



2009 ASE Refrigerant Recovery and Recycling Training Booklet

- This online version of the booklet contains the same content as the 2009 printed version, with the exception of the quiz. You may take the quiz online at www.asecampus.com.
- If you would like to review this booklet offline, please save a copy to your desktop or other location.
- If you need access to the training booklet in the future, you can download a copy from the ASE website at www.ase.com or from the ASE Campus home page at www.asecampus.com.





Refrigerant Recovery and Recycling

REVIEW AND QUIZ



This booklet is distributed free of charge and is not to be sold.

The Future Is Now



We're making progress. Responsible air conditioning service practices, along with the phase-out of ozone-depleting substances like R-12, should help return the earth's ozone layer to normal levels around 2050. While that's certainly good news, there's more work to be done. R-134a may be more ozone-friendly than R-12, but R-134a also has a downside—it's a greenhouse gas and contributes to the threat of global warming. Although a replacement for R-134a is yet to be chosen, your role as a service technician will continue to play a key part in environmental stewardship.

Auto makers began their transition from R-12 to R-134a with 1992 models. This transition was completed with the 1994 model year. For you, however, the future isn't as cut-and-dried. EPA acceptance of alternative refrigerants other than R-134a, the ban on some refrigerants because of flammability concerns, illegal smuggling of R-12 into the U.S. from foreign countries, and the possibility of cross-contamination with other refrigerants—all require almost constant attention. (On that note, here are a few important historical benchmarks: The deadline for mandatory recovery of R-134a was November 15, 1995. After that date, venting of R-134a became illegal. Recycling of R-134a, using EPA-approved equipment, became mandatory on January 29, 1998.) As always, be sure to check state and local regulations as they may differ from federal requirements.

On December 31, 2007, EPA formally adopted a new standard for refrigerant handling equipment. Known as J2788 from the Society of Automotive Engineers (SAE), it supersedes standard J2210. The new standard includes upgraded performance requirements for refrigerant handling equipment. This doesn't make older equipment obsolete, so you needn't worry about already existing refrigerant handling equipment.

Make a commitment to yourself and your customers to stay informed on any news affecting the world of air conditioning service. You should also be aware that the EPA has a Stratospheric Ozone Protection Hotline that can be used to get answers to your questions and to request printed information. Best of all, it's free. Just call 1-800-296-1996, between the hours of 10 a.m. and 4 p.m. Eastern Time. Information is also available at www.epa.gov/ozone/title6/609 on the EPA website.

Timothy A. Zilke
President, ASE

NOTE: The ASE Refrigerant Recovery and Recycling Review and Quiz is an EPA-approved program that meets Section 609 regulations as set forth in Section 609 of the Clean Air Act Amendments of 1990. Accordingly, this program is intended only for technicians servicing motor vehicle air conditioning. Under no circumstances should this program be considered as acceptable for Section 608 compliance, a separate requirement that applies to the servicing of other types of air conditioning systems, such as those used in commercial and residential applications. Furthermore, some state and local jurisdictions have adopted their own requirements for credentials, so check with your state and local authorities for details.

Certification earned as a result of a passing score on the enclosed quiz is only deemed as certification in the context of the U.S. EPA. This credential is not the equivalent of technical certification from the main ASE testing and certification program. For more information, refer to the ASE test Registration Booklet or visit the ASE website at www.ase.com.



National Institute for
**AUTOMOTIVE
SERVICE
EXCELLENCE**

COVER: On October 1, 2005, the minimum ozone value was recorded at 102 Dobson Units. The average concentration of ozone in the atmosphere is about 300 Dobson Units; any area where the concentration drops below 220 Dobson Units is considered part of the ozone hole, shown here outlined in blue.

Image courtesy of NASA/Goddard Space Flight Center, Scientific Visualization Studio.

Copyright 2009, National Institute for Automotive Service Excellence.

The 'Hole' Story About the Ozone Layer

The Good and Bad of CFCs

When R-12 (often referred to by its brand name, Freon) was introduced in 1930, the industry hailed it as a miracle chemical. It was non-poisonous, easy and cheap to manufacture and quite stable. The first in a family of chlorofluorocarbons (CFCs) yet to come, R-12's apparent stability and low cost made air conditioning the creature comfort of the 20th century.

Unfortunately, scientific findings prove that we may have a big price to pay in the future for the comfort we've enjoyed in the past. The findings show that CFCs, like R-12, as well as bromines from the halons used in fire extinguishers, are depleting the Earth's protective ozone layer located in the stratosphere some 10 to 30 miles above the planet's surface. This precious layer of ozone filters out most of the sun's harmful ultraviolet radiation.

The EPA assessed and detailed some of the key risks associated with excess UV radiation. These include increased reports of skin cancer, negative effects on the body's immune system, an increase in the number of eye cataracts, damage to vegetation, adverse effects on sea life, and an increase in ground-level ozone (a contributor to higher smog levels).

Each year, about a half-million people contract basal and squamous cell skin cancers. Although these are the most treatable, for about one percent of the population, they are fatal. Additionally, about 25,000 cases of malignant melanoma, a much more

serious form of skin cancer, occur each year. In about 20 percent of the cases, this cancer is fatal. If there is an increase in UV radiation, the risks go up for all types of skin cancer. The latest predictions are 200,000 additional cancer cases per year.

Cataracts cloud the lens of the eye, which can lead to blindness. According to studies, increased UV radiation may lead to an additional 18 million new cases of cataracts. With ozone layer damage now in check, it is estimated that over 90 percent of those cataract cases can be prevented.

Some scientists theorize that increased UV radiation suppresses the ability of the body's immune system to fend off diseases such as herpes simplex. Although it is not caused by exposure to UV radiation, AIDS (Acquired Immune Deficiency Syndrome) is a horrifying example of a major breakdown of the body's immune system.

Research indicates that vegetation, particularly crops, can be adversely affected by UV radiation. Combined with a bad growing season such as a drought, severe crop reductions could have a devastating effect on the world's food and biofuels supply.

In the sea, plankton (floating or weakly swimming animal and plant life) and some species' larvae may be killed off or reduced by increased UV radiation. Plankton and larvae are near the bottom of the food chain and many other marine animals feed on these life forms. Loss of these food sources could have an impact on the food chain, all the way up to humans.

The Ozone Layer...Under Chemical Attack

According to the EPA sources, 30 percent of all CFCs (chlorofluorocarbons) released into the atmosphere come from mobile air conditioners. Some of the refrigerant leaks out, of course, but the majority of CFC releases occur during air conditioning service and repair. This means that you have direct control over its release and must recover and recycle to prevent this from happening.

CFCs destroy the ozone in the stratosphere through chemical reaction. Ozone is a chemical compound consisting of three oxygen atoms in each molecule. Ozone molecules are similar to oxygen molecules because they contain oxygen atoms.



EPA Information Resources

Official documents and fact sheets produced by the EPA are available at no charge. To receive copies, you may:

1. Order from the EPA Stratospheric Ozone Protection Hotline 1-800-296-1996 between the hours of 10 a.m. and 4 p.m. Eastern Time. Use the document name as it appears in this publication.
2. Visit www.epa.gov/ozone/title6/609 on the World Wide Web, the U.S. EPA Stratospheric Ozone website.



