SECTION 609 MOTOR VEHICLE AIR CONDITIONING CERTIFICATION TEST & PREPARATORY MANUAL

WHO MUST BE CERTIFIED?

Any person that services **Motor Vehicle Air Conditioning (MVAC)** must be certified. Servicing of motor vehicle air conditioning includes repairs, leak testing, and "topping off" of air conditioning systems low on refrigerant, as well as any other repair to the vehicle which requires dismantling any part of the air conditioner. **NOTE:** Service performed on HCFC-22 air conditioner systems typically found on busses, is NOT covered under section 609, but rather section 608 of the Clean Air Act. Technician certification IS required under section 608. For more information on Section 608 certification, contact The ESCO Institute at 1 (800)726-9696.

TEST FORMAT

The certification test contains 50 multiple choice questions. All of the information necessary for the technician to achieve a passing score on the certification test is contained within this manual. The certification test will contain a variety of questions from each of the topics covered.

TRAINING and CERTIFICATION

Technician training and certification are not intended to test skills necessary to diagnose problems with, or to repair, motor vehicle air conditioners. Rather, training and certification teach and test technicians on how to properly recover and recycle refrigerant, appropriate handling of refrigerants, the law, and why it must be done to protect the stratospheric ozone layer.

TEST ADMINISTRATION & GRADING

All tests are electronically graded and records are maintained at the ESCO Institute's Program Development and Grading Center, located in Mount Prospect IL. All inquiries and correspondence should be directed to The ESCO Institute P.O. Box 521 Mount Prospect, IL. 60056.

A technician who successfully completes the exam, by achieving a score of 84% or higher, will receive a certification ID card bearing the technicians name and certificate number. A technician's certification number will be the same as their social security number. Technicians who fail to achieve a passing score will receive a failure notice. Technicians should allow 2 to 3 weeks for the results of their certification exam.

STRATOSPHERIC OZONE DEPLETION

During the last half century, CFC refrigerants (chlorine - fluorine - carbon) have dramatically changed our lifestyles. Little did we know that the use and release of these compounds into the atmosphere would have devastating effects on the Earth's environment. The greatest effect is far removed from the Earth's surface, in the Stratosphere. Located between 10 and 30 miles above the Earth's surface, the Stratosphere contains the Ozone layer. The Ozone layer is the earth's security blanket. The Ozone layer serves two important functions. Ozone protects us from harmful Ultra Violet Radiation and helps to maintain stable Earth temperatures. Depletion of Ozone in the Stratosphere causes;

- **Increased eye disease**
- **Skin cancer**
- **Crop loss**
- **Deforestation**
- **Reduced marine life**
- **Increased ground level ozone**

An Ozone molecule consists of three oxygen atoms **(O_3)**. When CFC's are released into the atmosphere, the Ozone molecule is broken down. The Chlorine in the CFC is the culprit. A single Chlorine atom attacks the ozone molecule, taking one of its oxygen atoms, creating Chlorine Monoxide **(CIO)** and Oxygen **(O_2)**. The Chlorine Monoxide molecule then goes on to attack another ozone molecule, taking another oxygen atom, forming more **O_2** and then releasing the single Chlorine atom. The Chlorine atom continues this chain reaction destroying as many as **100,000** ozone molecules. It is now clear why the production of CFC refrigerants must be phased out and CFC's currently in use must be captured and recycled. Technicians must never intentionally vent refrigerants to the atmosphere.

Section 609 of the Federal Clean Air Act, as regulated by the US Environmental Protection Agency (EPA), requires facilities that repair or service motor vehicle air conditioning systems, or dismantle a motor vehicle air conditioner to service other parts of an automobile, must certify to the EPA that they are using approved recovery equipment, and that no person may service a motor vehicle air conditioner unless they have been properly trained and certified in how to properly recover and recycle refrigerants. The final regulations for section 609 became effective as of August 13, 1992.

MONTREAL PROTOCOL

The Montreal Protocol is an international agreement (treaty) regulating the production and use of CFC's, HCFC's, halons, methyl chloroform, and carbon tetrachloride entered into force in mid 1989. This landmark agreement initially called for a production and consumption freeze. It currently calls for a stepwise reduction and eventual production phase out of various ozone depleting substances. The production phase-out of CFC's was completed on December 31, 1995.

