System Charging



- Capillary Tube Systems
- Thermostatic Expansion Valve Systems
- Charging by Weight

Preface

The purpose of this publication is to provide service technicians with the general knowledge necessary to properly charge a Heat Pump system or an Air Conditioning system. This manual outlines, in detail, recommended charging procedures to be followed on all capillary tube and expansion valve systems.

Before any of the procedures outlined in this manual can be initiated the service technician must have all the necessary tools as listed under equipment on page 4.

In addition to tools proper airflow must be verified prior to any attempt to charge a system. The system should be checked to confirm that all air filters are clean, that the blower assembly and coil are free of dirt and that the duct system is adequate. If proper airflow is not available all associated problems must be corrected prior to attempting any charging procedure.

Cooling performance can be checked when outdoor temperature is above 75°. Heating performance can be checked when the outdoor temperature is below 60°.

Section 608, paragraph C of the Clean Air Act of 1990 states:

Effective July 1, 1992, it shall be unlawful for any person, in the course of maintaining, servicing, repairing, or disposing of an air conditioning system, to knowingly vent or release any CFC or HCFC refrigerant. Minimal releases (air purges of refrigerant hoses) associated with good faith attempts to recapture or recycle are exempt from the ban on venting.

The Clean Air Act has provisions for significant fines and/or imprisonment for noncompliance. These fines could range from \$5,000 to \$25,000 per day.

Note: This publication is general in nature and is intended for INSTRUCTIONAL PURPOSES ONLY. It is not to be used for equipment selection, application, installation, or specific service procedures.

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IMPORTANT

These procedures should be followed at initial start-up and at anytime the power has been removed for 12 hours or more.

To prevent compressor damage which may result from the presence of LIQUID refrigerant in the crankcase:

- 1. Make certain the room thermostat is in "off" position. (The compressor is not to operate.)
- 2. Apply power by closing the system disconnect switch. This energizes the compressor heater which evaporates the liquid refrigerant in the crankcase. Allow 30 minutes for each pound of refrigerant in the system as noted on the unit nameplate.
- 3. After proper elapsed time the thermostat may be set to operate the compressor.
- 4. Except as required for safety while servicing DO NOT OPEN SYSTEM DISCONNECT SWITCH.

Refrigerant System Charging

Refrigerant charging is one of the most important and probably least understood service procedures practiced in the air conditioning industry. Improperly charged systems lead to inefficient operation and premature equipment failure. The graph below illustrates a typical package cooling system charge

Refrigerant Charge



Note:

 The package cooling system used to develop the above information utilized a TXV refrigerant metering device.

Service Tools — Equipment

The Service Tools needed to PROPERLY charge a refrigeration system includes:

- 1. Manifold Gauges
- 2. Electronic Temperature Analyzer (Temperature measurements should be made with a good quality electronic temperature tester such as a Robinair 12860, Annie A-8, Electro-medic M-99, or equivalent.)
- 3. Sling Psychrometer
- 4. Refrigerant- 22 (Mono-chlorodiflouromethane)
- 5. Approved refrigerant recovery system and holding tank.

being varied from 50% undercharge to 37.5% overcharge. Airflow and temperatures were held constant at ARI standard conditions as the charge was varied. Note the change in capacity, power input and EER as each pound of refrigerant was added above 50% undercharge.

Correct Charge

- Optimum capacity
- Highest possible EER
- Longest equipment life

Undercharge

- · Capacity decreases
- Power input decreases but not in proportion to capacity
- · EER goes down
- · Equipment life is shortened

Overcharge

- Capacity decreases as more charge is added beyond the optimized capacity
- Power input increases
- EER decreases
- · Equipment life is shortened

	BTU Output
CCN =	Power Input
	BTU Output
COP =	BTU Input

2. Field conditions different from ARI conditions (95° db outdoor air, 80° db-67° wb return air) will yield results that vary from the graphs in this example.

2

Metering Devices

We use various types of refrigerant metering devices in air conditioning and heat pump systems. The cooling units we will discuss are equipped with Flow Control Check Valves (FCCV), see diagram below left, Capillary Tubes, Bleed-Type Thermostatic Expansion Valves (TXV-B) and Non-Bleed Thermostatic Expansion Valves (TXV-NB), see diagram below right. Current heat pump units which we will cover are equipped with Bleed and Non-Bleed TXV in outdoor sections with everything but Capillary Tubes on indoor coils. The CCBA and CUBA coils have a fixed flow control device for coolingonly applications.

The FCCV Flow Control is used on TXA-C and TXC-C universal convertible coils. This metering device is applied to these coils for cooling and heat pump applications with 10 and 11 SEER products respectively. Package products may either use a FCCV or Capillary Tube metering devices. (FCCV coils are not an approved combination with a 5 ton 12 SEER or any 14 SEER outdoor units. These units can easily be overcharged with this type of metering device because the large volume of refrigerant in the system may not show an increase in head pressure. Only TVX coils should be used.)

Care should be taken that the proper size FCCV is matched to the outdoor unit to insure that the correct volume of refrigerant is flowing through the system (approx. 3 lbs/ton/minute). The orifice size of the FCCV is marked on the side of the metering device. TXA-C and TXC-C coils are shipped with the orifice size that matches the most commonly used outdoor unit with that particular coil combination. That size is indicated on the tag on the coil connection end. Correct orifice size is dependent on the outdoor unit model. The proper orifice for the indoor unit is in a small bag attached to the outdoor unit. (Orifices shipped with indoor coils may or may not be correct for the outdoor unit, so the installer must verify size at the time of installation.) Refer to Service Facts which also shows the proper size and type of metering device for the application.

