

ET Summit 2024

Presented by



Preparing Technicians for the Next Generation of Refrigerants

What industry stakeholders need to know



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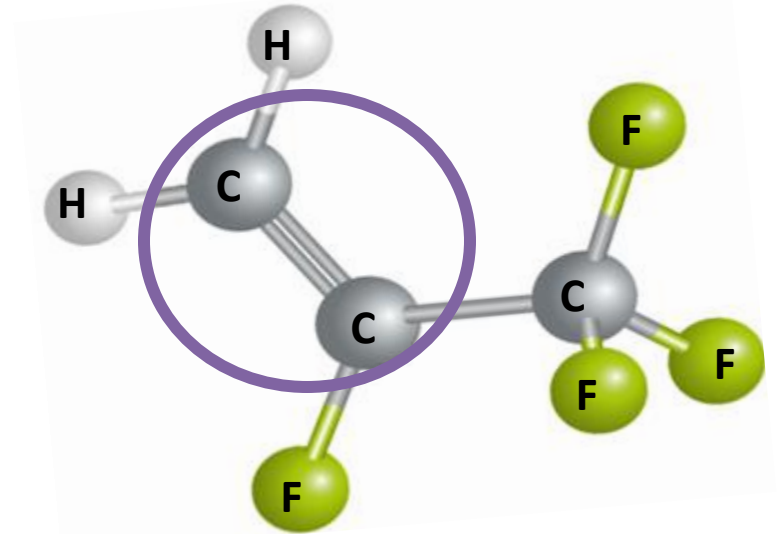
Chemours Company

Agenda

- **Drivers for Refrigerant Transition**
- **Refrigerant Classification**
- **Model Codes**
- **Equipment Standards**
- **A2L Installation and Service Highlights**
- **Additional Training Resources**
- **Summary**

Key Acronyms

- **ODP:** Ozone Depletion Potential (Montreal Protocol)
 - **GWP:** Global Warming Potential (Kigali Amendment)
 - **CO₂-eq:** Carbon Dioxide Equivalent (ratio based off CO₂)
-
- **CFC:** Chlorofluorocarbon. Chlorine, Fluorine, Carbon. Example R-12
 - **HCFC:** Hydrochlorofluorocarbon. Hydrogen, Chlorine, Fluorine, Carbon. Example R-22
 - **HFC:** Hydrofluorocarbon. Hydrogen, Fluorine, Carbon. Examples R-404A, R-410A.
 - **HFO:** Hydrofluoroolefins. Hydrogen, Fluorine, Carbon. Example HFO-1234yf. Lower GWP refrigerants, generally A2L ASHRAE Classification.



Environmental Considerations: ODP VS GWP

Global Warming Potential (GWP):
The potential for a gas to trap heat in the atmosphere, resulting in climate change.

Ozone Depletion Potential (ODP):
The potential for substances to reduce the amount of ozone in the atmosphere that blocks harmful radiation from the sun.



