Evacuation and Charging

1006-0028 Technical Training Module TRM-2

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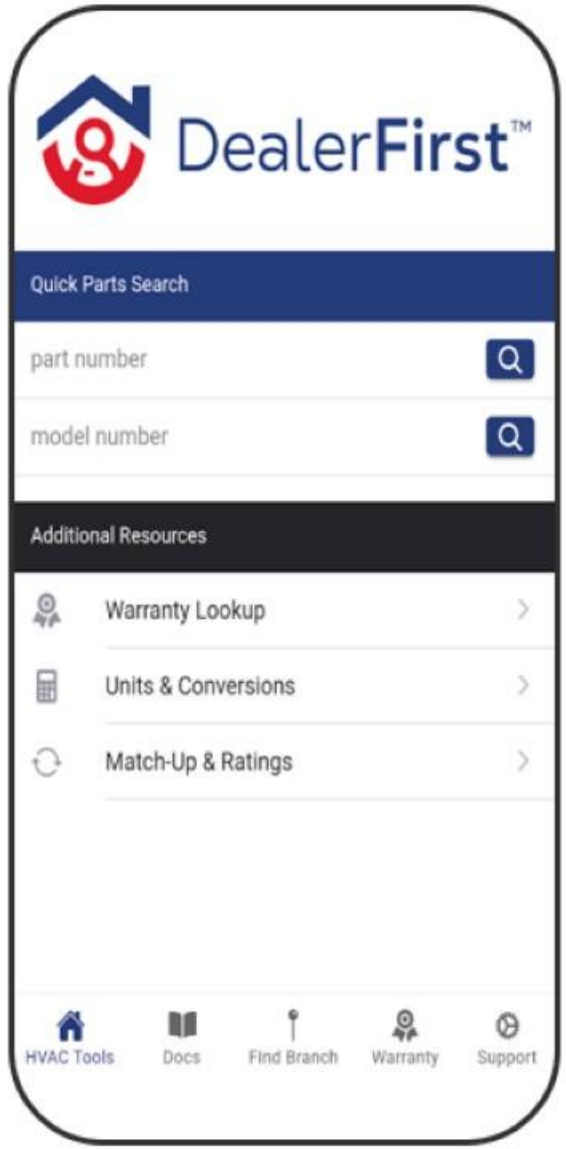
Resources

Dealer First Mobile App

Quick easy, "on the go" access to:

- Warranty Express access
- Match-up and ratings
- Product/diagnostic information
- Documents, Support and more