At present, HFC-134a is used by most new car manufacturers as a replacement for CFC-12 and older vehicles may be converted to use HFC-134a by following proper retrofit procedures. Although HFC-134a is considered ozone friendly, it is not without environmental impact. It has been found to be a greenhouse gas and contributes to the problems of global warming. Effective November 15, 1995, HFC-134a must be recovered.

PENALTY

Section 609 of the Federal Clean Air Act, is regulated by the United States Environmental Agency (EPA). Failure to comply could cost you and your company as much as $27,500 per day, per violation; and there is a bounty of up to $10,000 to lure your competitors, customers and fellow workers to turn you in for any violation. Service technicians who violate the provisions of the Clean Air Act may be fined, lose their certification, and may be required to appear in Federal court.

THE THREE "R's"
RECOVER - RECYCLE - RECLAIM

The processes of recovery, recycling, and reclaiming sound similar, but they are quite different.

To **RECOVER** is to remove refrigerant in any condition from a system and store it in an approved external container. Recovered refrigerant may not be returned to a motor vehicle air conditioning system (MVAC) without first being recycled or reclaimed.

To **RECYCLE** is to clean refrigerant for reuse by separating the oil and removing moisture by passing it through one or more filter driers. Recycled refrigerant may be returned to a MVAC. Contaminants in recycled refrigerant are limited to moisture, refrigerant oil, and non-condensable gases to the levels set by the Society of Automotive Engineers.

To **RECLAIM** is to process refrigerant to a level equal to new product specifications as determined by chemical analysis. RECLAIMED refrigerant must meet standards set forth by the Air Conditioning and Refrigeration Institute in ARI standard 700-93. Reclaimed refrigerant is intended for sale and may be used in any application.

REQUIRED EQUIPMENT

The EPA has approved the use of two types of equipment, recover/recycle and recover only. The recover/recycle equipment extracts the refrigerant from the vehicle and cleans the refrigerant on-site. The recover only equipment extracts the refrigerant into an approved container to be sent off-site for reclamation. Either recover only, or recover/recycle equipment may only be used for the refrigerant for which it was designed. NOTE: UL first certified recovery/ recycling equipment in September 1989. Approved equipment must bear a label that states "design certified to meet SAE standards". Do not confuse this with other UL labels that indicate equipment safety performance.

Facilities that service or dismantle motor vehicle air conditioners must certify to the EPA that they are using approved equipment. Servicing of motor vehicle air conditioners includes repairs, leak testing, and "topping off" systems low on refrigerant. Certification that a facility is using approved equipment by certified technicians is not transferable. If a facility changes ownership, the new owner must submit a new certification statement to the EPA within 30 days of the change of ownership.

Recover/recycle equipment must be certified by an EPA approved independent standards testing organization, i.e. UL or ETL, to extract and recycle refrigerant from a motor vehicle air conditioner to a standard set forth by the Society of Automotive Engineers (SAE). The equipment standards were SAE J1990 for CFC-12 and SAE J2210 for HFC-134a. A motor vehicle air conditioning industry sponsored research project indicated that equipment designed to meet SAE standards J2210 did not recover refrigerant from MVAC systems as well as was previously assumed. **As much as 30% of refrigerant remained in an MVAC system when J2210 recovery equipment indicated all refrigerant had been recovered.** MVAC service technicians rely on complete refrigerant recovery to refill MVAC systems according to the motor vehicle manufacturer specification. In light of substandard recovery performance, SAE revised their standards to include performance standards that ensure an improved standard of refrigerant recovery and recharge. **SAE replaced standard J2210 with standard J2788 in October 2006.** J2788 encompasses all of J2210, adds standards on recharging of MVAC systems, and adds performance standards to improve equipment refrigerant recovery performance. Specifically**, J2788 sets a recharge accuracy standard of 0.5 ounces and requires 95% recovery of refrigerant from an MVAC system**.

Effective January 29, 1998, the EPA adopted rulings for recover/recycle equipment where CFC-12 and HFC-134a shares a common refrigerant circuit. These single circuit machines contain special features to prevent cross-contamination in the refrigerant circuit and must meet SAE standard J1770. Other dual refrigerant units are essentially two recycling machines in one cabinet that do not share a common refrigerant circuit. These units must meet SAE J1990 and SAE J2788 standards.

