GM	WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW17363

Driveline Cold Follow Ability Test of Rotating Shaft Seals

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 purpose of this standard is to check sealing during simulated cold weather driving. This condition includes maximum and minimum shaft-to-seal interference, Shaft to Bore Misalignment (STBM), and Dynamic Run Out (DRO). Bore is inspected for cracks from thermal contraction from cold.

1.2 Applicability. This standard applies to shaft seals included in driveline components or assemblies. This is not intended to apply to seals for powertrain, engines, or transmissions applications. This is not for seals without a spring on the main seal lip (i.e., Poly Tetra Fluoro Ethylene (PTFE) and wiper seals).

1.3 Remarks.

1.3.1 Expectation is that each seal completes at least 12 h of testing, without leakage. If seal cannot pass 12 h of testing without leakage, investigate and report the reason for the variation.

1.3.2 Refer to 5.2 for additional expectations.

1.3.3 Test lab shall provide the Design Release Engineer (DRE) with test results written in Data Sheet CG4361.

Note: Deviations from the specifications in this standard are permissible when authorized by the DRE.

Note: Test at maximum and minimum of STBM and DRO, calculated from design tolerance stack-ups that include bending deflection and shaft-to-bore coaxiality. Request this information from the assembly designer or Tier 1 Supplier.

Note: Test at speeds (S) and temperatures (T) specified in the Vehicle Technical Specification (VTS). Request these from the DRE. Run tests using Table 2, Default Test Values, when approved by the DRE.

2 References

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

2.1 External Standards/Specifications.

ISO 6194-1 RMA OS-1-1

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- CG4361
- Freudenberg Sealing Technologies, Weinheim, Germany, www.fst.de
- German Institute of Standardization (DIN), Berlin, Germany, www.din.de
- Rubber Manufacturers Association (RMA), Washington, DC, www.rma.org
- Statement of Requirements (SOR)
- Vehicle Technical Specifications (VTS)

3 Resources

3.1 Facilities.

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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.

3.1.3 Testing area shall be orderly and clean. Food, drink, spills and trash shall not be visible. Test altering contamination, both metallic and non-metallic, shall be kept separate from testing samples and equipment.

3.2 Equipment.

3.2.1 A seal test machine is required per Rubber Manufacturers Association (RMA) or German Institute of Standardization (DIN) equipped with programmable speed and temperature control.

3.2.2 A radial lip force measurement machine is required, per DIN (e.g., Freudenberg Sealing Technologies).

3.2.3 A sight glass tube with measurement scale is required to set the shaft oil level and monitor changes.

3.2.4 Measurement gauges or devices shall have a label showing the most recent date of calibration check.

3.3 Test Vehicle/Test Piece.

3.3.1 Test a minimum of four (4) seals (reference 4.1.1, Seal Preparation).

3.3.2 After operation and radial load measurement, the lip loading must exceed a measurement result of 0.1 N/mm of circumference upon a shaft with Least Material Condition (LMC) dimensions.

3.3.3 Refer to 5.2 for additional expectations.

3.4 Test Time.

Calendar time:	8 days
Test time:	144 hours
Coordination time:	32 hours

Note:

Project Schedule Long: 8 days (measurement time + one (1) test station running until suspend time).

Project Schedule Short: 6 days (measurement time + four (4) test stations running until expected time).

Measurement Time: 2 days (four (4) seals + all shafts + all bores + all installations, i.e., STBM and DRO).

3.4.1 Stop test machine after D2 (see Table 2) of operation, or if leakage is detected. Leakage is oil that contacts the bore.

3.4.2 Target D1 (see Table 2) of operation without leakage. Results that deviate from target require DRE approval. Plan to test four (4) seals. Four (4) tests may require 8 days or more depending on number of testers used. Factor in one (1) 24 h break-in conditioning per seal.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills.

