



SURFACE VEHICLE INFORMATION REPORT

SAE J2219 AUG2011

Issued 1991-09

Stabilized 2011-08

Superseding J2219 JUL2011

Mobile Air Conditioning Industry Criteria and Guidelines

RATIONALE

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1. **Scope**—The purpose of this SAE Information Report is to provide information on refrigerant issues of concern to the mobile air-conditioning industry.

2. **References**

2.1 **Applicable Publications**—The following publications form a part of this document to the extent specified herein. Specific detail information shall be obtained from the appropriate SAE document. The latest issue of SAE Publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1.1 *Service Activities*

SAE J639—Safety and Containment of Refrigerant for Mechanical Vapor Compression Systems used for Mobile Air Conditioning Systems

SAE J1629—Cautionary Statements for Handling HFC-134a During Mobile Air Conditioning Service

SAE J2196—Service Hose for Automotive Air Conditioning

SAE J2197—HFC-134a Service Hose Fittings for Automotive Air Conditioning Service Equipment

2.1.1.2 *Technician Service Procedures*

SAE J1628—Technician Procedure for Using Electronic Refrigerant Leak Detectors for Service of Mobile Air Conditioning Systems

SAE J1629—Cautionary Statements For Handling HFC-134a

SAE J1989—Recommended Service Procedure for Containment of R12

SAE J2211—Recommended Service Procedure for Containment of HFC-134a

2.1.1.3 *Service Equipment*

SAE J1627—Rating Criteria for Electronic Leak Detectors

SAE J1990—Extraction and Recycle Equipment for Mobile Automotive Air Conditioning Systems

SAE J1991—Standard of Purity for use in Mobile Air Conditioning Systems

SAE J2209—CFC-12 Extraction Equipment for Mobile Air Conditioning Systems

SAE J2210—HFC-134a Recycling Equipment for Mobile Air Conditioning Systems

SAE J2099—Standard of Purity for Recycled HFC-134a for use in Mobile Air Conditioning Systems

SAE J1732—HFC-134a Extraction Equipment For Mobile Air Condition Systems

SAE J1770—Automotive Refrigerant Recycle Equipment for Multiple Refrigerants (R12/R134a)

SAE J1771—Refrigerant Identifiers

2.1.1.4 System Components

SAE J51—Automotive Air Conditioning Hose

SAE J2064—R134a Refrigerant Automotive Air Conditioning Hose

2.1.1.5 Retrofit Documents

SAE J1657—Selection Criteria for Retrofit Refrigerants to Replace R12 in Mobile Air Conditioning Systems

SAE J1658—Alternate Refrigerant Consistency Criteria for Use in Mobile Air Conditioning Systems

SAE J1659—Vehicle Testing Requirements for Replacement Refrigerants for use in R12 Mobile Air Conditioning Systems

SAE J1660—Fittings and Labels for Retrofit or R12 Mobile Air Conditioning Systems to R134a

SAE J1661—Procedure for Retrofitting R12 Mobile Air Conditioning Systems to R134a

SAE J1662—Material Compatibility With Alternate Refrigerants

2.2 Other Publications

1990 Federal Clean Air Act, Section 608 and 609

ARI Standard 700-93

3. CFC-12 Phase Out—CFCs have been shown to be detrimental to the Earth's ozone layer which acts to shield the Earth from the sun's harmful ultraviolet rays. In response to this threat, the United Nations was successful in bringing about an international agreement, known as the Montreal Protocol, to phase-out the production of all CFCs. In the United States, the Clean Air Act of 1990 and action by President Bush, supported the Montreal Protocol by calling for an accelerated phase-down that started in 1991 with full production ban on December 31, 1995. It is legal to sell and use CFC-12 for servicing mobile air conditioning systems until supplies are no longer available.

3.1 CFC-12 Shortages Predicted—The phase-down will result in progressively less refrigerant being available for service. This will mean that shortages in the supply of CFC-12 will occur in the 1990s. Vehicle OEMs were fully aware of this situation and worked both to conserve the available supply of CFC-12 and to deal effectively with retrofitting vehicles with R134a refrigerant when appropriate.

3.1.1 The Federal government imposed a tax on the sale of new CFCs. The tax amount has increased each year and new product in inventory, in excess of 400 pounds, is subject to a floor stock tax at the time of each increase.