- User Friendly Interface
- Available on Apple® App Store or on Google Play™



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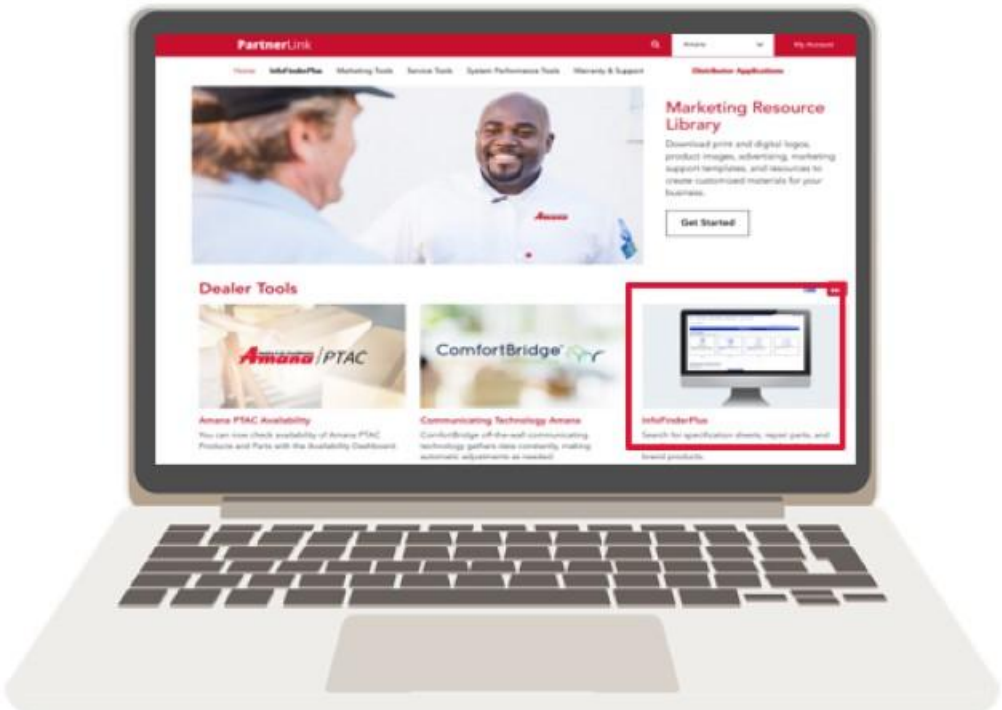
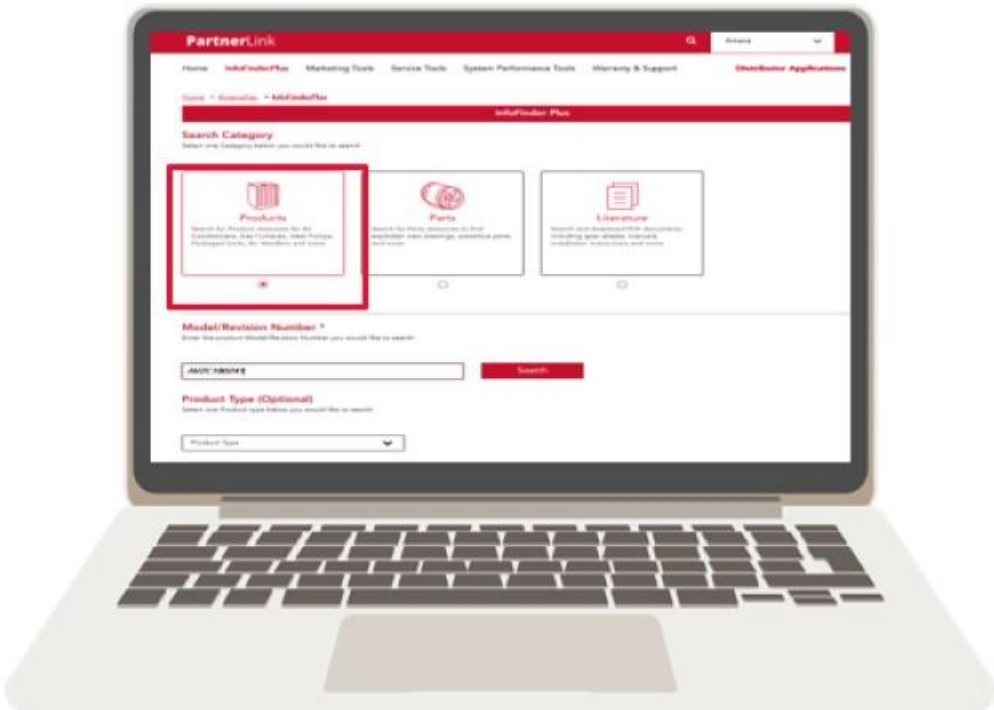
Resources

- **PartnerLink** resource for equipment manuals, information, and guides
- https://partnerlinkmarketing.goodmanmfg.com/
- Login with credentials
- Select option for “Communicating Technology” or “InfoFinderPlus”





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Safety Considerations

Recognize These Symbols As A Safety Precaution.

- As a professional installer/servicer you have an obligation to know all safety precautions and related items.
- It is your responsibility to service the product safely.
- If there is a direct conflict between existing practices and the content of the equipment's installation or service manual, the manual takes precedence.

DANGER

CAUTION / WARNING

Course Content

Module 1

Purpose Of Evacuation

Module 2

Tools

Module 3

Evacuation Procedure

Module 4

Charging

Module 1

Purpose Of Evacuation

Learning Objective

- Discuss why evacuation is important for long system life

Purpose Of Evacuation

What Is Evacuation

Evacuation is the most important part of the entire service procedure.

- Evacuation is the process of removing of non-condensable gasses and moisture from a refrigeration system using a deep vacuum.
- The life and efficiency of the equipment is dependent upon the thoroughness exercised by the technician when evacuating the system.
- Why do we evacuate?
  - To remove air and other non-condensable gasses from the system
  - To remove moisture from the system

Purpose Of Evacuation

Non-Condensable Gasses

Non-condensable gasses are gasses that can not be condensed into a liquid inside of an air conditioning system.

