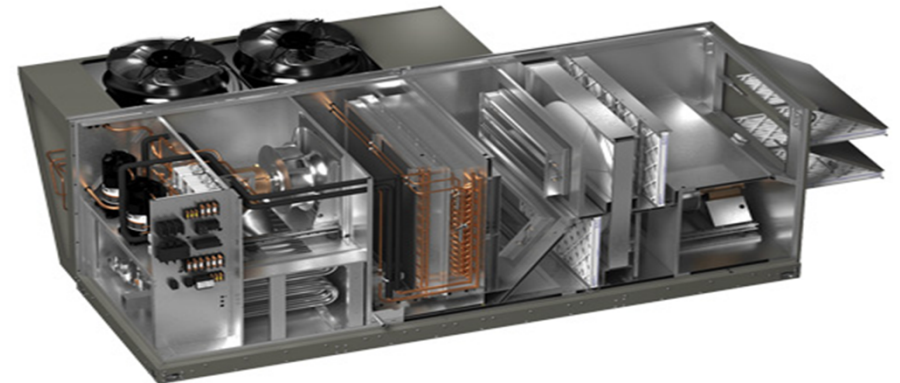
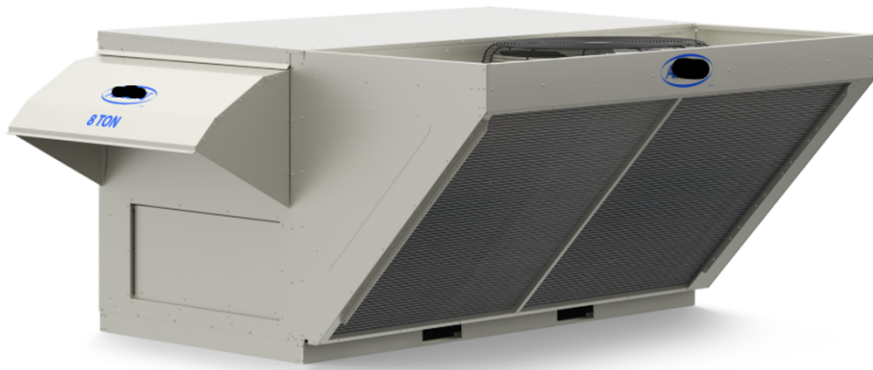