However, the oxygen molecules that sustain our lives contain two oxygen atoms (O₂), whereas the ozone molecules that poison the atmosphere contain three oxygen atoms (O₃). Oxygen is essential to life, but ozone is harmful when breathed and it contributes to smog.

While ozone is bad when at the earth's surface, in the stratosphere it is essential to our survival. It acts as a sunscreen, protecting humans, plants and animals from the harmful effects of excessive ultraviolet radiation.

It is the inherent stability of CFCs, the quality which proved so beneficial to mankind, that makes them such a threat to the ozone layer. Once CFCs are released into the atmosphere, they travel high into the stratosphere where they can linger for a hundred years or more.

Under the influence of sunlight, a chlorine atom is released from a CFC molecule and reacts with one of the oxygen atoms in the ozone to produce chlorine monoxide and free oxygen. Neither of these can filter out the sun's ultraviolet radiation the way ozone can. For each one percent of ozone reduction, one and one-half to two percent more UV radiation reaches the surface of the earth.

All the World Meets in Montreal

In response to increased scientific evidence of significant ozone depletion, the landmark international environmental agreement, "The Montreal Protocol on Substances that Deplete the Ozone Layer," was signed in September 1987. The original Protocol called for a 50 percent reduction in CFCs by the year 1998. The discovery of a seasonal "ozone hole" over Antarctica in 1985 highlighted the need for more stringent measures. In June 1990, the Protocol was amended to completely phase out production of CFCs and halons (used in fire extinguishers) by the year 2000. In November 1992, in response to scientific findings indicating that ozone depletion was more severe than anticipated, the parties of the Montreal Protocol voted to accelerate the phase-out to the end of 1995. Currently, more than 160 nations representing over 95 percent of the world's consumption of CFCs are parties to the Protocol.

Section 609 of the Clean Air Act Amendments of 1990

The most important parts of the amendments to Section 609 of the Federal Clean Air Act have to do with servicing motor vehicle air conditioning and technician certification. The Act states:

Servicing Motor Vehicle Air Conditioners—

Effective January 1, 1992, no person repairing or servicing motor vehicles for consideration may perform any service on a motor vehicle air conditioner involving the refrigerant for such air conditioner without properly using approved refrigerant recycling equipment and no such person may perform such service unless such person has been properly trained and certified.

Certification—(1)...each person performing service on motor vehicle air conditioners for consideration shall certify to the Administrator:

(A) that such person has acquired, and is properly using, approved refrigerant recycling equipment in service on motor vehicle air conditioners involving refrigerant and that each individual authorized by such person to perform such service is properly trained and certified...

(2) Effective January 1, 1993 each person... shall submit a certification under paragraph (1) (A).

(3) Each certification under this subsection shall contain the name and address of the person certifying under this subsection and the serial number of each unit of approved recycling equipment acquired by such person and shall be signed and attested by the owner or another responsible officer. Certifications under paragraph (1) (A) may be made by submitting the required information to the Administrator on a standard form provided by the manufacturer of certified refrigerant recycling equipment.

A Word About Alternative Refrigerants

Important: The sale of any size container of ozone-depleting refrigerant, including refrigerant blends, is restricted to technicians who have been properly trained and certified. As this booklet went to press, there was no sales restriction on R-134a; however, this is subject to change. Consult the EPA Information Resources listed in this booklet for the current status on sales restrictions.

Refrigerant producers and the motor vehicle manufacturers conducted exhaustive research on alternative refrigerants to R-12 and finally chose R-134a because of its safety, performance and non-ozone-depleting characteristics. By the 1994 model year, all vehicle manufacturers had made the switch to R-134a as the original equipment refrigerant.

It is possible to change older R-12 systems over to R-134a, a process known as a retrofit or conversion. Although requirements vary depending on the year, make, and model of the vehicle, this procedure usually includes changing certain system components, as well as the addition of R-134a-compatible refrigerant oil prior to charging with R-134a. For best results, check with the vehicle manufacturer for specific retrofit guidelines and the availability of retrofit kits. Retrofit kits and information are also available from various aftermarket sources. General retrofit guidelines are also available from the EPA. Order “Keeping Your Customer’s Car Cool: Some Guidance On Retrofitting A/C Systems To R-134a” from the EPA Hotline, or from the EPA website as listed under “EPA Information Resources.” One important note: Prior to charging with R-134a, all R-12 must be removed. R-12 and R-134a must never be mixed.

Replacement Refrigerants

Retrofitting R-12 MVAC systems to use other refrigerants was driven by the expense and scarcity of R-12. Despite the fact that this is not the case with R-134a, there are refrigerants intended for use as “retrofit” substitutes for R-134a. Two such refrigerants are GHG-X8 and ES-12a. Both are claimed by their makers to provide performance advantages, or to be more environmentally friendly than R-134a. However, the OEM vehicle and system manufacturers recommend that only R-134a be used in their MVAC systems.

The world of alternative refrigerants is changing rapidly, so it’s wise to keep a close eye on industry journals for news of other alternatives that may be listed as acceptable, under certain use conditions, by the EPA as per its Significant New Alternatives Policy (SNAP). Although R-134a remains as the only OEM-recommended refrigerant for retrofitting, the EPA developed the chart on page 6 to list other alternative refrigerants. (The information on this chart is current as of March 1, 2009; updated copies can be obtained by calling the Ozone Protection Hotline, or visiting the EPA website). This chart not only lists the refrigerant names, but also contains other important information regarding the status of acceptability or unacceptability. Only the refrigerants listed in the “Acceptable Subject to Use Conditions” category may be legally installed in a mobile A/C system. It is also important to note that this designation does not indicate the performance level of these refrigerants in any given A/C system. Additional refrigerants may be listed as acceptable in the future. Also note that some refrigerants are listed as unacceptable due to flammability, or the fact that they contain CFC-12. These refrigerants are listed in the chart on page 7.

As this booklet went to press, the EPA is aware that the following states and localities prohibit the use of flammable refrigerants in automotive air conditioners: Arkansas, Arizona, Connecticut, Florida, Idaho, Indiana, Kansas, Louisiana, Maryland, North Dakota, Oklahoma, Texas, Utah, Virginia, Washington, and the District of Columbia.

Use Conditions

Under the SNAP rule, each alternative refrigerant must be used in accordance with the conditions listed. If you choose to use an alternative refrigerant, make sure that you pay strict attention to these conditions. In addition, be sure that the shop has dedicated recovery and/or recycling equipment for that refrigerant.

Unique Fittings

Each alternative refrigerant must be used with a unique set of service fittings to prevent the accidental mixing of different refrigerants. These fittings are attachment points on the vehicle itself, on all recovery and recycling equipment, on can taps and other charging equipment, and on all refrigerant con-





tainers. If the vehicle is being retrofitted, any service fittings not converted to the new refrigerant must be permanently disabled. Unique fittings help prevent cross-contamination. They also help protect the purity of the recycled supply of R-12, which means it will last longer, so fewer retrofits will be necessary nationwide. The list of fittings is available in an EPA Fact Sheet titled “Fitting Sizes and Label Colors for Motor Vehicle Refrigerants.”