- These include:
  - Air
  - Nitrogen
  - Any other undesirable gasses
- Non-condensable gasses in a system take up space in the condenser causing:
  - Higher condensing pressure
  - Higher compression ratios
  - Increased power usage
  - Reduced performance

Purpose Of Evacuation

Moisture

Moisture is a contaminant inside of the sealed refrigerant system which can also cause performance related issues.

- Moisture chemically reacts with the refrigerant and oil in the system to create:
  - Acid
  - Sludge
- Intermittent problems can be caused by moisture freezing within the system.
  - Ice can form at the point of expansion causing a restriction in:
    - TXV
    - Flow Rater
    - Capillary Tubing

Purpose Of Evacuation

Sources Of Moisture

Moisture can be found in all solids and gasses.

- Moisture can be in the form of:
  - Water Droplets
  - Water Vapor
- Common sources of moisture within an air conditioning system are:
  - Air
  - Poor quality refrigerant
  - Contaminated oil
  - Copper and brass components
  - System components exposed to the air during assembly

Purpose Of Evacuation

Acid

Acid is a contaminant created within the system commonly caused by improper evacuation

- Moisture will chemically react with refrigerant to form hydrochloric and/or hydrofluoric acid
  - Which attacks motor winding insulation causing electrical failures
  - Causes corrosion of internal metal parts resulting in mechanical failures
  - Moisture can also react directly with POE (polyolester) oils to form organic acids

Purpose Of Evacuation

Sludge

Sludge is a system contaminant that can also be created by improper evacuation .

- Sludge occurs when moisture chemically reacts with refrigerant and oil causing the oil to break down and create a tar like substance which results in:
  - Loss of the oils lubricating properties
  - Mechanical failures
  - Plugged filters or orifices

Purpose Of Evacuation

Copper Plating

Copper plating can occur on systems that are contaminated with acid.

- Acid will remove small amounts of copper and brass from components inside of the system.
- Copper particles will then be deposited on the high pressure, high temperature, moving parts within the compressor such as bearing surfaces.
- This build up of copper can result in mechanical failure by:
  - Causing compressor to seize due to reduced clearances
  - Preventing proper lubrication of moving parts

Purpose Of Evacuation

Polyolester (POE) Oils

Polyolester (POE) oils are extremely hygroscopic meaning that they will readily absorb moisture from the air.

- POE oil is made from organic acid in an esterification reaction.
- When exposed to water the POE lubricant hydrolytically decomposes back into an organic acid.
  - Oil will lose its lubrication properties
  - Causes the formation of sludge
- The amount of acid generated from POE hydrolysis is dependent on the amount of water available.
  - More water causes more acid to form.
- Any moisture that remains in the system will immediately combine with the oil to form acid.

Purpose Of Evacuation

Polyvinyl Ether (PVE) Oils

Polyvinyl Ether (PVE) is a synthetic oil that is being used as an alternative to POE oil. It is more hygroscopic than POE oil but does not undergo hydrolysis in the presence of water.

- Hydrolysis is the chemical breakdown of a compound due to reaction with water
- Improved miscibility and lower hydrolysis than POE.
- Not compatible with POE and mineral oils.

PVE Oil

POE Comparison

			FB-POE	PVE
Compressors	Dielectric Strength & Resistivity		3	3
	Lubricity	P-V Coefficient	2	3
		EP Agent Effectiveness	1	3
	Compatibility with Motor Materials		3	3
	Compatibility with Organic Materials		3	3
	Compatibility with Dry Bearings		2	3
	Reciprocating Compressor Noise Control		1	3
Systems	Capillary Tube Blockage	Hydrolytic Stability	2	3
		Tribological Chemical Reaction	2	3
		Process Fluid Solubility	1	2
		Contaminant Control	1	2
	Miscibility with Refrigerants		3	4

Base line = Mineral Oil/HCFC-22
Ratings on a scale of 1 (lowest) to 4 (highest)

Purpose Of Evacuation

How Evacuation Removes Moisture

Moisture can only be removed from a refrigeration system as a vapor.

- To change a liquid to a vapor:
  - Liquid water must be heated to its boiling point (212°F at sea level)

    Or
  - Pressure must be reduced to lower the waters boiling point

Or

Since raising the temperature of an entire air conditioning system to 212°F is impractical, the systems pressure must be reduced to a point where water boils below the ambient temperature.

Purpose Of Evacuation

Pressure Versus Boiling Point Of Water

The boiling point of water depends on its surrounding pressure.

