**BSR/ASHRAE Addendum k**
**to ANSI/ASHRAE Standard 15-2024**

**First Public Review Draft**

# Proposed Addendum k to Standard 15-2024, Safety Standard for Refrigeration Systems

**First Public Review (June 2025)**
**(Draft shows Proposed Changes to Current Standard)**

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## FOREWORD

*This proposed Addendum revises ANSI/ASHRAE Standard 15-2024 to incorporate elevation adjusted values for RCL and LFL, introduced as $RCL_e$ and $LFL_e$, to modify permissible charge allowances in connected spaces, as well as required minimum ventilation opening and minimum airflow requirements for installations based on elevation relative to mean sea level. The current standard does not address elevation adjustment, which means calculated values such as EDVC will remain the same at sea level and at 10,000 ft above sea level. This addendum introduces elevation adjustment in the newly inserted Section 6.4 by providing a table that can be used to determine adjustment factor based on building ground level elevation or by direct means of calculation using the altitude adjustment equation taken from ANSI/ASHRAE Standard 34, an option being given to the reader of this standard.*

***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 k to Standard 15-2024

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

### 3. DEFINITIONS

[ … ]

**3.2 Acronyms, Abbreviations, and Initialisms**

*RCL* *RCL* expressed as ppm v/v

$RCL_M$ *RCL* expressed as lb/1000 ft³ (g/m³)

$RCL_e$ Elevation adjusted $RCL_M$ expressed as lb/1000 ft³ (g/m³)

*LFL* *LFL* expressed as ppm v/v

$LFL_M$ *LFL* expressed as lb/1000 ft³ (g/m³)

$LFL_e$ Elevation adjusted $LFL_M$ expressed as lb/1000 ft³ (g/m³)

***Modify Section 6 as follows. The remainder of Section 6 remains unchanged.***

### 6. REFRIGERANT SAFETY CLASSIFICATION AND ELEVATION ADJUSTMENT

[ … ]

***6.4. Elevation Adjustment**

The elevation adjusted *RCL* ($RCL_e$) value *shall* be calculated using Equation 6-1a or 6-1b and the elevation adjusted *LFL* ($LFL_e$) *shall* be calculated using Equation 6-1c or 6-1d. For elevations less than or equal to 2000 ft (610 m), $RCL_e = RCL_M$, and $LFL_e = LFL_M$. Interpolation between rows of Table 6-1 *shall not* be permissible.

Where elevation adjustment of *refrigerant* charge is *specified*, compliance *shall not* be achieved by reducing the equipment *refrigerant* charge to less than that shown in the manufacturer's installation instructions.

***Informative Note:*** Under no circumstances is it acceptable to install equipment with a *refrigerant* charge less than the manufacturer requires. If compliance cannot be achieved with the equipment charged to this level, the *effective dispersal volume* must be increased, or equipment with a compliant charge must be selected.

$$RCL_e = RCL_M \times AF \quad (6\text{-}1a)$$

$$RCL_e = RCL_M \times [1 - (b \times h)] \quad (6\text{-}1b)$$

$$LFL_e = LFL_M \times AF \quad (6\text{-}1c)$$

$$LFL_e = LFL_M \times [1 - (b \times h)] \quad (6\text{-}1d)$$

where

$RCL_M$ = *RCL* expressed as lb/1000 ft³ (g/m³)

$LFL_M$ = *LFL* expressed as lb/1000 ft³ (g/m³)

AF = Adjustment Factor for elevation as given in Table 6-1

$b = 2.42 \times 10^{-5}$ for ft ($7.94 \times 10^{-5}$ for m)

h = elevation above mean sea level in ft (m)

Elevation (h) *shall* be determined as the highest part of the surface of the ground next to the building in which the *refrigeration system* is installed, relative to mean sea level. Where elevation is measured in feet, it is rounded to the nearest multiple of 100 ft. Where elevation is measured in meters, it is rounded to the nearest multiple of 50 m.

