GM WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW17376

Elastomer O-rings for Engine Oil

1 Scope

1.1 Material Description. This standard covers static sealing O-rings used in gas, hybrid, and diesel engine oils. It outlines the recommended types of materials and applications (Table 1). The second section provides longer term qualifications for approving each source/material type (Table 2) and the final section (Table 3) provides a standard content template for all prints/drawing using part properties where size permits. The print property template allows GM Powertrain to reinforce and standardize the desired material properties related to functional needs and actual part data for quality control.

This standard does not supercede GMW standards already containing O-ring requirements. See remarks in 1.4 through 1.4.2.

1.2 Symbols. O-rings may be marked to designate the type of material and/or source from which the part was fabricated for the purpose of traceability and sorting. Surface etching by Light Amplification by Stimulated Emission of Radiation (LASER) and imbedded chips are used for assembly verification. Colored compounds also improve sorting.

1.3 Applicability.

1.3.1 Use the initial compound requirements defined in Table 2 to qualify all candidate compounds. Basic SAE J200M/ASTM D2000M classifications using slab or sheet form are only applied to O-rings too small or large (see 1.4) with properties to failure that cannot be measured before reaching the maximum travel limits of the tensile test machine.

1.3.2 Use the Table 3 template for O-ring prints with data from the production intent part described on that drawing. If the as received production part size does not permit testing, use the Table 2 properties and data will be the default.

1.3.3 Establish production part state of cure using compression set (see 3.5.8).

1.3.4 This standard supports engine material bill of requirements for oil (Table 1) using material types recommended for that media.

1.4 Remarks. The compound properties for each type of elastomer are listed in Table 2 and Table 3. Table 2 (values) and Table 1 (class and type) are a compilation of data from multiple approved compounds and hardness ranges (50 Shore A to 80 Shore A) using the SAE AS568D-214 size O-ring (Inside Diameter (ID) 25 mm × 3.5 mm cross section). Table 3 properties are generated to represent one production part compound from print dimensions. Table 3 results are placed on the part print using data from the production part.

1.4.1 Functional Noun Name. GM prints use O-ring to describe any circular shaped, press-in-place gasket even though the cross section is not circular. The part print functional name may not include O-ring in the drawing title block even if it is a toroid shape. Regardless of the GM Functional Name Assignment (FNA) convention, this standard is used exclusively for elastomer O-rings with a toroid (circular) cross section.

1.4.2 Fluorocarbon Behavior in Fuel Diluted Oil. For methanol and ethanol diluted oil conditions, the percent fluorine level (higher is desired) is most important. In biodiesel diluted conditions with oil, the cure type (peroxide) and no metal oxides, take precedence over percent fluorine. The metal oxides have no significant impact on fluorocarbon (FKM) Type II, III, IV or V peroxide cure systems. There is no impact on color choice for carbon black filled and mineral filled systems. There are variations in naming conventions for metal oxides. For example, ceramic type mineral systems are metal oxides and are being used successfully in mobility systems where zinc, calcium or magnesium oxides would not be successful in that application.

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Table 1: Material and Application Criteria Designation

Class	Type	Temperature Range Degrees Celsius Note 1	Application	Elastomer Note 2
A	1	-25 to 165	Resistant to flex fuel dilution, 5% to 10% by volume	ACM
B	1	-22 to 150	Resistant to flex fuel dilution, 5% to 10% by volume	HNBR
C	1	-15 to 175	Resistant to flex fuel dilution, 5% to 10% by volume High temperature resistance	FKM/FPM
C	2	-29 to 165	Improved low temperature, high cost Flex fuel and oil resistant	FKM/FPM
D	1	-25 to 165	Gas engine Fuel dilution 5% to 10% by volume	AEM

Note 1: The temperature range represents the elastomer type and not fluid media capability as defined by ASTM D1329 TR10 and SAE J2236 respectively.
Note 2: Nomenclature as defined by ASTM D1418 or ISO 1629. ACM = polyacrylate; AEM = ethylene acrylic; FKM/FPM = fluorocarbon; and HNBR = Hydrogenated Nitrile Rubber.

2 References

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

2.1 External Standards/Specifications.

ASTM D297	ASTM D1505	ISO 815	SAE AS568D
ASTM D395	ASTM D2000M	ISO 1629	SAE J200M
ASTM D624	ASTM D2240	ISO 2781	SAE J2236
ASTM D1329	ASTM D3418	ISO 2921	
ASTM D1414	ISO 34-1	ISO 3601-1	
ASTM D1415	ISO 48	ISO 7619-1	
ASTM D1418	ISO 188	ISO 11357	

2.2 GM Standards/Specifications.

GMW3059	GMW15117	GMW16955	GMW17205
GMW3155	GMW16678	GMW17113	

2.3 Additional References.

IHS, Incorporated, Englewood, Colorado (www.ihs.com)

3 Requirements

3.1 Materials. The O-ring compound shall meet the table and document requirements. The tested part represents the production release intent, including integrally colored rubber (other than black) and surface coatings.

3.2 Selection of Materials.

3.2.1 Preliminary Drawings. For prints where no production source is chosen, select according to Table 1, the Class and Type meeting the temperature and fluid resistance requirements for end use.

