

# The Global Refrigerant Changeover: Progress and Issues



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President & CEO

# For Discussion Today

- Kigali Amendment – Where we stand in the U.S.
- Safety – What our research is showing
- Global state of safety standards
- Additional challenges and opportunities

# AHRI is a Trade Association



319:

**Member Companies:** Over 95% of all HVACR products manufactured and installed in North America; more than 70% of global products



102:

**AHRI standards and guidelines** in use across the globe



44:

**AHRI Certification Programs:** Nearly 900 participants representing over 70% of all HVACR products manufactured globally

# AHRI Members Manufacture:



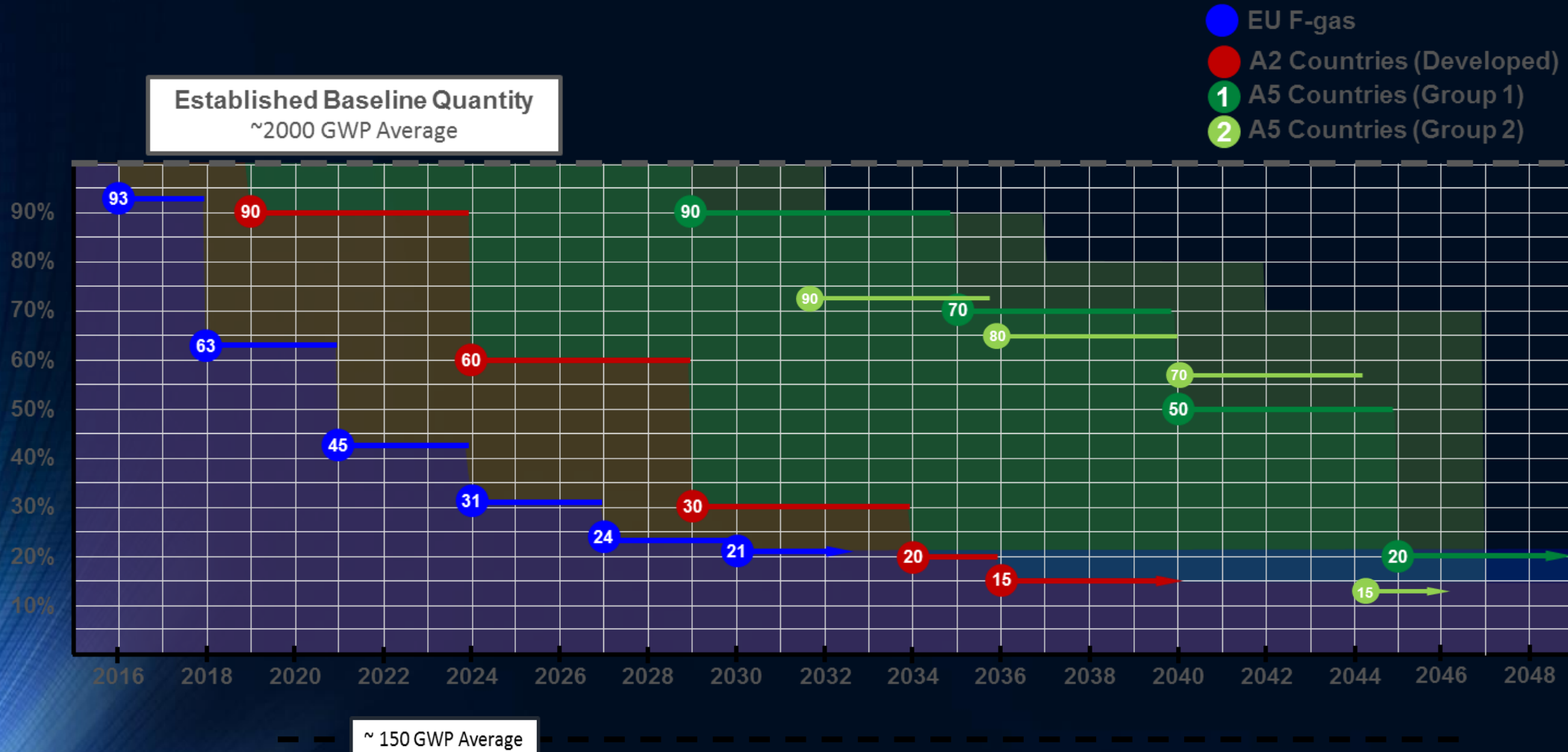
- Residential and commercial central air conditioners, heat pumps, and components
- Residential and commercial furnaces, boilers, and components
- Residential and commercial water heaters and components
- Commercial refrigeration equipment and components



