Ducted System's A2L Best Practices Installation and Service

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Authored By Mark Petty

YORK®

A2L Review

Why are we changing the refrigerant for our equipment?

Kigali Amendment to the Montreal Protocol – effective in 2019, an international agreement to:

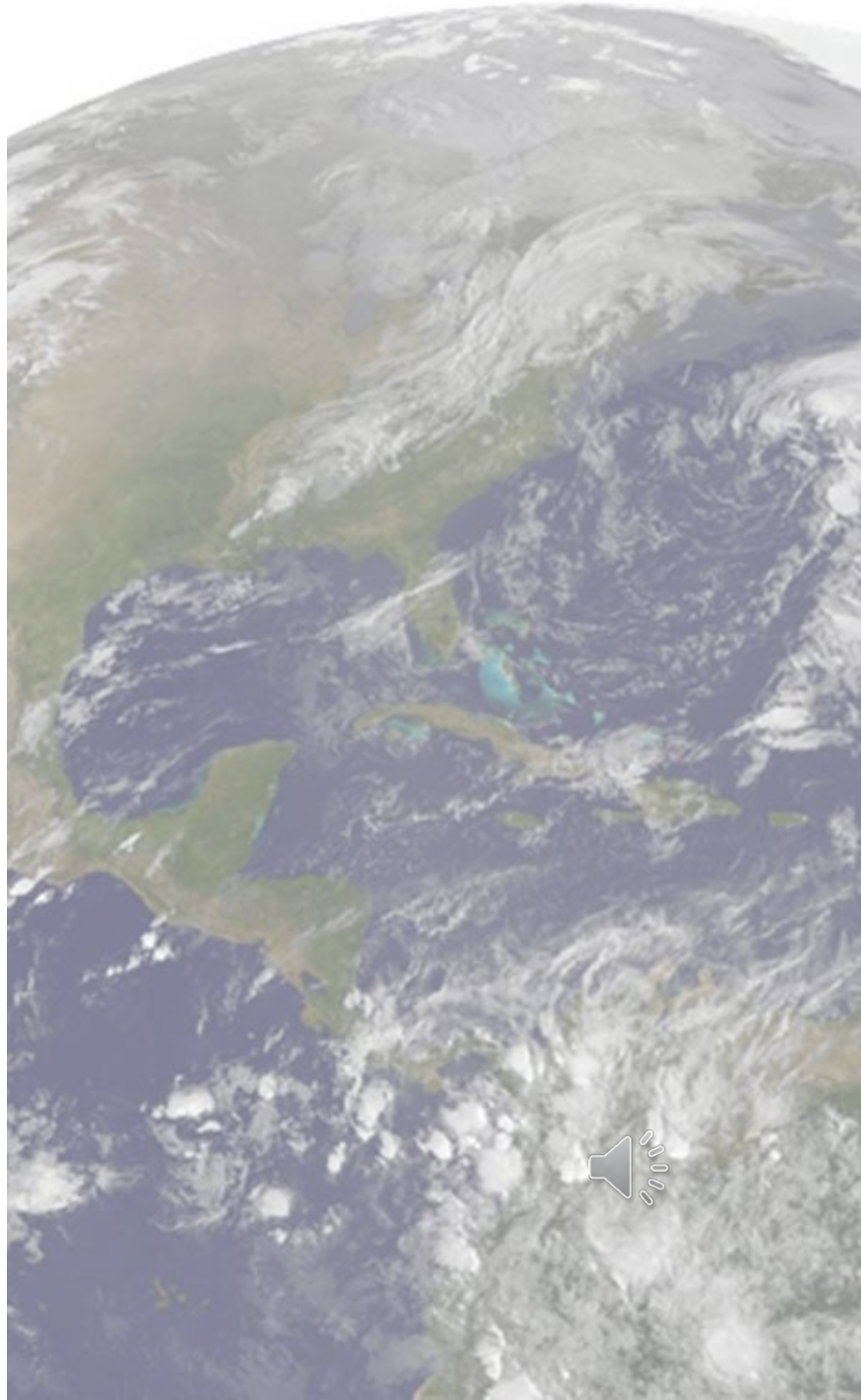
- **Transition to lower global warming potential (GWP) refrigera**
- **“phasedown” HFC [R-410A] production and consumption**
  - **Has been ratified by 90+ countries including Canada**
  - **Ratified by the U.S. 10/31/2022**

