Virtual Town Hall on A2L Refrigerant & Energy Storage Systems

December 10, 2024 FINAL

FDNY

Robert S. Tucker

Commissioner

Bureau of Fire Prevention

Thomas J. Currao

Chief of Fire Prevention

INTRODUCTION

FDNY

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STEVEN ERTRACHTER	**EXECUTIVE DIRECTOR**
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JAMES PIROT	**LIEUTENANT**

A2L Refrigerant & Energy Storage Systems – Program

Welcome by Assistant Chief Thomas Currao

Introduction of FDNY and Participants. Please state Name & Affiliation.

Please hold all questions until the end of each Presenter's Power Point.

You can raise your hand and we answer Questions after the Presenter finishes.

Hazards

Lt. Pirot

Why are A2L Refrigerants being introduced into NYC?

What is the difference between different refrigerants?

What is the FDNY doing about this important issue?

Summary -I

A2L refrigerants have low Global Warming Potential, which makes them more desirable from an environmental standpoint, the downside to this is they are flammable.

Combustion byproducts can include Hydrogen fluoride which can lead to pulmonary edema along with the threat of encountering a Phosgene gas.

Frost bite is a concern if contacted by refrigerant.

Enhanced leak detection systems are necessary due to the flammability and other hazards.

Flammability: Although they burn more slowly than A3 refrigerants, A2L refrigerants can and will burn if ignited.

There are several new label requirements for systems charged with flammable refrigerants. Some of these requirements are satisfied at the time of manufacture, while others will have to be met by field personal. Technicians should be familiar with such labels

Summary -II

The maximum allowable quantity of refrigerant depends on many factors:

- The refrigerant Classification
- The type and location of equipment
- The number of occupants in space
- The size of the space

In the event of a leak, it is crucial to avoid accidental ignition of refrigerants.

Under no circumstances should different refrigerants be mixed in the same recovery tank.

Use equipment intended for A2L refrigerants.

Ventilation needed so that you do not approach the LFL level

A2L Frequently Answered Questions

1. Q: When is the phase down of old products such as hydrofluorocarbons (HFCs)?

A: On January 1, 2025, new standards for manufacturing refrigerants will go into effect. Until then, existing refrigerants will be used, after which A2L will replace older high-impact refrigerants.

2. Q: Topics related to Fire Code for A2L refrigerants:
Will FDNY require technician certification?
Storage on premises for routine maintenance (20% in cylinders or tanks – recovery cylinders)?
Warehouse storage requirements (cylinders)?

A: FDNY is still working on the Fire Code/Rules and will notify in the future.

3. Q: Topics related to NYC DOB code/NYC DOT for A2L refrigerants:
Leak detection system for A2L refrigerant?
Transportation of cylinders for A2L Refrigerant?

A: Waiting for NYC DOB/DOT new regulations.

Licensing

Steve Ertrachter

Certificate of Qualification & Fitness.

Certificate of Qualification

The newly developed A2L Refrigerants is required to be included in the RSOE Training Courses as of January 1, 2025.

It shall be the responsibility of the Refrigeration Engineers to stay up to date with the current standards and practices of the industry.

As always safety is the key, it shall continue to be the responsibility of all parties involved to maintain an efficient workplace

The required amount of instruction time for the RSOE course shall be the same:

- No less then 200 hours of instructional training, of which no less than 25 hours, shall consist of practical skill exercise and hands-on demonstrations

The A2L Power Point will be included in the first part of Certificate of Qualification Exam (Z-51) starting from **1/1/2025**

Certificate of Qualification FAQ

1. Q: Topics related to this study guide and FDNY written tests:
Will there be questions in the written test for refrigeration tests?
If yes, when will it start?
A: There will be questions in the written test on January 1,2025,

2. Q: Will A2L refrigerant be included in the Simulator test?
A: At this time, it will not be included in the practical test.

3. Q Will the FDNY require all current Certificate of Qualifications holders to attend any future continuing education program on this topic?
A. Yes, eventually.

ESS Related Certificate of Fitness Categories

B28 Premise Related

W28 General Supervision

W27 General Supervision

ESS Certificate of Fitness/ Categories - I

- The B-28 Certificate of Fitness is required for supervision of Stationary Energy Storage System installations. Stationary storage battery systems are commonly used in office buildings and other commercial and residential buildings to provide power for various applications. Premise related.
- The material includes information for requirements and procedures for the installation, operation, inspection, maintenance, commissioning and decommissioning of outdoor and indoor stationary storage battery systems.
- Section FC 608 of the 2022 Fire Code (indoor and outdoor installations) and Fire Department rule 3 RCNY 608-01(outdoor installations) sets forth the requirements for Stationary Energy Storage System Installations in NYC.

ESS Certificate of Fitness Categories/ - II

B-28/W-28 COF applicants need to submit the Battery System Training Verification Letter. Applicant must present an affidavit from the battery system owner, manufacturer or the installer of the battery system stating that this applicant has been trained and is knowledgeable with the battery system he/she will supervise. Sample of verification letter link, Battery System Training Verification Letter

(2) B-28/W-28 COF applicants need to submit the Employer Recommendation Letter. Sample of employer recommendation letter link, B-28 Sample of Recommendation Letter

(3) B-28 COF is premises related, the B-28 COF authorizes the holder to supervise any indoor and outdoor stationary battery system that is NOT designated as a mobile system.

(4) **W-28 COF holder is only authorized to supervise the mobile battery system. W-28 COF is citywide.**

ESS Certificate of Fitness Categories/- III

Training- B-28/W-28 COF applicants need to submit the Battery System Training Verification Letter.

Applicant must present an affidavit from the battery system owner, manufacturer or the installer of the battery system stating that this applicant has been trained and is knowledgeable with the battery system he/she will supervise. Sample of verification letter link, Battery System Training Verification Letter

(2) B-28/W-28 COF applicants need to submit the Employer Recommendation Letter. Sample of employer recommendation letter link, B-28 Sample of Recommendation Letter

(3) **W-28 COF holder is only authorized to supervise the mobile battery system. W-28 COF is citywide.**

ESS Certificate of Fitness Categories/ IV

W-27 Supervision of Stationary Energy Storage Systems (ESS) in Group R-3 Occupancies (Citywide)

- W-27 Certificate of Fitness for Supervision of Stationary Energy Storage System installed in the Group R3 occupancies.
- W-27 Certificate of Fitness who is responsible for the safe operation and maintenance of an ESS at a specific site location. A person providing general supervision does not have to be present on the premises when the ESS is in operation, but is responsible for ensuring that it is installed, operated and maintained in accordance with the NYC Fire Code and other applicable laws, rules and regulations.

Fire Code Process

Kelly Carr, Esq. and Shaji Joseph

Discussion on current legislation and process to revise.

Fire Code Considerations

Supervision

- What quantity of A2L will require Personal Supervision?

Storage

- What is the maximum allowable quantity per control area?

Conclusion

Questions & Comments from Presenters and/or Attendees

Table of Content

A2L Refrigeration Information for Q-01/Q-99 Certificate of Qualification for RSOE

Glossary/Terms

- AHRI- Air Conditioning, Heating, & Refrigeration Institute
- AIM Act-American Innovation and Manufacturing Act
- ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
- CARB-California Air Resource Board
- CFC-Chlorofluorocarbons
- DOT-Department of Transportation
- EPA-Environmental Protection Agency
- FDNY- New York City Fire Department
- GWP-Global Warming Potential
- HC-Hydrocarbon
- HFC-Hydrofluorocarbons
- HFO-Hydrofluoroolefin
- HOC- Heat of Combustion
- HVACR-heating, ventilation, air conditioning, and refrigeration
- LFL-Lower Flammable Limit
- OSHA-Occupational Safety and Health Administration
- PPE- Personal Protective Equipment
- PT-Pressure Temperature
- PTACS-Packaged terminal air conditioner system
- S-Maximum Laminar Burning Velocity
- SNAP-Significant New Alternative Policy
- TT-Technology Transition
- UL-Underwriter's Laboratories Solutions

Introduction

Climate change and environmental degradation are the threat to the world. The new standards for manufacturing refrigerants will be in effect on January 1, 2025. This will start the process of scaling down the production on A1 refrigerants

Congress passed the American Innovation and Manufacturing (AIM) Act that helps industries transition to more environmentally friendly refrigerants in 2020. On January 1, **2025**, new standards for manufacturing with **refrigerants** will go into effect

A2L (HFO-Hydrofluoroolefin) will be the replacement for older, high-impact refrigerants such as A1 (HFC-HydroFluoroCarbon) and HCFC-Hydrochlorofluorocarbons in air conditioning and commercial refrigeration systems

ASHRAE 34-2022 safety classification categorizes A2L refrigerants by mild flammability, low toxicity, and low global warming potential (GWP)

