GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW3152

Static Sealing Pressure 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 static measurement of applied sealing pressure and its distribution between the gasket and joint surfaces using color forming pressure sensitive films (e.g., Prescale from FUJIFILM Electronic Materials U.S.A., Inc., or PressureX from Sensor Products Inc.) From the color intensity, it is possible to visually and quantitatively measure sealing pressure and its distribution across the contact surface. This procedure is recommended for use on all compression gaskets, O-rings, and seals as an initial sealing pressure analysis tool during the development and validation of a part, component or assembly.

1.2 Applicability. This procedure is recommended for use on all compression gaskets, O-rings, and seals.

1.3 Remarks.

1.3.1 Supplier Note. 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 GMPT release engineer who is responsible for the tested part.

1.3.2 Color developing pressure sensitive film(s) contain microcapsules of color-forming material, adjusted to break at different pressure levels. The change in color density depends on the amount of pressure applied. Various film grades (measurement ranges) are available (see Table 2). Absolute pressure is determined from color density using a reflective (optical) densitometer designed for the films. Scanning (pixel imaging) the color density film and image analysis with math-based software is also available (see 3.2.5.2 and Figure 2 and Figure 3).

1.3.3 Additional Remarks.

1.3.3.1 This test is used with GMW3149 or GMW3155, as an evaluation of seal integrity. GMW3152 determines if there is sufficient and contiguous contact pressure between the seal and joint members using the appropriate film grade at the start of test.

1.3.3.1.1 Water, oil and dust present on the surface of pressure sensitive films will hinder proper color intensity development severely limiting End of Test (EOT) measurement.

1.3.3.2 Results from this test may give insight for placement of dynamic pressure mapping sensors (e.g., from Tekscan Inc.) used in GMW3137.

1.3.3.3 Results from this test experience provide insight into the minimum joint assembly pressure needed for the medium being sealed and the gasket type used. See Table 1.

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Table 1: Typical Film Ranges for Gaskets and Seals

Type of Seal	Media Pressure, kPa	Recommended Film Range
Elastomer	Oil/Air, 0 to 35	Ultra-Super Low and Super Low
Elastomer	Oil/Coolant, 0 to 550	Ultra-Super Low and Super Low
Die-Cut Soft Gaskets	Oil/Coolant, 0 to 550	Low
Graphite - Metal	Hot gas, 0 to 35	Super Low
Graphite - Metal	Combustion gas, > 3500	Medium and High
No Seal	Hot gas, 0 to 35	Medium
Metal	Hot gas, 0 to 35	Low
Multi-layered Steel (MLS) Gasket, Cylinder Head Gasket (CHG)	Combustion gas, > 3500	Medium and High
MLS Gasket, Exhaust Manifold Gasket (EMG)	Combustion gas, > 3500	Medium and High

1.3.3.4 Limitations. For joints larger than the film width, use multiple segments butt-joined to provide a total color distribution map.

1.3.3.4.1 Do not use this procedure to determine changes in sealing pressure related to surface finish variations. Color forming pressure sensitive films will bleed a short distance which may give an unrealistic impression of a joint with a rough surface finish.

1.3.3.4.2 Color forming pressure sensitive film impression corresponds to the maximum pressure obtained during assembly, not necessarily pressure at final torque. Phenomena such as flange bending may cause unloading prior to achieving final torque, which would not show up on the color impression. Therefore, use GMW3137.

1.3.3.4.3 Oil and other staining contamination of the film adversely affect color intensity measurement**.**

Note: Do not take or use readings in the oil contaminated areas. Clean per 3.3.6.

1.3.3.5 Load Measurement Range. Currently there are seven (7) grades and measurement ranges of film(s) as shown in Table 2. Consult supplier literature for specific grade ranges.

Table 2: Paper Grade and Measurement Range

Grade	Type	Pressure Range (MPa)	Pressure Range (pounds per square inch (psi))
Extreme low	Two sheet	0.014 to 0.14	6 to 20
Ultra-low	Two sheet	0.2 to 0.6	28 to 85
Super low	Two sheet	0.5 to 2.45	71 to 356
Low	Two sheet	2.45 to 9.8	356 to 1422
Medium	Mono sheet	9.8 to 49	1422 to 7112
High	Mono sheet	49 to 127	7112 to 18 490
Super High	Mono sheet	127 to 294	18 490 to 42 670

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1.3.3.6 Temperature and Humidity Range. Unless otherwise specified, load measurements are between 20% to 90% relative humidity (RH) and 23 °C ± 3 °C. Film measurement range is 25 °C to 35 °C. Excursion temperature measurement up to 70 °C is possible, with the lowest temperature for possible use is around -20 °C.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3137	GMW3149	GMW3155	GMW14165

2.3 Additional References.

- FUJIFILM Electronic Materials U.S.A., Inc., Industrial Products Division, 80 Circuit Drive, North Kingstown, RI, 02852.
- Microsoft Corporation, One Microsoft Way, Redmond, WA.
- Raymond Engineering, Inc., 217 Smith St., Middletown, CT, 06457-1739.
- Sensor Products Inc., 300 Madison Avenue, Madison, NJ, 07940 (email : www.sensorprod.com).
- StressTel, Deterco, Inc., 6633 Polk Street, Houston, TX, 77011-4509 (www.deterco.com/products/stresstel).
- Tekscan Inc., 307 West First Street, South Boston, MA, 02127-1309.

3 Resources

3.1 Facilities.

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 Calibrated torque wrench suited for specified measurement range.

3.2.2 Pressure sensitive film in required pressure range (e.g., Prescale from FUJIFILM Electronic Materials U.S.A., Inc., or PressureX from Sensor Products Inc.) See Table 2.

3.2.3 Computerized densitometer to measure color density of the pressure imprint on the film (this ensures that the limitations of the film are not exceeded).

Note: The film is still the limiting factor in color intensity accuracy. The ability to read the film has its own variation. Film manufacturers claim a ± 2% pressure accuracy using a densitometer.

3.2.4 Test stands for holding subassemblies or engines.

3.2.5 Optional Equipment.

3.2.5.1 Optical Scanner. Imaging area, 230 mm x 356 mm or larger. Resolution 100 dots per inch (DPI) or higher. Scanner allows the software to digitize the color image.

3.2.5.2 Software Package. Algorithm software from Microsoft Corporation that takes the digitized color image (100 DPI) from an imaging area and magnifies it for more detailed pressure analysis. Topaq from Sensor Products, Inc. and Prescale from FUJIFILM Electronic Materials U.S.A., Inc. are commercial software packages.

Note: The film is still the limiting factor in color intensity accuracy. The ability to read the film has its own variation.

3.3 Test Vehicle/Test Piece.

3.3.1 Utilize all appropriate components that are part of the sealing system being analyzed. Fabricated parts may be used to achieve the desired tolerance limits. Whenever possible use:

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

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