A/C service equipment and hoses are affected by the regulations regarding unique fittings. Manifold gauges allow you to have access to A/C systems so that you may diagnose system problems and also charge, recover, and/or recycle refrigerant. A standard fitting may be used at the end of the hoses attached to the manifold gauges, but unique fittings must be permanently attached to the ends of the hoses that connect to vehicle A/C systems and also to the ends that connect to recovery or recycling equipment. Refrigerant identifiers may be used with multiple refrigerants. The connector between the identifier, or similar service equipment, and the service hose may be standardized and work with multiple hoses. For each refrigerant, however, you must use a hose that has a fitting unique to that refrigerant. This fitting must be permanently attached to the end connecting to the vehicle or other refrigerant source. The guiding principle is that once attached to a hose, the fitting is permanent and is not to be removed.

Labels

Whenever a vehicle’s original equipment refrigerant is replaced by any other type, a detailed label giving specific information about the alternative must be applied. The label’s background color is chosen by the refrigerant manufacturer to be unique, and the label colors for each refrigerant are listed in an EPA fact sheet titled “Fitting Sizes and Label Colors for Motor Vehicle Refrigerants.” The label shows:

- the name and address of the technician and the company performing the retrofit;
- the date of the retrofit;
- the trade name, charge amount, and, when applicable, the ASHRAE numerical designation of the refrigerant;

- the type, manufacturer, and amount of lubricant used; and
- if the refrigerant is or contains an ozone-depleting substance, the phrase “ozone depleter.”

This label covers up information about the old refrigerant, and provides valuable details on the alternative and how it was used.

Remove Original Refrigerant

The original R-12 must be removed from the system prior to charging with the alternative refrigerant. This procedure will help prevent the contamination of one refrigerant with another. Refrigerants mixed within a system probably won’t perform properly and could damage the system. As mentioned above, this requirement means that no alternative can be used as a “drop in.”

Barrier Hoses

HCFC-22, a component in some alternative blend refrigerants, can seep out through traditional hoses. Therefore, when using these blends, you must ensure that the system is equipped with the less permeable “barrier” type hoses. These hoses must be installed if the system currently uses old, non-barrier hoses.

Compressor Shutoff Switch

Some systems have a device that automatically releases refrigerant to the atmosphere to prevent extremely high A/C pressures. When retrofitting any system with such a device to use a new refrigerant, you must also install a high-pressure shutoff switch. This switch will prevent the compressor from increasing the pressure to the point where the refrigerant is vented.

Venting any motor vehicle air conditioning (MVAC) refrigerant into the atmosphere is illegal. Therefore, technicians must recover all refrigerants and not release them into the atmosphere.

As of June 1, 1998, the EPA allows refrigerant blends used in motor vehicle air conditioning systems to be recycled, provided that the recycling equipment meets the Underwriters Laboratories (UL) Standard 2964.

Recycling equipment meeting this Standard should adequately remove oil, moisture and other impurities.

R-12 System Retrofitting Guidelines

- Use the proper safety gear when servicing MVAC systems
 - Determine the need to retrofit
 - Identify the current refrigerant
 - Determine the need for additional system repairs
 - Select the replacement refrigerant (the OEM recommendation is R-134a)
 - Check for non-compatible system components
 - Review EPA “use conditions” for the new refrigerant
 - Communicate recommendations to the customer
 - Completely recover all of the old refrigerant
 - Make any necessary system repairs
 - Replace non-compatible components
 - Install the specified type and amount of lubricant
 - Install a high pressure shut-off switch if required
 - Install the required service port adapters and ID label
- Evacuate the system
 - Charge the system with the correct amount of new refrigerant—usually 80% to 90% of the original R-12 charge level if using R-134a
 - Leak test the entire system
 - Performance test the system

EPA does not allow recycled blend refrigerants to be recharged into a vehicle other than the one from which it was removed. The only exception to this is for fleets of vehicles with a common owner. Recycled blend refrigerant may be moved among vehicles only within such a fleet.

Using a recycling machine designed to process R-12 or R-134a to recycle these alternative blends is not allowed. In accordance with the use conditions required under the Significant New Alternatives Policy (SNAP) program, the recovery/recycling equipment that is used must be dedicated to a specific refrigerant by permanently installing the fittings that are unique to that refrigerant.



Substitutes Acceptable Subject to Use Conditions for CFC-12 (class I ODS) in MVACs

SNAP-related information published in the *Federal Register* takes precedence over all information here.

Substitute (Name Used in the Federal Register)	Trade Name	Retrofit/ New
HCFC-22		R, N (Buses Only)*
HFC-134a		R, N
HFC-152a		N
R-406A	GHG, GHG-X3, GHG-12, McCool, Autofrost X3	R, N
GHG-X4, R-414A (HCFC Blend Xi)	GHG-X4, Autofrost, Chill-it, Autofrost X4	R, N
Small auxiliary power units that include an engine, electrical alternator, water pump, air conditioning compressor and a heat exchanger used in tractor trailers in conjunction with passenger compartment climate control systems that already use an acceptable substitute refrigerant.		R, N
Hot Shot, R-414B (HCFC Blend Omicron)	Hot Shot, Kar Kool	R, N
FRIGC FR-12, (HCFC Blend Beta), R-416A	FRIGC FR-12	R, N
Free Zone, (HCFC Blend Delta)	Free Zone / RB-276	R, N
Freeze 12	Freeze 12	R, N
GHG-X5	GHG-X5	R, N
GHG-HP (HCFC Blend Lambda)	GHG-HP	R, N
Ikon 12, Ikon A (Blend Zeta)	Ikon 12	R, N
SP34E	SP34E	R, N
Stirling Cycle		N
CO ₂		N
RS-24	RS-24	R, N
Evaporative Cooling		N
R-426A	RS-24	R, N

Key: R = Retrofit Uses, N = New Uses

* Refrigerated cargo areas and buses using HCFC-22 are not included in the definitions of "motor vehicle air-conditioners" or "motor vehicle-like air-conditioners" under EPA regulations for servicing of motor vehicle air conditioners.

For most recent information or updates, please visit: <http://www.epa.gov/ozone/strathome.html>



Unacceptable Substitute Refrigerants

Substitutes are reviewed on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is also available.

Note: SNAP Notices and Final Rules published in the *Federal Register* take precedence over all information here.

