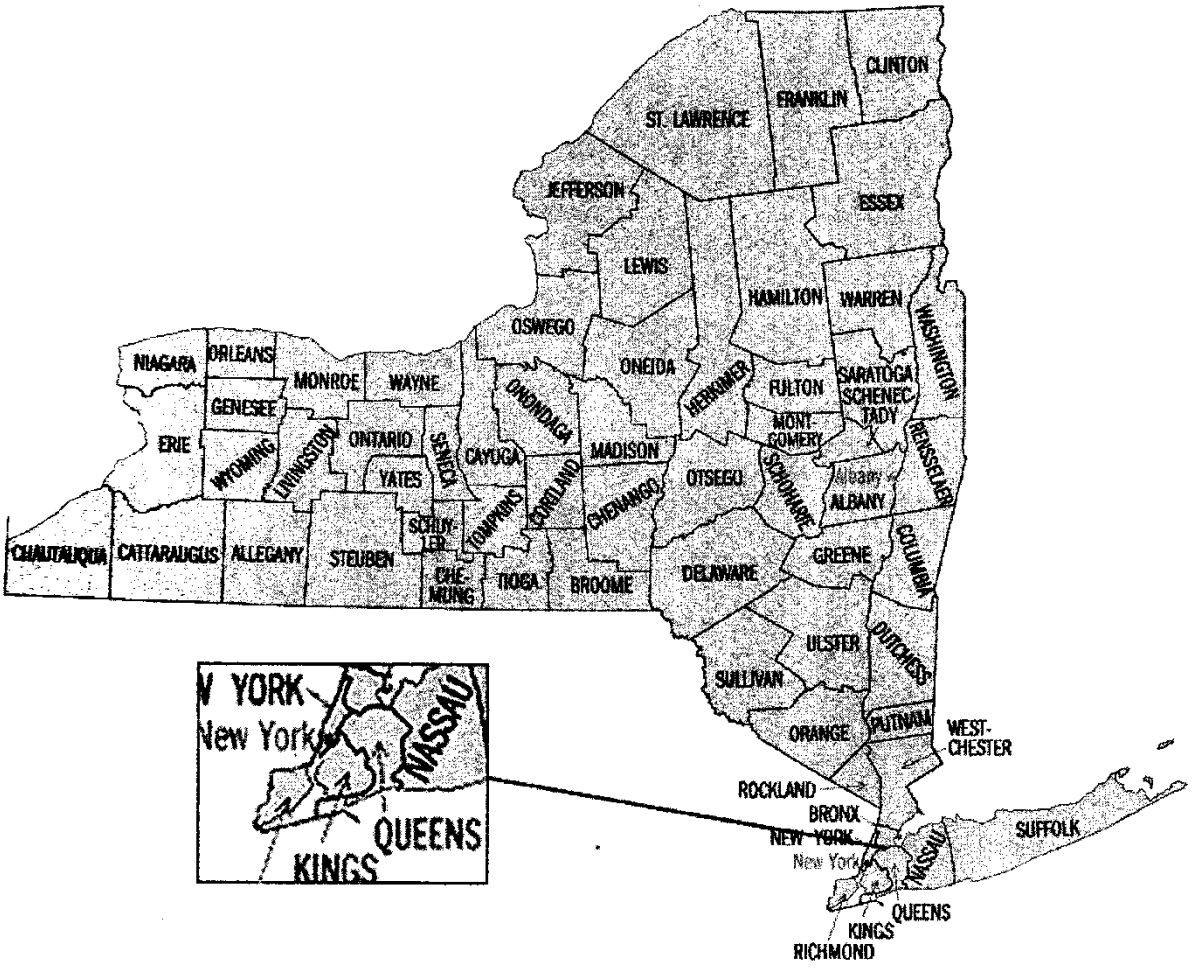
SECTION 609
TECHNICIAN TRAINING AND CERTIFICATION PROGRAM

Presented by:

THE NEW YORK STATE ASSOCIATION OF SERVICE STATIONS and REPAIR SHOPS, Inc.



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New York State Association Of
Service Stations And Repair Shops, Inc.

Ralph Bombardiere
Executive Director
New York State Association
Of Service Stations &
Repair Shops

In 1955 the United States Congress passed the Air Pollution Control Act of 1955. Many states had already passed legislation dealing with air pollution. The language of this bill identified air pollution as a national problem and determined that steps needed to be taken to improve air quality and make people aware of this environmental hazard.

Congress passed the Clean Air Act of 1963 which dealt with reducing air pollution by setting emissions standards for stationary sources such as power plants and steel mills. Amendments to the Clean Air Act were passed in 1965 through 1969 which authorized the Secretary of Health, Education and Welfare (HEW) to set standards for, among other things, auto emissions. It also authorized research on low emissions fuels and automobiles.

The Clean Air Act of 1970 was a major revision setting more demanding standards for ambient air quality, new limits on emissions from both stationary and mobile sources and increased funds for air pollution research.

The Montreal Protocol Substances That Deplete the Ozone Layer is a landmark international agreement designed to protect the stratospheric ozone layer. The treaty was signed in 1987 and amended in 1990, 1992, 1997, and 1999. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere – chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform – are to be phased out by 1996 (2005 for methyl chloroform). Scientific theory and evidence suggest that, once emitted to the atmosphere, these compounds could significantly deplete the stratospheric ozone layer that shields the planet from damaging UV-B radiation.

Due to growing environmental concerns the Clean Air Act was revised in 1990 to address five major concerns: air quality standards, motor vehicle emissions and alternative fuels, toxic and pollutants, acid rain, and stratospheric ozone depletion.

One of the major contaminants that scientists have identified is chlorofluorocarbons or as we call them R12/Freon. Scientists have determined that when R12 is released into the atmosphere it rises to the stratosphere where the chlorine atoms are released. The chlorine atoms than eats away at the ozone layer causing a depletion that allows ultraviolet rays to hit the earth causing cancer and damage to wildlife and crops.

In an effort to control the release of R12 into the atmosphere the United States Environmental Protection Agency with authority from the Clean Air Act required the elimination of the use of R12, and its replacement, and guidelines for the automotive industry for the capturing, recycling, and removal of R12 from automobile air conditioning systems.

In it's regulations, EPA mandated that every technician working on an automobile air conditioning system must be certified. Recent changes to the regulations include hydrochlofluorocarbns (HCFC's) and hydroflourocarbons (HFC's) in these requirements.

To accommodate EPA's requirement, and to provide a service to our members, the New York State Association of Service Stations and Repair Shops developed a course that was approved by EPA. Passing this course provides technicians with the certification to purchase a host of refrigerants and to repair automobile air conditioning systems.

This booklet serves as a training vehicle to receive the certification. The technician must read and understand each item addressed in the booklet. After the booklet has been read and understood, and the certification included in the booklet has been filled out, there is a forty question test that the technician must complete. The completed certification and test answer sheet must be sent to the Gasoline Retailers Association of New York at 6 Walker Way, Albany, New York 12205. A check in the amount of $15.00 ($30 for non-members) made payable to the New York State Association of Service Stations and Repair Shops must also be included. Once the test is graded, and the technician passes, the certification card and certificate will be mailed to the technician within two to three weeks. This is proof that you have completed and understood the necessary course that will permit you to purchase refrigerants and to repair automobile air conditioning systems.

The fines for non-compliance are heavy. Technicians must be certified or they are not permitted to work on automobile air conditioning systems.

If you have any questions please contact the Association office at 518 452-4367.

U.S EPA A/C CERTIFICATION MVAC
STUDENT COMPLETION RECORD

Course Date (MM) (DD) (YY

Certified Inspector Number

First Name Middle Initial

Last Name

Social Security or Alien Registration Number Birthdate (MM) (DD) (YY

Address – Number, Street, Apt.

City State Zip Code

County Code County Name ( ) - Home Telephone Number

MVAC

0 : 1 : 0

5 : 7 : 4

: :

NYSASSRS, Inc. (GRANY)
Agent Name

RALPH BOMBARDIERE
Instructor Name

Assistant or Co-Instructor Name

Business Name or Employer Name

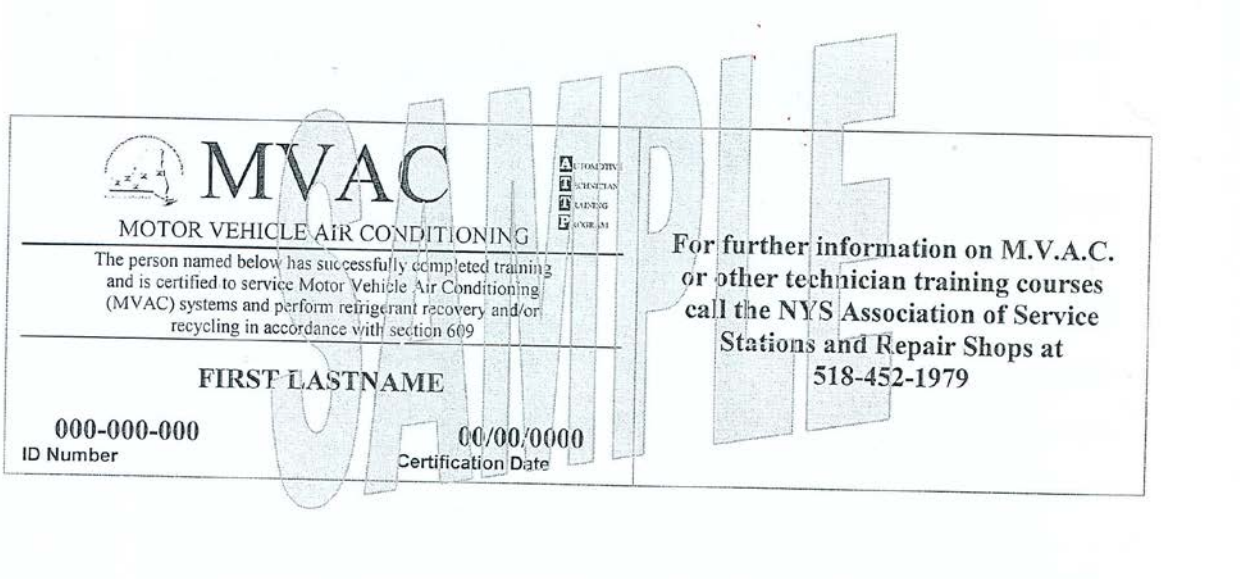
Address – Number, Street

City State Zip Code

( ) -
Business Telephone Number

(FOR DMV USE ONLY) **MVAC Test Score: _____**

Carefully print all information requested. This information is used to produce your MVAC certification card.



Upon submission of the completed certification and the successful passing of the test enclosed in this booklet, the above card will be mailed to the address indicated on the certification.

Keep this card in a safe place as it is your proof of having completed the section 609 motor vehicle air conditioning course approved by the United States Environmental Protection Agency. With this card you can legally purchase refrigerants and repair air conditioning systems attached to a motor vehicle engine.

This card is good for as long as you are in the industry. The Administrator reserves the right to specify the need for technician recertification at some future date, if necessary..

MVAC RECOVER, RECOVER/RECYCLE OR RECOVER/RECYCLE/RECHARGE EQUIPMENT CERTIFICATION FORM

1 _____
NAME OF ESTABLISHMENT

_____
STREET

_____
CITY, STATE, ZIP CODE

_____
TELEPHONE NUMBER

2 _____
NAME OF EQUIPMENT MANUFACTURER & MODEL NUM

_____
SERIAL NUMBER(S) YEAR

3 I certify that I have approved recover, recover/recycle, or recover/recycle/recharge equipment under Section 609 of the Clean Air Act. I certify that only properly trained and certified technicians operate the equipment and that the information given above is true and correct.

_____
SIGNATURE OF OWNER/OPERATOR DATE

_____
NAME (PRINT) TITLE

SEND THIS FORM TO THE EPA REGIONAL OFFICE LISTED UNDER YOUR STATE OR TERRITORY IN WHICH THE ESTABLISHMENT IS LOCATED.

MAILING ADDRESSES CAN BE FOUND ON THE REVERSE SIDE OF THIS FORM.

MVAC RECOVER, RECOVER/RECYCLE OR RECOVER/RECYCLE/RECHARGE EQUIPMENT CERTIFICATION FORM INSTRUCTIONS

Motor vehicle refrigerant recover, recover/recycle, or recover/recycle/recharge equipment must be acquired by January 1, 1992 and certified to EPA on or before January 1, 1993 under Section 609 of the Clean Air Act. To certify your equipment, please complete the above form according to the following instructions and mail to the appropriate EPA region based on where your establishment is located.

1 Please provide the name, address, and telephone number of the establishment where the equipment is located.

2 Please provide the name brand, model number, year and serial number(s) of the equipment acquired for use at the above establishment.

3 The certification statement must be signed by the person who has acquired the equipment (the person may be the owner of the establishment or another responsible officer). The person who signs is certifying that they have acquired the equipment, that each individual authorized to use the equipment is properly trained and certified, and that the information provided is true and correct.

40 CFR 82.40 - Technician training and certification.

Any technician training and certification program may apply for approval.. Each program must provide adequate training, through one or more of the following means: on-the-job training, training through self-study of instructional material, or on-site training involving instructors, videos or a hands-on demonstration. Certification tests must adequately and sufficiently cover the following:

- The standards established for the service and repair of MVACs and MVAC-like appliances These standards relate to the recommended service procedures for the containment of refrigerant, extraction equipment, extraction and recycle equipment, and the standard of purity for refrigerant in motor vehicle air conditioners.
- Anticipated future technological developments,
- The environmental consequences of refrigerant release and the adverse effects of stratospheric ozone layer depletion.
- As of August 13, 1992, the requirements imposed by the Administrator under section 609 of the Act.

Completed tests must be graded by an entity or individual who receives no benefit based on the outcome of testing; a fee may be charged for grading. Sufficient measures must be taken at the test site to ensure that tests are completed honestly by each technician. Each test must provide a means of verifying the identification of the individual taking the test. *Students seeking certification will be required to present to the proctor a copy of a valid state or federal picture ID. The proctor will be the owner or manager of the repair shop the test taker works for. If the person seeking certification is the owner or manager they may ask the owner or manager of another shop to proctor the exam. In either case both the proctor and the student must provide a Xerox copy of their ID an sign the test paper.*

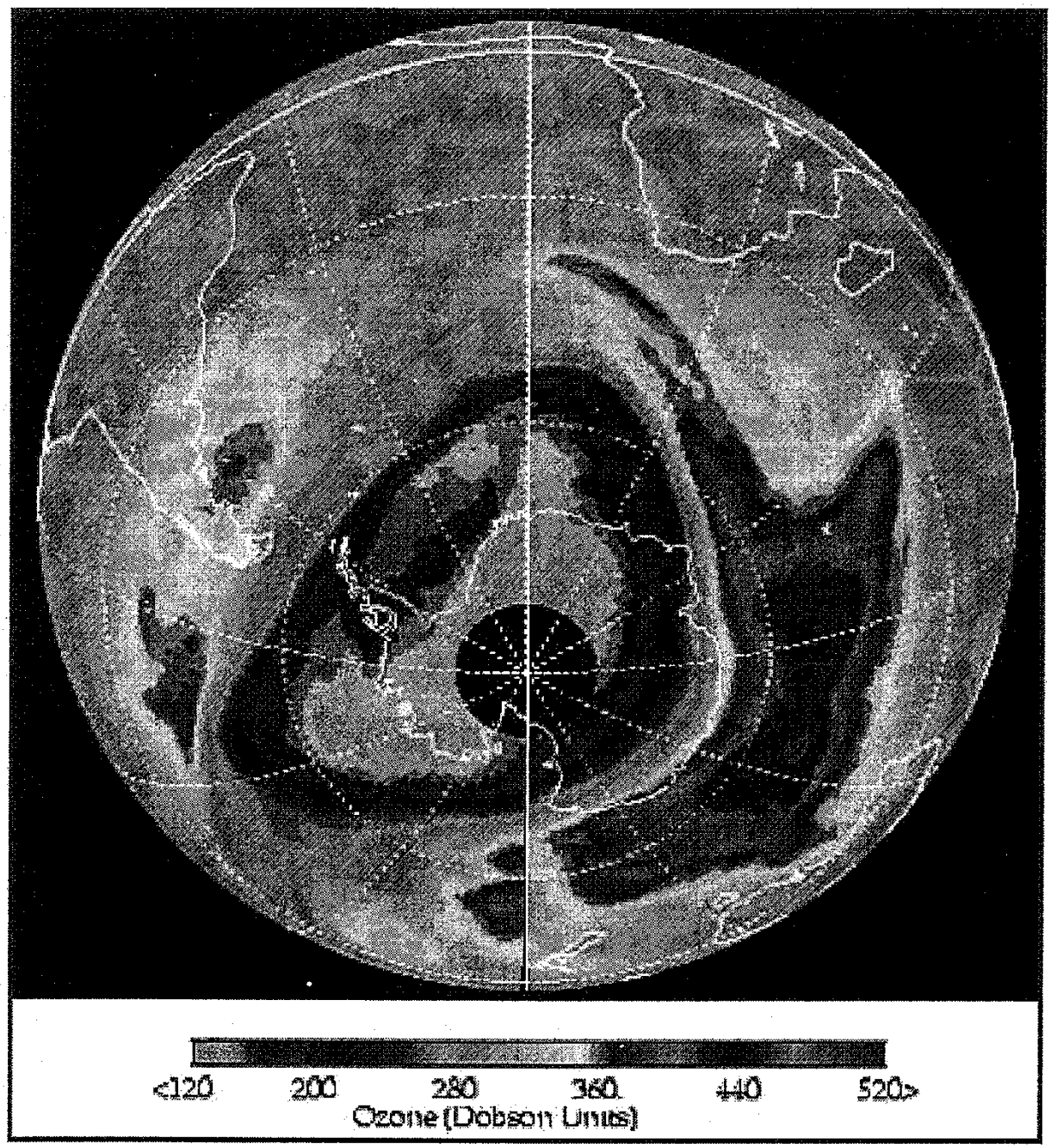
Proof of certification. Each certification program must offer individual proof of certification, such as a certificate, wallet-sized card, or display card, upon successful completion of the test. Each certification program must provide a unique number for each certified technician. *We will provide a wallet sized card as certificate.*

Technical revisions. Directors of approved certification programs must conduct periodic reviews of test subject material and update the material based upon the latest technological developments in motor vehicle air conditioner service and repair. A written summary of the review and any changes made must be submitted to the Administrator every two years.

Recertification. The Administrator reserves the right to specify the need for technician recertification at some future date, if necessary.

Authorized representatives of the Administrator may require technicians to demonstrate on the business entity's premises their ability to perform proper procedures for recovering and/or recycling refrigerant. *Failure to demonstrate or failure to properly use the equipment may result in revocation of the technician's certificate by the Administrator*. Technicians whose certification is revoked must be recertified before servicing or repairing any motor vehicle air conditioners.

OZONE DEPLETION PROCESS



The illustration represents what the ozone hole looks like. Chlorine atoms from refrigerants eat away at the ozone cover and have opened a hole that allow ultra-violet rays to strike the earth.

The Connection Between Ozone Layer Depletion and UVB Radiation

Reductions in stratospheric ozone levels will lead to higher levels of UVB reaching the Earth's surface. The sun's output of UVB does not change; rather, less ozone means less protection, and hence more UVB reaches the Earth. Studies have shown that in the Antarctic, the amount of UVB measured at the surface can double during the annual ozone hole. Another study confirmed the relationship between reduced ozone and increased UVB levels in Canada during the past several years.

Effects on Human Health

Laboratory and epidemiological studies demonstrate that UVB causes nonmelanoma skin cancer and plays a major role in malignant melanoma development. In addition, UVB has been linked to cataracts -- a clouding of the eye's lens. All sunlight contains some UVB, even with normal stratospheric ozone levels. It is always important to protect your skin and eyes from the sun. Ozone layer depletion increases the amount of UVB and the risk of health effects.

EPA uses the Atmospheric and Health Effects Framework (AHEF) model to estimate skin cancer cases and deaths avoided by protecting the ozone layer. EPA's peer-reviewed report, released July 30, 2010, shows that AHEF now has the capability to model avoided cataract cases. These results showed preliminarily estimates of more than 22 million additional new cataract cases avoided for Americans born between the years 1985 and 2100.

Effects on Plants

Physiological and developmental processes of plants are affected by UVB radiation, even by the amount of UVB in present-day sunlight. Despite mechanisms to reduce or repair these effects and a limited ability to adapt to increased levels of UVB, plant growth can be directly affected by UVB radiation.

Indirect changes caused by UVB (such as changes in plant form, how nutrients are distributed within the plant, timing of developmental phases and secondary metabolism) may be equally, or sometimes more, important than damaging effects of UVB. These changes can have important implications for plant competitive balance, herbivory, plant diseases, and biogeochemical cycles.

Effects on Marine Ecosystems

Phytoplankton form the foundation of aquatic food webs. Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity. The position of the organisms in the euphotic zone is influenced by the action of wind and waves. In addition, many phytoplankton are capable of active movements that enhance their productivity and, therefore, their survival. Exposure to solar UVB radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms. Scientists have demonstrated a direct reduction in phytoplankton production due to ozone depletion-related increases in UVB. One study has indicated a 6-12% reduction in the marginal ice zone.

Solar UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development. Even at current levels, solar UVB radiation is a

limiting factor, and small increases in UVB exposure could result in significant reduction in the size of the population of animals that eat these smaller creatures.

Effects on Biogeochemical Cycles

Increases in solar UV radiation could affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically-important trace gases e.g., carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulfide (COS) and possibly other gases, including ozone. These potential changes would contribute to biosphere-atmosphere feedbacks that attenuate or reinforce the atmospheric buildup of these gases.

Effects on Materials

Synthetic polymers, naturally occurring biopolymers, as well as some other materials of commercial interest are adversely affected by solar UV radiation. Today's materials are somewhat protected from UVB by special additives. Therefore, any increase in solar UVB levels will therefore accelerate their breakdown, limiting the length of time for which they are useful outdoors.

To address the depletion in the stratospheric ozone layer an international conference was called known as the Montreal Protocol.

Alternate Refrigerants

CFC-and other hydrofluorocarbons have global warming potentials in varying amounts. These Global Warming Potentials (GWP) are relative to that of CO2, and were assigned in the IPCC Fourth Assessment Report: Climate Change 2007 (AR 4). They are displayed in the following table:

Environmental Impacts of MVAC Refrigerants		
Refrigerant	Global Warming Potential	Ozone Depleting
CFC-12	10,900	Yes
HFC-134a	1,430	No
HFC-152a	124	No
HFO-1234yf	4	No
CO_2 (R-744)	1	No

Thus we see that although HFC-134a has the advantages of not being Ozone Depleting it still has 12 times the global warming potential of HFC 152a and 350 that of HFO-1234yf and therefore is not very desirable as a refrigerant. CFC12 has a global warming potential almost 7 times higher and also is ozone depleting and is therefore to be used in only a few instances.

Because of the deleterious effects it is illegal to knowingly vent or release refrigerants (except CO2)

Environmental Impact of Motor Vehicle Air Conditioners

(see **https://www.epa.gov/sites/production/files/2015-08/documents/section_609_of_the_clean_air_act_motor_vehicle_air_conditioning.pdf**

Older model MVACs used CFC-12 (also known by trade names, such as Freon®). When CFCs leak from MVACs into the atmosphere, strong radiation in the atmosphere will break the molecules apart and release chlorine atoms, each of which can destroy over 100,000 ozone molecules.

MVACs can have serious impacts on climate. For example, the global warming potential (GWP) of CFC-12 is approximately 10,000 times greater than that of carbon dioxide (CO2), a greenhouse gas that contributes to climate change. Currently, most MVACs use HFC-134a (also known as R-134a), a refrigerant that does not deplete the ozone layer, but has a GWP that is approximately 1,400 times greater than CO2. Alternative refrigerants such as CO2 and hydrofluoroolefin (HFO)-1234yf do not deplete the ozone layer and have much lower GWPs than CFC- 12 or HFC-134a. CO2 has a GWP of 1 and HFO-1234yf has a GWP of 4. MVACs alone represent about 15% of the global use of HFCs.

Because of the potential damage that refrigerants can do to the environment, Section 609 of the Clean Air Act (CAA) directs EPA to establish requirements to prevent the release of refrigerants during the servicing of MVACs and MVAC-like appliances and to require recycling of used refrigerants. MVAC- like appliances are mechanical vapor compression, open-drive compressor appliances used to cool the driver's or passenger's compartment of a non- road vehicle, including agricultural and construction vehicles.

Refrigerant Transition & Environmental Impacts

(see https://www.epa.gov/mvac/refrigerant-transition-environmmental-impacts

Use of the ozone-depleting refrigerant, chlorofluorocarbon (CFC)-12, in new motor vehicle air conditioning (MVAC) systems ended in the mid-1990s in the United States. Since 1994, the most common refrigerant used in MVAC systems has been hydrofluorocarbon (HFC)-134a. HFCs are intentionally-made fluorinated greenhouse gases used in the same applications where ozone-depleting substances have been used, including motor vehicle air conditioning. Like the ozone-depleting substances they replace, most HFCs are potent greenhouse gases with very high global warming potentials (GWPs). In 2012, automobile manufacturers began the transition to new, climate-friendly alternative refrigerants. As a result of a July 2015 rulemaking, by model year 2021, the MVAC systems in newly manufactured light-duty vehicles in the United States will no longer use HFC-134a.

40 CFR 82.34 - Prohibitions and required practices.

In order to repair or service MVAC's or MVAC like appliances involving the refrigerant for such appliance

- A person must use properly approved equipment 40 CFR§ 82.36
- AND such person repairing or servicing an MVAC or MVAC-like appliance must be properly trained and certified by a technician certification program approved by the Administrator pursuant to either 40 CFR§ 82.40 or § 82.161(a)(5).
- MVAC-like appliance means mechanical vapor compression, open-drive compressor appliances with a normal charge of 20 pounds or less of refrigerant used to cool the driver's or passenger's compartment of an off-road motor vehicle. This includes the air-conditioning equipment found on agricultural or construction vehicles. *This definition is not intended to cover appliances using R-22 refrigerant.*

Effective November 15, 1992, no person may sell or distribute, or offer for sale or distribution, any class I or class II substance that is suitable for use as a refrigerant in motor vehicle air-conditioner and that is in a container which contains less than 20 pounds of such refrigerant to any person unless that person is properly trained and certified under 40 CFR§ 82.40 or intended the containers for resale only, and so certifies to the seller under 40 CFR§ 82.42(b)(3). Class I and Class II refrigerants are recognized by the Montreal Protocol as Ozone Depleting Substances. *For example, Freon (R12, CFC12) is a Class I substance.*
No technician training programs may issue certificates unless the program complies with all of the standards in § 82.40(a). *We are allowed to issue such certificates.*

Motor vehicle disposal facilities. Any refrigerant that is extracted from an MVAC or an MVAC-like appliance bound for disposal and located at a motor vehicle disposal facility may not be subsequently used to charge or recharge an MVAC or MVAC-like appliance, unless, prior to such charging or recharging, the refrigerant is either:

- Recovered, and reclaimed in accordance with the regulations promulgated under 82.32(e)(2). -- Refrigerant may be recycled off-site only if the refrigerant is extracted using recover only equipment, and is subsequently recycled off-site by equipment owned by the person that owns both the recover only equipment and owns or operates the establishment at which the refrigerant was extracted. In any event, approved equipment must be used to extract refrigerant prior to performing any service during which discharge of refrigerant from the motor vehicle air conditioner can reasonably be expected. <u>Intentionally venting or disposing of refrigerant to the atmosphere is an improper use of equipment.</u>
- Recovered using approved refrigerant recycling equipment dedicated for use with MVACs and MVAC-like appliances, either by a certified technician or by an employee, owner, or operator of, or contractor to, the disposal facility; and
- Subsequently recycled by the facility that charges or recharges the refrigerant into an MVAC or MVAC-like appliance, properly using approved refrigerant recycling equipment in accordance with any applicable recommended service procedures.

Any refrigerant the sale of which is restricted under subpart F that is extracted from an MVAC or an MVAC-like appliance bound for disposal and located at a motor vehicle disposal facility but not subsequently reclaimed, may be sold prior to its subsequent re-use only to a certified technician. Said technician who obtains such a refrigerant may subsequently re-use such refrigerant only in an MVAC or MVAC-like appliance, and only if it has been reclaimed or properly recycled.

40 CFR 82.36 - Approved refrigerant handling equipment.

Refrigerant recycling equipment must be certified by the Administrator or an independent standards testing organization approved by the Administrator to meet the following standard:

- Equipment that recovers and recycles CFC-12 refrigerant must meet the standards set forth in appendix A of this subpart.
- Equipment that recovers but does not recycle CFC-12 refrigerant must meet the standards set forth in appendix B of this subpart
- Effective January 1, 2008, equipment that recovers and recycles HFC-134a refrigerant and equipment that recovers and recycles HFC-134a refrigerant and recharges systems with HFC-134a refrigerant must meet the standards set forth in appendix C of this subpart
- Effective October 31, 2008, equipment that recovers but does not recycle HFC-134a refrigerant must meet the standards set forth in appendix D of this subpart
- Equipment that recovers and recycles both CFC-12 and HFC-134a using common circuitry must meet the standards set forth in appendix E of this subpart
- Equipment that recovers but does not recycle refrigerants other than HFC-134a and CFC-12 must meet the standards set forth in appendix F of this subpart

Refrigerant recycling equipment that has not been certified under the previous paragraph of this section shall be considered approved if it is substantially identical to the applicable equipment certified under the previous paragraph of this section, and

- For equipment that recovers and recycles CFC-12 refrigerant, it was initially purchased before September 4, 1991;
- For equipment that recovers but does not recycle CFC-12 refrigerant, it was initially purchased before April 22, 1992;
- For equipment that recovers and recycles HFC-134a refrigerant, it was initially purchased before March 6, 1996;
- For equipment that recovers but does not recycle HFC-134a refrigerant, it was initially purchased before March 6, 1996;
- For equipment that recovers but does not recycle any single, specific refrigerant other than CFC-12 or HFC-134a, it was initially purchased before March 6, 1996; and
- For equipment that recovers and recycles HFC-134a and CFC-12 refrigerant using common circuitry, it was initially purchased before March 6, 1996.

Equipment manufacturers or owners may request a determination by the Administrator by submitting an application and supporting documents that indicate that the equipment is substantially identical to approved equipment to: MVACs Recycling Program Manager, Stratospheric Protection Division (6205J), U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460, Attn: Substantially Identical Equipment Review. Authorized representatives of the Administrator may inspect equipment for which approval is being sought and request samples of refrigerant that has been extracted and/or recycled using the equipment. Equipment that fails to meet appropriate standards will not be considered approved.

Refrigerant recycling equipment that recovers or recovers and recycles CFC-12 refrigerant and has not been certified or approved shall be considered approved for use with an MVAC-like appliance if it was manufactured or imported before November 15, 1993, and is capable of

reducing the system pressure to 102 mm of mercury vacuum under the conditions set forth in appendix A of this subpart.

The Administrator will maintain a list of approved equipment by manufacturer and model. Persons interested in obtaining a copy of the list should send written inquiries to the address in paragraph (b) of this section.

40 CFR 82.42 - Certification, recordkeeping and public notification requirements.

Certification requirements. Any person repairing or servicing motor vehicle air conditioners for consideration shall certify to the Administrator that such person has acquired, and is properly using, approved equipment and that each individual authorized to use the equipment is properly trained and certified. Certification shall take the form of a statement signed by the owner of the equipment or another responsible officer *as shown on Page 6.*

Recordkeeping requirements.

- Any person who owns approved refrigerant recycling equipment must maintain records of the name and address of any facility to which refrigerant is sent.
- Any person who owns approved refrigerant recycling equipment must retain records demonstrating that all persons authorized to operate the equipment are currently certified
- Any person who sells or distributes any class I or class II substance that is suitable for use as a refrigerant in a motor vehicle air conditioner and that is in a container of less than 20 pounds of such refrigerant must verify that the purchaser is properly trained and certified. The seller must have a reasonable basis for believing that the information presented by the purchaser is accurate. The only exception to these requirements is if the purchaser is purchasing the small containers for resale only. In this case, the seller must obtain a written statement from the purchaser that the containers are for resale only and indicate the purchasers name and business address. Records required under this paragraph must be retained for a period of three years.
- *All records required to be maintained pursuant to this section must be kept for a minimum of three years unless otherwise indicated. Entities which service motor vehicle air conditioners for consideration must keep these records on-site.*
- All entities which service motor vehicle air conditioners for consideration must allow an authorized representative of the Administrator entry onto their premises (upon presentation of his or her credentials) and give the authorized representative access to all records required to be maintained pursuant to this section.

Public notification. Any person who conducts any retail sales of a class I or class II substance that is suitable for use as a refrigerant in a motor vehicle air conditioner, and that is in a container of less than 20 pounds of refrigerant, must prominently display a sign where sales of such containers occur which states:

"It is a violation of federal law to sell containers of Class I and Class II refrigerant of less than 20 pounds of such refrigerant to anyone who is not properly trained and certified to operate approved refrigerant recycling equipment."

Standards Established For The Service And Repair of R12 MVAC's And MVAC Like Appliances (40 CFR 82, Subpart B, Appendix A)

Standard of Purity for Use In Mobile Air-Conditioning Systems

TAKEN FROM J1991 AUG 2011

Due to the CFC's damaging effect on the ozone layer, recycle of CFC-12 (R-12) used in mobile air-conditioning systems is required to reduce system venting during normal service operations. Establishing recycle specifications for R-12 will assure that system operation with recycled R-12 will provide the same level of performance as new refrigerant.

Extensive field testing with the EPA and the auto industry indicate that reuse of R-12 removed from mobile air-conditioning systems can be considered, if the refrigerant is cleaned to a specific standard. The purpose of this standard is to establish the specific minimum levels of R-12 purity required for recycled R-12 removed from mobile automotive air-conditioning systems.

The refrigerant in this document shall have been directly removed from, and intended to be returned to, a mobile air-conditioning system. The contaminants in this recycled refrigerant 12 shall be limited to moisture, refrigerant oil, and noncondensable gases, which shall not exceed the following level:

- Moisture: 15 ppm by weight.
- Refrigerant Oil: 4000 ppm by weight.
- Noncondensable Gases (air): 330 ppm by weight.

Refrigeration Recycle Equipment Used in Direct Mobile Air-Conditioning Service Operations Requirement shall meet SAE J1990, which covers additional moisture, acid, and filter requirements and shall have a label indicating that it is certified to meet this document.
Purity Specification of Recycled R-12 Supplied in Containers From Other Recycle Sources for service of mobile air-conditioning systems, shall meet ARI Standard 700-88 (Air Conditioning and Refrigeration Institute).
The recycle equipment shall be operated in accordance with SAE J1989.

Extraction and Recycle Equipment for Mobile Automotive Air Conditioning Systems
TAKEN FROM J1990 MAY 2011
Specification and General Description

- The equipment must be able to extract and process CFC-12 from mobile air-conditioning systems. The equipment shall process the contaminated R-12 samples as defined in 8.4 and shall clean the refrigerant to the level as defined in SAE J1991.
- The equipment shall be suitable for use in an automotive service environment and be capable of continuous operation in ambients from 10 to 49 °C.
- The equipment must be certified by Underwriters Laboratories or an equivalent certifying laboratory.
- The equipment shall have a label "Design Certified by (Company Name) to Meet SAE J1991". The minimum letter size shall be bold type 3 mm in height.

Refrigeration Recycle Equipment Requirements

- Moisture and Acid—The equipment shall incorporate a desiccant package that must be replaced before saturated with moisture and whose mineral acid capacity is at least 5% by weight of total system dry desiccant.
    - The equipment shall be provided with a moisture detection device that will reliably indicate when moisture in the CFC-12 exceeds the allowable level and requires the filter/dryer replacement.
- Filter—The equipment shall incorporate an in-line filter that will trap particulates of 15 µm or greater.
- Noncondensable Gas.
    - The equipment shall either automatically purge noncondensables (NCGs) if the acceptable level is exceeded or incorporate a device to alert the operator that NCG level has been exceeded. NCG removal must be part of normal operation of the equipment and instructions must be provided to enable the task to be accomplished within 30 minutes.
    - Refrigerant loss from noncondensable gas purging during testing described in Section 8 shall not exceed five percent (5%) by weight of the total contaminated refrigerant removed from the test system.
    - Transfer of Recycled Refrigerant—Recycled refrigerant for recharging and transfer shall be taken from the liquid phase only.

Safety Requirements -- The equipment must comply with applicable federal, state and local requirements on equipment related to the handling of R-12 material. Safety precautions or notices related to the safe operation of the equipment shall be prominently displayed on the equipment and should also state "Caution—Should Be Operated By Qualified Personnel".

Operating Instructions -- The equipment manufacturer must provide operating instructions, necessary maintenance procedures, and source information for replacement parts and repair. The equipment must prominently display the manufacturer's name, address and any items that require maintenance or replacement that affect the proper operation of the equipment. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation.

Functional Description

- The equipment must be capable of ensuring recovery of the R-12 from the system being service, by reducing the system pressure below atmospheric to a minimum of 102 mm of mercury.
- To prevent overcharge, the equipment must be equipped to protect the tank used to store the recycled refrigerant with a shutoff device and a mechanical pressure relief valve.
- Portable refillable tanks or containers used in conjunction with this equipment must meet applicable Department of Transportation (DOT) or Underwriters Laboratories (UL) Standards and be adaptable to existing refrigerant service and charging equipment.
- During operation, the equipment shall provide overfill protection to assure the storage container, internal or external, liquid fill does not exceed 80% of the tank's rated volume at 21.1 °C (70 °F) per DOT standards, CFR title 49, § 173.304 and American Society of Mechanical Engineers.
    - Additional Storage Tank Requirements.
    - The cylinder valve shall comply with the standard for cylinder valves, UL 1769.
    - The pressure relief device shall comply with the Pressure Relief Device Standard Part 1—Cylinders for Compressed Gases, CGA Pamphlet S-1.1.

