



# Introduction to Refrigerant R-454B

October 2023

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# Introduction to R-454B

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The material in this presentation is focused on the change from R-410A to R-454B refrigerant in Ducted Systems products and the impact to manufacturing, distribution and HVAC contractors.

Dates included in the presentation are intended to serve as a reminder of the compressed timeline for refrigerant change.

The material is not comprehensive – several items remain in flux right now, especially at the local level.

Economic, political, social or other non-technical topics are not addressed by the presentation.

GWP drives R-410A to  
R-454B change

**GWP = Global Warming Potential**

- A lower GWP number indicates less “greenhouse gas” affect
- R-410A has a GWP rating of 2088
- R-454B has a GWP rating of 467

# Regulations Impacting Manufacturing – International

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Kigali Amendment to the Montreal Protocol – effective in 2019, an international agreement to:

Transition to lower global warming potential (GWP) refrigerants.

“Phasedown” HFC [R-410A] production and consumption

- Has been ratified by 90+ countries including Canada
- Ratified by the U.S. 10/31/2022

# Regulations Impacting Manufacturing – North America

## Canada: Ozone-Depleting Substances and Halocarbon Alternatives Regulations (ODSHAR) Amendments

- “Phasedown” of HFC [R-410A] production and consumption per the Kigali Amendment
- Set a 2000 GWP limit for refrigerants used in residential and light commercial HVAC

## United States: American Innovation and Manufacturing (AIM) Act – signed into law 11/27/2020

- “Phasedown” of HFC [R-410A] production and consumption similar to the Kigali Amendment
- Set a 750 GWP limit for refrigerants used in residential and light commercial HVAC manufactured 1/1/2025 and later

# Regulations Impacting Manufacturing: Conclusion

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- Ducted Systems will not manufacture R-410A products after 12/31/2024; will begin phase-in of R-454B products prior to the cut-off date
  - Later in the presentation: the AIM Act (US) also has provisions that impact distribution and contracting
  - Canada: Beside the change to R-454B, ODSHAR amendments do not address distribution and HVAC contracting practices
    - There are other industry regulations that parallel much of the discussion of US regulations

# Why R-454B? or Flammability: The elephant in the room

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Suitable low GWP A/C refrigerants are listed as flammable refrigerants

- R-454B has favorable flammability characteristics compared to other low GWP refrigerants
- Factors of GWP, performance, industry acceptance, etc. were also weighed in choosing R-454B

# R-454B Flammability Information

R-454B is in ASHRAE Safety Group A2L (A2L refrigerant) – a relatively new category for “mildly flammable” refrigerants

A

Non-Toxic

2

Flammable

L

Low burning velocity; less than 3.9 in/sec (10 cm/sec)  
R-454B has a burning velocity of 2.0 in/sec (10 times slower than ethanol)

For the A2L safety group: The Heat of Combustion (HOC) must be less than 8169 BTUs/lb

R-454B HOC:  $\approx$  4342 BTUs/lb

# More R-454B Flammability Information

A mix of R-454B vapor and air is only combustible in a relatively narrow range

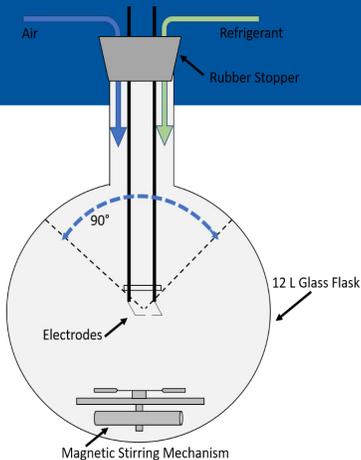
- The Lower Flammability Limit and Upper Flammability Limit bracket the concentrations of R-454B vapor in air where combustion is possible
  - Concentrations below the Lower Flammability Limit are too lean to support combustion
    - R-454B Lower Flammability Limit: 11.25% (volume) Method: ASTM E681
  - Concentrations above the Upper Flammability Limit are too rich to support combustion
    - R-454B Upper Flammability Limit: 22% (volume) Method: ASTM E681

**Key concept:** Lower Flammability Limit – This will come up later in the discussion of refrigerant leak sensing and application factors.

# R-454B Flammability Information

Refrigerant flammability is rated by the ASTM E681 test

At 140°F, refrigerant and air mixed in a flask with an ignitor



Flame spread less than 90° from ignitor

- Considered to have “no flame propagation”
- Class 1, non-flammable rating

Flame spread more than 90° from ignitor

- Class 2 (or higher), flammable rating
- Class 2L, lower flammability rating if also has low burning velocity & low heat of combustion

Flame spread more than 90° from ignitor and has high burning velocity or high heat of combustion

- Class 3, higher flammability rating

# More R-454B Flammability Information

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A combustible mix of R-454B vapor and air has an ignition temperature above 1472°F (800°C)

Requires an open flame or “high energy ignition source” to ignite

- Static electricity discharge, toaster, or hair dryer – listed as 400°C or less ignition sources – typically cannot ignite a combustible mix of R-454B vapor and air

# More R-454B Flammability Information

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If a combustible mix of R-454B vapor and air ignites:

Caution: The faint blue flame may not be easily visible in bright light.

Hazardous combustion products: hydrogen fluoride, carbonyl fluoride, carbon oxides, fluorine compounds

- Similar (if not the same) noxious chemicals produced by burning R-410A

Extinguished by: water spray, alcohol-resistant foam, carbon dioxide (CO<sub>2</sub>), dry chemical

- Most practical recommendation: carry general-purpose, Class A-B-C dry chemical fire extinguishers
  - DOT requirement for fire extinguisher in the vehicle transporting flammable gases
  - At location of installation and service

# Other R-454B properties

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Generic name:  
Refrigerant R-454B

- Chemours trade name: Opteon™ XL41
- Carrier trade name: Puron Advance™

Hydrofluro-olefin  
(HFO) based  
refrigerant

- Also described as an HFO/HFC refrigerant
- POE oil used for compressor lubrication

