BUILDINGENERGY NYC

The Path to Greener HVAC Refrigerants

J. Kelly Hearnsberger, Daikin Comfort Technologies
Ben Hiller, Northeast Energy Efficiency Partnerships

Curated by Michaela Boren (32BJ Training Fund) and
Amalia Cuadra (EN-POWER GROUP)

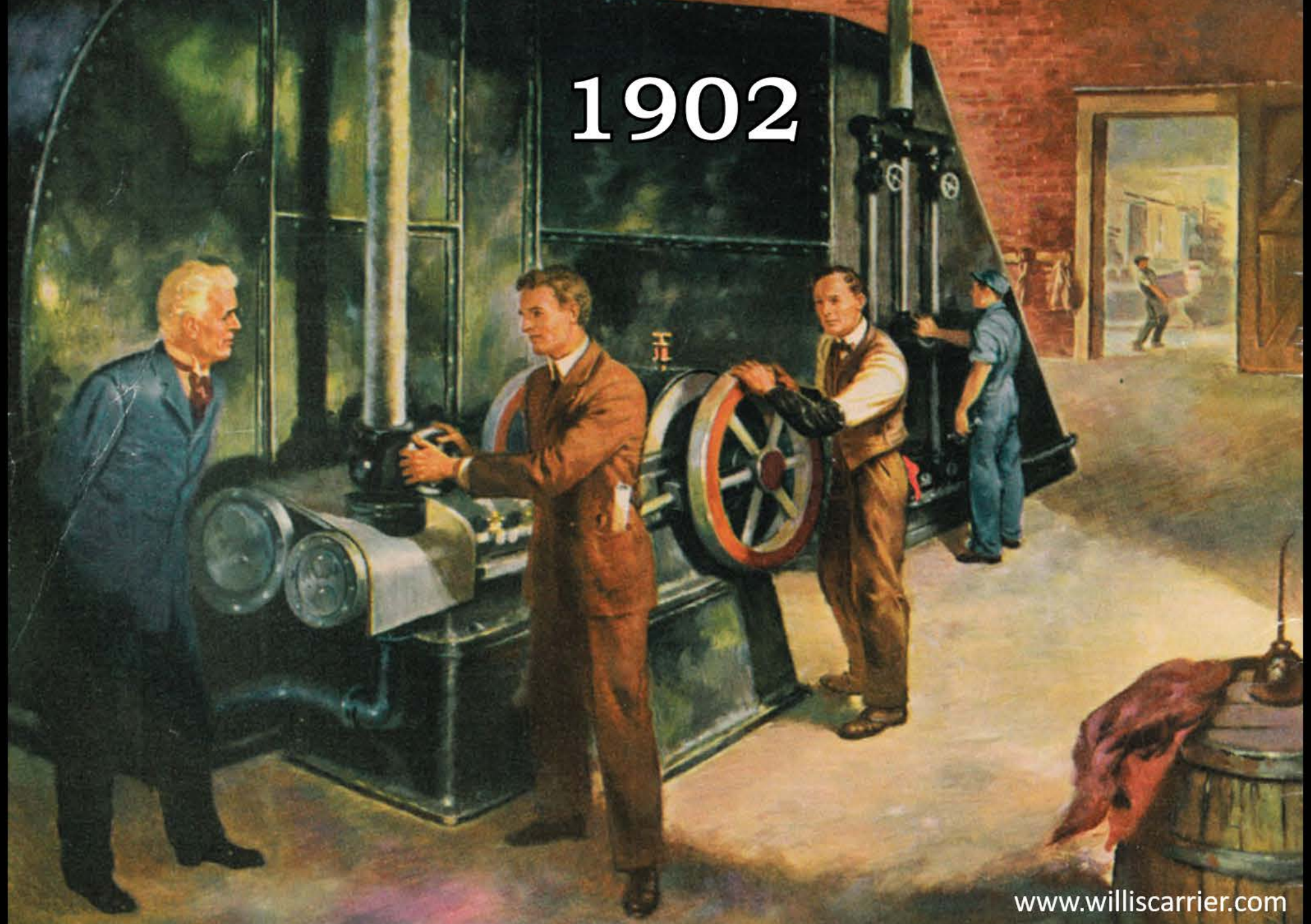
Northeast Sustainable Energy Association (NESEA)
September 15, 2022

The Path to Greener HVAC Refrigerants

Ozone Depletion Potential

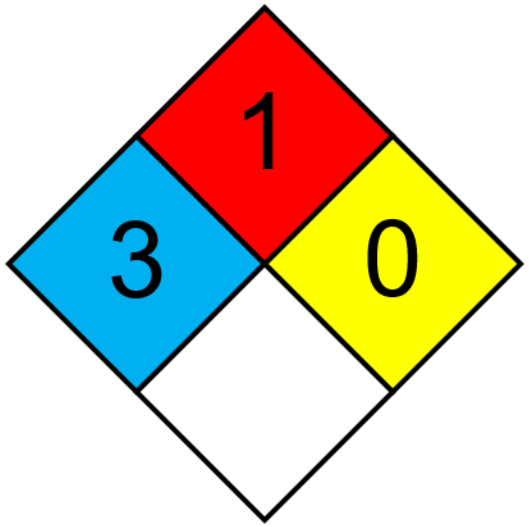
Global Warming Potential

Energy Efficiency

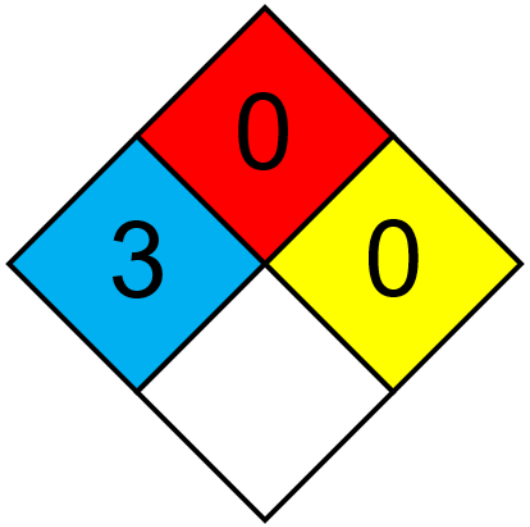

1902
www.williscarrier.com

Industry Standard Refrigerants
1902 - 1928

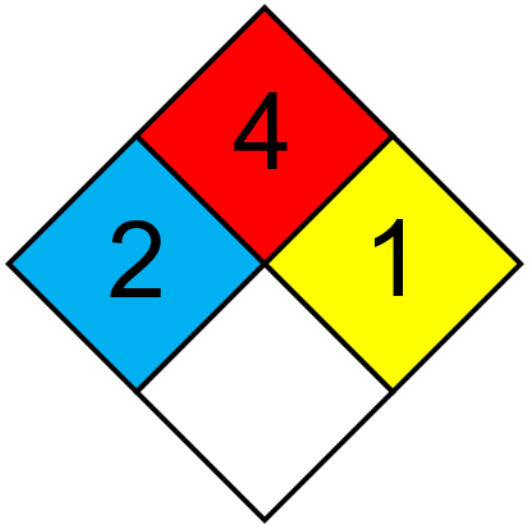
Ammonia



Sulfur Dioxide



Methyl Chloride



1928

"FREON"

By

Doctor Thomas Midgley, Jr.

DUPONT

GM

Frigidaire

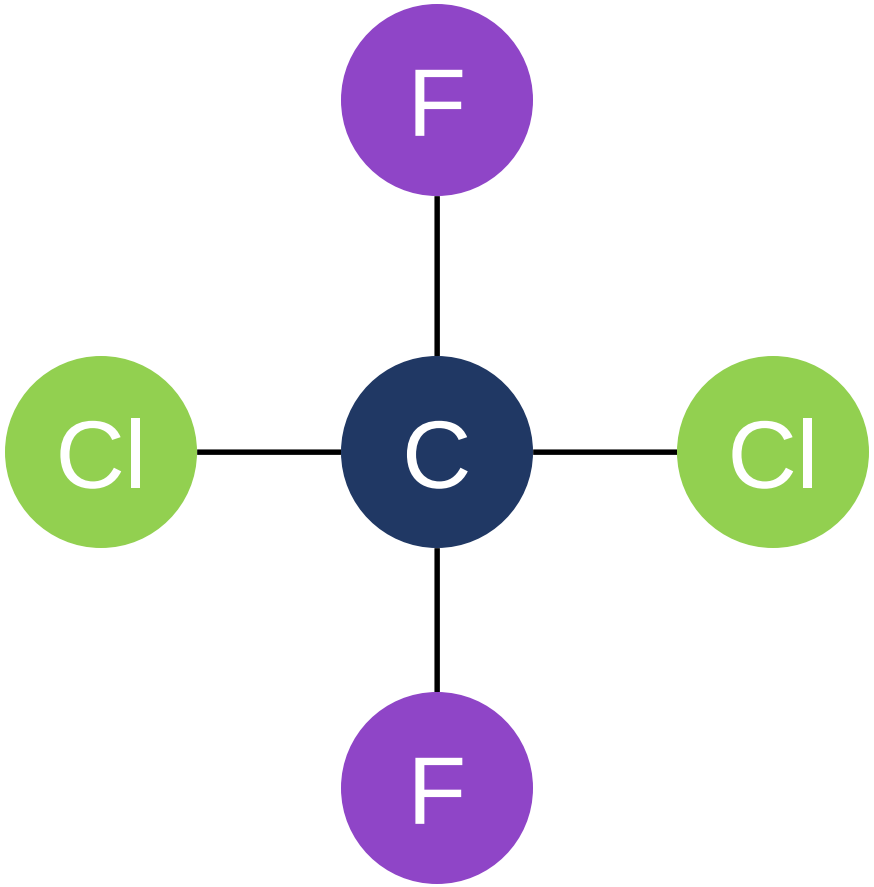
Periodic Table of the Elements

1 IA 1A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Chlorofluorocarbon (CFC)

Chlorofluorocarbon (CFC)

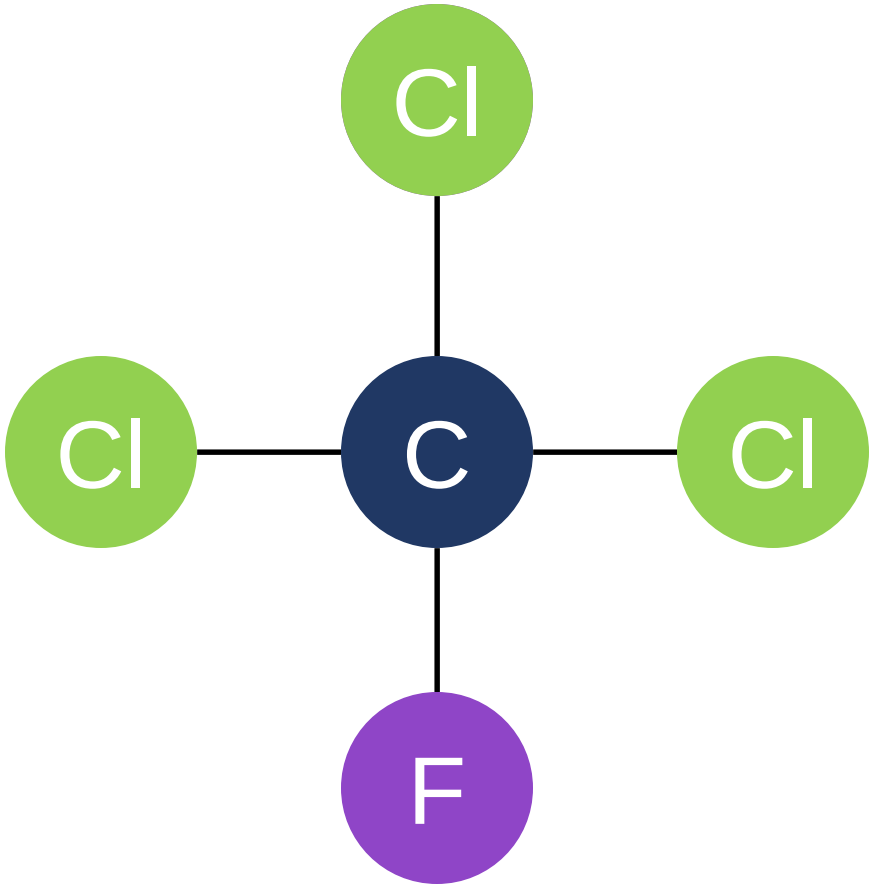


CCl_2F_2

Dichlorodifluoromethane

R-12

Chlorofluorocarbon (CFC)



CCl_3F

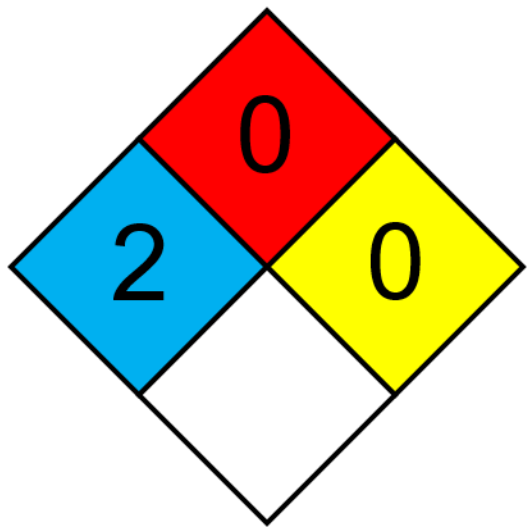
Trichlorofluoromethane

R-11

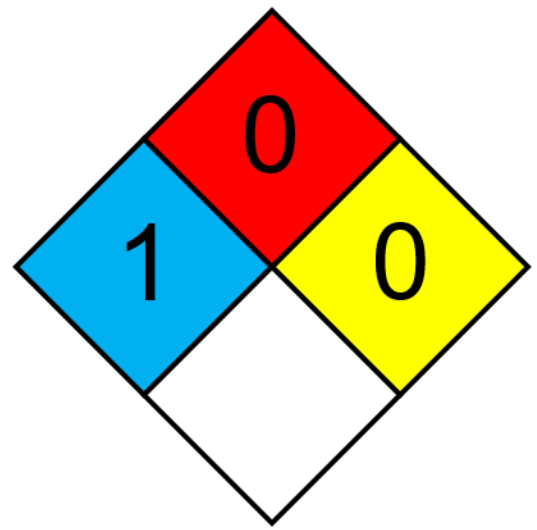
Chlorofluorocarbons (CFCs)