- As pressure is decreased – the boiling point decreases
- As pressure is increased – the boiling point increases

Pressure Versus Boiling Point Of Water			
Boiling Point °F	PSIA	Microns	In. Hg Vacuum
212	14.7	760,000	0
158	4.519	233,680	20.72
104	1.066	55,118	27.75
80	0.491	25,400	28.92
59	0.246	12,700	29.42
32	0.088	4,572	29.74
6	0.0245	1,270	29.87
-24	0.0049	254	29.91

Purpose Of Evacuation

Factors That Affect The Speed Of Evacuation

External factors

- Ambient temperature
- Quality of tools
- Size of vacuum pump
- Size of hoses
- Number of access fittings
- System connections
  - High & low side

Internal factors

- The size of the system
- The complexity of the piping
- The system components
  - Oil separators
  - Accumulators
  - Valves

Module 2

Tools

Learning Objective

- Discuss tools needed to perform a proper evacuation

Tools

Micron Gauge

The instrument use to accurately measure the deep vacuum levels needed for properly evacuating an air conditioning system is the **Micron Gauge.**

- 1 micron is equal to 1/1,000,000 of a meter of mercury
- 1 inHg is equal to 25,400 microns
- Atmospheric pressure is 760,000 microns or:
  - 760 mmHg
  - 29.92 inHg
  - 0 PSIG
  - 14.7 PSIA

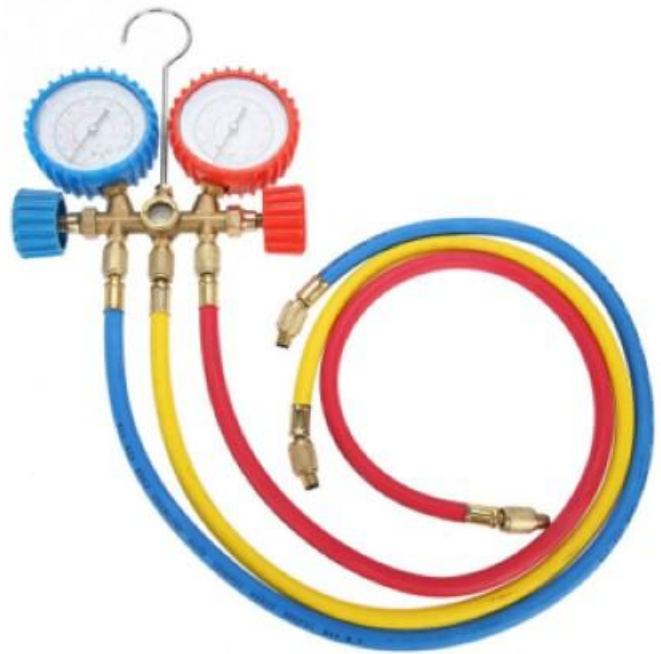
Compound gauges, vacuum gauges, and manometers do not have the resolution needed to properly measure the systems vacuum level.

Tools

Manifold Gauges

Manifold gauges are not recommended for evacuation but will be required for charging.

- Evacuation times may be increase when using a manifold gauge set due to:
  - Increased pressure drop due to reduced diameter and longer length of hoses
  - Additional fittings and valves causing restrictions or leaks

