Refrigerant Transition Update

The Impact of Refrigerant Choice on the Design Sustainability of Your Projects

Steve Kujak – Director Next Generation Refrigerant Research

11/13/2023

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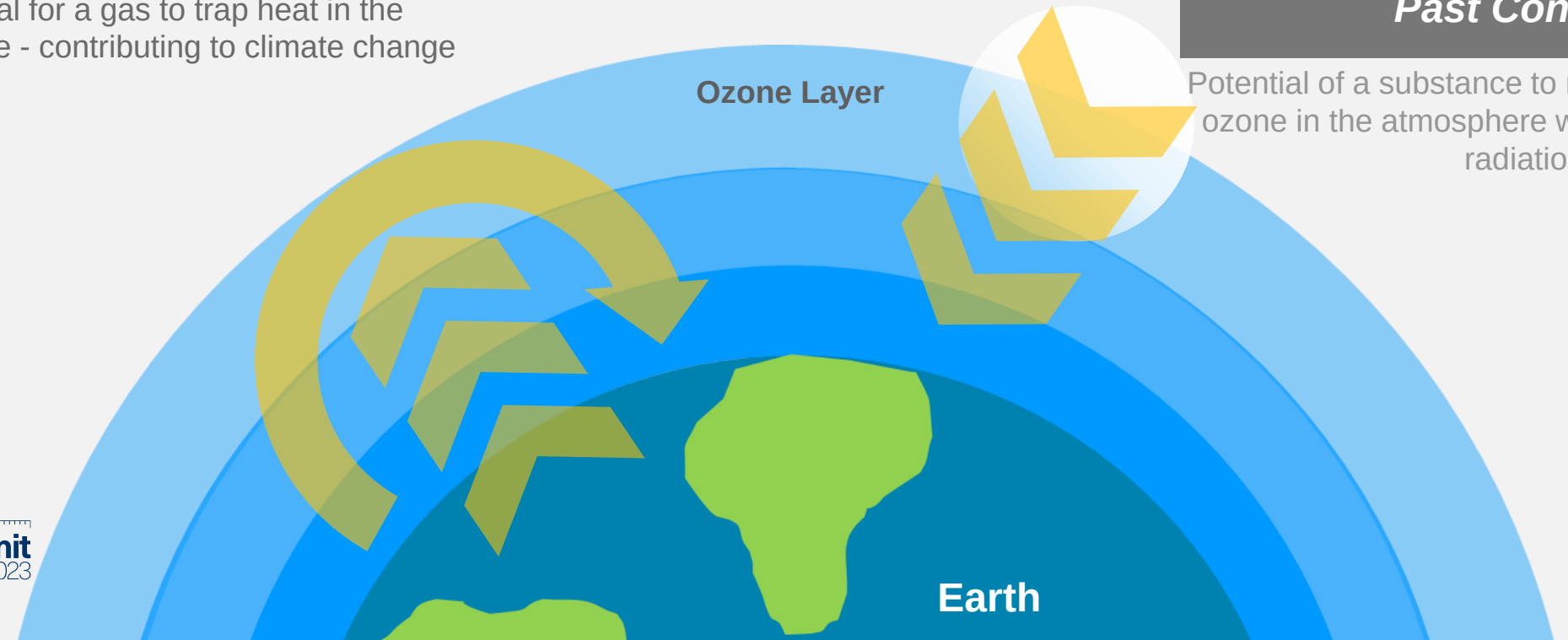
Why Are Refrigerants Transitioning?

Global Warming Potential (GWP)
Current Concern

Potential for a gas to trap heat in the atmosphere - contributing to climate change

Ozone Depletion Potential (ODP)
Past Concern

Potential of a substance to reduce the amount of ozone in the atmosphere which blocks harmful radiation

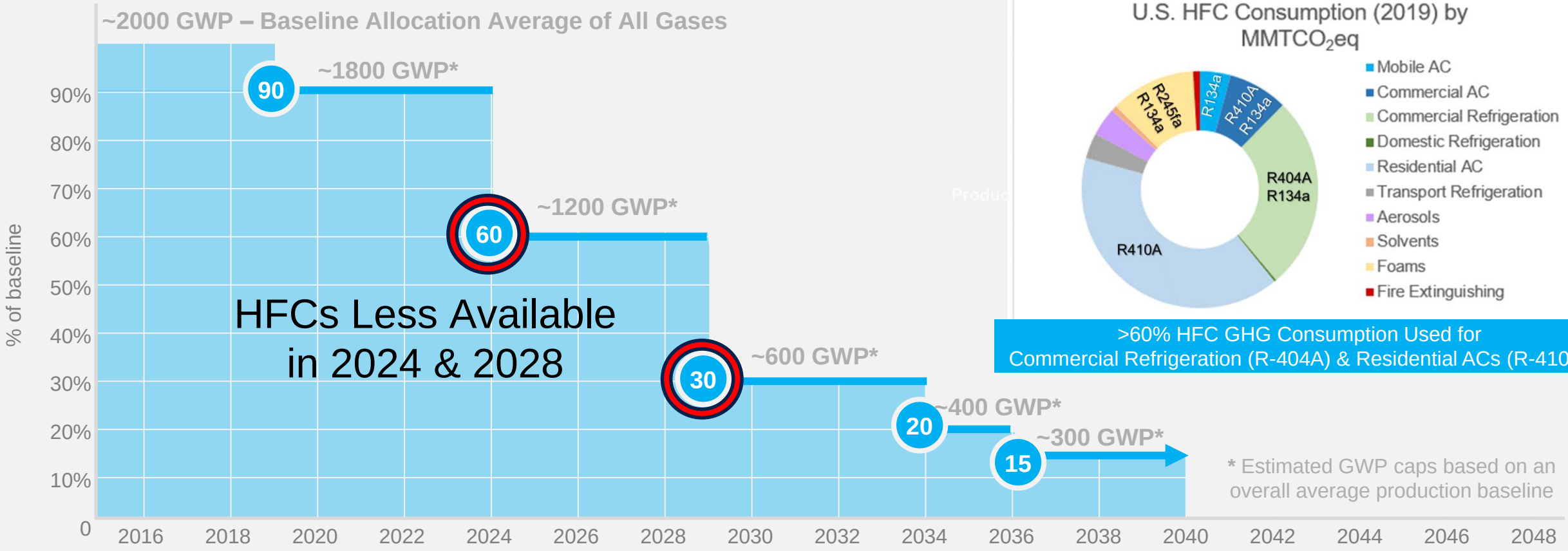


Regulatory Landscape

U.S. HFC Transition – Allocation Reduction Schedule

AIM Act Requires Production/Consumption Reductions through Allocations Following the Montreal Protocol Kigali Schedule for Developed Countries

October 2023 American Innovation and Manufacturing (AIM) Act Technology Transition (TT) Rule



>60% HFC GHG Consumption Used for Commercial Refrigeration (R-404A) & Residential ACs (R-410A)

GWP Phasedown Program – Not Refrigerant Phaseout

Reduced Refrigerant GWP Production Allocations + Reduced GWP in New Products

U.S. EPA HFC Technology Transfer Rule

Chillers/Heating: 700 GWP

- Comfort cooling: 2025
- Skating rinks: 2025
- Data centers: 2025
- Industrial Process Refrigeration (IPR) with temperature of chilled fluid
  - > -22 °F (-30 °C) (2026)
  - -50 °C (-58 °F) to -30 °C (-22 °F) (2028)
  - <-50 °C (-58 °F) no mandate

Data centers; self-contained; 700 GWP: 2027

Air conditioning (AC) / heat pumps (HPs): 700 GWP

- Unitary (light commercial and residential): 2025
- Dehumidifiers: 2025
- Variable refrigerant flow ≥ 65,000 BTU/h (5.4T): 2026

Refrigeration

- Stand-alone: 150 GWP; 2025
- Non-chiller IPR (2026), remote condensing (2026), supermarket (2027)
  - > 200 lbs charge: 150 GWP
  - ≤ 200 lbs charge: 300 GWP
  - High temperature side of cascade system: 300 GWP
  - IPR, where refrigerant entering evaporator Is between 30 and 50°C: 2028

Foams: 150 GWP

- Excluding marine space vehicles, military and aerospace uses: 2025
- Military and aerospace uses: 2026
- Foams for export: 2028

USEPA TT Rule Fact Sheet

October 2023 American Innovation and Manufacturing (AIM) Act Technology Transition (TT) Rule

https://www.epa.gov/climate-hfcs-reduction/regulatory-actions-technology-transitions

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Other Details – Product, System & Repair

The final rule makes a distinction between RACHP products and systems. The rule restricts the manufacture and import of certain RACHP products and the installation of certain RACHP systems.