1928 - 1996

R-12



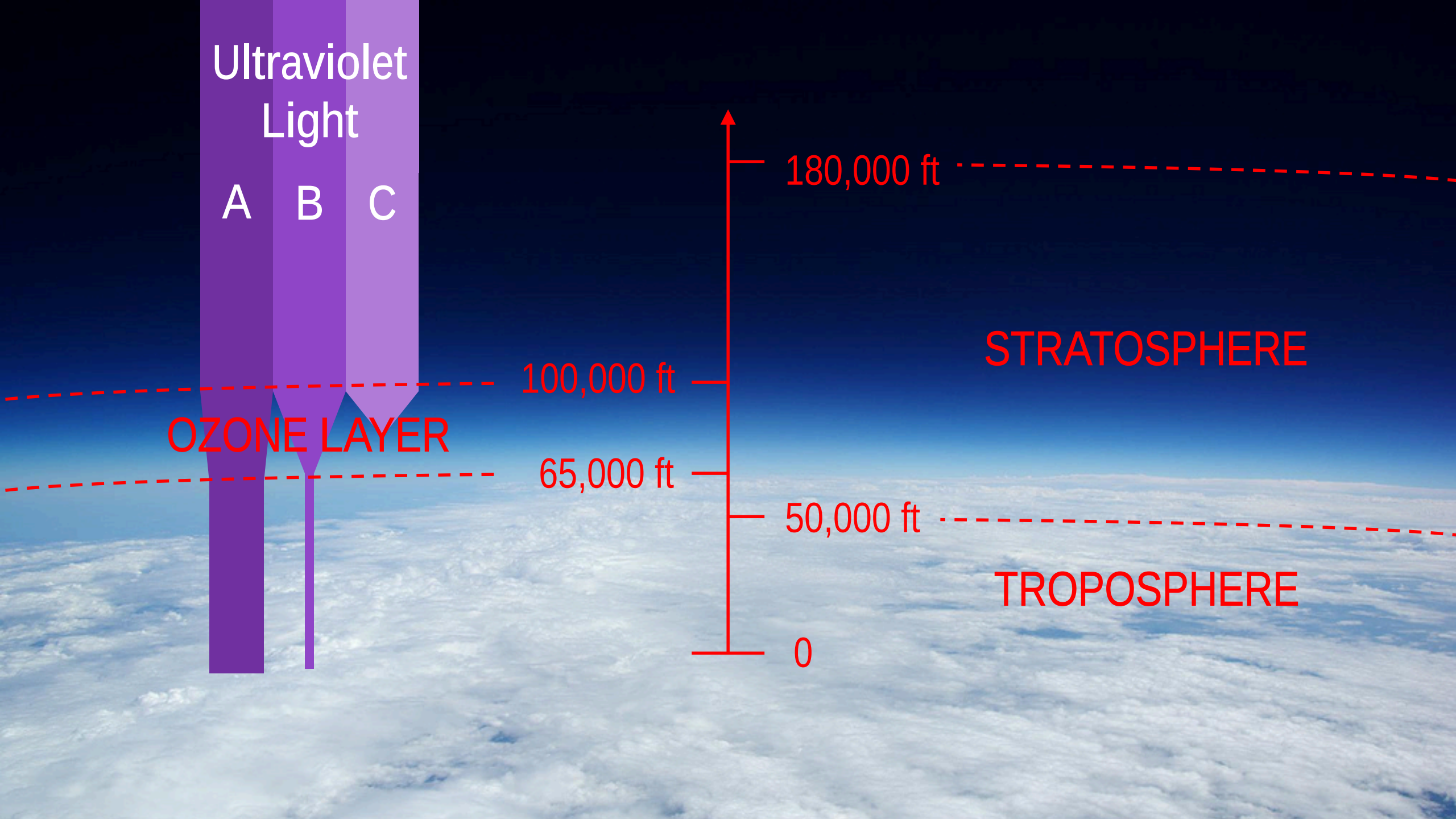
R-11

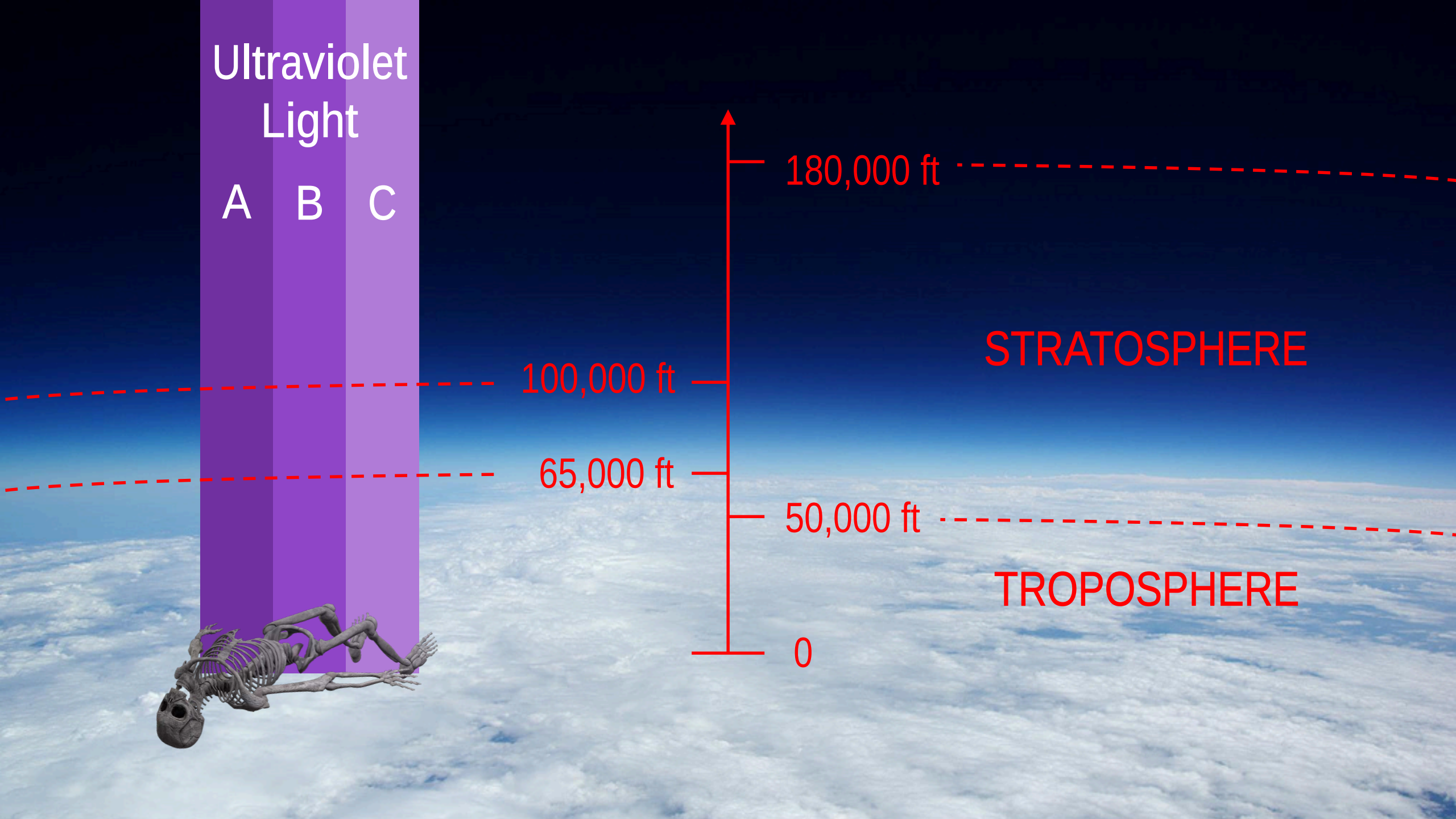


1984

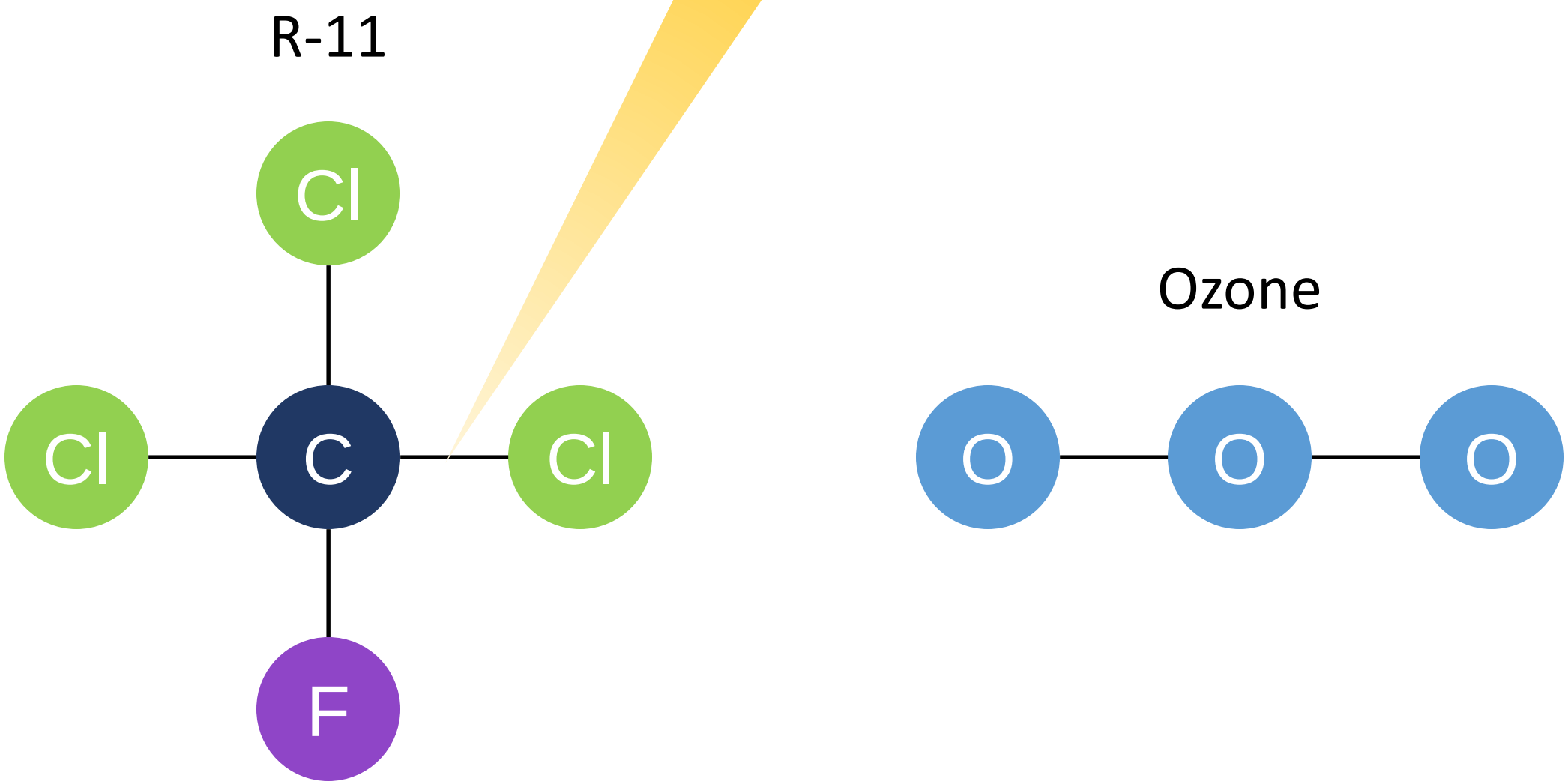
The Ozone Hole

JOSEPH FARMAN BRIAN GARDINER JONATHAN SHANKLIN

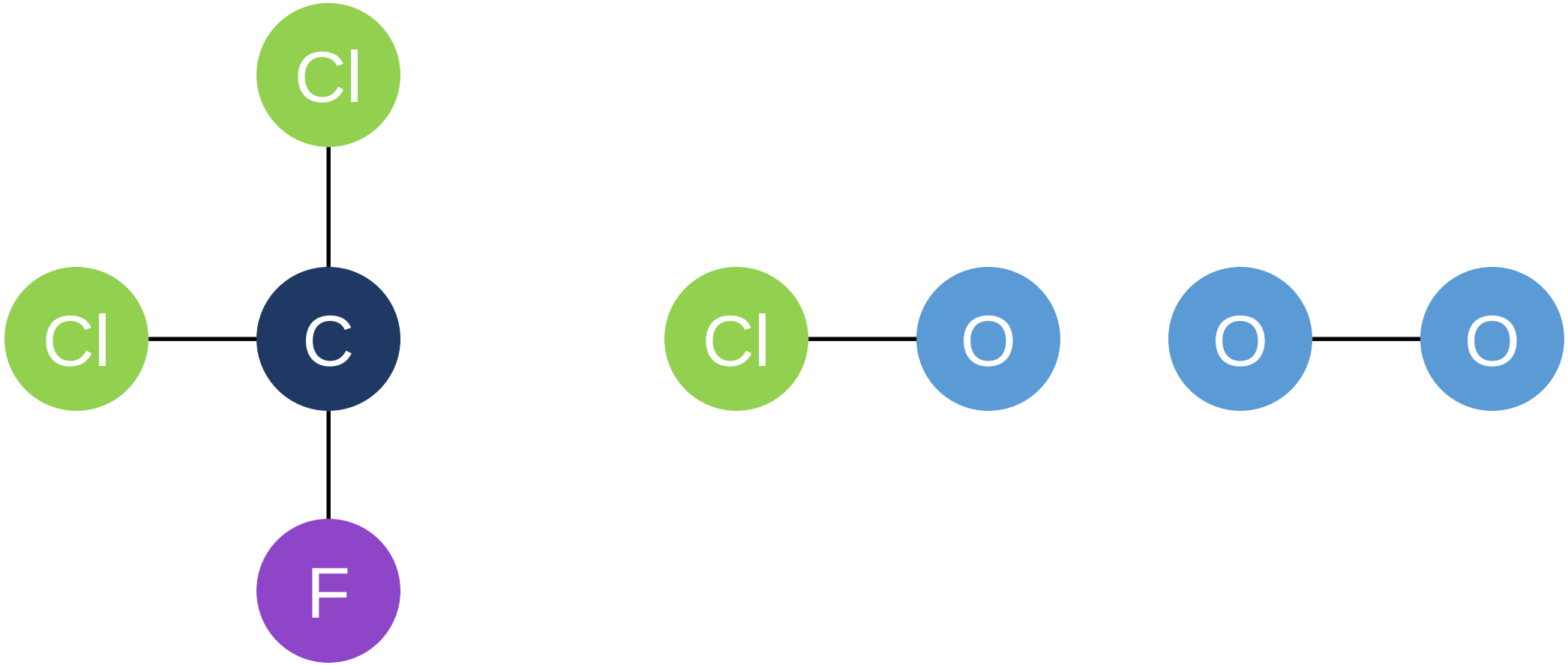

Ultraviolet Light
A B C
180,000 ft
STRATOSPHERE
100,000 ft
OZONE LAYER
65,000 ft
50,000 ft
TROPOSPHERE
0


