



U-3ARC TRAINING WEBINAR N°21

Good Servicing Practices For Flammable Refrigerants

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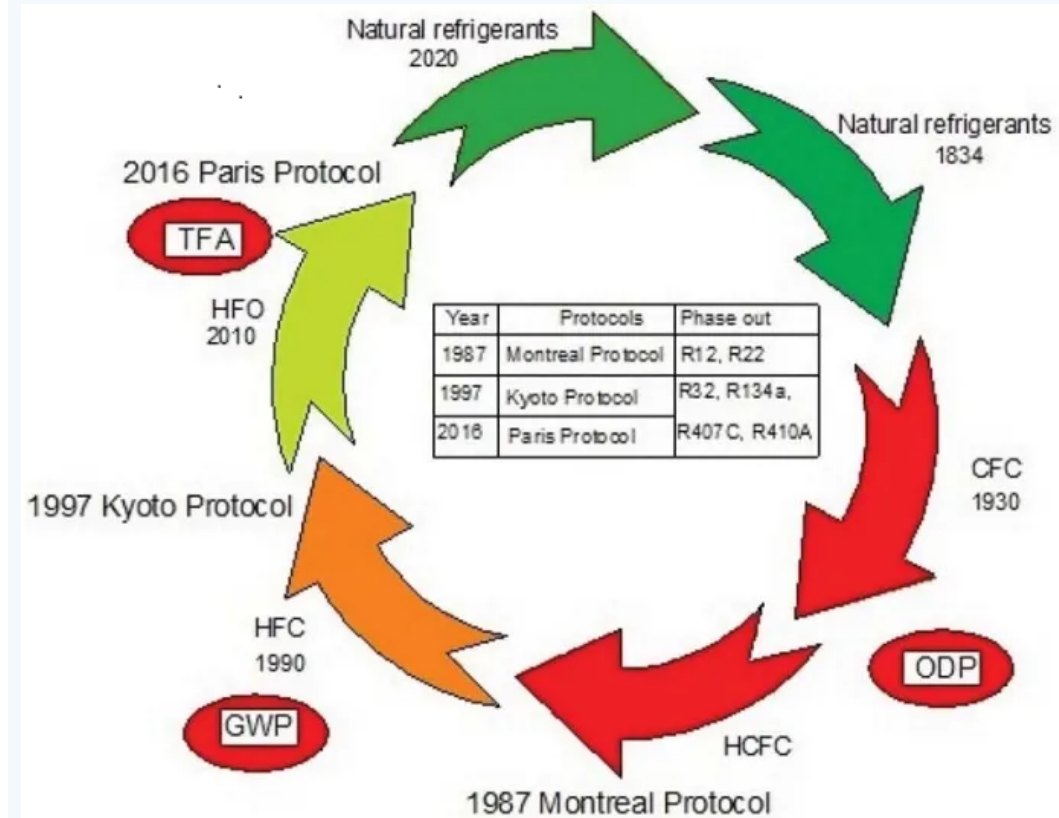