TXC-E high efficiency coils are equipped with Bleed-Type TXVs for refrigerant control. The diaphragm on the TXV opens or closes the valve orifice to maintain a preset superheat and control refrigerant flow as load conditions on the evaporator change. When the compressor shuts off, refrigerant is able to bleed between the high pressure side upstream of the TXV and the low pressure downstream of the TXV; the system will equalize within 3-5 minutes. Also, these coils have a larger internal volume in order to support additional charge and provide for higher efficiencies. These coils are designed to be matched with 12 SEER outdoor units for higher SEER requirements. These coils can also be mated to 10 and 11 SEER units.

The TXC-S variable speed coils are equipped with Non-Bleed TXVs (TXV-NB). These coils do not equalize or bleed through the valve orifice which helps to prevent refrigerant from migrating back to the compressor after system shutdown. These coils should only be applied to outdoor products that are equipped with quick start components because of the pressure differential during system start up. Scroll compressor unit does not require a quick start component. Variable speed coils are mated with 12 and 14 SEER products for high efficiency.

Because today's high efficiency systems require additional refrigerant volume to produce the needed capacity and efficiency, it is important that systems be installed with the proper size indoor coils equipped with the necessary metering device. Failure to do so could cause a decrease in reliability, capacity and efficiency.



Accutron[™] Flow Control Check Valve (FCCV)





Cooling Systems

The diagram below illustrates the proper Manifold Gauge and Temperature Analyzer connections for charging a split cooling system.



Split System

- Attach center hose from manifold to drum of refrigerant. Purge center hose with a minimum amount of refrigerant. Use the guidelines for deminimus release of refrigerant.
- 2. Purge with a minimum amount of refrigerant and attach suction (compound) gauge hose to the suction line (larger refrigerant line) pressure tap. This pressure tap is located on the suction line service valve.
- 3. Purge with a minimum amount of refrigerant and attach the high pressure gauge hose to the liquid line (smaller refrigerant line) pressure tap. This pressure tap is located on the liquid line service valve.
- 4. Attach temperature probe securely to the suction line near the service valve (if charging a cooling system with capillary tubes or checking TXV superheat). Insulate the probe with suction line insulation to prevent the element from being influenced by the surrounding air. Allow adequate time for system temperatures to stabilize before recording the temperature.

Cooling Package System

- Attach center hose from manifold to drum of refrigerant. Purge center hose with a minimum amount of refrigerant. Use the guidelines for deminimus release of refrigerant.
- Purge with a minimum amount of refrigerant and attach suction (compound) gauge hose to the suction line (larger refrigerant line) pressure tap. This pressure tap may be located on the inside of the cabinet. For example: on the Voyager and Impack lines.
- 3. Purge with a minimum amount of refrigerant and attach high pressure gauge hose to the liquid line (smaller refrigerant line) pressure tap. This pressure tap is located inside the cabinet.
- 4. Attach temperature probe securely to the suction line approximately 6" away from compressor, if charging a cooling system with capillary tubes or checking TXV superheat. Insulate the probe with suction line insulation to prevent the element from being influenced by the surrounding air. Allow adequate time for system temperatures to stabilize before recording the temperature.

On either style of system, if refrigerant must be removed to achieve charge balance, an approved refrigerant recovery system and an approved storage tank must be used.

Heat Pump Systems

The diagram below illustrates the proper Manifold Gauge and Temperature Analyzer connections for charging a split heat pump system in the cooling or heating mode.



Heat Pump Split System

- Attach center hose from manifold to drum of refrigerant. Purge with a minimum amount of refrigerant. Use the guidelines for deminimus release of refrigerant.
- Purge with a minimum amount of refrigerant and attach suction (compound) gauge hose to low side charging port. This charging port (pressure tap)★ on older models protrudes from the corner service valve panel of the heat pump and is piped directly to the suction line at the compressor. On current models this pressure tap is inside the cabinet.
- Purge with a minimum amount of refrigerant and attach the high pressure gauge hose to the high side charging port. The high and low sides charging ports (pressure taps)★ on older models protrude from the corner service valve panel of the heat pump and are piped directly to the discharge and suction lines at the compressor. Use this tap to obtain head pressure when charging heat pumps in the heating or cooling mode. DO NOT use the pressure tap on the liquid line (small) service valve for charging or performance measurements. On current models, this pressure tap is inside the cabinet.
- 4. Attach the temperature probe securely to the suction line near the service valve if charging a system with indoor capillary tubes by the super heat method or a heat pump with capillary tubes by the hot gas method. Insulate the probe with suction line insulation to prevent the element from being influenced by the surrounding air. Allow adequate time for recording the temperature.

Heat Pump Package System

- Attach center hose from manifold to drum of refrigerant.. Purge center hose with a minimum amount of refrigerant. Use the guidelines for deminimus release of refrigerant.
- 2. Purge with a minimum amount of refrigerant and attach suction (compound) gauge hose to low side charging port. This charging port (pressure tap) is inside the cabinet of the heat pump and is piped directly to the suction line at the Compressor.
- 3. Purge with a minimum amount of refrigerant and attach the high pressure gauge hose to the high side charging port. The high side charging port (pressure tap) is inside the cabinet of the heat pump and is piped directly to the discharge line at the compressor. Use this tap to obtain head pressure when charging heat pumps in the heating or cooling mode.
- 4. Attach the temperature probe securely to the suction line approximately 6" away from compressor, if charging a system with indoor capillary tubes by the superheat method or a heat pump with capillary tubes by the hot gas method. Insulate the probe with suction line insulation to prevent the element from being influenced by the surrounding air. Allow adequate time for recording the temperature.

On either style of system, if refrigerant must be removed to achieve charge balance, an approved refrigerant recovery system and an approved storage tank must be used.

Equipment Pressure Taps (General)

Pressure taps may be located on the equipment cabinet, on the refrigerant lines, or on refrigerant line service valves. Some equipment may have pressure taps at more than one location. See the charging charts located on the equipment for selecting proper pressure taps. Inaccurate pressure readings will occur if the wrong taps are used. Pressure taps located on or inside the equipment cabinet must be used on heat pumps. Inaccurate readings and damage to pressure gauges will result if the wrong taps are used.

