CLIMATEMASTER®

EarthPure

EarthPure R410a Application and Service Guide

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Although the bulk of this manual will be information regarding EarthPure R410a, R407c will also be discussed. Consult the ClimateMaster Tech 1 service guide for a more detailed descriptions of the general procedures.

EarthPure R410a Overview

R410a is a non-chlorine based (HFC) refrigerant, that with R407c and R134a, is seen as the future of all refrigerants used worldwide. R410a characteristics compared to R22 are:

- Binary and near azeotropic mixture of R32-50% and R125-50%
- Higher efficiencies
- Higher operating pressures
- Requires POE oil in compressors
- In some systems can result in smaller heat exchangers with the same performance
- Low global warming potential and zero ozone depletion (0.39/0.0)
- Temperature glide of 0.2°F
- Containers are "Rose" colored

R407c Overview

R407a is a non-chlorine based (HFC) refrigerant. R407c characteristics compared to R22 are:

- Ternary and near azeotropic mixture of R32-23%, R125-25%, R134a-52%
- Slightly lower efficiencies
- Nearly equal operating pressures
- Requires POE oil in compressors
- Considered a near drop-in replacement for R22
- Low global warming potential and zero ozone depletion (0.34/0.0)
- Temperature glide of 10°F
- Containers are "Medium Brown" colored

What is "Glide"?

Pure compounds like CFC-R12 boil and condense at exactly the same temperature for a given pressure. Near-azeotropic blends are not pure compounds but a blend of compounds. These compounds will have a temperature glide or range of temperatures in which the blend will boil or condense. In these situations, for example R407c, a chart listing a bubble and dew point will be used as the pressure/temperature chart since it has a glide of 10°F. The bubble point is used for subcooling calculations and the dew point is used for superheat calculations as in Table 1. R410a has a very small glide (0.2°F) and acts as a single component refrigerant. Therefore R410a can utilize a more traditional table with only one pressure column as shown in Table 2.

What is "Fractionation"?

Many of the newer refrigerants are a blend of two or more other refrigerants. At various conditions these components can separate and change the ratio of the original mixture and in effect change the total performance of the remaining blend. Therefore it is recommended to use the refrigerant in liquid form, insuring that all of the components are handled together in the proper blend.

Table 1. R407c Pressure/Temperature Chart

R407c		
Temperature °F	**Bubble Pressure** (for subcooling) psig	**Dew Pressure** for (superheat) psig
-15	17.2	9.2
-10	21.0	12.3
-5	25.1	15.7
0	29.5	19.4
5	34.4	23.4
10	39.6	27.8
15	45.2	32.6
20	51.3	37.8
25	57.8	43.4
30	64.8	49.4
35	72.4	56.0
40	80.4	63.0
45	89.0	70.6
50	98.1	78.7
55	107.9	87.4
60	118.2	96.7
65	129.2	106.6
70	140.9	117.1
75	153.2	128.4
80	166.2	140.4
85	180.0	153.1
90	194.6	166.5
95	209.9	180.8
100	226.0	195.9
105	243.0	211.9
110	260.8	228.7
115	279.5	246.5
120	299.0	265.3
125	319.6	285.0
130	341.0	305.8
135	363.4	327.6
140	386.9	350.5
145	411.3	374.6
150	436.8	399.8

Table 2. R410a Pressure/Temperature Chart

R410a	
Temperature °F	**Pressure** psig
-15	31.3
-10	36.5
-5	42.2
0	48.4
5	55.1
10	62.4
15	70.2
20	78.5
25	87.5
30	97.2
35	107.5
40	118.5
45	130.2
50	142.7
55	156.0
60	170.1
65	185.1
70	201.0
75	217.8
80	235.6
85	254.5
90	274.3
95	295.3
100	317.4
105	340.6
110	365.1
115	390.9
120	418.0
125	446.5
130	476.5
135	508.0
140	541.2
145	576.0
150	612.8

Component Considerations for R410a

Compressor

Wall thickness has increased with the increase of operating pressures of R410a. The internal pressure relief valve setting has been increased from 375-450 psig for R22 to 550-625 psig for R410a. Although the discharge pressure is higher in R410a the discharge temperature should be lower due its higher vapor heat capacity. Desuperheating hot water generators must be designed around this lower hot gas temperatures as well. High pressure switches will now open at 600 psig ±10 psig and reset at 450 ±10 psig. The compressor oil must be polyolester (POE) based. Mineral oils should never be used. POE oils also absorb moisture very easily. For this reason any compressor using POE oil should only be exposed to ambient air for short periods of time during manufacture or service. See the service section of this manual for more information.

