ENVIRONMENTALLY SAFE
R-410A SERVICE TECHNIQUES

R-410A Training Supplement

to the Desktop Reference and Training Guide

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PREFACE

The information in this course is intended for educational purposes only. Procedures described are for use only by qualified air conditioning and refrigeration service technicians. **This training course is not a substitute for any equipment Manufacturer's Operator Manual.**

Take safety precautions when using all HVAC equipment. Improper use of HVAC equipment can cause explosion and serious personal injury. Always read the entire Manufacturer's Operator Manual before turning on any equipment for the first time! Use extreme caution when working with refrigerants; hoses may contain liquid refrigerant under pressure. Use only approved refillable storage cylinders. Do not overfill any storage cylinder beyond its rated capacity. Always wear safety glasses. Protect the skin from flash freezing. **Never turn on any equipment if you do not understand its operation. Where procedures described in this manual differ from those of a specific equipment manufacturer, the equipment manufacturer's instructions should be followed.**

Do not leave any refrigerant recovery or recovery–recycling machine ON and unsupervised. All refrigerant recovery and recycling devices are to be used by trained and certified refrigeration technicians only! Again, misuse of refrigerant recovery and recycling devices can cause explosion and personal injury.

Technical and legislative information presented in this book is current as of the date of the manual's latest

publication. Due to rapidly advancing technology and changing regulations in the refrigerant recovery and recovery-recycling field, no representation can be made for the future accuracy of the information. Visit the EPA's Internet Home Page at http://www.epa.gov for the latest details.

Mainstream Engineering Corporation assumes no liability for the use of information presented in this publication. This information is presented for educational purposes only. Manufacturer's Operator Manuals must be consulted for the proper operation of any piece of equipment. The content of this course is limited to information and service practices needed to contain, conserve, and re-use refrigerants, and to prevent their escape into the atmosphere. This manual is not intended to teach air conditioning–refrigeration system installation, troubleshooting, or repair. Refrigeration technicians should already be knowledgeable in these areas prior to taking this course. **This Supplemental Manual is to be used with (and requires a knowledge of the methods and procedures described in) the "Desktop Reference and Training Guide for 608 Certification in the Proper Use of Refrigerants, Including Recovery, Recycling, and Reclamation," Eleventh Edition, Published April 2004.** This supplemental manual was prepared assuming the technician is already knowledgeable with the information contained in the 11th edition of the Desktop Reference and Training Guide.

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Introduction

On November 14, 1994, the U.S. Environmental Protection Agency (EPA) implemented the Clean Air Act, which requires certification of personnel who work with refrigerants. **Air conditioning and refrigeration personnel today are in a position of increasing responsibility, both to implement procedures resulting from refrigerant regulations and to provide answers to customers' questions and technical problems.** Safety continues to be a primary concern when using both new and familiar methods and equipment.

Some users of this manual will also be aware of additional information that is not included here. The intent is to present a course concentrating on practical, basic information that is most needed, and that can be readily applied on the job with the most effective results. You should continue to use this manual as a reference source, adding information that you find useful. Refer to our Internet homepage addresses at http://www.qwik.com and http://www.epatest.com.

This manual is in a continual state of evolution and re-writing, partly because of changing EPA regulations and partly because of information feedback from technicians in the field. If you believe sections of this manual require improvement or that additional information should be added, please write to us and we will consider your suggestions for future editions. In the past, we have received very useful comments and suggestions from refrigeration technicians in the field, and to all those who have helped in the past, we owe a sincere debt of gratitude. Suggestions on the improvement of this course or any Mainstream product are always welcome. For

suggestions related to this course, please write to Robert P. Scaringe, Ph.D., P.E., Refrigeration Certification Program, Mainstream Engineering Corporation, Pines Industrial Center, 200 Yellow Place, Rockledge, Florida 32955 or e-mail your comments to rps@mainstream-engr.com.

Phase-Out Schedule for HCFCs Including R-22

Under the terms of the Montreal Protocol, the U.S. has agreed to meet certain obligations relating to the Phase-Out of HCFCs by specific dates.

January 1, 2004:

In accordance with the terms of the Montreal Protocol, the amount of all HCFCs that can be produced nationwide must be reduced by 35% by 2004. In order to achieve this goal, the U.S. ceased production of HCFC-141b, the most ozone-damaging of this class of chemicals, on January 1, 2003. This production ban will greatly reduce nationwide use of HCFCs as a group, and so the 2004 deadline had a minimal effect on R-22 supplies.

