

WHITE PAPER

CODE ROAD MAP: ADDRESSING FEDERALLY MANDATED A2L REFRIGERANTS FOR COMFORT AIR WITH OLDER ADOPTED CODES

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Introduction

To align with the American Innovation and Manufacturing (AIM) Act of 2020 and the Kigali Amendment to the Montreal Protocol (2022), the U.S. Environmental Protection Agency (EPA) has mandated an 85% nationwide phasedown of high-global warming potential (GWP) hydrofluorocarbon (HFC) refrigerants by 2036. This includes most legacy non-flammable refrigerants that have been used in commercial and residential buildings for decades.



In place of the high-GWP HFC refrigerants, a new generation of refrigerants has been introduced, offering similar operating characteristics and improved energy efficiency when compared to legacy HFC refrigerants. These refrigerants are classified as A2L refrigerants by ASHRAE Standard 34. The focus of this paper is new commercial and residential buildings being built in the United States to a base International Building Code (IBC) and does not address one-family, two-family, or townhouses.

What Do These Changes Mean?

- + Existing, installed refrigeration equipment is not impacted by this phasedown.
- + Refrigeration equipment utilizing legacy HFC refrigerants that were manufactured prior to January 1, 2025 may continue to be installed until December 31, 2025.
- + New refrigeration equipment (HVAC) manufactured in 2025 and beyond must utilize lower-GWP refrigerants, like A2L.

- + In the U.S., the federal mandate supersedes any state regulations, and older higher GWP refrigerants, like the non-flammable (A1 refrigerants), are not permitted to be utilized in new HVAC equipment being manufactured currently.
- + Older code editions are adopted and still being used in various U.S. states, counties, cities, and towns. These older editions are based on the use of non-flammable A-1 refrigerants and do not address the newer A2L refrigerants and their hazards.

The International Code Council (ICC) publishes model building, residential, mechanical, and fire codes which are ultimately adopted throughout the U.S. in various local jurisdictions with or without local amendments. Many states and local jurisdictions adopt the 2021 (or earlier) editions of the ICC suite of codes, including the International Building Code (IBC), International Mechanical Code (IMC), and International Fire Code (IFC).

Problem

The 2018, 2015, 2012, and prior editions of the ICC codes (IBC, IMC, and IFC) did not contemplate or address hazards from A2L refrigerants for human comfort air conditioning. The 2021 ICC codes did start contemplating A2L refrigerants for human comfort air conditioning, but there are some issues with these codes, such as the 2021 IMC code in not identifying A2L refrigerants in Table 1103.1 and it did not reference the 2022 ASHRAE Schedule 15. Given that federal regulations take precedence over local and state requirements, the industry is in a precarious position attempting to utilize the locally adopted older codes, while being forced to use a refrigerant other than the non-flammable A-1 refrigerants that were contemplated by the older adopted codes. There is no other choice than to use the lower-GWP refrigerants (principally the new A2L refrigerants since they are the most practical choice), in new construction. Unfortunately, the new A2L refrigerants are lower flammable, meaning buildings will be introducing an increased hazard compared to the previous non-flammable A1 refrigerants. So, if we are stuck with using A2L refrigerants in new buildings and utilizing older codes that did not allow or address this increased hazard for human comfort air conditioning (refrigeration), what is the code path that can bridge the gap between the older codes and address the new hazard being introduced?

A2L Refrigerant Characteristics + Hazards

Prior to the introduction of the A2L classification category, ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Standard 34 had three refrigerant categories for lower toxic refrigerants:

- + A1 (non-flammable)
- + A2 (flammable)
- + A3 (highly flammable)

A2L refrigerants are characterized by lower flammability, lower burning velocity, low toxicity, and low-GWP by ASHRAE Schedule 34, so they fall between the A1 and A2 classifications. For decades, most commercial and residential occupancies for comfort air have utilized A1 refrigerants, which pose no significant risk. In contrast, A2 and A3 refrigerants were used in specialized applications such as grocery store refrigeration and distribution centers and required more stringent code provisions. A2L refrigerants are defined as Category 1B flammable gases with low burning velocities in the 2024 ICC codes.