Unacceptable Substitutes for ODS in Refrigeration and Air Conditioning



Substitute (Name Used in the Federal Register)	ODS	End-uses	Reason
	Being Replaced		
All flammable refrigerants, including OZ-12® (Hydrocarbon Blend A), HC-12a® (Hydrocarbon Blend B), and Duracool 12a except HFC-152a in new MVACs	CFC-12	Motor vehicle air conditioning, retrofit and new	Lack of adequate assessment that characterizes incremental flammability risk
OZ-12® (Hydrocarbon Blend A), HC-12a® (Hydrocarbon Blend B), and Duracool 12a	CFC-12	All end-uses other than industrial process refrigeration, retrofit and new	Lack of adequate assessment that characterizes incremental flammability risk
R-141b	CFC-11	Centrifugal chillers, new	High ODP; other substitutes with lower overall risk have been identified
R-176 (R-176 contains CFC-12, HCFC-22, and HCFC-142b. It is a different product from RB-276, typically sold under the name "Free Zone.")	CFC-12	All end-uses, retrofit and new	Contains CFC-12
R-403B	R-502	All end-uses, retrofit and new	Contains a perfluorocarbon that exhibits extremely high GWP and very long lifetime
R-405A	CFC-12	All end-uses, retrofit and new	Contains a perfluorocarbon that exhibits extremely high GWP and very long lifetime
MT-31	all CFCs and HCFCs	All end-uses, retrofit and new	Toxicity of a constituent
Hexafluoropropylene (HFP) and blends containing it	all CFCs and HCFCs	All end-uses, retrofit and new	HFP is toxic
NARM-22	HCFC-22	All end-uses, retrofit and new	Contains HCFC-22
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 Retail Food Refrigeration; retrofit and new	Unacceptably high greenhouse gas emissions from direct release of refrigerant to the atmosphere

For most recent information or updates, please visit: <http://www.epa.gov/ozone/strathome.html>

Setting the Standards for Recovery and Recycling



The Society of Automotive Engineers (SAE) publishes various standards that apply to the recovery and recycling of refrigerant. Standards that apply specifically to R-12 refrigerant include J1770, J1989, J1990, J1991 and J2209. The EPA recognizes each of these standards in its final rules regarding Section 609 of the Clean Air Act.

Similar SAE standards also apply to the recovery and recycling of R-134a refrigerant. Specifically, these consist of J1770, J2099, J2197, J2210, J2211 and J2788. SAE standard J2788 supersedes the older J2210 standard. J2788 only applies to refrigerant handling equipment manufactured or imported after December 31, 2007.

Single-circuit machines use the same internal plumbing circuit to recover and recycle both R-12 and R-134a, and must meet SAE standard J1770. Dual-circuit machines of this type are not required to meet the SAE J1770 standard.

SAE standards J1990 (for R-12) and J2788 (for R-134a) address specifications for recovery and recycling equipment. For instance, the specifications of hardware-related items like hoses and filters are covered. The standards also state that service hoses must have shutoff devices located within 12 inches (30 cm) of the hose ends to prevent the unnecessary release of refrigerant when they are disconnected.

SAE purity standards for recycled R-12 and R-134a ensure that the refrigerants provide proper system performance and longevity. J1991 is a purity standard for recycled R-12 and specifies a limit, in parts per million (ppm) by weight, for three different contaminants: 1) moisture—15 ppm by weight, 2) refrigerant oil—4,000 ppm by weight, and 3) non-condensable gases (air)—330 ppm by weight.

In a similar sense, standard J2099 specifies the maximum levels of contaminants for R-134a: 1) moisture—50 ppm by weight, 2) lubricant—500 ppm by weight, and 3) non-condensable gases (air)—150 ppm by weight.

The EPA requires machines used for the recovery/recycling of R-12 and R-134a to be tested by an approved independent standards testing organization. The tests ensure that the recycled refrigerant meets the applicable SAE purity standard.

SAE standard J2209 states the requirements of equipment used for R-12 recovery-only. SAE standard J2810 states the requirements for equipment used for R-134a recovery only. Recovery-only equipment can't recycle refrigerant or recharge a system, but may be beneficial to some operations such as automotive salvage yards or service businesses with multiple outlets.



The Right Way to Recover Refrigerant

To keep the discharge of refrigerant to a minimum when recovering it, follow these guidelines outlined in SAE standards J1989 (R-12) and J2211 (R-134a).

1. The equipment hoses must have shutoff valves within 12 in. (30 cm) of the service ends. With the valves closed, connect the hoses to the vehicle's air conditioning service fittings.
2. Always follow the equipment manufacturer's recommended procedures for use. Recover the refrigerant from the vehicle and continue the process until the vehicle's system shows vacuum instead of pressure. Turn off the recovery/recycling unit for at least five minutes. If the system still has pressure, repeat the recovery process to remove any remaining refrigerant. Continue until the A/C system holds a stable vacuum for two minutes.
3. Close the valves in the recovery/recycling unit's service lines and disconnect them from the system's service fittings. On recovery/recycling stations with automatic shutoff valves, make sure they work properly. SAE standard J2211 offers the following additions to the recovery procedure:
 - Verify that the system has a refrigerant charge before recovery to prevent the recovery of non-condensable gases (air).
 - Evacuate the system to a minimum of 102mm (4 in. Hg.) vacuum.
 - If components show signs of icing during recovery, mild heat may be applied to ease the recovery process.
 - After the refrigerant is completely recovered, measure and replace any recovered oil with the same amount and type.



Among other hardware requirements, J2209 states, “The equipment discharge or transfer fitting shall be unique to prevent the unintentional use of extracted (recovered) R-12 to be used for recharging auto air conditioners.”

Recovery-only equipment that extracts a single, specific refrigerant other than R-12 or R-134a does not have to meet a specific SAE standard, but rather a standard formulated by EPA. This allows recovery-only equipment of this type to be tested and certified by UL or ETL. If an alternative blend refrigerant manufacturer sells equipment for that refrigerant, the equipment must have been tested by UL or ETL to meet EPA standards for use only with that particular alternative blend refrigerant.

The EPA allows the use of recovery-only equipment as long as: 1) the equipment meets the J2209 standard, 2) the recovery process is performed properly, and 3) the recovered refrigerant is sent to an off-site facility where the refrigerant is reclaimed, not recycled. Reclaimed refrigerant must meet a more stringent, like-new purity standard called ARI700-93, established by the Air Conditioning and Refrigeration Institute (ARI).

The EPA does provide an exception to mandatory reclaiming: Owners of multiple service facilities are allowed to recycle, rather than reclaim, recovered refrigerant. This does not apply to franchised organizations or chain stores.

Service hose specifications are covered under SAE standard J2196. Since R-134a is made up of smaller molecules than R-12, R-134a tends to leak through hoses easier than R-12. SAE addresses the difference between the two refrigerants by establishing different hose specifications for each of them.

Service hoses for R-12 will be marked “SAE J2196.” The low-side hose will be solid blue or black with a blue stripe; the high-side hose will be solid red or black with a red stripe. The utility hose will be either solid yellow or white, or black with a yellow or white stripe.

R-134a service hoses will be labeled “SAE J2196/R-134a.” These hoses will be color-coded as follows: solid blue with a black stripe for the low-side hose, solid red with a black stripe for the high-side hose, and solid yellow with a black stripe for the utility hose.

To minimize the chances of mixing R-12 and R-134a during service, SAE also specifies different fittings for service hoses. Standard J2197 requires hoses for R-134a service to have a 1/2-in.-16 ACME thread for connection to manifold gauges or recovery/recycling/recharging equipment. This is different than the 7/16-in.-20 fitting used on R-12 equipment.

The “business end” of R-134a service hoses can connect directly to a quick coupler that connects to the vehicle, or an optional M14 X 1.5 fitting can be used between the hose and quick coupler.

SAE standard J639 stipulates the different sizes of service fittings used on R-12 and R-134a systems. Unlike R-12 systems which typically use threaded service fittings for the high and low sides, R-134a systems use quick-coupler fittings without external threads. To ensure proper connection of service hoses, the high-side fitting has a 16mm O.D. and the low-side fitting has a 13mm O.D.

The most important SAE standards that affect you are J1989 (R-12) and J2211 (R-134a). Both standards establish guidelines for the correct use of recovery/recycling equipment when servicing automotive A/C systems.