January 1, 2010:

After 2010, chemical manufacturers may still produce R-22 to service existing equipment, **but not for use in new equipment**. Air conditioning and heat pump manufacturers will only be able to use pre-existing supplies of R-22 to produce new air conditioners and heat pumps. These existing supplies would include R-22 recovered from existing equipment and recycled. It is likely that rather than depend on this very tentative supply of R-22 for new equipment, manufactures will instead utilize R-410A in all new units.

January 1, 2020:

Use of existing refrigerant, including refrigerant that has been recovered and recycled, will be allowed beyond 2020 to service existing systems, but chemical manufacturers will no longer be able to produce R-22 to service existing air conditioners and heat pumps.

Alternatives to R-22 in Residential Air Conditioning

As R-22 is gradually phased out, non-ozone-depleting alternative refrigerants are being introduced. Under the Clean Air Act, EPA reviews alternatives to ozone-depleting substances like R-22 in order to evaluate their effects on human health and the environment. EPA has reviewed several of these alternatives to R-22 and has compiled a list of substitutes that the EPA has determined are acceptable. One of these substitutes is R-410A, a blend of Hydrofluorocarbons (HFCs), substances that do not contribute to depletion of the ozone layer, but, like R-22, contribute to global warming. There are several reasons why R-410A is becoming the chosen replacement for R-22 in new systems. These reasons include

⇒ **Higher Capacity Equipment:** Equipment designed for HFC-410A has demonstrated up to 40% greater capacity when compared to current R-22 equipment.

⇒ **Easy Servicing:** HFC-410A while a blend is a near azeotropic mixture, meaning it behaves almost like a pure refrigerant and therefore it can be repeatedly topped off.

⇒ **Safe and Easy to Use:** HFC-410A has an A1 ASHRAE safety classification.

⇒ **Higher Efficiency:** HFC-410A systems exhibit about a 10% increase in the Coefficient of Performance. That means that A/C and Heat Pump systems can be designed to meet the proposed DOE guidelines of 12 to 14

SEER

Other possible replacement refrigerants for R-22 systems, which are on the list of acceptable substitutes, include R-134a and R-407C. Neither of these two refrigerants have the benefits of R-410A. An R-134a system will have a lower Coefficient of Performance and the system will be larger than a comparable R-410A system. R-407C while not as good a replacement as R-410A, is finding applications in R-22 retrofit applications, because the pressure is comparable with that of R-22 systems (Figure 1), thereby greatly simplifying the refrigerant change over. **You cannot charge existing R-22 systems with R-410A, because the R-22 components were never pressure rated for the higher pressure of an R-410A system**. Of course, the EPA will continue to review new non-ozone-depleting refrigerants as they are developed, but the industry appears to have agreed on R-410A as the best refrigerant to replace R-22, for new high-efficiency air conditioning and heat pump applications.

Many Names for the Identical Compound

R-410A is manufactured and sold under various trade names, including GENETRON AZ-20®, SUVA 410A®, and Puron®. Suva® 410A is DuPont's registered trademark name for R-410A and Puron® is Carrier Corporation's registered trademark for R-410A. All these refrigerants are R-410A, they all have the same chemical composition (Table 1) and they all can be used interchangeably in servicing R-410A units. R-410B has a very similar vapor pressure curve and performance when compared to R-410A. While thermodynamically, 410A and 410B are very similar, there is little if any R-410B being manufactured, since there is no economic or technical justification for two practically identical refrigerants and the industry has chosen one of the two refrigerants, namely R-410A. The industry's choice of R-410A over R-410B is related to patent licensing and legal issues; it is not related to technical superiority of one of these refrigerants compared to the other.

Table 1. Percentage Composition of Substitutes for HCFC-22

Trade Name	ASHRAE Number	HFC-32	HFC-125	HFC-134a
KLEA 407C, AC9000	407C	23%	25%	52%
AZ-20, Puron, Suva 9100	410A	50%	50%	
AC9100	410B	45%	55%	

Refrigerant 410A

Refrigerant 410A is a near azeotropic refrigerant, meaning that while it is a non-azeotrope refrigerant it exhibits a very low temperature glide during evaporation or condensation, making it behave very nearly like an azeotropic refrigerant. This means that while it is still best when charging to remove the R-410A as a liquid from the storage cylinder, there are no concerns about fractionalization of the R-410A refrigerant should a leak occur. That means that a R-410A system can be topped-off without any concern about altering the composition of the blend. Typically, these are all items of concern when dealing with non-azeotropic refrigerants, but again R-410A behaves nearly like an azeotropic refrigerant.

