Seminar 28: Updates to ASHRAE 15 and UL 60335-2-40 and UL 60335-2-89

Updates to ASHRAE Standard 15, 2024 Edition, for Flammable Refrigerants

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Learning Objectives

- **Identify the GWP limit for Commercial Refrigeration, Air-Conditioning**
- Explain how to calculate charges for systems utilizing A2L refrigerants
- Identify the key mitigation for HVAC&R
- **Identify the industry impact of the EPA's Technology Transition and related SNAP Rules**

Acknowledgements

Potential Bias

I am an employee of the Chemours Company

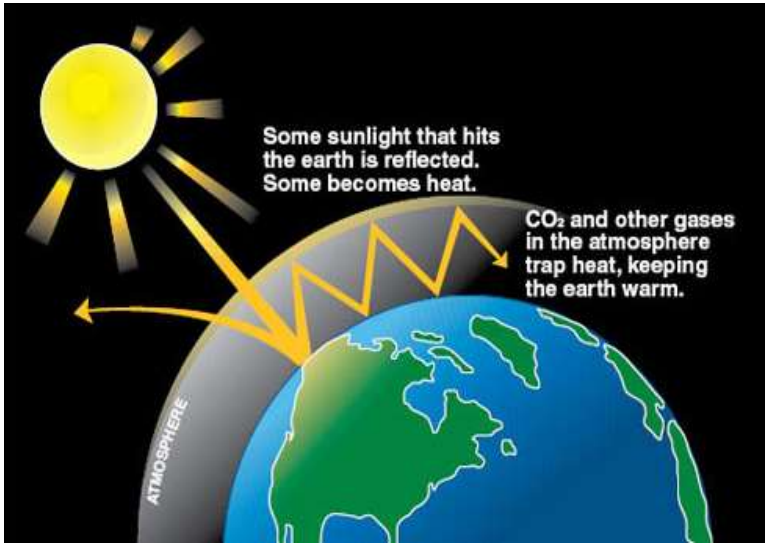
Discussion Topics

- Flammable Refrigerants Background
- Regulatory Update
- ASHRAE Standard 15 Addenda (2022 Edition)*

*Disclaimer: Some images and text are taken directly from ASHRAE Standard 15 (2022) and should not be copied

Environmental Considerations

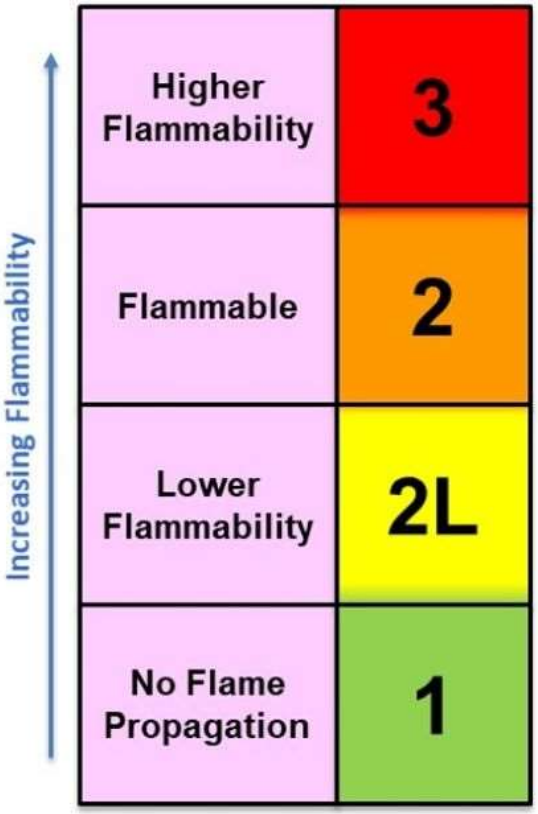
Global Warming Potential (GWP)



Phase DOWN of HFCs

(Non-ozone Depleting – High GWP)

Kigali Amendment



Focus on expanding usage

Comparison of Flammability Parameters

- **More favorable flammability parameters can lead to lower risk!**

ASHRAE #	R-290 (Propane)	R-32	R-1234yf	Risk Trend
Safety Group	A3	A2L	A2L	
LFL (g/m^3)	38	307	289	LFL ↑, Risk ↓
MIE (mJ)	0.25	30 – 100	> 5,000	MIE ↑, Risk ↓
S_u (cm/s)	46	6.7	1.5	S_u ↓, Risk ↓
HOC (kJ /g)	46.3	9.4	10.7	HOC ↓, Risk ↓