Table 6-1 Elevation Adjustment Factor

| Elevation[a] | | Adjustment Factor AF |
|---|---|---|
| ft | m | |
| h ≤ 2000 | h ≤ 610 | 1.00 |
| 2000 < h ≤ 4000 | 610 < h ≤ 1220 | 0.90 |
| 4000 < h ≤ 6000 | 1220 < h ≤ 1830 | 0.86 |
| 6000 < h ≤ 8000 | 1830 < h ≤ 2440 | 0.81 |
| 8000 < h ≤ 10000 | 2440 < h ≤ 3050 | 0.76 |
| 10000 < h ≤ 12000 | 3050 < h ≤ 3660 | 0.71 |
| 12000 < h ≤ 14000 | 3660 < h ≤ 4265 | 0.66 |
| h >14000 | h > 4265 | 0.61 |

[a]Elevation above mean sea level

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

## 7. RESTRICTIONS ON REFRIGERANT USE

[ … ]

### 7.2.3 Volume Calculations.

[…]

**7.2.3.2.1 Natural Ventilation Opening for Group A1 Refrigerants.** The minimum size of the opening for a Group A1 *refrigerant* ($A_{vent}$) *shall* be calculated using Equation 7-1a or 7-1b:

$$A_{vent} = \frac{m_{rel} - m_{room}}{\sout{RCL}RCL_e \times 0.833} \times \sqrt{\frac{A}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad (7\text{-}1a\ [I\text{-}P])$$

$$A_{vent} = \frac{m_{rel} - m_{room}}{\text{~~RCL~~}RCL_e \times 208} \times 1000 \times \sqrt{\frac{A}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad \text{(7-1b [SI])}$$

where

$A_{vent}$ = minimum area of a permanent opening, ft$^2$ (m$^2$)

$m_{rel}$ = *releasable refrigerant charge*, lb (kg)

$m_{room}$ = allowable *refrigerant* charge of an individual room, lb (kg); ($V_{eff}$, used to calculate *EDVC*, is the volume of an individual room.)

~~*RCL = refrigerant concentration limit*, lb/1000 ft$^3$ (kg/m$^3$)~~

*RCL$_e$* = elevation adjusted *refrigerant concentration limit*, lb/1000 ft$^3$ (g/m$^3$) calculated per Section 6.4

$A$ = actual area of the individual room, ft$^2$ (m$^2$)

$M_a$ = *relative molar mass* of air, 29.0, dimensionless

$M_r$ = *relative molar mass* of the *refrigerant*, dimensionless

$g$ = acceleration due to gravity, 32.2 ft/s$^2$ (9.81 m/s$^2$)

0.833 = I-P conversion factor

208 = SI conversion factor

**7.2.3.2.2 Natural Ventilation Opening for Group A2L, A2, or A3 Refrigerants.** The minimum size of the opening for a Group A2L, A2, or A3 *refrigerant* ($A_{vent}$) *shall* be calculated using Equation 7-2a or 7-2b:

$$A_{vent} = \frac{m_{rel} - m_{room}}{\text{~~LFL~~}LFL_e \times 0.417} \times \sqrt{\frac{A}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad \text{(7-2a [I-P])}$$

$$A_{vent} = \frac{m_{rel} - m_{room}}{\text{~~LFL~~}LFL_e \times 104} \times 1000 \times \sqrt{\frac{A}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad \text{(7-2b [SI])}$$

where

$A_{vent}$ = minimum area of a permanent opening, ft$^2$ (m$^2$)

$m_{rel}$ = *releasable refrigerant charge*, lb (kg)

$m_{room}$ = allowable *refrigerant* charge of an individual room, lb (kg); ($V_{eff}$, used to calculate *EDVC*, is the volume of an individual room.)

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

*LFL$_e$* = elevation adjusted *lower flammability limit*, lb/1000 ft$^3$ (g/m$^3$) calculated per Section 6.4

$A$ = actual area of the individual room, ft$^2$ (m$^2$)

$M_a$ = *relative molar mass* of air, 29.0, dimensionless

$M_r$ = *relative molar mass* of the *refrigerant*, dimensionless

$g$ = acceleration due to gravity, 32.2 ft/s$^2$ (9.81 m/s$^2$)

0.417 = I-P conversion factor

104 = SI conversion factor

**7.3 Refrigerant System Charge Limits.**

[…]

**7.3.1 EDVC Calculation.** The maximum charge permitted for an *effective dispersal volume shall* be calculated using Equation 7-3a or 7-3b, except for *refrigeration systems* covered by Section 7.3.1.1:

$$EDVC = \text{~~RCL~~}RCL_e \times V_{eff} \times F_{occ} \times 1000 \quad \text{(7-3a [I-P])}$$

$$EDVC = \text{~~RCL~~}RCL_e \times V_{eff} \times F_{occ}/1000 \quad \text{(7-3b [SI])}$$

where

$EDVC$ = *effective dispersal volume charge*, lb (kg)

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

*RCL$_e$* = elevation adjusted *refrigerant concentration limit*, lb/1000 ft$^3$ (g/m$^3$) calculated per Section 6.4

$V_{eff}$ = *effective dispersal volume*, ft³ (m³), established using Sections 7.2.1 through 7.2.3
$F_{occ}$ = *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.)