A2L Review

GWP = Global Warming Potential

GWP drives R-410A to an A2L change

- A lower GWP number indicates **less** "greenhouse gas" affect
- 2021 JCI made a choice to use R-454 for Ducted Systems refrigerant
- R-410A has a GWP rating of **2088**
- R-454B has a GWP rating of **467**



A2L Review

R-454B is in ASRAE Safety Group A2L ("A2L refrigerant") – a relatively new category for "mildly flammable" refrigerants

- **A = non-toxic**
- **2 = flammable**
- **L = low burning velocity; less than 3.9 in/sec (10 cm/sec)**
  - **R-454B has a burning velocity of 2.0 in/sec – almost 10 times slower than ethanol**

- *Also, for the A2L safety group: the Heat Of Combustion (HOC) must be less than **8169** BTUs/lb*
  - *R-454B HOC: ≈**4342** BTUs/lb*

A2L Review

Why the choice of R-454B? (Mildly Flammable)

Suitable low GWP A/C refrigerants are listed as flammable refrigerants

- R-454B has favorable flammability characteristics compared to other low GWP refrigerants
- Factors of GWP, performance, industry acceptance, etc. were also weighed in choosing R-454B
- *Pressures and Temperatures closely mirror those of R-410A*
- *R-454B is rated as a A2L Refrigerant*

A2L Review

A mix of R-454B vapor and air is only combustible in a *relatively narrow range*

- The Lower Flammability Limit and Upper Flammability Limit bracket the concentrations of R-454B vapor in air where combustion is possible
  - **Concentrations below the Lower Flammability Limit are too lean to support combustion**
    - **R-454B Lower Flammability Limit: 11.25% (volume) Method: ASTM E681**
  - **Concentrations above the Upper Flammability Limit are too rich to support combustion**
    - **R-454B Upper Flammability Limit: 22% (volume) Method: ASTM E681**
- **Key concept: Lower Flammability Limit**

A2L Review

A combustible mix of R-454B vapor and air has an ignition temperature above 1472°F (800°C)

- Requires an open flame or “high energy ignition source” to ignite
  - Static electricity discharge, toaster, or hair dryer – listed as 400°C or less ignition sources – typically cannot ignite a combustible mix of R-454B vapor and air

Ignition Temperature >1472°F

Opteon

A2L Review

- **R-454B Compared to R-410A**

- R-454B has 82.3% of R-410A mass flow (lb/min/ton)
- R-454B has 93.5% of R-410A liquid density
  - Lower mass flow and refrigerant density affect equipment design and split-system piping calculations
- R-454B discharge temperature is typically ≈10 to 15°F more than R-410A
  - May be noticed in residential products that monitor discharge temp
- R-454B system performance: ≈3% gain in efficiency, ≈2% loss in capacity in a system with the same design characteristics as R-410A

	R-454B	R-410A
0 psig	-57.09°F	-60.46°F
40°F	107 psig	118.4 psig
45°F	117.8 psig	130.1 psig
50°F	129.3 psig	142.6 psig
95°F	270.4 psig	295.4 psig
110°F	335.2 psig	365.4 psig
125°F	410.8 psig	446.8 psig

source of data in above table: Danfoss Refrigerant Slider app - dew setting

A2L Best Practices

Working with R-454B *is not* a giant shift from working with R-410A.