Composition:  
68.9% R-32, 31.1%  
R-1234yf

- R-32 is half of R-410A, R-1234yf is an automotive A/C refrigerant

Ozone Depletion  
Potential (ODP): 0

Global Warming  
Potential (GWP):  
467



## R-454B and “phasedown” Regulations

### **R-454B is subject to “phasedown” regulations**

- Despite the “hydrofluoro-olefin based” and “HFO/HFC” naming
- The HFC R-32 component of R-454B is named in the “phasedown” regulations

# Dew Point, Bubble Point & Temperature Glide R-454B & Other Blended Refrigerants

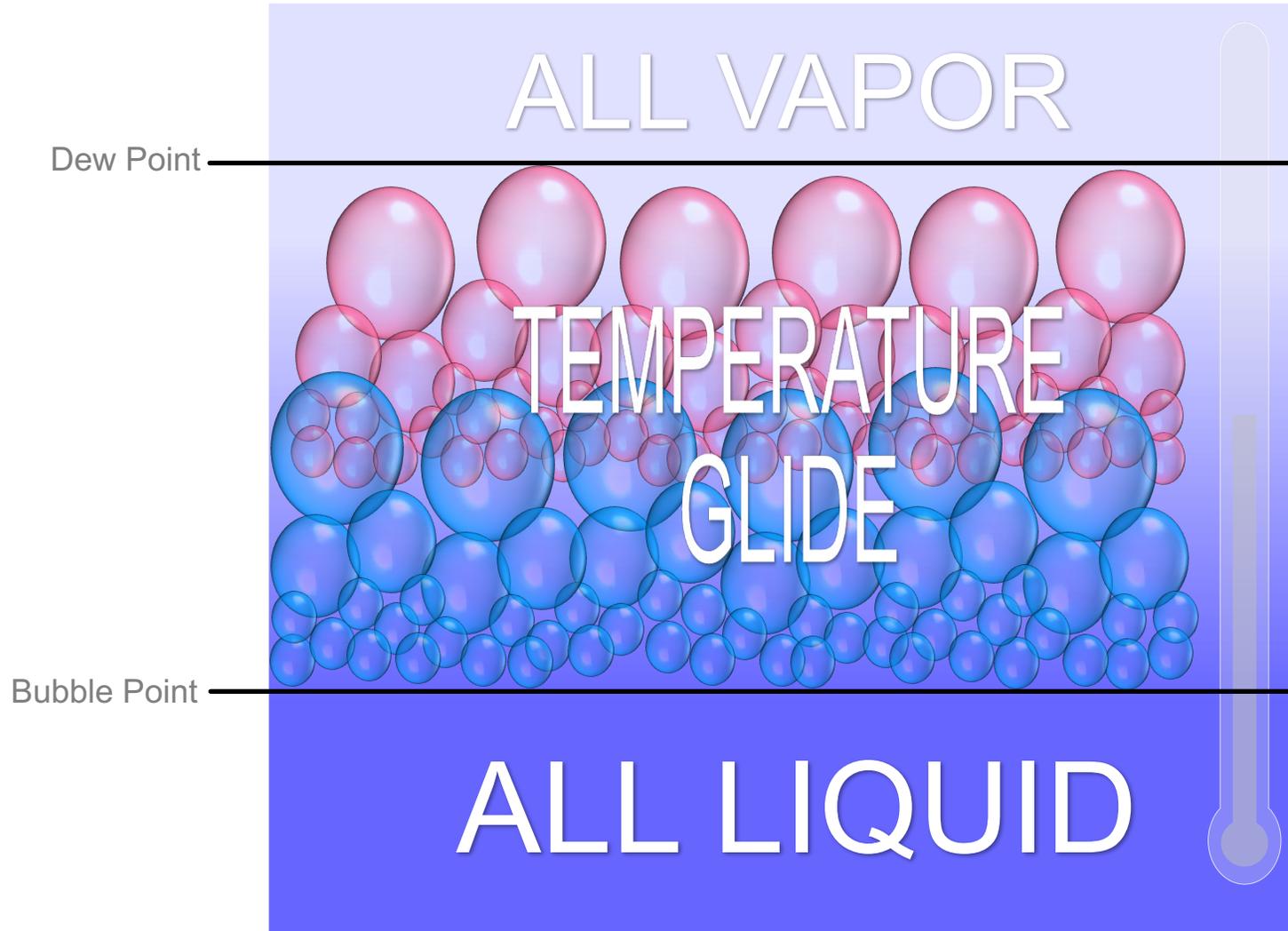
Both refrigerant components completely boiled at temps above Dew Point

Condensation begins with temps falling to Dew Point

Temperature Glide: Temp range between Dew Point and Bubble Point where refrigerant components are in a mix of vapor and liquid

Boiling begins with temps rising to Bubble Point

Both refrigerant components completely condensed at temps below Bubble Point



# Other R-454B properties

Temperature Glide @ 45°F evaporator: 2.35°F

- Use dew point data for calculation of superheat

Temperature Glide @ 105°F condenser: 2.3°F

- Use bubble point data for calculation of subcooling

Charge can be “topped-off” – fractionization is not an issue

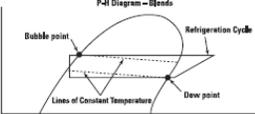
R-454B vapor density is 2.2 times heavier than air



Refrigerants by The Chemours Company

### Pressure-Temperature Guide for A/C

Key: Green (n of Hg) = Vacuum  
 Black (psig) = Saturated Vapor (calculate superheat)  
 Bold (psig) = Saturated Liquid (calculate subcooling)



To determine superheat, use dew point values.  
 To determine subcooling, use bubble point values.

**DO NOT MIX REFRIGERANTS**  
 No A2L refrigerant is to be used as a retrofit refrigerant  
 A2L refrigerants can only be used in new equipment  
 Always remove refrigerant blends from the cylinder as liquid

For refrigerant related support, contact our Tech2Tech Support Team:  
[tech2tech@chemours.com](mailto:tech2tech@chemours.com) 866-433-TECH (B324)



To add our Tech2Tech Support as a contact in your mobile device, use the QR Code above.