Many manufacturers have already started building R-410A systems, and these systems operate at higher pressure. While most new tools, gauges, and recovery/recycling equipment are being fabricated to accommodate the higher pressure of R-410A, most of the older tools were never designed for the higher operating pressure of R-410A.

Depending on the age of some of your tools, working with R-410A, may require new tools, recovery tanks, and recovery/recycling machines that are rated for R-410A's higher operating pressure. The high-pressure gauge on a service manifold set has a continuous scale, usually calibrated to read from 0 to 500 psig. This does not mean the gauge set is actually rated for use up to 500 psia. A typical rating on older gauge sets and/or hoses is only 340 psig. When using R-410A you must use a gauge set rated for at least 800 psig (with a 4,000 psig burst pressure on the manifold and the hoses). R-410A requires recovery tanks and recovery/recycling machines rated for at least 400 psig.

Table 2. Theoretical Air Conditioner Performance Comparison
Assuming 110°F Condenser, 45°F Evaporator, 5°F Subcooling, 15°F Superheat

	R-22	R-407C	R-410A
Compression Ratio	2.66	2.83	2.62
Compressor Discharge Temperature	171°F	167°F	166°F
Compressor Discharge Pressure	226 psig	241 psig	364 psig
Temperature Glide	0°F	9°F	0°F

As can be seen from Table 2, the higher discharge pressure of the R-410 means that old line sets and recovery tanks, which where normally rated for 350 psig maximum operating pressures are inadequate for use with R-410A. Check your equipment to see if it has been designed for use with R-410A. Figure 1 displays a plot of the saturation pressure of various new refrigerants. R-22 has also been plotted on this graph to provide a means of comparison. Table 5 contains a more detailed table of the Saturation Pressure-Temperature behavior of R-410A.

