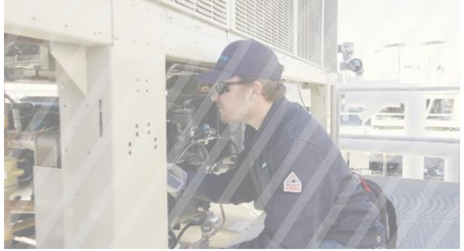

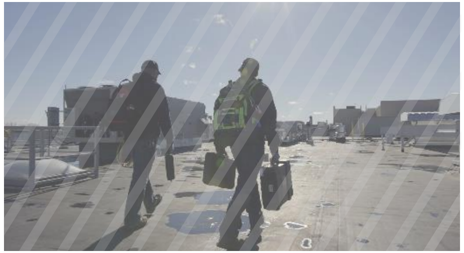

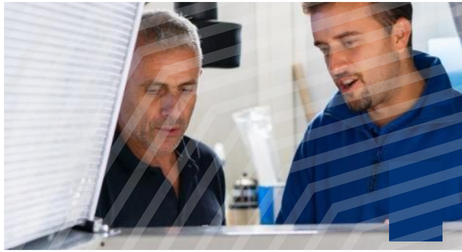

ASHRAE Standards 15 and 34

Preparing for A2L Refrigerants

Sharon Haeg, HVAC Systems Business Development Manager

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- Always consult your state & local codes, which may take precedence over standards like ASHRAE Standards 15, 34, or other standards which vary in adoption, complete or partial, by state. Also note that a state may adopt a different year of the standard than the latest version.
- The local Authority Having Jurisdiction (AHJ) has the final authority in interpreting code requirements. When in doubt, contact the AHJ.

Agenda to Address Common Questions

1. Regulations and standards driving changes for equipment

2. What is being done to ensure A2L refrigerants can be safely used?

3. What do I need to do to prepare?

   - Design requirements
   - Refrigerant detection / control signals
   - Ventilation
   - Refrigerant piping

AIM Act: Law Passed Dec. 2020 | EPA Rulemaking Status

EPA

The AIM Act gives authority to the EPA to phase down HFC refrigerants in the US

Old news: EPA must write rules to *phase down* production and consumption of bulk HFCs to 15% of baseline, maximize reclamation, minimize releases from equipment and facilitate transition through sector-based restrictions

PHASEDOWN

via CO2eq Allocations of Bulk HFCs

(Supply Side constraints)

TECHNOLOGY TRANSITIONS

Sector based controls

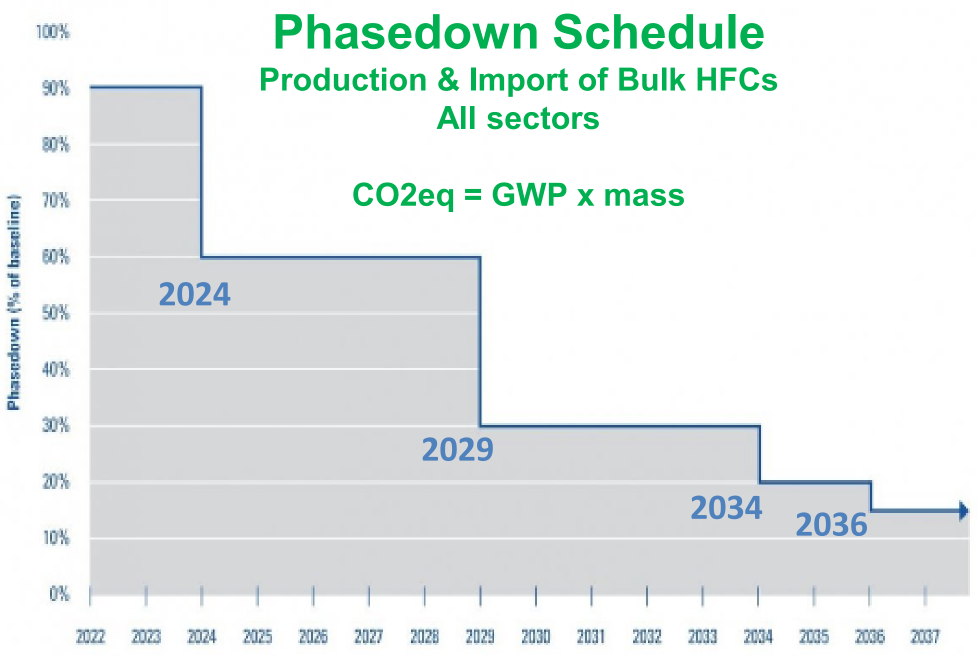
SNAP restrictions

REFRIGERANT MANAGEMENT

Minimizing leaks

Maximizing recovery & reclamation

AIM Act: EPA Phasedown and Allocations



CO2eq Phasedown

- Baseline over 300 million metric tonnes CO2 equivalency
- Phases down creating supply shortage of HFCs

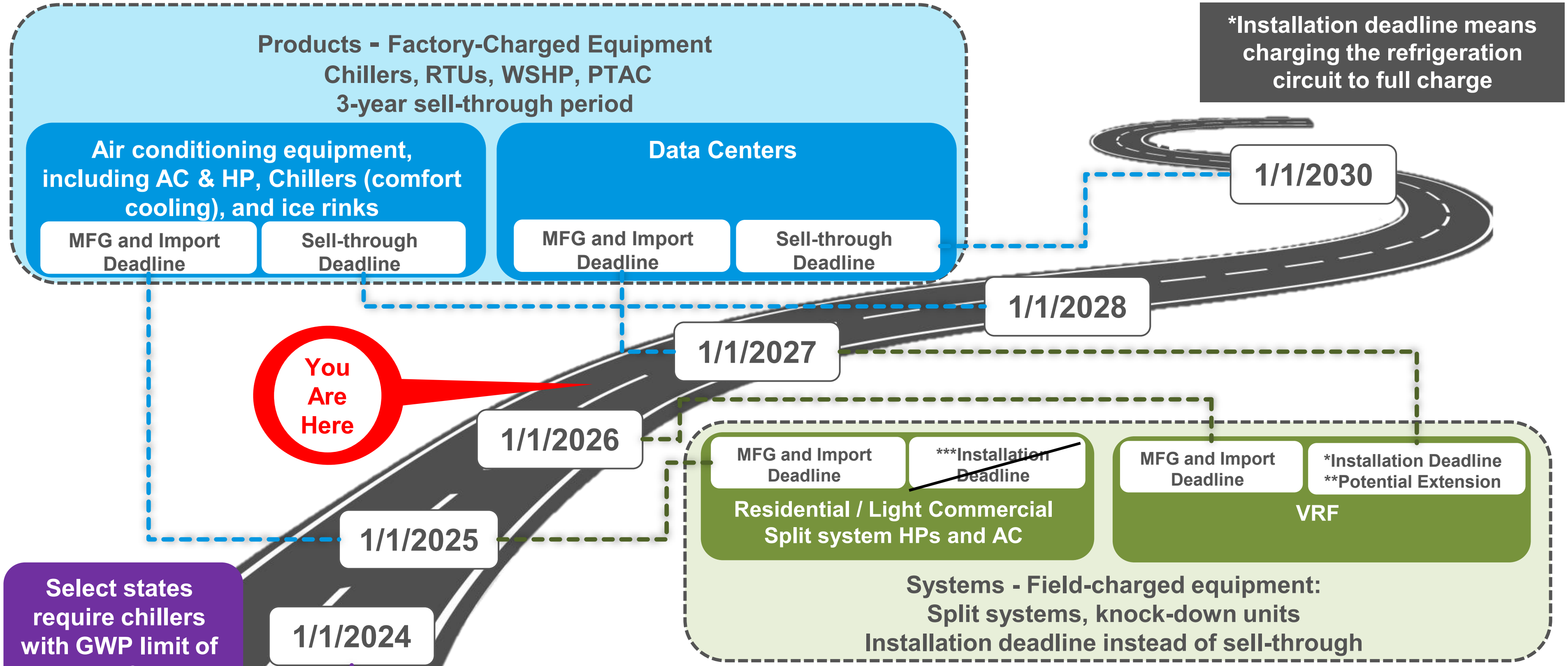
Not refrigerant specific – not a phaseout

- All bulk virgin HFCs in all sectors
- Produced in USA and imported

Existing equipment may be serviced

- Installed base can be serviced
- Will need to transition to lower GWP refrigerants

AIM Act: EPA Technology Transition



**For projects that were issued a building permit which approved the use of an HFC or blend containing an HFC in a VRF system prior to October 5, 2023, installation is allowed until January 1, 2028.

***Installation deadline for Residential / Light Commercial removed per Final Rule May 2026.

Applicable ASHRAE Standards – 15 and 34

Define Refrigerant Classes and Safety Requirements

- The standards are referenced by, or adopted in part/whole, or copied into various building codes
  - National model building codes are then adopted by individual jurisdictions
  - International Mechanical Code (IMC)
  - International Fire Code (IFC)
  - Uniform Mechanical Code (UMC)
- State/Local Building Codes
- Published every 3 years
- Note: Canada uses CSA B52 instead of ASHRAE 15


ASHRAE
STANDARD

ANSI/ASHRAE Standard 34-2022
(Supersedes ANSI/ASHRAE Standard 34-2019)
Includes ANSI/ASHRAE addenda listed in Appendix J

Designation and Safety Classification of Refrigerants

ASHRAE
STANDARD

ANSI/ASHRAE Standard 15-2022
(Supersedes ANSI/ASHRAE Standard 15-2019)
Includes ANSI/ASHRAE addenda listed in Appendix G

Safety Standard for Refrigeration Systems

See Informative Appendix G for approval dates by ASHRAE and the American National Standards Institute.

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ANSI

Agenda to Address Common Questions

1 Regulations and standards driving changes for equipment

2 What is being done to ensure A2L refrigerants can be safely used?

3 What do I need to do to prepare?

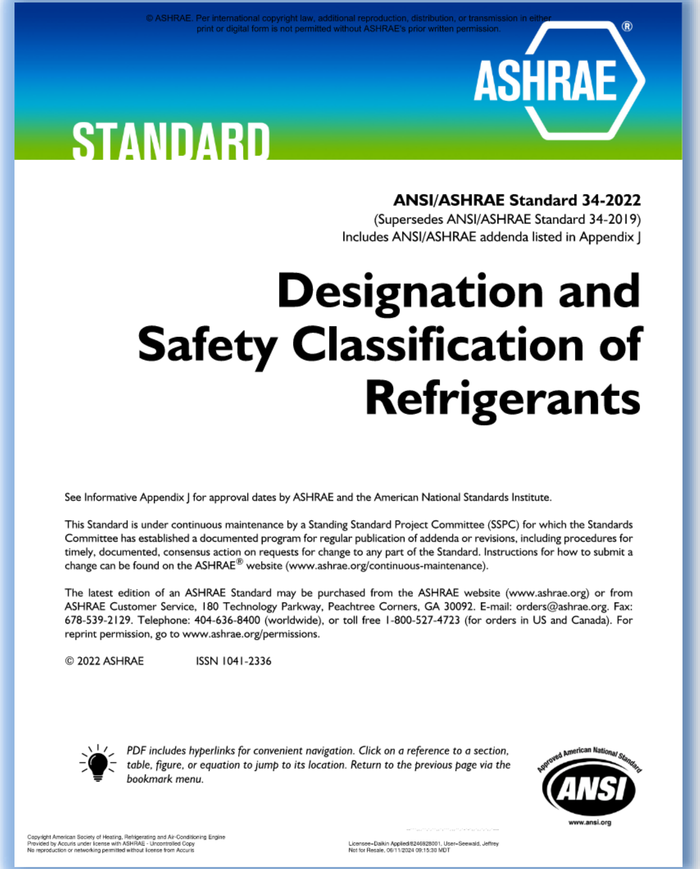
- Design requirements
- Refrigerant detection / control signals
- Ventilation
- Refrigerant piping

ASHRAE Standard 34-2022

Designation and Safety Classification of Refrigerants

ASHRAE Standard 34 describes a shorthand way of naming refrigerants, and it assigns safety classifications and refrigerant concentration limits based on toxicity and flammability data.

- Numbering and designation of refrigerants
- Safety group classifications
- Refrigerant concentration limits & other data



ASHRAE

STANDARD

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ASHRAE Standard 34 Basics – Safety Groups

Flammability + Toxicity = Safety Group

Flammability	Lower Toxicity	Higher Toxicity
Class 3 Higher flammability	A3	B3
Class 2 Flammable	A2	B2
Class 2L Lower flammability	A2L	B2L
Class 1 No flame propagation	A1	B1

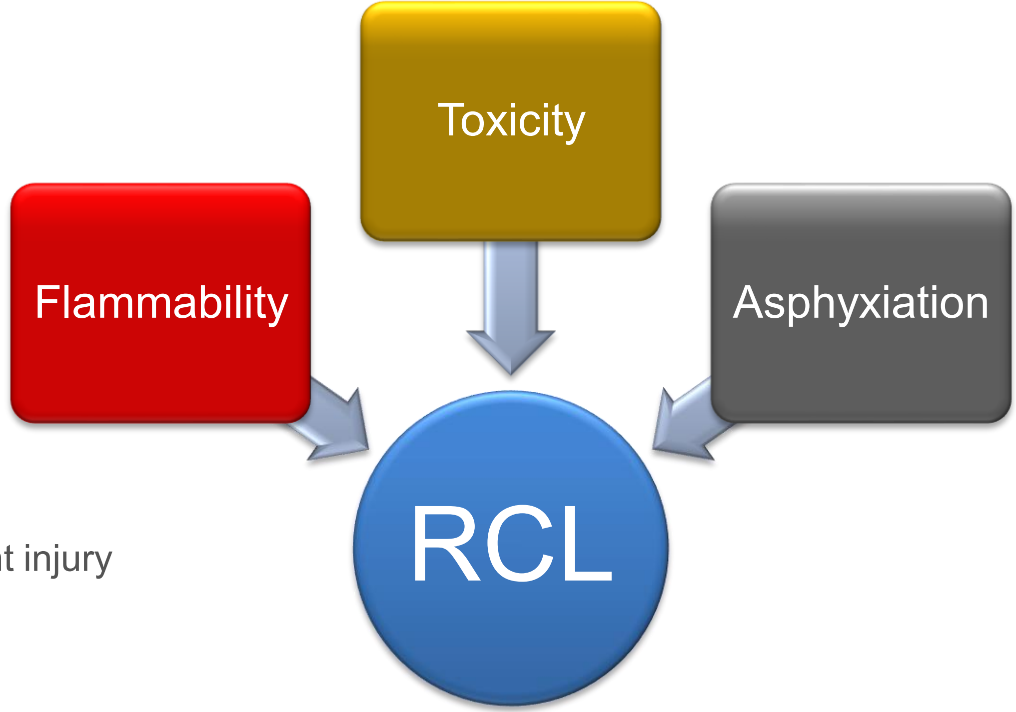
Toxicity →

ASHRAE Standard 34 Basics: RCL

Refrigerant Concentration Limit

Establishes maximum allowable concentration of refrigerant based on worst case (lowest value) of:

- Flammability risk: FCL
  - With factor of safety, FCL = 25% of LFL
- Acute toxicity risk: ATEL, worst case of:
  - Mortality
  - Cardiac sensitization
  - Anesthetic or central nervous system effects
  - Other escape impairing effects and permanent injury
- Asphyxiation risk: ODL
  - Oxygen deprivation limit



A2L Refrigerants – How Flammable Are They?

