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2025 Refrigerant Transition

A transition to A2L refrigerant and how these refrigerants impact the safe construction of buildings and the application of the International Mechanical Code

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Executive Summary

The purpose of this report is to provide guidance for the safe use of A2L refrigerants with in buildings. The A2L refrigerant safety class is a subcategory of A2 with a low burn velocity. The use of A2L refrigerants in HVAC systems has not been widely used in the United States to date, and this type of refrigerant requires additional safety measures beyond the commonly used A1 refrigerants such as R-410A.

Considerations discussed are the following:

1. Refrigerant Mitigation Controls – the safety measures to safely control the release of refrigerants in HVAC&R systems allowed by UL 60335-2-40, UL 60335-2-89 for manufactured listed and labeled equipment.
2. Refrigerant Shaft Alternatives – the safe installation of refrigerants to minimize refrigerant leakage into the smallest space through which refrigerant piping passes through.

These measures are a part of the 2022 version ASHRAE Standard 15: Safety Standard for Refrigeration Systems.

Recommendation of code amendments are provided to assist in the better alignment of the 2024 International Mechanical Code and ASHRAE 15-2022 for HVAC&R systems installed within buildings.

Introduction

On December 27, 2020 the AIM Act was passed and signed by Former President Donald J. Trump. The Act gave the U.S. Environmental Protection Agency (EPA) the authority regulate the use of hydrofluorocarbon (HFC) refrigerants.[1]
The EPA has mandated beginning January 1, 2025[2] HVAC manufacturers are no longer allowed to manufacture HVAC systems that use refrigerants with a Global Warming Potential (GWP) greater than 700. The reason for the change is to decrease the impact of refrigerants on global warming and climate change.

The change to low GWP refrigerants, is currently limited to A2L refrigerants. A2L is a refrigerant classification that has been determined to be non-toxic and mildly flammable. A further explanation of refrigerant classifications is discussed further in this document under 'Background and History'.

With the refrigerant type used to meet the low GWP mandate, there are safety concerns related what new systems must have to mitigate issues that can arise from refrigerant leaks and fire safety.

In the EPA's final ruling[3] dated December 26, 2023 the phase out of high global warming potential refrigerants placed restrictions on the manufacture, distribution, sale, installation import, and export of products containing refrigerants with a GWP level greater than 700.

The installation of stationary residential and light commercial air conditioning and heat pumps was extended to January 1, 2026. The current installation date for Variable

Refrigerant Flow systems is also January 1, 2026.[4]

Background and History

There has been over 40 years of history of refrigerant changes beginning in the 1980s with the Montreal Protocol. In 1979, it was discovered there was a hole in the ozone layer above Antarctica in the southern hemisphere of Earth[5]. Scientist discovered Chlorofluorocarbons (CFC), an example R-12, and Hydrochlorofluorocarbons (HCFC), an example R-22, accumulated in the atmosphere causing seasonal thinning of the ozone layer.

In 1987, the Montreal Protocol provide a method for a phase out plan to reduce the use of ozone depleting substances including refrigerants like CFCs and HCFCs. When these refrigerants and other ozone-depleting substances were phased out, the thinning and hole in the ozone layer began to close. Since the Montreal Protocol, the ozone hole area was largest in 2000 and was the thinnest in 1994.[6]

In 2016, the Kigali Amendment to the Montreal Protocol was adopted and in January 1, 2019 the amendment entered into force with the United States ratifying the amendment in 2022.[7] The Kigali Amendment's focus purpose is to phase down the use of Hydrofluorocarbons (HFC), an example is R-410a. HFCs have a high GWP.

Residential and commercial HVAC systems used R-12, up until the 1950s when new systems were changed to R-22.[8] In 2010, R-22 systems could no longer be manufactured and on January 1, 2020 the EPA banned the production and import of R-22 refrigerant. After this date, only recovered, recycled and reclaimed R-22 can be used.[9]

In 2010 when R-22 was no longer allowed to be used in systems, R-410A became the predominant refrigerant used in residential and commercial HVAC systems. R-410A operated at higher pressures allowing for efficiency gains with a similar system size.

R-410A was intended as only a transitional refrigerant, however the industry was challenged with finding a refrigerant that met several requirements:

1. A Zero Ozone Depletion Factor (ODP)
2. A Low Global Warming Factor (GWP) below 700
3. Efficient thermal transfer at operating pressures at or below R-410A.
4. A non-toxic refrigerant for the use in systems where the refrigerant coil is directly in the air stream, a refrigerant that is a Toxicity 'A' classification.
5. A non-flammable refrigerant that is a Flammability '1' classification.

The passage of Kigali Amendment and the AIM Act, manufactures were able to meet 4 of the 5 objectives with current technology.

Two refrigerants became the front runners as a replacement for R-410A. These were R-32 and R-454B. These refrigerants met 4 of the 5 objectives. The objective no current refrigerant is able to meet is number 5, a non-flammable refrigerant that is a Flammability '1' classification while still meeting the others. Below is a chart of refrigerant properties

showing the refrigerant type, refrigerant classification, ODP, GWP as well as refrigerant concentration limit (RCL) and low flammability limit (LFL).

