Refrigerants are Changing

(How we got here & where we're going)

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http://www.ahrinet.org/SafeRefrigerant
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AHRI…

Is one of the nation's larger trade associations

- 300+ HVACR and water heating manufacturers across 40+ product sections
- $42 billion revenue
- 125,000 / 1.2 million jobs (direct and indirect)
- NY Top 10 for employment (direct and indirect)

Establishes 100+ international industry standards & guidelines

Administers 40+ rigorous certification programs

Administers a comprehensive industry statistics program

Our Members are Manufacturers

Cooling & heating products for residential, commercial & industrial applications:

central AC & heating equipment

components for heating, AC & refrigeration systems

hydronic heating equipment

water heating equipment

commercial & industrial AC, heating & ventilation equipment

commercial & industrial refrigeration equipment

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Overview

- Introduction
- Refrigerant regulatory landscape
- Low global warming potential (GWP) refrigerants, including the new A2L safety category
- Technical research and development informing the standards
- Safety standard upgrades for flammable refrigerants (UL60335-2-40 and ASHRAE 15/15.2)

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What are The World's Goals?

- Reduce greenhouse gas emissions to cap global temperature increase to 2°C
  - Aspirational goal is no more than 1.5°C
  - 1.5°C → 2°C temperature rise
    - 250 million more people exposed to drought and its consequences
    - 1.7 billion more people exposed to extreme temperatures (> 1/5 of the current global population)
  - HFC transition is estimated to reduce temperature rise by up to 0.5°C
    - Refrigerants can have up to 14,000 times the greenhouse gas impact of carbon dioxide

- Some low global warming potential (GWP) refrigerants have different flammability and toxicity characteristics

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The World Is Regulating Hydrofluorocarbon (HFC) Refrigerants

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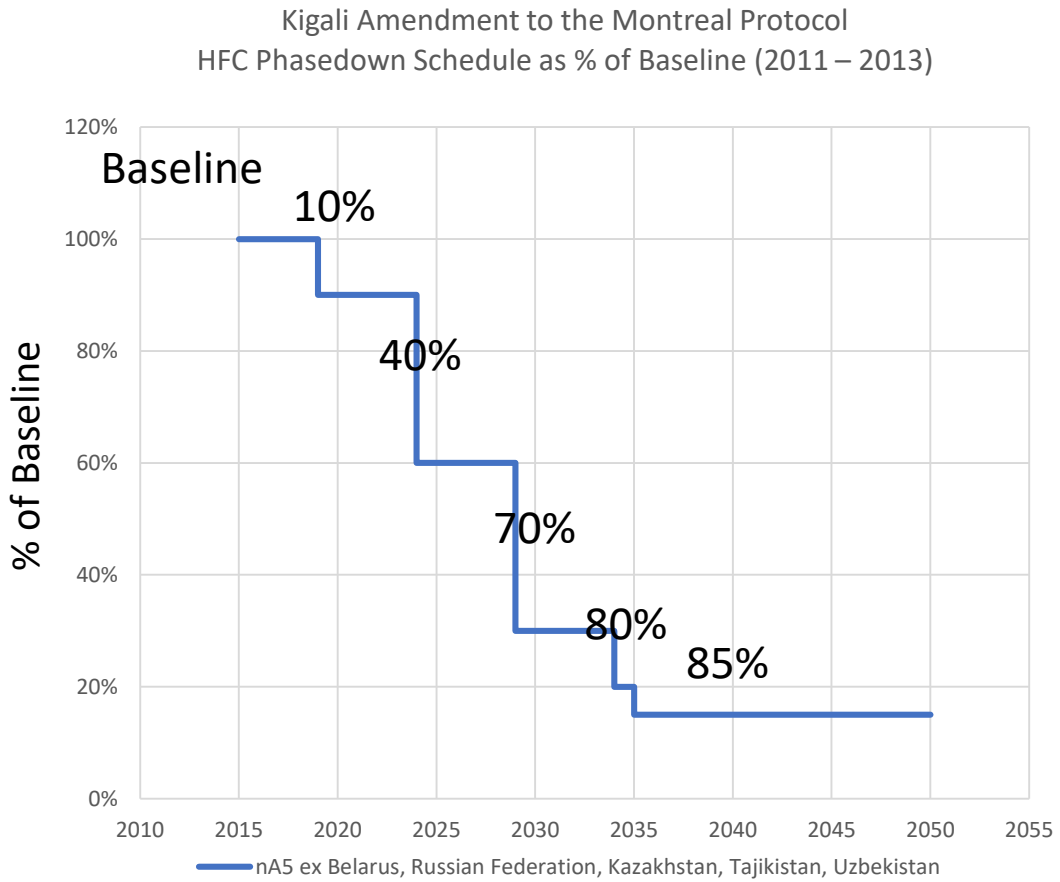
The Montreal Protocol Kigali HFC Amendment



- U.S. has not ratified the amendment
- The Federal Government is not phasing down HFC refrigerants
- Canada and Mexico have ratified the amendment
- States are taking action independently with some coordination through the Climate Alliance
- In 2017, California proposed transition dates:
  - Air-Conditioning: Jan 1, 2021
  - Commercial Refrigeration: Jan 1, 2022

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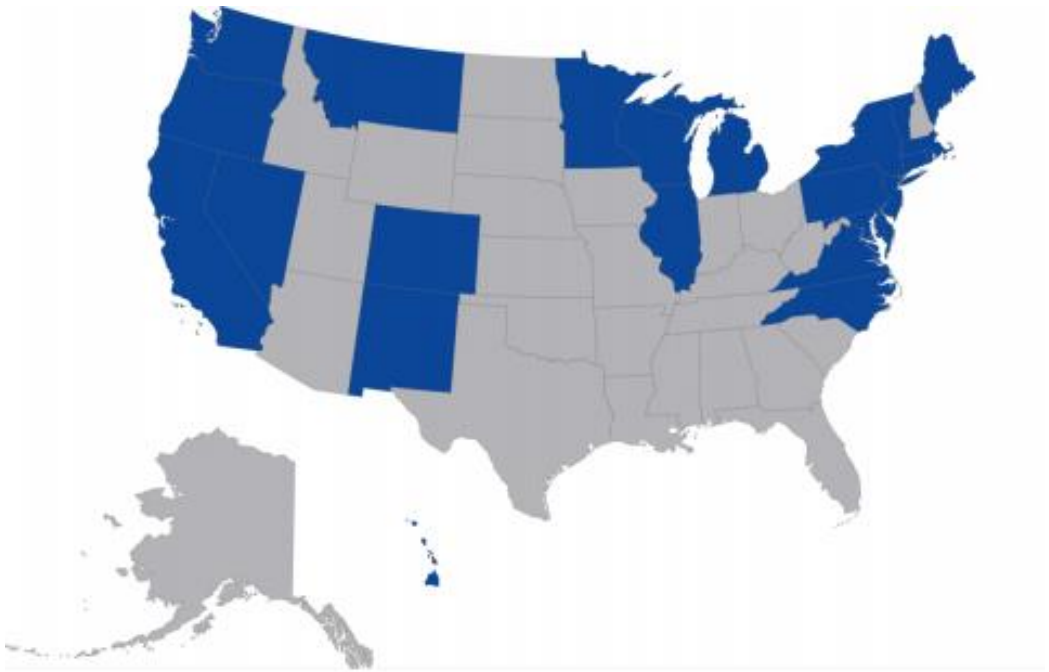
U.S. Climate Alliance: States Regulating Refrigerants

- August 4, 2017: U.S. submitted formal notice of withdrawal from Paris Climate Agreement withdrawing, at the earliest, Nov. 4, 2020



- United States Climate Alliance States commit to reduce emissions commensurate with U.S. commitment. 392 mayors also committed to the Paris Climate Agreement reductions

- 9 states have included HFCs in this effort

Bottom Line:

To date, 9 of the 25 climate alliance states are proposing regulating refrigerants

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California

- In 2017, the California Air Resources Board (CARB) proposed high global warming potential refrigerant bans*:
  - Air-Conditioning: Jan 1, 2021
  - Commercial Refrigeration: Jan 1, 2022
  - Chillers: Jan 1, 2024 (finalized)
- AHRI counterproposals:
  - Air-Conditioning: 2023
    - Safety Standards ASHRAE 15 (2019) and UL 60335-2-40 3rd edition (November 2019) have been published
    - Harmonize with new minimum energy efficiency standards going into effect in 2023
  - Commercial Refrigeration: Maintain a medium-GWP (seems to be rejected by CARB)
  - Commercial Refrigeration: 2024 low-GWP (no feedback from CARB to date)
    - The harmonized Canada / U.S. working group (CANENA) for commercial refrigeration safety standard started evaluation of IEC 60335-2-89 and initiated 2H 2019
    - ASHRAE 15 commercial refrigeration upgrades are starting soon

* Public Workshop on Rulemaking Proposal: High Global Warming Potential Refrigerant Emissions Reductions California Air Resources Board October 24, 2017

https://ww3.arb.ca.gov/cc/shortlived/meetings/10242017/public_workshop_snap-california_10-24-17_presentation.pdf?_ga=2.182187808.621576105.1573738237-276427812.1565094831

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Regulatory Policy "Writing on the Wall"

- Millions of dollars in research internationally and in U.S.
- Safety standards development internationally and in U.S.
- AHRI Safe Refrigerant Transition Task Force developing training resources for organizations that would like to use it
  - A2L refrigerant training programs already in place in Europe, Australia, and Japan; several companies are training in the U.S.
  - Several companies have already started training technicians in the U.S.