# Big Changes are Underway

- High-GWP refrigerants are being phased down globally
- Drivers:
  - Montreal Protocol – Kigali Amendment
  - Europe - F-gas regulations
  - U.S. – EPA, California
  - Canada
  - Japan
  - Australia

# Montreal Protocol - Kigali Amendment



Recently Ratified Kigali Amendment – Transition to Start in U.S. in 2019

Source: Steve Kujak, ngd@solr.com



# Kigali Amendment: Current U.S. Status

- Treaty is under consideration by the White House
- Process is:
  - President submits to U.S. Senate and requests ratification
  - Senate must approve by two-thirds majority (67 votes)
  - Treaty goes into effect
- AHRI and others are talking with White House, agency staff, and Senators about why industry supports the amendment
- Industry continues to move forward toward implementation

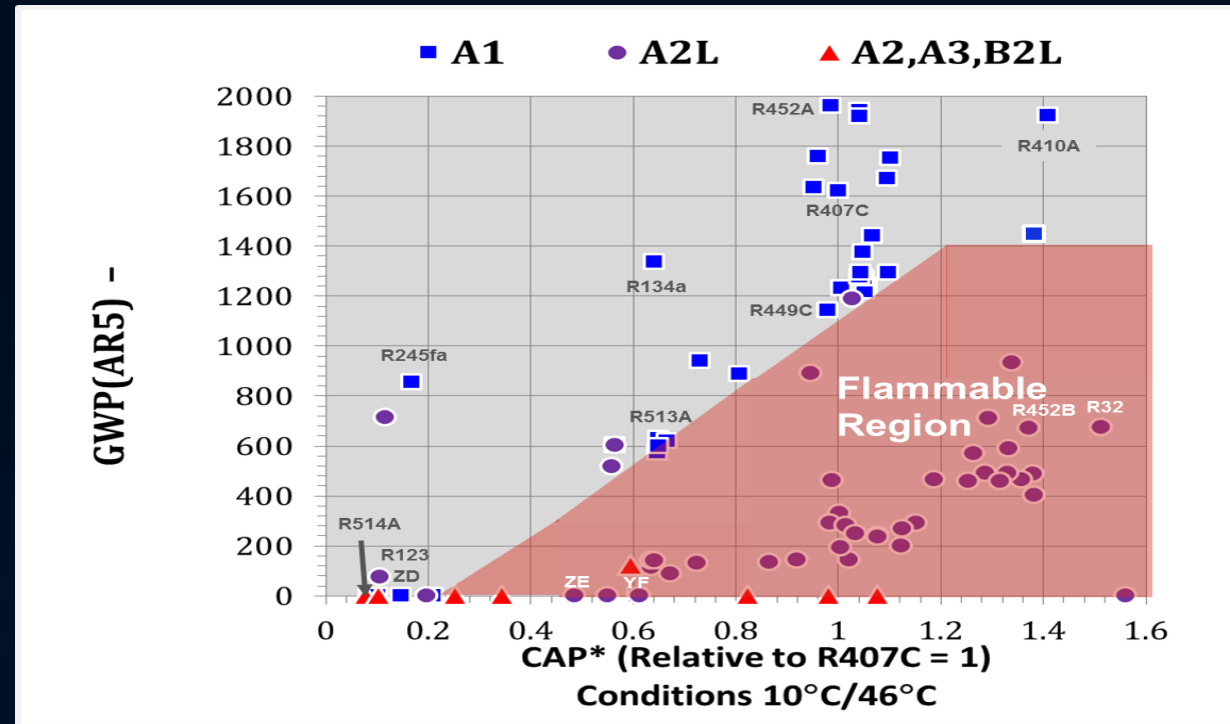
# What Happens Until Treaty is Ratified?