NOTE—Recycled refrigerant from mobile air conditioning systems is not taxable.

3.2 Federal Clean Air Act Section 609—Effective July 14, 1992, prohibit the release of CFC-12 and HCFC refrigerants during service of mobile air conditioning systems. Recycle of HFC-134a used in mobile air conditioning systems is required during air conditioning system service effective November 15, 1995.

3.2.1 Some larger road vehicles, such as buses, that use HCFC-22 for cooling systems or refrigerant systems for cargo are not covered under the automotive requirements and must comply with Section 608 Type II technician certification. Speciality vehicles such as off-road and farm equipment that use automotive type air conditioning systems that are identified under Section 608 must follow the service requirements identified under Section 609 to be in compliance.

- 3.2.2 The intent of SAE "J" standards is to assure that the recycled refrigerant used in servicing mobile air conditioning systems provides a purity that will not affect the performance, operation, and warranty of the system. In SAE J1991 (R12) and J2099 (R134a) purity specifications, the document states "the refrigerant in this document shall have been directly removed from, and intended to be returned to, a mobile air conditioning system." The purity specification of reclaimed R12 or R134a refrigerant supplied in containers from other sources, for service of mobile air-conditioning system, shall meet the appropriate ARI Standard 700 (which is an industry purity standard for refrigerants).
- 3.2.3 The SAE documents J1989 and J1990 are referred to in Section 609 of the Federal Clean Air Act, and also in many state and local laws.
- 3.3 Equipment Certification**—Certified recycle equipment is required by the Clean Air Act to meet SAE J1990 standard.
- 3.3.1 Equipment Certification must include a label stating "design certified for compliance with the appropriate SAE J document," (e.g., SAE J1991 (R12) or SAE J2099 (R134a)).
- 3.3.2 Equipment that has safety certification, such as Underwriters Laboratories "UL," does not mean it is in compliance with SAE requirements. The equipment must also have SAE J1991 certification to comply with the Clean Air Act.
- 3.4 HFC-134a The New OEM Refrigerant**—The auto industry selected HFC-134a, which is non-ozone depleting, for new vehicle production starting with 1992 models. The new HFC-134a system phase-in was completed in 1994.
- 3.4.1 The OEMs have established the necessary procedures and service information for maintaining these HFC-134a Systems.
- 3.4.2 SAE documents also cover service, containment, and recycle requirements for HFC-134a systems.
- 4. Refrigerant Recycling Required**—SAE, in conjunction with Environmental Protection Agency (EPA) and the auto industry, developed documents covering servicing procedures of mobile systems. These include service procedures, recycle equipment specifications, and standard of purity for recycled refrigerants.
- 4.1 Service Equipment**
- 4.1.1 The mobile air conditioning industry has established performance certification requirements for recycle and extraction equipment and purity requirements for recycle equipment. Use of certified ARI-740 equipment cannot be used to service mobile air conditioning systems unless it complies with SAE refrigerant purity requirements, or Section 609 of The Clean Air Act requirements.
- 4.2** This group of SAE documents address equipment and purity requirements for both R12 and R134a refrigerants.
- 4.2.1 SAE J1990—EXTRACTION AND RECYCLE EQUIPMENT FOR MOBILE AUTOMOTIVE AIR CONDITIONING SYSTEMS—This covers equipment certification for recycling CFC-12 to meet the standard of purity.
- 4.2.2 SAE J2209—CFC-12 EXTRACTION EQUIPMENT FOR MOBILE AIR CONDITIONING SYSTEMS—This covers equipment certification for removal of CFC-12 from mobile A/C systems that shall be sent off-site for process to meet the appropriate ARI 700 purity level.
- 4.2.3 SAE J2210—HFC-134a RECYCLING EQUIPMENT FOR MOBILE AIR CONDITIONING SYSTEMS—This covers equipment certification for recycling of HFC-134a to meet the standard of purity.

- 4.2.4 SAE J1732—HFC-134a EXTRACTION EQUIPMENT FOR MOBILE AIR CONDITIONING SYSTEMS—This covers equipment certification for removal of HFC-134a from mobile A/C systems that shall be sent off-site for process to meet the appropriate ARI 700 purity level.
- 4.2.5 SAE 1770—AUTOMOTIVE REFRIGERANT RECYCLE EQUIPMENT FOR MULTIPLE REFRIGERANTS—(R12/R134a)—Equipment that recycle both R12 and R134a using common refrigerant circuits must meet the requirements of SAE J1770 to assure maximum allowable levels of cross contamination in the recycled refrigerants.