Ultraviolet Light
A B C
180,000 ft
100,000 ft
65,000 ft
50,000 ft
0
STRATOSPHERE
TROPOSPHERE

CFCs Destroy Ozone



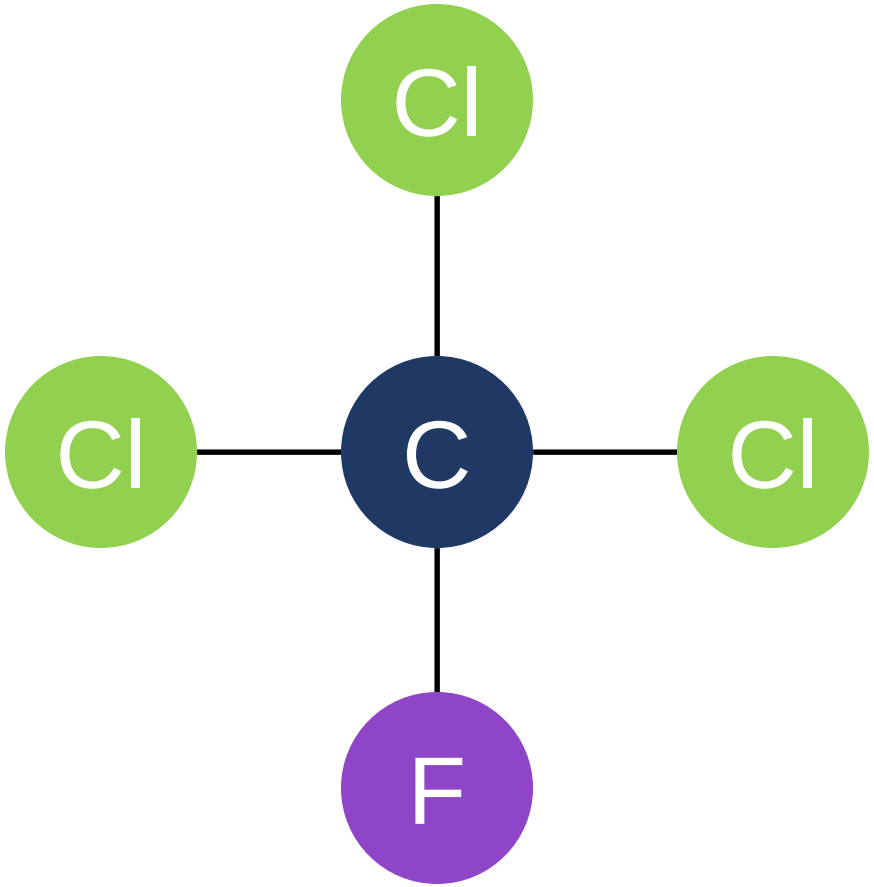
CFCs Destroy Ozone



1987

Montreal Protocol

Chlorofluorocarbon (CFC)

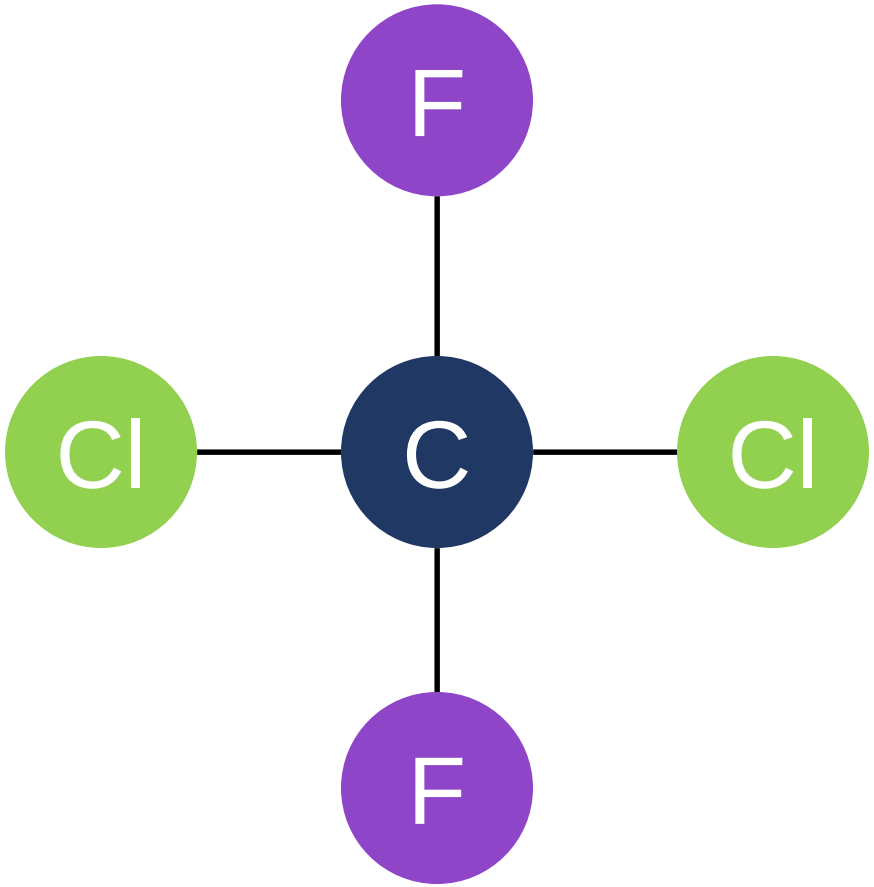


R-11

ODP: 1

No New Production: 1996

Chlorofluorocarbon (CFC)

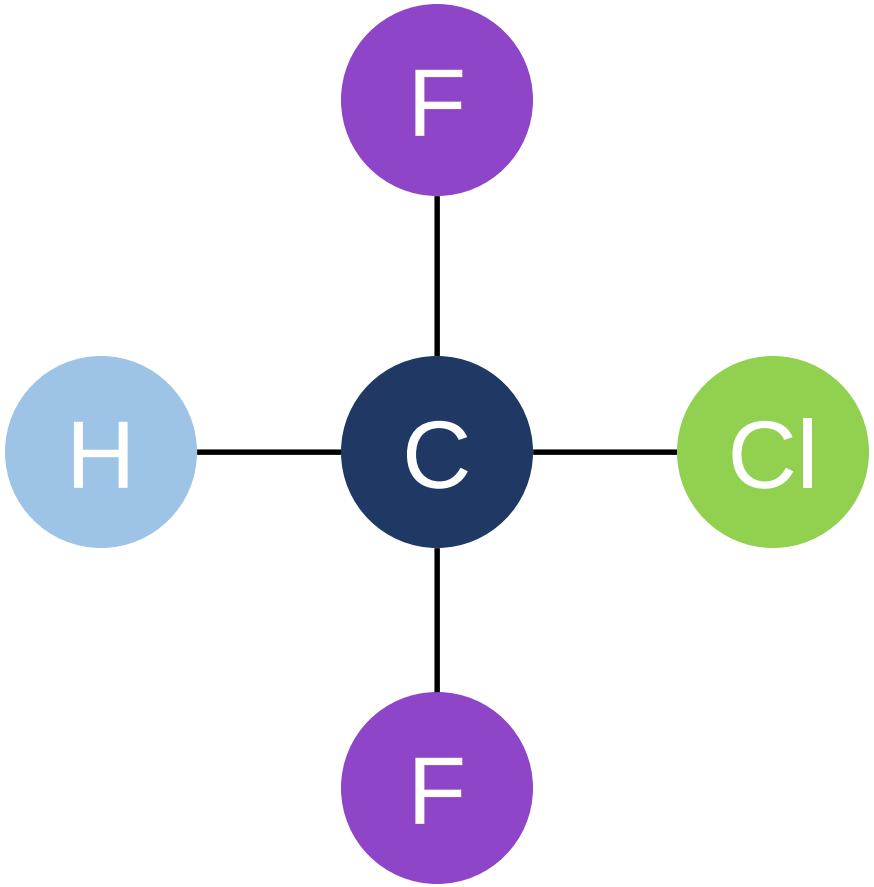


R-12

ODP: 1

No New Production: 1996

HydroChlorofluorocarbon (HCFC)



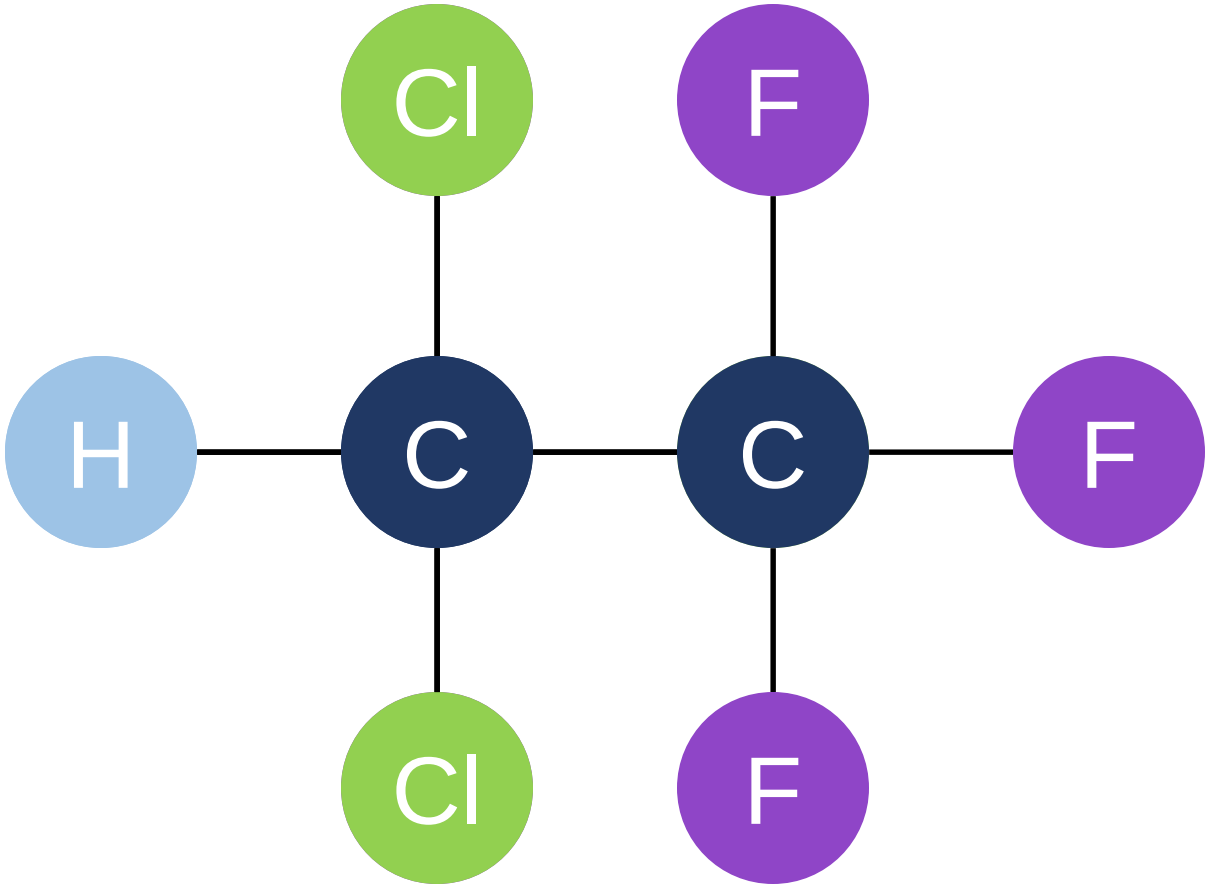
R-22

ODP: 0.05

No New Equipment: 2010

No New Production: 2020

HydroChlorofluorocarbon (HCFC)