Equipment manufactured to SAE standards is capable of cleaning recyclable refrigerants, such as CFC-12 and HFC-134a, to an acceptable level only if it was removed from a MVAC. Refrigerants from other types of systems may contain impurities that the equipment cannot remove, such as acids from a hermetically sealed compressor that has experienced a "burn-out". Do not attempt to recover or recycle refrigerants from any system other than a MVAC.

Recover-only equipment extracts refrigerant, but does not clean it. The standards for recover-only equipment were SAE J2209 for CFC-12 and SAE J1732 for HFC-134a until **September 16, 2008, when the EPA replaced standard J1732 with J2810. This** action was a direct result of a research project, which indicated that **as much as 30% of refrigerant remained in an MVAC system when J1732 recovery equipment indicated all refrigerant had been recovered.** Recovered refrigerant cannot be used to charge a MVAC without first being recycled or reclaimed. Recovered refrigerant may be recycled using approved recycling equipment. Otherwise, recovered refrigerant must be sent to an off-site reclamation facility. The service establishment must maintain records identifying the reclamation facility where recovered refrigerant is sent.

Alternative Refrigerant Recovery: The new rulings also adopt a standard for equipment that recovers a single, specific refrigerant other than CFC-12 or HFC-134a. This is not a specific SAE standard, but is one formulated by the EPA allowing UL and ETL to approve recovery only equipment designed to extract a single alternative refrigerant. Most of the alternative refrigerants that are approved under the **EPA's SNAP (Significant New Alternatives Policy) program** for use in motor vehicle air conditioners are blended compounds that may contain ozone depleting substances such as HCFC-22. Recovery of these blended refrigerants requires a dedicated piece of equipment. They may not be recovered using the same equipment used for CFC-12 or HFC-134a. It is a violation of EPA regulations to recycle these refrigerants. The EPA requires that these blended refrigerants be sent to a certified reclaim facility.

Contaminated refrigerants must be handled with some extra precautions. If you are unsure about a refrigerant, EPA strongly recommends (but does not require) that technicians obtain a refrigerant identifier as a useful tool. When a technician encounters a "mystery" refrigerant, it must be recovered using a piece of equipment dedicated to this purpose. Unapproved refrigerants may contain a high percentage of flammable substances, such as propane or butane, and a fire hazard may result. Check with your equipment manufacturer to be sure the equipment has protection against risks of ignition. Once the refrigerant has been recovered, it must be properly stored and/or sent to a reclamation facility to be reclaimed or destroyed.

EPA maintains a list of certified reclaimers which is available through the Stratospheric Ozone Protection Hotline (1-800-296-1996) or at the EPA's web site (http//www.epa.gov/ozone/title6/608/reclist.html)

REFRIGERANTS FROM NON-MOBILE SOURCES

Refrigerant recovered from non-mobile sources, such as residential or commercial air conditioners or refrigeration systems may not be used in MVAC systems or recovered using MVAC recovery equipment. It is required that MVAC equipment be only used on MVAC systems.

LOW GLOBAL WARMING POTENTIAL (GWP) REFRIGERANT SYSTEMS

The impact that refrigerants such as HFC134A has on global warming is 1,300 times that of carbon dioxide. The Global Warming Potential of Carbon Dioxide (CO_2) is used as the baseline against which all other gases are measured. (**CO_2 = 1.0 GWP — HFC134A = 1,300.0 GWP**). In other words, releasing 1 pound of R134A is equal to emitting into our atmosphere 1,300 pounds of **CO_2**.

R-744 (CO_2)

CO_2 can be used as a refrigerant. Its refrigerant nomenclature (name) is R744. R-744 systems are in development and are expected to enter the original equipment market in the near future. CO_2 systems are more fuel-efficient and can increase cooling performance as compared to R-134A systems. CO2 systems operate at **7 to 10 times** the pressure of systems containing R-134A. **Due to the very high pressures associated with R744 EPA has established conditions of use.**

Conditional Use of R-744 (CO_2)

Engineering strategies or devices shall be incorporated into the system such that foreseeable leaks into the passenger compartment do not result in concentrations greater than the CO_2 short-term exposure limit (STEL) of 3% for 15 minutes. Manufacturers must adhere to all the safety requirements listed in the Society of Automotive Engineers (SAE) Standard J639, including unique fittings and a high pressure system warning label.

