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

SAE Recommended Practice
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Submitted for Recognition as
an American National Standard

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LABORATORY TESTING OF VEHICLE AND INDUSTRIAL HEAT
EXCHANGERS FOR DURABILITY UNDER VIBRATION INDUCED LOADING

1. PURPOSE:

This recommended practice provides a test guideline for determining the durability of a heat exchanger under specified vibration loading.

2. SCOPE:

This 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.

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, electro hydraulic is suggested, higher frequencies may require electrodynamic).

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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.

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:

Accelerometers

Automatic Data Logging Equipment

Automatic Emergency Shutdown

Cycle Counters

Digital Signal Analyzer

Function Generator (sine wave, random noise, square wave, ramp function, etc.)

Load Transducers

Pressure Gauges

Pressure Regulators

Road Data Recording Equipment

Safety features as specified by regulatory codes and common practices

Strain Measurement Equipment

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.

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:

- . Condition of unit prior to test (new or previous history)
- . Unit Orientation (Ref. 5.2)
- . Test Mode (Ref. 5.3)
- . Pressure and Temperature (Ref. 5.4)
- . Duration of Test (Ref. 5.5)
- . Location of leaks and structural damage (Ref. 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 recommended practice 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.

RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J1542

SAE J1597

APPLICATION:

This 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.

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