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Transition to Low-GWP Refrigerants

What's the same?

- The majority of the physical and chemical properties of these new Class A2L refrigerants are no different from traditional A1 (CFC, HCFC, and HFC) refrigerants

What's different?

- Low-GWP refrigerants include some lower flammability (Class A2L) and higher toxicity refrigerants

What do I need to do about it?

- Stakeholders must be aware of and properly trained in the mitigation of risks due to the lower flammability or higher toxicity properties associated with the new refrigerants

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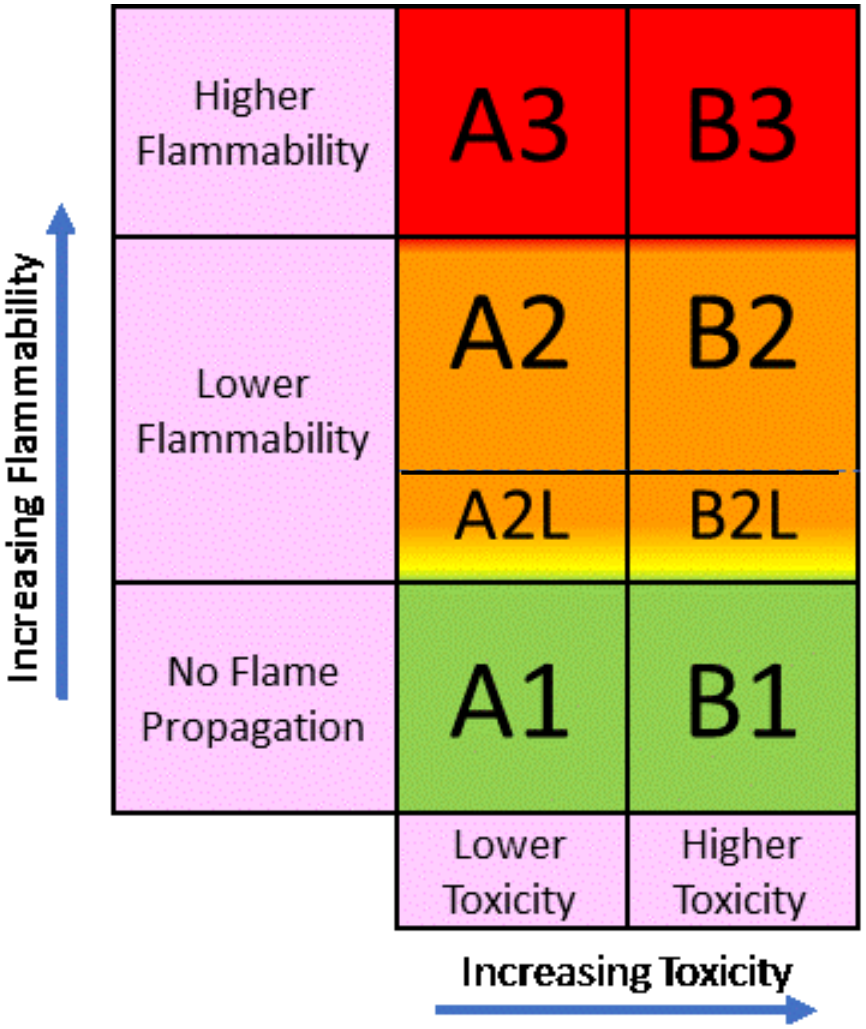
ASHRAE 34 and ISO 817 Refrigerant Classification



Class 3 Requirements

1. Exhibit flame propagation @ 60°C & 101.3 kPa
2. LFL ≤ 0.10 kg/m^3 or HOC ≥ 19,000 kJ/kg

Class 2 Requirements

1. Exhibit flame propagation @ 60°C & 101.3 kPa
2. LFL > 0.10 kg/m^3
3. HOC < 19,000 kJ/kg

Class 2L Requirements

1. Same as Class 2 requirements & $S_u \leq 10$ cm/s

Class 1 Requirements

1. No flame propagation @ 60°C & 101.3 kPa

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Refrigerant Concentration Limit (RCL)

- RCLs are used to determine the maximum concentration limit allowed in an occupied space of a refrigerant
- The RCL is based on either toxicity or flammability (lower flammability limit) or both

What's the same?

- RCLs are still used to determine allowed concentrations in occupied spaces
- Mitigation is required at a percentage of the RCL as determined by safety standards

What's different?

- R-410A has an RCL of 140,000 ppm
- Low-GWP replacements for air-conditioning have RCLs between 30,000 and 50,000 ppm

What do I need to know?

- Mitigation will be needed if 25% of LFL is reached
- Refrigerants with RCLs based on toxicity limits may required similar mitigation

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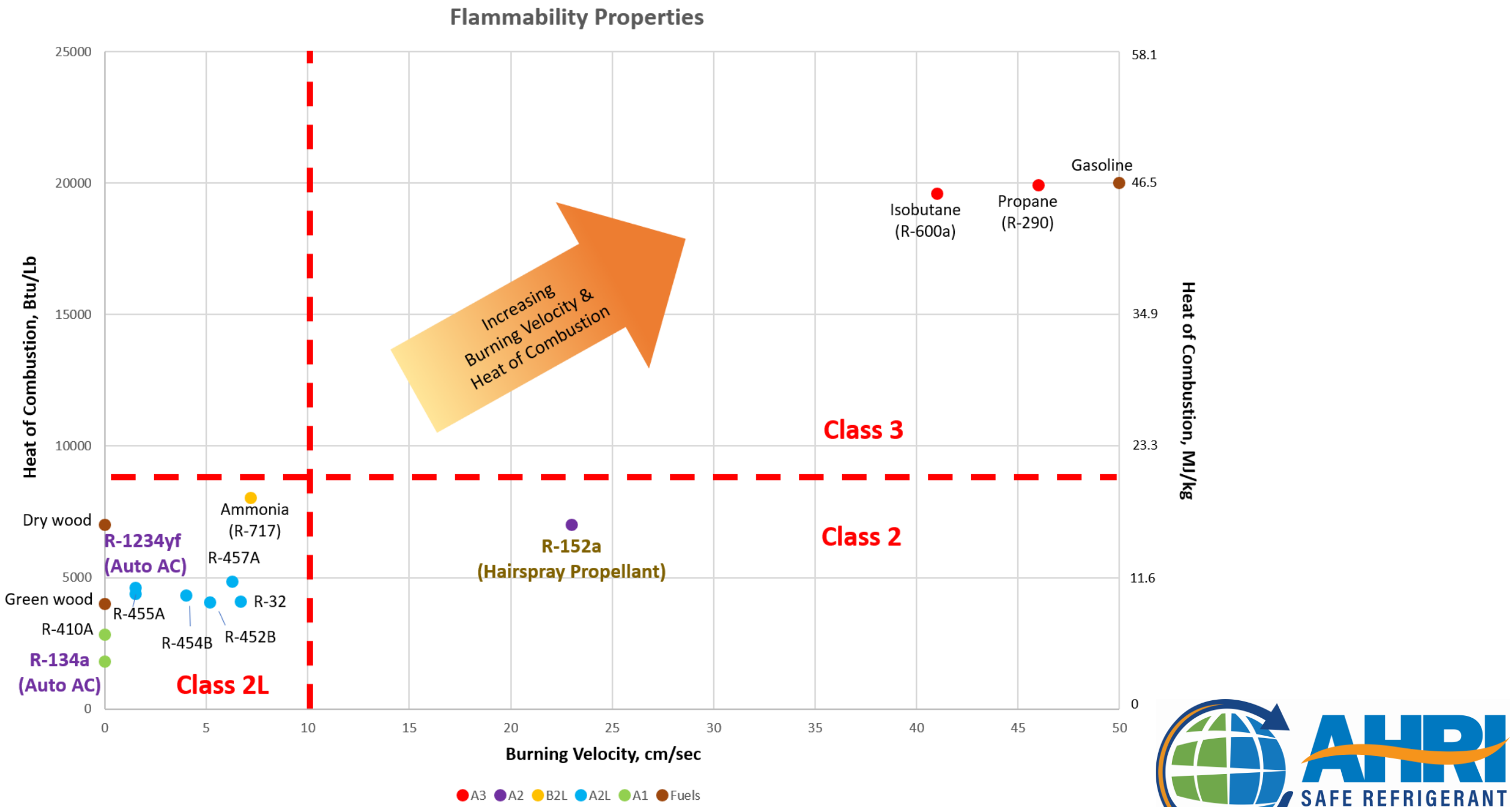