5. **Purity of Refrigerant**

- 5.1 **SAE J1991—Standard of Purity for use in Mobile Air Conditioning Systems**—This identifies the purity level of recycled R12 refrigerant after a contaminated sample has been processed in accordance with SAE J1990.
- 5.1.1 PURITY OF RECYCLED REFRIGERANT—SAE J1991 standard of purity states, "the refrigerant in this document shall have been directly removed from, and intended to be returned to, a mobile air conditioning system. Purity specification of reclaimed R12 refrigerant supplied in containers from other sources, for service of mobile air conditioning systems, shall meet ARI Standard 700-93."
- 5.1.2 With many other uses of CFC-12 it is important that the source of the refrigerant be known. Since CFC-12 is used in systems, such as refrigerators, water chillers, and central cooling systems, other contaminants and acids can be present.
- 5.1.3 Use of recycle equipment that meets SAE J1990 requirements may not purify the other used sources of CFC-12 to meet mobile air conditioning purity requirements.
- 5.1.4 CFC-12 from any source, other than a mobile air conditioning system, should not be used unless it has been returned to a reclamation facility that can return the purity to ARI 700-93 specification.
- 5.1.5 Use of refrigerant from other sources that contains acids and other contaminants, as well as a possible mixture of other refrigerants, will cause problems in mobile air conditioning systems.
- 5.2 **SAE J2099—Standard of Purity for Recycled HFC-134a for use in Mobile Air Conditioning Systems**—This identifies the purity level of recycled refrigerant after a contaminated sample has been processed in SAE J2210.
- ## 6. **Technician Service Procedures**
- 6.1 Two documents provide technician service procedures when servicing mobile air conditioning systems using R12 and R134a refrigerants.
- 6.2 **SAE J1989—Recommended Service Procedure for Containment of R12**—This document covers the technician refrigerant recovery procedure when servicing R12 mobile air conditioning systems and identification of excess NCGs.
- 6.3 **SAE J2211—Recommended Service Procedure for Containment of HFC-134a**—This document covers the technician refrigerant recovery procedure when servicing HFC-134a mobile air conditioning systems and identification of excess NCGs.
- ## 7. **System Service**—The design of systems affects the amount of time required to extract all of the refrigerant prior to opening the system for repair.

- 7.1 Systems using an accumulator require special attention, additional time and precautions. When refrigerant is removed during extraction from accumulator systems, the low system pressure results in the accumulator becoming very cold with external frost sometimes being in evidence.
- 7.2 Since the accumulator contains both lubricant and refrigerant, a large quantity of refrigerant will remain in the system until the system has equalized. Until the accumulator reaches the temperature of the surrounding area it will continue to outgas refrigerant.
- 7.3 Since both the lubricant and refrigerant are at this condition, venting and safety are of concern. If the liquid refrigerant has not been completely removed and the refrigerant lines are opened, as the accumulator warms a sudden release of the mixture can occur.
- 7.4 Use of external heat sources will raise the pressure in the accumulator and reduce the extraction time. **At no time should an open flame torch be used.**
- 7.5 All the refrigerant must be removed before opening any of the system refrigerant connections.
- 7.6 SAE J1989 and J2211 provide procedures to assure that the refrigerant has been extracted from the mobile air conditioning system.
8. **Service Procedures**—The SAE documents J1989 (R12) and J2211 (R134a) provide guidelines for containment and assurance that all the refrigerant has been removed from the system during service activity.
- 8.1 **Refrigerant Containing Noncondensable Gases (Air)**—If recycled refrigerant contains noncondensable gases (air) in excess of the allowable amount, high system operating pressure will occur, resulting in loss of performance and possible system damage.
- 8.2 Properly operating recycle equipment will remove excess air, provide the maximum level of allowable air in recycled refrigerant, and provide recycled refrigerant ready for use.
- 8.3 Verification for excess noncondensable contents in auxiliary portable containers of recycled refrigerant is important. Proper procedure to assure correct noncondensable level is outlined in SAE J1989 (R12) and SAE J2211 (R134a).
- 8.3.1 If the container contains excess air, as identified in the procedures in 8.3, it should be completely recycled.
- NOTE—Only "DOT" refillable certified containers should be used.
9. **System Lubricant Charge**—It is important that system lubricant charge be maintained to assure proper system operation.
- 9.1 Component replacement should follow guidelines supplied by the manufacturer for lubricant addition during system service.
- 9.2 In general, recycle equipment will remove very little, if any, lubricant from the air conditioning system during the extraction operation. Design of refrigerant extraction/recycle equipment requires that the amount of lubricant removed during refrigerant removal be measured.
- 9.3 The removed lubricant must not be reused in the system. If air conditioning system lubricant addition is required only new lubricant, as specified by the manufacturer, should be added.
- 9.4 Used lubricant should be disposed of in accordance with local, state, and Federal laws.

