SAE International™

SURFACE VEHICLE STANDARD

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HFC-134a Refrigerant Electronic Leak Detectors, Minimum Performance Criteria

RATIONALE

The need to reduce HFC-134a emissions has led to improved designs of mobile air conditioning systems, including smaller refrigerant charges and tighter seals to better contain the smaller charges. That in turn has created the need for a generation of leak detectors capable of finding very small to moderate leaks, both to address environmental concerns for effective leak detection and repair in service, and to enhance customer satisfaction by identifying all leaks that are of repairable sizes, as indicated by original equipment manufacturers.

FOREWORD

The purpose of this SAE Standard is to establish minimum performance criteria for a modern class of electronic probe-type leak detectors intended for use in automotive air conditioning systems with HFC-134a refrigerant.

1. SCOPE

This SAE Standard provides testing and functional requirements to meet specified minimum performance criteria for electronic probe-type leak detectors. So they will identify smaller refrigerant leaks when servicing all motor vehicle air conditioning systems, including those engineered with improved sealing and smaller refrigerant charges to address environmental concerns and increase system efficiency. This document does not address any safety issues concerning their design or use.

2. REFERENCES

2.1 Applicable Publication

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

2.1.1 SAE Publication

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.

SAE J1739 Potential Failure Mode and Effects Analysis in Design (Design FMEA) and Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA) and Effects Analysis for Machinery (Machinery FMEA)

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3. GENERAL DESCRIPTION AND OPERATING INSTRUCTIONS

3.1 The detector shall be suitable for use in an automotive service garage and operate in ambient temperatures of 15 to 49 °C (59 to 120 °F).

3.2 The detector shall have at least three scales that can be manually selected: (1) 4 g/yr (0.15 oz/yr); (2) 7 g/yr (0.25 oz/yr); (3) 14 g/yr (0.5 oz/yr).

It shall be tested to meet the performance specifications of this standard by a qualified independent laboratory. The laboratory shall maintain all documentation related to its testing, including calibration and maintenance data for its equipment, for a period of five years following the test of the specific detector.

3.3 If it passes, the detector shall carry a label that states “Design certified by (name of testing laboratory) to meet SAE J2791 with lettering in bold face type at least 3 mm high.

3.4 If it does not pass, the detector may be retested subject to the limits of Section 10. If a detector fails beyond these retest limits, it may be retested only after the marketer has documented changes made to correct the failure and given the data to the testing laboratory. A detector must pass the procedures in Sections 7 and 8. A failure in either or both of those sections requires a complete retest. The detector also must meet the requirements of Section 9, passing the no-false-triggering requirement for transmission oil and engine oil (Nos. 14 and 15) and clearing within 20 seconds after a permitted false-trigger.

4. WHAT MUST ACCOMPANY THE DETECTOR

4.1 The marketing company shall provide operating instructions for the detector that cover calibration, operating instructions and maintenance, including replacement of any sensors, filters or power supply.

4.2 Tools, adapters and needed adjustment and calibration devices (including calibration and/or reference bottles) for the detector must be included with the detector.

4.3 The marketing company shall provide all needed safety information and labeling.

4.4 The marketing company shall provide the Section 9 list of all common under hood chemicals that may affect the operation of an electronic leak detector and indicate by Y, if its detector will false-trigger from exposure to each of the chemicals on the list, or N if it will not false-trigger.

4.5 The resistance to false triggering shall be based on the test procedures described in Section 9. False triggering is defined as the detector making the same or similar indication (sound and/or light) as if it detected a refrigerant leak.

5. REQUIRED BASIC FUNCTIONS

5.1 The detector may self-calibrate or require manual calibration, but once calibrated for an operation, it must hold that calibration for a time sufficient to perform the operations described in Sections 7 and 8 (including 8.1 to 8.6). This does not preclude automatic recalibration for a probe that has been inserted into a contaminated atmosphere (as per Section 8), readjustment of sensitivity by operator selection, or an audible-and-or-visual warning of a condition beyond the operating scope of its design. The latter must be obviously different from the indication of a refrigerant leak, although the same functional trigger may be used. Example: a steady indicator light vs. a flashing indicator light.

5.2 The detector must demonstrate automotive garage durability by continuing to function normally after being dropped 1.2 m (4.0 ft) to a hard surface, such as a concrete floor, four times. This test may be performed with the detector in a protective caddy, provided the caddy is a standard part of the basic detector kit, and does not affect in-shop use of the detector, or testing of the detector under all procedures in Sections 7, 8, 9 and 10.

