



A/C Hose/Pipe Assembly Dynamic Strain Measurement

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. To physically measure the strain on an air conditioning (A/C) hose/pipe assembly (A/C line), as installed in a vehicle under dynamic conditions.

A/C Suction and Discharge lines connecting the compressor to the evaporator and condenser are the most likely subjects for this measurement. They typically must react to the full relative motion between the engine/compressor and non-moving components in the engine compartment.

The data resulting from this test may be used to perform analysis of line strength and durability.

It may be possible to limit or eliminate the need for physical testing if analysis of the hose/pipe assembly determines the design has an adequate design margin. Input data for math analysis of motion and stresses may be available from Powertrain roll files; results of vehicle durability simulation, etc. (See Figure A1: Test Flow.)

1.2 Applicability. All vehicles equipped with an air conditioning system (see Figure A1: Test Flow).

1.3 Remarks.

1.3.1 Uniform Parts Code(s) (UPC). UPCs comprehended in this standard include codes 1A2G and 1A2K.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3238

GMW3423

GMW3425

GMW14907

2.3 Additional References.

- CG2290
- DR.MF.BB
- DR.MF.NL
- DR.MF.PB
- DR.MF.PS
- DR.MF.SD
- DR.MF.TW
- Example Report: 2004 GMT275 A/C Line Strain Road Load Data Acquisition (RLDA). Search Criteria: Author = Craig Marshall, Program = GMT257. This test was run at Milford Proving Ground (MPG) using GMW15742.

3 Resources

3.1 Facilities. Complete testing requires use of proving ground (PG) road facilities and/or other methods to simulate the road facility under dynamic conditions. The test facilities referenced in 4.3.1.1 thru 4.3.1.11 are

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available at most GM proving grounds. In cases where the Milford Proving Ground (MPG) road facility has not been reproduced at other proving grounds, it should be possible to provide similar vehicle inputs using a towing dynamometer on the local road system (see 3.2.1). Substitutions/exceptions must be agreed to in advance by the Validation Engineer and noted in the test report.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 A towing dynamometer is required at proving grounds other than MPG, since they lack the physical 7.2% and 11.6% hills.

3.2.2 Equipment for Measuring A/C Pipe Bending and Twisting Motions.

3.2.2.1 Tech II, Scan Tool, or other service tool capable of reading engine revolutions per minute (rpm) and A/C pressure transducer signals from the Powertrain Control Module (PCM), Vehicle Control Module (VCM), etc.

Note: If an appropriate electronic service tool is not available, see 3.2.2.2.

3.2.2.2 Pressure gauge or pressure transducer for installation on the discharge side of the A/C refrigerant system (0 kPa to 3447 kPa) to be used to monitor 2413 kPa head pressure during measurements. This instrumentation is needed if an appropriate electronic service tool is not available.

3.2.2.3 Optical transducer with signal conditioning (pulse output) to sense the reflective tape on the compressor pulley.

Note: An engine tachometer with a pulse output has been used in the past. However, due to differing designs of some electrical firing systems, this may cause errors in the data that may not be discovered. For simplicity, it is recommended that an optical transducer system be used. In addition, the optical transducer allows testing of diesel engines.

If a service tool with pulse output is not available, the optical sensor will also be used to sense engine crankshaft speed/position. Only one optical sensor is required, as sensing of the pulley and crankshaft is not done at the same time.

3.2.2.4 Reflective tape to place on the A/C compressor pulley and engine crankshaft to allow the optical transducer to sense the rotation.

3.2.2.5 Strobe light, B & K Stroboscope, Type 4913 or equivalent.

3.2.2.6 Marking pen to identify maximum bending or twisting motion locations on the A/C hose/pipe test sample, e.g., permanent marker, paint pen, or other durable marker.

3.2.3 Equipment for Measurement During Road Events.

3.2.3.1 Service tool capable of reading the engine rpm and vehicle A/C pressure transducer signal from the PCM, VCM, etc., and capable of providing output for data acquisition. If an appropriate electronic service tool is not available, see 3.2.3.2 to 3.2.3.2.3.