SAFETY GROUP	Freon® 410A (R-410A)		Opteon® XL41 (R-454B)		Freon® 407C (R-407C)		Freon® NU-299 (R-422B)		Freon® MOSP® (R-438A)		Freon® R2 (R-22)	
	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig	psig
-50	4.9	3.1	10.8	11.4	11.5	8.8						
-45	7.6	5.6	8.0	8.6	8.4	2.6						
-40	10.7	8.4	4.6	5.4	5.2	0.6						
-35	14.0	11.3	0.9	1.3	1.6	2.6						
-30	17.7	14.8	1.6	1.1	1.2	4.9						
-25	21.8	18.5	3.9	3.2	3.5	7.4						
-20	26.2	22.8	6.5	5.7	5.9	11.4						
-18	28.1	24.3	7.6	6.7	7.0	11.4						
-16	30.0	26.1	8.7	7.8	8.1	12.6						
-14	32.0	27.9	9.9	8.9	9.2	13.9						
-12	34.1	29.8	11.1	10.1	10.4	15.2						
-10	36.3	31.8	12.3	11.3	11.6	16.5						
-8	38.5	33.8	13.7	12.5	12.9	17.9						
-6	40.8	35.9	15.0	13.8	14.2	19.4						
-4	43.2	38.1	16.4	15.2	15.6	20.9						
-2	45.7	40.4	17.9	16.6	17.0	22.4						
0	48.2	42.7	19.4	18.0	18.5	24.0						
2	50.8	45.1	21.0	19.5	20.0	25.7						
4	53.5	47.6	22.6	21.1	21.6	27.4						
6	56.3	50.1	24.3	22.7	23.2	29.2						
8	59.2	52.7	26.1	24.4	24.9	31.0						
10	62.2	55.4	27.9	26.1	26.6	32.8						
12	65.2	58.2	29.8	27.8	28.4	34.6						
14	68.4	61.1	31.7	29.7	30.3	36.8						
16	71.6	64.1	33.7	31.6	32.2	38.8						
18	74.9	67.1	35.7	33.5	34.2	40.9						
20	78.4	70.3	37.9	35.5	36.2	43.1						
22	81.9	73.5	40.1	37.6	38.3	45.3						
24	85.5	76.8	42.3	39.7	40.5	47.6						
26	89.2	80.3	44.7	41.9	42.8	50.0						
28	93.1	83.8	47.1	44.2	45.1	52.4						
30	97.0	87.4	49.6	46.6	47.5	55.0						
32	101.1	91.1	52.1	49.0	49.9	57.5						
34	105.2	94.9	54.8	51.5	52.5	60.2						
36	109.5	98.8	57.5	54.0	55.1	62.9						
38	113.9	102.9	60.3	56.7	57.7	65.7						
40	118.4	107.0	63.2	59.4	60.5	68.6						
42	123.0	111.2	66.1	62.1	63.3	71.5						
44	127.7	115.6	69.2	65.0	66.3	74.5						
46	132.6	120.0	72.3	67.9	69.3	77.6						
48	137.5	124.6	75.5	71.0	72.3	80.8						
50	142.6	129.3	78.8	74.1	75.5	84.1						
52	148.4	140.0	82.2	88.6	84.6	87.4						
54	153.8	145.1	85.7	92.1	88.3	90.8						
56	159.3	150.3	89.3	95.6	102.1	94.4						
58	164.9	155.7	93.0	99.3	105.9	98.0						
60	170.7	161.1	96.8	103.0	109.8	101.6						
65	185.8	175.4	128.9	112.7	120.1	113.3						
70	201.8	190.5	140.5	123.0	131.0	121.4						
75	218.7	206.5	152.8	133.9	142.5	132.2						
80	236.5	223.4	165.8	145.4	154.7	143.6						
82	244.0	230.4	171.3	150.2	159.8	148.4						
84	251.6	237.6	176.8	155.1	165.0	153.2						
86	259.3	244.9	182.4	160.1	170.3	158.2						
88	267.3	252.4	188.2	165.2	175.7	163.2						
90	275.4	260.1	194.1	170.4	181.2	168.4						
92	283.6	267.9	200.1	175.7	186.8	173.7						
94	292.1	275.8	206.3	181.2	192.6	179.1						
96	300.7	284.0	212.5	186.7	198.5	184.6						
98	309.5	292.3	219.0	192.4	204.5	190.2						
100	318.5	300.8	225.5	198.2	210.6	195.9						
102	327.7	309.4	232.2	204.1	216.8	201.8						
104	337.1	318.3	239.0	210.2	223.2	207.7						
106	346.7	327.3	245.9	216.3	229.7	213.8						
108	356.5	336.5	253.0	222.6	236.4	220.0						
110	366.4	345.9	260.3	229.0	243.1	226.4						
112	376.6	355.5	267.6	235.6	250.1	232.8						
114	387.0	365.2	275.1	242.3	257.1	239.4						
116	397.6	375.2	282.8	249.1	264.3	246.1						
118	408.4	385.3	290.6	256.0	271.6	253.0						
120	419.4	395.7	298.6	263.1	279.1	260.0						
122	430.7	406.2	306.7	270.3	286.7	267.1						
124	442.1	417.0	315.0	277.7	294.4	274.3						
126	453.8	427.9	323.4	285.2	302.3	281.7						
128	465.6	439.1	332.0	292.6	310.4	289.2						
130	477.9	450.5	340.7	300.6	318.5	296.9						
135	509.4	480.0	363.3	320.7	339.7	316.7						
140	542.5	510.7	387.0	341.8	361.9	337.4						
150	613.9	576.8	437.5	387.1	409.2	381.7						

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OPTVLPAC-2 05/22



# Other R-454B properties

## R-454B Cylinders

- Red stripe or top to indicate flammable
- Pop-off relief valve rather than rupture disk
  - Minimized release for burst prevention
  - Upright storage and transport so the pop-off valve is in the vapor section of the cylinder
- Cylinders are expected to have left-hand thread connections
- ~~▪ Note: the AIM Act also requires use of refillable and trackable refrigerant cylinders; details TBD
  - Disposable cylinders will not be produced after 12/31/2024 or sold after 12/31/2026~~

United States Court of Appeals  
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FILED ON: JUNE 20, 2023

**ORDERED** and **ADJUDGED** that ... the QR-code and refillable-cylinder parts of EPA's Phasedown Rule be vacated and remanded to the agency, in accordance with the opinion of the court filed herein this date.



