# CHARGING THE SYSTEM

***Warning - the Clean Air Act of the United States and similar laws in many other countries require that any person servicing a refrigeration system be licensed in the use of a certified recovery device and that such a device be on location at all times during the service call. Failure to comply may result in fines up to $50,000.00 per incident. Some of the procedures described herein may need to be modified to meet the requirements of these governing laws. It is the installer/technician's responsibility to comply.***

**Materials Required**

- HFC -134a Refrigerant gas

**Tools Required**

- 1/4" square or open-end wrench
- Refrigeration service gauge set
- Refrigeration vacuum pump
- Electronic leak detector (recommended)
- Liquid soap (bubble detector) & brush
- High pressure nitrogen tank with 200 psi regulator
- Certified recovery device and HFC-134a tank
- Refrigerant weighing scale (optional)

## Introduction - Certification And The Law

The refrigerant used in your system, HFC-134a, is considered "environmentally friendly" due to its zero ozone depletion rate and has become the world-wide defacto standard replacement gas for CFC-12 in many applications. However, while HFC-134a does not deplete the ozone level, it can contribute to global warming if released indiscriminately into the air. For this reason, most countries regulate its use and require that it be "recovered" in the same way as the ozone depleting gases.

What this means to the owner-installer is that you cannot legally charge, refill or otherwise service the refrigerant carrying portion your refrigeration system without a certification. For some owner-installers, this does not present an immediate problem since it is often a good idea to have a professional evacuate, leak-check and charge the newly installed system anyway. On the other hand, some owners would like the option of doing it all themselves and would like to be able to freely purchase refrigeration gas and service equipment. If you fall into this category, we suggest that you consider getting yourself "certified". To do so requires that you take a brief (usually 1-2 hours) review class and a certification test which immediately follows. Most people, even those with no refrigeration background, pass the test with little problem. For information on classes and test dates in your area, contact your local professional refrigeration supply outlets. The certification you are seeking is the 608 certification. There is a 609 certification (even easier) available, however, this certification applies only to car air conditioning systems and does not legally permit you to work on any system installed on a boat.

*Note: When hiring a "professional" to work on your system you should verify that they are working under a 608 certification. Although there is no legal risk to you, there is good reason to be highly skeptical of any marine refrigeration service person working under a 609 certification.*

# Opening the Compressor and Base Valves

The RParts system is delivered to you with a charge of oil held in the compressor crankcase. Throughout the shipping and mounting process the rotolock valves have been closed to prevent loss of oil and contamination from moisture and particulate matter. The initial oil charge is adequate for most systems. There is no need to add additional oil at the time of charging even though a small amount of the oil may be lost during the system evacuation.

Wait until you are ready to begin leak-checking (see below) before you open the valves. If the process is delayed for any reason, close the valves tightly. This prevents moisture laden air from contaminating the oil.

*Note: The normal operating positions for both base valves is the "back seated" (ie. fully open) position*

# Leak Checking the System

No matter how much care is taken when running the copper tubing, chances are good that there will be one or more "leaks" which will need to be repaired before the system can be evacuated and charged. Many installers simply put on the vacuum pump and check to see if the system holds a vacuum for a period of time. This technique is strongly discouraged for the following reasons:

1. When the system is at full vacuum there is only a 15 psi pressure differential with the ambient air. Such a low differential makes detection of small leaks very difficult.

2. When leaks are present air and moisture from the outside are circulated through the system.

3. If a leak is detected, there is no way to identify its origin.

4. Newly soldered joints often have a coating of flux left filling pinholes. This can act as a "one-way" valve preventing leaks on suction but permitting them upon pressurization.

A much more thorough check can be made by using pressurized nitrogen to elevate the internal pressure above the normal operating system pressure. Since nitrogen cannot be detected by electronic refrigerant leak detectors, a mixture of liquid soap and water is brushed on every joint and a visual inspection is made for "bubbles".