Three phase 7.5 ton and larger split system models have pressure taps located on service valves which are closed when the valves are fully open in their operating position (backseated). After connecting gauges to pressure taps, the service valves are turned one turn in a clockwise direction to open the pressure taps. Do not exceed one turn.

When pressure measurements have been completed, return the valves to their fully backseated position. Replace and tighten valve caps securely to prevent leaks. Cover caps on pressure taps should always be replaced and tightened after making pressure measurements to prevent leaks. Do not overtighten caps on Schrader type pressure taps. The tap may be damaged preventing future use.

Manifold Gauge Removal

Caution must be used when removing hoses from a refrigerant system. When attaching and removing manifold gauges access valve actuators manufactured by Robinair, Watsco, J.B. Industries, Imperial Eastman and Delco may be used to prevent loss of refrigerant charge. Liquid refrigerant when released can cause severe burns and permanent eye damage. Always wear safety glasses, face mask and protective clothing when handling refrigerants.

Charging Capillary Tube/FCCV – Cooling Mode Only – R-22

Current Superheat Method

- Measure indoor dry bulb temperature. (Return air at air handler).
- 2. Measure outdoor dry bulb temperature. (Measure at outdoor unit).
- Measure suction pressure at suction pressure tap.
- Measure suction temperature before the suction service valve on a split system or 6" away from the compressor on a package system.
- 5. You may determine the actual system superheat in degrees by referring to a temperature pressure chart or the low side manifold gauge and the measured suction line temperature.
- 6. *Find the intersection when the outdoor temperature and indoor temperature and read degrees superheat. If unit superheat is more than 5° above chart value, add R-22 until within 5°. If unit superheat is more than 5° below chart value, remove R-22 until within 5°, using an approved recovery system.
- 7. If superheat is below the 5° limit line, DO NOT ADD R-22.



Charts based on 400 CFM/ton indoor airflow and 50% relative humidity, use only on systems that cool with an FCCV or capillary tube.

*If Relative Humidity is above 70% or below 20% use indoor Wet Bulb Temperature.

Example Slide Rule Calculation – R-22



Current Method Split System with a TWV036A Air Handler Cooling System with FCCV or Capillary Tubes Indoor Air Flow 1200 CFM



PERFORMANCE CURVES ARE NOT UNIVERSAL Indoor Unit Alternates See Correction Table

CORRECTION TABLE

Indoor Unit	CFM	Corr. S	Press. H
COOLING WITH CAPIL	LARY		
BXA036A200A	1200	-3	-6
BXA736M2HPA	1200	-3	-6
BXA736D200A	1200	0	0
BXF036A200A	1200	-2	-4
BXA042A200A	1350	0	0
BXF048A200A	1350	3	6
BWH736A100A	1200	0	0
BWV036A100E	1200	0	0
BWV736A100E	1200	0	0
BWV042A100C	1350	3	6
COOLING WITH FCCV			
TWV036A140A*	1200	0	0

Cooling performance can be checked when the outdoor temperature is above 75°F.

To check cooling performance, allow pressures to stabilize and measure indoor wet bulb temperature, outdoor temperature and pressures (both head and suction).

Locate outdoor dry bulb and indoor wet bulb temperature. Find the intersection of the outdoor dry bulb temperature and indoor wet bulb temperature. Read head (or liquid) and suction pressure value in the left hand column of the chart.

 $\begin{array}{l} \mbox{Actual Head Pressure should be} \\ \pm 10 \mbox{ PSIG of chart.} \end{array}$

Suction Pressure should be ± 3 PSIG of chart.

Example:

Outdoor Dry Bulb Temperature = 90° F Indoor Wet Bulb Temperature = 67° F

Answer:

Suction Pressure @ 1200 CFM = 75 PSIG Head Pressure @ 1200 CFM = 225 PSIG

*Note: Interconnecting Lines: Gas - 7/8" O.D.: Liquid - 5/16" O.D.

†These graphs are for checking unit performance only.

They are not to be used for system charging. To charge systems with indoor capillary tube, see superheat graphs or capillary tube slide rule calculation on pages 7 and 8.

Charging and Performance – Cooling Mode – R-22

PERFORMANCE CURVES ARE NOT UNIVERSAL Indoor Unit Alternates See Correction Table

Current Method Split System with a TXC730P3HPA Coil Cooling System with Thermal Expansion Valve. Indoor Airflow 1060 CFM



*Note: Interconnecting Lines: Gas - 7/8" O.D.: Liquid - 5/16" O.D.

CORRECTION TABLE

Indoor Unit	CFM	Corr. S	Press. H
TWH036A140A	1200	0	0
TWH736A140A	1200	0	0
TWH042A140A	1350	3	6
TWH742A140A	1350	2	4
TWH048A140A	1350	5	10
COOLING WITH TXV			
BXA730P3HPA	1125	-5	-10
BXA736P3HPA	1200	-2	-4
BXF736P3HPA	1200	0	0
BXA742P3HPA	1350	0	0
BXF748P3HPA	1350	2	4
TXC730P3HPA	1060	0	0
TXC730P6HPB*	1060	0	0
ТХС736РЗНРА	1200	3	6

Cooling performance can be checked when the outdoor temperature is above 75°.

To check cooling performance, allow pressures to stabilize and measure indoor wet bulb temperature, outdoor dry bulb temperature and pressures (both head and suction).

Locate outdoor dry bulb and indoor wet bulb temperature. Find the intersection of the outdoor dry bulb temperature and indoor wet bulb temperature. Read head (or liquid) and suction pressure value in the left hand column of the chart.

Actual Head Pressure should be ± 10 PSIG of chart.