Other classifications include B1, B2L, B2, and B3, with the B indicating increased toxicity. Given that, the B category is not typically utilized for human comfort air conditioning, but may be used in industrial facilities, cold

storage warehouses, and food distribution centers.

Below is a chart of the ASHRAE refrigerant classifications, including example refrigerants and where the new A2L comfort air refrigerants fall within this classification system.

ASHRAE SCHEDULE 34 REFRIGERANT CLASSIFICATION				
Flammability	Refrigerant Classification	Example Refrigerants	Refrigerant Classification	Example Refrigerants
Highly Flammable	A3 (not utilized in residential and typical commercial buildings)	R-290 (Propane) R-1270	B3	Not typically utilized except in research
Flammable	A2 (not utilized in residential and typical commercial buildings)	R-152a R-516A	B2 (not utilized in residential and typical commercial buildings and rarely used)	R-764 R-40
Lower Flammable	A2L	R32 R451A R-1234ze R454B	B2L (not utilized in residential and typical commercial buildings)	R-717blends (Ammonia)
Non-Flammable	A1 (phased out – has been the predominant refrigerant for residential and commercial HVAC equipment)	R22 R410A R-134a	B1 (phased out – not utilized in residential and typical commercial buildings for HVAC)	R-123
A = Lower Toxicity			B = Higher Toxicity	

Most commercial refrigeration systems are closed systems (i.e., do not emit hazardous vapors during normal operation) that operate at relatively high pressures (greater than 100 psi). While A2L refrigerants are lower flammable, accidental release of the refrigerant at a high pressure could be hazardous, depending on the quantity, volume of space the refrigerant is released into, ventilation rates, and configuration of the space. There is a potential fire and/or explosion hazard if the refrigerant concentration is between the lower flammability limit (LFL) and the upper flammability limit (UFL) and an ignition source is found. Ignition sources can be readily available where unclassified electrical equipment is present (e.g., electrical outlets, equipment, lighting, etc.).

New Building Requirements for A2L Refrigerants

The 2024 editions of the IBC, IMC, IFC, and by reference the 2022 edition of ASHRAE Standard 15 address more completely the use of A2L refrigerants in comfort air conditioning systems and provide the most current and comprehensive code requirements for addressing hazards related to A2L refrigerants. The requirements associated with A2L refrigerants depend on the size, quantity, and configuration of the system. Examples of features that may or may not be required include: dedicated machinery rooms, fire-rated machinery rooms, ventilated mechanical rooms, refrigerant detection systems, fire-rated shafts, ventilated shafts, and/or hazardous classification of electrical equipment.

The ICC recognizes that many jurisdictions have adopted earlier editions of ICC codes that predate the 2024 version. To address the refrigerant-related gaps in these earlier editions, the ICC has compiled A2L refrigerant-related code provisions to consider adopting as amendments to previous code editions. These are available online at <https://www.iccsafe.org/products-and-services/i-codes/a2l-refrigerants-transition/>.

The ICC has released free downloadable PDFs outlining the specific code updates needed to bridge the gaps between the older code editions and the 2024 ICC suite of A2L codes requirements. These updates are only related to requirements for A2L refrigerants. There is a separate PDF document for each edition (2021, 2018, 2015, and 2012) of the IBC, IMC, and IFC, resulting in 12 separate documents that outline the code changes needed to address the A2L refrigerant hazard in older codes (2012 to 2021 editions). The IMC has the largest number of changes, since it is the document that has most of the A2L technical design requirements. However, other documents (like the IBC and IFC) require some edits to address the A2L requirements – particularly where referenced by the IMC.

The following sections summarize the 2024 editions of codes and standards commonly used in building design that may include requirements related to refrigeration systems.

