



Dynamic Sealing Stress Measurement for Powertrain Sealing Systems

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 describes the continuous measurement of stress (distribution) between the static gasket, O-ring or seal and joint surfaces using an electronic sensor film (e.g., Tekscan, FlexiForce Division). Stress measurement is a change in the sensor's electrical resistance as a function of load. The sensor's multiple contact points create a grid or stress distribution response. The changing (dynamic) force on a gasket given the tightening method, temperature, and sensor capability is observed (visual display) and measured.

1.2 Applicability.

1.2.1 Differences from GMW3152. GMW3152 (Static Sealing Pressure Measurement for Powertrain Sealing Systems) uses pressure sensitive micro-encapsulated color forming film, measuring only the maximum pressure under specified assembly conditions. This procedure is used where a more detailed level of surface contact pressure analysis is needed.

1.2.2 Test results may be used to verify finite element analysis stress results.

1.2.3 Useful for comparing component elements, e.g., various torque sequences or effect of torque on flange distortion and contact seal force.

1.2.4 Limitations. For joints larger than the sensor, use multiple sensors (butt joint) and combine the pressure maps to provide a total load distribution.

1.2.4.1 Consult the sensor manufacturer on calibration, accuracy, resolution and drift with used sensors. Replace if measurement problems cannot be resolved.

1.2.4.2 Results are rate dependent. Data output is screen displayed in Two Dimensional (2D) or Three Dimensional (3D). Skill in print configuration and code for data printout is required.

1.2.4.3 Measurements during thermal cycling are not practical due to calibration shifts in sensor and impact of joint motion on sensor durability. The sensor film may also become a leak path if used during GMW3155.

1.2.5 Load Measurement Range. Tekscan sensors have a 4.5 N to 445 N range (1 lb_F to 100 lb_F).

1.2.6 Temperature and Humidity Range. Unless otherwise specified, load measurements are at 0% to 100% relative humidity and 23 °C ± 3 °C. High temperature sensors are now available for measurements up to 150 °C. Standard sensor measurement range is -9 °C to 50 °C under isothermal conditions.

Note: Sensors are not temperature compensating. Calibrate at the measured temperature.

1.3 Remarks. This procedure is mandatory on production drawings requiring its use, for any material, design or process change made to all production static powertrain sealing systems. The minimum required sealing pressure is specified by the GM Powertrain release engineer responsible for the tested part or in the appropriate Statement of Requirements, Bill of Design or Bill of Material level.

1.3.1 The values stated in either the International System of Units or English units are to be regarded separately as standard. Combining values from the two systems may result in nonconformance with the test procedure.

2 References

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

2.1 External Standards/Specifications.

ASTM D412

2.2 GM Standards/Specifications.

GMW3152

GMW3155

GMW14165

2.3 Additional References.

Bill of Design

Bill of Material

Statement of Requirements

3 Resources

3.1 Facilities. A suitable area or room for conducting testing with a stable and known environment. See 4.2.1.

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 Basic. This subsection describes the minimum essential equipment.

3.2.1.1 Calibrated torque wrench capable of measuring the specified test joint fastener specifications.

3.2.1.2 Computer capable of running sensor software (e.g., Tekscan).

3.2.1.3 Sensor software and hardware.

3.2.1.4 Real time pressure mapping, sensors and instrument for quantitative measurement of sealing force. Appropriate sensor and sensor maps.

3.2.1.5 A calibration device capable of applying a constant force; see displacement test machine described in ASTM D412.

3.2.1.6 Test stands for holding subassemblies or engines.

3.2.2 Optional. Equipment added capability and convenience.

3.2.2.1 Data Acquisition System. Microsoft Disk Operating System (MS-DOS) compatible personal computer system to gather and store data from the measurement system. The computer shall be of sufficient capability to meet or exceed the needs of the data acquisition system.

3.2.2.2 Thermal test chamber(s) capable of -50 °C to 200 °C with interior sufficient to hold fixture(s). Needed for fixture measurements and sensor calibration.

3.2.2.3 Protective Devices. Provide protection of the equipment electronics and data preservation from static charge, power fluctuations or loss.

3.2.2.4 Bolt load measuring device (ultrasonic, strain gages, etc.), calibrated fasteners for assembling the components.

3.3 Test Vehicle/Test Piece.

3.3.1 Utilize all appropriate components of the sealing system being analyzed. Fabricate parts to achieve the desired tolerance limits. Whenever possible use:

- Production-intent components and assemblies.
- Production-intent fastening specifications and tightening sequence.

3.3.2 Use All New Fasteners. Unless otherwise specified by the requester, fasteners are reused for each run down of the joint.

3.3.3 Sufficient gaskets to complete required number of run downs. Do not re-use gaskets after initial tightening sequence unless specified by the requesting engineer.

3.3.4 Shimming material the same thickness (0.1 mm) as sensor. Used on joints larger than the sensor. Polyester film (DuPont Mylar) or used pressure sensitive color forming film works well. See 4.3.

3.3.5 Record the level of components or parts used in the test. Accepted identification includes level: mule, beta, etc. See GMW3155, 3.5.6.

3.3.6 Additional parts are required to evaluate compression and stress on the gasket/seal defined by the intended limit stack (minimum/maximum tolerance). Stack tolerance will be in the axial or radial direction depending on the design intent of applied load.

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