Condenser/Evaporator Heat Exchangers

The heat exchangers must be designed to have a working pressure above the 600 psig level. In some cases this can mean a thicker wall.

Filter Driers

Liquid filter driers must have working pressure of no less than 600 psig and be approved for use with R410a. A 100% molecular sieve with no activated Alumina is recommended for maximum moisture removal. It is always required to install a new filter drier whenever the system is opened.

Suction line filter driers should only be used after a burn out and should be removed after an appropriate clean-up time.

Thermostatic Expansion Valves

R410a metering devices are about 15% smaller than R22 devices. The selective charge used in the bulb must be matched for R410a operation, therefore a txv must be designed for R410A use. Metering devices for R22 and R410a are NOT interchangeable.

Refrigerant Tubing

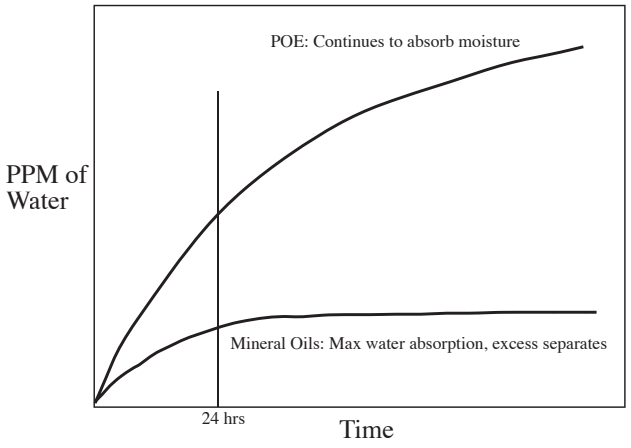
There are no general changes to the tubing other than the working pressure increase to 600 psig. Generally the lower refrigerant flow rate of R410a versus R22 does not result in any pipe diameter changes.

Polyolester Oils

POE oils are very hygroscopic. That is to say they readily absorb moisture and hold it. For this reason POE oils should be limited in their exposure to ambient air during manufacture or service. The lubricant should be exposed to ambient air for no more than 15 minutes. Always store POE oil in glass or metal containers. Pumps are recommended to move the oil from containers to the refrigeration system. If the system is under a vacuum, break the vacuum with the refrigerant or dry nitrogen. It is never recommended to break the vacuum with air. Liquid line filter driers should be used to remove any moisture in the system. Charging system may also contain a replaceable filter drier for improved moisture removal. In summary:

- POE oil is hygroscopic and will readily absorb moisture
- Never store POE oil in plastic containers. Always use metal or glass
- Use a pump to transfer POE lubricants
- Use an approved POE lubricant. They aren't all interchangeable

Figure 1. PPM of Water Absorbed Over Time



- A vacuum pump will not adequately remove moisture from the POE lubricants. Use a filter drier and replace whenever the system is opened.
- POE's can be irritating to the skin
- POE's can damage some roofing membrane materials
- POE's are better solvents than mineral oils
- Leave POE Refrigerant circuits open no more than 15 minutes

Approved POE Oils for Copeland R410a and R407c compressors are:

- Copeland Ultra 22CC
- Copeland 3MA (scroll compressors only)
- Mobil EAL Arctic 22CC
- ICI (Virginia KMP) Emkarate RL32CF
- Thermal Zone 22CC

Service Tools

It is recommended that a separate R410a tool set be employed to avoid the problem of mixing refrigerants on the job site.

Gauge Manifold Sets

A specific gauge set for use with R410a is required. These will allow pressure measurements to 800 psig on the high side and 250 psig on the low side. Hoses will have a service rating of 800 psig.

Vacuum Pump

A 500 micron evacuation will not be sufficient to separate moisture from POE oil in R410a systems. It is for this reason that an R410a approved liquid line filter drier should be installed everytime the system is opened.