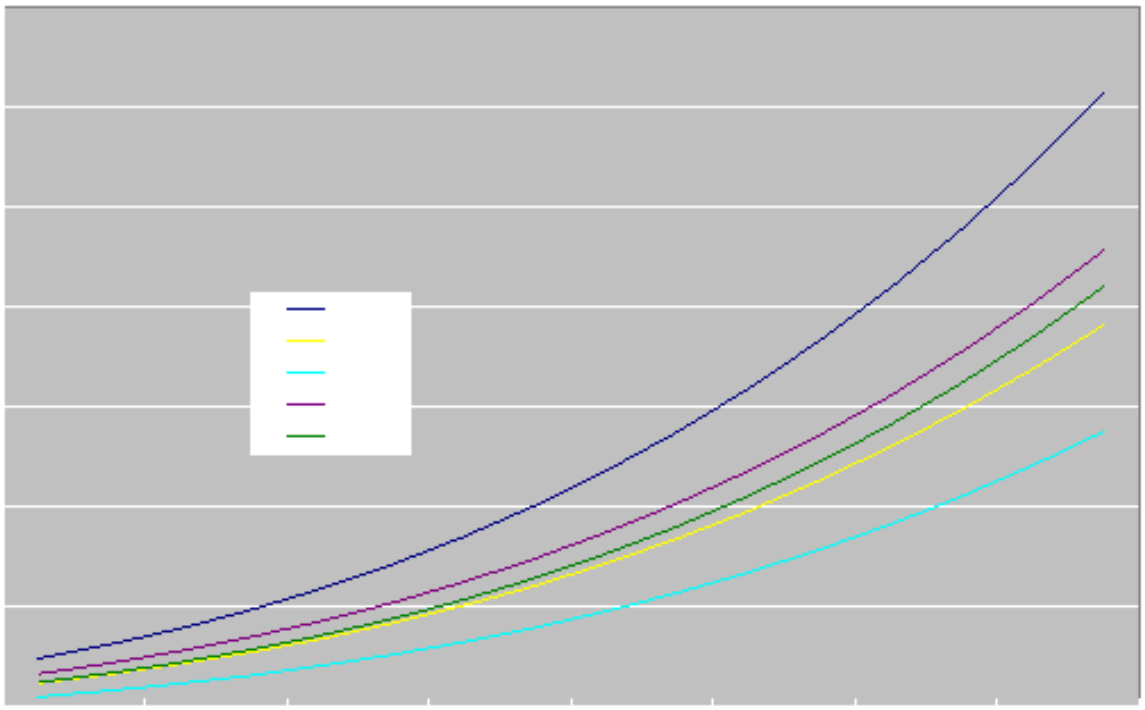

Figure 1. Comparison of the Saturation Pressure of Common 400 Series Blends

Servicing existing units

Existing units using R-22 can continue to be serviced with R-22. There is no EPA requirement to change or convert R-22 units for use with a non-ozone-depleting substitute refrigerant. In addition, the new substitute refrigerants cannot be used without making some changes to system components. As a result, service technicians who repair leaks to the system will probably continue to charge R-22 into the system as part of the repair.

R-410A be not be used to retrofit existing R-22 equipment because of the much higher discharge pressure and cooling capacity. R-410A can **ONLY** be used in equipment designed specifically for R-410A.

R-22 systems can be retrofitted for R-407C, and since the saturation pressures are similar many of the components of the R-22 system can be used in the R-407C system. However, R-407C it is **not a direct drop in replacement**. Since R-22 can still be used, and because there are no current or future proposed requirement to force the conversion of R-22 systems, there is no incentive to convert existing R-22 systems to R-407C. As a practical matter, there are very few R-407C conversions.

Installing new units

The transition away from ozone-depleting R-22 to systems that rely on replacement refrigerants like R-410A has required redesign of heat pump and air conditioning systems. New systems incorporate compressors and other components specifically designed for use with specific replacement refrigerants. Because of the higher pressure for

R-410A, most system components have been designed with increased wall thickness. In addition, expansion valves specifically designed for R-410A and filter-dryers specifically designed for R-410A, **must be used**.

DISPOSABLE REFRIGERANT CYLINDERS

Size and Color Codes

New virgin refrigerant for use by air conditioning and refrigeration service personnel are usually packaged in disposable containers. Disposables are manufactured in three sizes: 15-, 30-, and 50-pound capacities and should never be refilled. **New disposable containers use a check valve and cannot be refilled.** Refrigerant manufacturers voluntarily color code cylinders for their chlorofluorocarbon products. Table 3 lists the color-coding for common refrigerant blends; however, the shade of color may vary somewhat among manufacturers.

Table 3. Tank Color Coding for Common 400 Series Blends

R-401A	light purple
R-401B	yellow-brown
R-401C	blue-green
R-402A	light green-brown
R-402B	green-brown
R-404A	orange
R-407C	medium brown
R-410A	pink

DOT 39 (DAC) cylinders which are used for CFCs, HCFCs, and most HFCs are manufactured to handle the highest-pressure refrigerant, CFC-502, however they cannot be used for R-410A. **DOT 39 (400) cylinders are designed to handle R-410A**.. The D.O.T. requires that disposable cylinders for R-410A be rated for a service pressure of 400 psig. **Cylinders rated for R-410A must be rated for a service pressure of 400 psig**. The R-410A cylinders are leak tested at 500 psig. Also, by the D.O.T. Specification 39, one cylinder per thousand is pressurized to the point of failure and this cylinder must not rupture below 1000 psig for the R-410A cylinders. These tests are intended to assure that users receive safe and leak-free containers. A comparison of the disposable cylinder design details for R-410A cylinders and R-22 cylinders is presented in Table 4.

Every cylinder is equipped with a safety-relief device that will vent pressure from the cylinder before it reaches the rupture point. Two versions are approved for D.O.T. 39 refrigerant cylinders. The most common is a rupture disk, typically welded to the cylinder shoulder. Should R-410A cylinder pressure exceed the safety-relief pressure (minimum pressure is 525 psig for R-410A), the disk will burst and the cylinder content will vent and prevent an explosion. The second design is a spring-loaded relief port integrated in the valve stem. When the internal pressure on this design exceeds the relief pressure, the pressure forces the spring to open and the contents are vented through the relief port.

Cylinders can become over-pressurized for several reasons. However, the primary cause is overheating. When temperatures increase, the liquid refrigerant expands into the vapor space above the liquid causing pressure to rise gradually as long as a vapor space is available for expansion. However, if no vapor space is available due to an overfilled cylinder (and no pressure-relief valve exists), the liquid will continue to expand and the cylinder will rupture to provide room for the expanding liquid. When a cylinder ruptures, the pressure drop causes the liquid refrigerant to flash into vapor and sustains the explosive behavior of the rupture until all the liquid is vaporized.