Suction Pressure should be ± 3 PSIG of chart.

Example:

Outdoor Dry Bulb Temperature = 85° F Indoor Wet Bulb Temperature = 67° F

Answer:

Suction Pressure @1060 CFM = 74 PSIG Head Pressure @ 1060 CFM = 210 PSIG



- 1. Measure Liquid Line Temperature and Refrigerant Pressure at service valves.
- 2. Determine total refrigerant pipe length and height (lift) if indoor section is above the condenser. Plot the intersection of the two points on the Curve Selection Chart to determine which curve to use.
- 3. Plot the pressure and temperature on the TXV Charging Curve.
- 4. If the lines cross above the curve, remove refrigerant; if below curve, add refrigerant.
- 5. Whenever charge is removed or added, the system must be operated for a minimum of 20 minutes to stabilize before additional measurements can be made.
- 6. When system is correctly charged, refer to System Performance Curves to verify charge and performance.
- 7. **Exception** Model 6H0024A100A will have 30° subcooling in cooling. Its system performance charts are with 30° subcooling.

Performance – Heating Mode – R-22

Heat Pump with Capillary Tubes or FCCV

These charts are located in the outdoor section along with the charging charts. If the unit has a capillary tube outdoors these charts should NOT be used for charging but only to ensure you are in the ball park on the charge and that the system is working properly. Once this has been established you should use the charging chart on the outdoor unit. A typical chart is shown on the next page to fine tune the charge for maximum efficiency.

To use the chart:

- 1. Read indoor and outdoor temperatures at the air handler and outdoor unit respectively.
- 2. Measure head and suction pressures at the outside pressure tap.

- To check either HEAD or SUCTION PRESSURE enter the chart on the bottom scale marked OUTDOOR TEMPERATURE.
- 4. Draw a vertical line up to the INDOOR TEMPERA-TURE and read SUCTION PRESSURE or HEAD PRESSURE horizontally to the left in the appropriate airflow column.
- 5. The HEAD PRESSURE reading on the gauge should be equal to, or within 5 PSIG BELOW the chart reading.
- 6. The SUCTION PRESSURE reading on the gauge should be within ±3 PSIG of the chart reading.



This is a Typical Chart and is Not Universal for All Heat Pumps.

Heat Pump with Capillary Tubes or FCCV

- 1. Unit must be in the Heating Mode with stabilized running conditions and coil must be free of ice.
- 2. Measure suction pressure and discharge pressure and check against pressure curve performance in the outdoor unit. If pressures are within tolerance proceed with the following steps. If pressures are not within tolerance see preceding page.
- 3. Measure outdoor dry bulb temperature at the outdoor unit.
- 4. Measure indoor dry bulb temperature at the air handler.

- 5. Measure Hot Gas temperature near outdoor unit.
- 6. Using the Charging Chart on the outdoor unit find the intersection where the outdoor temperature and the indoor temperature meet. Read hot gas temperature for this intersection. If measured hot gas temperature is more than 2° above chart value, add R-22 until within 2 degrees. If measured hot gas temperature is more than 2° below chart value, remove R-22 until within 2°, using an approved recovery system.



This is a Typical Chart and is Not Universal for All Heat Pumps.

Charging - Heating Mode - R-22 - continued

Current Method Split Heat Pump with a TWV030A Air Handler Heat Pump with TXV Outdoor Unit Indoor Airflow 1000 CFM



CORRECTION TABLE

PERFORMANCE CURVES ARE NOT UNIVERSAL Indoor Unit Alternates See Correction Table

	0514	Corr.	Press.
Indoor Unit	CFIVI	5	н
TXA036A4HPA	1125	-1	-15
TXA736A4HPA	1125	-1	-15
TXC042A4HPA	1125	-1	-20
TXA042A4HPA	1125	-1	-20
TXA742A4HPA	1125	-1	-20
TWV025A140A	900	1	15
TWV725A140A	900	1	15
TWV730A140A	1000	0	0
TWV036A140A	1125	-1	-15
TWV736A140A	1125	-1	-15
TWV042A140A	1125	-1	-20
TWV742A140A	1125	-1	-20
TWH024A140A	900	1	15
TWH742A140A	900	1	15
TWH030A140A	1000	0	0
TWH730A140A	1000	0	0
TWH036A140A	1125	-1	-15
TWH736A140A	1125	-1	-15
TWH042A140A	1125	-1	-20
TWH742A140A	1125	-1	-20

Heating performance can be checked when the outdoor temperature is below 60°F.

To check heating performance, allow pressures to stabilize and measure indoor dry bulb temperature, outdoor temperature and pressures (both head and suction).

Locate outdoor and indoor dry bulb temperature, find the intersection of the outdoor temperature and indoor temperature and read head or suction pressure value in the left hand column of the chart.

Actual Head Pressure should be: Equal to or less than 5 PSIG of chart. Suction Pressure should be \pm 3 PSIG of chart.

Charging By Weight

When a refrigerant system is opened, as in compressor replacement, the service technician may want to recharge the system by weight.

Package Systems

The charge stamped on the unit's nameplate is the total charge. With an accurate scale the weight method of charging is a rapid and accurate method of charging.

Split Systems

Charging by weight using unit's nameplate information only is not an approved method. Prior to 8/98, the refrigerant charge stamped on the outdoor unit nameplate was the total system charge when installed with 25 feet of refrigerant lines and with the indoor coil or air handler that the outdoor unit was rated with. The Department of Energy, test procedures require the manufacturer to test and rate their outdoor unit with their highest sales volume indoor coil or air handler. This rated combination is listed in the Air Conditioning and Refrigeration Institute Directory, ARI. In the ARI Directory this tested combination is noted by a ‡ sign. Unless you have this tested combination installed, which is listed in the ARI Directory only, the charge stamped on the outdoor unit nameplate is of little use. Further, this nameplate stamping is not the charge always shipped in the outdoor unit.