3.2.3.2 Additional equipment required if available service tool is **not** capable of reading engine rpm, etc., per 3.2.3.1.

3.2.3.2.1 Engine tachometer with analog output.

3.2.3.2.2 Pressure transducer (0 kPa to 3447 kPa). Use the same one installed for the strobe evaluation.

3.2.3.2.3 Pressure gauge or readout from the A/C refrigerant pressure transducer (0 kPa to 3447 kPa) to be used to monitor 2413 kPa (350 psi) head pressure during measurements.

3.2.3.3 Monitoring device to indicate if A/C compressor turns off during test, e.g., 12 V test light.

3.2.3.4 Data acquisition device.

3.2.3.5 Appropriate strain gauges and instrumentation for the A/C hose/pipe assembly test sample.

3.2.3.6 Equipment to recover refrigerant and recharge the A/C system.

3.3 Test Vehicle/Test Piece. A design-representative vehicle and at least one extra set of lines to be instrumented and measured.

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3.3.1 Test Vehicle. For development testing, the vehicle must be built to design or test intent, including an operational A/C system with the correct A/C hardware installed.

In addition, for Validation testing, vehicle hardware and components which could affect test results must represent production intent, e.g., engine; suspension; body structure; Condenser Radiator Fan Module (CRFM), etc.

The vehicle shall be tested at Curb Mass plus driver and instrumentation, also known as Lightly Loaded Vehicle Mass (LLVM).

3.3.2 Test Piece. An A/C hose/pipe assembly is required for strain gauging (see 3.5.4).

3.4 Test Time. The following is an estimate of the time needed to perform this procedure.

Calendar time includes preparation and other downtime, actual test, and analysis of data.

Calendar time: 10 days

Test hours: 40 hours

Coordination hours: 40 hours

3.5 Test Required Information. The test requestor shall provide the following required information.

3.5.1 Information necessary to determine desired strain gauge locations.

Note: Suction lines can create excessive strain in the Evaporator tubes near the Thermostatic Expansion Valve (TXV), potentially causing the tube to experience a fatigue fracture. Where the suction line has potentially high strain levels, include strain gauges on the tubes near the TXV and any other areas of concern on the body of the Evaporator assembly.

3.5.1.1 Reference drawings of the A/C lines to be tested. If some or all locations have already been determined, the drawings should be marked to indicate gauge locations and orientations. The drawings may also be used to document the locations of interest as determined during test preparation.

3.5.1.2 Math-Based Gauge Location. Where math-based analysis has been used to predict high stress areas in the hose/pipe assembly, apply strain gauges at the specified locations on the test piece (see 4.1.2).

3.5.1.3 Gauge Locations From Previous Physical-Test. Locations may be provided from previous testing if applicable.

3.5.2 Maximum Engine Sweep rpm. The maximum sweep rpm for the strobe evaluation shall be the lesser of engine redline or A/C compressor redline.

3.5.3 Number of Cylinders in the A/C Compressor. This is used to determine the number of pieces of reflective tape required to trigger the strobe for the dominant order of the A/C compressor.

3.5.4 Strain Gauging Plan. If a supplier plans to provide instrumented test pieces to the proving ground, the gauges and wiring must be of a type/brand compatible with the PG instrumentation requirements. As an option, the supplier may use other types/brands of gauges but will need to provide its own data acquisition instrumentation and personnel to perform the data collection.

3.6 Personnel/Skills.

3.6.1 Personnel approved and experienced in driving the road events (see 4.3.1.1 thru 4.3.1.11).

3.6.2 Personnel with strain gauge and instrumentation skills. These skills are typically available at GM Proving Grounds through Road Load Data Acquisition (RLDA), Special Test, or similar support groups. As an alternate source, the A/C line supplier may choose to provide their own skilled personnel.

4 Procedure

4.1 Preparation.

4.1.1 Bending or Twisting Motions During Strobe Sweeps. This should be performed when the analysis available is insufficient to predict areas of concern. The following paragraphs are designed to determine areas of maximum bending and/or twisting motion in the hose/pipe assembly. The test results are then used for planning the strain gauging for the test piece to be used during subsequent testing. A strobe light is used and set at the following frequencies:

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