The New Refrigerant

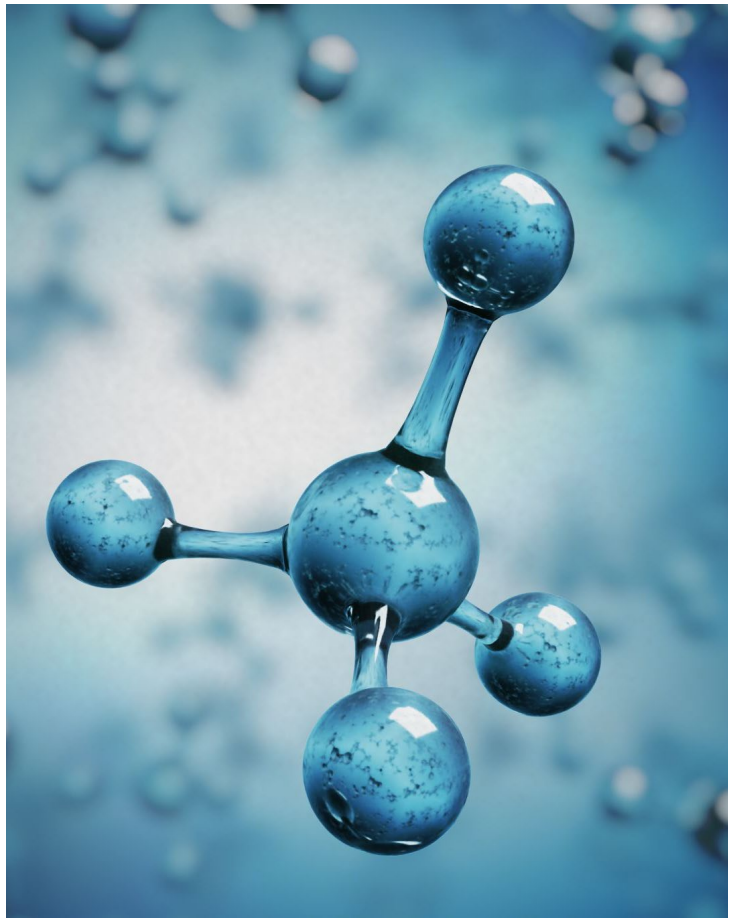
Global Warming Potential

- *What is global warming potential?* (GWP)
  - Global warming potential is a measure of how much heat a refrigerant traps in the atmosphere in relation to a similar mass of carbon dioxide. The lower the GWP, the more desirable the refrigerant becomes from an environment protective point of view
  - Generally, a refrigerant with a GWP of 2500 or less is considered acceptable refrigerant choice when it comes to reducing contribution to global warming
  - HFC's and other greenhouse gasses tend to have high GWP and are less desirable from an environmental protective standpoint
  - HC refrigerants contain low GWP, which makes them more desirable from an environmental standpoint, the downside to this is they are flammable

What is “NEW” with the new refrigerants?

- Refrigerant transition will require lower and higher flammability refrigerants to be used to meet regulations
- Lower flammability or A2L refrigerants are characterized as having a low flame speed (BV<10cm/sec) and lower heat of combustion (HOC)
- Higher flammability refrigerants include hydrocarbons-HC such as propane (R-290) and isobutane (R-600a) that have higher flame speeds and HOC

What are the Hazards of Refrigerants?



- Combustion byproducts can include Hydrogen fluoride which can lead to pulmonary edema along with the threat of encountering a Phosgene gas
- Hydrofluoric acid can be encountered if water is present
- Oxygen Deprivation is possible in tight and enclosed spaces (Crawl space or Machine room)
- Frostbite is possible due to quickly releasing liquid refrigerant

ENVIRONMENTAL BENEFITS OF A2L REFRIGERANTS

- Low GWP: Significantly lower than traditional HFCs (e.g., GWP of R-410A is around 2000)
- Ozone-Friendly: Do not deplete the ozone layer
- Supports Climate Goals: Aligns with global agreements like the Paris Accord
- High Efficiency: Many A2L refrigerants are more efficient, leading to lower energy consumption
- Cost Savings: Reduced energy bills for consumers and businesses

New Refrigerants

- Many new low GWP refrigerants are ASHRAE A2L
- All new refrigerants must be approved by the U.S. Environmental Protection Agency (EPA) through the SNAP process
- By Legislative mandate, EPA must consider the safety, toxicity, flammability, and environmental factors before approving refrigerants
- All flammable refrigerants are subject to additional safety requirements by EPA

New Refrigerants

- EPA Allows Flammable Refrigerants:
  - Residential and light commercial air conditioning (May 2021)
  - Smaller equipment (window units and PTACS) (2015)
  - Chillers (2012)
  - Self-contained refrigeration (A3 higher flammability refrigerants) (2012)
  - Auto air conditioning (2011)

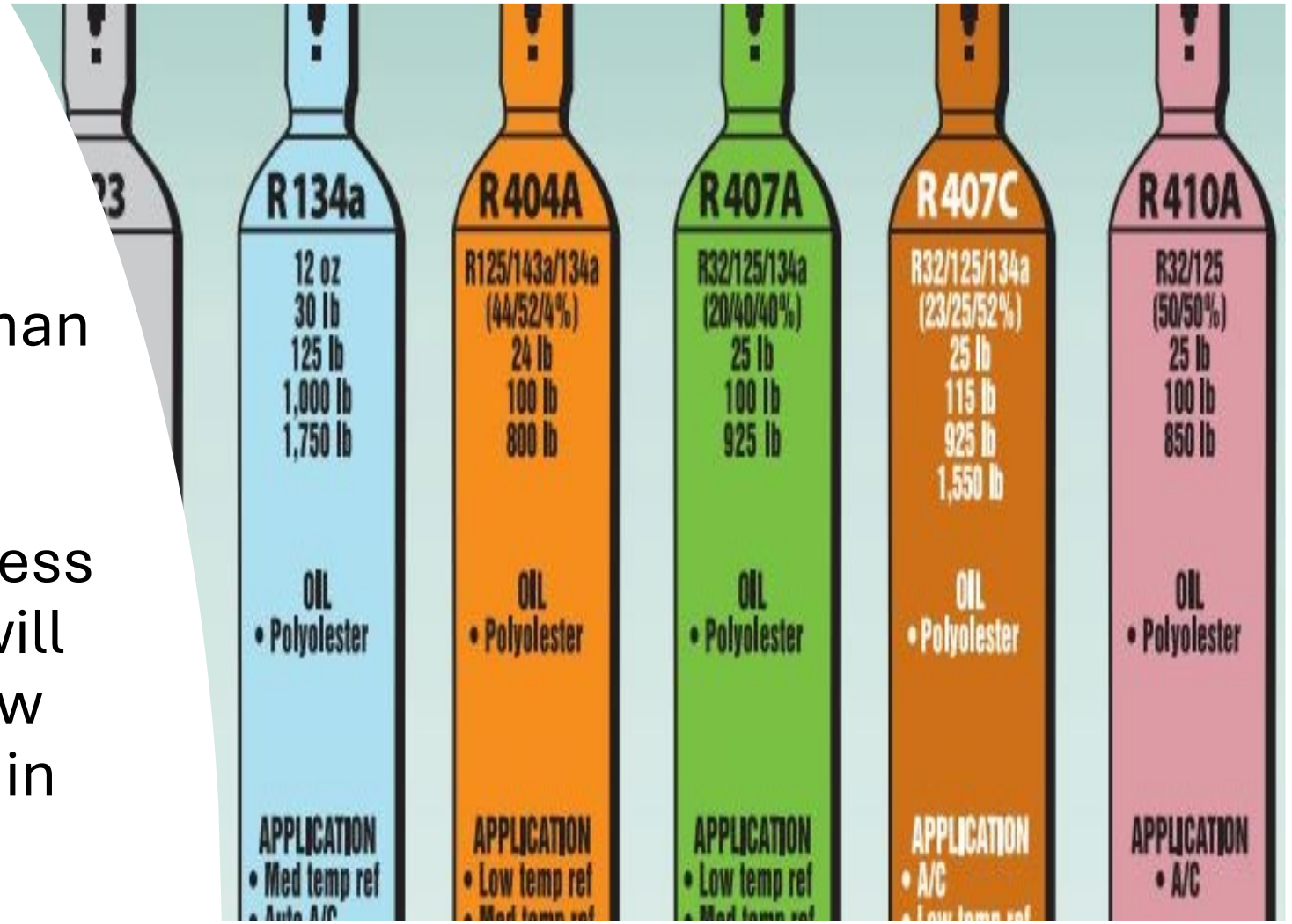
WHAT IS THE IMPORTANCE OF GWP

- Global warming potential (GWP) is a measure of how much potential energy the emissions of one ton of a particular gas will absorb over a given period, relative to the emissions of one ton of carbon dioxide (CO_2)
- The word “potential” is used because GWP only becomes a factor if a leak occurs. (Refrigerants are not meant for release into the environment.)
- For example, energy efficiency is a vital factor when choosing between low GWP solutions. Trials have shown that refrigeration systems using the HFO refrigerants R-454C and R-454A produce 10-year total emissions of up to 25% lower than a CO_2 (R-744) booster system and up to 15% lower than a propane (R-290)/glycol system

REFRIGERANT	TYPE	GWP
R-404A	HFC	3,920
R-410A	HFC	2,088
R-134a	HFC	1,430
R-1234yf	HFO	<1

WHY ARE WE SEEING A CHANGE FROM HFC TO A2L REFRIGERANTS

- Hydrofluorocarbons (HFCs) have a high global warming potential (GWP)
- HFCs have a GWP that is thousands of times greater than carbon dioxide (CO2) on a pound-for-pound basis.
- The R-410a phasedown process began in 2022, and the EPA will prohibit the production of new equipment that uses R-410a in 2025