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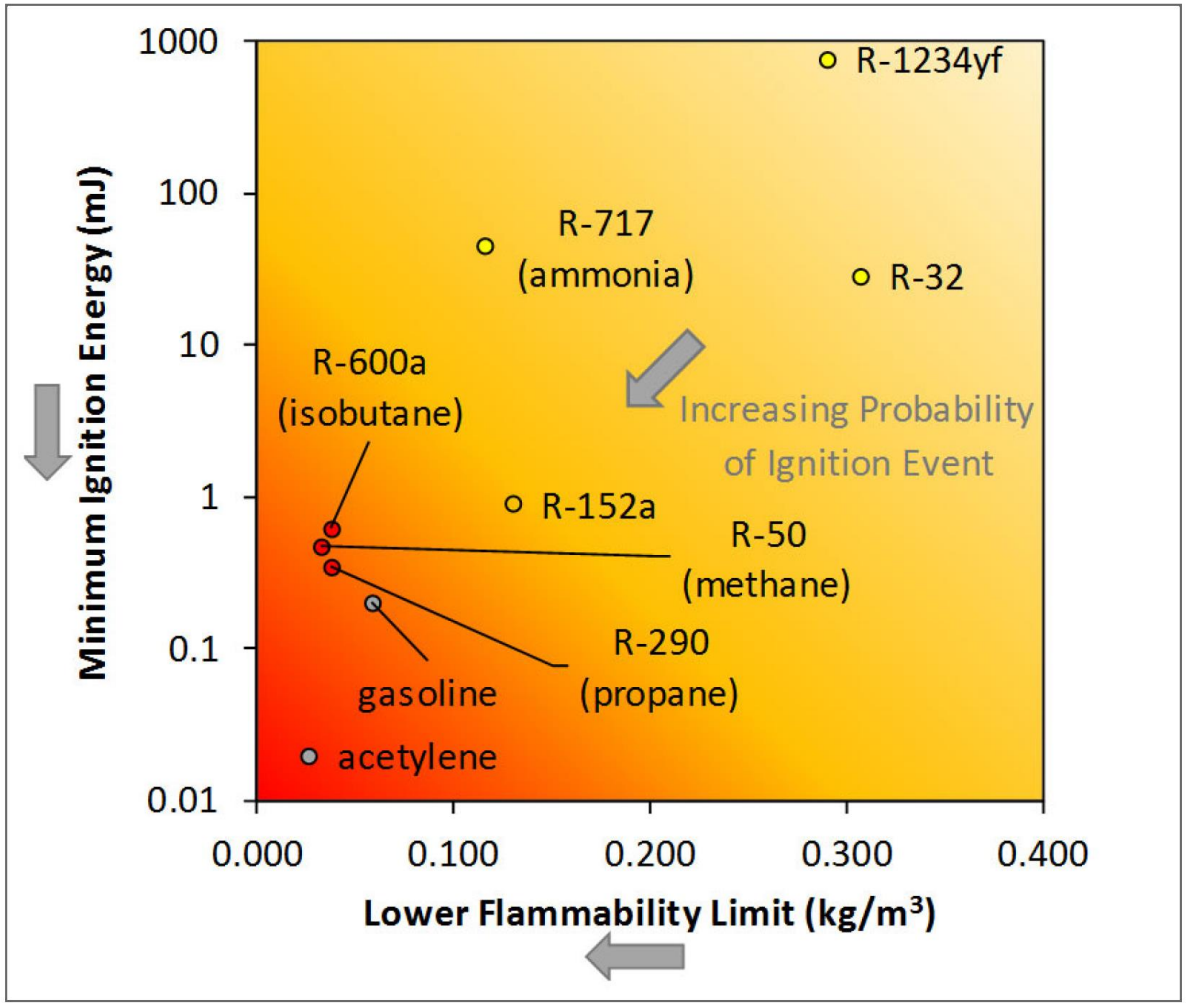
Flammability – Minimum Ignition Energy (MIE)



- Hydrocarbons require relatively low energy levels to ignite
- MIEs of A2Ls are much higher than hydrocarbons
- Many potential ignition sources for hydrocarbons (e.g., static spark) will not ignite A2Ls
- Many common household items (toasters, electric heaters, etc.) will not ignite A2Ls

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HF is a Decomposition Product of ALL Fluorocarbon Refrigerants

A1 and New A2L refrigerants and the generation of Hydrofluoric Acid (HF)

What's the same?

- HF forms when any fluorocarbon refrigerant, including those used today, undergoes combustion, partial combustion, or thermal decomposition
- HF is a skin and lung irritant

What's different?

- A2L refrigerants are classified as flammable at 60°C

What do I need to know?

- HF may be present after decomposition (e.g. due to a fire), so personal protective equipment should be worn by technicians and first responders regardless of refrigerant when there is potential for exposure

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Refrigerant Decomposition Products

- HF (hydrogen fluoride) can be formed when any fluorine containing refrigerant (even non-flammable) undergoes combustion, partial combustion, or thermal decomposition, i.e. exposed to open flames

HFC-134a: Complete Combustion Reaction

$$2CF_3CFH_2 + 3O_2 + 2H_2O \rightarrow 2CO_2 + 4HF$$

- COF_2 (carbonyl fluoride) is a short-lived, transient intermediate product, which if produced during combustion, reacts immediately with any moisture forming HF, thus minimal risk of direct exposure COF_2 exists

Safety data sheets for Class A1 and A2L refrigerants today call for firefighters to, "Wear full protective clothing and self-contained breathing apparatus."

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A1 vs A2L Equipment Involved in a Fire Has the Same Hazards

AC systems in buildings in an externally fueled fire (e.g. wildfire burning at 800°C to 1200°C or more)

What's the same?

There have already been combustion tests by NFPA and in Japan showing the similar outcomes for equipment containing A1 or A2L refrigerants involved in a fire

- All air-conditioning systems are required to have over-pressure protection for safety
  - Refrigerant and oil will be released into the atmosphere in a fire
- While not flammable at 60°C, even A1 refrigerants are combustible at these higher temperatures
  - R-410A (A1 which is 50% R-32) hot surface ignition temperature has been estimated at 790±10 °C
  - R-32 (classified as A2L) has been estimated at 764±10°C[6]
  - When 1% oil is added, as found in most AC systems, hot surface ignition temperatures are reduced by more than 120°C
  - The presence of oil in the refrigerant dominates the hot surface ignition temperature

What's different?

- If R-32 were to burn in a fire, a 15 lb. charge would add the fuel equivalent of 3.4 pounds more of dry firewood to the fire compared to R-410A
- Most homes would contain smaller charge sizes than 15 lbs.

What do I need to know?

- AC systems have pressure relief and will release refrigerant and oil in a fire

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Safety Standards Updated Based on Extensive Research

- More than a decade of research is available from testing for Japan and Europe
  - Nearly $7 million has been invested in the U.S. to understand low-GWP refrigerants
- Research informed conservative modifications to safety standards. For example:
  - Test results from AHRI research showed that a sensor trip time of 30 seconds was not fast enough for residential units, so a shorter period is required in the safety standard
  - The charge size for cord-connected equipment was reduced in the U.S. and Canada by 50%
  - Isolation valves are now required for VRF systems and refrigerant leaks
  - Refrigerant charge for A2 and A3 refrigerants in appliances was reduced to 114 g from 150 g approved by EPA compared to Europe which just approved 500 g
- Research also showed that the MIE of common household items like electric heaters do not ignite the A2L refrigerants
- Current research all over the world will support optimization for future products

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Extensive Research on Flammable Refrigerants

- Testing
  - AHRTI-9007: Benchmarking Risk by Whole Room Scale Leaks and Ignitions Testing
  - AHRTI-9013: A2L Consequence Study
  - AHRTI-9012/Oak Ridge National Laboratory (ORNL): Real-world Leak Assessments of Alternative Flammable Refrigerants
  - AHRTI-9008: Investigation of Hot surface Ignition Temperature (HSIT) for A2L Refrigerants
  - AHRI-8017: Investigation of Energy Produced by Potential Ignition Sources in Residential Application
- Modeling
  - 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
- Servicing
  - ASHRAE-1807:Guidelines for Flammable Refrigerant Handling, Transporting, Storing and Equipment Servicing, Installation and Dismantling
  - ASHRAE-1808: Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints
- Detection
  - AHRTI-9009: Leak Detection of A2L Refrigerants in HVACR Equipment