Table 1. Refrigerant Properties[1011]

Refrigerant	Classification	ODP	GWP	RCL (lb/1000 ft^3)	LFL (lb/1000 ft^3)
R-12 (CFC)	A1	0.73	10,800	5.9	-
R-22 (HCFC)	A1	0.034	1,760	13	-
R-32 (HFC)	A2L	0	677	4.8	19.1
R-134a (HFC)	A1	0	1300	13	-
R-290 (HC - Propane)	A3	0	5	0.59	2.4
R-410A	A1	0	1920	26	-
R-454B	A2L	0	467	3.1	22.0

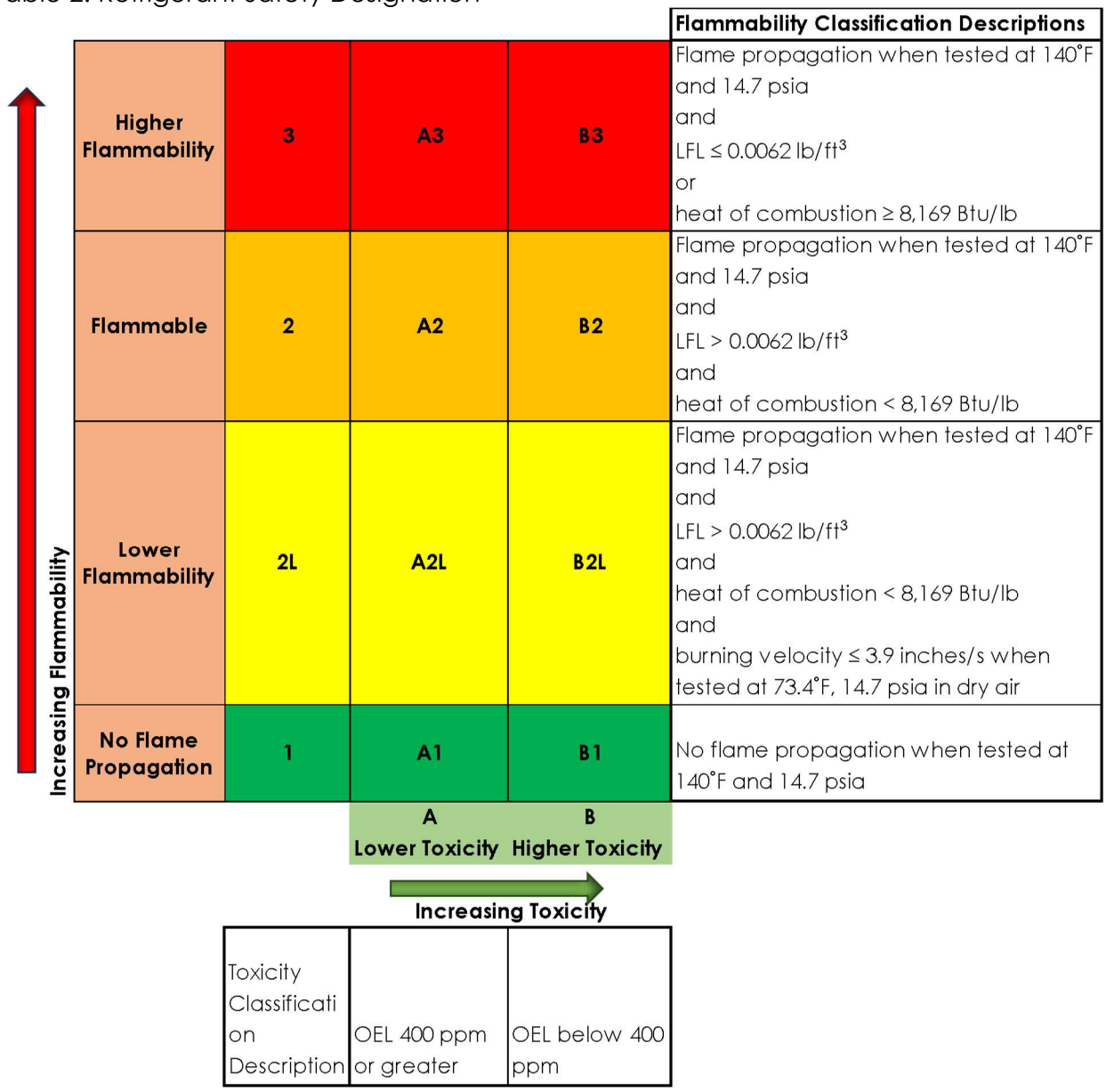
In the chart above, R-32 and R-454B have a classification of A2L. This classification is based on ASHRAE Standard 34-2022: Designation and Safety Classification of Refrigerants.

In ASHRAE Standard 34, refrigerants are given 2 designations. A letter 'A' or 'B' for their toxicity and a number 1, 2L, 2 or 3 for their flammability.