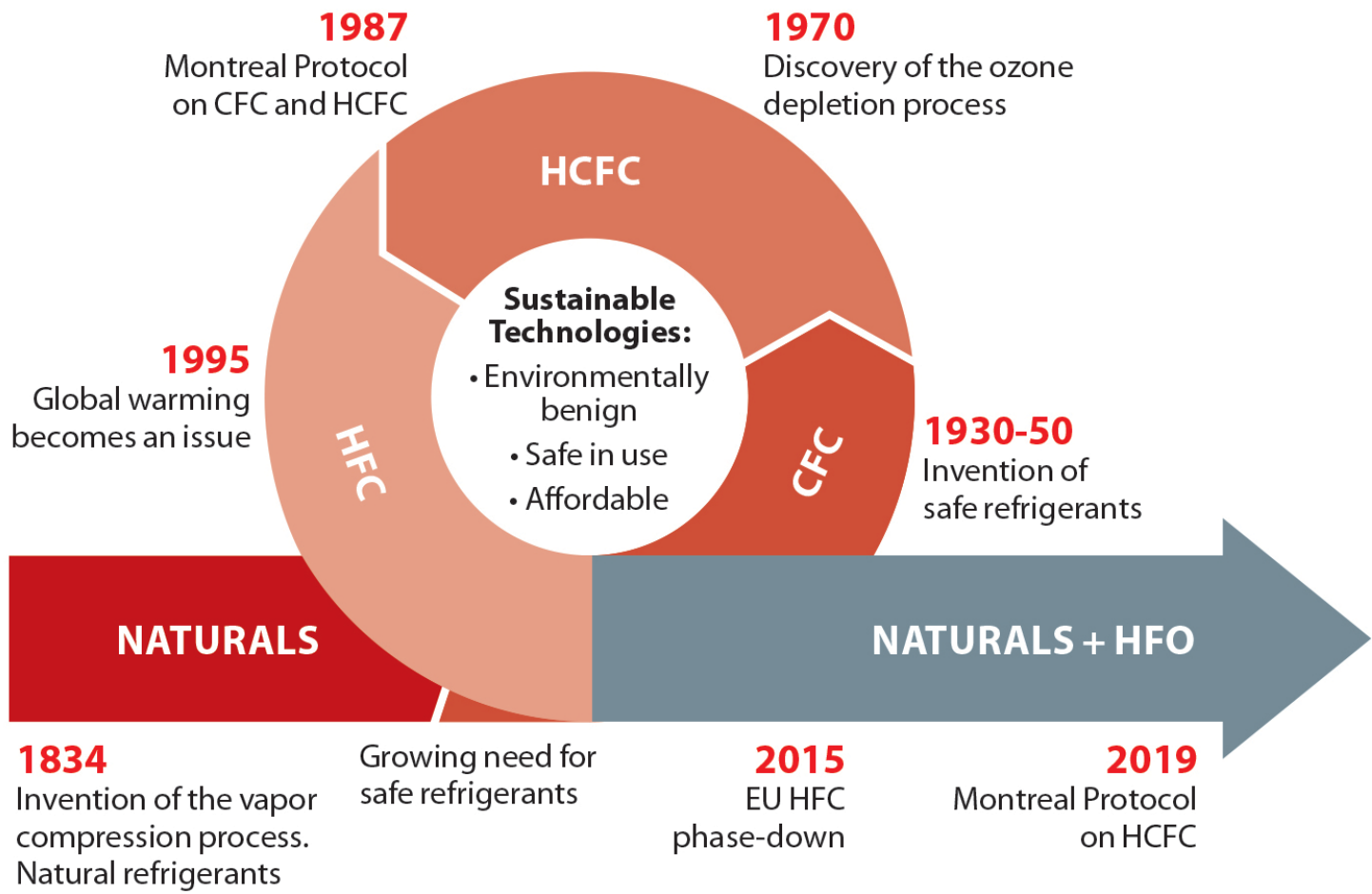
- I. History of refrigerants
- II. Flammable Refrigerants
- III. Handling & Transportation of Flammable Refrigerants (Standards & norms)
- IV. Tools & equipment
- V. Conclusion