A2Ls have 'lower flammability'

Burning Velocity (S_u)

- How fast does a flame propagate (<0.1 m/s)

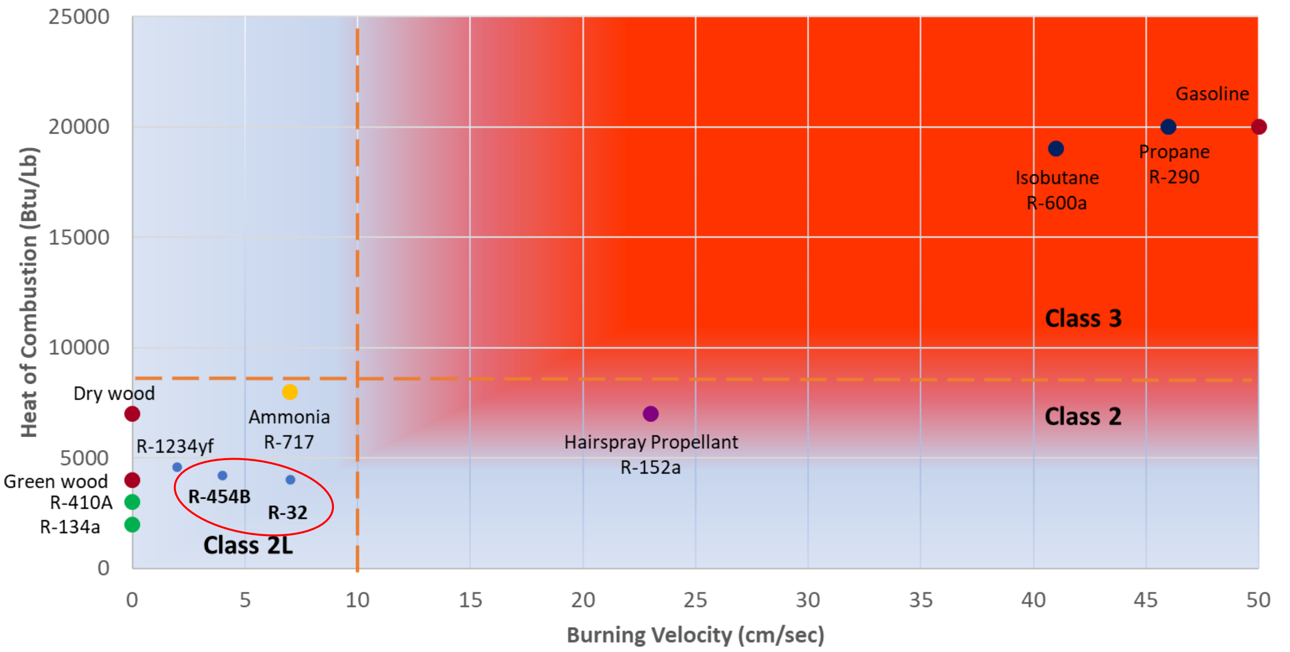
Heat of combustion (HOC)

- How much energy is released by burning (< 1900 kJ/kg)

Lower Flammability Limit (LFL)

- What is the concentration required to burn (> 0.1 kg/m^3)

Relatively lower burning velocity & heat generation



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- How fast does a flame propagate (<0.1 m/s)

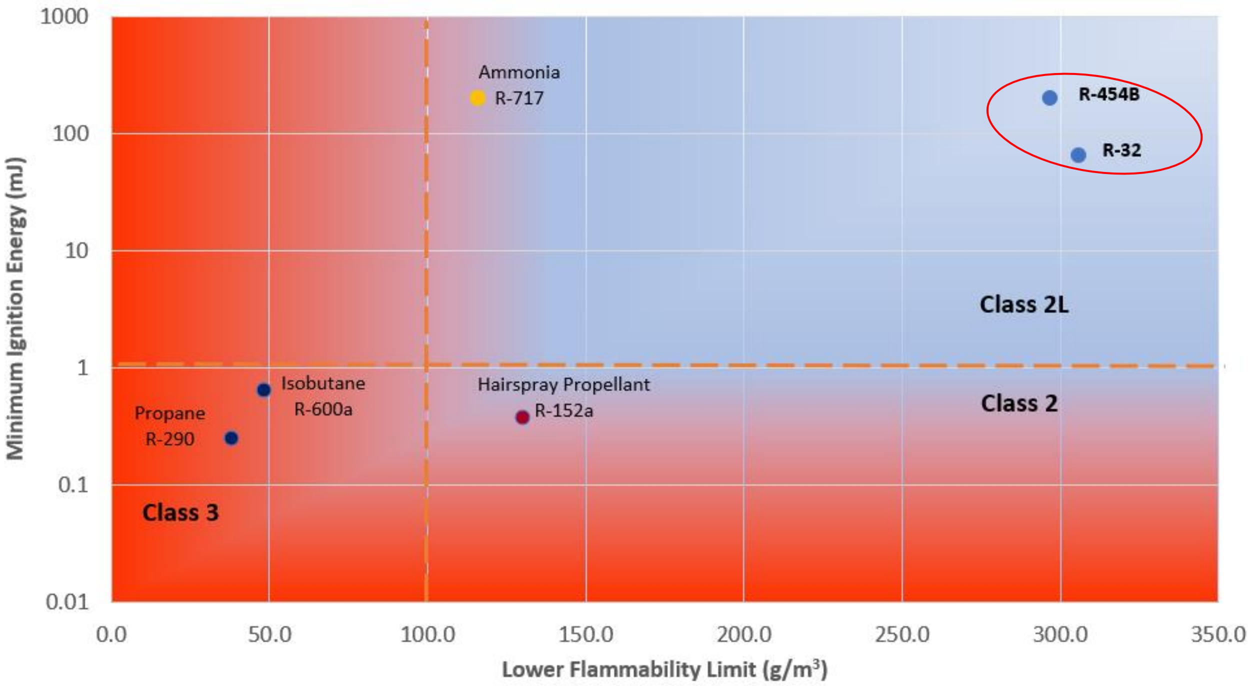
Heat of combustion (HOC)

- How much energy is released by burning (< 1900 kJ/kg)

Lower Flammability Limit (LFL)

- What is the concentration required to burn (> 0.1 kg/m^3)

More difficult to ignite / higher concentration required



‘New’ and Legacy Refrigerant Properties

‘New’ and Legacy Refrigerant Properties

Refrigerant	ASHRAE 34 Classification	GWP_{100} (AR4)	RCL (g/m³)	Composition	Efficiency	Capacity	Toxicity
R-410A Substitutes							
R-410A	A1	2088	420	50% R-32 / 50% R-125			Green
R-32	A2L	675	77	PURE 100% R-32	Green	Green	Green
R-454B	A2L	466	74**	68.9% R-32 / 31.1% R-1234yf	Yellow	Red	Green
R-134a Substitutes							
R-134a	A1	1430	210				Green
R-513A	A1	630*	320	44% R-134a / 56% R-1234yf	Red	Yellow	Green
R-515B	A1	292*	290	91.1% R-1234ze(E) / 8.90% R-227ea	Yellow	Red	Green
R-1234ze(E)	A2L	1	76		Yellow	Red	Green
R-123 Substitutes							
R-123	B1	77	57				Red
R-1233zd(E)	A1	2*	85		Yellow	Green	Green
R-514A	B1	2*	14	74.7% R-1336mzz(E) / 25.3% R-1130(E)	Yellow	Red	Red

*Refrigerant was not included in AR4, AR5 values are utilized in lieu of AR4

**ASHRAE 34 previously listed an RCL of 49, but that value was later updated in Addendum "a" of Standard 34-2022

Agenda to Address Common Questions

1 Regulations and standards driving changes for equipment

2 What is being done to ensure A2L refrigerants can be safely used?

3 What do I need to do to prepare?

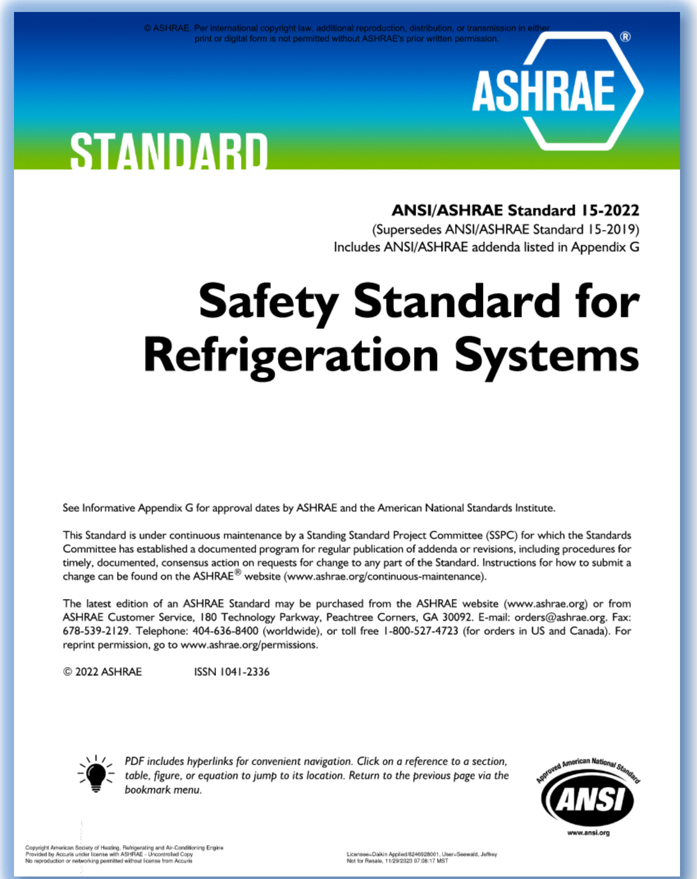
- Design requirements
- Refrigerant detection / control signals
- Ventilation
- Refrigerant piping

ASHRAE Standard 15-2022

Safety Standard for Refrigeration Systems

ASHRAE Standard 15 specifies requirements for the safe design, construction, installation, and operation of refrigeration systems.

- Changes to **refrigerant use restrictions**, especially for A2Ls
- Refrigerant overpressure protection and **piping**
- Volume and **refrigerant charge limit** calculations
- **Refrigerant detector**/detection and mitigation actions
- Machinery room requirements



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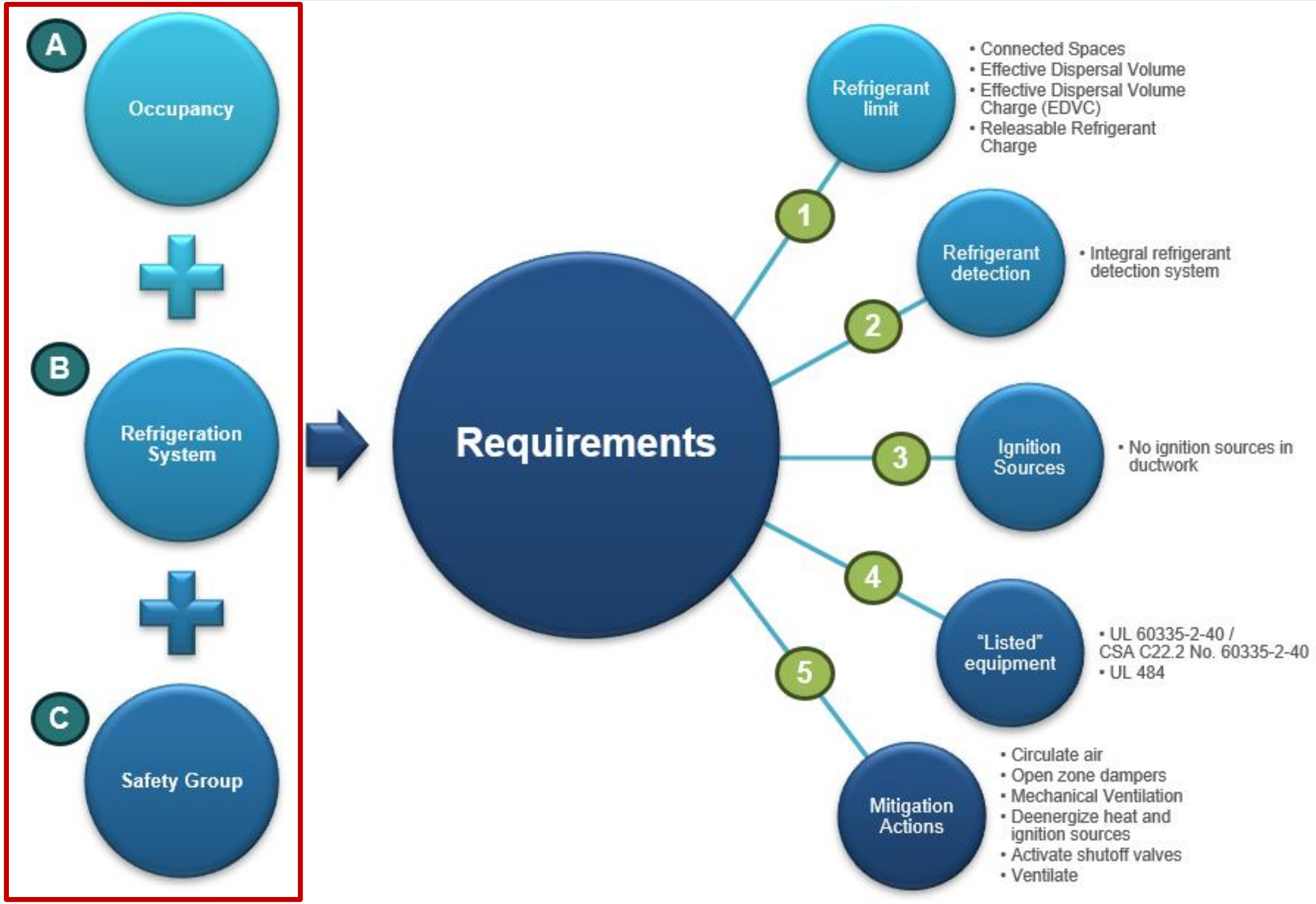
ASHRAE web site has errata sheet corrections and interpretations. Download them.