The Toxicity classification is based on a occupational exposure limit (OEL) of 400 ppm. An 'A' designation is given to refrigerants if the OEL is 400 ppm or greater, and 'B' is given when the OEL is below 400 ppm.

The Flammability Classification is classified based on flame propagation, lower flammability limit, heat of combustion and burn velocity.

Table 2. Refrigerant Safety Designation[12]



The 2L flammability classification was first introduced as a separate designation in the 2024 International Mechanical Code (IMC), however the code and the HVAC manufacturing industry did not align well. The IMC, based on the requirements in chapter 11, saw no difference with A2 and A2L refrigerants and treated them relatively the same with few exceptions except the recognition of the new UL 60335-2-40 standard for factory-built equipment and appliances. The code as written limited the refrigerant charge of Group A2 and A3 refrigerants in high-probability systems, a system where the refrigerant coil has a potential of leaking refrigerant into the air stream or occupied space, to 6.6 lbs in a single circuit without allowance for a higher level before building areas would be required to meet the requirements of Machinery Rooms.

Manufacturers and ASHRAE Standard 15 have developed methods for the safe use of Group A2L refrigerants in nonindustrial buildings. The use of refrigerant sensors, refrigerant mitigation strategies including refrigerant dilution into a large space volume and the use of automatic safety valves to isolate and limit refrigerant leaks.

Issues with the transition as it relates to the building code and mechanical code

The 2024 International Mechanical Code began to recognize A2L refrigerant classification, prior to this publication A2L was required to meet the requirements of A2 refrigerant classifications. In the 2024 IMC safety measures provided in ASHRAE Standard 15 are not permitted in some situations.

The following are issues of where the mechanical code is not aligned with ASHRAE Standard 15.

1. The first issue is allowing an exception for shafts for refrigerants other than Group A1 even when the refrigerant concentration is below the allowable limit for the smallest space the piping passes through.
    1.1. A 2027 proposed amendment M75-24 is requesting the removal of 'using Group A1 refrigerant' from 1109.2.5 to better align with ASHRAE standard 15.
    1.2. Prior to 2021 IMC, refrigerant penetrations were not required to be in a shaft unless the refrigerant system exceed the refrigerant concentration limits. 2018 IMC section 1107.2.2(4) and (5).
2. The refrigerant concentration limits prior to the 2024 IMC did not take into account the LFL of refrigerants and R-454B's RCL was published at 22 lb/1000 ft^3 creating an unsafe situation.
    2.1. This has been revised in the 2024 IMC.
3. The equipment listing required by Table 1101.2 Factory-Built Equipment and Appliance is UL 60335-2-40 and UL 60335-2-89. In these UL standards, refrigerant mitigation measures are required.
    3.1. The mechanical code does not provide provisions when these mitigation measures are used, making compliance with the UL standard and building code overly complex.
    3.2. Section 1104.2 requires 'all components containing the refrigerant shall be located either outdoor or in a machinery room where the quantity of refrigerant in an independent circuit of a refrigeration systems exceeds the amounts shown in Table 1103.1.
        3.2.1. Using exception 2, a Variable Refrigerant Flow (VRF) system can exempt the piping leading from the outdoor unit to the Branch selector box or Heat recovery unit to be exempted from being a machinery room, however based on the 'all components' language the refrigerant piping and air handlers downstream would be required to be in a machinery room even if refrigerant mitigation strategies are used.

Recommendations for the 2024 IMC

- Remove Group A1 from 1109.2.5 exception 2 to allow any refrigerant as long as the refrigerant concentration is not exceeded, similar to ASHRAE 15-2022. This is similar to the 2018 IMC for refrigerant piping penetrations.
- Add exception for refrigerant mitigation controls to be used as an exception to 1104.2. This is in alignment with UL 60335-2-40 and UL 60335-2-89 for factory-built equipment and appliances. This includes activation of air circulation fan of the equipment, open zoning dampers to facility an increase in dispersal volume, active automatic safety shutoff valves, activate of mechanical ventilation, de-energize potential ignition sources including electric resistance heat installed in air ducts that are connected to the refrigeration system.
- Add exception for continuous piping tested in accordance with ASHRAE 15-2022 section 9.13.6 for expansion valves in a continuous piping system.
- All manufacturers and ASHRAE Standard 15 to determine a method for Variable Refrigerant Flow systems with Branch selector boxes are not required to be located in machinery rooms.

2024 IMC sections recommended changes

Chapter 2 Definitions **Add**

effective dispersal volume charge (EDVC): the maximum refrigerant charge permitted for an effective dispersal volume.