5.3 The detector must demonstrate automotive garage durability by continuing to function normally after

- the probe tip has been submerged to a depth of six mm (0.25 in) in a pan of water and drawn through the water at a rate of 75 mm (3 in) per second for two seconds and
- then, after wiping clean and given any other cleaning/maintenance prescribed by the manufacturer in its operating instructions manual, including but not limited to a sensor replacement or filter change.

6. LEAK DETECTION TEST EQUIPMENT

6.1 The testing shall be performed with the probe in a 610 mm (2 ft) cube clear sealed chamber as described in the appendix. Figures A1 and A2.

6.1.1 Illustrations and details of the chamber are described in the Appendix. A vertical wall of the chamber shall have a slot 200 mm (8 in) wide or wider, and large enough for a probe from an externally mounted detector to go through. The slot opening shall be sealed with

- overlapping strips of a rubber material that conforms sufficiently around the probe to maintain the specified level of contaminated atmosphere, or
- a butt-joint of conforming rubber seals with additional sealing from face seals on the detector probe neck that are in contact with the butt joint.

The rubber strips and face seals may be lubricated to provide smooth movement of the probe and any surrounding brace as described in 6.3.

6.1.2 The chamber shall have an access door large enough to insert a calibrated leak standard, a cylindrical sleeve or round-hole access point for a gas-tight syringe, and a built-in mixing fan (120 V, approximately 40 cfm) to circulate an injection of refrigerant gas to produce uniform distribution of injected gas for a contaminated atmosphere test. The chamber should have a provision for attaching a vacuum source (such as a small household vacuum motor) to permit rapid clearing of the chamber following a contaminated atmosphere test. The cylindrical sleeve or round-hole access shall include a sealing plug or other provision for sealing following use of the gas-tight syringe.

6.1.3 The four calibrated leak standards used for the tests shall be calibrated per methods and instruments per the National Institute of Standards and Technology, Washington, DC 20234, and the standards shall be rated accurate to within ±20%. The leak rates shall be in common units –14 g/yr (0.5 oz/yr), 7 g/yr (0.25 oz/yr), 4 g/yr (0.15 oz/yr) and 2.0 g/yr (0.0625 oz/yr). The leak standards shall contain 100% HFC-134a. The standards or their mounting locations in the chamber shall ensure the base of the standard is 75 mm (3 in) or more from the floor of the chamber. This is to provide a sufficient drop for refrigerant coming from the leak standard orifice, to minimize refrigerant puddling around the orifice and/or orifice shroud if used. To mitigate testing inconsistency from possible air turbulence caused by the moving probe, the leak standards may be equipped (as a certification test option) with a shroud around the orifice port. The shroud protrusion from the orifice port shall be no more than 6 mm +0/-0.2 mm (0.236 in +0/-.01 in). A view of a sample configuration, with dimensions within those ranges is shown in the Appendix, as Figure A3. If a shroud is used with any leak standard, this shroud also must be used with all other leak standards for certification of a detector.

6.1.4 The detector shall be mounted on a table with a moving platform, designed to produce a horizontal reciprocating motion of at least 150 mm (6 in), and a motor drive adjusted to move the platform so the probe tip passes the specified calibrated leak at a rate of 75 mm (3 in) per second, from a distance of 9.5 mm (3/8 in) per 7.2 All moving probe tests in this standard shall be performed at that rate as the probe passes the orifice of the calibrated leak standard. The platform shall stop at each end of its travel for no less than eight, no more than 10 seconds. The stop may be manually controlled by a test operator or performed automatically with a switch at each end-of-travel and a timer.

6.2 It is necessary to hold steady the detector's flexible neck and probe, as the detector probe moves side to side through the sealed slot in the vertical wall of the chamber. If the design of the flex neck requires, this may be done by adding to the platform a brace (may be C or U channel) sized to hold the flex neck and probe securely, and long enough to protrude through the slot to within a distance conveniently short of the 9.5 mm (3/8 in) from the orifice of the calibrated leak.

7. DETECTOR REQUIRED PERFORMANCE AND TEST PROCEDURE

7.1 Begin all testing for a single detector with a chamber cleared of refrigerant from any previous testing. Give the calibrated leak standard any maintenance/cleaning prescribed by the manufacturer. Perform the leakage rate tests separately, with the specific calibrated leak standard in the same position within the chamber. Position the calibrated leak standard so its orifice is at the exact midpoint of the moving platform's travel.