- Industry continues to prepare for HFC phase down, but:
  - ▣ Some states are enacting their own restrictions





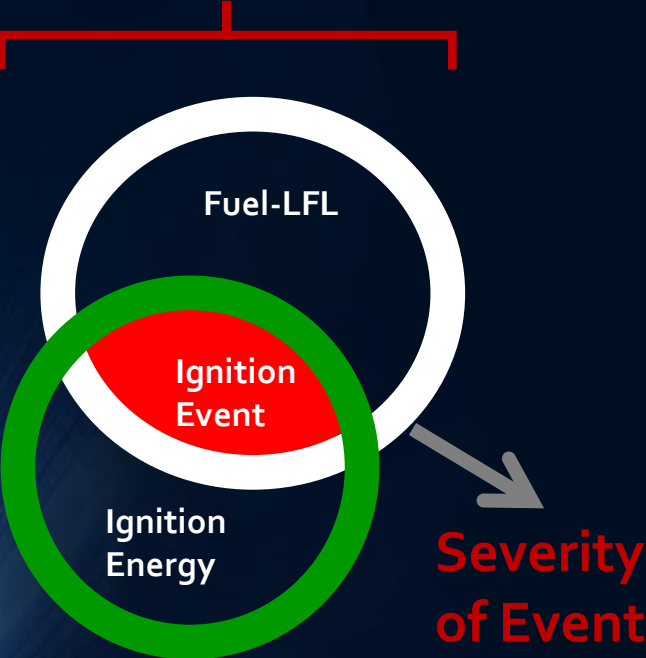
# Flammability - Next Generation Low-GWP Alternatives



Low Pressure – Ultra Low (<10 GWP) Non-Flammables Available  
Medium Pressure – ~300-600 GWP Non-Flammable Limit  
High Pressure – ~1400 GWP Non-Flammable Limit

# Flammability Risks and Impacts

Probability of Event



Severity of Event

Risk = Likelihood & Severity							
?Likelihood?	Frequently	10 <sup>-2</sup>					
	Occasionally	10 <sup>-3</sup>					
	Rare	10 <sup>-4</sup>	Always				
	Usually not	10 <sup>-5</sup>	Acceptable				
	Very Difficult	10 <sup>-6</sup>					
	Extremely Difficult	10 <sup>-7</sup>					
	Near Zero	10 <sup>-8</sup>					
<div>Probability of Event</div>			0	I	II	III	IV
			No Damage	Minor Damage (smoke, small localized events)	Light Damage (Fire from product, minor pressure rise, light injury)	Major Damage (fire and human injury)	Lethal Damage (permanent injury, death, burn down house)
			?Severity?				

Flammability is a Continuum and Not Specific Limits "Flammable is Flammable"

# Identifying and Addressing Refrigerant Flammability Risks



**Flammability Risks : A Cradle-to-Grave Understanding Needed**

# Safety – What Our Research is Showing Us

- First phase of flammability research is in final stages
- Greater understanding of event severity and ignition likelihood
- Still need to understand mitigation risks and impacts



# AHRI Flammability Research



- Whole room scale leak and ignition testing (AHRTI-9007-01)
- Potential ignition sources evaluation (AHRI-8017)
- Hot surface ignition temperature testing (AHRTI-9008)