Refrigerant Detection System: The product safety standard addresses both refrigerant detection systems and leak detection systems. In the product safety standard, a leak detection system is defined as "a sensing system which responds to refrigerant leaking from a refrigerating system." A leak detection system may include gas sensing, ultrasonic, or other such methods that meet the standards UL 60335-2-40/CSA C22.2 No. 60335-2-40 or UL 60335-2-89/CSA C22.2 No. 60335-2-89. [ASHRAE 15-2022: 3.1]

Refrigerant Detector: "Refrigerant sensor" is another term for refrigerant detector. A refrigerant sensor is a sensing element combined with electronic circuitry that provides a digital output or an analog signal output that corresponds to the sensed refrigerant gas concentration. [ASHRAE 15-2022: 3.1]

1101.7 Changing refrigerant.

Changes of refrigerant in an existing system to a refrigerant with a different *refrigerant designation* shall be allowed only where in accordance with the following:

1. The owner or the owner's authorized agent shall be notified prior to making a change of refrigerant, and the change of refrigerant shall not be made where the owner objects to the change.
2. The change in refrigerant shall be in accordance with one of the following:
    1. Written instructions of the original equipment manufacturer.
    2. An evaluation of the system by a *registered design professional* or by an *approved* agency that validates safety and suitability of the replacement refrigerant.
    3. *Approved* by the code official.

3. Where the replacement refrigerant is classified into the same safety group, requirements that were applicable to the existing system shall continue to apply.
4. Where the replacement refrigerant is classified into a different safety group, the system shall comply with the requirements of this ~~standard~~ code for a new installation, and the change of refrigerant shall require code official approval.

Reason: Editorial – this is copied from ASHRAE Standard 15-2022. The International Mechanical Code is a code not a standard.
Cost Impact: None.

1104.2 Machinery room.
Except as provided in Sections 1104.2.1 and 1104.2.2, all components containing the refrigerant shall be located either outdoors or in a *machinery room* where the quantity of refrigerant in an independent circuit of a *refrigeration system* exceeds the amounts shown in Table 1103.1. For refrigerant blends not listed in Table 1103.1, the same requirement shall apply where the amount for any blend component exceeds that indicated in Table 1103.1 for that component. This requirement shall also apply where the combined amount of the blend components exceeds a limit of 69,100 parts per million (ppm) by volume. *Machinery rooms* required by this section shall be constructed and maintained in accordance with Section 1105 for Group A1 and B1 refrigerants and in accordance with Sections 1105 and 1106 for Group A2, B2, A3 and B3 refrigerants.
Exceptions:
1. Machinery rooms are not required for listed equipment and appliances containing not more than 6.6 pounds (3 kg) of refrigerant, regardless of the refrigerant's safety classification, where installed in accordance with the equipment's or appliance's listing and the equipment or appliance manufacturer's installation instructions.
2. Piping in compliance with Section 1107 is allowed in other locations to connect components installed in a machinery room with those installed outdoors.
3. ***ADD*** *Release mitigation controls are provided in accordance with ASHRAE 15-2022 Section 7.3.4.4 to limit a release by automatically isolating leaking piping or equipment.*

Reason: Refrigeration systems with release mitigation strategies can safely isolate a section to prevent a full single circuit discharge of a refrigerant with automatic safety shutoff valves. An example of this is in VRF systems where Branch selector boxes/Heat recovery units (BSB/HRU) can be installed with automatic safety valves to prevent full discharge of refrigerant downstream of the BSB/HRU.
Cost Impact: Savings because this is in alignment with ASHRAE 15 and the entire system would not need to be located in a machinery room while still providing building and occupant protection. This allows the use of VRF systems to be installed in buildings as long as they meet the requirements of ASHRAE 15-2022 section 7.3.4.4.

Add Sections from ASHRAE 15-2022 into the 2024 IMC to allow Refrigerant Mitigation Systems.[13]
1104.3.5 Refrigerant Mitigation Systems. Refrigerant Systems using 1104.2 exception 3 shall comply 1104.3.5.1 through 1104.3.5.3.

1104.3.5.1 Release Mitigation Controls. Release mitigation controls used to limit the releasable refrigerant charge (m_{rel}) shall comply with the following: [ASHRAE 15-2022:7.3.4.4]

1. Release mitigation systems shall be components of a refrigeration system that is listed per UL 60335-2-40 5/CSA C22.2 No. 60335-2-40 6 or UL 60335-2-89 7/CSA C22.2 No. 60335-2-89 8 and evaluated by the nationally recognized testing laboratory as part of the listing.
2. Release mitigation controls shall only be permitted for reducing the releasable refrigerant charge (m_{rel}) on a refrigeration system where each indoor unit has a cooling capacity of 5 tons (17.5 kW) or less.
3. Release mitigation controls shall be activated by a refrigerant detection system. A refrigerant detector shall be located either in all refrigeration equipment serving the spaces or in all spaces served by the release-mitigation-controlled circuit. The refrigerant detector shall activate the release mitigation controls and isolate all possible paths of refrigerant that can leak into the space(s).
4. In the event of a failure of the release mitigation controls or a refrigerant detector, the release mitigation controls shall isolate all possible paths of refrigerant that can leak into the space(s).
5. Refrigerant detectors shall comply with Section 7.6.2.4 and shall activate the mitigation controls per Section 7.6.2.5. For Group A1 refrigerants, 100% of RCL shall be substituted in place of 25% of LFL.

