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SURFACE VEHICLE RECOMMENDED PRACTICE

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Submitted for recognition as an American National Standard

Compatibility of Retrofit Refrigerants with Air-Conditioning System Materials

***Foreword*—**Refrigerants and refrigerant mixtures that might contain CFCs, HCFCs, HFCs, and hydrocarbons are being considered for introduction into the automotive aftermarket as retrofit refrigerants to service existing motor vehicles equipped with CFC-12 (R-12) mobile air-conditioning (A/C) systems. This document addresses the compatibility of air-conditioning system materials and components with such candidate retrofit refrigerants.

***1. Scope*—**The purpose of this SAE Recommended Practice is to provide criteria for determining the compatibility of air-conditioning (A/C) system materials/components with candidate retrofit refrigerants intended to replace CFC-12 (R12) in mobile A/C systems originally designed to use CFC-12 (R-12).

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1657—Selection Criteria for Retrofit Refrigerants to Replace CFC-12 (R-12) in Mobile Air-Conditioning Systems

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 2670-88—Method for Measuring Wear Properties of Fluid Lubricants (Falex Method)
ASTM D 3233-86—Method for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Method)

2.1.3 ASHRAE PUBLICATION—Available from ASHRAE, 1791 Tullie Circle NE, Atlanta, GA 30329-2305.

ASHRAE Standard 97-1989—Sealed Glass Tube Method to Test the Chemical Stability of Material for Use Within Refrigerant Systems

3. General Requirements

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

3.2 For each refrigerant candidate, a recommended companion lubricant or class of lubricants shall be identified.

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4. Noncompliance with Acceptance Criteria

4.1 Failure to meet the acceptance criteria of any section contained herein shall require documentation of specific remedial action necessary to overcome the deficiency (see SAE J1657, 3.3).

5. Lubricant/Refrigerant Miscibility

5.1 The recommended retrofit lubricant shall, to ensure adequate lubricant return to the compressor, exhibit circulation characteristics in the candidate refrigerant comparable to that of mineral oil in CFC-12 (R-12). Such lubricant circulation shall be determined by measuring the concentration of lubricant in a refrigerant sample taken from the liquid line during A/C system operation. The concentration of lubricant in the candidate refrigerant liquid line sample shall not be less than that observed for an identical system charged with CFC-12 (R-12) and mineral oil (specified in 6.4) operated under identical, steady-state test conditions, first at 2500 compressor RPMs followed immediately by testing at 1000 compressor RPMs.

In lieu of lubricant circulation data, the miscibility of the recommended lubricant in the candidate refrigerant shall serve as the acceptance criteria. Multiple liquid phases shall not exist between –10 °C and +25 °C.

6. Retrofit Refrigerant/Lubricant Stability

6.1 The retrofit refrigerant/lubricant combination shall be tested per ANSI/ASHRAE Standard 97-1989 as follows:

6.2 Testing shall be conducted for 14 days at 175 °C in the presence of steel, aluminum, and copper coupons, so assembled that copper is not in direct contact with steel.

6.3 The combination of candidate refrigerant and its companion lubricant, each containing the manufacturer's maximum level of as-received moisture, when tested per 6.2, shall show no more than 1% decomposition of the refrigerant and no chemical attack on the surface of the metal coupons as evidenced by a change in coupon weight and surface microfinish (staining is acceptable).

6.4 The combination of candidate refrigerant and its companion lubricant, each containing the manufacturer's maximum level of as-received moisture, when tested per 6.2 in the presence of residual CFC-12 (R-12) (constituting 2% of the total refrigerant charge) and mineral oils (constituting 10% of the total lubricant charge), shall show no more retrofit refrigerant decomposition than that permitted in 6.3.

Decomposition shall be measured by gas chromatography of stoichiometric reaction products (e.g., R22 for CFC-12 (R-12)).

This test shall be performed for both types of mineral oils in use today with CFC-12 (R-12), i.e., BVM100N, from B-V Associates, Inc., of Wixom, Michigan (or an equivalent OEM-approved paraffinic mobile A/C CFC-12 (R-12) lubricant), and Suniso 5GS, from Witco Corp. (or an equivalent OEM-approved naphthenic mobile A/C CFC-12 (R-12) lubricant).

7. Refrigerant/Lubricant Lubricating Properties

7.1 The following tests are, by intent, comparative in nature and, hence, the results are not necessarily directly dependent upon the precise test method(s) used. The recommended test method is ASTM D 2670-88. Comparable information may also be obtained using ASTM D 3233-86 (Load to Failure).

This test shall be performed for both types of mineral oils in use today with CFC-12 (R-12), i.e., BVM100N, from B-V Associates, Inc., of Wixom, Michigan (or an equivalent OEM-approved paraffinic mobile A/C CFC-12 (R-12) lubricant), and Suniso 5GS, from Witco Corp. (or an equivalent OEM-approved naphthenic mobile A/C R-12 lubricant).

7.2 **Failure Load (Seizure) Test—**Pin & Vee Block Failure Load Testing is to be conducted using AISI 1137 steel vee-blocks and pins and a 90:10 mixture of the companion lubricant and mineral oil, saturated with the candidate refrigerant. Failure load (seizure), torque, and temperature shall be recorded for each run. A minimum of three runs are required for each refrigerant, i.e., CFC-12 (R-12) and the candidate.

