7.3.2.1 Closures.** Closures in the air distribution system, such as dampers, *shall* be evaluated as part of the analysis as follows: ~~considered. If~~ where one or more spaces ~~of several arranged in parallel~~ can be closed off from the source of the *refrigerant* leak, ~~their~~ the volumes of such space(s) *shall not* be used in the calculation.

[ … ]

**7.3.3 *Spaces with Active Air Circulation.** For refrigeration systems having a *refrigerant detector* in accordance with Section 7.6.5 or having continuous air circulation, where leaked *refrigerant* can disperse into a space or *connected spaces* through an air distribution system, or part thereof, the *effective dispersal volume* used in calculating the *refrigerant* charge limit *shall* be the volume of all spaces served by the refrigeration system and volume of the *ductwork*.

**7.3.4 ****Connected Spaces* **with Active Ventilation.** For refrigeration systems using Group A2L *refrigerant*, where two or more spaces are connected by a mechanical ventilation system meeting the requirements of Section 7.6.4 that can be used to disperse leaking *refrigerant*, the *effective dispersal volume* used in calculating the *refrigerant* charge limit *shall* be the cumulative volume of such *connected spaces*, including the volume of any transfer air *ductwork*.

[ … ]

**7.6 Group A2L *Refrigerants* for Human Comfort.** High-probability systems using Group A2L *refrigerants* for human comfort applications *shall* comply with this section.

~~**7.6.1 *Refrigerant Concentration Limits***~~

~~**7.6.1.1** *Occupied spaces shall* comply with Section 7.2.~~

~~**7.6.1.2** Unoccupied spaces with *refrigerant* containing equipment, including but not limited to *piping* or tubing, *shall* comply with Section 7.2 except as permitted by Section 7.6.4.~~

**7.6.1 *Refrigerant* Quantity Limits.** All spaces to which *refrigerant* has potential to leak *shall* comply with Section 7.2, except as permitted by Section 7.6.4.

[ … ]

~~**7.6.4 *Compressors* and *Pressure Vessel* Located Indoors.** For refrigeration *compressors* and *pressure vessels* located in an indoor space that is accessible only during service and maintenance, it *shall* be permissible to exceed the *RCL* if all of the following provisions are met:~~

~~a. The *refrigerant* charge of largest independent refrigerating circuit *shall not* exceed~~

~~1. 6.6 lb (3 kg) for residential and institutional *occupancies* and~~

~~1. 22 lb (10 kg) for commercial and public/large mercantile *occupancies*.~~

~~b. The space where the equipment is located *shall* be provided with a mechanical ventilation system in accordance with Section 7.6.4(c) and a *refrigerant detector* in accordance with Section 7.6.5. The mechanical ventilation system *shall* be started when the *refrigerant detector* senses *refrigerant* in accordance with Section 7.6.5. The mechanical ventilation system *shall* continue to operate for at least five minutes after the *refrigerant detector* has sensed a drop in the *refrigerant* concentration below the value *specified* in Section 7.6.5(b).~~

~~c. A mechanical ventilation system *shall* be provided that will mix air with leaked *refrigerant* and remove it from the space where the equipment is located. The space *shall* be provided with an exhaust fan. The exhaust fan *shall* remove air from the space where the equipment is located in accordance with the following equation:~~

$$Q_{min} = 1000 \times M/LFL \quad \text{(I-P)}$$

$$Q_{min} = 60{,}000 \times M/LFL \quad \text{(SI)}$$

~~where~~

~~$Q_{min}$ = minimum airflow rate, $ft^3$/min ($m^3$/h)~~

~~$M$ = *refrigerant* charge of the largest independent refrigerating circuit of the system, lb (kg)~~

~~$LFL$ = *lower flammability limit*, lb per 1000 $ft^3$ ($g/m^3$)~~

~~d. The *exhaust air shall* be located where *refrigerant* from a leak is expected to accumulate. The bottom of the air inlet elevation *shall* be within 12 in. (30 cm) of the lowest elevation in the space where the *compressor* or *pressure vessel* is located. Provision *shall* be made for *makeup air* to replace that being exhausted. Openings for the *makeup air shall* be positioned such that air will mix with leaked *refrigerant*.~~

