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A2L REFRIGERANT & MITIGATION

WHITE PAPER

WHERE A2L IS HEADED AND HOW IT CAN PROTECT THE HOMEOWNER

USA INNOVATION

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Introduction
The HVAC industry is evolving to meet environmental regulations and safety standards. One major change is the adoption of A2L refrigerants, which are mildly flammable but have a lower global warming potential (GWP) than traditional refrigerants. This guide explains what A2L refrigerants are, why they matter, and how A2L mitigation boards work to keep systems safe.

A2L refrigerants—classified as non-toxic and only mildly flammable—are quickly becoming a popular solution for significantly lowering global warming potential (GWP). As the cooling industry continues its move away from high-GWP refrigerants, more systems are now benefiting from environmentally friendlier options. The next major step in this transition is achieving ultra-low GWP performance. Natural refrigerants such as R290 and CO_2 are already being adopted across a variety of applications. However, for contractors seeking a cost-effective alternative that works within a traditional system design, A2L refrigerants are an ideal fit—delivering GWP reductions of 90% or more.And while their mild flammability often raises questions, A2L refrigerants are safe and straightforward to work with when basic safety practices are followed.

Benefits of A2L Refrigerants
The primary benefit is the GWP level. The very low GWP levels make A2L an attractive choice as regulations continue to evolve. These refrigerants are typically easy to use and don't add complexity to your system. Overall, A2L refrigerants are a safe option for most air conditioning, heat pump and refrigeration applications.

Why Does Safety Matter?
Although A2Ls are only mildly flammable, leaks in confined spaces can pose ignition risks. That's why mitigation systems are essential

The Role of Mitigation Boards in A2L Systems
As HVAC systems adopt A2L refrigerants mitigation boards have become a crucial safety technology. These boards support compliance by monitoring refrigerant leaks and triggering appropriate responses.

Core Functions
- Refrigerant leak detection integration
- Automatic system shut-off
- Fan activation for dilution
- Compressor disable functions

These features help OEMs to meet new safety requirements and help installers achieve code-compliant installations. Mitigation technology is quickly becoming a standard in equipment design for A2L applications.

How People are Using It
- Contractors: Updating installation practices to include leak detection and ventilation requirements.
- Wholesalers: Stocking A2L-compatible components and tools.
- Manufacturers: Integrating mitigation boards and sensors into new equipment designs.

Where A2L Mitigation Boards are Typically Used:
An A2L mitigation board is used anywhere an HVAC or refrigeration system is designed to operate with A2L-class refrigerants (such as R-32 or R-454B).

- **Residential & Commercial HVAC systems -** A2L mitigation boards are built into or installed near HVAC equipment to meet new A2L safety requirements (e.g., UL60335-2-40). They connect to leak sensors and perform actions like shutting down compressors, activating alarms, or increasing ventilation when a leak is detected.

- **Inside or Near the Air-Handler/Evaporator Section** - In most factory-installed setups, sensors are placed inside the evaporator coil section, with the mitigation board mounted externally near the air handler, typically within 8 feet of the sensor. This allows fast response if refrigerant accumulates in the cabinet.

- **Walk-in Coolers, Freezers, and Refrigeration Units -** Systems using A2L refrigerants in commercial refrigeration (e.g., walk-in units) require mitigation hardware depending on refrigerant charge limits. Mitigation boards help meet UL safety thresholds by coordinating leak detection, alarms, and ventilation actions.

- **OEM HVAC-R Equipment Using Next-Generation Flammable Refrigerants -** Manufacturers integrate mitigation boards into new A2L-compliant systems. These boards

The Regulatory Landscape Driving A2L Adoption

Environmental regulations at both national and international levels are accelerating the transition toward low-GWP refrigerants. Key drivers include:

Global Beginnings: Kigali Amendment (2016)

The Kigali amendment, adopted in 2016 under the Montreal Protocol, is a global agreement that aims to phase down high-GWP hydrofluorocarbons (HFCS) worldwide; This set the groundwork for transitioning to low-GWP alternatives, including A2L refinements.

2016 — **U.S. Legislation: AIM Act & EPA Snap**

December 2020

The American Innovation and Manufacturing (AIM) Act authorizes the EPA to reduce HFC production and consumption by 85% by 2036.

June 2021

EPA approves A2L refrigerants for residential air conditioning under SHAP, enabling regulatory compliance and market introduction.

'22 - '23 — **Industry Preparation & Early Deployment**

AIM Act Phase 1

~40% reduction achieved, major OEMs start R-454B and R-32 integration.

Safety Standard Update

ASHRAE Standard 45 and UL 60335-2-40 evolve to account for A2L low GWP and mild flammability.

2024 — **Code Updates & Manufacturer Rollouts**

The 2024 I-CODES (IMC, IRC, IFC)

Incorporate provisions for safe installation of A2L refrigerants; U.S. states begin updating local codes. AJRI launches an interactive map of code adoption

OEMS increasingly release R-454B based equipment; many enter the market before 2025 mandates.