Kigali Amendment (HFC) (International) Phase Down

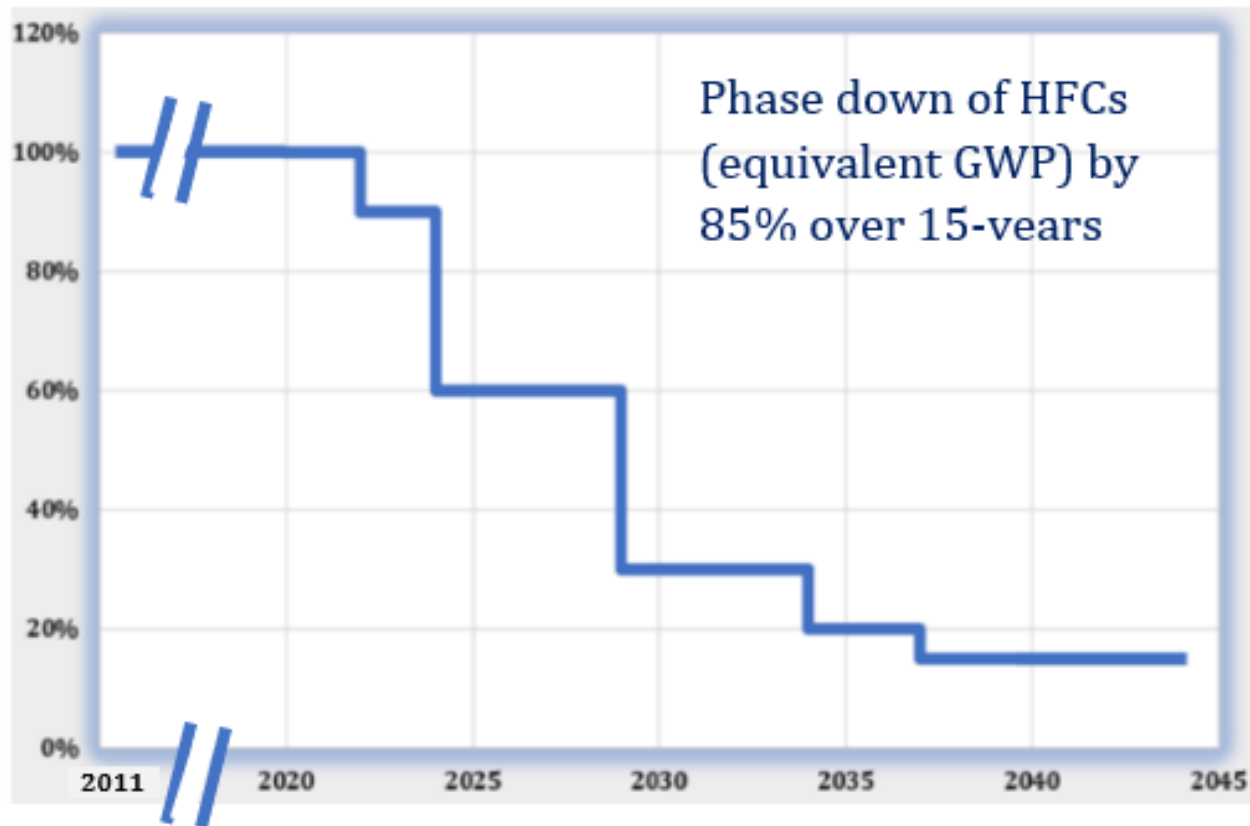
ASHRAE 34 "R"-#	ODP	GWP	Composition
R-410A	0.0	2,088	R-32/125
R-454B	0.0	466	R-32/1234yf
R-32	0.0	675	CH ₂ F ₂ (HFC)

Montreal Protocol (CFC/HCFC) (International) Phase Out

ASHRAE 34 "R"-#	ODP	Composition
R-12	1.00	CCl ₂ F ₂ (CFC)
R-22	0.50	CHClF ₂ (HCFC)
R-410A	0.0	R-32/125

American Innovation and Manufacturing Act of 2020

Aim Act Phasedown Schedule



- The phasedown began in 2022!
- Reductions in production and an consumption are based on 2011-2013
 - 2022: 10% reduction
 - 2024: 40% reduction
 - 2029: 70% reduction
 - 2034: 80% reduction
 - 2036: 85% reduction
- **Consumption = Production + Imports - Exports**

Key Points about the Transition

- All new refrigerants must be approved by the U.S. Environmental Protection Agency (EPA) (SNAP listing!)
- By legislative mandate, the EPA must consider the safety, toxicity, flammability, and environmental factors before approving new refrigerants and/or applications. All refrigerants with flammability class 2, 2L and 3 are subject to additional safety requirements by EPA
- Low GWP A2L, A2, and A3 refrigerants will only be used in new systems/applications that are designed to mitigate risks, and where allowed by appropriate codes and standards
- Low GWP refrigerants are already being used safely
 - Nearly 100% of new light duty cars sold in the U.S. and Canada now contain a low GWP A2L refrigerant
 - Air conditioning and refrigeration equipment in the EU, Australia, Japan, Thailand and other countries contain low-GWP refrigerants
 - Small appliances in the U.S. contain low GWP refrigerants

Key Points about the Transition to Low-GWP Refrigerants

What's the same?

- Hydrogen fluoride gas is formed upon combustion of any fluorinated refrigerant
- Oxygen Deprivation is possible in tight and enclosed spaces
- Frostbite is possible due to quickly releasing liquid refrigerant
- Personal protective equipment (PPE) should still be used by firefighters and technicians

What's different?

- Lower (A2L) and higher (A3) flammability refrigerants will be used to comply with regulations
- A2L refrigerants are characterized as having a low flame speed ($BV < 10$ cm/sec) and low heat of combustion (HOC)
- A3 refrigerants (e.g., propane) have high flame speeds and HOC

What do I need to know?