Leak Detectors

An approved leak detector for HFC refrigerants can be used in R410a systems. Older R22 leak detectors and Halide torch leak detectors can not be used in R410a service. Never use a mixture of air and R410a to leak check. As a mixture it may become flammable at pressures above amtospheric. Nitrogen and trace R410a or nitrogen alone can be safely used for leak testing in R410a systems. Six approved leak detector types for alternative refrigerants are:

- Non-selective detectors
- Halogen specific
- Compound specific
- Infrared based
- Flourescent dyes
- Ultrasonic

Active Recovery Equipment (Self-Contained)

Due to the increased pressure of R410a, recovery equipment has been redesigned to handle these higher pressures. Recovery equipment rated for R410a must be used. Recovery cylinders must have a service pressure rating of 400 psig (DOT 4BA 400 and DOT 4BW 400 are acceptable). DO NOT USE STANDARD DOT RECOVERY OR STORAGE CYLINDERS WITH A 300 PSIG RATING WITH R410A!

Other Service Tools

Other service tools such as the micron gauge and vacuum pump are adequate for both R22 and R410a service.

Service Procedures

Leak Detection

If an R410a system develops a leak, the technician does not have to recover the the remaining refrigerant from the system before topping-off the system. Because R410a is close to being an azeotropic blend, it behaves like a pure compound or single component refrigerant. The technician can use the existing refrigerant in the system after leaks have occurred. There is no significant change in the refrigerant composition during multiple leaks and recharges. However the service technician must remember that when adding R410a to the system, it must come out of the charging cylinder as a liquid to avoid fractionation and for optimum system performance. If the refrigeration system has lost its complete charge, the system should be leak checked, repaired, liquid line filter drier replaced and evacuated below 500 microns. A digital scale or a calibrated charging cylinder designed for the greater pressures of R410a should then be used to recharge R410a back into the system.

The Refrigerant Recycling Regulations Section 608 of the Clean Air Act states that the technician must find and repair substantial leaks of systems with 50 lbs. or more of refrigerant. Substantial leaks are defined as:

- 35% annual leak rate of commercial and industrial refrigeration
- 15% annual leak rate comfort cooling chillers and all other equipment

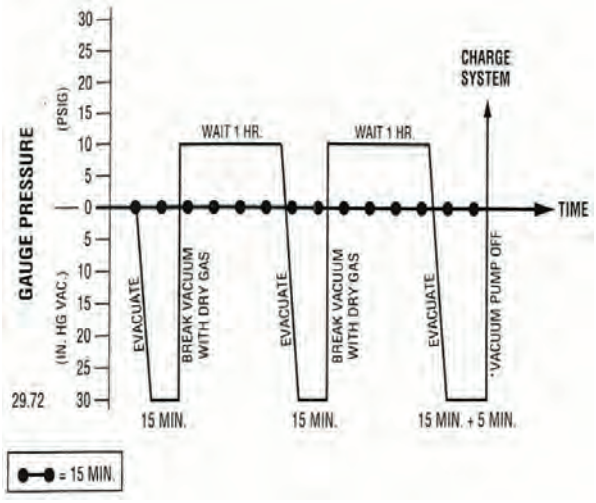
R407c Considerations

R407c equipment for leak detection are the same as R410a. However, the technician CANNOT use the existing refrigerant in the system after leaks have occurred. There can be a significant change in the refrigerant composition during multiple leaks and recharges. Unit should be recharged using the ClimateMaster's recommended charge. However the service technician must remember that when adding R407c to the system, it must come out of the charging cylinder as a liquid to avoid fractionation and for optimum system performance

Refrigerant Recovery

Use an R410a approved recovery device. Due to the increased pressure of R410a, recovery equipment has been redesigned to handle these higher pressures. Recovery equipment rated for R410a must be used. Recovery cylinders must have a service pressure rating of 400 psig (DOT 4BA 400 and DOT 4BW 400 are acceptable). DO NOT USE STANDARD DOT RECOVERY OR STORAGE CYLINDERS WITH A 300 PSIG RATING WITH R410A! As stated earlier, a specific gauge set for use with R410a is required. These will allow pressure measurements to 800 psig on the high side and 250 psig on the low side. Hoses will have a service rating 800 psig. R407c storage tanks do not need the higher pressure ratings.

Figure 2. Triple Vacuum Procedure



Evacuation

ClimateMaster recommends two evacuation methods, the deep vacuum method and the "Triple Vac" method.