Product - functional upon leaving a factory. Examples of products include window air conditioning units, refrigerators, and stand-alone ice machines. EPA is restricting the sale, distribution, and export of products containing higher GWP HFCs 3 year sell through after the manufacture/ import restriction dates. Some chillers could be considered products if only electrical and water connections are required at time of install.

System - is assembled and charged in the field using multiple components. Examples include supermarket refrigeration systems that include a centralized compressor room and mini-split air conditioners. Components include equipment such as compressors, condensers, and display cabinets (does not include controls, fans and other components). In this rule, EPA is not restricting the manufacture, import, sale, distribution, or export of components that are used to repair existing RACHP systems. No sell through!

Repair - generally any individual refrigeration component(s) of an existing system using a high GWP refrigerants can be repaired or replaced (see further details for systems with multiple evaporators). Dry or partially charged condenser assemblies (outdoor units) can continue to be used to repair systems.

FAQ Additions to TT Webpage

Additional State Actions on HFC Technology

11 States – Chillers Only

CA, CO, DE, MA, MD, ME, NJ, NY, RI, VA, VT, WA

- **Chillers (comfort)**
  - **No R134a or R410A**
  - **1/1/2024**
  - **Manufacture date**

California Only

- **Unitary/Res**
  - 750 GWP (follow USEPA 700 GWP limit)
  - 1/1/2025
  - Manufacture date
- **VRF**
  - 750 GWP (follow USEPA 700 GWP limit)
  - 1/1/2026
  - Manufacture date
- **Ice rinks** (new facilities) **/ Industrial refrigeration**
  - 150 GWP (USEPA 700 GWP)
  - 1/1/2025
  - Manufacture date

Most States Will Allow USEPA to Enforce HFC Technology Transition Rules
States Can Put in Place More Restrictive Rules – Not Less

Refrigerant Choices

Next-Generation Refrigerants is About Balancing Critical Factors

SAFETY
EFFICIENCY
ENVIRONMENT

There is No Perfect Refrigerant

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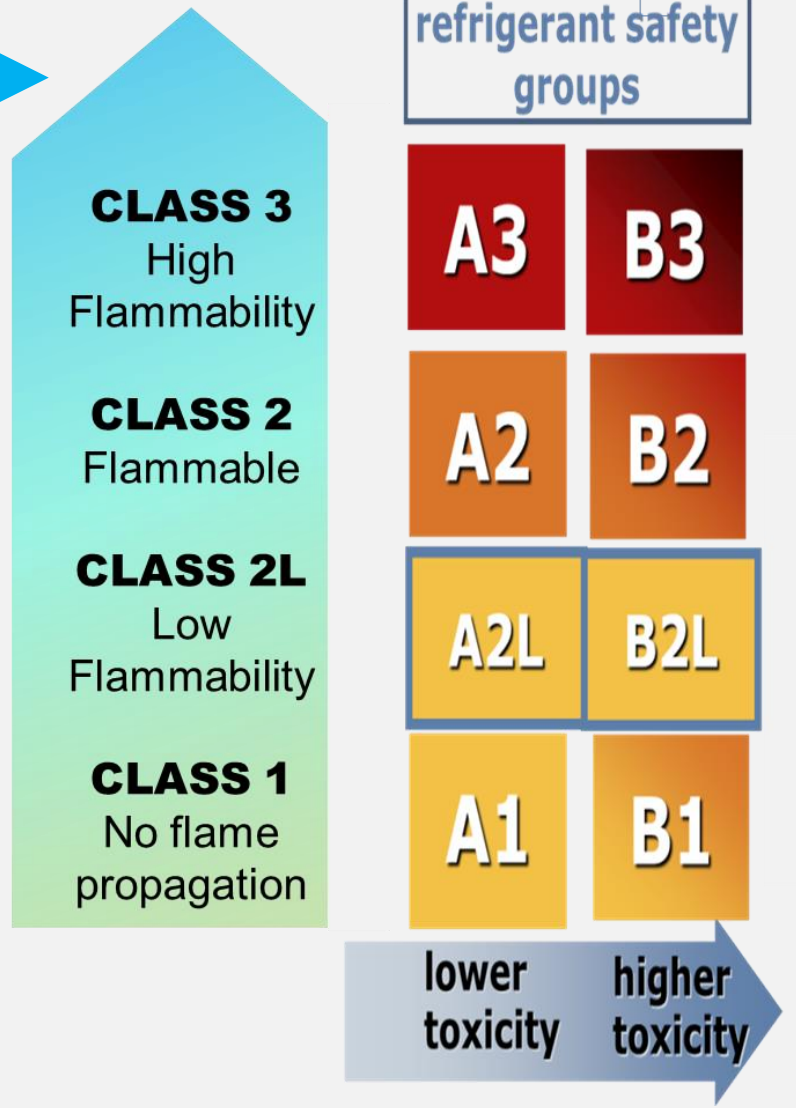
Next Generation Refrigerant Safety



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Closer Look - Low Pressure Options

		Baseline	Ultra-Low GWP	
		R-123	R-514A	R-1233zd(E)
Flammability	ASHRAE Class	1	1	1
Toxicity[1]	ASHRAE Class	Higher (B)	Higher (B)	Lower (A)
	OEL (ppm)	50	320	800
Efficiency (COP)		8.95	8.91	8.87
Capacity Change		baseline	~5% loss	~35% gain
GWP[2]		77	1.7	1
Atmospheric Life		1.3 years	22 days	26 days

*Modeling Conditions: 100% isentropic compressor efficiency, 95°F/44°F, 0 superheat, 0 subcooling

[1]None of these refrigerants shown in the table are considered "toxic" or "highly toxic" as defined by the IFC, UFC, NFPA 1 or OSHA regulations.

[2]GWP values reported are per the Fourth Assessment Report (AR4) of the IPCC (Intergovermental Panel on Climate Change).