# R-454B Compared to R-410A

R-454B has 82.3% of R-410A mass flow (lb/min/ton)

R-454B has 93.5% of R-410A liquid density

Lower mass flow and refrigerant density affect equipment design and split-system piping calculations

R-454B discharge temperature is typically  $\approx 10$  to  $15^\circ\text{F}$  more than R-410A

May be noticed in residential products that monitor discharge temp

R-454B system performance:  $\approx 3\%$  gain in efficiency,  $\approx 2\%$  loss capacity in a system with the same design characteristics as R-410A

	R-454B	R-410A
0 psig	$-57.09^\circ\text{F}$	$-60.46^\circ\text{F}$
$40^\circ\text{F}$	107 psig	118.4 psig
$45^\circ\text{F}$	117.8 psig	130.1 psig
$50^\circ\text{F}$	129.3 psig	142.6 psig
$95^\circ\text{F}$	270.4 psig	295.4 psig
$110^\circ\text{F}$	335.2 psig	365.4 psig
$125^\circ\text{F}$	410.8 psig	446.8 psig

source of data in above table: Danfoss Refrigerant Slider app - dew setting

# Ducted Systems Equipment Updates for R-454B

## Nomenclature character change indicating R-454B



### Commercial Products (Premier: TBD)

- “K” = R-454B A/C
- “W” = R-454B Heat Pump

### Residential Products

- Split system outdoor: 6<sup>th</sup> character, “E” = R-454B
- Split system indoor: 5<sup>th</sup> character, “5” = R-454B
- Package: 4<sup>th</sup> character “E” = R-454B

# Ducted Systems Equipment Updates for R-454B

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## Compressors: models adjusted for R-454B use

Some vendors (Copeland) only offer compressors rated solely for R-454B use

Other vendors (Danfoss) offer compressors rated for use with multiple refrigerants

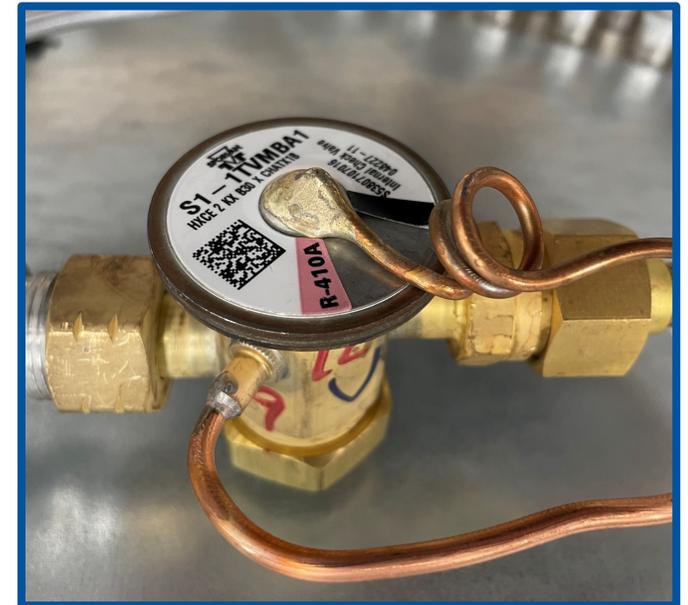
Though happening around the same time, changes to the vendor-supplied piping of tandem compressor sets is not linked to the change to R-454B

# Ducted Systems Equipment Updates for R-454B

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## TXVs: dedicated to R-454B use

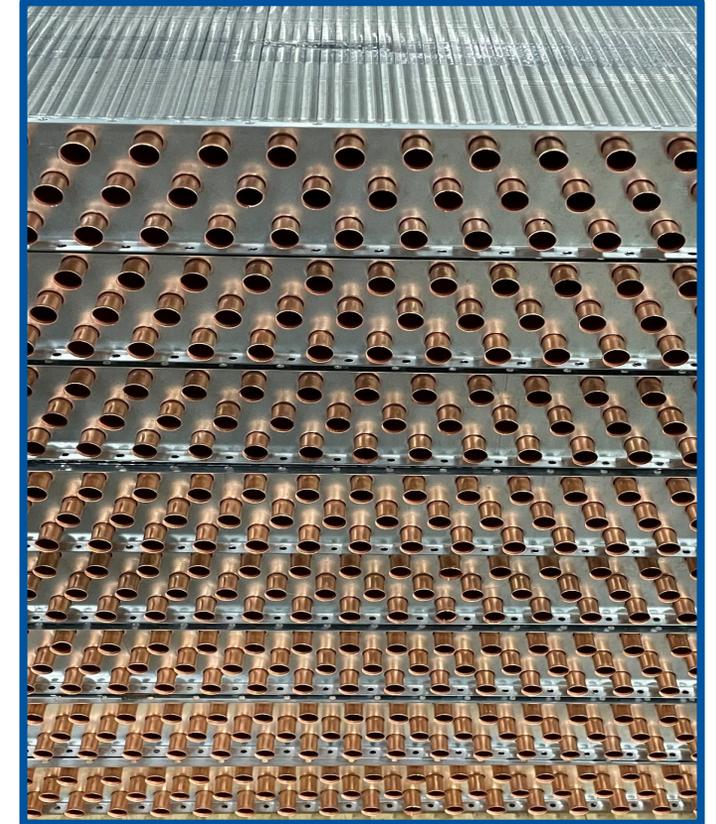
- May be the same valve from the vendor – but with adjustments and Source1 part number for R-454B use
- The few R-410A unit models that used orifice metering will have TXV metering for similar R-454B models