Related EPA Activities

- SNAP Rule 23 (May 6, 2021 – Residential & Light Commercial ACs & HPs)
  - List 6 A2Ls as *Acceptable, Subject to Use Conditions*
- SNAP Rule 25 (April 28, 2023 – AC Chillers & Residential DHs)
  - List 6 A2Ls as *Acceptable, Subject to Use Conditions*
- SNAP Rule 26 (June 13, 2024 – Refrigeration End-Uses)
  - List A2Ls as *Acceptable, Subject to Use Conditions*
  - Lists R-290 as *Acceptable, Subject to Use Conditions*
- Technology Transitions Rule
  - Sets 700 GWP limit for most stationary AC / HP applications starting 01/01/2025
    - Compliance date of 01/01/2026 for variable refrigerant flow systems
  - Sets 150 – 700 GWP limits for most refrigeration end-uses
    - Compliance dates vary from 01/01/2025 – 01/01/2028

Addenda to ASHRAE 15 (2022 Edition)

Addenda to the 2022 Edition of ANSI/ASHRAE Standard 15	
Addendum a – Overpressure protection	Addendum m – Molar Mass
Addendum b – Pressure Relief Devices	Addendum o – Machinery Room Ventilation
Addendum c – ting vs. tion	Addendum p – Normative Reference Updates
Addendum e – Human Comfort	Addendum q – System Clarification
Addendum f – General vs. Specific	Addendum r – Refrigerant Handling, Transportation, & Storage
Addendum g – Refrigerant Detection System (RDS)	**Addendum t – Group Controllers (Data Centers)**
Addendum h – EDVC Conversion Factors	Addendum v – Pressure Vessel Definition
Addendum i – Vacuum Pressure Requirements	**Addendum w – Machinery Room Special Requirements (A2L & B2L)**
Addendum l – EDVC Clarification	Addendum ab – Housing Other Equipment in Machinery Rooms

Addendum e – Human Comfort

- Removed the terms ***Human Comfort*** and ***Other Than Human Comfort***
  - High Probability Air Conditioners, Heat Pumps, and Dehumidifiers
  - High Probability Systems Other Than Air Conditioners, Heat Pumps, and Dehumidifiers

- **Section 7.6**
  - **Clarified as High Probability ACs, HPs, & DHs using Group A2L refrigerants**
  - **Within the scope of UL 484 or UL 60335-2-40 / CSA C22.2 No. 60335-2-40**

- **Section 7.7**
  - **Clarified as High Probability ComRef Systems using Group A2L refrigerants**
  - **Within the scope of UL 60335-2-89 / CSA C22.2 No. 60335-2-89**

- **Section 7.8**
  - **Clarified as High Probability ComRef Systems using Group A2 refrigerants**
  - **Within the scope of UL 60335-2-89 / CSA C22.2 No. 60335-2-89**

Addendum g – Refrigerant Detection System (RDS)

- Section 7.6 (High Probability ACs, HPs, & DHs using Group **A2L** refrigerants)
  - Clarifies RDS requirements upon failure of a self-diagnosis check

7.6.2.4* The refrigerant detection system shall comply with the following:

[…]

f. Upon failure of a self-diagnostic check, energize *air circulation* fans of the equipment.

g. Where required per Section 7.6.4, and upon failure of a self-diagnostic check, activate the mechanical ventilation system serving the space or *connected spaces*.

[…]

Addendum h – EDVC Conversion Factors

– **Systems w/o air circulation use Table 7-1 or 7-2 (based on UL 60335-2-40)**

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

where

$EDVC$ = *effective dispersal volume charge*, ft^3 (m^3)

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

F_{LFL} = *LFL* conversion factor from Table 7-3

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.)

Table 7-2 Refrigerant Charge Limit (M_{def}), kg (SI)

	Height, m							
Floor Area, m^2	≤0.60	1.00	1.40	1.80	2.00	2.20	2.45	≥2.74
5	1.8	1.8	1.8	18	1.8	1.8	1.9	2.1
10	1.8	1.8	2.1	2.8	3.1	3.4	3.7	4.2
15	1.8	2.2	3.1	4.0	4.4	4.8	5.4	6.0
20	1.8	2.5	3.6	4.6	5.1	5.6	6.2	7.0
25	1.8	2.8	4.0	5.1	5.7	6.3	7.0	7.8
30	1.9	3.1	4.4	5.6	6.2	6.9	7.6	8.5
35	2.0	3.4	4.7	6.1	6.7	7.4	8.2	9.2
40	2.2	3.6	5.0	6.5	7.2	7.9	8.8	9.9
45	2.3	3.8	5.3	6.9	7.6	8.4	9.4	10.5

Table 7-3 LFL Conversion Factor

Refrigerant	F_{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

Addendum h – EDVC Conversion Factors

– **Systems w/o air circulation use Table 7-1 or 7-2 (based on UL 60335-2-40)**

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

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

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.)