TECH SESSION

TOPIC: A2L REFRIGERANT TRANSITION
IMPACT/CHANGES TO RTU MANUFACTURING



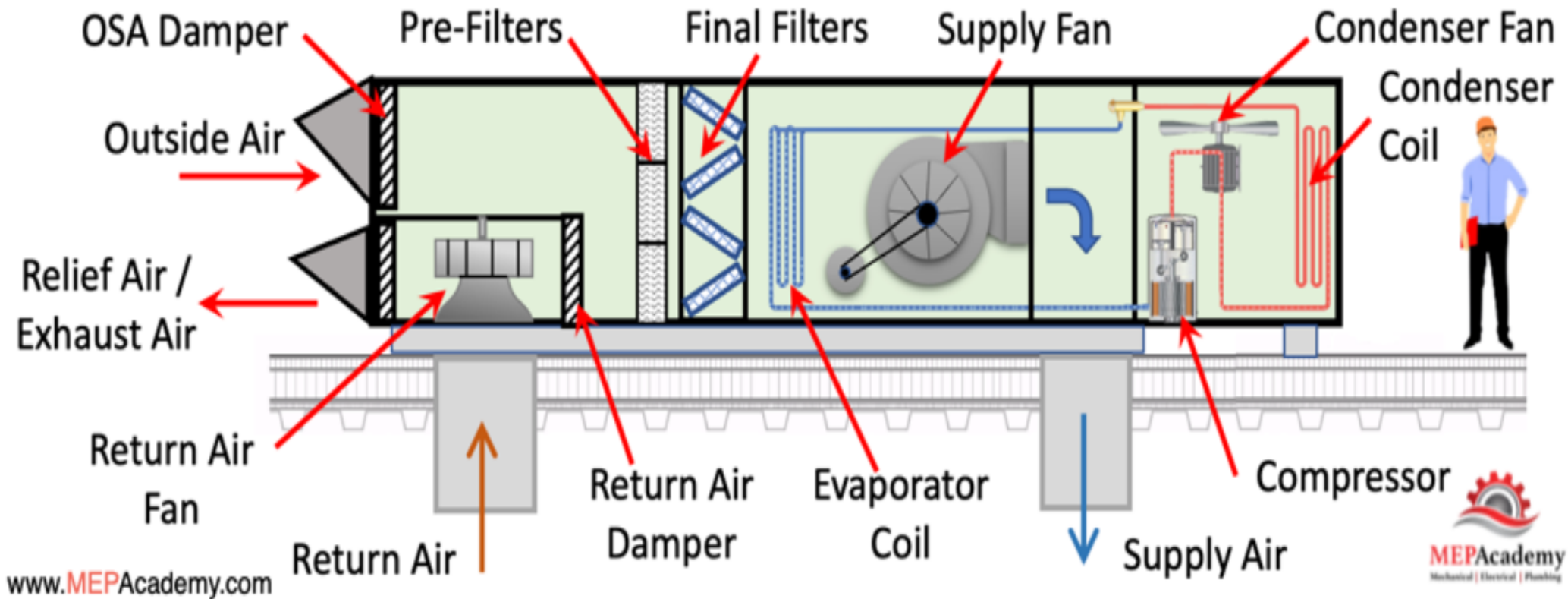
PRESENTER: **EVAN COHEN**

Partner, APA HVAC TECHNOLOGIES CONNECTICUT

AGENDA

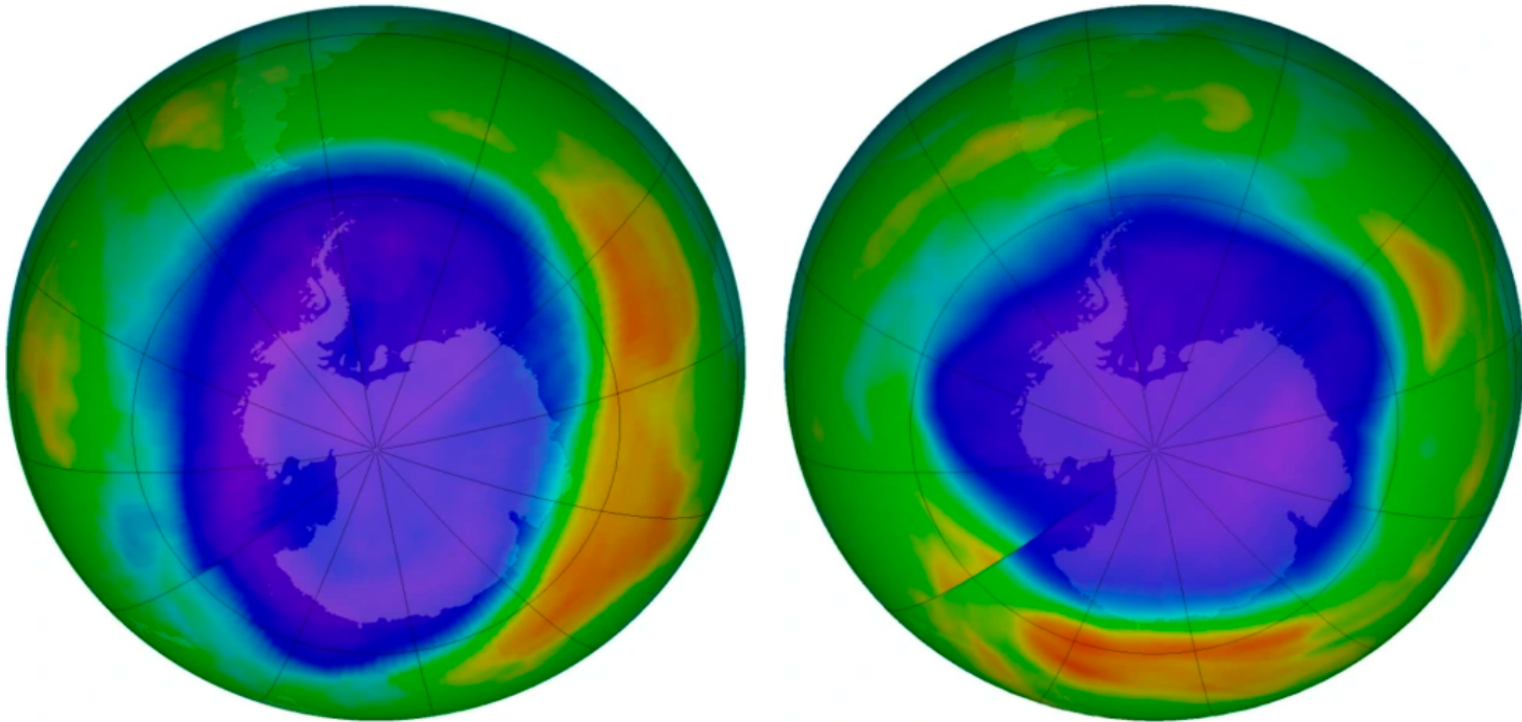
- Basic Anatomy of a Rooftop Unit (RTU)
- Past vs Present/Montreal Protocol/EPA/AIM
- Refrigerants
- UL 60335-2-40 / A2L Safety Requirements
 - Leak detection
- Building Codes / Transportation of A2L
- Alternative Refrigerants
- EXAMPLES IN PRACTICE
 - R410a vs R454B performance comparison
 - Leak detection
 - Sequence of operation
 - EDVC calculation
 - Minimum CFM calculation
- QUESTIONS

