Field Charging Air Conditioning, Refrigeration And Heat Pump Systems With Copeland Scroll Compressors.

These guidelines are intended for use with Copeland Scroll compressors only with R22, R407C, R134a, R404A, R507, and R410A refrigerants. They do not apply to Copeland reciprocating compressors or competitive Scroll compressors.

As a general rule Copeland does NOT recommend field charging A/C or refrigeration systems but recognizes that in many cases there is no practical alternative. Factory charging is preferred for several reasons:-

- The process is controlled and systematic
- The environment is clean and dry
- The evacuation and charging equipment is more accurate
- Overcharging is avoided
- Final quality can be more easily assured.

In certain situations where line length is unpredictable it is not possible to completely charge a system in the factory but partial charging is possible. Copeland supports this as a better alternative than complete field charging.

Regrettably some OEMs do not factory charge because “it increases the system cost.”
This is a myth – factory charging will always be a more efficient process than field charging, the OEM will have a better refrigerant price than the installer and OEM field failures will be considerably reduced. The final cost of a factory charged system to an end user will always be lower and the system will be more reliable.

Field Charging – Several things can go Wrong….

Scroll compressors have a very high volumetric efficiency and quickly pump a deep vacuum if there is insufficient refrigerant in the system or if refrigerant is added too slowly. Operation with low suction pressure will quickly lead to very high discharge temperatures. While this process is happening the scrolls are not being well lubricated – scrolls depend on the oil mist in the refrigerant for lubrication. A lack of lubrication leads to high friction between the scroll flanks and tips and generates additional heat. The combination of heat of compression and heat from increased friction is concentrated in a small localized discharge area where temperatures can quickly rise to more than 300C. These extreme temperatures damage the Scroll spirals and the orbiting Scroll bearing. This damage can occur in less than one minute especially on larger compressors.
Failure may occur in the first few hours or the damage done during field charging may show up some time later.
Smaller compressors may survive incorrect charging because final system charges are low and total charging time is limited. Copeland Quantum and Quest families have an internal discharge temperature protector that offers some protection from incorrect charging procedures.
Other typical field charging problems include undercharging, overcharging, moisture or air in the system etc. In time each one of these problems can cause compressor failure.

Equipment

Minimal equipment is required for field charging but the job is often poorly executed due to a lack of understanding. The minimum equipment required to do a satisfactory job is:-

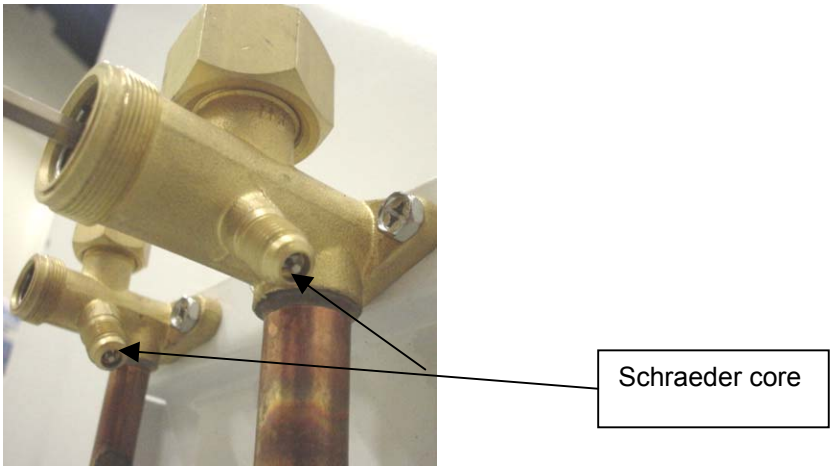
Set of service gauges
Hoses
Vacuum pump
Vacuum gauge
Scales
Thermometer

Charging Hoses

Most field charging is done using standard service hoses. Hoses are made in different colors with different working pressures and with different leak rates but the most important point is the presence or absence of Schraeder valve depressors. Shraeder valve depressors severely restrict the flow through the service hoses. This slows evacuation and vapor charging dramatically. In most cases the Schraeder depressor can be removed but it is simpler to have one set of hoses with and one set without Schraeder depressors.