    - The tank assembly shall be marked to indicate the first retest date, which shall be 5 years after date of manufacture. The marking shall indicate that retest must be performed every subsequent 5 years. The marking shall be in letters at least 1/4 in high.
- All flexible hoses must meet SAE J2196 hose specification effective January 1, 1992.
- Service hoses must have shutoff devices located within 30 cm (12 in) of the connection point to the system being serviced to minimize introduction of noncondensable gases into the recovery equipment and the release of the refrigerant when being disconnected.
- The equipment must be able to separate the lubricant from the recovered refrigerant and accurately indicate the amount removed during the process, in 30 ml units. Refrigerant dissolves in lubricant sample. This creates the illusion that more lubricant has been recovered than actually has been. The equipment lubricant measuring system must take in account such dissolved refrigerant to prevent overcharging the vehicle system with lubricant. Note: Use only new lubricant to replace the amount removed during the recycle process. Used lubricant should be discarded per applicable federal, state, and local requirements.
    - This statement shall be predominantly identified in the service manual
      Note: Use only new lubricant to replace the amount removed during the recovery / recycle process. Used lubricant should be discarded per applicable federal, state, and local requirements.
- The equipment must be capable of continuous operation in ambient of 10 to 49 °C (50 to 120 °F).
- The equipment should be compatible with leak detection material that may be present in the mobile AC system.

8. Testing

This test procedure and the requirement are used for evaluation of the equipment for its ability to clean the contaminated R-12 refrigerant.

- The equipment shall clean the contaminated R-12 refrigerant to the minimum purity level as defined in SAE J1991, when tested in accordance with the following conditions:
- For test validation, the equipment is to be operated according to the manufacturer's instructions.
- The equipment must be preconditioned with 13.6 kg (30 lb) of the standard contaminated R-12 at an ambient of 21 °C (70 °F) before starting the test cycle. Sample amounts are not to exceed 1.13 kg (2.5 lb) with sample amounts to be repeated every 5 min. The sample method fixture, defined in Fig. 1, shall be operated at 24 °C -(75 °F).
- Contaminated R-12 Samples.
    - Standard contaminated R-12 refrigerant shall consist of liquid R-12 with 100 ppm (by weight) moisture at 21 °C (70 °F) and 45,000 ppm (by weight) mineral oil 525 suspension nominal and 770 ppm by weight of noncondensable gases (air).
    - High moisture contaminated sample shall consist of R-12 vapor with 1,000 ppm (by weight) moisture.
    - High oil contaminated sample shall consist of R-12 with 200,000 ppm (by weight) mineral oil 525 suspension viscosity nominal.

Test Cycle.

After preconditioning as stated in 8.3, the test cycle is started, processing the following contaminated samples through the equipment:

- 13.6 kg (30 lb) of standard contaminated R-12.

- 1 kg (2.2 lb) of high oil contaminated R-12.
- 4.5 kg (10 lb) of standard contaminated R-12.
- 1 kg (2.2 lb) of high moisture contaminated R-12.

Equipment Operating Ambient. -- The R-12 is to be cleaned to the minimum purity level, as defined in SAE J1991, with the equipment operating in a stable ambient of 10, 21, and 49 °C (50, 70, and 120 °F) and processing the samples. The processed contaminated sample shall be analyzed according to the following procedure.

Quantitative Determination of Moisture.

The recycled liquid phase sample of CFC-12 shall be analyzed for moisture content via Karl Fischer coulometer titration or an equivalent method. The Karl Fischer apparatus is an instrument for precise determination of small amounts of water dissolved in liquid and/or gas samples. In conducting the test, a weighed sample of 30 to 130 grams is vaporized directly into the Karl Fischer analyte. A coulometer titration is conducted and the results are calculated and displayed as parts per million moisture (weight).

8.9 Determination of Percent Lubricant.

The amount of oil in the recycled sample of CFC-12 is to be determined by gravimetric analysis.

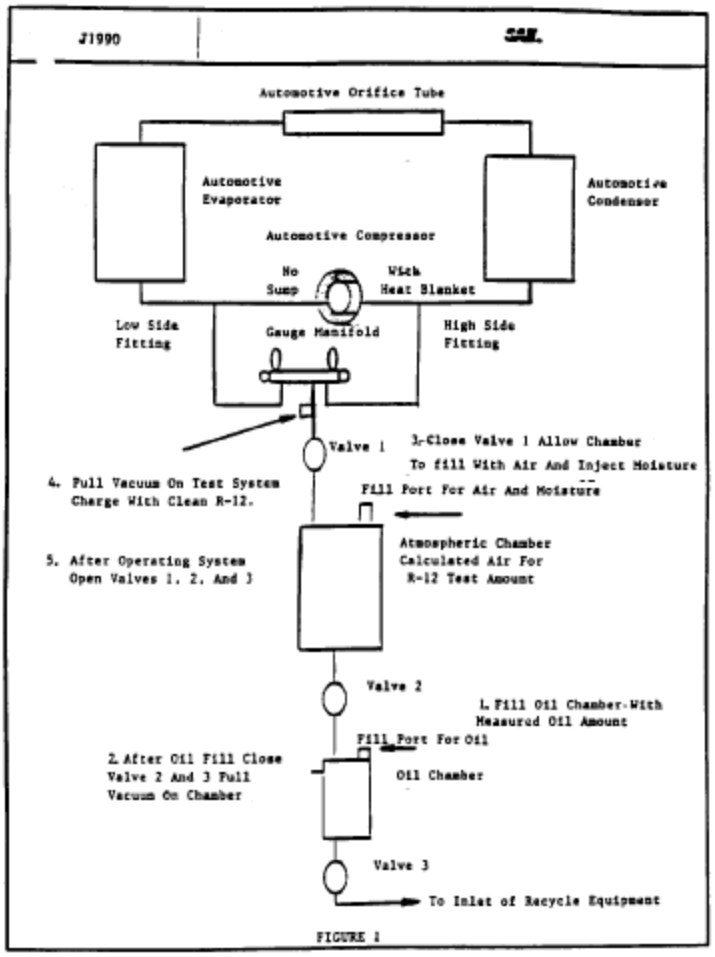
- Following venting of noncondensable, in accordance with the manufacturer's operating instructions, the refrigerant container shall be shaken for 5 minutes prior to extracting samples for test.
- A weighted sample of 175 to 225 grams of liquid CFC-12 is allowed to evaporate at room temperature. The percent oil is to be calculated from the weight of the original sample and the residue remaining after the evaporation.

Noncondensable Gas.

The amount of noncondensable gas is to be determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A Porapak Q column at 130 °C and a hot wire detector may be used for analysis.

- This test shall be conducted on recycled refrigerant (taken from the liquid phase) within 30 minutes after the proper venting of noncondensable.
- Samples shall be shaken for 8 hours prior to retesting while at a temperature of 24 ±2.8 °C (75 ±5 °F). Known volumes of refrigerant vapor are to be injected for separation and analysis by means of gas chromatography. A Porapak Q column at 130 °C (266 °F) and a hot wire detector are to be used for the analysis.
- This test shall be conducted at 21 and 49 °C and may be performed in conjunction with the testing defined in Section 8.6. The equipment shall process at least 13.6 kg of standard contaminated refrigerant for this test.

8.11 Sample Requirements -- The sample shall be tested at ambient temperatures of 10, 21, and 49 °C (50, 70, and 120 °F).



Recommended Service Procedure for the Containment of R-12

TAKEN FROM J1989 MAY 2011

Refrigerant Recovery Procedure

- Connect the recovery unit service hoses, which shall have shutoff valves within 12 in (30 cm) of the service ends, to the vehicle air-conditioning system service ports.
- Operate the recovery equipment as covered by the equipment manufacturers recommended procedure. Start the recovery process and remove the refrigerant from the vehicle AC system. Operate the recovery unit until the vehicle system has been reduced from a pressure to a vacuum. With the recovery unit shut off for at least 5 min, determine that there is no refrigerant remaining in the vehicle AC system. If the vehicle system has pressure, additional recovery operation is required to remove the remaining refrigerant. Repeat the operation until the vehicle AC system vacuum level remains stable for 2 min.
- Close the valves in the service lines and then remove the service lines from the vehicle system. Proceed with the repair/service. If the recovery equipment has automatic closing valves, be sure they are properly operating.

Service With Manifold Gage Set

- Service hoses must have shutoff valves in the high, low, and center service hoses within 12 in (30 cm) of the service ends. Valves must be closed prior to hose removal from the air-conditioning system. This will reduce the volume of refrigerant contained in the service hose that would otherwise be vented to atmosphere.
- During all service operations, the valves should be closed until connected to the vehicle air-conditioning system or the charging source to avoid introduction of air and to contain the refrigerant rather than vent open to atmosphere.
- When the manifold gage set is disconnected from the air-conditioning system or when the center hose is moved to another device which cannot accept refrigerant pressure, the gage set hoses should first be attached to the reclaim equipment to recover the refrigerant from the hoses.

5. Recycled Refrigerant Checking Procedure for Stored Portable Auxiliary Container

- To determine if the recycled refrigerant container has excess noncondensable gases (air), the container must be stored at a temperature of 65 °F (18.3 °C) or above for a period of time, 12 h, protected from direct sun.
- Install a calibrated pressure gage, with 1 psig divisions (0.07 kg), to the container and determine the container pressure.
- With a calibrated thermometer, measure the air temperature within 4 in (10 cm) of the container surface.
- Compare the observed container pressure and air temperature to determine if the container exceeds the pressure limits found on Table 1, e.g., air temperature 70 °F (21 °C) pressure must not exceed 80 psig (5.62 kg/cm 2).
- If the container pressure is less than the Table 1 values and has been recycled, limits of noncondensable gases (air) have not been exceeded and the refrigerant may be used.
- If the pressure is greater than the range and the container contains recycled material, slowly vent from the top of the container a small amount of vapor into the recycle equipment until the pressure is less than the pressure shown on Table 1.
- If the container still exceeds the pressure shown on Table 1, the entire contents of the container shall be recycled.

TABLE 1

Temp °F	Psig	Temp °F	Psig	Temp °F	Psig	Temp °F	Psig	Temp °F	Psig
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

TABLE 1 (METRIC)

Temp ˚C	Pres	Temp ˚C	Pres	Temp ˚C	Pres	Temp ˚C	Pres	Temp ˚C	PRres
Pres kg/sq cm.									
18.3	5.20	23.9	6.11	29.4	7.17	35.0	8.29	40.5	9.56
18.8	5.27	24.4	6.18	30.0	7.24	35.5	8.43	41.1	9.70
19.4	5.34	25.0	6.32	30.5	7.38	36.1	8.57	41.6	9.84
20.0	5.48	25.5	6.46	31.1	7.52	36.6	8.71	42.2	9.98
20.5	5.55	26.1	6.60	31.6	7.59	37.2	8.78	42.7	10.12
21.1	5.62	26.6	6.74	32.2	7.73	37.7	8.92	43.3	10.26
21.6	5.76	27.2	6.88	32.7	7.80	38.3	9.06	43.9	10.40
22.2	5.83	27.7	6.95	33.3	7.94	38.8	9.13	44.4	10.54
22.7	5.90	28.3	7.03	33.9	8.08	39.4	9.27	45.0	10.68
23.3	6.04	28.9	7.10	34.4	8.15	40.0	9.42	45.5	10.82

Containers for Storage of Recycled Refrigerant

Recycled refrigerant should not be salvaged or stored in disposable refrigerant containers. This is the type of container in which virgin refrigerant is sold. Use only DOT CFR title 49 or UL approved storage containers for recycled refrigerant. Any container of recycled refrigerant that has been stored or transferred must be checked prior to use as defined in section 5.

Transfer of Recycled Refrigerant

When external portable containers are used for transfer, the container must be evacuated at least 27 in of vacuum (75 mm Hg absolute pressure) prior to transfer of the recycled refrigerant. External portable containers must meet DOT and UL standards. To prevent on-site overfilling when transferring to external containers, the safe filling level must be controlled by weight and must not exceed 60% of container gross weight rating.

Disposal of Empty/Near Empty Containers

Since all the refrigerant may not be removed from disposable refrigerant containers during normal system charging procedures, empty/near empty container contents should be reclaimed prior to disposal of the container. Attach the container to the recovery unit and remove the remaining refrigerant. When the container has been reduced from a pressure to a vacuum, the container valve can be closed. The container should be marked empty and is ready for disposal.

Standards Established For The Service And Repair of R12 MVAC's And MVAC Like Appliances (40 CFR 82, Subpart B, Appendix B)

SAE Recommended Practice: CFC-12 (R-12) Extraction Equipment for Mobile Automotive Air-Conditioning Systems

40 CFR 82, Subpart B, Appendix B to Subpart B of Part 82 - Standard for Recover Equipment
TAKEN FROM J2209AUG2011
The purpose of this document is to provide equipment specifications for CFC-12 (R-12) recovery for recycling on-site or for transport off-site to a refrigerant reclamation facility that will process it to ARI (Air-Conditioning and Refrigeration Institute) standard 700-93 as a minimum. It is not acceptable that the refrigerant removed from a mobile air-conditioning system, with this equipment, be directly returned to a mobile air-conditioning system.
This information applies to equipment used to service automobiles, light trucks, and other vehicles with similar CFC-12 systems.

Specifications and General Description

- The equipment must be able to extract CFC-12 from a mobile air-conditioning system.
- The equipment discharge or transfer fitting shall be unique to prevent the unintentional use of extracted CFC-12 to be used for recharging auto air conditioners.
- The equipment shall be suitable for use in an automotive service garage environment as defined in 6.8.
- Equipment Certification—The equipment must be certified by Underwriters Laboratories or an equivalent certifying laboratory to meet this standard.
- Label Requirements—The equipment shall have a label "Design Certified by (company name) to meet SAE J2209 for use with CFC-12. The refrigerant from this equipment must be processed to ARI 700-93 specifications before reuse in a mobile air-conditioning system." The minimum letter size shall be bold type 3mm in height.

Safety Requirements

The equipment must comply with applicable federal, state and local requirements on equipment related to the handling of R-12 material. Safety precautions or notices or labels related to the safe operation of the equipment shall also be prominently displayed on the equipment and should also state "CAUTION—SHOULD BE OPERATED BY CERTIFIED PERSONNEL." The safety identification shall be located on the front near the controls. The equipment must comply with applicable safety standards for electrical and mechanical requirements.

5. Operating Instructions

The equipment manufacturer must provide operating instructions, necessary maintenance procedures and source information for replacement parts and repair. The equipment must prominently display the manufacturer's name, address and any items that require maintenance or replacement that affect the proper operation of the equipment. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation.

6. Functional Description

- The equipment must be capable of ensuring recovery of the CFC-12 from the system being serviced, by reducing the system pressure to a minimum of 102 mm of mercury below

atmospheric. To prevent system delayed outgassing, the unit must have a device that assures that the refrigerant has been recovered from the air-conditioning system.

- Testing laboratory certification of the equipment capability is required which shall process contaminated refrigerant samples at specific temperatures.
- The equipment must be preconditioned with 13.6 kg of the standard contaminated CFC-12 at an ambient of 21 °C before starting the test cycle. Sample amounts are not to exceed 1.13 kg with sample amounts to be repeated every 5 minutes. The sample method fixture defined in Figure 1 of appendix A shall be operated at 24 °C. Contaminated CFC-12 samples shall be processed at ambient temperatures of 10 and 49 °C. Standard contaminated CFC-12 refrigerant, 13.6 Kg sample size, shall consist of liquid CFC-12 with 100 ppm (by weight) moisture at 21 °C and 45,000 ppm (by weight) mineral oil 525 suspension nominal and 770 ppm (by weight) of noncondensable gases (air).
- Portable refillable containers used in conjunction with this equipment must meet applicable DOT standards.
    - 6.3.1 The container color must be gray with yellow top to identify that it contains used CFC-12 refrigerant. It must be permanently marked on the outside surface in black print at least 20 mm high “DIRTY R-12—DO NOT USE, MUST BE REPROCESSED”.
    - 6.3.2 The portable refillable container shall have a SAE 3/8 inch flare male thread connection as identified in SAE J639 CFC-12 High Pressure Charging Valve Figure 2.
    - 6.3.3 During operation the equipment shall provide overfill protection to assure that the storage container liquid fill does not exceed 80% of the tank's rated volume at 21 °C per DOT standard, CFR Title 49, section 173.304 and the American Society of Mechanical Engineers.

Additional Storage Tank Requirements.

- The cylinder valve shall comply with the standard for cylinder valves, UL 1769.
- The pressure relief device shall comply with the pressure relief device standard part 1, CGA pamphlet S-1.1.
- The container assembly shall be marked to indicate the first retest date, which shall be 5 years after date of manufacture. The marking shall indicate that retest must be performed every subsequent five years. The marking shall be in letters at least 6 mm high.

- All flexible hoses must meet SAE J2196 standard for service hoses.
- Service hoses must have shutoff devices located within 30 cm of the connection point to the system being serviced to minimize introduction of noncondensable gases into the recovery equipment during connection and the release of the refrigerant during disconnection.
- The equipment must be able to separate the lubricant from the recovered refrigerant and accurately indicate the amount removed from the system during processing in 30 ml units.
    - 6.7.1 The purpose of indicating the amount of lubricant removed is to ensure that a proper amount is returned to the mobile air-conditioning system for compressor lubrication.
    - 6.7.2 Refrigerant dissolved in this lubricant must be accounted for to prevent system lubricant overcharge of the mobile air-conditioning system.
    - 6.7.3 Only new lubricant, as identified by the system manufacturer, should be replaced in the mobile air-conditioning system.

    - 6.7.4 Removed lubricant from the system and/or the equipment shall be disposed of in accordance with applicable federal, state and local procedures and regulations.
- The equipment must be capable of continuous operation in ambient temperatures of 10 °C to 49 °C and comply with 6.1.
- The equipment should be compatible with leak detection material that may be present in the mobile air-conditioning system.
- For test validation, the equipment is to be operated according to the manufacturer's instructions.

Standard for Recovery/Recycle and Recovery/Recycle/Recharging Equipment for HFC-134a Refrigerant (40 CFR 82, Subpart B, Appendix C)

Standard of Purity for Recycled r-134a and R-1234yf for use in Mobile Air Conditioning Systems
TAKEN FROM SAE J2099 APR2012

Requirements for recycle equipment used for on-site A/C Service operations

The refrigerant referred to in this standard, prior to its removal from a MAC system, shall have been identified with equipment certified to SAE J1771 for R-134a refrigerant or SAE J2912 for R-1234yf refrigerant as at least 98% pure, and SHALL HAVE been directly removed from, and intended to be returned to, a mobile A/C system that uses the specified refrigerant. The recycle equipment and operation shall meet SAE J2788 for R-134a, SAE J2843 for R-1234yf, or both SAE J2788 and SAE J2843 for both refrigerants, which have additional requirements for moisture, acid, and filter requirements.

Contaminants in this recycled refrigerant shall be limited to refrigerant system lubricant (high boiling residue), non-condensable gases, and moisture, which, when measured in the refrigerant liquid phase, shall not exceed the following levels as measured by the accompanying procedures in section 5, or equivalent test procedures.

- Lubricant -- 500 ppm by weight, by gravimetric method
- Air -- 1.5% by volume, at 23.9 ºC by gas chromatography
- Moisture -- 50 ppm by weight, by Karl Fischer method or equivalent analysis,

The amount of lubricant in the recycled refrigerant sample shall be determined via gravimetric analysis. The methodology shall account for the hygroscopicity of the lubricant. Following venting of non-condensable gases in accordance with the manufacturer's operating instructions, the refrigerant container shall be shaken for 5 min prior to extracting samples for testing. A weighed sample of 175 to 225 g of liquid refrigerant is allowed to evaporate at room temperature. The percent lubricant is calculated from weights of the original sample and the residue remaining after evaporation.

The amount of non-condensable gases shall be determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A Porapak Q column at 130 °C (266 °F) and a hot wire detector may be used for the analysis. This test shall be conducted on liquid phase samples of recycled refrigerant taken from a full container within 30 min following the proper venting of non-condensable gases. The liquid phase samples in 5.2.2 shall be vaporized completely prior to gas chromatographic analysis

The recycled liquid phase sample of refrigerant shall be analyzed for moisture content via Karl Fischer coulometric titration, or an equivalent method. The Karl Fischer apparatus is an instrument for precise determination of small amounts of water dissolved in liquid and/or gas samples. In conducting this test, a weighed sample of 30 to 130 grams is vaporized directly into the Karl Fischer anolyte. A coulometric titration is conducted and the results are reported as parts-per-million moisture (by weight).

Purity of Refrigerant From Other Sources

The purity of R-134a intended for servicing mobile A/C systems, supplied in containers from other sources, shall meet SAE J2776 refrigerant purity for new refrigerant. The purity of R-1234yf intended for servicing mobile A/C systems, supplied in containers from other sources, shall meet SAE J2844 refrigerant purity for new refrigerant.

R-134a Recovery/Recycle/Recharging Equipment for Mobile Air Conditioning Systems

TAKEN FROM J2788 JAN 2013

1. Scope

The purpose of this SAE Standard is to establish the specific minimum equipment performance requirements for recovery and recycling of HFC-134a that has been directly removed from, and is intended for reuse in, mobile air-conditioning (A/C) systems. It also is intended to establish requirements for equipment used to recharge HFC-134a to an accuracy level that meets Section 9 of this document and SAE J2099. The requirements apply to the following types of service equipment and their specific applications.

- Recovery/Recycling Equipment,
- Recovery/Recycling—Refrigerant Charging,
- Refrigerant Recharging Equipment Only.

Improved refrigerant recovery equipment is required to ensure adequate refrigerant recovery to reduce emissions and provide for accurate recharging of mobile air conditioning systems. Therefore, 12 months following the publication date of this standard, requirements in this standard supplements and supersedes, SAE J2210.

3. Specification and General Description

- The equipment must be able to remove and process HFC-134a (R-134a) from mobile A/C systems to the purity level specified in SAE J2099.
- The equipment shall be suitable for use in an automotive service garage environment and be capable of continuous operation in ambients from 10 °C to 49 °C (50 °F to 120 °F). If it is designed to recharge a system, and it uses a scale for this purpose, the scale must demonstrate the ability to maintain accuracy per the test in 10.2.
- The equipment must be certified that it meets this specification by an EPA listed certifying laboratory.
- The equipment shall have a label, which states, “Certified by (Certifying Agent) to Meet SAE J2788 superseding SAE J2210” in bold-type letters a minimum of 3 mm (1/8 in) in height.

4. Refrigerant Recycling Equipment Requirements

- Moisture and Acid -- The equipment shall incorporate a desiccant package that must be replaced before saturation with moisture, and whose mineral acid capacity is at least 5% by weight of the dry desiccant.
    - The equipment shall be provided with a means of indicating when the filter desiccant moisture capacity has reached the allowable limit and desiccant replacement is required. This may include a reliable means of detecting moisture level or an algorithm based on the amount refrigerant recovered. The user must be clearly alerted to replace the filter prior to the full saturation. Warnings shall be displayed on screens and (printed on printouts where applicable). The warnings must explain that the machine is approaching the end of filter life. The manufacturer must incorporate a lockout when the end of filter life is reached.
    - The manufacturer shall use an identification system to ensure that a new filter has been installed to reset the machine for operation.
- Filter -- The equipment shall incorporate an in-line filter that will trap particulates of 15 micron spherical diameter or greater.
- Scale (if used) -- The scale must maintain accuracy when moved

- Purging Noncondensable Gases -- The equipment shall automatically purge noncondensables (NCGs), which are primarily air, if the acceptable level is exceeded. NCG removal must be part of the normal operation of the equipment and instructions must be provided to enable the task to be accomplished within 30 min (to reach the refrigerant purity level specified in SAE J2099). Refrigerant loss from noncondensable gas purging during testing shall be minimized by a method that initiates a purge when the machine has not been in use for a period long enough for air-refrigerant separation in the tank to have occurred.
- Recycled refrigerant for recharging and transfer shall be taken from the liquid phase only.

Safety Requirements

The equipment must comply with applicable federal, state, and local requirements on equipment related to handling HFC-134a material. Safety precautions or notices related to safe operation of the equipment shall be prominently displayed on the equipment and should also state "CAUTION—SHOULD BE OPERATED BY QUALIFIED PERSONNEL." Under NO CIRCUMSTANCES should any equipment be pressure tested or leak tested with air/HFC-134a mixtures. Do not use compressed air (shop air) or leak detection in systems containing HFC-134a.

Operating Instructions

- The equipment manufacturer shall provide a warning in the instruction manual regarding the possibility of refrigerant contamination in the mobile A/C system being serviced.
    - If recovery/recycle equipment has refrigerant identification equipment, the refrigerant identification equipment shall meet the requirements of SAE J1771.
    - Recovery/recycling equipment not having refrigerant identification capability shall have instructions in the equipment manual covering possible contamination problems to the equipment and the contamination of the existing recycled refrigerant in the container in the equipment.
- The equipment manufacturer must provide operating instructions, including proper attainment of vehicle system vacuum (i.e., when to stop the extraction process), filter/desiccant replacement, and purging of noncondensable gases (air). Also to be included are any other necessary maintenance procedures, source information for replacement parts and, repair and safety precautions. The manual shall identify the proper maintaining of hose and seals to prevent the addition of excess air, due to leaks, during the recovery process, which would increase the NCG level in the recovered refrigerant.
- The equipment must prominently display the manufacturer's name, address, the type of refrigerant it is designed to recycle, a service telephone number, and the part number for the replacement filter/drier.

Functional Description

The ability of the equipment to meet the refrigerant recovery and recharge specifications of this section shall be determined by test procedures. (PERFORMED BY A CERTIFIED TEST LAB OR MANUFACTURER)

- The equipment must be capable of continuous operation in ambient temperatures of 10 °C (50 °F) to 49 °C (120 °F). Continuous is defined as completing recovery/recycle and recharge (if applicable) operations with no more than a brief reset period between vehicles, and shall not include time delays for allowing a system to outgas (which shall be part of the recovery period provided by this standard). Continuous may include time out for an air purge if necessary, although it is understood that extended equipment-off time is preferred to allow NCG and refrigerant separation in the supply tank for optimum results.

    - The equipment shall be capable of removing a minimum of 95.0% of the refrigerant from the test system in 30 minutes or less, without external heating, or use of any device (such as shields, reflectors, special lights, etc.) which could heat components of the system. The recovery procedures shall be based on 21 to 24 °C (70 to 75 °F) ambient temperature. The test system for qualifying shall be a 1.4 kg (3.0 lbs) capacity orifice tube/accumulator system in a 2005 Chevrolet Suburban with front and rear A/C, or the test option described in 10.5, and shall be determined by accurately weighing the recovery machine with the resolution and accuracy of within 3 g (.006 lb) in the range of the machine's weight. The laboratory shall maintain records of the vehicle, including its VIN (vehicle identification number).
    - However, the preceding shall not preclude a brief period of engine operation at fast idle (up to 15 minutes, up to 2000 rpm) to circulate refrigerant and oil, and provide some engine and warm-up of A/C refrigeration components. The laboratory shall monitor coolant temperature per the vehicle engine coolant temperature sensor, and coolant temperature shall not be allowed to exceed 105 °C (221 °F). The time required shall not be included in the total time of 30 minutes.
    - The refrigerant that is recovered, following oil separation, shall be measured and the quantity displayed, accurate to within ±30 g (1.0 oz). The equipment must include a provision for checking the accuracy.
- During recovery operation, the equipment shall provide overfill protection to assure that the liquid fill of the storage container (which may be integral or external) does not exceed 80% of the tank's rated volume at 21 °C per Department of Transportation (DOT) Standard, CFR Title 49, Section 173.304 and the American Society of Mechanical Engineers.
- Portable refillable tanks or containers used in conjunction with this equipment must be labeled “HFC-134a (R-134a),” meet applicable Department of Transportation (DOT) or Underwriters Laboratories (UL) Standards, and shall incorporate fittings per SAE J2197.
    - The cylinder valve shall comply with the standard for cylinder valves, UL 1769.
    - The pressure relief device shall comply with the Pressure Relief Device Standard Part 1—Cylinders for Compressed Gases, CGA Pamphlet S-1.1.
    - The tank assembly shall be marked to indicate the first retest date, which shall be 5 years after the date of manufacture. The marking shall indicate that retest must be performed every subsequent 5 years. SAE J2296 provides an inspection procedure. The marking shall be in letters at least 6 mm (1/4 in) high.
    - ASME tanks as defined in UL-1963 may be used and are exempt from the retest requirements.
- If the machine is designed for recharging, and the marketer permits use of a non-refillable refrigerant tank, the machine shall include a way to ensure refrigerant remaining in the tank (called the “heel”) to no more than 2% of tank rated capacity when the tank is indicated to be empty. This may be done by the machine marketer as follows:
    - Specify a non-venting procedure, to minimize the amount of unused refrigerant remaining in the tank. The machine shall include any devices required for the procedure, other than ordinary service shop tools and supplies, and include in the operator's manual, any instructions.
    - Provide an automatic or (with instructions in the operator's manual) semi-automatic non-venting procedure with the machine.

- The laboratory shall test for the 2% capability. For testing purposes it may use a refillable tank, minimum 15 lb capacity (6.8 kg) containing a minimum of 7.5 lbs (3.4 kg) refrigerant. The test is as follows:
    - Weigh the tank at the start of the test, on a scale accurate to plus/minus 3 grams, to ensure it contains sufficient refrigerant.
    - Operate the machine to remove refrigerant from the tank, charging into a holding container until the tank is indicated to be empty. Continue with the marketer's recommended procedure for the 2% capability.
    - Weigh the tank, on a scale accurate to plus/minus 3 grams.
    - Using the recovery compressor and/or a vacuum pump, draw the tank into a vacuum of 9 to 10 inches Mercury (225 to 250 mm Mercury). The tank must hold that vacuum with a decay of less than 10% in 10 minutes. If vacuum decays 10% or more, the procedure shall be repeated as necessary to ensure the tank is empty.
    - Weigh the tank on a scale accurate to plus/minus 3 grams. The difference in weight from Steps 3 to 5 shall be within 2% of the weight of the amount of refrigerant that is the tanks rated capacity.
    - This test may be performed at the conclusion of testing in 10.4 or 10.5. If the machine passes or has passed all other testing in this standard, the marketer may make modifications in procedure and/or machine operation and retest once at a later date, within 90 days. If the machine fails the retest, the machine must be completely retested per this standard, or may be certified per the following alternative. The marketer of the machine may specify use of a non-refillable refrigerant tank that provides for recycling and/or disposal of the residual refrigerant, in either case in a manner that does not vent. Or the marketer may exclude use of a one-way container, in
- All flexible hoses must comply with SAE J2196.
- Service hoses must have shutoff devices located at the connection point to the system being serviced. Any hoses or lines connected to refrigerant containers on or in the machine also shall have shutoff devices at the connection points, so that the containers may be changed without loss of refrigerant. A tank that is a permanent installation is exempt from this requirement.
- The equipment shall separate oil from the refrigerant, measure the amount accurate to 20 ml (0.7 oz.), so the technician has an accurate basis for adding oil to the system. This statement shall be predominately identified in the equipment service manual.
  NOTE: Use only new lubricant to replace the amount removed during the recycling process. Used lubricant should be discarded per applicable federal, state and local requirements.

8. Testing

This test procedure and its requirements are to be used to determine the ability of the recycling equipment to adequately recycle contaminated refrigerant. The equipment shall be able to clean the contaminated refrigerant in to the purity level defined in SAE J2099 and the equipment shall be operated in accordance with the manufacturer's operating instructions.

- Contaminated HFC-134a (R-134a) Sample
    - The standard contaminated refrigerant shall consist of liquid HFC-134a with 1300 ppm (by weight) moisture (equivalent to saturation at 38 °C, 100 °F), 45000 ppm (by weight) HFC-134a compatible lubricant, and 1000 ppm (by weight) of noncondensable gases (air).

    - The HFC-134a compatible lubricant referred to in 8.3.1, shall be polyalkylene glycol (PAG), ISO 100 such as UCLN or PAG ISO 46-55, such as Idemitsu or equivalent, which shall contain no more than 1000 ppm by weight of moisture.
    - Although the test lubricant is a PAG, to conform to that used in the test vehicle system, the equipment manufacturer also shall ensure that it is compatible with polyol ester lubricant, such as ND 11 as used in electrically driven compressors in some hybrid vehicles.
- Test Cycle -- The equipment must be preconditioned by processing 13.6 kg (30 lb) of the standard contaminated HFC-134a at an ambient of 21 to 24 °C (70 to 75 °F) before starting the test cycle. 1.13 kg (2.56 lb) samples are to be processed at 5 min intervals. The test fixture, depicted in Figure 1, shall be operated at 21 to 24 °C (70 to 75 °F). Following the preconditioning procedure per 8.4.1, 18.2 kg (40 lb) of standard contaminated HFC-134a are to be processed by the equipment.
- Sample Requirements -- Samples of the standard contaminated refrigerant from 8.3.1 shall be processed as required in 8.6 and shall be analyzed after said processing as defined in 8.7, 8.8, and 8.9. Note exception for noncondensable gas determination in 8.9.4.
- Equipment Operating Ambient -- The HFC-134a is to be cleaned to the purity level, as defined in SAE J2099, with the equipment operating in a stable ambient of 10, 21, and 49 °C (50, 70 and 120 °F) while processing the samples as defined in 8.4.
- Quantitative Determination of Moisture -- The recycled liquid phase sample of HFC-134a shall be analyzed for moisture content via Karl Fischer coulometric titration, or an equivalent method. The Karl Fischer apparatus is an instrument for precise determination of small amounts of water dissolved in liquid and/or gas samples. In conducting this test, a weighed sample of 30 to 130 g is vaporized directly into the Karl Fischer anolyte. A coulometric titration is conducted and the results are reported as parts per million moisture (weight).
- Determination of Percent Lubricant -- The amount of lubricant in the recycled HFC-134a sample shall be determined via gravimetric analysis. The methodology must account for the hygroscopicity of the lubricant. Following venting of noncondensable gases in accordance with the manufacturer's operating instructions, the refrigerant container shall be shaken for 5 min prior to extracting samples for testing.A weighed sample of 175 to 225 g of liquid HFC-134a is allowed to evaporate at room temperature. The percent lubricant is calculated from weights of the original sample and the residue remaining after evaporation.
- Noncondensable Gases—Testing for Amount
    - 8.9.1The amount of noncondensable gases shall be determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A Porapak Q column at 130 °C (266 °F) and a hot wire detector may be used for the analysis.
    - 8.9.2This test shall be conducted on liquid phase samples of recycled refrigerant taken from a full container as defined in 7.2 within 30 min following the proper venting of noncondensable gases.
    - 8.9.3The liquid phase samples in 8.9.2 shall be vaporized completely prior to gas chromatographic analysis.
    - 8.9.4This test shall be conducted at 10 and 49 °C (50 and 120 °F) and may be performed in conjunction with the testing defined in 8.6. The equipment shall process at least 13.6 kg (30 lb) of standard contaminated refrigerant for this test.

- 8.9.5The equipment shall be capable of charging refrigerant into systems with various lubrication types and shall deliver less than 1% by weight residual oil during system charge if the machine permits oil charging with refrigerant (due to residual oil in the service hoses and recovery unit refrigerant circuit from prior recovery, diagnostics and oil injection. This shall be determined during SAE J2099 testing.)

9.Recharging the System

- It is the responsibility of the equipment manufacturer to ensure that the vacuum removal performance leaves the system 98% free of NCGs before recharging, following recovery and recycle under the provisions of this document. The equipment must be capable of both indicating and recharging the system to within 15 g (0.50 oz) of vehicle manufacturer's specifications. The laboratory shall test for this capability by choosing a charge amount that is within the range of the vehicle manufacturer's specifications. The equipment must indicate and charge the system with that chosen amount, within ±15 g (0.5 oz).
- Example: If 500 g is chosen, the actual and indicated charge must be 485 to 515 g, with any difference between actual and indicated charge within the laboratory scale accuracy requirements of this standard. If a scale is used in the machine, the equipment manufacturer shall provide a method or service for the technician to check scale accuracy, and include any necessary accuracy-checking device (such as a calibration weight(s)) with the machine. If a mass flow system is used for charge determination, it must maintain accuracy equal to the 15 g (0.50 oz) specification. The equipment manufacturer shall provide a method for checking accuracy and include any necessary accuracy testing device(s) with the machine. If the accuracy testing device(s) for a scale or mass flow machine includes a consumable, the manufacturer shall include a quantity of replacement or refill devices for five years of periodic testing as recommended.
- If any other system is used for charge determination, such as a positive displacement pump, the equipment manufacturer shall provide a method and any needed device(s) to check accuracy that is/are appropriate for its method of operation, including any temperature-compensating trim if used.

Equipment Test Procedure by Laboratory for Recovery/Recycling and
Recovery/Recycling/Recharging Machines

Preliminary: Ambient (in shop) temperature shall be 21 to 24 °C (70 to 75 °F). Test vehicle shall be “overnight cold” (not run for at least eight hours).

The machine must have a self-contained provision for checking accuracy of the indicated amount of refrigerant recovered in liquid or vapor or mixture form(s) from a vehicle system and (if applicable) charged into a vehicle, and adjusting if necessary, to meet requirements of 9.1, 9.2. Therefore: If the machine uses a scale for that purpose, check the accuracy of that scale and make any adjustment if necessary. If an alternative method of measuring refrigerant is used, follow the equipment manufacturer's procedure for ensuring accuracy. Next, move the machine, such as by rolling it, along the floor, a minimum of 20 feet (6.1 meters) within 10 seconds. Follow with the test procedure in 10.3, then 10.4 or 10.5.

10.3Test Procedure

If desired, this test procedure may be preceded by engine/system operation for up to 15 minutes, up to 2000 rpm.

1. You must start with an empty system, using this method: (a) Operate machine to recover refrigerant, per equipment manufacturer's instructions. (b) Deep-vacuum system to a minimum of 710 mm (28 in) of mercury. (c) Monitor vacuum for decay, checking every 20 minutes. If

decay exceeds 75 mm (3 in), deep vacuum the system again. When system holds 710 mm (28 in) 75 mm (3 in) of mercury vacuum for three hours, it is considered empty.
2. Place machine on a platform scale with the capacity to weigh the recovery/recycle/recharge machine, and with the resolution and accuracy of within ±3 g (.006 lb) in the range of the machine's weight. Weight should include the machine's service hoses draped over the machine, and with the machine's oil reservoir removed. If necessary to add oil to vehicle system as a result of a system operation preparatory to the recovery process, inject the needed quantity through the service valve at this time.
3. Record weight of machine in as weight A.
4. Reconnect service hoses to the test vehicle.
5. Follow the equipment manufacturer's specified procedure for charging the vehicle manufacturer's recommended amount of refrigerant into the system. Note: if this does not apply to the machine under test, i.e. a recovery/recycling only machine, the use of charging equipment that meets this standard and the platform scale shall be used to verify the accuracy of the charge.
6. Disconnect the service hoses from the test vehicle and drape them on the machine. Check and record the weight of the machine. Record this weight as weight B. The difference between weight A and weight B should be equal to the recommended charge that was installed per the machine's display, within 15 g (0.5 oz). If the difference is greater than 15 g (±3 g), the machine fails the charge accuracy test, and no other tests shall be performed at that time. The manufacturer must document changes made to improve accuracy and furnish them to the laboratory prior to a new test. Exception: If the maximum deviation is no more than a total of 20 g, the calibration of the scale or other measuring system may be rechecked and readjusted once, and the entire test repeated just once.

