SAE International™ SURFACE VEHICLE STANDARD

SAE J2851 FEB2011

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R-1234yf [HFO-1234yf] Refrigerant Recovery Equipment for Mobile Automotive Air-Conditioning Systems

RATIONALE

This standard is required to support the introduction of the new refrigerant R-1234yf.

1. SCOPE

This standard is for R-1234yf recovery (extraction) only equipment for on-site refrigerant recovery from Mobile Air Conditioning (MAC) systems**.**

NOTE: R-1234yf is a mildly flammable refrigerant [refrigerants called mildly flammable have a maximum burning velocity of< 0.10 m/s when tested at 23 °C and 101.3 kPa] (ASHRAE 34 and ISO 817 Class 2L).

1.1 Purpose

The purpose of this SAE Standard is to provide minimum performance and operating requirements for equipment used to recover R-1234yf. Recovered refrigerant is to be returned to a refrigerant reclamation facility that will process it appropriately as per AHRI 700 standard, or it may be locally recycled using on-site equipment designed and certified to SAE J2843 standard which will process the refrigerant to SAE J2099 standard. It is not acceptable that the refrigerant removed from a MAC system with this equipment be directly returned to any MAC system without further processing as described.

This information applies to equipment used to service automobiles, light trucks, and other vehicles with similar R-1234yf MAC systems.

1.2 Refrigerant recovery equipment is required to ensure adequate refrigerant recovery and to reduce emissions during the removal of refrigerant from mobile air conditioning systems.

1.3 Equipment shall be certified to meet all performance requirements outlined in this document and international and regional construction and safety requirements as outlined in Section 9 of this document.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
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2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

2.1.1.1 System Design Guidelines

SAE J639 Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems

SAE J2844 R-1234yf New Refrigerant Purity and Container Requirements Used in Mobile Air-Conditioning Systems

2.1.1.2 Service Activities

SAE J2888 R-1234yf Service Hose, Fittings and Couplers for Mobile Refrigerant Systems Service Equipment

2.1.1.3 Technician Service Procedures

SAE J2845 Technician Training for Safe Service and Containment of Refrigerants Used in Mobile A/C Systems (R-744, and R-1234yf)

2.1.1.4 Service Equipment

SAE J2099 Standard of Purity for Recycled HFC-134a (R-134a) and HFO-1234yf (R-1234yf) or Use in Mobile Air-conditioning Systems

SAE J2296 Retest of Refrigerant Cylinder

SAE J2927 R-1234yf Refrigerant Identifier Installed in Recovery and Recycling Equipment for Use in Mobile Air Conditioning

2.1.1.5 Reference Documents

SAE 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) Automotive Quality and Process Improvement Committee

SAE J2911 Certification Requirements for Mobile Air Conditioning System Components, Service Equipment, and Service Technicians to Meet SAE J Standards

2.1.2 AHRI Publication

Available from Air Conditioning and Refrigeration Institute, 1501 Wilson Boulevard, Sixth Floor, Arlington, VA 22209.

AHRI 700 Specifications for Fluorocarbon Refrigerants

2.1.3 CGA Publication

Available from CGA, Crystal Gateway #1, Suite 501, 1235 Jefferson Davis Highway, Arlington, VA 22202.

CGA S-1.1 Pressure Relief Device Standard Part 1 - Cylinders for Compressed Gases

2.1.4 DOT Specification

Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

DOT Standard CFR 49, Section 173.304 Shippers - General Requirements for Shipments and Packagings

2.1.5 UL Publications

Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 600622096.

UL 1769 Cylinder Valves

UL 1963 Refrigerant Recovery/charge Equipment

2.1.6 Other Publications

ANSI/ISA 12.12.01 Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III Divisions 1 and 2 Hazardous (Classified) Locations (these standards reference NFPA-70 and NFPA497)

3. SPECIFICATIONS AND GENERAL DESCRIPTION

3.1 The equipment must be able to recover (extract) R-1234yf refrigerant from a MAC system as per the test procedure of Sections 7 and 8.