- A2L refrigerants are difficult to ignite, have slow flame speed, and low heat of combustion
- Stakeholders should be trained for working with new lower GWP refrigerants

Refrigerant Classification or Groupings



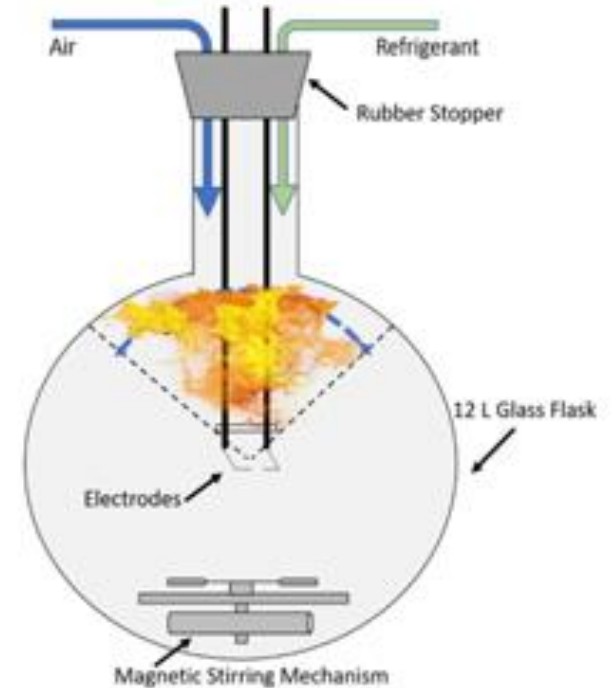
Who determines the safety classification of refrigerants?

- The U.S. follows ANSI/ASHRAE Standard 34 to provide refrigerant safety classification
- ASHRAE, formerly known as “The American Society of Heating, Refrigeration and Air Conditioning Engineers” is a consensus group of industry experts that reviews refrigerant information and assigns submitted refrigerants to a safety group
- ASHRAE Standard 34 establishes a simple means of referring to common refrigerants in a way other than by their chemical name, formula, or trade name.
- ASHRAE assigns numbers and safety classifications to the refrigerants based on toxicity and flammability data submitted by the refrigerant’s producer. For pure compounds, the numbers are based on chemical formula
- There is no “non-flammable” classification.

ASHRAE STANDARD 34: Flammability & Toxicity

Increasing Flammability ↑	Higher Flammability	A3	B3
	Flammable	A2	B2
	Lower Flammability	A2L	B2L
	No Flame Propagation	A1	B1
		Lower Toxicity	Higher Toxicity
		Increasing Toxicity →	

<p>Class 3 Requirements</p> <ol style="list-style-type: none"> 1. Exhibit flame propagation @ 60°C & 101.3 kPa 2. LFL ≤ 0.10 kg/m³ or HOC ≥ 19,000 kJ/kg
<p>Class 2 Requirements</p> <ol style="list-style-type: none"> 1. Exhibit flame propagation @ 60°C & 101.3 kPa 2. LFL > 0.10 kg/m³ 3. HOC < 19,000 kJ/kg
<p>Class 2L Requirements</p> <ol style="list-style-type: none"> 1. Exhibit flame propagation @ 60°C & 101.3 kPa 2. LFL > 0.10 kg/m³ 3. HOC < 19,000 kJ/kg 4. S_u ≤ 10 cm/s
<p>Class 1 Requirements</p> <ol style="list-style-type: none"> 1. No flame propagation @ 60°C & 101.3 kPa



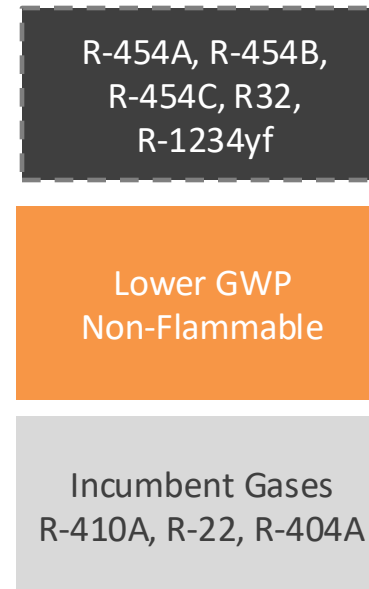
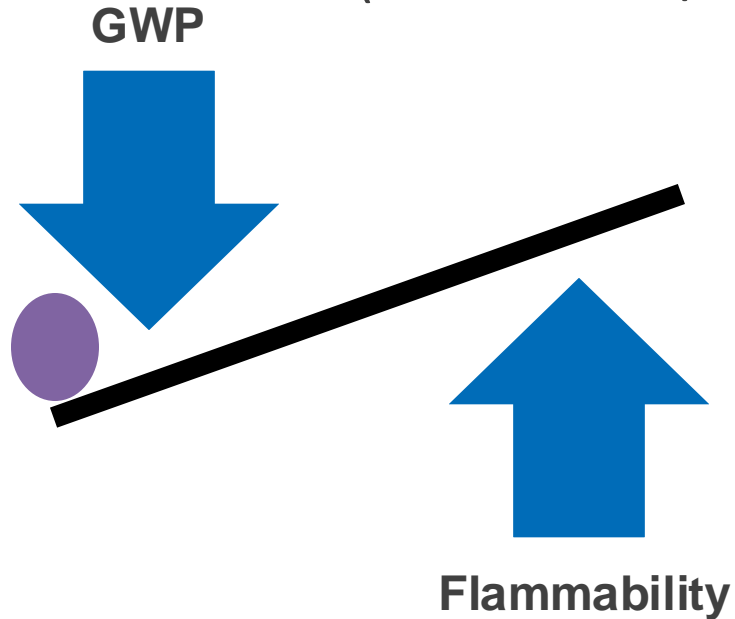
E68 -Flammability Test