OBJECTIVES

1. To list major highly flammable refrigerants
2. To identify ignition sources
3. To handle flammable refrigerants safely
4. To apply safe technics when handling flammable refrigerants

History of refrigerants



Flammable Refrigerants

Flammable refrigerants characteristics

Hydro fluoro carbone
Hfc



	Type	Key facts	GWP ²	Sat temp ³	Typical applications
R32	Hydro fluoro carbon, HFC	Lower flammability	675	-52°C	Split air conditioning
R1234ze	Unsaturated HFC (aka hydro fluoro olefin, HFO)	Lower flammability	7	-19°C	Chillers, split air conditioning, integrals
R1234yf	Unsaturated HFC (aka hydro fluoro olefin, HFO)	Lower flammability	4	-29.5°C	Chillers, air conditioning, heat pumps
R600a	Isobutane, C ₄ H ₁₀ , hydrocarbon (HC)	Higher flammability	3	-12°C	Domestic and small commercial systems
R290	Propane, C ₃ H ₈ , hydrocarbon (HC)	Higher flammability	3	-42°C	Chillers, integrals
R1270	Propene (propylene), C ₃ H ₆ , hydrocarbon (HC)	Higher flammability	2	-48°C	Chillers, integrals


Hydro fluoro olefin
HFO

Hydro carbone
Hc


Flammable Refrigerants



Refrigerants Safety classification



HIGHER FLAMMABILITY	A3 R-50, R-170, R-290, R-600a, R-441a, R-1270	B3 R-1140
LOWER FLAMMABILITY	A2 R-142b, R-152a	B2 R-30, R-40, R-611, R-717
	A2L HFO-1234yf, HFO-1234ze	
NO FLAME PROPAGATION	A1 R-11–R-14, R-22, R-113, R-114, R-115, R-134a, R-410A, R-449B, R-1234zd	B1 R-10, R-21, R-123, R-764
	LOWER TOXICITY	HIGHER TOXICITY



Flammable Refrigerants

Refrigerants Safety information



Refrigerant	Safety classification ^a	LFL, kg/m ³ ^b	Auto ignition temp, °C	PL, kg/m ³ ^c	ATEL / ODL ^d
HFC R32	A2L	0.307	648	0.061	0.30
HFO R1234ze	A2L	0.303	368	0.061	0.28
HFO R1234yf	A2L	0.289	405	0.058	0.47
HC R600a	A3	0.043	460	0.011	0.059
HC R290	A3	0.038	470	0.008	0.09
HC R1270	A3	0.047	455	0.008	0.0017

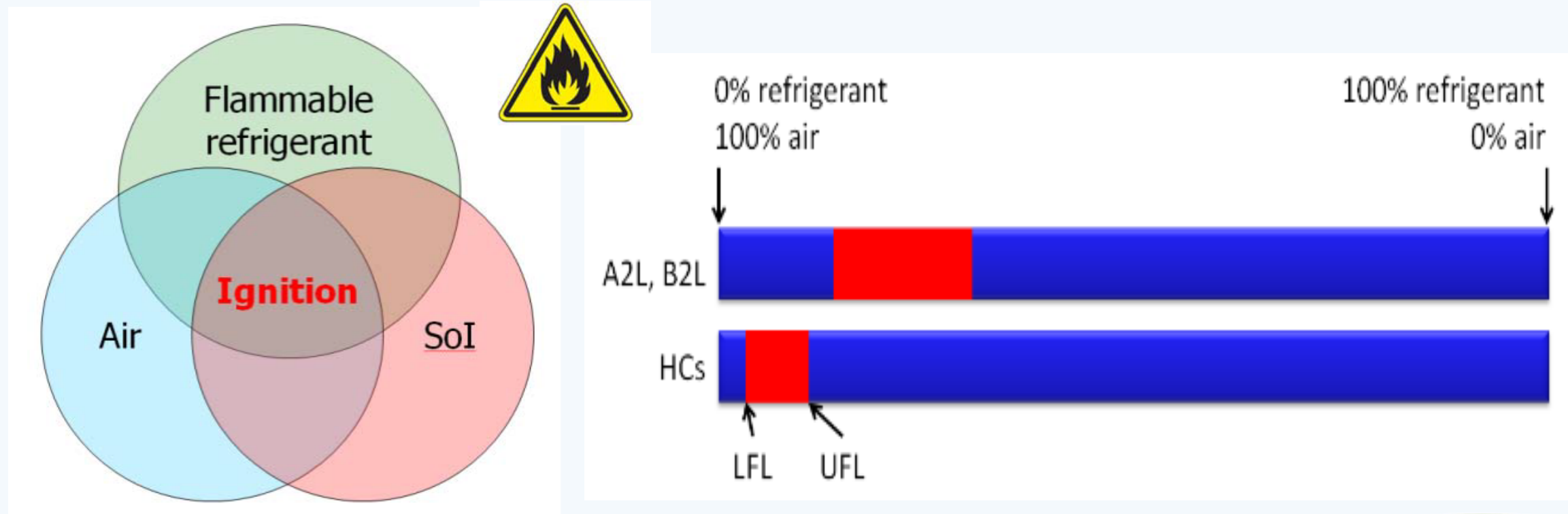
c. PL is the Practical Limit as listed in EN378-1. The practical limit for refrigerant represents the concentration used for simplified calculation to determine the maximum acceptable amount of refrigerant in an occupied space. For flammable refrigerants it is approximately 20% LFL

Flammable Refrigerants



Refrigerants Safety information

- Three conditions are required for combustion- Fuel, oxygen and source of ignition
- For all flammable refrigerants combustion will occur if the refrigerant concentration in air is between the lower and upper flammability source of ignition