ASHRAE Standard 15



System Parameters

A — Occupancy Classification

ASHRAE Standard 15, Section 4

Classification
Institutional
Public assembly
Residential
Commercial
Large mercantile
Industrial
Mixed

- Different occupancy types may require different actions

B — Refrigeration System Classification

ASHRAE Standard 15, Section 5

Classification
High Probability
Low Probability

C — Safety Group

ASHRAE Standard 15, Section 6

Per ASHRAE Standard 34

	Lower Toxicity	Higher Toxicity
Class 3 Higher flammability	A3	B3
Class 2 Flammable	A2	B2
Class 2L Lower flammability	A2L	B2L
Class 1 No flame propagation	A1	B1

System Parameters – Occupancy Classification

Occupancy Classification

A

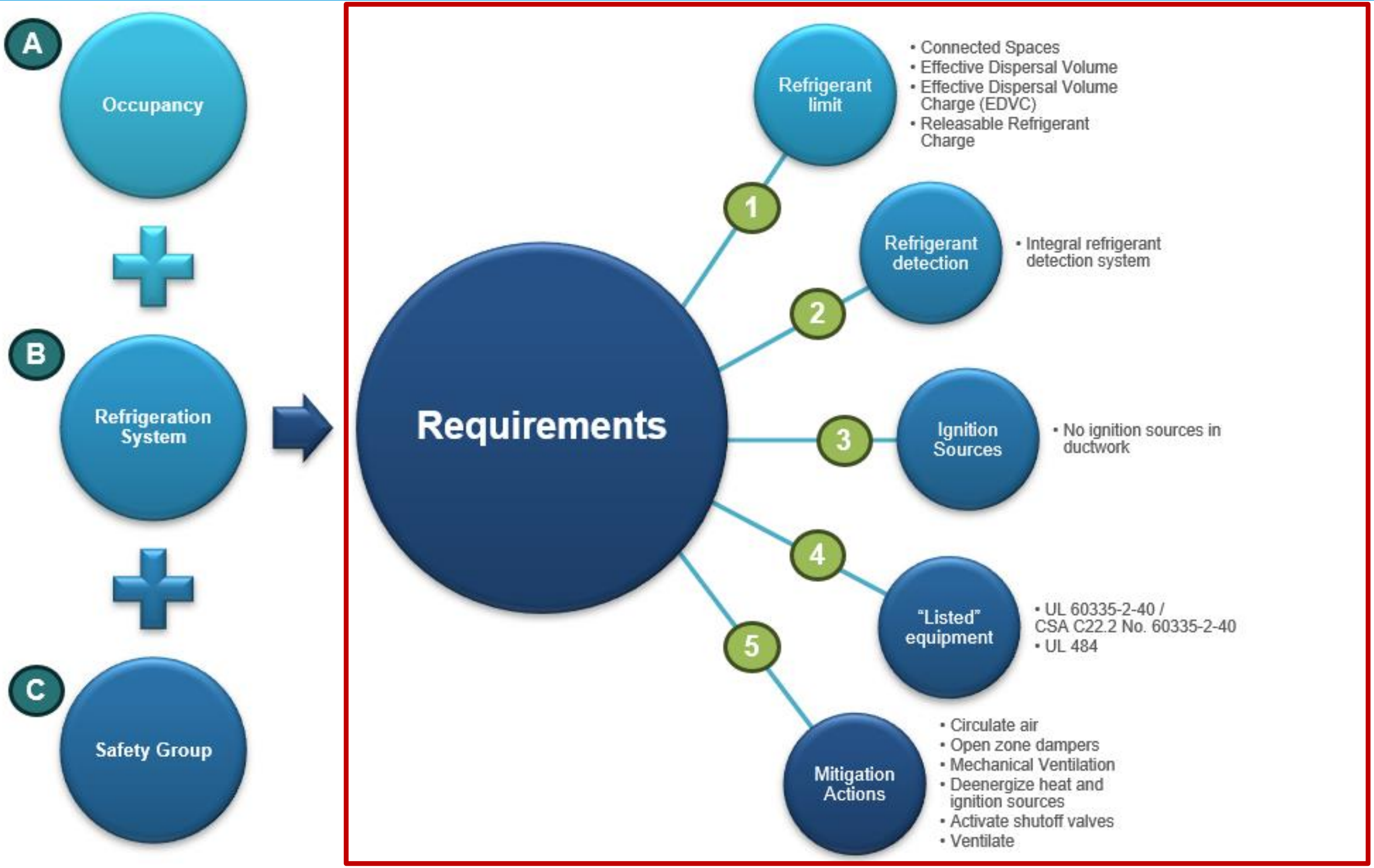
Classification	Definition A premise or that portion of a premise…	Examples
Institutional	from which, because they are disabled, debilitated, or confined, occupants cannot readily leave without the assistance of others	Hospitals, nursing homes, prisons
Public assembly	here large numbers of people congregate and from which occupants cannot quickly vacate the space	Auditoriums, ballrooms, classrooms, restaurants, theaters, depots
Residential	that provides the occupants with complete independent living facilities, including permanent provisions for living, sleeping, eating, cooking, and sanitation	Hotels, dormitories, apartments
Commercial	where people transact business, receive personal service, or purchase food and other goods	Office and professional buildings, markets (excluding large mercantile)
Large mercantile	where more than 100 persons congregate on levels above or below street level to purchase personal merchandise	Shopping malls
Industrial	is a premise or that portion of a premise that is not open to the public, where access by authorized persons is controlled, and that is used to manufacture, process, or store goods	Manufacturing plants, processing plants, storage facilities
Mixed	two or more occupancies are located within the same building	Combination of one or more of the above space types

Refrigeration System Classification

B

Classification	Definition	Examples
High Probability	Any system where leakage of refrigerant has **high probability to enter the occupied space**.	**Direct Systems** • Direct expansion (DX) split system • Packaged RTU • Water source heat pump • VRF • PTAC
Low Probability	Any system where leakage of refrigerant **cannot enter the occupied space**.	**Indirect closed systems** • Water-cooled chiller in machinery room • Air-cooled chiller outdoors • Water-to-water heat pump in machinery room

ASHRAE Standard 15



Refrigerant Limits

1

- Check the **releasable refrigerant charge (M_{rel})** against the **Effective Dispersal Volume Charge (EDVC)**
  - The **smallest volume into which refrigerant disperses shall be used** when determining EDVC
  - For A2Ls, both occupied and non-occupied spaces must be considered (7.2.2.2)

$$M_{rel} \leq EDVC$$

- Equations to calculate EDVC vary depending on refrigerant safety group and system characteristics

If you don't comply initially, you can consider additional mitigation strategies

Calculating EDVC

1

Establish ***Effective Dispersal Volume*** (7.2.3.1 to 7.2.3.4)

- Identify exempted spaces (7.2.3.1.1)
- Determine if any spaces are ‘connected spaces’ via natural openings or through air circulation
- Consider closures (such as dampers that can close during a refrigerant leak)

Calculate Effective Dispersal Volume Charge **EDVC** per the equation in 7.3.1

- Or, apply 7.6.1.1 for an A2L refrigerant with detection and air circulation
- Or, apply 7.6.1.2 for an A2L refrigerant without detection and air circulation

Determine **releasable refrigerant charge M_{rel}**

- Systems without release mitigation controls, M_{rel} is the system charge of the largest independent circuit.
- Systems with release mitigation controls, M_{rel} determined per section 7.3.4.3

$$M_{rel} \leq EDVC$$

Effective Dispersal Volume

1

Establish ***Effective Dispersal Volume***
(7.2.3.1 to 7.2.3.4)

- Identify exempted spaces (7.2.3.1.1)
- Determine if any spaces are 'connected spaces' via natural openings or through air circulation
- Consider closures (such as dampers that can close during a refrigerant leak)

Exempted Spaces 7.2.3.1.1:

The areas that contain only continuous *refrigerant piping, or* contain only joints and connections that have been tested in accordance with Section 9.13, are exempt from the *effective dispersal volume* calculation unless these areas are part of *connected spaces* per Section 7.2.3.2.

Effective Dispersal Volume

1

Establish ***Effective Dispersal Volume***
(7.2.3.1 to 7.2.3.4)

- Identify exempted spaces (7.2.3.1.1)
- Determine if any spaces are 'connected spaces' via natural openings or through air circulation
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The areas that contain only continuous *refrigerant piping, or* contain only joints and connections that have been tested in accordance with Section 9.13, are exempt from the *effective dispersal volume* calculation unless these areas are part of *connected spaces* per Section 7.2.3.2.

Determine if any spaces are 'connected spaces"

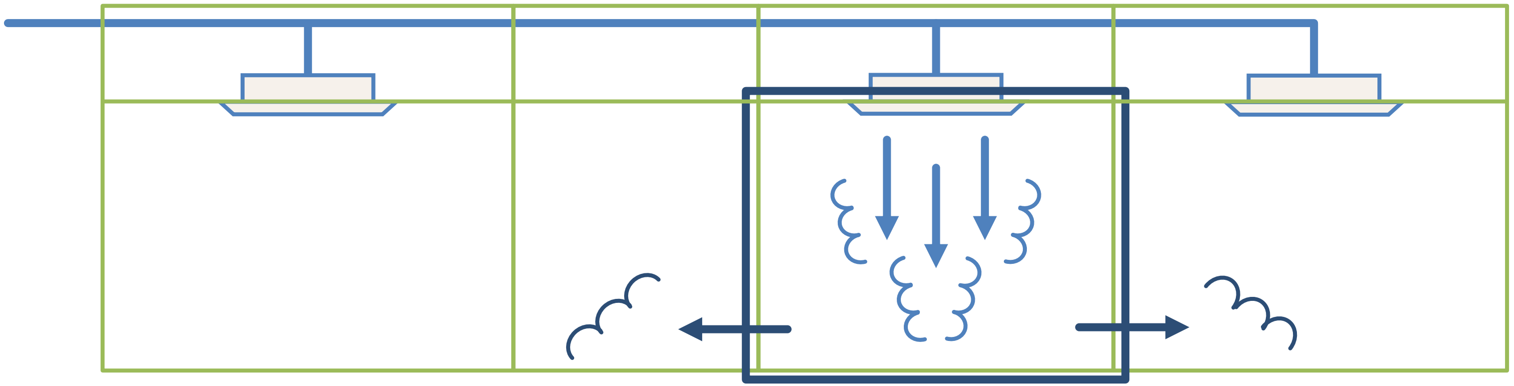
Effective Dispersal Volume

Natural Ventilation

1

Connected spaces can help comply with EDVC requirements

- Natural ventilation openings may be used to increase the effective dispersal volume by connecting separate enclosed spaces with openings to allow refrigerant to disperse
- Size openings in accordance with sections 7.2.3.2.1 or 7.2.3.2.2
- Any openings above 12in from the floor shall not be considered



Effective Dispersal Volume

Ducted Air Distribution

1

Connected spaces can help comply with EDVC requirements

- Ducted Air Distribution and Mechanical Ventilation Systems may be used to increase the effective dispersal volume by connecting separate enclosed spaces
- Follow guidelines for Connected Spaces via Ducted Air Distribution System 7.2.3.3 and/or Connected Spaces via Mechanical Ventilation 7.2.3.4

Effective Dispersal Volume

1

Establish ***Effective Dispersal Volume*** (7.2.3.1 to 7.2.3.4)

- Identify exempted spaces (7.2.3.1.1)
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The areas that contain only continuous *refrigerant piping, or* contain only joints and connections that have been tested in accordance with Section 9.13, are exempt from the *effective dispersal volume* calculation unless these areas are part of *connected spaces* per Section 7.2.3.2.

Closures 7.2.3.3.1:

Closures in the air distribution system *shall* be considered. If one or more spaces of several arranged in parallel can be closed off from the source of the *refrigerant* leak, their volumes *shall not* be used in the calculation. Smoke dampers, fire dampers, and combination smoke/fire dampers that close only in an emergency not associated with a *refrigerant leak* shall not be classified as closure devices. Dampers, such as variable-air-volume (VAV) boxes, *shall not* be considered a closure, provided the airflow is not reduced below 10% of its maximum.