10.4Recovery Test Using a Vehicle

1. Following a successful system charge, the system and engine shall be run for 15 minutes at 2000 rpm to circulate oil and refrigerant, following which engine and system shall rest for eight hours. Then the laboratory may begin the recovery test. If the machine manufacturer specifies, operate the engine/system for up to 15 minutes, at up to 2000 rpm, then shut off engine/system.
2. If the machine has an automatic air purge, disable it. Check the weight of the machine with the platform scale (service hoses draped over machine, oil reservoir removed). Record the number as Weight C. Reinstall oil reservoir if it had been removed in the recovery procedure.
3. Start timer. Connect service hoses to system of test vehicle and perform recovery per the equipment manufacturer's instructions. The vehicle system service valves' cores must remain in the fittings for this procedure.
4. When recovery is completed, including from service hoses if that is part of the recommended procedure, disconnect hoses and drape over machine. Stop timer. The elapsed time shall be 30.0 minutes or less. If it is in excess of this time, the machine fails the test and no retest is allowed. The manufacturer must document changes made to the machine to improve its performance before a new test is allowed, and furnish them to the laboratory.
5. If the recovery is completed in no more than the 30.0 minutes, measure the oil level in the reservoir, remove the reservoir and then determine the amount of refrigerant recovered, as detailed in Nos. 6 and 7: As measured by the machine and also by noting the weight of the platform scale, which shall be recorded as Weight D.
6. The platform scale shall indicate that a minimum of 95% of the amount charged into the system has been recovered. If the platform scale indicates a lower percentage has been recovered, the machine fails the recovery test.

7. The machine display shall indicate that a minimum of 95.0% of the amount charged into the system has been recovered, within a tolerance of ±30 g (1 oz) when compared with the platform scale (Weight D minus Weight C). The 30 g (1 oz) tolerance may produce a machine display reading that is below the 95.0% recovery. If a greater difference between machine and platform scale occurs, the machine fails the recovery test.

10.5Recovery Test Fixture Test Option

If an equipment manufacturer chooses, as an alternative to the actual vehicle, it may certify to SAE J2788 with a laboratory fixture that is composed entirely of all the original equipment parts of a single model year for the 3.0 lb capacity front/rear A/C system in the 2005-07 Chevrolet Suburban. All parts must be those OE-specified for one model year system and no parts may be eliminated or bypassed from the chosen system, or reproduced by a non-OE source. No parts may be added and/or relocated from the OE position in the 2005-07 Suburban. No parts may be modified in any way that could affect system performance for testing under this standard, except adding refrigerant line bends and/or loops to make the system more compact. Reducing the total length of the lines, however, is not permitted. The fixture system shall be powered by an electric motor, run at a speed not to exceed 2000 rpm, and for this test option, no system warm-up or equivalent procedure may be used. The certifying laboratory shall maintain records of all parts purchased, including invoices and payments. The assembly of the parts shall, as an outside-the-vehicle package, duplicate the OE system and its routing, including bends, except for permitted additions of bends and/or loops in refrigerant lines. Aside from the absence of engine operation and the limitations posed by the standard and the use of the electric motor, the test shall otherwise be the same as the test on the Suburban, including test temperature.

Standard for Recovery Only Equipment for HFC-134a Refrigerant (40 CFR 82, Subpart B, Appendix D)

TAKEN FROM SAE J2810 OCT2007

Foreword

This Appendix establishes the specific minimum equipment requirements for the recovery of HFC-134a that has been directly removed from, motor vehicle air-conditioning systems.

Specifications and General Description

- The equipment must be able to recover (extract) HFC-134a (R-134a) refrigerant from a mobile A/C system.
- The equipment shall be suitable for use in an automotive service garage environment.
- The equipment shall be certified by an EPA-listed laboratory to meet this standard. SAE J2810.
- The equipment shall have a label with bold type, minimum 3 mm high, saying "Design Certified by (certifying agent, EPA listed laboratory) to meet SAE J2810 for use only with HFC-134a (R-134a). If it is to be re-used in an A/C system, the refrigerant recovered with this equipment must be processed to the appropriate ARI 700 specifications or to specifications by using equipment certified to perform to SAE J2788."
- 3.5SAE J1739 -- Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), and Potential Failure Mode and Effects Analysis for Machinery (Machinery FMEA) shall be applied to the design and development of service equipment.

Safety Requirements

- The equipment must comply with applicable federal, state, and local requirements on equipment related to the handling of HFC-134a (R-134a) material. Safety precautions or notices, labels, related to the safe operation of the equipment shall also be prominently displayed on the equipment and should state "CAUTION—SHOULD BE OPERATED ONLY BY CERTIFIED PERSONNEL." The safety identification shall be located on the front near the controls.
- The equipment must comply with applicable safety standards for the electrical and mechanical systems.

5. Operating Instructions

- The equipment manufacturer must provide operating instructions that include information required by SAE J639, necessary maintenance procedures, and source information for replacement parts and repair.
- The instruction manual shall include the following information on the lubricant removed. Only new lubricant, as identified by the system manufacturer, should be replaced in the mobile A/C system. Removed lubricant from the system and/or the equipment shall be disposed of in accordance with the applicable federal, state, and local procedures and regulations.
- The equipment must prominently display the manufacturer's name, address, the type of refrigerant it is designed to extract (R-134a), a service telephone number, and any items that require maintenance or replacement that affect the proper operation of the equipment. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation.

- The equipment manufacturer shall provide a warning in the instruction manual regarding the possibility of refrigerant contamination from hydrocarbons, leak sealants and refrigerants other than R-134a in the mobile A/C system being serviced.
- Recovery equipment having refrigerant identification equipment shall meet the requirements of SAE J1771.
- Recovery equipment not having refrigerant identification capability shall have instructions warning the technician that failure to verify that the system contains only R-134a potentially exposes him or her to danger from flammable refrigerants and health hazards from toxic refrigerants. The instructions also shall alert to possible contamination problems to the recovery equipment from sealants and refrigerants other than R-134a, and to the fact that a refrigerant other than R-134a would require special handling by someone with specific expertise and equipment.

6. Function Description

- The equipment must be capable of continuous operation in ambient temperatures of 10 °C (50 °F) to 49 °C (120 °F). Continuous is defined as completing recovery operation with no more than a brief reset between servicing vehicles, and shall not include time delays for allowing a system to outgas (which shall be part of the recovery period provided by this standard).
    - The equipment shall demonstrate ability to recovery a minimum of 95.0% of the refrigerant from the test vehicle in 30.0 minutes or less, without prior engine operation (for previous eight hours minimum), external heating or use of any device (such as shields, reflectors, special lights, etc.), which could heat components of the system. The recovery procedure shall be based on a test at 21 °C to 24 °C (70 °F to 75 °F) ambient temperature. The test system for qualifying shall be a 1.4 kg (3.0 lbs) capacity orifice tube/accumulator system in a 2005-07 Chevrolet Suburban with front and rear A/C or the test option described in section 9.
    - The equipment shall demonstrate ability to recover a minimum of 85% of the refrigerant from the test vehicle or system of in 30.0 minutes or less, at an ambient temperature of 10 °C to 13 °C (50 °F to 55 °F), subject to the same restrictions regarding engine operation and external heating.
    - During recovery operation, the equipment shall provide overfill protection so that the liquid fill of the storage container does not exceed 80% of the tank's rated volume at 21 °C (70 °F). This will ensure that the container meets Department of Transportation (DOT) Standard, CFR Title 49, section 173.304 and the American Society of Mechanical Engineers.
    - Portable refillable tanks or containers used in conjunction with this equipment must be labeled “HFC-134a (R-134a) and meet applicable Department of Transportation (DOT) or Underwriters Laboratories (UL) Standards, and incorporate fittings per SAE J2197.
    - The cylinder valves shall comply with the standard for cylinder valves UL 1769.
    - The pressure relief device shall comply with the Pressure Relief Device Standard Part 1—Cylinders for Compressed Gasses CGA Pamphlet S-1.1.
    - The tank assembly shall be marked to indicate the first retest date, which shall be five years from the date of manufacture. The marking shall indicate that retest must be performed every subsequent five years. SAE J2296 provides an inspection procedure.

The marking shall be in letters at least 6 mm (0.25 in) high. If ASME tanks, as defined in UL-1963, are used, they are exempt from the retest requirements.

- If the marketer permits use of a refillable refrigerant tank, a method must be provided (including any necessary fittings) for transfer to a system that ensures proper handling (recycling or other, environmentally-legal disposal). Restricting the equipment to use of non-refillable tanks eliminates compliance with this provision.
- Prior to testing under this standard, the equipment must be preconditioned with a minimum of 13.6 kg of the standard contaminated HFC-134a (R-134a) at an ambient of 21 °C before starting the test cycle. Sample amounts are not to exceed 1.13 kg with sample amounts to be repeated every 5 min. The test fixture shown in Figure 1 shall be operated at 21 °C. Contaminated HFC-134a (R-134a) samples shall be processed at ambient temperatures of 10 °C and 49 °C (50 °F to 120 °F), without the equipment shutting down due to any safety devices employed in this equipment.
    - Contaminated HFC-134a (R-134a) sample shall be standard contaminated HFC-134a (R-134a) refrigerant, 13.6 kg sample size, consisting of liquid HFC-134a (R-134a) with 1300 ppm (by weight) moisture at 21 °C (70 °F) and 45 000 ppm (by weight) of oil (polyalkylene glycol oil with 46-160 cst viscosity at 40 °C) and 1000 ppm by weight of noncondensable gases (air).
    - Portable refillable containers used in conjunction with this equipment must meet applicable DOT Standards. The color of the container must be blue with a yellow top to indicate the container holds used HFC-134a (R-134a) refrigerant. The container must be permanently marked on the outside surface in black print at least 20 mm high, “CONTAMINATED HFC-134a (R-134a)—DO NOT USE, MUST BE REPROCESSED.”
    - 6.3.3The portable refillable container shall have a 1/2 in ACME thread.
- Additional Storage Tank Requirements.
    - The cylinder valve shall comply with UL 1769.
- All flexible hoses must meet SAE J2196 for service hoses.
- Service hoses must have shutoff devices located at the connection points to the system being serviced to minimize introduction of noncondensable gases into the recovery equipment during connection and the release of the refrigerant during disconnection.
- The equipment must be able to separate the lubricant from recovered refrigerant and accurately indicate the amount removed from the simulated automotive system during processing in 20 mL (0.7 fl oz) units.
- The purpose of indicating the amount of lubricant removed is to ensure that a proper amount of new lubricant is returned to the mobile A/C system for compressor lubrication, if the system is to be charged with equipment meeting SAE J2788.
- Refrigerant dissolved in this lubricant must be accounted for to prevent lubricant overcharge of the mobile A/C system.
- The equipment must be capable of continuous operation in ambient temperatures of 10 °C to 49 °C (50 °F to120 °F) and comply with 6.1 to 6.4 of this standard.
- For test validation, the equipment is to be operated according to the manufacturer's instructions.
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7. Test Procedure A at 21 °C to 24 °C (70 °F to 75 °F).

The test vehicle (2005-2007 Chevrolet Suburban with rear A/C system—1.4 kg/ 3.0 lb) or laboratory fixture per section 10.5 of SAE J2788, shall be prepared as for SAE J2788, section 10.3, following Steps 1, 2, 3, 4, and then the following:

- Using a machine certified to SAE J2788 and with the machine on a platform scale with accuracy to within plus/minus 3.0 grams at the weight of the machine, charge the system to the vehicle manufacturer's recommended amount of refrigerant (1.4 kg-3.0 lb). The actual charge amount per the reading on the platform scale shall be used as the basis for the recovery efficiency of the recovery-only machine being tested to this standard. Run the engine (or operate test fixture with electric motor) for up to 15 minutes at up to 2000 rpm to circulate oil and refrigerant. The system then must rest for eight hours.
- Place the recovery machine on the platform scale and record the weight with the hoses draped over the machine. Ambient temperature shall be within the range of 21 °C to 24 °C (70 °F to 75 °F) for this test, which shall be performed without the immediately prior engine operation permitted by SAE J2788, Section 10.3, Step No.1. The only permitted engine operation is as specified in 7.1.
- Start the timer. Connect the service hoses to the system of the test vehicle and perform the recovery per the equipment manufacturer's instructions. The vehicle system's service valve cores must remain in the fittings for this procedure.
- When recovery is completed, including from the service hoses if that is part of the recommended procedure, disconnect the hoses and drape over the machine. Stop the timer. The elapsed time shall be no more than 30 minutes.
- Remove the oil reservoir, empty and reinstall. The platform scale shall indicate that a minimum of 95.0% of the refrigerant has been recovered, based on the charge amount indicated by the platform scale. If the machine has recovered the minimum of 95.0% within the 30.0 minutes, the next test shall be performed. If it fails this test, the marketer of the equipment must document changes to the equipment to upgrade performance before a retest is allowed. If it passes, the laboratory can proceed to Test Procedure B-10 °C to 13 °C (50 °F to 55 °F).

Test Procedure B at 10 °C to 13 °C (50 °F to 55 °F).

The test vehicle (2005-2007 Chevrolet Suburban front/rear A/C system (1.4 kg/3.0 lb) or test fixture per section 10.5 of SAE J2788, shall be prepared as per 7.0 and 7.1 of this standard, and then the following:

- Place the recovery machine on the platform scale and record the weight with the hoses draped over the machine.
- Ambient temperature at this time shall be no higher than 10 °C to13 °C (50 °F to 55 °F).
- Start the timer. Connect the service hoses to the system of the test vehicle and perform the recovery per the equipment manufacturer's instructions. This also shall be performed without the immediately prior engine operation permitted by SAE J2788, section 10.4, Step No. 1. The vehicle system's service valve cores must remain in the fittings for this procedure.
- When recovery is completed, including from the service hoses if that is part of the recommended procedure, disconnect the hoses and drape over the machine. Stop the timer. The elapsed time shall be no more than 30 minutes.
- Remove the oil reservoir, empty and reinstall. The platform scale shall indicate that a minimum of 85.0% of the refrigerant has been recovered, based on the charge amount indicated by the platform scale. If the machine has recovered the minimum of 85.0% within

the 30 minutes, it has passed the test procedure and if it meets all other requirements of this standard, it is certified.

9. Test Option

- As in SAE J2788, Section 10.5, as an alternative to a 2005-2007 Chevrolet Suburban with rear A/C (1.4 kg-3.0 lb) system, a laboratory test fixture may be used to certify to SAE J2810 the fixture must be composed entirely of all the original equipment parts of a single model year for the 1.4 kg (3.0 lb) capacity system. All parts must be those OE-specified for one model year system and no parts may be eliminated or bypassed from the chosen system or reproduced from a non-OE source. No parts may be added and/or relocated from the OE position in the 2005-07 Suburban. No parts may be modified in any way that could affect system performance for testing under this standard, except adding refrigerant line bends and/or loops to make the system more compact. Reducing the total length of the lines, however, is not permitted.
- The fixture systems for this standard shall not be powered by an electric motor during recovery, although a motor can be used, run at a speed not to exceed 2000 rpm, as part of the preparatory process, including installation of the charge.

The Standard for Automotive Refrigerant Recycling Equipment Intended for Use With Both CFC-12 and HFC-134a (40 CFR 82, Subpart B, Appendix E)

Taken from SAE J1770 NOV 2010

The purpose of this standard is to establish specific minimum equipment requirements for automotive refrigerant recycling equipment intended for use with both CFC-12 and HFC-134a in a common refrigerant circuit. Establishing such specifications will assure that this equipment does not cross contaminate refrigerant above specified limits when used under normal operating conditions.

Specification and General Description

The equipment shall be suitable for use in an automotive service garage environment and be capable of continuous operation in ambients from 10 to 49 °C. The equipment must be certified that it meets this specification by Underwriters Laboratories Inc. (UL), or by an equivalent Nationally Recognized Testing Laboratory (NRTL). The equipment shall have a label which states "Design Certified by (Certifying Agent) to meet SAE J1770 for recycling CFC-12 and HFC-134a using common refrigerant circuits", in bold-type letters a minimum of 3 mm in height.

Equipment Requirements

General

- The equipment shall be capable of preventing cross contamination to the level required by Section 9.2.1.G before an operation involving a different refrigerant can begin. The equipment must prevent initiation of the recovery operation if the equipment is not set up properly.
- If an operator action is required to clear the unit prior to reconnecting for a different refrigerant, the equipment shall be provided with a means which indicates which refrigerant was last processed.
- Means shall be provided to prevent recovery from both an CFC-12 and HFC-134a mobile air conditioning system concurrently.
- Transfer of recycled refrigerant—Recycled refrigerant for recharging and transfer shall be taken from the liquid phase only.

Seat Leakage Test

Valves, including electrically operated solenoid valves, that are used to isolate CFC-12 and HFC-134a refrigerant circuits, shall have a seat leakage rate not exceeding 15 g/yr (1/2 oz/yr) before and after 100,000 cycles of operation. This Endurance Test shall be conducted with HFC-134a at maximum operating pressure as determined by sections 8.1 and 8.2. The Seat Leakage Test shall be performed at 1.5 times this pressure at an ambient of 24 °C.

Interlocks

Electrical interlock devices used to prevent cross contamination of refrigerant shall be operated for 100,000 cycles and there shall be no failure that would permit cross contamination of refrigerant. Solid state inter lock devices shall comply with the Transient Overvoltage Test and the Fast Transient (Electric Noise) Test contained in the Standard for Tests for Safety Related Controls Employing Solid-State Devices, UL 991.

Noncondensable Gases

- The equipment shall either automatically purge noncondensables (NCGs) if the acceptable level is exceeded or incorporate a device that indicates to the operator the NCG level has been exceeded. A pressure gauge used to indicate an NCG level shall be readable in 1 psig increments. NCG removal must be part of the normal operation of the equipment and instructions must be provided to enable the task to be accomplished within 30 minutes.
- Refrigerant loss from noncondensable gas purging, oil removal, and refrigerant clearing shall not exceed more than 5 percent by weight of the total amount of refrigerant through the equipment.

Filter

A 15 micron filter, or other equivalent means, to remove particulates of 15 micrometers spherical diameter or greater shall be located before any manual electrically operated valves that may cause cross contamination.

Moisture and Acid

- The equipment shall incorporate a desiccant package that must be replaced before saturated with moisture, and whose acid capacity is at least 5% by weight of the dry desiccant.
- The equipment shall be provided with a moisture detection means that will reliably indicate when moisture in the HFC-134a exceeds 50 ppm, or in the CFC-12 exceeds 15 ppm, and requires the filter/drier replacement.

Operating Instructions

- The equipment manufacturer must provide operating instructions, including proper attainment of vehicle system vacuum (i.e., when to stop the extraction process, and also to stop the extraction process if it is noticed that the A/C system being serviced has a leak), filter/desiccant replacement, and purging of noncondensable gases (air). The instructions shall indicate that the correct sequence of operation be followed so that the equipment can properly remove contaminates to the acceptable level. Also to be included are any other necessary maintenance procedures, source information for replacement parts and repair, and safety precautions.
- The equipment must prominently display the manufacturer's name, address, the type of refrigerant (CFC-12 and HFC-134a), a service telephone number, and the part number for the replacement filter/drier. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation.

Safety Requirements

- The equipment must comply with applicable federal, state, and local requirements on equipment related to handling CFC-12 and HFC-134a material. Safety precautions or notices related to the safe operation of the equipment shall be prominently displayed on the equipment and should also state “CAUTION—SHOULD BE OPERATED BY QUALIFIED PERSONNEL”.
- HFC-134a has been shown to be nonflammable at ambient temperature and atmospheric pressure. The following statement shall be in the operating manual: “Caution: HFC-134a service equipment or vehicle A/C systems should not be pressure tested or leak tested with compressed air. Some mixtures of air and HFC-134a have been shown to be combustible at elevated pressures (when contained in a pipe or tank). These mixtures may be potentially dangerous, causing injury or property damage. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.”

Functional Description

General

- The equipment must be capable of ensuring recovery of the CFC-12 and HFC-134a from the system being serviced, by reducing the system to a minimum of 102 mm of mercury below atmospheric pressure (i.e., vacuum).
- The equipment must be compatible with leak detection material that may be present in the mobile A/C system.

Shut Off Device

To prevent overcharge, the equipment must be equipped to protect the tank used to store the recycled refrigerant with a shutoff device and a mechanical pressure relief valve.

Storage Tanks

- Portable refillable tanks or containers shall be supplied with this equipment and must be labeled "HFC-134a" or "CFC-12" as appropriate, meet applicable Department of Transportation (DOT) or NRTL's Standards and be adaptable to existing refrigerant service and charging equipment.
- The cylinder valve shall comply with the Standard for Cylinder Valves, UL 1769.
- The pressure relief device shall comply with the Pressure Relief Device Standard Part 1—Cylinders for Compressed Gases, CGA Pamphlet S-1.1.
- The tank assembly shall be marked to indicate the first retest date, which shall be 5 years after the date of manufacture. The marking shall indicate that retest must be performed every subsequent 5 years. The marking shall be in letters at least 6 mm high.

Overfill Protection

During operation, the equipment must provide overfill protection to assure that during filling or transfer, the tank or storage container cannot exceed 80% of volume at 21.1 °C of its maximum rating as defined by DOT standards, 49 CFR 173.304 and American Society of Mechanical Engineers.

Hoses and Connections

- Separate inlet and outlet hoses with fittings and separate connections shall be provided for each refrigerant circuit.
- All flexible hoses and fittings must meet SAE J2196 (for CFC-12) and SAE J2197 (for HFC-134a).
- Service hoses must have shutoff devices located within 30 cm of the connection point to the system being serviced.

Lubricant Separation

- The equipment must be able to separate the lubricant from the removed refrigerant and accurately indicate the amount of lubricant removed during the process, in 30 mL (1 fl oz) units. Refrigerant dissolves in lubricant and, as a result, increases the volume of the recovered lubricant sample. This creates the illusion that more lubricant has been recovered that actually has been. The equipment lubricant measuring system must take into account such dissolved refrigerant removed from the A/C system being serviced to prevent overcharging the vehicle system with lubricant.
  (NOTE: Use only new lubricant to replace the amount removed the recycling process. Used lubricant should be discarded per applicable federal, state and local requirements.)
- The equipment must be provided with some means, such as a lockout device, which will prevent initiation of the recovery operation after switching to the other refrigerant, if the lubricant has not been drained from the oil separator.

8. Testing

8.0Equipment shall be tested in sequence as noted The filter/drier may be replaced only as noted

CFC-12 Recycling Cycle

- The maximum operating pressure of the equipment shall be determined when recycling CFC-12 while conducting the following tests. This pressure is needed for the Seat Leakage Test, Section 4.2.
- The equipment must be preconditioned with 13.6 kg of the standard contaminated CFC-12 (see section 8.1.2a) at an ambient of 21 °C before starting the test cycle. Sample amounts shall be 1.13 kg with sample amounts to be repeated every 5 minutes. The sample method fixture, defined in Figure 1 to Appendix A, shall be operated at 21 °C.
- Standard contaminated CFC-12 refrigerant shall consist of liquid CFC-12 with 100 ppm (by weight) moisture at 21 °C and 45,000 ppm (by weight) mineral oil 525 suspension viscosity nominal and 770 ppm by weight of noncondensable gases (air).
- The high moisture contaminated sample shall consist of CFC-12 vapor with 1000 ppm (by weight) moisture.
- The high oil contaminated sample shall consist of CFC-12 with 200,000 ppm (by weight) mineral oil 525 suspension viscosity nominal.
- After preconditioning as stated in section 8.1.2, the test cycle is started, processing the following contaminated samples through the equipment.

A. 13.6 kg (1.13 kg per batch) of standard contaminated CFC-12.
B. 1 kg of high oil contaminated CFC-12.
C. 4.5 kg (1.13 kg per batch) of standard contaminated CFC-12.
D. 1 kg of high moisture contaminated CFC-12.

- The CFC-12 is to be cleaned to the minimum purity level, as defined in SAE J1991, with the equipment operating in a stable ambient of 10, 21, and 49 °C and processing the samples as defined in section 8.1.5.

HFC-134a Recycling Cycle

- The maximum operating pressure of the equipment shall be determined when recycling HFC-134a while conducting the following tests. This pressure is needed for the Seat Leakage Test, Section 4.2.
- The equipment must be preconditioned by processing 13.6 kg of the standard contaminated HFC-134a (see section 8.2.2a) at an ambient of 21 °C before starting the test cycle. 1.13 kg samples are to be processed at 5 minute intervals. The text fixture shown in Figure 1 to Appendix A shall be operated at 21 °C.
- The standard contaminated refrigerant shall consist of liquid HFC-134a with 1300 ppm (by weight) moisture (equivalent to saturation at 38°[100 °F]), 45,000 ppm (by weight) HFC-134a compatible lubricant, and 1000 ppm (by weight) of noncondensable gases (air).
- The HFC-134a compatible lubricant referred to in section 8.2.2a shall be a polyalkylene glycol based synthetic lubricant or equivalent, which shall contain no more than 1000 ppm by weight of moisture.
- Following the preconditioning procedure per section 8.2.2, 18.2 kg of standard contaminated HFC-134a are to be processed by the equipment at each stable ambient temperature of 10, 21, and 49 °C.
- The HFC-134a is to be cleaned to the purity level, as defined in SAE J2099.

Refrigerant Cross Contamination Test

General

- For test validation, the equipment is to be operated according to the manufacturer's instruction.
- The equipment shall clean the contaminated CFC-12 refrigerant to the minimum purity level as defined in Appendix A, when tested in accordance with the requirements in section 8.1.
- The equipment shall clean the contaminated HFC-134a refrigerant to the purity level defined in Appendix C, when tested in accordance with the requirements in section 8.2.

Test Cycle

The following method shall be used after the tests and requirements in Sections 8.1 and 8.2, respectively, are completed. Following the manufacturer's instructions, the equipment shall be cleared of HFC-134a, prior to beginning step A. The only refrigerant used for this is noted in steps A, C, and E of section 9.2.1. The test fixture shown in Figure 1 to Appendix A shall be used and the test shall be conducted at 10, 21, and 49 °C ambients.

A. A 1.13 kg standard contaminated sample of CFC-12 (see section 8.1.2a) shall be processed by the equipment.

B. Follow manufacturer's instructions to clear the equipment of CFC-12 before processing HFC-134a.

C. Process a 1.13 kg, standard contaminated sample of HFC-134a (see section 8.2.2a) through the equipment.

D. Follow manufacturer's instructions to clear the equipment of HFC-134a before processing CFC-12.

E. Process a 1.13 kg standard contaminated sample of CFC-12 (see section 8.1.2a) through the equipment.

F. Follow manufacturer's instructions to clear the equipment of CFC-12.

G. The amount of cross contaminated refrigerant, as determined by gas chromatography, in samples processed during steps C and E of section 9.2.1., shall not exceed 0.5 percent by weight.

Sample Analysis

General

The processed contaminated samples shall be analyzed according to the following procedure.

Quantitative Determination of Moisture

The recycled liquid phase sample of refrigerant shall be analyzed for moisture content via Karl Fischer coulometer titration or an equivalent method. The Karl Fischer apparatus is an instrument for precise determination of small amounts of water dissolved in liquid and/or gas samples.

In conducting the test, a weighed sample of 30 to 130 g is vaporized directly into the Karl Fischer anolyte. A coulometer titration is conducted and the results are calculated and displayed as parts per million moisture (weight).

Determination of Percent Lubricant

The amount of lubricant in the recycled sample of refrigerant/lubricant is to be determined by gravimetric analysis. Following venting of noncondensable, in accordance with the manufacturer's operating instructions, the refrigerant container shall be shaken for 5 minutes prior to extracting samples for test. A weighed sample of 175 to 225 g of liquid refrigerant/lubricant is allowed to evaporate at room temperature. The percent lubricant is to be calculated from the weight of the original sample and the residue remaining after the evaporation.

Noncondensable Gas

- The amount of noncondensable gas is to be determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A Propak Q column at 130 °C and a hot wire detector may be used for analysis.
- This test shall be conducted on liquid phase samples of recycled refrigerant taken from a full container as defined in 7.4 within 30 minutes following the proper venting of noncondensable gases.
- The samples shall be shaken for at least 15 minutes prior to testing while at a temperature of 24 °C ±2.8 °C.

10.5 Refrigerant Cross Contamination

The amount of cross contamination of CFC-12 in HFC-134a or HFC-134a in CFC-12 shall not exceed 0.5 percent by weight as determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A 1% SP-1000 on Carbopack B (60/80 mesh) column may be used for the analysis.

Standard for Recover-Only Equipment That Extracts a Single, Specific Refrigerant Other Than CFC-12 or HFC-134a (40 CFR 82, Subpart B, Appendix F)

Foreword

These specifications are for equipment that recover, but do not recycle, any single, specific automotive refrigerant other than CFC-12 or HFC-134a, including a blend refrigerant.
The purpose of this standard is to provide equipment specifications for the recovery of any single, specific refrigerant other than CFC-12 or HFC-134a, including a blend refrigerant, which are either (1) to be returned to a refrigerant reclamation facility that will process the refrigerant to ARI Standard 700-93 or equivalent new product specifications at a minimum, or (2) to be recycled in approved refrigerant recycling equipment, or (3) to be destroyed. This standard applies to equipment used to service automobiles, light trucks, and other vehicles with similar air conditioning systems.

Specifications and General Description

- The equipment must be able to extract from a mobile air conditioning system the refrigerant other than CFC-12 or HFC-134a to which the equipment is dedicated.
- The equipment shall be suitable for use in an automotive service garage environment as defined in section 6.8.
- The equipment discharge or transfer fitting shall be unique to prevent the unintentional use of the extracted refrigerant for recharging auto air conditioners.
- Equipment Certification-The equipment shall be certified by Underwriters Laboratories or an—equivalent certifying laboratory to meet this standard.
- Label Requirements—The equipment shall have a label “Designed Certified by (Company Name) to meet EPA requirements for use only with (the applicable refrigerant). The refrigerant from this equipment must be processed to ARI 700-93 specifications or equivalent new product specifications before reuse in a mobile air-conditioning system.” The minimum letter size shall be bold type 3 mm in height.

Safety Requirements

The equipment must comply with applicable federal, state, and local requirements on equipment related to the handling of the applicable refrigerant material. Safety precautions or notices or labels related to the safe operation of the equipment shall also be prominently displayed on the equipment and should state “CAUTION—SHOULD BE OPERATED BY CERTIFIED PERSONNEL.” The safety identification shall be located on the front near the controls. The equipment must comply with applicable safety standards for electrical and mechanical requirements.

Operating Instructions

- The equipment manufacturer must provide operating instructions that include information equivalent to that required by SAE J1629, necessary maintenance procedures, and source information for replacement parts and repair.
- The instruction manual shall include the following information on the lubricant removed: Only new lubricant, as identified by the system manufacturer, should be replaced in the air conditioning system. Removed lubricant from the system and/or the equipment shall be disposed on in accordance with the applicable federal, state, and local procedures and regulations.

- The equipment must prominently display the manufacturer's name, address, the type of refrigerant it is designed to extract, a service telephone number, and any items that require maintenance or replacement that affect the proper operation of the equipment. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation.

Functional Description

- The equipment must be capable of ensuring removal of refrigerant from the system being serviced by reducing the system pressure to a minimum of 102 mm (4 in) of mercury below atmospheric pressure (i.e., to a vacuum). To prevent system delayed outgassing, the unit must have a device that assures that the refrigerant has been recovered from the air-conditioning system.
- Testing laboratory certification of the equipment capability is required which shall process contaminated refrigerant samples at specific temperatures.
- The equipment must be preconditioned by processing 13.6 kg (30 lb) of the standard contaminated refrigerant at an ambient of 21 °C (70 °F) before starting the test cycle. Sample amounts are not to exceed 1.13 kg (2.5 lb) with sample amounts to be processed at 5 min. intervals. The test method fixture shall be operated at 21 °C (70 °F). Contaminated refrigerant samples shall be processed at ambient temperatures of 10 and 49 °C, without equipment shutting due to any safety devices employed in this equipment.
- Standard contaminated refrigerant, 13.6 kg (30 lb) sample size, shall consist of liquid refrigerant with 1000 ppm (by weight) moisture at 21 °C and 45,000 ppm (by weight) of oil (total of one-third mineral oil 525 suspension nominal, one-third PAG with 100 cSt viscosity at 40 °C or equivalent, and one-third POE with 68 cSt viscosity at 40 °C or equivalent) and 1000 ppm by weight of noncondensable gases (air). Refrigerant shall be identified prior to the recovery process to ±2% of the original manufacturer's formulation submitted to, and accepted by, EPA under its Significant New Alternatives Policy program, with the exception that any flammable components shall be identified to ±1%.
- Portable refillable containers used in conjunction with this equipment must meet applicable DOT Standards.
    - The container color must be gray with a yellow top to identify that it contains used refrigerant. It must be permanently marked on the outside surface in black print at least 20 mm high “DIRTY [NAME OF REFRIGERANT]—DO NOT USE, MUST BE PROCESSED”.
    - The portable refillable container shall have a unique thread connection for the specific refrigerant.
    - During operation, the equipment shall provide overfill protection to assure that the storage container liquid fill does not exceed 80% of the tank's rated volume at 21 °C per DOT Standard, 49 CFR 173.304, and the American Society of Mechanical Engineers.
- Additional Storage Tank Requirements
    - The cylinder valve shall comply with UL 1769.
    - The pressure relief device shall comply with CGA Pamphlet S-1.1.
    - The container assembly shall be marked to indicate the first retest date, which shall be 5 years after date of manufacture. The marking shall indicate that retest must be performed every subsequent 5 years. The marking shall be in letters at least 6 mm high.

- All flexible hoses must meet SAE J2196 for service hoses except that fittings shall be unique to the applicable refrigerant.
- Service hoses must have shutoff devices located within 30 cm of the connection point to the system being serviced to minimize introduction of noncondensable gases into the recovery equipment during connection and the release of the refrigerant during disconnection.
- The equipment must be able to separate the lubricant from the recovered refrigerant and accurately indicate the amount removed from the simulated automotive system during processing in 30 mL units.
    - The purpose of indicating the amount of lubricant is to ensure that a proper amount of new lubricant is returned to the mobile air conditioning system for compressor lubrication.
    - Refrigerant dissolved in this lubricant must be accounted for to prevent system lubricant overcharge of the mobile air-conditioning system.
- The equipment must be capable of continuous operation in temperatures of 10 to 49 °C and must comply with 6.1 and 6.2.

7. For test validation, the equipment is to be operated according to the manufacturer's instructions.

Application

The purpose of this standard is to provide equipment specifications for the recovery of any refrigerant other than CFC-12 or HFC-134a for return to a refrigerant reclamation facility that will process it to ARI Standard 700-93 (or for recycling in other EPA approved recycling equipment, in the event that EPA in the future designates a standard for equipment capable of recycling refrigerants other than CFC-12 or HFC-134a).

40 CFR 82.161 - Technician 608 certification.

Technician section 608 certification.

- Effective November 14, 1994, technicians, except technicians who successfully completed voluntary certification programs that apply for approval under § 82.161(g) by December 9, 1994, must be certified by an approved technician certification program under the requirements of this paragraph. Effective May 15, 1995, all technicians must be certified by an approved technician certification program under the requirements of this paragraph.
    - Technicians, as defined in § 82.152, who maintain, service, or repair small appliances must be properly certified as Type I technicians.
    - Technicians who maintain, service, or repair medium-, high-, or very high-pressure appliances, except small appliances, MVACs, and MVAC-like appliances, or dispose of medium-, high-, or very high-pressure appliances, except small appliances, MVACs, and MVAC-like appliances, must be properly certified as Type II technicians.
    - Technicians who maintain, service, or repair low-pressure appliances or dispose of low-pressure appliances must be properly certified as Type III technicians.
    - Technicians who maintain, service, or repair low- and high-pressure equipment as described above must be properly certified as Universal technicians.
    - Technicians who maintain, service, or repair MVAC-like appliances must either be properly certified as Type II technicians or complete the training and certification test offered by a training and certification program approved under § 82.40 *(SECTION 609).*

      NOTE: Technicians certified under Section 608 are permitted to purchase HCFC-22 (R-22). Technicians certified under Section 609 are not. HCFC-12 is the refrigerant of choice in refrigerator trucks.
    - Apprentices are exempt from this requirement provided the apprentice is closely and continually supervised by a certified technician while performing any maintenance, service, repair, or disposal that could reasonably be expected to release refrigerant from appliances into the environment. The supervising certified technician is responsible for ensuring that the apprentice complies with this subpart.
- Test Subject Material. The Administrator shall maintain a bank of test questions divided into four groups, including a core group and three technical groups. The Administrator shall release this bank of questions only to approved technician certification programs. Tests for each type of certification shall include a minimum of 25 questions drawn from the core group and a minimum of 25 questions drawn from each relevant technical group. These questions shall address the subject areas listed in appendix D.
- Program Approval. Persons may seek approval of any technician certification program (program), in accordance with the provisions of this paragraph, by submitting to the Administrator at the address in § 82.160(a) verification that the program meets all of the standards listed in appendix D and the following standards:
    - Alternative Examinations. Programs are encouraged to make provisions for non-English speaking technicians by providing tests in other languages or allowing the use of a translator when taking the test. If a translator is used, the certificate received must indicate that translator assistance was required. A test may be administered

orally to any person who makes this request, in writing, to the program at least 30 days before the scheduled date for the examination. The letter must explain why the request is being made.

- Recertification. The Administrator reserves the right to specify the need for technician recertification at some future date, if necessary, by placing a notice in the Federal Register.
- Proof of Certification. Programs must issue individuals a wallet-sized card to be used as proof of certification, upon successful completion of the test. Programs must issue an identification card to technicians that receive a score of 70 percent or higher on the closed-book certification exam, within 30 days. Programs providing Type I certification using the mail-in format, must issue a permanent identification card to technicians that receive a score of 84 percent or higher on the certification exam, no later than 30 days after the program has received the exam and any additional required material. Each card must include, at minimum, the name of the certifying program, and the date the organization became a certifying program, the name of the person certified, the type of certification, a unique number for the certified person, and the following text:
  [Name of person] has been certified as a [Type I, Type II, Type III, and/or Universal, as appropriate] technician as required by 40 CFR part 82, subpart F.
- (4) The Administrator reserves the right to consider other factors deemed relevant to ensure the effectiveness of certification programs.