R-514A & R-1233zd(E) Both Good Choices
Non-Flammable (Class 1), Ultra Low GWPs with High Efficiency Available Now

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Closer Look - Medium Pressure Options

		Baseline	Lower GWP		Ultra-Low GWP	
		R-134a	R-513A	R-515B	R-1234yf	R-1234ze(E)
Flammability	ASHRAE Class	1	1	1	2L	2L
Toxicity[1]	ASHRAE Class	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)
	OEL (ppm)	1000	650	810	500	800
Efficiency (COP)		8.47	8.27	8.32	8.17	8.45
Capacity Change		baseline	similar	~25% loss	~5% loss	~25% loss
GWP[2]		1430	630	298	6	4
Atmospheric Life		13.4 years	5.9 years	3.1 years	11 days	18 days

*Modeling Conditions: 100% isentropic compressor efficiency, 95°F/44°F, 0 superheat, 0 subcooling
*R-513A introduced for ice rinks applications in 2019

R-513A & R-515B Good Solutions for Existing Mechanical Rooms Longer Term – Flammable Solutions Required to Meet GWP Goals

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Closer Look – High Pressure A/C Options

		Baseline	Lower GWP	
		R-410A	R-454B	R-32
Flammability	ASHRAE Class	1	2L	2L
Toxicity[1]	ASHRAE Class	Lower (A)	Lower (A)	Lower (A)
	OEL (ppm)	1000	850	1000
Efficiency (COP)		7.99	8.16	8.22
Capacity Change		baseline	~3% loss	~8% gain
GWP[2]		2088	467	675
Atmospheric Life		17 years	3.6 years	5.2 years

*Modeling Conditions: 100% isentropic compressor efficiency, 95°F/44°F, 0 superheat, 0 subcooling

Glide: difference between when a refrigerant condenses (dew point) and when it boils (bubble point) at constant pressure

Comparing refrigerants R454B vs R32

R-454B & R-32 Good “Interim” Solutions
R-454B Offers Best Choice of GWP vs Available Allocation Over the Phase Down

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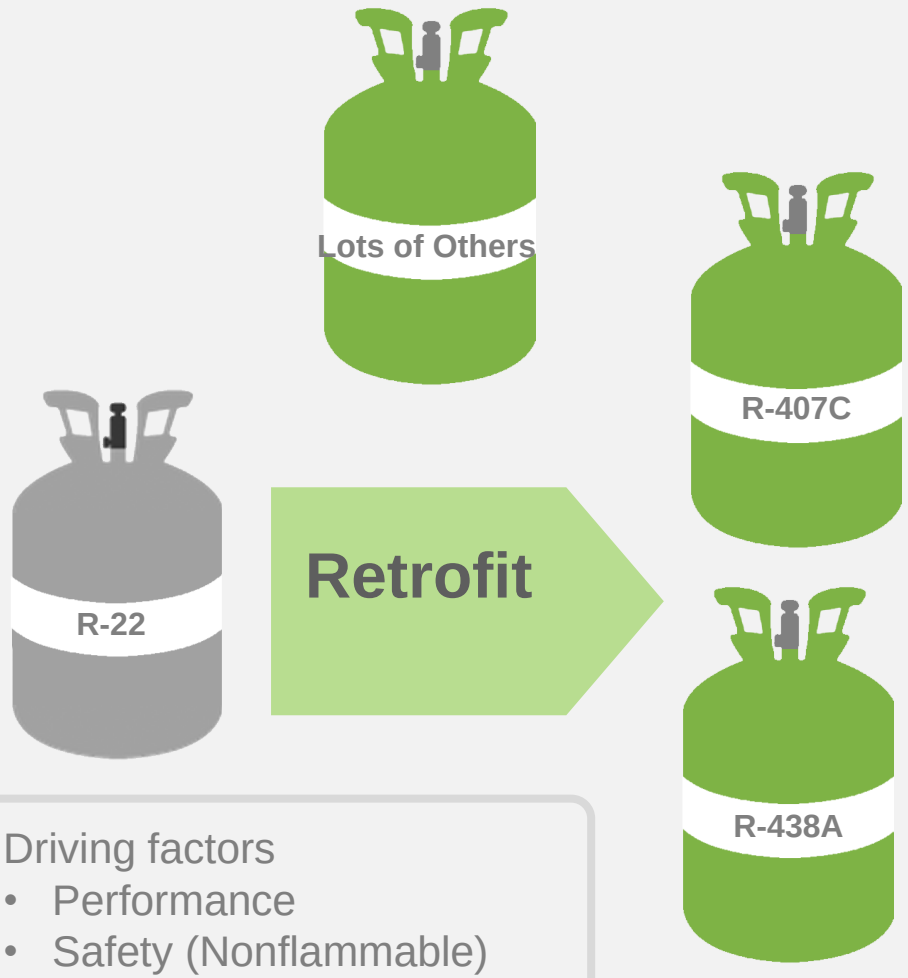
R-410A Retrofits or Conversions



Driving factors
- Performance
- Safety (Nonflammable)
- Cost

"Reasonable Performance"

Driving factors
- Performance
- Safety (Nonflammable)
- Cost

"No Nonflammables with Reasonable Performance"

A2L Flammable Refrigerants Not Allowed to Retrofit A1 Equipment

Sustainability Impacts of Refrigerant Choice

Refrigerant Impact – 6,000 Ton Plant

Trane myCO2e refrigerant comparison tool

CO_2e Impact Statement

Project Name: 6,000 Ton Plant

Refrigerants must be evaluated today for Global Warming Potential. Each refrigerant has an associated GWP value that determines the impact per pound. The more refrigerant released to the atmosphere, the greater the negative Carbon impact of that chiller.

	Trane® CTV	Trane ECTV	Competitor
Chiller Information			
Chiller Type	Centrifugal	Centrifugal	Centrifugal
Refrigerant Type	R-514A	R-1234ze(E)	R-513A
Total Refrigerant Charge	9,600	6,684	12,288
GWP of Refrigerant	1.7	4	630
Annual Leakage Rate	0.5%	2.0%	2.0%
CO_2e Results			
CO_2e Initial Charge Risk (MT)	7.4	12.1	3511.5
CO_2e Lifetime Leakage (MT)	0.9	5.6	1615.3
CO_2e Equip. Service End of Life (MT)	0.7	1.2	351.2
Total CO_2e (MT)	**9.0**	**18.9**	**5478.0**
Estimated Refrigerant Service Cost ($)	**30,912**	**98,388**	**107,397**

	Trane® CTV	Trane ECTV	Competitor
Carbon Offsets			
Companies today are often under pressure from consumers and shareholders to counterbalance any carbon emissions by purchasing Carbon Offsets. Current cost is $16.99 per Metric Ton https://terrapass.com/product/business-carbon-offset			
Total Cost of CO_2 Offset ($)	**153**	**321**	**93,072**
Gasoline Equivalency			
To put Carbon Impact from chillers into relatable terms, the equivalent amount of emissions from a vehicle burning gasoline can be used as a comparison.			
Gallons of Gasoline Equivalency	**1,016**	**2,138**	**619,017**

The chiller option with the lowest overall Carbon Impact is the Trane® CTV

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https://www.trane.com/commercial/north-america/us/en/products-systems/design-and-analysis-tools/trane-design-tools/myco2e-tool.html

Refrigerant Impact
Single Whole Unit Loss (1,500T, R-134a)

EPA United States Environmental Protection Agency

Environmental Topics | Laws & Regulations | Report a Violation | About EPA

Energy and the Environment

Greenhouse Gas Equivalencies Calculator

Convert emissions or energy data into concrete terms you can understand — such as the annual CO_2 emissions of cars, households, and power plants.

The Greenhouse Gas Equivalencies calculator allows you to **convert emissions or energy data to the equivalent amount of carbon dioxide (CO_2) emissions from using that amount**. The calculator helps you translate abstract measurements into concrete terms you can understand, such as the annual emissions from cars, households, or power plants. This calculator may be useful in communicating your greenhouse gas reduction strategy, reduction targets, or other initiatives aimed at reducing greenhouse gas emissions.

Updated March 2022

These estimates are approximate and should not be used for emission inventories or formal carbon emissions analysis. See Calculations & References for equations and sources used.