Calculating EDVC

1

Establish ***Effective Dispersal Volume*** (7.2.3.1 to 7.2.3.4)

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- Determine if any spaces are 'connected spaces' via natural openings or through air circulation
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- Or, apply 7.6.1.2 for an A2L refrigerant without detection and air circulation

7.6.1.1 Refrigeration Systems with Air Circulation

$$EDVC = Veff \times LFL \times CF \times F_{occ}$$

7.6.1.2 Other Refrigeration Systems

$$EDVC = Mdef \times FLFL \times Focc$$

Calculating EDVC

1

Establish ***Effective Dispersal Volume*** (7.2.3.1 to 7.2.3.4)

- Identify exempted spaces (7.2.3.1.1)
- Determine if any spaces are 'connected spaces' via natural openings or through air circulation
- Consider closures (such as dampers that can close during a refrigerant leak)

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Determine **releasable refrigerant charge M_{rel}**

- Systems without release mitigation controls, M_{rel} is the system charge of the largest independent circuit.
- Systems with release mitigation controls, M_{rel} determined per section 7.3.4.3

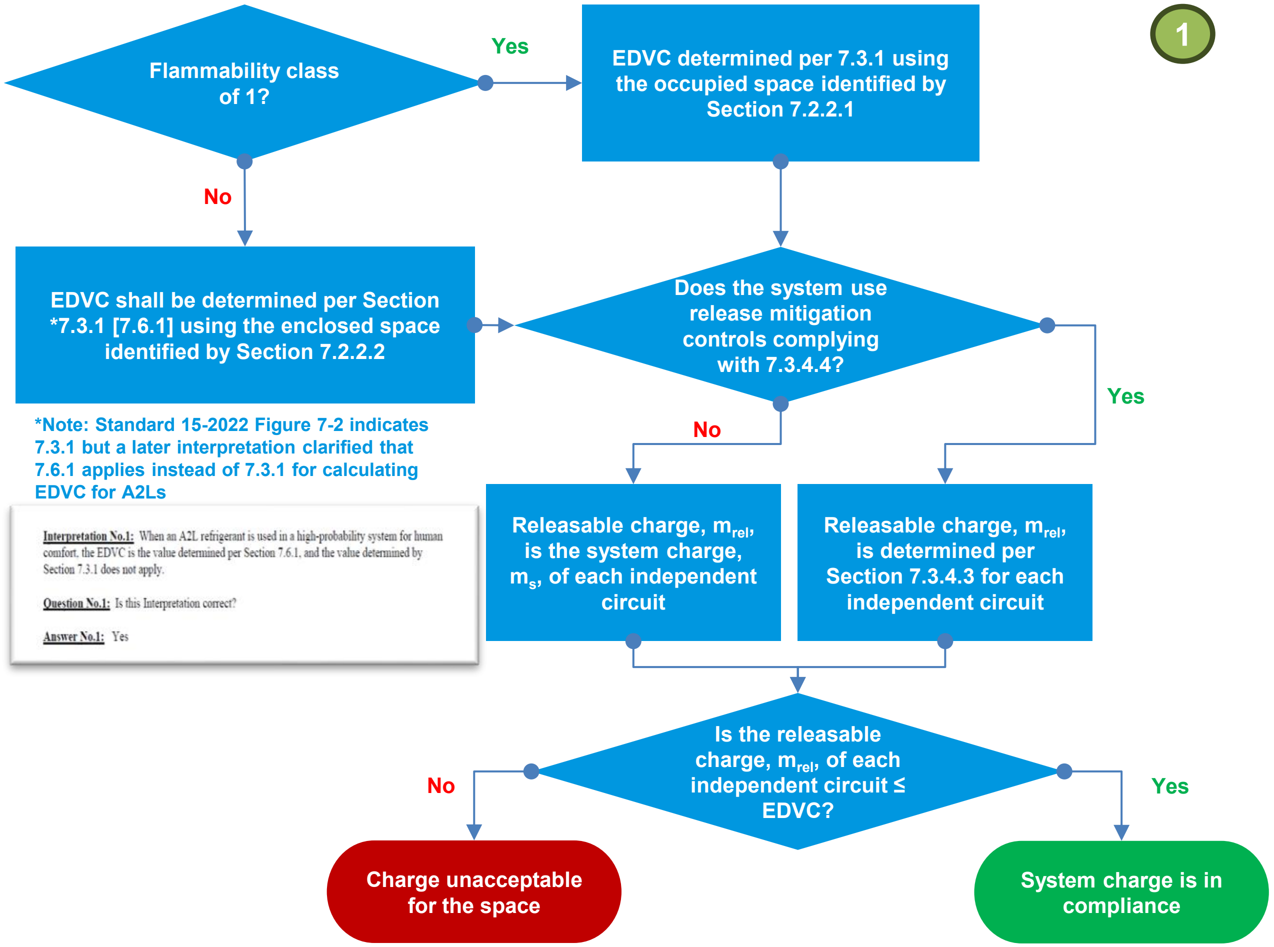
$$M_{rel} \leq EDVC$$

Refrigerant Limits

Simplified Flowchart

Refrigerant System Charge Limit Compliance Path

- Simplified flowchart (Figures 7-1 and 7-2)
- Simplifying assumptions:
  - Unit has a refrigerant charge > 22 lb
  - The unit is not in a public corridor or lobby
  - High probability system for human comfort not in a machinery room or outdoors
  - Not in a laboratory
  - Not an industrial occupancy or refrigerated room



*Note: Standard 15-2022 Figure 7-2 indicates 7.3.1 but a later interpretation clarified that 7.6.1 applies instead of 7.3.1 for calculating EDVC for A2Ls

Interpretation No.1: When an A2L refrigerant is used in a high-probability system for human comfort, the EDVC is the value determined per Section 7.6.1, and the value determined by Section 7.3.1 does not apply.

Question No.1: Is this Interpretation correct?

Answer No.1: Yes

Refrigerant Limits

Notable Exceptions

1

Listed equipment with refrigerant charge ≤ 6.6 lb

- If in a public corridor or lobby, must be a unit system and if not an A1, have EDVC calculated
- If not in a public corridor or lobby, charge complies if installed in accordance with listing and OEM instructions

Systems in industrial occupancy or refrigerated room

- If all conditions of Section 7.3.3 are met, are considered to have system charge in compliance

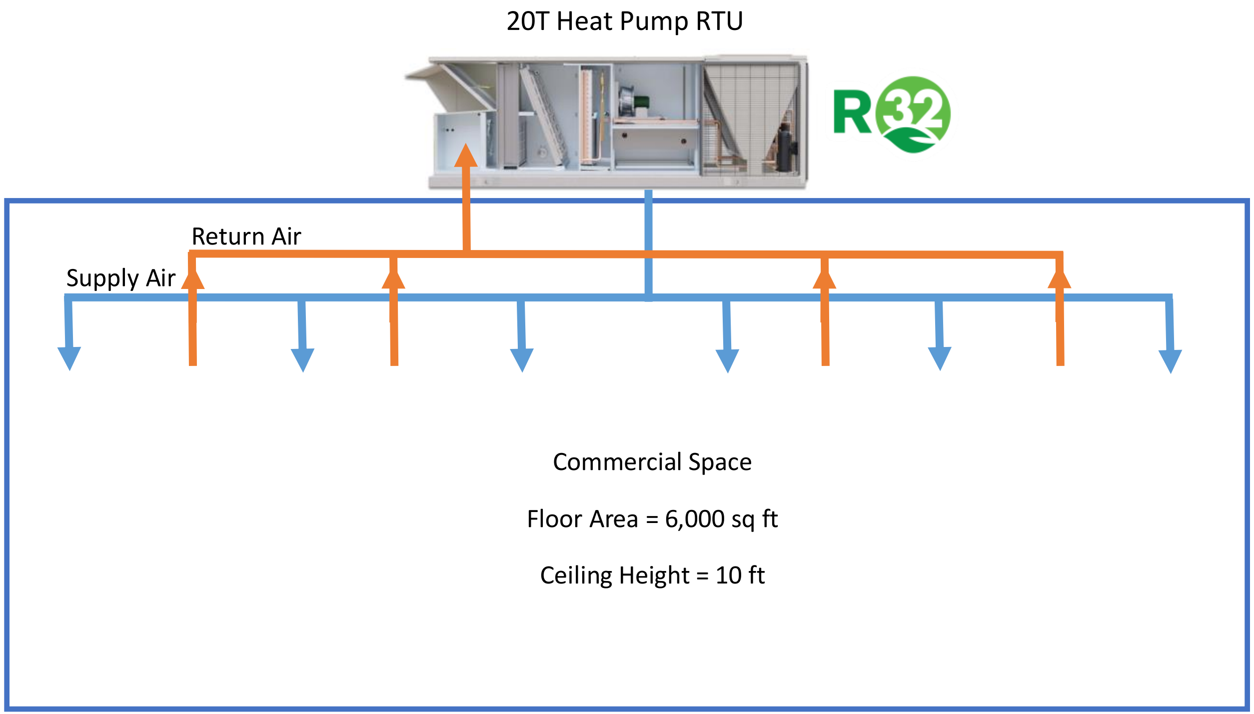
Listed self-contained equipment in a commercial occupancy, not in a public corridor or lobby, with refrigerant charge ≤ 22 lb

- System charge considered in compliance
- Self-contained system definition: a complete, factory-assembled and factory-tested system that is shipped in one or more sections and has no refrigerant-containing parts that are joined in the field by other than companion valves or block valves

Refrigerant Limits

EDVC Calculation

1

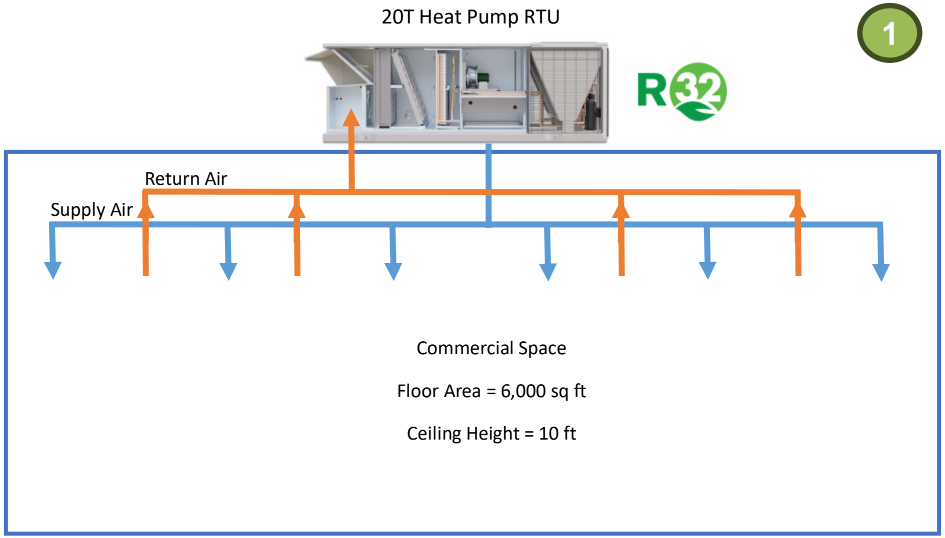


Refrigerant Limits

EDVC Calculation

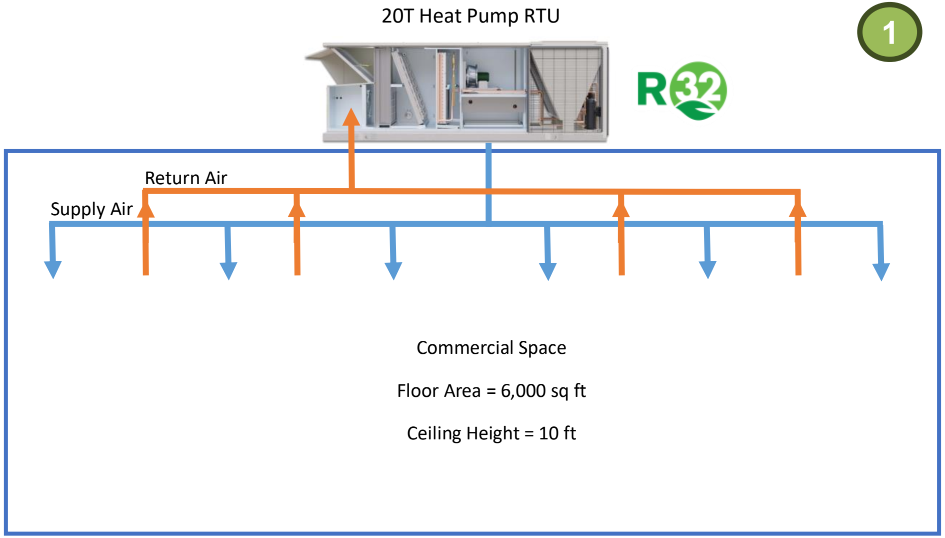
<u>Determining Effective Dispersal Volume:</u>

- **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)



Refrigerant Limits

EDVC Calculation



1

Determining Effective Dispersal Volume:

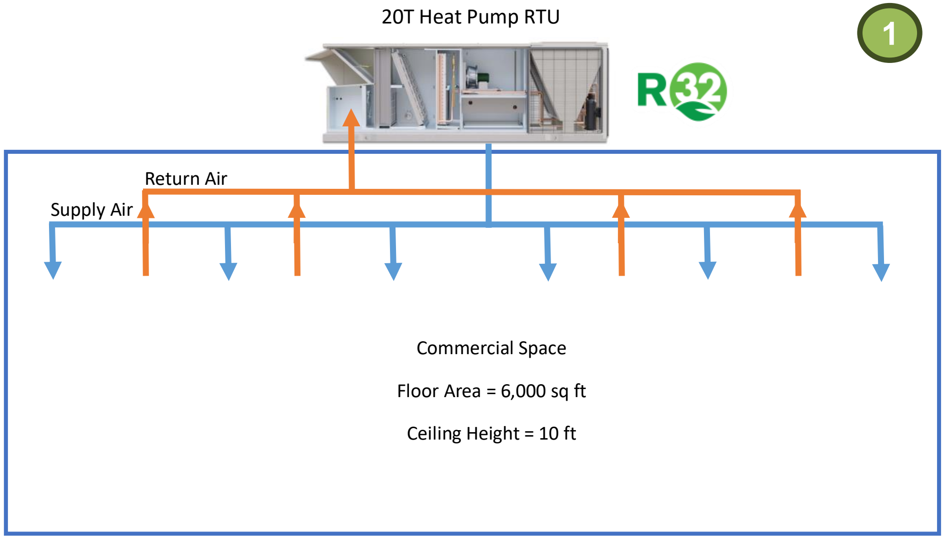
- **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)
- **Connected Spaces**: Ducted Air Distribution System
  - Total volume: spaces + duct volume

$$V_{eff} = 6{,}000\ ft^3 \times 10ft + 5{,}500\ ft^3 = \mathbf{65{,}500\ ft^3}$$

Refrigerant Limits

EDVC Calculation

- Determining Effective Dispersal Volume:
  - **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)
- Connected Spaces: Ducted Air Distribution System
  - 8 classrooms, 1 small group, 1 office
  - Total volume: spaces + duct volume
- Closures: no closures in the system



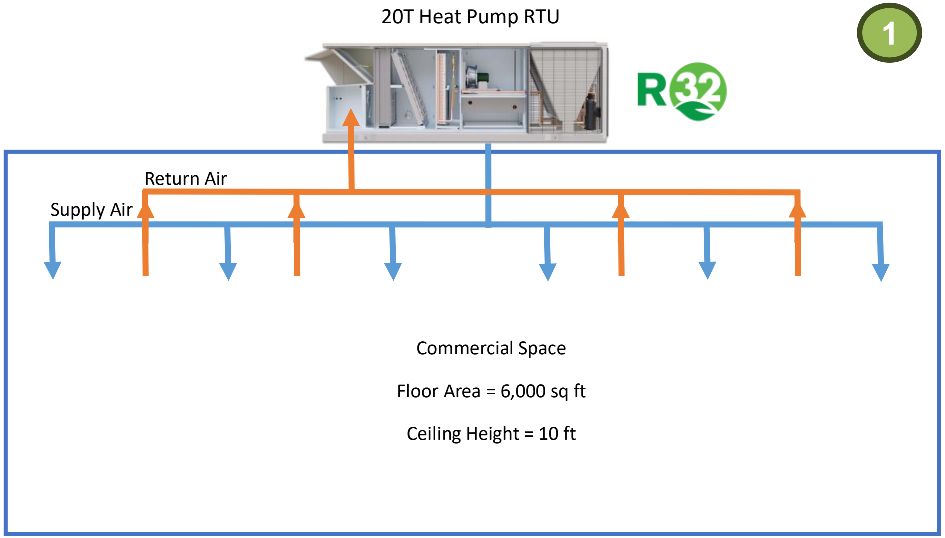
Refrigerant Limits

EDVC Calculation

- Calculate EDVC Equation 7.6.1.1

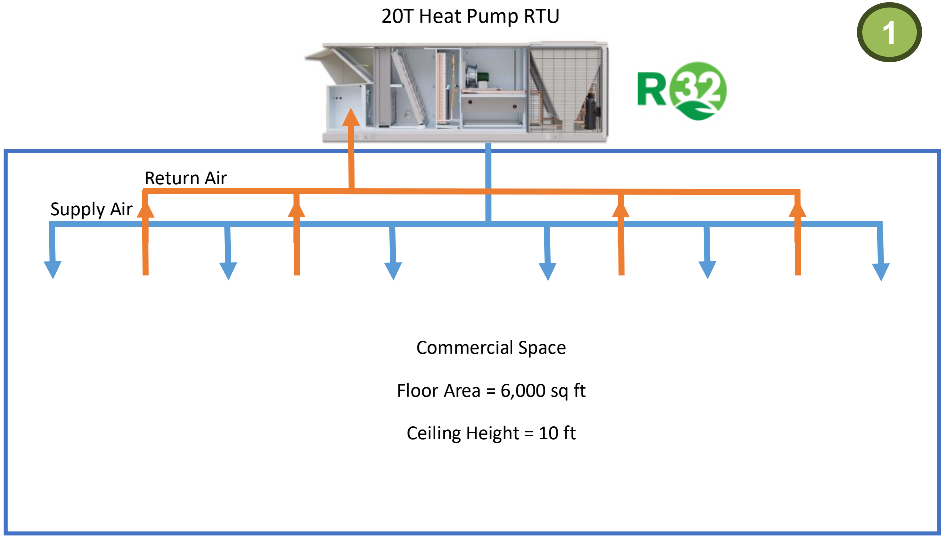
$$EDVC = V_{eff} \times LFL \times CF \times F_{occ}$$

  - **V_{eff} = 65,500 ft^3**
  - Refrigerant **LFL** (R-32) in ASHRAE Standard 34, Table 4-1 = **0.0191 lb/ft^3**
  - Concentration Factor, **CF = 0.5**
  - Occupancy classification: **Commercial Occupancy, *F_{occ} = 1.0***



Refrigerant Limits

EDVC Calculation



- Calculate EDVC Equation 7.6.1.1

$$EDVC = V_{eff} \times LFL \times CF \times F_{occc}$$

  - **V_{eff} = 65,500 ft^3**
  - Refrigerant **LFL** (R-32) in ASHRAE Standard 34, Table 4-1 = **0.0191 lb/ft^3**
  - Concentration Factor, **CF = 0.5**
  - Occupancy classification: **Commercial Occupancy, *F_{occ} = 1.0***

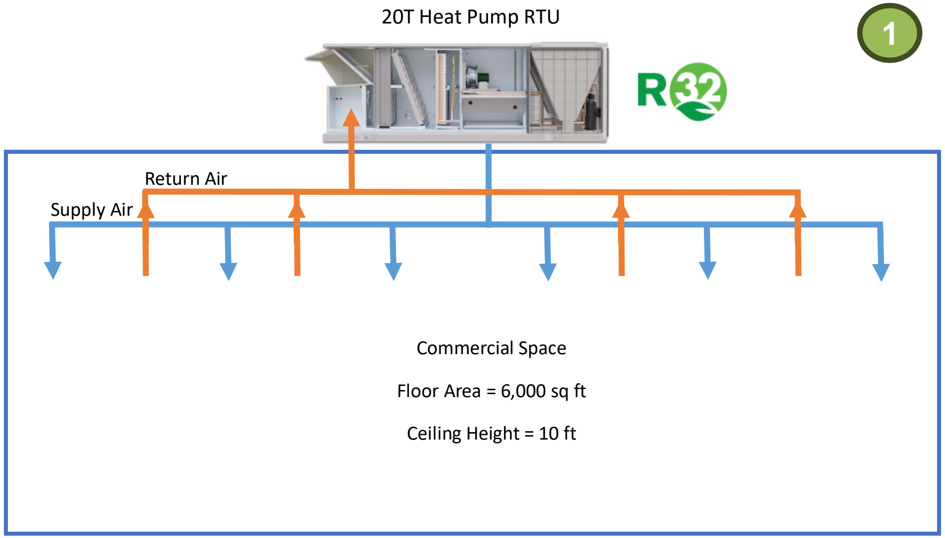
$$\mathbf{EDVC} = 65{,}500\ ft^3 \times 0.0191\ {}^{lb}/_{ft^3} \times 0.5 \times 1.0 = \mathbf{625\ lbs}$$