ASHRAE Standard 34 Applied

Lowering GWP, results in increasing flammability properties

R-410A = 2,088 GWP (50% R-32 / 50% R-125)

R-454B = 466 GWP (68.9% R-32 / 31.1% R-1234yf)



Increasing Flammability	Higher Flammability	A3	B3
	Flammable	A2	B2
	Lower Flammability	A2L	B2L
	No Flame Propagation	A1	B1
		Lower Toxicity	Higher Toxicity
		Increasing Toxicity	

Building Code Status- Interactive Map

Please select a state from dropdown below:

California ▼

California

Legislation

Passed: [AB 209](#)
Effective Date: 7/1/2024

AC Codes

Updated: Yes
Effective Date: 7/1/2024

[State Code - AC](#)

Refrigeration Codes

Updated: Yes
Effective Date: 7/1/2024

[State Code - Refrigeration](#)

Warehousing Codes

Updated: No

[State Code - Warehousing](#)

Standards Currently Referenced

ASHRAE 15: 2022
ASHRAE 34: 2022
UL 60335-2-40: 2022
UL 60335-2-89: 2021

Provides interactive online access to where state and local building codes have been updated or legislation passed to allow equipment using A2L refrigerants
<https://www.ahrinet.org/a2l-refrigerant-building-code-map>



Standards Adoption

- UL 60335-2-40, 2-89
- ASHRAE 15 & 34
- NFPA 1, 55, etc.

Equipment Categories

- AC
- Refrigeration
- Warehousing

Updated as information changes

Note: This is for information only, regulatory information should always be verified

Codes and Standards for AC and Refrigeration

UL

Standards 60335-2-40(4th Ed) / 60335-2-89(2nd Ed)

- Editions currently published enabling A2Ls
- 3rd edition of 2-89 and 4.1 edition of 2-40 under development.
- Charge sizes vary by application

ASHRAE

Standard 15

Addendum I (2019) addresses flammables in refrigeration applications

- Up to 13*LFL for A2s & A3s
- Up to 260*LFL for A2Ls

Building Codes

Model, State, & Local Codes (IMC/IRC/UMC)

Many states now enable the use of A2Ls.

- Normal code adoption through the codes process

Please be sure to check your state and location regulations. They are always being updated.

Two Key U.S. Equipment Standards



UL 60335-2-40, 3rd edition (4th edition in process) published December 2019

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

UL 60335-2-89, 2nd edition, published October 2021

Standard for Household And Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Commercial Refrigerating Appliances and Ice Makers with an Incorporated or Remote Refrigerant Unit or Motor-Compressor



Both standards contain design information to use flammable refrigerants, including A2L refrigerants

Two Key US Installation Standards

ASHRAE 15: 2022 *Safety Standard for Refrigeration Systems*

- Broad application / installation standard
- Standard covers equipment under UL 60335-2-40, UL 60335-2-89, etc.
- Extensive changes in 2022 edition of ASHRAE Standard 15
 - Many address the use of flammable refrigerants
 - Reviewing the addenda (2019 version) provides helpful context
- Latest research considered during development process; safety/innovation never stop



ASHRAE 15.2: 2022 *Safety Standard for Refrigeration Systems in Residential Applications*

- Installation standard for residential systems
- Standard covers equipment under UL 60335-2-40 and UL 1995 used in residential applications
 - a. One and two-family *dwelling*s and townhouses,
 - b. Detached outbuildings associated with a one or two-family *dwelling* or townhouse and located on the same property included in a) above, and
 - c. individual *dwelling units* and *sleeping units located in a multi-family occupancy*

Goal of Standards: Prevent Ignition

Goal of the UL and ASHRAE standards:

- Prevent the LFL concentration from being reached in an occupied space
 - Limits on equipment refrigerant charge and/or mitigation requirements.
 - Mitigation may include detection, circulation or ventilation to reduce refrigerant concentration $\frac{1}{X}$ X safety factor used
 - Rigorous piping standards to prevent leaks
- Removal of ignition sources from equipment design and installation

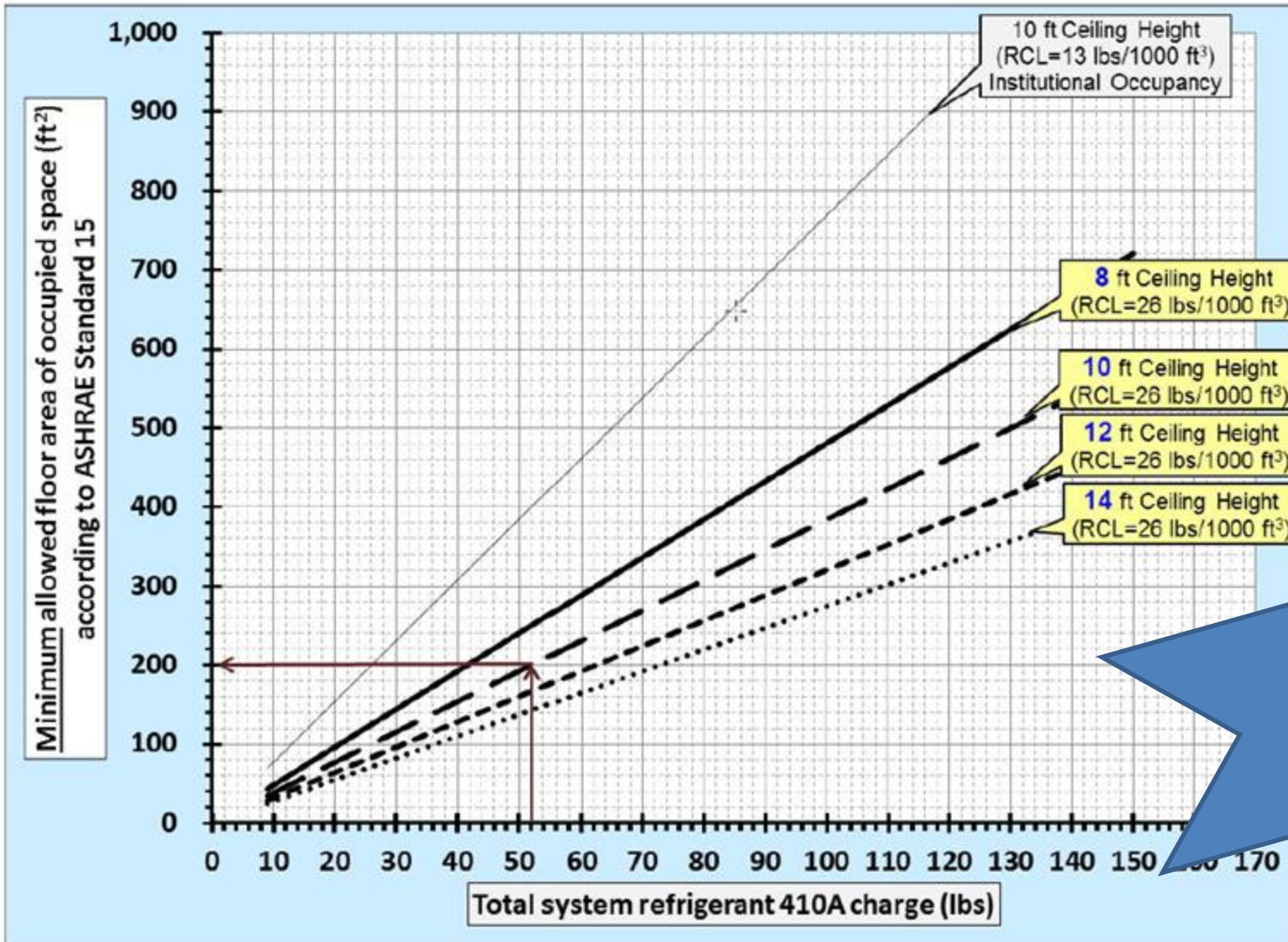
Mitigation strategies may include, but are not limited to:

- Active refrigerant alarms (room sensors)
- Permanent space ventilation
- Constant airflow (blower operation)
- Systems with an automatic refrigerant pumpdown (isolation valve)