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Key Points About the Transition

- Most of the basic chemical/physical properties of next-generation refrigerants are very similar to previous generation (CFC/HCFC/HFC) refrigerants
- Many new refrigerants are blends which include refrigerants that are currently part of Class A1 refrigerant blends (e.g., R-410A is 50% R-32, a Class A2L refrigerant)
- Class A2L refrigerants are already being used safely
  - Global auto industry (including U.S. and Canada)
  - Air-conditioning and refrigeration equipment in the European Union, Australia, Japan, Thailand, and other countries
  - Small appliances, as approved by the EPA
- Flammable refrigerants will only be used in new systems/applications that are designed to mitigate risks, and where allowed by appropriate codes and standards
- Safety data sheet requirements for handling should be followed for all refrigerants
- A1 and A2L refrigerants:
  - Form HF
  - Low fuel load (heat of combustion) especially when mitigation measures are employed
  - Equipment containing a refrigerant involved in fire behave the same

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Summary of A2L Refrigerant Flammability

- Compared to propane and natural gas, A2L refrigerants have much lower flammability risk due to:
  - Higher Lower Flammability Limit – higher concentration to become flammable
  - Higher Minimum Ignition Energy – harder to ignite
  - Lower Heat of Combustion – less energy released if burned
  - Lower Burning Velocity – more difficult for flames to spread

LFL R-32 (A2L) = 14.4%
LFL Propane (A3) = 2.1%

- Compared to A1 refrigerants, A2Ls have slightly higher flammability properties but if burned, produce similar types and amounts of by-products (HF)
- Compared to A1 refrigerants, A2Ls have slightly higher heat of combustion/fuel value
- A2L's allow for use of much lower GWP refrigerants
- Flammability risks from A2L refrigerants will be mitigated by a variety of equipment design changes, applicable codes and standards, and training of installers and service technicians

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Safe Transition to Low GWP Refrigerants

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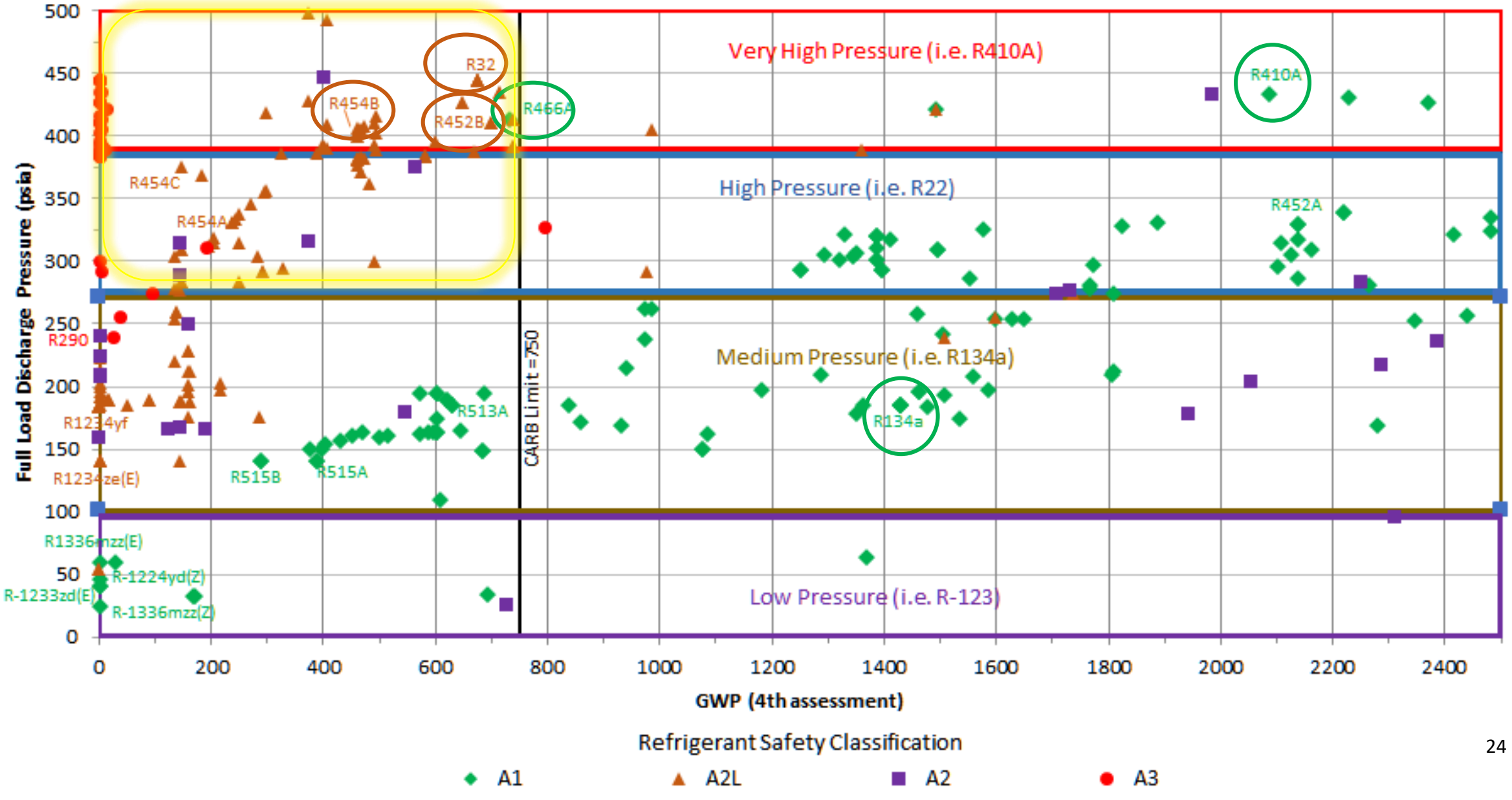
Future Refrigerant Options for Residential and Light Commercial



Refrigerant Safety Classifications

ASHRAE 34 and EN 378

Higher Flammability (explosive)	Ignites very easily Potentially Explosive		**A3** R-429A, R-430A, R-431A, R-435A, R-290 (Propane), Butane, Butene, Butyne,	**B3**
			High Flammability	
Low Flammability	Ignites Easily Relatively High Energy Release		**A2** R-152a, R-413A, R-439A, R-440A	**B2** R40 Methyl Chloride
			Flammable	
Lower Flammability	"Mildly Flammable" Difficult to Ignite Relatively Low Energy Release Low Flame Speed	 Low Grade Coal	**maximum burning velocity of ≤10 cm/sec** **A2L** R-1234yf, R-1234ze(E), R-32, R-452B, R-454B, R-454A	**New** **B2L** R717 (Amonnia)
			Lower Flammability	
No Flame Proprogation	No Ignition at ≤63 C but still may be flammable at higher temperatures and in building fires		**A1** R-22, R-410A, R-407C, R-404A, R-134a, R-448A, R-449A, R-513A, R-452A R-1233zd(E), R-448A, R-450A, R-466A	**B1** R-123, R-514A
			No Flame Proprogation	
			Lower Toxicity [OEL of 400 ppm or greater.]	400 ppm **Higher Toxicity** [OEL of less than 400 ppm.]