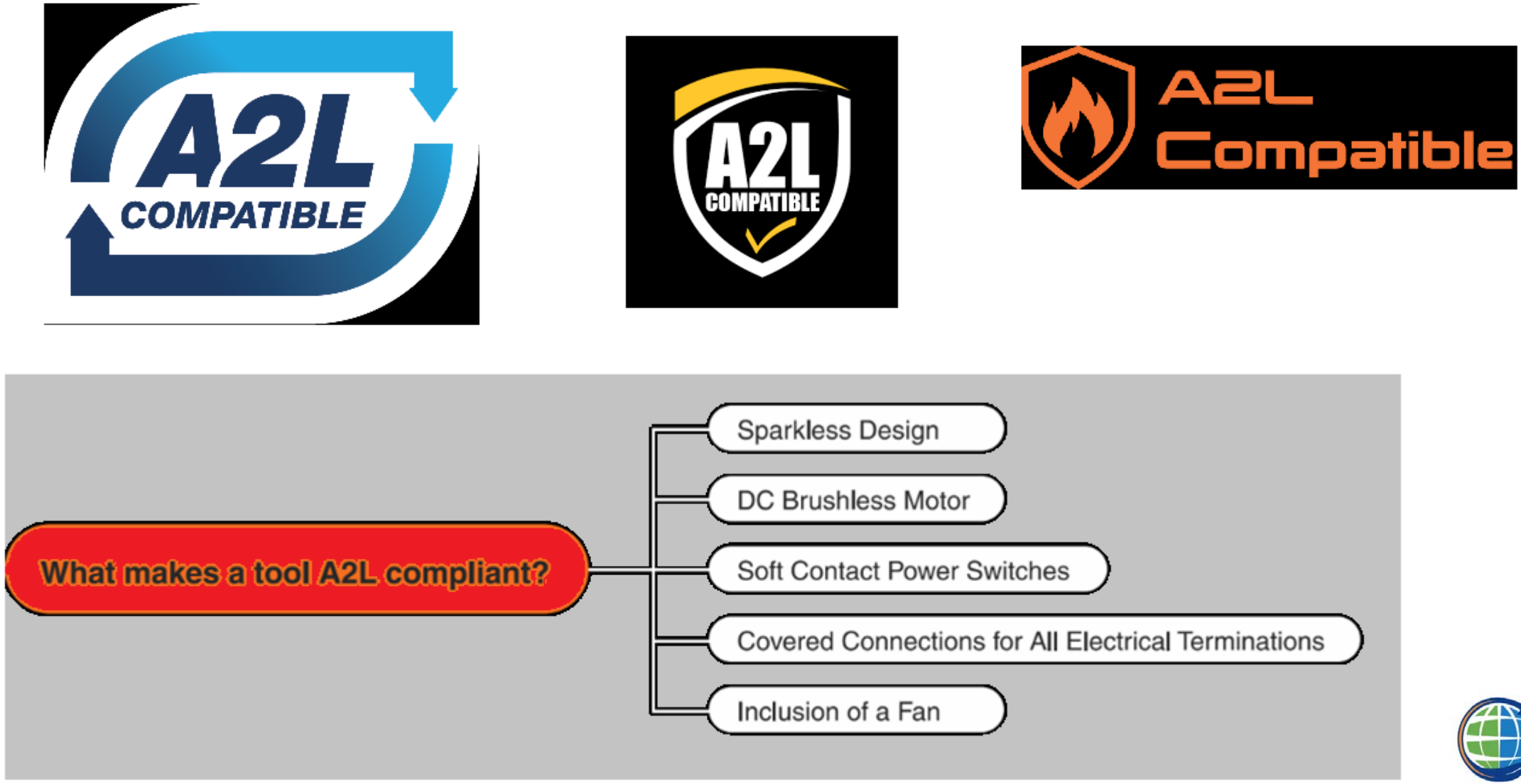
Pressures and temperatures are very close to the same.

Many of the same procedures (best practices) have over decades, remained the same. Some practices and tools have changed to maintain safety when working with R-454B due to its slightly flammable nature.

A2L Best Practices (Tools)

Service Item	R-410A	Opteon™ XL
Gauge manifold	Routine	Routine
Charging hose	Routine	Routine
Torque wrench	Routine	Routine
Flare tool	Routine	Routine
Pipe cutter	Routine	Routine
Pipe bender	Routine	Routine
Hex wrench	Routine	Routine
Ventilation Fan, if low ventilation	Routine	Routine
Scales	Routine	Routine
Vacuum pump	Routine	2L approved
Dry Powder/CO2 Fire Extinguisher	Not necessary	Chemical compatible
Gas Detector	Routine	2L approved
Electronic leak detector	Routine	2L approved
Refrigerant recovery cylinder	Routine	Updated labeling (check available guidelines)
Recovery machines	Routine	2L approved

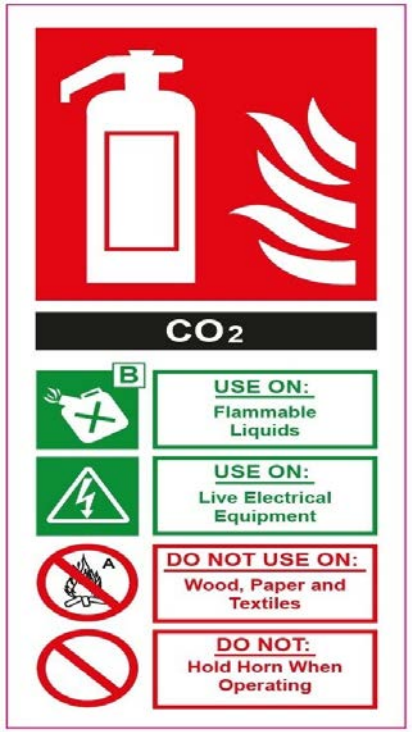
A2L Best Practices (Tools A2L Compliant)