The units are shipped with the minimum operating charge. The minimum charge is the charge required for 25 feet of line for units produced prior to 8/98. For units produced after this date, the shipped charge is the total system charge when installed with 15 feet of refrigerant lines and the smallest indoor coil, by internal volume, that the unit is listed within the ARI Directory. The smallest indoor coil may not be the ‡ tested combination. This minimum operating charge is shipped in the unit so at start up time no refrigerant recovery will be necessary.

Indoor coils are shipped with a 10 PSIG nitrogen holding charge.

Evacuation

When the refrigerant lines installation is completed and leak checked they and the indoor coil must be dehydrated. Proper dehydration is achieved when these components are evacuated to a minimum of 500 microns.

Calibrating Pressure Gauges

To check pressure gauges, connect the low pressure gauge to a cylinder of CFC-12 and the high pressure gauge to a cylinder of HCFC-22. Make sure the cylinders have been left standing in a stable environment, away from radiant heat sources, for several hours. This guarantees that the temperature inside the cylinder is the same as the temperature outside the cylinder. Measure the temperature of the air around the cylinders. Now compare the pressure indicated on the gauges to the Temperature-Pressure Chart. Use the adjustment screw on the gauges to calibrate them to this pressure.

EXAMPLE: The air temperature is 75°F. The low pressure gauge (connected to the cylinder of CFC-12) should be adjusted to indicate 77 PSIG. The high pressure gauge (connected to HCFC-22) should indicate 132.25 PSIG – or as close as we can read it.

We don't need a pressure/temperature chart to make this check. Most manifold gauges used for refrigeration and air conditioning have this chart "built into" the scales, right on the gauge. Figure 1 is a copy of the scales on a typical set of refrigeration gauges. Notice the inside scales labeled HCFC-22, CFC-12 and CFC-502. The values on these scales are the saturation temperatures for the pressures indicated.

If the low pressure gauge is connected to a cylinder of CFC-12, and the air temperature is 75°F, adjust the needle to indicate a temperature of 75°F on the CFC-12 (middle) scale. The pressure reading is about 77 PSIG.

Finally, after calibrating the high pressure gauge to HCFC-22, calibrate it also to CFC-12. This gives us two reference points for more accuracy.

Due to the rough handling these test instruments go through day after day, it is important to develop a habit of routine maintenance and calibration. These instruments are our "eyes and ears." How can we quickly and accurately service equipment if we can't trust the measurements we make?



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Refrigerant Circuit	<u> </u>	<u> </u>	<u> </u>		<u> </u>	<u> </u>	<u> </u>	<u> </u>	—	<u> </u>	<u> </u>	<u> </u>	—	—	<u> </u>	—	<u> </u>	-	<u> </u>)	<u> </u>	—	 `	<u> </u>	Ì	<u> </u>	Ì	<u> </u>	<u> </u>	—	٦
Head Pressure Too High	C H																P P		S S	P	S			Р	S S						
Head Pressure Too Low	C H											_			S S	P P						S S	S S		S S	S		P P		_	
Suction Pressure Too High	C H											_			S S		Ρ	Ρ				S	S S			S P		Ρ			
Suction Pressure Too Low	C H															P P				S			S S	Ρ	S S						
Liquid Refrigerant Floodback(TXV)	C H																					P P						P P			
Liquid Refrigerant Floodback Cap Tube	C H											_					P P			S S	S S		S S	P P					_		
ID Coil Frosting	C H															Ρ				S	S										
Compressor Runs Inadequate or No Cooling/Heating	C H														S S	P P		S	S S				S S	P P	S S	S S	S	S S		_	
Electrical																															
Compressor & OD Fan Will Not Start	C H	P P	P P						S S	P P	S S	P P	P P																		
Compressor Will Not Start But OD Fan Runs	C H		P P	S S	P P	S S	S S	S S						P P																	
OD Fan Will Not Start	C H		P P		P			S S				_																		-	_
Compressor Hums But Will Not Start	C H				P P	S S	S S	S S						P P																	
Compressor Cycles On IOL	C H		P	S S	P	S S	S S	S S				_		P P	S S	P P	P P	S S		S S			S S	P P		S S			_	_	-
ID Blower Will Not Start	C H	P	P P						S S	P P	S S		S S																		_
Defrost	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_					_	_	_	_	_	_	_	_	_	_	
Unit Will Not Initiate Defrost	C H																										Р		Р	Ρ	P
Defrost Terminates On Time	C H															Ρ													_	P	P
Unit Icing Up	C H															Ρ				S	S						Р			S	P
C - Cooling H - Heating		P S	- P - S	rin ec	1ar on	ry (dar	Cau ry (use Cai	is Use	S																					

Refrigerant 410A

Background

The traditional refrigerants, which have been used in central air conditioning systems for the past fifty years, have been declared to be a threat to the environment. This is due to the presence of Chlorine in their chemical make-up. As a consequence, the air conditioning industry has been required to search for a suitable replacement for the most popular of the current refrigerants, Refrigerant 22.

Since there are concerns of efficiency and service use, as well as the environmental issues, the job has not been easy. To locate a replacement and qualify it for use in the products we manufacture has taken years of work. The refrigerant chosen at this time is Refrigerant 410A. Continuing study will be conducted into other alternates.

Refrigerant Characteristics

The refrigerants developed in the nineteen twenties, using chlorine, such as Refrigerant 22, were uniform in their chemical make-up. Such refrigerants are called compounds. Each molecule of the refrigerant is like every other molecule. There is no way in the field to separate the elements of a compound once it has been made. Only the most sophisticated laboratory equipment can break the building blocks of the refrigerant apart. They contained Hydrogen, Chlorine, Fluorine, and Carbon. These refrigerants were called HCFC's.

