GM WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW16633

Exhaust Gas Heat Recovery Unit Validation Tests

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. The intent of this standard is to define a set of validation tests for an Exhaust Gas Heat Recovery (EGHR) Unit which are not covered by other existing GM Test Procedures.

1.2 Symbols. Not applicable.

1.3 Applicability. This standard includes EGHRs which are directly close coupled to the catalytic converter or hard mounted to the engine (Close Coupled EGHR (CC-EGHR)) and EGHR which are installed in an under floor position mounted after the flex coupling (Under Floor (UF-EGHR)). It is applicable for all EGHR Systems for cars and light commercial vehicles.

1.4 Remarks. This standard establishes the minimum requirements for the validation of an EGHR. All requirements of this specification must be met in order to demonstrate Design Validation (DV) and Product Validation (PV). It does not cover all necessary functional or validation tests which are described in the corresponding Subsystem Technical Specification (SSTS) for the EGHR. For a complete validation of the EGHR refer to the “Validation Cross Reference Index for EGHR” as described in the SSTS “Exhaust Gas Heat Recovery Unit”.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3059 GMW3420 GMW15261

2.3 Additional References.

Exhaust Gas Heat Recovery (EGHR) Unit Subsystem Technical Specification (SSTS)

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities.

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

3.1.1.2 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.

Usage of alternative facilities needs the prior approval by the General Motors Design Release Engineer (DRE) and the General Motors Validation Engineer.

3.1.1.3 Burst pressure test bench with a maximum pressure of 3 MPa.

3.1.1.4 Climate chamber which can be cooled down to -30 °C, capable to contain the EGHR.

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3.1.2 Equipment.

3.1.2.1 Instrumentation and recording equipment for the documentation of all test parameters. Details can be found in the appropriate test description.

3.1.2.2 Controllable hot gas source (fuel burner) with a maximum mass flow of 540 kg/h (150 g/s) at +1000 °C.

Note: The above required values can be adjusted based on the requirements given by the program specific EGHR SSTS.

3.1.2.3 Controllable coolant loop with a coolant flow of 25 L/minute at +100 °C.

3.1.2.4 Air blower capable to deliver fresh air at Room Temperature (RT) ≙ +23 °C ± 5 °C at the same mass flow like the hot gas source.

3.1.2.5 A control device capable to switch the actuator automatically between “Non-Recovery Mode” and “Recovery Mode”. A full actuator cycle (switching from “Non-Recovery Mode” to “Recovery Mode” and back to “Non-Recovery Mode”) shall be completed within a maximum time of 3 s.

Note: Only necessary for an EGHR with non-thermostatic actuator.

3.1.2.6 Electromagnetic or hydraulic shaker with a minimum acceleration of 8G (78.5 m/s²) and a minimum frequency of 200 Hz.

3.1.3 Test Vehicle/Test Piece. EGHR test samples equipped with interfaces (exhaust pipe flanges, coolant connectors) according to the release drawing.

3.1.4 Test Time.

Calendar time:	60 d to 220 d (dependent on actuator technology)
Test time:	1100 h to 5000 h (dependent on actuator technology)
Coordination time:	30 h

3.1.5 Test Required Information. Not applicable.

3.1.6 Personnel/Skills.

- Experience in bench testing of automotive components.
- Experience in test instrumentation.
- Knowledge of mechanical and electrical systems.
- Experience in data acquisition and control systems.
- Analytical, critical thinking, troubleshooting, and problem solving skills.
- Oral and written communication skills.

3.2 Preparation. As described in the appropriate test description of Section 4 and referenced GM test standards and procedures.

3.3 Conditions.

3.3.1 Environmental Conditions. Unless otherwise required by the appropriate test, all tests shall be performed at +23 °C ± 5 °C, together with the exhaust systems connectors and the fluid loop connectors. The connectors shall be assembled with the nominal torque given by the release drawing.

3.3.2 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.

3.4 Instructions. Follow all instructions of Section 4 and referenced GM test standards and procedures.

3.5 Data. Not applicable.

3.6 Safety. This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

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3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Test Results. The test results shall be compiled to a test report which contains the information defined in 3.7.1.1 through 3.7.1.3.

3.7.1.1 Test Piece Description. Part name and/or number, development state, date of manufacture, drawing number and drawing state.

3.7.1.2 Summary of Test Results. Documentation of individual test results, target values, rating of test results (OK, Not OK (NOK)) and deviations from the test procedure, if necessary. Test incidents shall be documented additionally with pictures.

3.7.1.3 Test Description. Description and pictures of test setup. Calibration of test equipment.

4 Requirements and Procedure

4.1 Maximum Exhaust Gas Pressure Test. The EGHR shall withstand high pressure on the exhaust gas side as defined in 4.1.1 through 4.1.3.2.