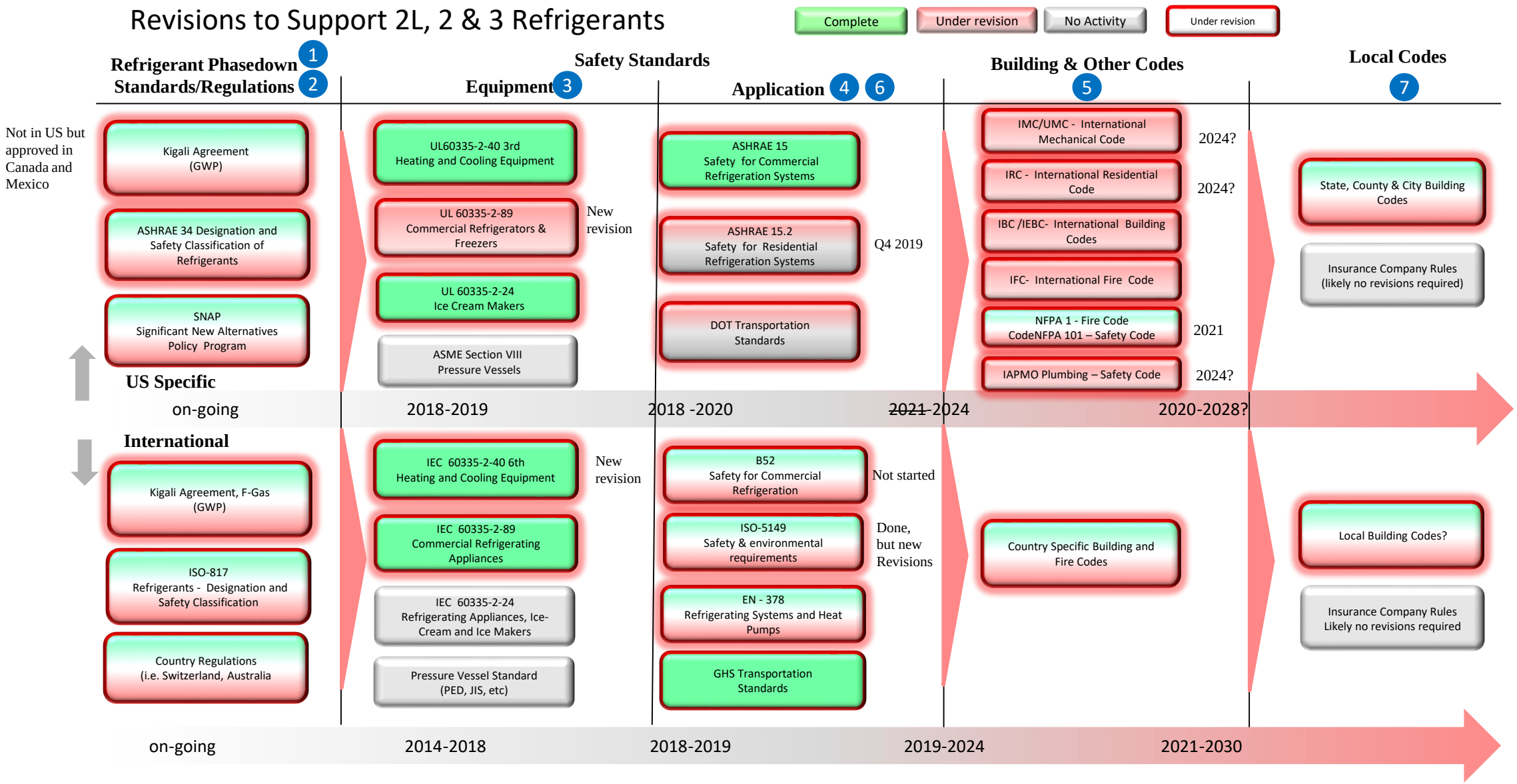
Burning Velocity and Heat of Combustion — Increase

Decreased RCL — Increase

Refrigerant Safety Classifications Properties

Refrigerant	Components Composition%	Safety Classification ASHRAE 34	Exposure Limit (RCL)	GWP (4th)	Operating Pressure @ 120 F SDT	LFL nominal composition	UFL nominal composition	Burning Velocity (Su)	Minimum Ignition Energy (MIE)	Heat of Combustion (HOC)	Auto Ignition Temperature (AIT)	Hot Surface Temperature (HOC)
			ppm	CO_2e	psia	% v/v	% v/v	cm/sec	mJ	KJg	°C	°C
R-410A	R-32/R-125 50/50	A1	140,000	2,088	433.6	-	-	-	-	5.91	>750	-
R-134a	1,1,1,2-tetrafluoroethane 10000%	A1	50,000	1,430	185.9	-	-	-	-	?	>750	-
R-404A	R-125/R-134a/R-143a 44/4/52	A1	126,000	3,922	325.8	-	-	-	-	?	<750	
R-466A	R-32/R-125/CF3I 49/11.5/39.5	A1	30,000	733	412.6	-	-	-	-	?	?	
R-513A	R-134a/R-1234yf 44/56	A1	72,000	629	184.98	-	-	-	-	?	?	
R-1234yf	2,3,3,3-tetrafluoropropene 100%	A2L	16,000*	0.31	185.0	6.20%	12.30%	1.5	8000	10.7	405	700
R-32	difuoroemethane 100%	A2L	36,000*	675	444.0	14.4%	29.30%	6.7	21-24	9.38	648	700
R-452B	R32/R125/R1234yf 67/7/26	A2L	30,000*	697	410.1	11.9%	21.60%	3.3	100-300	9.45	?	700
R-454B	R-32/R-1234yf 68.9/31.1	A2L	30,000*	465	405.5	11.8%	21.50%	5.2	100-300	10.3	?	700
R-152a	1,1 difluoroethane 100%	A2	12,000*	124	166.1	4.80%	8.0%	23	0.38	16.3	455	355
R-290	propane 100%	A3	5,300*	3.30	242.5	2.10%	9.5%	46	0.25	46.3	470	370

Global A2L Standards and Codes – Stationary Products



Equipment and Application Safety Standards

Considerable work has been underway on the revisions of UL60335-2-40 and ASHRAE 15 and both are completed and published

UL60335-2-40 3rd edition (approved)

- Standard developed based on IEC60335-2-40 6th edition and is a modification to the UL60335-2-40 2nd edition to **add A2L refrigerants**
- Standard went through two public reviews, extensive comments and modifications, and followed **ANSI procedures**
- Overall is **more conservative** than the IEC60335-2-40 6th edition source standard
- Standard is completed and approved in both the U.S. and Canada, and was published on Nov 1, 2019
- This standard will **replace UL 1995** on 1/1/2024 and is an overall equipment safety standard
- It is a complex standard covering **all safety for HVAC products** and not just A2L
- Standard training material and user guides are being developed

ASHRAE 15-2019 (approved)

- The ASHRAE 15 standard was updated for use with A2L refrigerants in **direct systems through addendum d** and for **machine rooms through addendum h** and these were published in September 2018
- The complete updated standard was republished as the 2019 version on 7/30/2019, along with an updated version of ASHRAE 34
- The standard also reflects the results of research and the **conservative approach** to insure the safe application of A2L refrigerants
- It requires products to be **listed (labeled),** which means approval to a standards like UL60335-2-40

ASHRAE 15.2 (proposed)

- This is a new standard aimed at developing a **simplified standard** based on UL60335-2-40 and ASHRAE 15 for **residential applications**
- This was done to **align with the IRC standard for residential applications**
- Some have stated that this standard needs to be completed to allow updates to the IRC which is incorrect and **everything in the proposed ASHRAE 15.2 standard is already covered by UL 60335-2-40 and ASHRAE 15,** and was only intended for future use as a **simplified residential safety standard**
- Standard has been in development for several years and is set to be **published in 2020**

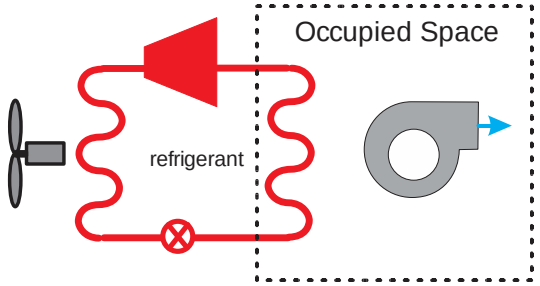
Safety Standard Safe Application of A2L Refrigerant Approach

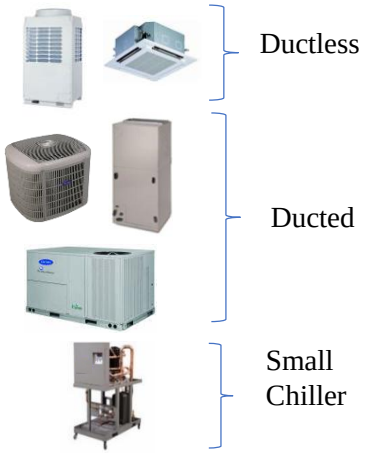
- There has been confusion concerning the safety standard and how they are intended to be used

- The overall approach involves the following for direct systems (residential and light commercial);
  0. Fundamental approach is to prevent ignition and combustion (baseline strategy)
  1. Control of competent ignition sources and isolation from flammable refrigerants
  2. Refrigerant charge limits (m1, m2, m3) combined with item 7
  3. Refrigerant piping design qualification and protection
  4. Labeling and literature
  5. Factory-installed UL60335-2-40 application approved refrigerant detectors in all units above m1 charge
  6. Active mitigation using circulation and dilution (not just an alarm like fire and smoke detectors)
  7. Minimum occupied area (A_{min}) checks combined with charge limits in item 2
  8. Service training and education and likely technician certification