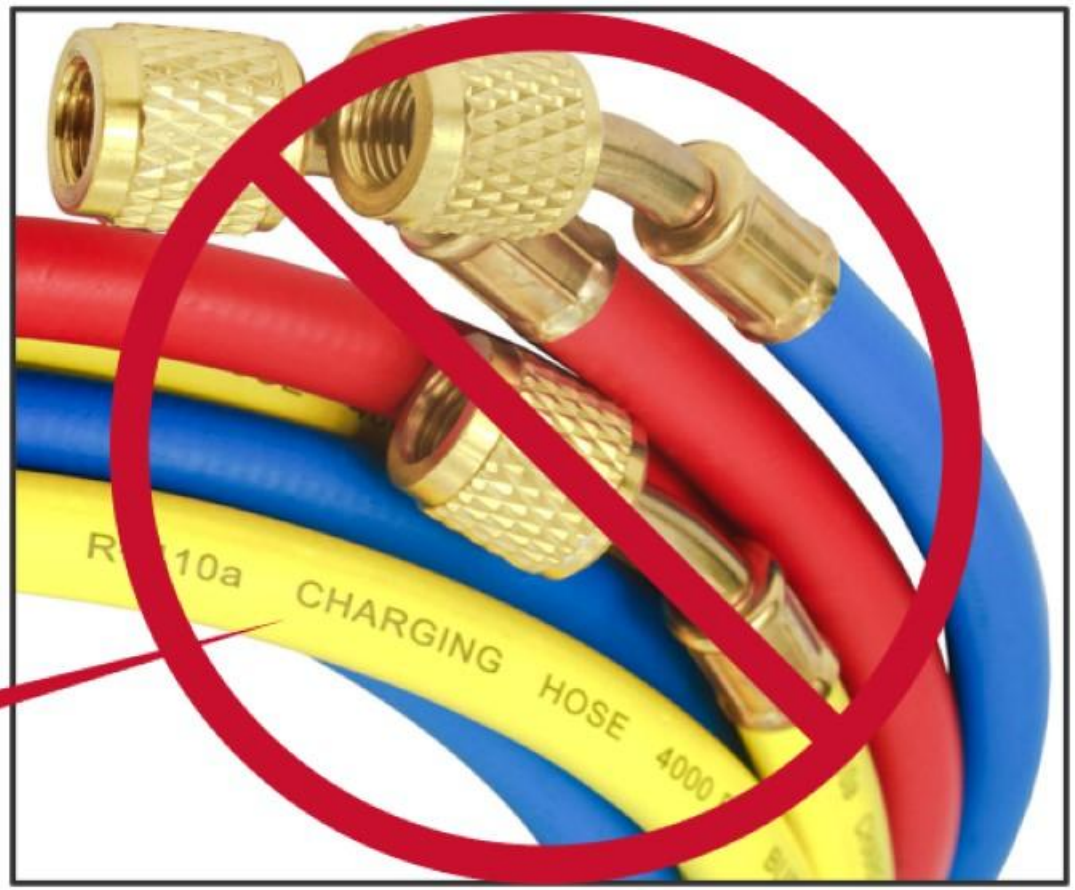


Tools

Charging Hoses

Many refrigeration manifolds come with charging hoses that are not vacuum rated.

- These hoses are gas permeable and will allow a small amount of air to pass through the wall of the hose under deep vacuum conditions.
  - This can prevent proper system evacuation
  - May cause a leak to be indicated during a standing vacuum leak test