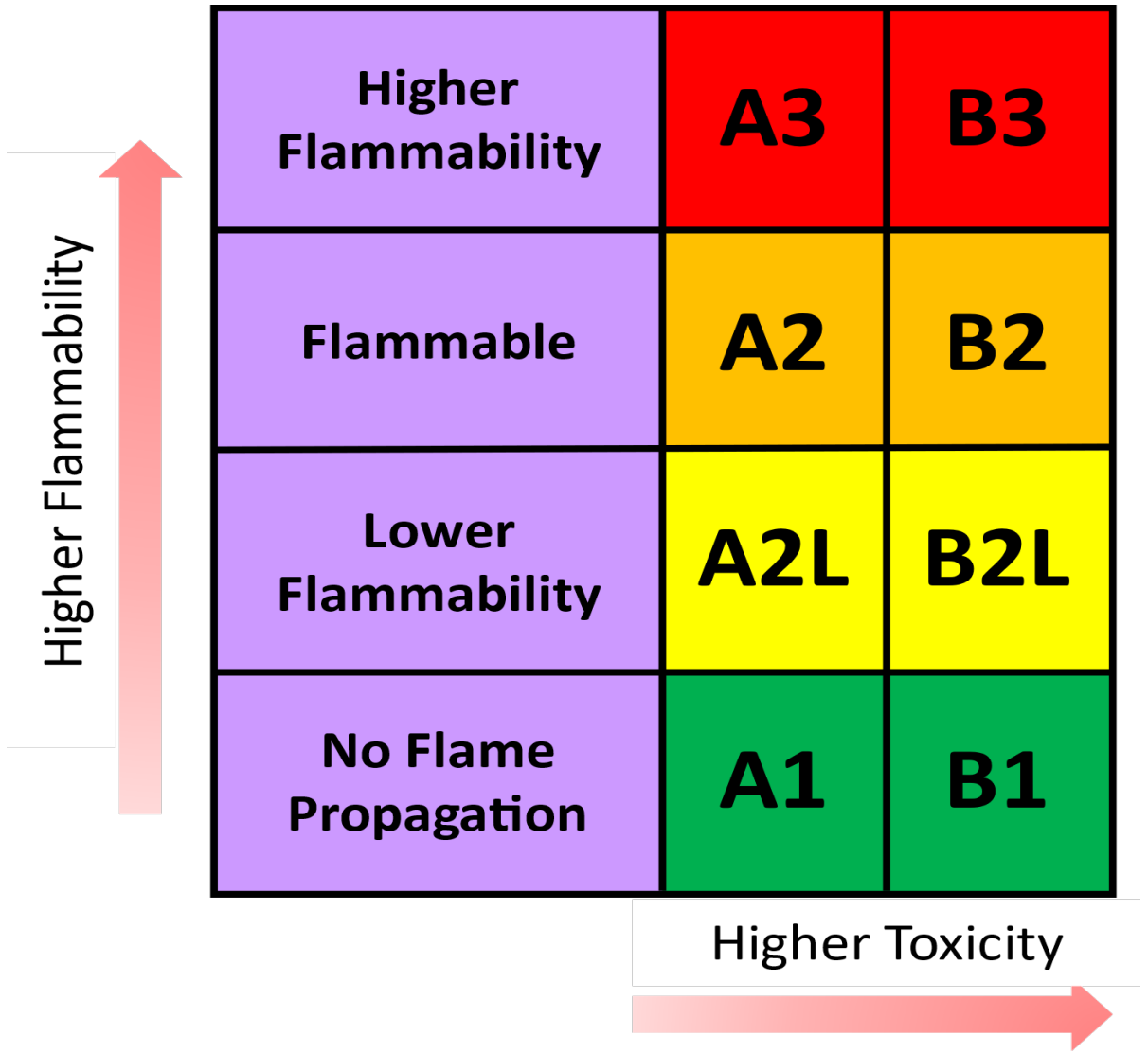
WHAT DOES A2L STAND FOR?

- A2L is an ASHRAE safety classification that stands for:

A = non-toxic

2 = flammable

L = low burning velocity



UNDERSTANDING SAFETY

- Technicians must undergo training to handle A2L refrigerants safely
- Existing refrigeration and HVAC systems may need replacement to accommodate A2L refrigerants
- A2L refrigerants are classified as mildly flammable, which raises safety considerations in their use
- Specific handling and installation protocols have been developed to mitigate risks
- Understanding ignition sources (e.g., electrical sparks, leaks) is crucial for safety
- Enhanced leak detection systems are necessary due to the flammability of A2L refrigerants

HOW WE WILL COMBAT SAFETY RISKS ON OUR JOB SITES

- Training: Technicians should be properly trained before handling A2L refrigerants
- Safety labels: A2L cylinders have red bands to indicate that they are mildly flammable
- Spark-proof tools: Use tools that are designed to prevent sparks
- Leak detection: Use continuous leak detection systems to identify and address leaks promptly
- Approved containers: Use dedicated cylinders for storage to prevent contamination and ensure safe transportation

COMPOSITION OF A2L REFRIGERANTS

- A2L refrigerants can be made of pure HFOs, pure HFCs, HFO blends, or a variety of other chemical compositions
- Some examples of A2L refrigerants include R-32, R-1234yf, R-1234ze, R-452B, R-454A, R-454B, R-454C, R-455A, and R-457A

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Legislation

Break Down

Regulatory Landscape

International Level

Montreal Protocol

Phaseouts, like R-22

Kigali Amendment

Phasedowns, like R-410A

US Federal Level

AIM Act

EPA details emerging

SNAP Rule 23

A2L refrigerants for A/C's

US State Level

CARB

Various timelines for A/C

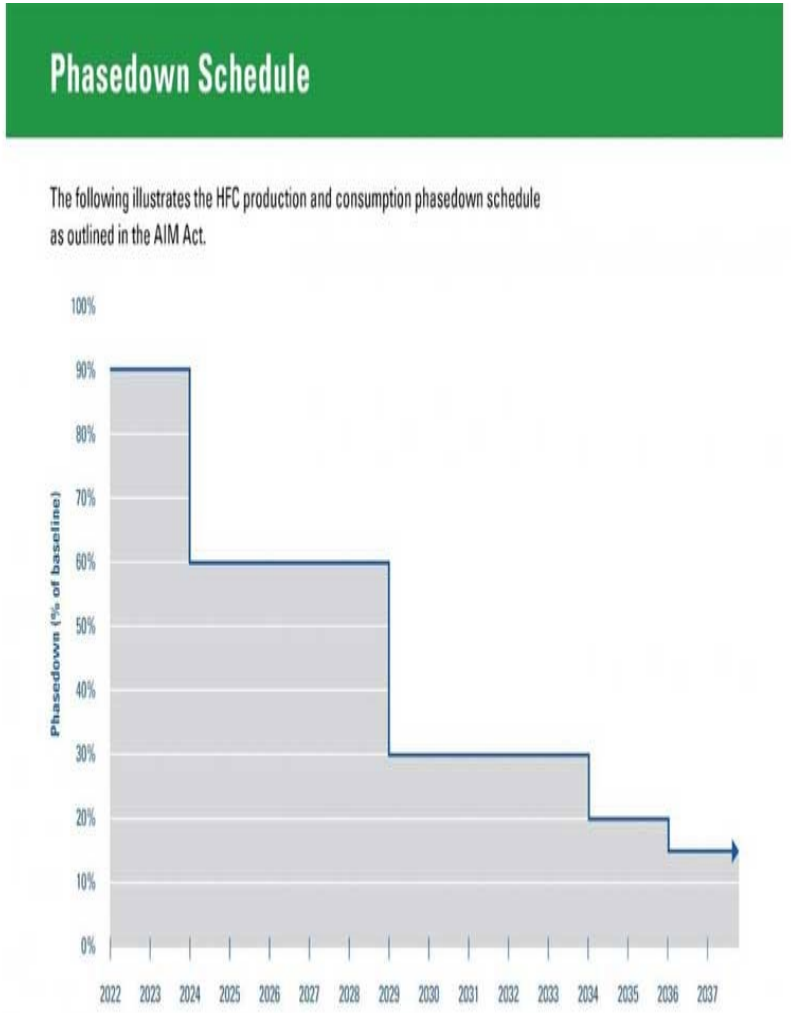
Climate Alliance

24 states following similar plans

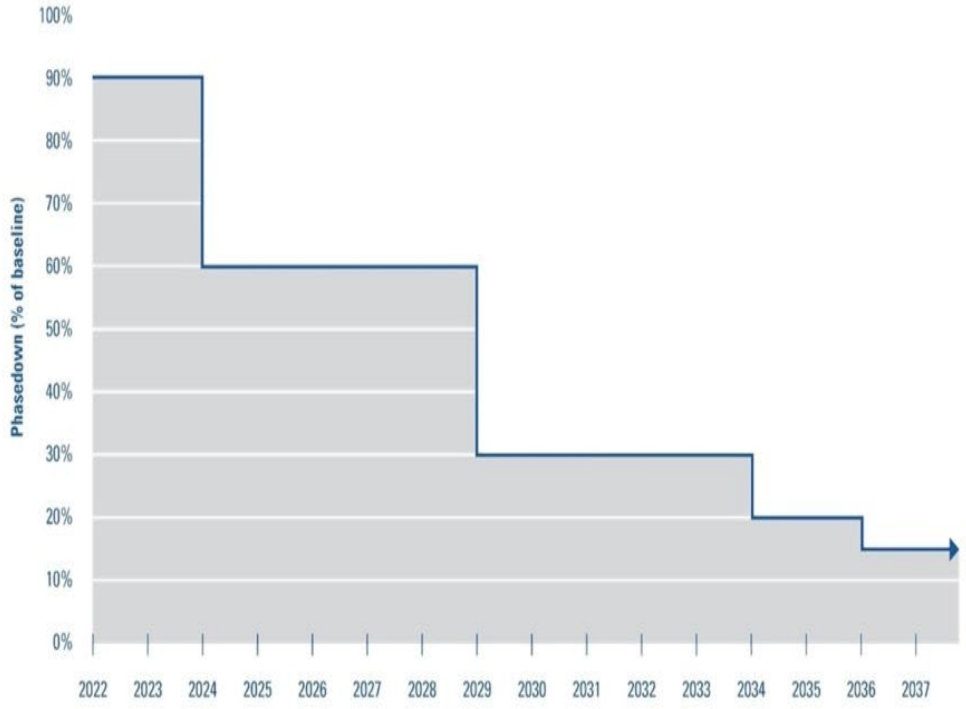
NEW YORK PHASEDOWN

- New York State is proposing a state-only approach to phasing down hydrofluorocarbons (HFCs) that includes the following restrictions:
  - 2025: Additional HFCs will be prohibited from use in regulated equipment, including supermarket systems and new refrigeration facilities
  - 2034: All regulated equipment will be banned from using substances with a 20-year global warming potential greater than 10
  - 2037: The goal is to peak at an 85% cut in HFCs