Safety Standard Application Classifications

Direct System
Refrigerant can leak into the occupied space





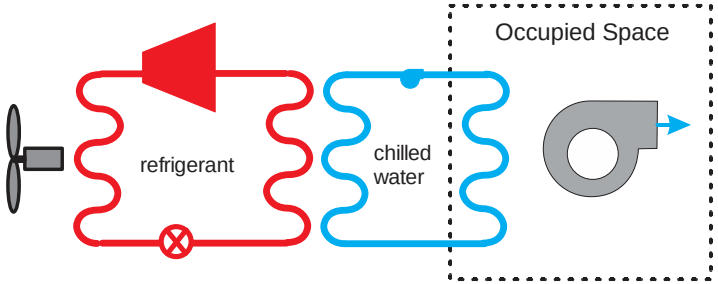
Ductless

Ducted

Small Chiller

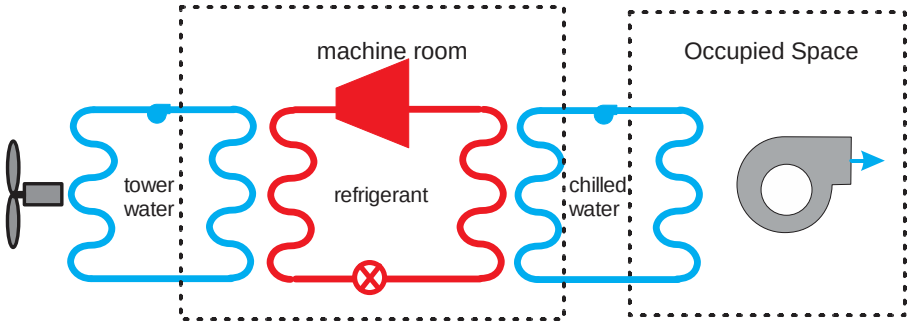
Indirect Systems

Refrigerant Leak Isolated by secondary loop



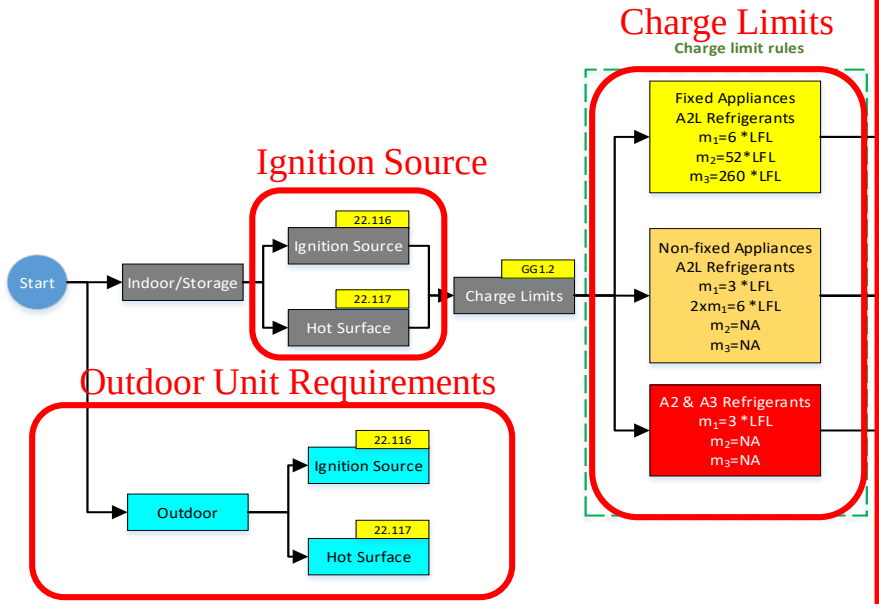
Outdoor

Equipment outdoors or in a machine room



Indoor

UL60335-2-40 3rd Edition Flammable Refrigerant Requirements

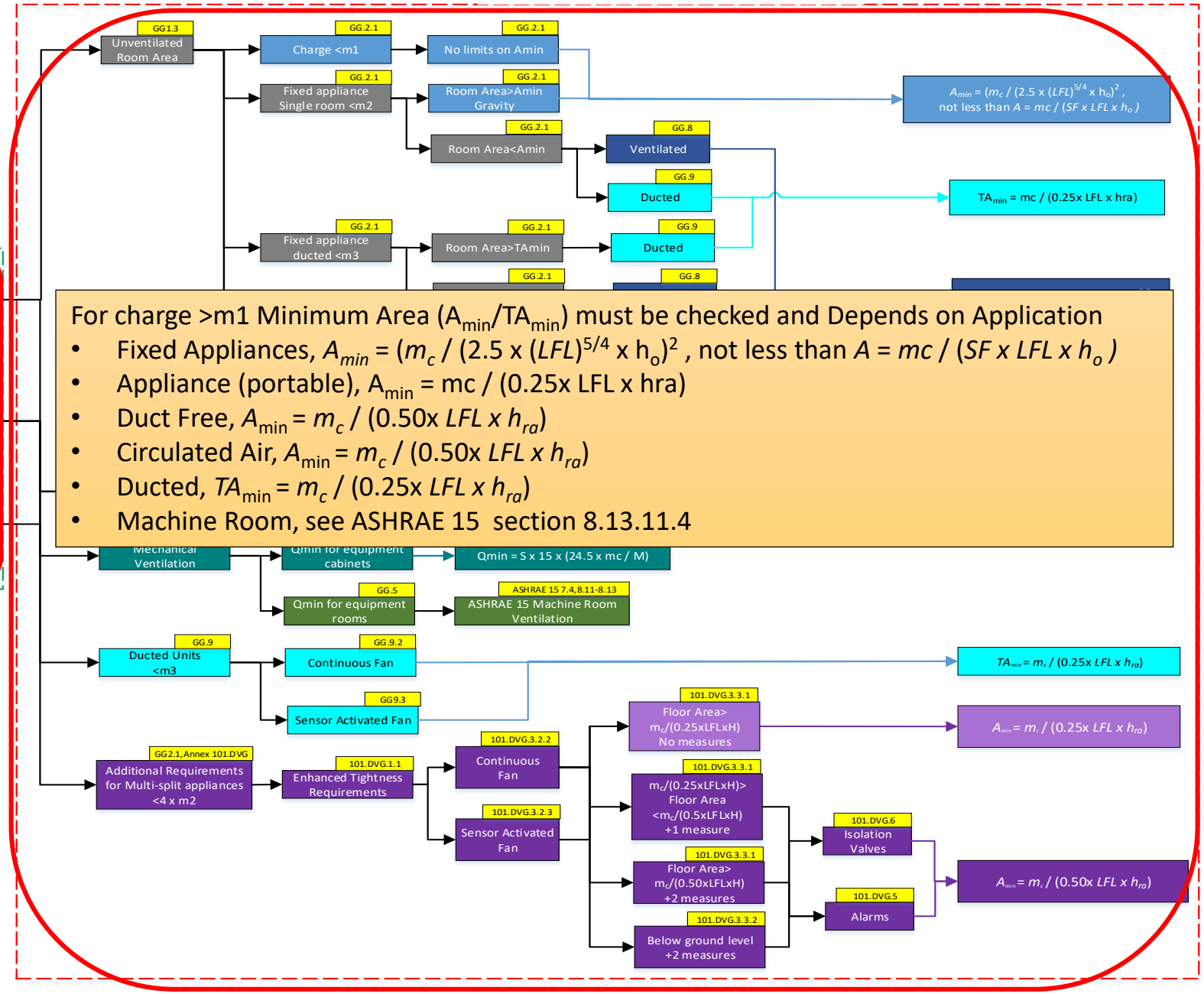


Requirements Summary

1. Ignition Source Control
2. Maximum Charge Limits per circuit
3. Minimum floor area for dilution based on air delivery approach and product

This is a flow chart of the requirements in UL60335-2-40 and is part of a 1st Draft Users Guide Developed by Carrier

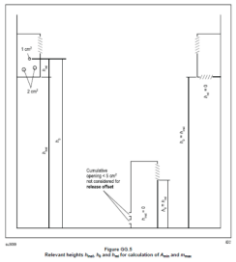
Room Area Check for Dilution



Safe Application of A2L Refrigerants Summary

UL60335-2-40 3rd Edition Summary for a **Residential Ducted Unit (Direct System)** A2L Refrigerant Requirements

Minimum Area Check (A_{min})
- Safety factor of 4
- Or safety factor of 2 with additional measures
- Per Annex GG



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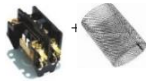
Service Training
and Education Annex DD, Annex HH