R-152a

R-152a an HFC compound operates with similar characteristics to that of R-134a but possesses a much lower **GWP (120 to 140)** versus 1300 GWP for R-134a. R-152a systems utilize from 7% to 22% less energy to produce the same cooling. **Due to flammability concerns, EPA has established conditions of use for R-152a.**

Conditional Use of HFC-152a

Engineering strategies or devices shall be incorporated into the system such that foreseeable leaks into the passenger compartment do not result in HFC-152a concentrations of 3.7% or above in any part of the free space inside the passenger compartment for more than 15 seconds. Manufacturers must adhere to all the safety requirements listed in the Society of Automotive Engineers (SAE) Standard J639, including unique fittings and a flammable refrigerant warning label.

HFO-1234yf

The Hydro Fluoro Olefin Refrigerant HFO-1234yf was developed through a joint project between DuPont and Honeywell. HFO-1234yf is expected to become the preferred global alternative refrigerant candidate for automotive OEM applications and the aftermarket. HFO-1234yf has a GWP of 4 and an ODP of zero.

HFO-1234yf has a cooling capacity that is comparable to HFC-134a and is compatible with HFC-134a components. Furthermore, this refrigerant does have a flammability factor, which will need to be addressed prior to its adoption as a substitute for HFC-134a.

RECOVERY CYLINDERS

Recovery cylinders differ in many ways from disposable cylinders. Disposable cylinders such as those used for new product, are not refillable and **MUST NEVER** be used for recovery.

Recovery cylinders are specifically designed to be refilled. Recovery cylinders have at least two ports, one vapor and one liquid. The EPA is concerned about over pressurization or heating of these cylinders, resulting in a possible explosion. The EPA requires that a refillable refrigerant cylinder MUST NOT BE FILLED ABOVE 80% of its capacity by weight, and that the safe filling level be controlled by either mechanical float devices, electronic shut-off, or weight.

Before you begin transferring recycled refrigerant into an empty storage cylinder, in order to remove non-condensable gases, the cylinder must be evacuated to at least 27 in. HG of vacuum. Refillable cylinders must be UL or DOT approved and must be hydrostatically tested and date stamped every five years.

DISPOSAL OF EMPTY / NEAR EMPTY CYLINDERS

Before disposing of an empty or near empty disposable cylinder, the remaining refrigerant MUST be recovered. Attach the cylinder to the recovery unit and remove any remaining refrigerant. Once the cylinder has been reduced from a pressure to a vacuum, it should be marked "empty" and is ready for disposal.

SHIPPING & TRANSPORTING

When transporting cylinders containing used refrigerant, the Department of Transportation requires that you attach DOT classification tags and place a refrigerant label on each cylinder. Refillable cylinders used for transporting recovered pressurized refrigerant must be DOT approved. All refrigerant recovery cylinders should be inspected for rust. If they show signs of rust, they should be reduced to 0 psig and discarded. Some states may require special shipping procedures to be followed based on their classification of used refrigerants. Check with the DOT and EPA in the state of origin.

RECOVERY REQUIREMENTS

During service or dismantling of motor vehicle air conditioning systems, containment of the refrigerant is mandatory. Never open a system without first following proper recovery procedures as set forth by SAE J1989 for CFC-12 and SAE J2011 for HFC-134a. The following procedure will serve as a guideline to refrigerant recovery; always operate the recovery equipment according to the manufacturers' recommendations.

Connect the recovery equipment to the vehicle's service ports. Operate the recovery unit to remove the refrigerant until the system has been reduced from a pressure to a vacuum. With the recovery unit shut off, **wait at least 5 minutes** to determine if all refrigerant has been removed. If the system returns to a positive pressure, indicating that there is still refrigerant left in the system, additional recovery is required. Repeat the recovery operation until the vehicle A/C system **vacuum remains stable for 2 minutes.**

MANIFOLD GAUGE SET

When servicing a system with a manifold gauge set, the high, low, and center hoses must have shut off valves within 12 inches (30 cm) of the service ends. Shut off valves can be manually operated or close automatically when the hose is removed. During all service operations, the shut off valves should be closed until connected to the system or the charging source to prevent the introduction of air and to contain rather than vent any refrigerant. When the gauge set is removed from the vehicle or charging source, it must be connected to the recovery equipment to recover the refrigerant from the hoses.