Place the selection (*italics*) on the print identifying the *material type*, GMW17376, *class and type to Table 2* as in the following example; Material: ACM meeting GMW17376, Class A, Type 1 to Table 2 requirements. Once this step is completed, move to 3.2.2 or 3.2.3.

3.2.2 Identify Current Approvals for Prototype Parts. Using GMW17376, search for approved compounds and sources in MATSPC through GM Supply Power. A MATSPC listing means the compound and source has successfully completed all Table 2 requirements and is ready to be used on GM production intent prints.

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3.2.3. Qualifying a Compound. If your prototype compound is not listed in MATSPC, the compound supplier must submit Table 2 test data to all relevant Class and Type applications to the engine materials engineer. This step must be completed before GMW3155 testing and Production Part Approval Process (PPAP). Do not release a production print specification to Table 3 requirements until the qualifying compound is listed in MATSPC under Table 2 requirements.

3.2.4 Production Print Specifications. Once a compound is approved to the desired Class and Type end use, print specifications use Table 3 test template with limits set by the production part results. See 3.8. At the time of production print release, remove any Table 2 references. The only exception is where the released O-ring size cannot be tested. In those situations see 1.3.2, 3.3, and 3.5. Otherwise, all production released drawings must list the Table 3 limits from production intent part testing.

3.3 Shape and Dimensions. Unless otherwise specified, the shape and size of test pieces shall be in accordance with the relevant test procedure. To qualify a compound to Table 2, use ISO 3601-1 or SAE AS568D-214 size O-rings (25 mm ± 0.25 mm × 3.5 mm ± 0.1 mm) prepared under the same conditions as in volume production parts. Use Table 3 properties to develop print specifications based on the released O-ring print ID and cross section or cord width.

3.4 Appearance. The tested O-ring surface is smooth and flaw free per ISO 3601-1, Grade S.

3.5 O-ring Property Tests (Table 2 and Table 3). The following are measured on the O-ring to ASTM D1414 with noted exceptions:

3.5.1 Size Effects on Testing. This standard covers O-ring ID sizes from 8 mm to 100 mm. Select the test conditions for size and speed designated in 3.5.1.1 and 3.5.1.2.

3.5.1.1 Test Spool Diameters. The **bold** bulleted item is for Table 2.

- O-rings with less than 12.7 mm ID shall be pulled on 3.18 mm diameter spools
- O-rings from 12.73 mm ID to 25.40 mm ID shall be pulled on 6.35 mm diameter spools
- O-rings greater than 25.40 mm ID shall be pulled on 12.7 mm diameter spools
- All spools are 7 mm wide

3.5.1.2 Test Pull Rate. The **bold** bulleted item is for Table 2.

- O-rings with less than 12.7 mm ID shall be pulled at a rate of 152.4 mm/minute
- O-rings from 12.73 mm ID to 38.1 mm ID shall be pulled at a rate of 254.0 mm/minute
- O-rings greater 38.1 mm ID shall be pulled at a rate of 508.0 mm/minute

3.5.2 Hardness (Surface). Test pieces taken from elastomeric rings shall have a diameter of at least 1.5 mm. The measurement is made top dead center with the O-ring supported on both sides for stability.

3.5.2.1 Micro-hardness (Cross Section). When part surface measurement is not practical or desired, the cross section of the part is measured when supported in captive resin. Part micro-hardness measurements are made per ASTM D1415, Type M or ISO 48, Method M. Measurements shall follow the Appendix A, Section A1 conditions.

3.5.2.2 Print Designations for Micro-hardness Method. The part print shall indicate which hardness method by using the word surface in parenthesis or cross section in parenthesis after the numerical range. Slab measurements require no designation after the numerical range. The range around the nominal is always ± 4 International Rubber Hardness Degrees (IRHD).

3.5.3 Tensile Strength, Tensile Stress and Elongation. Follow 3.5.1, 3.5.1.1 and 3.5.1.2 based on the required part size.

3.5.4 Tear, Long Term Heat Resistance, Compression Stress Relaxation and Low Temperature Properties. Measured on non-O-ring specimens listed in the test method for Table 2.

3.5.5 Fluid Immersion and Measured Properties. Immersion equipment accommodations are expected to accommodate whole O-rings up to 100 mm ID without contacting the container walls for all table properties. Proper spacing is necessary to prevent O-rings from contacting one another.

3.5.6 Low Temperature (Drawing Only – Table 3). Report glass transition temperature, Tg per ASTM D3418 or ISO 11357 Part 2, on a segment of the O-ring.

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3.5.7 Relative Density (Drawing Only – Table 3). Report the nominal value with a ± 0.02 variation. Tighter tolerances are permitted with compound supplier agreement.

3.5.8 Compression Set Test. Compression set is used to evaluate state of cure. This will be done for every approved compound following the steps in 3.5.8.1. The individual compound record is reported as outlined in Table 3 for the part print.