  The proposed regulations are intended to take effect by the end of 2024. However, the U.S. EPA issued an interim final rule on December 26, 2023, that delays the implementation of some elements of the phase-out until January 1, 2026



HFC PHASEDOWN IN MOTION



- Regulatory Actions:
  - The Kigali Amendment to the Montreal Protocol aims to phase down the use of HFCs globally
  - Countries are setting timelines to reduce HFC consumption and production
  - This phasedown represents a significant shift toward more environmentally friendly practices in the HVACR industry

American Innovation And Manufacturing Act

1. Context: Under The American Innovation and Manufacturing Act (AIM Act), EPA can “partially, fully, or on a graduated schedule” restrict HFC use in specific sectors and subsectors
2. Finalized Rule: Restricts HFC’s used in refrigeration, Aerosols, foams, AC, and heat pump products and equipment by setting GWP thresholds for most sectors
3. Scope: Applies to NEW products, systems and components only. Does not include retrofit or sale/maintenance of used equipment in the US. Will apply to product imports/export
4. Transition Dates: In most cases, manufacture/import/install prohibition begins on Jan. 1, 2025, and prohibition of sale, distribution, and export of PRODUCTS begins three years after manufacture/import prohibition

American Innovation And Manufacturing Act

The AIM ACT mandates a 15-year phasedown of HFCs at a national level, administered by EPA, and aligned with Kigali schedule

It requires EPA to implement an 85% phasedown of the production and consumption of HFC's, so they reach approximately 15% of their 2011-2013 average annual levels by 2036

It also authorizes EPA to adopt sector-specific HFC use restrictions referred to by AIM as "technology transitions"

Lastly, AIM Act requires EPA to promulgate reg's for purpose of maximizing reclamation and minimizing releases of HFCs from equipment

EPA Finalized Technology Transitions (TT) rule

On October 6, 2023, EPA finalized a rule to restrict certain HFCs in certain applications using its authority under the AIM Act. Prohibitions largely align or build upon those in SNAP 20/21 (Significant New Alternative Policy), adopted by States and CARB(California Air Resource Board)

Context: Under the AIM Act, EPA can "partially, fully, or on a graduated schedule" restrict HFC use in specific sectors and subsectors

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PROPOSED INDUSTRY HFC PHASE-DOWN

AIR CONDITIONING AND INDUSTRIAL PROCESS REFRIGERATION (IPR)

Chillers	AR4 GWP Limit	Transition Date
Chillers (designed for chilled fluid leaving temperature > +35 º F)	750	January 1, 2024
Chillers (designed for chilled fluid leaving temperature ≤+35 º and > -10º F)	1500	January 1, 2024
Chillers (designed for chilled fluid leaving temperature ≤-10 º to -50 º F)	2200	January 1, 2024
Chillers (< 20lbs charge) (designed for chilled fluid leaving temperature <+35 º F)	2200	January 1, 2024

RULES

EPA Finalized Technology Transitions (TT) rule

On October 6, 2023, EPA finalized a rule to restrict certain HFCs in certain applications using its authority under the AIM Act. Prohibitions largely align or build upon those in SNAP 20/21, adopted by States and jurisdiction

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Safety & Flammability

Safety Group

- Being that these refrigerants have a lower GWP, they have become very desirable for manufacturers as they are widely accepted as an environmentally friendly refrigerant choice
- Their flammability has forced safety rules and regulations into effect
- To keep things organized there are groupings for these refrigerants
- When being categorized into their respective groups, things such as flammability and toxicity are considered

THE DANGERS OF THE SWITCH TO A2L REFRIGERANTS

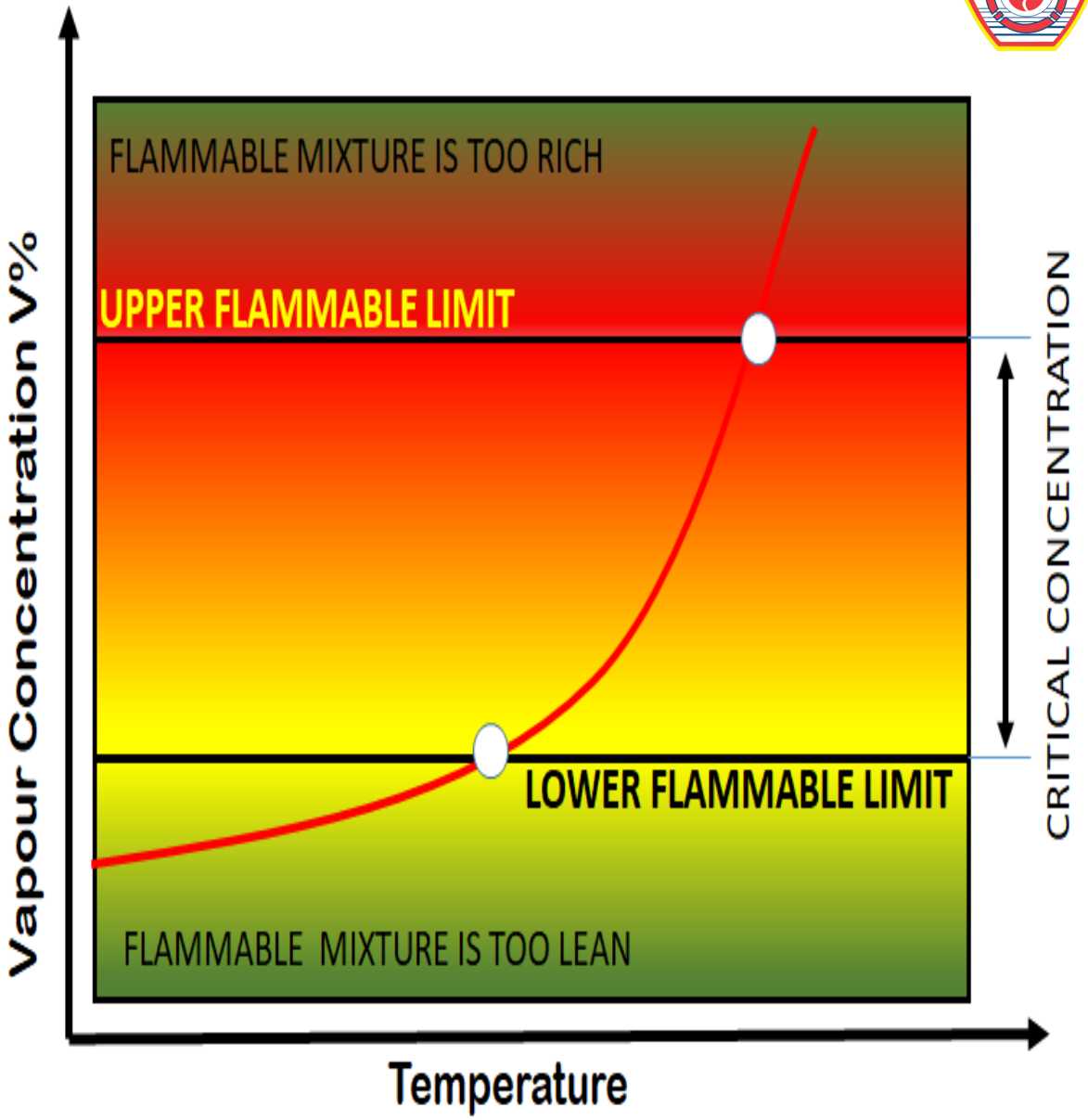
- A2L refrigerants are mildly flammable and pose some safety risks
- Leak risk: Fires are most likely to occur if there is a leak, so it's important to have safety features in place to detect leaks and shut down the system
- Safety equipment: Personal protective equipment (PPE) like gloves and eyewear should be worn when working with A2L refrigerants. A dry-powder Class B fire extinguisher should also be accessible
- Flammability: Although they burn more slowly than A3 refrigerants, A2L refrigerants can and will burn if ignited

Measuring Flammability of a Refrigerant

- To properly categorize these refrigerants, it is important to understand just how flammable they are as it may vary from refrigerant to refrigerant
- A class and number will be assigned to each refrigerant. The flammability will dictate the number selected per refrigerant. The flammability is calculated by reviewing 3 characteristics
  - Lower Flammability Limit (LFL)
  - Heat of Combustion (HOC)
  - Maximum Laminar Burning Velocity (S)