Hose with Schraeder valve Depressor **Hose without Schraeder valve Depressor**

Hose selection is important depending whether the system is being evacuated or charged. Charging liquid from the cylinder into the liquid line should be carried out using an open hose connected to an unrestricted fitting. This will reduce charging time.



Typical service valves found on factory charged mini split A/C units. Note Schraeder cores are in place.

Most split systems have a suitable connection on the outdoor unit.

Schraeder Valves

Schraeder valve with core in place

Schraeder valve with core removed

Schraeder valves provide easy system access for pressure reading and addition of refrigerant. On small systems they provide a reasonable connection for evacuation also. However Schraeder valves and the hoses connected to them cause very severe pressure drops and can multiply evacuation time by a factor of 4 or 5.
On the positive side Schraeder valves provide a restriction that slows the speed of liquid charging into the suction side. When a pressure drop is desirable (charging liquid into suction) connect via a Schraeder valve. When a pressure drop is detrimental (evacuation) connect via an open fitting.

How much refrigerant?

The proper refrigerant charge should be determined by the system manufacturer during development testing and recommendations should be followed by the installer. In the event of this information being unavailable the task of the installer is more difficult.

If the installer cannot find the correct charge but the system must be started, refrigerant should be carefully added to the system until reasonable sub-cooling is measured in the liquid line and reasonable suction superheat is measured at the compressor suction. Suction and discharge pressures must be monitored carefully during the charging process.

Charge limits

Copeland publishes charge limits for different compressor models, these limits are shown in table 1. If the total charge exceeds these limits the system should have a crankcase heater and/or pump down cycle and/or accumulator to prevent liquid damage to the compressor. Some systems may require accumulators to limit liquid floodback even though the charge is lower than the published limit.
See the Application Engineering Bulletin related to the specific model for details.

TABLE 1	A/C MODELS	Lbs	Kg.	REFRIGERATION MODELS
Quantum	ZR18 to ZR48	8	3.6	ZF06 to ZF11
Quest	ZR46 to ZR81	10	4.5	ZF13 to ZF18
Summit	ZR84 to ZR144	16	7.3	
Specter	ZR90 to ZR19M	17	7.7	ZF24 to ZF48
LCS	ZR250	25	11.4	
LCS	ZR300	30	13.6	

The charge limit for Tandem compressors is NOT double the charge limit for single compressors. In flooded start situations when one compressor is started it will draw liquid from the idle compressor so a more appropriate guideline for a Tandem charge limit is 1.20 x Single compressor charge limit.

Charging Procedures - Single Phase Compressors

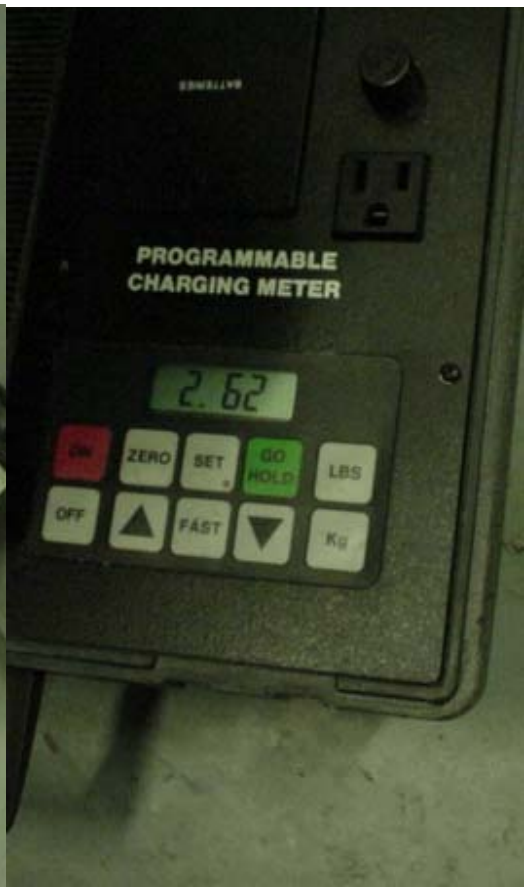
Evacuate the system to 500 microns Hg. (67Pa). To reduce evacuation time, use short, large diameter hoses and connect to unrestricted service ports on the system. Quality of vacuum cannot be determined by time – a reliable vacuum gauge must be used. A battery powered model similar to the gauge shown below is practical since it avoids the necessity of finding a correct power outlet.