Key UL 60335-2-40 Standard Information for Installation

- Different Equipment standards may be noted on equipment
 - UL 60335-2-40 is a performance standard
 - UL 60335-2-40 incorporates equipment previously listed to UL 1995, UL 484, UL474
- Different Labels will be seen
- Be prepared to see the flammable label
 - Be prepared to look at service information
 - Technicians will need to note
 - Refrigerant amount and type
 - Pressure check
 - Date of installation
- Equipment Piping Requirements
- Refrigerant Detection Systems
 - Those will be required by some systems
 - No audible alarm required.
 - Just need to provide output to system
- Charge and Installation Limits
 - Check allowable refrigerant amounts
 - Check allowable minimum floor requirements

Installation System Chart- Example of R-410A RCL and Minimum Allowable Floor Space



EXAMPLE ONLY

COMPARISON TESTING TABLE – UL 1995, UL 484, AND UL 60335-2-40

Test	UL 1995 ED 4	UL 484 Test ED 9	UL 60335-2-40 ED 3
	Test Clause	Test Clause	Test Clause
Input	40	47	10
Temperature Operation - motor	41	-	11
Temperature - hot water or steam	42	53	11
Cooling Operation T+P	43	48	11
Heating Operation T+P	44	48	11
Indoor Fan Failure (HP Mode)	45	-	19.101
Continuity of Operation (EH)	46.2, 46.8	54	11
Limit Control Cutout (EH)	46.10, 46.16	-	19.2DV.2
Heating Operation (EH)	46.17	-	19.2DV.3
Restricted Inlet (EH)	47.11	55.3	19.2DV.4
Fan Failure (EH)	47.12	55.4	19.101
Blocked Outlet (EH)	47.13	55.2	19.101DV.1
Backup Protection (EH)	48	Part of 55	19.105DV D1
Fan Motor Failure (AC)	51	51	19.101
Dielectric Voltage-Withstand	54	50	13.3, 16.3
Condensate Drain Blockage	55	58	15.3
Loading	56	56	21.101DV
Stability	-	57	20.1, 22.101DV
Spillage	-	59	15.101
Rain	60	45	15.2
Strength	63	70	EE.2-EE.4
Fatigue	64	71	EE.5
Leakage Current	68	44	13.2, 16.2
Starting	69	49	9DV
Strain Relief	70	72	25.15
Flexing	80	-	23.3
Leak Simulation	-	Appendix D	Annex FF



Reference: Intertek training material

Note: This table does not reflect that the testing procedures and pass/fail criteria are the same, it is only intended to show a comparison of what tests could be applicable and their respective clause number.

A2L Equipment: Installation and Repairs (per Annex DD UL 2-40)

Requirement	A1	A2L
Safely remove refrigerant following local and national codes	Required	Required
Purge circuit with inert gas (i.e. oxygen free nitrogen)	Best Practice	Required
Evacuate	Best Practice	Required
Purge with inert gas for 5 min	Best Practice	Required
Evacuate again	Best Practice	Required
Open the circuit by cutting or brazing	Final step	Final step
Repair the systems and for brazing purge with nitrogen during brazing	Required	Required
Leak test and pressure test the unit	Best Practice	Required
Evacuate the system	Required	Required
Charge the system (See DD.10)	Required	Required

New Servicing Labels

- There are several new labeling requirements for systems charged with flammable refrigerants.
- Some of these requirements are satisfied at the time of equipment manufacture, while others will have to be met by field personnel.
- UL equipment standards require that systems charged with a flammable refrigerant have a label affixed to the unit that is filled out by the installing technician with permanent marker.

COMPANY NAME _____

EVACUATION LEVEL _____ TEST DATE _____

LEAK TEST PRESSURE _____ TEST DATE _____

REFRIGERANT TYPE _____

TOTAL REFRIGERANT CHARGE _____ LBS _____ OZ

SERVICE RECORD

_____ DATE _____

_____ DATE _____

_____ DATE _____

_____ DATE _____

_____ DATE _____

_____ DATE _____

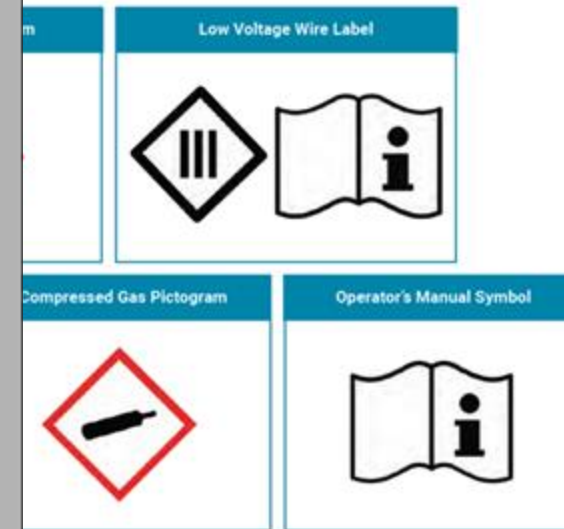
_____ DATE _____

_____ DATE _____

_____ DATE _____

_____ DATE _____

_____ DATE _____



Installing or Servicing A2L Equipment

Safety First!

