SURFACE VEHICLE STANDARD

SAE New J2788

REV. 2006

Issued 1991-12
Revised 1999-02

Superseding J2210 MAR97

Revision as of April 2006

HFC-134a (R-134a) Recovery/Recycling Equipment and Recovery/Recycling/Recharging for Mobile Air-Conditioning Systems

Foreword— ***This standard supersedes the requirements of J2210 to reduce refrigerant emissions during servicing and provides requirements for charging refrigerant into mobile air conditioning systems.*** This SAE Standard is to establish the specific minimum equipment requirements for the recovery/recycling and recovery/recycling/recharging of HFC-134a that has been directly removed from, and is intended for reuse in, mobile air-conditioning systems. Establishing such specifications will ensure that system operation with recycled HFC-134a will provide the same level of performance and durability as new refrigerant.

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 9.0 of this document and SAE J2099.

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J2099—Standard of Purity for Recycled HFC-134a (R-134a) for Use in Mobile Air-Conditioning Systems
SAE J2196—Service Hoses for Automotive Air-Conditioning
SAE J2197—Service Hose Fittings for Automotive Air-Conditioning
SAE J2296—Retest of Refrigerant Container

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.

OT Standard, CFR Title 49, Section 173.304—Shippers—General Requirements for Shipments and Packagings

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

Printed in U.S.A.

2.1.4 UL PUBLICATIONS—Available from Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 1769—Cylinder Valves
UL 1963—Refrigerant Recovery/Recycling Equipment

3. Specification and General Description

3.1 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.

3.2 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 (50 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 11.0

3.3 The equipment must be certified that it meets this specification by an EPA listed certifying laboratory.

3.4 The equipment shall have a label which states "Certified by (Certifying Agent) to Meet SAE JXXX replacing J2210" in bold-type letters a minimum of 3 mm (1/8 in.) in height.

4. Refrigerant Recycling Equipment Requirements

4.1 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.

4.1.1 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 lock-out when the end of filter life is reached.

4.1.2 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 must maintain accuracy when moved, as per the test in 11.0

4.4. If the machine is equipped with a single recovery compressor, the compressor itself (separated if necessary from equipment electronic controls) must be capable of drawing down to at least 19.0 in/Hg (475-482 mm/Hg), within 3.0 minutes of operation when connected to a 0.5 liter (or 16 f.l. oz) container. Simillarly, if the machine is equipped with two recovery compressors, each must be capable of drawing down to eat least 9.0 in/Hg (225-230 mm/Hg) within 3.0 minutes when connected separately to a 0.25-lliter (or 8 fl.oz) container. If the machine uses a single compressor with another recovery assist feature, the single compressor must be capable of pulling down to 9.0 in/Hg (225-230 mm/Hg) within 3.0 minutes when connected to a 0.25 liter container, and must meet all applicable requirements of 11.0.

4.4 Noncondensable Gases

4.4.1 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 J2099).

4.4.2 Refrigerant loss from noncondensable gas purging during the testing described in Section 8 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.

4.5 Recharging and Transfer of Recycled Refrigerant—Recycled refrigerant for recharging and transfer shall be taken from the liquid phase only.

5. Safety Requirements

5.1 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."

5.2 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..

6. Operating Instructions

6.1 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.

6.1.1 If recovery/recycle equipment has refrigerant identification equipment, the refrigerant identification equipment shall meet the requirements of SAE J1771.

6.1.2 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.

6.2 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.

6.2.1 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, increasing the NCG level in the recovered refrigerant.

6.3 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.

7. Functional Description

The ability of the equipment to meet the refrigerant recovery and recharge specifications of this section shall be determined by the test procedures of 11.0.

7.1 The equipment must be capable of continuous operation in ambient temperatures of 10 degrees C. (50 degrees F.) to 49 degrees C. (120 degrees F.). Continuous is defined as completing recovery/recyle 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.

7.1.2 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 21-24 degrees C. (70-75 degrees F.) ambient temperature. The test system for qualifying shall be a 1.4 kg (3.0 lbs.) capacity orifice tube/accumulator system (a 2005 Chevrolet Suburban with front and rear A/C) and shall be determined by accurately weighing the recovery machine.