The rupture of a refrigerant cylinder containing liquid refrigerant that flashes into vapor is far worse than the rupture of a compressed-air cylinder under the same pressure.

If a refrigerant cylinder reaches a full-of-liquid (no vapor space) condition, the internal pressure rises very rapidly under minor increases in temperature. If the safety valve is not able to vent this rapid increase in pressure, the cylinder will explode. Safety valves are very important. Never tamper with a cylinder safety device.

Cylinders can be over-pressurized if they are connected to the discharge side of a refrigeration, air conditioning, or recovery system. In such a case, the compressor can create a pressure and flow that is greater than the flow capacity of the relief device on the cylinder, thereby defeating the purpose of the relief valves and possibly resulting in cylinder rupture.

Disposable cylinders should be emptied of all contents using a refrigerant recovery device. Once emptied, the cylinder's valve should be opened to allow air to enter, and the cylinder should be punctured with the valve still open (rendered useless). Used cylinders can be recycled with other scrap metal. Never leave used cylinders with any residual refrigerant, either outdoors or at a job site. **The internal pressure of a cylinder with one ounce of liquid refrigerant is exactly the same as a full cylinder.** An abandoned cylinder will eventually deteriorate and can explode if the cylinder wall weakens. Never refill a disposable cylinder.

Table 4. Disposable Cylinder Design Details

Cylinder Type:	**R-410A**	**R-22**
Service Pressure	400 psig	260 psig
Test Pressure	500 psig	325 psig
Burst Pressure	1000 psig	650 psig
Minimum Rupture-Disk Relief Pressure	525 psig	340 psig
Maximum Rupture-Disk Relief Pressure	800 psig	520 psig

WARNING: Hot-weather recovery operations can result in very high storage-tank pressures and therefore disposable cylinders should never be refilled or used as a recovery tank. Rust, dents, and other damage can significantly reduce the burst pressure of disposable cylinders.

WARNING: Transportation of refilled D.O.T. 39 cylinders is illegal and subject to a penalty of a

fine up to $25,000 and five years imprisonment. The use of a refilled D.O.T. 39 cylinder also violates OSHA workplace regulations and may violate state laws.

REFILLABLE CYLINDERS

Special R-410A refillable cylinders, also referred to as “recovery cylinders” or “recovery tanks”, are available for the transportation of R-410A used in the air conditioning and refrigeration. These refillable cylinders are also regulated in their design, fabrication, and testing by the D.O.T. for use in transportation of R-410A.

Recovery cylinders are painted yellow in the shoulder area and 12 inches down the side; the manufacturer paints the remainder of the cylinder body gray. We recommend that a pink color stripe (in accordance with the color-coding convention for new refrigerant cylinders) and the words “Contains R-410A” be painted on the tank in order to indicate the type of recovered refrigerant being stored in the tank and also to minimize the potential for accidental refrigerant mixing. If R-410A is mixed with R-22 it may be impossible to reclaim. For refrigeration technicians using recycling machines, we further suggest that a “CLEAN” recovery tank be used for recycled refrigerant and a “DIRTY” recovery tank be used for recovered but not recycled refrigerant. Marking the recovery tanks as “CLEAN” and “DIRTY” will help avoid contamination of otherwise clean refrigerant by putting it into a recovery tank that once held dirty refrigerant.

R-410A refillable cylinders satisfy the DOT requirements of either 4BA400 or 4BW400 specifications. The 4BA cylinder is comprised of two deep-drawn, carbon-steel heads welded together with one girth seam; the 4BW cylinder is comprised of two separate heads on opposite ends of a center cylindrical section.

The 4BA cylinders are generally sized for refrigerant capacities of 50 lbs. or less, with the most widely used sizes being 15 lbs., 30 lbs., 37 lbs., and 50 lbs., respectively. The R-410A cylinders **must be rated for at least 400 psig**. However, not every recovery tank is rated for 400 psig! Be careful, and read the nameplate, only use recovery tanks rated for use with R-410A. The pressure rating should be indicated on all pressure vessels. If not contact the specific cylinder manufacturer to verify capacity, suitability for R-410A and the design operating pressure.

WARNING: According to the American Society of Mechanical Engineers Pressure Vessel Code, the pressure rating must be 285 psig or higher for R-407C, and 400 psig or higher for R-410A. Do not use any storage or recovery tank with a maximum pressure rating less than 400 psig for R-410A. Recovery tanks for R-410A should be specified as DOT 4BA400 or 4BW400.