Anatomy of a Rooftop Unit



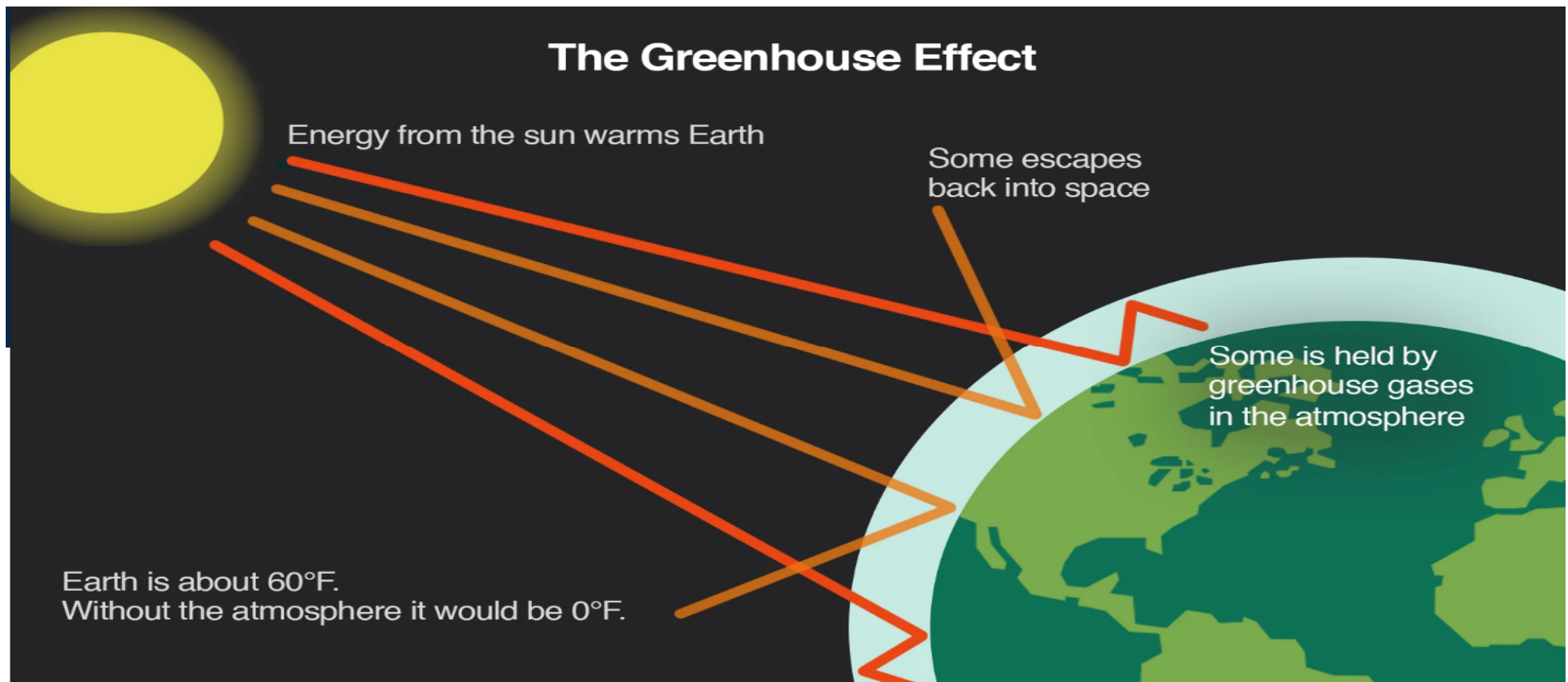
PAST

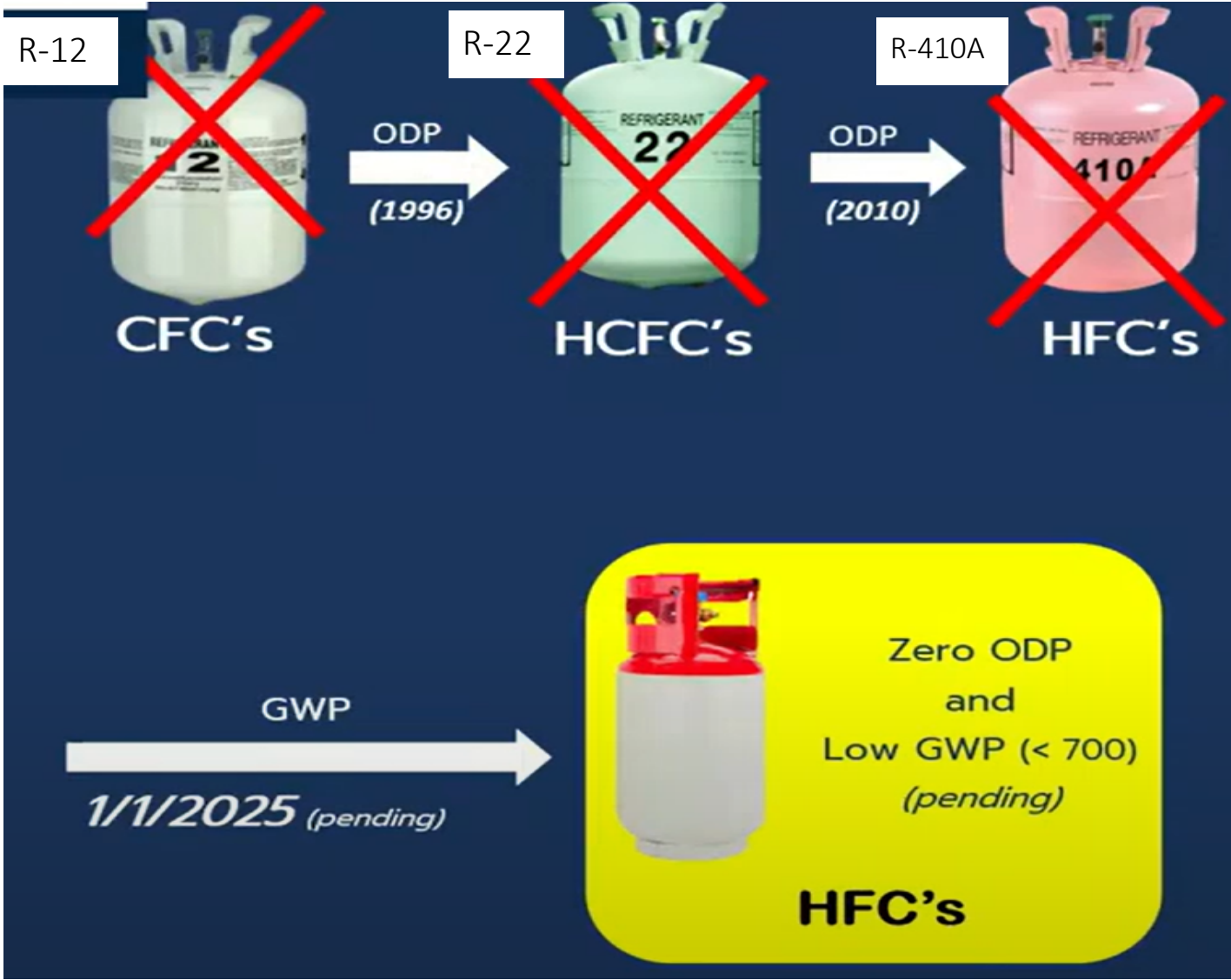
- CFC, HCFC (R-12, R-22) High ODP (Ozone Depletion Potential)
 - Caused Ozone Ddepletion



PRESENT

- HFC (R-410A, R-134A) High GWP Global Warming Potential
 - Cause Global Warming





PRESENT

➤ MONTREAL PROTOCOL

➤ Kigali amendment (2016)

➤ US EPA – AIM Act (Dec 2020)