Servicing A/C Systems With Manifold Gauges

If you choose to use manifold gauges during A/C service, observe the following to minimize refrigerant discharge:

1. Make sure the gauge’s hoses have shutoff valves within 12 in. (30 cm) of their service ends. The valves must be closed before removing them from an A/C system’s service fittings.
2. The shutoff valves must be closed at all times when the gauge hoses are not connected to an A/C system or charging source. This keeps the amount of refrigerant escaping into the atmosphere to a minimum and limits the amount of air entering the hoses.
3. After disconnecting the hoses (or before moving the gauge center hose to a device that cannot accept refrigerant), remove any remaining refrigerant from the hoses by connecting them to a recovery/recycling unit.



Checking Recycled Refrigerant Stored In Portable Containers

To make sure recycled refrigerant is ready for use, follow these steps and refer to the charts below:



1. To check for excess non-condensable gases (air), keep the container at 65°F (18.3°C) or above for at least 12 hours, out of direct sunlight.
2. Connect a pressure gauge, calibrated in 1-psi divisions (0.1 kg/cm²), to the container and read the pressure. A pressure gauge calibrated in kilopascals (kPa) can be used when checking recycled R-134a against its metric pressure chart.
3. Measure the air temperature within 4 in. (10cm) of the container with an accurate thermometer.
4. Compare the pressure to the charts. See if the pressure is at, or below, the limits shown.
5. If the pressure of the recycled refrigerant is lower than the limit shown for a given temperature, the refrigerant is OK to use as is.
6. If the refrigerant's pressure is higher than the limit shown for a given temperature, slowly vent the vapor from the top of the container into the recovery/recycling unit. Continue until the pressure falls below the limit shown in the charts.

NOTE: If the recycled refrigerant is R-134a, and the pressure still exceeds the limits in the charts below, shake the container and let it stand for several minutes. If the pressure then falls below the limits, it is OK to use.
7. Should the pressure inside the container still exceed the pressure limit shown, recycle the entire contents.

**Standard Temperature/
Pressure Chart for R-134a**

°F	PSI	°F	PSI	°F	PSI	°F	PSI	°F	PSI
65	69	77	86	89	107	101	131	113	158
66	70	78	88	90	109	102	133	114	160
67	71	79	90	91	111	103	135	115	163
68	73	80	91	92	113	104	137	116	165
69	74	81	93	93	115	105	139	117	168
70	76	82	95	94	117	106	142	118	171
71	77	83	96	95	118	107	144	119	173
72	79	84	98	96	120	108	146	120	176
73	80	85	100	97	122	109	149		
74	82	86	102	98	125	110	151		
75	83	87	103	99	127	111	153		
76	85	88	105	100	129	112	156		

**Metric Temperature/
Pressure Chart for R-134a**

°C	kPa	°C	kPa	°C	kPa
18	476	29	676	40	945
19	483	30	703	41	979
20	503	31	724	42	1007
21	524	32	752	43	1027
22	545	33	765	44	1055
23	552	34	793	45	1089
24	572	35	814	46	1124
25	593	36	841	47	1158
26	621	37	876	48	1179
27	642	38	889	49	1214
28	655	39	917		



Determining the Proper Refrigerant and Preventing Cross-Contamination

As a service technician, you need to be aware of the hazards involved when an A/C system becomes cross-contaminated. Simply put, cross-contamination means the system has been partially charged with refrigerant other than the type designated on the system information label.

If cross-contaminated, the A/C system can suffer reduced performance, damage from chemical breakdown, and lubrication problems. If a recovery/recycling machine is connected to a cross-contaminated system, the machine will have to be cleaned out and major components like filters and dehydrators will have to be replaced. Additionally, should a contaminated recovery/recycling machine be connected to other A/C systems before the problem is discovered, the cross-contamination can spread like a virus and infect other systems serviced by that equipment.

Unfortunately, a cross-contaminated system may be difficult to detect on-site. Electronic refrigerant identifiers are becoming a more common and affordable means of detecting refrigerant cross-contamination. Short of sending a sample to a lab, a refrigerant identifier may be your best protection against cross-contamination. SAE established the J1771 standard for refrigerant identification equipment. When claiming to meet this standard, manufacturers of identifier equipment are required to

label the unit, stating its level of accuracy.

If contaminated or unknown refrigerant is detected, it must be disposed of properly. The EPA prohibits venting of any automotive refrigerant into the atmosphere (including “unacceptable” refrigerants), no matter what combination of chemicals is in the refrigerant. The best way that you can recover contaminated or unfamiliar refrigerant is to dedicate a recovery-only unit to any refrigerant that cannot be positively identified.

Unknown refrigerant should be recovered into a standard DOT-approved, gray-with-yellow-top recovery tank. Make sure that you never fill a tank beyond 60% of its gross weighted capacity as specified in the SAE J1989 and J2211 standards. When storing this tank, check local ordinances that govern the storage of combustible or hazardous materials.

There are various ways to legally dispose of contaminated or unknown refrigerants. If you have a contract with a waste processor, contact them regarding disposal of the material. You may also want to contact one or more reclaimers, which will send the refrigerant off-site for either destruction or reclamation. Due to the expense involved with either procedure, be sure to investigate all expenses that may be incurred for processing the material.

Standard Temperature/ Pressure Chart for R-12

°F	PSI	°F	PSI	°F	PSI	°F	PSI	°F	PSI
65	74	75	87	85	102	95	118	105	136
66	75	76	88	86	103	96	120	106	138
67	76	77	90	87	105	97	122	107	140
68	78	78	92	88	107	98	124	108	142
69	79	79	94	89	108	99	125	109	144
70	80	80	96	90	110	100	127	110	146
71	82	81	98	91	111	101	129	111	148
72	83	82	99	92	113	102	130	112	150
73	84	83	100	93	115	103	132	113	152
74	86	84	101	94	116	104	134	114	154

Metric Temperature/ Pressure Chart for R-12

°C	kg/cm ²	°C	kg/cm ²	°C	kg/cm ²
18	5.2	28	7.0	38	9.0
19	5.3	29	7.1	39	9.2
20	5.5	30	7.2	40	9.4
21	5.6	31	7.5	41	9.6
22	5.8	32	7.7	42	9.9
23	6.0	33	7.9	43	10.0
24	6.1	34	8.1	44	10.4
25	6.3	35	8.3	45	10.7
26	6.6	36	8.5	46	10.9
27	6.8	37	8.7	47	11.0



The EPA maintains a list of refrigerant reclaimers. Order “Refrigerant Reclaimers” through the Ozone Protection Hotline or the EPA website.

The best defense against cross-contamination is a program of prevention. The first step before servicing any A/C system is to find out the vehicle’s service history, if possible. If the vehicle has been to several shops to cure a mysterious A/C problem, be extremely wary.

Next, inspect the service fittings for signs of tampering. Makeshift or damaged fittings could be another clue that the system has been cross-contaminated. Finally, refuse to service the vehicle if your inspection makes you suspicious about the system’s refrigerant charge.