The alternative refrigerants are different in the materials used to make them. They are also different in the manner in which they are made. Refrigerants like Refrigerant 410A are mixtures of chemicals. This means its components are not as tightly bonded together and may separate when released from pressure. It is said to be near AZEOTROPIC in its construction. This word means that it is a mixture, not a compound. It is manufactured by combining Refrigerant 32 and Refrigerant 125. Both of these refrigerants are made of Hydrogen, Fluorine, and Carbon and are referred to as HFC's.

The most important reason for using an alternate refrigerant is that it does not contain any Chlorine.

Under Federal law, no release of refrigerant is allowed beyond the minimum required to do service to the products. This "DE MINIMUS" or "least possible" loss must be closely observed during service to avoid being subject to possible fines and worse. Even the alternative refrigerants cannot be released to atmosphere. The EPA (Environmental Protection Agency) requires they must be collected and handled as the existing refrigerants are handled. The issue here is not Ozone Depletion but the contribution to Global Warming and the waste of a valuable resource.

The alternative refrigerant R-410A is not a "drop-in" replacement for R-22. Since they use different oils, different drier construction materials and different expansion devices, they require the greatest caution in replacement situations. At this time, R410A is intended for use in new equipment.

The service tools that are used for the alternative refrigerant are not the same as the tools used for the current refrigerants and this will be explained in this manual. Please read and heed the warnings included in the material in this manual and the manufactures' literature included with the products containing this alternative refrigerant.

Refrigerant Safety

The alternative refrigerant, R-410A, like R-22 is a safe product. The same precautions must be observed when using either one. However, the technician must be aware of several differences in the handling of R-410A.

When the cylinders containing Refrigerant 410A are sitting upright, the valve will release liquid refrigerant. As you can see in Figure 1, there is a dip tube in the tank reaching to near the bottom of the cylinder. To charge with vapor, turn the cylinder upside down as shown in Figure 2. For cylinders made after 2/99, turn the cylinder upside down as shown in Figure 1A for liquid and upright for vapor as shown in Figure 2A.

Refrigerant cylinders containing Refrigerant 410A are ROSE colored for identification.

Refrigerant cylinders should never be stored at 125°F or higher temperatures.

Never charge any refrigerant cylinder to greater than 80% of its capacity. This was true for Refrigerant 22 and is also true for Refrigerant 410A.

Refrigerant 410A boils at -62.9°F. when released to atmosphere. This is twenty degrees colder than Refrigerant 22. The danger of frostbite is much

greater on exposed skin. Wear gloves and protect your eyes with safety glasses at all times.

This refrigerant, like Refrigerant 22, is low in toxicity but it can still be harmful to humans as it displaces oxygen. Since it is heavier than air, it will form puddles in low places. Use adequate ventilation near equipment that is leaking.

Refrigerant 410A is classified as non-flammable. Like Refrigerant 22, when mixed with air under pressure it can ignite. Make sure the system is without pressure before using a torch for a repair.

Recovery cylinders used with Refrigerant 410A are not the same cylinders used for Refrigerant 22. Refrigerant 410A recovery cylinders are constructed and tested to higher pressures, 400 PSIG (Pounds to the Square Inch Gauge).

Since the vapor pressure of Refrigerant 410A is from 50% to 70% higher than Refrigerant 22 at the same temperature, service hoses, manifolds and gauges are all constructed to withstand higher pressures. See Figure 3 for the gauge faces.

The oils used with the alternative refrigerant are also different. The oil used with the HCFC refrigerants such as 22 was mineral oil based. The oil used











Figure 2P

NO Dip Tube on cylinders manufactured after Feb. 1999.

Refrigerant Safety

with Refrigerant 410A is a synthetic oil called POLYOLESTER, abbreviated POE. This oil requires special handling. Since it is hygroscopic in nature, (it picks up moisture from the air), it must be kept sealed until used. Liquid line driers must be changed whenever the system is opened for service. A good vacuum cannot adequately remove the moisture from the synthetic oil as it did from a mineral oil based lubricant.

The only system additive that may be used is AcidAway. This additive has **ONLY** been approved for **Refrigerant 22**, when used in accordance with the manufacturers' instructions. All other additives are discouraged and are not recommended.

The last caution will seem unusual to the technician. Synthetic oil will attack many materials used in roofing. When service is required on equipment mounted on a roof, the surrounding roof must be protected from oil spray or spills. A plastic covering or tarp must be spread around the work area. This caution must be taken seriously! Wiping up spilled oil will not stop it from causing long term damage to roofing materials.



Figure 3

Application Notes

Replacement of a unit using Refrigerant 22 with a unit using Refrigerant 410A requires that both the indoor and outdoor units be replaced. If the existing line sets are the correct size and the oil from the replaced unit did not contain any acid, the existing line set may be used. The technician should make every effort to eliminate any low spots in the lines forming traps. Blow through the lines with dry nitrogen to reduce the amount of oil remaining in the lines. Then the lines may be used.

Line set lengths and lift restrictions will be similar to those found in R22 systems. This table is shown for training only, and must be used only for that purpose. For line sizing, use Pub. No. 32-3009 latest edition.

	5 Ton	4 Ton	3.5 Ton	3 Ton	2.5 Ton	2 Ton	1.5 Ton	1 Ton
	7/8	7/8	3/4	3/4	5/8	5/8	5/8	1/2
R22	1 1/8	1 1/8	7/8	7/8	3/4	3/4	3/4	5/8
	1 3/8		1 1/8		7/8	7/8		
	3/4	3/4		5/8	5/8*	5/8*	1/2*	1/2*
R410A	7/8*	7/8*	3/4*	3/4*	3/4	3/4	5/8	5/8
	1 1/8	1 1/8	7/8	7/8	7/8	7/8	3/4	
Liquid Line	3/8	3/8	3/8	3/8	5/16	5/16	1/4	1/4

*Rated tube size

System Charging Using R-410A

Charging systems with refrigerants which are classified as AZEOTROPIC, such as R-410A, require special technique. The blended refrigerants may tend to separate when charging is done with only the vapor. This may lead to FRACTIONATION, when the refrigerants in the blend do not boil off at the exact same temperature. Fortunately, R-410A has a wellmatched pair of refrigerants. The difference in boiling points is less than a degree. This means that for our purposes the refrigerant does not require you to calculate the temperature difference known as GLIDE. For all our work, the refrigerant will have a single boiling point for each pressure.