International Building Code (IBC)

The following sections of the IBC have requirements associated with refrigerants:

- + Chapter 2 – Definition of flammable gas
- + Chapter 3 – Maximum allowable quantity per control area of hazardous materials and examples of Group H-2 and H-3 occupancies
- + Chapter 4 – Explosion control requirements

IBC Chapter 3 classifies a building, or part thereof, into a group based on the specific purpose for which it is designed, occupied, and used. A high-hazard Group H occupancy classification is given to facilities where operations or storage of materials are deemed to be extremely hazardous to life and/or property.

2024 IBC Table 307.1.1 (prior editions Section 307.1.1, Item 7) exempts refrigeration systems that utilize refrigerants that may be flammable or toxic from a Group H classification. This means the presence of refrigeration systems does not alter the occupancy classification of the building, provided they are installed in accordance with the IFC. The IMC also has specific limitations on the quantity and type of refrigerants that can be used, depending on the occupancy classification of the building.

Relative to the new federal requirements for refrigerants (AIM Act of 2020), there are no changes in the application of the IBC – meaning even in older IBC editions, refrigeration systems utilizing new A2L refrigerants are still exempt from a Group H occupancy classification. However, be aware that even though the IBC exempts refrigeration systems from triggering a Group H occupancy classification, the IMC, IFC, and ASHRAE Standard 15 still include many building-related requirements associated with refrigerants that would still be required and applicable.

International Fire Code (IFC)

The 2024 edition of the IFC modified Sections 608.17 and 608.18 to require refrigerant detectors and mechanical ventilation in the refrigerant machinery room. Additionally, the definition of flammable gas, explosion control requirements (IFC Table 911.1), and portions of Section 5003 were updated to reflect the two categories of flammable gases (Category 1A and 1B) to address the new A2L refrigerants. Most A2L refrigerants meet the definition of a Category 1B flammable gas.

International Mechanical Code (IMC)

Numerous requirements were added to the 2024 IMC that may apply to the design and installation of systems using A2L refrigerants. Firstly, A2L refrigerants are now permitted for use in air conditioning systems for human comfort use. Additional requirements related to A2L refrigerants are summarized in Table 1 below.

ASHRAE STANDARD 15

Since the IMC’s first release in 2000, ASHRAE Standard 15 has been referenced for refrigerant piping design and installation for systems containing a refrigerant other than ammonia (2024 IMC §1101.1.1). ASHRAE Standard 15 specifies requirements for the safe design, construction, installation, and operation of refrigeration systems. It is important to note that ASHRAE Standard 15 requirements do not supersede the IMC requirements. **IMC Section 102.4.1 states “where conflicts occur between provisions of this code and the referenced standards, the provisions of this code shall apply.”**

The 2024 IMC references the 2022 edition of ASHRAE Standard 15 (IMC Chapter 15). The ASHRAE Standard 15 has some exceptions that would allow the elimination of A2L-related requirements (e.g., shaft exhaust), but the IMC does not contain those same exceptions. Remember the IMC requirements take priority; so in cases like shaft ventilation, it is required per IMC Section 1109.3.2, regardless of the ASHRAE Standard 15 exception.

Some requirements related to A2L refrigerants in 2022 edition are summarized in Table 1 below

2024 IMC vs. 2022 ASHRAE Standard 15

Table 1 below summarizes and compares some of the A2L-related requirements in the 2024 IMC and the referenced 2022 ASHRAE Standard 15:

TABLE 1 -2024 IMC VS. 2022 ASHRAE STANDARD 15		
Element	2024 IMC	2022 ASHRAE Standard 15
Volume & Charge Calculations	No volume or charge calculations required.	The following must be calculated: 1. Effective dispersal volume – the space where refrigerant is expected to disperse in a leak, per Sections 7.2.1–7.2.3. 2. Effective dispersal volume charge (EDVC) – the maximum allowable charge for that volume, per Section 7.3, 7.6, or 7.7.
Hazardous Area Classification*	Class I, Division 2 hazardous (classified) electrical is not required in machinery rooms where only A2L refrigerants are used (IMC §1106.3).	Electrical equipment must comply with NFPA 70 (§8.5). Class I, Division 2 hazardous (classified) electrical location designation may be required, depending on ventilation and detection (§8.11.6).