'25 - '26 — **Mandatory Switch Begins**

January 2025

A2L use required after 1 Jan 2025, with up to 3 years of sell-through allowed. Split systems & mini-splits: deadline 1 Jan 2026 with a 1-year sell-through.

January 2026

New residential and light-commercial systems must use refrigerants with GWP ≤700, effectively banning R-410A on new builds.

'26 + — **Full Commercial Adoption and Phase-Downs**

All newly installed commercial refrigeration systems must utilize low-GWP refrigerants, with A2Ls taking precedence.

Continued deployment: Refrigerant phases continue, targeting 70% HFC reduction by 2029, and the ultimate goal of 85% cut by 2036.

As these standards evolve, OEMs, technicians, and contractors must adapt their system designs, installation practices, and safety protocols.

continuously monitor A2L sensors and execute mitigation such as shutting down equipment or communicating with system controllers via MODBUS.

- **Field-Installed A2L Mitigation Kits -** When retrofitting or installing systems, A2L-trained HVAC contractors mount the mitigation board inside a control box near the furnace or evaporator coil, connecting it to sensors, wiring harnesses, and airflow systems.

Rapid OEM Adoption
Manufacturers are rolling out new equipment platforms built specifically for A2L refrigerants. These include:

- Heat pumps
- Residential split systems
- Rooftop units
- Variable refrigerant flow (VRF) systems

This wave of updated equipment is reshaping technician training requirements and industry norms, providing increased safety and easier certification and market acceptance of new refrigerant technologies

Contractor Readiness
A2L mitigation systems must be installed by contractors specifically trained in A2L refrigerant handling and safety. Which typically includes understanding of the following:

- A2L refrigerant safety protocols (mild flammability, LFL thresholds, and ignition prevention)
- Leak detection and verification procedures using approved A2L tools (vacuum pumps, leak detectors, recovery machines, regulators)
- Proper handling and brazing techniques to prevent leaks in A2L systems
- Electrical integration of mitigation control boards with furnace/air-handler low-voltage wiring
- Sensor placement requirements and airflow considerations
- Code and UL mitigation requirements, especially UL 60335-2-40/-2-89 categories and charge-limit–triggered mitigation rules
- These essential trainings are generally delivered by OEM distributor trainings, manufacturer certification modules, industry associations (ACCA, RSES) and local licensing agencies adopting A2L codes.

To stay compliant with safety regulations and manufacturer warranty conditions, contractors must document that A2L-specific training has been completed.

Why It's Important to the Homeowner
With newer HVAC systems transitioning to A2L refrigerants like R-454B and R-32, safety and compliance matter more than ever. An A2L mitigation board with sensors plays a crucial role in protecting both the home and the HVAC equipment.

In simple terms, an A2L mitigation board with sensors acts like a smoke detector and safety shutoff system for modern day refrigerants. It keeps your home safe, protects your HVAC investment, aligns with new regulations, and gives homeowners peace of mind as the industry shifts to more environmentally friendly—but mildly flammable—refrigerants.

The mitigation board protects the HVAC system from damage such as:

- Burnout of the compressor
- Mechanical failures caused by refrigerant loss
- High repair bills

The sensor capability, on the other hand helps provide better whole-home coverage and includes MODBUS communication for advanced monitoring. This leads to better leak coverage for larger homes or multi-zone HVAC systems, more accurate detection and a smarter, more responsive HVAC safety system.

Spotlight Technology: The ICM-A2L-24C-DUAL Mitigation Control Board
As A2L refrigerants become the new standard in residential and light-commercial HVAC systems, manufacturers and installers require advanced safety solutions. The ICM-A2L-24C-DUAL, developed by ICM Controls, represents a next-generation approach to A2L mitigation technology—combining dual-circuit capability, intelligent control logic, and integration flexibility to meet evolving industry requirements.

Purpose-Built for A2L Refrigerant Safety
The ICM-A2L-24C-DUAL is engineered to help HVAC OEMs and installers meet UL 60335-2-40 mitigation requirements by providing a fast, re-

liable response to refrigerant leak conditions. As A2L refrigerants introduce mild flammability considerations, mitigation controls are essential to ensuring occupant safety and equipment protection.

Key functions include:

- Integration with refrigerant leak detectors to initiate rapid safety actions
- Automatic system disable, preventing compressor operation during alarm conditions
- Fan activation to dilute leaked refrigerant, reducing concentration below flammability limits
- Communication via sensor

These features directly support the refrigerant-leak mitigation actions required under UL and ASHRAE standards.

Designed for Flexibility & Field Durability

To support the broad range of equipment transitioning to R-454B and other A2Ls, the ICM-A2L-24C-DUAL is built with:

- 24V control system compatibility
- Factory configurable logic to meet specific OEM requirements
- High-reliability components suited for demanding HVAC environments
- A compact footprint for easy integration into new platform designs

Its dual-circuit functionality reduces the need for multiple independent boards, simplifying both system architecture and installation labor.