~~1. Air that is exhausted from the ventilation system *shall* be either~~

~~2. discharged outside of the building envelope or~~

~~e. discharged to an indoor space, provided that the *refrigerant* concentration will not exceed the limit *specified* in Section 7.6.1.~~

~~f. In addition to the requirements of Section 7.6.3, there *shall* be no open-flame-producing devices that do not contain a flame arrestor, or hot surfaces exceeding 1290°F (700°C) that are installed within space where the equipment is located.~~

**7.6.4 Mechanical Ventilation.** Where Section 7.3.4 is used for calculation of *effective dispersal volume*, mechanical ventilation *shall* comply with this section. Where a *ventilated enclosure* is provided to control a

*refrigerant* leak, the equipment and *ventilated enclosure shall* be *listed* and installed in accordance with UL 60335-2-40[18] / CSA C22.2 No. 60335-2-40[19], and *shall not* be required to comply with this section.

a. Mechanical ventilation *shall* be provided that will remove leaked *refrigerant* from the space where *refrigerant* leaking from the equipment is expected to accumulate. The space *shall* be provided with an exhaust or transfer fan.

1. Fans used to *exhaust air* from the space or transfer air to another indoor space *shall* comply with the following equation:

$$Q_{min} = Q_{REQ}/C_{LFL}$$

where

$Q_{min}$ = minimum mechanical ventilation airflow rate, $ft^3$/min ($m^3$/h)

$Q_{REQ}$ = the required ventilation, as determined from Table 7-1

$C_{LFL}$ = the *lower flammability limit* conversion factor, as determined from Table 7-2

**Table 7-1 Required Ventilation for A2L Systems[a]**

| Excluded Charge $(M - M_{VOL})$[b] | | $Q_{REQ}$ | | Excluded Charge $(M - M_{VOL})$[b] | | $Q_{REQ}$ | |
|---|---|---|---|---|---|---|---|
| lb | kg | $ft^3$/min | $m^3$/hr | lb | kg | $ft^3$/min | $m^3$/hr |
| 3.8 | 1.7 | 100 | 170 | 91.8 | 41.6 | 2400 | 4080 |
| 7.6 | 3.5 | 200 | 340 | 95.6 | 43.4 | 2500 | 4250 |
| 11.5 | 5.2 | 300 | 510 | 99.4 | 45.1 | 2600 | 4420 |
| 15.3 | 6.9 | 400 | 680 | 103.2 | 46.8 | 2700 | 4590 |
| 19.1 | 8.7 | 500 | 850 | 107.1 | 48.6 | 2800 | 4760 |
| 22.9 | 10.4 | 600 | 1020 | 110.9 | 50.3 | 2900 | 4930 |
| 26.8 | 12.1 | 700 | 1190 | 114.7 | 52.0 | 3000 | 5100 |
| 30.6 | 13.9 | 800 | 1360 | 118.5 | 53.8 | 3100 | 5270 |
| 34.4 | 15.6 | 900 | 1530 | 122.4 | 55.5 | 3200 | 5440 |
| 38.2 | 17.3 | 1000 | 1700 | 126.2 | 57.2 | 3300 | 5610 |
| 42.1 | 19.1 | 1100 | 1870 | 130.0 | 59.0 | 3400 | 5780 |
| 45.9 | 20.8 | 1200 | 2040 | 133.8 | 60.7 | 3500 | 5950 |
| 49.7 | 22.5 | 1300 | 2210 | 137.6 | 62.4 | 3600 | 6120 |
| 53.5 | 24.3 | 1400 | 2380 | 141.5 | 64.2 | 3700 | 6290 |
| 57.4 | 26.0 | 1500 | 2550 | 145.3 | 65.9 | 3800 | 6460 |
| 61.2 | 27.7 | 1600 | 2720 | 149.1 | 67.6 | 3900 | 6630 |
| 65.0 | 29.5 | 1700 | 2890 | 152.9 | 69.4 | 4000 | 6800 |
| 68.8 | 31.2 | 1800 | 3060 | 156.8 | 71.1 | 4100 | 6970 |
| 72.6 | 32.9 | 1900 | 3230 | 160.6 | 72.8 | 4200 | 7140 |
| 76.5 | 34.7 | 2000 | 3400 | 164.4 | 74.6 | 4300 | 7310 |
| 80.3 | 36.4 | 2100 | 3570 | 168.2 | 76.3 | 4400 | 7480 |
| 84.1 | 38.1 | 2200 | 3740 | 172.1 | 78.0 | 4500 | 7650 |
| 87.9 | 39.9 | 2300 | 3910 | 175.5 | 79.6 | 4590 | 7803 |