7.2 Adjust the detector and probe position for all tests so detector and probe are at one extreme end of the test table sweep. The probe must sense three leakage rates: of 4 g/yr (0.15 oz/yr), 7 g/yr (0.25 oz/yr) and 14 g/yr (0.5 oz/yr) when moved at a rate of 75 mm/sec (3 in/sec) past a calibrated leak standard, coming no closer than 9.5 mm (3/8 in) from the orifice of the calibrated leak. The 9.5 mm (3/8 in) distance from the orifice of the calibrated leak standard shall be horizontal or up to 45 degrees downward offset. Under these same operating conditions, the detector also shall not indicate a leak of 2.0 g/yr (0.0725 oz/yr) leak with the detector sensitivity selector in the 4 g/yr (0.15 oz/yr) position, a 4 g/yr (0.15 oz/yr) leak with the sensitivity selector in the 7 g/yr (0.25 oz/yr) position, and a 7 g/yr (0.25 oz/yr) leak with the sensitivity selector in the 14 g/yr (0.5 oz/yr) position.

7.2.1 Begin with the calibrated leak standard for 2.0 g/yr (0.0725 oz/yr) in position. Warm up the detector, select 4 g/yr (0.15 oz/yr) and operate the moving table so the probe sweeps past the calibrated leak standard a total of 10 times (five side to side and back again movements at the specified rate and distance from the orifice). The probe shall indicate no leak nine of 10 times or the leak detector fails.

7.2.2 Replace the 2.0 g/yr (0.0725 oz/yr) calibrated leak standard with the 4 g/yr (0.15 oz/yr) calibrated leak standard. Operate the moving table so the probe sweeps past the calibrated leak standard orifice a total of 10 times (five side to side and back again movements). The probe must sense the leak within two seconds and clear within two seconds of passing the orifice, at least nine of the 10 times. "Clear" is defined as a clearly audible reduction in sound and/or substantial decrease in indicator lighting from the indication of a leak. If after an apparent "Clear" the detector sounds in the stop period at each end of travel, following any one of the 10 sweeps past the calibrated leak standard, the leak detector fails.

7.2.3 Immediately following the 4 g/yr (0.15 oz/yr) test, move the detector sensitivity selector to the 7 g/yr (0.25 oz/yr) position and perform a 10-sweep test with the 4 g/yr-calibrated leak standard still in position. The detector shall indicate no leak at least nine of 10 times or it fails.

7.3 Replace the 4 g/yr (0.15 oz/yr) calibrated leak standard with the 7 g/yr (0.25 oz/yr) calibrated leak standard and leave the detector sensitivity selector in the 7 g/yr (0.25 oz/yr) position. Perform a 10-sweep test and the detector shall indicate a leak within two seconds of passing the calibrated leak standard orifice, then clear within two seconds, at least nine of the 10 times, or it fails.

7.4 Immediately following the 7 g/yr (0.25 oz/yr) test, leave the 7 g/yr (0.25 oz/yr) calibrated leak standard in position and move the detector sensitivity selector to the 14 g/yr (0.5 oz/yr) position. Perform a 10-sweep test and the detector shall indicate no leak at least nine of the 10 times, or it fails.

7.5 With the detector sensitivity selector remaining in the 14 g/yr (0.5 oz/yr) position, replace the 7 g/yr (0.25 oz/yr) calibrated leak standard with a 14 g/yr (0.5 oz/yr) calibrated leak standard.. Perform a 10-sweep test and the detector shall indicate a leak within two seconds of passing the calibrated leak standard orifice, then clear within two seconds, at least nine of the 10 times, or it fails. .

8. DETECTOR REQUIRED PERFORMANCE IN A CONTAMINATED ATMOSPHERE

Test for detector clearing in a contaminated atmosphere and then sensing a 4 g/yr (0.15 oz/yr) leak. This test shall be performed with the 4 g/yr (0.15 oz/yr) calibrated leak standard in the chamber, replacing the 14 g/yr (0.25 oz/yr) calibrated leak standard.

8.1 The probe of a self-clearing detector (turned off) shall remain in the chamber, to test its ability to clear in a contaminated atmosphere. Inject a volume of R134a (amount sufficient to produce 500 ppm in the chamber) with a gas-tight syringe through the cylindrical access, into the chamber, seal the cylindrical access and mix the refrigerant with the air in the chamber by operation of the mixing fan for four to five minutes. Monitor the refrigerant contamination in the chamber, using a refrigerant monitor with accuracy of within ±10% as rated by the manufacturer, within the required contaminated atmosphere ranges of this section. The contaminated atmosphere shall be in the range of 450 to 550 ppm at the start (60 seconds after the mixing fan is turned off) and shall remain above 50 percent of that initial level at the conclusion of the sweep test.