Homeowner Protection:

This product is especially important to have within the home as there are smaller enclosed areas where refrigerant can accumulate (closets, attics, and hallways) which can make it more difficult for occupants to detect or recognize warning signs. An integrated mitigation system addresses these challenges head-on by:

- Preventing ignition-level concentrations
- Protecting sleeping occupants
- Providing real-time alerts and diagnostics
- Reducing liability for installers and builders

Mitigation systems thus serve as a critical bridge between new refrigerant technologies and homeowner safety expectations.

Where and How A2L Mitigation Boards are Installed?

Provided are detailed steps for mounting a typical A2L Mitigation Control System.

1. Placement of the Refrigerant Detection Sensor:
   The A2L refrigerant sensor is mounted on a vertical surface inside the evaporator coil compartment, typically in the drain pan area, in a location where it cannot get wet, (refrigerant is heaverier than air, will sink), using a supplied sensor bracket or double sided tape (within three feet of the furnace or air handler for effective detection).

   Key details:
   - Sensor must be vertically oriented
   - Cable must be routed through an opening with a grommet and drip loop to avoid moisture intrusion
   - Sensor placement varies by coil type (A-coil, slab coil, horizontal coil, plenum systems), but always in a location where leaked refrigerant will naturally settle

2. Installation of the Mitigation Control Board:
   The mitigation board is installed in a field-mounted enclosure that must be secured to a flat, vertical surface near the coil, usually on a wall or nearby framing (not directly on the furnace or coil cabinet, to avoid vibration and heat exposure) using either two-sided tape or screws provided with the kit.

3. Wiring Connections:
   Mitigation boards tie into the HVAC control system through low-voltage wiring, generally:

   - 24V Hot (R) from furnace/thermostat
   - 24V Common (C)
   - Y1 Interruption Circuit to shut down cooling upon detection
   - Outdoor condenser contactor (CC) connection

   The system wiring ensures:
   - Compressor shutdown during leak events
   - Air-moving equipment starts in mitigation mode
   - Fault indication status

Realistic Case Scenario: How an A2L Mitigation System Protected a Homeowner:
In late summer, a homeowner in a newly constructed residence experienced an unexpected but potentially dangerous event involving their A2L-based HVAC system. During routine operation, a minor refrigerant leak developed within the indoor air-handling unit—an event that, without proper safeguards, could have led to elevated concentrations of mildly flammable A2L refrigerant in a confined space.

Thanks to the home's integrated A2L mitigation system, the leak was detected and controlled before it posed a risk to safety, property, or system integrity.

Early Leak Detection
The system's built-in A2L refrigerant sensor continuously monitored the air in the mechanical closet. When refrigerant levels exceeded the preset detection threshold, the sensor triggered an immediate alert to both the HVAC control board and the mitigation controller. This early warning ensured that the refrigerant concentration never approached dangerous levels.

Automatic System Response
Within seconds, the mitigation system initiated a coordinated response:

- Forced ventilation activated, rapidly diluting the leaked refrigerant.
- The HVAC compressor shut down to prevent further refrigerant movement,
- System blowers engaged in a controlled mode to direct airflow toward the mitigation venting path.

This orchestration ensured that refrigerant levels stayed well below the lower flammability limit (LFL), preventing ignition risks and protecting the homeowner.

Contractor Intervention & Resolution
When the technician arrived, the system had already stabilized the environment, allowing the contractor to quickly identify a compromised flare fitting that caused the leak. After repairs and system re-verification, the A2L monitoring and mitigation features returned to standby mode.

Outcome
The A2L mitigation system successfully:

- Prevented hazardous refrigerant accumulation
- Eliminated potential ignition risk
- Protected the homeowner from exposure
- Reduced service time by providing accurate event diagnostics

This scenario demonstrates how modern A2L mitigation technology transforms a potentially dangerous situation into a controlled, low-impact maintenance event—offering peace of mind for homeowners and confidence for installers implementing A2L-based HVAC system

Long-Term Outlook
A2L refrigerants will dominate the near-term future for residential and commercial HVAC due to:

- Their balance of safety, cost, and performance
- Regulatory alignment
- Compatibility with mainstream system designs

The next generation of A2L mitigation systems will integrate advanced technologies such as:

- Cloud-connected monitoring for remote alerts
- Predictive analytics to identify refrigerant-loss patterns
- Smart-home system integration (HVAC + IAQ + safety alerts)

These advancements will transform A2L mitigation from purely reactive systems into proactive, intelligent protection solutions.

Conclusion
The HVAC industry is entering a trans-formative era. A2L refrigerants offer a practical, low-GWP solution that supports global sustainability initiatives while preserving familiar system architectures. With the addition of mitigation boards and updated safety standards, these refrigerants can be integrated safely and effectively across a wide range of applications.

Contractors, OEMs, and technicians who embrace these changes will be better positioned to meet future code requirements, protect customers, and stay competitive in a rapidly shifting market.

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