Evacuation Requirements for R-410A

(Except small appliances)

Technicians are required to evacuate R-410A air-conditioning and refrigeration equipment to 0.0 psig, and the recovery or recycling equipment must be certified for R-410A use by an EPA-approved equipment testing organization.

Evacuation Requirements for Small Appliances using R-410A

When using recycling and recovery equipment manufactured on or after November 15, 1993, 90% of the

refrigerant from the small appliance must be recovered if the compressor on the appliance is operational, and 80% of the refrigerant must be recovered if the compressor is not operational. When using recycling and recovery equipment manufactured before November 15, 1993, 80% of the refrigerant from the small appliance must be recovered.

Storage Requirements

The storage requirements for R-410A are the same as R-22 and other refrigerants and include the requirement to:

- Ø Store in a clean dry area out of direct sunlight
- Ø Never heat cylinder above 125°F (52°C), or allow refrigerant cylinders to be stored in an area that will exceed this temperature
- Ø Keep the valves tightly closed.
- Ø Keep the valve caps and hoods in place when the cylinder is not in use.
- Ø Always label and secure the cylinders.

Safety Precautions

1. Always wear protective goggles when working with refrigerant. If liquid refrigerant gets in your eye, permanent blindness may result.

2. Do not allow refrigerant to come in contact with your skin. Refrigerant has a very low boiling point, which will cause frostbite.

3. All refrigerant handling, charging, and recycling operations should be performed in locations with adequate ventilation of at least four air changes per hour. Avoid prolonged breathing of the vapor. Prolonged inhalation of refrigerant is extremely dangerous; death can occur without warning.

4. Do not use a recovery unit in the vicinity of spilled or open containers of gasoline, thinners, or any other flammable liquid or vapor unless the equipment is expressly designed (explosion proof designs) for such environments. Do not operate where flammable vapor is present.

5. Do not leave any recovery or recycling machine on and unsupervised.

6. Do not attempt to fill any vessels, containers, cylinders, charging equipment, or storage tanks that are not D.O.T.-approved and equipped with a safety-vent valve. Do not transfer refrigerant to non-refillable cylinders.

7. Do not fill any storage tank or vessel with refrigerant beyond 80% of its capacity.

8. Do not disconnect or tamper with the electrical high-pressure, low-pressure, or liquid-level safety shut-off.

Additional Safe Handling Practices for R-410A

The pressure of R-410A is significantly higher than R-22. This does not mean that R-410A, or equipment containing R-410A is unsafe, but it does mean you need tools and equipment that were designed for this higher pressure. You must use AC equipment; cylinders and service tools have been re-engineered to handle the higher pressure.

When servicing R-410A equipment make sure you use reversing valves, expansion valves, filter-driers, and other components specifically designed for R-410A.

Cylinders used for new R-410A, as well as recovered R-410A have both been redesigned for the higher pressure.

Service equipment must also be designed for R-410A:

- Ø High-pressure manifold gauge and hose sets (must have 4000 psi burst pressure and 800 psi working pressure).
- Ø High-pressure recovery machine certified for use with R-410A.
- Ø High-pressure recovery tanks, such as DOT 4BA400 or 4BW400.

Frequently Asked Questions

What is Puron?
Both Puron® and Suva® 410A are marketing brands for ASHRAE R-410A refrigerant. Puron is Carrier Corporation's brand name and Suva® 410A is the DuPont brand for R-410A. Both have the same chemical composition and can be used interchangeably.

Can R-410A be used to retrofit existing R-22 equipment?
NO! Because of the much higher discharge pressure and cooling capacity, R-410A should ONLY be used in equipment designed specifically for R-410A.

Do I need different service tools to work on R-410A systems?
Yes. Because of the higher pressure, you should use manifold gauge sets designed for R-410A. In addition, you should use a recovery machine and recovery tanks designed for the higher pressure of R-410A. Recovery tanks should be specified as DOT 4BA400 or 4BW400.

What type lubricant should be used with R-410A?
A high-quality POE (polyolester) specified by the compressor or system OEM.

Since R-410A is a higher-pressure refrigerant, can I store it in the back of my service van like I did with R-22?
Yes, as long as the temperature does not exceed 125ºF. **This is the same guidance given for R-22 and other common refrigerants.** However, you must realize that on a hot sunny day, the temperature inside a closed van or truck can exceed 125ºF, so if you are storing any refrigerants in your vehicle, don't let the temperature get to 125ºF.