3.6.1 Test operator shall have reading skills suitable for understanding this specification. Operator shall be able to perform simple calculations on an electronic calculator and identify measurements exceeding the tolerance. Operator shall be able to make accurate measurements with calipers, scales and gages.

3.6.2 Test Technician should be proficient in operation of the facilities listed in 3.1, as well as in proper selection and operation of the equipment listed in 3.2, and familiar with the general operation of seals.

4 Procedure

4.1 Preparation.

4.1.1 Seal Preparation.

4.1.1.1 Mark seals Number 1 through Number 4.

4.1.1.2 Measure diameters and widths before inserting seal into seal test machine.

4.1.1.3 See Table 1 for measurements to report. Record results in Data Sheet CG4361.

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Table 1: Measurements to Report

Measurement	Before Test	After Test	Comments
Seal Outer Diameter (OD)	Measure	Do Not Measure	
Shaft OD	Measure	Do Not Measure	
Bore Inner Diameter (ID)	Measure	Do Not Measure	
Bore Roughness Arithmetic Average (Ra)	Measure	Do Not Measure	
Seal Lip ID (with spring)	Measure	Do Not Measure	
Sealing Surface Roughness (Ra, Roughness Peak to Valley Average (Rz) and Roughness Average Maximum Peak Height (Rpm))	Measure	Do Not Measure	
STBM, DRO	Measure	Do Not Measure	
Radial Lip Force (with spring)	Measure	Do Not Measure	
Radial Lip Force (without spring)	Measure	Do Not Measure	

Table 2: Default Test Values

Test Condition	High Speed [Note] (Pinion Seal)	Low Speed [Note] (Wheel Seal)
S1 = Starting Speed	99 rpm	36 rpm
S2 = 8 km/h (5 mph) Speed	400 rpm	144 rpm
S3 = 88 km/h (55 mph) Speed	1991 rpm	716 rpm
S4 = 113 km/h (70 mph) Speed	2391 rpm	860 rpm
S5 = 145 km/h (90 mph) Speed	3584 rpm	1190 rpm
S6 = Break-in Speed	4000 rpm	1200 rpm
D1 = Typical Duration Before Leakage	12 h	12 h
D2 = Duration Before Suspending Test	12 h	12 h
T1 = Cold Starting Temperature (Oil)	-40 °C	-40 °C
T2 = Cold Operating Temperature (Oil)	-30 °C	-30 °C
T3 = Idle Temperature (Oil)	38 °C	38 °C
T4 = Maximum Continuous Temperature (Oil)	135 °C	135 °C
T5 = Maximum Excursion Temperature (Oil)	163 °C	163 °C
Maximum Shaft to Bore Misalignment (STBM)	0.15 mm	0.25 mm
Maximum Dynamic Run Out (DRO)	0.1 mm	0.25 mm
Shaft Material (Steel)	SAE 1050	SAE 1050
Bore Material (Aluminum)	Aluminum Association (AA) A356.2 – T6	AA A356.2 – T6

Note: 3000 rpm threshold between High Speed and Low Speed.

4.1.2 Bore Preparation.

4.1.2.1 Make one (1) test bore from same material and properties as mass production bores. If unavailable use the default bore material specified in Table 2. Make additional bores if necessary to achieve STBM requirements.

4.1.2.2 Make one (1) test bore at Maximum Material Content (MMC) with minimum ID ± 0.1 mm (tightest fit).

4.1.2.3 Lead in chamfer = 20 degrees ± 5 degrees.

4.1.2.4 Axial Chamfer Depth = 1.2 mm ± 0.1 mm.

4.1.2.5 Ra = 1.2 µm ± 0.4 µm.

4.1.2.6 Measure roughness using a 0.8 mm cutoff and 5 µm radius with 90 degree angle diamond-tip stylus.

4.1.2.7 Filter signal through a digital (M-1) Gaussian phase-corrected filter. Traversed length = 4.8 mm ± 0.1mm.

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