The Voice of European Air-Conditioning, Refrigeration and Heat Pumps Contractors

EQUIPMENT FOR REFRIGERANTS WITH LOWER (A2L) AND HIGHER (A3) FLAMMABILITY

AREA (www.area-eur.be) is the European organisation of air-conditioning, refrigeration and heat pumps contractors. Established in 1988, AREA voices the interests of 21 national members from 19 European countries, representing more than 9,000 companies across Europe (mainly small to medium sized enterprises), employing some 125,000 people and with an annual turnover approaching € 20 billion.

In the future we will see more alternative refrigerants to HFCs due to EU F-gas Regulation and International future phase down of High Global Warming Potential Substances. To lower Global Warming Impact it is necessary to have as refrigerant a less stable molecule, which means that the substance become flammable. The equipment and the tools for installing, maintenance and repairing of future equipment containing flammable Low GWP refrigerants need to be properly handled by competent personnel.

For the competence of the Personnel, refer to AREA Guideline: "Guidance on minimum requirements for contractors' training & certification", 2014.

This guide gives Service Technicians a tool to understand what equipment that should be used to serve refrigeration plants containing flammable Low GWP refrigerants in category A2L (lower flammability) or A3 (higher flammability). Please always refer to the manufacturer of your equipment for specific information regarding which category your tool is applicable for.

List of refrigerants covered by this document:

Lower flammability A2L-refrigerants:
Low GWP – HFOs – Mixtures HFCs-HFOs (R32, R1234yf, R1234ze, R444, R445A, R454A, and R454B… List is not complete, and please check with EN 378:2015, Annex E for details on safety classification)

Higher flammability A3-refrigerants:
HC – Hydrocarbons R290 (propane) – R1270 (propylene) – R600 (butane) - R600a (isobutane)

All these refrigerants are flammable refrigerants at +20°C, with the exception of R1234ze, which is not flammable below +30°C.

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TRANSPORT OF FLAMMABLE REFRIGERANTS

Be aware that transport of flammable refrigerants are only allowed for a limited quantity (check ADR/ national legislation) and only if the refrigerant is transported directly from pick-up to worksite. Use preferably an open air truck, but ensure proper ventilation if the truck is enclosed.

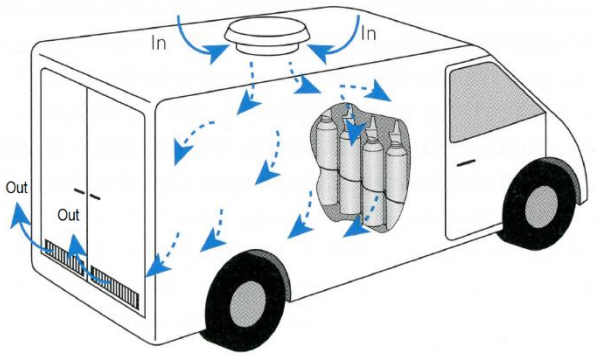

Figure 1

LOWER FLAMMABILITY A2L-REFRIGERANTS

A2L are lower flammability **refrigerants** with a maximum burning velocity less than 10 cm/sec (ASHRAE 34 – ISO5149). Following a few, but important safety precautions, like handling by a competent refrigeration service engineer, they are not very different from use of HFCs class A1 refrigerants. One of the main dangers is the danger of pooling. Pooling means creating a temporary flammable zone when leaking refrigerant (heavier than air) gather in small spaces. High-energy sparks in such area could cause ignition and flame propagation.

Tools and Equipment

Some standard tools and equipment can be used safely with flammable refrigerants, including gauge manifold sets.

AREA recommends the use of vacuum pumps approved for use with A2L-refrigerants. Old vacuum pumps with brushed motor should not be used because of the high energy spark these create. Modern vacuum pumps with brushless EC motors can be used if the pump is switched on by an external power source and not by the on/off switch mounted on the pump.

In addition, the flammable refrigerant discharged by the pump is usually safely dispersed and does not result in a flammable zone (ATEX zone 2 = an area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will only exist for a short time), providing the pump is located in a well-ventilated area. The section on evacuation below shows how you can avoid the hazard associated with the switch.

Standard recovery machines cannot be safely used to recover flammable refrigerants and therefore must not be used. Unlike vacuum pumps there are several sources of ignition (e.g. on / off switches, relays, pressure switches).

In addition, a leak would result in a flammable zone around the machine. These hazards cannot be avoided; therefore the correct recovery machine must be used.