3.2 The equipment shall be suitable for use in an automotive service garage environment as defined in 6.8.

3.3 The equipment must be certified that it meets requirements of this document and the requirements of SAE J2911.

3.3.1 The manufacturer can state certification of compliance with this Standard only after meeting the requirements in SAE J2911 “Procedure for Certification That Requirements for Mobile Air Conditioning System Components, Service Equipment and Service Technicians Training Meet SAE J Standards”. (See Appendix B for additional information.)

3.3.2 Certification of compliance to the requirements of 3.3 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 Ch. I (7–1–08 Edition) 82.38.

4. SAFETY REQUIREMENTS

4.1 Construction

4.1.1 Electrical requirements for R-1234yf Equipment

See Section 9 listing international and regional construction and safety requirements.

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

Any user maintenance procedure (such as filter change or tank evacuation) must assure that procedures are in place to collect and safely vent any residual refrigerant before the system is opened.

4.1.3 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-1234 as required in SAE J2888.

4.1.4 Ventilation of Equipment Enclosure

Equipment shall be constructed with at least [6 air exchanges per hour] ventilation 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. 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.

4.2 The equipment must comply with applicable federal, state, and local requirements on equipment related to handling R-1234yf 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."

4.3 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.

5. OPERATING INSTRUCTIONS

5.1 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.

5.1.1 The instruction manual shall include the following information regarding MAC system lubricant replacement:

NOTE: Only new lubricant, as identified by the system manufacturer, shall be replaced 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.

5.2 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.

5.3 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-1234yf in the MAC system being serviced.

5.4 Recovery equipment having refrigerant identification equipment shall meet the requirements of SAE J2927.

5.5 Recovery equipment not having refrigerant identification capability shall have instructions warning the technician that failure to verify that the system contains only R-1234yf potentially exposes him or her to danger from more flammable refrigerants and health hazards from toxic refrigerants. The instructions also shall alert the technician to possible contamination problems to the recovery equipment from sealants and refrigerants other than R-1234yf, and to the fact that a refrigerant other than R-1234yf would require special handling by someone with specific expertise and equipment.

6. FUNCTIONAL DESCRIPTION

6.1 Equipment Performance Requirements

6.1.1 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).

6.1.2 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 (R-1234yf equivalent system) with front and rear A/C or the test option described in Section 8.

NOTE: Ensure that refrigerant does not come into contact with hot surfaces during this part of process.

6.1.3 The equipment shall demonstrate ability to recover a minimum of 85% of the refrigerant from the test vehicle or system as per 6.1.1. 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.

6.2 Refrigerant Storage Tank

6.2.1 Tank Over-fill Protection

See Section 9 listing international/regional construction and safety requirements.

6.2.2 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.

6.2.3 Portable refillable containers used in conjunction with this equipment must meet applicable DOT Standards. The container color must be white with a red shoulder stripe to identify that it contains used R-1234yf refrigerant. It must be permanently marked on the outside surface in black print of at least 20 mm "CONTAMINATED R-1234yf —DO NOT USE, MUST BE REPROCESSED

6.3 Fittings and Flexible Hoses

6.3.1 The refillable container shall have a fitting that complies with SAE J2844.

6.3.2 All flexible hoses must meet SAE J2888 for service hoses.

6.3.3 Service hoses must have shutoff devices located at the connection points to the system being serviced to minimize introduction of non-condensable gases into the recovery equipment during connection and the release of the refrigerant during disconnection.

6.4 Test Cycle

6.4.1 Background

6.4.1.1 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 10 ml (0.3 fl oz) units.

6.4.1.2 The purpose of indicating the amount of lubricant removed is to ensure that a proper amount of new lubricant is returned to the MAC system for compressor lubrication, if the system is to be charged with equipment meeting SAE J2843.