# Ducted Systems Equipment Updates for R-454B

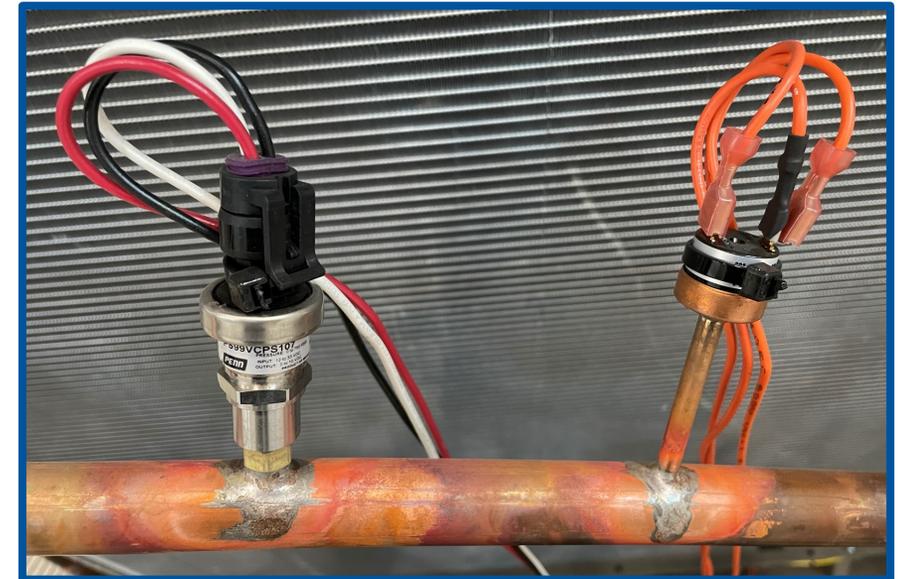
## Evaporator & condenser coils:

- No / minor adjustment for R-454B use – preliminary, subject to full lab tests



# Ducted Systems Equipment Updates for R-454B

Adjustment to pressure switch cut-out settings, low ambient condenser fan speed control pressure setpoints: TBD



# Ducted Systems Equipment Updates for R-454B

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Additional labeling for R-454B: flammable refrigerant

# Ducted Systems Equipment Updates for R-454B

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**Refrigerant leak detection sensors** and new controller to accept refrigerant leak detection input / respond to refrigerant leak detected: details TBD

Sensor(s) strategically located (low) in the unit

Detection threshold below 25% of the Lower Flammability Limit concentration

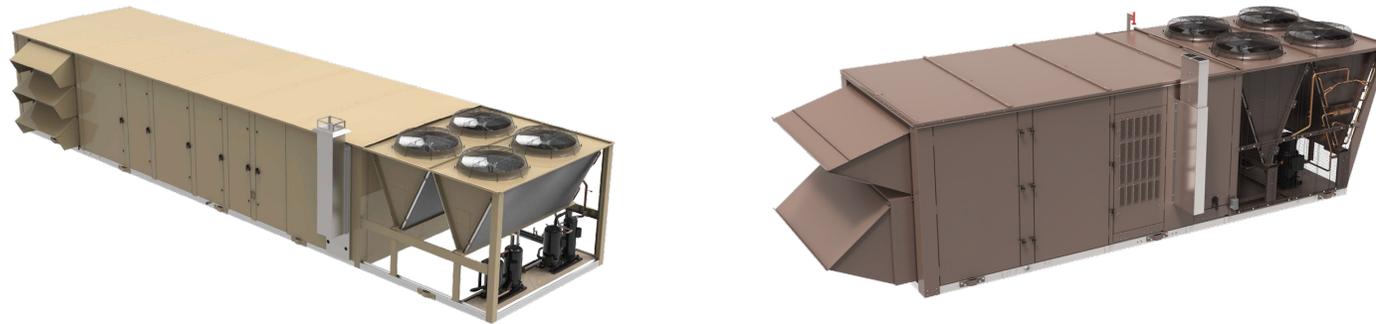
Unit indoor blower operates to disperse refrigerant vapor in response to leak detected

Per UL standard

# Ducted Systems Equipment Updates for R-454B

Charge limit of 26.6 lbs. (12 kg) to be below US DOT HAZMAT protocols for transportation of units

**Note:** Affects Premier & Select: resolution TBD



# Ducted Systems Equipment Updates for R-454B

Possible for Norman-built 3 thru 5-ton package units: commercial applications only

Differing overall UL/CSA standards for residential or commercial applications – unrelated to the R-454B change

Different building and fire code standards A2L refrigerants in residential or commercial applications



# R-454B Impact to Manufacturing Summary

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**It is clear what results are needed to comply with regulation – manufacture products with low GWP refrigerant by 1/1/2025**

- Work is underway to make the change to R-454B
  - Engineering for R-454B is well understood though technical details are TBD at this point
  - Re-certification of all products
  - Manufacturing plant infrastructure for R-454B
- Compressed timeline for the change to R-454B...

# Impact to Distribution

## R-410A Unit Availability Through the Transition to R-454B

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From EPA publication *Protecting our Climate by Reducing Use of Hydrofluorocarbons* dated December 2022:

“The proposed rule would prohibit manufacture and import of products containing restricted HFCs by January 1, 2025, in most cases, and would prohibit the sale, distribution, and export of products containing restricted HFCs a year later, which in most cases would be January 1, 2026.”

- “proposed rule”: published late-2021, effective late-2023
  - “most cases”: includes Ducted System products
  - “restricted HFCs”: includes R-410A
  - Past rule loopholes that allowed the build and sale of dry charge units are closed
- 
- In-stock R-410A units cannot be sold after 12/31/2025
    - Factory and Distribution risks to stockpiling R-410A units
    - Expect “last call” R-410A unit buildouts to be lean

# Regulations Impacting Distribution and HVAC Contracting

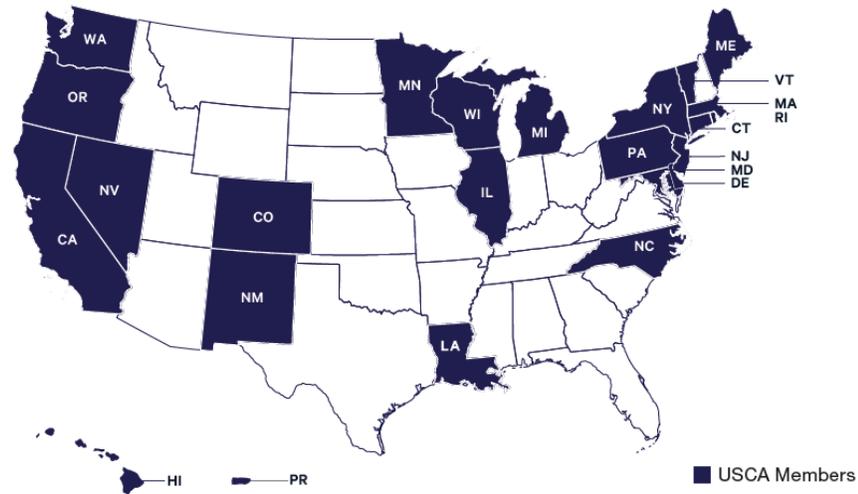
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- Canada: industry regulations parallel much of the discussion of US regulations
  - There is variation in Provincial codes
- United States:
  - Significant New Alternative Policy (SNAP) Rules 20 and 21
  - AIM Act
  - Local transportation authority
  - Local building and fire codes
- Generally, details for local regulation of A2L refrigerant and units are uneven or late to be adopted