To reduce the likelihood of cross-contamination, vehicle manufacturers equip their R-12 and R-134a A/C systems differently. To determine the correct refrigerant for the system you’re servicing, look for a name plate, tag or label with the words, “CAUTION—SYSTEM TO BE SERVICED BY QUALIFIED PERSONNEL.” This plate can be found under the hood, near an A/C system component not normally replaced during routine service. Look on the plate, tag or label for the specific type and charge of refrigerant to be used, as well as the correct type of lubricant.

Service fittings are another way of distinguishing R-12 from R-134a systems. R-12 systems typically have threaded fittings for both the high and low sides. R-134a systems have quick-coupler style fittings for both the high and low sides with no external threads.

Used R-134a Refrigerant From Non-Mobile Sources

Since EPA regulations prevent the venting of all refrigerants, your sources for refrigerant may include “used” refrigerant. Because R-134a is used in applications other than motor vehicles, there is a potential for used refrigerant to be from a non-MVAC source. This introduces the possibility that used refrigerant could contain contaminants different from those that may exist in MVAC systems. These contaminants, which may not be removed by the normal MVAC recycling process, may cause damage to MVAC systems, and also to your MVAC recovery and recycling equipment. Never use MVAC recovery and recycling equipment to remove refrigerant from

non-MVAC systems. Also, do not charge non-MVAC refrigerant into an MVAC system unless the refrigerant is first reclaimed by an EPA-certified facility to meet the “like new” purity standard ARI-700-93, established by the Air Conditioning and Refrigerant Institute (ARI).

Your Customer Has Options

It’s wise to advise your customer of the economy of a leak-free system. Leak repair often pays for itself in the long run by avoiding repeated “top-offs” of increasingly expensive refrigerant. Although this is sound advice, you should never imply that leak repair is required under federal law. To do so would constitute consumer fraud. In most areas of the country, customers can simply choose to have their systems “topped-off,” if they desire.

Some state and local jurisdictions, however, do require that all leaks be repaired. For example, Wisconsin; parts of California; Colorado; Austin, Texas and Albuquerque, New Mexico, have regulations in place that supersede the federal requirements. For complete details, check with your state or local agencies.

Locating and Repairing MVAC System Refrigerant Leaks

A low refrigerant charge often contributes to insufficient MVAC cooling. Although federal law does not require a leaking system to be repaired prior to charging, consumers often choose the economy of system repair. Leak repair is also the most environmentally responsible action. Finding and repairing MVAC system leaks represents a high percentage of MVAC service work.

You have two primary tools to choose from when performing the essential task of leak detection. Probe-type electronic leak detectors are most popular, and SAE Standard J2791 establishes minimum performance requirements for detectors used on MVAC systems that contain R-134a refrigerant. Among these requirements is a minimum of three leak-detection scales that you can manually select: (1) 4 grams (0.141 oz) per year; (2) 7 grams (0.247 oz) per year; and (3) 14 grams (0.494 oz) per year. J2791 also requires the detector manufacturer to supply a list of common underhood chemicals that will cause “false-triggering” of the detector. Older R-12 electronic leak detectors are not as accurate or sensitive as detectors that meet SAE Standard J2791.

SAE Standard J1628 establishes “Best Practices” procedures for using electronic leak detectors meeting the SAE Standard J2791 requirements. The SAE J1628 Standard states that you should:

- Leak test when the system is not operating.
- Ensure that the MVAC system static charge pressure is at least 50 psi (340 kPa), and that ambient system temperature is a minimum of 59° F (15° C).
- Perform a visual inspection of the system, locating potential leaks by the accumulation of system lubricant or by visible hose/line damage.
- Continue to check the entire system, even if one leak is detected.
- Check the service valves with the caps in place, and also with the caps removed.
- Maintain a distance of 3/8 in. (9.5mm) between the detector probe and the surface being checked, and move the probe at a speed no faster than 3 inches (75mm) per second.
- Use the 7 grams (0.247 oz) per year setting to retest a leak found on the 4 grams (0.141 oz) setting to help determine if the leak is of a repairable size.
- Leak test an evaporator core by operating the A/C system blower on the high setting for a minimum of 15 seconds. Turn off the blower, and wait at least 13 minutes for any potential leaking refrigerant to accumulate in the evaporator case. Next, insert the leak detector probe into the blower motor resistor block opening, or the evaporator condensate drain hole (provided no moisture is present — it could damage the probe’s sensing tip), or the closest duct opening to the evaporator.
- Leak test the service ports and also the repair area after a repair is performed.

You may also use fluorescent dyes to detect leaks in MVAC systems. These dyes glow when exposed to ultraviolet (UV) “black” light, and since they circulate inside the system with the refrigerant and lubricant, dye residue will accumulate at the point of any leak. SAE Standard J2297 establishes standards for stability and compatibility of fluorescent dyes for use in mobile R-134a systems.

Fluorescent dye leak-detection “starter kits” are available from a number of manufacturers, and normally include the dye, a tool used to inject the dye into the system, and a UV “black” light to detect leaks. Suppliers of leak-detecting dyes meeting SAE Standard J2297 requirements must provide underhood labels you can use to indicate that fluorescent dye was installed and to identify the dye manufacturer. The label must also state: “Caution— System to be Serviced by Qualified Personnel”.

There are additional SAE Standards relating to fluorescent dyes. SAE Standard J2298 covers the procedures for using leak detection dyes, and SAE Standard J2299 establishes the standards for the performance of leak-detection dye injection equipment.

General warnings and cautions for the use of leak-detecting dyes include:

- **Warning!** Ultraviolet light is hazardous if eyes and skin are exposed over time. Ultraviolet light exposure should be minimized by wearing UV-blocking eyewear, always directing the light source away from one’s body, and protecting bare skin.
- **Caution!** Any dyes used must be either expressly endorsed by the A/C system and/or vehicle manufacturer, or meet the requirements of SAE J2297.

To follow the “Best Practices” outlined in the SAE Standard J2298 for using leak-finding dyes, you should:

- Use only dyes that meet the SAE J2297 Standard.
- Before injecting dye, check the engine compartment for a sticker indicating that dye is already installed. An alternate method is to remove the low side service port cap and depress the valve stem for an instant to determine if dye is in the system. If dye is present at the low-side service port, proceed to check for leaks.
- Add dye as per the manufacturer’s instructions, provided that no dye was previously added to the system.



- Place the identification label supplied by the dye manufacturer in a prominent place in the engine compartment, near the A/C charge label if possible.
- Verify that the A/C system has sufficient refrigerant as per factory specifications, then operate the system for a minimum of 15 minutes to circulate the dye.
- Inspect the entire A/C system with an ultraviolet lamp with the engine not operating.
- Trace the entire refrigerant system, concentrating on areas that are leak-prone, such as hose-to-line couplings, service ports, etc. Check for evaporator leaks by illuminating the condensate drain hole. Only large leaks may be detected at this stage, due to the limited length of time the dye has been allowed to accumulate at any leakage site. If a leak cannot be found, ask the customer to return in a week or more after operating the A/C system as much as possible. This extended operating time should cause sufficient dye to collect at the leak site, allowing detection.
- Continue to check the rest of the system if a leak is found, as other leaks may be present.
- Verify any small leak by using an electronic leak detector as per SAE Standard J1628 to determine whether the leak is of a repairable size as defined by the vehicle or MVAC system manufacturer. Some compressor shaft seal lubricant leakage may be normal for the system in question.
- Remove any fluorescent residue using a cleaner approved by the vehicle or MVAC system manufacturer after the leak is repaired.