- If approval is denied under this section, the Administrator shall give written notice to the program setting forth the basis for her or his determination.
- If at any time an approved program violates any of the above requirements, the Administrator reserves the right to revoke approval in accordance with § 82.169. In such cases, the Administrator or her or his designated representative shall give notice to the organization setting forth the basis for her or his determination.
- Authorized representatives of the Administrator may require technicians to demonstrate on the business entity's premises their ability to perform proper procedures for recovering and/or recycling refrigerant. Failure to demonstrate or failure to properly use the equipment may result in revocation of the certificate. Failure to abide by any of the provisions of this subpart may also result in revocation or suspension of the certificate. If a technician's certificate is revoked, the technician would need to recertify before maintaining, servicing, repairing or disposing of any appliances.
- Any person seeking approval of a technician certification program may also seek approval to certify technicians who successfully completed a voluntary certification program operated previously by that person. Interested persons must submit to the Administrator at the address in § 82.160(a) verification that the voluntary certification program substantially complied with most of the standards of § 82.161(c) and appendix D of subpart F of this part. If the program did not test or train participants on some elements of the test subject material, the person must submit supplementary information on the omitted material to the Administrator for approval and verify that the approved information will be provided to technicians pursuant to section j of appendix D of subpart F of this part. In this case, the person may not issue a certification card to a technician until he or she has received a signed statement from the technician indicating that the technician has read the supplementary information. Approval may be granted for Type I, Type II, or Type III certification, or some combination

of these, depending upon the coverage in the voluntary certification program of the information in each Type. In order to have their voluntary programs considered for approval, persons must submit applications both for approval as a technician certification program and for approval as a voluntary program by December 9, 1994.

- Persons who are approved to certify technicians who successfully completed their voluntary programs pursuant to § 82.161(g)(1) must:
    - Notify technicians who successfully completed their voluntary programs of the Administrator's decision within 60 days of that decision;
    - Send any supplementary materials required pursuant to § 82.161(g)(1) to technicians who successfully completed their voluntary programs within 60 days of the Administrator's decision; and
    - Send certification cards to technicians who successfully completed their voluntary programs within 60 days of receipt of signed statements from the technicians indicating that the technicians have read the supplementary information.
- Persons who are disapproved to certify technicians who successfully completed their voluntary programs pursuant to § 82.161(g)(1) must notify technicians who successfully completed their voluntary programs of the Administrator's decision within 30 days of that decision.
- Persons who withdraw applications for voluntary program approval submitted pursuant to § 82.161(g)(1) must inform technicians who successfully completed their voluntary programs of the withdrawal by the later of 30 days after the withdrawal or December 9, 1994.
- Technicians who successfully completed voluntary certification programs may receive certification in a given Type through that program only if:
    - The voluntary certification program successfully completed by the technician is approved for that Type pursuant to § 82.161(g)(1) ;
    - The technician successfully completed the portions of the voluntary certification program that correspond to that Type; and
    - The technician reads any supplementary materials required by the Administrator pursuant to § 82.161(g)(1) and section j of appendix D of subpart F of this part, and returns the signed statement required by § 82.161(g)(1).

J2064 FEB2011 -- R134a Refrigerant Automotive Air-Conditioned Hose

MANUFACTURE

Size -- Standard dimensions are given in the first column of Table 1. Other sizes are permitted as long as section 4.1 Bulk Hose Identification is satisfied.

Types Including, but not limited to the following:

Type A - Elastomeric, Textile Reinforced The hose shall be built having a suitable seamless synthetic elastomeric tube. The reinforcement shall consist of textile yarn, cord, or fabric adhered to the tube and cover. The outer cover shall be heat- and ozone-resistant synthetic elastomer.

Type B - Elastomeric, Wire Reinforced -- The hose shall be built having a suitable seamless synthetic elastomeric tube. The reinforcement shall consist of steel wire adhered to the elastomeric tube. The cover shall consist of a heat-resistant textile yarn impregnated with a synthetic elastomeric cement.

Type C - Barrier, Textile Reinforced -- The hose shall have a suitable thermoplastic barrier between elastomeric layers. The reinforcement shall consist of suitable textile yarn, cord, or fabric adhered to the tube and cover. The outer cover shall be heat- and ozone-resistant synthetic elastomer.

Type D -- Thermoplastic, Textile Reinforced, Elastomeric Cover

The hose shall have a suitable thermoplastic tube. The reinforcement shall consist of a suitable textile yarn, cord, or fabric adhered to the tube and cover. The outer cover shall be heat- and ozone-resistant synthetic elastomer.

Type E - Veneer, Textile Reinforced -- The hose shall have a suitable thermoplastic veneer lining the inside diameter with an elastomeric tube outer layer. The reinforcement shall consist of a textile yarn, cord, or fabric adhered to the tube and cover. The cover shall be heat- and ozone-resistant synthetic elastomer.

Type F - Veneer, Barrier, Thermoplastic Liner -- The hose shall have a suitable thermoplastic veneer liner with a thermoplastic barrier between elastomeric layers. The reinforcement shall consist of a suitable textile yarn, cord, or fabric adhered to the tube and cover. The cover shall be heat- and ozone-resistant elastomer.

Moisture Vapor Ingression Hose Classes --The following classes are established based upon hose material configuration. Class I - Not greater than 0.039 g/cm2/year

Class II - Not greater than 0.111 g/cm2/year

HOSE IDENTIFICATION

Bulk Hose Identification -- The hose shall be identified with the SAE number, refrigerant, type, class, and size of inside diameter in fraction of inches and/or metric millimeter equivalents, and hose manufacturer's code marking. This marking shall appear on the outer cover of the hose at intervals not greater than 380 mm.

Hose Assembly Identification -- A hose marked "J2064 - R134a", "J2064 - R-1234yf" or "J2064 - R134a/R-1234yf" signifies that it has been coupled, tested, and has met the requirements of SAE J2064 for the marked refrigerant(s). A hose marked "J2064" without any reference to refrigerant signifies that it has been coupled, tested, and has met the requirements of SAE J2064 for R134a only.

Hose Assemblies may be fabricated by the manufacturer, an agent for or customer of the manufacturer, or by the user. Fabrication of permanently attached fittings to refrigerant hose requires specialized assembly equipment. Refrigerant hose from one manufacturer may not be compatible with fittings supplied by another manufacturer. Similarly, assembly equipment from one manufacturer may not be interchangeable with that of another manufacturer.

TESTING

The test procedures described in the current issue of ASTM D 380 shall be followed whenever applicable.

Sample Conditioning -- Charged Samples shall be stabilized for 24 h at 23 °C ± 2 °C prior to testing. Samples shall be checked to ensure specified charge and identify charge loss.

Permeation Test

Test Specimens - 107 cm Samples

The test specimens are to consist of four coupled hose assemblies that have 107 cm ± 1.2 cm of exposed hose between couplings. Three of the coupled hose assemblies are to be used for determining the permeation rate through the hose at a specific temperature. The fourth coupled and plugged hose assembly is to be used for a control hose. One end of each hose assembly is to be fitted with a capped charge fitting. The other end is to be attached to a canister (optional) or plugged with a fitting. If a canister is used, the coupled hose assemblies are to be connected to canisters each having an internal volume of 510 cm3 ± 25 cm3 and having a minimum burst strength of 8.6 MPa.

Charging Procedure and Initial Weights

The coupled hose assemblies are to be weighed and recorded to 0.01 g to establish an initial weight prior to charging. The test samples (control sample not charged) are to be evacuated then charged with refrigerant to 70% ± 3% of the internal volume of the assembly and then reweighed. Cooling of samples is recommended for ease of charging.

Temperature Exposure -- The test temperature is 80 °C ± 2 °C.

Establish Constant Loss Rate

Weigh the samples at the end of the first 24 h temperature exposure and weighing at periodic intervals (minimum period must be 24 h). The weighings shall be reported in net loss of grams, charged sample weight loss minus control sample weight loss. The net weight loss versus time shall continue to be recorded until steady state is reached. Steady state is reached when the last four readings are within 10% of the lowest reading or after 25 days, whichever comes first.

Loss Rate Determination

No charged specimen may lose more than 40 g during the first 24 h period. The permeation rate for each specimen may be determined as follows:

- For Samples that Meet the 10% Rule - Establish the slope of steady-state net loss in grams per day for the 107 cm length specimen and multiply by factors in Table 1 to obtain permeation rate.
- For Samples that Run for 25 Days - The final weighing period, in which the data recorded will be used to determine the permeation rate, shall be the last 5 days or 7 days of the test period. The samples during the final period shall be weighed 5 times at least 24 h apart. The total net weight loss for the final period, divided by the number of days in the period is multiplied by the factors in Table 1 to obtain the permeation rate.
- At the end of the temperature exposure period, the refrigerant charge remaining shall be 50% of the original charge minimum. At the conclusion of the test, the refrigerant charge in each specimen shall be exhausted to a suitable reclamation container.

TABLE 1 - CONVERSION FACTORS

Nominal Hose Size Mean Hose ID Multiply g/day by Factor Shown Multiply g/day mm (in)	mm (in)	to Obtain kg/m2/year	to Obtain lb/ft2/ year
8 (5/16)	8.1 (0.320)	13.414	2.748
10 (13/32)	10.6 (0.418)	10.251	2.100
13 (1/2)	13.0 (0.510)	8.358	1.713
16 (5/8)	16.1 (0.635)	6.749	1.383
19 (3/4)	19.4 (0.765)	5.601	1.148

In order to obtain conversion factor for hoses not listed in Table 1, use the following equations:
for kg/m2/year, Factor = 108.66/D
where:
D = Inner Diameter (mm)
for lb/ft2/year, Factor = 0.877/D
where:
D = Inner Diameter (inches)
Acceptance Determination
The coupled hose assembly shall not be permeable to a refrigerant loss at a rate greater than those listed in Table 1A below.

TABLE 1A - PERMEATION LIMITS

Refrigerant Hose Type	R-134a	R-1234yf
A, B	15 kg/m2/year	18 kg/m2/year
C, D, E, F	5 kg/m2/year	5 kg/m2/year

Coupling Integrity -- It is the hose coupler's responsibility to ensure that the combination of coupling type and specific Hose Manufacturer's Hose Material will meet the following acceptance criteria at all possible combinations of dimensional tolerances.
Test Specimens
Six coupled assemblies shall have 76 mm ± 3 mm of exposed hose and 56 mm ± 8 mm of straight tubing between the couplings with suitable connector and sealed at the other (pinch-welding permitted). Each assembly is attached to a canister with a minimum internal volume of 900 cm3 and equipped with a charging fitting. The minimum canister volume ensures a maximum pressure loss of 0.10 MPa between recharges. A seventh coupled assembly is used as a volatility sample to account for weight losses not associated with refrigerant losses.
Test Procedure with the Appropriate Refrigerant
Charging
Calculate the internal volume of the hose and canister assembly. Charge the canister assembly with an amount of refrigerant compatible lubricant equivalent to half of the internal volume of the hose assembly. Calculate the charge weight of refrigerant by multiplying the system volume less the lubricant volume by using the table below. Evacuate the sample, without removing the lubricant, and add the charge weight ±1 g of refrigerant and record original weight. Check all

fittings to ensure against extraneous refrigerant leakage. After charging, agitate the assembly to insure mixing with the lubricant and wetting of all internal surfaces. Hoses need to be dry to obtain accurate weighings. All weighings are to be made at 18 to 29 °C to the nearest 0.01 g.

TABLE 3 - CHARGE DENSITY

	Temperature [deg C]	Pressure [MPa]	Density [g/cm3]
R134a	125	2.07	0.0783
HFO1234yf	125	2.07	0.085

Example:
Hose Assembly Volume 19.8 cm3 Canister Volume 1260 cm3
Lubricant Volume = (Hose Assembly Volume) / 2 = 9.9 cm3
Charge Weight = (Canister Volume + Hose Assembly Volume - Lubricant Volume) x 0.0783 g/cm3
= (1260 cm3 + 19.8 cm3 - 9.9 cm3) x 0.0783 g/cm3
= 1269.9 cm3 x 0.0783 g/cm3
= 99.4 g

Test Exposure
The assembly shall be oriented such that the liquid phase will always drain into the test coupling assembly. The test shall include four exposure intervals with Test Option 1 or six exposure intervals with Test Option 2, each followed by a leakage evaluation and possible recharging before the next exposure.
Test Option 1 - The four exposure intervals in sequential order are as follows:

- Exposure 1 - 96 h at 125 °C ± 2 °C with canister pressure at 2.07 MPa.
- Exposure 2 - 48 h thermal cycling from -30 to 125 °C in a timer-controlled chamber. The chamber temperature shall change every 4 h and canisters shall reach the desired temperature within 3 h after a temperature change.
- c. Exposure 3 - 96 h at 125 °C ± 2 °C with canister pressure at 2.07 MPa.
- d. Exposure 4 - 48 h thermal cycling from -30 to 125 °C in a timer-controlled chamber. The chamber temperature shall change every 4 h and canisters shall reach the desired temperature within 3 h after a temperature change.

Test Option 2 - The six exposure intervals in sequential order are as follows:

- Exposure 1 - 96 h at 121 °C ± 2 °C with canister pressure at 2.0 MPa.
- Exposure 2 - 48 h at -29 to 121 °C in a timer-controlled chamber. The chamber temperature shall change every 4 h and canisters shall reach the desired temperature within 3 h after a temperature change.
- Exposure 3 - 96 h at 121 °C ± 2 °C with canister pressure at 2.0 MPa.
- Exposure 4 - 48 h at -29 to 121 °C in a timer-controlled chamber. The chamber temperature shall change every 4 h and canisters shall reach the desired temperature within 3 h after a temperature change.
- Exposure 5 - 96 h at 121 °C ± 2 °C with canister pressure at 2.0 MPa.
- Exposure 6 - 48 h at -29 to 121 °C in a timer-controlled chamber. The chamber temperature shall change every 4 h and canisters shall reach the desired temperature within 3 h after a temperature change.

Leakage Evaluation

At the end of each exposure interval, as soon as a canister assembly reaches room temperature of 18 to 29 °C, it shall be evaluated as follows:

- Examine each sample and note any sign of leakage or abnormalities.
- Wipe any visible fluid from the hose assembly, then weigh and record the loss in grams for the interval (less the volatility loss).
- If the net loss is greater than 7 g, terminate the test.
- Flex test the coupled assembly on the canister to ±15 degrees (±8 degrees for hoses 19 mm ID or greater). Make 10 flex cycles in approximately 10 s in each of two perpendicular planes on a coupling assembly. Immediately evaluate and note the presence of hissing (charge loss) or fluid leakage at each coupling.
- Wipe any visible fluid from the hose assembly and reweigh. Continue with the next exposure interval if the weight is within 7 g of original weight. If not, recharge to original weight before continuing. Maintaining the weight within 7 g of original weight insures that the canister assembly Refrigerant restarting pressure shall be no less than 2.0 MPa at 125 □C.

Acceptance Determination

- Applies to six canister assemblies (12 couplings).
- Maximum net weight loss per canister (2 couplings) per Test Option 1 or Test Option 2 shall not exceed 10 g.

Aging Test

- Capped hose assembly shall be evacuated and charged with one atmosphere of refrigerant or nitrogen before coiling around the mandrel of the designated size. Place in a circulating air oven for the time and at the temperature specified. Allow the hose assembly to cool to room temperature, after removal from the oven. Open the hose assembly to a straight length and examine the hose for internal and external cracks visible to the naked eye for exposed hose only.

Cold Test -- The hose shall show no evidence of cracking or breaking when tested as specified. The mandrel used for the hose shall have a diameter eight times the nominal OD of the hose. The test hose assembly shall have a free hose length not less than 600 mm or more than 1000 mm.

- Load the test hose assembly to 70% of capacity with refrigerant at room temperature. For convenience, the hose assembly and refrigerant may be chilled below the boiling point of the refrigerant in order that the refrigerant may be handled in the liquid state. Place the loaded hose assembly in an air oven at 70 °C ± 2 °C for 48 h. Remove hose assembly from the air oven and allow to cool to room temperature.
- Place the hose assembly in a straight position along with designated size mandrel in a cold chamber at -30 °C for 24 h. The cold chamber shall be capable of maintaining a uniform atmosphere of cold dry or a mixture of air and carbon dioxide at the specified temperature with a tolerance of ±2 °C. Without removing the hose assembly from the cold chamber, bend it through 180 degrees over the mandrel of the designated size at a uniform rate within a time period of 4 to 8 s. The refrigerant charge in each specimen shall be exhausted into a suitable reclamation container. Examine the hose for internal or external cracks or disintegration.

Vacuum Flattening -- Flattening of a hose restricts internal fluid flow. This test evaluates the hose construction at room temperature condition for its ability to resist internal area reduction under vacuum conditions. The coupled hose assembly shall be bent (with the natural curvature of the hose) at room temperature into a "U" shape, with the inside radius of the "U" equal to five times (six times for 19 mm and greater nominal ID) the normal outside diameter of the hose.

Measure the minimum outside diameter of the hose in any plane at the base of the "U" (hose OD shall not be less than 80% of original OD). Evacuate the hose to an absolute pressure of 10 mm Hg ± 5 mm Hg. Maintain this pressure in the bent hose specimen for 2 min. At the end of this period, while the hose is still under vacuum, measure the minimum outside diameter in any place at the base of the "U"

Acceptance Criteria

- The minimum diameter dimension shall not be less than 80% of the minimum hose outside diameter as measured in
- 5.6.2 in the "U" shape prior to the application of the vacuum.
- Examine the hose externally for cracks or loose cover. If these imperfections exist, the hose fails.
- If the hose passes (5.6.3.a and b) cut the hose off at the coupling and section longitudinally. Check the hose internally for blisters, delamination, cracks, or other surface imperfections. Any such imperfections result in hose failure.

Length Change -- All hose types shall not contract in length more than 4% or elongate more than 2% when subjected to a pressure of 2.4 MPa for suction hose and 2.7 MPa for liquid and discharge hose. Test in accordance with ASTM D 380.

Bursting Strength -- The minimum bursting strength for hose and hose assemblies shall be 8.3 MPa for discharge and liquid line, 8.3 MPa for suction hose. Test in accordance with ASTM D 380.

Proof Test -- All hose shall satisfactorily withstand a hydrostatic proof test with a minimum hydrostatic pressure equal to 50% of the minimum required burst strength for a period not less than 30 s or more than 5 min.

Extraction Test -- The extractables of the inside surface of the hose tube shall not exceed 118 g/m2 and any extractables shall be oily or soft/greasy in nature. The test hose assembly shall have a free hose length not less than 450 mm or more than 1000 mm.

- Fill the hose assembly to capacity with suitable solvent and then empty it immediately to remove any surface material. Load the hose assembly to approximately 70% capacity with refrigerant at room temperature. For convenience, the hose assembly and refrigerant may be chilled below the boiling point of refrigerant in order that the refrigerant may be handled in the liquid state. Place the loaded hose assembly in the air oven at 70 °C ± 2 °C for 24 h. At the end of the aging period, chill the hose assembly to –30 °C or colder and pour the liquid refrigerant into a weighed vacuum flask, chilled to –30 °C or colder, then attach the flask to an appropriate refrigerant recovery unit and recover all refrigerant. After the refrigerant has evaporated, condition the beaker at approximately 70 °C for 1 h to remove condensed moisture, then weigh the beaker again. Report the extract in terms of grams per square meter (milligrams per square inch) of the hose inner surface based on the nominal inside diameter of the hose.

Ozone Test -- When the hose is bent around a mandrel with a diameter 8 times the nominal diameter of the hose and exposed for 70 h to ozone air atmosphere in which the ozone partial pressure is 50 MPa ± 5 MPa at 40 °C ± 2 °C, the outer cover of the hose shall show no cracks when examined under 7X magnification. The test hose shall be about 250 mm longer than the mandrel circumference. Test in accordance with ASTM D 380.

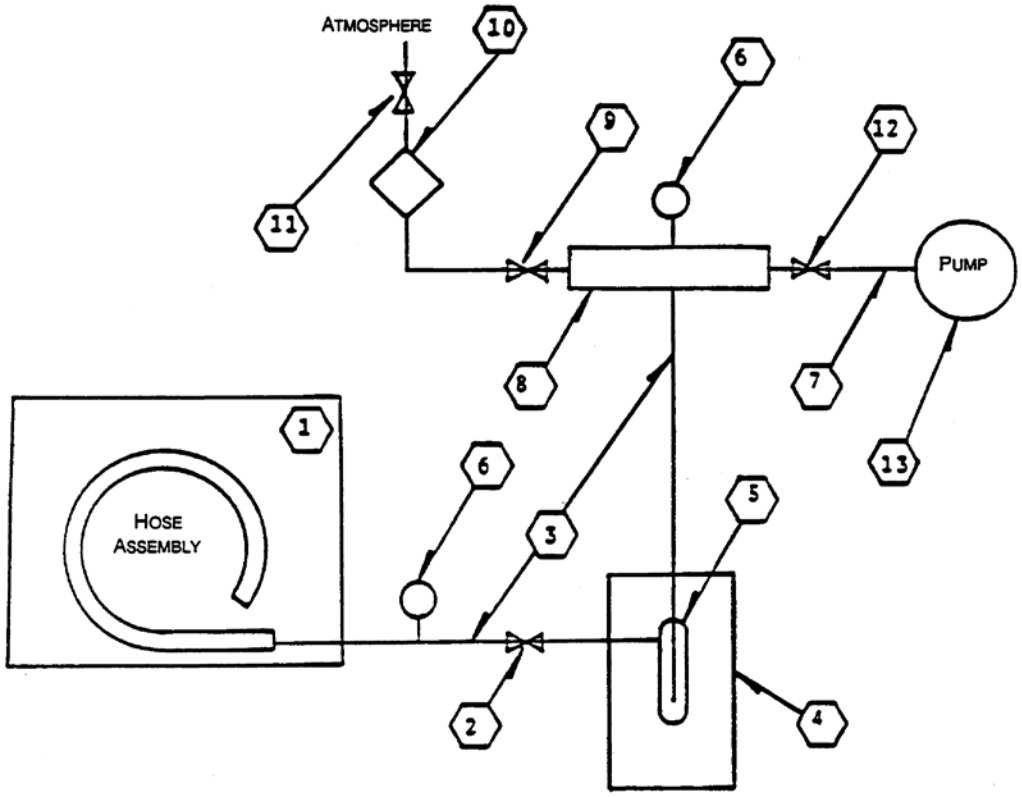
Cleanliness Test -- The bore of all hose and hose assemblies shall be clean and dry. When subjected to this test, there shall not be more than 270 mg/m2 of foreign material. The test hose shall not be less than 300 mm.

Procedure -- Bend the hose or hose assembly to a "U" shape, the legs of the "U" being of equal length. Position the hose in a vertical plane and fill the hose to capacity with suitable solvent. Then filter the suitable solvent through a prepared Gooch crucible, sintered glass crucible, or 0.8 μm filter of known weight. After drying at approximately 70 °C for 20 min, determine by weight difference of the insoluble contamination.

Moisture Ingression -- The purpose of the moisture ingression test is to measure the amount of moisture that permeates the hose samples when the hose samples are subjected to a humid environment with vacuum being drawn on the ID of the hose samples.

Test Apparatus –See Figure 1.

a. Humidity chamber b. Methanol cold bath maintained at –70 °C or lower (see Figure 1)
c. Vacuum/cold trap system d. Vacuum pump e. Nitrogen gas or dry air supply
f. Distilled water g. Oven capable of 80 °C
h. Drying desiccator i. Balance capable of 0.1 mg accuracy



LEGEND

Item	Description
1	Humidity Chamber
2	Stainless Steel Valve
3	Copper or Stainless Tubing
4	Methanol/Dry Ice Bath
5	Glass Vacuum Traps
6	Vacuum Gauges
7	Vacuum Hose
8	Vacuum Manifold
9	Stainless Steel Valve
10	Desiccant Dryer (Indicating Silica Gel)
11	Quick Open Valve
12	Vacuum Valve
13	Vacuum Pump

Test Samples

- Install test assemblies in the humidity cabinet by plugging one end fitting and attaching the other end to the vacuum lines located in the cabinet. Arrange the test assemblies to maximize surface exposure to environmental conditions (see Figure 1).
- Seal the humidity cabinet and set the dry bulb temperature at 50 °C and wet at 47.2 °C. Allow cabinet to stabilize for at least 4 h at the specified temperatures and 85% ± 5% relative humidity.
- Thoroughly clean all vacuum traps, inside and out, by using compressed air and suitable solvent.
- Wipe off traps and then place in an oven set at 80 °C minimum for 1 h.
- Upon removing the traps from the oven, immediately transfer to a drying desiccator for stabilization to room temperature.
- After the traps reach room temperature, remove one at a time, wipe trap exterior with lint-free towels, and immediately weigh to the nearest 0.1 mg. Plug the end of the trap immediately. Record these weighs.
- Immediately after weighing, install the traps (Item 3 in Figure 1) in a bath maintained at -70 °C and attach traps to connecting lines using vacuum grease on all O-ring connections.
- After all connections are made, turn on the vacuum pump and open valve no. 12 and then valve no. 2 and no. 11.
    - A quick vacuum check can be done by closing valve no.12.
    - Shut off the pump for approximately 5 min noting any vacuum drop. If there is any loss, the leak shall be sealed and then rechecked.
    - Restart the vacuum pump and open valve no. 12.
    - After running system for 1 h, close valve no. 12 and turn off the vacuum pump for 30 min. If there is any loss of vacuum, the test is to be discontinued. Leak is to be sealed and the technician is to return to step c.
- Once the system is evacuated and integrity is ensured, maintain vacuum pump with a maximum pressure of 50 mm of Hg (95 kPa). Record time and temperatures.
- j. After a 24 h time duration has taken place, proceed to the sequence of operation in step k. Longer periods may be used as long as the data is adjusted for the specified time period (96 h and 72 h periods recommended).
- k. Sequence of operation (for installation of new moisture traps).
    - Record time and temperatures.
    - Close valve no. 2.
    - Close valve no. 12.
    - Turn off vacuum pump.
    - Slowly open valve no. 9 and then valve no. 11. This sequence is necessary to ensure the traps are charged with dry nitrogen or dry air atmospheric pressure. (Nitrogen source should have regulator set at 1 psi.)
    - Remove traps one at a time and immediately plug all tubing connections.
    - Install another set of traps that were already prepared from steps d through g.
    - Allow traps to return to room temperature in a desiccator.
    - Wipe the trap exterior with lint-free towels, remove plugs, and immediately weigh each.
    - Calculate the change in weight and record.

- Repeat steps h, k, and I at 96 h and 72 h intervals until steady state conditions are achieved. Steady-state is reached when one of the two following conditions have been met:
    - The last four readings are all within 10% of the lowest reading of the last four.
    - 28 days have passed and the calculated ingression rate is less than 50% of the assigned specification limit.
- Calculate the rate of moisture ingression to the test specification that has been assigned (see examples 1 and 2) reading.

Example1:

$$\text{Average Condensate Weight} = (\text{Reading 1} + \text{Reading 2} + \text{Reading 3} + \text{Reading 4})/4$$

NOTE: Last four readings after steady state is achieved are used for calculation of rate. Reading is for a 2-h reading or adjusted reading time, and for a 152 cm exposed hose lengths as taken from the moisture ingression test data sheet.

Example 2:
To convert the average condensate weight from g/24 h/152 cm length, multiply the average condensate weight by the following number, depending on hose ID to arrive at g/cm2/year (see Table 2).

n. Acceptance Determination
Class I - Moisture Resistant = 0.039 g/cm2/year
Class II - Medium Moisture Resistant = 0.111 g/cm2/year

TABLE 2 - MOISTURE INGRESSION RATE CONVERSION TABLE

(column 1)Nominal Hose Size mm (in)
(column 2)Mean Hose ID mm (in)
(column 3)Multiply g/day by Factor Shown to Obtain g/in2/year
(column 4)Multiply g/day by Factor Shown to Obtain g/cm2/ year

8 (5/16)	8.1 (0.320)	6.092	0.9443
10 (13/32)	10.6 (0.418)	4.655	0.7216
13 (1/2)	13.0 (0.510)	3.796	0.5884
16 (5/8)	16.1 (0.635)	3.065	0.4751
19 (3/4)	19.4 (0.765)	2.544	0.3943

In order to obtain conversion factor for hoses not listed in table 1, use the following equations:
for kg/m2/year, Factor = 7.649/D
where:
D = Inner Diameter (mm)
for lb/ft2/year, Factor = 1.943/D
where:
D = Inner Diameter (inches)

COMPONENTS FOR R-134a FIELD-COUPLED HOSE ASSEMBLIES

This section applies to hose assemblies when designed for use with only R-134a refrigerant. Insufficient data exist on field coupled R-1234yf refrigerant hose assemblies. When sufficient data becomes available on refrigerant emissions and safety implication of field coupling hose assemblies designed for use with R-1234yf refrigerant is available, this standard will be updated. Until such time it is not recommended that R-1234yf refrigerant hose assemblies be field coupled. It is the responsibility of the assembly manufacturer ("coupler") to ensure that the assemblies meet the acceptance criteria for this specification. However, it is acceptable for a hose and/or component supplier to accept this responsibility when the following conditions are met.

Component Validation

For the validation of non-assembled components, the expected variation of the key performance characteristics of the components to be used in a field coupled assembly shall be determined by statistical means. Field coupled assemblies shall be constructed of components that are three standard deviations off of the mean as well as on the mean of the statistical study and selected to provide the minimum, nominal and maximum conditions for evaluation and validation. The variables studied and represented in the validation shall include all variables, which significantly affect the performance of the hose coupling (i.e., crimp diameter, hose O.D., hose I.D., stem O.D., collar wall, etc.).

Validation Tests

All tests within this specification must be conducted in order to validate a design. However, only the following tests are required on the full range of assembly variations:

Burst

Coupling Integrity

Components Marking

Components to be sold unassembled, but with validation shall be durably marked as follows:

"SAE J2064 – p/n",

where p/n (part number) uniquely identifies both the component manufacturer and component part number.

Component Manufacturer's Responsibility

The component manufacturer selling a component marked "SAE J2064" shall supply to their customers a spec sheet describing exactly which component goes together with which hose (supplier name, size and part number) and how they should be assembled (including tool part numbers and tolerances) in order to achieve a validated hose coupling.

Upon request, the supplier shall furnish test data.

SAE J639 DEC 2011 SAFETY STANDADRDS FOR MOTOR VEHICLE REFRIGERANT VAPOR COMPRESSION SYSTEMS

REFRIGERANTS

R-134a

HFC-134a,1,1,1,2-Tetrafluoroethane (CH2FCF3) thermodynamic properties are similar to R-12 (dichlorodifluoromethane) but without its ozone depletion potential. It has a boiling point of −26.3°C, a vapor pressure of 572 kPa absolute at 20°C, and a global warming potential (GWP) of 1430. Its safety is proven in use.

R-1234yf

HFO-1234yf, 2,3,3,3-Tetrafluoroprop-1-ene (CF3CFCH2), is an olefin containing hydrogen, fluorine and carbon with thermodynamic properties similar to R-134a. This refrigerant is a mildly flammable gas. It has a boiling point of –29.2°C, a vapor pressure of 583 kPa absolute at 20°C, no ozone depletion potential, and a global warming potential (GWP) of 4.

R-744

Carbon dioxide (CO2) is a natural refrigerant. It operates at high pressures when used in MAC systems. It has a boiling point at -78,5 °C, a critical temperature of 31°C, a critical pressure of 7.38 MPa, a vapor pressure of is 5.73 MPa absolute at 20°C, no ozone depletion potential, and a global warming potential (GWP) of 1

SYSTEM AND COMPONENT REQUIREMENTS -- In no case shall any high-pressure side refrigerant pressure relief valves (or burst disks) have an activation pressure greater than the maximum working pressure listed below.

R-134a Refrigerant

The maximum working pressure on the high-pressure side shall not exceed 4.14 MPa. Gauge [600 psig]. The maximum pressure on the low-pressure side shall not exceed 1.38 MPa (according to saturation pressure of R-134a at 54 °C).The maximum component temperature at the outlet of the compressor including lines to the condenser shall not exceed 160˚C during intermittent (5 min) MAC system operation and 150˚C during continuous vehicle operation of the mobile air conditioning system.

R-1234yf Refrigerant

The maximum working pressure on the high-pressure side shall not exceed 4.14 MPa. Gauge [600 psig]. The maximum pressure on the low-pressure side shall not exceed 1.46 MPa (according to saturation pressure of R- 1234yf at 56 °C).The maximum component temperature at the outlet of the compressor including lines to the condenser shall not exceed 160˚C during intermittent (5 min) MAC system operation and 150˚C during continuous vehicle operation of the mobile air conditioning system..

R-744 Refrigerant

The maximum working pressure on the high-pressure side shall not exceed 17 MPa. (Absolute) The maximum working (or system off) pressure on the low-pressure side shall not exceed 13.0 MPa. (Absolute)The maximum component temperature at the outlet of the compressor including lines to the gas cooler shall not exceed 190 °C during intermittent (5 min) MAC system operation and 175 °C during continuous operation. The maximum working temperature for the gas cooler shall not exceed 180°C during intermittent (5 min) operation and 165 °C during continuous MAC system operation.

COMPRESSOR DESIGN REQUIREMENTS

Compressor assemblies shall be designed to incorporate devices that will cut off transmission of power to the compressor, in the event a compressor internal structural failure results in excessive compressor torque. Such devices shall be incorporated into the compressor pulley or compressor itself or implemented in vehicle software. These devices will aid in the prevention of ejection of components caused by rupture or fragmentation of the housings wall.

Evaporators Design Requirements

Evaporators for use in R-744 and R-1234yf systems shall meet the requirements of SAE J2842 Standard (HFO- 1234yf and R-744 Design Criteria and Certification for OEM Mobile Air Conditioning Evaporator and Service Replacements) which includes labeling requirements. Vehicles equipped with R-744 or R-1234yf refrigerant system evaporator(s) shall include in their service manual that only new and SAE J2842 certified evaporator(s) shall be used as replacement parts.

Pressure Relief Devices

The refrigerant high-pressure side shall have a pressure relief device located in the high pressure side of the compressor or immediately adjacent to the compressor discharge fitting. These devices shall be designed to minimize direct impingement of the refrigerant and oil on hot surfaces. The refrigerant system high-pressure side relief device shall be self-sealing. In no case shall the maximum release (blow off) pressure be greater than the maximum refrigerant working pressure.

Refrigerant Sensing Devices

When servicing a replaceable sensing device (e.g., pressure, temperature) attached to any MAC component in the refrigeration system circuit and in direct contact with the refrigerant, it shall be designed to prevent unexpected separation and/or rapid release of refrigerant. Sensors intended to be replaced while the refrigeration system is charged (under pressure) shall have a self sealing (e.g., valve core) fitting on the refrigerant side component to prevent significant refrigerant release should the sensor be removed. The sensor assembly shall have the female thread and the component it mounts to shall have the male thread to identify that the component can be removed while the system is under pressure. Sensors that are intended to be replaced from a discharged refrigeration system (not under pressure) shall employ a male thread while the female thread shall be used on the refrigeration system component to which the sensor is mounted. The sensor male thread connection shall have sufficient length and a venting action such that service personnel would be alerted by only a limited refrigerant release before total mechanical separation takes place.

System Burst Pressure Requirements

New components (not previously subjected to cycling fatigue stresses) on the high-pressure side of the system shall have a burst pressure not less than two times the defined maximum high side working pressure. The burst pressure shall not be less than 1.5 times the maximum working pressure when tested at the maximum operating temperature (applies to R-744 only).

Adjacent cavities internal to the compressor which are exposed to different pressures during system operation (high-side cavity adjacent to a low-side cavity) shall be burst tested at worse case conditions. Cavities exposed to the high-side pressure shall be burst tested at twice the maximum high-side working pressure, while the adjacent low side pressure cavity is maintained at a pressure not to exceed the maximum low-side working pressure. This test applies separately to both: (1) any discharge chamber adjacent to a suction chamber and (2) the crankcase chamber adjacent to any discharge chamber. The test shall be conducted at room temperature 21C +/-5C.

Components on the low-pressure side of the system shall have a burst pressure not less than two times the maximum low side pressure. Components designed for the low-pressure side in cooling mode that are used in a heat pump system shall have an ultimate burst pressure not less than two times the maximum heat pump system working pressure.

SERVICE PORT FITTINGS

The refrigeration system shall have low side and high side service [port] fittings and shall be fitted with protective or sealing caps. The service fittings should be rigidly connected to the refrigerant lines or components in a location such that attaching and removing the service couplings do not permanently deform the piping. Only the specified fittings in this standard may be used for service connections. The high and low side pressure service fittings shall be unique to each other and unique for each refrigerant used in MAC systems. Service fittings are identified in this standard. This will prevent the unintentional mechanical connection of a low-pressure container or service hose to the high-pressure side of the system and potential system refrigerant cross-contamination. Service fittings shall be located (engine compartment vehicle body locations) and being easily accessible to attach service equipment service hoses.

To prevent mixing of R-12 and R-134a refrigerants in mobile A/C system service, Figures 1 and 2 illustrate the low and high-pressure fittings for R-12 refrigerant. These fittings are shown for reference to create and verify adaptors to retrofit older MAC systems to R-134a. Figure 3a & 3b illustrate the high and low-pressure fittings for R-134a. The internal threads are optional for R-134a sealing caps and no external threads are allowed on the fittings. Fitting adaptors shall not be created to allow conversion between any refrigerants other than R-12 to R-134a.