3.5.8.1 State of Cure (Drawing Only – Table 3). The maximum compression set for a compound is determined by measuring its set using specimens cured to the torque of 90 (dN·m) on a rheometer cure curve. Test O-rings will be molded at various times and temperatures, including post cure to establish the required maximum cure time index. The qualifying compound shall be tested at Tc50, Tc70, Tc90 and Tc95 conditions with compression set reported at each level. The cured specimens will be tested for 70 h at 150 °C. Full cure is defined as the compression set value at T90. Table 3 compression set will represent multiple compounds, but records will be kept on each compound and may be placed on the drawing using that compound. Any result above that maximum will be considered under cured.

3.6 Part Storage. The maximum storage time is 7 years.

3.7 Table 2 Data Requirements. Approved compound specification values (with noted exceptions, see 3.7.1) are statistically based on a six sigma limit spread in (normal distribution) data from minimum of six (6) production lots (five (5) data points/lot). Tentative approval, signified by the letter **T**, will be given based on data from one production and three (3) lab lots. Tier 1 sources shall be responsible for continuing to submit data until the total number of samples is met for full qualifications as stated in the first (1st) line of this paragraph. Appropriate industry statistical standards, methods or practices should be used when generating data.

3.7.1 Test Frequency for Table 2. Chemical requirements of Table 2 long term aging tests (1008 h) and part performance requirements, shall be performed once for initial approval. Unless otherwise specified in the test procedure, all of the once for initial approval tests and compression set tests, shall be run on three specimens from one production batch with each meeting the requirements. The noted exceptions, part micro-hardness and adhesion (carrier gaskets) shall be run on five (5) random samples at two (2) widely diverging points on the part from each of three (3) production lots.

Table 2: Compound Qualification Properties

Property	Test Method	Unit	Value
Hardness			
All Classes, all Types	ASTM D1415 or ISO 48 Method M	IRHD	To be reported
All Classes, all Types	ISO 48 Method M (measured on cross section)	IRHD	To be reported
Hardness			
All Classes, all Types	ASTM D2240 or ISO 7619-1	Shore A	To be reported
Density			
All Classes, all Types	ASTM D297, ASTM D1505 or ISO 2781	Grams/cubic centimeter	To be reported

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Elongation at Break			
Class A	ASTM D1414 or ISO 3601-1	Percent	165 minimum
Class B	ASTM D1414 or ISO 3601-1	Percent	170 minimum
Type C, all types	ASTM D1414 or ISO 3601-1	Percent	175 minimum
Type D	ASTM D1414 or ISO 3601-1	Percent	170 minimum
Tensile Stress at 50% Elongation			
Class A	ASTM D1414 or ISO 3601-1	Megapascals	2 minimum
Class B	ASTM D1414 or ISO 3601-1	Megapascals	2 minimum
Class C, all types	ASTM D1414 or ISO 3601-1	Megapascals	2.5 minimum
Type D	ASTM D1414 or ISO 3601-1	Megapascals	2 minimum
Tensile Strength			
Class A and D	ASTM D1414 or ISO 3601-1	Megapascals	6.5 minimum
Class B	ASTM D1414 or ISO 3601-1	Megapascals	10 minimum
Class C, all types	ASTM D1414 or ISO 3601-1	Megapascals	7 minimum
Tear Strength			
Class A and D	ASTM D624, Die C, specimens are un-nicked ISO 34-1 Method A (trouser test piece)	Kilonewtons/meter Newtons/millimeter	15 minimum 3 minimum
Class B	ASTM D624, Die C, specimens are un-nicked or ISO 34-1, Method A	Kilonewtons/meter Newtons/millimeter	18 minimum 3 minimum
Class C, all types	ASTM D624, Die C, specimens are un-nicked or ISO 34-1, Method A	Kilonewtons/meter Newtons/millimeter	18 minimum 3 minimum
Long term Age Resistance			
Class B	SAE J2236, 1008 h at +150 °C Change in Elongation at break Change in Tensile strength	 Percent Percent	 -50 maximum -50 maximum
Class A and D Class C, Type 2	SAE J2236, 1008 h at +165 °C Change in Elongation at break Change in Tensile strength	 Percent Percent	 -50 maximum -50 maximum
Class C, Type 1	SAE J2236, 1008 h at +175 °C Change in Elongation at break Change in Tensile strength	 Percent Percent	 -50 maximum -50 maximum
Compressive Stress Relaxation Note 1			
Class A and D	GMW17113, AC/AM1AZD0, 1512 h at +150 °C	Percent Retained Sealing Force	20 minimum
Class B	GMW17113, AC/AM1AZD0, 1512 h at +150 °C	Percent Retained Sealing Force	10 minimum
Class C, all types	GMW17113, AC/AM1AZD0, 1512 h at +150 °C	Percent Retained Sealing Force	30 minimum
Low Temperature Retraction, TR_{10}			
Class A and D	ASTM D1329 or ISO 2921	Degrees Celsius or colder	-25
Class B	ASTM D1329 or ISO 2921	Degrees Celsius or colder	-22
Class C, Type 1	ASTM D1329 or ISO 2921	Degrees Celsius or colder	-15
Class C, Type 2	ASTM D1329 or ISO 2921	Degrees Celsius or colder	-29

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