7.1.2.1 However, the preceding shall not preclude a brief period of engine operation at fast idle (up to 15 minutes, up to 2000 r.p.m.) to provide some engine and warmup of A/C refrigeration components. The time required shall not be included in the total time of 30 minutes set forth in 7.1.2.

7.1.3 The refrigerant that is recovered, following oil separation, shall be measured and the quantity displayed, accurate to within 30 grams (1.0 ounce). The equipment must include a provision for checking and adjusting the accuracy, per the requirements of 9.1.

7.2 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.

7.3 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.

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

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

7.3.3 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.

7.3.4 ASME tanks as defined in UL-1963 may be used and are exempt from the retest requirements.

7.4 All flexible hoses must comply with SAE J2196.

7.5 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.

7.6 The equipment shall separate oil from the refrigerant, measure the amount accurate to (20 ml) (o.7 oz.), so the technician has an accurate basis for adding oil to the system.

7.6.1 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.

7.6.2 The equipment design, in conjunction with its recovery and recharge operations, shall have removed the refrigerant from the service hoses, so that when the hoses are disconnected from the vehicle system, refrigerant is not vented..

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.

8.1 The equipment shall be able to clean the contaminated refrigerant 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 HFC-134a (R-134a) Sample

8.3.1 The standard contaminated refrigerant shall consist of liquid HFC-134a with 1300 ppm (by weight) moisture (equivalent to saturation at 38 °C, 100 F), 45 000 ppm (by weight) HFC-134a compatible lubricant, and 1000 ppm (by weight) of noncondensable gases (air).

8.3.1.1 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.

8.3.1.2 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.

8.3.1.3 The machine's service hoses and the specified service procedure shall not permit cross-contamination between polyalkylene glycol and polyol ester oils in excess of 1% be weight. This shall be confirmed by the independent testing laboratory.

8.4 Test Cycle

8.4.1 The equipment must be preconditioned by processing 13.6 kg (30 lb.) of the standard contaminated HFC-134a at an ambient of 21-24 degrees C (70-75 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- 24 degrees C (70-75 degrees F).

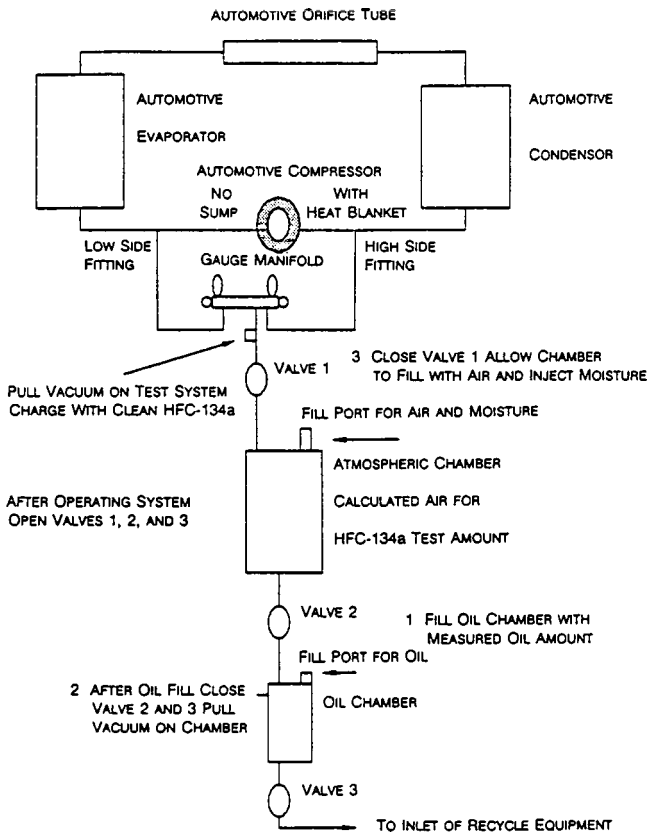

FIGURE 1—TEST FIXTURE

8.4.2 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.

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 exception for noncondensable gas determination in 8.9.4.

8.6 Equipment Operating Ambient

8.6.1 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 degree C (50, 70 and 120 degree 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 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.

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 (weight).

8.8 Determination of Percent Lubricant

8.8.1 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.

8.8.2 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.