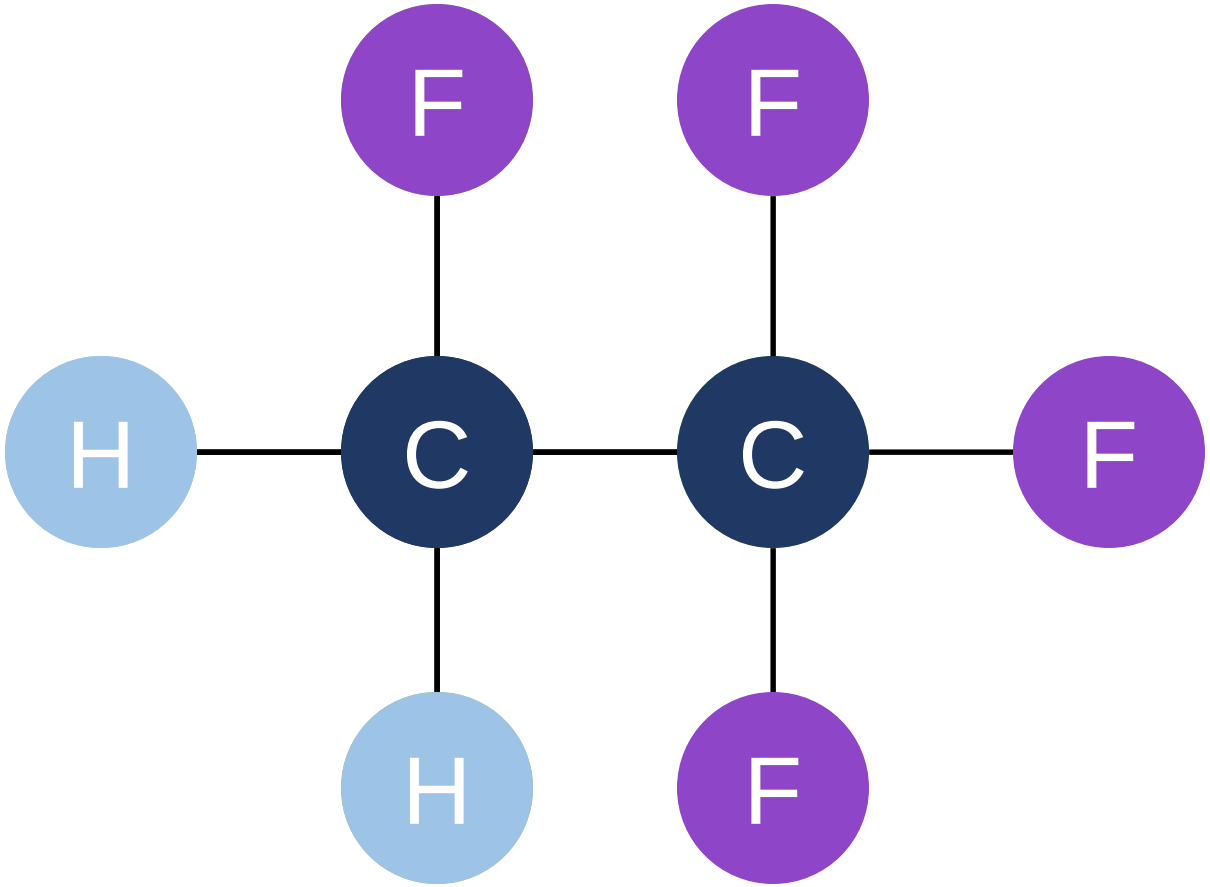
R-123

ODP: 0.02

No New Equipment: 2020

No New Production: 2030

Hydrofluorocarbon (HFC)



R-134a

ODP: 0

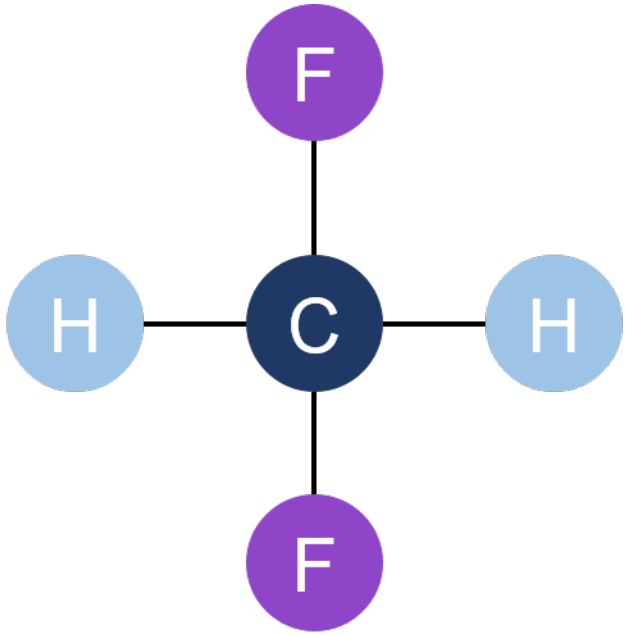
GWP: 1,300

Hydrofluorocarbon (HFC) Blend

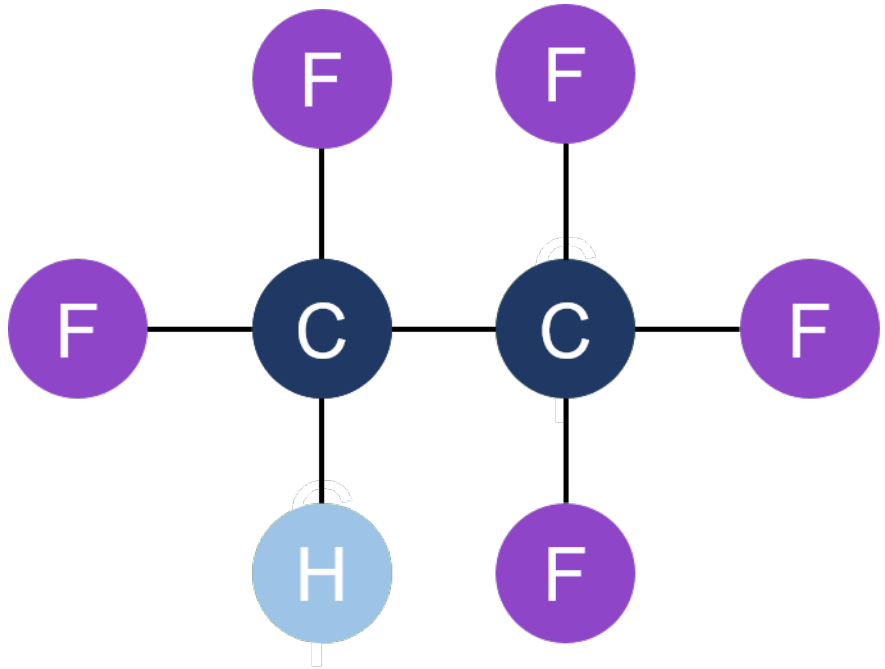
R-410A

ODP: 0

GWP: 1,924



50% R-32

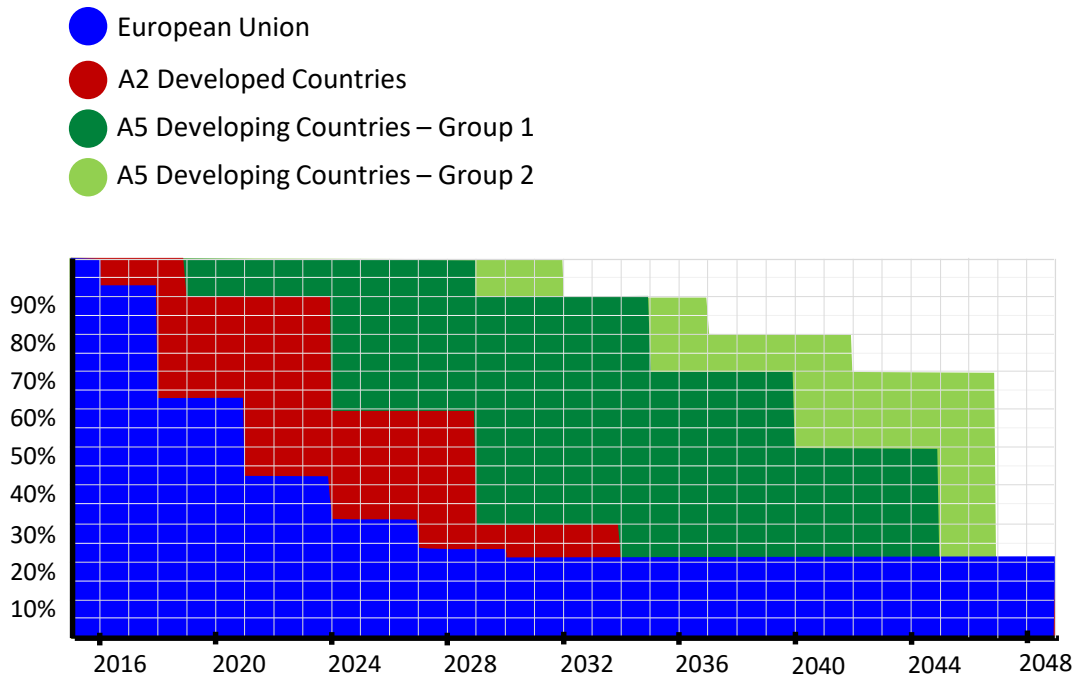


50% R-125

2016

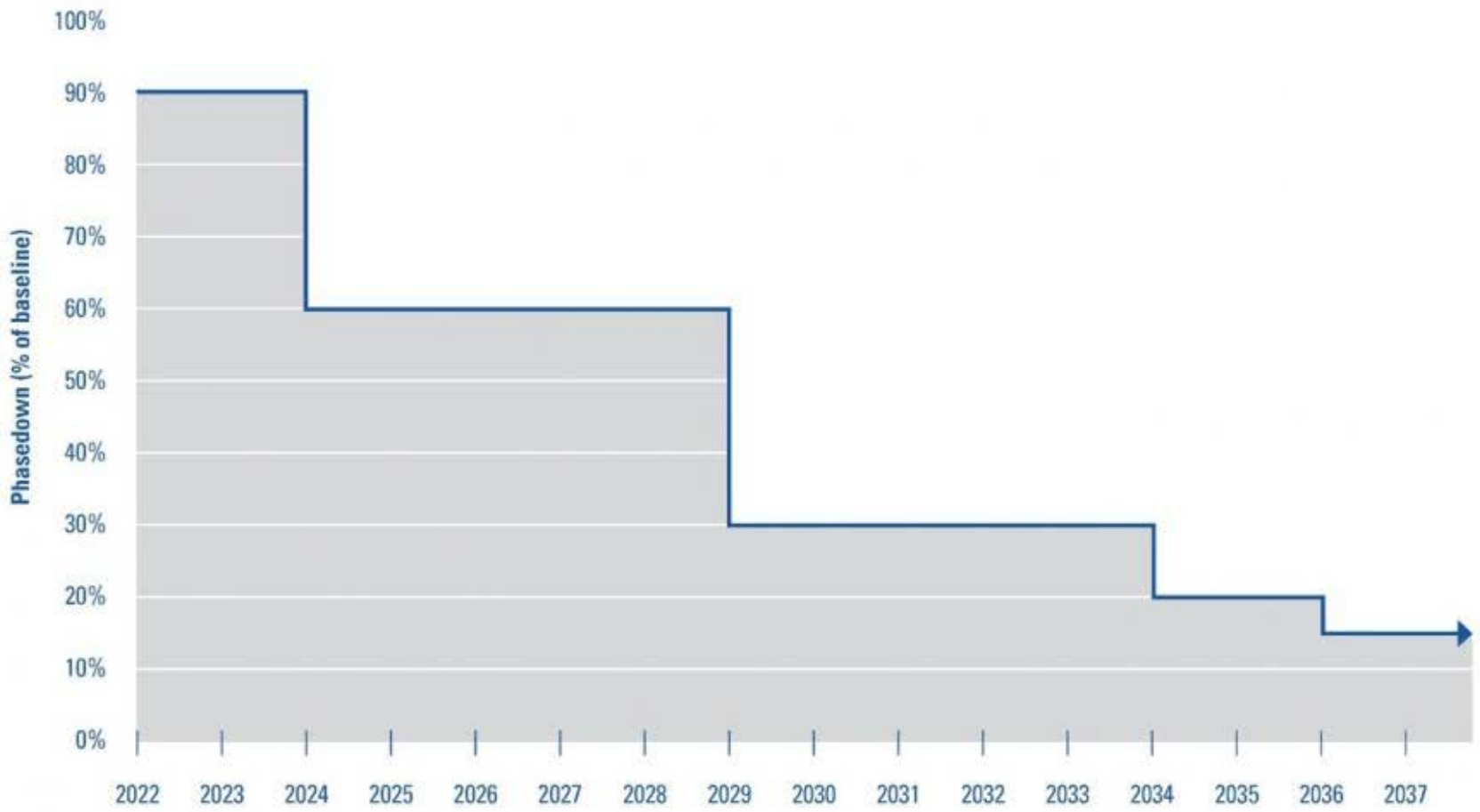
The Kigali Amendment to the Montreal Protocol

Global HFC Phase-down



2020

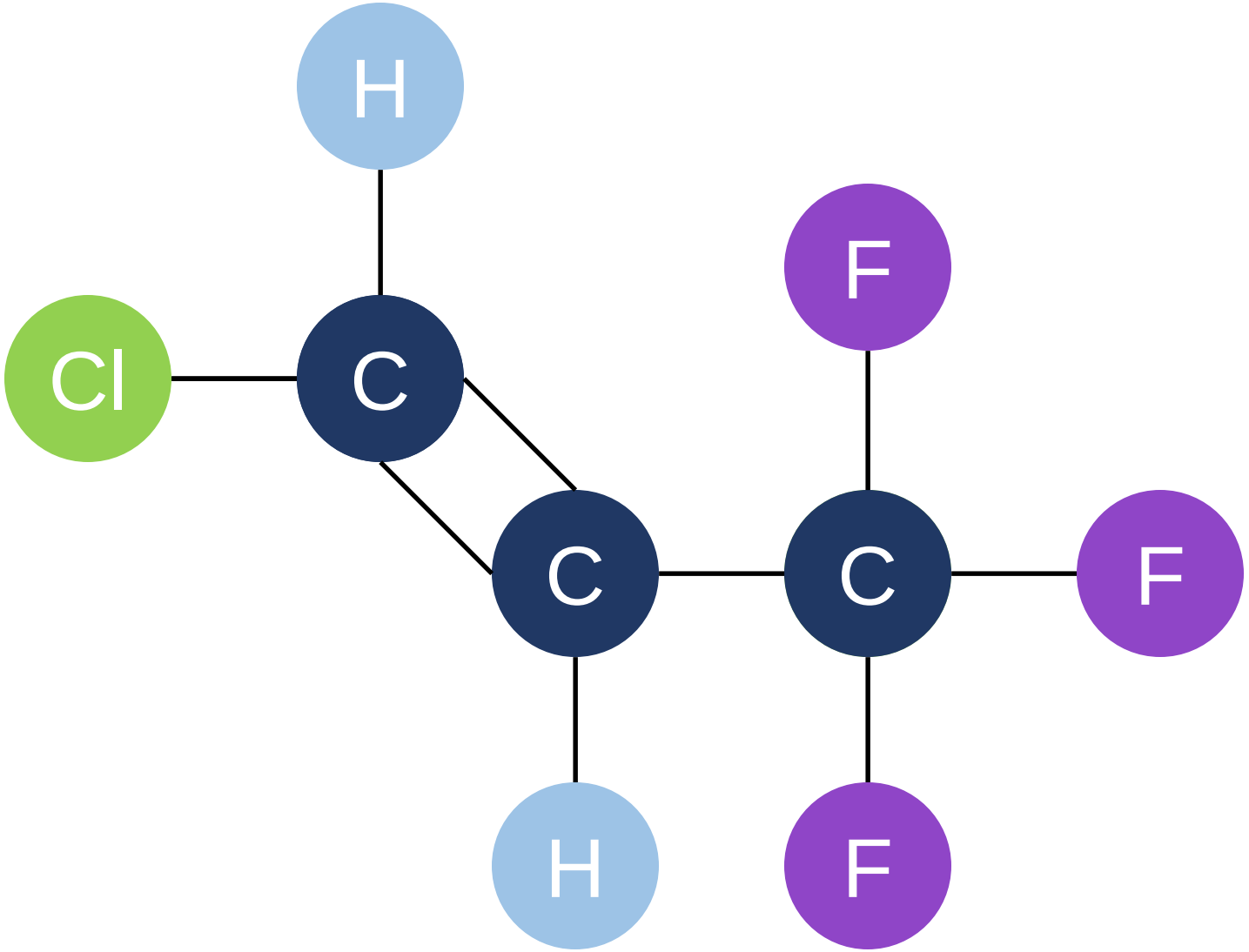
AIM Act to phase down HFC production 85% over 15 years