[…]

**7.5 Additional Restrictions**

[…]

**7.5.1.2 Corridors and Lobbies.** *Refrigeration systems* in a public *corridor* or *lobby shall* comply with the following:
a. *Refrigeration systems shall* be limited to *unit systems*.
b. The *refrigerant* charge *shall* be limited based on the *refrigerant* charge quantity as *specified* in Section 7.3.
c. *Refrigeration systems* containing Class 2L, 2, or 3 *refrigerants shall* be *listed*, and the *refrigerant* charge *shall* be limited for each *unit system*, calculated in accordance with Equation 7-7a or 7-7b:

$$m_s = 0.106 \times ~~LFL~~LFL_e \quad \text{(7-7a [I-P])}$$

$$m_s = 3 \times ~~LFL~~LFL_e \times 0.001 \quad \text{(7-7b [SI])}$$

where
$m_s$ = *system refrigerant charge*, lb (kg)
~~*LFL = lower flammability limit* per ASHRAE Standard 34, lb/1000 ft³ (kg/m³)~~
$LFL_e$ = elevation adjusted *lower flammability limit*, lb/1000 ft³ (g/m³) calculated per Section 6.4
0.106 = a constant with units of 1000 ft³
3 = a constant with units of m³

[…]

**7.6 High-Probability Air Conditioners, Heat Pumps, and Dehumidifiers Using Group A2L Refrigerants.** Air conditioners, *heat pumps*, or dehumidifiers classified as *high-probability systems*, and within the scope of UL 484[11] or UL 60335-2-40[5]/CSA C22.2 No. 60335-2-40,[6] *shall* comply with this section.

**7.6.1 Refrigerant Quantity Limits.** The maximum *refrigerant* charge of any *independent circuit* of each *refrigeration system shall* be as *specified* in Sections 7.6.1.1 and 7.6.1.2.

**7.6.1.1* Refrigeration Systems with Air Circulation.** Where an air conditioner, *heat pump*, or dehumidifier classified as a *high-probability system* and using Group A2L *refrigerants* has either

[…]

$$EDVC = V_{eff} \times ~~LFL~~LFL_e \times \text{CF} \times F_{occ} \times 0.001 \quad \text{(7-8)}$$

where
*EDVC* = *effective dispersal volume charge*, lb (kg)
$V_{eff}$ = *effective dispersal volume*, ft³ (m³)
~~*LFL = lower flammability limit*, lb/ft³ (kg/m³)~~
$LFL_e$ = elevation adjusted *lower flammability limit*, lb/1000 ft³ (g/m³) calculated per Section 6.4
CF = concentration factor, value of 0.5
$F_{occ}$ = *occupancy* adjustment factor; (For all *occupancies* other than *institutional occupancies*, $F_{occ}$ has a value of 1. For *institutional occupancies*, $F_{occ}$ has a value of 0.5.)

**7.6.1.2* Other Refrigeration Systems.** For any *refrigeration system* not meeting the requirements of Section 7.6.1.1, the *refrigerant* charge of the largest *independent circuit* of the system (*ms*) *shall not* exceed the value from Equation 7-9a:

$$EDVC = M_{def} \times F_{LFL} \times F_{occ} \times AF \quad \text{(7-9a)}$$

where

*EDVC* = *effective dispersal volume charge*, lb (kg)

$M_{def}$ = *refrigerant* charge from Table 7-1 (lb) or Table 7-2 (kg)

$F_{LFL}$ = *LFL* conversion factor from Table 7-3, or for *refrigerant designations* not in Table 7-3, use Equation 7-9b

AF = Adjustment Factor for elevation as given in Table 6-1, AF = 1.0 if elevation (h) is less than or equal to 2000 ft (610 m)