Shaft Enclosures	Shaft enclosures are required for A2L refrigerant pipes that penetrate 2 or more floor/ceiling assemblies (i.e., where piping extends through 3 or more stories) (IMC §1109.2.5).	Shaft enclosures (rated per the building code) are required for A2L refrigerant pipes that penetrate 2 or more floor/ceiling assemblies (i.e., where piping extends through 3 or more stories) (§9.12.1.5).
Piping Protection	Refrigerant piping installed in studs, joists, rafters, or similar member spaces and located less than 1.25 inches from the nearest edge of the member, shall be continuously protected by steel shield plates that extend not less than 2 inches on both sides of the tube (IMC §1109.3.1).	Refrigerant piping installed in studs, joists, or similar member spaces and located less than 1.5 inches from the nearest edge of the member, shall be continuously protected by steel shield plates that extend not less than 2 inches above sole plates and below top plates (§9.12.1.2(a)).
Shaft Ventilation	Refrigerant pipe shafts with systems using Group A2L refrigerant must be ventilated (IMC §1109.3.2).	Refrigerant pipe shafts must be naturally or mechanically ventilated (§9.12.2.2), unless the refrigerant pipe is double-wall, where interstitial space is vented outdoors (§9.12.2.2 Item c).
Machinery Rooms	Machinery rooms are required where the quantity of refrigerant in an independent circuit of a refrigeration system exceeds the amounts in IMC Table 1103.1 (IMC §1104.2).	Machinery room required when refrigerant quantity exceeds limits defined in Sections 7.2 and 7.3 (§7.4).
Machinery Room Ventilation	Machinery rooms for Group A2L refrigerants must have a mechanical ventilation system complying with ASHRAE 15 and emergency ventilation activated by a detector (IMC §1106.4).	Machinery rooms with only A2L or B2L refrigerants must meet one of the following (§8.11.6):* <ol style="list-style-type: none"> Be provided with ventilation per Section 8.11.6.1 and refrigerant detection per Section 8.11.6.2. or <ol style="list-style-type: none"> Be designated as Class I, Division 2 hazardous (classified) electrical location per NFPA 70.
Refrigerant Detection	Refrigerant detectors must be provided in machinery rooms (IMC §1105.3, IFC §608.9). Machinery rooms for Group A2L refrigerants must have emergency ventilation activated by a detector (IMC §1106.4).	

*Regardless of IMC or ASHRAE requirements or exceptions, each room or area utilizing flammable or combustible materials other than A2L should be reviewed individually to determine hazardous (classified) electrical location designation in accordance with NFPA 70, the National Electrical Code.

2024 ASHRAE STANDARD 15

The 2024 edition of ASHRAE Standard 15 was released in October 2024, a year early to better align with the model code revision cycle. This was a one-time exception to establish a new three-year cycle moving forward. The 2024 edition of ASHRAE Standard 15 has the most up to date information related to A2L, but the 2024 IMC references the 2022 ASHRAE Schedule 15.

The only notable change related to A2L requirements in the 2024 ASHRAE Standard 15 is an adjustment to the requirements for machinery room ventilation, detection, and hazardous (classified) electrical locations in Section

8.11.6. The specific amendment allows the use of the Section 8.9.6 ventilation airflow rate where classified electrical equipment is also chosen as the compliance path, making ignition source engineering controls the primary means of risk management to mitigate the flammability hazard in machinery rooms utilizing Class 2L refrigerants, in the same manner as the requirements for Class 2 and Class 3 refrigerants (ASHRAE 15 Table G-1 Addendum w).

2027 IMC PROPOSED CHANGES

The 2027 IMC code development process is under way. The ICC Code Council Committee Action Hearing #1 contained changes to the 2027 IMC related to allowing unrated shafts for refrigerants meeting the limitation of Table 1103.1 and an allowance to eliminate the ventilation of the shaft when the piping system is continuous without fittings located in the shaft. Part of the proposed changes is attempting to align the IMC and ASHRAE Schedule 15. The IMC public hearings will not occur until 2026, so the final IMC 2027 changes are far from over, and until the 2027 IMC is approved there is no way at this time to know what proposed changes or other changes will make it into the 2027 IMC. The committee would typically have a second hearing and the final approved 2027 IMC will most likely be in second half of 2026.