Reports available at: <http://ahrinet.org/arep.aspx>





# Whole Room Scale Testing-AHRTI Project 9007

- Conduct refrigerant leak and ignition testing under whole room conditions:
  - Understand the risk relative to A1 refrigerants while considering ambient conditions and lubricant
  - Investigate control limits and safety factors that are proposed/defined by relevant safety standards
  - Determine main effects that affect the severity of refrigerant thermal events
- Testing on A2Ls is completed, and testing on A3 refrigerant R290 is ongoing

# Whole Room Scale Testing: Findings

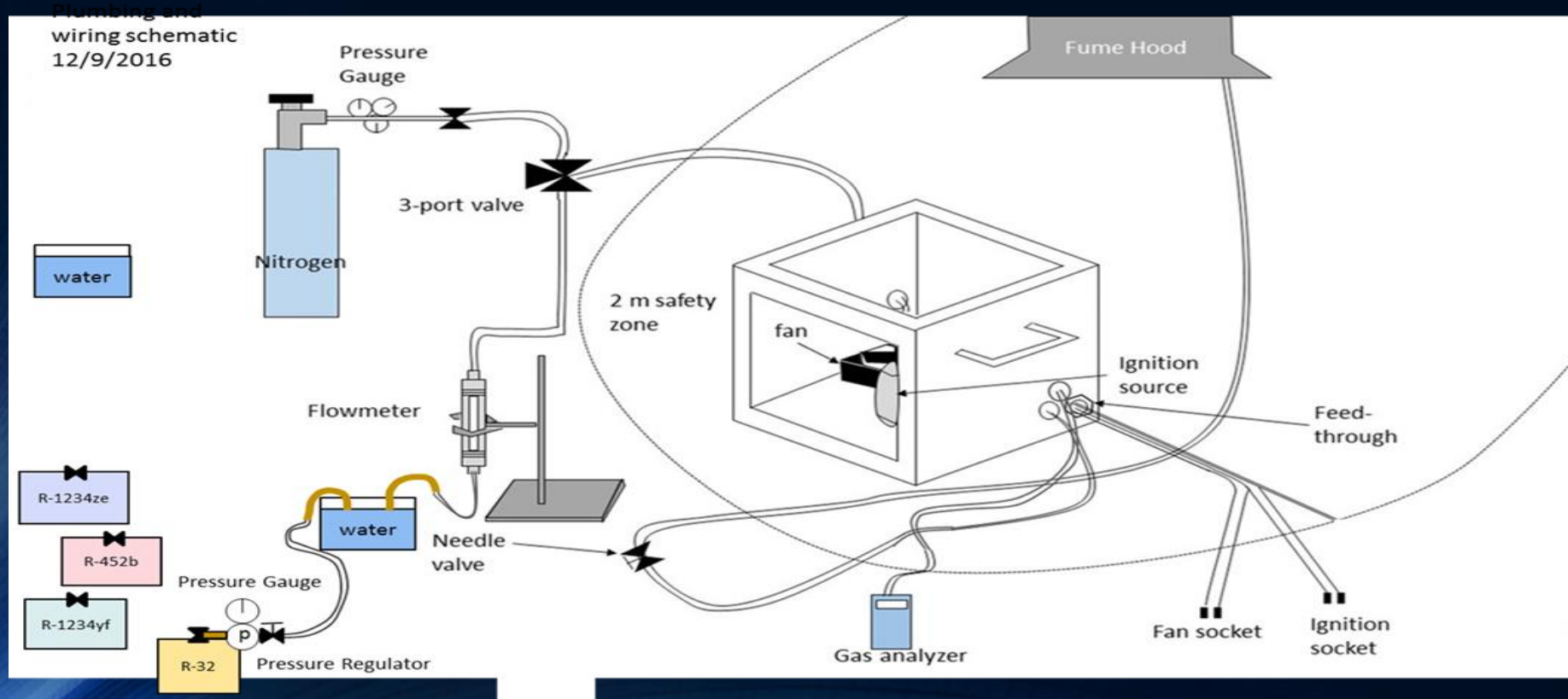
- Studied severity, rather than probability, of an ignition event
  - Some ignition tests represented extremely unlikely worst case scenarios
  - Small statistical sample sizes should discourage broad conclusions
- Future work:
  - Characterize refrigerant leak scenarios with actual equipment in “on” and “off” states
  - Real world ignition sources in terms of ignition energy, quantity, spatial location throughout the room, and activation frequency