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

where

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

$LFL_{R\text{-}32}$ = *lower flammability limit* of R-32, lb/1000 ft^3 (g/m^3)

Table 7-3 LFL Conversion Factor

Refrigerant	F_{LFL}
R-32	1.00
R-452B	1.02
R-454A	0.90
R-454B	0.96
R-454C	0.94
R-457A	0.65

Addendum I – EDVC Clarification

- **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:

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

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

where

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

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

V_{eff} = *effective dispersal volume*, ft^3 (m^3), 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.)

Addendum I – EDVC Clarification

- **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:

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

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

where

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

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

V_{eff} = *effective dispersal volume*, ft^3 (m^3), 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.)

7.3.1.1 EDVC Calculation for High-Probability Air Conditioners, Heat Pumps, and Dehumidifiers Using Group A2L Refrigerants. The maximum charge permitted for an *effective dispersal volume shall* be calculated according to Section 7.6 for air conditioners, *heat pumps*, or dehumidifiers classified as a *high-probability system* and using Group A2L *refrigerants*.

Addendum t – Group Controllers (Data Centers)

- **3.1 Defined Terms**

[…]

group controller: an electrical or electronic control system that monitors and responds to distinct signals from two or more *refrigeration systems*.

[…]

safety shutoff valve: an automatically controlled *refrigerant* valve for the purpose of limiting the amount of *refrigerant* released into a space when a *refrigerant* leak is detected.

[…]

Addendum t – Group Controllers (Data Centers)

7.3.4.4 Release Mitigation Controls. […]

h. *Safety shutoff valves shall* be accessible to authorized personnel.

i. Where applied to standby or redundant *refrigeration systems*, *safety shutoff valves shall* be in the closed position for both standby mode and off mode.

[…]

7.6.2.5* Mitigation Action Requirements. […]

Where *safety shutoff valves* have the ability to be automatically reset, it *shall not* be permissible for the *safety shutoff valves* to be automatically reset until the *refrigerant detection system* has not detected a concentration of *refrigerant* above the set point of Section 7.6.2.4(a) for at least two (2) hours.

[…]

Addendum t – Group Controllers (Data Centers)

7.6.2.6* Group Controllers. Utilization of a *group controller* for multiple *refrigeration systems* serving the same space or *connected spaces shall* comply with the following:

a. The *refrigerant detection system* for each *refrigeration system shall* provide a signal to notify the *group controller* when *mitigation actions* of Section 7.6.2.5 are required.

b. Where a *group controller* determines that a signal is provided by one or more specific *refrigeration systems*, it *shall* be permissible for the *group controller* to require only those specific *refrigeration systems* activate or deactivate *mitigation actions* required by Section 7.6.2.5.

c. Where a *group controller* cannot determine the specific source of a signal, the *group controller shall* require all *refrigeration systems* serving the same space or *connected spaces* to activate *mitigation actions* in accordance with Section 7.6.2.5.

d. A *group controller shall not* deactivate *mitigation actions* where a *refrigerant detection system* outputs a signal to require *refrigerant detector* replacement.

Addendum w – Machinery Room Special Requirements (A2L & B2L)

8.11.6 When any *refrigerant* of Groups A2, A3, B2, or B3 are used, the *machinery room shall* be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with the *National Electric Code*® [4] (NFPA 70). When the only flammable *refrigerants* used are from Group A2L or B2L, the *machinery room shall* comply with both Section 8.11.6.1 for ventilation and Section 8.11.6.2 for *refrigerant* detection, or *shall* be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with the NFPA 70.

8.11.6 Where any *refrigerant* of Groups A2, A3, B2, or B3 are used, the *machinery room shall* be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with the *National Electric Code*® (NFPA 70).[4]

Where flammable *refrigerants* only from Groups A2L or B2L are used, the *machinery room shall* meet one of the following requirements:

a. Be provided with ventilation per Section 8.11.6.1 and *refrigerant* detection per Section 8.11.6.2.

b. Be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70, and be provided with ventilation per Section 8.9.6 and *refrigerant* detection per Section 8.11.6.2. Compliance with Section 8.11.11 *shall not* be required.

Conclusion

- Extensive changes in 2024 edition of ASHRAE Standard 15
  - Many address the use of flammable refrigerants
- Reviewing the addenda provides helpful context
- Latest research considered during development process
- Safety and innovation never stop

Questions

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