- Read the OEM equipment manuals. (RTFM)
- Follow lockout/tagout procedures when needed.
- Verify no voltage is present before working.
- Ensure area is well ventilated

Evaluate work area:

- a) Ignition sources.
- b) Flammable vapors.
- c) Confined spaces
- d) Clear exit points.

Recommended to have a 10' work perimeter (Not Required At This Time but Recommended). SEE ANNEX HH in 2-40.



Safety and PPE



A2L Tools

Service Item (versus R410A)	A2L
Refrigerant Recovery Cylinder	Red stripe, left-handed threads, GHS Label
Vacuum Pump	Check with Manufacturer
Recovery Machines	Move to 2L compatible
Gas Detector	Move to 2L compatible
Electronic Leak Detector	Move to 2L compatible
Scales	No changes
Ventilation Fan	Similar* (*may be differences in machine rooms)
Electrical Hand Tools	Non-sparking (AHRI – 8017)
Dry Chemical /CO ₂ Fire Extinguisher	Chemical compatible



Use Service Tools that meet Refrigerant Rating

Service Vehicles



Service Vehicles:

- Under the “materials of trade,” it’s business as usual
- Same restrictions in place 440 pounds, regardless of the hazard
- Federally, there are no placards required for service vehicles
- No ventilation required
- A2L tanks will be able to lay horizontally

DOT Special Permit

6. HAZARDOUS MATERIALS (49 CFR 172.101):

Hazardous Materials Description			
Proper Shipping Name	Hazard Class/ Division	Identification Number	Packing Group
Difluoromethane or Refrigerant Gas R 32*	2.1	UN3252	N/A
Liquefied gas, flammable, n.o.s.*	2.1	UN3161	N/A

* Gases authorized for transportation under this special permit must meet the criteria of the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (Seventh Revised Edition) Category 1B or equivalent American Society of Heating, Refrigerating and Air-Conditioning Engineers A2L.



New A2L Service Tank Design

Rupture DISC (CG-1). Used for ASHRAE 34 A1. Set pressure defined by cylinder working pressure and burst with all contents released. Burst temperature at ~125-130°F, the pressure will vary depending on the refrigerant.

Spring-loaded relief (CG-7). Used for ASHRAE 34 A2L. Set pressure are defined by cylinder working pressures, and the valve only releases enough gas to return below the cylinder's max pressure. Burst temperature ~155°-160°F, the pressure will vary depending on the refrigerant.



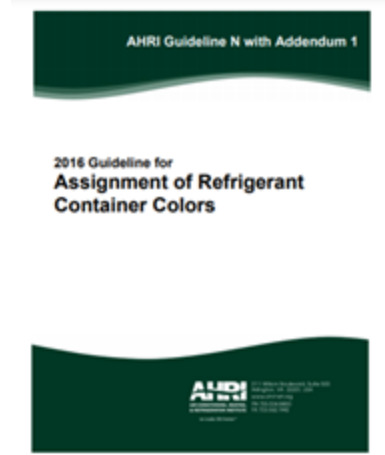
AHRI – Guideline N



Name That Refrigerant!

AHRI Guideline N- Pub Jan. 2020

Section 2.1 “This guideline also recommends a universal container color of light green gray PMS 413 (RAL 7044) for all Refrigerants.”



Summary

Contractors need to prepare

- Understanding changes in codes, communicating with stakeholders, and training are key!
- Start flammable refrigerants training now
 - know your state and local building codes (online adoption map)
- Understand installation standards for equipment (US, ASHRAE)
- Develop communication plan- why new refrigerants
- Secure sources of reclaim material; it's going to become less available and more expensive over time
- Do not mix refrigerant- it will be worthless
- Update your EPA Section 609 licenses and AIM act requirements
- Upgrade any service equipment that isn't A2L compatible



Technician Training Resources

While A2L refrigerants will be handled similarly to A1 refrigerants, training is the best path to excellence!

Technician training is available through many training organizations.

Available in a variety of platforms

- Digital, Online, Paper, Training Seminars

AHRI

ACCA

The HVAC School Podcast

ESCO

RSES

Copeland

Fieldpiece

NRTLs


OEMs

Chemical Companies

..... Just to name a few.