8.2 Turn on the self-clearing detector, set to 4 g/yr (0.15 oz/yr) sensitivity and allow it to warm up. Once the detector is warmed up, shut off the mixing fan for the contaminated atmosphere test. The detector shall clear in the contaminated atmosphere within sixty seconds after the mixing fan has stopped, or it fails.

8.3 If the detector is not a self-clearing type, but can be cleared within the chamber by manual adjustment, turn on the detector, set to 4 g/yr sensitivity and allow to warm up. Shut off the mixing fan and immediately perform the manual clearing adjustment. The detector must clear in the contaminated atmosphere within sixty seconds after the mixing fan has stopped, or it fails.

8.4 If the detector is designed to clear only with a calibration bottle, perform that procedure, inject the HFC-134a into the chamber and mix with the mixing fan for four to five minutes. Shut off the fan. Wait 60 seconds and insert the detector probe into the chamber. The detector shall not indicate any leak. If it does, it fails.

8.5 Follow the contaminated atmosphere test immediately with a 10-sweep moving probe test (minimum gap of 9.5 mm or 3/8 in, at a rate of 75 mm/sec or 3 in/sec) with the 4 g/yr calibrated leak standard.

8.6 The probe must indicate the leak within two seconds of passing the calibrated leak standard orifice from the 9.5 mm (3/8 in) distance and clear within two seconds, at least nine of 10 times, or it fails.

9. FALSE-TRIGGERING OF THE DETECTOR

It is recognized that an electronic leak detector may falsely indicate a leak in the presence of certain under hood chemicals. Therefore the detector shall be tested against the following substances, using the procedures described or equivalent. If substances other than specified are used, the laboratory shall ensure they are chemically equivalent and maintain records of the substitution in the SAE J2791 certification documentation.

Although false triggering is allowed by this standard for many chemicals, it is not allowed for mineral engine oil or transmission oil. The marketer of the leak detector shall list all the chemicals and by a Y or N in an adjacent box, indicate if the detector will or will not false-trigger from each chemical. That list must be included with the leak detector, such as in the instruction manual.

If a detector probe false-triggers from a permitted chemical, it shall immediately be removed, and to pass the test, the detector must clear in no more than 20 seconds. The detector shall be fully warmed up and set for 4 g/yr (0.15 oz/yr) sensitivity prior to a false-triggering test. In all cases the detector probe shall be brought gradually to the surface of the chemical until/if it false-triggers, but no closer than within 3/8 in (9.5 mm), and held there for a minimum of five seconds. If it false-triggers, it shall immediately be pulled out of the beaker, or a short distance (approximately 75 mm or 3 in or more) away from the chemical if on a brush or dish. It must clear within 20 seconds after being pulled away, or it fails the test. All tests shall be performed at 60 to 80 °F (15 to 27 °C) with chemicals in this temperature range except as noted, and in still air.

The manufacturer of the detector shall explain in the operating instructions that if the detector takes longer than two seconds to clear as a result of exposure to one of the chemicals in this section (up to the test limit of 20 seconds), this indicates the probe apparently has encountered a large sample of contaminant, not necessarily a refrigerant leak. The instructions should add that the test area should be inspected for one of the permitted chemicals on the false-trigger list.

1. Windshield washer solvent (methanol base). Pour into a beaker or petri dish.

2. Ford spot and stain remover (F3AZ-19521-WA). Pour into a beaker or petri dish.

3. Ford rust penetrant and inhibitor (F2AZ-19A501-A). Spray from aerosol onto a dish surface, until there is a liquid accumulation.

4. Ford gasket and trim adhesive (F3AZ-19B508-AA). Unthread and remove cap with brush holding a thick film of the liquid for test.

5. Permatex Natural Blue cleaner and degreaser (biodegradable, non-caustic, with no chlorinated solvent, no petroleum solvent, no phosphate). Pour into a beaker or petri dish.

6. Ford brake parts cleaner (F6AZ-2C410-AB). Spray from aerosol onto a dish surface, until there is a liquid accumulation.

7. Ford clear silicone rubber (F7AZ-19554-CA). Extrude bead 50 mm (2.0 in) or longer onto a dish surface.

8. Motorcraft G-05 anti-freeze/coolant. Pour into a beaker or petri dish. Heat to 150 to 180 °F (66 to 82 °C).

9. Gunk Liquid Wrench. Pour into a beaker or petri dish.

10. Ford Pumice/Lotion hand cleaner (petroleum distillate, alcohol). Extrude from container onto a dish.

11. Ford Motorcraft DOT3 brake fluid. Pour fluid into beaker or petri dish.

12. Ford Spray Carburetor Tune-Up Cleaner (D9AZ-19579-AA). Spray from aerosol onto a dish surface, until there is a liquid accumulation.