A2L Best Practices (Tools)

Fire Extinguisher (CO2 Dry Powder Class B)

CO2 fire extinguishers are designed for Class B liquid fires & safe to use on live electrical. Class B fires that can be extinguished with a carbon dioxide extinguisher include flammable liquids and gases, solvents, oil, greases (excluding cooking oils/greases), tars, oil-based paints and lacquers.



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A2L Best Practices (Tools)

The leak checking device must be rated for HFO (Hydrofluoroolefin) refrigerants and/or be A2L compatible. The device should be labeled A2L compatible or use for HFO/A2L refrigerants. The use of designed “soap bubbles” are still acceptable way to find larger leaks, electronic leak detectors A2L Compatible, are better practice to finding small leaks

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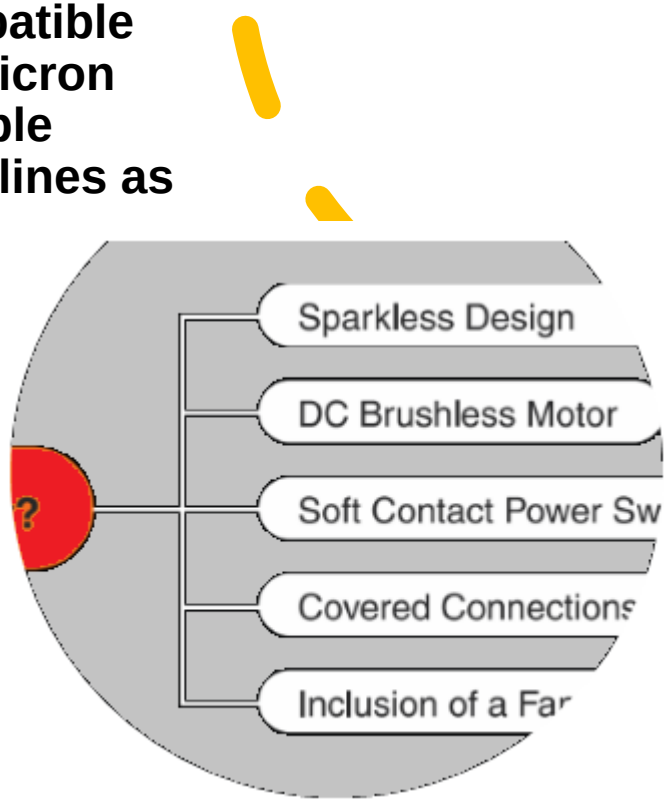
A2L Best Practices (Tools)

- **Vacuum pumps must be A2L compatible and must be able to achieve a 500-micron vacuum or greater. An A2L compatible vacuum pump must follow the guidelines as shown in the slides before.**



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A2L Best Practices (Tools)

All A2L refrigerant cylinders and recovery cylinders access valves will be left-handed threads.

Hose adapters will need to convert the right-handed flare hose fittings to access the left-handed A2L cylinder adapter

Pressure relief valve — In the event of excessively high cylinder pressure, A2L cylinders include a pressure relief valve that's designed to only release enough refrigerant to reduce the pressure in that cylinder. Upon release the valve will reset.

Red band/stripe — A2L cylinders will have a red band (stripe) or the entire top painted red to indicate the presence of the mildly flammable refrigerant

•Adapter 1/4" LH FFL TO 1/4" RH MFL, STR

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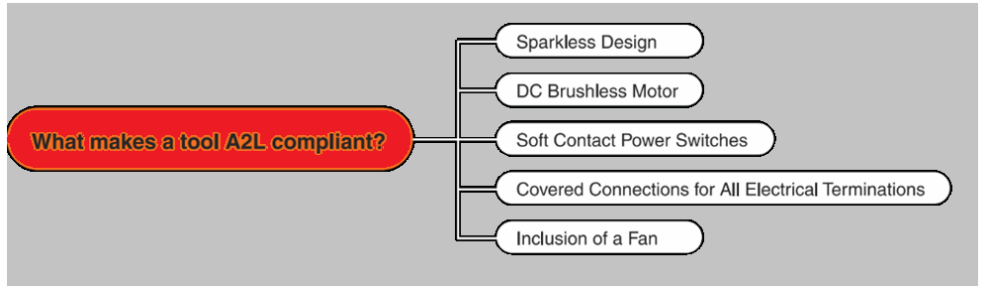
A2L Best Practices (Tools)

Recovery machines must be A2L compatible and able to recover both vapor and liquid A2L refrigerant.