Electronic Vacuum Gauge

Turn the refrigerant cylinder upside down, purge the charging hose and charge liquid through the liquid line charging port until refrigerant no longer flows or until the correct charge has been weighed in. If additional charge is required start the system and slowly bleed liquid into the suction side until the system is full.

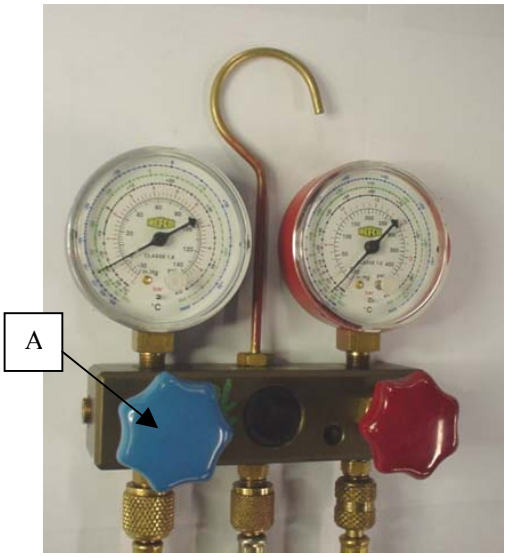
Copeland recommends charging liquid in a CONTROLLED manner into the suction side until the system is full. This recommendation does not hold true for reciprocating compressors where liquid charging into the suction side could cause severe damage.

Charging Cylinder on Scale



Close-up of scale

Carefully monitor the suction and discharge pressures – ensure that the suction pressure does not fall below 25 psig (1.7 bar) at any time during the charging process.
CAUTION: Manifold Gauge will show cylinder pressure rather than suction pressure if the cylinder valve and Manifold valve “A” are both open.



There are many ways of charging liquid in a “controlled manner” into the suction side:-

- Use valve A on the manifold gauge set
- Use the valve on the refrigerant cylinder
- Charge through a Schraeder valve
- Use a hose with a Schraeder valve depressor
- Charge into the suction side at some distance from the compressor.
- All of the above

Charging Procedures - Three phase compressors

The fundamental procedure is the same as for single phase models but the compressor can run in the wrong direction on starting. If this happens reverse any two phases and start again. Short term reverse rotation will not damage the compressor.
As compressors get larger the importance of correct field charging procedures grows exponentially. Unfortunately larger systems are often field charged which leads to many infant failures. All Specter and LCS compressors have internal discharge temperature protectors which are very effective in preventing dangerously high discharge temperatures during charging. The protection module will trip and lock the compressor out for 30 minutes.. It is not normally necessary to wait 30 minutes for the module to reset. When the compressor has cooled down the module can be reset by breaking the power supply to the control circuit. Very often the serviceman does not understand why the module tripped and uses a jumper wire to bypass it. He continues to charge the system and removes the jumper when charging is complete. The compressor may or may not run with the protector back in the circuit but it is certain that the compressor has been damaged and premature failure is inevitable.
NEVER JUMPER MOTOR PROTECTORS – there is always a reason for a protector trip.

Refrigeration systems

Most refrigeration systems with Scroll compressors will have liquid receivers and liquid line sight glasses. The general rules for charging are the same – charge liquid into the liquid line or receiver until cylinder pressure and system pressure is the same. Top up by charging liquid in a controlled manner through the suction side. Low temperature refrigeration Scroll compressors have a liquid injection system that prevents overheating when operating at low suction pressures. The injection system does not work effectively during charging since the liquid supply is limited so it is equally important to avoid low suction pressures.
Refrigeration systems are generally less sensitive to slight overcharge than A/C systems because the liquid receiver acts as a buffer. Charging can usually regarded as complete when the system is operating at stabilized temperatures for some time and the liquid line sight glass is clear. Never allow the refrigeration system to operate with the suction pressure below atmospheric pressure.