



Powertrain Mount Thermal Test Environment Simulation

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. This procedure specifies methods for the reproduction of thermal environments during laboratory durability testing of the powertrain mounting system. It applies to all powertrain mount laboratory durability test procedures.

1.2 Applicability. This procedure applies to all passenger cars and light duty trucks having powertrains mounted on frames, cradles, and/or body structure. Additionally, it applies to transverse and longitudinal mounted powertrains as well as front, rear, and all wheel drive powertrain configurations.

1.3 Remarks. The powertrain mounting system under evaluation includes rubber, hydraulic or controlled mounts, dampers and associated brackets and fasteners. The mount, damper, and/or bracket interface with the powertrain, body, and/or frame may also be evaluated.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14555

2.3 Additional References.

Statement of Requirements (SOR)

3 Resources

3.1 Facilities. A well-equipped laboratory capable of running powertrain mount durability tests.

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 Heat Gun Blower. These are used to subject the mounts to a specified temperature simulating the underhood thermal environment experienced in the vehicle during severe operation. See Figure A4 (Appendix A). Heat ducts are used to convey heat to the mount location where an oven-roasting bag (turkey bag) surrounds the mount/bracket and contains the desired thermal environment. See Figure A4 (Appendix A).

3.2.2 Heat Source Temperature Controller. A heat source must be controlled to provide the elevated thermal environment required for powertrain mount durability testing. The controller, (see Figure A6, Appendix A) should be capable of controlling the heat source with the output of a thermocouple to within 1 °C.

3.3 Test Vehicle/Test Piece. As specified for the applicable mount durability test.

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3.4 Test Time.

Calendar time: 1 day
Test hours: 0 hours
Coordination hours: 4 hours

3.5 Test Required Information.

 Not applicable.

3.6 Personnel/Skills. Those executing this procedure should be familiar with powertrain mount laboratory durability testing procedures and thermal measurement practices used in GMW14555. No special skills are required to perform the indicated tasks.

4 Procedure

4.1 Preparation. When the powertrain mount validation plan is being developed, the validation engineer, design engineer and test engineer must discuss the need for accurate thermal data. Planning at this early stage will ensure that due consideration will be given to the effects of vehicle thermal environment on the durability of the powertrain mounting system. Refer to thermal requirements in the program specific Statement of Requirements (SOR) for further guidance.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 The test conditions described are intended for the actual operation of the test with test samples in place. The development of the drive files does not need to be conducted at elevated temperature.

4.3 Instructions.

4.3.1 Establish Thermocouple Locations. It is necessary to fully understand the temperature environment of all powertrain mounts during a wide range of vehicle operating conditions. A critical element of gaining this understanding is proper selection of temperature measurement locations. Figures A1 and A2 (Appendix A) show examples of measurement locations on a powertrain mount.

Past practice for the vehicle program to be evaluated should be considered, including guidance from thermal model results. In general, it is desirable to include one or more measurement locations on the exterior of the mount, with particular attention to points close to heat sources, such as an exhaust manifold. In addition, possible locations can include inside an external can, at the mount interface to engine side brackets, and perhaps embedded into the mount rubber. Decisions should be made in consultation with the thermal development engineer.

It is important to clearly document temperature measurement locations at all stages. Temperature measurement locations must be consistent at each stage of the thermal development process and during lab testing.

4.3.2 Record Operational Temperature Data. In-vehicle measurements should be made in accordance with GMW14555 Powertrain Cooling and Thermal Performance for Passenger Vehicles. For the purpose of this procedure, data is required from Condition 1 of GMW14555, also referred to as the Global Sequence Procedure. For some vehicles, it is possible that the highest powertrain mount temperatures will occur at conditions of lower ambient temperatures than those specified for GMW14555 Condition 1. Therefore, it is advisable to measure data at the Condition 1 mid-ambient conditions as specified in GMW14555. Specific conditions noted in that section are 20 °C with no air conditioning and 30 °C with air conditioning.

4.3.2.1 Analytical Temperature Estimates. When powertrain mount durability tests are to be run early in a vehicle program development (such as for component level design validation), direct vehicle measurements may not yet be available. In such cases the design engineer, thermal development engineer and validation engineer should consider use of data from previous vehicle models or from Computer Aided Engineering (CAE) thermal models.