What **is Lower Flammability Limit?**

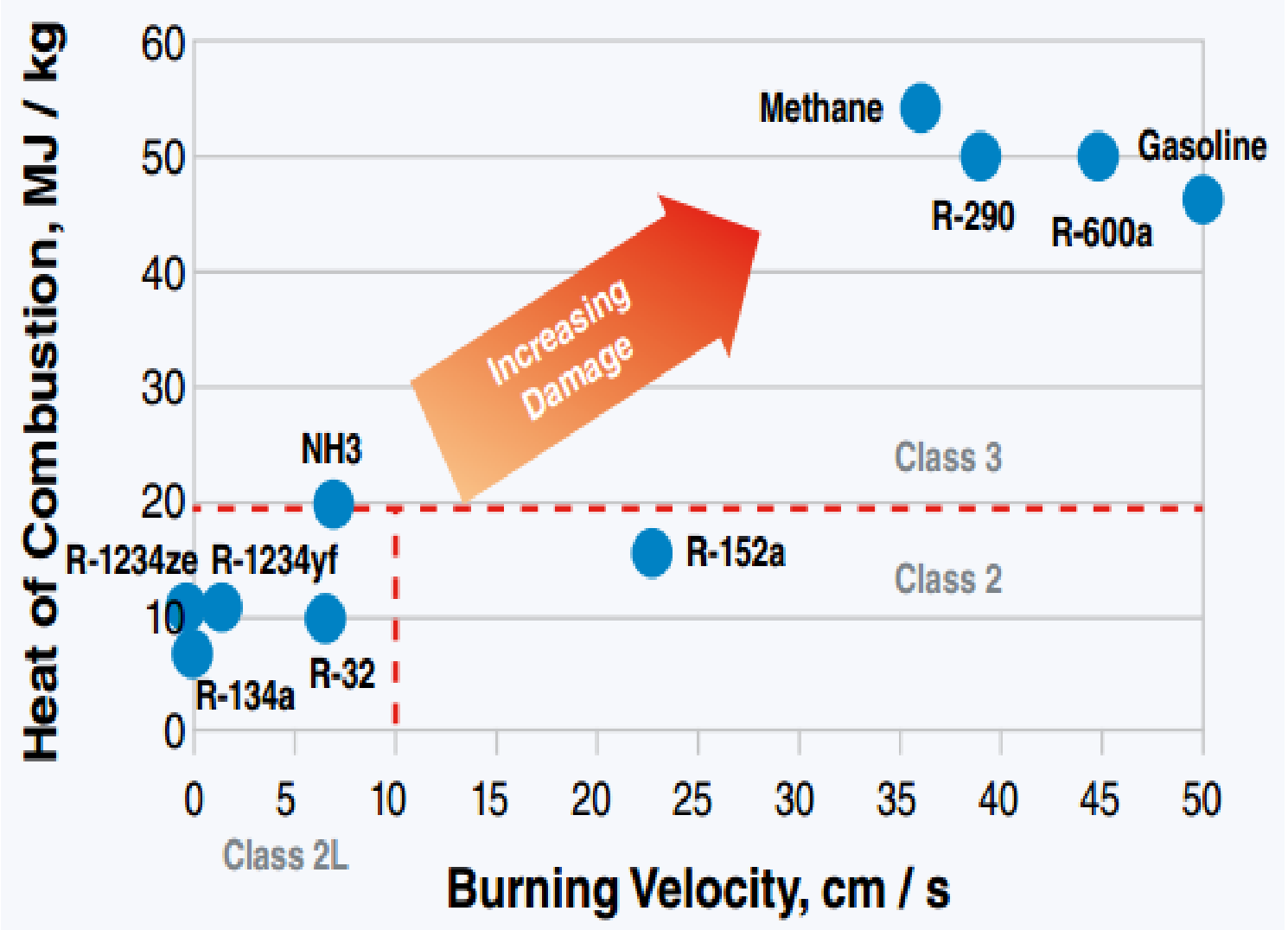
- Lower flammability limit (LFL):
- The lowest concentration or percentage of a gas, or vapor contained in air, capable of producing a flash of fire in the presence of an ignition source



What is Heat of Combustion?

Heat of Combustion

- The heat released when a substance is combusted



Measuring Flammability

- Class 3 refrigerants are refrigerants that contain a low LFL, a high HOC, and exhibits flame propagation at 140 degrees at atmospheric pressure
- Class 2 refrigerants are refrigerants that higher LFL, and a HOC less than the limits above for class 3 refrigerants and exhibits flame propagation at 140 degrees at atmospheric pressure
- Class 2L exhibits all of the same as class two refrigerants, but it also has a significantly lower burning velocity. The lower burning velocity contributes to its much slower rates of combustion than the class 3 and class 2 refrigerants

Refrigerant Class Chart

Higher Flammability

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

Higher Toxicity

Class 3 Requirements

1. Exhibit flame propagation @ 60ºC & 101.3 kPa
2. LFL ≤ 0.10 kg/m³ or HOC ≥ 19,000 kJ/kg

Class 2 Requirements

1. Exhibit flame propagation @ 60ºC & 101.3 kPa
2. LFL > 0.10 kg/m³
3. HOC < 19,000 kJ/kg

Class 2L Requirements

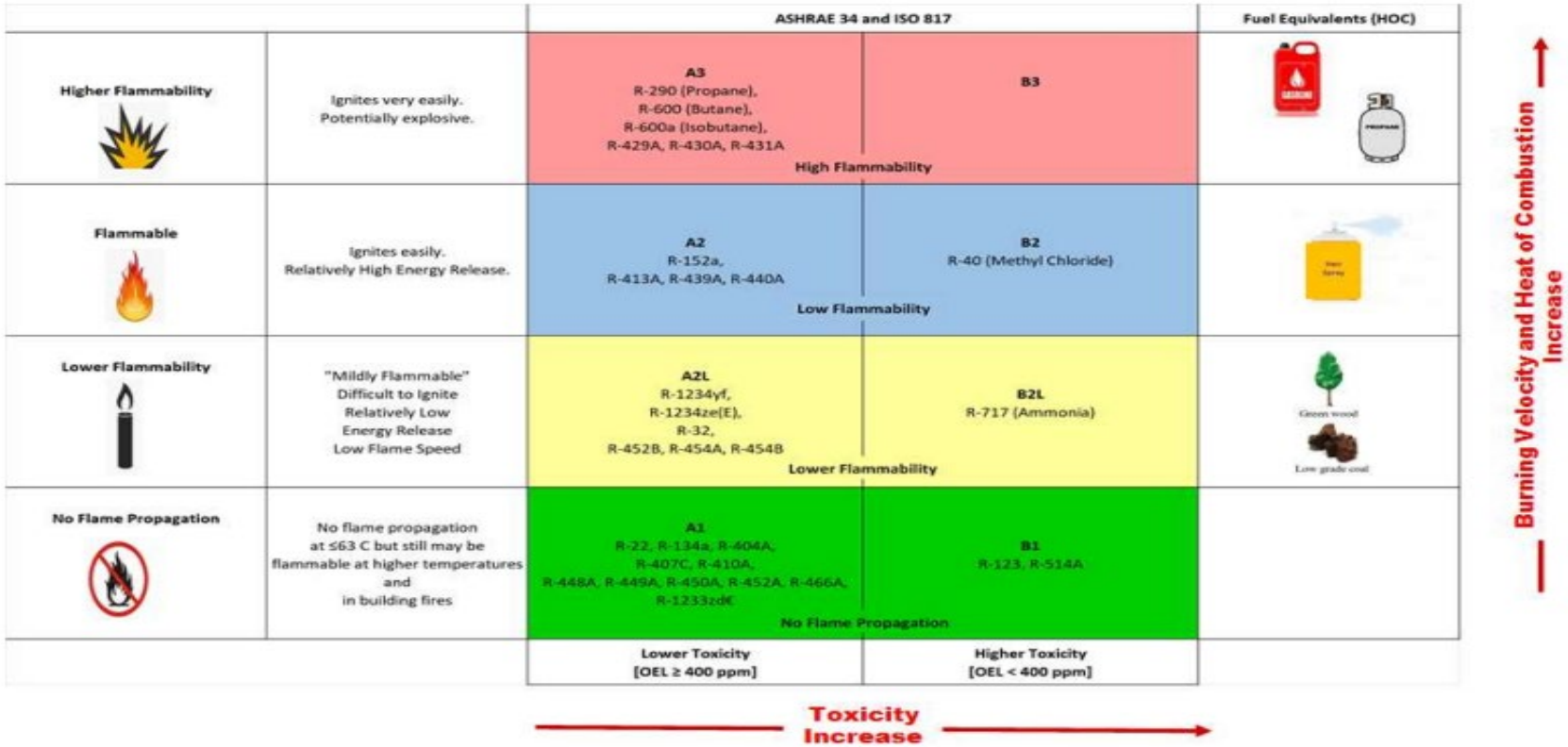
1. Exhibit flame propagation @ 60ºC & 101.3 kPa
2. LFL > 0.10 kg/m³
3. HOC < 19,000 kJ/kg
4. S_u ≤ - 10 cm/s

Class 1 Requirements

1. No flame propagation @ 60ºC & 101.3 kPa

kPa = pressure in kilopascals
kJ/kg = energy in kilojoules per kilogram
S_u = burning velocity in centimeters per second

ASHRAE STANDARD 34-FLAMMABILITY AND GWP



- Lower GWP will help sustain the Environment
- Flammability increases risks due to the associated dangers
- As the GWP is Lowered the Flammability increases