1104.3.5.2 The refrigerant detection system shall comply with the following: [ASHRAE 15-2022:7.6.2.4]

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.
2. Field recalibration of the refrigerant detection system shall not be permitted.
3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.
4. Have access for replacement of refrigerant detection system components.
5. Have self-diagnostics to determine operational status of the sensing element.
6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.
7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, –1%).

   NOTE: Validation of meeting requirements 1, 2, 3, 5, 6 and 7 can be accomplished by verifying the refrigerant detector meets the requirements of UL 60335-2-40, Annex LL.

1104.3.5.3 Mitigation Action Requirements. The following mitigation actions shall be completed in not more than 15 seconds after the initiation of the output signal of Section 1104.3.5.2(7) and shall be maintained for at least 5 minutes after the output signal has reset:

1. Energize the air circulation fan(s) of the equipment per the manufacturer's instructions.
2. Open zoning dampers, or set zone dampers to full airflow set point, that are installed in the air ducts connected to the refrigeration system.
3. Activate mechanical ventilation if required by Section 1104.3.5.3.1.
4. De-energize electric resistance heat installed in the air duct that is connected to the refrigeration system.
5. Activate safety shutoff valves utilized to reduce releasable refrigerant charge.
6. De-energize potential ignition sources, including open flames and unclassified electrical sources of ignition with apparent power rating greater than 1 kVA, where the apparent power is the product of the circuit voltage and current rating.
   NOTE: The manufacturer's equipment shall be reviewed to determine which of these requirements are performed by the installed equipment.
   3 – The ventilation requirements in this chapter are different than chapter 4, Ventilation. This chapter serves as a refrigerant safety mitigation method for reducing the refrigerant concentration within a space.
   5 – safety shutoff valves located on the low-pressure side of the refrigeration system may remain open during a pump down sequence to reduce releasable refrigerant charge. The pump down cycle shall not reduce the low-pressure side below atmospheric pressure, and the safety shutoff valve shall close at the end of the pump down cycle sequence.
   6 – Potential ignition sources are those defined in UL 60335-2-40, including arcs and sparks from electrical components and hot surfaces.

1104.3.5.3.1 Mechanical Ventilation for refrigerant safety mitigation. Mechanical ventilation for refrigerant safety mitigation shall comply with this section. Where a ventilated enclosure is provided to control a refrigerant leak, the refrigeration system and ventilated enclosure shall be listed and installed in accordance with UL 60335-2-40/CSA C22.2 No. 60335-2-40 and shall not be required to comply with this section.

1. Mechanical ventilation shall be provided that will remove leaked refrigerant from the space where refrigerant leaking from the refrigeration system is expected to accumulate. The space shall be provided with an exhaust or transfer fan. Fans used to exhaust air from the space or transfer air to a separate indoor space shall comply with Equation 1104.3.5.3.1-1:

$$Q_{min} = \frac{Q_{req}}{C_{LFL}} \qquad \text{Equation 1104.3.5.3.1-1}$$

Where:
Qmin = minimum mechanical ventilation airflow rate, ft3/min
Qreq = required ventilation as determined from Table 1104.3.5.3.1-1
C_{LFL} = lower flammability limit conversion factor as determined from 1104.3.5.3.1--2

Table 1104.3.5.3.1-1 Required Ventilation for A2L Systems

Excluded Charge (m_s–EDVC)[b]		Q_{req}		Excluded Charge (m_s–EDVC)[b]		Q_{req}	
lb	kg	ft³/min	m³/h	lb	kg	ft³/min	m³/h
3.8	1.7	100	170	91.8	41.6	2400	4080
7.6	3.5	200	340	95.6	43.4	2500	4250
11.5	5.2	300	510	99.4	45.1	2600	4420
15.3	6.9	400	680	103.2	46.8	2700	4590
19.1	8.7	500	850	107.1	48.6	2800	4760
22.9	10.4	600	1020	110.9	50.3	2900	4930
26.8	12.1	700	1190	114.7	52	3000	5100
30.6	13.9	800	1360	118.5	53.8	3100	5270
34.4	15.6	900	1530	122.4	55.5	3200	5440
38.2	17.3	1000	1700	126.2	57.2	3300	5610
42.1	19.1	1100	1870	130	59	3400	5780
45.9	20.8	1200	2040	133.8	60.7	3500	5950
49.7	22.5	1300	2210	137.6	62.4	3600	6120
53.5	24.3	1400	2380	141.5	64.2	3700	6290
57.4	26	1500	2550	145.3	65.9	3800	6460
61.2	27.7	1600	2720	149.1	67.6	3900	6630
65	29.5	1700	2890	152.9	69.4	4000	6800
68.8	31.2	1800	3060	156.8	71.1	4100	6970
72.6	32.9	1900	3230	160.6	72.8	4200	7140
76.5	34.7	2000	3400	164.4	74.6	4300	7310
80.3	36.4	2100	3570	168.2	76.3	4400	7480
84.1	38.1	2200	3740	172.1	78	4500	7650
87.9	39.9	2300	3910	175.5	79.6	4590	7803

a. Charge sizes and ventilation rates shown in this table are based on R-32.
b. (m_s – EDVC) is the amount of refrigerant charge that is removed by mechanical ventilation and is therefore not included in calculations to determine compliance with Table 1103.1. m_s and EDVC are as defined in Section 7.6.4(a).

