



## WHEN THE REFRIGERANT CHANGES, SO DOES THE ELECTROMECHANICAL CONTACTOR

The shift away from high global warming potential (GWP) hydrofluorocarbon (HFC) refrigerants is doing something most engineers didn't anticipate. It is forcing a reexamination of electrical switching components that have gone largely unchanged for decades.

GWP measures how much heat a greenhouse gas traps relative to carbon dioxide over a given period, and it is the number driving this massive regulatory transition. For years, electromechanical contactors, disconnect switches and control relays were selected based only on electrical performance — voltage, current rating and duty cycle. But because many low-GWP HFC alternatives are mildly flammable, a new parameter has appeared on the spec sheet that has nothing to do with electricity: flame arrest.

This shift is a result of the American Innovation and Manufacturing (AIM) Act, which mandates an 85% reduction in HFCs by 2036. As of January 1, 2025, the importation of equipment with R-410A (GWP of 2,088) has ceased, replaced by a new generation of refrigerants like R-454B and R-32. While these gases are environmentally superior, their ASHRAE A2L classification means they require an electrical architecture designed to contain potential ignition.

Not every electrical device in a refrigeration or HVAC system needs A2L certification, however. The components in scope are those that produce arcs during normal operation or under fault conditions. Two questions determine whether a device qualifies. Does it arc? Could leaked refrigerant reach it?

## THE ARC-PRODUCING COMPONENTS THAT MUST COMPLY

**Electromechanical contactors and mini-contactors.** Every time an electromechanical contactor opens or closes to control a compressor, fan or defrost circuit, it makes an arc at the contact gap. In a refrigerant-present atmosphere, that arc is a credible ignition source. A2L compliance demands that contactor housings meet the Annex JJ maximum gap dimensions, so any flame initiated inside the housing cannot propagate through the enclosure openings into the surrounding atmosphere. Meeting those dimensions requires new tooling, retesting and certification under the UL component category LZGH2/8.

**Disconnect switches.** Disconnectors used for circuit isolation make the same type of arc as electromechanical contactors. A disconnector operated in an area where leaked refrigerant could accumulate poses an identical ignition risk and must meet the same Annex JJ gap geometry and arc containment requirements.

Substituting a non-certified disconnector of similar current rating into an A2L system introduces an unqualified ignition source into the circuit.

**Electromechanical and monitoring relays.** Control relays used for sequencing, safety interlocking or demand logic share the Annex JJ requirement whenever they sit within a potential refrigerant leak zone. Flammable gas requirements include:

- Evaluation of spark-producing components.
- Determination of arcs and hot surfaces under normal and abnormal conditions.
- FMEA demonstrating that no fault can generate an arc capable of reaching the gas's self-ignition temperature.

**Motor protection circuit breakers.** Motor protection circuit breakers (MPCBs) in compressor circuits also fall within the scope of A2L compliance when they are located in the potential refrigerant leak zone.

## WHAT'S GENERALLY EXEMPT

Components that do not arc, such as transformers or sealed solid-state electronics that cannot produce sufficient arc energy under any fault condition, typically do not require A2L-specific certification. However, exemption still requires a documented FMEA showing that no fault scenario can generate ignition-capable energy.



## A2L REPLACEMENT REFRIGERANTS AT A GLANCE

The ASHRAE A2L classification means lower toxicity (A), flammable (2) and low burning velocity at or below 10 cm/s (L). The table below compares the leading A2L replacements against the legacy R-410A they are displacing.

Refrigerant	ASHRAE Class	GWP (100-yr)	Burning Velocity	LFL (% v/v)	Status
R-32	A2L	677	~6-8 cm/s	~13.3%	Used purely in Asia; component of blends
R-452B	A2L	676	< 10 cm/s	~13.5%	Used by some OEMs as R-410A alternative
R-454B (Opteon XL41)	A2L	466	< 10 cm/s	~13%	Leading North American R-410A successor
R-454A	A2L	239	< 10 cm/s	~11%	Lower GWP, lower capacity
R-454C	A2L	148	< 10 cm/s	~10%	Light commercial refrigeration
R-1234yf	A2L	< 1	~1-3 cm/s	~6.2%	Mobile A/C; component of blends
R-410A (legacy)	A1	2,088	Non-flammable	N/A	Banned in new equipment from Jan. 2025

*ASHRAE Standard 34 classifications.*

The high LFL values — typically 10 to 19 percent volume in air compared to roughly 2 percent for propane — mean that a large concentration must accumulate before a flammable mixture forms. The high minimum ignition energy means A2L gases need a powerful source to ignite. An electrical arc from an electromechanical contactor or switch supplies more than enough energy, which is why switching components are the primary focus of A2L compliance.

## THE STANDARDS AND CERTIFICATION PATHWAY

Two product-level standards govern compliance. IEC/UL/EN 60335-2-40 covers heat pumps, air conditioners and dehumidifiers, and IEC/UL/EN 60335-2-89 covers commercial refrigerating appliances. Component specifiers should know four annexes in particular:

- Annex JJ establishes maximum opening dimensions for electromechanical contactor and relay housings.
- Annex KK addresses hot surface ignition temperature testing under both normal and fault conditions.
- Annex LL and PP cover refrigerant detection systems.
- Annex NN specifies flame arrest enclosure verification.