When adding nitrogen to the system be sure to add it to the *high pressure and low pressure sides simultaneously*. Do not pressurize the low pressure side alone. The total system pressure should be slowly elevated to 200 psi. Under no condition should test pressure exceed 250 psi. **WARNING: NEVER USE OXYGEN TO PRESSURIZE A REFRIGERATION SYSTEM. EXPLOSION AND INJURY OR DEATH MAY RESULT.**

# Evacuating the System

Once the system has been thoroughly leak checked, it is time to evacuate the system. This process removes not only air (and residual nitrogen) from the system, but moisture as well. It is important to use a high-quality refrigeration vacuum pump and to ensure that the pump has clean, fresh oil. Old and/or contaminated oil in a vacuum pump prevents the pump from achieving the high level of vacuum required to properly dehydrate the system.

**Getting Started**

**Step 1 -** Connect the gauge set.

Remove the covers from the base valves and use a 1/4"square wrench to turn the valves first counter-clockwise to the "back-seated" position then clock-wise 1 full turn to the "service" position. Remove the service port caps and screw the gauge set into place. Remember that the RED hose connects to the discharge valve and the BLUE hose to the suction valve. The center hose (which can be WHITE, YELLOW or BLACK) is connected to the vacuum pump.

**Step 2 -** Evacuating the system.

Fully open both valves on the gauge set and vacuum pump, and turn on the vacuum pump. You should see the needles on both gauges quickly pull below "0". With continued evacuating, the suction gauge should soon indicate 29 - 30 inches. Failure to reach this vacuum indicates either a defective vacuum pump or a severe system leak.

*Note: Systems which have been previously leak checked with elevated nitrogen pressure may require that the vacuum pump be run for several hours before the system pressure will stabilize at 29 - 30 inches. This is caused by the oil in the system absorbing the nitrogen which then 'boils off' as vacuum is applied.*

To completely dehydrate the system, the vacuum pump must be left running for an extended period of time. How long depends on the ambient temperature since heat tends to "boil off" moisture more quickly. The following table assumes use of a high-quality two-stage vacuum pump.

| Ambient Temperature | Recommended Evacuation Time |
|---|---|
| $90^{o}$ F / $32^{0}$ C | 1 Hour |
| $80^{o}$ F / $27^{0}$ C | 1 Hour |
| $70^{o}$ F / $21^{0}$ C | 2 Hours |
| $65^{o}$ F / $18^{0}$ C | 6 Hours |
| $60^{o}$ F / $15^{0}$ C | 24 Hours |
| $50^{o}$ F / $10^{0}$ C | 48 Hours |

If a system must be evacuated at temperatures below $50^{o}$ F/$10^{0}$ C it will be necessary to heat up the tubing and components. Use a safe and gentle heat source such as incandescent lamps and/or electric room heaters.

**Step 3 -** Disconnect the vacuum pump and attach the refrigerant cylinder.
Close both valves on the gauge set and turn off the vacuum pump. Disconnect the center hose from the vacuum pump. (Check the gauge to see that the system is still in a full vacuum. If not, you did not properly close the gauge set valves and steps #1 and #2 must be repeated.) Attach the center hose to the refrigerant cylinder and loosen it slightly at the gauge set connection. Holding the refrigerant cylinder upright, crack the cylinder valve to purge air from the hose then tighten all connections.

**Step 4 -** Fill with an initial charge.
Open both valves on the gauge set. Then, while holding the refrigerant cylinder upright, fully open the refrigerant cylinder valve. Allow the pressure to equalize (NOTE: If you are using small 16 oz cans, shake the refrigerant cylinder to see if any liquid remains. If not, close all gauge and cylinder valves and remove the empty cylinder. Attach a full refrigerant cylinder to the white hose and purge it as before and repeat step 4 until the system pressure is equal to the cylinder pressure and liquid remains in the cylinder.)

**Step 5 -** Checking for leaks
Even if no leaks were detected previously, all connections should be thoroughly checked once again. The preferred method for leak detection in a charged system is with the use of an electronic detection device made especially for HFC-134a. *Old style leak detectors designed for use with CFC or HCFC refrigerants will not work with HFC-134a*. If an electronic leak detector is not available, satisfactory results can be obtained by carefully brushing all connections with soapy water and looking for bubble formation.