Refrigerant Limits

EDVC Calculation

- Determine Mrel

$$M_{rel} = 31.2\ lbs$$



Refrigerant Limits

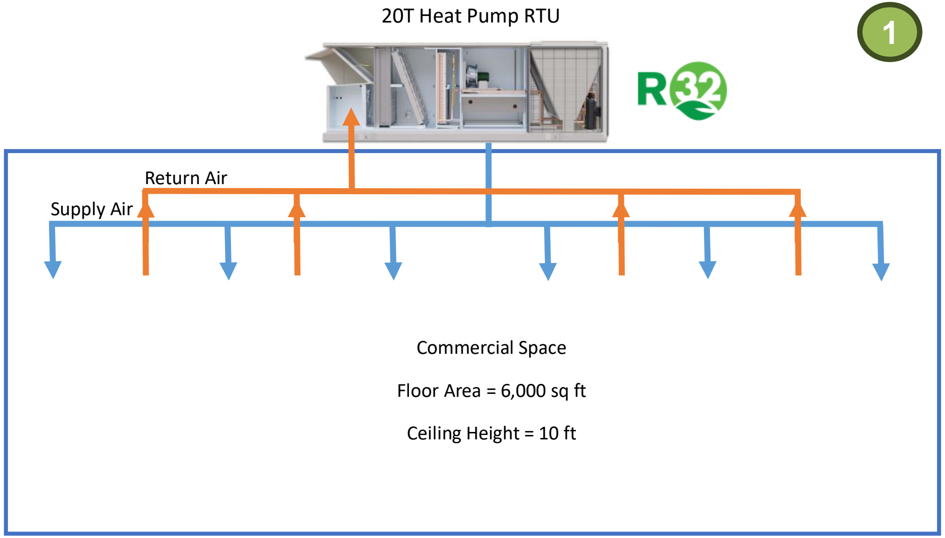
EDVC Calculation

1

- Determine Mrel

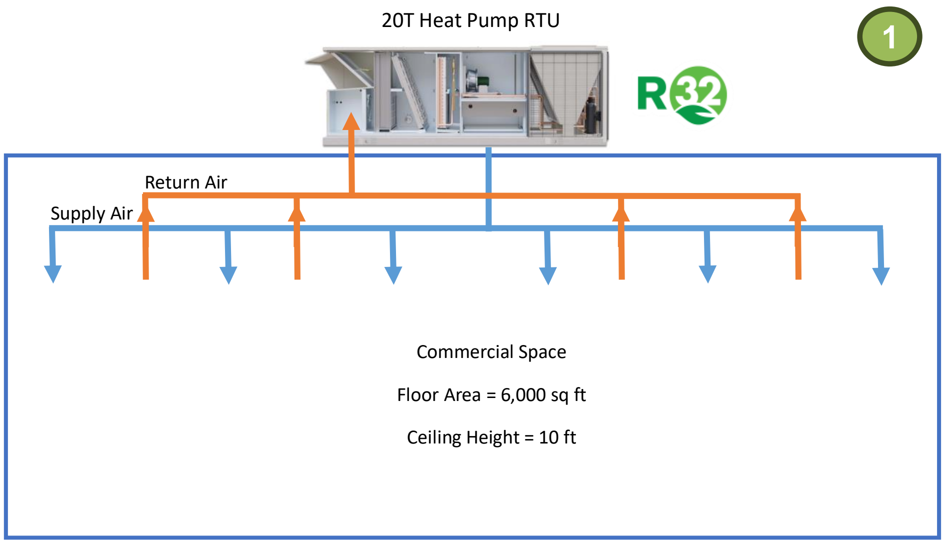
$$M_{rel} = 31.2\ lbs$$

$$625\ lbs \geq 31.2\ lbs$$



Refrigerant Limits

EDVC Calculation



- Determine Mrel

$$\boldsymbol{M_{rel} = 31.2\ lbs}$$

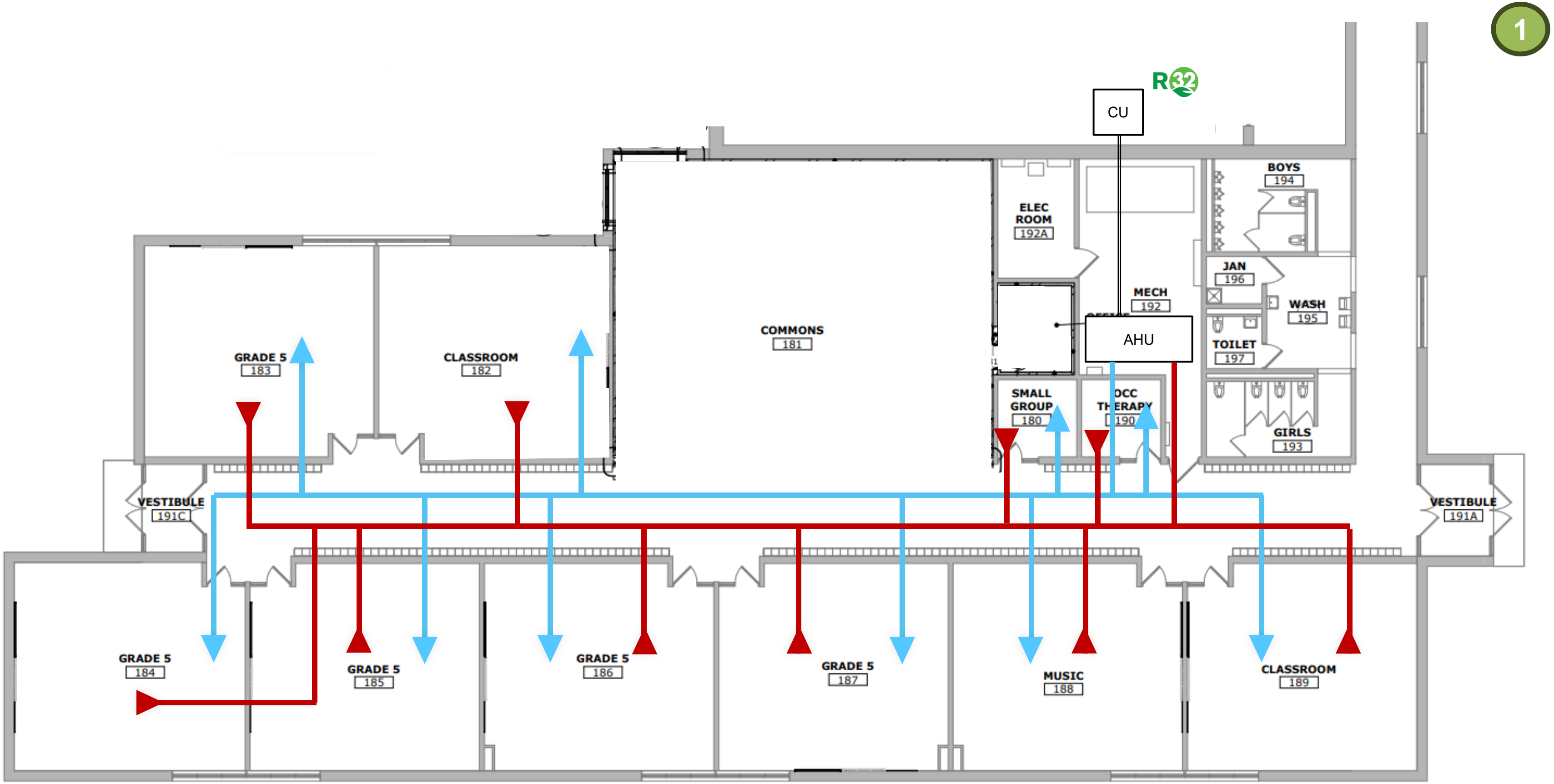
$$625\ lbs \geq 31.2\ lbs$$

$$EDVC \geq M_{rel}$$

System is in compliance with EDVC

Refrigerant Limits

EDVC Calculation

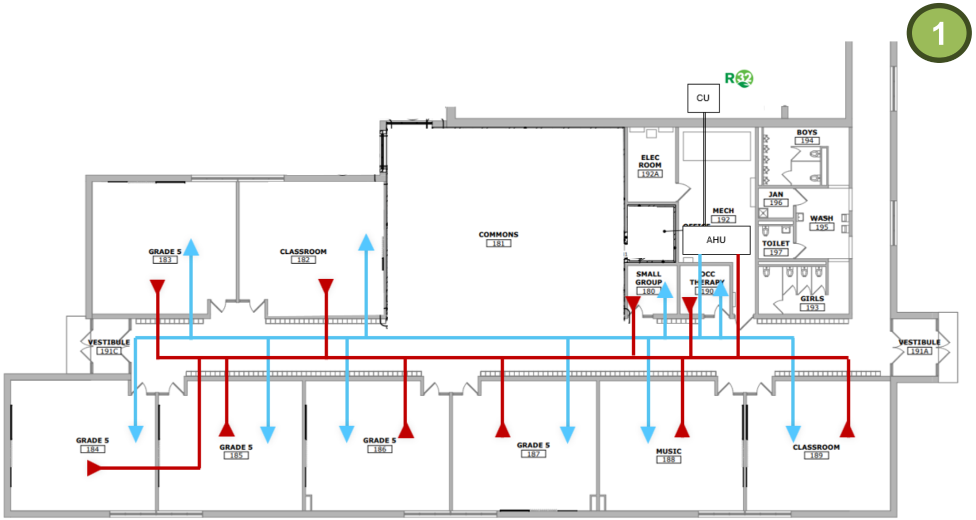


Refrigerant Limits

EDVC Calculation

Determining Effective Dispersal Volume:

- **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)



Refrigerant Limits

EDVC Calculation

Determining Effective Dispersal Volume:

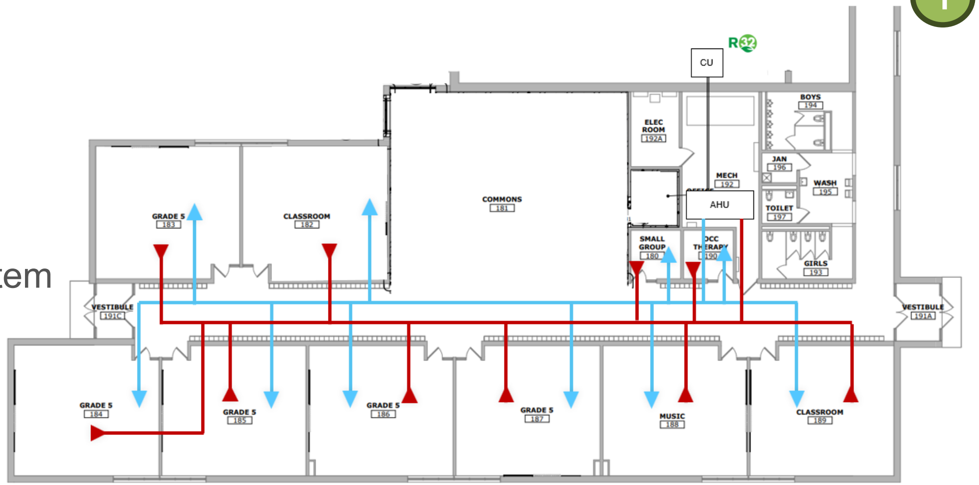
- **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)

- **Connected Spaces**: Ducted Air Distribution System
  - 8 classrooms, 1 small group, 1 office
  - Total volume: spaces + duct volume

Space	*Area (sq ft)*	*Ceiling Heigh (ft)*	*Volume (cu ft)*
Classrooms	*8000*	*9*	*72000*
Office	*120*	*8*	*960*
Small Group	*120*	*8*	*960*
Total			***73920***

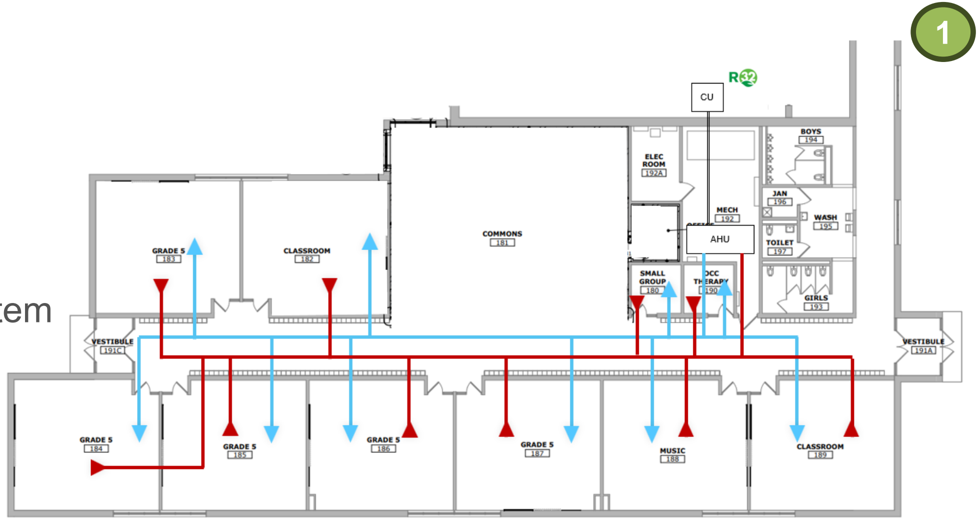
Volume of Ductwork = 8,500 ft³

1



Refrigerant Limits

EDVC Calculation



Determining Effective Dispersal Volume:

- **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)
- **Connected Spaces**: Ducted Air Distribution System
  - 8 classrooms, 1 small group, 1 office
  - Total volume: spaces + duct volume

Space	*Area (sq ft)*	*Ceiling Heigh (ft)*	*Volume (cu ft)*
Classrooms	*8000*	*9*	*72000*
Office	*120*	*8*	*960*
Small Group	*120*	*8*	*960*
Total			***73920***

Volume of Ductwork = 8,500 ft³

$$V_{eff} = 73{,}920\ ft^3 + 8{,}500\ ft^3 = \mathbf{82,420\ ft^3}$$

Refrigerant Limits

EDVC Calculation

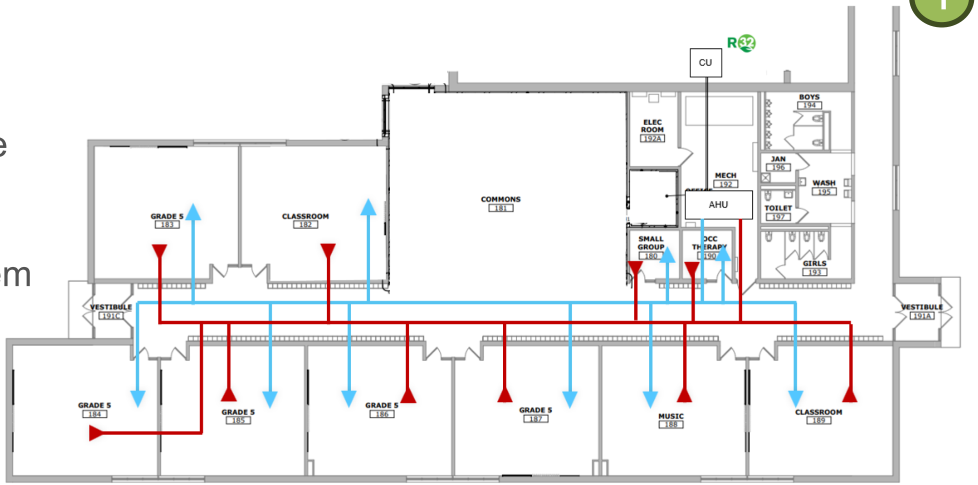
- Determining Effective Dispersal Volume:
  - **Exempt spaces:** Mechanical Room (piping is tested in accordance with section 7.2.3.2 of the standard)

- Connected Spaces: Ducted Air Distribution System
  - 8 classrooms, 1 small group, 1 office
  - Total volume: spaces + duct volume

$$V_{eff} = 73{,}920\ ft^3 + 8{,}500\ ft^3 = \mathbf{82,420\ ft^3}$$

- Closures: no closures in the system

1



Refrigerant Limits

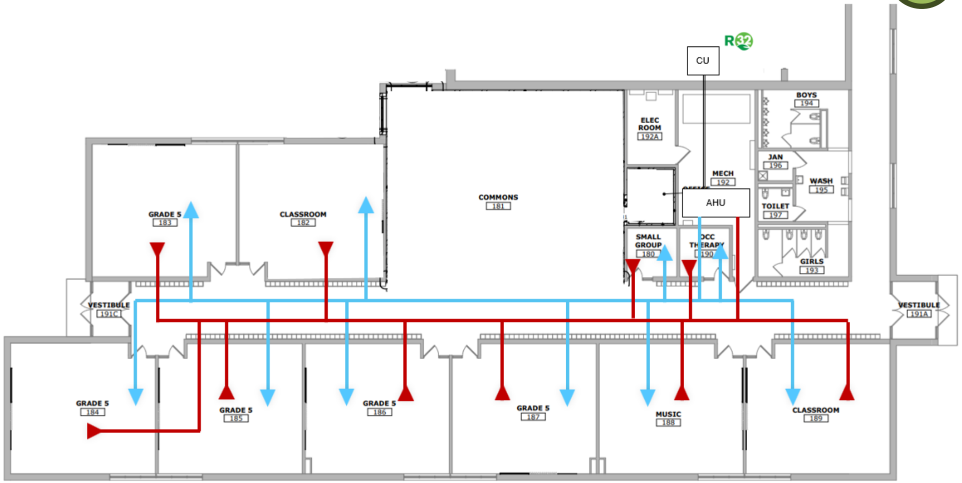
EDVC Calculation

1

- Calculate EDVC Equation 7.6.1.1

$$EDVC = V_{eff} \times LFL \times CF \times F_{occ}$$

  - **V_{eff} = 82,420 ft^3**
  - Refrigerant **LFL** (R-32) in ASHRAE Standard 34, Table 4-1 = **0.0191 lb/ft^3**
  - Concentration Factor, **CF = 0.5**
  - Occupancy classification: **Public Assembly, *F_{occ}* = *1.0***



Refrigerant Limits

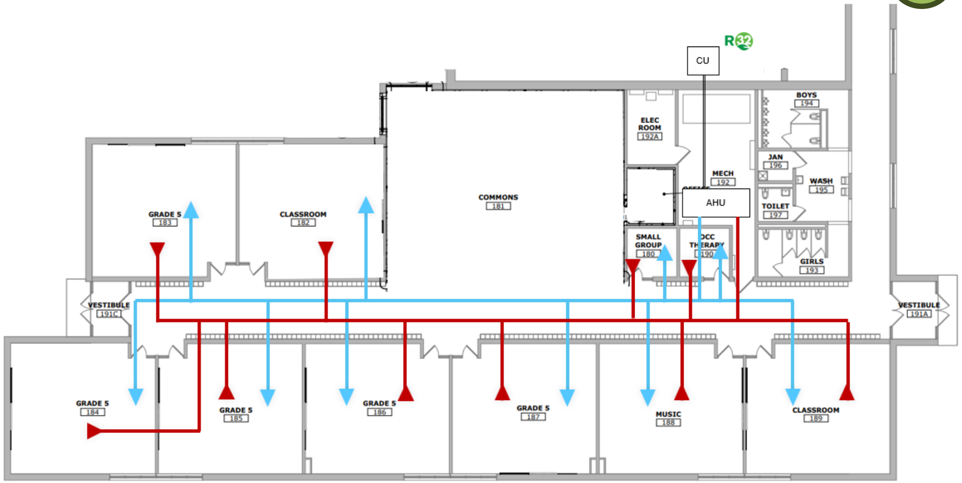
EDVC Calculation

1

- Calculate EDVC Equation 7.6.1.1

$$EDVC = V_{eff} \times LFL \times CF \times F_{occ}$$

  - $\mathbf{V_{eff} = 82{,}420\ ft^3}$
  - Refrigerant **LFL** (R-32) in ASHRAE Standard 34, Table 4-1 = $\mathbf{0.0191\ lb/ft^3}$
  - Concentration Factor, **CF = 0.5**
  - Occupancy classification: **Public Assembly, F_{occ} = *1.0***



