

R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems**RATIONALE**

This SAE Standard is revised such that the pressurized leak check is conducted with the HVAC blower on "Low" and the SAE J2913 compliant leak detector set to high sensitivity (4 grams per year leak rate).

1. SCOPE

This SAE Standard applies to equipment to be used with R-1234yf refrigerant only. It establishes requirements for equipment used to recharge R-1234yf to an accuracy level that meets Section 9 of this document and purity levels defined in SAE J2099. Refrigerant service equipment is required to ensure adequate refrigerant recovery to reduce emissions and provide for accurate recharging of mobile air conditioning systems. Equipment shall be certified to meet all performance requirements outlined in this document and international/regional construction and safety requirements as outlined in this document.

1.1 Purpose

The purpose of this SAE Standard is to establish the specific minimum equipment requirements for the recovery/recycle/recharge of HFO-1234yf (R-1234yf) refrigerant that has been directly removed from, and is intended for reuse in, mobile air conditioning systems and system recharging of recycled or virgin R-1234yf. Establishing such specifications will ensure that system operation with recycled R-1234yf will provide the same level of performance and durability as new refrigerant.

NOTE: R-1234yf is mildly flammable [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).

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2. REFERENCES

2.1 Applicable Documents

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 Compressions Systems
- SAE J2844 R-1234yf (HFO-1234yf) New Refrigerant Purity and Container Requirements for Use 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 R-1234yf [HFO-1234yf] and R-744 Technician Training for Service and Containment of Refrigerants Used in Mobile A/C Systems

2.1.1.4 Service Equipment

- SAE J2099 Standard of Purity for Recycled HFC-134a (R-134a) and HFO-1234yf (R-1234yf) for Use in Mobile Air-Conditioning Systems
- SAE J2296 Retest of Refrigerant Cylinder
- SAE J2912 Performance Requirements for R-134a and R-1234yf Refrigerant Diagnostic Identifiers (RDI) for Use with Mobile Air Conditioning Systems
- SAE J2913 R-1234yf [HFO-1234yf] Refrigerant Electronic Leak Detectors, Minimum Performance Criteria
- SAE J2927 R-1234yf Refrigerant Identifier Installed in Recovery and Recycling Equipment for Use with Mobile A/C Systems

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)
- SAE J2911 Procedure for Certification that Requirements for Mobile Air Conditioning System Components, Service Equipment, and Service Technician Training Meet SAE J Standards

2.1.2 CGA Publications

Available from CGA, Crystal Square #2, Jefferson Davis Highway, Arlington, VA 22202-4102.

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

2.1.3 DOT Publications

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

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

2.1.4 UL Publications

UL is currently in the process of updating UL 1963 to comprehend the use with A2L fluids. All references to UL 1963 within this document shall be to UL1963 (version 4). The following are exceptions to UL1963:

1. A hazardous location plug shall not be required.
2. A hose assembly inside the machine shall not exceed 0.91 meters (3 feet) in length.
3. The hose tensile pull requirement shall be 113 Kg (250 lbs) minimum.
4. The required hose permeation shall be 4.9 Kg/m² (1 Lb/Ft²) /yr. maximum.

Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 1769 Cylinder Valves

UL 1963 [version 4] Refrigerant Recovery/charge Equipment

2.1.5 Other Publications

ANSI/ISA 12.12.01 (Current Revision) 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. SPECIFICATION AND GENERAL DESCRIPTION

- 3.1 The equipment shall be able to remove, recover, recycle and recharge R-1234yf refrigerant on-site from MAC systems per the test procedures in Sections 8, 9, and 10.
- 3.2 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.
- 3.3 The equipment shall 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. (See Appendix B for additional information.)
 - 3.3.2 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.

4. REFRIGERANT RECYCLING EQUIPMENT REQUIREMENTS

4.1 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.

4.1.1 The manufacturer shall use an identification system to ensure that a new filter has been installed to reset the machine for operation.

4.2 Filter

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

4.3 Scale (If Used)

The scale shall maintain accuracy when moved, as per the test in Section 10.

4.4 Requirements for Non-condensable Gases (NCGs)

4.4.1.1 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).

4.4.1.2 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.

4.4.2 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.

4.4.2.1 Refrigerant loss from non-condensable gas purging shall not exceed 5% by weight of the total refrigerant removed from the test system

4.5 The tank shall be tested on each charge cycle for non-condensable gasses and a purge performed if required.

4.6 Recharging and Transfer of Recycled Refrigerant

4.6.1 Refrigerant for recharging and transfer shall be taken from the liquid phase only.

5. SAFETY REQUIREMENTS

5.1 Construction

5.1.1 Electrical Requirements for R-1234yf Equipment

5.1.1.1 See Section 11 listing international/regional construction and safety requirements.

5.1.2 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.

5.1.3 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-1234yf as required in SAE J2888.