Make sure that the recovery cylinder is DOT approved for A2L refrigerant



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A2L Best Practices

Before Installing or Servicing Equipment

- **SAFETY FIRST!**
- Read SDS and OEM Equipment Manual.
- Follow lockout/tagout procedures when needed.
- Verify no voltage is present before working.
- Ensure area is well ventilated.
- Evaluate jobsite for a) ignition sources, b) flammable vapors, c) controlling area, d) confined spaces, and e) clear exit points.

A2L Installation

- Follow OEM guidelines for minimum room area/refrigerant charge limits.
- Ensure mitigation components are installed and operating per OEM instructions.
- Use locking refrigerant caps to prevent unauthorized access to the system.
- Ensure a filter drier is installed.

A2L Evacuation and Pressure Test

- Consult the OEM instructions to determine proper evacuation targets/procedures.
- Pressure test field erected components.
- Evacuate the system before charging using an A2L rated vacuum pump.
- Record a) *date*, b) *test pressure, and* c) *vacuum level on the label* (UL 60335-2-40).

A2L Charging (if required)

- Do NOT exceed the maximum allowable refrigerant charge per OEM instructions. (Charge amounts may vary due to line-sets.)
- Follow OEMs procedure for proper charging techniques. (Superheat/Subcooling)
- If refrigerant is a 400-series, the refrigerant must leave the cylinder in 'liquid form.'
- Record a) *date* and b) *total refrigerant charge weight on the unit label* (UL 60335-2-40).

A2L System Repairs

- Leak check to verify no refrigerant is present.
- Ensure equipment is grounded before working.
- Use proper capacitor discharge methods.
- Use only OEM approved replacement parts.
- Use nitrogen before and during all brazing.

A2L Recovery

- Do NOT vent.
- Do NOT mix refrigerants.
- Use recovery tools rated for use with A2L refrigerants.
- Recover all refrigerants before opening system.
- Recover into DOT approved recovery cylinder.
- Do not exceed cylinder fill weights.
- Label recovery cylinder contents.

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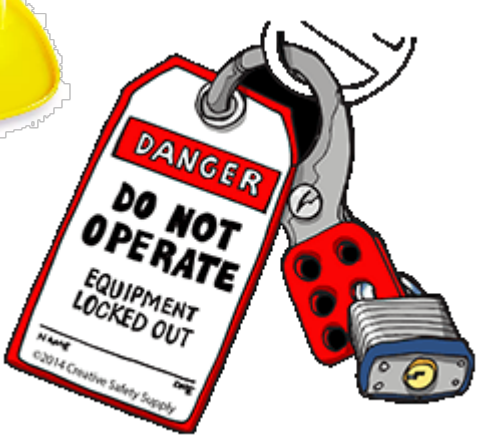
A2L Best Practices (Safety)

- Always read the JCI installation manual
- Always wear your basic PPE (Personal Protective Equipment)
- Reduce any chances of sparking or open flames when R-454B refrigerant is present
- Use tools approved/compatible for working with A2L refrigerants
- Check to make sure all voltages are not present
- Make sure area of work is well ventilated
- Make sure RDS is in place for the A2L system
- Follow Lock-Out – Tag-Out procedures when needed



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A2L Best Practices (Safety)

(RDS) Refrigerant Detection System

UL Standard 60335-2-40 Leak Detector Specification

Refrigerant leak detection systems are required to have both sensors and control logic electronics that activate the evaporator fan and use circulated air to quickly disperse and dilute refrigerant in the event of a leak. This is intended to prevent the formation of refrigerant concentrations.