# Whole Room Scale Testing: Findings

- Lubricant, room temperature, and humidity had no effect or reduced event severity
- High charge, high leak rate, low release height, and obstructions increase event severity
- No major differences between R-452B and R-32. But R-457A reacted more quickly than R-455A
- For certain equipment such as reach-in coolers, charge size matters
- Fans must activate quickly before ignition occurs
- Hazardous fluorine compounds can form when any HFC/HFO is burned

# Potential Ignition Sources Testing- AHRI Project 8017

- Determine the viability of various ignition sources to ignite A2L refrigerants in air



# Potential Ignition Sources Testing: Findings

- Majority of common tested potential ignition sources unable to ignite the A2L refrigerants/air mixtures (R32, R452B, R1234yf, and R1234ze)
- The tests resulting in ignition were open flame (lighter, match, and candle) and hot ni-chrome wire
- Refrigerants R32, R452B, and R1234ze were not ignited at hot plate temperatures up to 850°C (1562°F)
- Refrigerants with 3% oil were not ignited at hot plate temperatures up to 800°C (1472°F)
- Further testing with different hot surface geometries found in actual heating systems (e.g., heating coils in HVAC) is recommended



# Hot Surface Ignition Temperature (HIST)- AHRTI 9008

Refrigerant	Oil	Target Plate Temp. ( °C/ °F)	Target Chamber Air Temp. ( °C/ °F)	Humidity Ratio (kg/kg or lb/lb))	Ignition
R32	None	850/1562	93/200	0.023	0/5
R-452B	None	850/1562	93/200	0.023	0/5
R-1234ze	None	850/1562	93/200	0.023	0/5
R32	3%	700/1292	93/200	0.023	0/5
R-452B	3%	700/1292	93/200	0.023	0/5
R-1234ze	3%	700/1292	93/200	0.023	0/5
R32	3%	800/1472	93/200	0.023	0/5
R-452B	3%	800/1472	93/200	0.023	0/5
R-1234ze	3%	800/1472	93/200	0.023	0/5

# New Refrigerant Research Proposed

- Assess refrigerant detector characteristics for use in HVACR equipment (\$300,000)
- Assess the effectiveness of mitigations requirement: air circulation and releasable charge with shut-off valves (\$300,000)
- Leak rate characterization (\$300,000)
- Mitigation assessment of commercial refrigeration and air conditioning products through whole room testing (\$450,000)
- Combustion products risk study (\$250,000)