6.4.2 The test fixture shown in Figure 1 shall be used to process contaminated R-1234yf samples at ambient temperatures of 10 and 49 ºC (50 and 120 °F) without interruption.

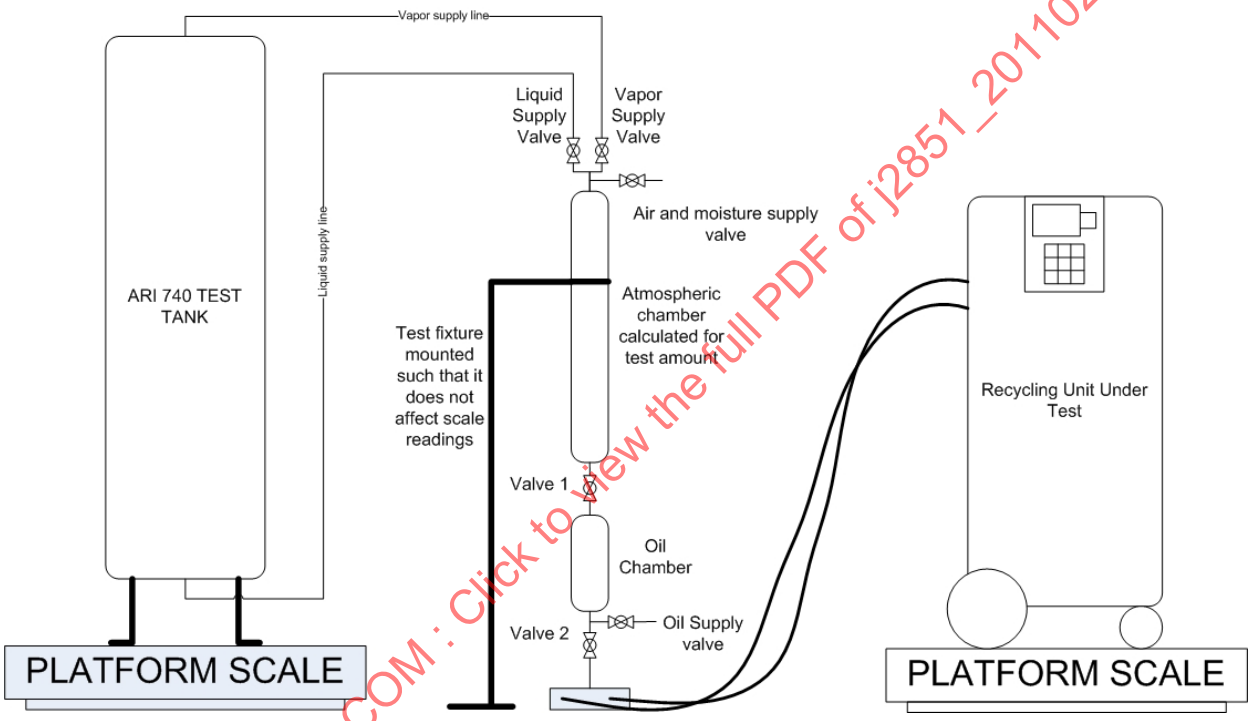

FIGURE 1 - TEST FIXTURE

6.4.3 Contaminated R-1234yf sample shall be R-1234yf refrigerant, 18.2 kg sample size, consisting of liquid R-1234yf with 45 000 ppm (by weight) of oil (polyalkylene glycol oil with 46 to 160 cst viscosity at 40 °C).

6.4.4 The equipment must be preconditioned by recovering 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 (2.56 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).

6.4.5 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.

6.4.6 Following the preconditioning procedure per 6.4.4, 18.2 kg (40 lb) of standard contaminated R-1234yf are to be processed by the equipment.

6.4.7 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.

6.5 Sample Requirements

6.5.1 Samples of the standard contaminated refrigerant from 6.4.3. shall be processed as required in 6.4.4 to 6.4.7 and shall be analyzed after said processing as defined in 6.7.