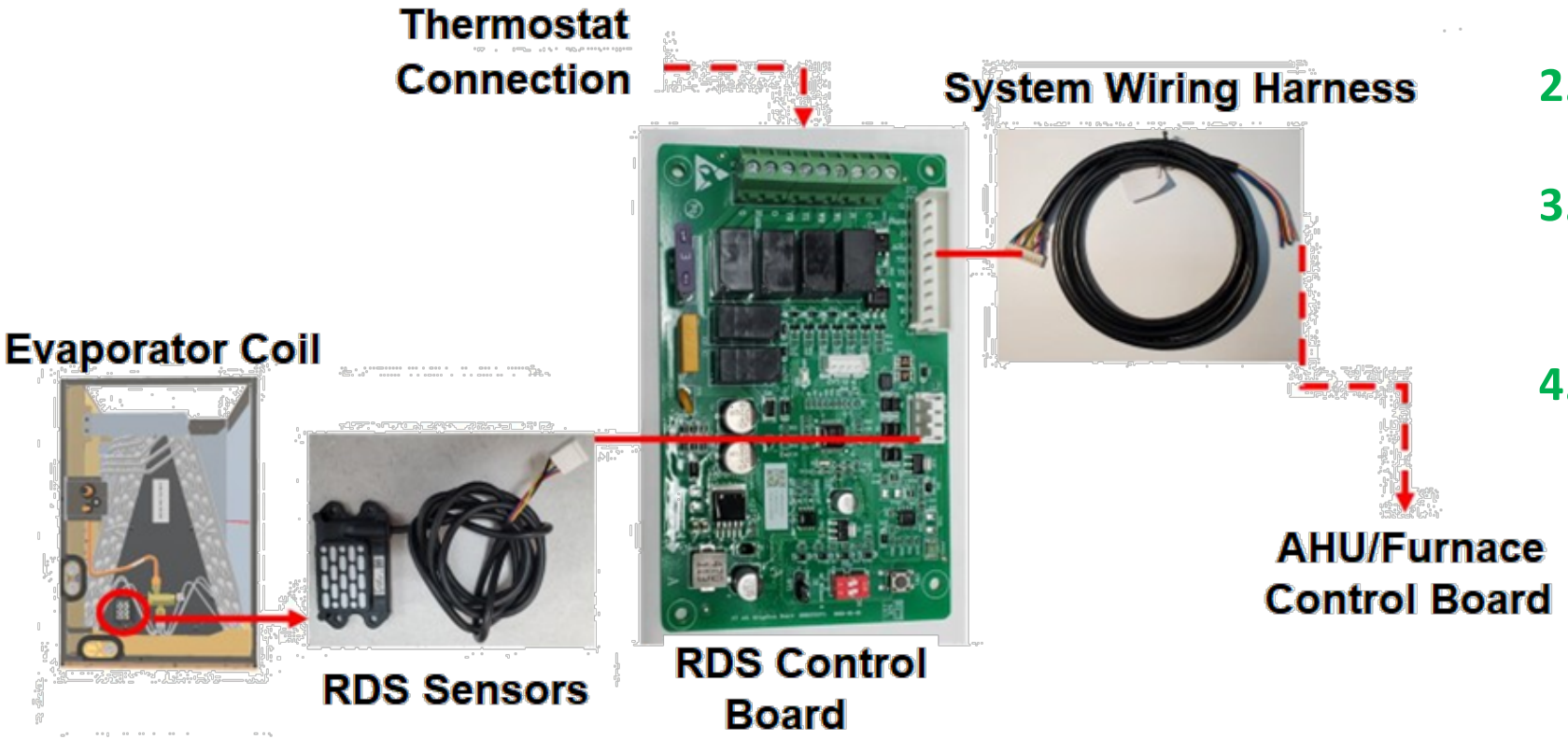
Once a refrigerant leak has been detected, heating/cooling call will be terminated immediately, and the indoor blower will be immediately initiated to dilute the concentration or leaking refrigerant.

A2L Best Practices (Safety)

System Leak Detector

(RDS) *Refrigerant Detection System*

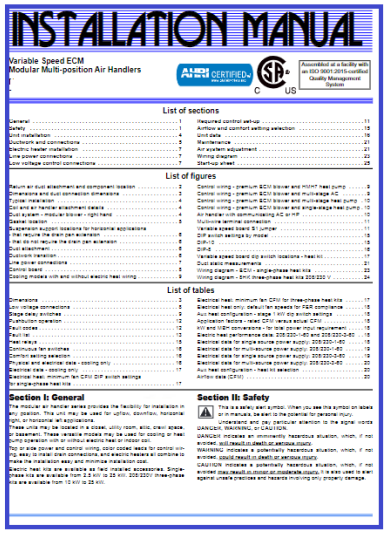
UL Standard 60335-2-40 Leak Detector Specification