- Kigali ratified by US Senate 9/21/2022

- 3 parts of EPA

- HFC phase down

- 10% less than baseline -- 2022 & 2023

- 40% less than baseline -- 2024 to 2028

- 70% less than baseline -- 2029 to 2033

- 80% less than baseline -- 2034 to 2035

- 85% less than baseline -- 2036 and beyond

- Refrigerant prices increased 1000% in 2015 in Europe when they took similar action

- R32 is an HFC and component in all R410A replacements

US EPA TECHNOLOGY TRANSITION RULE



• Definitions

- Product – manufactured in a plant
- System – assembled in the field
 - The manufactured date for a system is the day that refrigerant is charged in the field
 - Considered a new system when the condensing unit and indoor coil are replaced at the same time
- Specified components
 - Condensing unit, condenser, compressor, evaporator unit, evaporator
 - No end dates in rule for specified components
 - Specified components must be labeled “For servicing existing equipment only” when installed after specified dates
- Any person who assembles, contracts for, takes ownership of, or operates a system is responsible for adhering to the rule
 - Consumers not subject to the rule
 - Manufacturer not subject to the rule (for systems)

US EPA TECHNOLOGY TRANSITION RULE

• Dates

- Residential and commercial AC/HP + chillers
 - GWP < 700 -- 1/1/2025
 - Equipment must installed before 1/1/2028
 - Split systems must have refrigerant charged by 1/1/2026
 - Equipment must be built before 1/1/2025
- VRF
 - GWP < 700 -- 1/1/2026
 - Equipment must be installed with refrigerant before 1/1/2027
- Data center
 - GWP < 700 – 1/1/2027

REFRIGERANTS

R-32

- Type: HFC
- GWP: 675
- Oil: POE-46
- Azeotropic, no glide



REFRIGERANTS

R-454B

- Type: HFO blend
- GWP: 466
- Oil: POE-32
- Near-azeotropic blend; mild glide
 - Similar to R-410A



REFRIGERANTS

➔ R410A GWP 2,088

➔ R32 GWP 675

- Low-cost refrigerant
- High discharge temp
- More expensive components
- More development cost
- Daikin

➔ R454B GWP 467

- More expensive refrigerant
 - R32 + R1234yf
- Close drop-in for R410A
- Less expensive components
- Carrier
- JCI
- Trane
- Lennox
- AAON



REFRIGERANTS



R410A vs R454B vs R32

Fluid	ASHRAE 34	GWP	Component Mix - Ratio %	Operating Pressure
		CO ₂ e		psia
R410A	A1	2,088	R-32/R-125 - 50/50	434
R454B	A2L	466	R-32/R-1234yf - 69/31	405
R32	A2L	675	R-32 - 100%	444

Discharge Temperatures:

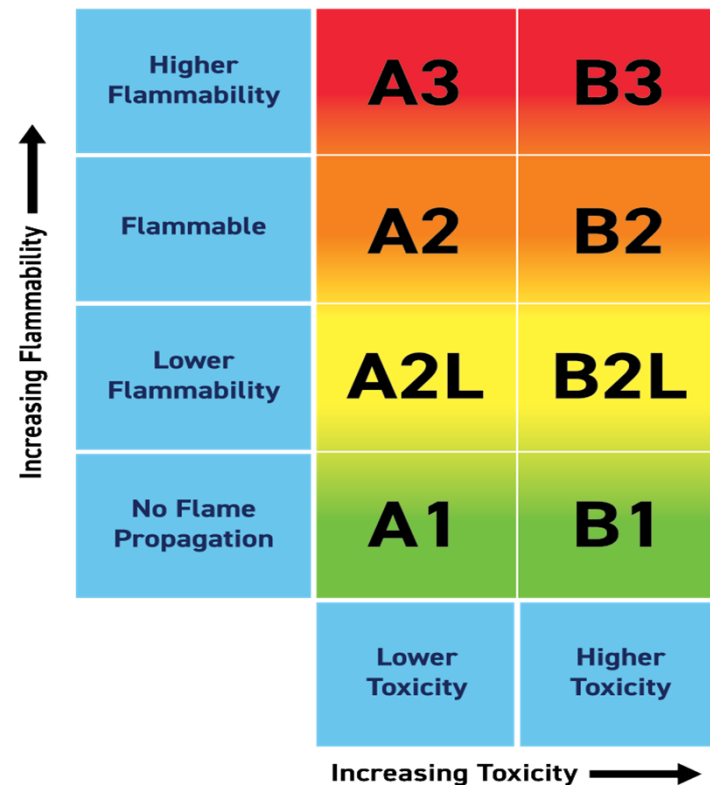
Refrigerant R32 has (30 to 55°F) higher discharge temperature than R410A.