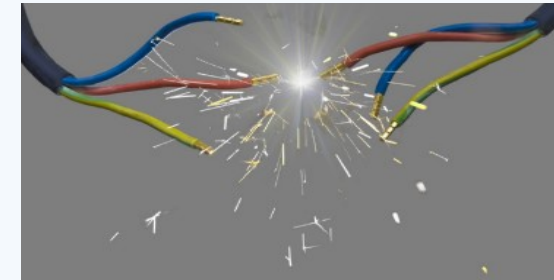
- Flames

- brazing torches
- match etc



- Sparks

- unsealed electrical switches
- loose wires &
- loose joints and terminations




- Static electricity





Simple Precautions

- Do not smoke 
- Do not keep ignition sources within 2m
- Do not let **HC** refrigerant accumulate
- Work in naturally well ventilated area, outdoors or use forced / Induced ventilation system
- Wear gloves, goggles, clothing that covers human body while handling
- Store Minimum **HC** indoors

Safety Precautions – Cylinder Safety



Care of refrigerant cylinders



**NO ROLLING
NO DROPPING**



**TANK UNDER
PRESSURE**



**NO DIRECT
HEATING**



**NO
PUNCTURING**

**BOTH MAY CAUSE
EXPLOSION**



Safety - check of the working area

- Work in confined spaces must be avoided. The area around the workspace is to be sectioned off.
- The area shall be checked with an appropriate HC refrigerant detector prior to and during work.



Safety Precautions – Eye Protection



- Direct contact to skin with liquefied product or cold vapor may cause freeze burns and frostbite.
- These are non-toxic by inhalation but high concentrations may cause central nervous system depression such as dizziness, drowsiness, headache, and similar narcotic symptoms, but no long-term effects



Refrigerant operates at extreme pressure changes.



Eye irritation and even frostbite on the eyes.

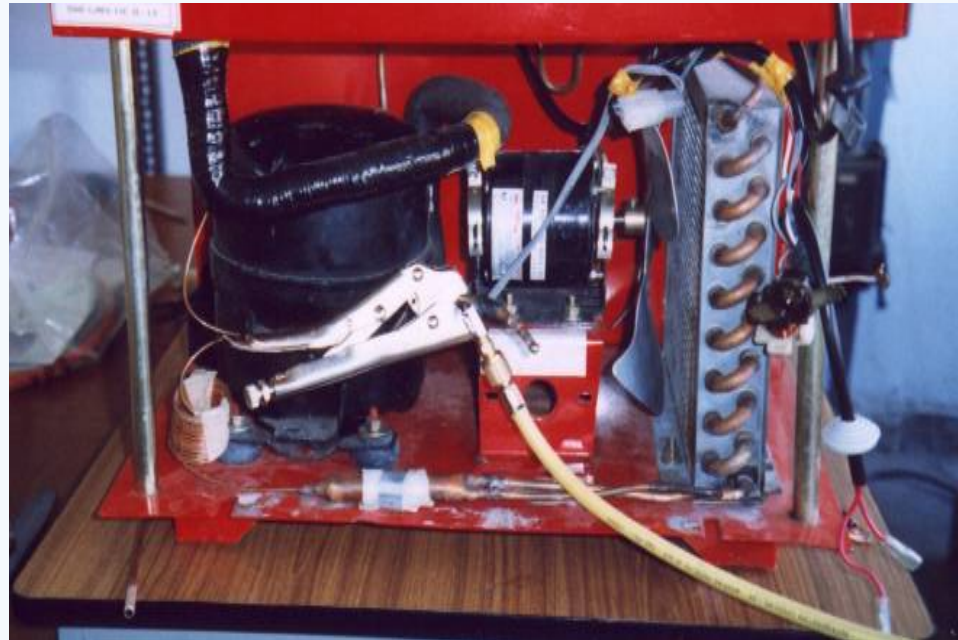


Safety Goggles



Servicing Procedure of HC Based Equipment

- Safe venting of HCs to open air. HCs do not need to be recovered
- Vent safely - Use piercing pliers or piercing valve & a long hose to reach safe area outside