Greenhouse Gas Equivalencies CALCULATOR

Step 2 - View results

1,993 Metric Tons **of Carbon Dioxide (CO_2) equivalent**

This is equivalent to greenhouse gas emissions from:

429 gasoline-powered passenger vehicles driven for one year	**4,946,075** miles driven by an average gasoline-powered passenger vehicle

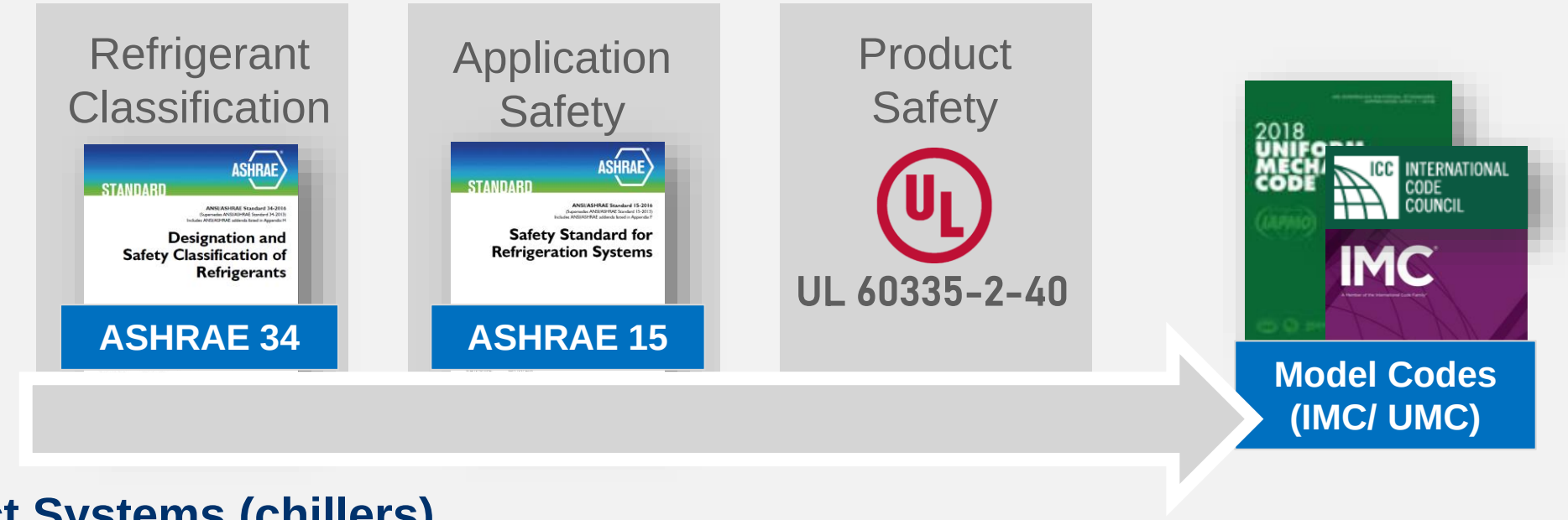
This is equivalent to CO_2 emissions from:

224,217 gallons of gasoline consumed	**195,738** gallons of diesel consumed

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Standard 15 Changes & Application of A2Ls

Updated Safety Standards and Model Codes



Indirect Systems (chillers)

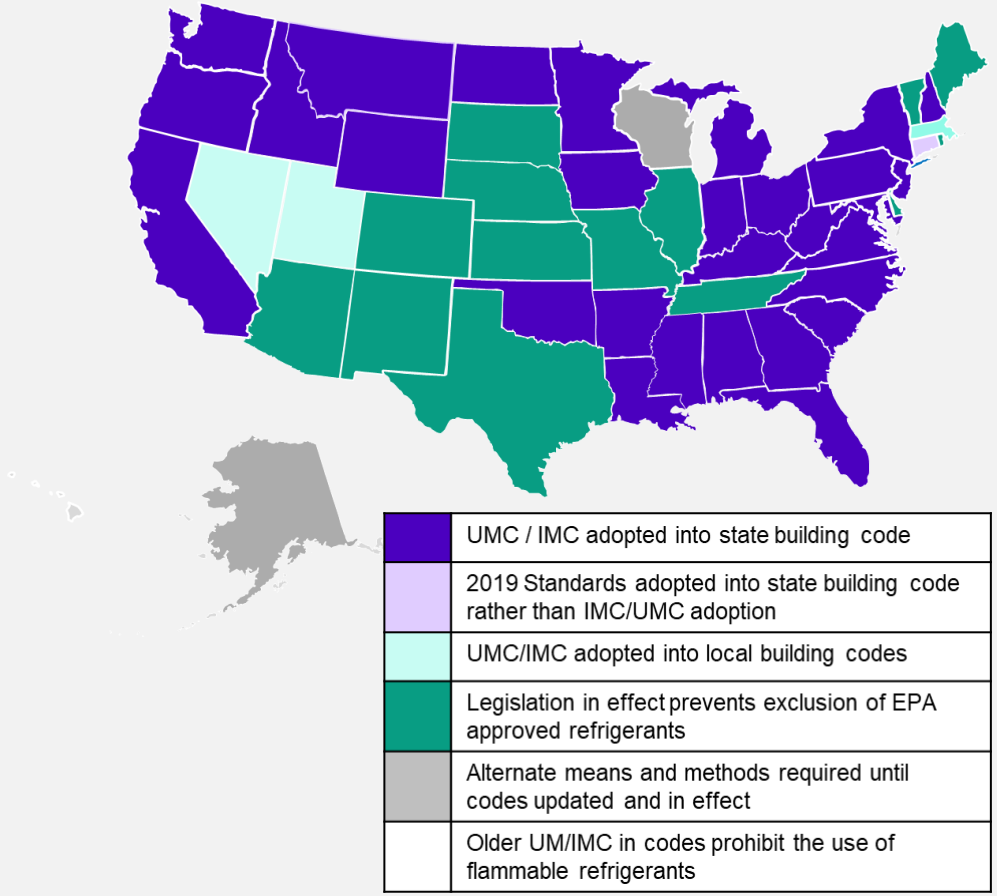
- 2018 UMC/IMC (Install as A2) UL 60335-2-40 2018
- 2021 UMC/IMC (ASHRAE 15 2019 + UL 60335-2-40 2019)
- ASHRAE 15 2022 + UL 60335-2-40 2022 are being adopted into state codes

Direct Systems (Unitary/VRF)

- 2024 UMC/IMC (ASHRAE 15 2022 + UL 60335-2-40 2022)
- ASHRAE 15 2019 and UL 60335-2-40 2019 are being adopted into existing state codes

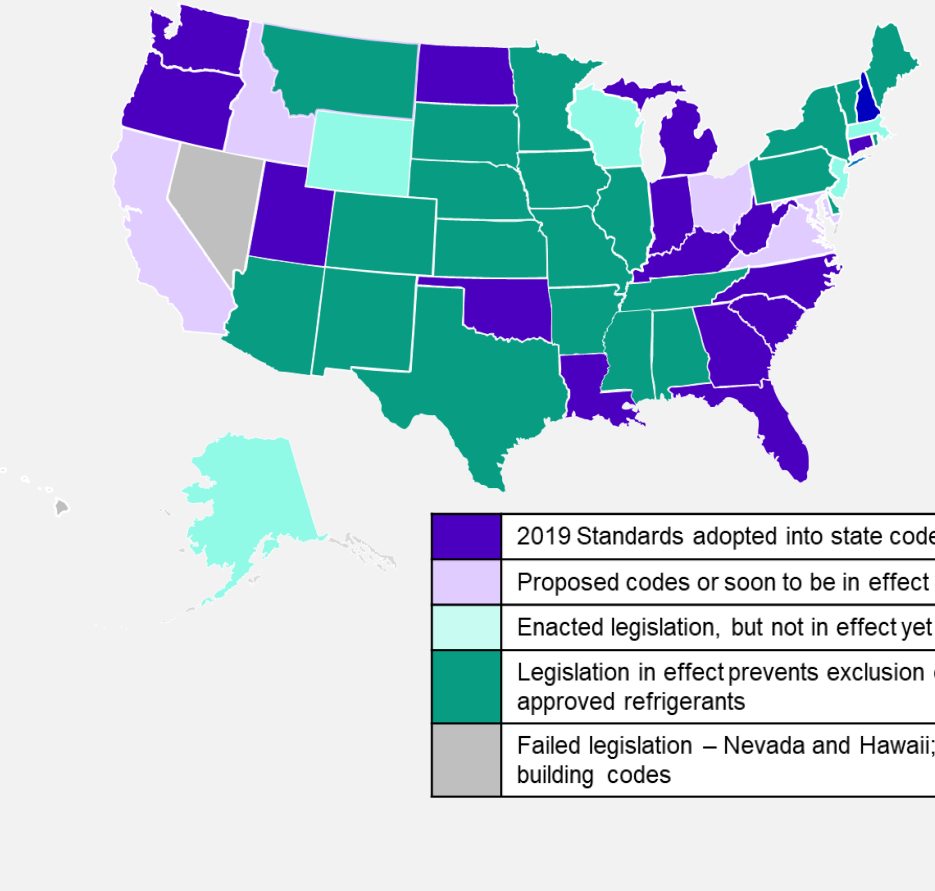
States are Updating Codes and Enacting Legislation to Enable A2Ls in Equipment (as of July 1, 2023)