RECYCLING REQUIREMENTS

Approved recycling equipment must meet all of the criteria that recovery only equipment must meet. In addition, recycling equipment must clean the used refrigerant to the minimum purity level as defined in SAE standards before it can be used in a motor vehicle air conditioning system.

	CFC -12 = SAE J1991	HFC - 134a = SAE J2099
Moisture:	**15 PPM by weight**	**50 PPM by weight**
Refrigerant oil:	**4000 PPM by weight**	**500 PPM by weight**
Noncondensable gas:	**330 PPM by weight**	**150 PPM by weight**

The equipment incorporates an in-line filter/desiccant package and a moisture indicator that will alert the operator when the moisture in the refrigerant exceeds the allowable level.

The equipment must also be capable of separating the oil from the refrigerant and accurately indicate the amount removed during processing. Since refrigerant dissolves in the oil, the measuring system must take into account the dissolved refrigerant to prevent overcharging the vehicle with new lubricant. The equipment should also be compatible with leak detection dye that may be found in some systems.

CHECKING FOR NON-CONDENSABLE GASES

Before charging a vehicle air conditioning system with recycled refrigerant, the refrigerant container should be tested for the presence of non-condensable gases (air). Some refrigerant recycling units are equipped with a device that automatically purges non-condensables during the recycling process. Check your equipment manufacturers operating instructions. If the equipment does not have such a device, the refrigerant can be tested for non-condensables as follows:

- The container must be stored at a temperature 65° F (18.3° C) or above for a period of twelve hours, out of direct sunlight.
- Install a calibrated pressure gauge with 1 psig divisions to the container and determine the container pressure.
- With an accurate thermometer, measure the air temperature within 4 inches of the container surface.
- Compare the container pressure and temperature to determine if the container exceeds the pressure limits found on Table 1 (located on page 10).

LEAK TESTING

Although the EPA has not mandated leak repair at this time, when servicing an automotive air conditioning system, you should repair leaks whenever possible. Adding refrigerant to a leaking system is harmful to the environment, a waste of valuable refrigerant and it is unlawful in some states. Before beginning a service job, the technician should perform a thorough visual inspection and leak check of the system.

When using an electronic leak detector, always follow the manufacturer's operating instructions. In addition to the manufacturer's instructions, the following should be observed;

1. Always leak test with the engine off.
2. Only, a small amount of refrigerant is required to perform a leak test. A gauge reading of 50 psi is all that is needed. At temperatures below 50°F., leaks may not be measurable, since 50 psi may not be attainable.
3. To avoid contaminating the tip of your leak detector, remove excessive dirt from suspected leak areas. Do not use cleaners or solvents, your detector may be sensitive to their ingredients.
4. Visually inspect the system, and look for signs of air conditioning oil leakage, damage, and corrosion on all lines, hoses, and components. Each suspected area should be carefully checked.
5. Follow the system around in a continuous path to ensure that no areas are missed. If a leak is found, continue to check the remainder of the system for additional leaks.
6. At each area checked, move the probe tip around the location at about 1" per second while holding the probe no more than 1/4" above the surface of the area being leak checked.
7. To verify an apparent leak, blow shop air into the area of the suspected leak to clear any refrigerant that may linger and repeat the leak check.
8. To leak test an evaporator core, operate the air conditioner with the blower motor on high for a minimum of 20 seconds. Shut the air conditioner and blower motor off and wait for the refrigerant to accumulate. Insert the leak detector probe into the blower resistor block or the condensate drain hole (if no water is present). If the detector indicates a leak, the evaporator or the line connections to the evaporator are leaking.

After a system has been opened for repair, the system should be properly leak tested before charging with refrigerant. The system should hold a deep vacuum (27 in HG. or more) for at least one minute before charging. If the system will not hold a deep vacuum, a minimum amount of refrigerant (enough to produce a positive pressure) can be added for leak testing.

An alternate method of leak testing is to use Nitrogen (an inert gas) to pressurize the system, and then pinpoint leaks with a soap and water solution. Whenever dry nitrogen from a cylinder is used in a service procedure, you should always charge through a pressure regulator, and have a pressure relief valve installed downstream from the regulator.

NEVER pressurize the system with oxygen or compressed air. When mixed with refrigerants and their lubricants, oxygen or compressed air can cause an explosion.