a. Charge sizes and ventilation rates shown in this table are based on R-32.

b. $(M - M_{VOL})$ is the amount of *refrigerant* charge that is removed by mechanical ventilation and is therefore not included in calculations to determine compliance with Section 7.2. $M$ and $M_{VOL}$ are as defined below.

**Table 7-2 *Lower Flammability Limit* Conversion Factor**

| *Refrigerant* Number | $C_{LFL}$ |
|---|---|
| R-32 | 1.00 |
| R-452B | 1.02 |
| R-454A | 0.92 |
| R-454B | 0.97 |
| R-454C | 0.95 |
| R-457A | 0.71 |

When the *refrigerant* charge necessary to be removed by ventilation is known, in order to be compliant with Section 7.2, an alternative method to determine $Q_{REQ}$ uses the following equations. This alternative method *shall* be used for all A2L *refrigerants* not *listed* in Table 7-2.

$$Q_{REQ} = \frac{M - M_{VOL}}{4 \times LFL} \times SF_{Vent} \quad \text{(I-P)}$$

$$Q_{REQ} = \frac{M - M_{VOL}}{4 \times LFL} \times SF_{Vent} \times 60 \quad \text{(SI)}$$

$$M_{VOL} = RCL \times V \times F_{OCC}$$

where

$Q_{REQ}$ = required minimum mechanical ventilation airflow rate, $ft^3/min$ ($m^3/h$)

$M$ = *refrigerant* charge of the largest *independent circuit* of the system, lb (kg)

$M_{VOL}$ = *refrigerant* charge permitted in the space

$RCL$ = *refrigerant concentration limit*, $lb/ft^3$ ($kg/m^3$)

$V$ = volume of space established in accordance with Section 7.3, $ft^3$ ($m^3$)

$F_{OCC}$ = *occupancy* adjustment factor. For all *occupancies* other than institutional, $F_{OCC}$ has a value of 1. For institutional *occupancies*, $F_{OCC}$ has a value of 0.5.

$LFL$ = *lower flammability limit*, $lb/ft^3$ ($kg/m^3$)

4 = assumed leak time (4 minutes)

$SF_{Vent}$ = safety factor, value of 2

60 = conversion of minutes to hours

b. *Mechanical ventilation *shall* be permitted to be continuous or activated by a *refrigerant detector*. Building fire and smoke systems may override this function.

1. **Continuous Ventilation.** Where continuous ventilation is provided, ventilation function *shall* be continuously verified per Section 7.6.4(b)(3).
2. ***Refrigerant Detector* Activated Ventilation.** Where ventilation is activated by a *refrigerant detector*, the *refrigerant detector shall* be in accordance with Section 7.6.5. Upon *refrigerant detector* activation, the mechanical ventilation *shall* be started and *shall* continue to operate for at least five minutes after the *refrigerant detector* has sensed a drop in the *refrigerant* concentration below the setpoint value. Ventilation function of *refrigerant detector* activated ventilation *shall* be verified in accordance with Section 7.6.4(b)(3) by a monthly self-test.
3. **Verification of Ventilation Function.** Ventilation function *shall* be verified by a method that confirms operation of the required fans. Upon detection of a ventilation system failure, *compressor*

operation *shall* be stopped, and a notification *shall* be provided. The notification *shall* be to an operator workstation through a building automation system or by a local audible alarm.