8.8.3 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.

8.9 Noncondensable Gases

8.9.1 The 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 degrees C (266 degrees 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 7.2 within 30 min following the proper venting of noncondensable 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 49 degrees C (50 and 120 degrees 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 The 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-2099 testing.)

9.0 Recharging the System

9.1 If the equipment has the capability to recharge the system, it also shall be capable of NCG removal by pulling down to 50,000 microns (28.0 in.) of mercury at sea level, either with the recovery compressor or a separate vacuum pump, to remove NCGs from the system prior to recharging. To minimize loss of refrigerant, the equipment shall operate in the NCG removal mode for no longer than 6 minutes as a default mode, and it is the responsibility of the equipment manufacturer to ensure that the vacuum removal performance leaves the system 98% free of NCGs after 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 grams (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 grams (0.5 oz). Example: if 500 grams is chosen, the actual and indicated charge must be 485-515 grams, 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 perform to check and adjust scale accuracy, and include any necessary calibration device (such as a weight) with the machine.

If a mass flow system is used for charge determination, it must maintain accuracy equal to the 15 gram (0.50 oz) specification. The equipment manufacturer shall provide a method for checking accuracy and include any necessary calibration device(s) with the machine.

If the calibration 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 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.

10. Notes

10.1 Marginal Indicia—The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

11*. Equipment Test Procedure by laboratory for recovery/recycling and recovery/recycling/recharging machines.*

11. 1 Preliminary: Ambient (in shop) temperature shall be 21-24 degrees C. (70-75 degrees F.). Test vehicle shall be "overnight cold" (not run for at least eight hours).

11.2 The machine must have a self-contained provision for checking accuracy of the indicated amount of refrigerant recovered 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.

Move the machine, such as by rolling it, along the floor, a minimum of 20 feet (6.1 meters) within 10 seconds. After allowing 1-2.0 minutes for the machine to settle, add a calibrated weight (including a centering device) of at least 16 oz (455 grams) and the scale shall show a weight increase of the amount of weight added, ,accurate to within 0.1 oz (2.8 grams). If the scale fails thus test, no further testing shall me performed. The machine may not be retested until the manufacturer of the equipment verifies that changes were made to correct the failure and documentation is furnished to the testing laboratory. If the scale passes, the test procedure may proceed as follows:

11.3. CHARGING TEST: If desired, this test procedure may be preceded by engine operation for up to 15 minutes, up to 2000 r.pm. The equipment manufacturer is permitted to run the engine with the A/C on, although best results are likely to be obtained with the A/C on but compressor disengaged or in minimum displacement,, temperature control at maximum heat and HVAC controls set for coolant flow through the heater core. Physically disconnecting an A/C compressor clutch is permitted.

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 again. When system holds 710 mm (28 in) +0/-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 2.3 grams (.005-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 grams (0.5 oz). If the difference is greater than 15 grams (plus/minus 2.3 grams), 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 deviation is no more than a total of 20 grams, the calibration of the scale or other measuring system may be rechecked and readjusted once, and the entire test repeated just once.

11.4 RECOVERY TEST

1. Following a successful system charge, the system and engine 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 r.p.m., 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.

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 grams (one oz) when compared with the platform scale (Weight D minus Weight C). The 30-gram (one 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.

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—The purpose of this SAE Standard is to establish the specific minimum equipment requirements for recycling HFC-134a (R-134a) that has been directly removed from, and is intended for reuse in, mobile air-conditioning (A/C) systems.

Reference Section

SAE J639—Safety and Containment of Refrigerant for Mechanical Compression Systems Used for Mobile Air-Conditioning Systems

SAE J1771—Criteria for Refrigerant Identification Equipment for Use with Mobile Air-Conditioning Systems

SAE J2099—Standard of Purity for Recycled HFC-134a (R-134a) for Use in Mobile Air-Conditioning Systems

SAE J2196—Service Hoses for Automotive Air-Conditioning

SAE J2197—Service Hose Fittings for Automotive Air-Conditioning SAE

J2296—Retest of Refrigerant Container

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

1769—Cylinder Valves

UL 1963—Refrigerant Recovery/Recycling Equipment

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

Developed by the SAE Interior Climate Control Standards Committee