Although the use of fluorescent dyes is widespread in the MVAC service industry, some OEM manufacturers may prohibit using dyes in their systems, and others only permit specific dyes to be used. Therefore, you should always service vehicles following the manufacturer's recommendations.

Finishing the Job

Locating leaks is the first part of the service job, but stopping the leaks is what keeps refrigerant out of the atmosphere, and also makes for happy customers. Correctly repairing leaks depends on a number of factors relating to where the leak is located and

which components are leaking. If you replace a component, you should verify correct system lubricant levels, lubricate fitting "O" rings before installing, tighten fittings and connection-flange bolts to manufacturer's recommended torque specifications, and always check for leaks after you recharge the system.

Replacing and Repairing MVAC Hoses

SAE Standard J2064 covers refrigerant hose and hose assemblies for R-134a systems. This includes requirements for labeling, hose dimensions, materials, construction, permeation rates, burst strength, connection integrity, and the required testing procedures. Be sure to use hose components labeled as being compliant with J2064.

Since refrigerant leaks often come from MVAC hose and hose-to-fitting connections, effective repair and replacement of these components helps to keep refrigerant out of the atmosphere. Research shows that approximately 50% of leaking hose assemblies are replaced with a complete new assembly, but the rest are repaired/replaced using hoses assembled at the point of vehicle service.

The switch from CFC-12 to R-134a refrigerant required a change in the components of MVAC hoses. R-134a systems use "barrier" style hose to minimize refrigerant leakage. This type of hose requires special fittings with smaller "barbs" at the hose connection to prevent damage to the barrier layer of the hose. Barrier hose fitting connections require a different type of crimp than CFC-12 connections, so suitable crimping equipment is necessary.

"Reduced barrier" hose used first for heavy truck applications, represents the latest barrier hose technology available for use in automobiles. Reduced barrier hose has the same inside diameter as conventional MVAC barrier hose, but has a smaller outside diameter. This type of hose requires its own crimping equipment and methods.

To create reliable hose assemblies, first ensure the compatibility of the MVAC hose, fittings, ferrules, crimping dies and equipment. Start by measuring the inside and outside diameter of the hose, and then the inside diameter of the ferrule to ensure these items match. Also, measure the length of the ferrule to make sure it's correct, and verify that the diameter of the fitting is correct for the hose size. Do not "double-crimp" fittings because you can



cause fitting distortion and leaks. Always follow the manufacturer's instructions for the products and equipment that you are using, and contact the manufacturer of the equipment, or your parts supplier, if you have any questions about compatibility.

Properly Charging MVAC Systems

- **Warning!** Never attempt to add refrigerant to the high-pressure side of an operating MVAC system! Doing so could result in excessive pressure being transferred from the MVAC system into the charging apparatus, causing possible severe bodily injury!
- **Caution!** When servicing MVAC systems, always work in a well-ventilated area, away from sparks or open flame. Wear eye protection at all times, and wear gloves to protect the skin whenever handling chemicals, including refrigerants and refrigerant oils.

Today's MVAC systems use smaller refrigerant capacities than the systems of just a few years ago. Proper design ensures that these lower-capacity systems will perform well, but cooling performance can decrease dramatically if the refrigerant charge level is not correct. An over-charged system will produce higher-than-normal operating pressures, causing reduced cooling and possible system damage. Systems that are low on refrigerant also exhibit reduced cooling, and may suffer component damage from lack of lubrication, because the refrigerant in MVAC systems circulates the lubricant. A seemingly small amount of additional or missing refrigerant can have a significant impact on system performance.

The first step in accurate MVAC system charging involves determining the manufacturer's refrigerant charge specification. This information is usually found in the capacities section of the vehicle Owner's Manual, on the MVAC identification label located in the vehicle engine compartment, or in technical resources such as service manuals or online service information.

There are instances when simply finding the charge amount is not enough because some vehicle manufacturers list MVAC refrigerant capacities in ounces, and some list them in pounds and tenths of pounds. You can use these methods to convert the system capacity listing to match the measurement units of your charging equipment.

- If the refrigerant charge specification of the system is listed in *ounces*, and the charging equipment is calibrated in *pounds*, *divide* the system capacity by 16 to convert from ounces to pounds.
 1. Example: The system capacity is 28 ounces.
 $28 \text{ oz.} \div 16 = 1.75 \text{ lbs. (0.794 kg)}$.
- If the refrigerant charge specification of the system is listed in *pounds and tenths of pounds*, and the charging equipment is calibrated in *ounces*, *multiply* the system capacity by 16 to convert from pounds to ounces.
 1. Example: The system capacity is 2.25 pounds.
 $2.25 \text{ lbs.} \times 16 = 36 \text{ oz (1020 g)}$.
- If the refrigerant charge specification of the system is listed in *pounds and ounces*, and the charging scale is calibrated in *ounces* only, *multiply* the total number of whole pounds by 16, then *add* the number of additional ounces to arrive at the total system capacity in ounces.
 1. Example: The system capacity is 1 pound, 12 ounces. $1 \text{ lb.} \times 16 = 16 \text{ oz}$. Then $16 \text{ oz.} + 12 \text{ oz.} = 28 \text{ oz. (794 g)}$ total system capacity.
- To convert *tenths of a pound into ounces*, *multiply* each *tenth of a pound* by 16 to arrive at the total ounces represented.
 1. Example: Convert 4/10 of a pound into ounces.
 $0.4 \text{ lbs.} \times 16 = 6.4 \text{ oz. (181 g)}$.
- To convert *ounces into tenths of a pound*, *divide* the number of ounces by 16 to arrive at the tenths of pounds.
 1. Example: Convert 8 ounces into tenths of a pound. $8 \text{ oz.} \div 16 = 0.5 \text{ lbs. (0.227 kg)}$.
- If the refrigerant charge specification is listed in *grams*, and the charging equipment is calibrated in *ounces*, *multiply* the system capacity by .0353 to convert grams to ounces.
 1. Example: Convert 600 grams into ounces.
 $600 \text{ g} \times .0353 = 21.18 \text{ oz}$.
- If the refrigerant charge specification is listed in *kilograms*, and the charging equipment is calibrated in *pounds*, *multiply* the system capacity by 2.20 to convert kilograms to pounds.
 1. Example: Convert 1.5 kg into pounds. $1.5 \text{ kg} \times 2.205 = 3.307 \text{ lb}$.



After you determine the required charge level for the MVAC system, make sure that the correct amount of refrigerant actually enters the system being serviced. Since the charge level accuracy is so critical with smaller capacity MVAC systems, OEM vehicle manufacturers often specify that systems should be charged by weight, using an accurate scale or other device. Charging equipment scales may lose calibration, so the equipment manufacturers require regular calibration checks. One calibration method would be to place a static weight of known value on the scale to verify the scale reading. Recalibration may also be as simple as pressing the “reset” button to zero the scale. Information on the testing frequency, and the methods for verifying accuracy are usually included in the operating instructions for the equipment, or you can contact the equipment manufacturer.