- 9.5** Removal of a large quantity of lubricant during extraction may be an indication that the air conditioning system has been overcharged with lubricant.
- 9.6** Closed circuit power flushing to establish proper system lubricant level may be required. (SAE J1661)
- 9.7** If in doubt, refer to the system manufacturer service manual to assure proper lubricant charge.
- 9.8** If the measured lubricant sample, removed during the extraction operation, contains refrigerant dissolved in the lubricant, replacing this amount may result in replacement of excess new lubricant causing system overcharge.
- 10. Service Activities**—When servicing the refrigerant system use of eye protection is required.
- 10.1 SAE J1629**—Cautionary Statements for Handling HFC-134a During Mobile Air Conditioning Service are identified.
- 10.1.1** Avoid breathing air conditioning refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose, and throat. **To remove HFC-134a from air conditioning system, use service equipment certified to meet the requirements of SAE J2210.**
- 10.1.2** Do not pressure test or leak test HFC-134a service equipment and/or vehicle air conditioning systems with compressed air. Some mixtures of air and HFC-134a have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage.
- 10.2 Service Tools**—Service equipment including recycle equipment, hoses, and gauge manifolds must be used with only one refrigerant. Use of equipment on systems with different refrigerants will result in contamination caused from refrigerant and lubricant residue in the lines being charged directly to the system and equipment.
- 10.3 SAE J2196—Service Hose for Automotive Air Conditioning**—This defines service equipment (gauge lines), hose emission rates, hose construction requirements, and appropriate markings.
- 10.4 SAE J2197—HFC-134a Service Hose Fittings for Automotive Air Conditioning Service Equipment**
- 10.4.1** To prevent mixing of HFC-134a, with other refrigerants, an 1/2 in Acme thread fitting for containers was developed by the "Compressed Gas Association" (CGA) for small cans and 30 pound containers. This 1/2-in Acme thread is also required on HFC-134a automotive service equipment and a 14 mm hose fitting to prevent cross contamination between refrigerants.
- 10.5 Flushing of Systems**—The past practice of open flushing systems with CFCs such as CFC-11 and CFC-12 can no longer be continued because Federal and local laws prohibit venting of CFCs to the atmosphere. For many years, R11 and R113 have been used for open vent flushing when cleaning mobile air conditioning systems. Technical information indicates that even small amounts of R11 residue will cause problems when used in conjunction with HFC-134a systems.
- 10.5.1** Methylchloroform (1,1,1 trichloroethane) is also covered by the Montreal Protocol phase-out and should not be considered for flushing.
- 10.5.2** Use of recycle equipment with adapters for closed loop power flushing of the system can provide containment, remove lubricant, and clean the refrigerant. Verify equipment capability with the manufacturer.
- 10.5.3** Due to small refrigerant passages within air conditioning system components (evaporator/condenser refrigerant circuits) flushing may not remove failed compressor material from some system components. Some A/C system manufacturers recommend that flushing not be considered after mechanical failure. The use of an in-line filter is considered the more effective method of containing the failed particles.