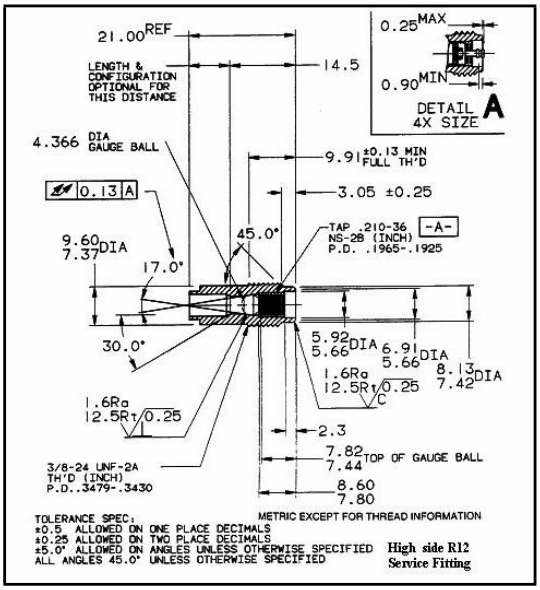


FIGURE 1 - R-12 LOW SIDE SERVICE FITTING

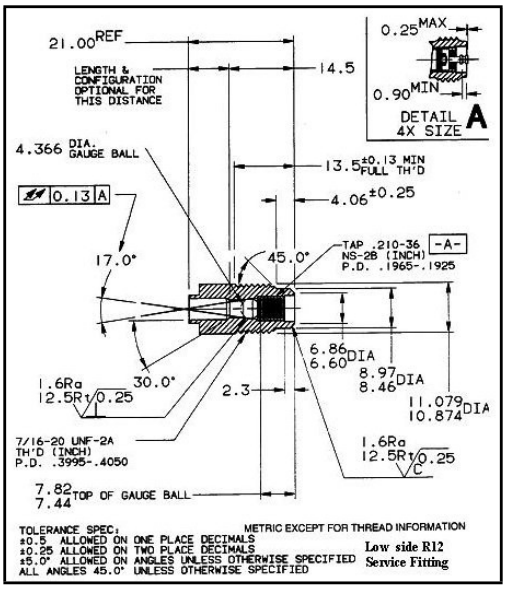


FIGURE 2 - R-12 HIGH SIDE SERVICE FITTING

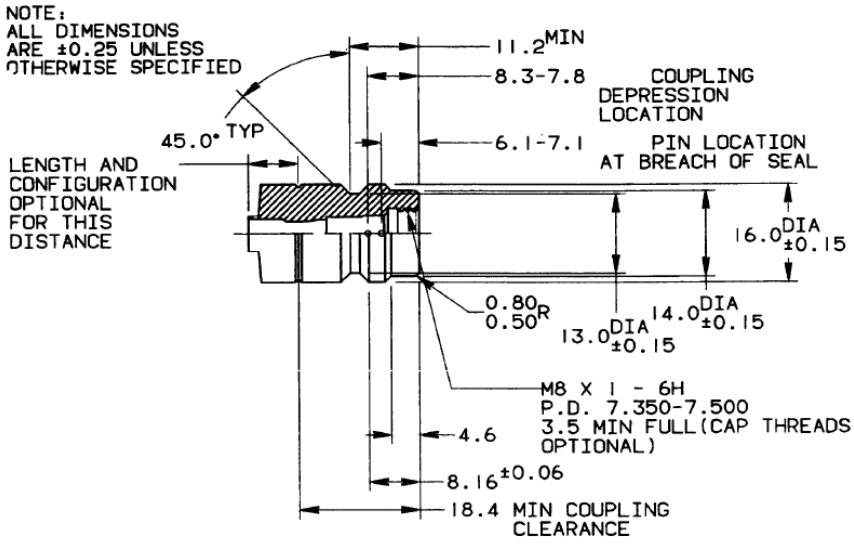


FIGURE 3A - R-134a HIGH SIDE SERVICE FITTING (DIMENSIONS ARE METRIC)

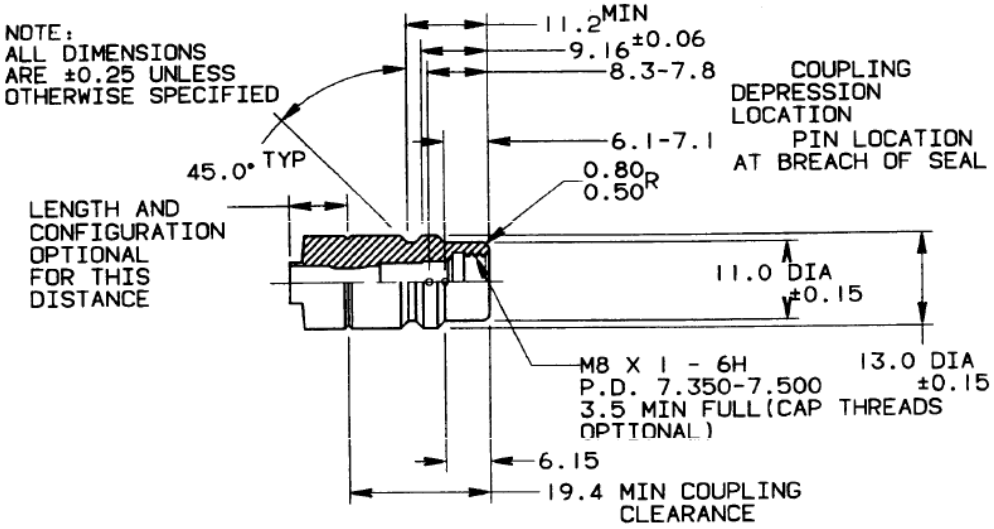


FIGURE 3B - R-134a LOW SIDE SERVICE FITTING (DIMENSIONS ARE METRIC)

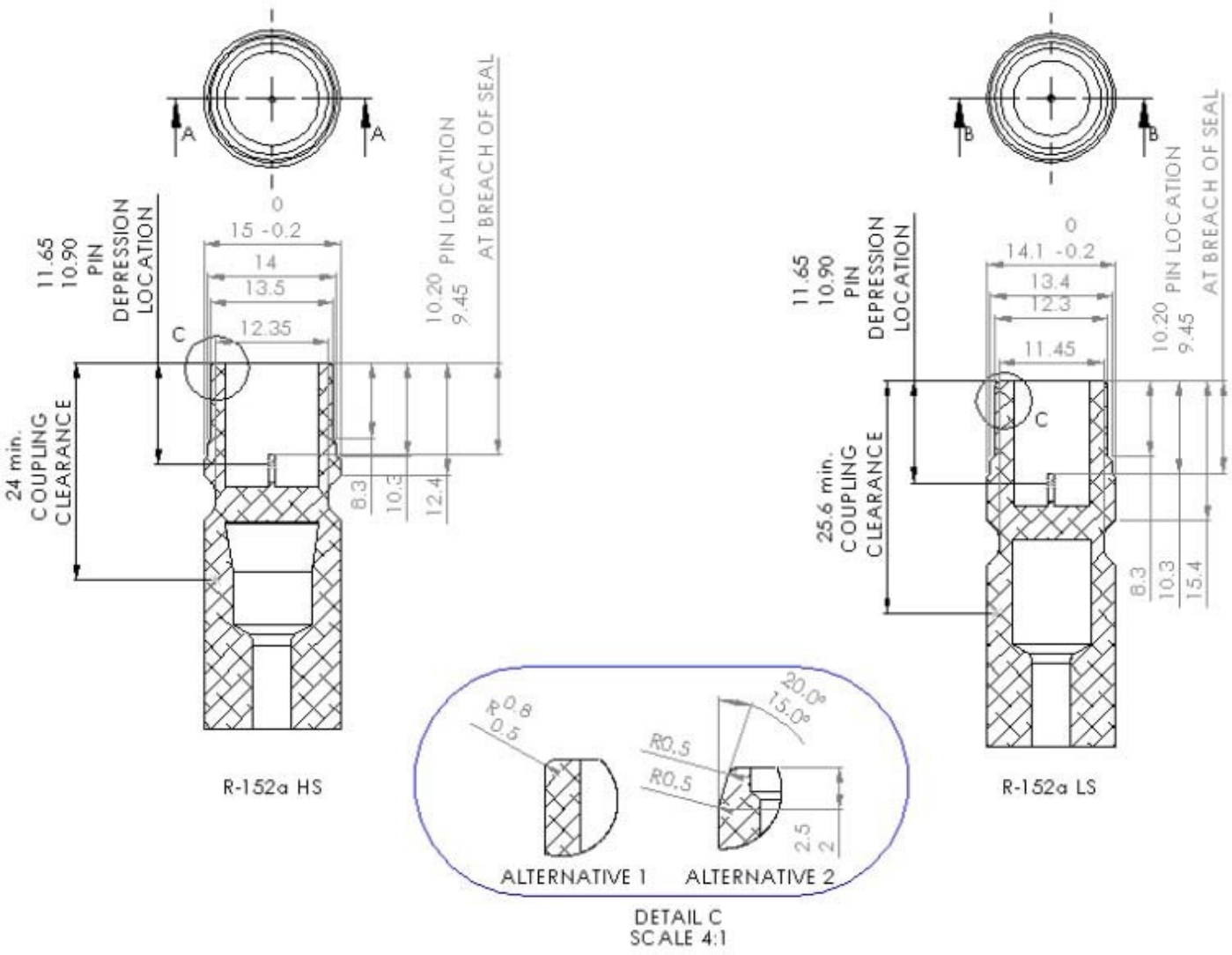


FIGURE 4 - R-152A (HFC-152A) SERVICE FITTINGS HIGH AND LOW SIDE

NOTE: Service fittings dimensions are provisional and shall not be used pending final production commercialization and use of the refrigerant has been established.

Figure 4 and portions of Table 1 (Refrigerant Service Fitting Dimensions) define the preliminary design for R-152a service fittings No external threads are allowed on these fittings. These specific service fittings were established as part of the industry's evaluation of Lower GWP refrigerants and are maintained for future design guidance to prevent potential refrigerant cross contamination between MAC systems.

The R-152a service fittings dimensions are provisional and shall not be used pending final production commercialization and use of the refrigerant has been established

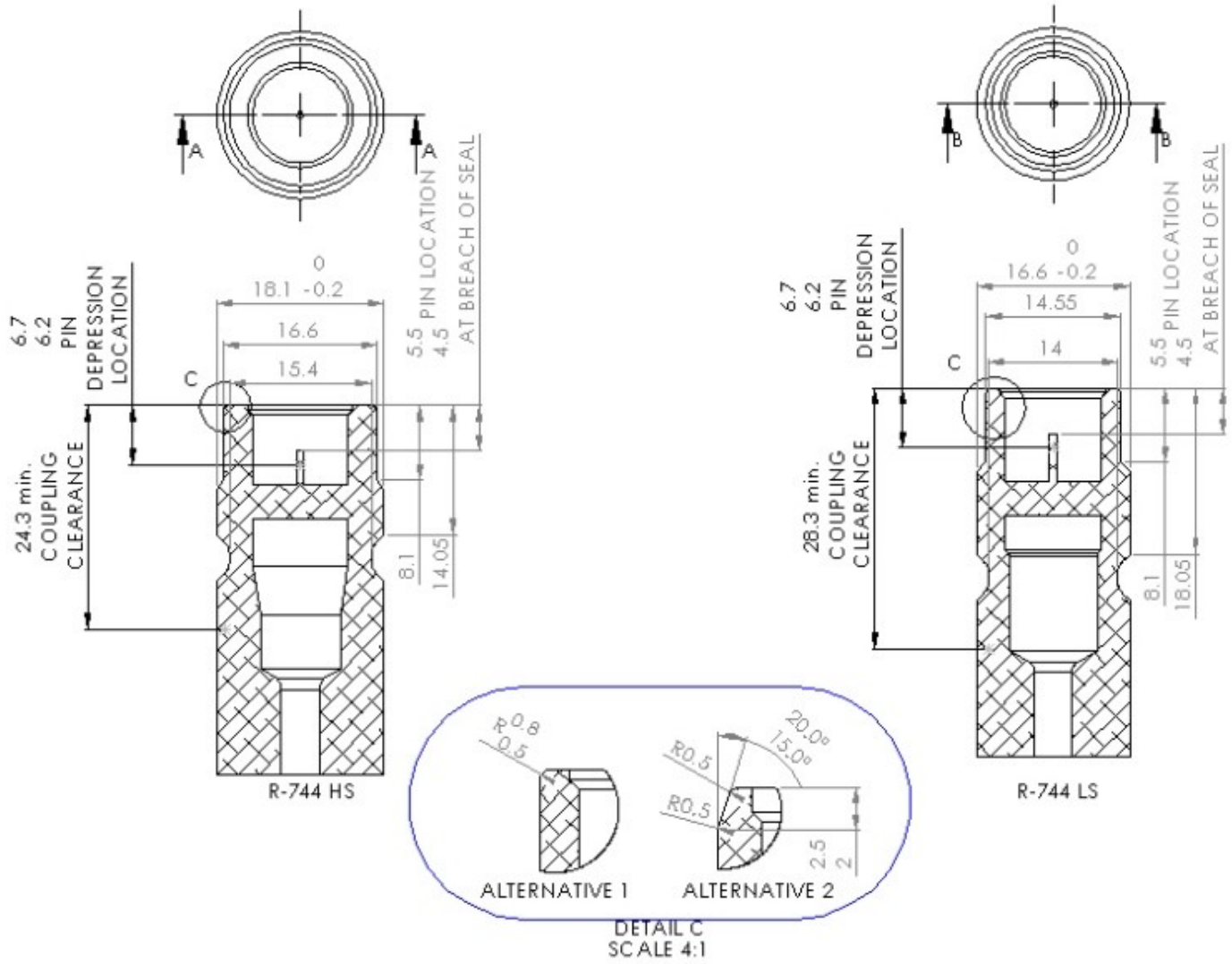


FIGURE 5 - CARBON DIOXIDE R-744 SERVICE FITTINGS HIGH AND LOW SIDE

NOTE: Service fittings dimensions are provisional and shall not be used pending final production commercialization and use of the refrigerant has been established.

Figure 5 and portions of Table 1 (Refrigerant Service Fitting Dimensions) define the preliminary design for R-744 service fittings. No external threads are allowed on these fittings.

The R-744 service fittings dimensions are provisional and shall not be used pending final production commercialization and use of the refrigerant has been established.

The high side pressure fitting shall be located only on the higher-pressure side of the refrigerant circuit regardless of operating mode (air conditioning or heat pump). The high- side fitting for R-744 shall be located downstream of the gas cooler outlet. The low-pressure side fitting shall also be located only on the lower pressure side of the refrigerant circuit regardless of operating mode (air conditioning or heat pump). The high side fitting shall be the larger diameter of the two fittings.

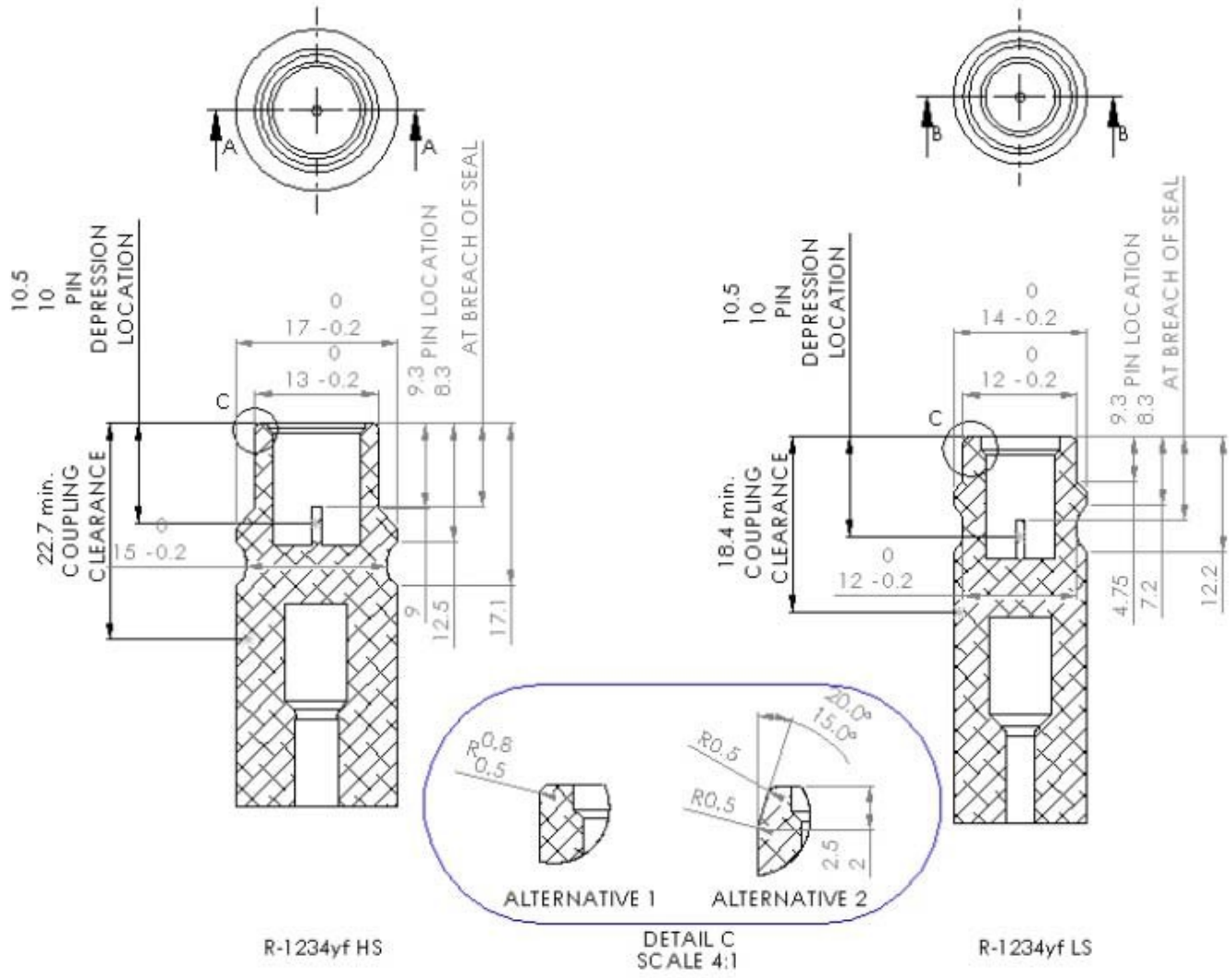


FIGURE 6 - R-1234YF SERVICE FITTINGS HIGH AND LOW SIDE

Figure 6 and portions of Table 1 (Refrigerant Service Fitting Dimensions) define the service fittings established for R-1234yf. No external threads are allowed on these fittings. The high side fitting shall be the larger diameter of the two fittings.

SERVICE FITTING QUICK COUPLER

Quick release service charge couplers used in conjunction with the service fittings in Figures 3 through 6 shall have a pressure relief feature to prevent coupling blow-off during installation and removal. The coupler depressor shall have a concave radius of 1.9 mm to provide a self-alignment feature to the valve pin as shown in Figure 7. The coupling depressor travel that activates the valve core shall have a pin located at "breach of seal" from the face of the fitting as identified in Table 1 (Refrigerant Service Fitting Dimensions) for each refrigerant. The pin depression location is defined as the pin being in end position at maximal open valve. Pin depression location may be increased in factory applications based on the capability of the valve design. "Breach of seal" is defined as the point that the valve starts to open and the pressure integrity of the valve is breached and allowing communication between the coupler and the refrigerant in the MAC system.

Charge couplings shall open refrigerant communication to the service hose according to the mandatory- dimensioned features shown in Table 1. All service charge couplings used in conjunction with fittings in Figures 3 through 6 shall have a pressure relief feature to prevent coupling blow-off during installation and removal. The coupler depressor shall provide a self-alignment feature. All service couplings used in conjunction with fittings in Figures 3 through 6 shall have a separate and distinct action (screw, lever, etc.) to open and close the service valve in addition to the coupler quick connect attachment to the valve housing. Also, the service coupler must not be able to uncouple from the service valve with the valve open. Charge couplings used in conjunction with service fittings shall comply with the all SAE requirements for the corresponding refrigerant. The charge service coupling must be designed for sealing on the outer diameter of the charge port to prevent leakage due to variation in the charge port end configuration as described in SAE J2888.

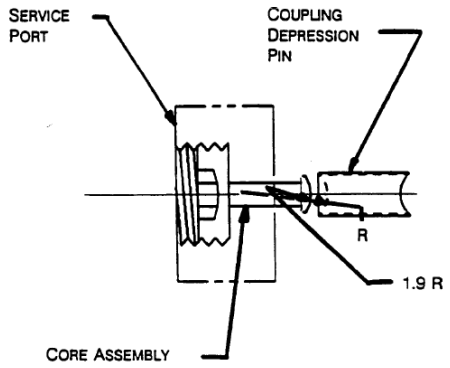


FIGURE 7 - SERVICE FITTINGS PIN DESIGN

TABLE 1 - REFRIGERANT SERVICE PORT FITTING DIMENSIONS

	R-134a High Side Valve	R-134a Low Side Valve	R-152a High Side Valve	R-152a Low Side Valve	R-744 High Side Valve	R-744 Low Side Valve	R-1234yf High Side Valve	R-1234yf Low Side Valve
OD	16 ±0.15 mm	13 ±0.15 mm	15 +0/-0.2 mm	14.1 +0/-0.2 mm	18.1 +0/-0.2 mm	16.6 +0/-0.2 mm	17 +0/-0.2 mm	14 +0/-0.2 mm
Pin location at breach of seal	6.1 - 7.1 mm	6.1 - 7.1 mm	9.45 - 10.2 mm	9.45 - 10.2 mm	4.5 - 5.5 mm	4.5 - 5.5 mm	8.3 - 9.3 mm	8.3 - 9.3 mm
Pin depression location	7.8 - 8.3 mm	7.8 - 8.3 mm	11.65 - 10.9 mm	11.65 - 10.9 mm	6.2 - 6.7 mm	6.2 - 6.7 mm	10 - 10.5 mm	10 - 10.5 mm
Min coupling clearance	18.4 mm	19.4 mm	24 mm	25.6 mm	24.3 mm	28.3 mm	22.7 mm	18.4 mm

NOTE: R-152a and R-744 Service fittings dimensions are provisional and shall not be used pending final production commercialization and use of the refrigerant has been established.

SERVICE FITTING CAPS

MAC systems using R-134a, R-152a or R-1234yf shall use a sealed service-fitting cap. The cap seal feature may be internal within the cap or on the surface of the service fitting (Example - shown in Figure 8).

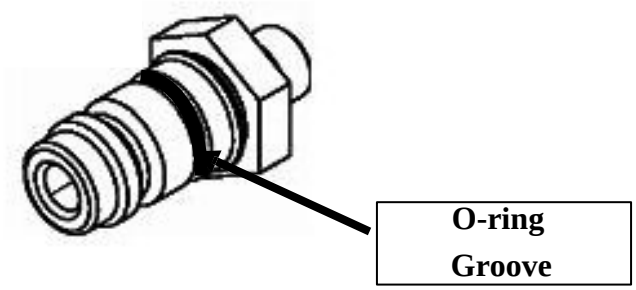


FIGURE 8 - SERVICE FITTING O-RING CAP SEAL

MAC systems shall have fitting caps that provide a covering to minimize dirt/dust from entering the service fittings. Caps for R-744 fittings shall have a vent so that refrigerant cannot become trapped under the cap posing a safety concern when removed (potential for cap to become a projectile and/or create a potentially harmful spray of refrigerant).

All refrigerant systems having service fitting caps identified in 9.1 and 9.2 should have a device that assures the cap cannot easily be misplaced during service. (Example: A strap may be used to tether the cap to the service fitting as identified in Figure 9.)

FIGURE 9 - EXAMPLE: SERVICE CAP AND TETHER

REQUIREMENTS FOR MAC SYSTEM LABELING

A plainly legible and durable refrigerant label (defined below) shall be mounted in a clearly visible location under hood that does not require the removal of any parts or covers to be read. If this label is attached to another serviceable or replaceable part, then that part must be supplied in service with a new label meeting all the requirements specified in this document. (If vehicle has single and multiple evaporator systems, multiple replacement labels shall be supplied with the service part along with proper installation instructions. One label showing both charges is also acceptable.) The refrigerant label may use symbols in place of words. Figure 10 shows the approved symbols with their meanings. The label requires only the symbols appropriate for the refrigerant used in the specific MAC system. An example of a label for R-1234yf using symbols is shown in Figure 11 (using 0.726 kg or 726 g of refrigerant charge). An example (using symbols) of an R-744 label is shown in Figure 12. The same is shown in Figure 13 for an R-134a label. Label Requirements when using symbols For R-1234yf and R-744, the label shall use PMS color standards (Pantone Orange [151] or yellow per ANSI Z535 “caution” and Pantone Black and White or equivalents). The label material and construction shall conform to all specifications and requirements appropriate for the intended installed location in the engine compartment. The label shall remain permanently attached and legible for the life of the vehicle. Testing of decals shall meet ANSI/UL 969-1991. The nameplate or label shall: identify the refrigerant; state the amount of refrigerant charge in grams (or kilograms to three decimal places); include the flammability symbol if the refrigerant is flammable; , identify the lubricant (PAG or POE); include the name or logo of the original equipment vehicle manufacturer responsible for design compliance to SAE J639 standard.. The label shall include the certified technician symbol and reference meeting SAE J2842 and SAE J2845 standards for R-1234yf and R-744 systems. The label shall include the service manual symbol for R-134a systems. The label, with all the above information, shall have a minimum size of 60mm by 30mm. It shall have text in bold-type letters having a minimum of 3 mm in height for identifying refrigerant, lubricant type and refrigerant charge amount. The label size can be increased as needed to accommodate additional information.

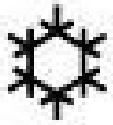
Symbol Name	Reference	Graphic
Caution	**ISO 7000 0434**	
Air Conditioning System (MAC)	**ISO 2575 D01**	
MAC System Lubricant Type **(PAG –POE)**		
See Vehicle Service Manual For MAC Service Information		
Requires Registered Technician to Service MAC System		
Flammable Refrigerant		
For Safety System Components **Shall Be Replaced** **Shall Not Be Repaired or Salvaged For Reuse**		

FIGURE 10 - SYMBOLS

Optional (symbol only) Label Designs for R-1234yf and R-744 (Figures 11 and 12)

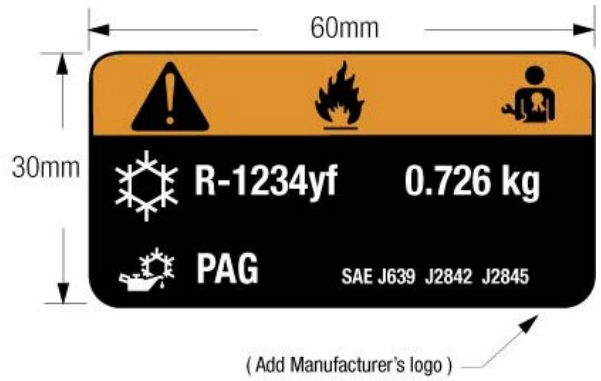


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FIGURE 11 - R-1234YF VEHICLE LABEL

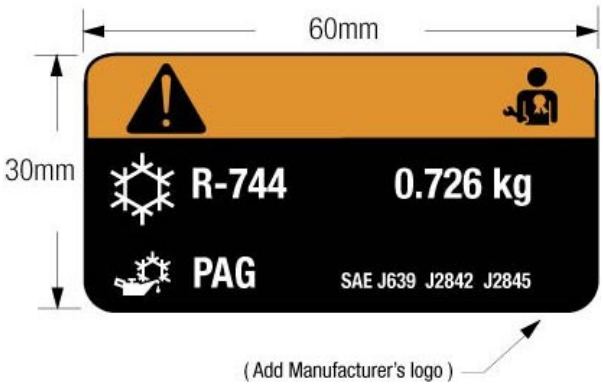

FIGURE 12 - R-744 VEHICLE LABEL

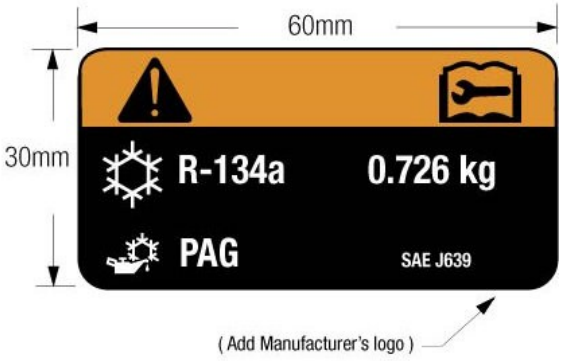

FIGURE 13 - OPTIONAL R-134a VEHICLE LABEL

The optional nameplate or tag for systems that do not use symbols, shall include identification of the refrigerant, shall indicate the lubricant type, and the amount of refrigerant charge. The nameplate or tag shall contain the name of the refrigeration system manufacturer or the merchandiser responsible for design compliance with this document. It shall also reference appropriate repair practices. The plate or tag shall also state.

CAUTION SYSTEM CONTAINS REFRIGERANT XXX UNDER HIGH PRESSURE-TO BE SERVICED
ONLY BY QUALIFIED PERSONNEL" (XXX should be replaced by actual refrigerant type.)

SHOP (SERVICE) MANUALS AND OWNER'S (MANUALS) GUIDES
For all refrigerants covered by this document, the shop (service) manual for each vehicle shall include all of the information of Section 10.1 including: identification of the refrigerant used; recommended amount of refrigerant charge; precise lubricant specification type and amount; flammability, high pressure, and/or toxicity of the refrigerant (if applicable) and all SAE references. Specific information for both single and multiple evaporator systems should be included (If applicable). For all refrigerants covered by this document, the owner's (manual) guide shall contain the refrigerant name, charge amount, and lubricant specification and amount.

Additional requirements for shop manuals and owner's (manual) guide for vehicles equipped with R-744 and R- 1234yf

The owner's (manual) guide shall reference J2845 Technician Training for Safe Service and Containment of Refrigerants Used in Mobile A/C Systems (R-744, and HFO-1234yf) and clearly state that the refrigerant system should only be serviced by trained and certified technicians to insure proper and safe operation.

The owners and shop service (manual) guide shall state that the air conditioning evaporator (cooling coil) shall never be repaired or replaced with one removed from a used or salvaged vehicle and that new replacement MAC evaporators shall be certified (and labeled) as meeting SAE Standard J2842 HFO-1234yf and R744 Design Criteria and Certification for OEM Mobile Air Conditioning Evaporator and Service Replacements

R-744 and R-1234yf MAC systems that have SAE standards and requirements associated with servicing shall be clearly identified in the shop (service) manual. This shall include, but not limited to: replacement components; special tools and equipment required; processes and procedures and technician certification and training. The shop (service) manual shall also contain information on the disabling of used or salvaged evaporators.

The symbols and definitions, found in Figure 10, shall be included in both the vehicle shop (service) manual and owners (manual) guide if used on the vehicle label.

Replacement refrigerant label(s) must be applied as specified when replacing a part to which it is attached.

1. REFRIGERANT LINE ROUTING AND REFRIGERANT CONNECTIONS

R-134a Refrigerant

The safety of R-134a MAC refrigerant systems have been proven in use. No restrictions apply for arrangement and positioning of refrigerant system connections, components, piping or pressure relief valves beyond current manufacturer's best practices and design guidelines.

With R-1234yf and R-744

Refrigerant systems connections shall be located outside the passenger compartment and outside the cabin airflow path. or designed to prevent leakage if the connections are located inside the cabin or in the cabin air flow path, and for safety to follow the service and repair leakage recommendations. Service procedures shall be defined in the service shop manual to state the process to prevent any leakage of refrigerant connections in the cabin (or in airflow path). All MAC system service fittings shall be located for ease of attachment of service hoses and shall be designed to minimize direct impingement of refrigerant on the service technician. Piping shall be of robust design to avoid damage or permanent deformation while connecting / disconnecting the service hose coupling(s) from factory charging and service equipment.

R-744

R-744 gas coolers shall be designed such that breakage/leakage during a vehicle collision does not cause a hazard due to projectile fragmentation outside the vehicle. The material selection shall be sufficiently ductile to prevent small segments from fragmenting. The mechanical strength of R-744 hose/pipe crimps should be sufficient to avoid mechanical separation (disconnection) at the crimp to avoid rapid uncontrolled movement of the hose (whipping). If this is not achievable, hoses shall be restrained in the area of the crimp to prevent rapid uncontrolled movement.

TECHNICIAN SERVICE PRACTICES

Avoid breathing any refrigerant vapor and lubricant mist. To remove refrigerant from a MAC system, use service equipment designed for recovery and removal that is certified to meet the requirements of the appropriate SAE Standards. Do not increase pressure, in any R-134a, or R-1234yf mobile A/C system with shop air or another refrigerant such as HCFC-22 (R-22) for leak checking, due to potential chemical reactions, flammability of air/R-134a at elevated pressure, contamination of the system, and possible structural damage to the system. Meeting the requirements of SAE J2845 provides information and guidelines for technicians working on R-744 and R-1234yf refrigerant systems, for their personal safety. To prevent accidental release of refrigerant and minimize safety concerns, the installation of any refrigerant service equipment to the vehicle shall only be done with the engine off and after the refrigerant high side pressure has been reduced (approximately 2 to 3 min).

To remove R-134a from a MAC system use only recovery and recycle equipment designed for R-134a and certified to meet the requirements of SAE J2788 or SAE J2810. When retrofitting to remove R-12 from the A/C system, use service equipment designed for R-12 recovery/recycling certified to meet the requirements of SAE J1990.

Due to the higher pressures associated with R-744 refrigerant, recovery and recharging of MAC systems shall only be appropriate when new SAE J Standards are developed for service equipment designed and certified to meet the appropriate SAE J Standards. Un-controlled release of R-744 refrigerant in the work area may result in high concentrations of carbon dioxide that can be hazardous. Servicing of R-744 systems shall only be done in well-ventilated work areas.

Service hoses shall meet all SAE requirements for the corresponding refrigerant. All service hoses for use in MAC systems with R-134a shall meet SAE Standard J2197. All service hoses for use in MAC systems with R-1234yf shall meet SAE Standard J2888. All service hoses for use in MAC systems with R-744 shall meet appropriate SAE Standards when they are developed.

To remove R-1234yf from the A/C system use service equipment designed for recovery/recycling/recharging certified to meet the requirements of SAE J2843 or J2851 HFC-1234yf recovery equipment that allows for off-site refrigerant reprocessing. Un-controlled release of R-1234yf refrigerant in the work area may result in high concentrations of R-1234yf that can be flammable. Servicing of R-1234yf systems shall only be done in well-ventilated work areas.

All refrigerants shall meet the corresponding SAE purity standards. All R-744 refrigerants shall meet the purity level as defined in SAE standard J2683 All R-134a refrigerants shall meet the purity level as defined in SAE standard J2776

All R-1234yf refrigerants shall meet the purity level as defined in SAE standard J2844

All recycled R-134a and HFO-1234yf refrigerants shall meet the purity levels defined in SAE standard J2099 All R-744 refrigerants shall not be recycled and reused, but must be handled according to appropriate SAE standards when they are developed or by any legal standards that is more restrictive than the SAE standard. All refrigerants recovered with recovery only equipment, that can be recycled but not processed by the appropriate on-site recycling equipment shall be sent off-site to a refrigerant processing facility. Refrigerant returned from an off-site refrigerant processing facility shall meet the corresponding SAE refrigerant purity standard for new refrigerant. The proper handling procedures should be followed for all refrigerants as designated by the refrigerant manufacturer's Material Safety Data Sheet (MSDS).

Service personnel shall be aware of the high pressure relief valve location when servicing the vehicle. Service personnel shall not be under the vehicle when charging the refrigerant system due to potential sudden release of the high pressure relief valve.

ADDITIVES

Any chemical additive used in MAC refrigerant systems shall be chemically compatible with the total refrigerant system and shall meet the following requirements and shall be considered in the risk assessment of the system: SAE standard J2670 addresses these requirements when used with R-134a and R-1234yf refrigerants. All refrigerant dyes shall meet the requirements for each MAC refrigerant system. R-134a and R-1234yf dyes shall meet SAE J2297 requirements.

SERVICE EQUIPMENT FOR MAC SYSTEMS

- All service equipment shall meet the appropriate SAE J standards requirements
- SAE standard J1739 (Potential Failure Mode and Effects Analysis [FMEA]) or equivalent procedures shall be applied to the development of service equipment and its use by the manufacturer of the service equipment

Information on Unique Fitting sizes and Labeling colors is available at https://www.epa.gov/mvac/unique-fittings-label-colors-mvac-refrigerants.

Service Procedures for the containment of CFC-12, HFC-134a, HFO-1234yf & R-744

TAKEN FROM J1989 MAY2011 – RECOMMENDED SERVICE PROCEDURE FOR THE CONTAINMENT OF CFC-12 (R-12)

Refrigerant Recovery Procedure

- Since the A/C system may contain another refrigerant, a combination of refrigerants or excess noncondensables (NCG'S), the system's contents should be identified before removing the refrigerant. Not identifying the refrigerant type prior to removal can result in contamination of recovery/recycle (R/R) equipment. Use of refrigerant identification equipment certified to SAE J 1771 should be used to determine what refrigerant is in the mobile A/C system about to be recovered.
- Connect the recovery unit service hoses, which shall have shut-off valves within 30 cm of the service ends, to the vehicle air-conditioning system service ports.
- Operate the recovery equipment as covered by the equipment manufacturers recommended procedure.
    - Start the recovery process and remove the refrigerant from the vehicle A/C system. Operate the recovery unit until the vehicle system has been reduced from a pressure to a vacuum. Continue the process until the system pressure has been reduced to a minimum of 102 mm of Mercury below atmospheric pressure (vacuum). With the recovery unit shut off for at least 5 min, unless there is a device that identifies the refrigerant has been removed, determine that there is no refrigerant remaining in the vehicle A/C system. If the vehicle system has risen above a vacuum (0 kPa), additional recovery operation is required to remove the remaining refrigerant. Repeat the operation until the vehicle A/C system vacuum level remains stable for 2 min.

    - Caution shall be taken to assure that the seals on all service hose connections are in good condition. Cut seals and leaking service hoses will cause the recovery equipment to draw air into the unit. These leaks, as well as a leak in the mobile A/C system being serviced, may result in the automatic shut off device in the recovery unit not to function properly. By allowing the recovery equipment to draw air from these leaks will result in excess air, noncondensable (NCG) being mixed with the recovered refrigerant. The excess noncondensables (NCG's) are difficult to remove from the refrigerant and will result in pressures higher than normal in the recovery/recycle equipment.
- Close the valves in the service lines and then remove the service lines from the vehicle system. Proceed with the repair/service. If the recovery equipment has automatic closing valves, be sure they are properly operating.

Service with Manifold Gage Set

- Service hoses shall have shutoff valves in the high, low, and center service hoses within 30 cm of the service ends. Valves must be closed prior to hose removal from the A/C system.

This will reduce the volume of refrigerant contained in the service hose that would otherwise be vented to atmosphere.

- During all service operations, the valves should be closed until connected to the vehicle A/C system or the charging source to avoid introduction of air and to contain the refrigerant rather than venting to the atmosphere.
- When the manifold gage set is disconnected from the air-conditioning system or when the center hose is moved to another device which cannot accept refrigerant pressure, the gage set hoses should first be attached to the reclaim equipment to recover the refrigerant from the hoses.