13. Ford silicone lubricant (COAZ-19553-AA). Extrude bead 50 mm (2.0 in) or longer onto dish surface.

14. Dexron automatic transmission fluid heated to 150 to 180 °F (66 to 82 °C). Pour into a beaker or petri dish.

15. Mineral engine oil heated to 150 to 180 °F (66 to 82 °C). Pour into a beaker or petri dish.

10. REPEATING A TEST PROCEDURE AFTER A FAILURE

If a detector fails only one 10-sweep test, but passes all the other sweep tests, that one procedure may be repeated once. However, if it fails a second time, the entire test must be repeated, but not until the marketer has provided documentation to the test facility of changes made to the detector.

If a detector fails more than one 10-sweep test, it may repeat the entire test procedure once. If it fails to pass a second time, it may not be retested until the marketer has provided documentation to the test facility of changes made to the detector.

If a detector passes all the sweep tests, but fails a false-triggering test (either by false-triggering on engine or transmission oil, or by failing to clear from another chemical false trigger within 20 seconds), it may be retested against that chemical again, only at the conclusion of all other tests. If it fails a second time, it may not be retested until the marketer has provided documentation to the test facility of changes made to the detector.

11. NOTES

11.1 Marginal Indicia

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE ICC STANDARDS COMMITTEE

APPENDIX A

The sealed chamber shall be built to the dimensions shown – a 610 mm (2 ft) cube, with an access sleeve on or near the top for injecting refrigerant R134a with a gas-tight syringe, an access door on a vertical wall, large enough to insert a calibrated leak standard and with a sealing surface when closed. It shall have a mixing fan (120 V, approximately 40 cfm) installed on the base, and a vacuum motor mount on the top (so with the access door opened the chamber can be quickly purged of contaminated atmosphere). The slot through which the detector probe passes and sweeps back and forth shall have an overlapping double-strip arrangement of conformable rubber material to seal the chamber around the pass-through of the probe, or the butt joint with face sealing as described in 6.1.1. See illustrations.

The table with the reciprocating platform for the detector testing shall be as described in 6.1.4.

A.1 HOW TO USE A DETECTOR THAT MEETS THIS STANDARD

The marketer shall provide a prominent warning, accompanying the chart of false triggers, to caution the technician against using cleaning agents or solvents on or near refrigerant lines, and to wipe away both dirt or potential false-triggering chemicals, using a dry shop towel or shop air. The marketer also shall explain that a detector may false-trigger in a contaminated atmosphere, and what steps to take (if any), and/or what time to allow for the detector to clear.

A.1.1 Other instructions that accompany the detector shall include the following:

Leak test with the engine off.

a. Charge the system with sufficient refrigerant to have a gauge pressure of at least 340 kPa (50 psi) with the system off. At ambient temperatures below 15 °C (59 °F) leaks may not be measurable because the pressure may not be reached.

b. Visually trace the entire refrigerant system, and look for signs of air conditioning lubricant leakage, damage and corrosion on all lines, hoses and components. Check each questionable area with the detector probe, as well as all fittings, hose-to-line couplings, refrigerant controls, service valves with caps in place, brazed or welded areas, and areas around attachment points and hold-downs on lines and components. If looking for an apparently larger leak, check first at the 7 g/yr or 14 g/yr position.

c. Always follow the refrigerant system around in a continuous path so that no areas of potential leaks are missed. If a leak is found, always continue to test the remainder of the system.

d. Recheck service valves with caps removed. Blow shop air over service valve to clear immediate area, and then check with detector on 7 g/yr setting.

e. Move the detector at a rate of no more than 75 mm/sec (3 in/sec) and as close as possible to 9.5 mm (3/8 in) from the surface, completely encircling each test position (switch, sensor, refrigerant tubing connection, etc).

f. Slower movement and closer approach of the probe normally improves the likelihood of finding a leak. However, detectors made to meet this standard are based on air sampling from the 9.5 mm (3/8 in) distance. So retest is advisable when a leak appears to be found at the most sensitive settings, particularly if the probe was in a static position on a joint, or making physical contact with a joint, as it was moving. Repeat with a moving probe test at that location, taking care to maintain the small gap (9.5 mm or 3/8 in) to confirm that the leak is of repairable size. Use of the 7 g/yr (0.25 oz/yr) position of the detector, after finding an apparent leak with the 4 g/yr (0.15 oz/yr) setting, also may be helpful.