Leak Repair

The EPA encourages, but does not require leak detection and repair.
Refrigerant leaks detected at compressor crank seals, fittings, valves/connectors, hoses and lines should be repaired. Repairs and replacements should be made through the following steps:

1. Recover and recycle any refrigerant remaining in the A/C system into an approved refrigerant cylinder.
2. Remove and replace leaking compressor shaft seals, fittings, valves/connectors, hoses and lines to manufacturer’s specifications.
3. Tighten fittings to appropriate ft/lbs where applicable.
4. Following the leak testing procedures above, leak test the system.
5. Evacuate, dehydrate by pulling a deep vacuum and test MVAC system to manufacturer’s specifications.

NOTE: Some states and local governments may have laws stricter than the federal law concerning the issue of leak repairs.

PROPER CHARGING AND RECHARGING OF MVAC SYSTEMS:

After system evacuation, and dehydration the system can be charged with new or recycled refrigerant. In order to operate efficiently, the system must be critically charged (exact pounds and ounces). The refrigerant type and critical charge level is normally found on the specification decal fastened on or close to the AC system under the hood, in the vehicle service manual, by the vehicle manufacturer or after market AC equipment supplier.

An incorrect system charge reduces efficiency and comfort. An **undercharged system** will result in insufficient cooling, possible icing of the evaporator, and lower pressures that can cause the system to shut down. An **overcharged system** can result in excessively high pressures, leading to system failure, and possible venting.

The only accurate method to charge a system that requires a critical charge is to **weigh the refrigerant into the system**. It is important to verify the accuracy of charging scales and recalibrate them as per the manufacturer's instructions. **You should place a static known value weight onto the scale to verify the scale's accuracy.**

Note: Most charging scales have a zeroing feature that calibrates the scale to zero. The most common procedure is to; 1) place the refrigerant cylinder on the scale, 2) depress the zeroing switch or button until the readout is zero, 3) begin charging and note the readout as it changes, 4) stop charging when the readout is equal to the total required charge.

Some charging equipment as well as manifold gauges may have metric displays. A kilogram is equal to 2.2 pounds. One ounce is equal to 28.3495 grams**. One gram is equal to 0.035273 ounces**

POUNDS TO KILOGRAMS				
1 lb	**2 lb**	**3 lb**	**4 lb**	**5 lb**
0.454 kg	**0.907 kg**	**1.361 kg**	**1.814 kg**	**2.268 kg**

POUNDS TO GRAMS				
1 lb	**2 lb**	**3 lb**	**4 lb**	**5 lb**
453.592 g	**907.185 g**	**1360.777 g**	**1814.269 g**	**2267.961 g**

POUNDS TO OUNCES				
1 lb	**2 lb**	**3 lb**	**4 lb**	**5 lb**
16 oz	**32 oz**	**48 oz**	**64 oz**	**80 oz**

KIOLOGRAMS TO GRAMS				
0.454 kg (1 LB)	**0.907 kg (2 LB)**	**1.361 kg (3 LB)**	**1.814 kg (4 LB)**	**2.268 kg (5 LB)**
454 g	**907 g**	**1361 g**	**1814 g**	**2268 g**

OUNCES TO GRAMS				
1 oz	**2 oz**	**3 oz**	**4 oz**	**5 oz**
28.350 g	**56.699 g**	**85.0486 g**	**113.398 g**	**141.748**
6 oz	**7 oz**	**8 oz**	**9 oz**	**10 oz**
170.097 g	**198.447 g**	**226.796 g**	**255.146 g**	**283.495 g**
11 oz	**12 oz**	**13 oz**	**14 oz**	**15 oz**
311.845 g	**340.194 g**	**368.544 g**	**396.893 g**	**425.243 g**
16 oz				
453.592 g				

SAFETY

The EPA is not only concerned with the prevention of refrigerant venting, but is also concerned with the technicians overall safety. When handling refrigerants or operating recover/ recycle equipment, you should wear safety glasses, protective gloves, and follow all equipment manufacturers' safety procedures.

Always review the material safety data sheets when working with any solvents, chemicals, or refrigerants.

In the event of a large release of refrigerant in a confined area, **IMMEDIATELY VACATE AND VENTILATE** the area. Inhaling refrigerant vapors can cause heart irregularities, unconsciousness, and oxygen deprivation leading to death.

NEVER expose CFC-12 to open flames or hot glowing surfaces. At high temperatures, R-12 will form Hydrochloric acid, Hydrofluoric acid, and Phosgene gas.