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

$$F_{LFL} = \left(\frac{\text{~~LFL~~}LFL_M}{LFL_{R-32}}\right)^{1.25} \quad (7\text{-}9b)$$

where

~~*LFL = lower flammability limit*, lb/1000 ft³ (g/m³)~~

*$LFL_M$ = lower flammability limit*, lb/1000 ft³ (g/m³)

$LFL_{R\text{-}32}$ = *lower flammability limit* of R-32, lb/1000 ft³ (g/m³)

**7.6.4* Mechanical Ventilation.** Mechanical ventilation for *refrigerant* safety mitigation *shall* comply with this section. Where a *ventilated enclosure* is provided to control a *refrigerant* leak, the *refrigeration system* and *ventilated enclosure shall* be *listed* and installed in accordance with UL 60335-2-40 5/CSA C22.2 No. 60335-2-40 6 and *shall not* be required to comply with this section.

[…]

When the *refrigerant* charge necessary to be removed by ventilation is known, in order to be compliant with Section 7.3, an alternative method to determine $Q_{req}$ uses Equation 7-11a or 7-11b. This alternative method *shall* be used for all A2L *refrigerants* not *listed* in Table 7-5.

$$Q_{req} = \frac{m_s - EDVC}{4 \times \text{~~LFL~~}LFL_e} \times 1000 \times SF_{vent} \quad (7\text{-}11a\ [I\text{-}P])$$

$$Q_{req} = \frac{m_s - EDVC}{4 \times \text{~~LFL~~}LFL_e} \times 1000 \times SF_{vent} \times 60 \quad (7\text{-}11b\ [SI])$$

where

$Q_{req}$ = required minimum mechanical ventilation airflow rate, ft³/min (m³/h)

$m_s$ = largest *system refrigerant charge* from *independent circuit*, lb (kg)

*EDVC* = *effective dispersal volume charge*, lb (kg)

~~*LFL = lower flammability limit*, lb/ft³ (kg/m³)~~

*$LFL_e$* = elevation adjusted *lower flammability limit*, lb/1000 ft³ (g/m³) calculated per Section 6.4

4 = assumed leak time (4 minutes)

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

60 = conversion of minutes to hours

[…]

**7.7* High-Probability Commercial Refrigeration Systems Using Group A2L Refrigerants.** *High-probability systems* using Group A2L *refrigerants* for commercial refrigeration applications within the scope of UL 60335-2-89 [7]/CSA C22.2 No. 60335-2-89 [8] *shall* comply with this section.

[…]

**7.7.5 Compressors and Pressure Vessels 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 maximum *refrigerant* charge calculated in accordance with Section 7.3, provided a mechanical ventilation system is used to prevent exceeding the ~~*RCL*~~*$RCL_e$* and all of the following provisions are met:

***Modify Section 8 as follows. The remainder of Section 8 remains unchanged.***

**8. INSTALLATION RESTRICTIONS**

[ … ]

**8.11 Machinery Room, Special Requirements, A2L and B2L.** In cases *specified* in Section 7.4, and when a *refrigeration system* is located indoors, *machinery rooms shall* comply with Sections 8.11.1 through 8.11.10 in addition to Sections 8.9.1 through 8.9.4.

[…]

**8.11.9** *Refrigerant detectors* required by Section 8.11.8 *shall* meet all of the following conditions:

[…]

d. The *refrigerant detector shall* have a set point not greater than the applicable *refrigerant concentration limit* (*RCL*) value as published in ASHRAE Standard 34.3 The applicable *RCL* value *shall* be the lowest *RCL* value for any *refrigerant designation* in the *machinery room*. For *refrigerants* that do not have a published *RCL* value in Standard 34, use a value determined in accordance with the *RCL* as defined by Standard 34 where *approved* by the AHJ. When the *refrigerant concentration limit* (*RCL*) is adjusted for elevation, the set point of the *refrigerant detector shall not* be greater than the elevation adjusted *refrigerant concentration limit* ($RCL_e$) for any *refrigerant designation* used in the *machinery room*.

[…]

**INFORMATIVE APPENDIX A**
**EXPLANATORY MATERIAL**

[ … ]

**Section 6.4**

Elevation can be determined using a nationally recognized source (for example, the U.S. Geological Survey National Map, https://apps.nationalmap.gov/viewer/, or Google Earth, earth.google.com), an altimeter, or elevation certificates for the building, if available.