7.3 **Acceptance Criteria—**The average load to failure for the candidate refrigerant/lubricant combination shall not be less than that for identical testing using CFC-12 (R-12) and an OEM-approved CFC-12 (R-12) lubricant.

7.4 **Wear Test—**Pin & Vee Block Wear Testing is to be conducted using AISI 1137 steel vee-blocks and pins and a 90:10 mixture of the companion lubricant and mineral oil, saturated with the candidate refrigerant. Record pin and block wear scar dimensions and weight losses. A minimum of three runs are required for each refrigerant, i.e., CFC-12 (R-12) and the candidate.

7.5 **Acceptance Criteria—**Neither average wear scar dimensions nor average weight losses of the pin and vee blocks for the candidate refrigerant/lubricant combination shall exceed that for identical testing using CFC-12 (R-12) and an OEM-approved CFC-12 (R-12) lubricant.

8. Desiccant Compatibility (Molecular Sieve Desiccant)

8.1 The following test procedure consists of activating (drying) the desiccant, minimal hydration to simulate the "as-received" condition, dividing the desiccant into a test group and a control group, exposing the test group desiccant to the refrigerant/lubricant pair as specified as follows, conditioning the desiccant (test and control groups) for analysis after exposure, analysis of both test and control groups, and comparison of results with the acceptance criteria.

8.2 **Activating the Desiccant—**Activate the desiccant by heating a column of desiccant at 325 °C for 16 h while purging the column with dry nitrogen.

8.3 **Hydrating the Desiccant—**Hydrate the activated desiccant to 5 wt % moisture by exposure to moist air.

8.4 **Exposure to Refrigerant/Lubricant—**The test group desiccant shall be exposed to a solution of the candidate refrigerant containing 5 wt % companion lubricant at 93 °C for a period of 30 days. Approximately one-half of the desiccant shall be immersed in the liquid solution while the remaining one-half shall be exposed to the solution's vapor. After exposure, condition the desiccant per 8.5.

8.5 **Post-Exposure Conditioning—**Condition the test group desiccant and the control group desiccant to remove any unreacted refrigerant absorbed in either the desiccant or lubricant coating remaining on the desiccant. The process is:

a. Grind the sample to a coarse powder using a mortar and pestle.
b. Leave sample uncovered at ambient conditions to partially hydrate for at least 48 h.
c. Place the sample in a ceramic crucible in a programmable oven, purged with air, and exhausted to a fume hood. Program the oven as follows:

1. From room temperature, increase temperature 2 °C/min
2. Hold 2 h at 50 °C
3. Hold 2 h at 120 °C
4. Hold 6 h (minimum) at 288 °C

8.6 Desiccant Analysis—Analyze the test group desiccant and the control group desiccant for fluoride ion content via pyrohydrolysis with vanadium pentoxide followed by ion selective electrode potentiometry[1].

8.7 Acceptance Criteria—The exposed desiccant shall contain no more than 0.25 wt % fluorides.

9. Polymeric Materials Compatibility

9.1 Compatibility With Elastomers

9.1.1 Elastomers included in this testing are to be representative samples of Neoprene WRT, Nitrile (NBR), and Hydrogenated Nitrile (HNBR) actually used in R12 mobile air conditioning systems by original equipment manufacturers. Samples may be in slab form for this testing.

9.1.2 Die cut elastomer specimens of known length (100 mm minimum is recommended) shall be immersed in a 50/50 vol % solution of the candidate refrigerant and its companion lubricant and aged. Either of the following test schedules may be used, i.e., aging for 30 days at 80 °C or aging for 14 days at 100 °C. After aging, the specimen lengths are to be remeasured immediately after opening the test container, after which the percent linear swell is to be calculated.

9.1.3 ACCEPTANCE CRITERIA—Linear swell shall not exceed the following limits: −1 to + 10%.

9.2 Compatibility With Plastics

9.2.1 Polymers included in this testing are to be representative samples of Nylon 66, PTFE, Polyimide, PET, and PBT actually used in CFC-21 (R12) mobile A/C systems by original equipment manufacturers. Samples may be in strip or slab form for testing.

9.2.2 Appropriate specimens shall be immersed in a 50/50 vol % solution of the candidate refrigerant and its companion lubricant and aged. Either of the following test schedules may be used, i.e., aging for 30 days at 80 °C or aging for 14 days at 100 °C. After aging, the specimens are to be tested immediately after opening the test container per 9.2.3.

9.2.3 ACCEPTANCE CRITERIA—The maximum change in weight shall be −1 to +5%. In addition, there shall be no visual evidence of material degradation, such as color change, blistering, cracking, or crazing.

PREPARED BY THE SAE INTERIOR CLIMATE CONTROL STANDARDS COMMITTEE

1. The detailed test method entitled "Determination of Fluoride in Aluminosilicates by Pyrohydrolysis—Selective Electrode," an adaptation of that referenced in Analytical Chemistry, 32,118ff, (1960), can be obtained from UOP Molecular Sieves, 25111 Country Club Blvd., Suite 265, N. Olmsted, OH 44070.