AHRI
SAFE REFRIGERANT
TRANSITION TASK FORCE

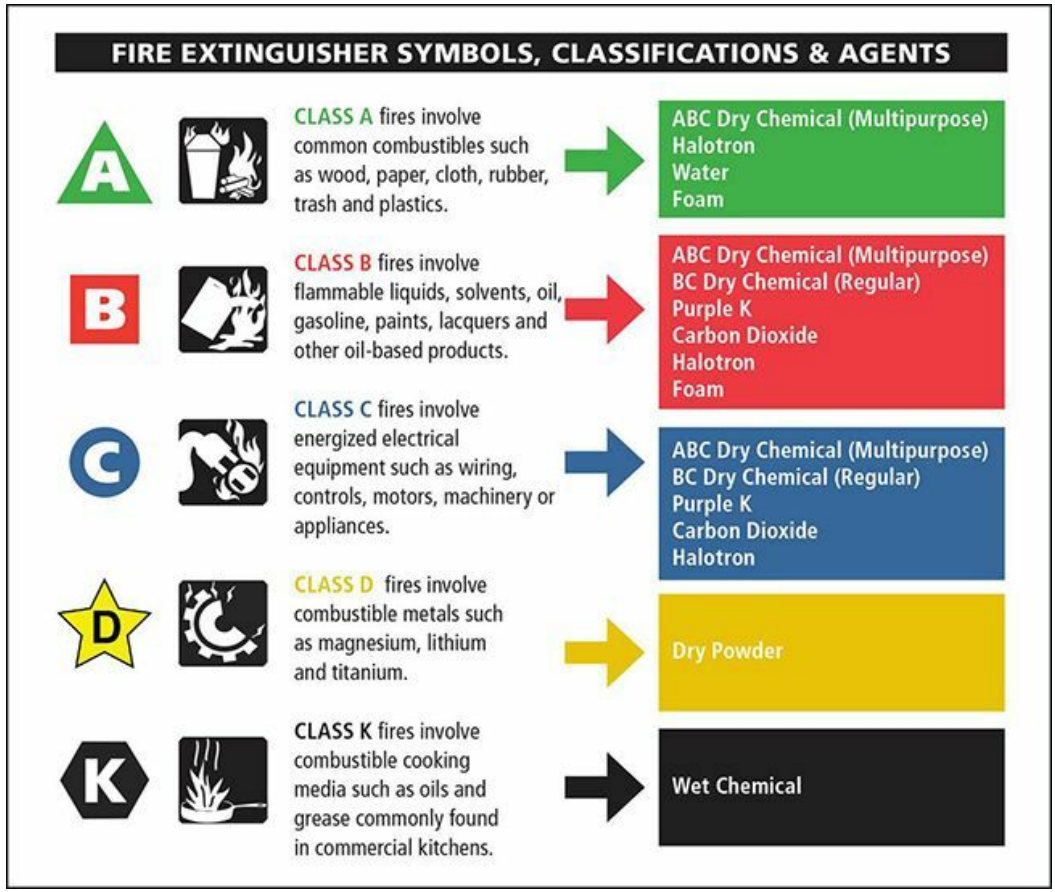
Ignition Sources

- In the event of a leak, it is crucial to avoid accidental ignition of refrigerants
- Flammable refrigerants will not ignite if the concentration level within the vicinity of the ignition source remains below the LFL of said refrigerant
- Refrigerants that fall in class A3, can be ignited by a relatively weak static spark. It is critical that all equipment is properly grounded, all electrical connections are made tightly to avoid arching, and all ferrous materials be removed from vicinity

Transportation

Transportation of A2L Refrigerants

- From a storage area to a jobsite in the same manner as other flammable gasses like oxygen and acetylene
- DOT requires that when transporting flammable refrigerants, vehicles be equipped with a class B (dry powder) fire extinguisher
- Keep a written inventory of the of the gasses being transported, the SDS of each refrigerant, and some form of security to prevent theft as well as unauthorized access
- DOT rules also prohibit smoking within 25 feet of flammable gasses



Transportation of A2L Refrigerants

- DOT regulations for transportation of A2L's
  - Refrigerant cylinders weighing over 2.2lbs, must be equipped with a pressure relief valve in place of a rupture disc
  - A relief valve (unlike a rupture disc) will open when pressure exceeds its limit, and close when pressure drops below its set point
  - This will help in preventing large refrigerant leaks (should the tank over pressurize)
  - Depending on state or local codes, proper ventilation may need to be available on service vehicles

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STORAGE

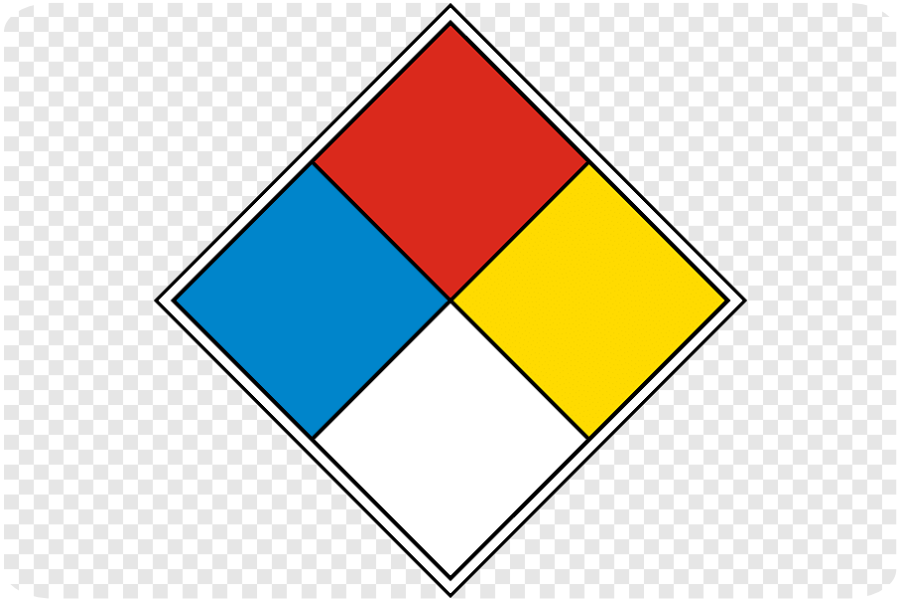
A2L Storage

- Cylinders must be stored in the upright position so that the pressure relief valve is in contact with the vapor of the refrigerant
- Refer to state and local codes to verify the amount of refrigerant which can be stored in a certain space
- New refrigerant sensors may need to be installed
- Standards may now call for the use of active sensors which can activate mechanical ventilation, force equipment pump down, or de-energize a system completely

A2L STORAGE

The National Fire Protection Association (NFPA) fire safety storage requirements mandate that a storage facility must match the following guidelines

- Obtain a permit from a local fire code official (FDNY)
- Have no open flames, high temperature devices, or combustion appliances in the storage area
- Post visible hazard identification signs around the storage area
- Post “no smoking” signs within a certain distance of the storage area
- Maintain a Hazardous Materials Management plan for the site
- Maintain the SDS sheet for each type of gas stored onsite



SAFETY REMINDERS

- Adequate ventilation is essential in areas where A2L refrigerants are used to prevent accumulation of flammable mixtures
- Use of sensors that can detect both refrigerant leaks and combustion risk
- Developing clear protocols for emergency situations involving A2L refrigerants
- Training personnel on emergency response procedures to handle potential fire incidents
- Class one division two electrical classification maybe required in rooms or spaces where adequate ventilation is not provided

SOME DIFFERENCES TO NOTE ON WORKING WITH A2L BASED SYSTEMS

- Let's use R454B as an example
- Repair Considerations:
  - When working on systems with R454B, technicians must ensure compatibility of components, as R454B operates at different pressures and may require specific materials (like certain oils and seals) that differ from those used in R410A and R22 systems. Additionally, because R454B is mildly flammable, safety protocols during repairs—such as proper ventilation and use of appropriate tools—are essential to minimize risks. This contrasts with R410A and R22, which have different safety and handling requirements
  - R454B systems may require different leak detection methods, as traditional methods used for R410A and R22 may not be suitable. Technicians should be trained in using specific leak detection tools that can effectively identify R454B leaks, considering its lower detection threshold
  - When servicing R454B systems, it's important to follow specific charging procedures, as overcharging can lead to efficiency loss or system damage. Unlike R22 and R410A, R454B requires careful monitoring of superheat and subcooling to maintain optimal performance

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JOB SITE SAFETY

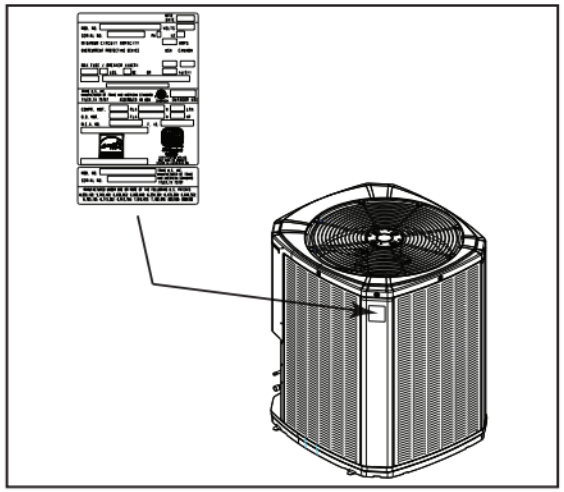
JOB SITE SAFETY

- When working with refrigerants on a jobsite, safety should always be priority. A proper lockout/tagout procedure should be used when the equipment is de-energized. The person performing the work should carry the only key. A multimeter should be used to verify that there is no voltage present before beginning work. The area should be well ventilated to prevent oxygen displacement and suffocation in the event of a refrigerant leak
- With proper ventilation on a jobsite, flammable refrigerants can be stored below their flammability limit or LFL. As in the past, we will continue to defer to OSHA, Local building codes , regulation and standards for proper work environment procedures

SAFETY

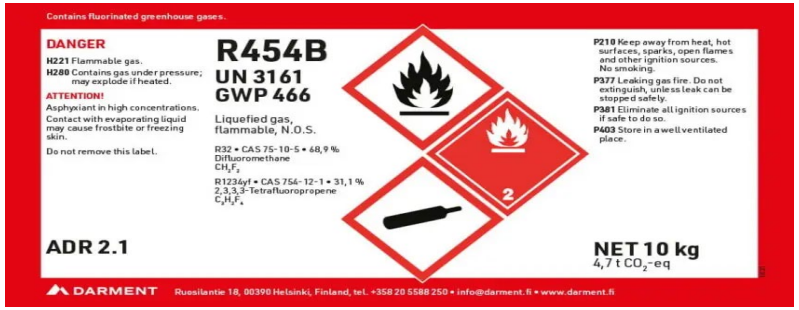
- Designate a safe perimeter around the work area using cones or proper labelled barriers, this will reduce the possible ignition source from being introduced into the area while work is being performed
- There are several new label requirements for systems charged with flammable refrigerants. Some of these requirements are satisfied at the time of manufacture, while others will have to be met by field personal. Technicians should be familiar with such labels