Table 1104.3.5.3.1-2 Lower Flammability Limit Conversion Factor

Refrigerant Number	C_{LFL}
R-32	1
R-452B	1.02
R-454A	0.92
R-454B	0.97
R-454C	0.95
R-457A	0.71

When the refrigerant charge necessary to be removed by ventilation is known, in order to be compliant with Table 1103.1, an alternative method to determine Q_{req} uses Equation 1104.3.5.3.1-2. This alternative method shall be used for all A2L refrigerants not listed in Table 1104.3.5.3.1-2.

$$Q_{req} = \frac{m_s - ED}{t \times LFL} \times SF_{vent}$$ Equation 1104.3.5.3.1-2

Where
Qreq = required minimum mechanical ventilation airflow rate, ft3/min
ms = largest system refrigerant charge from independent circuit, lb
EDVC = effective dispersal volume charge, lb
LFL = lower flammability limit, lb/ft3
t = assumed leak time, value of 4 minutes
SFvent = safety factor, value of 2

2. Mechanical ventilation shall be permitted to be continuous or activated by a refrigerant detector. Building fire and smoke systems shall be permitted to override this function.
   2.1. Continuous Ventilation. Where continuous ventilation is provided, ventilation function shall be continuously verified per Section 1104.3.5.3.1(2.3).
   2.2. Refrigerant Detector Activated Ventilation. Where ventilation is activated by a refrigerant detector, the refrigerant detector shall be in accordance with Section 1104.3.5.2. Upon refrigerant detector activation, the mechanical ventilation shall be activated and shall continue to operate for at least 5 minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the set point value. For mechanical ventilation systems used solely for refrigerant safety mitigation, ventilation function of refrigerant detector activated ventilation shall be verified in accordance with Section 1104.3.5.3.1(2.3) by a monthly self-test.
   2.3. Verification of Ventilation Function. Ventilation function shall be verified by a method that confirms operation of the required fans. On detection of a ventilation system failure, compressor operation shall be stopped, and a notification shall be provided. The notification shall be to an operator workstation through a building automation system or by a local audible alarm.
3. While the ventilation system is operating, makeup air shall be provided, and the volume of makeup air shall not exceed the volume of air being exhausted or transferred out of the space. Openings for makeup air shall be positioned to facilitate mixing of makeup air with leaked refrigerant. Inlets for exhaust air, and inlets used to mechanically transfer air to a separate indoor space, shall be located such that the bottom of the inlet is within 12 in. of the lowest elevation in the space where leaked refrigerant would be expected to accumulate.
4. The refrigerant concentration of an indoor effective dispersal volume shall not exceed the limit specified below.
   4.1. Refrigerant Quantity Limits. The maximum refrigerant charge of any independent circuit of each refrigeration system shall be as specified in

Sections 4.1.1 and 4.1.2.

4.1.1. Refrigeration Systems with Air Circulation. Where a high-probability system for human comfort using Group A2L refrigerants has either

4.1.1.1. Air circulation initiated by a refrigerant detector in compliance with Section 1104.3.5.2

or

4.1.1.2. Continuous air circulation,

the refrigerant charge quantity shall be limited per Equation 1104.3.5.3.1(4-1). Control of continuous air circulation shall be performed by the listed equipment and shall operate continuously other than short periods for maintenance and service:

$$EDVC = V_{eff} \times LFL \times CF \times F_{OCC} \qquad \text{Equation 1104.3.5.3.1(4-1)}$$

Where

EDVC = effective dispersal volume charge, lb
V_{eff} = effective dispersal volume, ft^3
LFL = lower flammability limit, lb/ft3
CF = concentration factor, value of 0.5
F_{occ} = occupancy adjustment factor; (For all occupancies other than institutional occupancies, F_{occ} has a value of 1. For institutional occupancies, F_{occ} has a value of 0.5.)

4.1.2. Other Refrigeration Systems. For any refrigeration system not meeting the requirements of Section 1104.3.5.3.1(4.1.1), the refrigerant charge of the largest independent circuit of the system (m_s) shall not exceed the value from Equation 1104.3.5.3.1(4-2):

$$EDVC = M_{def} \times F_{LFL} \times F_{OCC} \qquad \text{Equation 1104.3.5.3.1(4-2)}$$

Where

EDVC = effective dispersal volume charge, lb
M_{def} = refrigerant charge from Table 1104.3.5.3.1-3 (lb)
F_{LFL} = lower flammability limit, lb/ft3
F_{occ} = occupancy adjustment factor; (For all occupancies other than institutional occupancies, F_{occ} has a value of 1. For institutional occupancies, F_{occ} has a value of 0.5.)