R410A and R454B: 115-125F

R32: 180-230F

REFRIGERANTS

- Changing to low GWP refrigerants
- All new R-410A replacements are mildly flammable
- Low flammability risk
- Electrical components won't ignite
- Slow moving flame < 4"/second
- Requires constant ignition source
- New compressors, valves, leak detectors, etc.
- Building codes or laws must be updated to recognize A2Ls
- Building codes on 3 year cycle
- Most states 2015 or 2018 building codes



REFRIGERANT FLAMMABILITY

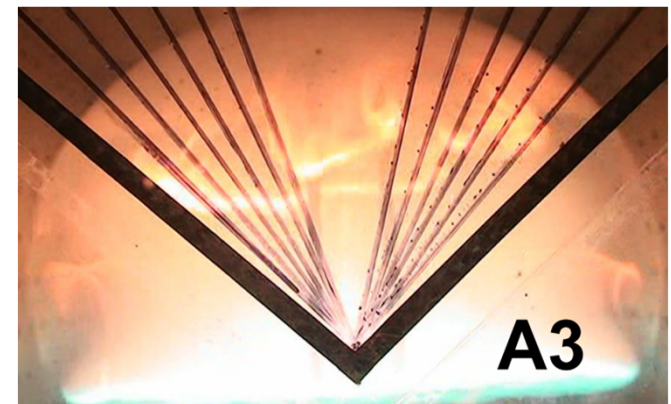
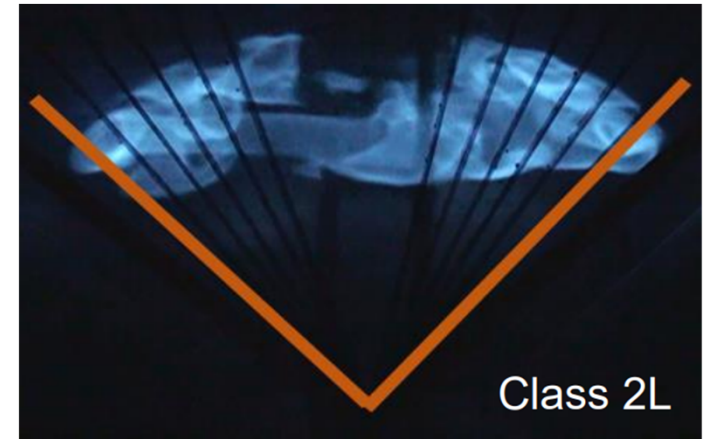
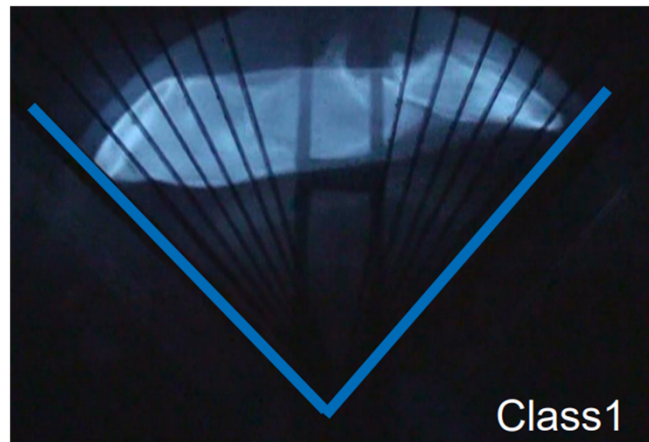
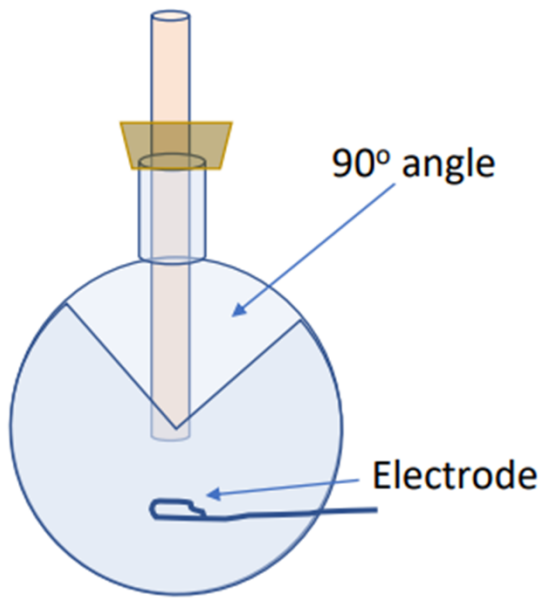
RV propane explosion Nov 19 in PA



