SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1659

REAF. FEB1999

Issued 1993-06
Reaffirmed 1999-02

Superseding J1659 JUN93

Submitted for recognition as an American National Standard

Vehicle Testing Requirements for Replacement Refrigerants for CFC-12 (R-12) Mobile Air-Conditioning Systems

1. *Scope*—The purpose of this SAE Recommended Practice is to establish the specific criteria for the selection of a replacement refrigerant for mobile CFC-12 (R-12) air-conditioning (A/C) systems. This document provides guidelines for qualifying candidate refrigerant. The requirements include laboratory and field testing. The alternate refrigerant shall provide comparable system performance as CFC-12 (R-12) as defined herein. The vehicle testing shall be conducted on representative vehicle manufacturer's product line, in which the refrigerant is intended to be used, such as cycling clutch orifice tube, constant run orifice tube, cycling clutch expansion valve, or continuous run expansion valve refrigerant system.

This document is complete only when combined with the requirements of SAE J1657.

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 J51—Automotive Air-Conditioning Hoses
SAE J639—Safety and Containment of Refrigerant for Vapor Compression Systems Used for Mobile Air-Conditioning Systems
SAE J1657—Selection Criteria for Retrofit Refrigerants to Replace CFC-12 (R-12) in Mobile Air-Conditioning Systems
SAE J1658—Alternate Refrigerant Consistency Criteria for Use in Mobile Air-Conditioning Systems
SAE J2064—HFC-134a (R-134a) Refrigerant Automotive Air-Conditioning Hose

3. *Vehicle Testing*

3.1 The refrigerant shall be tested in mobile A/C systems that are representative of current industry technology such as, but not limited to:

3.1.1 That control refrigerant flow by an expansion valve or orifice tube device.

3.1.2 That control evaporator operation, to prevent freeze-up, by cycling, continuous operation or varying the capacity of the compressor.

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

3.1.3 That the testing shall include a representative sample of systems which the replacement refrigerant would be considered for use as an alternate in a mobile A/C system.

3.1.4 The A/C system shall be inspected and qualified to represent the manufacturer's original design intent for system components, controls, and CFC-12 (R-12) system refrigerant charge.

3.2 The rating for the replacement refrigerant shall be compared to the performance with the CFC-12 (R-12) refrigerant as defined for:

3.2.1 System operating pressures.

3.2.2 System operating temperatures.

3.2.3 Refrigerant system charge amount.

3.2.4 If the system has a cycling clutch control, and to maintain the expected compressor clutch durability, the cycle rate, when in excess of four per minute, shall not exceed 125% of the CFC-12 (R-12) rate under any weather load conditions as defined in 7.1.4.

3.2.5 The vehicle after qualification shall be tested with the released CFC-12 (R-12) refrigerant to establish the baseline data. The same vehicle after the necessary retrofit will be tested with the alternate refrigerant for comparison to the CFC-12 (R-12) performance data. This vehicle testing sequence, or comparable A/C system manufacturer's test, is required for compliance as appropriate in Sections 4, 5, and 6 of this document.

4. Climatic Chamber Testing Requirements

4.1 The refrigerant shall be tested in a mobile A/C system under controlled conditions, such as an environmental test chamber, and the comparison results shall be reported.

4.1.1 The test chamber shall be able to control vehicle and wind speed ±2 km/h, temperature ±1.0 °C, and humidity ±1.5% RH.

4.1.1.1 The test chamber shall be maintained at 40 °C and 40% relative humidity.

4.1.1.2 The test chamber shall have a vehicle dynamometer which can impose the representative vehicle engine road load conditions.

4.1.2 The vehicle's representation of the various system designs, as noted in Section 3, shall be qualified to represent original production design released material (e.g., OEM production/service parts).

4.1.3 Instrumentation on the vehicle required for data collection shall include:

4.1.3.1 A/C system high and low side pressures.

4.1.3.2 System Temperatures

a. Vehicle front inlet grille
b. Evaporator inlet air
c. Average outlet temperature of all panel A/C outlets

4.1.3.3 System air distribution motor voltage.

4.1.4 TEST CONDITIONS

4.1.4.1 The system shall be operated on 100% outside air selection for maximum load and tested for operation of soak and cool down, stabilized road speeds, and idle conditions. Vehicle A/C systems that do not provide outside air operation shall be run with at least two vehicle windows completely open to provide load to the evaporator, except in 4.1.4.7 when the windows shall be closed.