When determining M_{def}, the floor area shall be the floor area of the volume of space established in accordance with 1104.2 in cubic feet. The height shall be the lowest point of any opening in the supply air duct, the return air duct, or the equipment providing air circulation. Heights below 2.0 ft shall use the first height column. Heights greater than 9.0 ft shall use the last height column. For floor areas or heights in between the values listed, linear interpolation or the next lower value shall be used. For spaces with varying floor elevations, the highest floor level relative to an opening shall be used to determine height. For floor areas less than 50 ft^2, use 4.0 lb.

Table 1104.3.5.3.1-3 Refrigerant Charge Limit (M_{def}), lb

	Height, ft							
Floor Area, ft2	≤2	3.3	4.6	5.9	6.6	7.2	8	≥9
50	4	4	4	4	4	4	4	4.3
100	4	4	4.4	5.6	6.3	6.9	7.7	8.6
125	4	4	5.5	7	7.8	8.6	9.6	10.7
150	4	4.7	6.5	8.4	9.3	10.3	11.4	12.8
175	4	5	7.1	9.1	10.1	11.1	12.4	13.8
200	4	5.4	7.6	9.7	10.8	11.9	13.2	14.8
225	4	5.7	8	10.3	11.4	12.6	14	15.7
250	4	6	8.4	10.9	12.1	13.3	14.8	16.5
300	4	6.6	9.3	11.9	13.2	14.5	16.2	18.1
350	4.3	7.1	10	12.8	14.3	15.7	17.5	19.6
400	4.6	7.6	10.7	13.7	15.3	16.8	18.7	20.9
450	4.9	8.1	11.3	14.6	16.2	17.8	19.8	22.2
500	5.1	8.5	11.9	15.4	17.1	18.8	20.9	23.4
600	5.6	9.3	13.1	16.8	18.7	20.6	22.9	25.6
700	6.1	10.1	14.1	18.2	20.2	22.2	24.7	27.7
800	6.5	10.8	15.1	19.4	21.6	23.7	26.4	29.6
900	6.9	11.4	16	20.6	22.9	25.2	28	31.4
1000	7.2	12.1	16.9	21.7	24.1	26.5	29.6	33.1
1200	7.9	13.2	18.5	23.8	26.4	29.1	32.4	36.3
1400	8.6	14.3	20	25.7	28.6	31.4	35	39.2
1600	9.2	15.3	21.4	27.5	30.5	33.6	37.4	41.9
1800	9.7	16.2	22.7	29.1	32.4	35.6	39.7	44.4
2000	10.2	17.1	23.9	30.7	34.1	37.5	41.8	46.8
2250	10.9	18.1	25.3	32.6	36.2	39.8	44.3	49.6
2500	11.4	19.1	26.7	34.3	38.2	42	46.7	52.3
2750	12	20	28	36	40	44	49	54.9
3000	12.5	20.9	29.3	37.6	41.8	46	51.2	57.3
3500	13.5	22.6	31.6	40.6	45.1	49.7	55.3	61.9
4000	14.5	24.1	33.8	43.4	48.3	53.1	59.1	66.2
4500	15.4	25.6	35.8	46.1	51.2	56.3	62.7	70.2
5000	16.2	27	37.8	48.6	54	59.4	66.1	74
6000	17.7	29.6	41.4	53.2	59.1	65	72.4	81.1
7000	19.2	31.9	44.7	57.5	63.8	70.2	78.2	87.6
8000	20.5	34.1	47.8	61.4	68.3	75.1	83.6	93.6
9000	21.7	36.2	50.7	65.2	72.4	79.6	88.7	99.3

10000	22.9	38.2	53.4	68.7	76.3	83.9	93.5	104.7
15000	28	46.7	65.4	84.1	93.5	102.8	114.5	128.2
20000	32.4	54	75.5	97.1	107.9	118.7	132.2	148
25000	36.2	60.3	84.5	108.6	120.7	132.7	147.8	165.5
28000	38.3	63.8	89.4	114.9	127.7	140.5	156.4	175.1

5. In addition to the requirements of section 1104.3.4, there shall be no open-flame-producing devices that do not contain a flame arrestor, or hot surfaces exceeding 1290°F (700°C), installed within the space where the equipment is located.
6. Electric motors larger than 1 hp driving fans located in the airstream of the discharge side of the ventilation system shall be of the totally enclosed or hermetically sealed type.
7. Fan rotating elements shall be nonferrous or non-sparking, or the casing shall consist of or be lined with such material.
8. Ventilation fans shall be listed in accordance with UL 507 12 or UL 705 13.
9. The discharge air openings of the ventilation system shall be located so as to prevent recirculation of exhaust air back into the space.

Reason: Including 1104.3.5 clarifies the use of release mitigation measures allowed in ASHRAE 15-2022. These sections are located in ASHRAE 15-2022; however, the IMC does not provide release mitigation strategies within the code itself. These section will permit the use of release mitigation strategies.
Cost impact: None, this is a part of ASHRAE 15-2022, however is not clearly stated in the code.

1109.2.5 Refrigerant pipe shafts. Refrigerant piping that penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistance-rated shaft enclosure. The fire-resistance-rated shaft enclosure shall comply with Section 713 of the International Building Code.