1. Detection of refrigerant leak by the A2L sensor
2. The sensor reports leak to the RDS control board.
3. The RDS control board interrupts the present call for either cooling or heating
4. The control board energizes the blower to dilute any A2L gases that could be present

A2L Best Practices (Installation)

- Follow the JCI guidelines for clearances and charge limitations
- Make sure mitigation control is in place and wired correctly as per JCI instructions
- Use refrigerant access locking caps to prevent unauthorized access to system
- Make sure that a filter drier is installed in the liquid side of the refrigerant circuit(s). If this is a heat pump installation a bi-flow drier must be installed in the liquid line. Never install a suction drier in the liquid line


INSTALLATION MANUAL

Variable Speed ECM
Modular Multi-position Air Handlers

List of sections

List of figures

List of tables

Section I: General

Section II: Safety

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A2L Best Practices(Evacuation)

- When replacing a system for a new R-454B system or components:
- Recover all the refrigerant DO NOT Mix refrigerants
- 1 Purge the refrigeration circuit with an inert gas such as Nitrogen
- 2 Evacuate the line set (existing or new)
- 3 Purge the refrigeration circuit with nitrogen again
- Always preform a pressure test inert gas such as Nitrogen
- After the new A2L system components are installed, evacuate the line set down to 500 microns of vacuum.

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A2L Best Practices(Leak Repair)

- When repairing a leak in a refrigerant line or component first make sure all A2L refrigerant has been removed and evacuated from the system
- Run dry nitrogen through-out the system (just enough to have a small presence of nitrogen to prevent an oxygen presence while brazing) usually 1 to 2 PSI. After repair has been completed, leak check system again
- Evacuate system as instructed previously. Be sure evacuate with approved vacuum pump to 500 microns.

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A2L Best Practices(Recovery)

- Always verify that the recovery machine is operating normally before performing a recovery. If you suspect the recovery machine may have an issue it must be serviced by an Appion Factory Service Center.
- A temporary flammable zone should be created with a 3-meter perimeter around the work area.
- Place “No Smoking”, “Do Not Enter”, and any other appropriate warning signs in the area.
- A CO2 or dry powder-type fire extinguisher should be available within the work area.
- Use a suitable flammable gas detector to monitor the air in the work area for refrigerant gas concentrations.
- Ensure adequate ventilation of the area.
- Service equipment should be connected to and disconnected from a power source outside of the flammable zone.
- Properly ground the recovery machine, tank, hoses, system, and other elements to prevent static buildup.
- Do not reset the service equipment circuit breaker unless power has been removed from the equipment or the area is free of ignitable concentrations.
- Disable and lock off the power to the system being serviced.
- **Do not mix A2L refrigerants with air**. All precautions must be taken to eliminate the mixing of air with flammable refrigerants, including monitoring the recovery cylinder for air content.
- When recovery is complete, purge the system with oxygen-free dry nitrogen (OFDN). Do not use compressed air or oxygen.

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A2L Best Practices (Leak Check)

ANSI/ASHRAE Standard 15-2022

9. DESIGN AND CONSTRUCTION OF EQUIPMENT AND SYSTEMS Table 9-7 Duration of Leak Test

High Side Pressure
475 PSIG
Low Side Pressure
260 PSIG

Leak Test	Pipe Length, L (ft)	Pipe Length, L (m)	Maximum Nominal Pipe Size NPS (in.)	Maximum Nominal Pipe Size DN (mm)	Minimum Period of Test hours
Pressure Test	$L \leq 100$	$L \leq 30$	NPS ≤ 3/4	DN ≤ 20	0.25
			3/4 < NPS ≤ 3	20 < DN ≤ 75	1.0
			3 < NPS	75 < DN	24
	$100 < L \leq 200$	$30 < L \leq 61$	NPS ≤ 3	DN ≤ 75	1.0
			3 < NPS	75 < DN	24
	$200 < L$	$61 < L$	Any	Any	24
Vacuum Test	$L \leq 100$	$L \leq 30$	NPS ≤ 3/4	DN ≤ 20	1.0
			3/4 < NPS ≤ 3	20 < DN ≤ 75	8.0
			3 < NPS	75 < DN	24
	$100 < L \leq 200$	$30 < L \leq 61$	NPS ≤ 3	DN ≤ 75	8.0
			3 < NPS	75 < DN	24
	$200 < L$	$61 < L$	Any	Any	24

Vacuum Test
500 microns **not to gain more than .029 psi within the allotted test period time**

Informative Note: The maximum nominal pipe size is the largest interconnecting field piping installed.