4.1.4.2 The test facility shall be prestabilized at the test condition prior to any test period for at least 1 h.

4.1.4.3 The vehicle shall be soaked at the test temperature for 1 h with doors and windows open and engine off.

4.1.4.4 The vehicle doors and windows shall be closed, vehicle started, the A/C system set for high blower, 100% outside air, and operate the vehicle and wind speed at 50 km/h in the gear ratio recommended by the manufacturer. All data shall be recorded prior to starting the vehicle and every 5 min for 30 min.

4.1.4.5 The vehicle and wind speed shall be increased to 80 km/h and all data recorded every 5 min for an additional 30 min period.

4.1.4.6 At the end of the 60 min period, the vehicle shall be brought to an idle condition neutral, with the air flow to the front vehicle grille not exceeding 5 km/h, and all the data shall be recorded every 3 min for at least 15 min or until the A/C system high side pressure exceeds 3000 kPa or the engine reaches boil conditions, which is the calculated engine coolant, pressure/temperature index, or when coolant is discharged from the system.

4.1.4.7 After completing the idle test in 4.1.4.6 to determine compressor clutch cycle rate, the system shall be operated on recirculated air (maximum cooling vehicle windows closed) for 60 min at 80 km/h and all data recorded every 5 min.

4.1.4.8 If any A/C system cycling occurs, the high and low temperature and pressure data shall be recorded.

5. Testing of Replacement Refrigerant for Evaporator Control

5.1 The same vehicle that was used in Section 4 or 6 shall be modified as required and modification identified for parts and refrigerant charge amount.

5.1.1 Evaporator freeze-up protection control setting changes must be identified and established prior to vehicle testing. This includes pressure switches, electronic and mechanical temperature switches for compressor clutch operation, and control systems for variable displacement compressors.

5.1.2 The purpose of this test is to establish the requirements that will assure that the mobile A/C system operation under high moisture loads will not result in loss of system performance due to evaporator core icing reducing system air flow.

5.1.3 The test can be conducted in an environmental test chamber or on a public or test course road system.

5.1.4 TEST CONDITIONS

5.1.4.1 The A/C system shall be operated on 100% outside air with the system blower setting on low position, between an ambient of 32 °C, at a minimum of 50% relative humidity and 35 °C, at a minimum 45% relative humidity, at a constant vehicle speed of 80 km/h for 2 h. If the system does not provide selection of 100% outside air, the system shall be operated in the recirculation mode with at least one vehicle window open to introduce load on the evaporator.

5.1.4.2 The air pressure differential between the passenger compartment and the evaporator core inlet shall be measured with a device that will indicate in Pa (mm) of water.

5.1.4.3 The differential pressure shall be recorded every 5 min for the 2 h period.

5.1.4.4 After the first 15 min of operation, the pressure differential shall not change more than 10% during the remaining 105 min of the test.

5.1.4.5 When a significant change of pressure occurs, it is an indication of evaporator ice build-up, reducing system air flow, which indicates an incorrect evaporator freeze control setting.

5.1.4.6 If the system exhibits evaporator ice build-up, the control setting shall be changed and the test re-run so that no excessive loss of system air flow occurs.

5.1.4.7 All data shall be recorded every 5 min during the test period.

5.1.4.7.1 System blower voltage.

5.1.4.7.2 If a compressor cycling clutch system is used for evaporator control, the compressor cycle rate shall not exceed the cycles per minute identified in 7.1.

5.1.4.7.3 Temperature from at least one A/C panel outlet.

5.1.4.7.4 Evaporator inlet air temperature.

5.1.4.7.5 Ambient weather conditions dry and wet bulb readings.

5.1.4.7.6 Air pressure differential between passenger compartment and the evaporator core inlet.

6. Road Evaluation Procedure

6.1 Road evaluation, using public roads or a test course, of replacement refrigerant requires all system prerequisites as identified for climatic chamber testing in this document.