Exceptions:
1. Refrigeration systems using R-718 refrigerant (water).
2. Piping in a direct refrigeration system ~~using Group A1~~ where the refrigerant quantity does not exceed the limits of Table 1103.1 for the smallest occupied space through which the piping passes.
3. Piping located on the exterior of the building where vented to the outdoors.

2024 IRC sections recommended changes

ADD IRC 1404.2 Refrigeration systems using a refrigerant other than ammonia shall comply with ASHRAE 15-2022.]

Cross reference sections of ASHRAE Standard 15-2022 and 2024 IMC

ASHRAE 15-2022 Section Numbers	2024 IMC Section Numbers

5.3 Changing Refrigerant	1101.7 Changing Refrigerants
7. Restriction on Refrigerant Use	1104 Refrigeration System Application Requirements
7.2 Volume Calculations	1104.4 Volume calculations
7.4 Location in a Machinery Room or Outdoors	1104.2 Machinery Room
7.3 Refrigerant System Charge Limits	1104.3.5 Refrigerant Mitigation System Limits
7.3.4.4 Release Mitigation Controls	1104.3.5.1 Release Mitigation Controls
7.6.1Refrigerant Quantity Limits	1104.3.5.3.1(4) The refrigerant concentration of an indoor effective dispersal volume shall not exceed the limit specified below:
7.6.1.1 Refrigeration Systems with Air Circulation	1104.3.5.3.1(4.1) Refrigeration Systems with Air Circulation
7.6.1.2 Other Refrigeration Systems	1104.3.5.3.1(4.2) Other Refrigeration Systems
7.6.2 Listing and Installation Requirements	1101.2 Factory-built equipment and appliances
7.6.2.4 The refrigerant detection systems shall comply	1104.3.5.2 The refrigerant detection systems shall comply
7.6.2.5 Mitigation Action Requirements.	1104.3.5.3 Mitigation Action Requirements.
7.6.3 Ignition Sources Located in Ductwork	1104.3.4 Protection from refrigerant decomposition.
7.6.4 Mechanical Ventilation	1104.3.5.3.1 Mechanical Ventilation for refrigerant safety mitigation
9.10 Refrigerant Piping, Valves, Fittings and Related Parts	1107 Piping Materials
9.10.2 Reuse of Piping Materials on Existing Systems	1107.2 Used Materials
9.11 Joints and Connections	1108 Joints and Connections
9.12 Refrigerant Pipe Installation	1109 Refrigerant Pipe Installation
9.12.1.2 Pipe Protection	1109.2.2 Refrigerant Pipe enclosure
9.12.1.3 Prohibited Locations	1109.2.3 Prohibited Locations
9.12.1.4 Piping in Concrete Floors	1109.2.4 Piping in concrete floors
9.12.1.5 Refrigerant Pipe Shafts	1109.2.5 Refrigerant Pipe Shafts
9.12.1.5.1 Shaft Alternatives	1109.2.5 Exceptions
9.12.2 Installation Requirements for Flammable Refrigerants	1109.3 Installation requirements for Group A2L, A2, A3, B2L, B2 or B3 refrigerants.
9.12.2.1 Pipe Protection	1109.3.1 Protection against damage
9.12.2.2 Shaft Ventilation	1109.3.2 Shaft ventilation
9.12.3 Refrigerant Pipe Penetrations	1109.4 Refrigerant pipe penetrations
9.12.4 Stress and Strain	1109.5 Stress and strain
9.12.5 Stop Valves	1109.6 Stop valves

9.12.5.1 Refrigerating Systems Containing More Than 6.6 lb (3.0 kg) of Refrigerant	1109.6.1 Refrigeration systems containing more than 6.6 pounds (3.0 kg) of refrigerant
9.12.5.2 Refrigerating Systems Containing More Than 110 lb (50 kg) of Refrigerant	1109.6.2 Refrigeration systems containing more than 100 pounds (45 kg) of refrigerant
9.13 Refrigerating System Testing	1110 Refrigeration Piping System Test
9.15 Service Provisions	306 Access and Service Space

Conclusions

With the EPA federally mandating low GWP refrigerants, and the manufacturers using refrigerants with a safety group of A2L, the building codes and mechanical codes needed to be updated to account for the safety protocols required as part of the equipment and appliance standard. ASHRAE Standard 15 is the HVAC&R industry standard regarding refrigeration safety. We recommend aligning with the 2024 IMC with ASHRAE Standard 15, per the suggestions above, to allow for safer and more cost effective construction.

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10 2021 ASHRAE Handbook Fundamental Table 3B. Refrigerant Environmental Properties.

11 2021ASHRAE Handbook Fundamentals Table 4 Environmental Properties of Refrigerant Blends

12 ASHRAE Standard 34: Designation and Safety Classification of Refrigerants. (2022) www.ashrae.org

13 ASHRAE Standard 15: Safety Standard for Refrigeration Systems (2022) www.ashrae.org