Is R-410A a blend refrigerant?
Yes. It is a blend of HFC-32 and HFC-125 (50/50 wt%) that performs very much like a single component refrigerant.

Is PURON® is different than R-410A?
R-410A is the same refrigerant whether it is called Puron®, Suva® 410A, Genetron® AZ20, Forane® 410A or Klea® 66. Puron® is Carrier's brand name for R-410A.

Is R-410A is more toxic than R-22?
The safety and toxicity characteristics of R-410A have been thoroughly studied by reputable companies and organizations around the world. They have concluded that R-410A can be handled safely when the proper protective equipment is used and when appropriate safety guidelines are followed. These safety practices are very similar to the practices that have been used with R-22 and other HFC and HCFC refrigerants. The physical and chemical properties of R-410A are very similar to those for R-22 as well as most of today's HFC refrigerants. The major difference is the higher pressure. Since certain concentrations of R-410A with air can become combustible, never mix R-410A with air or oxygen for either leak testing or pressurizing a system. As with any refrigerant, another safety concern is the exposure to the evaporating liquid.

Is R-410A more dangerous because of its higher pressures?
The pressure of R-410A is significantly higher than R-22. This does not mean that R-410A, or equipment containing R-410A is unsafe. It does mean that technicians must use AC equipment; cylinders and service tools have been re-engineered to handle these higher pressures.

Are you required to have a license or to be certified to handle and purchase R-410A?
You are required to have an EPA Section 608 Type II or Universal certification license.

Should I charge R-410A as a liquid or vapor into a system?
Even though R-410A performs very similar to a single component refrigerant, it should be removed from the cylinder as a liquid to insure optimum and consistent performance.

If you have a leak from an R-410A system, does the entire charge have to be replaced, or can the system be topped off?
Since R-410A acts very much like a single component refrigerant, any change in composition due to a leak is minimal. The system can be topped off, without removing the entire charge. There is no practical limit to the number of times the unit can be topped-off. However, we do recommend that all leaks be repaired before topping a system off. Excessive superheat is an indication of low charge, and the possibility of a leak in the system should be considered.

Can R-410A be used to retrofit existing R-22 equipment?
There has been some confusion around this issue. Retrofit normally refers to the process of replacing the refrigerant in an existing piece of equipment with some equipment changes. The magnitude of the changes depends on the refrigerant as well as the equipment design. **Existing R-22 systems are not designed to handle the much higher cooling capacity and discharge pressure of R-410A**. To retrofit an existing R-22 system, nearly all of the components would need to be replaced. This is very labor intensive and costly and would not be justified economically. R-22 can still be used, and there is no current, future, or proposed EPA requirement to force the conversion of R-22 systems, so there is no incentive to convert existing R-22 systems.

Why are so many of the new refrigerants "blends"?
Manufacturers combine refrigerant components into blends to develop cost-effective alternatives that match CFC performance and properties. Blends are not new; R-502 is a blend of 22/115 developed in the 1950s to improve on R-22's low-temperature performance. Blends have 400 or 500 series ASHRAE numbers, e.g., 401A, 404A, 409A, 507. When a refrigerant mixture exhibits a distinct boiling point (e.g. it behaves as a single “new” refrigerant), it is

designated as an azeotropic blend and is given a 500 series ASHRAE designation. When the refrigerant mixture has a boiling range it is referred to as a non-azeotropic or zeotropic refrigerant and is given a 400 series ASHRAE designation. R-410A is a "near-azeotropic" refrigerant since it behaves almost like a 500 series azeotropic blend with almost no difference between the saturated vapor and saturated liquid pressures at the same temperature (see Table 5).

REVIEW TOPICS

- Oils that will be used with most HFC-410A air conditioning applications are ester-based synthetic (POE) oils.

- When you use one recovery machine for both HFC refrigerants (such as R-134a, R-410A, R-407C) as well as HCFC (such as HCFC-22, HCFC-123, HCFC-124) or CFC refrigerants, special precautions must be taken to avoid contamination of the synthetic POE oil (used with HFCs) with the mineral oil from the HCFC and CFC refrigerants. It is recommended that a set of hoses, gauges, vacuum pump, recovery machine, and oil containers be dedicated for HFCs only. (It is an EPA regulation that any person who opens an appliance for maintenance, service or repair must have at least one self-contained recovery machine available at their place of business. The only exception to this rule are persons working on small appliances.)