Most states have already enabled A2Ls for **chillers**



	UMC / IMC adopted into state building code
	2019 Standards adopted into state building code rather than IMC/UMC adoption
	UMC/IMC adopted into local building codes
	Legislation in effect prevents exclusion of EPA approved refrigerants
	Alternate means and methods required until codes updated and in effect
	Older UM/IMC in codes prohibit the use of flammable refrigerants

States are enabling A2Ls for **direct systems**



	2019 Standards adopted into state codes
	Proposed codes or soon to be in effect
	Enacted legislation, but not in effect yet
	Legislation in effect prevents exclusion of EPA approved refrigerants
	Failed legislation – Nevada and Hawaii; pursuing building codes

Alternate Means and Methods Code Process Needed for Latest Standard Practices
ASHRAE & AHRI Funded by USDOE to Finalize by EOY 2024

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Standard 15 - A2L Application Examples

Indirect Systems – Machinery Rooms

Impacted Product Types:

Chillers

Impacted Refrigerants:

R-1234ze | R-32 | R-454B | R-1234yf

NEW REQUIREMENTS

Space Refrigerant Detectors:

- **When activated increase airflow supplied to the occupied space and turns off compressors, heaters, and other electrical devices. (25% of LFL Lower Flammability Limit)**
- **Must activate in under 15 seconds**

Remote Control:

- **Must be possible to initiate a chiller stop and initiate the ventilation sequence from immediately outside the machinery room.**

Multiport Refrigerant Detector:

- **Are no longer allowed for 2L refrigerants**

Ventilation Rates:

- **2 rates required**
  - **Trouble Alarm**
  - **Emergency Alarm**
- **Increased ventilation rates**

Detection & Ventilation Practices Continue

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Summary of Refrigerant Safety Data Standard 34

Refrigerant number	Safety group	OEL (ppm)	RCL (lbs/1000 ft^3)	LFL (lbs/1000 ft^3)	Code classification
R-123	B1	500	3.5		Neither
R-514A	B1	320	0.86		Neither
R-1233zd(E)	A1	800	5.3		Neither
R-134a	A1	1000	13		Neither
R-717	B2L	25	0.014	7.2	Neither
R-513A	A1	650	20		Neither
R-515B	A1	810	18		Neither
R-1234ze(E)	A2L	800	4.7	18.8	Neither
R-410A	A1	1000	26		Neither
R-454B	A2L	850	4.6	18.5	Neither
R-32	A2L	1000	4.8	19.1	Neither
R-290	A3	1000	0.59	2.4	Neither

Flammability Limits Usually Set Safety Protocols
Few Exceptions – Ammonia (R-717)

Machinery Room Ventilation Example
Large Water Chiller Installed Indoors

600-ton water chiller, single refrigeration circuit

Refrigerant charge (G) = 1800 lbs of R-134a

Single circuit: m_{rel} = 1800 lbs

RCL for R-134a (A1) = 13 lbs/1000 ft^3 = 0.013 lbs/ft^3

Installed in a separate mechanical space

Effective dispersal volume (V_{eff}) = room volume = 32,400 ft^3

"Commercial" occupancy: F_{occ} = 1.0

EDVC = 0.013 lbs/ft^3×32,400 ft^3×1.0 = 421 lbs

mrel > EDVC, so this space does NOT comply with Section 7.3
(per Section 7.4, all components must be installed in a "machinery room")

The ENL video can be viewed from trane.com at:
https://mylearning.tranetechnologies.com/lmt/clmsCatalogDetails.prMain?in_sessionId=J004095J3845194J&in_from_module=CLMSBROWSEV2.PRMAIN&in_offeringId=632897871

For the application manual, I would just list it and tell them to request it from their account manager. Internally, it is posted at:
https://hub.tranetechnologies.com/docs/DOC-195617

Comparison A1/B1 vs A2L Ventilation Machinery Room Installations

Refrigerant	Refrigerant safety classification	Refrigerant charge, G	Alarm (level 2) ventilation rate, Q
R-134a	A1	750 lbs	2740 cfm
R-123	B1	500 lbs	2240 cfm
R-514A	B1	850 lbs	2920 cfm
R-1234ze	A2L	1200 lbs	18,000 cfm
R-1234ze	A2L	850 lbs	12,750 cfm (4.4x)

20+ yr. Old Unit
Lower Efficiency
w Lower Charge

Impact of 4:1 safety factor on LFL

Example: 500-ton water-cooled chiller, single refrigeration circuit Alarm (or Level 2 Ventilation)

Standard 15 - A2L Application Examples

Direct Systems

Impacted Product Types:

RTU's | VRF | WSHP | Splits

Impacted Refrigerants:

R-32 | R-454B

NEW REQUIREMENTS

Equipment Refrigerant Detectors:

- **Factory installed at the evaporator coil**
- **Must act quickly (<15 seconds) and at low levels (25 percent of Lower Flammability Limit)**
- **When activated increase airflow supplied to the occupied space and turns off compressors, heaters, and other electrical devices**

Ignition Sources

- **Avoid locating potential ignition sources in ductwork**
  - **Electric resistance allowed with minimum CFM (200 ft/min)**

Control of Refrigerant Charge, Detection with Air Circulation

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Section 7.6.1.1, Equation 7-8
EDVC for Systems With Air Circulation

$$EDVC = V_{eff} \times LFL \times 0.50 \times F_{occ}$$

where:

V_{eff} = effective dispersal volume per Sections 7.2.1 – 7.2.3, ft^3

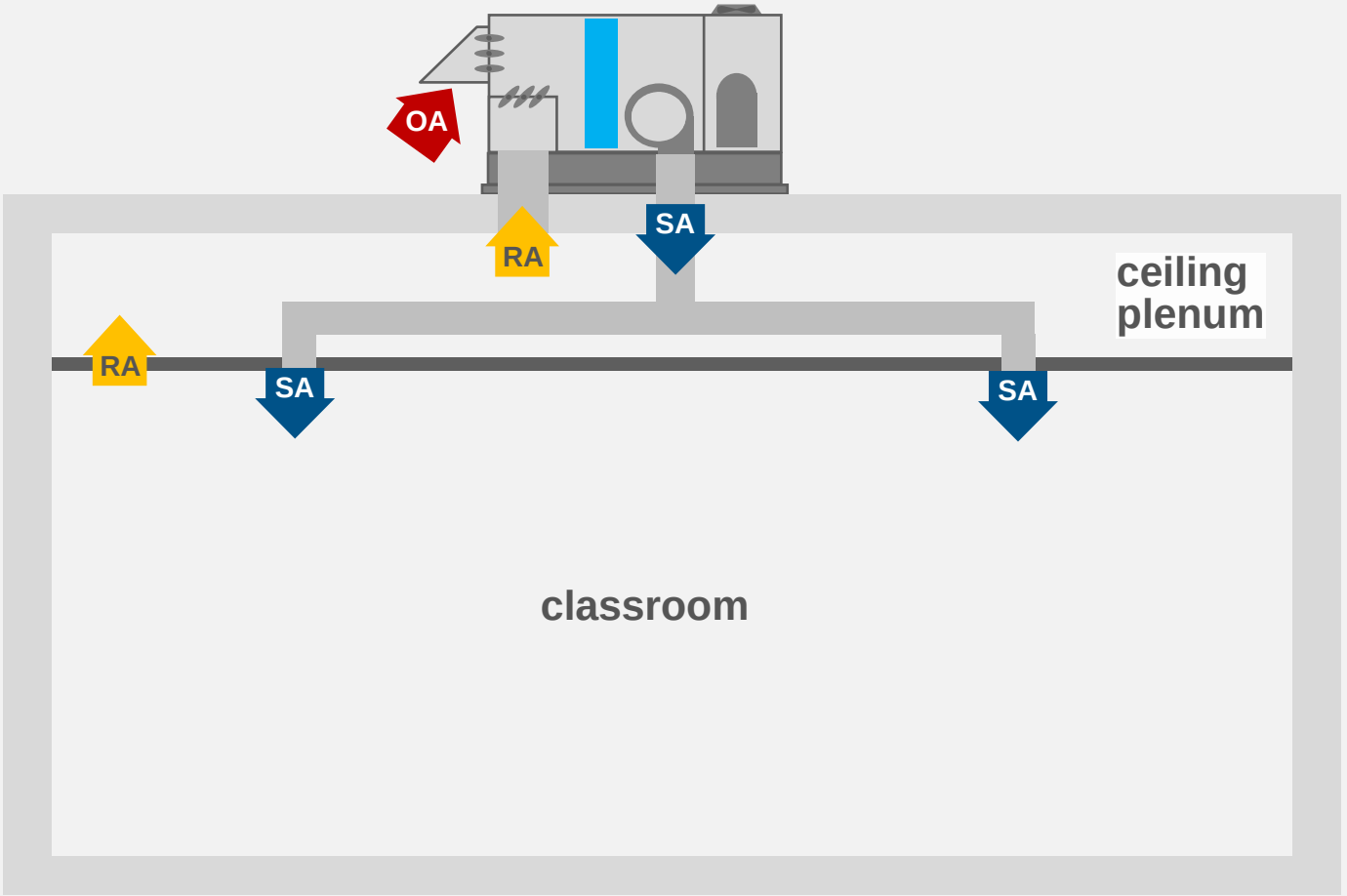
LFL = lower flammability limit published in ASHRAE 34, lb/ft^3 *

F_{occ} = occupancy adjustment factor (0.5 for institutional; 1.0 for all others)

* Note that values tabulated in ASHRAE Standard 34 are in units of $lb/1000\ ft^3$, so be sure to convert to the correct units when using this formula.

Packaged Rooftop Unit Serving Classroom

space	volume (ft^3)
classroom	10,000
ceiling plenum	1500
sum	**11,500**



Packaged Rooftop Unit Serving Classroom

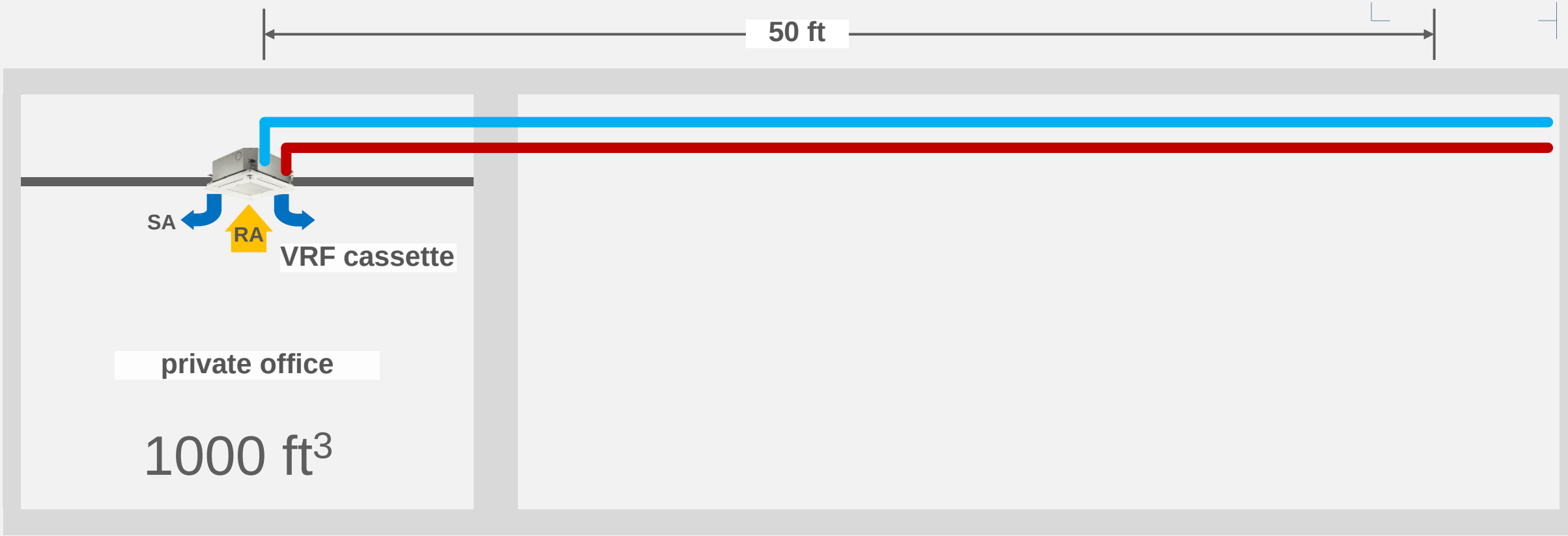
If the system uses a **Group A2L** refrigerant:

- **Refrigerant charge = 5.1 lbs of R-454B**
- ***Single*** **circuit: m_{rel} = 5.1 lbs (largest charged circuit)**
- **LFL for R-454B (A2L) = 18.5 lbs/1000 ft^3 = 0.0185 lbs/ft^3**
- **Equipped with a refrigerant detector to initiate air circulation**

EDVC = 0.0185 lbs/ft^3×11,500 ft^3×0.5×1.0 = 106 lbs

mrel << EDVC, so this system complies with Section 7.6.1
Expect similar results for multiple zone VAV rooftop systems