LABELLING AND MARKING REQUIREMENTS



- UNDERWRITERS LABORATORIES' (UL) standards require that systems charged with a flammable refrigerant have a label affixed to the unit that is filled out by the installing engineer/technician with permanent ink to include:
  - Name of installer/contractor
  - Evacuation level achieved after installation
  - Pressure used to test the system for leaks
  - Date that the pressure test and evacuation were completed
  - Total refrigerant charge in pounds/ounces in the system

LABELLING AND MARKING REQUIREMENTS



Shown above is an example label indicating the presence of a mildly flammable refrigerant. This helps technicians and personnel recognize the potential hazards associated with the refrigerant

- **Label Specifications:**
  - **The labels should include the refrigerant type (e.g., R454B). The flammability classification (A2L). Safety precautions, such as "Mildly Flammable Refrigerant—Handle with Care"**
- **Location of Labels:**
  - **Labels must be placed near the service valves in a visible location, typically on or adjacent to the valve itself, to ensure they are easily seen during maintenance and repairs**
- **Regulatory Compliance:**
  - **Labels and markings should comply with local regulations and industry standards, such as those set by ASHRAE, EPA, and relevant safety organizations**
- **Color Coding:**
  - **While not universally required, using color coding (e.g., green for A2L refrigerants) can enhance visibility and help differentiate between refrigerant types at a glance**
- **Instructional Labels:**
  - **Additional instructional labels may be needed to provide guidance on proper handling and safety measures when working with A2L refrigerants**

REFRIGERATION SYSTEM

	Freon™ 410A (R-410A)	Opteon™ XL41 (R-454B)	Freon™ 407C (R-407C)	Freon™ NU-22B™ (R-422B)	Freon™ MO99™ (R-438A)	Freon™ 22 (R-22)	R-32
SAFETY GROUP	A1	A2L	A1	A1	A1	A1	A2L
°F	psig	psig	psig	psig	psig	psig	psig
-50	4.9	3.1	11.0	11.6	11.4	6.1	5.2
-45	7.6	5.6	8.0	8.7	8.5	2.7	8.0
-40	10.7	8.4	4.6	5.5	5.2	0.6	11.0
-35	14.0	11.4	0.9	1.9	1.5	2.6	14.4
-30	17.7	14.8	1.6	1.1	1.2	4.9	18.2
-25	21.8	18.5	3.9	3.2	3.5	7.4	22.3
-20	26.2	22.6	6.5	5.7	5.9	10.2	26.8
-18	28.1	24.3	7.6	6.7	7.0	11.4	28.7
-16	30.0	26.1	8.7	7.8	8.1	12.6	30.7
-14	32.0	27.9	9.9	8.9	9.2	13.9	32.8
-12	34.1	29.8	11.1	10.1	10.4	15.2	34.9
-10	36.3	31.8	12.3	11.3	11.6	16.5	37.1
-8	38.5	33.8	13.7	12.5	12.9	17.9	39.4
-6	40.8	35.9	15.0	13.8	14.2	19.4	41.7
-4	43.2	38.1	16.4	15.2	15.6	20.9	44.2
-2	45.7	40.4	17.9	16.6	17.0	22.4	46.7
0	48.2	42.7	19.4	18.0	18.5	24.0	49.3
2	50.8	45.1	21.0	19.5	20.0	25.7	51.9
4	53.5	47.6	22.6	21.1	21.6	27.4	54.7
6	56.3	50.1	24.3	22.7	23.2	29.2	57.5
8	59.2	52.7	26.1	24.4	24.9	31.0	60.5
10	62.2	55.4	27.9	26.1	26.6	32.8	63.5
12	65.2	58.2	29.8	27.8	28.4	34.8	66.6
14	68.4	61.1	31.7	29.7	30.3	36.8	69.8
16	71.6	64.1	33.7	31.6	32.2	38.8	73.1
18	74.9	67.1	35.7	33.5	34.2	40.9	76.5
20	78.4	70.3	37.9	35.5	36.2	43.1	80.0
22	81.9	73.5	40.1	37.6	38.3	45.3	83.6
24	85.5	76.8	42.3	39.7	40.5	47.6	87.3
26	89.2	80.3	44.7	41.9	42.8	50.0	91.1
28	93.1	83.8	47.1	44.2	45.1	52.4	95.1
30	97.0	87.4	49.6	46.6	47.5	55.0	99.1
32	101.1	91.1	52.1	49.0	49.9	57.5	103.2
34	105.2	94.9	54.8	51.5	52.5	60.2	107.5
36	109.5	98.8	57.5	54.0	55.1	62.9	111.9
38	113.9	102.9	60.3	56.6	57.7	65.7	116.3
40	118.4	107.0	63.2	59.4	60.5	68.6	121.0
42	123.0	111.2	66.1	62.1	63.3	71.5	125.7
44	127.7	115.6	69.2	65.0	66.3	74.5	130.5
46	132.6	120.0	72.3	67.9	69.3	77.6	135.5

- Whether we have a system operating with a CFC, HFC, HCFC or HFO our fundamental knowledge and experience of troubleshooting the system does not change much
- Some of you may remember the transition from R22 to 410A
- Use your PT Chart to calculate system pressures

  Example:
  - An R22 system operating with an evaporator saturation temperature of 40 degrees will have an operating pressure of around 69 psig.
  - Match that temperature to your PT Chart for R32 and you will find that your operating pressure should be around 121 psig.
  - Knowing that simple technique, (along with your knowledge of service work), will allow for an easy transition when charging systems with subcooling superheat methods

Charging Limitations

- Being that these refrigerants are combustible, limiting the amount in each space reduces the risk of severe explosion
- The maximum allowable quantity of refrigerant depends on many factors
  - The refrigerant Classification
  - The type and location of equipment
  - The number of occupants in space
  - The size of the space
- Charge limitations are intended to reduce the risk of accidents by lowering severity of events

Pressure

It is common HVAC knowledge, that an increase in temperature will result in an increase in pressure. This is where pressure reliefs may come into play

With nonflammable refrigerants, pressure increase due to fire in mechanical room, can be relieved by opening pressure relief valve and relieving refrigerant into space

This is of course, not the case with flammable refrigerants. In many cases, piping the discharge of the relief valve out of the mechanical room and outside may be the safest way

Installation

Requirements for installations of systems that utilize Flammable Refrigerants

1

Ground indoor and outdoor units to prevent line set from becoming an electrical conductor

2

Include tag on machine with full charge amount and type of refrigerant, and clearly mark its flammability

Installation

When installing Flammable refrigeration equipment, always follow local building code and safe industry practices

Long standing pressure tests performed with nitrogen along with proper equipment can confirm no leaks after installation

- Record the details of the leak check including things such as , time, pressure at start, and pressure at finish

Establish and maintain proper ventilation of indoor areas where unit has been installed to avoid hazardous levels of refrigerant

Installation systems requirements which utilize Flammable Refrigerants.

- Install refrigerant leak detecting sensors in accordance with manufacturers specifications
- Install all outdoor A2l and A3 equipment with adequate clearance from any door, window, or penetration where refrigerant could leak into space during an active leak condition
- Do not install any flammable refrigerant equipment in any means of egress to prevent potential ignition situations in high traffic areas

FIELD PROCEDURES

- As with other refrigeration systems, A2L systems must be evacuated prior to being charged. The vacuum pump must be rated for use with A2L refrigerants
- The service and installation procedures for equipment charged with A2L refrigerant should be in accordance to manufactures specifications
- As we have been discussing, our main source of concern and difference is the constant awareness and attention to safety we must have due to the refrigerant's higher flammability

Recovering Flammable Refrigerants

When recovering flammable refrigerants, First determine the proper recovery cylinder

The cylinder must be suitable for flammable gasses

- Checking the notation on the tank will help you identify its application

The recovery machine must also be suitable for flammable gasses

- Regular standard recovery machines used for HFC,CFC refrigerants should not be used with HC (flammable) refrigerants as they have several ignition sources such as the on off switch, relays, and pressure switches

Mitigating the Risks of Leaks

Providing	Providing adequate room relative to refrigerant charge quantity, to avoid flammable refrigerants occupying the air space in said room during an active leak condition
Using	Using leak detecting devices in conjunction with exhaust systems to purge spaces of flammable refrigerants
Placing	Placing units outside when possible

Leaks

- Leaks are inevitable within refrigerant circuits, regardless of type of refrigerant.
- With the introduction of flammable refrigerants being used, it is important to develop management techniques to identify, rectify, and reduce potential leaks. A few of the strategies being put into play are
  - *Leak detecting sensors to trigger an alert of an active leak*
  - *Manufacturers to reduce amount of braze joints, threads, and flares to reduce the leak potential*
  - *Lower refrigerant charge quantities*
  - *Improve overall reliability of machines, to encourage less service.*

A2L SYSTEM REPAIR

- **Below are considerations to be made when working on A2L systems**
  - **Start by ensuring the unit is properly grounded**
  - **Discharge capacitors in a way that will not cause a spark**
  - **Reassemble sealed enclosures properly, if worn or damaged, replace them**
  - **When troubleshooting, intrinsically safe components are the only types that can be worked on while live within a flammable atmosphere**
  - **Replace components with OEM parts only**
  - **Check all components thoroughly after repair before putting the system back online**

REFRIGERANT RECOVERY

- A2L refrigerants must be recovered prior to opening a system for repair or disposing of it
  - The tools used for the recovery of A2L refrigerants must be rated for use with flammable gasses

  These would include:
  - The recovery machine
  - Gauge manifold hoses
  - The recovery tank (marked with a red stripe)
  - Any other accessories exposed to the refrigerant
- Under no circumstances should different refrigerants be mixed in the same recovery tank