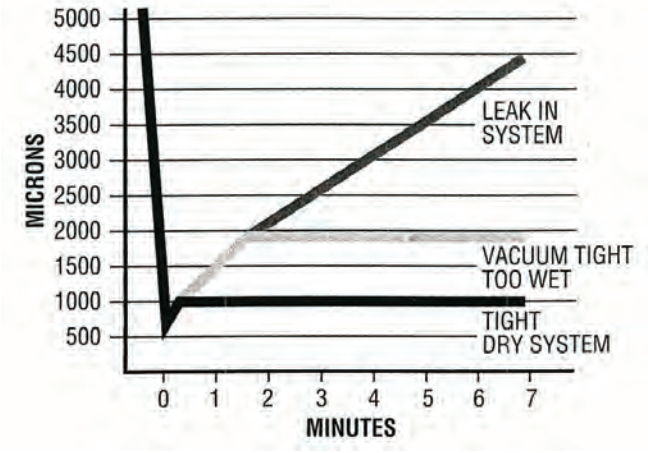
The Deep Vacuum Method

The deep vacuum method requires a vacuum pump capable of at least a 500 micron vacuum and a micron gauge capable of measuring this vacuum. The deep vacuum method is the most positive way of assuring a system is free of air and moisture and is the recommended method by ClimateMaster.

Triple Vacuum Method

The triple vac method should only be used when the vac pump is not capable of pulling a 500 micron vacuum. **Note: Warranty labor allowance may not cover the complete service time with this method.** See Figure 2.

Figure 3. Vacuum and Time



the following is the Triple Vac procedure.

1. The unit should be evacuated to at least 29.72 in. Hg.
2. Break the vacuum with dry nitrogen and wait 1 hour.
3. Evacuate until at least 29.72 in. Hg. is reached and then continue for 15 minutes.
4. Break the vacuum with dry nitrogen and wait 1 hour.
5. Evacuate until at least 29.72 in. Hg. is reached and then continue for 20 minutes.
6. Isolate and Turn Vac Pump Off and wait. Vac measurement should stay low and not rise above 29.5 other wise leak or moisture still remains in system.

Refrigerant Charging

An undercharged txv unit can be identified by:

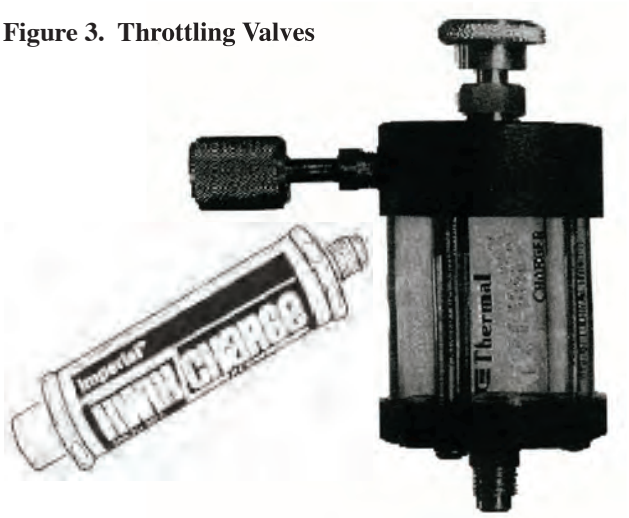
- Low evaporating pressure
- High superheat
- Low subcooling

An overcharged txv unit can be identified by:

- High subcooling
- High head pressures

Even though R410a has a very small fractionation potential it cannot be ignored completely when charging. To avoid fractionation. charging of a system with R410a should be done with LIQUID from the tank to maintain optimum system performance. To insure that the proper blend of refrigerant be used, it is important that liquid only be removed from the storage tank. Some cylinders use dip tubes which allow liquid to be extracted from the cylinder. These can be identified as recovery tanks with yellow tops and gray bottom and have a dual liquid and vapor valve assembly. Storage tanks without dip tubes will need to be tipped upside down in order for liquid to be removed. Once the liquid is removed from the storage cylinder, it can be charged into the system in the vapor state as long as all of the refrigerant is used from the charging cylinder. Liquid charging can be accomplished by using:

Figure 3. Throttling Valves



- A throttling valve (Figure 3) to insure the liquid vaporizes as it enters the suction line of the unit.
- The gauge set as a throttling device and restrict liquid from flooding the compressor during charging.

Recharging should always be accomplished by using the nameplate charge. When this is not possible, charging using the subcooling method can be done using the following procedure. This method requires accurate gauges and a digital strap-on temperature meter.