6.6 Equipment Operating Ambient

6.6.1 The R-1234yf is to be cleaned to the purity level for High Boiling Residue (lubricant), 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 6.4.5 to 6.4.7.

6.7 Determination of Percent Lubricant

6.7.1 The amount of lubricant in the recovered R-1234yf sample shall be determined via gravimetric analysis. The methodology must account for the hygroscopicity of the lubricant.

6.7.2 The refrigerant container shall be shaken for 5 min prior to extracting samples for testing.

6.7.3 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.

6.8 The equipment must be capable of continuous operation in ambient temperatures of 10 to 50 °C (50 to 120 °F) and comply with 6.1 to 6.4 of this standard.

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

7. TEST PROCEDURE A AT 21 TO 24 °C (70 TO 75 °F)

Use the test vehicle (2005 to 2009 Chevrolet Suburban R-1234yf equivalent system) with rear A/C system refrigerant charge of -1.4 kg/3 lb) or laboratory fixture per Section 8.

7.1 Using a machine certified to SAE J2843 and with the machine on a platform scale with accuracy to within plus/minus 3 g at the weight of the machine, charge the system to the vehicle manufacturer’s recommended amount of refrigerant (1.4 kg/3 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.

7.2 Charging the Test Stand

1. You must 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 minus 710 mm Hg (minus 27.9 in Hg). (c) Monitor vacuum for decay, checking every 20 min. If decay exceeds 75 mm Hg (3 in Hg), evacuate the system again. When system holds 710 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 plus/minus 2.3 g in the range of the machine’s weight.

3. Follow the equipment manufacturer’s specified procedure for charging the vehicle manufacturer’s recommended amount of refrigerant into the system. The platform scale shall be used to verify the accuracy of the charge. Record the amount charged.

7.3 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. Place the recovery machine to be tested on the platform scale and record the weight with the hoses draped over the machine. Ambient temperature shall be within the range of 21 to 24 °C (70 to 75 °F) for this test, which shall be performed without the immediately prior engine operation permitted by SAE J2851, Section 7.2, Step No.1. The only permitted engine operation is as specified in Section 7.

3. 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.

4. 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 min.

5. 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 when compared to the amount of refrigerant charged in 7.2 step 3 above. If the machine has recovered the minimum of 95.0% within 30 min at an ambient temperature of 21 to 24 °C, then repeat the test procedure at an ambient temperature of 10 to 13 °C to verify the equipment can remove a minimum of 85.0% of the charge within 30 min. If it fails this test, the marketer of the equipment must document changes to the equipment to upgrade performance before a retest is allowed.

8. TEST OPTION

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-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, 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 R-1234yf designated system per Section 7 including test temperature.

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.

9. INTERNATIONAL AND REGIONAL REQUIREMENTS

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

9.1.1 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.

9.1.2 Electrical Requirements for R-1234yf

Non-incendive 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 R-1234yf:

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

9.1.2.2 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.

9.1.2.3 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 faston connectors are not to be opened under load within classified location

Components used must limit surface temperature to not more than 400 ºC

9.1.3 Labeling

9.1.3.1 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 3 mm (1/8 in) in height.

9.1.3.2 In addition the following shall be included on the label:

a. The applicable marking requirements of UL 1963

b. Warning markings appropriate to describe refrigerant flammability (location, color, ISO symbols, text font and verbiage).

c. The refrigerant for which the equipment is certified to service.

9.1.4 Storage Tank and Overfill Requirements

9.1.4.1 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.

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 which are pressure vessels the bearing ASME Code “U” as defined in UL-1963 may be used and are exempt from the retest requirements

9.1.4.2 Storage Vessel Requirements (unique labeling/color)

Portable refillable tanks or containers used in conjunction with this equipment must be labeled R“R-1234yf," meet applicable Department of Transportation (DOT) or Underwriters Laboratories (UL) Standards, and shall incorporate fittings per SAE J2888. 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 tank fittings use the low side vehicle R-1234yf fitting found in SAE J639.