Solution

In the U.S., when an architect, engineer on a design team, fire protection engineer, or code consultant encounters a practical difficulty involved in carrying out the provisions of the IBC, IFC, or IMC, the code official has the authority to grant modifications upon request of the owner or the owner's authorized agent. The request must detail the specific reason that the prescriptive requirements of the code are impractical, why the proposed modification is in compliance with the intent and purpose of the code, and that such modification does not lessen health, accessibility, structural, life, or fire safety (IBC §104.10, IFC §104.2.4, IMC §104.2.4). The code official is then charged with reviewing the rationale and documents submitted and deciding whether to approve or deny the request for the specific project.

The current A2L refrigerant scenario/issue is a perfect example of a practical difficulty – designers are federally required to specify refrigeration equipment utilizing A2L refrigerants; however, older adopted codes do not contemplate or address the hazards from these refrigerants, making it impossible to comply with the older codes.

The recommended code path is as follows:

1. Request a code modification on the basis of practical difficulty as expressly permitted by code (IBC §104.10, IFC §104.2.4, IMC §104.2.4)
 - a. Justification: Federal regulations require the use of A2L refrigerants that are not addressed in locally adopted code editions. Older code documents would categorize A2L refrigerants as A2 refrigerants that are either not permitted or have much more restrictive code requirements, which would also misclassify the hazard of the A2L refrigerant.
2. Proposed modifications
 - a. Reference the 2024 editions of the IBC, IFC, and IMC and utilize the ICC online code modifications A2L requirements for your project as the code requirements to address the A2L hazard. This may or may not include a dedicated mechanical room, refrigerant detection system, fire-rated rooms, fire-rated shafts, ventilated rooms, ventilated shafts, and/or hazardous NEC classifications based on the particular project, refrigerant quantity, and configuration/design.

Another code path is using Alternate Means and Methods (e.g. IBC §104.11), but we do not recommend that code path, since it requires much more substantiation and testing.

As an Authority Having Jurisdiction (AHJ), architect, mechanical engineer, fire protection engineer, or code consultant, it is important to understand a code modification in the U.S. is needed to address the A2L refrigerant for comfort air for new buildings when older base codes (IBC, IMC, IFC) are applicable to the project. This modification is permitted by the codes, but does require submission to the AHJ, as well as their review and approval. In some cases, the local AHJ may transfer the review and approval to an appeals or variance board for their review and findings.

It is imperative that there is good communication between the design team and the various AHJs, since it may be possible to have a single code modification deal with the overall A2L issue. Alternatively, there may need to be multiple, separate code modifications – one for each applicable code being modified. Furthermore, there is potential for additional issues, such as jurisdictions adopting NFPA 1 as the local fire code rather than the IFC or Uniform Mechanical Code (UMC) instead of the IMC. The A2L requirements may not align between the IFC and NFPA 1, UMC and IMC, or any other local code amendments that may impact the A2L requirements. These types of nuances and local impacts need to be part of the analysis and proposed code modification for a project.

Conclusion

As of January 1, 2025, all new manufactured refrigeration units are federally required to utilize refrigerants with a lower GWP (e.g. A2L Refrigerants as the most practical). A new generation of refrigerants (A2L) has been introduced, offering similar operating characteristics and improved energy efficiency when compared to legacy HFC refrigerants. AHJs and design teams for projects where older codes (earlier than the 2024 ICC suite) are adopted should be aware that code modification is needed to address the hazards of A2L refrigerant being introduced into new buildings for comfort air. The 2024 IMC and the referenced 2022 ASHRAE Schedule 15 have the most current technical and comprehensive requirements addressing A2L refrigerants and the associated hazards. The ICC A2L code modifications for the IBC, IMC, and IFC should be utilized as the basis for the code modification, which provides a comprehensive and coordinated approach across the various applicable codes.