4.3.3 Establish Test Point Temperature. For each relevant temperature measurement location, a time history of the temperature from GMW14555 Condition 1 will be provided. The desired test point temperature is equal to

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the time average temperature noted during the last 5 minutes of operation during the city schedule sequence. See Figure A3 (Appendix A) for an example of this determination.

If, as suggested in 4.3.2, the recorded temperature at a mount location was higher for mid-ambient conditions (i.e., 20 °C or 30 °C), then that time history should be used as the basis for establishing the test point temperature. Should the test point temperature as determined by the above process be found to be 70 °C or less, the test condition for that mount location may be permitted to be run at lab ambient. Material test data for rubber suggests that if the test temperature is below 70 °C, no significant difference will be noted from running the same test at ambient temperature. The design engineer should confirm that such an assumption is valid for the specific material to be tested.

Correlation studies conducted by GMNA thermal engineers have concluded that the test point temperature as described corresponds to approximately the continuous temperature limit for a 95th percentile severe customer. Such a customer can be expected to expose powertrain mounts to this temperature for as much as 1400 h over the life of a vehicle. It is not uncommon for each mount location to have a somewhat different test point temperature.

4.3.4 Install Test Heat System. Sections 4.3.4.1 through 4.3.4.4 describe a heat system that has been used with success in GMNA. Deviations or alternate heat systems are permitted if they achieve the same performance and desired results.

4.3.4.1 Heat System. For subsystem and subassembly tests, each mount location will require a separate heat source. The heat source is a forced air heat gun. Heated air will be delivered to the mount by way of flexible hose designed to withstand the temperatures to be delivered (typically 80 °C to 110 °C). The mount will be enclosed with a transparent plastic bag, attached to the hose in such a way as to direct the heated air around the mount. (In GMNA, cooking bags commonly referred to as **turkey bags** have been used successfully.) A vent hole should be provided opposite the hose to allow the escape of air pressure after it has flowed over the mount. See Figure A4 (Appendix A) for an example of the described heat system.

Use a thermocouple probe to determine the temperature gradient within the bag, and adjust the configuration to eliminate excessive hot and cold spots in the vicinity of the mount.

4.3.4.2 Temperature Control System. A simple closed loop electrical control system is required to maintain consistent temperature in the vicinity of the mount under test. Feedback to the control system will typically be in the form of a single thermocouple placed in the airstream near the mount. This thermocouple should be placed within 50 mm of the mount. This control feedback thermocouple will remain in place throughout the test duration. The controller should be capable of controlling the temperature within ± 1 °C.

The control thermocouple is distinct from the thermocouples used to record operational temperature data as previously described. However, during the test setup phase, the feedback thermocouple must be correlated to the measurement locations. For instance, if a thermocouple placed on the forward exterior of an engine mount achieved a test point temperature of 95 °C, then the heat system should be adjusted until a stable temperature of 95 °C is achieved in the laboratory for the same location. Ample time must be allowed for all elements of the test system to achieve steady state. Once the desired test point has been achieved at the measurement location, the temperature of the feedback thermocouple should be noted. When the test sample is placed on the test site, the noted feedback temperature must be controlled. See Figure A5 (Appendix A) for a conceptual diagram.

4.3.4.3 Double Heat Bag. Under some test conditions, a single heat source may be incapable of recreating the desired thermal environment. In particular, an unheated engine block used as part of a subsystem test may act as a heat sink cooling engine side mount brackets. This condition may be noted as a disparity between good correlation of a surface thermocouple and poor correlation for a thermocouple placed on the mount interface with the engine side mount bracket. Improved correlation may be achieved by use of a second heat source.

The criterion for consideration of using a double heat bag or other means should be when the differential between mount insert temperature and surface temperature is greater than 5 °C. The test engineer, validation engineer and design engineer must balance the various requirements and test complexity to determine the final test design.

The second heat source would consist of an identical heat system described in this section. The hose is attached to a second bag which surrounds the engine side bracket completely. This bag must be installed prior to attaching the engine side bracket to the engine block. Figure A7 (Appendix A) shows an example of such a system.

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