- 10.5.4 Use of other flushing solvents are areas of concern since, depending on the boiling point, the vacuum pump may not remove the solvent which will remain in the system, possibly affecting the chemical stability of the refrigerant for future use and the vehicle air conditioning system. In addition, safety concerns for flushing material that have low-flash temperatures can become flammable under normal conditions.
- 10.5.5 The use of flushing solvents, and procedures not approved by the air conditioning system manufacturer, may affect system seals and O-rings, remain in the system, and may result in future system failures.
- 10.5.6 To power flush a separate part or the complete system, the flushing equipment must be in series with the portion which is being flushed. Attaching to the system at the gauge service ports, even with the valve cores removed will not provide adequate system flushing. Using this method will result in the flushing being confined to the system's lowest pressure circuit and may not result in the removal of material.
- 10.5.7 Due to the complex air conditioning system chemical stability concerns SAE has not established documents for system flushing requirements, other than using the system refrigerant (R12 or R134a) as a flushing media.

NOTE—Use only specified equipment and refrigerant when servicing mobile air conditioning systems to prevent contamination. Do not use CFC-11 or CFC-12 for flushing HFC-134a systems.

- 11. Leak Detection Devices**—To assure that serviced systems are returned to original design intent leakage specification, leak detection devices should be used. Proper use of leak detection equipment is important since leaks may occur in locations that are not directly visible to the technician.
- 11.1 Electronic Detectors**—Some electronic leak detectors will only indicate when subjected to CFC-12 and will not indicate on HFC-134a. Newer design electronic detectors will provide leakage identification of both refrigerants. The detector manufacturer can verify the type of refrigerant that the unit will identify.
- 11.2 SAE J1627—Rating Criteria for Electronic Leak Detectors**—This document establishes the criteria for electronic leak detectors to identify refrigerant leaks.
- 11.3 SAE J1628—Technician Procedure for Using Electronic Refrigerant Leak Detectors for Service of Mobile Air Conditioning Systems**—This document provides guidelines for the technician when using an electronic leak detector in determining a system refrigerant leak.
- 11.4** Leaks can be identified when the system pressure is at least 50 psig. This system pressure can be achieved with a refrigerant charge in the range of 7 to 15% of the total system charge amount. The system does not require a complete charge for leak identification.
- 11.5** Proper use of the detector, as identified by the manufacturer, is important in determining the system leak.
- 11.5.1** To keep systems from chemical contamination, it is recommended that leak detection be done only with the refrigerant which is specified for the system. Use of "shop air" for leak detection introduces both air and moisture into the system. Use of other gases having higher pressures, such as nitrogen, can result in system damage (e.g., evaporator failure) and may contaminate the lubricant.
- 11.6 Trace Dyes**—The chemical composition and amount of trace (leak) dyes when injected in mobile air conditioning systems may cause problems. Trace dyes cannot identify the degree of leakage, as compared to the requirements of electronic leak detection devices.
- 11.7** Leak dyes should not be added to any mobile air conditioning system unless the specific product has been approved by the "OEM" system manufacturer.
- 11.8** SAE guidelines for trace dyes are being developed.

12. General Service

12.1 Correct air conditioning system refrigerant charge amounts should be used when servicing to maintain proper system operation. Use of electronic and mechanical measurement devices dispensing refrigerant should periodically be checked. It should also be noted that some governmental agencies require certification of the equipment when selling products by weight or volume.

12.2 Refrigerant Handling/Identification to Prevent Cross Contamination

12.2.1 There is no "drop in" refrigerant for retrofitting existing CFC-12 systems approved to date by the air conditioning system manufacturers.

12.3 Refrigeration Identification—With "trademark" refrigerant products in the marketplace it is important that the refrigerant container be verified for containing the proper refrigerant (R12/R134a) prior to use in mobile air conditioning systems.

12.4 System Identification—Only two refrigerants, CFC-12 and HFC-134a, are considered acceptable by both the auto manufacturers and the EPA Significant New Alternatives Policy "SNAP" program for use in passenger and truck mobile air conditioning systems that have been specifically designed, or modified, for each refrigerant. To distinguish CFC-12 from HFC-134a, different system service fittings, labels, and refrigerant containers have been provided. (Some bus systems use HCFC-22 for the refrigerant charge.)

12.4.1 Other refrigerants have been identified as environmentally acceptable replacements for CFC-12 under the EPA Significant New Alternatives Policy "SNAP" rule. This "SNAP" listing identifies the acceptable chemical composition; however, the EPA "SNAP" program did not test these refrigerants for performance, operation, or durability in mobile air conditioning systems.