Refrigerator explosion in NC



REFRIGERANT FLAMMABILITY



A2L SAFETY REQUIREMENTS

- Leak detection and charge limits based on LFL
 - LFL – Lower Flammability Limit
 - R454B – 0.0188 lb/ft³ (UL 60335-2-40) or 0.022 lb/ft³ (ASHRAE 34)
 - R32 – 0.0191 lb/ft³
 - R290 (propane) – 0.00237 lb/ft³
 - Leak detection required to detect 25% of LFL

REFRIGERANT DETECTION SYSTEM

→ Sensor

- 15+ lifespan
- Immune to “poisoning”
- Auto self calibration
- UL certified
- Must alarm at 25% LFL
- Auto reset

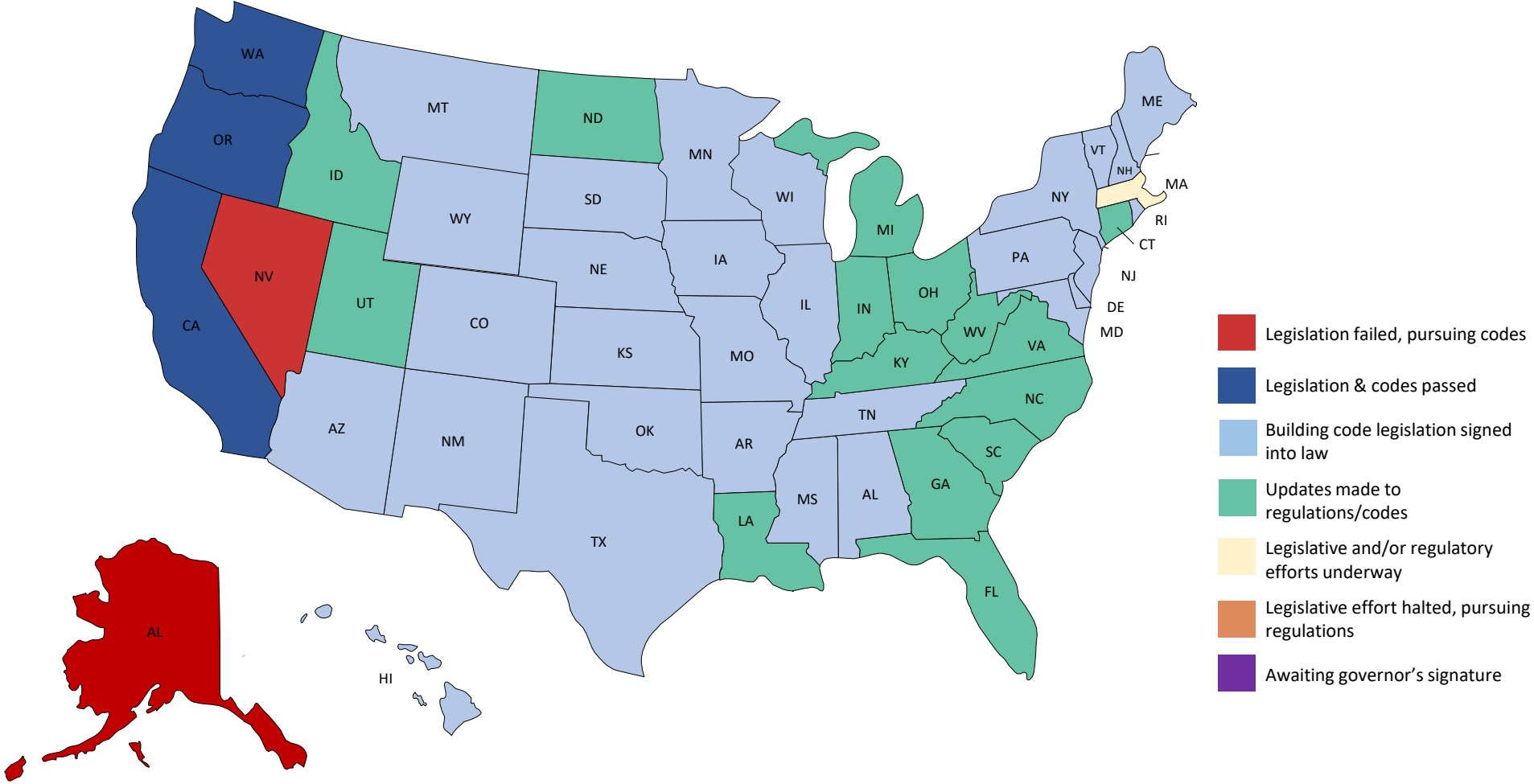


REFRIGERANT DETECTION SYSTEM

- ➔ Leak detector or loss of sensor
 - Supply fan activated
 - Compressors locked out
 - Alarm relay activated
 - Service required
 - Open VAV boxes
 - Increase airflow
 - Alarm auto reset after alarm is cleared
 - Auto reset
- ➔ Building commissioning very important



A2I Refrigerant Building Code Map | AHRI (ahrinet.org)



A2L REFRIGERANT TRANSPORTATION

→ US DOT special permit required

- 2 different permits
 - Units with < 44 lbs of refrigerant
 - No special labels required
 - No air or water transport
 - Units with $44 \leq 5,000$ lbs of refrigerant
 - Labeling required on outside of unit
 - No enclosed vehicle transport, no water or air transport
- Permit must be carried aboard each vehicle
- Any incident where gas is released must be reported to DOT
- Inform your 3rd party shippers
- Canada—DOT permits are valid until first destination in Canada



ALTERNATE REFRIGERANTS

➔ Naturals

- R717 (ammonia) GWP = 0, B2L
 - Toxic, mildly flammable
 - Must evacuate when leak detected
 - Not allowed by ASHRAE 15 (high probability systems)
 - Corrosive to copper
- R290 (propane) GWP = 3, A3
 - Very flammable
 - Current max charge 0.33 lb
 - Max charge 1 -2 lb in future



- R744 (CO2) GWP = 1, A1
 - Very high pressure
 - 1,000 psi @ 84F
 - 250 psi @ 84F for R410A