8

Ignition Source Isolation
Per UL 60335-2-40
Annex FF

1



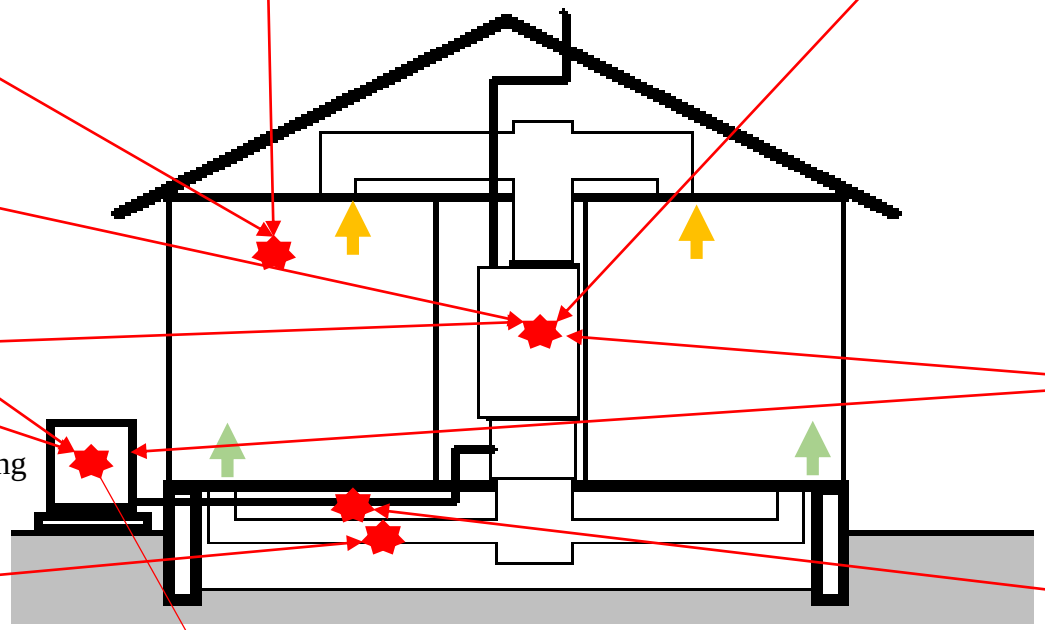
No Competent Ignition
Sources in unit and ducts
Per 22.116, Annex KK, 22,117

1

6

Active mitigation for leaks
detect, circulate an dilute
Annex GG

Residential Down Flow
Air Conditioners with Gas Heat



2

Refrigerant Charge Limits (UL60335-2-40)
m1, m2, m3 per Annex GG1.2
R-32 m1=4.1 lbs., m2=26.8 lbs., m3=134.1 lbs.
R-454B m1= 4.0 lbs., m2= 26.0, m3=130.2 lbs.

5

Factory Installed Refrigerant Detector
- UL60335-2-40, IEC60079-29-1 and Annex LL, Annex MM
- UL qualification testing
- UL approved
- Safety Circuit approved
- Factory Calibrated
- Self Test Routine (one time/hr.)
- Fail safe mode with fan on
- Field inspection enable feature

4

Labeling and Literature
Per UL60335-2-40
Per 101, Annex DD

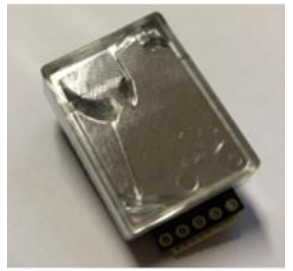
3

Refrigerant Piping (UL60335-2-40)
Per 22.116, 101.DVG
- Protected lines
- Qualified joints (ISO 14903)
- Field pressure test
- Additional requirements for VRF

Refrigerant Sensors/Detectors

- There has been confusion about listed sensor availability

- UL60335-2-40 as well as ASHRAE 15 have developed new comprehensive requirements for sensors and detectors which require new qualification and certification to UL60335-2-40, but the basic sensor technology is the same as used for machine rooms and other industrial applications, and are being used in Japan and Europe
  - The **sensor technologies** are the same as used to measure refrigerants in machine rooms and other gases like CO in homes
  - **Detector** is the new hardware containing the logic and controls that have been developed and defined as part of the new UL60335-2-40 requirements



Refrigerant Sensor

Refrigerant Detector

- Key features of the detector package are;
  1. Detectors must be **factory installed** on all direct system units with a charge above m_1
  2. Unlike a smoke detector that sounds a passive alarm, the UL60335-2-40 standard requires detectors to have **active mitigation** by turning on the indoor fans, to mitigate refrigerant leaks via dilution and in some cases, ventilation
  3. The standard requires, at a minimum, an **indicating sensor/detector** that detects refrigerant and takes action, but do not have to have readouts and alarms
  4. The detector and mitigation will be **inspected and tested** per the requirements of, IEC60079-29-1, as modified by annex LL and annex MM for HVAC applications (IEC60079-29-1 is mine safety standard that is referenced by UL60335-2-40)
  5. Refrigerant-specific setpoint is **factory set and sealed**, with no field adjustment permitted, but internal calibration software routines are allowed
  6. Setpoint, location, and response time are **validated by UL60335-2-40 testing per annex MM**

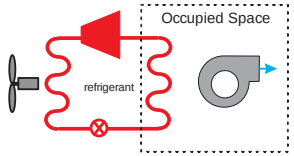
Refrigerant Sensors/Detectors

Key features of the detector systems (continued):

7. Must **respond in 10 seconds** when exposed to 100% of LFL
8. **Self-test protocols** are requested that run every hour to ensure proper operation and function
9. Detector software and fan system are considered part of a **Protective Electronic Circuit** and will be evaluated as a safety circuit, as part of the listing of the equipment per UL60335-2-40
10. In the event of **detector failure, indoor fan activates** and maintains a required airflow to prevent flammable concentrations forming if initiated. As noted earlier, once there is airflow, it is not possible to get to a flammable concentration level. This fail-safe mode is maintained until the detector is replaced
11. Routine factory inspections will be conducted by UL as part of the listing requirements
12. Detector **markings identify the manufacturer and refrigerants used**
13. **Testing is required** to determine sensor/detector accuracy vibration, range, setpoint verification, and response time
14. Sensors and detectors must pass **long term durability, stability and reliability requirements**
15. **Poisoning test exposure** required for common fluids, as defined in UL60335-2-40 annex LL, seen in buildings
16. If the detector has a **defined life** and requires replacement after a given period, the detection system shall initiate an alarm or indication that replacement is required

It is **3 years** before new UL60335-2-40 detectors will be needed but field trials and qualification are already underway by manufacturers

A2L Refrigerant Requirements - Direct Systems



Product and Application Requirements (UL60335-2-40/CSA 22.2, ASHRAE 15.2, ASHRAE 15, B52, EPA)

Application
Refrigerant Charge
Limits/circuit

A3 limits to 114 g (m1)

Limit	Equation	R--32	R-452B
<m1	=3 or 6*LFL	2 or 4.1lb	2 or 4.0 lbs
<m2	=52*LFL	35.1 lb	34.7 lbs
<2 x m2	=104*LFL	70.1	69.5 lbs
>m3	=260*LFL	175.4	173.7 lbs

All Systems → No sensor requirements or area check, but other requirements still apply

Appliances → $A_{min} = (mc / (2.5 \times (LFL)5/4 \times ho)^2$, not less than $A = mc / (SF \times LFL \times ho)$

Ductless → $A_{min} = m_c/(0.25 \times LFL \times h_o)$

Ductless<35kW Multisplit → *sensor and* $A_{min} = m_c/(0.50 \times LFL \times h_{ra})$

Ducted → *sensor and* $TA_{min} = m_c/(0.25 \times LFL \times H)$

Ducted/Ductless → Sensor External Mechanical ventilation

Check A_{min}
Validation Testing
Labeling of h_o
Room connection

(New Cylinder colors AHRI Guideline N and AHRI Guideline G for fittings left hand threads for flammable)

New Reclaim LH Threads

Refrigerant detector above m1 for ducted and circulation m2 or <Amin VRF in unit

Indoor airflow verification for electric heat (only if no refrigerant detector)

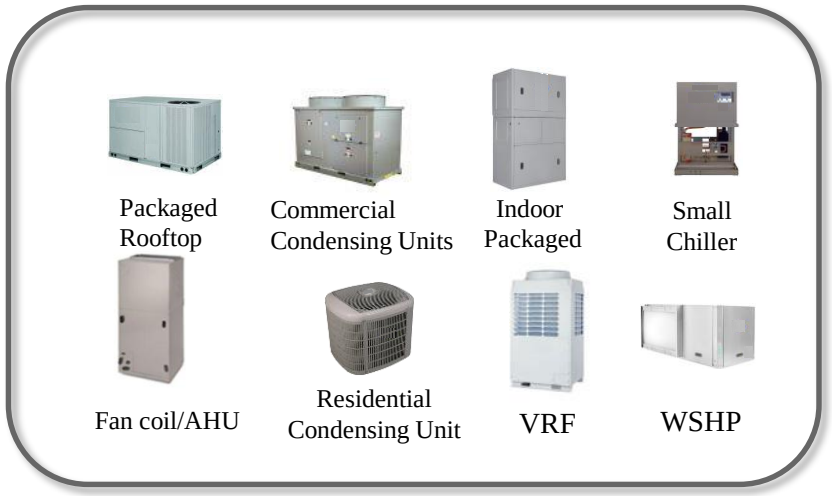
Hot surface limit of <700 C Except for heat with sensor or airflow verification

Tubing protection for exposed piping greater than 6.6 ft.