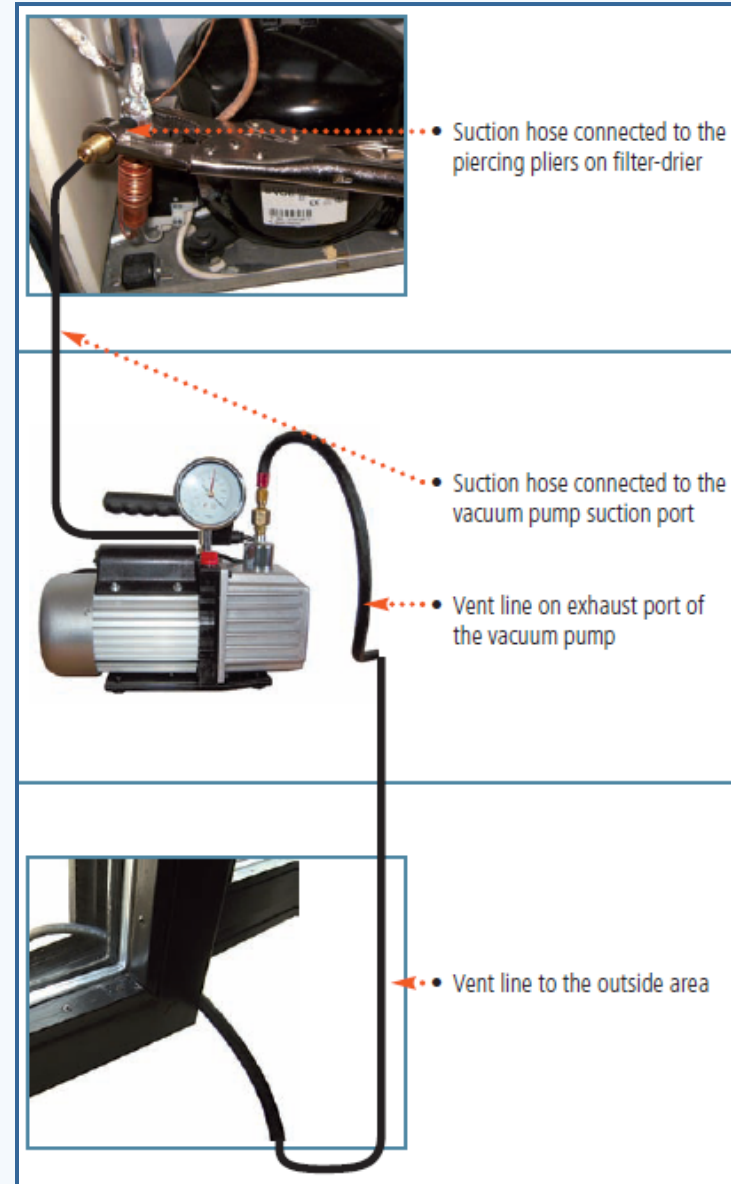
Removal of Left-over Refrigerant



- Ensure most of the HC Refrigerant has been removed before opening the refrigeration System

- Remove the refrigerant using a vacuum pump

(Pressure in the system should not be reduced to below 2 psig or 0.137895 bar)