The use of liquid in charging is not new. We have charged the high side of the system with liquid for many years. Charging the low side with liquid will require the use of a special charging metering device. A Chargefaster (CH200) by Watsco or its equivalent must be used. This device allows the refrigerant to be taken from the cylinder as liquid but puts it into the system as a vapor. Remember the refrigerant cylinder will dispense liquid when it is upright because of the cylinder dip tube on cylinders manufactured before Feb. 1999. The cylinder must be inverted if manufactured after Feb. 1999 to obtain liquid for charging. To dispense vapor directly, the cylinder must be in the upright position.

The subcooling method of charging will be used in the cooling cycle when an expansion value (TXV) is installed in the system.

In this method of charge adjustment, an accurate reading of the temperature of one of the refrigerant lines is required. The standard service thermometer is not accurate or fast enough to properly react. An electronic temperature tester, such as an Annie A-8 or equivalent, should be used. The sensing element must be tightly connected to the tubing and insulated from the ambient air. The charts for charge adjustment will be found in the equipment and the service literature for the product.

While charging the system, allow sufficient time for the system to react to the adjustment before adding or removing charge.

R-410A Temperature and Pressure Chart

TEMP	R410	TEMP	R410	TEMP	R410
-60	1.2	16	71.7	44	127.3
-55	3.4	17	73.3	45	129.7
-50	5.8	18	75.0	46	132.2
-45	8.6	19	76.6	47	134.6
-40	11.6	20	78.3	48	137.1
-35	14.9	21	80.1	49	139.6
-30	18.5	22	81.8	50	142.2
-25	22.5	23	83.6	55	155.5
-20	26.9	24	85.4	60	169.6
-15	31.7	25	87.3	65	184.6
-10	36.8	26	89.1	70	200.6
-5	42.5	27	91.0	75	217.4
0	48.6	28	92.9	80	235.3
1	49.9	29	94.9	85	254.1
2	51.2	30	96.8	90	274.1
3	52.5	31	98.8	95	295.1
4	53.8	32 1	00.8	100	317.2
5	55.2	33 1	02.9	105	340.5
6	56.6	34 1	05.0	110	365.0
7	58.0	35 1	07.1	115	390.7
8	59.4	36 1	09.2	120	417.7
9	60.9	37 1	11.4	125	445.9
10	62.3	38 1	13.6	130	475.6
11	63.8	39 1	15.8	135	506.5
12	65.4	40 1	18.0	140	539.0
13	66.9	41 1	20.3	145	572.8
14	68.5	42 1	22.6	150	608.1
15	70.0	43 1	25.0	155	645.0

Pub No. 34-3400-01

Figure 4

Subcooling Charging Table

REQ	UIRED LI	IQUID LIN	IE TEMPE	RATURE		
LIQUID PRESSURE		REQUIRED	SUBCOOLI	NG TEMPER	ATURE (°F)	
AT SERVICE VALVE (PSIG)	8	10	12	14	16	18
189	58	56	54	52	50	48
195	60	58	56	54	52	50
202	62	60	58	56	54	52
208	64	62	60	58	56	54
215	66	64	62	60	58	56
222	68	66	64	62	60	58
229	70	68	66	64	62	60
236	72	70	68	66	64	62
243	74	72	70	68	66	64
251	76	74	72	70	68	66
259	78	76	74	72	70	68
266	80	78	76	74	72	70
274	82	80	78	76	74	72
283	84	82	80	78	76	74
291	86	84	82	80	78	76
299	88	86	84	82	80	78
308	90	88	86	84	82	80
317	92	90	88	86	84	82
326	94	92	90	88	86	84
335	96	94	92	90	88	86
345	98	96	94	92	90	88
354	100	98	96	94	92	90
364	102	100	98	96	94	92
374	104	102	100	98	96	94
384	106	104	102	100	98	96
395	108	106	104	102	100	98
406	110	108	106	104	102	100
416	112	110	108	106	104	102
427	114	112	110	108	106	104
439	116	114	112	110	108	106
450	118	116	114	112	110	108
462	120	118	116	114	112	110
474	122	120	118	116	114	112
486	124	122	120	118	116	114
499	126	124	122	120	118	116
511	128	126	124	122	120	118

Figure 5

410A Refrigerant

In the cooling cycle the Subcooling chart shown in Figure 5 will help you to make the decisions when charging units equipped with thermostatic expansion valves (TXV). Since the valve controls the superheat, subcooling must be used to determine the correct charge level.

It is recommended that charging be done in the liquid phase. When adding liquid refrigerant into the low side of the system, a charge-metering device is recommended (WATSCO CH200, or equivalent). Allow ample time when adding refrigerant for the system to balance out, to avoid having to recover refrigerant.

Existing Halide leak detectors do not work with R-410A. Existing acid test kits do not work with R-410A. (New kits are being developed.) Existing driers do not work with R-410A. Note that although R-410A does not deplete the ozone layer, all refrigerants must be recovered.

R-410A systems use POE oil, which is not compatible with the oils used in R-22 systems. If existing refrigerant lines are to be used with an R-410A system (assuming that the line sizes are acceptable), they must be thoroughly blown out with dry nitrogen to remove the old oil. Blow vertical sections from top to bottom.