VRF System in “Commercial” Occupancy



VRF System in “Commercial” Occupancy

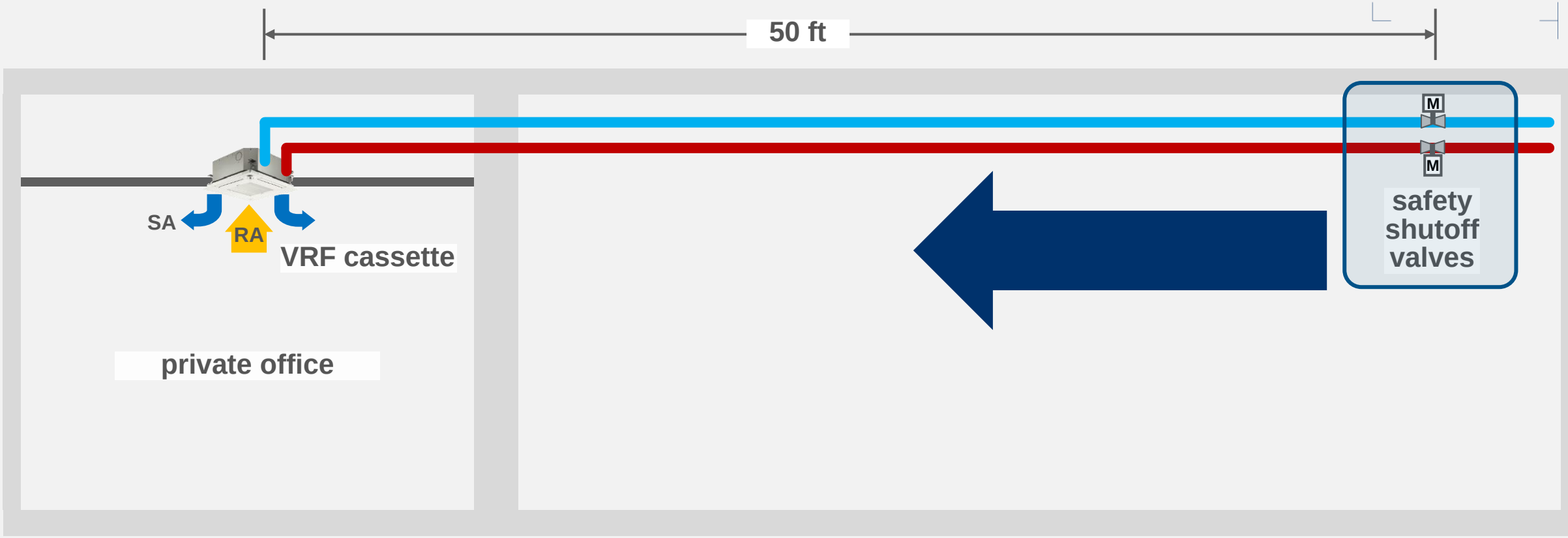
If the system uses a **Group A2L** refrigerant:

- **Total refrigerant charge = 27 lbs of R-454B**
- **Single circuit: m_{rel} = 27 lbs**
- **LFL for R-454B (A2L) = 18.5 lbs/1000 ft^3 = 0.0185 lbs/ft^3**
- **Effective dispersal volume, V_{eff} = 1000 ft^3**
- **Equipped with a refrigerant detector to initiate air circulation**

EDVC = 0.0185 lbs/ft^3×1000 ft^3×0.5×1.0 = 9.25 lbs

m_{rel} > EDVC, so this system does NOT comply with Section 7.6.1

Standard Allows for Release Mitigation Controls



With release mitigation controls, m_{rel} is reduced to 9.32 lbs, which is still higher than the EDVC of 9.25 lbs, so this system does NOT comply with Section 7.3.

Section 7.6.2.4

Refrigerant Detection System Requirements

- Capable of detecting specific refrigerant being used
- If refrigerant concentration ≥ 0.25×LFL, generate an output signal in ≤ 30 seconds to initiate mitigation actions
- Setpoint not adjustable, recalibration not permitted
- Must include self-diagnostics, energize air circulation fan(s) upon failure of a self-diagnostic check
- Must allow access for replacement

Sections 7.2.3.1.1
Exempted Spaces

- Areas only with continuous *refrigerant piping*, or joints that have been tested in accordance with Section 9.13, are exempt from the EDVC

Table 9-13 Duration of Leak Test

	Pipe Length, L		Maximum Nominal Pipe Size		Minimum Period of Test
Leak Test	ft	m	NPS, in.	DN, mm	hours
Pressure test	$L \leq 100$	$L \leq 30$	NPS $\leq$ 3/4	DN $\leq$ 20	0.25
			3/4 < NPS $\leq$ 3	20 < DN $\leq$ 75	1.0
			3 < NPS	75 < DN	24
	$100 < L \leq 200$	$30 < L \leq 61$	NPS $\leq$ 3	DN $\leq$ 75	1.0
			3 < NPS	75 < DN	24
	$200 < L$	$61 < L$	Any	Any	24
Vacuum test	$L \leq 100$	$L \leq 30$	NPS $\leq$ 3/4	DN $\leq$ 20	1.0
			3/4 < NPS $\leq$ 3	20 < DN $\leq$ 75	8.0
			3 < NPS	75 < DN	24
	$100 < L \leq 200$	$30 < L \leq 61$	NPS $\leq$ 3	DN $\leq$ 75	8.0
			3 < NPS	75 < DN	24
	$200 < L$	$61 < L$	Any	Any	24

Informative Note: The maximum nominal pipe size is the largest interconnecting field *piping* installed.

Sections 9.12.1.5 and 9.12.2.2

Refrigerant Pipe Shafts

Refrigerant piping that penetrates two or more floors must be enclosed in fire-resistance-rated shaft enclosure

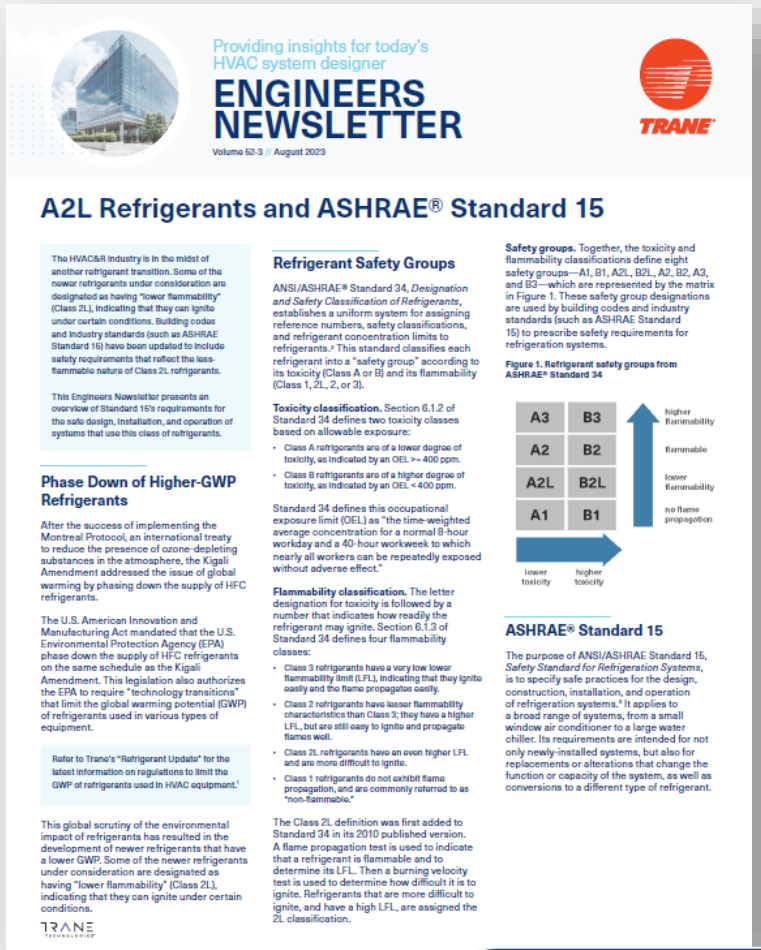
- **Other utilities can be routed inside this same shaft.**
- **Not required for a high-probability system if RCL not exceeded for smallest occupied space piping passes through**

For flammable refrigerants, pipe shaft must be ventilated

Section 9.13
Inspection and Leak Testing

9.13.7 Contractor or Engineer. *The installing contractor or registered design professional of record shall issue a certificate of test, verifying strength test in accordance with Section 9.13.5 and… Section 9.13.6, to the AHJ for all systems containing 55 lb (25 kg) or more of refrigerant…. The certification of test shall be signed by the installing contractor or registered design professional and shall be made part of the public record.*

Where to Learn More



Providing insights for today's HVAC system designer

ENGINEERS NEWSLETTER

Volume 52-3 // August 2023

A2L Refrigerants and ASHRAE® Standard 15

The HVAC&R industry is in the midst of another refrigerant transition. Some of the newer refrigerants under consideration are designated as having "lower flammability" (Class 2L), indicating that they can ignite under certain conditions. Building codes and industry standards (such as ASHRAE Standard 15) have been updated to include safety requirements that reflect the less-flammable nature of Class 2L refrigerants.