Warehouse Storage- A2L Focused



A2L Cylinder Storage Options

Characteristic	Shelf Storage	Rack Storage	Solid-pile
Storage design	Shelf cannot exceed 30" from front to back	Each level designed to hold pallet loads	Pallets stacked one upon another
Construction materials	Steel shelves	Steel rack	NA
Storage height	Maximum 6' to top of product	Can exceed 6' Limited by sprinkler design	Can exceed 6' Limited by sprinkler design
Sprinkler system design	Ordinary Hazard Group 2	Extra Hazard Group 1	Extra Hazard Group 1
Separation from flammable liquids	Required	Required	Required
Storage of other flammable or combustible products above A2L refrigerants	Prohibited	Prohibited	Prohibited
Storage of flammable liquids adjacent to A2L refrigerants	20' separation	20' separation	20' separation
Storage of flammable liquids with secondary containment adjacent to A2L refrigerants	10' separation to containment area	10' separation to containment area	10' separation to containment area

For more information, visit www.nfpa.org and www.iccsafe.org.

For information purposes only. Always check with local and state building authorities regarding cylinder storage requirements.

The 2024 International Fire Code (IFC) & the National Fire Protection Association (NFPA) codes & standards were recently updated to include A2L refrigerants. Model codes & standards are adopted by many states and localities. Fire marshals & building officials use the maximum allowable quantities (MAQ) contained in the IFC or NFPA 55 to provide A2L storage guidance.



The MAQ for ASHRAE A2L refrigerant storage is based on the type of occupancy and the number of control areas in the building. Each building can have up to four control areas, increasing the total amount of refrigerant that can be stored in the building. 2024 Codes have been revised & the table shows maximum quantities in each control area for



A building protected with fire sprinklers can include 1-hour fire-resistance-rated walls to create 4 separate control areas. Each control area can store up to 40,000 lbs. of liquefied Group A2L refrigerants. See



Construction of a 1-hour fire barrier can be as simple as a wood stud wall covered with fire-resistant gypsum board. All entrances through the 1-hour fire barriers must be protected with a fire-rated device, such as roll-down shutters or fire doors.

Occupancy Classification	Maximum Allowable Quantity (MAQ) in a Single Control Area	
	Non-sprinklered	Sprinklered
M – mercantile	20,000 lbs.	40,000 lbs.
S – storage/warehouse	20,000 lbs.	40,000 lbs.
F – factory/filling facility	10,000 lbs.	20,000 lbs.

For more information, visit www.nfpa.org and www.iccsafe.org.

The code will classify the storage method as either:

1) Shelf Storage



2) Rack Storage



3) Solid Pile



A2L Equipment Best Practices



Before Installing or Servicing Equipment

- **SAFETY FIRST!**
- Read SDS and OEM Equipment Manual.
- Follow lockout/tagout procedures when needed.
- Verify no voltage is present before working.
- Ensure area is well ventilated.
- Evaluate jobsite for a) ignition sources, b) flammable vapors, c) controlling area, d) confined spaces, and e) clear exit points.

A2L Installation

- Follow OEM guidelines for minimum room area/refrigerant charge limits.
- Ensure mitigation components are installed and operating per OEM instructions.
- Use locking refrigerant caps to prevent unauthorized access to the system.
- Ensure a filter drier is installed.

A2L Evacuation and Pressure Test

- Consult the OEM instructions to determine proper evacuation targets/procedures.
- Pressure test field erected components.
- Evacuate the system before charging using an A2L rated vacuum pump.
- Record a) *date*, b) *test pressure*, and c) *vacuum level on the label* (UL 60335-2-40).

A2L Charging (if required)

- Do NOT exceed the maximum allowable refrigerant charge per OEM instructions. (Charge amounts may vary due to line-sets.)
- Follow OEMs procedure for proper charging techniques. (Superheat/Subcooling)
- If refrigerant is a 400-series, the refrigerant must leave the cylinder in 'liquid form.'
- Record a) *date* and b) *total refrigerant charge weight on the unit label* (UL 60335-2-40).

A2L System Repairs

- Leak check to verify no refrigerant is present.
- Ensure equipment is grounded before working.
- Use proper capacitor discharge methods.
- Use only OEM approved replacement parts.
- Use nitrogen before and during all brazing.

A2L Recovery

- Do NOT vent.
- Do NOT mix refrigerants.
- Use recovery tools rated for use with A2L refrigerants.
- Recover all refrigerants before opening system.
- Recover into DOT approved recovery cylinder.
- Do not exceed cylinder fill weights.
- Label recovery cylinder contents.

Thank you for having me!

Acknowledgements: Don Gillis, Chuck Allgood and Tony Stasio

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