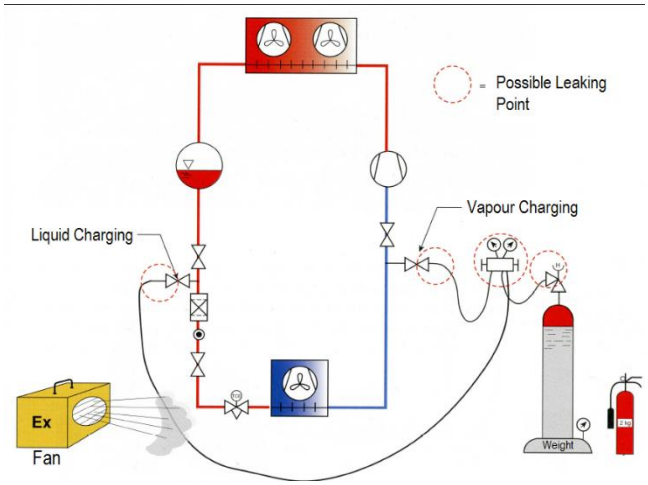

Figure 2 Possible sources for leakage and safety equipment used when filling flammable refrigerant

Leak detection

Most electronic leak detectors used for HFC and HCFC leak detection are not safe and sensitive for use with flammable refrigerants, so electronic detectors specifically for flammable gases (or leak detection spray) must be used.

Flammable refrigerant systems must be leak tested using a method that is safe and sensitive:

- Leak detection spray
- A suitable electronic flammable gas detector (examples are shown in the photos below).

If you cannot find leaks using these methods you should recover the remaining charge and leak tightness test the system using OFN (Oxygen Free Nitrogen).

Figure 3 electronic leak detectors suitable for flammable refrigerants

Refrigerant recovery

A2L-flammable refrigerant must be recovered using a suitable recovery machine (a standard recovery machine for halocarbon type refrigerants must not be used).

Evacuate the recovery cylinder to remove air before filling it with flammable refrigerant.

- Do not mix flammable refrigerants with other types of refrigerant in a recovery cylinder.
- When recovering hydrocarbon refrigerants, do not fill the recovery cylinders with more than 45% of the HFC safe fill weight.
- Label the recovery cylinder to show it contains a flammable substance.

A2L synthetic refrigerants (as HFOs and R32) must be recovered as the HFC refrigerants and not vented to the atmosphere.

Figure 4 Recovery machine for use with flammable refrigerants

Evacuation

If a vacuum pump approved for A2L-refrigerants is not available, check that actual vacuum pump and ensure that the on/off switch is the only source of ignition. If this is the case the vacuum pump can be safely used with flammable A2L-refrigerant if the on / off switch is not used:

- Move the switch to the on position and plug the pump into a socket outside the 3 m zone and control it from this socket.
- Locate the vacuum pump in a well-ventilated area or outside.

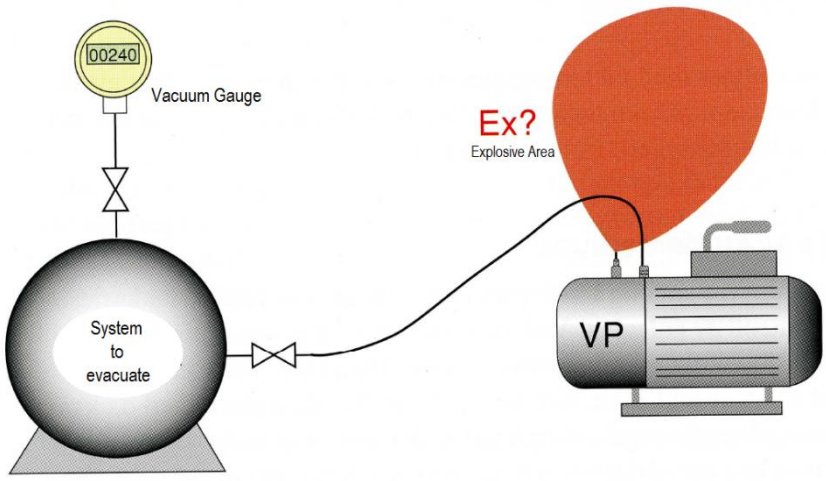

Figure 5

REFRIGERANT R32

Specification of Refrigerant Cylinder

- Red shoulder (flammable gas).
- Left thread (an adapter piece is required to connect manifold).
- Minimum test pressure = 48 bar.
- Fill rate for recovery bottles for R32 is 60%.

Service Tools for R32

■Tool Compatibility
[If Switching Over from R410A]
Because R32 has approximately the same pressure as R410A, the refrigerant oil is also Polyolester (POE) oil, and it can be accommodated with the same contamination control (preventing impurity contamination) as R410A without a large difference, tools that are used with

R410A can be shared with R32 after confirmation from tooling supplier.