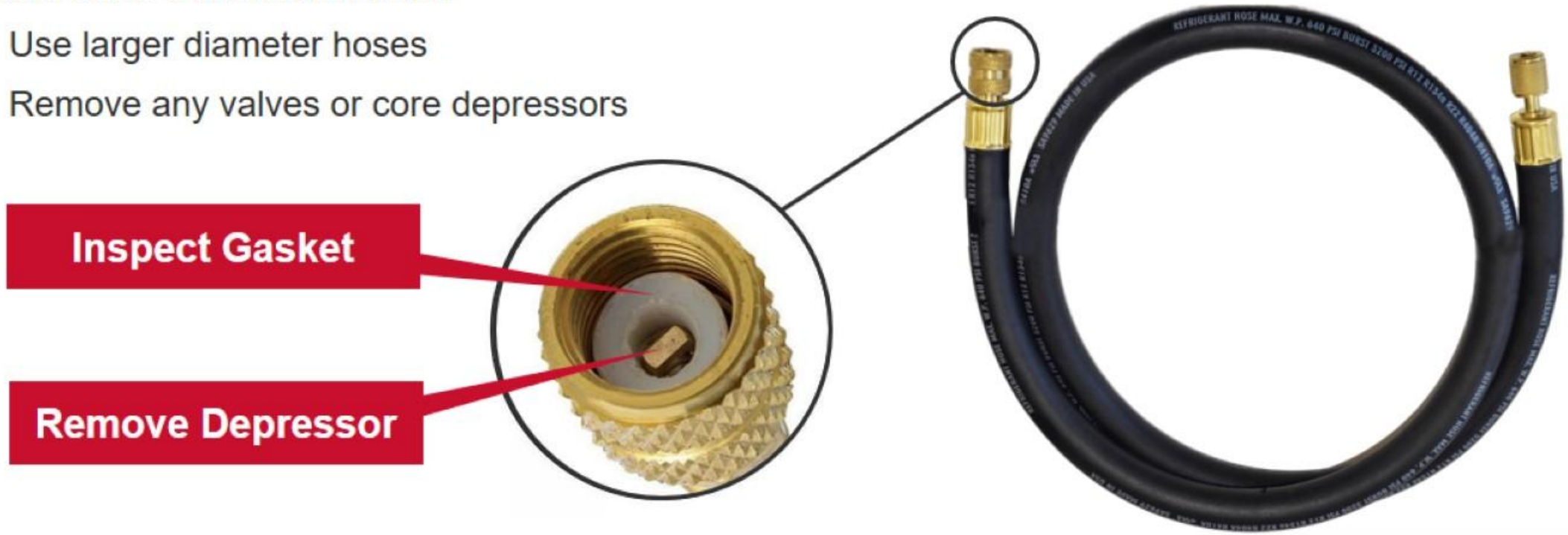
Not Vacuum Rated

Tools

Vacuum Hoses

Use only **Vacuum Rated** hoses for connecting the vacuum pump and micron gauge to the system.

- Ensure hoses are in good condition
- Check the gaskets in the ends of the hose to ensure they are not damaged
- To decrease evacuation time:
  - Use larger diameter hoses
  - Remove any valves or core depressors

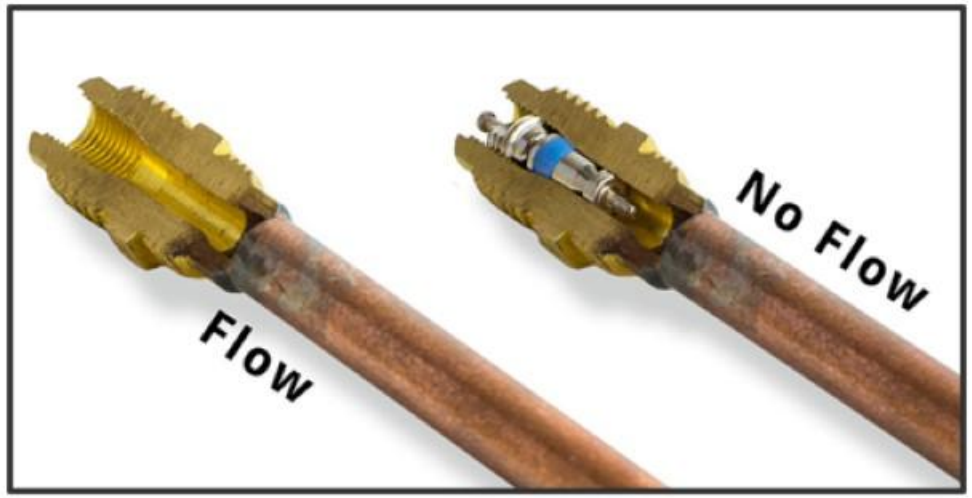


Tools

Core Removal Tool

Use of **Vacuum Rated** core removal tools during evacuation will greatly reduce the time required for evacuation by removing the restriction caused by the Schrader cores.

- Core removal tool attaches to the ¼" flair fitting on the air conditioners service valve.
- It allows for removal of the Schrader core.
- The valve on the tool can then be closed preventing air from entering the system.
- Replace the core and remove the tool after the system has been pressurized with refrigerant.



Tools

Vacuum Pump

Evacuation is accomplished with the use of a deep vacuum pump.

- The most used vacuum pump for HVAC service is the two-stage rotary vane vacuum pump.
  - Larger CFM capacity than single stage pumps
  - Achieves a deeper vacuum than single stage pumps
  - Capable of pulling a system down below 250 microns

Vacuum Pump – Gas Ballast Valve

Some vacuum pumps are equipped with a gas ballast valve.

- The gas ballast valve should be open at the beginning of evacuation.
  - Mixes dry ambient air with high humidity air from the system
  - Reduces moisture that is condensed into the oil
  - Helps the oil last longer
- Close the gas ballast valve once any water vapor has been pumped away.
  - This usually occurs between 1,000 – 3,000 microns

Tools

Vacuum Pump – Size

Vacuum pumps are rated in Cubic Feet per Minute (CFM) free air through the pump .

- As a rule of thumb:
  - Square the CFM capacity of the pump
    - Example: 3 x 3 = 9
    - A 3 CFM rated pump will be good for 9 tons of system capacity
- Multiple pumps connected to the same system are OK.

Tools

Vacuum Pump Oil

Vacuum pump manufacturers recommend frequently changing the oil in the vacuum pump .