Red pantone service port (EPA Requirement)

Field Piping Design, (joints, protection) & Pressure proof test

Direct System Product Type

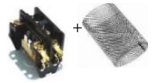


Laboratory Upgrades (Manufacturers and Certification)

Production Processes

Warehouse and Shipping (DOT/GHS)

Safety / circulation control and unit interlock (UL Safety Circuit)



Ignition Source Flame arrestors or control box qualification

New Warming labels on units and packaging

Amin, h_o and charge tracking on unit nameplate

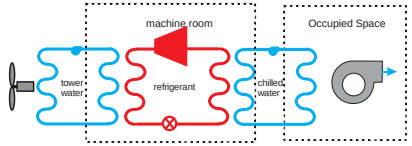
Isolation valves for multiple evaporator systems (VRF)
Also additional requirements options per 101 DVG.2

Relief valves vented outdoors

New service requirements and procedures

Training, Literature and Technician Certification? (Nate, HRAI, ACCA)

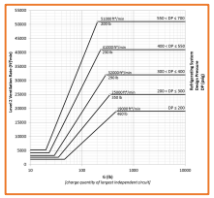
A2L Requirements Indoor Indirect Systems



Product and Application Requirements (UL60335-2-40/CSA 22.2, ASHRAE 15, B52, EPA)

Revised/Increased machine Room Ventilation as a function of charge

ASHRAE 15-2019



ASHRAE 15 addendum h increased ventilation as a function of charge

Safety / ventilation control interface and Inspection

Machine room requirements access controls, alarms, ventilation

Refrigerant sensor (already required for A1)

Hot surface limit of <700 C

New Warming labels on units and packaging

Flame arrestors or control box qualification for units and machine room

Machine Room Indoor Indirect Product Types

Routine inspection & Leak checking, CARB EPA Rule 608 >50 lbs.

Laboratory Upgrades

LH Threads

New

Reclaim

(New Cylinder colors AHRI Guideline N and AHRI Guideline G for fittings left hand threads for flammable)

Red pantone service port (EPA Requirement)

No open flame combustion

Machine Room Electrical Protection

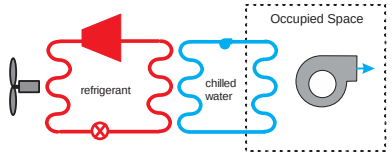
Relief valves vented outdoors And refrigerant relief on waterside

Production Processes

New service requirements and procedures

Training and Literature Machine Room Guidelines (NATE, HRAI)

A2L Requirements Outdoor Indirect Systems



Likely Product Impacts (UL60335-2-40/CSA 22.2, ASHRAE 15, B52, EPA)

No charge limits

(New Cylinder colors AHRI Guideline N and AHRI Guideline G for fittings left hand threads for flammable)

New Reclaim

LH Threads

No ventilation requirements

Refrigerant sensor (not required)

Hot surface limit of <700 C

New Warming labels on units and packaging

refrigerant relief sizing for waterside to be able to handle refrigerant

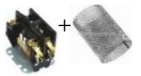
Outdoor Indirect Systems

Routine Inspection & Leak checking Section 608 and CARB

Laboratory Upgrades

Located 20 ft from building intake (ASHRAE 15)

Red pantone service port (EPA Requirement)



Flame arrestors or control box qualification for units

Production Processes

New service requirements and procedures

Training and Literature & Machine Room Guidelines (NATE, ACCA, HRAI)

Service Training

- There has been confusion about service training availability.
- **UL 60335-2-40 includes a new annex DD** outlines requirements for servicing and service training for use of A2L refrigerants.
- **UL60335-2-40 includes another new annex HH** defining requirements for competent service personnel.
- Contrary to the confusion, a local installer and AHJ **does not have to buy** and understand UL60335-2-40, because the standard requires that the **service and installation instructions for the product include the requirements of Annex DD,** so they will be provided with the product. Annex DD is an outline of the requirements.
- **Service training exists and the NATE exam** was developed over a year ago but was **placed on hold in the U.S. as service firms indicated they were not ready to start training -** first likely installations were to be in 1/1/2023 and that was four years away. Instead NATE moved their focus to Europe and developing countries that were ready to be trained and beginning to use A2L and A3 refrigerants.
- **Globally the industry has developed significant training material** in Europe, Japan, Australia, and Canada; more is in process, including work by the AHRI Safe Transition Task Force.
- **Manufacturers are also updating their training programs** for both in-person, hands on training and for on-line training classes.
- **Target audiences include**: First responders, installers, service technicians, certification/licensing groups, AHJ's/code officials, property owners, engineers/architects/builders, wholesale distributors, industry organizations and shipping firms.

Bottom line: Service training is well underway and has been started earlier than prior refrigerant regulatory-induced changes (i.e. R22 to R-410A in 2010).

UL60335-2-40 DD.9 Servicing Refrigerant System Summary - Example

Safety training is a key issue. Requirements have been included in the 3rd Edition and are needed for new installation instruction. The following is an example showing the revisions for the servicing of A2L and A2/A3 refrigerants:

Requirement	A1	A2L	A2&A3	Comment
Safely Remove Refrigerant following local and national codes	Required	Required	Required	EPA Rule 608, which requires recovery except for Natural refrigerants
Purge Circuit with Inert gas (i.e. oxygen free nitrogen)	Not required	**Required**	Required	Repeat as necessary
Evacuate	Not required	**Required**	Required	Insure outlet of pump is not near an ignition source
Purge with Inert Gas for 5 min	Not required	Optional	Required	Second purge
Evacuate again	Not required	Optional	Required	Included in Annex HH
Open the circuit by cutting or brazing	Final step	Final step	Final step	Final repair preparation. Should also state not to leave the system open for long periods
Repair the systems and for brazing purge with nitrogen during brazing	Required	Required	Required	Included in Annex HH
Leak Test and Pressure Test the unit	Not required	**Required**	Required	Part of DD.10
Evacuate the system	required	required	required	Follow industry practices for evacuation
Charge the system (See DD.10)	required	required	required	See DD-10 and mfg. charging procedures

Summary

- World is transitioning to low-GWP refrigerants, including A2L mildly flammable refrigerants.
- 9 U.S. states and Canada are actively pursuing the phasedown of HFC refrigerants, with California considering proposals for actions, starting as early as 2022 (commercial refrigeration).
- AHRI Safe Refrigerant Transition Task Force is actively working to provide training and other resources to help ensure a safe transition to A2L refrigerants in North America.
- A1 and A2L refrigerants have similar outcomes if equipment is involved in a fire.
- Extensive research on A2L flammability has been conducted since 2006.
- Results of this research has now been incorporated into approved standards: UL 60335-2-40, 3rd Edition and ASHRAE 15.
- Service training materials are already in place in regions/countries outside of the U.S. where A2L refrigerants are already in active use.

Additional Information

Task Group	Description
0	Overall Task Force
1	Installation Operation and Maintenance
2	Codes and Standards * Codes and Standard for AC * Codes and Standards for Commercial * Refrigeration/Transport * Equipment Design
3	Bulb Storage/Manufacturing Facilities
4	DOT, Shipping/Packaging and Handling/Warehouse
5	Recovery, Reclaim, and Destruction
6	Communications * Interaction with Energy Efficiency * Public Documents * Website
7	Safety Training * Technical Training * First Responders Training * Building code inspectors (AHJ) * Others

- AHRI Safe Refrigerant Transition Task Force has 7 working groups open to volunteers
- Task force is working on communications, training materials and information related to the new regulations and safe use of flammable refrigerants
- Visit www.ahrinet.org/SafeRefrigerant for more information

AHRI SAFE REFRIGERANT TRANSITION TASK FORCE

Thank You for Joining Us!

- Visit the Safe Refrigerant Transition Task Force page - in the Policy section of the AHRI website - for more information: http://www.ahrinet.org/SafeRefrigerant

- Note the Terms of Use referenced in this presentation, listed under Resources: http://www.ahrinet.org/App_Content/ahri/files/Resources/AHRI_Safe_Transition_Terms_of_Use.pdf

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