 - Requires stainless steel refrigerant and coil tubing
 - Welding instead of brazing
 - Efficient for heating
 - Poor efficiency for cooling



REFRIGERANT ALTERNATIVES

• No other replacements for R410A

- Future lower GWP refrigs similar to R22 with approx. 150 GWP
- Chemours announced search for new molecule

• Low pressure refrigerants (similar to R134a)

- Small pressure drop dramatically affect performance
 - Requires large pipe sizes – increases cost
 - Requires larger compressors
- R1234ze – GWP = 7, A2L
 - 25% less capacity than R134a
 - 0 psi @ -2°F – leaks in coil draw ambient air into system (heat pump)

A2L CHARGE LIMITS

- ➔ Effective Dispersal Volume Charge (lbs) -- EDCV
 - With air circulation (either constant or activated by leak detector) for human comfort
 - $EDCV = V_{\text{eff}} \times LFL \times CF \times F_{\text{OCC}}$
 - V_{eff} – Effective dispersal volume
 - LFL – Lower Flammability Limit
 - CF – Concentration Factor = 0.5
 - F_{OCC} – Occupancy Factor
 - 0.5 for institutions (i.e hospitals, prisons)
 - 1.0 for all other
 - Largest individual refrigeration system in equipment

A2L CHARGE LIMITS

➔ Required Minimum CFM (ASHRAE 15)

$$Q_{req} = \frac{M - M_{vol}}{4 \times LFL} \times SF_{vent}$$

- Q_{req} – Required minimum CFM
- LFL – Lower Flammability Limit
- M – Largest refrigerant charge of the largest independent circuit
- M_{vol} – refrigerant charge permitted in the space (our case 0)
- SF_{vent} – Safety Factor = 2

- ➔ EXAMPLES OF LEAK SOO
- ➔ EXAMPLES OF 410A vs R454b performance
- ➔ EXAMPLES OF EDVC and Minimum CFM

Learning Questions:

1. What are the two refrigerants RTU manufacturers are transitioning to?
2. What does GWP stand for?
3. What do the letters and numbers mean referring to “A2L” refrigerants?
4. What is the minimum A2L leak detector lifespan for RTUs?



QUESTIONS