Low Pressure Refrigerants – Easy to replace

Pressure	Type	Refrigerant	Toxicity	Flammability	ODP	GWP
Low	CFC	R-11	A	1	1	4,660
	HCFC	R-123	B	1	0.01	79
	HFO	R-514A	B	1	0	2
	HCFO	R-1233zd	A	1	0	1

Hydrochlorofluoro-olefin (HCFO)



R-1233zd

ODP: 0

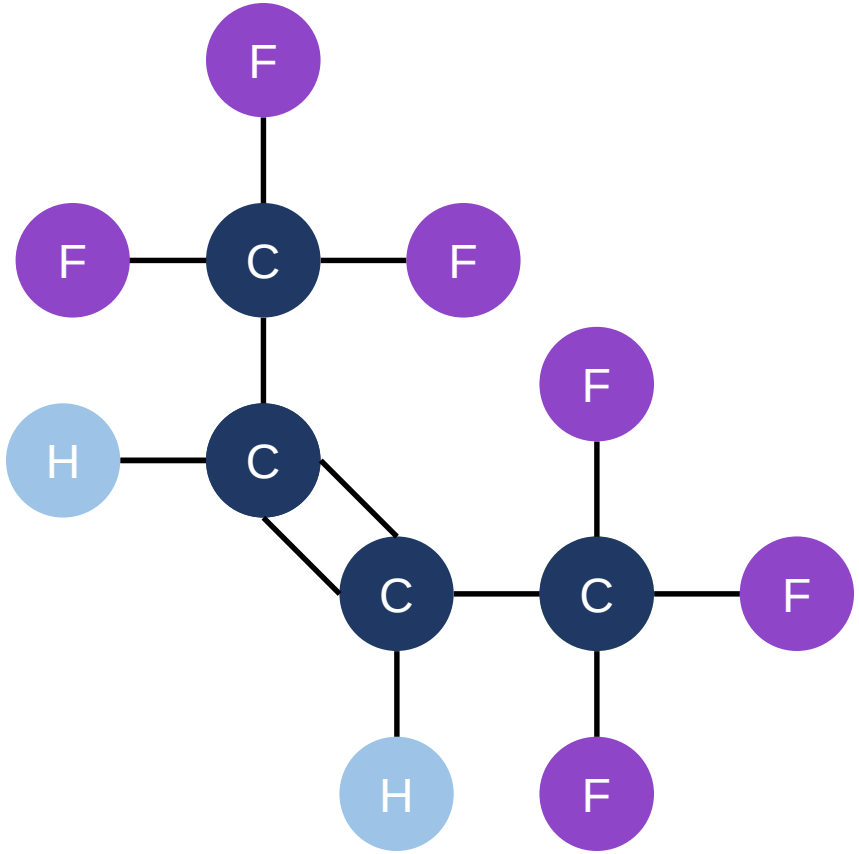
GWP: 1

Hydrofluoro-olefin (HFO) Blend

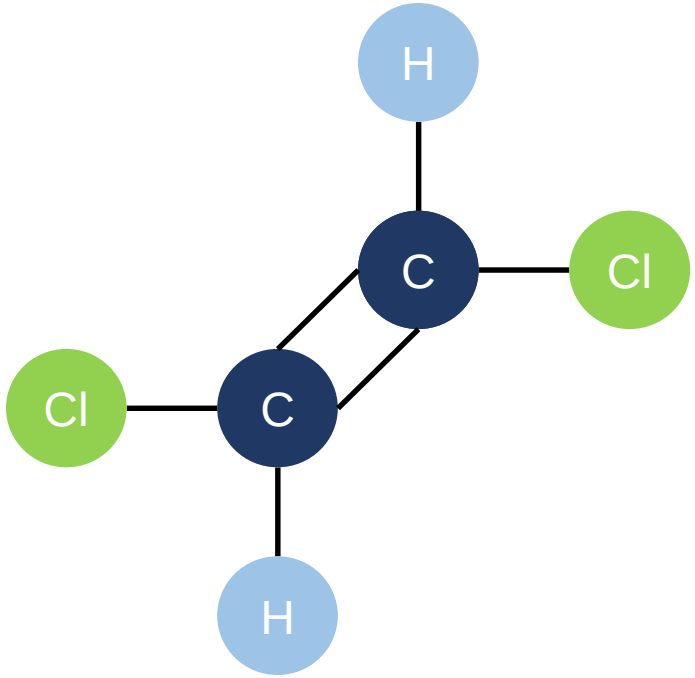
R-514A

ODP: 0

GWP: 1.5



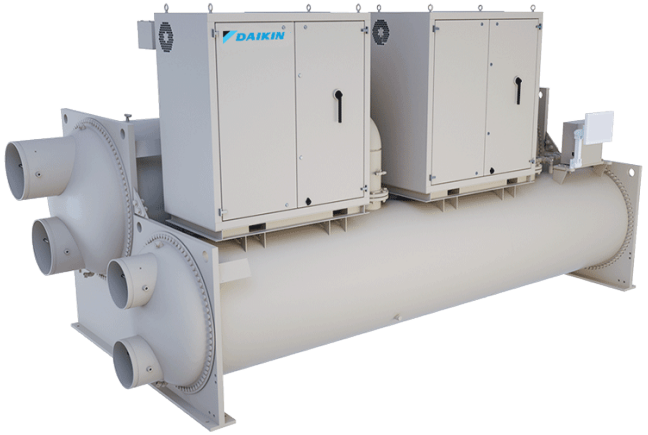
74.7% R-1336mzz(Z)



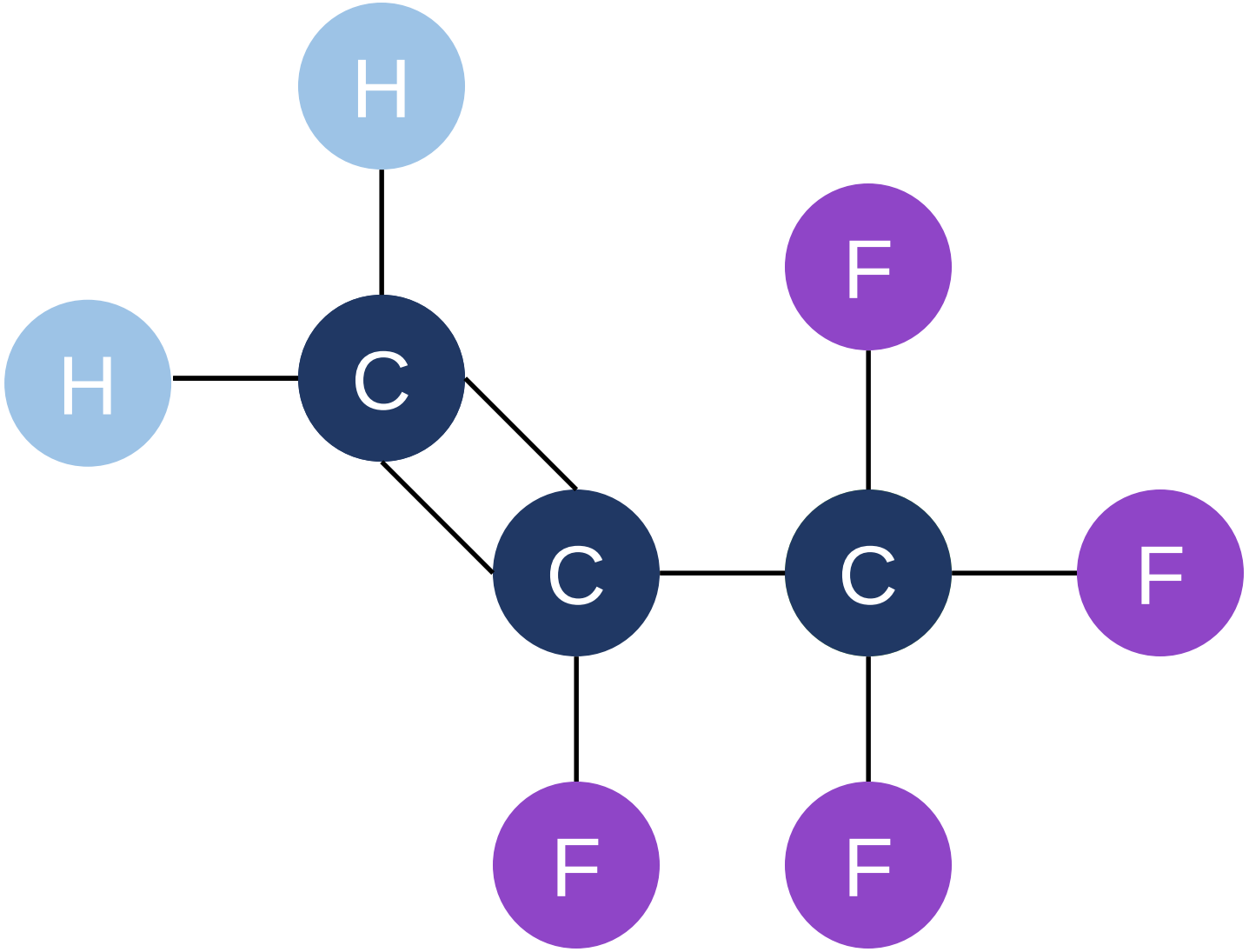
25.3% R-1130(E)

Medium Pressure Refrigerants – Easy to replace

Pressure	Type	Refrigerant	Toxicity	Flammability	ODP	GWP
Medium	CFC	R-12	A	1	1	10,200
	HFC	R-134a	A	1	0	1,300
	HFO	R-513A	A	1	0	573
	HFO	R-1234ze	A	2L – BV 0.0	0	1
	HFO	R-1234yf	A	2L – BV 1.5	0	1



Hydrofluoro-olefin (HFO)



R-1234yf

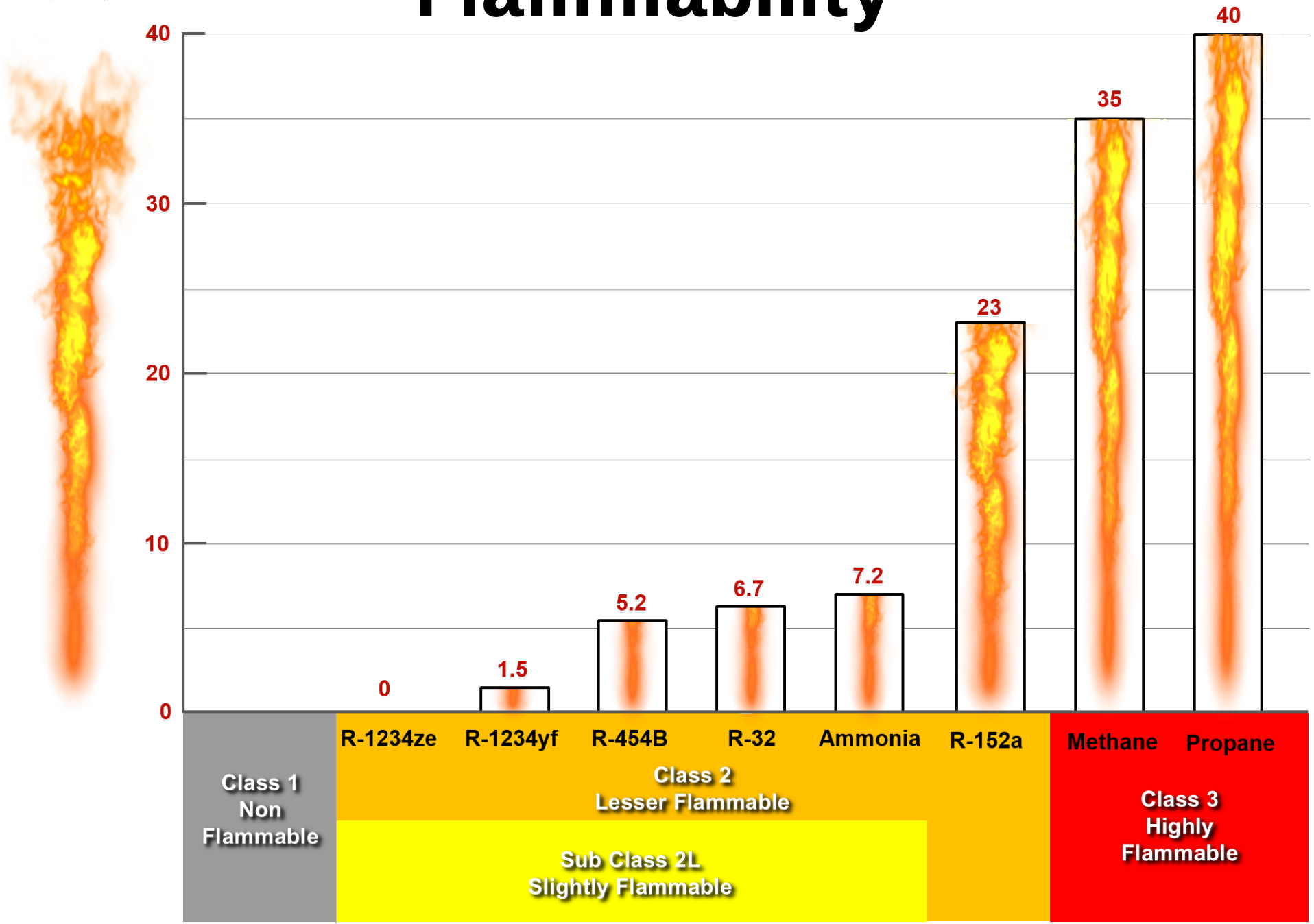
ODP: 0

GWP: 1

High Pressure Refrigerants – Challenging to replace

Pressure	Type	Refrigerant	Toxicity	Flammability	ODP	GWP
High	HCFC	R-22	A	1	0.05	1,810
	HFC	R-410A	A	1	0	1,924
	HFC	R-32	A	2L – BV 6.7	0	677
	HFC	R-454B	A	2L – BV 5.2	0	467
	HFC	R-152a	A	2 – BV 23	0	138
		R-290 (Propane)	A	3 – BV 40	0	5

Flammability



Toxicity Classes A&B – Long Term Exposure

Occupational Exposure Limit (OEL)

The time-weighted average concentration for a normal eight-hour work day and a 40-hour work week to which nearly all workers can be repeatedly exposed without adverse effect.