Supplemental Refrigerant Checking Procedure for Stored Portable Containers

- Certified recycling equipment and the accompanying recycling procedure, when properly followed, will deliver use-ready refrigerant. In the event that the full recycling procedure was not followed or the technician is unsure about the noncondensable gas content of a given tank of refrigerant, this procedure can be used to determine whether the recycled refrigerant container meets the specification for noncondensable gases (air).
    - Since refrigerant contamination can occur from many sources, it is important that the recycled CFC-12 (R-12) refrigerant not be contaminated. CFC-12 (R-12) refrigerant with a contamination amount of more than 2 to 3% by weight (7 to 8% by volume) can cause many different problems if used in the mobile A/C system.
      Depending upon the type and amount of contamination, mobile A/C system operation can be affected including, reduced cooling performance, improper refrigerant control calibration, higher operating pressures, and chemical reactions.
    - To determine if a container of CFC-12 (R-12) refrigerant is contaminated, it should be checked by using a SAE J 1771 certified refrigerant identifier.
    - If refrigerant identification equipment is not available, than the use of a pressure gauge with readable divisions of 7 kPa can provide some guidance if the container of refrigerant is contaminated. This procedure cannot be used on a mobile A/C system since it is very difficult to be assured that all the A/C system refrigerant parts are at the same temperature. If the container pressure exceeds the recommended pressure/temperature indicated on the table, it may not only contain excess air but may contain a mixture of other refrigerants. Since identification of contaminated refrigerant by the pressure/temperature relationship procedure is not reliable, this procedure should be used with caution.
      NOTE-THE USE OF REFRIGERANT WITH EXCESS AIR WILL RESULT IN HIGHER SYSTEM OPERATING PRESSURES AND MAY CAUSE A/C SYSTEM DAMAGE.
    - If the container of refrigerant is contaminated, it should be sent off-site for the appropriate processing.
- If this procedure is used, the container must be stored at a temperature of 18 °C or above for at least 12 h, protected from direct sunlight.
- Install a calibrated pressure gage, with 7 kPa divisions, on the container and read container pressure.
- Attach a temperature-measuring device to the lower one-half of the refrigerant container surface so that an indication of the temperature inside can be identified. Insulate the temperature-measuring device so that it provides a good indication of the container surface temperature. The use of only the air temperature surrounding the refrigerant container can

result in incorrect refrigerant temperature information. For example, a container located on a concrete or other surface, the refrigerant can be colder than the air temperature, which will result in an incorrect reading.

- 5.5 Compare the observed container pressure and container surface temperature to the values given in Tables 1 (Metric) or 2 (English) to determine whether the container pressure is below the pressure limit. For example, in Table 1 at a container surface temperature of 21 °C, the container pressure must not exceed 562 kPa.
- 5.6 If the refrigerant in the container has been recycled and the container pressure is less than the limit in Tables 1 and 2, the refrigerant may be used.

TABLE 1-CFC-12 (R-12) REFRIGERANT-MAXIMUM ALLOWABLE CONTAI NER PRESSURE/TEMPERATURE FOR NONCONDENSABLE (NCG)-METRIC

°C	kPa	°C	kPa	°C	kPa	°C	kPa	°C	kPa
18	520	24	611	29	717	35	829	40	956
19	527	24	618	30	724	35	843	41	970
19	534	25	632	31	738	36	857	42	984
20	548	26	646	31	752	37	871	42	998
20	555	26	660	32	759	37	878	43	1012
21	562	27	674	32	773	38	892	43	1026
21	576	27	688	33	780	38	906	44	1040
22	583	28	695	33	794	39	913	44	1054
23	590	28	703	34	808	39	927	45	1068
23	604	29	710	34	815	40	942	46	1082

TABLE 2-CFC-12 (R-12) REFRIGERANT-MAXIMUM ALLOWABLE CONTAI NER PRESSURE/TEMPERATURE FOR NONCONDENSABLE (NCG)-ENGLISH

°F	psig	°F	psig	°F	psig	°F	psig	°F	psig
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

- If the refrigerant in the container has been recycled and the container pressure exceeds the limit in Tables 1 or 2, there may be a possibility that the refrigerant is contaminated and unusable.
- The pressure/temperature relationships in Table 3 only compare CFC-12 (R-12) refrigerant contaminated with air and different mixtures of HFC-134a (R-134a). Contaminated CFC-12 (R-12) mixed with other refrigerants will result in different pressure/temperature readings.

TABLE 3-(ENGLISH) WITH HFC-134a (R-134a) CONTAMINATION
% PERCENT BY WEIGHT -- ESTIMATED CONTAMINATED PRESSURE ±2%

°F	Pure R12 psig	Max NCG psig	2% R134a psig	5% R134a psig	10% R134a psig	25% R134a psig	50% R134a psig
65	64	74	67	71	74	83	84
70	70	80	74	79	82	90	91
75	77	87	81	85	91	99	101
80	84	96	88	93	99	107	110
85	92	102	96	101	108	116	120
90	100	110	105	111	116	125	129
95	108	118	114	119	126	135	139
100	117	127	123	127	135	145	151
105	127	136	132	138	146	158	163
110	136	146	142	147	156	170	175
115	147	156	152	159	166	183	190
120	158	167	164	170	177	195	205

  - If it has been determined that the container only contains R12 refrigerant and excess air (NCG), slowly vent the air with the container upright into the recovery/recycle equipment until the pressure is less than the pressure shown in Tables 1 or 2.
  - Caution should be taken to not vent the container too rapidly since the refrigerant in the container will become cooler during the venting process. This temperature change can be noted by observing the container surface temperatures as required in 5.4.
- If, after shaking the container and letting it stand for a few minutes, the container pressure still exceeds the pressure/temperature limits in Tables 1 or 2, the entire content of the container shall be recycled or sent off-site to be reclaimed.

Containers For Storage of Recycled Refrigerant

Recycled refrigerant, for safety, should not be salvaged or stored in disposable refrigerant containers. This is the type of container in which virgin refrigerant is sold. Use only DOT CFR Title 49 or UL approved storage containers for recycled refrigerant. Any container of recycled refrigerant that has been stored or transferred must be checked prior to use as defined in the previous section.

Transfer of Recycled Refrigerant

When external portable containers are used for transfer, the container must be evacuated to at least 635 Hg below atmosphere (vacuum) prior to transfer of the recycled refrigerant. External portable containers must meet DOT and UL standards. To prevent on-site overfilling when transferring to external containers, the safe filling level must not exceed 60% of container gross weight rating.

Disposal of Empty/Near Empty Containers

Since all the refrigerant may not be removed from disposable refrigerant containers during normal system charging procedures, empty/near empty container contents should be reclaimed prior to disposal of the container. Attach the container to a recovery unit and remove the

remaining refrigerant. When the container has been reduced from pressure to a vacuum, the container valve can be closed. The container should be marked empty and is ready for disposal.

Retest of Refrigerant Containers.

DOT regulatins require that reusable containers be retested every 5 years. SAEJ2296 provides and inspection procedure.

TAKEN FROM J2211 NOV2011 – RECOMMENDED SERVICE PROCEDURE OF THE CONTAINMENT OF HFC-134A(R-134A)

Definitions

Recovery/Recycling Unit – Refers to a single piece of equipment that performs both functions of recovery and recycling of refrigerants per SAE J2210

Recovery -- Refers to that portion of the recover unit operation that removes the refrigerant from the mobile A/C system and places it in the recover unit storage container per SAE J1732.

Recycle – Refers to that portion of the recycling unit operation that process the refrigerant for reuse on the same job site to the purity specifications of SAE J2099.

Service Procedure

- Before attempting to remove refrigerant from the mobile A/C system determine the refrigerant in the system. Use of refrigerant identification equipment certified to SAE J1771 should be used to determine what refrigerant is in the mobile A/C system about to be recovered.
- Connect the recovery/recycling or recovery unit services hoses, which shall have shutoff devices (e.g., valves, quick couples) within 50 cm of the services ends, to the vehicle A/C service port per SAE J639. Hoses shall conform to SAE J2196 and fittings shall conform to SAE J2197.
- Operate the recovery/recycling or recovery equipment as recommended by the equipment manufacturer's procedure.
    - Verify that the vehicle A/C system has refrigerant pressure. Should the recovery equipment indicate that the A/C system does not have pressure, do not attempt to process the discharged system as this will introduce air (noncondensable gas) into the recovery/recycling equipment which must later be removed.
    - Begin the recycling process by removing the refrigerant from the vehicle A/C system. Continue the process until the system pressure has been reduced to a minimum of 102 mm of Mercury below atmospheric pressure (vacuum). If A/C components show evidence of icing, the component can be gently heated to facilitate refrigerant removal. With the recycling unit shut off for at least 5 min, unless the equipment has a device that assures there is no remaining refrigerant, check A/C system pressure. If this pressure has risen above vacuum (0 kPa), additional recovery operation is required to remove the remaining refrigerant. Repeat the operation until the system pressure remains stable at vacuum for 2 min.
    - Caution shall be taken to assure that the seal on all service hose connections be in good condition. Cut seals and leaking service hoses will cause the recovery equipment to draw air into the unit. These leaks, as well as, a leak in the mobile A/C system being serviced may result in the automatic shut off device in the recovery unit not to function properly. By allowing the recovery equipment to draw air from these

leaks will result in excess noncondensables (NCG) air being mixed with the recovered refrigerant. The excess noncondensables (NCG) is difficult to remove from the refrigerant and will result in pressures higher than normal in the recovery/recycle equipment.

- Close the valves in the service lines and then remove the service lines from the vehicle system. If the recovery equipment has automatic closing valves (quick couples), be sure they are operating properly. Proceed with the repair/service.
- Upon completion of refrigerant removal from the A/C system, determine the amount of lubricant removed during the process and replenish the system with new lubricant, which is identified on the A/C system label. Used lubricant should be discarded per applicable federal, state, and local requirements.

Service with a Manifold Gauge Set

- Hoses must have shutoff devices (e.g., valves) within 30 cm of the service ends. Valves must be closed prior to hose removal from the A/C system to prevent refrigerant loss to the atmosphere.
- Service hose valves should be closed until connected to the vehicle A/C system or to the charging source to exclude air and/or contain the refrigerant.
- When the manifold gauge set is disconnected from the A/C system, or when the service hose is moved to another device that cannot accept refrigerant pressure, the gauge set hoses should be attached to the recycling equipment to recover the refrigerant from the hoses.

Supplemental Refrigerant Checking Procedure for Stored Portable Containers

- Certified recycling equipment and the accompanying recycling procedure, when properly followed, will deliver use-ready refrigerant. In the event that the full recycling procedure was not followed or the technician is unsure about the noncondensable gas content of a given tank of refrigerant, a second complete recycling process must be performed. To determine if a container of HFC-134a (R-134a) refrigerant is contaminated, it should be checked by using a SAE J1771 certified refrigerant identifier.
    - If a refrigerant identifier is not available, the use of a pressure gauge with readable divisions of 7 kPa can provide some guidance if the container of refrigerant is contaminated. This procedure cannot be used on a mobile A/C system since it is very difficult to be assured that all the A/C system refrigerant parts are at the same temperature. If the container pressure exceeds the recommended pressure/temperature indicated on Tables 1 and 2, it may not only contain excess air, but may contain a mixture of other refrigerants.
    - Since identification of contaminated refrigerant by the pressure/temperature procedure is not reliable, this procedure should be used with caution when determining if the recycled refrigerant container meets the specification for noncondensable gases (air).

  NOTE-THE USE OF REFRIGERANT WITH EXCESS AIR WILL RESULT IN HIGHER SYSTEM OPERATING PRESSURES AND MAY CAUSE A/C SYSTEM DAMAGE.
- The container must be stored at a temperature of 18 °C or above for at least 12 h, protected from direct sunlight.
- Install a calibrated pressure gauge, with 7 kPa divisions, on the container and read container pressure.

- Attach a temperature-measuring device to the lower one half of the refrigerant container surface so that an indication of the temperature inside can be identified. The use of only the air temperature surrounding the refrigerant container can result in incorrect refrigerant temperature information. For example, a container located on a concrete or other surface, the refrigerant can be colder than the air temperature, which can result in an incorrect reading.
- Compare the observed container pressure and container surface temperature to the values given in Tables 1 (Metric) or 2 (English) to determine whether the container pressure is below the pressure limit. For example, at a container surface temperature of 21 °C or 70 °F, the container pressure must not exceed 524 kPa or 76 psig.

TABLE 1-HFC-134a (R-134a) REFRIGERANT-MAXIMUM ALLOWABLE CONTAINER PRESSURE (METRIC)

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

TABLE 2-HFC-134a (R-134a) REFRIGERANT MAXIMUM ALLOWABLE CONTAINER PRESSURE (ENGLISH)

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

- If the refrigerant in the container has been recycled and the container pressure is less than the limit in Table 1 or 2, the refrigerant may be used.
- If the refrigerant in the container has been recycled and the container pressure exceeds the limit in Table 1 or 2, there may be a possibility that the refrigerant is contaminated and unusable.

- The pressure/temperature relationships found in Table 3 compares different HFC-134a (R-134a) refrigerant contamination amounts due to air or CFC-12 (R-12) refrigerant.

TABLE 3-(ENGLISH) HFC-134a (R-134a)
REFRIGERANT PRESSURE (PSIG) WITH CFC-12 (R-12) CONTAMI NATION %
PERCENT BY WEIGHT
ESTIMATED CONTAMINATED PRESSURE ±2%

Temp °F	R-134a psig	Max NCG psig	2% R-12 psig	6% R-12 psig	10% R-12 psig	26% R-12 psig	60% R-12 psig
65	64	69	67	70	73	78	84
70	71	76	74	77	81	87	93
75	79	83	83	85	89	96	102
80	87	91	92	95	98	105	111
85	95	100	100	103	106	114	120
90	104	109	109	112	116	125	131
95	114	118	119	122	126	135	142
100	124	129	130	133	136	145	151
105	135	139	141	144	149	159	166
1 10	146	151	152	157	161	173	177
1 15	158	163	163	168	175	184	193
120	171	176	176	181	187	196	205

- If it has been determined that the container only contains HFC-134a (R-134a) refrigerant and excess air (NCG's) slowly vent, from the top of the container, a small amount of vapor into the recycle equipment until the pressure is less than the pressure shown in Table 1 or 2.
- Caution should be taken to not vent the container too rapidly since the refrigerant in the container will become cooler during the venting process. This temperature change can be noted by observing the container surface temperature.
- If, after shaking the container and letting it stand for a few minutes, the container pressure still exceeds the pressure limit shown in Table 1 or 2, the entire contents of the container shall be recycled or reclaimed.

Containers for Storage of Recycled Refrigerant

Recycled refrigerant, for safety, should not be salvaged or stored in disposable containers (this is one common type of container in which new refrigerant is sold). Use only DOT CFR Title 49 or UL approved storage containers, specifically marked for HFC-134a (R-134a), for recycled refrigerant. Any container of recycled refrigerant that has been stored or transferred must be checked prior to use.

Transfer of Recycled Refrigerant

When external portable containers are used for transfer of refrigerant, the container must be evacuated to at least 635 mm below atmospheric pressure (vacuum) prior to transfer of the recycled refrigerant to the container. External portable containers must meet DOT and UL standards. To prevent on-site overfilling when transferring to external containers, the safe filling level must be controlled by weight and must not exceed 60% of the container gross weight rating.

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Safety Note for HFC-134a (R-134a)

R-134a has been shown to be nonflammable at ambient temperatures and atmospheric pressure. However, test under controlled conditions, such as in a container or pipe, have indicated that at pressures above atmospheric and with air concentrations greater than 60% by volume, R-134a can form combustible mixtures. Under no conditions should any equipment be pressure or leak tested with air/R-134a mixtures. Do not use compressed air for leak detection in R-134a systems

Disposal of Empty / Near Empty Containers

Contents should be recycled prior to disposal of the container. Attach the container to the recycling unit and remove remaining refrigerant. When the container has been reduced from a pressure from a pressure to a vacuum, the container valve can be closed and the container removed from the unit. The container should be marked "Empty", after which it is ready for disposal.

Retest of Refrigerant Containers

DOT Regulations require that reusable containers be retested every 5 years. SAE J2296 provides an inspection procedure

TAKEN FROM J2845 JAN2013 – R-1234yf [HFO-1234yf] AND R744 TECHNICIAN TRAINING FOR SERVICE AND CONTAINMENT OF REFRIGERANTS USED IN MOBILE A/C SYSTEMS

TECHNICAL REQUIREMENTS

Some of the practices, techniques and procedures, as well as the information, tools and equipment which have been commonly used in mobile air conditioning system diagnosis and service of R-12 and R-134a will be different for MAC systems using R-744 and/or R-1234yf. No technician may perform service or repair on a mobile air conditioning system using R-744 and/or R-1234yf without being trained for the refrigerant being handled.

Service technicians shall be trained to always wear proper personal protective equipment while handling/servicing systems that contain any refrigerant. Service technicians shall read and follow the appropriate material safety data sheets, which provide information on safety and the proper personal protective equipment to use. These include but may not be limited to the following items:

- All contact with liquid or gaseous refrigerant shall be avoided.
- Goggles with side protection and gloves (insulated against heat loss and impermeable to refrigerant) shall be worn while working with the refrigerant circuit.
- Exposure of the skin to refrigerant may result in frostbite, in which case rub affected area with lukewarm water. A physician shall be consulted immediately regarding the affected skin areas.
- A physician shall be consulted immediately in the event of complaints following exposure to high refrigerant concentrations. Complaint symptoms may include: increased breathing rate, breathlessness, headache, accelerated pulse, dizziness.

- Avoid breathing A/C refrigerant and lubricant vapor or mist. To remove refrigerant from the A/C system, use service equipment designed for recovery of that refrigerant which is certified to meet the requirements of the appropriate SAE Standards.

Training shall discuss key differences between equipment and tools designed for each refrigerant and stress the use of proper equipment with designated refrigerant. Training shall discuss standard, hybrid and other commercialized alternative propulsion vehicles in the context of safety and performance of mobile A/C related issues (i.e., proper operation of the mobile air conditioning and cooling systems in a hybrid vehicle is important not only for passenger comfort, but for the optimal operation of on-board computers and battery packs). Technician training shall include:

- Differences between R-744 as compared to R-134a and/or R-1234yf as compared to R-134a (see Appendix A).
- Identification of unique fittings and labels for each refrigerant along with tank identification.
- Instructions on how to use refrigerant identification equipment.
- Instructions on how to use leak detection equipment and/or fluorescent dyes to identify leaks with each refrigerant.
- Instructions on how to contain and limit use of each refrigerant based on vehicle specifications, to promote technician safety and minimize the environmental impact of mobile air conditioning by using the appropriate SAE certified recovery, recycling and charging equipment.
- System servicing procedures as detailed in this standard.
- General safety best practices and specific safety best practices for each refrigerant. Technicians shall also have a good understanding of the safety requirements as defined in SAE J639.

UNIQUE FITTINGS AND LABELS

Technicians shall be informed that unique service fittings and labels for each refrigerant, are required. Fittings are discussed under J639

- •R-134a tank is light blue (PMS Color 2975).
- •R-1234yf tank is white with red band to denote flammability.
- •R-744 tank is gray (PMS Color 352).

4. REFRIGERANT IDENTIFICATION AND POTENTIAL CONTAMINATION

- Prior to servicing a MAC system, technicians shall be required to verify what refrigerant is in the system. This shall include checking the SAE J639 system label to get information about the type and quantity of refrigerant that should be in the A/C system and potential issues arising from accidental or intentional mixing of refrigerants. Technicians shall also be warned that fittings can be defeated with adapters, labels might never be installed, and even properly affixed labels can fall off or become illegible, and for these reasons the use of an SAE certified refrigerant identification device is required to prevent the spread of contaminated refrigerant to other vehicles and the refrigerant supply.
- Refrigerant recovery and recycling equipment is designed to process only one refrigerant for reuse. Recycling equipment will not segregate mixtures of refrigerants. Contaminated refrigerant (blend of more than one refrigerant or non-system refrigerant) in recovery/recycling equipment could lead to the potential contamination of more refrigerant. Technicians shall understand how to safely recover contaminated refrigerant and where to

find approved reclamation/destruction facilities for contaminated refrigerant along with applicable regulations that cover this situation. For more information see http://www.epa.gov/ozone/title6/608/reclamation/reclist.html.

- The technician shall understand that the use of a refrigerant identifier can provide an important safety warning that a hydrocarbon or other improper refrigerant has been charged into the system. Certain types of electronic leak detection devices (heated diode or corona discharge) as well as motors, switches, and controls on recovery and recycling machines, could generate sparks that could serve as ignition sources in the presence of refrigerants classified as flammable (A2, A2L or A3) by ASHRAE standard 34 2010.

ELECTRONIC LEAK DETECTION AND USE OF FLUORESCENT DYES

- Training shall incorporate pertinent information about equipment, tools and procedures specific to each refrigerant. Training shall incorporate pertinent references to SAE standards for electronic leak detectors and trace dyes as well as the technician procedure for using electronic refrigerant leak detectors, trace dyes and other methods.
- Leak detection for R-744 presents a unique challenge. R-744 (CO2) exists naturally and artificially in the atmosphere and could trigger detection devices when there is no system leak.
- Technicians shall be informed to use leak detection devices certified to SAE J2913 for use with R-1234yf. Certain leak detection devices (heated diode or corona discharge) could serve as ignition sources in the presence of hydrocarbons or other flammable refrigerants.

RECOVERY, RECYCLING AND CHARGING EQUIPMENT

- U.S. EPA regulations currently require recovery of all MAC refrigerants including R-744. Refrigerant oil shall be collected and disposed of in accordance with federal, state and local requirements. The proper recovery of CO2 from high-pressure systems is necessary to ensure a harmless depressurization and avoid technician exposure to unacceptable concentrations of CO2 in the work area. Similar considerations will apply to recharging the system. The technician shall be informed that R-744 systems operate at much higher pressures than current systems. They must be aware that release and rapid expansion of CO2 can cause serious injury and asphyxiation by displacing air.
- Motors, switches, battery cables, connections and controls on some recovery and recycling equipment could serve as ignition sources in the presence of R-1234yf. Technicians shall also be warned and told how to avoid other possible high amperage discharges, which might ignite certain refrigerant mixtures. Technician training shall incorporate pertinent elements of SAE J2843 for refrigerant recovery, recycling and recharging equipment. Technicians shall be informed that recharge equipment (and procedures) will be different from those used for current MAC systems. Automatic refrigerant recharge requirements will be included in certified recovery and recycling equipment:
- For example, before delivering a full system charge, equipment used to recharge R-1234yf systems will first place the system under a minimum vacuum of -0.09 MPa gauge (26.9 in of mercury). The machine will then monitor the applied vacuum, and note if it decays. If the slope of the vacuum decay exceeds 51mm Hg/min (2.0 in HG/min) in five minutes, a leak is indicated and the machine will not permit the recharge process to continue. The technician shall locate and repair the leak(s) before again attempting to recharge the system. Requirements shall be consistent with SAE J2843.

- If the system passes the vacuum decay check the machine shall instruct the user to turn the vehicle's HVAC blower motor on low (A/C Off) with air distribution mode set to "floor", to run the blower for 1-2 min to clear any residual contamination and to place an operating J2913 compliant leak detector's probe with the unit set for maximum sensitivity in the center of a floor ducts outlet. The machine shall require user to verify leak detector is in place and blower motor is on low. If "No" the machine shall not allow user to continue. If "Yes" the machine shall charge 15% of the refrigerant system charge specified on the SAE J639 vehicle label on both high and low sides of the system. The user will be required to monitor the J2913 leak detector for 5 min for indication of a leak. The machine shall require user verification if a leak is detected or not. If leak is detected the equipment shall continue to hold for further external leak checking and shall lock out all operations except recovery and/or re-evacuation.If vacuum decay and pressurized leak checks are passed, then the balance of the programmed amount shall be charged.
- Extra care shall be taken to avoid significant over-charging of the refrigerant system. If a refrigerant system with CO2 is overcharged it can lead to high-pressure build-up in the system and the technician needs to be made aware of potential pressure differences. If a refrigerant system with CO2 is overcharged and a leak into the passenger compartment occurs, the concentration in the passenger compartment could exceed the health based limit for CO2. If a refrigerant system with R-1234yf is overcharged and a leak into the passenger compartment occurs, the concentration in the passenger compartment could exceed the lower flammability limit. Should a significant ignition source occur within the area, with this high concentration in the passenger compartment, this could result in ignition of the refrigerant.

SYSTEM SERVICING PROCEDURES

Training shall incorporate pertinent information about service procedures specific to each refrigerant. Training shall incorporate pertinent references from SAE J2211, detailing recommended service procedures for containment of refrigerants. In general, low lying areas, such as workshop pits, shafts or cellar exits are areas where released refrigerant can pool in the absence of ventilation. Work areas shall be adequately ventilated to prevent R-1234yf plus air mixtures from reaching the flammability range of 6.2 to 12.3 % by volume.

R-1234yf

- Technicians shall be advised of the following general service procedures:
- Maintaining good ventilation in the work area.
- Open vehicle windows and doors when charging a MAC system to prevent an accumulation of refrigerant in case of a major refrigerant leak.
- Clean all dirt, grease and debris from and around connection joints before servicing and disassembly of refrigerant connections.
- Carefully inspect refrigerant connections, joint seals and seal surfaces for signs of wear, deformation, contamination or damage after disassembly. Prior to disassembly, look for presence of refrigerant oil on adjacent surfaces that could be sign of a leak.
- Seals/O-rings shall never be reused, but replaced with all new parts.
- Ensure proper alignment of male/female portions and seal so there is no misalignment and stress on the fitting connection.
- Refrigerant connection shall be tightened to correct bolt/nut torque value specified by manufacturer.

- Evaporators in vehicles equipped with R-744 or R-1234yf refrigerant systems, shall never be repaired or replaced with one removed from another or salvage vehicle and that new replacement MAC evaporators shall meet the appropriate SAE Standard J2842 and any labeling requirements.
- Specific issues related to hybrids and plug-in electric cars with high-voltage A/C systems. Training shall incorporate appropriate MAC procedures including those related to safety, and the importance and general description, of procedures for disabling a high-voltage system.

GENERAL AND SPECIFIC SAFETY PRACTICES

Refrigerant cylinders shall not be

- Exposed to direct sunlight or any other heat source.
- Subject to mechanical stress (e.g., dropping, throwing).
- Stored in shafts (below ground surfaces/enclosed areas) or in front of cellar windows.
- Filled in the workshop or by workshop personnel.
- Filled with another refrigerant.
- Transported without being securely stowed.

R-744

At a minimum, technician training shall incorporate information addressing the following key areas: R-744 cylinders have a higher pressure than technician is used to dealing with R-134a and R-1234yf refrigerants. Technician shall be made aware of increased pressure and the exposure limits for their personnel safety with the different refrigerants.

R-1234yf

Although design features are integrated into systems and R-1234yf is a mildly flammable refrigerant as classified by ASHRAE 34, various precautions shall be observed. R-1234yf-minimum technician training shall incorporate information addressing the following key areas:

- Service technicians shall not smoke or have an open flame while working on and/or servicing systems which contain R-1234yf.
- Technicians shall avoid R-1234yf coming in contact with open flames and hot surfaces, sparks and high-energy ignition sources as ignition may occur.
- Technicians shall be aware of the importance of using tools and service equipment designed for R-1234yf, including but not limited to leak detectors, recovery/recycling/recharging equipment, and MAC system components (such as evaporators, on-car refrigerant leak detection devices, etc.) required for use with R-1234yf systems.

APPENDIX A - COMPARISON
OF R-134a R-1234yf, R-744

	HFC-134a	HFO-1234yf	CO2
Basic Physical Properties			
Boiling Point, T_b	**-26°C**	**-29°C**	**-78.5C**
Critical Point, T_c	**102°C**	**95°C**	**31C**
P_{vap}, MPa (25°C)	**0.665**	**0.677**	**6.4**
P_{vap}, MPa (80°C)	**2.63**	**2.44**	
Liquid Density, kg/m^3 (25°C)	**1207**	**1094**	**711**
Vapor Density, kg/m^3 (25°C)	**32.4**	**37.6**	**243**
Flammabilit	**No**	**Yes**	**No**
Lower Flammability Level	**N/A**	**6.2%**	**N/A**
Upper Flammability Level	**N/A**	**12.3%**	**N/A**
AC System			
AC Type	**Vapor Compression**	**Vapor Compression**	**Super Critical Fluid**
AC Components	**Can use either R-134a evaporator or J2842**	**Use only evaporators which meet J2842**	**Use only evaporators whichmeet J2842**
Storage, Handling			
Container Type	**Light Blue Container, PMS Color 2975**	**Whie Container with Red Band**	**Gray Container, PMS Color 352**
Product Storage	**Do not expose to open flames, red hot surfaces, or temps in excess of 52C**	**Do not expose to open flames, red hot surfaces, or temps in excess of 52C**	**Do not expose to open flames, red hot surfaces, or temps in excess of 52C**
Personal Protective Equipment	**gloves, goggles**	**gloves, goggles**	**gloves, goggles**
Equipment			
Recovery/Recycling Equipment	**Only use equipment that meets J2210, superceded by J2788 and is for use with R-134a**	**Only use equipment that meets J2843 and is for use with HFO-1234yf**	**N/A**
Recovery Only	**Only use equipment that meets J1732, superseded by J2810 and is for use with R-134a**	**Only use equipment that meets J2851 and is for use with HFO-1234yf recovery for reclaim or destruction.**	**N/A**

FIGURE A1

Equipment for Recovery and Recovery/Recycling/Recharging Contaminated Or Flammable Refrigerants for Mobile Automotive Air Conditioning Systems

TAKEN FROM J2851 FEB2015 – RECOVERY EQUIPMENT FOR CONTAMINATED R-134a or R-1234yf REFRIGERANT FROM MOBILE AUTOMOTIVE AIR CONDITIONING SYSTEMS

RATIONALE – This standard is required to facilitate service of contaminated mobile air-conditioning (MAC) R-134a and/or R-1234yf refrigerant systems. If the MAC system refrigerant has been contaminated such that the refrigerant in the MAC system cannot be on-site recycled and meet J2099 with equipment that meets SAE J2788, J2843 or J3030, then it should be recovered and sent for proper disposal. If a refrigerant identifier that meets J2912 or J2927 indicates that the refrigerant has been contaminated, it should be removed only with equipment that meets this standard and then disposed of by a qualified facility.

SPECIFICATIONS AND GENERAL DESCRIPION

- The equipment must be able to recover (extract) contaminated refrigerant from a MAC system as per the test procedure.
- The equipment shall be suitable for use in an automotive service garage environment.
- The equipment must be certified that it meets requirements of this document and SAE J2911

Certification of compliance shall be made by an independent testing organization that has received approval by the EPA Administrator to certify equipment as meeting the standard requirements identified under US EPA 40 CFR 82.38

SAFETY REQUIREMENTS

Construction

Ventilation of Equipment Enclosure -- If equipment stores refrigerant inside an enclosure or cabinet the equipment shall provide [6 air exchanges per hour] ventilation to prevent buildup of concentrations of vapor in the enclosure or cabinet. At power up the fan shall be operated long enough to perform one air change prior to any other operation and shall operate continuously while the equipment is powered and shall have a means to detect loss of ventilation airflow and shall lock out operation of the unit if flow is not detected. Fan placement shall direct flow out of the cabinet so it is not pressurized. At least (2) Intake grills each of sufficient area to maintain 6 air change per hour flow shall be located on different surfaces and oriented to maximize cross flow within the cabinet.

Label -- The equipment must comply with applicable federal, state, and local requirements on equipment related to handling contaminated refrigerant material. Safety precautions or notices related to safe operation of the equipment shall be prominently displayed on the equipment and shall also state "CAUTION—SHALL BE OPERATED BY QUALIFIED PERSONNEL."

Under NO CIRCUMSTANCES shall any equipment be pressure tested or leak tested with air/ or air/refrigerant mixtures. Do not use compressed air (shop air) for leak detection in systems.

OPERATING INSTRUCTIONS

The equipment manufacturer shall provide operating instructions that include information required by SAE J639, necessary maintenance procedures, and source information for replacement parts and repair. The equipment must prominently display the manufacturer's name, address, a service telephone number, and any items that require maintenance or replacement that affect the proper operation of the equipment. Operation manuals must cover information for complete maintenance of the equipment to assure proper operation. The equipment manufacturer shall provide a warning in the instruction manual regarding the possibility of refrigerant contamination from hydrocarbons, and leak sealants.

FUNCTIONAL DESCRIPTION

Equipment Performance Requirements

- The equipment must be capable of continuous operation in ambient temperatures of 10 °C (50 °F) to 50 °C (120 °F). Continuous is defined as completing recover operation with no more than a brief reset between servicing vehicles, and shall not include time delays for allowing a system to outgas (which shall be part of the recovery period provided by this standard).
- The equipment shall demonstrate ability to recovery a minimum of 95.0% of the refrigerant from the test vehicle in 30 min or less, without prior engine operation (for previous 8 h minimum), external heating or use of any device (such as shields, reflectors, special lights, etc.), which could heat components of the system. The recovery procedure shall be based on a test at 21 to 24 °C (70 to 75 °F) ambient temperature. The test system for qualifying shall be a 1.4 kg (3 lb.) capacity orifice tube/accumulator system in a 2005 to 2009 Chevrolet Suburban with front and rear A/C
  NOTE: ENSURE THAT REFRIGERANT DOES NOT COME INTO CONTACT WITH HOT SURFACES DURING THIS PART OF PROCESS.
- The equipment shall demonstrate ability to recover a minimum of 85% of the refrigerant from the test vehicle or system as per 6.1.2. in 30 min or less, at an ambient temperature of 10 to 13 °C (50 to 55 °F), subject to the same restrictions regarding engine operation and external heating.

Fittings and Flexible Hoses

- All flexible hoses must meet the applicable sections of SAE J2197 or SAE J2888 for service hoses.
- Service hoses must have shutoff devices located at the connection points to the system being serviced to minimize emissions while connecting/disconnecting from the system being serviced.

RECOVERY EQUIPMENT VALIDATION TEST REQUIREMENTS

- Use of a test vehicle (2005 to 2009 Chevrolet Suburban) with rear A/C and a charge of 1.36 kg/3 lb or a laboratory fixture shall be used to validate the recovery efficiency of this equipment. For test validation, the equipment is to be operated to the manufacturer's instructions. Testing shall be done at a temperature of 21 to 24 °C (70 to 75 °F).
- Test vehicle shall be "overnight cold" (not run for at least 8 h).

- You shall start with an empty system, using this method: (a) Recover refrigerant from system, per equipment manufacturer's instructions. (b) Evacuate the system to a minimum of -710 mm Hg (-27.9 in Hg). (c) Monitor vacuum for decay, checking every 20 min. If decay exceeds 75 mm Hg (3.0 in Hg), evacuate the system again. When system holds 710 mm Hg plus 75 mm Hg, vacuum for three more hours, it is considered empty.
- Using a machine certified to SAE J2788 and with machine on a platform scale with accuracy to within plus/minus 3g at the weight of the machine, charge the system to 1.4kg/3 lb. The actual charge amount per the reading on the platform scale (hoses disconnected from the system after charge and draped over the machine) shall be used as the basis for the recovery efficiency of the recovery only machine being tested to this standard.

Recovery Test Procedure (using a vehicle)

1. Following a successful system charge, the system shall be run for 15 min at 2000 rpm to circulate oil and refrigerant, following which engine and system shall rest for 8 h. Then the laboratory may begin the recovery test. If the machine manufacturer specifies, operate the engine/system for up to 15 min, at up to 2000 rpm, then shut off engine/system.
2. Place the recovery machine being tested on the platform scale with the hoses draped over the unit and with recovery tank (if separate). Record the weight of the machine, hoses and the recovery tank (if separate) on the platform scale as (Weight a).
3. Start timer. Connect service hoses to system of test vehicle and perform recovery per the equipment manufacturer's instructions. The vehicle system service valves' cores shall remain in the fittings for this procedure.
4. When recovery is completed, including from service hoses if that is part of the recommended procedure, disconnect hoses and drape over machine (that is still on platform scale). Stop timer. The elapsed time shall be 30 min or less. If it is in excess of this time, the machine fails the test and no retest is allowed. The manufacturer shall document changes made to the machine to improve its performance before a new test is allowed, and furnish them to the laboratory.
5. If the recovery is completed in no more than the 30 min record the amount of refrigerant recovered by noting the weight of recovery unit, hoses and the recovery tank (if separate) on the platform scale (Weight b).
6. The platform scale shall indicate that a minimum of 95% of the amount charged into the system has been recovered. If the platform scale indicates a lower percentage has been recovered, the machine fails the recovery test. (Weight b – Weight a/ Charge Weight ≥ .95)

Optional Recovery Test Procedure (using a laboratory test fixture)

- If an equipment manufacturer chooses, as an alternative to the actual vehicle, it may certify to SAE J2851 with a laboratory fixture that is composed entirely of all the original equipment parts of a single model year for the 3.0-lb capacity front/rear A/C system of R-134a designated vehicle system.
- The fixture system shall be powered by an electric motor, run at a speed not to exceed 2000 rpm, and for this test option, no system warm-up or equivalent procedure may be used. The certifying laboratory shall maintain records of all parts purchased, including invoices and payments. The assembly of the parts shall, as an outside-the-vehicle package, duplicate the OE system and it's routing. Aside from the absence of engine operation and the limitations posed by the standard and the use of the electric motor, the test shall otherwise be the same as the vehicle test

- The fixture systems for this standard shall not be powered by an electric motor during recovery, although a motor can be used, as part of the preparatory process, as outlined above, including installation of the charge.

INTERNATIONAL AND REGIONAL REQUIREMENTS

Equipment that is to be used in North America (where NFPA and NEC guidelines apply) shall comply with the following.

General Construction and Test Requirements -- ANSI/ISA 12.12.01 shall apply to Recovery Recharge Equipment except that if the flammable refrigerant does not pose a hazard to certain parts of the Equipment, then the applicable requirements from UL 1963 may be applied.

Electrical Requirements for contaminated refrigerant -- Non-incendiary equipment technique is required. The unit shall be constructed using electrical components deemed safe for this level of refrigerant flammability.

Guidelines for Electrical Equipment in a Class 1, Division 2 Hazardous Location shall be followed. Guidelines included, but not limited to the following areas for equipment used for contaminated refrigerant.

Electric motors shall comply with requirements outlined in ANSI/ISA 12.12.01

All other electrical components (such as but not limited to: switches, relays, circuit breakers, solenoids) shall comply with requirements as outlined in ANSI/ISA 12.12.01.