This Engineers Newsletter presents an overview of Standard 15's requirements for the safe design, installation, and operation of systems that use this class of refrigerants.

Phase Down of Higher-GWP Refrigerants

After the success of implementing the Montreal Protocol, an international treaty to reduce the presence of ozone-depleting substances in the atmosphere, the Kigali Amendment addressed the issue of global warming by phasing down the supply of HFC refrigerants.

The U.S. American Innovation and Manufacturing Act mandated that the U.S. Environmental Protection Agency (EPA) phase down the supply of HFC refrigerants on the same schedule as the Kigali Amendment. This legislation also authorizes the EPA to require "technology transitions" that limit the global warming potential (GWP) of refrigerants used in various types of equipment.

Refer to Trane's "Refrigerant Update" for the latest information on regulations to limit the GWP of refrigerants used in HVAC equipment.[1]

This global scrutiny of the environmental impact of refrigerants has resulted in the development of newer refrigerants that have a lower GWP. Some of the newer refrigerants under consideration are designated as having "lower flammability" (Class 2L), indicating that they can ignite under certain conditions.

Refrigerant Safety Groups

ANSI/ASHRAE® Standard 34, *Designation and Safety Classification of Refrigerants*, establishes a uniform system for assigning reference numbers, safety classifications, and refrigerant concentration limits to refrigerants.[2] This standard classifies each refrigerant into a "safety group" according to its toxicity (Class A or B) and its flammability (Class 1, 2L, 2, or 3).

Toxicity classification. Section 6.1.2 of Standard 34 defines two toxicity classes based on allowable exposure:

- Class A refrigerants are of a lower degree of toxicity, as indicated by an OEL >= 400 ppm.
- Class B refrigerants are of a higher degree of toxicity, as indicated by an OEL < 400 ppm.

Standard 34 defines this occupational exposure limit (OEL) as "the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect."

Flammability classification. The letter designation for toxicity is followed by a number that indicates how readily the refrigerant may ignite. Section 6.1.3 of Standard 34 defines four flammability classes:

- Class 3 refrigerants have a very low lower flammability limit (LFL), indicating that they ignite easily and the flame propagates easily.
- Class 2 refrigerants have lesser flammability characteristics than Class 3; they have a higher LFL, but are still easy to ignite and propagate flames well.
- Class 2L refrigerants have an even higher LFL and are more difficult to ignite.
- Class 1 refrigerants do not exhibit flame propagation, and are commonly referred to as "non-flammable."

The Class 2L definition was first added to Standard 34 in its 2010 published version. A flame propagation test is used to indicate that a refrigerant is flammable and to determine its LFL. Then a burning velocity test is used to determine how difficult it is to ignite. Refrigerants that are more difficult to ignite, and have a high LFL, are assigned the 2L classification.

Safety groups. Together, the toxicity and flammability classifications define eight safety groups—A1, B1, A2L, B2L, A2, B2, A3, and B3—which are represented by the matrix in Figure 1. These safety group designations are used by building codes and industry standards (such as ASHRAE Standard 15) to prescribe safety requirements for refrigeration systems.

Figure 1. Refrigerant safety groups from ASHRAE® Standard 34

A3	B3
A2	B2
A2L	B2L
A1	B1

higher flammability; flammable; lower flammability; no flame propagation

lower toxicity; higher toxicity

ASHRAE® Standard 15

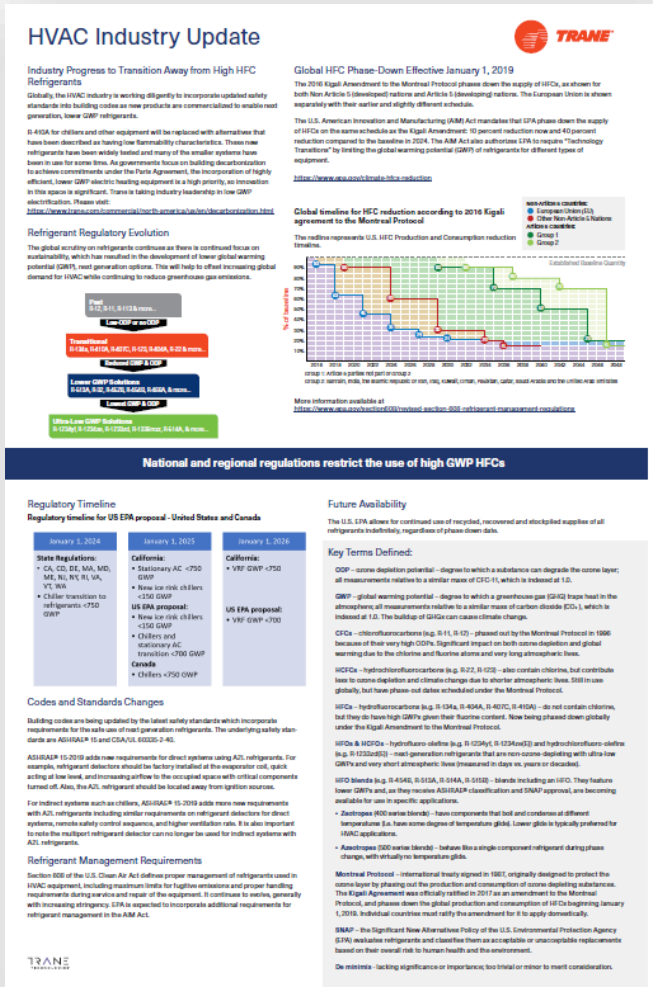
The purpose of ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, is to specify safe practices for the design, construction, installation, and operation of refrigeration systems.[3] It applies to a broad range of systems, from a small window air conditioner to a large water chiller. Its requirements are intended for not only newly-installed systems, but also for replacements or alterations that change the function or capacity of the system, as well as conversions to a different type of refrigerant.

Applications Engineering Manual

Refrigeration Systems and Machinery Rooms

Application Considerations for Compliance with ASHRAE® Standard 15-2022

July 2023 APP-APM001F-EN



HVAC Industry Update

Industry Progress to Transition Away from High HFC Refrigerants

Global HFC Phase-Down Effective January 1, 2019

Refrigerant Regulatory Evolution

Global timeline for HFC reduction according to 2016 Kigali agreement to the Montreal Protocol

National and regional regulations restrict the use of high GWP HFCs

Regulatory Timeline

Regulatory timeline for US EPA proposal - United States and Canada

Future Availability

Codes and Standards Changes

Refrigerant Management Requirements

Key Terms Defined:

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- This is not our first refrigerant transition! Trane is well prepared to offer products with lower GWP refrigerants well ahead of regulations
  - ***Next-generation Class 1 alternatives are available today R-513A, R-1233zd & R-514A***
  - ***R-454B products being to be rolled out – complete EOY 2024***
- There is no perfect refrigerant. Remember take a balanced approach
  - ***Safety, Efficiency, Environmental Impact***
  - **Most sustainable product provide the best balance that enables the LOWEST emissions, the HIGHEST efficiency and the LOWEST life-cycle costs**
  - ***Continued Leak tightness is key!***
- States are still updating the mechanical/building codes to enable A2L refrigerants
  - ***All states should be updated by 2024***
  - ***Standard 15 practices are updated to handle A2Ls – See Trane to Learn More***
- Contact your account manager for further questions

Use the Facts to Plan for Tomorrow

Thank you!

Any questions?

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