EVACUATION

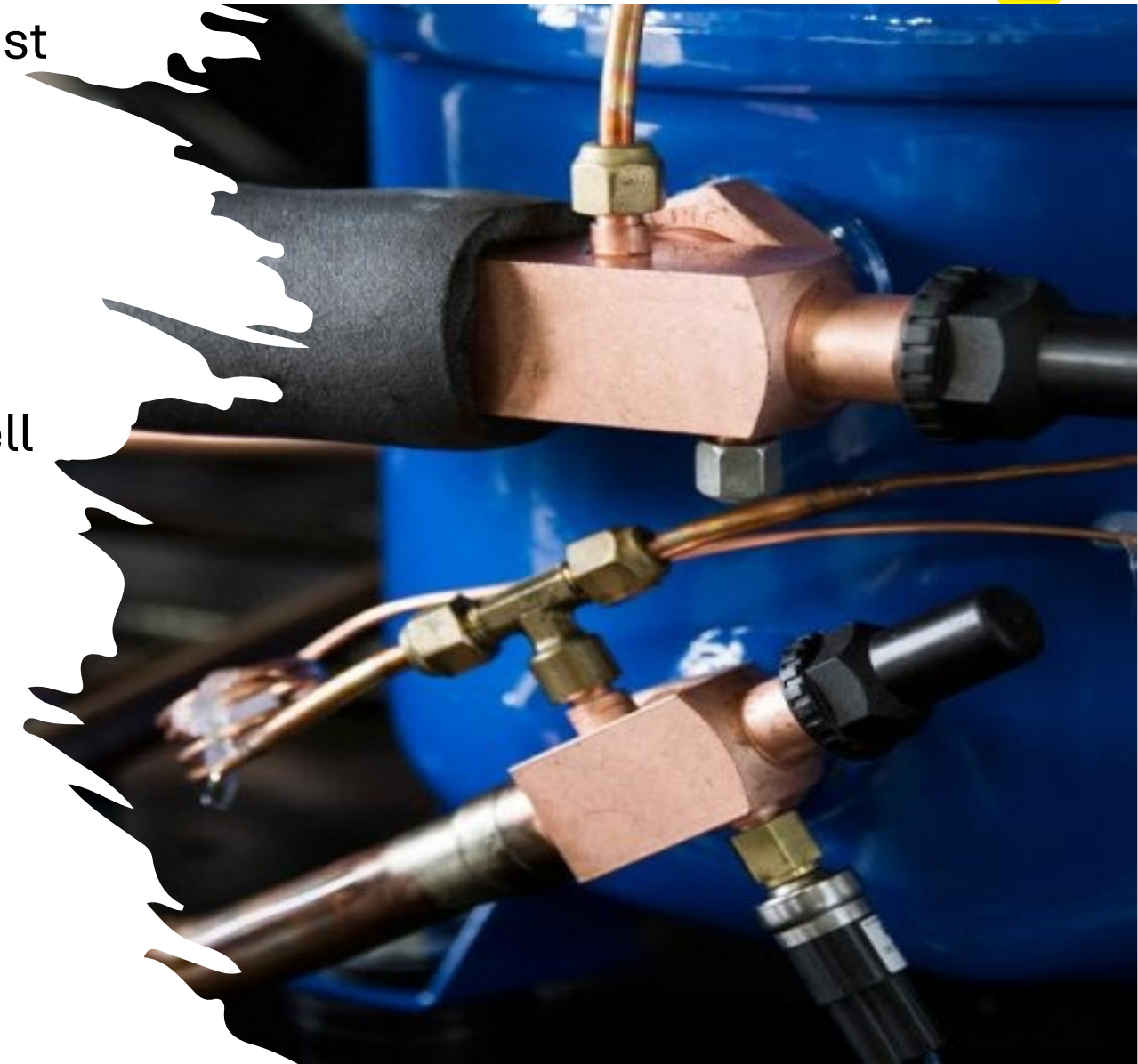
- Below are some of the various requirements specified by different A2L equipment manufacturers that engineers and techs should be aware of:
  - If a system was previously charged with an A2L refrigerant and oil is present in the lines, the system must be flushed with dry nitrogen prior to operation
  - The acceptable evacuation standard for a deep vacuum is 5oo microns
  - One aspect of evacuation with A2L's is the consideration to assure the vacuum pump vent outdoors or to a well-ventilated area

CHARGING

- **Additional considerations to be made aware of when charging a system**
  - Tools such as hoses and gauge manifold set should be rated for use with A2L refrigerants
  - Locking refrigerant caps should be used to prevent unauthorized access
  - A2L refrigerant cylinders will be color-coded gray with a red stripe
  - Some refrigerant manufacturers may use a revers thread ¼ inch port
  - When charging a new system, the total charge weight (and date of charge) must be recorded on a label affixed to the unit by the installer
  - Any additional refrigerant added must also be recorded on equipment
- When empty, A2L refrigerant tanks should be disposed of properly in accordance with New York City regulation

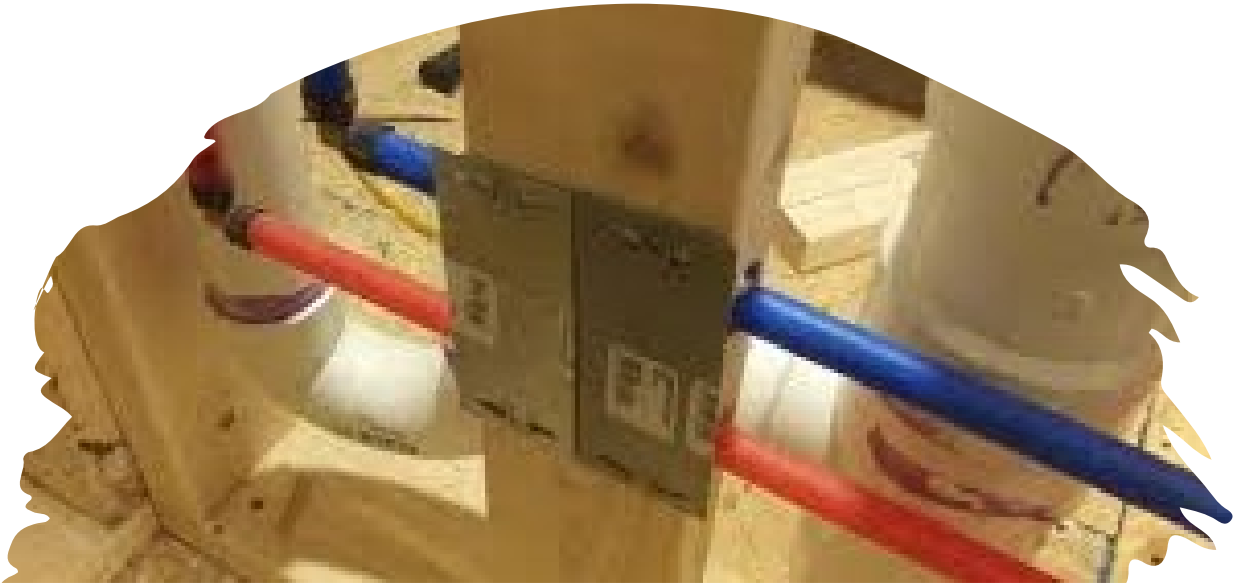
A2L REFRIGERANT PIPING

- Methods used to join sections of tubing must meet the level of safety outlined in the applicable codes and standards, and must be acceptable to the authority having jurisdiction
- As noted, once installed, refrigerant tubing must be pressure tested for strength, as well as leak tested for tightness



A2L REFRIGERANT PIPING

Refrigerant piping that is located inside of a wall or floorspace, where it passes through joists or studs, must be protected by strike plates, or other acceptable protective shielding. This prevents puncturing or accidental damage



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Summary

- HC refrigerants contain low GWP, which makes them more desirable from an environmental standpoint, the downside to this is they are flammable
- Combustion byproducts can include Hydrogen fluoride which can lead to pulmonary edema along with the threat of encountering a Phosgene gas
- Frost bit is a concern if contacted by refrigerant
- Enhanced leak detection systems are necessary due to the flammability of A2L refrigerants
- Flammability: Although they burn more slowly than A3 refrigerants, A2L refrigerants can and will burn if ignited
- DOT requires that when transporting flammable refrigerants, vehicles be equipped with a class B (dry powder) fire extinguisher
- Depending on state or local codes, proper ventilation may need to be available on service vehicles
- There are several new label requirements for systems charged with flammable refrigerants. Some of these requirements are satisfied at the time of manufacture, while others will have to be met by field personal. Technicians should be familiar with such labels
- The maximum allowable quantity of refrigerant depends on many factors.
  - The refrigerant Classification
  - The type and location of equipment
  - The number of occupants in space
  - The size of the space
- In the event of a leak, it is crucial to avoid accidental ignition of refrigerants.
- Under no circumstances should different refrigerants be mixed in the same recovery tank
- Use equipment intended for A2L refrigerants
- Ventilation needed so that you do not approach the LFL level

Reference Material

Appendix A:

- ASHRAE Standard15-2022, Safety Standard for Refrigeration Systems
- ASHRAE Standard 15.2-2022, Safety Standard for Refrigeration Systems in Residential Applications
- ASHRAE Standard 34-2022, Designation and Safety Classification of Refrigerants
- AHRI
- UL 60335-2-40 informative annex HH
- UL 60335-2-89 informative annex 101.DVT
- New York City Mechanical code
- New York City Fire Code

Appreciation & Acknowledgment

- Special Thanks for insights and information shared
  - Local 94 International Union of Operating Engineers
  - Local 30 International Union of Operating Engineers
- Thanks for the shared information and resources

  (ASHRAE)-American Society of Heating, Refrigerating, and Air- Conditioning Engineers

  (AHRI)Air-Conditioning, Heating, and Refrigeration Institute

  (UL)Underwriters Laboratories Solutions