5.1.4 Ventilation of Equipment Enclosure

5.1.4.1 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.

5.2 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."

5.3 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.

6. OPERATING INSTRUCTIONS

6.1 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.

6.1.1 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).

6.1.2 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.

6.1.3 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.

- 6.2 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 $\geq 98\% +2\%/-1\%$ R1234yf. Unacceptable readings shall prevent (lock out) the machine's ability to recover and/or transfer refrigerant until an acceptable identifier reading is received.
- 6.3 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.
- 6.3.1 The manual shall identify how to properly maintain hoses and seals to prevent contamination of refrigerant in the tank due to ingress of air (NCG) during the recovery process.
- 6.4 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.
- 6.5 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."

7. FUNCTIONAL DESCRIPTION OF THE EQUIPMENT

The equipment shall be capable of meeting the functional performance requirements defined in Section 10.

7.1 Equipment Operating Performance Expectations

- 7.1.1 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.
- 7.1.2 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.
- 7.1.3 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.
- 7.1.4 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 set forth in 7.1.1.

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

- 7.1.5 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, per the requirements of 9.2.

- 7.2 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 lb. 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.

7.3 Tank Over-fill Protection

See Section 11 listing international/regional construction and safety requirements.

- 7.4 All flexible hoses shall comply with SAE J2888.

- 7.5 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.

- 7.6 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.

- 7.6.1 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.

8. RECYCLING EQUIPMENT VALIDATION

8.1 The equipment shall be capable of cleaning and separating the items in the contaminated refrigerant defined in 8.3 to the purity level defined in SAE J2099.

8.2 The equipment shall be operated in accordance with the manufacturer's operating instructions.

8.3 Contaminated R-1234yf Sample Composition for Equipment Validation Testing

8.3.1 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).

8.3.1.1 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.

8.3.1.2 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.