Precautions while repairing



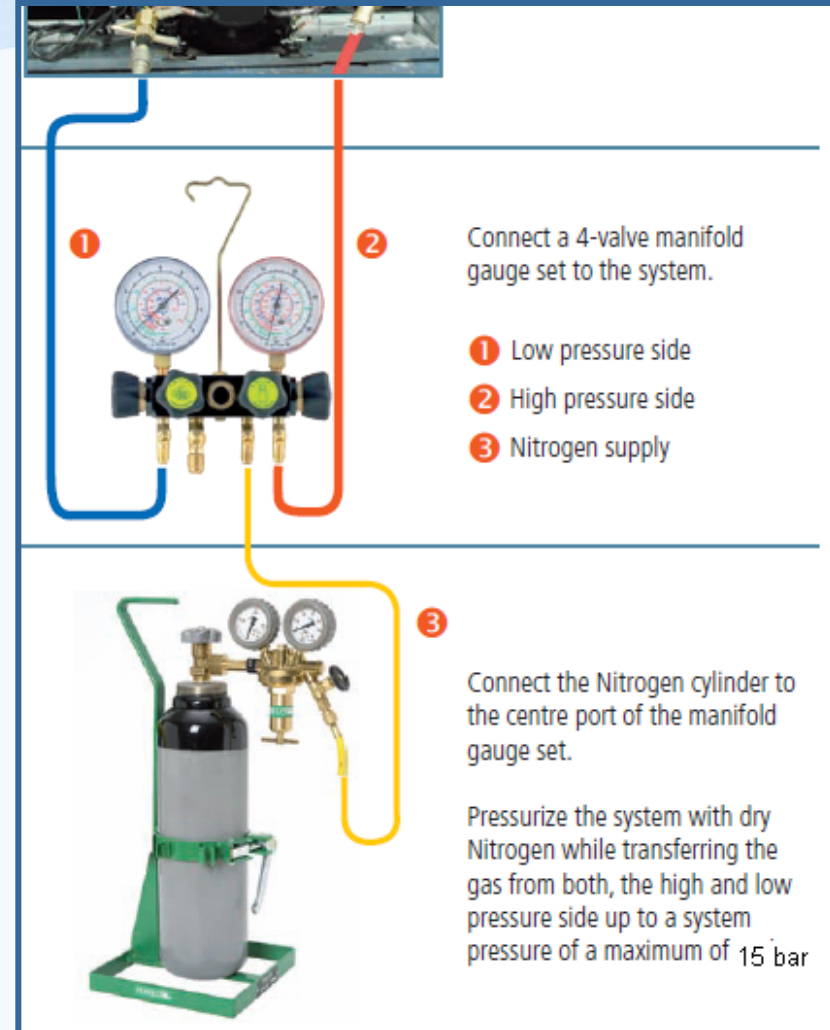
*Follow the precautions cited in ‘**HC Handling**’*

- Use correct components
(especially important for electrical devices with **HCs**)
- Do not braze with **HC** refrigerant in or around the system
- Braze in a well ventilated area

Pressure Testing and Leak Detection



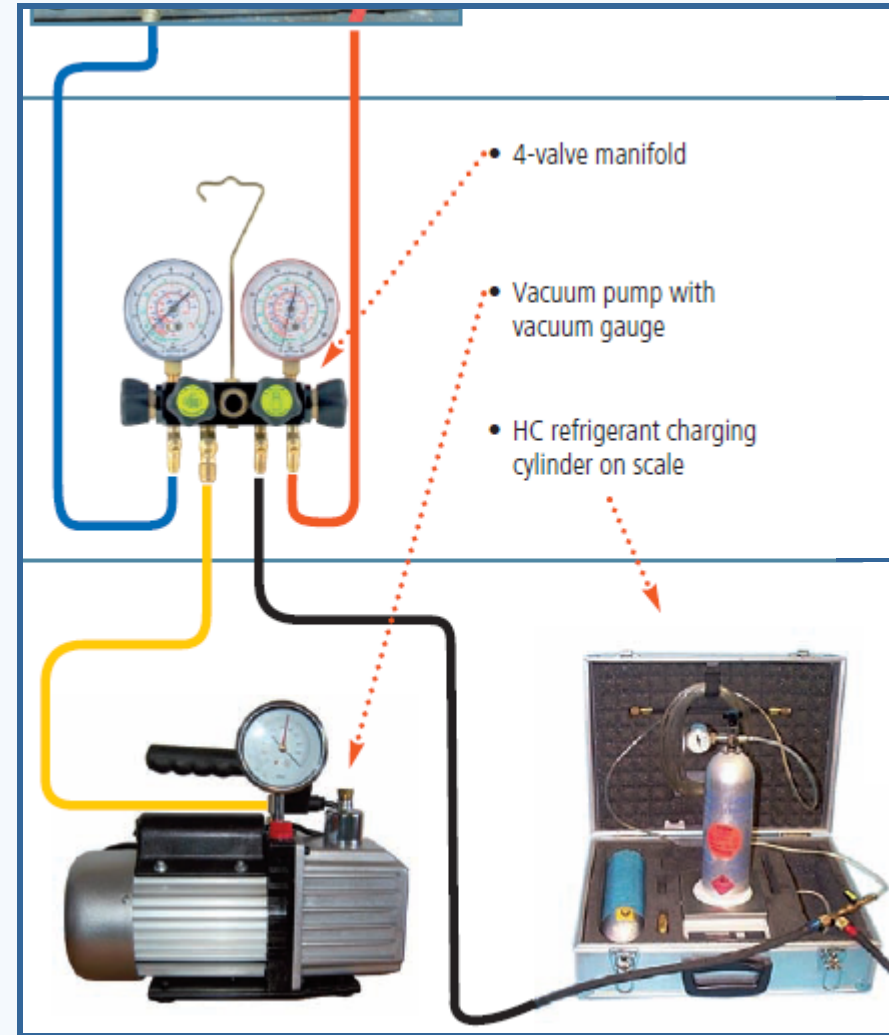
- Use Dry Nitrogen for leak testing after the system is reassembled and sealed
- Test pressure to be regulated to 15 bar or 217.557 psig
- Use soap solution for leak detection
- Process of leak detection is similar to **HCFCs**
- Brush each joint - look for bubbles