Class A: ≥ 400 ppm

Class B: < 400 ppm

SNAP
SIGNIFICANT • NEW • ALTERNATIVES • POLICY

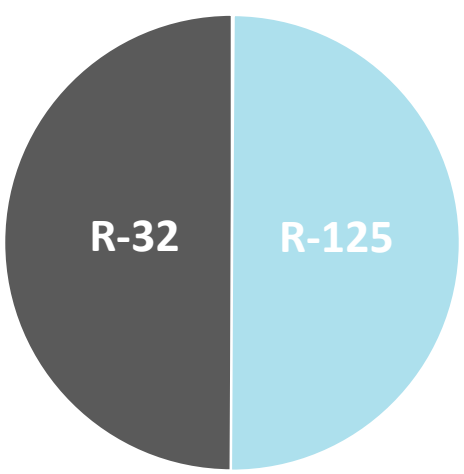
www.epa.gov/snap/refrigerant-safety

"Concerns with refrigerant safety have been heightened by negative marketing by competing equipment and refrigerant vendors. Frequent overstatement (to influence customer perceptions) coupled with contradictions have fueled discomfort in refrigerant choices for some alternative refrigerants."

Replacing R-410A

R-410A

1,924 GWP

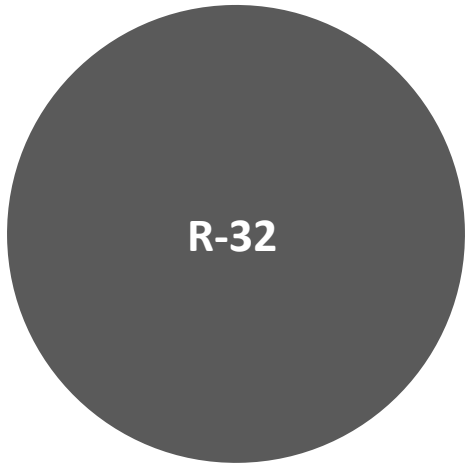


50% R-32

50% R-125

R-32

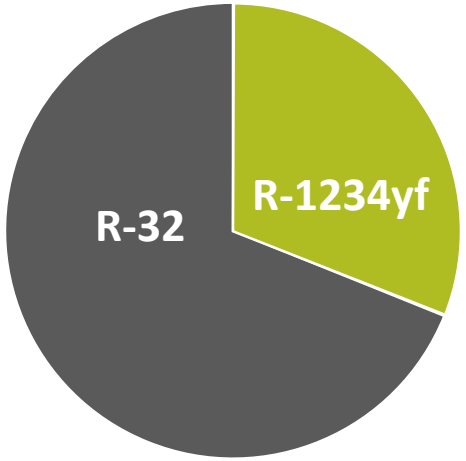
677 GWP



100% R-32

R-454B

467 GWP



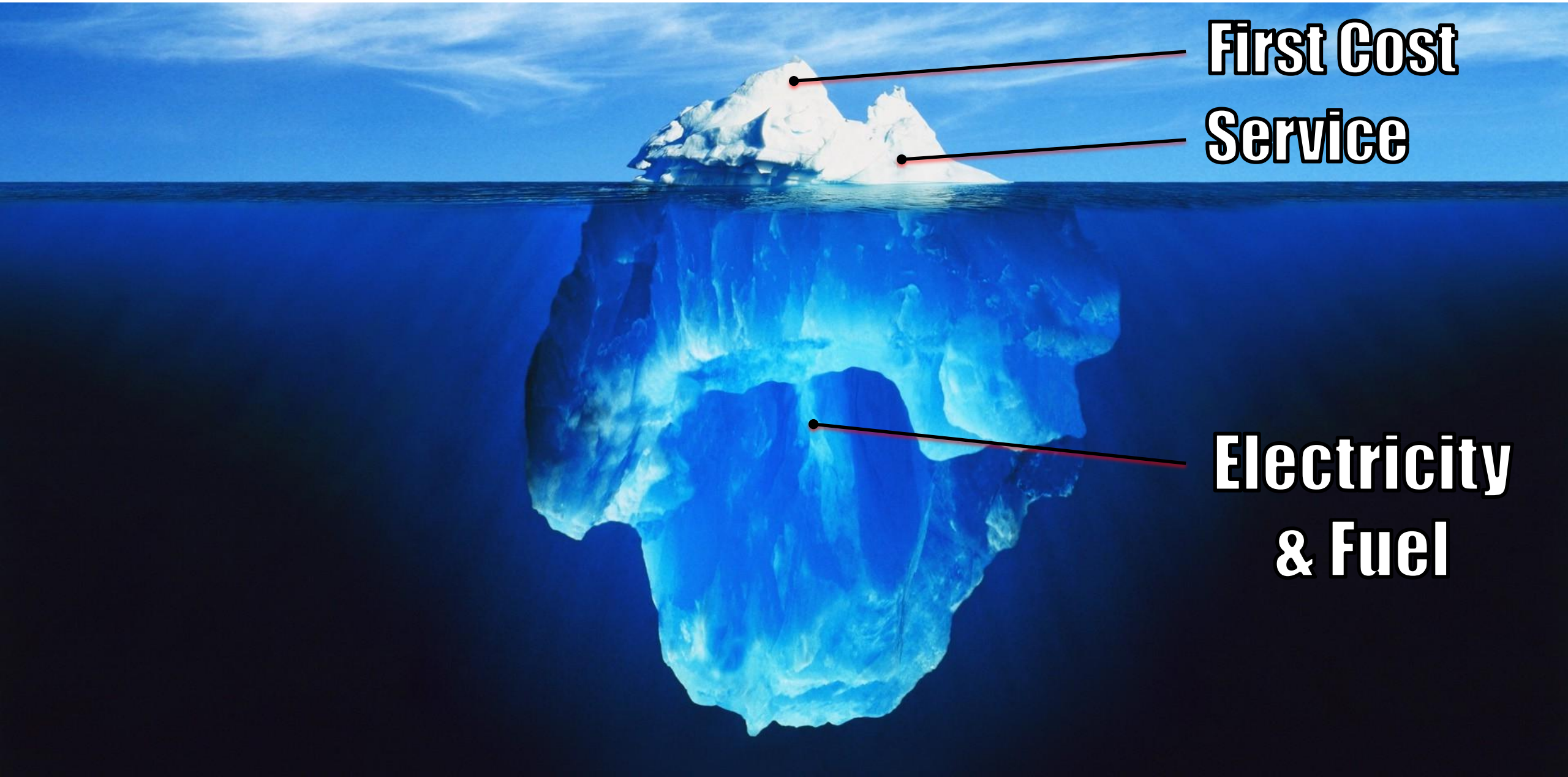
31.1% R-1234yf

68.9% R-32


FEDERAL RESERVE NOTE
DF 08345533 A
F6
DF 08345533 A

How much does an HVAC system cost?

$$$,$$$.$$



TRANE®

"Energy efficiency is, by far, the biggest impact to the environment, especially if you are able to contain the refrigerant inside the machine."

YORK®

"Efficiency is essential to a chiller's environmental impact. About 95% of a chiller's lifetime carbon footprint comes from indirect emissions."

DAIKIN

"For chillers, the vast majority of impact on climate change will come from generating electricity to run the equipment, versus refrigerant emissions."

EPA

"Energy efficiency is the main environmental consideration in the selection of a chiller as long as the equipment is carefully maintained and refrigerant emissions are kept near zero."

The Path to Greener HVAC Refrigerants

Ozone Depletion Potential

Global Warming Potential

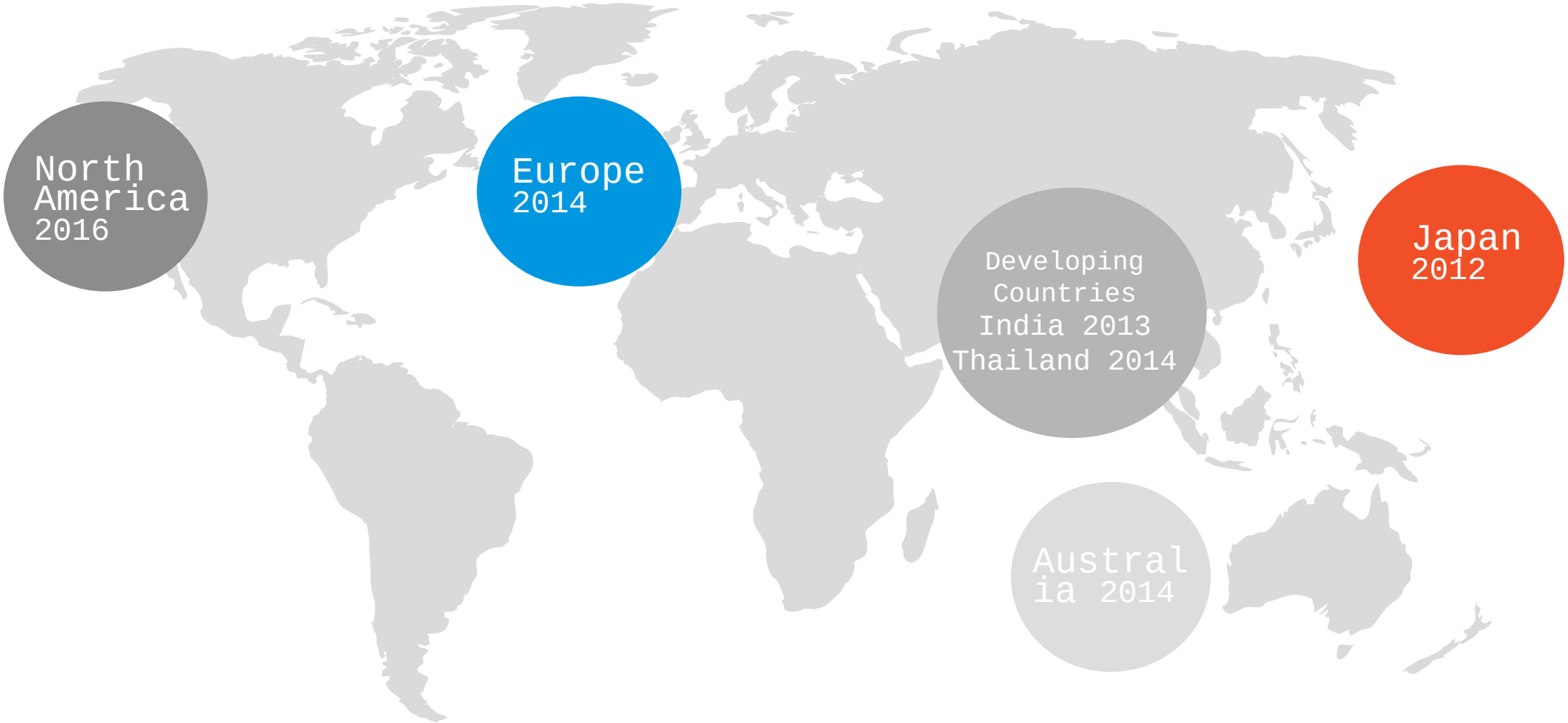
Energy Efficiency

AGENDA

- Products & Applications
- Regulatory Overview
- Safety Considerations
- Tools in the Trades
- Summary - Recap

R-32 IS A PROVEN COMMODITY USED GLOBALLY

R-32 has achieved a global installed base of over 190 million units in over 120 countries by more than 50 OEMs (*Daikin's estimate)



Daikin Global R32 Product Offering

Products will be ready when the codes, standards and market is ready

R-32 technology at its best

R32 Mini/Multi/Commercial Splits (Globally)

R32 VRV (Japan)

6-10 tons

R32 VRVS (Europe)

2-5 tons 1ph

6-24tons 3ph

R32 Compact Inverter Chillers (5-25 tons)

R-32 Altherma

Heat/Cool/Hot Water

Residential/ Multi-Family

Daikin Starts Global R32 Experience in North America

Daikin has chosen R32 as the next refrigerant in NA based on global experience and superior ease of use
Over 68% reduction in GWP (Global Warming Potential) from R410a and approx. 6-10% more efficient

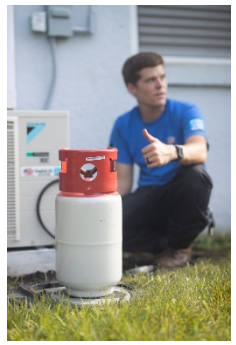
- Pure, single-component refrigerant
- Easy to top off, or clean and reuse on-site
- Easy to reclaim and recycle

Environmental Impact of Air Conditioner Refrigerants and Trends

	Ozone Depletion Potential (ODP)	100 Year Global Warming Potential of Different Refrigerants*1
R12 (CFC)	1.0	10,900
R22 (HCFC)	0.055	1,810
R410A (HFC)	0	2,090
R32 (HFC)	0	675

Over 190 million units from over 50 OEMs in over 120 countries through 2021

- Daikin has taken the lead in North America by launching the first systems with next generation low GWP R32 refrigerant.
- Installation in Florida residential 2021



Up to 12% higher SEER
Up to 18% higher HSPF
Up to 14% higher COP at 5F
Up to 21% higher max cooling capacity at 115F
Up to 51% higher max heating capacity at -13F

PRODUCT NEWS
Daikin Announces Daikin ATMOSPHERA with R-32 Refrigerant

Daikin Proves Cold Climate Heat Pumps in NYC – Centralized Oil Burner Boiler to de-centralized heating

- In 2020, Daikin converted the heating system in a nearly 100-year-old, 10-unit, multifamily Manhattan building from an oil-burning steam boiler to Daikin Aurora multi-split heat pumps. These 20 century buildings are common throughout the U.S. Northeast region. Daikin's demonstration project shows how its products can reduce fossil fuel heating and, in the process, bring 20 century buildings into the 21 century.