POE oils absorb moisture very quickly. Keep container tightly closed, whenever possible, and expose the system to the atmosphere as little as possible. POE oils can also damage a roof, if spilled.

Vacuum pumps can not remove all of the moisture from POE oils. **Change the liquid line drier anytime the system is opened to the atmosphere.**

Suction line driers are to be left in the system for no more than 72 hours. Use only liquid and suction line driers approved for R-410A.

Since all current R-410A systems are expansion valve systems, the refrigerant charge is to be checked by the subcooling method, See Charts 6 and 7 in the cooling cycle. In heating use the heating discharge pressure curves.

Maximum liquid line pressure drop with R-410A systems is 50 PSI (10° subcooling). Recommended suction line pressure drop (2°F) is 4.8 PSI (Round up to 5.0).

At this time, only matched systems are permitted with R-410A. Both indoor and outdoor units must be changed in a unit replacement.

R-410A boils at -62.9° at atmospheric pressure, so beware of frostbite!

Line set lengths and lift restrictions will be similar to those found in R22 systems, as long as the rise is limited to 60 feet and the length is 200 feet or less. Tables on the following pages show the line sizes.

R410A Split Cooling Units Only



- 1. Measure Liquid Line Temperature and Refrigerant Pressure at service valves.
- 2. Determine total refrigerant pipe length and height (lift) if indoor section is above the condenser. Plot the intersection of the two points on the Curve Selection Chart to determine which curve to use.
- 3. Plot the pressure and temperature on the TXV Charging Curve.
- 4. If the lines cross above the curve remove refrigerant, if below curve add refrigerant.
- Whenever charge is removed or added, the system must be operated for a minimum 20 minutes to stabilize before additional measurements can be made.
- 6. When system is correctly charged refer to System Performance Curves to verify charge and performance.

CHARGING CURVE SELECTION CHART



TOTAL REFRIGERNT LINE LENGTH (FEET)

ERPD 4292A DISTR T-1 A150999P05 REV.0

Chart 6

R410A Split Heat Pump Units Only



- 1. Measure Liquid Line Temperature and Refrigerant Pressure at service valves.
- 2. Determine total refrigerant pipe length and height (lift) if indoor section is above the condenser. Plot the intersection of the two points on the Curve Selection Chart to determine which curve to use.
- 3. Plot the pressure and temperature on the TXV Charging Curve.
- 4. If the lines cross above the curve remove refrigerant, if below curve add refrigerant.
- Whenever charge is removed or added, the system must be operated for a minimum 20 minutes to stabilize before additional measurements can be made.
- 6. When system is correctly charged refer to System Performance Curves to verify charge and performance.

CHARGING CURVE SELECTION CHART



TOTAL REFRIGERNT LINE LENGTH (FEET)

ERPD 4309B DISTR T-1 A150999P06 REV.0

Chart 7

R-410A Charging and Performance – Cooling Mode

Current Method Split System with a RWE040E13 Coil Cooling System with Thermal Expansion Valve. Indoor Airflow 1160 CFM



PERFORMANCE CURVES ARE NOT UNIVERSAL Indoor Unit Alternates See Correction Table

Alternate Inc	loor Unit	s With Th	ermal Exp	oansion V	alve
		Coc	oling	Hea	ting
Indoor Unit	CFM	Suction Pressure	Head Pressure	Suction Pressure	Head Pressure
RWE040E13*	1160	0	0	0	0
RWE037E13	1060	-7	-2	1	53

*Base Indoor Unit(s) Curves on 21X151830 Rev.0

Cooling performance can be checked when the outdoor temperature is above 65°.

PRESSURE CURVE CORRECTION PSIG

To check cooling performance, allow pressures to stabilize and measure indoor wet bulb temperature, outdoor dry bulb temperature and pressures (both head and suction).

Locate outdoor dry bulb and indoor wet bulb temperature. Find the intersection of the outdoor dry bulb temperature and indoor wet bulb temperature. Read head (or liquid) and suction pressure value in the left hand column of the chart.

Actual Head Pressure should be ± 20 PSIG of chart.

Suction Pressure should be ± 5 PSIG of chart.

Example:

Outdoor Dry Bulb Temperature = 85° F Indoor Wet Bulb Temperature = 67° F

Answer:

Suction Pressure @1160 CFM = 137 PSIG Head Pressure @ 1160 CFM = 340 PSIG

*Note: Interconnecting Lines: Gas - 3/4" O.D. Liquid - 3/8" O.D.

From Dwg. No. 21X151830 Rev. 0

R-410A Charging – Heating Mode

Current Method Split Heat Pump with a RWE040E13 Air Handler Heat Pump with TXV Outdoor Unit Indoor Airflow 1160 CFM



PERFORMANCE CURVES ARE NOT UNIVERSAL Indoor Unit Alternates See Correction Table

Alternate Inc	loor Unit	s With Th	ermal Ex	oansion V	alve
		Coc	oling	Неа	ting
Indoor Unit	CFM	Suction Pressure	Head Pressure	Suction Pressure	Head Pressure
RWE040E13*	1160	0	0	0	0
RWE037E13	1060	-7	-2	1	53

PRESSURE CURVE CORRECTION PSIG

*Base Indoor Unit(s) Curves on 21X151830 Rev.0

Heating performance can be checked when the outdoor temperature is below 60°F.

To check heating performance, allow pressures to stabilize and measure indoor dry bulb temperature, outdoor temperature and pressures (both head and suction).

Locate outdoor and indoor dry bulb temperature, find the intersection of the outdoor temperature and indoor temperature and read head or suction pressure value in the left hand column of the chart.

Actual Head Pressure should be: Equal to or less than 10 PSIG of chart.

Suction Pressure should be ± 5 PSIG of chart.

*Note: Interconnecting Lines: Gas - 3/4" O.D. Liquid - 3/8" O.D.

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Notes

Notes