1. Operate system for 10 minutes to stabilize.
2. Insure that the unit has proper water and air flow and the air filter is clean.
3. Attach gauges to discharge port and record the saturation temperature at this pressure using a pressure/temperature chart for R410a.
4. Measure the liquid line (LL) temperature (between aircoil and txv in heating and between coax and txv in cooling).
5. Subtract the LL temperature from the saturation pressure to find the subcooling. Consult Table 4 for appropriate values.
6. If the subcooling is too low add 2-4 oz., or too high, remove 2-4 oz. Typical values are shown in Table 4.

Superheat can be calculated similarly. This method also requires accurate gauges and a digital strap-on thermometer. Operate system for 10 minutes to stabilize.

2. Insure that the unit has proper water and air flow and the air filter is clean.
3. Attach gauges to suction port and record the saturation temperature at this pressure using a pressure/temperature chart for R410a.

Table 4. Tranquility Typical Pressure and Temperatures (TT*064 Shown)

TT*064		Full Load Cooling - without HWG active						Full Load Heating - without HWG active					
Entering Water Temp F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Super-heat	Sub-cooling	Water Temp Rise F	Air Temp Drop F DB	Suction Pressure PSIG	Discharge Pressure PSIG	Super-heat	Sub-cooling	Water Temp Drop F	Air Temp Rise F DB
30	7.5	117-127	170-190	27-32	15-20	18.2-20.2	17-23	66-76	282-302	10-16	9-14	8-10	19-25
	11.3	116-126	143-163	28-33	13-18	12.6-14.6	17-23	69-79	285-305	10-16	9-14	6-8	19-25
	15.0	115-125	135-155	29-34	12-17	7-9	17-23	72-82	289-309	10-16	10-15	4-6	20-26
50	7.5	128-138	238-258	16-21	14-19	20.5-22.5	21-27	90-100	310-330	11-17	12-17	11.3-13.3	24-30
	11.3	126-136	222-242	21-26	13-18	14.9-16.9	21-27	95-105	313-333	11-17	12-17	8.5-10.5	25-31
	15.0	125-135	205-225	26-31	12-17	9.2-11.2	21-27	99-109	316-336	11-17	12-17	5.7-7.7	26-32
70	7.5	135-145	315-335	10-15	14-19	21-23	22-28	115-125	337-357	12-18	14-19	14-16	28-35
	11.3	134-144	296-316	12-17	13-18	15.5-17.5	22-28	120-130	341-361	12-18	14-19	10.6-12.6	29-36
	15.0	133-143	276-296	15-20	11-16	10-12	22-28	126-136	345-365	12-18	15-20	7.3-9.3	30-37
90	7.5	139-149	408-428	10-15	15-20	20.1-22.1	21-27	157-167	390-410	15-20	14-19	18.2-20.2	37-45
	11.3	138-148	386-406	10-15	13-18	14.8-16.8	21-27	161-171	394-414	15-20	14-19	13.9-15.9	38-46
	15.0	138-148	364-384	10-15	11-16	9.5-11.5	21-27	166-176	398-418	15-20	15-20	9.6-11.6	39-47
110	7.5	144-154	515-535	8-13	14-19	19-21	20-26						
	11.3	143-153	493-513	8-13	13-18	14-16	20-26						
	15.0	142-152	469-489	8-13	12-17	9-11	20-26						

HWG should be disabled for accurate chart comparison
*Based on Nominal 400 cfm per ton airflow and 70°F EAT htg and 80/67°F EAT cooling
**Cooling air and water numbers can vary greatly with changes in humidity
Subcooling is based upon the head pressure at compressor service port

4. Measure the suction line temperature just prior to entering the compressor.

5. Subtract the saturation temperature from the suction temperature to find the superheat. Consult Table 4 for appropriate values.

6. If the superheat is too high then unit might still be undercharged. Txv's will mask overcharging in the superheat value by closing off the txv port and reducing the refrigerant flow. Therefore superheat CANNOT be used to identify an overcharged unit. Typical values are shown in Table 4.

Brazing

Always use dry nitrogen when brazing and wrap all components with damp rags to reduce heat damage. Never unbraze a liquid line filter drier. **Unbrazing a liquid line filter drier can release acids and contaminants back into the system.**

R407C Considerations

Since R407c can fractionate, it should always be charged using liquid into the suction line at low enough rates to allow vaporization before it enters the compressor. The same procedure can be used for both R410a and R407c as long as proper respect is given to the fractionation problem. R407c pressure temperature chart requires the bubble column for subcooling calculations and the dew point column for superheat calculations.