8.4 Test Cycle

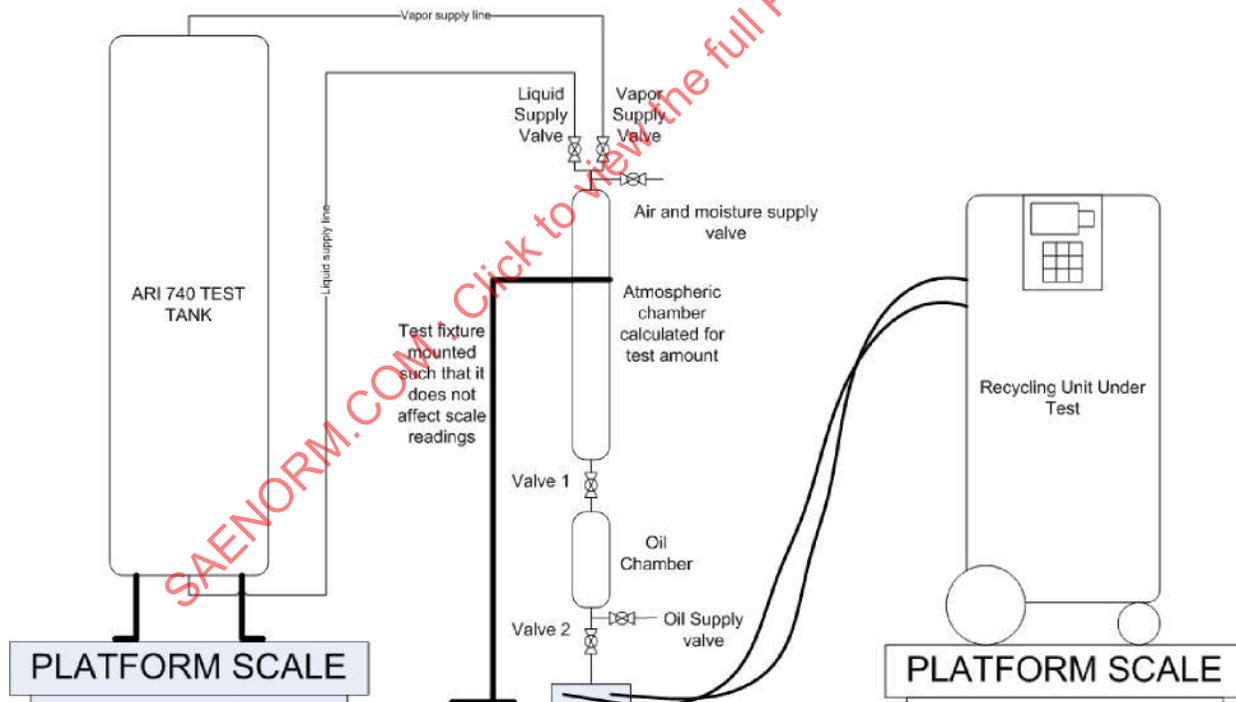


FIGURE 1 - TEST FIXTURE

- 8.4.1 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).
- 8.4.1.1 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.
- 8.4.2 Following the preconditioning procedure per 8.4.1, 18.2 kg (40 lb) of standard contaminated R-1234yf are to be processed by the equipment.
- 8.4.2.1 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.
- 8.4.3 After processing the 18.2 kg in 8.4.2, 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.
- 8.5 Sample Requirements
- 8.5.1 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 exceptions for non-condensable gas determination in 8.9.4.
- 8.6 Equipment Operating Ambient
- 8.6.1 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.
- 8.7 Quantitative Determination of Moisture
- 8.7.1 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.
- 8.7.2 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).
- 8.8 Determination of Percent Lubricant
- 8.8.1 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.
- 8.8.2 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.
- 8.8.3 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.
- 8.9 Non-condensable Gases
- 8.9.1 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.
- 8.9.2 This test shall be conducted on liquid phase samples of recycled refrigerant taken from a full container (as defined in 11.1.4.4) within 30 min following the proper venting of non-condensable gases.
- 8.9.3 The liquid phase samples in 8.9.2 shall be vaporized completely prior to gas chromatographic analysis.

- 8.9.4 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.
- 8.9.5 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 $\leq 0.1\%$ 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 $\leq 0.1\%$ 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.

- 8.9.5.1 The method to achieve the requirement in 8.9.5 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.

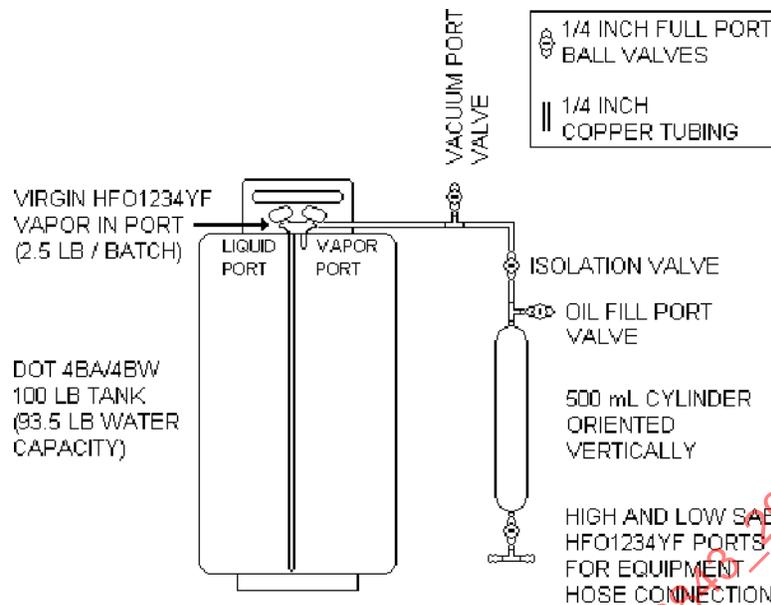


FIGURE 2 - SAE J2843 TEST APPARATUS

9. RECHARGING EQUIPMENT VALIDATION

- 9.1 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.
- 9.2 Accuracy and Calibration
- 9.2.1 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.
- 9.2.2 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.
- 9.2.3 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.
- 9.2.4 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.
- 9.2.5 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.
- 9.2.6 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.

9.3 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:

- 9.3.1 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.
- 9.3.2 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.
- 9.3.3 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.
- 9.3.4 The display shall continue with the question,
 - (a). "Was this test performed?" If the technician replies "Yes, the display next shall ask,
 - (b). "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,
 - (c). "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:
 - (d). "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.
- 9.3.5 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.
- 9.3.6 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.

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

- 10.1 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).
- 10.2 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:
- 10.2.1 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.
- 10.2.2 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.
- 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.

10.4 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.

10.5 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 its 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.

11. INTERNATIONAL AND REGIONAL REQUIREMENTS

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

11.1.1 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.

11.1.2 Electrical Requirements for R-1234yf

Non-incendive 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:

11.1.2.1 Electrical Components

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

11.1.2.1.2 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.

11.1.2.1.3 High-pressure cutout switch shall be sealed or located in explosion proof enclosure, per NEC article 501.115 (B) (1).

11.1.2.1.4 Labels shall indicate that proposed connectors are not to be opened under load within classified location.

11.1.2.1.5 Components used shall limit surface temperature to not more than 400 °C.

11.1.3 Labeling

11.1.3.1 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.

11.1.3.2 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 statements).
- c. The refrigerant that the equipment is certified to service.

11.1.4 Storage Tank and Overfill Requirements

11.1.4.1 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 (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.

11.1.4.2 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.

11.1.4.3 Cylinder Valve

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

11.1.4.4 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.

11.1.4.5 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.

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

11.2.1 General construction and test requirements related to electrical systems and pressurized tanks shall be met for the region where the equipment will be sold.

11.2.2 All other performance requirements of this standard shall be met for all regions.