Evacuation



- To remove non-condensable gases (e.g. air) & moisture
- Need a two stage vacuum pump - capable of developing blank off pressure of 20-50 microns Hg
- Need a micron gauge capable of reading pressures in 5 - 5000 Microns range



100 microns at psi Gauge will show 29.916

Charging procedure



- Charge evacuated systems only
- Charging should be done slowly / gradually
- Use weighing scales for accurate charge quantity
 - *greater accuracy required for HCs because of smaller quantity of charge*

Brazing of Process Tube



- Crimp (twice)
- Don't remove tool until tube is sealed,
- Braze to seal tube
- Remove crimping tool
- Check for leaks

Do not braze with refrigerant around the systems



TRANSPORTATION & STORAGE OF FLAMMABLE REFRIGERANT

- In transporting refrigerants, technicians need to clearly label its containers
- Cylinders must be firmly trapped
- Never roll a cylinder on its base or lay it down to roll it
- Store cylinders in a cool , well ventilated areas with low risk of fire and out of direct sunlight place



TRANSPORTATION & STORAGE OF FLAMMABLE REFRIGERANT

- **HC** Cylinder handling & storage similar to LPG
- Preferably store outside
 - in a secure, locked compound
(protected from weather and direct sun)
 - with no ignition source & no smoking within 2 m of cylinders
 - Never lie cylinders on their sides
- If inside, ensure that it is stored at ground floor and above, but not in basements or in a residential premises
- Install flammable gas alarm.

CHAPTER THREE

TOOLS & EQUIPMENT



Basic Tools required

- Pinch off tool
- Recovery machine
- Ventilation fan
- Leak detectors
- Charging valves
- Fire extinguishers
- Vacuum pumps



Charging Valve



- Recharging of refrigerant gas is typically carried out via a non-return service port or valve fitted to the system.



Recovery Machine





Ventilation Fan

A suitable ventilation fan should be used when working inside if there is insufficient natural ventilation. An example is shown in the photo which has an Ex rated fan motor and a 5 m extension lead so the fan can be switched outside the 2 m work area.





Pinch off tool

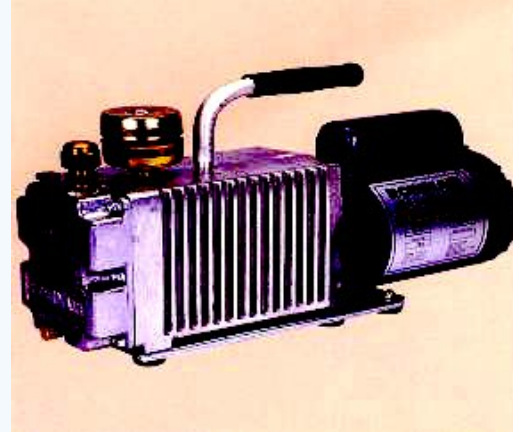
These AC/refrigeration accessories include pinch-off tools designed to temporarily close off tubing for disconnecting and making repairs without loss of liquid or gas.





Vacuum Pumps

Use specially designed vacuum pumps, capable of developing blank off pressure of 20 - 50 microns Hg





Leak detectors

The area shall be checked with an appropriate HC refrigerant detector prior to and during work.





Use dry powder fire
extinguisher





Conclusion

Hydrocarbons are highly flammable gasses they need to be handled with care.

Technicians need to under go training before handling these refrigerants



**THANK YOU FOR
PARTICIPATING**