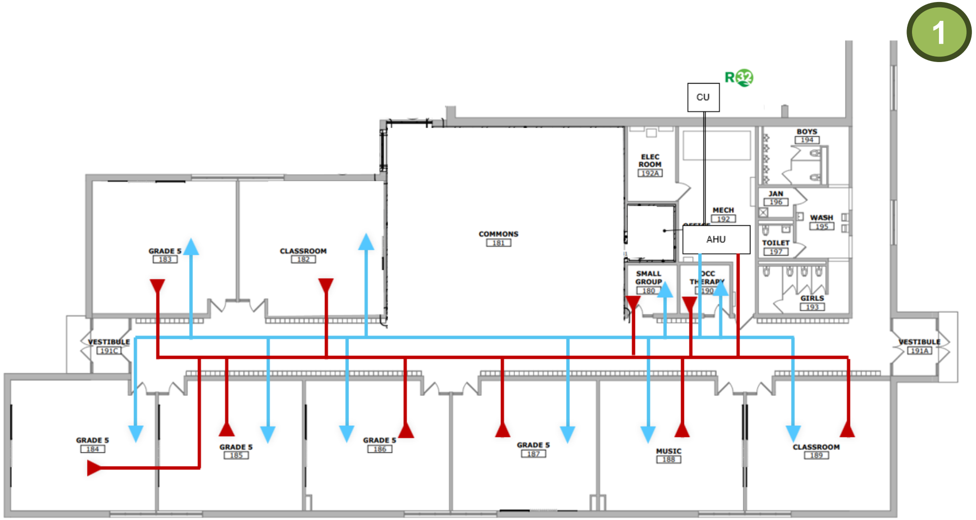
$$\textbf{EDVC} = 82{,}420\ ft^3 \times 0.0191\ {}^{lb}/_{ft^3} \times 0.5 \times 1.0 = \boldsymbol{787\ lbs}$$

Refrigerant Limits

EDVC Calculation

- Determine Mrel
  - Coil refrigerant charge circuit #1 = 6 lbs
  - Coil refrigerant charge circuit #2 = 5 lbs
  - Circuit #1 charge = 28 lbs
  - Circuit #2 charge = 27 lbs

$$M_{rel} = 6lbs + 28lb = \mathbf{34lbs}$$



Refrigerant Limits

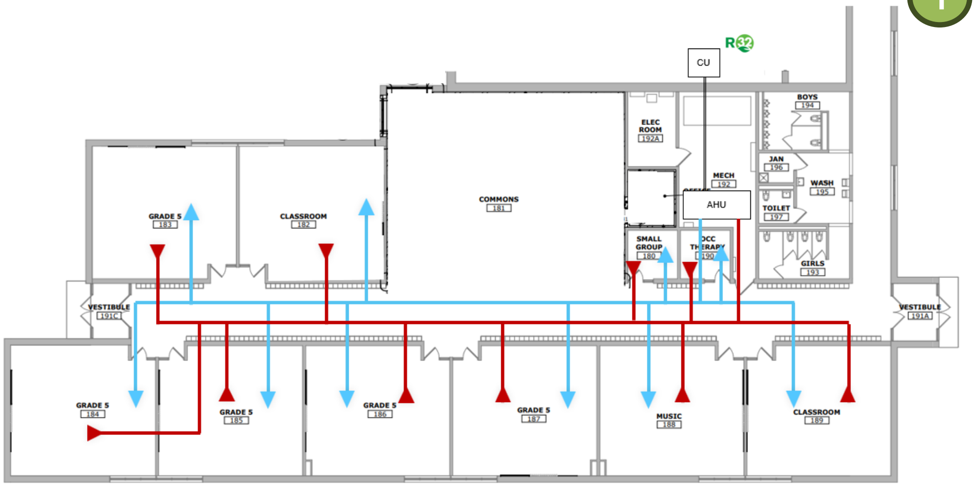
EDVC Calculation

1

- Determine Mrel
  - Coil refrigerant charge = 10 lbs
  - Circuit #1 charge = 28 lbs
  - Circuit #2 charge = 27 lbs

$$M_{rel} = 10lbs + 28lbs + 27lbs = \mathbf{65lbs}$$

$$787\ lbs \geq 34\ lbs$$



System is in compliance with EDVC

Refrigerant Detection Systems (7.6.2.3)

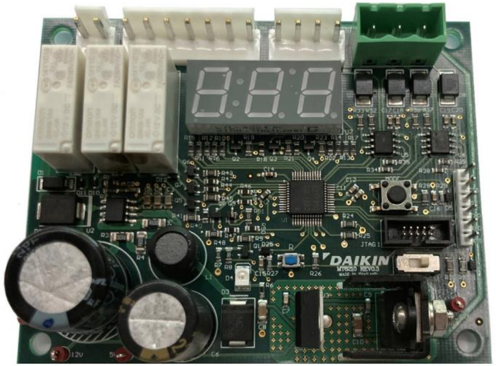
2

Refrigerant detectors required when:

- **Ducted HVAC systems with a releasable refrigerant charge (m_{rel}) more than 4.0 lb** (1.8 kg) and with any duct openings less than 5.9 ft (1.8 m) above the finished floor
- Ducted HVAC systems where spaces connected to the same **supply air duct are used as the dispersal floor area to calculate volume** per Section 7.2
- Refrigeration systems installed where the occupancy classification is **institutional occupancy**

Device output signals may need to be connected to other parts of the system (i.e. air dampers, blowers, etc) and must comply with the following:

- Setpoint is **not field adjustable**
- **Field recalibration** shall **not** be permitted.
- Be capable of detecting the presence of the refrigerant used in the system
- Have **access for replacement of refrigerant detection system components**.
- Have **self-diagnostics** to determine operational status of the sensing element.
  - **Energize air circulation fans of the equipment upon failure of a self-diagnostic check**.
- Generate an **output signal in no more than 30 seconds**



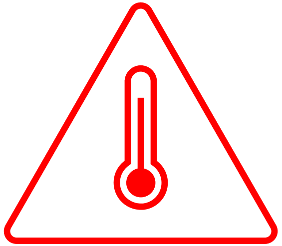
Ignition Sources

3

Ignition Sources in Ductwork (7.6.3)

- Open flame producing devices shall not be permanently installed in ductwork
- Unclassified electrical devices shall not be located in ductwork
- No devices with hot surfaces exceeding 1,290°F
  - Unless air flow velocity exceeds 200 ft/min
  - And, there is proof of air flow when the device is energized

Generally, the idea is to have heat sources in a listed unit, rather than separately in the ductwork



Listed Equipment

Product Safety Standard(s)

- Refrigeration systems **must be listed** in accordance with **UL 60335-2-40** for HVAC equipment with A2L refrigerants
- Sets safety requirements for equipment manufacturers
  - Leak testing
  - Ignition source restrictions
  - Equipment markings
- Requires certain information that **OEMs must include in IOMs**. For example:
  - Instructions for installation including refrigerant piping and SSOVs
  - Handling, installation, cleaning, servicing and disposal of refrigerant
- **Always refer to the manufacturer's IOM for specific installation requirements!**

4


UL 484

STANDAR

Room Air

UL 60335-2-40

STANDARD FOR SAFETY

Household and Similar Electrical Appliances – Safety – Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers

ASHRAE Standard 15 – Mitigation Actions

5

Mitigation Actions

- A — Air circulation
- B — Open zone dampers
- C — Mechanical Ventilation
- D — Activate shutoff valves
- E — Deenergize electric resistance heat and potential ignition sources

The following mitigation actions shall be **completed in not more than 15 seconds after the initiation of the output signal** of Section 7.6.2.4(g), and shall be maintained for at least 5 minutes after the output signal has reset

Air Circulation and Zone Dampers

A

7.6.2.5 a: Energize the *air circulation* fan(s) of the equipment per the *manufacturer's* instructions.

B

7.6.2.5 b: Open zoning dampers, or set zone dampers to full airflow setpoint, that are installed in the *air ducts* connected to the *refrigeration system*.

Minimum air circulation rates provided by the manufacturer are set by UL 60335-2-40 based on refrigerant type and charge.

The minimum airflow shall be determined as:

$$Q_{min} = 30 \times m_c / LFL \quad \text{(GG.15DV)}$$

where

Q_{min} is the minimum circulation airflow circulated to the total conditioned space in m^3/h

m_c is the actual refrigerant charge for a single REFRIGERATING SYSTEM in kg

***LFL* is the lower flammability limit in kg/m^3**

Mechanical Ventilation (7.6.4)

C

Mechanical Ventilation (when required)

Enable circulation fan

- For units with refrigerant detection, the unit's circulation fan must be enabled upon detection of a leak

Mechanical ventilation shall be provided that will remove leaked refrigerant from the space where refrigerant leaking from the refrigeration system is expected to accumulate.

- The space shall be provided with an exhaust or transfer fan. Fans used to exhaust air from the space or transfer air to a separate indoor space shall comply with Equation 7-10

Ventilation can be continuous or enabled via refrigerant detection system.

- Other energy codes may prohibit continuous fan operation

Ventilation does not have to be to the outdoors

- it can be to an alternative space

There are requirements for make-up air and disabling ignition sources

Requirements for locating openings to facilitate mixing and prevent exhaust recirculation

Equation 7-10:

$$Q_{min} = \frac{Q_{req}}{C_{LFL}}$$

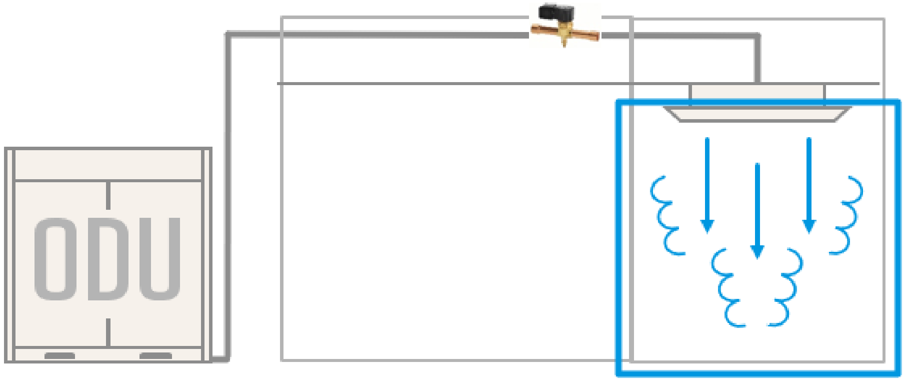
Where,

Q_{min} = *minimum mechanical ventilation airflow rate, ft^3/min (m^3/h)*
Q_{req} = *required ventilation as determined from Table 7-4*
C_{LFL} = *lower flammability limit conversion factor as determined from Table 7-5*

D

Release Mitigation Controls: Safety Shut Off Valves (7.3.4.4)

- Some equipment may include **Safety Shut Off Valves** (SSOV) to close when a leak is detected and limit the amount of refrigerant that can escape
- There are limits to when these devices can be used
  - 7.3.4.4(b): Release mitigation controls shall only be permitted for reducing the releasable refrigerant charge (m_{rel}) on a refrigeration system where **each indoor unit has a cooling capacity of 5 tons (17.5 kW) or less**.
- These controls are used to provide a smaller ‘releasable refrigerant charge’ to help comply with EDVC



De-energize Electric Resistance Heat and Potential Ignition Sources

E

7.6.2.5 d: De-energize electric resistance heat installed in an *air duct* that is connected to the *refrigeration system*.

7.6.2.5 f: De-energize potential ignition sources, including open flames and unclassified electrical sources of ignition with apparent power rating greater than 1kVA, where the apparent power is the product of the circuit voltage and current rating.

Refrigerant Piping

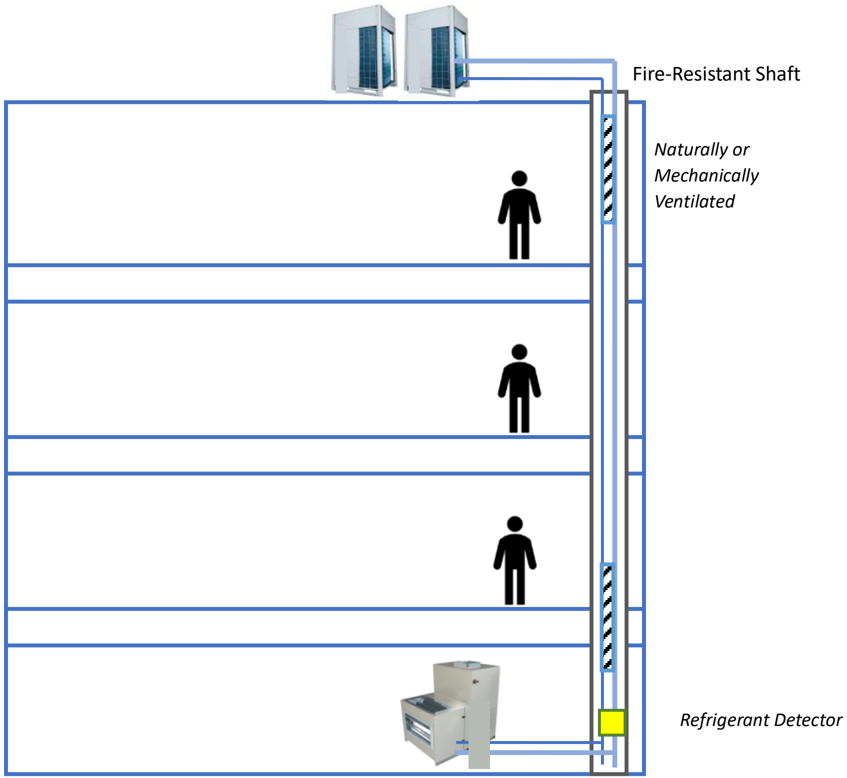
Are you penetrating two or more floor/ceiling assemblies?