12.5 Requirements in SAE J639 establish service fittings for CFC-12 and HFC-134a mobile air conditioning systems. CFC-12 systems use screw threads and HFC-134a systems use a quick couple design. Additional requirements include a system label that list the type and amount of refrigerant, and the type of lubricant required.

12.6 Containers of HFC-134a, for automotive use, have a unique fitting or hose connection and a light blue color (PMS 2975) for identification.

12.7 To prevent system cross contamination, SAE J2196 and J2197 require fittings and markings identifying HFC-134a service hoses, recycle equipment, and service gauge manifolds.

13. Consequences of Cross-Contamination

13.1 Mixing of Refrigerants

13.2 Under no circumstance should refrigerants be mixed either in a system or in recovery/recycle equipment since it will affect recycle programs and may cause equipment and system damage.

13.2.1 Damage can include compressor failure, damage to recycle equipment, and transfer of the mixed refrigerant to other vehicles causing additional problems.

13.3 With two acceptable refrigerants in the service sector, it is important that CFC-12 and HFC-134a not be mixed in a system. Use of other refrigerants can cause additional system and service equipment problems.

13.3.1 Use of hydrocarbon refrigerants may result in safety concerns including system operation, service equipment, and the technician.

13.3.2 Refrigerants containing CFCs or HCFCs can not be vented and require specific recovery and recycle equipment. These hydrocarbon or blend combination refrigerants must meet SAE J1657 requirements.

13.4 If CFC-12 and HFC-134a are mixed in the same system, increased pressures of up to 25% can occur resulting in loss of performance and system damage.

13.5 It is essential that the service technician use only the OEM recommended refrigerant and service equipment to make sure refrigerant mixing does not occur.

13.6 Recycle equipment that has been contaminated will identify that the refrigerant container contains excess NCGs (air) due to the higher pressure of the mixed refrigerants. Equipment having automatic NCG purge may vent the entire tank due to this pressure. On manual systems, if indicated gauge pressure is higher than NCG value, the container should be considered as being contaminated refrigerant. Refrigerant contamination levels in the 2% to 5% range may indicate pressure readings in the same range as identification for NCGs.

13.7 Use of refrigerants other than identified for the system during "top off" service activities, which is not a recommended service procedure, will not improve system performance, and may cause system damage.

13.8 With the concern regarding contaminated mobile air conditioning systems and refrigerant supplies SAE developed J1771 "Refrigerant Identification" equipment requirements.

14. **Desiccant Failure**—It has been determined that use of a new receiver/accumulator containing XH5 desiccant (originally used for R12 systems) breakdown may occur in an R134a refrigerant system, resulting in expensive system failure. When air conditioning system desiccant replacement is required XH7 or XH9 type or equivalent should be used for either R12 or R134a systems.

15. **Lubricants**

15.1 Current CFC-12 systems use mineral-based lubricants.

15.2 HFC-134a systems use several types of PAG lubricants and proper type and amount is important. The system label will identify the type of lubricant required.

15.3 The compressors have been developed by each manufacturer to use a specific lubricant and use of other lubricants may affect compressor operation, durability, and warranty. Use only the lubricant specified by the manufacturer since mixing of PAG lubricants may also cause system problems.

15.4 Polyalkylene Glycol (PAG) lubricants absorb moisture so air conditioning systems, during servicing, and containers of new lubricant should be kept closed to reduce moisture entry.

15.5 Lubricants used in R134a systems should be handled with care to prevent skin contact by using impervious gloves. If skin contact should occur, wash the material off with plenty of soap and water.

15.6 Lubricant contact may also cause damage to painted surfaces, plastic parts, and other vehicle components.

15.7 Coating at installation of O-rings and seals with mineral oil can be done since this small amount will not affect the system. This will also reduce the possibility of connector corrosion due to the PAGs absorbed moisture.

16. **Recommendations for Retrofitting CFC-12 Systems to a Non-CFC Refrigerant**—The world auto air conditioning manufacturers have selected HFC-134a as the replacement refrigerant for new vehicles, and for retrofitting the CFC-12 fleet. It is recommended that CFC-12 systems continue using CFC-12 until it is no longer available. These systems were designed to operate with CFC-12 and the system manufacturers have considered the necessary system modifications to retrofit them to HFC-134a. The industry will provide information, where applicable, on retrofitting a CFC-12 vehicle to use HFC-134a.