**Estimated Budget: \$1.6 million (AHRI to provide \$400,000)**

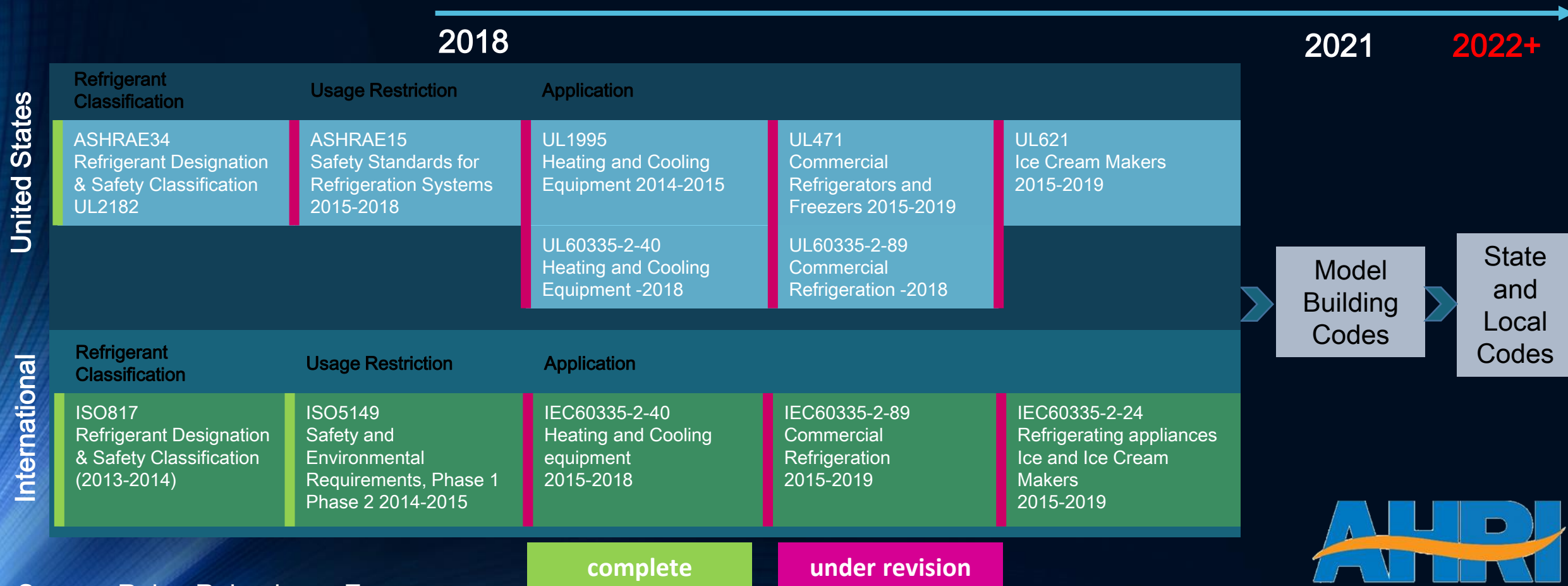
# Research Conclusions

- For some applications non-flammable refrigerants are or will be available
- Flammability is a continuum
- Flammable is flammable
- All flammable refrigerants need to be treated with the same level of respect
- Once A3 testing is complete, difference in incident severity between flammable and explosive refrigerants will be determined
- Equipment with flammable refrigerants looks or will look like equipment using non-flammable refrigerants!
- Everyone must be more vigilant in handling, servicing, and installing equipment using flammable refrigerants

# Challenges

- Regulatory and safety barriers must be adapted to allow the safe use of equipment using A2L and A3 refrigerants in homes and buildings
- Difference between available alternative refrigerants and equipment and commercially available refrigerants and equipment
- Knowledge of new technologies and refrigerants is limited for distributors, technicians, engineers, building owners, and consumers

# State of Safety Standards – Global View



Source: Rajan Rajendran - Emerson



# Commercial Availability



## Components (refrigerants, compressors, controls, valves, etc.)

- Design and testing of prototypes
- Regulatory approvals
- Retool and optimize manufacturing processes
- Production

## Equipment

- Design and testing of prototypes
- Regulatory approvals
- Retool and optimize manufacturing processes
- Production
- Equipment certification

## Distribution, Installation, Operation, and Maintenance

- Training (technicians, operators, building owners)
- Regulatory requirements for transportation, installation, and operation

# Education and Training

- Education and training are critically important
  - Most alternatives are either flammable or mildly flammable
- There are serious potential safety and efficiency issues with improper installation and maintenance



# Education and Training

## Global Refrigerant Management Initiative

- Launched in September 2014 by AHRI, the Alliance for Responsible Atmospheric Policy, and ABRAVA (Brazil)
- Participation by refrigerant organizations in Australia, Canada, China, Colombia, the EU, Japan, Mexico, and Korea

## UNEP-AHRI Refrigerant Driving License

- Aims to ensure safe management of refrigerants, especially in Article 5 nations
- Creates a global network to support safe handling



**We Are Committed – There's No Going Back**

**Industry is Committed to the Success of the Kigali  
Amendment**

**We must work together!**