System Cleanup After a Burnout

Some compressor electrical failures can cause the motor to burn and produce byproducts such as sludge and acid and contaminate the system. Test the oil for acid using a POE oil acid test kit to determine severity. If burnout is severe enugh, the system must be cleaned before replacement compressor is installed. Burnouts can be classified as mild and severe.

A mild burnout will have little to no characteristic odor. Compressor oil is clear to slightly discolored. An acid test of the oil will be negative. The liquid line filter drier should be replaced along with the compressor.

A severe burnout will have a strong, pungent rotten egg odor. Compressor oil will be dark and evidence of burning may be present in tubing connected to the compressor. An acid test of the compressor oil will be positive. Follow these additional steps:

1. TXV must be cleaned or replaced.

2. Drain any trapped oil from the accumulator (if present)

3. Replace liquid line filter drier.

4. After system is reassembled, install suction line filter drier (between compressor and accumulator if present).

5. Operate system for 10 hours. Monitor pressure drop across driers. If pressure drop exceeds 3 psi replace driers. Be sure to purge system with dry nitrogen when replacing driers. If suction line drier must be replaced retest pressure drop after additional 10 hours of operation. **After 10 hrs. of operation remove suction line filter drier and replace liquid line filter drier. Never leave a suction line filter drier in the system for more than 72 hrs actual time.**

Hot Water Generator Applications

The higher efficiency but lower heat capacity of refrigerant R410a results in a lower hot water generator (HWG) capacity. At times the units hot gas temperature may even be lower than the entering hot water. For this reason, special controls are needed to turn off the HWG pump to avoid removing heat from the water heater (reverse of the the intended process) and causing excessive energy use in the water heater. The Tranquility series has these controls built in and will generally shut off the pump with hot gas temperatures below 125°F.

MSDS Overview-EarthPure R410a

Consult the MSDS sheet for details.

Toxicity – R410a is low toxicity

Flammability – DOT considers R410a non-flammable

Combustibility – At pressures above one atmosphere, mixtures of air and R410a can become combustible.

Ingestion – If ingestion does occur, induce vomiting and seek medical attention.

Skin and eye contact – Avoid contact with skin and promptly flush eyes and skin with clean lukewarm water if contact is made. POE oils can cause skin irritation. Therefore gloves should be worn when handling POE lubricants. Promptly flush eyes and skin with clean lukewarm water if contact is made)

Inhalation – Inhaling high concentrations of refrigerant vapors can have a narcotic effect. A feeling of intoxication, dizziness loss of coordination and slurred speech are symptoms. Cardiac irregularities, unconsciousness, and ultimate death can result from breathing this concentration. If any of these symptoms become evident, move to fresh air and seek medical help immediately.

Refrigerant Decomposition – When refrigerants are exposed to high temperatures from open flames or heater elements, decomposition occurs. Decomposition produces toxic and irritating compounds, such as hydrogen fluoride with HFC's. The acidic vapors produced are dangerous and the area should be evacuated and ventilated.

Safety Overview

ASHRAE Standard 15 details safety precautions when handling refrigerants in commercial systems and should be read and understood. Refrigerants are especially dangerous in confined spaces.

- R410a has a much higher pressure (60%) associated with its operation and therefore has the potential for serious accidents.
- Use an R410a approved recovery device. Recovery cylinders must have a service pressure rating of 400 psig (DOT 4BA 400 and DOT 4BW 400 are acceptable). DO NOT USE STANDARD DOT RECOVERY OR STORAGE CYLINDERS WITH A 300 PSIG RATING WITH R410A! NEVER LET A CYLINDER GET ABOVE 125°F!
- The color code for R410A cylinders is “Rose” and R407c is “Chocolate Brown”.
- A 410a specific gauge set is required. These will allow pressure measurements to 800 psig on the high side and 250 psig on the low side. Hoses will have a service rating 800 psig.
- Do not mix air and R410a. the resulting mixture can be flammable above atmospheric pressure.
- Do not mix R410a and other refrigerants. Gauges, manifold, and hoses should be evacuated after each use. Dedicated equipment for R410a will go a long way toward eliminating this concern.
- Consult the MSDS sheet for details on toxicity, flammability, ingestion limits etc.
- Exposure is the same as R22 – 40 hour work week.

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