A2L Best Practices (Leak Check)

When trying to leak check a A2L refrigerant system (lines and components):

Check every brazed and/or screwed connection and all refrigerant components when conducting a total system leak check.

The leak checking device must be rated for HFO (Hydrofluoroolefin) refrigerants and/or be A2L compatible. The device should be labeled A2L compatible or use for HFO/A2L refrigerants.

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A2L Best Practices (Charging)

Do NOT mix refrigerants!!! R-454B systems should be charged ONLY with R-454B refrigerant

Do NOT exceed the maximum allowable amount of refrigerant as per the Installation and Tech Guide Manuals. (Charge amounts could vary depending on refrigerant line lengths and sizes)

Charge the system by methods outlined in the Installation Manual. Remember that R-454B is a 400 series and charge must be added in a liquid form.

All 400 Series ASHRAE-designated blends must be charged (leave the cylinder) in a liquid state. Charging by vapor will cause the blend to fractionate in the cylinder, creating an improper composition in the system and cylinder. This may result in decreased system performance and oil return problems.

Remember when using digital gauges that figures superheat and subcooling, those gauges must have a R-454B setting

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A2L Best Practices (System Repair)

Make sure electric voltage is been disconnected!

Make sure the cabinet and system components have been grounded.

When trouble-shooting equipment that has to be live, take precaution to eliminate any sparking of electrical components.

Do not discharge capacitors that causes a spark near the system.

Use only OEM approved parts when repairing a system.

SOURCE 1
HVAC Service Parts

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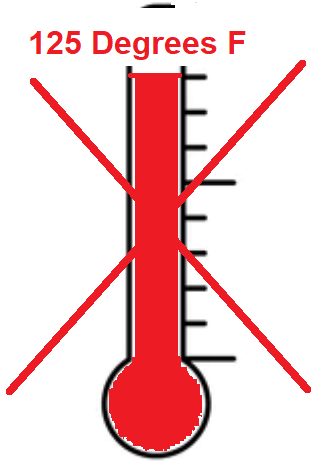
A2L Best Practices (Storage)

A2L refrigerant cylinders must be stored in an upright manner. All A2L refrigerant cylinders should be stored with the vapor space in contact with the pressure relief device, unless the cylinder is under 1.2L, according to DOT 49 CFR 173.301.

Accidental leakage is less likely to ignite in a liquid state.

<u>Do not</u> store refrigerants that will be exposed to open flames, sparks or hot surfaces

<u>Do not</u> store refrigerants in direct sunlight or areas greater than 125-degrees F.



Indoor Storage of A2L Refrigerants

www.nfpa.org
www.iccsafe.org

Characteristic	Shelf Storage	Rack Storage	Solid-pile
Storage design	Shelf cannot exceed 30" from front to back	Each level designed to hold pallet loads	Pallets stacked one upon another
Construction materials	Steel shelves	Steel rack	NA
Storage height	Maximum 6' to top of product	Can exceed 6' Limited by sprinkler design	Can exceed 6' Limited by sprinkler design
Sprinkler system design	Ordinary Hazard Group 2	Extra Hazard Group 1	Extra Hazard Group 1
Separation from flammable liquids	Required	Required	Required
Storage of other flammable or combustible products above A2L refrigerants	Prohibited	Prohibited	Prohibited
Storage of flammable liquids adjacent to A2L refrigerants	20' separation	20' separation	20' separation
Storage of flammable liquids with secondary containment adjacent to A2L refrigerants	10' separation to containment area	10' separation to containment area	10' separation to containment area

For more information, visit www.nfpa.org and www.iccsafe.org.

For information purposes only. Always check with local and state building authorities regarding cylinder storage requirements.

Maximum Allowable Quantiles of A2L's

Maximum Allowable Quantity (MAQ) in a Single Control Area		
Occupancy Classification	Non-sprinklered	Sprinklered
	Liquefied gas in cylinders	Liquefied gas in cylinders
M – mercantile	20,000 lbs.	40,000 lbs.
S – storage/warehouse	20,000 lbs.	40,000 lbs.
F – factory/filling facility	10,000 lbs.	20,000 lbs.

A2L Best Practices (Conclusion)

- Observing Best Practices are meant for the technician's safety
- Observing Best Practices are meant to provide safety to building owners and their property
- Observing Best Practices are meant to extend the lifecycle of the equipment
- Observing Best Practices are meant to provide the maximum performance of the equipment