- R-410A requires recovery tanks and recovery/recycling machines rated for at least 400 psig. The R-410A high-pressure manifold gauge and hose set must have a 4000 psig burst pressure and 800 psig working pressure.

- The high pressure gauge on a service manifold set has a continuous scale, usually calibrated to read from 0 to 500 psig. This does not mean the gauge set is actually rated for use up to 500 psia. A typical rating on older gauge sets and/or hoses is only 340 psig. When using R-410A you must use a gauge set rated for at least 800 psig (with a 4,000 psig burst pressure on the manifold and the hoses).

- Technicians receiving a passing grade on the Type II (high-pressure and very high pressure) examination are certified to recover refrigerant during the maintenance, service, or repair of high-pressure equipment (high-pressure CFC-12, HCFC-22, CFC-500, CFC-502, CFC-114, and very high pressure CFC-13, HFC-410A, CFC-503). Only Type II or Universal certified technicians are authorized to recover refrigerant from these units.

- The proper charging method for blended (non-azeotropic) refrigerants (400 Series) is to use a remove the charge from the cylinder as a liquid. Typical blended refrigerants will leak from a system in uneven amounts due to different vapor pressures of the components, and therefore they should not be topped off. However, while R-410A is a blend (thus the 400 series designation), it behaves as a near azeotropic refrigerant, and can be topped off, unlike other 400 series refrigerants.

- Never heat a refrigerant storage or recovery tank with an open flame because: it can result in venting refrigerant to the atmosphere; the tank may explode, causing serious injury to people nearby; and the refrigerant in the tank may decompose, forming a toxic material.

- Only mixtures of nitrogen and R-22 can be used as leak-test gases in an R-410 A system. The R-22 nitrogen leak test gas is not subject to the prohibition on venting because in these cases, the ozone-depleting compound is not used as a refrigerant. Before nitrogen can be added to a R-410A system, the system MUST be evacuated to 0.0 psig. Otherwise, the R-410A-nitrogen mixture will be considered a refrigerant, and its release will be a violation of EPA regulations and subject to fine.

- Never use oxygen or compressed air to leak-check hardware because R-410A, when mixed with air or

oxygen, can explode.

Table 5. Saturation Data for R-410A

Temperature (°F)	Liquid Pressure (psig)	Vapor Phase Pressure (psig)
-50	5	5
-48	6	6
-46	7	7
-44	8	8
-42	9	9
-40	11	11
-38	12	12
-36	13	13
-34	15	15
-32	16	16
-30	18	18
-28	19	19
-26	21	21
-24	23	23
-22	25	24
-20	26	26
-18	28	28
-16	30	30
-14	32	32
-12	34	34
-10	36	36
-8	39	39
-6	41	41
-4	43	43
-2	46	46
0	48	48
2	51	51
4	54	54
6	57	56
8	59	59
10	62	62
12	65	65
14	69	68
16	72	72
18	75	75
20	79	78
22	82	82
24	86	86
26	90	89
28	93	93
30	97	97

32	101	101

Table 5. Saturation Data for R-410A Continued

Temperature (°F)	Liquid Pressure (psig)	Vapor Phase Pressure (psig)
34	106	105
36	110	109
38	114	114
40	119	118
42	123	123
44	128	128
46	133	133
48	138	138
50	143	143
52	148	148
54	154	153
56	159	159
58	165	164
60	171	170
62	177	176
64	183	182
66	189	188
68	195	195
70	202	201
72	208	208
74	215	214
76	222	221
78	229	229
80	237	236
82	244	243
84	252	251
86	259	258
88	267	266
90	275	274
92	284	283
94	292	291
96	301	300
98	310	309
100	319	318
102	328	327
104	337	336
106	347	346
108	356	355
110	366	365
112	377	376
114	387	386
116	398	396

Table 5. Saturation Data for R-410A Continued

Temperature (°F)	Liquid Pressure (psig)	Vapor Phase Pressure (psig)
118	408	407
120	419	418
122	431	430
124	442	441
126	454	453
128	466	465
130	478	477
132	490	489
134	503	502
136	516	515
138	529	528
140	543	541
142	556	555
144	570	569
146	584	583
148	599	598
150	614	613
152	629	628
154	645	644
156	660	660
158	676	676
160	693	693