**Step 6 -** Starting the system.
The initial charge of refrigerant filled in step 4 is certain to be less than the total charge you will ultimately need. However, the final charge amount cannot be determined until the system is cold and the holding plates are partially frozen. It will therefore be necessary to activate the compressor and cool the system down. While it will be operating at less than optimum efficiency, the initial charge should be enough to allow the system to cool itself. However, it will be necessary to “top off” the charge once the plates get cold.

*Note: If you have a scale, you can “weigh in” the total correct charge of 4 lbs of refrigerant directly into the low-pressure side of the system.*

After a period of time (generally 5 to 15 minutes) the freezer plate(s) will begin to feel cool to the touch. Continue running the compressor until the freezer plate(s) cool to $30^0$F ($-1^0$C) or lower. If necessary, add more refrigerant to enable the plate to begin cooling down.

**Step 7 -** Topping off the system charge.
With the holding plate(s) cooled to $30^0$F ($-1^0$C) or lower, and the compressor still running, look at the sight glass on the R/A/D assembly. You should see liquid refrigerant splashing past. (The term “bubbles” is often used but is misleading). This indicates that the system is still undercharged. At this point you will want to add enough refrigerant to totally clear the sight glass. To do this, open the gauge set valve on the low pressure (suction) side only.

*Note: During normal operation of a properly charged system, it is generally possible to see liquid splashing in the sight glass for the first few minutes of operation. It is only after the plate(s) has cooled down that the sight glass should fill up and clear. A sight glass which clears very quickly after the compressor starts (particularly if the box and plates are at room temperature) often indicates an overcharged condition.*

**WARNING: WHEN THE COMPRESSOR IS RUNNING, ALL CHARGING MUST BE DONE THROUGH THE SUCTION SIDE - ATTEMPTING TO CHARGE THROUGH THE HIGH PRESSURE (DISCHARGE) SIDE MAY RESULT IN EXPLOSION OF THE REFRIGERANT CYLINDER AND SEVERE INJURY.**

With the gauge set low pressure valve fully open, watch the suction gauge and slowly open the gas cylinder valve. You will immediately see the suction side pressure begin to rise. Use the gas cylinder valve to maintain the suction pressure at 35 - 40 psi. *Note: If the cylinder gets very cold you can speed up the charging process by setting the cylinder in a pan of warm water.*

Watch the sight glass closely and close the gas valve completely as soon as it clears. Allow the system to continue operating for a few more minutes as you monitor the charge status through the sight glass. If bubbles should appear, add more refrigerant until it clears. (Should you need to change cylinders at any point during the operation, do not stop the compressor. Close the low pressure gauge set valve and the refrigerant cylinder valve. Disconnect the empty cylinder and attach a full one. *Remember to purge the white or center hose.* Re-open the low pressure gauge set valve and continue filling the system.

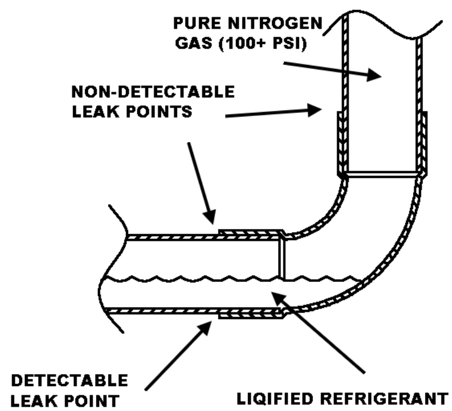
**Step 8 -** Removing the gauge set.
The system in now fully charged. Close the gauge set and cylinder valves. Before removing the gauge set the compressor rotolock valves must be fully back-seated (counter-clockwise). SLOWLY loosen the three hoses allowing time for the pressurized refrigerant to bleed off be fore making the final disconnect. Replace the protective caps on the rotolock service ports.

Many service technicians will just keep adding refrigerant in an attempt to “clear the sight glass” without regard to the temperature of the holding plates. If this is done when the holding plates are warm, it may result in a severely overcharged system.