More than 40%

of U.S. energy consumption comes from heating and cooling houses, buildings, and water

10 million+ homes
in the Northeast U.S. still rely on
gas-fired furnaces

That accounts for
20% of U.S. greenhouse gas emissions

Heat pumps are proven to be
3x more efficient
than fossil-fuel-burning furnaces

Measurements were taken throughout a period of over 18 months, using more than 100 sensors in the building to validate the heat pumps' performance and measure comfort:

The Daikin system reduced direct heating system emissions **58 percent** and building wide greenhouse gas emission (GHG) emissions by **49 percent.**

Switching to air-source heat pumps for heating reduced building energy costs by more than **16 percent**.

The cold-climate air source heat pumps provided **100 percent** of the space heating in the building for two full winters without ever needing to use the building's oil-fired boiler.

DOE Cold Climate Heat Pump Challenge Mandates Low GWP Refrigerants

While older heat pumps may have underperformed in cold climates, Daikin is proud to partner with the U.S. Department of Energy's Cold Climate Heat Pump Challenge to develop new variable speed inverter heat pump solutions utilizing lower GWP refrigerant R-32, which will deliver effective heating performance and efficiency in ambient temperatures of 5° Fahrenheit and below.

Performance Requirements

Seasonal Heating

- 8.5 HSPF2 (Region V)
- Heating at 5°F [-15°C]
- Minimum COP of 2.1-2.4 at 5°F
- Capacity ratio of 100% for 5°F capacity to 47°F capacity
- Minimum turndown ratio at 47°F
- Compressor cut-in and cut-out temperatures

Heating at -15°F [-26°C] (optional)

- HP operation at -15°F as measured by compressor cut-in and cut-out temperatures

Auxiliary heat

- Staged auxiliary heating

Low GWP Requirement

- Employ refrigerant with a global warming potential (GWP) value of no more than 750 (AR4,100 year)

OEM Partners

BOSCH Invented for life
LG
Carrier
Midea
DAIKIN
MITSUBISHI ELECTRIC Changes for the Better
Johnson Controls
Rheem
LENNOX
TRANE TECHNOLOGIES

AGENDA

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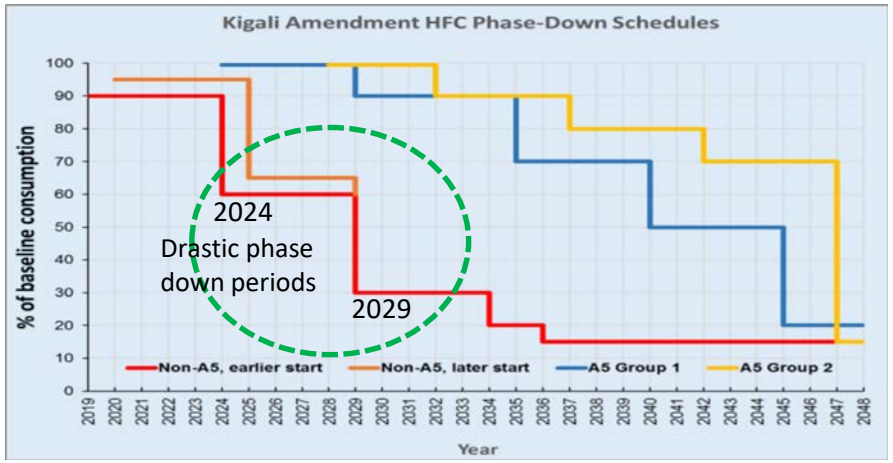
AIM Act will reduce R-410A production, Low-GWP Refrigerant acceptance increases

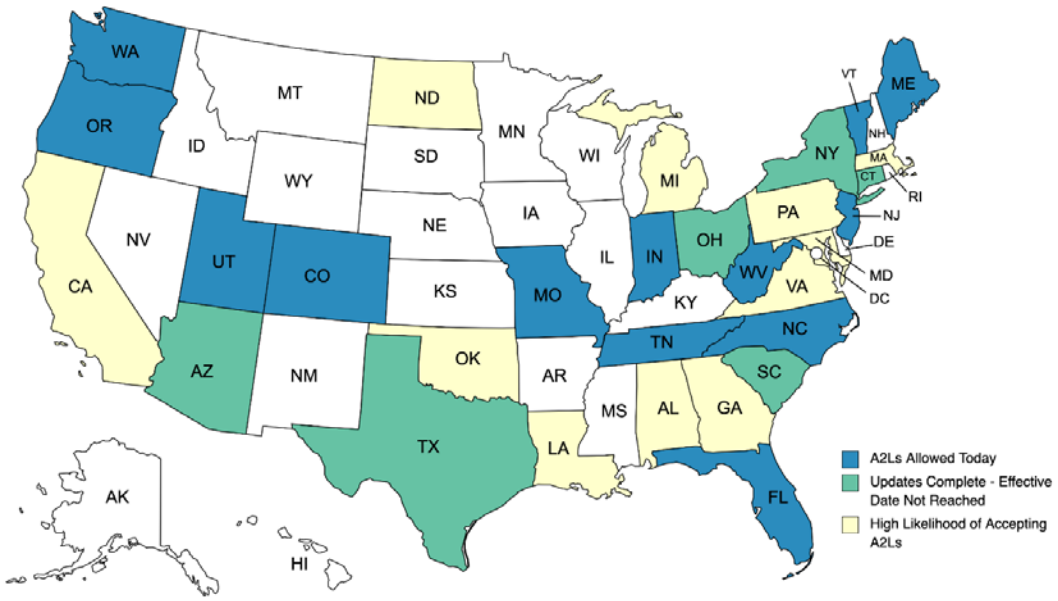
AIM Act passed in 2020 will address hydrofluorocarbon (HFC) use in three ways:

1. Phasing down the production and consumption
2. Maximizing reclamation and minimizing release from equipment
3. Facilitating the transformation to next-generation technologies.

AIM Act HFC Phasedown Schedule

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





- **CO, FL, IN, ME, MO, NC, NJ, OR, TN, UT, VT, WA, and WV already allow A2L refrigerants**
- **AZ, CT, NY, OH, SC, and TX are complete, just waiting for the effective dates**

Source: AHRI - Daikin Environmental Committee, extracted AHRI database

AIM Act: Law Passed Dec. 27, 2020: EPA Rulemaking Sept. 23

- EPA finalized rules to phase down production and consumption of bulk HFCs in 2022 and 2023
- Set the baseline
- 2024 allocations not in rule. 40% reduction guaranteed
- HFC allowance allocation and trading program. Can't carry forward unused allocations
- Imported Products Containing not included
- QR Codes on cylinders (tracking). Compliance is extended to 2025
- Disposable cylinders (heel). Compliance is extended to 2025
- Sector-based petitions not covered – but EPA has ruled in favor of 11 petitions
  - Align with CARB 750 limit and dates
  - Petitions can't delay the phasedown schedule
- Increase reclamation

- Early California Position: 750 GWP limit
  - Jan '23 for PTAC and Window AC
  - Jan '24 for Chillers
  - Jan '25 for Direct HVAC other than VRF
  - Jan '26 for VRF

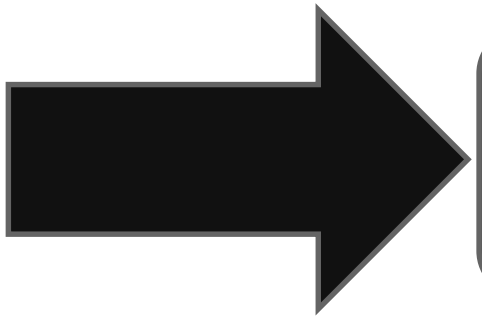
High probability USA will transition Chillers on Jan '24 and residential HVAC on Jan '25, same as CA. VRV/F will follow in '26.

THE CODE ADOPTION PROCESS FOR NEW TECHNOLOGY

New or Revised Product Safety Standard

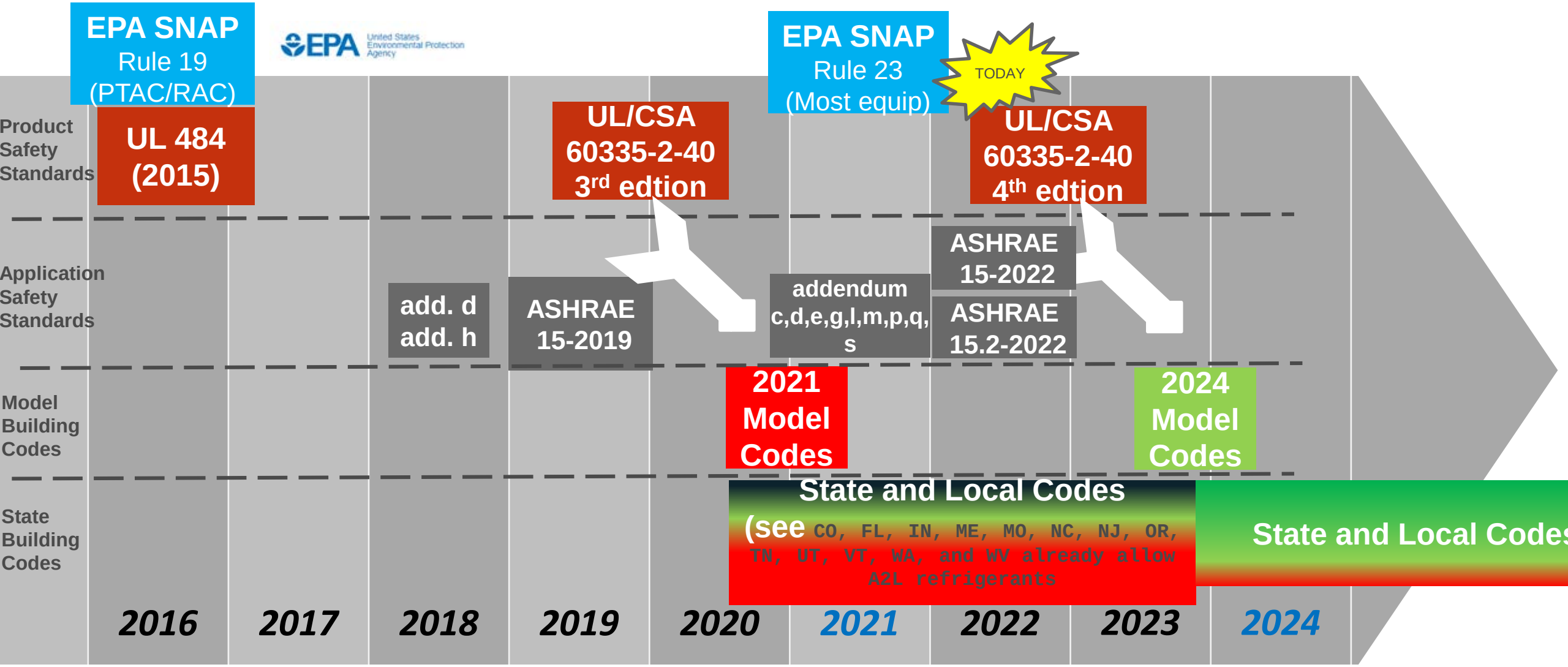
Updated Application Safety Standard

Updated Model Code (triennial)



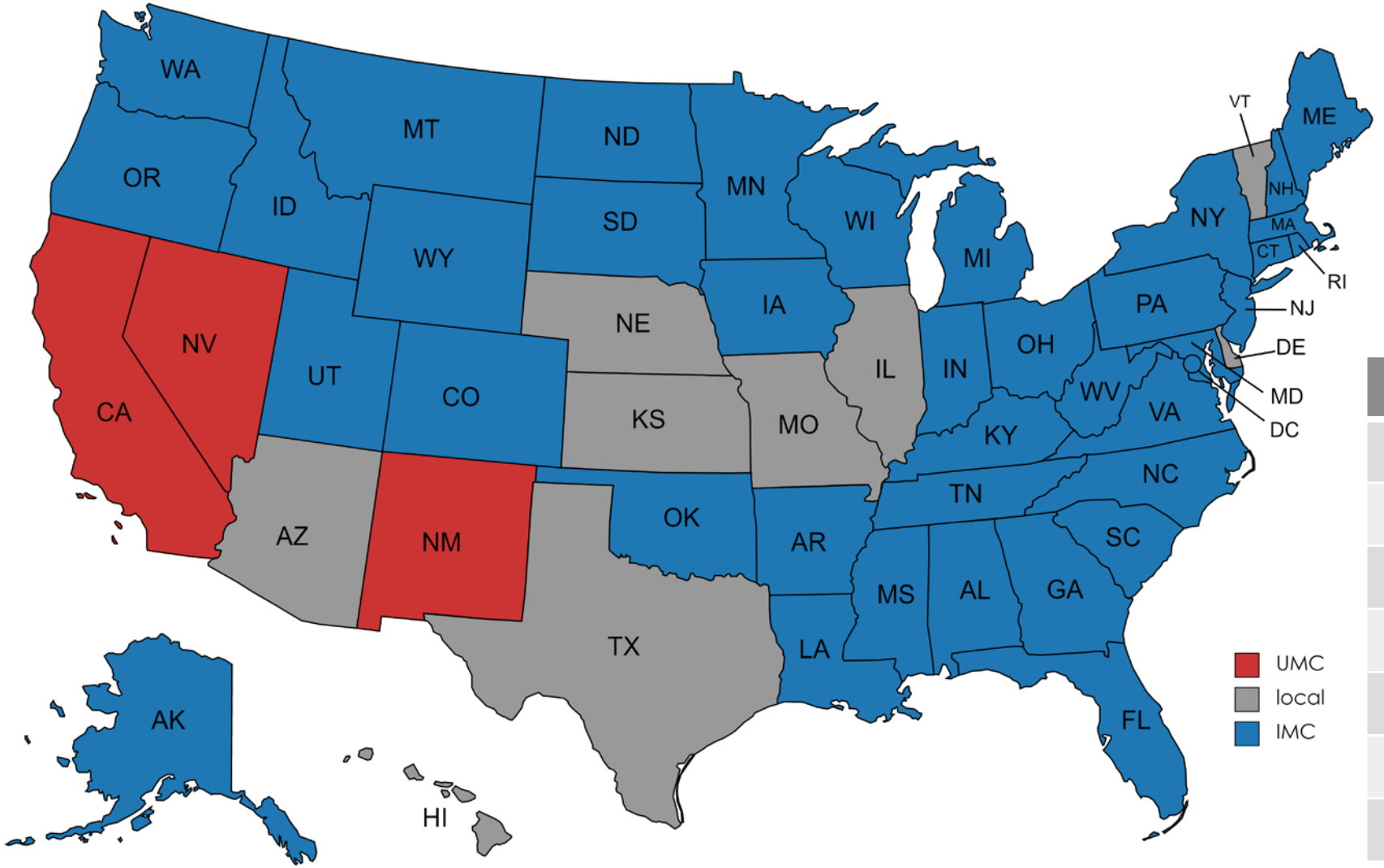
Your state code adopts model code*

Standard/Code Readiness - Group A2L



UMC, Uniform Mechanical Code
IMC/IRC, International Mechanical Code/International Residential Code