Before charging an empty MVAC system, the industry standard procedure calls for placing the system in a vacuum, using the appropriate equipment. This removes air and moisture so that the refrigerant encounters a minimum amount of contamination, ensuring good cooling performance.

It’s wise to partially charge the system to a pressure of at least 50 psi (340 kPa), so that you can leak check any serviced fittings or connections before proceeding. If all is good, continue to charge the system to the recommended capacity, and test system performance before you return the vehicle to the customer.

Play it Safe

Whenever you service air conditioning systems or operate recovery/recycling equipment, wear safety goggles, follow common shop safety practices, and follow all manufacturers’ instructions for equipment operation. In addition, **NEVER:**

- mix R-134a with air for the purpose of leak testing. If the mixture contains enough air and is under pressure, the mixture could ignite if it contacts a source of ignition.
- breathe A/C refrigerant, nor the mist or vapor from the system lubricant. This can cause irritation to the eyes, nose, and throat.
- use a disposable refrigerant tank for storing recycled refrigerant.

- transfer refrigerant into another tank unless it is DOT approved (look for DOT-4BA or DOT-4BW on the tank).
- fill a storage tank to more than 60% of its gross weight rating.
- handle any chemical, including refrigerant, without first consulting its MSDS (material safety data sheet).
- attempt to use any piece of equipment until you are fully trained to do so.
- service the recovery/recycling equipment (other than routine filter changes) without first consulting authorized service personnel.
- use electrical equipment in which switches are not at least 18 inches above the floor.
- use extension cords that are worn, frayed, have a lighter gauge than 14 AWG, or are any longer than necessary.
- use two-wire ungrounded extension cords.
- use a pigtail-type grounding adapter to circumvent the ground circuit of an extension cord.

On the Horizon

The change from R-12 to R-134a during the middle 1990’s was driven by the fact that the chlorine contained in R-12 depleted the earth’s stratospheric ozone layer. R-134a, while not ozone depleting, is identified as a “greenhouse” gas (GHG). Gasses in this category are believed to be a potential cause of climate change, and are assigned a “Global Warming Potential” (GWP) factor, based on the level of impact they may have. The lower the rating on the GWP scale, the less effect on climate change. The GWP rating for R-134a is 1300, and this relatively high GWP rating encouraged engineers to explore alternative systems and refrigerants. Three main contenders emerged.

R-152a has a GWP of 120 to 140, which is approximately 90% lower than R-134a. This refrigerant, used in various manufacturing processes for some time, is not a newly developed chemical. The advantages of R-152a include its compatibility with current MVAC system technology and materials, and operating pressures that are slightly less than R-134a. Also, due to a maximum operating pressure of 435 psi (30 bar), service procedures and service equipment design would not need to

change dramatically. R-152a is considered to be flammable under certain conditions, so safeguards to protect vehicle passengers are necessary and are already developed.

HFO-1234yf carries a GWP rating of 4 and shows promise as an alternative to R-134a for a couple of reasons. First, HFO-1234yf's performance most closely matches that of R-134a. This may reduce manufacturing conversion costs, because key system components need little redesign. Second, HFO-1234yf has the lowest overall impact on global warming. Although HFO-1234yf has a higher GWP than some other likely alternatives, it takes less fuel to power an MVAC system charged with HFO-1234yf. The resulting reduction in CO₂ emissions more than offsets HFO-1234yf's somewhat higher GWP, therefore resulting in the lowest impact on global warming.

R744 (Carbon Dioxide, or CO₂) has a GWP of 1, which is the lowest GWP rating of any available refrigerant, and serves as the baseline for the GWP rating system. CO₂ was used in some of the earliest refrigeration systems, so its performance characteristics are well understood. R744 systems have found favor with the European Union (EU) and are already in use to provide residential climate control, operating in air conditioners and heat pumps, while also having the potential to heat domestic water.

Development of MVAC systems using R744 has not been as rapid, but a number of European OEM vehicle manufacturers, as well as MVAC system manufacturers, have developed prototype systems.

The advantages of R744 MVAC systems include using refrigerant with the lowest GWP rating, smaller/lighter components, and lower charge levels than current R-134a systems. Other benefits include reduced direct and indirect greenhouse gas (GHG) emissions, rapid cooling capability, and the potential to provide rapid heat and defrost functions. However, since R744's maximum operating pressure of 1920 psi (133 bar) is much higher than R-134a, you will need special training and different equipment to service R744 systems. R744 displaces oxygen, so the suffocation risk to vehicle passengers has been addressed for vehicles designed to use this refrigerant.

A global decision has not been made on future MVAC systems, but most stakeholders agree that the selection of one global refrigerant offers the best solution. European Union regulations banning the use of refrigerants with a GWP rating of over 150 take effect in 2011, and seem to be driving the decision-making process. Whatever the final result, servicing MVAC systems of the future will require, as always, that you stay current with rapidly changing technology.





Storage Containers for Recycled Refrigerant

1. Use only DOT CFR Title 49 or UL-approved containers for recycled refrigerant. Look for DOT-4BA or DOT-4BW on the tank as proof. Containers are color-coded based on refrigerant type. R-12 containers are white as opposed to R-134a containers, which are sky blue. Refrigerant should never be collected, salvaged or stored in a disposable container.
2. Before any container of recycled refrigerant may be used, it must be checked for non-condensable gases (air). See the section titled “Checking Recycled Refrigerant in Portable Storage Containers” for the proper method.



Transferring Recycled Refrigerant

1. Use only containers meeting DOT approval and evacuate the container to at least 27 in. Hg vacuum (75mm Hg absolute pressure) before transferring the refrigerant.
2. To prevent overfilling during the transfer of refrigerant, never fill a container to more than 60% of its gross weight rating. (For example, 18 lb. in a 30 lb. container and 30 lb. in a 50-lb. container.)



Evacuating Disposable Refrigerant Containers

1. Disposable containers that appear to be empty still have traces of refrigerant in them. Remove all remaining refrigerant before disposing of the container.
2. Connect the recovery/recycling unit to the container and remove the remaining refrigerant. Once the container shows a vacuum rather than pressure, close its valve. Mark the container EMPTY and dispose of it in the trash.



Will You Be Ready for the Future?

Change is one thing that's certain in today's automotive repair and service industry. Staying ahead of all the developments isn't easy.



Did you know that ASE can help? Yes, ASE.

ASE tests are *relevant*—they are real-world, always have been.

ASE tests are *comprehensive*—they cover all major areas of auto, medium/ heavy truck, bus, collision, and engine machinist repair and service.

ASE tests are *current*—they are continually updated to include the latest technology.

ASE tests are *diagnostic*—they pinpoint areas of strength and weakness by means of a personalized score report mailed to each registered test taker.

Remember, the future is closer than you think...



*The Blue Seal
of Excellence*

National Institute for
**AUTOMOTIVE
SERVICE
EXCELLENCE**

Contact ASE for specific test dates.

For a Registration Booklet, call or write: ASE, 101 Blue Seal Drive S.E., Suite 101, Leesburg, VA 20175 • 703-669-6600

Register online: www.ase.com



National Institute for
**AUTOMOTIVE
SERVICE
EXCELLENCE**

101 Blue Seal Drive S.E.
Suite 101
Leesburg, VA 20175

www.ase.com



Printed on recycled paper.

Q1722PE (06/09)