HFC-134a

HFC-134a systems and equipment have unique service ports. These unique ports are designed to prevent HFC-134a and other refrigerants from being mixed together either in an air conditioning system or within the service equipment. In order to avoid cross contamination of refrigerants, as well as the different lubricants, separate equipment shall be used when servicing HFC-134a systems.

The required separate equipment includes but is not limited to;

- **Hoses — Gauges — Recovery and recycling equipment — Recovery cylinders — Oil containers**

HFC-134a will not mix with the mineral oil. The lubricants used with HFC-134a are Poly Alkylene Glycol (PAG) or Poly Oil Ester (POE) synthetic oils. Most, but not all, automakers equip their vehicles with PAG oils. PAG and POE oils are more hygroscopic than mineral oils. Hygroscopic oil has an affinity for moisture absorption. Therefore, the use of an XH-7 or XH-9 desiccant (drier) is necessary. Reasonable caution should be used when handling PAG oil. Avoid PAG oil contact with skin and painted surfaces. Make certain that when servicing a motor vehicle air conditioning system, you install the correct oil, as there are there are several different PAG oils. Using the wrong oil can cause serious damage to the system. When retrofitting a CFC-12 system to HFC-134a, follow all manufacturers recommended procedures.

It should also be noted that replacement hoses must meet the standard for permeability, **SAE J2064.** This SAE standard covers hose and hose assemblies intended for R134a refrigerant systems. The hose must minimize permeation of R134a, contamination of the system, and be functional within the temperature range of –22° F. to 257° F. (-30° C. to 125° C.).

RETROFITTING TO HFC-134a

The process of retrofitting a CFC-12 vehicle to HFC-134a may vary from vehicle to vehicle. Much of what you do will depend on the integrity of the system. Although there are certain general procedures that must be followed when retrofitting, you should consult the vehicle manufacturer and follow their recommendations.

GENERAL PROCEDURES;

1. Perform a leak test and replace any leaking components. Since HFC-134a has a molecule that is about 80% the size and weight of a CFC-12 molecule it will leak from rubber hoses and O rings. Replacement hoses and O-rings must be made of non-permeable material.

NOTE: Rubber hoses and O-rings used in CFC-12 systems become permeated with refrigerant oil. The refrigerant oil fills the pores & creates a reasonable seal. Although it is ideal to replace all rubber hoses & O-rings with the non-permeable type, these oil soaked rubber components will provide an acceptable seal for HFC-134a.

2. Recover any remaining CFC-12.

3. Connect an efficient vacuum pump to both the low and high sides. Operate the vacuum pump for 45 minutes after achieving a deep vacuum. (A vacuum of about 500 microns or 29.92" hg gauge pressure) This step is extremely important to insure that less than 1% CFC-12 remains in the systems oil. One percent or more CFC-12 can cause as much as a 50% rise in head pressure.

4. Replace the old drier or accumulator with a new one that contains an XH-7 or XH-9 desiccant.

5. Remove the compressor and drain the refrigerant oil. Replace any external compressor O-rings with the non-permeable type. Re-install the compressor and add the PAG oil.

6. Install new high side and low side 134a fittings.

7. Attach vacuum pump and achieve a deep vacuum.

NOTE: Remember that HFC-134a has about 80% the molecular weight of CFC-12 and the new drier or accumulator desiccant displaces approximately 15% more area than the old XH-5 desiccant. Where exact charging weight is not available, follow these steps;

8. Start the vehicle and run to operating temperature.

9. Place a large fan in front of the condenser to simulate 30 mph ram air.

10. Using an accurate thermometer, hold the thermometer 1" from the condenser and note the temperature. Add 40° F. to your reading (this will allow you to approximate the condenser core temperature).

11. Using a temperature pressure chart for HFC-134a, charge the system (with the engine and system on) until the high side gauge reading is equal to the approximate condenser core temperature. The system should now be fully charged.

12. It is important to verify that you have not over charged or under charged the system. Verification begins with checking the compression ratio. To check compression ratio, note on paper the low and high side gauge readings and add atmospheric pressure to both readings. Divide the high side reading (with the atmospheric pressure added) by the low side reading (with the atmospheric pressure added). The result should be between 6.5: 1 and 7.5: 1. A compression ratio of 8: 1 or higher may cause compressor failure. A high compression ratio can be caused by an overcharge, insufficient air flow or an inefficient condenser.