High-pressure Cutout Switch

- Use sealed or located in explosion proof enclosure, per NEC article 501.115 (B) (1)
- Labels need to indicate that proposed fasten connectors are not to be opened under load within classified location
- Components used must limit surface temperature to not more than 400 ºC

Labeling

- The equipment shall have a label which states "Certified by (Certifying Agency) to meet SAE J2851 and UL1963" in bold-type letters a minimum of 3mm (1/8 in) in height.
- In addition the following shall be included on the label:
    - The applicable marking requirements of UL 1963
    - Warning markings appropriate to describe refrigerant flammability (location, color, ISO symbols (ISO 7010:2011), text font and verbiage).
    - The refrigerant for which the equipment is certified to service. Labelling should be permanently marked on the outside equipment surfacein black print at least 6 mm high.
    - Depending on which refrigerant system the equipment is designed to service one of the following labels should be applied: “For contaminated mobile A/C systems designed for R-134a and R-1234yf” or for contaminated mobile A/C systems designed for R-134a” or “For contaminated mobile A/C systems designed for R-1234yf”.

Storage Vessel Requirements [unique labeling]

- Cylinders used in conjunction with this equipment must meet applicable DOT cylinder regulations. It must be permanently marked on the outside surface in black print of at least 10 mm "CONTAMINATED REFRIGERANT—DO NOT USE, MUST BE RECLAIMED or DESTROYED by an EPA authorized facility.
- Furthermore, since the refrigerant is contaminated with an unknown refrigerant, it shall be assumed to be flammable. Therefore, cylinder labeling shall also meet requirements for

flammable materials, i.e. , they shall be marked with appropriate flammable pictogram per regional shipping requirements. Options for types of cylinder labeling are as follows
    - Sticker attached to cylinder
    - Tag attached to cylinder underneath valve
    - Oversleeve attached to top of cylinder
    - Shoulder sleeve cuff
- No required PMS color for recovery cylinders in either US or EU. Therefore either grey with yellow shoulder or grey with red shoulder is acceptable.
- Cylinder Valve -- The cylinder valve shall comply with local regional/country requirements. The following valves are listed for reference US UL 1769, EU DIN 477-1.

Tank Over-fill Protection -- During recovery operation, the equipment shall provide overfill protection to assure that the liquid fill of the storage container (which may be integral or external) does not exceed 80% of the tank's rated volume at 21 °C per UL1963.

Pressure Relief Device -- The pressure relief device shall comply with the Pressure Relief Device Standard Part 1 - Cylinders for Compressed Gases, CGA Pamphlet S-1.1.

- Equipment that is to be sold in other regions shall comply with the following:
    - General construction and test requirements related to electrical systems and pressurized tanks shall be met for the region where the equipment will be sold.
    - All other performance requirements of this standard shall be met for all regions.

ADDITIONAL REFRIGERANT RECOVERY INFORMATION

While some MAC refrigerant systems may be contaminated such that they cannot be recycled on site, they may still have value at EPA approved recycling centers. Therefore it is highly advisable that service shops frequently check with known recyclers on possible recycling streams and determine how to handle these waste streams.

Forinstancce the following streams may have potential reclaim value and it may be better not to add additional refrigerants (i.e. HC's to this recovery cylinder. – R-134a/R-1234yf

TAKEN FROM J3030 JUL 2015 – AUTOMOTIVE REFRIGERANT RECOVERY/RECYCLING/RECHARGING EQUIPMENT INTENDED FOR USE WITH BOTH R-1234YF AND R-134a

SCOPE

The purpose of this SAE Standard is to establish the specific minimum equipment requirements for recovery/recycling/recharge equipment intended for use with both R-1234yf and R-134a in a common refrigerant circuit that has been directly removed from, and is intended for reuse in, mobile air-conditioning (A/C) systems. This document does not apply to equipment used for R-1234yf and R-134a having a common enclosure with separate circuits for each refrigerant, although some amount of separate circuitry for each refrigerant could be used.

SPECIFICATION AND GENERAL DESCRIPITION

The equipment shall be suitable for use in an automotive service garage environment and be capable of continuous operation in ambient temperatures from 10 to 49 °C.

- The equipment must be certified that it meets this standard by a certifying Laboratory as listed by the EPA administrator as identified under U.S. EPA 40 CFR Ch. 1 (7-01-08 edition) 82.38.
- The equipment must meet all feature content and functional requirements of both SAE J2788 for R-134a and SAE J2843 for R-1234yf, and pass all test requirements of these standards. In addition, it must pass a changeover test to determine that any refrigerant cross-contamination is within the limits of this standard, as described in Section 6 of this document. A changeover mode, beginning with a clearing procedure to minimize the amount of residual refrigerant in the plumbing lines, may be specified immediately prior to the test, which is described in Sections 5, 6.
- The laboratory may test R-134a for SAE J2788 and SAE J2843 for R-1234yf in either order. Before proceeding to the second refrigerant and following the second refrigerant but prior to the cross-contamination test, it must ensure the machine has been cleared of either choice for the first refrigerant using laboratory equipment of confirmed performance capability for the changeover mode previously described. It may not rely on the clearing procedure built into the machine by the equipment manufacturer, as this will not be validated until the entire SAE J3030 procedure has been completed.
- The equipment shall have a label which states "Design Certified by (Certifying Laboratory) to meet SAE J3030 for recovering, recycling and recharging R-1234yf or R134a using common refrigerant circuits, design certified to meet SAE J2788 certified for high-voltage service, when configured for R-134a. Design certified to meet SAE J2843 when configured for R-1234yf. Label shall use bold-type letters a minimum of 3 mm in height.

EQUIPMENT REQUIREMENTS FOR MACHINES DESIGNED TO USE BOTH REFRIGERANTS ON AN ONGOING BASIS

- The equipment shall have an electronically-controlled electro-mechanical lockout to permit the recovery, recycle, recharge sequence of either R-1234yf or R-134a, based on a sample from the vehicle system and a subsequent readout of the appropriate refrigerant from an identifier that meets SAE J2912. If it determines that the vehicle does not contain R-1234yf or R-134a in the required purity, it shall not permit refrigerant recovery.
- The equipment shall have a pre-select feature, so the operator can pick the refrigerant system he wishes to service. As a default, the equipment shall retain in non-volatile memory the refrigerant in the last system serviced, and display it when the machine is turned on, either as an externally-obvious mechanical setup, or by electronic display if the setup is internal. If the refrigerant service setup of the machine is different from the vehicle to be serviced, the machine shall require performing of the equipment manufacturer's specified clearing procedure. If the refrigerant is the same as in the previous operation of the machine, no clearing procedure will be necessary.
- Test - To establish basic eligibility for certification to this standard, the equipment shall be tested by the certifying laboratory to ensure it responds appropriately to the refrigerant identifier's signal using the following steps. The analyzer in this test shall be one certified to SAE J2912.
    - The machine shall be set to R-134a mode with an active SAE J2912-compliant refrigerant analyzer (also set to R-134a mode if necessary) attached internally or SAE J2912 attached externally

- The machine or analyzer shall be connected to an R-134a source by the certifying laboratory to verify that the machine accepts the refrigerant analyzer signal and allows recovery of that refrigerant.
- With the machine in R-134a mode, the machine and/or external analyzer shall be connected to an R-1234yf source to verify that the machine accepts the refrigerant analyzer R-12347yf signal and prevents recovery of the R-1234yf refrigerant.
- The machine and/or analyzer if necessary shall be set to R-1234yf mode with an active internal or external refrigerant analyzer attached to an R-1234yf source, The certifying laboratory shall test to ensure the analyzer instructs the machine to enter R-1234yf mode and that the machine accepts the analyzer signal and allows recovery of that refrigerant.
- With the machine in R-1234yf mode, the machine or analyzer shall be connected to an R-134a source to verify that the machine accepts the R-1234yf refrigerant analyzer signal and prevents recovery of the R-134a refrigerant.
- A physical means shall be provided to prevent recycle or recharge into both an R1234yf and R134a mobile air conditioning system concurrently. The certifying laboratory shall inspect for its presence and ensure it operates for this purpose.
- The machine shall not be equipped with refrigerant oil injection.
- Transfer of Recycled Refrigerant
- Recycled refrigerant for recharging and transfer shall be taken from the liquid phase only.

- Seat Leakage Tests -- Valves, including electrically operated solenoid valves, that are used to isolate R-1234yf and R-134a refrigerant circuits, shall have a seat leakage rate below 4 g/year (0.15 oz/year) before and after 100,000 cycles of operation. This endurance test shall be conducted with R-134a and R-1234yf at maximum operating pressure that would be encountered during the recycling procedures for SAE J2788 and SAE J2843. The Seat Leakage Tests shall be performed at 1.5 times this pressure at an ambient of 21-24 °C. These tests may be performed by the manufacturer/supplier of the parts and validating data supplied to the independent testing laboratory certifying the equipment to this standard.
- Interlocks -- Electrical interlock devices that are used to prevent cross contamination of refrigerant shall be operated for 100 000 cycles and there shall be no failure that would permit cross contamination of refrigerant. Solid state interlock devices shall comply with the requirements for a Class B Control Function per the Standard for Automatic Electrical Circuits for Household and Similar Use, Part 1 General Requirements UL 60730-1.

4.4 Equipment requirements for machines designed for a one-time changeover

4.4.1 Although the manufacturer may use an approach that includes mechanical or electro-mechanical switching, it also may choose to offer a conversion kit for the changeover. This kit must be designed to be tamper-resistant, in that once converted, the machine cannot be retrofitted to the first refrigerant. So that the tamper resistance should result in a machine that can only be serviced with parts for the refrigerant to which it was changed. The test laboratory certifying the equipment to this standard shall execute the changeover and evaluate it for what it can reasonably consider tamper resistance.

5. TESTING

The testing shall be separated into three modes, so that a failure in any one permits the equipment manufacturer to identify and address the applicable issue. However, the only mode for which a separate retest is permitted is the changeover. The test fixture shown as Figure 1 in SAE J2843, or a functional equivalent, should be used.
Although a clearing procedure between the tests for SAE J2788 and SAE J2843 is permitted, the laboratory shall perform testing for one of these two standards, then clear the machine per 3.3.1, as the equipment maker's clearing procedure is not validated until the final test for cross-contamination. If the machine meets the standard for one refrigerant, following its validated clearing procedure, the laboratory may proceed to perform the testing for the second standard. However, the cross-contamination test described in 6.2 must be performed last.
5.1 Equipment shall be tested in sequence as noted in SAE J2843 and SAE J2788, and only following successful completion of all testing to those standards, shall it undergo the changeover test to ensure there is no excessive cross-contamination, following the sequence in section 6

REFRIGERANT CROSS CONTAMINATION TEST
6.1 General
6.2 Test Cycle
The following method shall be used after the tests and requirements for SAE J2788 and J2843 are completed. If the machine has separate onboard tanks, one for each refrigerant, the laboratory shall ensure they are empty prior to beginning the cross-contamination testing.
Following the manufacturer's instructions, the equipment shall be cleared of R-134a, prior to beginning step a. The test fixture shown in SAE J2843, Figure 1, or a functional equivalent shall be used and the test shall be conducted at each stable ambient within the range of 10-13 ^{0}C, 21-24 ^{0}C and 48-50 ^{0}C for a machine designed to use both refrigerants on an ongoing basis. The cross-contamination samples are to be taken sequentially and as reasonably contemporaneously as possible at the three noted temperatures. The machine must pass the cross-contamination test at each of the temperatures. For a machine designed for a single, tamper-resistant (permanent) changeover, the test shall be conducted only at 21-24 ^{0}C.

- A 1.13 kg standard sample of virgin R-1234yf shall be processed by the equipment.
- Follow manufacturer's instructions to clear the equipment of R-1234yf before processing R134a. The refrigerant loss during processing of this sample shall be measured and shall not exceed 5% of the sample.
- Process a 1.13 kg, standard sample of virgin R-134a through the equipment.
- Follow manufacturer's instructions to clear the equipment of R-134a. The refrigerant loss during processing of this sample shall be measured and shall not exceed 5% of the sample.
- The amount of cross contaminated refrigerant, as determined by gas chromatography, in samples processed during steps a and c shall not exceed 0.5% by mass, as described in 7.1

REFRIGERANT CROSS CONTAAMINATION
The amount of cross contamination of R-1234yf in R-134a or R-134a in R-1234yf shall not exceed 0.5% by mass as determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. As an example, 1% SP-1000 on Carbopack B (60/80 mesh) column may be used for the analysis.

TAKEN FROM J2843 JAN2013 -- R-1234YF [HFO-1234YF] RECOVERY/RECYCLING/RECHARGING EQUIPMENT FOR FLAMMABLE REFRIGERANTS FOR MOBILE AIR-CONDITIONING SYSTEMS

SPECIFICATION AND GENERAL DESCRIPTION

- The equipment shall be able to remove, recover, recycle and recharge R-1234yf refrigerant on-site from MAC systems.
- The equipment shall be suitable for use in an automotive service garage environment and be capable of continuous operation in ambient temperatures from 10 to 50 °C (50 to 120 °F) and meet the accuracy defined in this standard.
- The equipment shall be certified that it meets requirements of this document and the requirements of SAE J2911.
- The manufacturer can state certification of compliance with this Standard only after meeting the requirements in SAE J2911.
- Any independent testing organization that has received approval by the Administrator to certify equipment as meeting the standard requirements identified under US EPA 40 CFR Ch. I (7-1-08 Edition) 82.38 shall provide certification of compliance in meeting the requirements in 3.3.

REFRIGERANT RECYCLING EQUIPMENT REQUIREMENTS

Moisture and Acid The equipment shall incorporate a desiccant package that shall be replaced before saturation with moisture, and whose mineral acid capacity is at least 5% by weight of the dry desiccant. Oil separation operation shall occur before the desiccant filter in the recovery circuit flow path to promote maximum desiccant life. The equipment shall be provided with a means of indicating when the filter desiccant moisture capacity has reached the allowable limit and desiccant replacement is required. This may include a reliable means of detecting moisture level or an algorithm based on the amount refrigerant recovered. The user shall be clearly alerted to replace the filter prior to the full saturation. Warnings shall be displayed on screens and printed on printouts where applicable. The warnings shall explain that the machine is approaching the end of filter life. The manufacturer shall incorporate a lockout when the end of filter life is reached. The manufacturer shall use an identification system to ensure that a new filter has been installed to reset the machine for operation.

Filter -- The equipment shall incorporate an in-line filter that will trap particulates of 15 micron spherical diameter or greater.

Scale (If Used) -- The scale shall maintain accuracy when moved, as per the test in Section 10.

Requirements for Non-condensable Gases (NCGs)

- The equipment shall automatically purge NCGs if the acceptable level is exceeded or incorporate a device to alert the operator that NCGs level has been exceeded. NCGs removal must be part of normal operation of the equipment and instructions must be provided to enable the task to be accomplished within 30 min (to reach the refrigerant purity level specified in SAE J2099 updated February, 2011).
- Equipment that uses the manual NCGs purge process shall provide a method to determine the temperature of the refrigerant in the container being purged. This is required for determining the container refrigerant pressure/temperature relationship as the container lowers in temperature during the purge process. This is required to alert the operator if they have

properly operated the purge cycle and determined the amount of NCGs remaining in the container that has been purged. The procedure shall be identified in the instruction manual provided with the recycling equipment.

- Pressure indicating device that are used to identify the NCGs level shall have readable divisions of 7 kPa values in order to identify the level of excess NCGs in the refrigerant.
- Refrigerant loss from non-condensable gas purging shall not exceed 5% by weight of the total refrigerant removed from the test system
- The tank shall be tested on each charge cycle for non-condensable gasses and a purge performed if required

*Recharging and Transfer of Recycled Refrigeran*t -- Refrigerant for recharging and transfer shall be taken from the liquid phase only.

SAFETY REQUIREMENTS

Construction

Release of R-1234yf in Normal Operation of the Equipment

Any component that normally releases small amounts of R-1234yf vapor into the cabinet shall have the vapor directed away from any potential ignition sources to be dispersed from the cabinet by the ventilation system. Any user maintenance procedure (such as filter change or tank evacuation) shall assure that procedures are in place to collect and/or safely vent any residual refrigerant before the system is opened.

Service Couplers

To avoid cross connection with non R-1234yf vehicle ports the equipment shall only use service couplers designed to SAE J2888 specifications and shall be marked R-1234yf as required in SAE J2888.

Ventilation of Equipment Enclosure

Equipment shall be constructed with at least six air exchanges per hour to prevent build up of concentrations of vapor in the enclosure or cabinet. At power up the fan shall be operated long enough to perform one air change prior to any other operation and shall operate continuously while the equipment is powered and shall have a means to detect loss of ventilation airflow and shall lock out operation of the unit if flow is not detected. The exception to this is that the fan may be momentarily shutoff for accurate scale reading, provided that the only component energized is the required control valve. To prevent build up of vapor within the cabinet the fan shall not be de-energized for more than 5 min while the recovery machine is powered. Fan placement, shall direct flow out of the cabinet so it is not pressurized. At least two intake grills each of sufficient area to maintain six air changes per hour flow shall be located on different surfaces and shall be located to maximize cross flow within the cabinet.

The equipment shall comply with applicable federal, state, and local requirements on equipment related to handling R-1234yf material. Safety precautions or notices related to recommended operation of the equipment shall be prominently displayed on the equipment and shall also state "CAUTION - SHALL BE OPERATED BY QUALIFIED PERSONNEL." Under NO CIRCUMSTANCES shall any equipment be pressure tested or leak tested with air/ or air/R-1234yf mixtures. Do not use compressed air (shop air) for leak detection in systems containing R-1234yf.

OPERATING INSTRUCTIONS

- The equipment shall have an integrated refrigerant identifier that complies with SAE J2927 or shall be capable of receiving input from a non-integrated, SAE J2912 compliant identifier, via an integrated USB port.
    - If not equipped with an integrated identifier, the equipment's integrated USB port designated to interface with the identifier shall comply with USB Communication Protocol: USB 2.0 or USB 3.0, CDC-ACM class (reference SAE J2912 appendix B).
    - The communication between the recovery machine and the SAE J2912 analyzer must be encrypted so as to avoid the use of non SAE J2912 certified devices to simulate the test results. The required encryption method is identified in SAE J2912.
    - The equipment shall be required to receive an acceptable reading from an integrated (SAE J2927 compliant) or a non-integrated (SAE J2912 compliant) refrigerant identifier before allowing recovery.
- If equipped with an independent refrigerant fill/source hose the equipment shall be required to receive an acceptable reading from an integrated (SAE J2927 compliant) or a non-integrated (SAE J2912 compliant) refrigerant identifier before allowing refrigerant to be transferred from an external source. An acceptable reading is ≥ 98% +2%/-1% R1234yf.Unacceptable readings shall prevent (lock out) the machine's ability to recover and/or transfer refrigerant until an acceptable identifier reading is received.
- The equipment manufacturer shall provide operating instructions, including instructions for proper attainment of vehicle system vacuum (i.e., when to stop the extraction process), and filter/desiccant replacement. Also to be included are any other necessary maintenance procedures, source information for replacement parts and, repair and safety precautions.
- The manual shall identify how to properly maintain hoses and seals to prevent contamination of refrigerant in the tank due to ingression of air (NCG) during the recovery process.
- The equipment shall prominently display the manufacturer's name, address, the type of refrigerant it is designed to recycle, a service telephone number, and the part number for the replacement filter/drier.
- The operating instruction shall state: "Only new lubricant, as specified by the system manufacturer, shall be installed in the MAC system. Lubricant removed from the system and/or the equipment shall be disposed of in accordance with the applicable federal, state and local procedures and regulations."

FUNCTIONAL DESCRIPTION OF THE EQUIPMENT

Equipment Operating Performance Expectations

- As part of the charge cycle, the equipment shall incorporate a vacuum decay leak check followed by a pressurized leak test. The charge cycle shall not progress to fully charge the vehicle without successfully completing both leak tests. The leak test parameters are defined in 9.3.
- The equipment shall be capable of continuous operation in ambient temperatures of 10 to 50 °C (50 to 120 °F). Continuous is defined as completing recovery/recycle and recharge (if applicable) operations with no more than a brief reset period between vehicles, and shall not include time delays for allowing a system to outgas (which shall be part of the recovery period provided by this standard). Continuous may include time out for an air purge if

necessary, although it is understood that extended equipment-off time is preferred to allow NCG and refrigerant separation in the supply tank for optimum results.

- The equipment shall be capable of removing a minimum of 95.0% of the refrigerant from the test system in 30 min or less, without external heating, or use of any device (such as shields, reflectors, special lights, etc.) which could heat components of the system. The recovery procedures shall be based on 21 to 24 °C (70 to 75 °F) ambient temperature. The test system for qualifying shall be a 1.4 kg (3 lb) capacity orifice tube/accumulator system in a 2005-2009 Chevrolet Suburban (R-1234yf equivalent system) with front and rear A/C, or the test fixture option described in 10.5 and shall be determined by accurately weighing the recovery machine, with the resolution and accuracy of within 2.3 g (0.005 lb) in the machine's weight range. The laboratory shall maintain records of the vehicle, including its VIN (vehicle identification number) or documentation for the test fixture, including purchase of all the component parts and graphic proof (photos, video, etc.) of the unit.
- The preceding shall not preclude a brief period of engine/AC operation at fast idle (up to 15 min, up to 2000 rpm) to circulate refrigerant and oil, and provide some engine and A/C warm-up. Where a vehicle is used the laboratory shall monitor coolant temperature per the vehicle engine coolant temperature sensor, and coolant temperature shall not be allowed to exceed 105 °C (221 °F). The time required shall not be included in the total time of 30 min.
- NOTE: Ensure that refrigerant does not come into contact with hot surfaces during this part of the process.
- The refrigerant that is recovered following oil separation shall be measured and the quantity displayed accurately to within ±30 g (±1.0 oz). The equipment shall include a provision for checking the accuracy.

If the machine is designed for recharging

- and the marketer permits use of a non-refillable refrigerant tank, the machine shall include a way to ensure virgin refrigerant remaining in the tank (called the "heel") is no more than 2% of the tank's rated capacity when the tank is indicated to be empty. This may be done by the machine marketer as follows:
- Specify a non-venting procedure to minimize the amount of unused virgin refrigerant remaining in the tank. The machine shall include any devices required for the procedure, other than ordinary service shop tools and supplies, and include instructions in the operator's manual. Provide an automatic or semi-automatic non-venting procedure with the machine.The laboratory shall test for the 2% capability. For testing purposes it may use a refillable tank, minimum 15 Ib. capacity (6.8 kg), containing a minimum of 7.5 lb (3.4 kg) of refrigerant.

The test is as follows:

1. Weigh the tank at the start of the test, on a scale accurate to ±3 g, to ensure it contains sufficient refrigerant.
2. Operate the machine to remove refrigerant from the tank, charging into a holding container until the tank is indicated to be empty. Continue with the marketer's recommended procedure for the 2% capability.
3. Weigh the tank, on a scale accurate to ±3 g.
4. Using the recovery compressor and/or a vacuum pump, draw the tank into a vacuum of -225 to 250 mm Hg (-9 to 10 in Hg) The tank shall hold that vacuum with a decay of less than 10% in 10 min. If vacuum decays 10% or more, the procedure shall be repeated as necessary to ensure the tank is empty.

5. Weigh the tank on a scale accurate to ±3 g. The difference in weight from Steps 3 to 5 shall be within 2% of the weight of the amount of refrigerant that is the tanks rated capacity.
6. This test may be performed at the conclusion of testing in 10.4 or 10.5. If the machine passes or has passed all other testing in this standard, the marketer may make modifications in procedure and/or machine operation and retest once at a later date, within 90 days. If the machine fails the retest, the machine shall be completely retested per this standard, or may be certified per the following alternative.

The marketer of the machine may specify use of a non-refillable refrigerant tank that provides for recycling and/or disposal of the residual refrigerant, in either case in a manner that does not vent. Or the marketer may exclude use of a one-way container, in the machine's operating instructions.

Tank Over-fill Protection

- All flexible hoses shall comply with SAE J2888.
- Service hoses shall have shutoff valves at the connection point to the system being serviced. Further, any hoses or lines to refrigerant storage/holding containers on or in the machine, shall have shutoff valves at the connection points to permit tank replacement or charging with refrigerant, without loss of refrigerant. A tank that is a permanent installation is exempt from this requirement.
- The equipment shall separate oil from the refrigerant, measure the amount recovered to an accuracy of 10 ml (0.3 oz), so the technician has an accurate basis for adding oil to the system.
- The following statement shall be prominently identified in the equipment service manual:

NOTE: ONLY NEW LUBRICANT, AS SPECIFIED BY THE SYSTEM MANUFACTURER, SHALL BE INSTALLED IN THE MAC SYSTEM. LUBRICANT REMOVED FROM THE SYSTEM AND/OR THE EQUIPMENT SHALL BE DISPOSED OF IN ACCORDANCE WITH THE APPLICABLE FEDERAL, STATE AND LOCAL PROCEDURES AND REGULATIONS.

RECYCLING EQUIPMENT VALIDATION

The equipment shall be capable of cleaning and separating the items in the contaminated refrigerant to the purity level defined in SAE J2099. The equipment shall be operated in accordance with the manufacturer's operating instructions.

Contaminated R-1234yf Sample Composition for Equipment Validation Testing

The standard contaminated refrigerant shall consist of liquid R-1234yf with 350 ppm by weight moisture (equivalent to 75% saturation at 40 °C, (104 °F), 45 000 ppm (by weight) R-1234yf compatible lubricant, and 1000 ppm (by weight) of non-condensable gases (air).

The R-1234yf compatible lubricant referred to in 8.3.1, shall be polyalkylene glycol (PAG), ISO 100 such as UCON, PAG ISO 46-55, Idemitsu, or equivalent, which shall contain no more than 1000 ppm by weight of moisture.

Although the lubricant in the contaminated refrigerant test sample is a PAG to conform to that used in the test vehicle system, the equipment manufacturer also shall ensure that the equipment is compatible with polyolester lubricant, such as ND11, as used in electrically-driven compressors in some hybrid vehicles.

Test Cycle

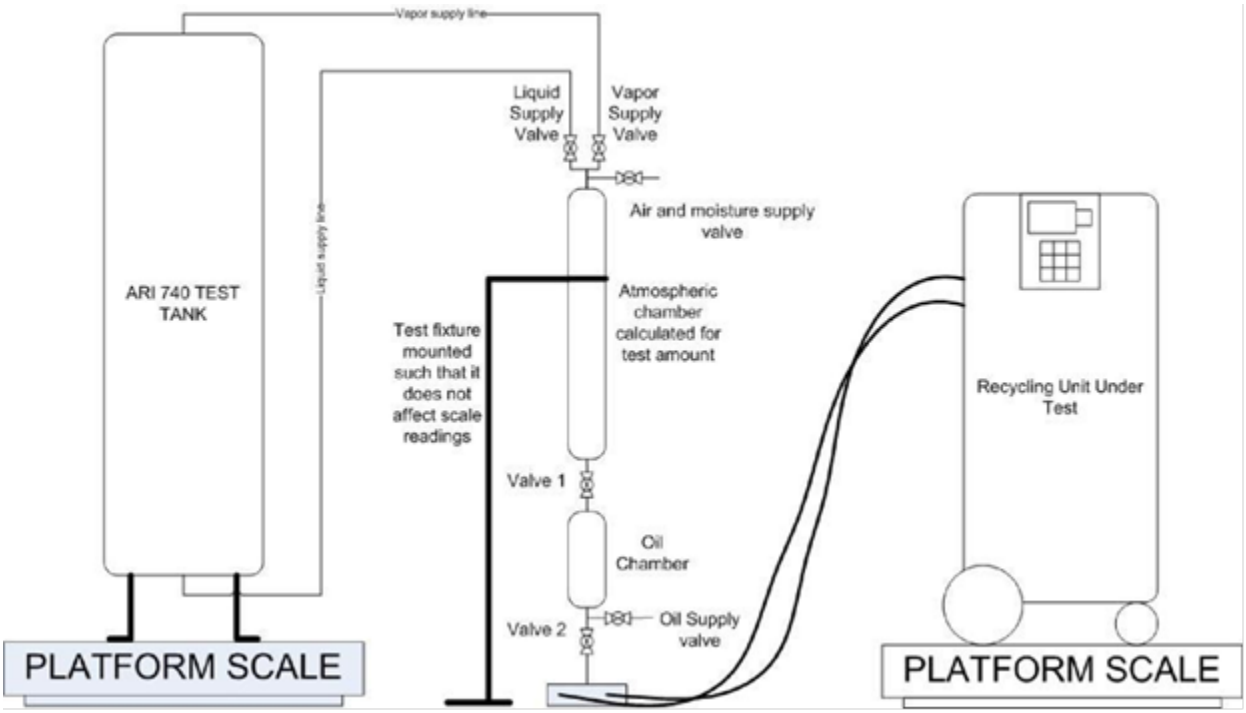

FIGURE 1. TEST FIXTURE

- The equipment shall be preconditioned by processing 13.6 kg (30 lb) of the standard contaminated R-1234yf at an ambient of 21 to 24 °C (70 to 75 °F) before starting the test cycle. 1.13 kg (2.50 lb) batches are to be processed at 5 min intervals. The test fixture, depicted in Figure 1, shall be operated at 21 to 24 °C (70 to 75 °F) Each of the 12 batches shall be processed by recovering 0.454 kg (1 lb) of liquid and 0.681 kg (1.5 lb) of vapor from the test fixture in Figure 1.
- Following the preconditioning procedure per, 18.2 kg (40 lb) of standard contaminated R-1234yf are to be processed by the equipment. Each of the 16 batches shall be processed by recovering 0.454 kg (1 lb) of liquid and 0.681 kg (1.5 lb) of vapor from the test fixture in Figure 1.
- After processing the 18.2 kg, measure the amount of refrigerant added to the test fixture. The total amount of loss (amount added to the test fixture minus net amount added to the test unit after non-condensable purges and oil drains) shall be less than 5% of the actual amount recovered from the test fixture.

Sample Requirements

Samples of the standard contaminated refrigerant from 8.3.1 shall be processed and shall be analyzed after said processing. Note exceptions for non-condensable gas determination.

Equipment Operating Ambient

The R-1234yf is to be cleaned to the purity level, as defined in SAE J2099 with the equipment operating in a stable ambient of 10, 21, and 50 °C (50, 70, and 120 °F) while processing the samples as defined in 8.4.

Quantitative Determination of Moisture

- The recycled liquid phase sample of R-1234yf shall be analyzed for moisture content via Karl Fischer coulometric titration, or an equivalent method. The Karl Fischer apparatus is an instrument for precise determination of small amounts of water dissolved in liquid and/or gas samples.
- In conducting this test, a weighed sample of 30 to 130 g is vaporized directly into the Karl Fischer anolyte. A coulometric titration is conducted and the results are reported as parts-per-million moisture (by weight).

Determination of Percent Lubricant

The amount of lubricant in the recycled R-1234yf sample shall be determined via gravimetric analysis. The methodology shall account for the hygroscopicity of the lubricant. Following venting of non-condensable gases in accordance with the manufacturer's operating instructions, the refrigerant container shall be shaken for 5 min prior to extracting samples for testing. A weighed sample of 175 to 225 g of liquid R-1234yf is allowed to evaporate at room temperature. The percent lubricant is calculated from weights of the original sample and the residue remaining after evaporation.

Non-condensable Gases

- The amount of non-condensable gases shall be determined by gas chromatography. A sample of vaporized refrigerant liquid shall be separated and analyzed by gas chromatography. A Porapak Q column at 130 °C (266 °F) and a hot wire detector may be used for the analysis.
- This test shall be conducted on liquid phase samples of recycled refrigerant taken from a full container within 30 min following the proper venting of non-condensable gases.
- The liquid phase samples in 8.9.2 shall be vaporized completely prior to gas chromatographic analysis.
- This test shall be conducted at 10 and 50 °C (50 and 120 °F) and may be performed in conjunction with the testing defined in 8.6. The equipment shall process at least 13.6 kg (30 lb) of standard contaminated refrigerant for this test.
- To eliminate oil cross contamination during charging and system issues with lower resistivity PAG oil, equipment shall be suitable for servicing systems with High Voltage Electric Compressors that use POE (polyolester) oil and shall meet the following criteria and be identified as instructed in 11.1.3.
- The equipment shall be capable of automatically charging refrigerant into a system with ≤0.1% by weight of any residual oil or shall always prompt the user to select normal or high voltage charging and shall then clearly provide the necessary steps to achieve ≤0.1% by weight maximum oil carryover. If the process is manual instructions shall be clearly printed on the machine face or attached in a robust manner.
- The method to achieve the requirement is at the discretion of the equipment manufacturer.

The percentage of residual oil in refrigerant shall be determined by conducting the following test using the specified test apparatus as shown in Figure 2. Equipment shall not have onboard oil or dye injection capability.

1. This test shall be conducted in an ambient environment 21 to 24 °C (70 to 75 °F).
2. Evacuate the equipment under test to -740 mm Hg (-29.1 in Hg) minimum (sea level) and then pressurize its recovery tank to 450 kPa (65 psig) with vapor R-1234yf.

3. Evacuate the SAE J2843 test Apparatus to -740 mm Hg (-29.1 in Hg) (sea level) via the VACUUM PORT and then close the VACUUM PORT VALVE.
4. Close the ISOLATION VALVE and allow the vacuum to draw 54 cc (1.8 oz) of 100 viscosity PAG oil into the 500 ml CYLINDER through the OIL FILL PORT and then close the OIL FILL PORT VALVE.
5. Add 1134 g (2.5 lb.) of vapor R-1234yf to the 100 lb TANK through the VIRGIN R-1234yf VAPOR IN PORT and then open the ISOLATION VALVE.
6. Connect the equipment hoses to the HIGH AND LOW SIDE SAE R-1234yf PORTS FOR EQUIPMENT HOSE CONNECTION and recover the vapor R-1234yf per the equipment instructions.
7. Repeat steps 3 through 6 two more times such that three total recoveries are performed.
8. Perform the equipment manufacturer's recommended procedure to minimize residual PAG oil in hoses and equipment as specified in the equipment's operator instructions.
9. Immediately charge 454 g (1.0 lb.) of liquid R-1234yf from the equipment into a clean, dry, evacuated 2 lb sampling cylinder.
10. Analyze the refrigerant to determine the weight percentage of lubricant per 8.8.
11. Percentage W/W (weight of oil/ weight of refrigerant plus weight of oil) shall be below 0.1% equipment passing this criterion shall be marked as outlined in 11.1.3.1 and shall have specific operating instructions clearly and permanently marked on the unit and in the operator's manual and/or automatic operation to assure the specification is met. The service hose(s) used for this test shall be the one(s) used for testing to all other parts of this standard and shall be documented and specified as a requirement for meeting the SAE J2843 high voltage requirement.

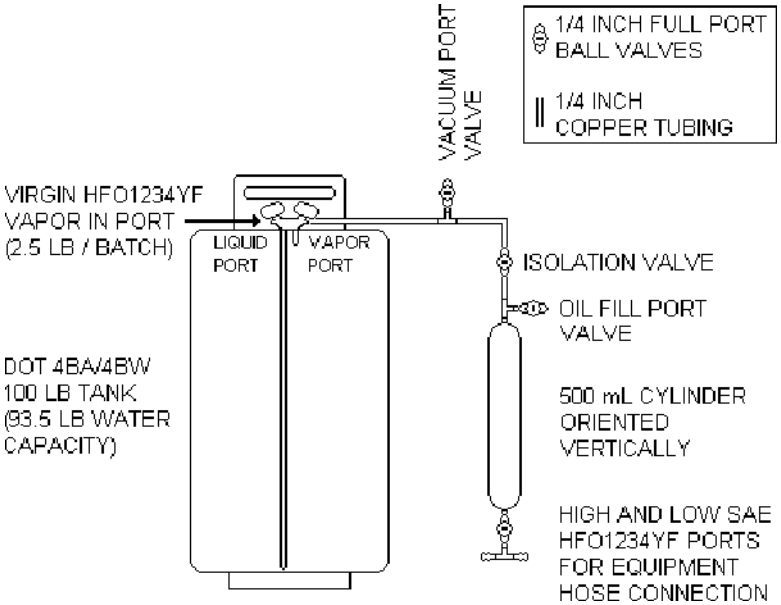

FIGURE 2 - SAE J2843 TEST APPARATUS

RECHARGING EQUIPMENT VALIDATION

It is the responsibility of the equipment manufacturer to ensure that the system evacuation process leaves the system 98% free of refrigerant and/or NCGs before recharging, following recovery and recycle provisions of this document.

Accuracy and Calibration

- All charge programming shall be entered only in SI Units and shall display in kg to 3 decimal places. The equipment shall be capable of both indicating and recharging the system to within 15 g (0.5 oz) of vehicle manufacturer's specifications. The laboratory shall test for this capability by choosing a charge amount that is within the range of the vehicle manufacturer's specifications. The equipment shall indicate and charge the system with that chosen amount, within ±15 g (0.5 oz). Example: if 500 g is chosen, the actual and indicated charge shall be 485 to 515 g, with any difference between actual and indicated charge within the laboratory scale accuracy requirements of this standard.
- If a scale is used in the machine, the equipment manufacturer shall provide a method or service for the technician to check scale accuracy, and include any necessary accuracy checking device (such as a calibration weight(s)) with the machine.
- If a mass flow system is used for charge determination, it shall maintain accuracy equal to the 15-g (0.50-oz) specification. The equipment manufacturer shall provide a method for checking accuracy and include any necessary accuracy testing device(s) with the machine.
- If the accuracy testing device(s) for a scale or mass flow machine includes a consumable, the manufacturer shall include a quantity of replacement or refill devices for five years of periodic testing as recommended.
- If any other system is used for charge determination, such as a positive displacement pump, the equipment manufacturer shall provide a method and any needed device(s) to check accuracy that is/are appropriate for its method of operation, including any temperature-compensating trim if used.
- The equipment manufacturer shall make a calibration service available to owners of the equipment as a means of maintaining the charge amount accuracy and precision within the allowable tolerance. They may charge a fee for the service.

Pre -Charge Leak Testing

To detect the possibility of a gross system leak (>0.3 g/s) prior to charging, units shall be constructed to perform the following sequence:

- The A/C system charge cycle shall begin with the equipment evacuating the A/C system to at least .011 MPa A (3.32 in Hg absolute). The evacuation must operate for a minimum of 5 min, and must reach and hold at or below.011 MPa A (3.32 in Hg absolute) during evacuation for at least 3 min.
- The evacuation process shall be halted upon meeting the above conditions and the system isolated from the vacuum source (internal vacuum pump). The equipment shall immediately begin to monitor the vacuum level for 5 min; if the slope of the vacuum decay exceeds 51 mm Hg/min (2.0 in Hg/min) during this time, the process shall be aborted and the unit shall only be enabled to either restart the vacuum process and vacuum decay or to charge 15% of the programmed charge (of the total system refrigerant charge indicated on the vehicle SAE J639 label) for the purpose of pressurized leak testing. Once 15% (+/- 15g) of the programmed charge has been added for the purpose of leak checking only vacuum and recovery modes will be enabled. After recovery, leak correction and evacuation, pre-charge leak testing can be restarted. Evacuation steps 9.3.1 and 9.3.2 may be automatically repeated one time prior to the programmed charge leak test.

