SAE INTERNATIONAL

SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Technician Procedures for Refrigerant Leak Detection in Service of Mobile Air Conditioning Systems

RATIONALE

This version of the recommended practice updates the previous one to reflect the latest procedures including those that have come into use with the industry changeover to R-1234yf.

FOREWORD

The purpose of this SAE Recommended Practice is to establish guidelines for leak detection procedures when servicing motor vehicle air-conditioning refrigerant systems. There are many approaches for determining the existence and location of a refrigerant system leak. However, many of these approaches will not provide reliable leak detection for small but still repairable leaks. When servicing MAC systems, it is important that they be repaired to maintain their design intent concerning refrigerant containment rates, for system performance, refrigerant system safety, and to protect the environment.

Single evaporator MAC systems can have a design intent refrigerant charge quantity of less than 567 g (20 ounces) and a refrigerant leakage rate of considerably less than 20 g/year. Identifying and repairing small system leaks is important, for system performance and reliability. In addition, some hybrid vehicles, or electric vehicles have larger refrigerant capacities than would normally be expected for vehicle size, because the vehicles incorporate an A/C refrigerant circuit for cooling the high-voltage battery pack and/or control electronics under certain operating conditions. And the air conditioning system may incorporate a heat pump circuit with an additional heat exchanger, to assist cabin heating. For these vehicles, refrigerant leak detection locations can also include r vehicle components other than the air conditioning system.

1. SCOPE

This SAE Recommended Practice applies to the use, by automotive service technicians, of generally available leak detection methods to service motor vehicle passenger compartment air conditioning systems.

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

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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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J639 Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems

SAE J2297 Ultraviolet Leak Detection: Stability and Compatibility Criteria of Fluorescent Refrigerant Leak Detection Dyes for Mobile R-134a and R-1234yf (HFO-1234yf) Air-Conditioning Systems

SAE J2791 HFC-134a Refrigerant Electronic Leak Detectors, Minimum Performance Criteria

SAE J2913 R-1234yf [HFO-1234yf] Refrigerant Electronic Leak Detectors, Minimum Performance Criteria

SAE J2970 Minimum Performance Requirements for Non-Refrigerant Tracer Gasses and Electronic Tracer Gas Leak Detectors

3. REFRIGERANT LEAK DETECTION METHODS COVERED IN THIS DOCUMENT

- Visible oil leakage on system parts, often highlighted by road film, particularly at system joints.
- Water/soap solution bubbles.
- Using electronic leak detection devices, particularly those certified to SAE Standards.
- Trace dye that meets SAE J2297 requirements.
- System vacuum and pressure decay (pressure change/loss over time). Except where vacuum and/or pressure decay is used on an isolated component, they are intended to confirm the existence of a leak in the overall system. The complete system test will not pinpoint the location of the leak. One of the methods described above will be needed to pinpoint the location of the leak. See Section 8 (pressure/vacuum change over time).
- Using non-refrigerant tracer gasses and electronic tracer gas leak detectors that meet SAE J2970.

3.1 Using the Appropriate Leak Detection Procedure

It is important to understand that some of the methods have limited ability to identify a leak, and the use of some methods (i.e., pressurizing the system with nitrogen gas or with a high pressure refrigerant) could cause damage to the refrigerant system. The industry has developed service procedures and equipment that provide appropriate ways to determine system refrigerant leakage and to minimize the use of additional refrigerant. In many cases, the technician will find it appropriate to use a combination of procedures to pinpoint a leak.

3.1.1 If the indicated leak is large, the technician should begin by confirming its existence by reviewing the vehicle A/C service history and visual inspection. A large leak is defined as one that results in a significant loss of the refrigerant charge within a single A/C cooling season, such as evidenced by failure to pass the vehicle manufacturer's cooling performance test. Very low or no pressure in the system when the vehicle is received might be an indication of a very large leak, although it is recognized that no system is perfectly sealed and over a period of years all systems suffer loss of refrigerant. On-road life of motor vehicles has been lengthening, and at the time of this revision is almost 12 years, while at the same time, refrigerant charges have been reduced and improvements in seals have been made. So hoses and elastomer joints that rarely were areas of common concern for leakage may now require more careful inspection because of the effects of ageing, including from underhood thermal change effects, exposure to road film, and seepage of underhood vehicle fluids.

3.2 Three levels of leak detection. Level 1 is for large leaks, and even if effective in pinpointing a large leak, should be followed by a subsequent level (Level 2 or Level 3) to ensure that all repairable leaks have been found.

3.3 The most effective and reliable refrigerant leak detection methods include the following steps, starting with methods that will locate major refrigerant leaks, to methods that will locate leakage rates of a few grams per year. It should be noted that to minimize MAC system refrigerant emissions and assure consumer satisfaction, identifying all potential system refrigerant leakage can only be accomplished by using the correct procedures and in conjunction with electronic and trace dye diagnostics.

4. INITIAL MAC SYSTEM INSPECTION LEVEL I PROCEDURE

4.1 Visual inspection and pressure test for major leakage (install a gauge set and check static pressure in the system). However, static pressure does not reflect state of refrigerant charge.

4.2 Visible oil leakage on system parts should be the first step in any leak test procedure. If vehicle has low or no pressure in the system when it arrives for service, it is important to take time to carefully perform this step.

4.2.1 Leakage may be indicated by oily dirt, particularly at refrigerant system joints. If the leakage is almost entirely from a single location, a refrigerant system having a large leak may have some indication of oil collection on the surface of the refrigerant part, and with exposure time, the area will collect dirt. Visually inspect the system, looking for oily dirt at refrigerant line joints and where lines and components may make physical contact, and rub through to produce a leak. Check the hood liner or surface to check for excessive oil accumulation due to a compressor shaft seal leak from a high-mount compressor. (Note: a small amount of oil is not necessarily an indication of a shaft seal leak.) If accessible, check the condensate drain of the evaporator for signs of oil which may indicate an evaporator leak.

4.2.2 Leakage indicated by trace dye already in the system. Many vehicle makers install trace dye in the A/C system during manufacturing. If so, trace dye is likely to produce visible evidence. See Section 5 for use of trace dye.

4.3 Use of Water or Soap Water Solution

If there is no or very low pressure in the system, skip this step. Bubbles from water and soap solution applied to refrigeration system parts/joints are only effective in locating and pinpointing very large refrigerant leaks, and therefore would require some recharging of the system first. Be sure to check for indication of dye before using water or soap water solution to avoid washing away the dye.

4.3.1 The limitations of using a liquid bubble leak detection method are indicated in the chart, Figure 1, which indicates that one bubble per second would be caused by leaks per year equal to or greater than double or triple the system capacity. Figure 1 also compares the soap solution bubble method with leak detection using SAE J2791/SAE J2913 electronic leak detectors.

4.3.2 As seen in Figure 1, using water or water and soap and looking for bubbles will not identify small leaks, since one bubble per second indicates a refrigerant leak of over 1276 g (45 ounces) per year, exceeding over twice the total system refrigerant charge requirements for most cars. When attempting to determine if the system has a smaller leak, but still large enough to require service, refrigerant leak bubble identification is of little value, and use of SAE-certified (SAE J2791/SAE J2913) electronic leak detectors and/or trace dye is required.

4.3.3 Figure 1 also compares water/soap detection for different SAE rated electronic leak detectors. One visible bubble per second indicates a refrigerant leak rate of approximately 1276 g (45 ounces) per year, as compared to using SAE J2791 or SAE J2913 electronic leak detectors certified to identify refrigerant leakage of 4 g (0.15 ounce) per year.