6.2 Road Testing Procedures

6.2.1 Since weather conditions for road testing can be a variable, two vehicles are required for comparison. It is advisable that the vehicles be similar; however, the base vehicle must remain unchanged (no system modifications) during the test program.

6.2.2 Both vehicles must be qualified to original design intent including the released refrigerant as defined in 3.1.4.

6.2.3 The test program consists of both vehicles being operated over a prescribed test course at the same time. The test program must be conducted in ambient above 38 °C between 1 and 3 pm with full solar load. The specific weather data temperature, relative humidity, wind speed and direction, and solar load shall be recorded during the test time period.

6.2.4 The test sequence shall compare the replacement refrigerant and CFC-12 (R-12), and the vehicles shall be qualified as required in Sections 3 and 4.

6.2.4.1 Instrumentation shall be installed as defined in 3.1.3 and data recorded.

a. TEST 1—Both vehicles, as qualified with the original released A/C system, are simultaneously run over the test course, in the gear ratio recommended by the manufacturer and data collected. The data differential between the vehicles are identified as a correction factor for the next test sequence.
b. TEST 2—One vehicle (A) remains unchanged as the base vehicle and the second vehicle (B) is modified for the alternate refrigerant. Both vehicles are again simultaneously run over the test course and data collected. The difference between the vehicles is compared and adjusted by the correction factor established in test 1. The amount of change is then established between the base and modified system.

6.2.5 TEST PROGRAM

6.2.5.1 Both vehicles are placed in an open area, with the front facing toward the sun, 1 h prior to start of test with the windows open.

6.2.5.2 After the 1 h soak, all data shall be recorded and the vehicle windows closed and the road test started. The vehicle is started and the A/C system set for high blower, 100% outside air and operated at a constant vehicle speed of 50 km/h, in the vehicle manufacturer's recommended gear ratio, recording data every 5 min for 30 min.

6.2.5.2.1 If the vehicle A/C system does not provide selection of outside air, the test shall be run with at least two windows completely open to provide load to the evaporator.

6.2.5.3 After the 50 km/h 30 min data has been recorded, the vehicle speed is increased to 80 km/h for an additional 30 min and the data recorded every 5 min. If compressor clutch cycling should occur, record all high and low data cycles.

6.2.5.4 After completion of the 80 km/h point, a city traffic schedule is to be completed. The course consists of four cycles consisting of three 30 s idles separated by a travel distance between each stop of 0.07 km (0.1 mile), not exceeding 50 km/h vehicle speed between stops, with a final 2 min idle at which time all data is recorded after 1-1/2 min of the idle. Each 2 min idle should result in the front of the vehicle being in a different compass direction (N, E, S, W, or any combination) to account for wind direction.

6.2.5.4.1 Drive sequence for first cycle:

a. Operate vehicle at 50 km/h for 0.13 km (0.2 mile) and stop.
b. Idle vehicle (in drive for automatic transmission, neutral for manual transmission) for 30 s.
c. Accelerate vehicle not to exceed 50 km/h and travel total distance of 0.07 km (0.1 mile) and stop.
d. Idle for 30 s.
e. Accelerate vehicle to 50 km/h and travel 0.07 km (0.1 mile) and stop.
f. Idle for 30 s.
g. Accelerate vehicle to 50 km/h and travel 0.07 km (0.1 mile) and stop.
h. Idle for 1 min and 30 s at which time record all data. After 2 min accelerate the vehicle to 50 km/h and repeat cycle for 2nd, 3rd, and 4th cycle.
i. Course should result in each 2 min idle having the front of vehicle headed in a different direction to account for wind.

6.2.5.5 After completion of the city traffic test in 6.2.5.4, the system shall be operated on recirculated air selection (max cooling vehicle windows closed) at which time the vehicle is operated for an additional 60 min at 80 km/h and data recorded every 5 min. This will identify expected system operating outlet temperatures, pressures, and compressor cycle rates (if applicable) that will be encountered when the vehicle interior temperature is achieving the system's maximum level of performance.