- With the 15% of the programmed charge installed, the machine display shall instruct the user to perform a pressurized leak test, using language approximately as follows: “HVAC blower motor on low, A/C switch off, air distribution mode set to “floor.” The technician shall insert a SAE J2913-compliant electronic leak detector, set to high [maximum] sensitivity (4 grams/year leak rate) into the center of a floor duct outlet, as far as possible. If the detector alarms, a leak is indicated and it shall be repaired.
- The display shall continue with the question,
    - “Was this test performed?” If the technician replies “Yes, the display next shall ask,
    - “Was a leak found? If technician replies “Yes” the machine shall only allow recovery and evacuation to allow repair. If the technician replies “No.” the display shall continue with,
    - “Is there an auxiliary evaporator?” If the technician replies “No” the machine shall permit completion of the recharge process. If the technician replies Yes, the display shall instruct the technician to perform a leak check with a J2913-compliant detector at a rear evaporator outlet, then ask:
    - “Was an auxiliary evaporator leak check performed?” If the technician replies “Yes,” the display will continue with “Was a leak found?” and if the answer is “Yes,” the machine shall only allow recovery and evacuation to allow repair. If the technician replies “No” the machine shall permit completion of the recharge process.
- To certify that the equipment is capable of meeting this requirement, the vacuum decay test shall be conducted on the test system described in 7.1.1 or 10.5, which has been fitted with a 0.25 mm (or 0.009 in) orifice at the test system accumulator pressure switch port, creating an equivalent 0.3 g/s leak at 40 °C (104 °F). The test agency shall assure that the equipment is capable of reaching at least 25.4 mm Hg (1 in Hg) absolute and that the pressure sensor is capable of accurately indicating a 10 mm Hg change.
- To be certified the equipment must reliably lock out full refrigerant charge capability upon failure of the vacuum decay test or a “Yes” response to the question “Was a leak found” of the pressurized leak test.

RECOVERY/CHARGE AND RECOVERY/CHARGE/RECHARGING EQUIPMENT VALIDATION TEST REQUIREMENTS

- Preliminary Ambient (in shop) temperature shall be 21 to 24 °C (70 to 75 °F). Test vehicle shall be “overnight cold” (not run for at least 8 h).
- The machine shall have a self-contained provision for checking accuracy of the indicated amount of refrigerant recovered in liquid or vapor or mixture form(s) from a vehicle system and (if applicable) charged into a vehicle, and adjust if necessary, to meet requirements of 9.2. Therefore:
- If the machine uses a scale for that purpose, check the accuracy of that scale and make any adjustment if necessary. If an alternative method of measuring refrigerant is used, follow the equipment manufacturer’s procedure for ensuring accuracy.
- Prior to conducting the recovery, recycle, recharge test, move the machine, such as by rolling it, along the floor, a minimum of 20 ft (6.1 m) within 10 s and then, follow with the test procedure in 10.3.

Charging Test Procedure

If desired, this test procedure may be preceded by engine/system operation for up to 15 min, up to 2000 rpm.

1. You shall start with an empty system, using this method: (a) Operate machine to recover refrigerant, per equipment manufacturer's instructions. (b) Evacuate the system to a minimum of -710 mm Hg (-27.9 in Hg). (c) Monitor vacuum for decay, checking every 20 min. If decay exceeds 75 mm Hg (3.0 in Hg), evacuate the system again. When system holds 710 mm Hg plus 75 mm Hg, vacuum for three more hours, it is considered empty.
2. Place machine on a platform scale with the capacity to weigh the recovery/recycle/recharge machine, and with the resolution and accuracy of within ±2.3 g in the range of the machine's weight. Weight shall include the machine's service hoses draped over the machine, and with the machine's oil reservoir removed. If necessary to add oil to vehicle system as a result of a system operation preparatory to the recovery process, inject the needed quantity through the service valve at this time.
3. Record weight of machine as weight A.
4. Reconnect service hoses to the test vehicle.
5. Follow the equipment manufacturer's specified procedure for charging the vehicle manufacturer's recommended amount of refrigerant into the system. Note: if this does not apply to the machine under test, i.e., a recovery/charge only machine, the use of charging equipment that meets this standard and the platform scale shall be used to verify the accuracy of the charge.
6. Disconnect the service hoses from the test vehicle and drape them on the machine. Check and record the weight of the machine. Record this weight as weight B. The difference between weight A and weight B shall be equal to the recommended charge that was installed per the machine's display, within 15 g. If the difference is greater than 15 g (±2.3 g), the machine fails the charge accuracy test and no other tests shall be performed at that time. The manufacturer shall document changes made to improve accuracy and furnish them to the laboratory prior to a new test. Exception: if the deviation is no more than a total of 20 g, the calibration of the scale or other measuring system may be rechecked and readjusted once, and the entire test repeated just once.

Recovery Test Procedure (using a vehicle)

1. Following a successful system charge, the system and engine shall be run for 15 min at 2000 rpm to circulate oil and refrigerant, following which engine and system shall rest for 8 h. Then the laboratory may begin the recovery test. If the machine manufacturer specifies, operate the engine/system for up to 15 min, at up to 2000 rpm, then shut off engine/system.
2. If the machine has an automatic air purge, disable it. Check the weight of the machine with the platform scale (service hoses draped over machine, oil reservoir removed). Record the number as Weight C. Reinstall oil reservoir if it had been removed in the recovery procedure.
3. Start timer. Connect service hoses to system of test vehicle and perform recovery per the equipment manufacturer's instructions. The vehicle system service valves' cores shall remain in the fittings for this procedure.
4. When recovery is completed, including from service hoses if that is part of the recommended procedure, disconnect hoses and drape over machine. Stop timer. The elapsed time shall be 30 min or less. If it is in excess of this time, the machine fails the test and no retest is allowed. The manufacturer shall document changes made to the machine to improve its performance before a new test is allowed, and furnish them to the laboratory.
5. If the recovery is completed in no more than the 30 min, measure the oil level in the reservoir, remove the reservoir and then determine the amount of refrigerant recovered, as detailed in Nos. 6 and 7: as measured by the machine and also by noting the weight of the platform scale, which shall be recorded as Weight D.

6. The platform scale shall indicate that a minimum of 95% of the amount charged into the system has been recovered. If the platform scale indicates a lower percentage has been recovered, the machine fails the recovery test.
7. The machine display shall indicate that a minimum of 95.0% of the amount charged into the system has been recovered, within a tolerance of 30 g (1.0 oz) when compared with the platform scale (Weight D minus Weight C). The 30-g (1.0-oz) tolerance may produce a machine display reading that is below the 95.0% recovery. If a greater difference between machine and platform scale occurs, the machine fails the recovery test.

Optional Recovery Test Procedure (using a laboratory rig)

If an equipment manufacturer chooses, as an alternative to the actual vehicle, it may certify to SAE J2843 with a laboratory fixture that is composed entirely of all the original equipment parts of a single model year for the 3.0-lb capacity front/rear A/C system of R-1234yf designated vehicle system as defined in Appendix A of this document

The fixture system shall be powered by an electric motor, run at a speed not to exceed 2000 rpm, and for this test option, no system warm-up or equivalent procedure may be used. The certifying laboratory shall maintain records of all parts purchased, including invoices and payments. The assembly of the parts shall, as an outside-the-vehicle package, duplicate the OE system and it's routing. [see Appendix A for detail system configuration] Aside from the absence of engine operation and the limitations posed by the standard and the use of the electric motor, the test shall otherwise be the same as the test on the R-1234yf designated system per 7.1.3 including test temperature.

INTERNATIONAL AND REGIONAL REQUIREMENTS

Equipment that is to be used in North America (where NFPA and NEC guidelines apply) shall comply with the following:

General Construction and Test Requirements

ANSI/ISA 12.12.01 shall apply to recovery recharge equipment except that if the flammable refrigerant does not pose a hazard to certain parts of the equipment, then the applicable requirements from UL 1963 may be applied.

Electrical Requirements for R-1234yf

Non-incendiary equipment technique is required. The unit shall be constructed using electrical components deemed acceptable for exposure to this level of refrigerant flammability. Guidelines for electrical equipment in a Class 1, Division 2 hazardous location shall be followed. Guidelines include, but are not limited to the following areas for equipment used for R-1234yf:

Electrical Components

Electric motors shall comply with requirements outlined in ANSI/ISA 12.12.01. All other electrical components (such as but not limited to: switches, relays, circuit breakers, solenoids) shall comply with requirements as outlined in ANSI/ISA 12.12.01. High-pressure cutout switch shall be sealed or located in explosion proof enclosure, per NEC article 501.115 (B) (1). Labels shall indicate that proposed connecters are not to be opened under load within classified location. Components used shall limit surface temperature to not more than 400 °C.

Labeling

The equipment shall have a label which states "Certified by (Certifying Agent) to Meet SAE J2843 and UL1963" in bold-type letters a minimum of 3 mm (1/8 in) in height. Directly below this marking the following shall be added: "Certified for High Voltage Electric Compressor Systems" in bold-type letters a minimum of 3 mm (1/8 in) in height.

In addition the following shall be included on the label:
The applicable marking requirements of UL 1963. Warning markings appropriate to describe refrigerant flammability (location, color, ISO symbols, text font and statements). The refrigerant that the equipment is certified to service.

Storage Tank and Overfill Requirements

Storage tanks shall be constructed under the following requirements: Department of Transportation (DOT) Standard, CFR Title 49, Section 173.304 and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel code Section VIII. The tank assembly shall be marked to indicate the first retest date, which shall be 5 years after the date of manufacture. The marking shall indicate that retest shall be performed every subsequent 5 years. SAE J2296 provides an inspection procedure. The marking shall be in letters at least 6 mm (1/4 in) high. ASME tanks which are pressure vessels bearing ASME Code "U" as defined in UL-1963 may be used and are exempt from the retest requirements.

Storage Vessel Requirements; Unique Labeling/Color

Portable refillable tanks or containers used in conjunction with this equipment shall be labeled "R-1234yf," meet applicable Department of Transportation (DOT) or Underwriters Laboratories (UL) Standards, and shall incorporate fittings per SAE J2844. In addition, containers shall be marked with a red band to distinguish the refrigerant from ASHRAE Class A1 refrigerants, (no red band on ASHRAE Class A1 containers). For refrigerant cylinder's fittings reference SAE J2844.

Cylinder Valve

The cylinder valve shall comply with the standard for cylinder valves, UL 1769.

Tank Over-fill Protection

During recovery operation, the equipment shall provide overfill protection to assure that the liquid fill of the storage container (which may be integral or external) does not exceed 80% of the tank's rated volume at 21 °C per UL1963.

Pressure Relief Device

The pressure relief device shall comply with the Pressure Relief Device Standard Part 1 - Cylinders for Compressed Gases, CGA Pamphlet S-1.1.

Equipment that is to be sold in other regions (countries and/or regulatory requirements) shall comply with the following:

General construction and test requirements related to electrical systems and pressurized tanks shall be met for the region where the equipment will be sold. All other performance requirements of this standard shall be met for all regions.

Ultraviolet Leak Detection

SAE J2298 AUG 2011 -- Ultraviolet Leak Detection: Procedure for Use of Refrigerant Leak Detection Dyes for Service of Mobile Air-Conditioning Systems

To assure safe and effective use of the ultraviolet leak detection method, use ultraviolet lamps and aftermarket fluorescent refrigerant leak detection dye injection devices which meet SAE J2299. UV-blocking protective eyewear should always be employed when performing ultraviolet leak detection.
Check in the engine compartment for an identification sticker indicating that a fluorescent leak detection dye has been previously added into the A/C system.
Remove the low-side service port sealing cap and direct the ultraviolet lamp into the valve stem area. Depressing the valve stem for an instant may be required to help bring some of the lubricant and dye out of the system. Observe these oil traces for fluorescence.
If fluorescence is observed in the low-side service port, assume that a fluorescent dye is within the system and proceed to search for leaks. If fluorescent material does exit the service port, note its location so that it does not provide false leak indications.
If no fluorescent dye has been previously installed into the A/C system, add the dye per the manufacturer's instructions. Place the identification label supplied with the dye in a prominent place within the engine compartment, preferably near the A/C charge label if possible. Verify that the A/C system has sufficient refrigerant. A minimum of 15 min of compressor operation is required to circulate the dye.
Inspect the system with an ultraviolet lamp when the engine is not operating. Perform the leak inspection under low ambient light conditions to increase the apparent brightness of the fluorescing leak sites.. Only larger leaks may be visible at this time since only a small amount of time has been allowed for the fluorescent dye-oil mixture to accumulate around leak sites. If a leak cannot be found, the customer may need to return in a week or more, after having operated the A/C system as much as possible, so that sufficient fluorescent dye-oil mixture has had time to collect at the leak site, making it visible under ultraviolet illumination. Bring the system's refrigerant charge up to the factory specification before returning the vehicle to the customer.
Trace the entire refrigerant system, paying special attention to signs of damage or corrosion on all fittings, hose-to-line couplings, refrigerant controls, service ports, brazed or welded areas, and areas around all attachment points. Check for evaporator leaks by illuminating the condensate drain hole with the ultraviolet lamp. If a leak is found, continue to check the remainder of the system as other leaks may be present.
Any smaller leak should be verified using an electronic leak detector as per SAE J1628 to determine if the vehicle or A/C manufacturer requires repair.
After repair, remove any residue with a cleaner approved by the manufacturer.

Leak Protection Procedures

A leak of 1 kg of refrigerant causes approximately the same environmental damage as driving a van 10,000 miles.

It is illegal to top up a system with refrigerant without first finding and repairing the leak(s).

SAE J1628 AUG 2011 –(R) Technician Procedures for Refrigerant Leak Detection in Service of Mobile Air Conditioning Systems

REFRIGERANT LEAK DETECTION METHODS COVERED IN THIS DOCUMENT

- Visible oil leakage on system parts, often highlighted by road film, particularly at system joints.
- Water/soap solution bubbles.
- Using electronic leak detection devices, particularly those certified to SAE standards.
- Trace dye that meets SAE J2297 requirements.
- System vacuum and pressure decay [pressure change/loss over time]. Except where vacuum and/or pressure decay is used on an isolated component, they are intended to confirm the existence of a leak in the overall system. The complete system- test will not pinpoint the location of the leak. One of the methods described above will be needed to pinpoint the location of the leak. Refer to No. 8, System Vacuum and Pressure Decay Procedures (pressure/vacuum change over time).

Using the Appropriate Leak Detection Procedure

It is important to understand that some of the methods have limited ability to identify a leak, and the use of some methods [i.e., pressurizing the system with nitrogen gas or with a high pressure refrigerant] could cause damage to the refrigerant system. The industry has developed service procedures and equipment that provide the most appropriate way to determine system refrigerant leakage and to minimize the use of additional refrigerant. In many cases, the technician will find it appropriate to use a combination of procedures to pinpoint a leak.

If the indicated leak is large, the technician should begin by confirming its existence by reviewing the vehicle A/C service history and visual inspection. A large leak is defined as one that results in a significant loss of the refrigerant charge within a single A/C cooling season, such as evidenced by failure to pass the vehicle manufacturer's cooling performance test. Very low or no pressure in the system when the vehicle is received might be an indication of a very large leak.

Three levels of leak detection. Level 1 is for large leaks, and even if effective in pinpointing a large leak, should be followed by a subsequent level (Level 2 or Level 3) to ensure that all repairable leaks have been found.

The most effective and reliable refrigerant leak detection methods include the following steps, starting with methods that will locate major refrigerant leaks, to methods that will locate leakage rates of a few grams per year. It should be noted that to minimize MAC system refrigerant emissions and assure consumer satisfaction, identifying all potential system refrigerant leakage

can only be accomplished by using the correct procedures and in conjunction with electronic and trace dye diagnostics.

INITIAL MAC SYSTEM INSPECTION LEVEL I PROCEDURE

- Visual inspection for major leakage [install a gage set and check static pressure in the system].
- Visible oil leakage on system parts should be the first step in any leak test procedure. If vehicle has low or no pressure in the system when it arrives for service, it is important to take time to carefully perform this step.
- Leakage may be indicated by oily dirt, particularly at refrigeration system joints. If the leakage is almost entirely from a single location, a refrigerant system having a large leak may have some indication of oil collection on the surface of the refrigerant part, and with exposure time, the area will collect dirt. Visually inspect the system, looking for oily dirt at refrigerant line joints and where lines and components may make physical contact, and rub through to produce a leak. Check the hood liner or surface to check for excessive oil accumulation due to a compressor shaft seal leak from a high-mount compressor. [Note: a small amount of oil is not necessarily an indication of a shaft seal leak.] If accessible, check the condensate drain of the evaporator for signs of oil which may indicate an evaporator leak.
- Leakage indicated by trace dye already in the system. Many vehicle makers install trace dye in the A/C system during manufacturing. If so, trace dye is likely to produce visible evidence. See Section 5 for use of trace dye.

Use of Water or Soap Water Solution

- If there is no or very low pressure in the system, skip this step. Bubbles from water and soap solution applied to refrigeration system parts/joints are only effective in locating and pinpointing large refrigerant leaks, and therefore would require some recharging of the system first. Be sure to check for indication of dye before using water or soap water solution to avoid washing away the dye.
- The limitations of using a liquid bubble leak detection method are that one bubble per second would be caused by leaks per year equal to double or triple the system capacity. Compare the soap solution bubble method with leak detection using SAE J1627 and SAE J2791/J2913 electronic leak detectors. Soap giving leak of 45 oz/year (or 1276 g/yr). Two common electronic leak detectors can sens3e a leak as small as 0.15 to 0.5 oz/year(or 4 to 14 g/yr)

LEVEL II LEAK DETECTION PROCEDURES

A full refrigerant charge is not required to detect leaks. If the work area temperature is in the range of 24 °C (75 °F) pressure need be in the range of 79 psig for HFC-134a, 82 psig for R-1234yf. The work area temperature must be warm enough (at least 15 °C [59 °F] for electronic leak detection

Step 1: Perform visual inspection.

Step 2: Check pressure in system. If less than appropriate for the ambient temperature, slowly add small amounts of refrigerant until pressure rises above this level. Ambient temperatures should be above 15 °C. Check for hissing noises as refrigerant is added as another check for gross leaks. If noise is heard, stop adding charge, determine the source, and repair the leak before adding more refrigerant.

Quick Leak Check Repair

For safety reasons, mixing refrigerant and air in the system, is not recommended. When using SAE J2843 R-1234yf equipment the automatic process will evacuate the system prior to refrigerant being charged into the system. Only the system refrigerant itself has been validated by SAE leak detection standards as a safe, effective pressurizing substance for electronic leak detection in automotive A/C systems.

Using Other Means to Introduce Pressure into the MAC System

Without proper equipment and precautions, the use of other pressurizing substances can be costly, and the ability to identify small refrigerant leaks becomes difficult or impossible. It is not recommended that a technician use any other methods for field service to identify system refrigerant leaks. The use of other substances may also result in safety concerns or system contamination if the substance is not properly removed, a pressurization substance other than the system's refrigerant, has not been tested to any SAE standard for suitability for A/C leak detection, and there are no affordable service shop usable, leak detection devices that have been tested to any SAE standard to demonstrate they can consistently measure the equivalent refrigerant leakage rate of less than 25 g per year. Current industry technology has not developed cost effective refrigerant leak detection equipment other than that meeting SAE J1627 and SAE J2791 Performance Criteria. For safety, under NO CIRCUMSTANCES shall any MAC system or service equipment be pressure tested or leak tested with air/or air and R-134a or R-1234yf mixtures.

Detectors can be used to identify refrigerant leakage. R-1234yf requires high energy sources to ignite, such as a hot, cherry red, surface or an open flame. However, only a detector that meets SAE J2913 has been designed and tested to assure safe operation with this A 2L refrigerant.

REFRIGERANT LEAK IDENTIFICATION PROCEDURES LEVEL III

General Instructions

The electronic leak detector shall be operated in accordance with its manufacturer's operating instructions, andwith reference to the basic procedures described in the appendix of SAE J1627, SAE J2791, or SAE J2913. Leak test with the engine and A/C system turned off.

With the system off, charge the A/C with sufficient refrigerant to attain a gauge pressure appropriate for the ambient temperature and the particular refrigerant. Do not continue to charge once this pressure is reached, as the pressure will not increase with added refrigerant once the saturation pressure is reached. At temperatures below 15 °C (59 °F), leaks may not be measurable, since this pressure may not be reached.

As a preliminary check to find a gross leak. If hiss is heard, determine the source and repair the leak before adding more refrigerant.

Refer to the operator's manual to determine which chemicals may cause the particular detector to false-trigger. Clean with a dry cloth, where necessary. Take care not to contaminate the detector probe tip if the part being tested is contaminated. If the part is particularly dirty, it should be wiped off with a dry shop towel or blown off with shop air. No cleaners or solvents shall be used, since many electronic detectors are sensitive to their ingredients.

If not already performed as part of the Level I inspection, visually trace the entire refrigerant system, and look for signs of air-conditioning lubricant leakage, damage, and corrosion on all lines, hoses, and components.

6.4 Warm up the detector. Based on the estimated leakage rate of the entire system, set the detector to the appropriate sensitivity. A detector that meets SAE J2791 and SAE J2913 has three

operator-selectable settings, for 4 g/year, 7 g/year, and 14 g/year. SAE J1627 leak detectors do not provide the same level of leak detection capability as the newer detectors. On late-model small-capacity systems, identifying smaller leaks is important, so it is recommended that the technician use electronic detectors meeting SAE J2791 or SAE J2913. Check each questionable area with the detector probe, as well as all fittings, hose to line couplings, refrigerant controls, service ports with caps in place, brazed and welded areas, and areas around attachment points and hold-downs on lines and components.

As noted, new, small capacity systems are likely to have leak rates of under 4 g/year for joints, so a greater leak rate from a joint is likely to be serviceable. On large capacity systems of older system designs, most of the joints checked had a leakage rate of less than 14 g/year. Any leak greater than 14 g/year indicates that the leak needs to be repaired. Using the leak detector probe, follow the refrigerant system around in a continuous path so that no areas of potential leaks are missed. If a leak is found, always continue to test the remainder of the system. At each area checked, move the probe around the location, at a rate no more than 75 mm/s (3 in/s), and no more than 9.5 mm (3/8 in) from the surface, completely encircling fittings, joints, service valves, switches and sensors. Slower and closer movement of the probe greatly improves the likelihood of finding a leak. However, resting the probe against a leak source may cause the detector to silence, as premium infrared detectors require a moving probe to create the voltage difference between the actual leak point versus an adjacent area. A heated-sensor detector that is parked (held) on a leak may sound a continuous alarm until moved. One way to verify a suspected leak is to blow shop air into the area of the suspected leak to clear the area of refrigerant, and if necessary, repeat the check of the area. In cases of very large leaks, blowing out the area with shop air often helps locate the exact position of the leak.

When testing for a leak at the compressor, move the probe along the compressor body joints, around the pressure relief valve and any switches, then all around the compressor nose area (compressor shaft seal). Inasmuch as many compressor shaft seals leak only occur during compressor operation, quantifying leakage rate, or even just verifying the existence of a shaft seal leak poses special problems, as the electronic leak detector test is made with the system off. The shaft seal is on the low-pressure side of the system, which adds to the difficulty. Although some refrigerant loss past shaft seals is normal, any triggering of a SAE J2791 or SAE J2913 electronic leak detector on settings below 14 g/year with the system off may indicate a significant leak has been found if no other leaks can be located.

Following any service to the vehicle's air conditioning refrigerant circuit, a leak test of the repaired components, the service ports, and the entire refrigerant circuit to assure there are no additional system refrigerant leaks should be performed.

LEAK DETECTION PROCEDURES FOR EVAPORATORS AND COMPRESSOR SHAFT SEALS

The location of the evaporator can make it difficult to determine if it is leaking. Isolating the evaporator from the system and connecting adapters to the evaporator refrigerant fittings, and performing a pressure and/or vacuum decay test, may pinpoint a large leak. However, tests have shown it will not identify leaks as well as other methods.

Allowing the vehicle to hot-soak in the sun on a warm day and or idle the engine with the A/C shut off, will increase the low-side system pressures and may increase the leakage. If the system contains trace dye, operate it and collect the condensate from the evaporator drain on a clean rag or paper towel. Using a powerful ultraviolet lamp aimed at the collected condensate (on

rag/towel), look for even a faint indication of fluorescence. Because foreign material may collect in the evaporator housing, dye may be absorbed into it, so absence of fluorescence is not a positive indicator of a leak-free evaporator. If the trace dye has just been installed, all leaks may not be immediately identified.
If there is partial access to the evaporator core, such as through the removal of a blower resistor, evaporator temperature sensor or blower motor, a visual inspection with a borescope with a ultra-violet lamp may identify a leak. A leak detector also may be used. Operate the A/C system for 15 min on high-speed then shut it off. Wait 10 to 15 min for any leaking refrigerant to accumulate in the case. Insert the detector probe and move it over the evaporator core and along the evaporator base.

LEAKAGE FROM COMPRESSOR SHAFT SEALS

A shaft seal with a significant operating leak is still likely to be leaking at least to some extent with the system off. To increase the A/C system refrigerant pressures: Using a shop protective cover (fender or seat cover), cover the condenser inlet area to reduce airflow to the condenser. Disconnecting the electric engine cooling fan will also result in increasing A/C system pressures. Set the controls for compressor operation, outside air (OSA), and high blower, and with reduced airflow through the condenser, the high side pressure should increase. Operate the engine at idle condition, while carefully monitoring coolant temperature, and shut off the engine before it approaches overheating. Do not allow A/C system pressures to exceed 350 psi. This method will cause A/C pressures to rise, and when the system is shut off and the pressures equalize in the compressor, the low side pressure will rise. Immediately probe the lowest area below the nose area of the compressor and the area between the clutch and the compressor body with an SAE J2791 or SAE J2913 leak detector set for maximum sensitivity.
If no leak can be found, including the shaft seal, and there is significant system refrigerant loss, and all other components have been checked for leakage, the possibility of a leaking shaft seal remains. To determine a possible shaft seal leak, immediately after the covered condenser idle test, it may be helpful to wrap a silicone wrap shower cap closely around the nose of the compressor, allow several hours to pass, and then insert the probe of an SAE J2791 or SAE J2913 detector under the shower cap to see if refrigerant has accumulated. If the leakage rate in the covered area exceeds 14 g/year, the shaft seal apparently is defective. Because most shaft seal leakage normally occurs with the system operating, even a leak of 7 g/year under these static conditions may be indicative of a significant operating leak, if no other leaks are found. Another approach is to install trace dye and allow enough time for it to circulate, and then inspect the nose area with an ultraviolet lamp. Many compressors have wells and/or felt in the shaft seal hub area, and it may be necessary to remove the clutch to find a dye trace in this area.

11. POTENTIAL LEAK SOURCES

Hybrid vehicles that use the A/C refrigeration system for high-voltage battery and/or electronics cooling have additional refrigerant lines, connections and heat exchangers that should be carefully leak-checked. Refrigerant leaks can occur from the multiple system connections. Variation of system designs, for both single and multiple evaporator systems can result in numerous line connections and rear systems in particular should be thoroughly leak checked.

Infrared Detection of refrigerant contamination identification and purity:

Functional Description
Contamination of refrigerants either in storage cylinders or vehicle air conditioning systems can lead to component corrosion, elevated head pressures and system failures when utilized by unsuspecting technicians. The ability of the technician to determine refrigerant type and purity is severely hampered by the presence of air when attempting to utilize temperature-pressure relations. The recent development of various substitute refrigerants further complicates the ability of a technician to identify refrigerant purity based upon temperature-pressure relationships. The substitute refrigerant blends can also introduce a flammability hazard to the refrigerant technician and the ultimate end user of the vehicle air conditioning system.

The Neutronics RI-2002PA Refrigerant Identifier will provide a fast, easy and accurate means to determine refrigerant purity in refrigerant storage cylinders or directly in vehicle air conditioning systems. The instrument utilizes non-dispersive infrared (NDIR) technology to determine the weight concentrations of refrigerant types R12, R134a, R22, as well as, hydrocarbons and air. Refrigerant purity is automatically determined for refrigerants R12 and R134a by the instrument to eliminate human error. Pure refrigerant is defined as a refrigerant mixture that contains 98%, by weight, or greater of either R12 or R134a. The instrument is supplied complete with a R12 and R134a sample hose, a R134a adapter fitting to permit sampling of ACME ported cylinders, a connected power cord and all required plumbing housed within a rugged portable case.

Sample gas is admitted into the instrument through the supplied sample hose and presented to the sensing device. The instrument provides the user with direct percent by weight concentrations of R12, R134a, R22 and hydrocarbons. If the sample is determined to be pure R12 or pure R134a, the instrument will also provide a direct readout of the weight percentage of air within the sample. Note that the instrument does not consider air to be a contaminate since it can be removed by some refrigerant recycling equipment or the Neutronics Air-Radicator. Since air is not considered a contaminate, it is possible to read 100% R12 plus 5% air. The instrument only considers the weights of the refrigerant and contaminates in the total mixture. The instrument interfaces with the user through the use of a 2-line 16-character alphanumeric display, status indicator lamps, push button communication switches and an alarm horn. Alarm indications are provided to alert of instrument fault conditions, potentially flammable refrigerant presence and contaminated refrigerant presence. Direct percent by weight concentrations of sample refrigerant is provided on the display as well as user directions and prompts. A printer port is supplied with the instrument that will interface with most parallel port printers.
The Neutronics RI-2002PA Refrigerant Identifier will provide the refrigerant technician with absolute knowledge of refrigerant purity and protection against refrigerant contamination and potential flammability.

BEST SERVICING PRACTICES

- In addition to the environmental benefits, keeping systems properly charged and leak-free will improve the energy efficiency of the unit, save the owner additional costs of refrigerant, and help maintain the reliability and longevity of the system
- EPA encourages technicians to find and fix leaks rather than repeatedly topping off with refrigerant
- Do not add more refrigerant than necessary, as this can cause system damage and decrease system performance
- There is no "drop-in" replacement for any refrigerant. Refrigerants should never be mixed or used in systems designed for other refrigerants.
- Refrigerant containers and systems have unique fittings to prevent the mixing of refrigerants. Adapters should not be used to convert a fitting.
- Beware of contaminated refrigerants, EPA understands that in some cases they are falsely packaged; consider purchasing certified refrigerant identification equipment
- Wear safety glasses and insulated gloves, and avoid direct contact of refrigerant with skin
- Work in a well-ventilated area; acute exposure to any refrigerant can lead to asphyxiation

List of states that prohibit use or sale of Hydrocarbon based refrigerants to DIY customers
The governor of Wisconsin signed legislation this year that blocks the state environmental agency from promulgating regulations prohibiting the sale or offering for sale refrigerant substitutes. This new law allows distributors to sell refrigerant in containers smaller than 15 pounds. Wisconsin had the only state law that prohibited the sale of the hydrofluorocarbon (HFC) refrigerant R-134a in containers for the do-it-yourself (DIY) customer. R-12 is not available for use in the United States, having been phased out in the mid 1990s.

Technicians are encouraged to check state and local regulations regarding compliance with SAE J639 & other requirements

EPA has materials available on retrofit procedures (e.g., **http://www.epa.gov/mvac**)

INCORRECT SYSTEM CHARGES

Incorrect Calculation of Charge

Incorrect calculation of charge can result in either of two scenarios, either

- Inadequate charging of the system resulting in decreased cooling capacity, or
- Overcharge of the system, resulting in either damage to the compressor, or release of the refrigerant by way of a blow back valve.

Any of these three scenarios is undesirable. Although equipment inaccuracy may be at fault the far more likely explanation is inaccurate calculation of charge by the technician, specifically conversion of ounces to pounds on the way to calculating the number of grams.

For example 8oz is ½ lbs or0.5 lbs. However a common error is to convert 8oz to 0.8 lbs. In actuality 0.8 oz is 12.8 oz.

To convert from ounces to pounds, divide the number of ounces by 16. Hence 4 ounces = 0.25 pounds. So if the total weight of a charged compressor should be 3 pounds 4 ounces, that converts to 3.25lbs. Multiplying by 454 grams per pound we get 1475.5 grams total weight. If the technician miscalculates the weight as 3.4 lbs than the total weight would be 1543.6 grams or 68.1 grams to high. Tolerance for these measurements are 15g. The measurements are 4.5 times out of tolerance.

Errors become even worse as the numbers of ounces rises. For example 12 oz converts to .75 lbs or 340.5 grams. If the technician incorrectly converts 12 oz to .12lbs , that converts to 54.5 grams. This is 19 times out of tolerance and sure to bring a complaint from the customer of inadequate cooling.

CONVERSION FACTORS

1 OUNCE (oz) =

0.0625 pounds (lb)
1/16 pounds (lb)
28.4 grams (g)
.00284 kilograms (kg)

1 POUND (lb) =

16 ounces (oz)
454 grams (g)
0.454 kilograms (kg)

1 GRAM (g) =

0.352 ounces (oz)
0.00220 pounds (lb)
0.001 kilograms (kg)

1 KILOGRAM (kg) =

35.2 ounces (oz)
2.20 pounds (lb)
1000 grams (g)

EQUIPMENT INACCURACY

When recharging the system to the amount specified by the vehicle manufacturer, it is necessary to charge the system with an accuracy of +/- 15g (0.5oz). The equipment manufacturer must provide a method or service to check the accuracy of the system.

If a scale is used and the desired charge is 500g, the actual charge must be within the range of 485g to 515g. The differential between the laboratory scale accuracy standard must be +/- 3g. The technician must use the supplied method usually calibration weights to verify scale accuracy. Calibration weights are used to check the zeroing process (that the scale registers 0 grams when nothing is on it) of the scale.

If a mass flow system is used for change determination, it must maintain accuracy equal to the 15g (0.5 oz) specification. The equipment manufacturer must provide a method and any necessary testing devices with the machine. It must also supply enough consumables to last 5 years for periodic testing as recommended.

If any other system is used for charge determination, such as a positive displacement pump, the manufacturer must provide a method and any needed devices to check accuracy, including temperature compensating trim, if used

Applicable Industry Standards (SAE)

SAE J639 DEC 2011 – Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems

SAE J2845 JAN 2013 – R-1234yf [HFO-1234yf] and R-744 Technician Traininfor Service and Containment of Refrigerants Used in Mobil A/C Systems

Standards on Refrigerant Purity and Containment

SAE J1999 AUG 2011 – Standard of Purity for Use in Mobile Air Conditioning Systems

SAE J2099 APR 2012 – (R) Standard of Purity for Recycled R-134a (HFC-134a) and R-1234yf (HFO-1234yf) for Use in Mobile Air Conditioning Systems

SAE J2211 NOV 2011 – Recommended Service Procedure for the Containment of HFC-134a (R-134a)

Industry Standards on Hoses Fittings and Couplings

SAE J2064 FEB 2011 – R134a Refrigerant Automotive Air Conditioned Hose

Industry Standards on Refrigerant Recovery, Recycling and Recharging Equipment

SAE J1990 MAY 2011 – Recovery and Recycle Equipment for Mobile Automotive Air-Conditioning Systems

SAE J2209 AUG 2011 -- CFC-12 (R-12) Refrigerant Recovery Equipment for Mobile Automotive Air-Conditioning Systems

SAE J2788 JAN 2013 -- HFC-134a (R-134a) Recovery/Recycle/Recharging Equipment for Mobile Air-Conditioning Systems

SAE J2810 OCT 2007 -- HFC-134a (R-134a) Refrigerant Recovery Equipment for Mobile Automotive Air-Conditioning Systems

SAE J2843 JAN 2013 -- R-1234yf Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems

SAE J2851 FEB 2015 – R-134a or R-1234yf Refrigerant Recovery Equipment for Contaminated Mobile Automotive Air-Conditioning Systems

SAE J3030 JUL 2015 – R-134a or R-1234yf Refrigerant Recovery/Recycling/Recharging Equipment Intended for use with both.

Industry Standards on Leak Detection Materials, Methods and Equipment

SAE J1628 AUG 2011 -- Technician Procedure for Using Electronic Refrigerant Leak Detectors for Service of Mobile Air-Conditioning Systems

SAE J2298 AUG 2011 -- Ultraviolet Leak Detection: Procedure for Use of Refrigerant Leak Detection Dyes for Service of Mobile Air-Conditioning Systems

Annex: Applicable Industry Standards

SAE J2776 Refrigerant Purity and Container Requirements for New HFC-134a 1,1,1, 2-Tetrafluoroethane Refrigerant Used in Mobile Air-Conditioning Systems
SAE J2844 R-1234yf New Refrigerant Purity and Container Requirements Used in Mobile Air-Conditioning Systems
SAE J2683 Refrigerant Purity and Container Requirements for Carbon Dioxide (CO2 R-744) Used in Mobile Air-Conditioning Systems
AHRI Standard 700: Specification for Fluorocarbon Refrigerants
SAE J2842 R-1234yf and R744 Design Criteria and Certification for OEM Mobile Air Conditioning Evaporator and Service Replacements
SAE J2296 Retest of Refrigerant Container
SAE J2197 HFC-134a (R-134a) Service Hose Fittings for Automotive Air-Conditioning Service Equipment
SAE J2888 R-1234yf Service Hose, Fittings and Couplers for Mobile Refrigerant Systems Service Equipment
SAE J2670 Stability and Compatibility Criteria for Additives and Flushing Materials Intended for Use in Vehicle Air-Conditioning Systems Using R-134a
SAE J2791 HFC-134a Refrigerant Electronic Leak Detectors, Minimum Performance Criteria
SAE J2297 Ultraviolet Leak Detection: Stability and Compatibility Criteria of Fluorescent Refrigerant Leak Detection Dyes for Mobile R-134a Air-Conditioning Systems
SAE J2912 R-1234yf Refrigerant Identification Equipment for Use with Mobile Air Conditioning Systems
SAE J2913 R-1234yf Refrigerant Electronic Leak Detectors, Minimum Performance Criteria
SAE J1627 Performance Criteria for Electronic Refrigerant Leak Detectors
SAE J2299 Ultraviolet Leak Detection: Performance Requirements for Fluorescent Refrigerant Leak Detection Dye Injection Equipment for Aftermarket Service of Mobile Air-Conditioning Systems