MECHANICAL CODE ADOPTION



Version	Quantity
IMC 2009	1
IMC 2012	3
IMC 2015	18
IMC 2018	16
IMC 2021	1
UMC 2015	1
UMC 2018	2

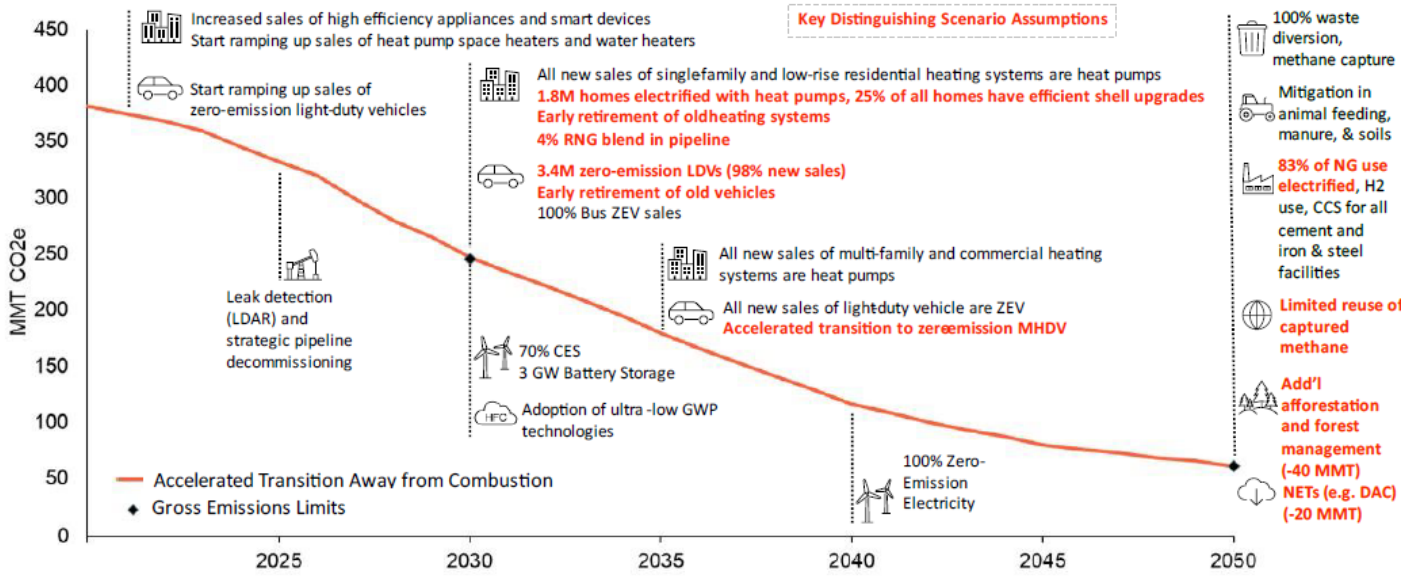
Based on upcodes.com

New York is pursuing a Future with reduced environmental impact from Refrigerants

- Governor Kathy Hochul signed "Advanced Building Codes Appliance and Equipment Efficiency Standards Act of 2022" on July 5th, 2022
- The law ensures that substances allowed under U.S. EPA's SNAP (Significant New Alternative Policy) are not prohibited by any building

NY's *Draft Scoping Plan* outlines refrigerant-related strategies the state needs to pursue to achieve long-term climate goals set forth in the Climate Leadership and Community Protection Act (CLCPA):

1. Transition to low-GWP Refrigerants and enhanced management
2. Adopting Ultra-Low GWP Technologies by 2030



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Safety Standards (subset of actual) – Based on Extensive Research

New Safety Requirements for Low GWP Refrigerants Understanding the Updated UL 60335-2-40 Refrigerant Detector Requirements and Future Standard Updates.

- AHRTI-9007: Benchmarking Risk by Whole Room Scale Leaks and Ignitions Testing
- AHRTI-9008: Investigation of Hot surface Ignition Temperature (HSIT) for A2L Refrigerants
- AHRTI-9009: Leak Detection of A2L Refrigerants in HVACR Equipment
- AHRTI-9012/Oak Ridge National Laboratory (ORNL): Real-world Leak Assessments of Alternative Flammable Refrigerants
- AHRTI-9015: Assessment of Refrigerant Leakage Mitigation Effectiveness for Air-Conditioning and Refrigeration Equipment
- AHRI-8017: Investigation of Energy Produced by Potential Ignition Sources in Residential Application
- ASHRAE-1806: Flammable Refrigerants Post-Ignition Simulation and Risk Assessment Update
- ORNL: Investigate the Proper Basis for Setting Charge Limits of A2L, A2, and A3 for Various Types of Products
- NIST: Modeling tools for low-GWP Refrigerant Blends Flammability
- ASHRAE-1808: Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints
- AHRI 8028: A2L Refrigerants and Firefighter Tactical Considerations

Mitigation Strategies – DX Human Comfort (and Refrigeration) Applications

System Design Considerations (select)

- Keep potential refrigerant charge released to a minimum
  - Verify minimum area (Amin) is met.
  - Locate equipment to minimizing piping - and charge.
  - Two smaller systems versus one larger system.
- Circulation
  - Most equipment will have refrigerant sensor to trigger air circulation in the event of detected refrigerant leak.
- Safety Shut-off Valves
  - Factory Installed Refrigerant Sensor, if applicable
  - Minimizes releasable charge, initiated by refrigerant sensor(s).
- Ventilation
  - Remove air/refrigerant mixture from smaller space to either larger space or outdoors, also initiated by refrigerant sensor(s).

Building Owners and Operators

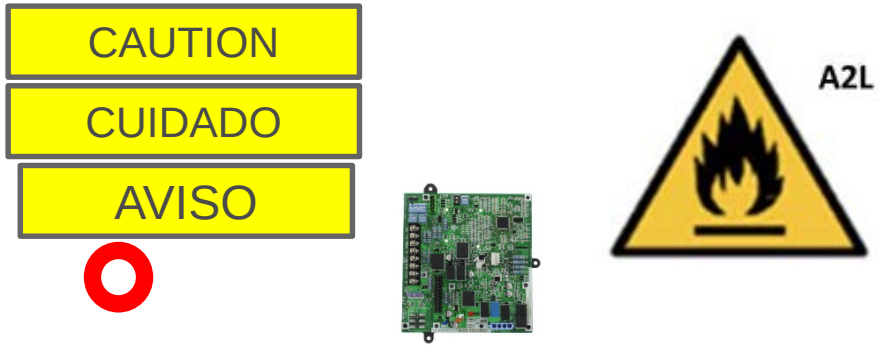
- Stay informed and trained on regulations and building codes for A2Ls
- Understand and only use contractors that are trained to install A2L equipment
- Understand and stay trained on safety procedures associated with leaks
- Know and actively prohibit ignition sources
- First responder training and procedures will need to be updated to incorporate the properties, hazards, and fire-fighting measures associated with Class A2L refrigerants

Product Differences

- New labeling requirements for A2L systems will be used, with new symbols indicating that A2L refrigerants are in use.
- Understand that A2L systems are uniquely designed with different compressor oils, design piping pressures, and specific heat exchangers, so it is prohibited to service existing A1 refrigeration equipment with new A2L refrigerants or vice-versa.

2021

Post 2023



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Tools for R-32

- Per the Environmental Protection Agency's (EPA) Significant New Alternative Policy Program (SNAP) guidelines, "spark proof tools are recommended"

Tooling	R-410A	R-32
Gauge Manifold	Normal	Different Scale
Vacuum pump	Normal	Equipped with oil backflow prevention function
Leak detector	Normal	HFC capable. Torch type models cannot be used
Recovery unit	Normal	Different – must be R-32 certified
Ventilation	Recommended	Necessary (fan)
Recovery cylinder	580 psig, right thread	696 psig, possibly left thread

AHRI Guideline M-2020

- Unique Fittings and Service Ports for Flammable Refrigerant Use
- Recommended Fittings for refrigerant cylinders should be of the type described in Table 1
  - A2L fittings on units are proposed to be the same as fittings on current A1 (most service fittings are ¼” SAE flare right hand thread), while fittings on cylinders on proposed to be left hand thread.
- This is a big notable item – left hand thread on cylinder, right hand thread on equipment

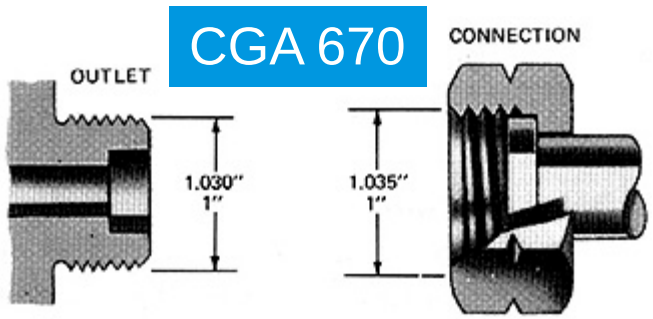


Table 1. Recommended Fittings for Refrigerant Cylinders	
Refrigerant Container Type	Refrigerant Classification
	A2L
<2 lb	CGA 164
>2&<50 lb	CGA 164
50 – 240 lb	CGA 670
>240-1000 lb	CGA 670

Note: SAE Flare is 45°, per SAE Standard J513

Tools for R-32

Gauge manifold and hoses

- Supports R-32 (R-410A) pressure
  - If the gauge manifold and hoses support R-410a, it can also be used with R-32 if the temperature is recalculated
  - High-pressure gauge: -14.5 to 753 psig
  - Low-pressure gauge: -14.5 to 536 psig
- Bore of connecting portion uses 5/16” flare screw

Recovery unit for R-32

- Supports R-32 (R-410A) pressure
- Some units have an ambient pressure switch which stops recovery above ambient pressure for leaking systems to prevent pulling air into recovery cylinder.
- Must be approved for A2L refrigerants

Tools for R-32

Vacuum pump

- Older vacuum pumps MAY NOT BE certified for A2L refrigerants.
- Equipped with oil backflow prevention function (In the case of using a vacuum pump without reverse flow preventive function, use only after connecting it to a reverse flow preventive vacuum adapter.)

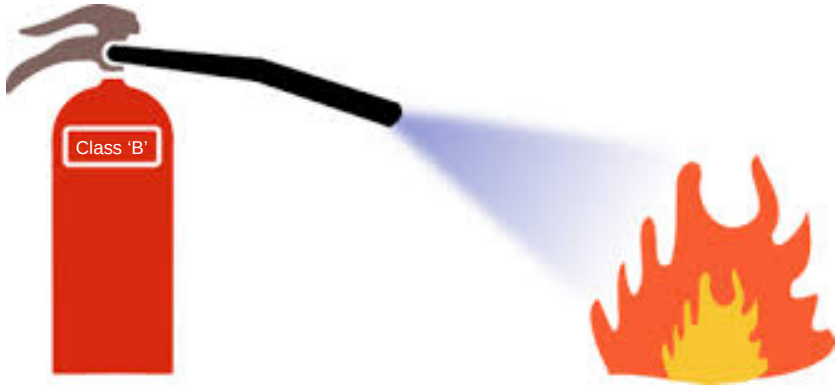
Electronic leak tester

- Detectors that can be used with R-410A can also be used for R-32 if approval from tooling manufacturer.
- Must be HFC capable
- Torch type models cannot be used.

Tools for R-32

- A monitor to check for presence of combustible gas should always be used when entering a service area
- No service should begin on the system until the area has been checked for flammable refrigerants.
- Monitors that use audible signals are recommended.
- The monitor should also remain on for the duration of work.

- A Class B dry powder type fire extinguisher shall be kept nearby when working with slightly flammable refrigerants.



Tools for R-32

Recovery Cylinder

- Only cylinders with pressure resistance to 696 psig or greater can be used.
- Keep in mind that the bottle might have left hand thread. In that case, an adapter piece is necessary.
- Never exceed the maximum allowable liquid fill weight of a cylinder
- Never mix recovered refrigerants.
- Label cylinder with refrigerant recovered

Adapter

- Adapter piece left thread to right thread
- Flammable gas cylinders may have left thread.
- This adapter piece converts left thread to right thread, for use of manifolds.

Wrap-Up

- Our Industry can safely commercialize low GWP refrigerants to reduce the impact of global warming

- Evolution of refrigerants – we can apply our knowledge to solve climate change by increasing energy efficiency with lower GWP refrigerants

Date	Event	New Refrigerants
1902	Invention of the modern air conditioner	Ammonia, Sulfur Dioxide, Methyl Chloride
1928	Invention of Freon to increase safety	CFCs
1987	Montreal Protocol to phase out Ozone Depletion Potential (ODP)	HFCs and HCFCs
2016	Kigali Amendment to phase down Global Warming Potential (GWP)	HFOs and HCFOs
2020	AIM Act to phase down HFC production 85% over 15 years	

- Codes and Standards need to rapidly embrace the changes – State and local code officials need to ensure smooth transition

- Heat Pumps will evolve and replace fossil fuel usage (aided by lower GWP refrigerants) – already proving acceptable – ccHP challenge

- Tools and Safety awareness training must accelerate in the trades