13. AFFIX HFC-134a LABEL TO THE SYSTEM: This final step is imperative to avoid future cross contamination.

OTHER ALTERNATIVES TO CFC-12

As blends make their way into the retrofit market, you will need to understand how blends function. Some of the blends are ternary, which means they are a three part blend. Most ternary blends are used with an alkyl benzene lubricant. Blended refrigerants will leak from a system in uneven amounts due to different vapor pressures. Due to these varying vapor pressures, charging in the liquid phase is required.

NOTE: If a blend contains HCFC-22 all hoses must be replaced with barrier type hoses.

EPA's SNAP program evaluates these substitutes to assess their effect on human health and the environment. Page 11 of this manual contains a partial list of alternative refrigerants and their status as of June 3, 1997.

Table 1
Presence of Non-Condensables / Maximum Allowable Pressure

TEMP ºF	CFC-12 psig	HFC-134a psig	TEMP ºF	CFC-12 psig	HFC-134a psig
65	74	69	93	115	115
66	75	70	94	116	117
67	76	71	95	118	118
68	78	73	96	120	120
69	79	74	97	122	122
70	80	76	98	124	125
71	82	77	99	125	127
72	83	79	100	127	129
73	84	80	101	129	131
74	86	82	102	130	133
75	87	83	103	132	135
76	88	85	104	134	137
77	90	86	105	136	139
78	92	88	106	138	142
79	94	90	107	140	144
80	96	91	108	142	146
81	98	93	109	144	149
82	99	95	110	146	151
83	100	96	111	148	153
84	101	98	112	150	156
85	102	100	113	152	158
86	103	102	114	154	160
87	105	103	115		163
88	107	105	116		165
89	108	107	117		168
90	110	109	118		171
91	111	111	119		173
92	113	113	120		176

Unacceptable Substitute Refrigerants Significant New Alternative Policy (SNAP) Program as of June 12, 2008				
Substitutes (Name used in Federal Register)	**Trade Name**	**ODS Being Replaced**	**End-Uses**	**Reason**
All flammable refrigerants, including OZ-12 (Hydrocarbon blend A) and HC12a (Hydrocarbon blend B) Except for HFC-152a in new MVAC equipment		CFC-12	Motor vehicle Air Conditioning retrofit and new	Lack of adequate risk assessment that characterizes incremental flammability risk
CZ-12 (Hydrocarbon blend A) and HC12a (Hydrocarbon blend B)	OZ-12 HC-12a	CFC-12	All end uses other than Industrial Process Refrigeration, retrofit and new	Lack of adequate risk assessment that characterizes incremental flammability risk
R-141b		CFC-11	Centrifugal Chillers new	High ODP, other substitutes with lower overall risks have been identified
R-176*		CFC-12	All end uses, retrofit and new	Contains CFC-12
R403B		R-502	All end uses other than Industrial Process Refrigeration, retrofit and new	Contains a perfluorcarbon that exhibits extremely high GWP and very long lifetime
R-405A		CFC-12	All end uses, retrofit and new	Contains a perfluorcarbon that exhibits extremely high GWP and very long lifetime
MT-31		All CFCs and HCFCs	All end uses, retrofit and new	A chemical in this blend presents an unacceptable toxicity risk
Hexafluoropylene (HFP) and all HFP containing blends		CFC-12, HCFC-22, R-502	All end uses, retrofit and new	presents an unacceptable toxicity risk
Self-Chilling cans using HFC-134a or HFC-152a		CFC-12, HCFC-22, R-502	Household refrigeration, Transport Refrigeration, Vending Machines, Cold Storage Warehouses and Retain Food Refrigeration; retrofit and new	Unacceptably high greenhouse gas emissions from direct release of refrigerant to the atmosphere
NARM-22		HCFC-22	All end uses, retrofit and new	Contains HCFC-22

*R-176 contains: CFC-12, HCFC-22, and HCFC-142b it is a different product from RB-276, generally sold under rhe name of Freezone.

Prohibited Flammable Refrigerants

Refrigerants that have a flammability concern and/ or listed by EPA as unacceptable substitutes can by found by visiting the EPA web-site http://www.epa.gov/EPA-AIR/2008/June/Day-12/a13086.htm.