4.1.1 Preparation. A leakage test according to GMW15261 shall be performed without heat treatment before the start of the test. Cap one (1) end of the exhaust path of the EGHR sample and connect the other end to a burst test fixture. The fixture shall have a pressure gage, pressure source and use water, hydraulic oil, or air, as pressure medium. The test setup shall allow venting of all air and is to be enclosed in a suitable chamber to prevent injury, in case a component shall burst.

4.1.2 Procedure. Apply ten (10) pressure cycles in Recovery Mode at the maximum pressure specified in the EGHR SSTS (between 0 MPa and 3 MPa) with a cycle time of 3 s ± 0.4 s according to Figure 1. Switch to Non-Recovery Mode and apply another ten (10) pressure cycles.

A leakage test according to GMW15261 shall be performed without heat treatment at end of the test.

4.1.3 Acceptance Requirements.

4.1.3.1 No cracks or damage in base material or weld area.

4.1.3.2 The EGHR test sample shall fulfill the exhaust gas leakage requirements of the EGHR SSTS when tested according to GMW15261 and performed without heat treatment at the end of the test.

4.2 Operating Durability in High Temperature Gas Environment. The EGHR shall be functional at high exhaust gas temperatures. Depending on the installed actuator technology the different test procedures listed in 4.2.2, shall be used.

4.2.1 Preparation. Set up the EGHR sample(s) on a test bench which contains the components:

- A controllable hot gas source (fuel burner) capable to deliver a maximum mass flow of 540 kg/h (150 g/s) at +1000 °C.

  Note: The preceding required values can be adjusted based on the requirements given by the program specific EGHR SSTS.

- A controllable coolant loop capable to deliver a minimum coolant flow of 25 L/minute at +100 °C. The coolant shall be a mixture of 60% water and 40% antifreeze according to GMW3420.

For EGHRs with an electrical or vacuum operated actuator the following additional equipment is necessary:

- An air blower capable to deliver fresh air at +23 °C ± 5 °C at the same mass flow like the hot gas source.
- A control device capable of switching the actuator automatically between “Non-Recovery Mode” and “Recovery Mode”.

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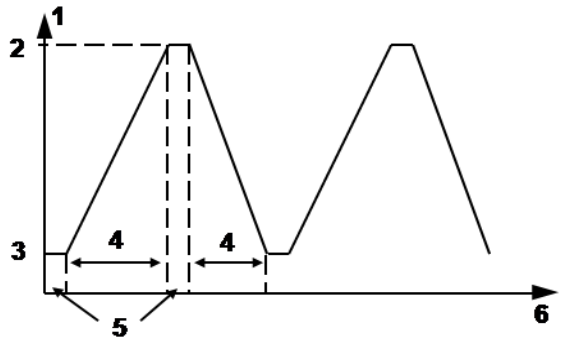

Note:

1. Pressure.
2. Maximum test pressure = 3 MPa ± 0.3 MPa.
3. Minimum test pressure = 0 MPa.
4. Time to increase/decrease pressure = 1 s ± 0.1 s.
5. Time to hold pressure = 0.5 s ± 0.1 s.
6. Test time.

Figure 1: Maximum Exhaust Gas Pressure Test

4.2.2 Procedures.

4.2.2.1 Thermostatic Actuator – Coolant Temperature Variation.

4.2.2.1.1 Perform a leakage test according to GMW15261 without heat treatment before the start of the test. Then set the exhaust gas mass flow to a value 25% below the maximal value for the heat Recovery Mode which is defined by the EGHR SSTS.

Note: This prevents the systems from switching to the Non-Recovery Mode by a passive override function.

4.2.2.1.2 Set the coolant volume flow to 25 L/minute and vary the coolant inlet temperature from a delta of -10 °C to +10 °C (-10 °K to +10 °K) around the temperature where the thermostatic actuator starts to switch from Recovery Mode to Non-Recovery Mode. The thermostatic actuator shall switch from Recovery Mode (fully closed) to Non-Recovery Mode (fully open) and back to Recovery Mode during the coolant temperature variation (= 1 cycle).

4.2.2.1.3 Run the required number of cycles at the exhaust gas temperature specified in the thermostatic actuator durability section of the EGHR SSTS.

4.2.2.1.4 Perform a leakage test according to GMW15261 without heat treatment at end of the test.

4.2.2.2 Electrical or Vacuum Actuator – Gas Temperature Variation.

4.2.2.2.1 The test conditions for non-thermostatic actuators are described in the appropriate actuator durability section of the EGHR SSTS.

4.2.2.2.2 Set the coolant volume flow to 25 L/minute at the coolant inlet temperature of the EGHR as specified by the EGHR SSTS. Set the exhaust gas mass flow and temperature to the values given by the EGHR SSTS. See Figure 2 for details of the test setup.

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