Table 1 Shared tools between common used refrigerants in Air Conditioning systems

Tool	R32	R410A	R22
Gauge manifold 	Slightly different scale for HFC32 and R410A so check with tool supplier if manifold is shareable		
Charge hose	Common		
Scale 	Common		
Pipe bender 	Common		
Pipe cutter 	Common		
Flaring tool 	Common		R22 type can be used by changing the work process
Torque wrench 	Common		Some flare nuts widths are different, others can be shared
Cylinder thread adaptor	Depends on the cylinder – some have different thread for flammable gases	Not applicable	
Vacuum pump 	Common		
Recovery pump 	Check with tool supplier if shareable		
Electr. Leak detector  **Torch type models CANNOT be used.**	Check with tool supplier if shareable		
Refrigerant recovery cylinder 			

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HIGHER FLAMMABILITY A3-REFRIGERANTS

A3 are refrigerants with higher flammability risk than A2L-refrigerants. The main difference is that a relatively weak spark can ignite a flammable mixture. Typical is static sparks from clothing, iron screw drivers, bad electrical grounding, or a torch switch turned on. Avoiding sparks, good ventilation and no leakage are key points to avoid a dangerous situation. Always use a personal leakage detector when working with A3-refrigerants. When working with A3-refrigerants, vacuum pump, working fan, weight, recovery unit, leak detector, and electrical drill must be approved for Ex-conditions, Zone 2 (ATEX).

Safety Procedure for the work area where HC systems are being serviced:

- There must be no source of ignition within 3m of the system (Compressor contactors, klixons, electrical connections)
- The area must be well ventilated
- The area must be monitored with a hydrocarbon leak detector

Recommended Procedure for recovery of HC Refrigerant Equipment from small refrigeration units:

- Plug in the ventilation fan 3m from the working area and position at floor level.
- Plug in the Recovery unit 3m from the working area and recover the hydrocarbon refrigerant.
- When the low-pressure lamp has illuminated switch the unit to low pressure override and allow to run for 2 minutes.
- Pressurise the system with OFN (Oxygen Free Nitrogen) to just above atmospheric pressure.
- Using a HC sensor check that no hydrocarbon refrigerant is in the air before lighting the brazing torch.
- Un-braze or cut the connections and complete the service operation.
- Braze back or better use mechanical/compression joint tool and connectors

Cylinders for flammable refrigerants have left thread to the traditional HFCs refrigerants to avoid using pipework and distraction of the technicians.

Recommendation for vacuum, recovery and leak check for A2L refrigerants remain valid for A3 refrigerants

For small quantities of Hydrocarbons to be evacuated, normal practice recommends to vent, but please refer always to your national legislation. See figure beneath:

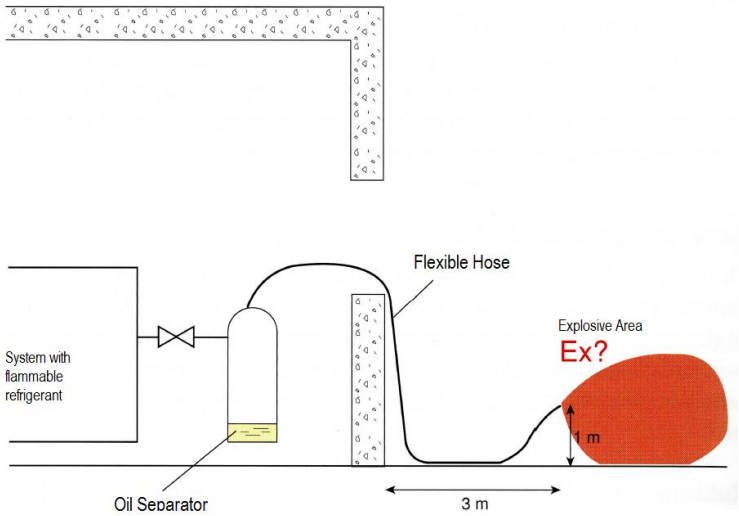

Figure 6 Example of safe venting of hydrocarbon refrigerant to outdoor location (if allowed by national legislation)

References:

Stig Rath (2015) *Kuldemontøren* www.bestselgerklubben.no

Daikin (2015) *Service manual for products using R32*

Real Alternatives (2015) *E-Learning on Alternative Refrigerants* Leonardo da Vinci EU Project www.realalternatives.eu

Caresaver (2014) *Universal Refrigerant Recovery Unit Operational Manual*