

Submitted for recognition as an American National Standard

**Laboratory Testing of Vehicle and Industrial Heat Exchangers
for Durability Under Vibration-Induced Loading**

1. **Scope**—This SAE Recommended Practice is applicable to all liquid-to-gas, liquid-to-liquid, gas-to-gas, and gas-to-liquid heat exchangers used in vehicle and industrial cooling systems. This document outlines the test to determine durability characteristics of the heat exchanger from vibration-induced loading.
 - 1.1 **Purpose**—This document provides a test guideline for determining the durability of a heat exchanger under specified vibration loading.
2. **References**
 - 2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.
 - 2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1542—Laboratory Testing of Vehicle and Industrial Heat Exchangers for Thermal Cycle Durability
SAE J1597—Laboratory Testing of Vehicle and Industrial Heat Exchangers for Pressure Cycle Durability
3. **Objective**—To verify compliance with established criteria that insures durability in a specific application. This document describes a system to induce stresses in a heat exchanger resulting from vibration loading. The process is accomplished by vibrating the unit at specified frequencies, and amplitudes or acceleration.
4. **Facility Requirement**—The facility should provide the following as required:
 - 4.1 Vibration equipment with controls on frequency, amplitude, and acceleration (for 50 Hz and below, electrohydraulic is suggested, higher frequencies may require electrodynamic).
 - 4.2 **Test Fixture**
 - 4.2.1 ACTUAL INSTALLATION
 - 4.2.2 If actual installation is not available, a fixture should support the heat exchanger with orientation as in service or as specified. The fixture must be rigid so as not to induce any additional dynamic inputs.
 - 4.3 Means of checking heat exchanger integrity.

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- 4.4 Equipment to monitor motion of unit during test.
- 4.5 Source for pressurizing and heating test unit if required.
- 4.6 Additional equipment may include but not be limited to the following:
- a. Accelerometers
 - b. Automatic data logging equipment
 - c. Automatic emergency shutdown
 - d. Cycle counters
 - e. Digital signal analyzer
 - f. Function generator (sine wave, random noise, square wave, ramp function, etc.)
 - g. Load transducers
 - h. Pressure gauges
 - i. Pressure regulators
 - j. Road data recording equipment
 - k. Safety features as specified by regulatory codes and common practices
 - l. Strain measurement equipment
 - m. Temperature monitoring and control equipment

5. Testing

- 5.1 Test heat exchanger for integrity.
- 5.2 Install test unit on vibration test fixture, fill with specified test fluid, orientation the same as in service or as specified, and to include all mounting hardware: isolators, tie rods, mounting brackets, etc. All heat exchanger mounted masses will affect the response characteristics of the test unit and should be attached. Examples of mounted masses for a radiator are: charge air cooler, condensers, oil cooler, air dryers, shrouds, shutter, etc.
- 5.3 Set up control system to obtain the specified vibration cycle under one of the following modes:
- 5.3.1 Road or duty cycle (simulation or replication).
 - 5.3.2 Failure mode simulation.
 - 5.3.3 Sine sweep at specified acceleration or amplitude.
 - 5.3.4 Resonant frequency at specified energy input.
 - 5.3.5 Random noise at specified acceleration levels.
 - 5.3.6 Per established specification.
- 5.4 Pressurize and heat the test unit if required.

CAUTION—Pressures exceeding specified maximum value can cause significant structural damage which will invalidate the test results. The system shall be capable of maintaining this pressure within 5% absolute pressure unless otherwise specified and should be measured within or as near the test units a possible.

- 5.5 Run test to specified duration or component failure.
- 5.6 Remove and test heat exchanger for leaks and structural damage.

6. Test Documentation

- 6.1** During and after test, document leakage rate(s), location(s), and structural failures for comparison to acceptance criteria.
- 6.2** Document the following:
- a. Condition of unit prior to test (new or previous history)
 - b. Unit Orientation (Reference to 5.2)
 - c. Test Mode (Reference to 5.3)
 - d. Pressure and Temperature (Reference to 5.4)
 - e. Duration of Test (Reference to 5.5)
 - f. Location of leaks and structural damage (Reference to 5.6)
- 6.3** Testing should be adequately documented to allow test reproduction. Documentation to include a test log of the complete test, recording any changes in the heat exchanger and fixture. Test log to include cycles or hours, time of day for all test starts and stops with reasons for stops.
- 7.** This document is valid for durability comparison of vibration induced loadings. Correlation to field results must be developed on an individual basis. Other tests affecting heat exchanger durability are SAE J1542 (Thermal Cycle) and SAE J1597 (Pressure Cycle). These tests can be run in combination as well as independently.

NOTE—Combination testing may make it difficult to determine cause of failure.

8. Notes

- 8.1 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.

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