- Vacuum pumps do not have filters and are intended to remove moisture so the oil will become:
  - Contaminated with particulate
  - Saturated with moisture
    - Can prevent the vacuum pump from achieving a deep vacuum
    - Causes poor lubrication and excessive wear
- Changing the oil:
  - Ensures the oil is in good condition
  - Helps to remove any contamination from the pump
  - Speeds up the evacuation process
  - Ensures the pump will keep running smoothly

Tools

Vacuum Tree

If the vacuum pump does not have enough connections for both vacuum hoses, a vacuum tree may be used to connect both vacuum lines to the pump

- May be used to isolate the vacuum pump from the system during a standing vacuum test

Tools

Refrigerant Scale

A quality refrigerant scale is needed to accurately measure the amount of refrigerant being added to or removed from the refrigeration system

- Must be capable of measuring in fractions of an ounce

Module 3

Evacuation Procedure

Learning Objective

- Discuss the process for performing a proper evacuation

Evacuation Procedure

Before Beginning Evacuation

- Sweep the system with nitrogen while brazing.
- Pressurize the system with dry nitrogen and check for leaks.
  - Do not exceed the “Low Side” test pressure.
  - You may also use a mixture of nitrogen and a “Trace Gas”.

Evacuation Procedure

Brazing With Nitrogen

- When copper is heated over 500°F, copper and oxygen react to create copper oxide.
  - We see this occur on the outside of the copper where oxygen is prevalent in the air.
  - This can also occur inside the copper if there is air inside the system rather than dry nitrogen.
- Flowing nitrogen while brazing:
  - Prevents copper oxide from forming by displacing oxygen.
  - Keeps lines, filter driers, screens, and compressor oil free from contamination.
  - Helps speed up the evacuation process.

Note: Flow nitrogen to displace oxygen – don't pressurize the system while brazing.

Evacuation Procedure

Leak Testing Post Brazing

Leak detection solution:

- Pressurize the system with dry nitrogen to the manufacturers recommended test pressure.
- Check any suspected areas for leaks using the manufactures recommendations for the leak detector solution.
- If any leaks are found - repair and retest system.

Electronic leak detector:

- Charge the system to 10 PSIG using the appropriate refrigerant.
- Use nitrogen to finish charging the system to normal working pressure.
- Check any suspected areas for leaks using the manufactures recommendations for the electronic leak detector.
- If any leaks are indicated - locate, repair, and retest system.

WARNING

TO AVOID POSSIBLE EXPLOSION, THE LINE FROM THE NITROGEN CYLINDER MUST INCLUDE A PRESSURE REGULATOR AND A PRESSURE RELIEF VALVE. THE PRESSURE RELIEF VALVE MUST BE SET TO OPEN AT NO MORE THAN 450 PSIG.

Evacuation Procedure

Before Connecting To the System

Before connecting any hoses, the vacuum pump, or the micron gauge, release any pressure from leak testing and ensure that the system is at atmospheric pressure.

- If pressure remains in the system:
  - Personal injury or property damage may result
  - Micron gauge may be damaged
  - Oil may be blown out of vacuum pump

Evacuation Procedure

Connecting To The System

1. Remove the Schrader cores from both service valves using core removal tools.
2. Leave the core removal tools on service valves.
3. Hook a micron gauge to the side-tap of one core removal tool.
4. Run vacuum rated hoses directly from the core removal tools to the vacuum pump.
   - If the vacuum pump doesn't have a dual connection, you can use a 'tee" to bring both hoses together and then connect to the vacuum pump.
   - Using a manifold gauge set for evacuation is not recommended.

Evacuation Procedure

Evacuating The System

1. Open the valves on the core removal tools and vacuum pump
2. Start the vacuum pump
3. Evacuate the system to 500 microns or less

Evacuation Procedure

Standing Vacuum Test

A standing vacuum test can be performed to see if the system will hold a vacuum

1. To test the system, close the valves located on the core removal tools
   - This will isolate the system and micron gauge from the vacuum pump
2. Turn off the vacuum pump and use the micron gauge to observe any changes in pressure
   - Hold vacuum for 10 minutes
   - Typically, pressure will rise slightly during this period and level off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Microns
SET
UNITS
RUN
MODE