# Federal Regulations – SNAP Rules 20 (2016) and 21 (2017)\*

## List acceptable and unacceptable refrigerants for new equipment and refrigerant retrofit

- R-454B and other A2L refrigerants are only acceptable for use in new equipment
- R-454B and other A2L refrigerants are unacceptable for use in retrofit
  - R-454B cannot be used in existing equipment rated for R-410A
- \* SNAP Rules 20 and 21 were challenged and partially vacated. Many states in the U.S. Climate Alliance organization have adopted SNAP Rules



# Federal Regulations – AIM Act

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“...provides new authority for the U.S. Environmental Protection Agency (EPA) to address hydrofluorocarbons (HFCs) in three ways:

- (1) phasing down production and consumption,
- (2) maximizing reclamation and minimizing releases from equipment, and
- (3) facilitating the transition to next-generation technologies through sector-based restrictions.”

# Federal Regulations – AIM Act

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- (1) phasing down production and consumption,
  - (2) maximizing reclamation and minimizing releases from equipment, and
  - (3) facilitating the transition to next-generation technologies through sector-based restrictions.”
- Item (3) concerns the previously discussed manufacturing change to R-454B

# Federal Regulations – AIM Act

“...provides new authority for the U.S. Environmental Protection Agency (EPA) to address hydrofluorocarbons (HFCs) in three ways:

- (1) phasing down production and consumption,
- (2) maximizing reclamation and minimizing releases from equipment, and
- (3) facilitating the transition to next-generation technologies through sector-based restrictions.”

- Expansion on Item (1): phase down to reach “85% below baseline levels by 2036 through an allowance allocation and trading program”
- Good news? – **residential** and **commercial** A/C has historically consumed a large portion of the HFC pie; allocations for the sector should be larger

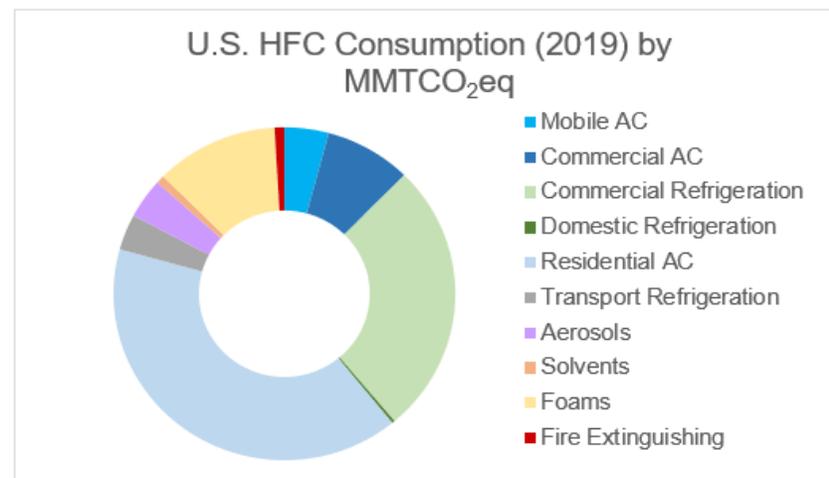


Image: EPA

# Federal Regulations – AIM Act

“...provides new authority for the U.S. Environmental Protection Agency (EPA) to address hydrofluorocarbons (HFCs) in three ways:

- (1) phasing down production and consumption,
- (2) maximizing reclamation and minimizing releases from equipment, and
- (3) facilitating the transition to next-generation technologies through sector-based restrictions.”

- Expansion on Item (2): EPA-managed refrigerant sales, reclamation program and system leakage level standards
- Bad news? – **residential** and **commercial** A/C has historically consumed a large portion of the HFC pie; there will likely be more attention to rule compliance

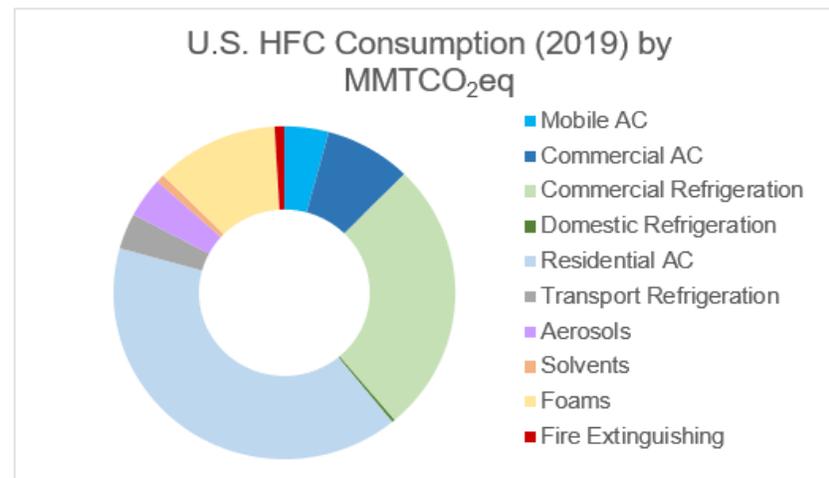


Image: EPA

# Federal Regulations – AIM Act

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“To ensure compliance with the phasedown limits, this final rule:

- Establishes an electronic tracking system for the movement of HFCs through commerce;
- ~~Requires the use of refillable cylinders and container labeling requirements;~~
- Establishes administrative consequences (e.g., revocation or retirement of allowances) for noncompliance that would be in addition to any civil and criminal enforcement action;
- Requires third-party auditing of companies’ recordkeeping and reporting; and
- Provides transparency of HFC production and consumption data for the general public and participants in the market, and supports enforcement and compliance efforts.”