The critical UL component category is LZGH2/8, developed under UL 60335-2-40. A certificate issued under LZGH2/8 proves the absence of any ignition source inside the unit per Clause 22, which enables UL to waive the more onerous Annex FF leak simulation testing at the system level. That waiver can shave weeks off the product development cycle.

This matters most for unprotected systems, where at least one part of the cooling system sits inside the food storage or occupied space. In these designs, a refrigerant leak could create ignitable conditions near electrical components. Compliance requires either component-level LZGH2/8 certification or a whole-enclosure flame arrest approach. Specifying LZGH2/8-certified electromechanical contactors and disconnectors takes the simpler path.

## SOLUTIONS FROM LOVATO ELECTRIC

### Electromechanical Contactors

LOVATO Electric's BG series mini-contactors and BF series contactors, including the DPBF series definite purposed rated versions, have completed the LZGH2/8 certification process and are certified under both UL 60335-2-40 (heat pumps, air conditioners, dehumidifiers) and UL 60335-2-89 (commercial refrigerating appliances).

The BG Series offers three-pole variants from 6A to 12A (3 to 7.5HP at 480V UL/CSA). Coils include AC, DC, and low-consumption DC. Termination options span screw, FASTON and rear PCB solder pin, making the series suitable for compact OEM refrigeration controller enclosures where refrigerant could stagnate near arcing contacts. The BF and DPBF Series contactor line is also A2L certified to extend coverage for larger current up to 150A (up to 100HP at 480V UL/CSA).

### Disconnect Switches

LOVATO Electric's GA Series disconnect switches cover 16A to 125A and are compatible with A2L refrigerant applications. Units from 16A to 40A measure only 36mm wide, while the 63A to 125A ratings use a 70mm body. All versions carry 800V rated insulation voltage, 8kV impulse withstand and 100,000-cycle electrical and mechanical life.

Units are available in direct operating, door-mount and door-coupling versions, DIN rail or screw mountable, and padlockable in the open position without additional accessories. That padlock capability matters more than it used to when the system contains a flammable refrigerant.



### Monitoring Relays

LOVATO Electric's PMV voltage monitoring relays are also A2L certified. They monitor voltage, current, and frequency in three-phase systems and are commonly installed in HVAC control panels. The range includes the PMV10 for phase loss and phase sequence monitoring, the PMV50 for min/max voltage with phase loss and sequence detection, and the PMV55 for single-phase min/max voltage, covering 208-480VAC at 50/60Hz.

### Motor Protection Circuit Breakers

LOVATO Electric's SMI series MPCBs are in the process of obtaining A2L approval, which will extend flame-arrest compliance to motor protection across the compressor circuit.

## LEAK DETECTION AND THE ELECTROMECHANICAL CONTACTOR'S EXPANDING ROLE

UL 60335-2-40 requires leak detection sensors that activate at less than 25 percent of the refrigerant's LFL. When concentrations approach threshold levels, the system must initiate ventilation or controlled shutdown.

That requirement changes what an electromechanical contactor does in the system. A mini-contactor controlling a ventilation fan is now a safety actuator. The disconnect switch is the device that isolates circuits when the detection alarm triggers. Because many A2L refrigerants are denser than air, detectors should sit at low points near coil connections, valves and compressor compartments.

Here's a quick checklist:

**Verify LZGH2/8 certification** on every electromechanical contactor, mini-contactor and disconnect switch in the refrigerant zone. A component with the right current rating but without A2L certification is a non-compliant ignition source.

**Confirm Annex JJ gap compliance.** The housing gap dimensions are a physical design parameter. There is no equivalence between A2L-certified and non-certified components of the same electrical rating.

**Check VFD listings.** Any drive previously listed under UL 508C must be re-specified against UL 61800-5-1 for A2L service. This is frequently missed in system conversions.

**Request FMEA documentation from component suppliers.** The analysis must demonstrate that no fault condition produces an arc reaching the refrigerant's self-ignition temperature.

**Build leak detection into the control architecture from the start.** Electromechanical contactors and disconnectors are part of the safety response chain. Specify them accordingly.

**Consider A2L compliance even where it isn't mandated yet.** Some sectors, like data center cooling, have no hard A2L requirement today. But many specifiers in those sectors are already requesting compliant components as an added safety margin, and the regulatory direction is clear. Designing A2L compliance into the BOM now avoids a second round of respecification later.

For decades, selecting refrigerants and electrical components were independent engineering decisions. With A2L, however, they are not. The flammable nature of the new refrigerants means every arc-producing device in the system poses a safety concern, and the standards now reflect that. Engineers who build this understanding into their specifications today will spend less time chasing compliance issues once the equipment reaches the test lab.



For more information, please visit our website at [www.lovatousa.com](http://www.lovatousa.com).



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