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49
Microns
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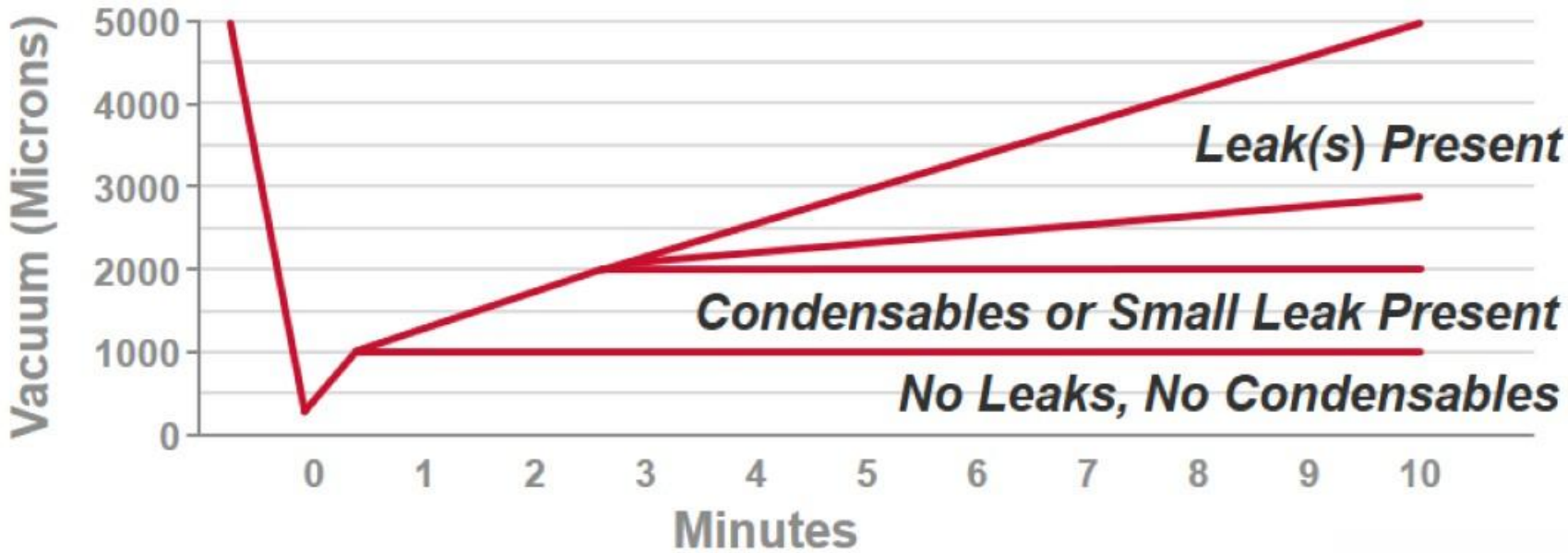
Evacuation Procedure

Standing Vacuum Test (Cont.)

- If the pressure rises to 1000 microns or less and remains steady, the system is considered leak-free; proceed to startup.
- If pressure rises above 1000 microns but holds steady below 2000 microns, moisture and/or non-condensables may be present or the system may have a small leak. Return to step 2: If the same result is encountered check for leaks as previously indicated and repair as necessary then repeat evacuation.
- If pressure rises above 2000 microns, a leak is present. Check for leaks as previously indicated and repair as necessary then repeat evacuation.



Evacuation Procedure

Triple Evacuation Method

On severely contaminated systems the triple evacuation method may be recommended.

1. Evacuate the system to 4,000 microns.
   - Hold vacuum for 15 minutes.
   - Break the vacuum with dry nitrogen and bring the system pressure up to 2-3 PSIG.
   - Hold for 20 minutes before releasing the nitrogen.
2. Evacuate to 1,500 microns.
   - Hold vacuum for 20 minutes.
   - Break the vacuum with dry nitrogen and bring the system pressure up to 2-3 PSIG.
   - Hold for 20 minutes before releasing the nitrogen.
3. Then evacuate the system until it is below 500 microns.
   - Hold vacuum for 60 minutes.
   - If the vacuum holds below 1,000 microns – proceed with system start-up.

Evacuation Procedure

Opening Service Valves

- Slowly open the liquid valve first.
  - When opening valves with c-clip retainers, open the valve until the top of the stem is 1/8” from the retainer.
  - When opening valves without a retainer, open the valve until it contacts the rolled lip of the valve body.
- Once the pressures have equalized open the suction service valve.
- Make sure the service valve caps are clean and apply refrigerant oil to the threads and sealing surfaces on the inside of the cap.
- Tighten the cap finger-tight and then tighten an additional 1/6 of a turn (one flat) to properly seat the sealing surfaces.

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