Source of quoted references in this and previous slides: *Final Rule – Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the American Innovation and Manufacturing (AIM) Act* Fact Sheet dated September 2021

# R-454B Topics Impacting Distribution and HVAC Contracting

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**“mildly flammable” is still FLAMMABLE – a cause of concern for local authorities and everyone else associated with:**

- Transportation of R-454B units and refrigerant cylinders
- Storage of R-454B units and refrigerant cylinders
- Application of R-454B systems
- Installation and service of R-454B systems

# Transport – “mildly flammable” is still FLAMMABLE

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**Regulation for transport of R-454B units and refrigerant is determined by the local transportation authority**

- Take care when travelling between areas served by different authorities

# Transport – “mildly flammable” is still FLAMMABLE

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## Regulation for transport of R-454B units and refrigerant is determined by the local transportation authority

- Transportation of units: R-454B shipping charge amount up to 26.6 lbs. is exempt from US DOT HAZMAT protocols
  - Note: Select & Premier charging TBD

# Transport – “mildly flammable” is still FLAMMABLE

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Regulation for transport of R-454B units and refrigerant is determined by the local transportation authority

Basic guidelines for ground transport of cylinders

- Must have a fire extinguisher in the vehicle
- Cylinders must be strapped upright, secure from theft and tampering
- Amount of A2L refrigerant (flammable gas) and vehicle ventilation are factors considered by the local transportation authority
  - May have different rules for bulk or individual cylinder transport

Placards are required by the local transportation authority

Air transport of A2L cylinders or units is not approved

# Storage – “mildly flammable” is still FLAMMABLE

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Regulation for storage of R-454B refrigerant and units is determined by the local fire and building codes

Basic guidelines for cylinder storage:

- Must have a fire extinguisher in the vicinity
- No smoking within 25 feet
- Cylinders must be stored upright

If the local authority has not adopted the 2024 International Fire Code or updated NFPA standards, bulk storage of A2L refrigerant is at most

- 150 lbs. in an un-sprinklered warehouse
- 300 lbs. in a sprinklered warehouse
- 600 lbs. in fire-rated cabinets

# Storage – “mildly flammable” is still FLAMMABLE

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**Regulation for storage of R-454B refrigerant and units is determined by the local fire and building codes**

For bulk storage of A2L refrigerant, the 2024 International Fire Code and updated NFPA standards consider factors of the storage “control area”

- Shelf, racked or stacked pallet storage
- Fire-rated walls and entry doors
- Sprinkler type and density

If the updated fire codes and standard are fully adopted by the local authority

- Up to 40,000 lbs. of A2L refrigerant can be stored in each “control area”
- Up to 4 “control areas” per building are allowed

# Storage – “mildly flammable” is still FLAMMABLE

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Regulation for storage of R-454B refrigerant and units is determined by the local fire and building codes

New unit storage will typically have few changes for R-454B

- Codes usually consider storage of an assembled product differently than the raw components
- Limited shipping charge amount

Note: Local building codes may further address leak detection and response for bulk storage of A2L refrigerant and R-454B units.

# Application – “mildly flammable” is still FLAMMABLE

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## Regulation for application of R-454B units determined by the local building codes

Existing building codes that prohibit application of equipment using flammable refrigerant will need to be adjusted for A2L refrigerants

# Application – “mildly flammable” is still FLAMMABLE

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## Regulation for application of R-454B units determined by the local building codes

Additional refrigerant leak detection sensor(s) within the space may be required (unconfirmed spaces)

- Lower Flammability Limit concentration calculations from system charge/space volume/floorspace (anticipated to be like European calcs)
  - Different factors based on application, equipment location and activity in the space
    - Residential or commercial
    - Mechanical room, rooftop, crawlspace, etc.
    - Sleeping quarters, retail space, etc.

If required, the characteristics needed for sensor(s) within the space

- Location and mounted height from floor
- Alarm response interlock
- Audible and/or visible alarm notification

# Application – “mildly flammable” is still FLAMMABLE

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## Regulation for application of R-454B units determined by the local building codes

Confined spaces shift the “primary hazard” for R-454B to asphyxiation, with flammability a “secondary hazard”

- Requirements for refrigerant leak detection and mitigation expected to be like those for existing refrigerants

# Application – “mildly flammable” is still FLAMMABLE

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## Split-system piping for R-454B

Codes may/may not allow use of compression-fit piping in accessible areas

### Piping in concealed spaces

- Must be continuous pipe or use brazed fittings
- May have more stringent leak inspection at rough-in
- May have additional puncture protection requirements

Best practice: Use proper refrigerant line sizing – in some cases, R-454B can use smaller line sizes than previous refrigerants

- Smaller system refrigerant charge
  - Has a positive influence on the Lower Flammability Limit concentration calculations
  - Reduces the need for off-cycle migration management measures
- Where property sized, existing R-410A refrigerant lines can be reused for R-454B

# R-454B Refrigerant System Service Procedures

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Technician qualification – the local authority may require A2L handling training/certification in addition to “EPA 608” certification

Gloves, safety glasses and workplace PPE

- Risk of frostbite from refrigerant
- Risk of chemical burns from POE oil



# R-454B Refrigerant System Service Procedures

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Before servicing the refrigerant system: avoid a possible “high energy ignition source”

Inspect the area – extinguish open flames, remove any other possible ignition source. No smoking.