c. While the ventilation system is operating, *makeup air shall* be provided, and the volume of *makeup air shall not* exceed the volume of air being exhausted or transferred out of the space. Openings for *makeup air shall* be positioned to facilitate mixing of *makeup air* with leaked *refrigerant*. Inlets for *exhaust air* and inlets used to mechanically transfer air to another indoor location *shall* be located such that the bottom of the inlet is within 12 in. (30 cm) of the lowest elevation in the space where leaked *refrigerant* would be expected to accumulate.

d. The *refrigerant* concentration of an indoor *effective dispersal volume shall not* exceed the limit *specified* in Section 7.6.1.

e. In addition to the requirements of Section 7.6.3, there *shall* be no open-flame-producing devices that do not contain a flame arrestor, or hot surfaces exceeding 1290°F (700°C), installed within the space where the equipment is located.

f. Electric motors larger than 1 *hp* driving fans located in the airstream of the discharge side of the ventilation system *shall* be of the totally enclosed or hermetically sealed type.

g. Fan rotating elements *shall* be nonferrous or non-sparking, or the casing *shall* consist of or be lined with such material.

h. Ventilation fans *shall* be *listed* in accordance with UL 507[20] or UL 705[21].

[ … ]

***Note to Reviewers: The 2019 published edition of ANSI/ASHRAE Standard 15-2019 was modified by Addendum f to insert a new Informative Appendix A, "Explanatory Material," redesignated the published Informative Appendix A, "Informative References," to Informative Appendix B, "Informative References," and redesignated the published Normative Appendix B, "Normative References," to Section 14, "Normative References." To reduce confusion, this proposed addendum uses the revisions published in Addendum f as a baseline.***

***Modify Section 14 as follows. The remainder of Section 14 remains unchanged.***

## 14. NORMATIVE REFERENCES

[ … ]

20. UL. 2017. UL 507, *Standard for Electric Fans*, 10th Edition. Northbrook, IL: UL LLC.

21. UL. 2017. UL 705, *Power Ventilators*, 7th Edition. Northbrook, IL: UL LLC.

[ … ]

***Modify Informative Appendix A as follows. The remainder of Informative Appendix A remains unchanged.***

**(This appendix 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.)**

## INFORMATIVE APPENDIX A—EXPLANATORY MATERIAL

Sections of the standard with associated explanatory information in this appendix are marked with an asterisk "*" after the section number, and the associated appendix information is located in a corresponding section number preceded by "A".

[ … ]

**A7.3.2** When a refrigeration system does not have a *refrigerant detector*, there will not necessarily be circulation

(or ventilation) airflow. Thus, systems in accordance with Section 7.3.2 (no *refrigerant* detection and/or no continuous airflow), must use the worst-case distribution of leaked *refrigerant*.

**A7.3.3** For refrigeration systems that do have a *refrigerant detector*, but does not have ventilation, the airflow will mix leaked *refrigerant* throughout the spaces connected to ductwork, therefore the volume of all rooms connected by ductwork is used.

**A7.3.4** For refrigeration systems with *refrigerant* detection and ventilation, circulation will distribute leaked *refrigerant* throughout the rooms connected to the ductwork, as well as locations connected to the ventilation.

**A7.6.4(b)** The continuous ventilation system can be shut down for short periods of time during service and maintenance of the ventilation system. Fan failure switches can be used to determine that the ventilation fan is not operating properly. Examples of fan failure switches include the following:

i. Hall effect switch on the fan shaft or blade pass
ii. pressure switch across the fan
iii. sail switch on the outlet of the fan
iv. on direct drive, a Hall effect switch on the motor shaft
v. on direct drive ECM and similar, a digital output indicating the motor is not turning, current draw, etc.