Refrigerant piping requires special construction per ASHRAE Standard 15 Section 9.12. Some examples (there are more):

- Refrigerant piping **that penetrates multiple floor/ceiling assemblies shall be permitted to be enclosed in a fire-resistance-rated shaft enclosure**.
- Refrigerant pipe shafts with systems **using only Group A2L or B2L refrigerants shall be naturally or mechanically ventilated**.

IMC 1109.2.5 Refrigerant pipe shafts

- Refrigerant piping that **penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistant rated shaft enclosure.** The fire-resistant-rated shaft enclosure shall comply with Section 713 of the *International Building Code.*



ASHRAE Standard 15 - Machinery Rooms

- **Some notable requirements:**
  - Tight fitting doors
  - Access restriction to authorized personnel
  - No airflow to or from an occupied space
  - Refrigerant detectors that can actuate an alarm and mechanical ventilation

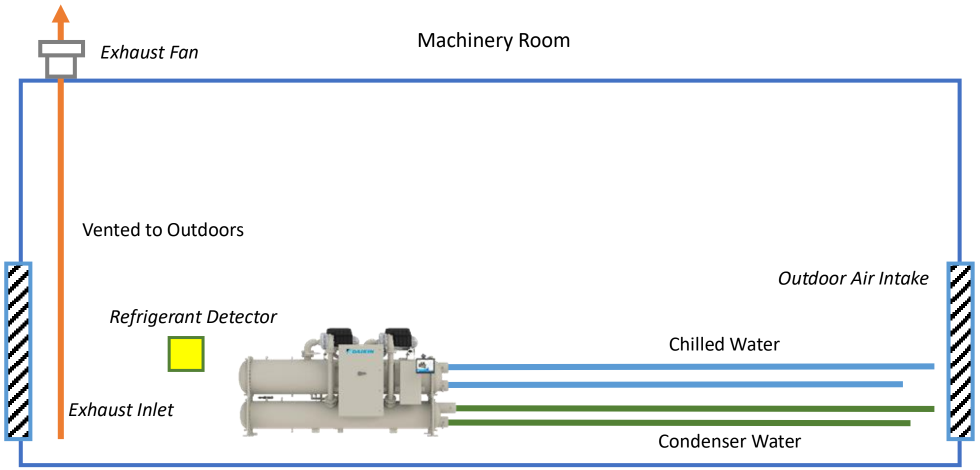
- **8.11.1 to 8.11.7** define special requirements for A2L and B2L refrigerants.
- **Elimination or interlocks** of ignition sources
- Ventilation for 2 different alarm states
  - **Trouble** (set point ≤ OEL): respond within 300 seconds, automatic reset of alarm and ventilation is permissible
  - **Emergency** (set point ≤ RCL): respond within 15 seconds, manual reset required for alarm and ventilation, higher CFM requirements

Machinery Room Requirements

Machinery Room Requirement	A1, B1	A2, B2, A3, B3	A2L, B2L
Equipment clearances with clear head room	Required (Section 8.9.1)	Required (Section 8.9.1)	Required (Section 8.9.1)
Tight-fitting, self-closing doors	Required (Section 8.9.2)	Required (Sections 8.9.2, 8.10.b)	Required (Sections 8.9.2, 8.11.2)
Exterior doors must not open under a fire escape or stairway	Not Required	Required (Section8.10.d)	Required (Section 8.11.4)
No openings to building, tightly-sealed penetrations	Required (Section 8.9.2)	Required (Sections 8.9.2, 8.10.e)	Required (Sections 8.9.2, 8.11.5)
Gasketed ductwork/AHU panels and doors	Required (Section 8.9.3)	Required (Section 8.9.3)	Required (Section 8.9.3)
Restricted access, door signs	Required (Sections 8.9.4, 10.1.3)	Required (Sections 8.9.4, 10.1.3)	Required (Sections 8.9.4, 10.1.3)
Refrigerant detector	Required (Section 8.9.5)	Required (Section 8.9.5)	Required (Sections 8.11.8 - 8.11.10)
Mechanical ventilation to the outdoors	Required (Section 8.9.6 - 8.9.8)	Required (Sections 8.9.6- 8.9.8)	Requirement Varies (Sections 8.9.6 – 8.9.8 or 8.11.11)
No open flames or hot surfaces	Exceptions Allowed (Section 8.9.9)	No Exceptions (Section 8.10a)	Exceptions Allowed (Section 8.11.1)
Non-combustable construction (walls, floor, ceiling)	Not Required	Required (Section 8.10.c)	Required (Section 8.11.3)
Conform to NEC Class 1, Division 2	Not Required	Required (Section 8.10.f)	May Not Be Required (comply with Section 8.11.6)
Remote control for shutting down equipment	Not Required	Required (Section 8.10.g)	Required (Section 8.11.7)

Notable Requirements for Machinery Rooms

- Refrigerant detection
- Visible and audible alarms
- Vented to outdoors
  - Low inlet
  - Powered exhaust fan
- Outdoor air intakes
- Two ventilation rates (A2L & B2L):
  - Level 1: Trouble (> OEL)
  - Level 2: Emergency Alarm (> RCL)



- Machinery: Refrigerating equipment forming a part of the refrigerating system, including (but not limited to) any or all of the following: compressor, condenser, liquid receiver, evaporator, and connecting piping
- Machinery Room: A designated space meeting the requirements of Sections 8.9, 8.10, and 8.11 that contains one or more refrigerating systems or portions thereof, such as compressors and pressure vessels

Machinery Room Ventilation Rates

Everything Except A2L and B2L

General Ventilation Requirements

Status	Ventilation Rate
Operated whenever machinery room is occupied	Continuously, at • 0.5 cfm/ft^2 (0.00254 m^3/s per m^2) of machinery room floor area, OR • 20 cfm (0.00944 m^3/s) per person
Operated whenever machinery room is occupied	Intermittently, at the airflow rate required to not exceed the higher of: • machinery room temperature 18°F (10°C) above the inlet air temperature, OR • machinery room temperature exceeding 122°F (50°C)
Ventilation during leak event (setpoint ≤ OEL)	• CFM = 100 × $G^{0.5}$ • G = largest circuit ref. charge (lbs)

Machinery Room Ventilation Rates

A2L & B2L

Refrigerant Detector Set Points, Response Times, Alarms, and Ventilation Levels

Limit Value	Response Time(s)	Alarm Type	Alarm Reset Type	Ventilation Level	Ventilation Reset Type
Set point ≤ OEL	≤ 300	Trouble	Automatic	Level 1	Automatic
Set point ≤ RCL	≤ 15	Emergency	Manual	Level 2	Manual

Level 1: Occupied or Trouble

Status	Level 1 Ventilation Rate
Operated whenever machinery room is occupied, AND Operated if refrigerant detector indicates refrigerant concentration exceeds the “trouble alarm” setpoint (must be set ≤ OEL)	Continuously, at the higher of the following airflow rates: • 0.5 cfm/ft^2 (0.00254 m^3/s per m^2) of machinery room floor area, OR • 20 cfm (0.00944 m^3/s) per person
Whenever machinery room is occupied	Intermittently, at the airflow rate required to not exceed the higher of: • machinery room temperature 18°F (10°C) above the inlet air temperature, OR • machinery room temperature exceeding 122°F (50°C)

Machinery Room Ventilation Rates

Level 2: Emergency (For A2Ls)

- Based on largest refrigerant charge & unit design pressure
- Cannot be less than the Level 1 rate
- A2Ls have more lenient mechanical room design requirements than class 2 or 3 refrigerants but may have higher ventilation rates during a Level 2 leak event
- Round **up** Q to 2 significant digits

Refrigerant Charge, G	Level 2 Ventilation Rate, Q
G < 0.1 × G'	Q >= Q' × 0.102 And Q >= Q_1
0.1 × G' <= G <= G'	Q >= Q' × [1 + 0.39 × ln (G/G')] And Q >= Q_1
G > G'	Q >= Q'

*Note: See section ASHRAE Standard 15-2022, section 8.11

Sample Calculation

Refrigerant	R-515B (A1)	R-1234ze (A2L)
Charge / Pressure	Largest Circuit Charge = 1000 lb	Largest Circuit Charge = 1000 lb Pressure = 14.7 + 185 psig = 199.7 psia
Method	Section 8.9.8.1: CFM = 100 × $G^{0.5}$	Section 8.11.11: Table 8-3 or Figure 8-1
Example	Q = 100 × $G^{0.5 = 100}$ = 100 × $1000^{0.5}$= 3,162 cfm **Q = 3,200 cfm**	G' = 21200 × $p^{-0.72}$ = 21200 × $199.7^{-0.72}$ = 467.8 lb Q' = 646 × $p^{0.62}$ = 646 × $199.7^{0.62}$ = 17,240 cfm G > G', therefore Q >= Q' **Q = 18,000 cfm**

Machinery Room Ventilation Rates

Level 2: Emergency (For A2Ls)

- Based on largest refrigerant charge & unit design pressure
- Cannot be less than the Level 1 rate
- A2Ls have more lenient mechanical room design requirements than class 2 or 3 refrigerants but may have higher ventilation rates during a Level 2 leak event
- Round **up** Q to 2 significant digits

Refrigerant Charge, G	Level 2 Ventilation Rate, Q
G < 0.1 × G’	Q >= Q' × 0.102 And Q >= Q_1
0.1 × G' <= G <= G'	Q >= Q' × [1 + 0.39 × ln (G/G’)] And Q >= Q_1
G > G'	Q >= Q’

*Note: See section ASHRAE Standard 15-2022, section 8.11

Sample Calculation

Refrigerant	R-515B (A1)	R-1234ze (A2L)
Charge / Pressure	Largest Circuit Charge = 1000 lb	Largest Circuit Charge = 1000 lb Pressure = 14.7 + 185 psig = 199.7 psia
Method		...ure 8-1
Example		...72 = 467.8 lb ...17,240 cfm G > G', therefore Q >= Q’ **Q = 18,000 cfm**

Note: Using Figure 8-1 may result in a higher ventilation rate than Table 8-3 when design pressure is on the lower end of each bucket

ASHRAE Standard 34

Terminology

Term	Definition
Burning velocity	The maximum velocity (in/s [cm/s]) at which a laminar flame propagates in a normal direction relative to the unburned gas ahead of it.
HOC	The heat released when a substance is combusted, determined as the difference in the enthalpy between the reactants (refrigerants and air) and their products after combustion as defined in Section 6.1.3.6. The heat or enthalpy of combustion is often expressed as energy per mass (e.g., Btu/lb [kJ/kg]).
LFL	The minimum concentration of a substance, e.g. a refrigerant, that is capable of propagating a flame through a homogeneous mixture of the substance and air under specified test conditions.
FCL	Flammable Concentration Limit, the refrigerant concentration limit, in air, intended to reduce the risk of fire or explosion in normally occupied, enclosed spaces, FCL = 25% × LFL
MIE	Minimum Ignition Energy (MIE) is the lowest energy required to ignite the flammable material in air or oxygen. The lowest value of the Minimum Ignition Energy is found at a certain optimum mixture of fuel and air.
OEL	The time-weighted average (TWA) concentration for a normal eight-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect, based on the OSHA PEL, ACGIH TLV-TWA, TERA OARS-WEEL, or consistent value.
RCL	The refrigerant concentration limit, in air, determined in accordance with this standard and intended to reduce the risks of acute toxicity, asphyxiation, and flammability hazards in normally occupied, enclosed spaces.
ATEL	Acute Toxicity Exposure Limit, a concentration limit intended to reduce the risks of acute toxicity hazards in normally occupied, enclosed spaces
ODL	Oxygen Deprivation Limit, the concentration of a refrigerant or other gas that results in insufficient oxygen for normal breathing

ASHRAE Standard 15

Terminology

Term	Definition
EDVC	Effective dispersal volume charge (EDVC), or the maximum refrigerant charge permitted for an effective dispersal volume.
Occupancy Classification	Characterizes the ability of people to respond to potential exposure to refrigerant, where classifications include institutional, public assembly, residential, commercial, large mercantile, industrial and mixed occupancy.
Refrigerating System Classification	Characterizes the refrigerating system, and in particular the method of extracting/delivering heat: direct or indirect, high-probability or low-probability.

Where Can I Go for Information?

Applying A2L Refrigerants:

- A2L Refrigerant Engineering Guide
- Navigating Retrofits and Replacements for High GWP Refrigerants Engineering Guide
- Navigating Retrofits and Replacements for High GWP Refrigerants Video
- Navigating the Hurdles of Low GWP Refrigerant Retrofits

Building Codes:

- ASHRAE Standards 15 and 34
- https://www.ashrae.org/technical-resources/bookstore/ashrae-refrigeration-resources
- https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

General Guidance:

- Preparing Buildings for A2L Refrigerants
- https://www.daikinapplied.com/decarbonization/refrigerants

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SAFE REFRIGERANT
TRANSITION TASK FORCE

Where Can I Go for Information?

General Guidance:

- AHRI Webcast Series
  - An Introduction to A2L Refrigerants
  - A2L Refrigerants Webinar Series Part 2 - Updates to Standards and Model Codes
  - A2L Refrigerants Webinar Series Part 3: State and Local Codes and Available Resources
- https://www.iccsafe.org/products-and-services/i-codes/a2l-refrigerants-transition/
- https://www.ashrae.org/news/ashraejournal/ashrae-journal-podcast-episode-3
- https://www.ahrinet.org/saferefrigerant
- https://www.acca.org/education/a2l-refrigerants
- https://www.rses.org/training/
- https://www.achrnews.com/articles/153195-understanding-a2l-refrigerants
- https://www.esmagazine.com/articles/99996-a2l-refrigerants-safely-addressing-refrigerant-flammability-concerns

Where Can I Go for Information?

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Thank you!