Lock-out/tag-out power supplies

Bleed down capacitors with a voltmeter

Allow VFDs and inverters time to discharge internal capacitors

# R-454B Refrigerant System Service Procedures

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Pay attention to low areas and confined spaces

Use a fan to ventilate and disperse refrigerant vapor

Extreme circumstances may require an oxygen mask

Bring a fire extinguisher to the area of service

Most practical recommendation: carry general-purpose, Class A-B-C dry chemical fire extinguishers

# R-454B Refrigerant System Service Procedures

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Use tools and equipment rated for  
A2L refrigerant use

Gauge set with low-loss hose fittings & compatible hose for the left-hand thread charging cylinder

Leak detector

Recovery machine & compatible hose for the left-hand thread recovery cylinder

Vacuum pump – with switch located away from the work zone

# R-454B Refrigerant System Service Procedures

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Replace the filter-drier any time the system is opened for repair

Use 5% or better silver content brazing alloy for installation and repair

# R-454B Refrigerant System Service Procedures

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Repair best practice for A2L refrigerants:

- After refrigerant recovery > purge with dry nitrogen for 5 minutes > before brazing
  - Added step to reduce/dilute residual refrigerant vapor that could ignite while brazing

Purge with dry nitrogen during brazing

- Reminder: Refrigeration oil is also combustible and burns with more energy than A2L refrigerant

Pressurize and leak test the system with dry nitrogen

# R-454B Refrigerant System Service Procedures

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Evacuate the system  
below 500 microns

Triple evacuation method is recommended

- Pull the system down to 3000 microns (or less)
- Bring the system up to 0 psig with dry nitrogen
- Pull the system down to 1500 microns (or less)
- Bring the system up to 0 psig with dry nitrogen
- Pull the system down below 500 microns

# R-454B Refrigerant System Service Procedures

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As with other refrigerant blends, R-454B leaves the cylinder as a liquid for charging

Charge the system, either by:

- Weight
- Dynamic measurements
  - Use bubble point data for calculation of subcooling
  - Use dew point data for calculation of superheat

Charge can be “topped-off” – fractionization is not an issue

# R-454B Refrigerant System Service Procedures

Baseline for:

- Leakage rate limits
- Lower Flammability Limit concentration calculations

Package products: done by the factory

Split systems: field responsibility

(Numero de serie) W120001110

<b>Factory Charge:</b> (Charge usine)	8	lbs	8	oz	<b>For Outdoor Use Only</b> (Pour usage extérieur seulement)
<b>*TOTAL CHARGE</b> (Charge totale)	<input type="text"/>	lbs	<input type="text"/>	oz	<b>*INSTALLER: Mark per Installation Instructions</b> (* INSTALLATEUR: Mark par les instructions d'installation)
<b>Design Pressure</b>	High Side – 448 PSIG		Low Side – 236 PSIG		

# R-454B Refrigerant System Service Procedures

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**Record the amount of R-454B used (and refrigerant recovered / reclaimed)**

- For recordkeeping compliance and usage allocations

# DO NOTs for any Refrigerant

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**DO NOT** introduce air or any other oxidizer to the system

Air/oxygen + refrigerant + oil + pressure + heat = a hazardous mix

**DO NOT** over-charge the system

Particularly for A2L refrigerants: has a negative influence on the Lower Flammability Limit concentration

**DO NOT** over-fill refrigerant cylinders

**DO NOT** expose refrigerant cylinders to temperatures above 125°F (52°C)

**DO NOT** mix refrigerants

# R-454B Impact to Distribution and HVAC Contracting

## Navigating through Transition

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### Clarify Local Uncertainties

- A2L refrigerant transport and storage
- Application codes and standards for equipment with A2L refrigerant
- Technician certification for A2L refrigerant handling

### Reach out to Localized Resources

- Transportation, fire and building code authorities
- HVAC distribution and contracting organizations like HARDI, ACCA, etc.

### Prepare

- Recordkeeping
- Technician A2L handling training/certification
- Tools and equipment rated for A2L refrigerant use
- Response to homeowner/end-user concerns for flammable refrigerant

# Refrigerant R-454B References and Aids

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## Handouts

- JCI Refrigerant R-454B White Paper
- R-454B MSDS sheet from Chemours
- R-454B End User Q&A

## [Upcoming] in DS Solutions Mobile App

- RDS (Refrigerant Detection System/Lower Flammability Limit concentration) calculator (RDS calculator online in Solution Navigator)
- R-454B Superheat/Subcool calculator

[Upcoming] Ducted Systems R-454B split system piping calculator

## Recommended: Danfoss Ref Tools Mobile App

- R-454B pressure/temperature and data in Ref Slider section



# Questions

# R-454B FAQs

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## Will R-454B explode?

- Due to the slow burning velocity, it is unlikely that R-454B will explode

## Could there be increased liability risk with a flammable refrigerant?

- Yes, but the risk is minimized when:
  - The equipment manufacturer's instructions are followed
  - There is adherence to codes and standards
  - Proper installation and service procedures are used

## “C'mon, I've been doin' this for \_\_\_ years, why's R-454B a big deal?”

- Never become complacent about proper procedures and safety practices
  - Elevated need for regulatory compliance in HVAC application, installation and service
  - Awareness that flammable refrigerants introduce another potential hazard to our workplace helps to keep everyone safe

# R-454B FAQs

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Is the change to R-454B temporary – will we need to go to another refrigerant in a few years?

- Current indications are that R-454B will be in use for the next decade

What happens after that?

- It is impossible to predict the future exactly, but the indications are that in 2036 new equipment will use refrigerant that has ultra low or 0 GWP

Why not use ultra low or 0 GWP refrigerant now?

- The ultra low or 0 GWP A/C refrigerants currently available have issues
  - Increased flammability (example: propane)
  - Toxicity (example: ammonia)
  - Performance / technology limitations (example: carbon dioxide)

# R-454B FAQs

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Are there other low GWP refrigerants for A/C?

- You may see R-32, another A2L refrigerant, used in other manufacturer's products. In the North American A/C market, Daikin is the largest adopter of R-32

Since the phasedown of HFCs / adoption of low GWP refrigerants is an international agreement, can we learn anything from overseas?

- Regulations and applications differ, few lessons from overseas apply to solutions for the North American A/C market

Are refrigerant costs going to increase due to production phasedown and allocations?

- Yes (there has already been R-410A cost increase), though there should be some modulation of refrigerant cost increase if the new regulations and improved practices reduce demand as intended

# R-454B FAQs

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## Do we know everything about the change to R-454B?

- No, this is a significant HVAC industry change in a short timeframe – anticipate more discovery as experience is gained
  - Uncertainties about regulations during this transitional period need clarified
  - Lessons to be learned from widespread use of R-454B & A2L refrigerants
  - Updates will be made as details become available
  - Ask that everyone stay vigilant in proper procedures and safety practices



Thank You