**Leak Checking**
There exists a large amount of confusion over the process of checking a system for leaks. This confusion is generated by a lack of understanding of the physical processes which significantly affect the two most common methods of performing leak checks.

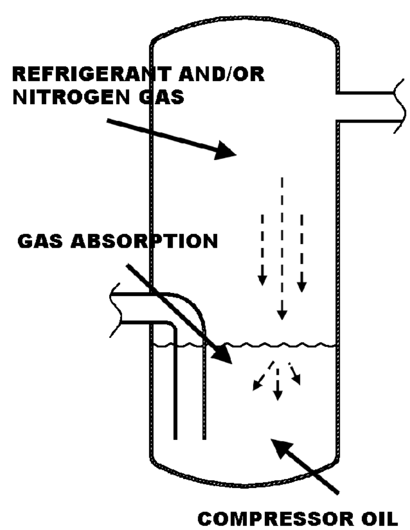
Method #1
In this method a small amount of HFC-134a, R-22 or other refrigerant gas is added to the system. To raise the internal pressure and make small leaks more apparent, a "back-charge" of nitrogen gas is added to elevate the internal tubing pressure to 150 - 250 PSI. An electronic refrigerant "sniffer" is then used to search for leaks around the joints and connections.

Problem with Method #1
At a typical ambient temperature, say $80^0$ F ($27^0$ C), HFC-134a liquefies at any pressure above 87 PSI (R-22 is slightly higher). As the nitrogen is added to the system the pressure increases above the liquefaction point of the refrigerant. The refrigerant gas turns to liquid, separates from the nitrogen and flows to the low points in the tubing. Since refrigerant "sniffers" are not sensitive to nitrogen, leaks which are located at the high points (above the level of the liquified refrigerant) cannot be detected.




Solution for Method #1
Elevating the pressure in a system above that which would be obtained with refrigerant alone can be helpful in locating leaks. However, the only reliable way to identify leaks in a system which is "back-charged" with nitrogen is to use a soapy bubble solution.

Method #2
This method often used in conjunction with method #1 (described above) but may also be used with refrigerant alone. The idea here is to attach a gauge set to the system and add refrigerant, nitrogen (or both) to the system to raise the internal pressure. A note is taken of what that pressure is. The system is left for a period of time (possibly overnight) and the gauges are then checked to see if the pressure has dropped.




Problem with Method #2
The fact is, that the pressure indicated on the gauges will always drop. While the technicians know this, they generally do not know why. What they will try to do is make a "best guess" as to whether the amount of the drop is severe enough to indicate a leak. Where is the gas going? Indeed, the gas may be lost through a leak. However, it also goes someplace else that is simply impossible for the technician to accurately quantify - into the compressor oil. As the system pressure increases the gas is slowly absorbed by the compressor oil which comes pre-charged in virtually all systems. This is analogous to the carbon dioxide gas which is absorbed into the liquid in a can of soda. As the gas is absorbed, the pressure in the system falls. How

much gas will be absorbed and how long it will take varies widely depending on the type and quantity of compressor oil, systems pressure and temperature.  The bottom line is, the system pressure is going to fall and there is no way of knowing if it is caused by absorption or a small leak.

*Note: A variation on this same problem occurs when the technician tries to evacuate the system.  As the pressure is reduced (by the vacuum pump) the gas which has been absorbed by the oil now begins to boil off (just at the carbon dioxide comes out of your soda when you open the top).  This greatly extends the time it takes pull the system pressure down to an acceptable level (29" mercury) and gives the technician the impression that he may be  pulling air into the system through a leak.*

Solution for Method #2

Monitoring pressure drop can be helpful in identifying leaks - particularly large ones.  With proper procedures and equipment it can also be used to indicate moderate leaks.  In practical terms it is not helpful when the leaks are very small.  To use this method effectively requires that the systems pressure be “topped-off” several times and time given to permit the pressure to completely stabilize.  This may take as long as 24 hours.  Also, the standard hoses found on refrigeration gauge sets are not designed to hold long-term pressure and are quite “permeable”.  To eliminate this variable it is necessary to use only special “high-vacuum” rated refrigerant hoses.