



Hydrogenated Nitrile Rubber for Engine Coolant Sealing

1 Scope

This specification covers hydrogenated nitrile rubber (HNBR) used in static sealing against extended life coolant for gas and diesel engines.

Note: The words **must**, **shall** or **will** as used in this document mean a mandatory requirement.

1.1 Material Description. Commercial compounds are divided into the following types:

1.1.1 Type A. All 25% to 36% acrylonitrile (ACN) HNBR gasket or o-ring compound(s) in contact with engine coolant for application temperatures with a functional temperature range of -29 °C to 125 °C (continuous) as defined by ASTM D1329 TR10 and SAE J2236 respectively.

1.1.2 Type B. All 36% to 44% acrylonitrile (ACN) HNBR gasket or o-ring compound(s) with a functional temperature range of -18 °C to 135 °C (continuous) as defined by ASTM D1329 TR10 and SAE J2236 respectively.

1.2 Symbols. Identify the elastomer nomenclature using ASTM D1418 or ISO 1629.

1.3 Applicability. This standard covers the use of hydrogenated nitrile elastomer whose function is to seal cooling system components (e.g., water pump, oil cooler or front engine cover, etc.) Type A is used for general use. Type B covers higher coolant operating temperatures (e.g., turbo).

1.3.1 Other Coolant Standards. Use GMW14747 for coolant joints not exposed to hydraulic fluids during initial assembly or service. Use GMW14751 for joints sealing oil and coolant simultaneously. Use GMW17470 as a lower cost alternative to GMW14751 for coolant joints with incidental exposure to hydraulic fluids during assembly or service.

1.4 Remarks.

1.4.1 The acrylonitrile (ACN) content of HNBR influences the low temperature of the compound. High ACN (35% to 43%) sacrifices low temperature flexibility. Low temperature HNBR typically has an ACN of 18% to 23%.

1.4.2 O-rings. Some prints/drawings identify "D" or racetrack shapes as o-rings. To avoid confusion, testing and table data only apply to the ASTM D1414 definition of an o-ring.

1.4.2.1 Tensile and elongation properties of o-rings are measured by spool separation, however, during this step, the elongation across the specimen width is not uniform. To minimize data variation, the recommended ratio of ring inside diameter (ID) to cross section width should be 9 to 1 or greater. Of greater interest is tensile stress at 20% to 50% elongation because it is closer to the performance range of the o-ring.

Note: The ratio for SAE AS568-214 size is 7 to 1.

1.4.2.2 Compression Set. Testing a whole o-ring for compression set is not permitted. Air trapped in the o-ring inside diameter results in a different thermal condition between the inside and outside surface of the specimen.

1.4.3 Elastomers used in part of assembly (POA) are usually selected by supplier specific criteria and often remain unspecified or unidentified on end user prints and drawings. As the original equipment manufacturer (OEM) end user, GM reserves the right (through directed buy) to define common rather than source specific requirements. Use this document in the appropriate Statement of Requirements, Appendix C and corporate prints and drawings using Section 8 Coding.

2 References

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

2.1 External Standards/Specifications.

ASTM D297	ASTM D1415	ISO 48	JIS K6251
ASTM D395	ASTM D1418	ISO 815-1	JIS K6252
ASTM D412	ASTM D1505	ISO 1629	JIS K6253

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ASTM D471	ASTM D3182	ISO 1817	JIS K6258
ASTM D624	ASTM D4968	ISO 2781	JIS K6261
ASTM D1329	ISO 34-1	ISO 17025	SAE AS568-214
ASTM D1414	ISO 37	ISO/TS 16949	SAE J2236

2.2 GM Standards/Specifications.

GMW3059	GMW14747	GMW16955	GMW17205
GMW3155	GMW14751	GMW17113	

2.3 Additional References.

- Association for Rubber Products Manufacturers (ARPM), Indianapolis, Indiana (www.arpminc.com) O-Ring Inspection Guide, Surface Imperfections Control (OR-1) and the Handbook for Molded, Extruded, Lathe Cut & Cellular Products.
- Automotive Industry Action Group (AIAG) D22, Best Practice Unified Procedure for Approval of Rubber and Plastic Formulation Ingredient Changes, 26200 Lahser Road, Suite 200, Southfield, MI 48033-7100.
- Axel Products, Incorporated, 2255 S. Industrial Hwy., Ann Arbor, Michigan 48104 (www.axelproducts.com).
- Component Statement of Requirements (SOR).
- Component Technical Specification (CTS).
- Corporate prints and drawings.
- Statement of Requirements, Appendix C.

3 Requirements

3.1 Compound Characterization for Finite Element Modeling. All elastomeric compounds qualifying to this standard must also be entered into the hyperelastic GM Material Property Database for finite element modeling unless otherwise specified by the Component Statement of Requirements (SOR) or Component Technical Specification (CTS). Axel Products, Incorporated is GM's sole global contract test facility as the equipment and test methods used are unique and confidential. A finite element development form is submitted with each elastomeric compound. The form is available from Axel Products, Incorporated or GM Engine Materials Engineering. Follow the form instructions. Table 1 shows where in the part and compound development process the data is characterized for hyperelastic modeling.

Table 1: Candidate Compound Requirements for Finite Element Analysis (FEA) Modeling Data

Part or Component Design Level	Compound Readiness at Submission Time	Intent	Requirements at Time of Characterization ^{Note 1}
Design Development, Production or Production Intent	Available from production batch process only	Represent properties from all mixing location(s)	One or more of the following: • Production drawing content met. • Production Part Approval Process (PPAP) started or successfully completed. • Design development before tooling and parts tested. • Satisfies all relevant GM documents. • Compound selected for production intent process and design.

Note 1: All validation testing including GMW3155 may not be completed at the time of compound characterization. Maintaining entries in the database will be reevaluated if the compound was the reason for a non-compliance to test requirements.

3.1.1 Test Samples. Unless otherwise specified, the shape and size of test pieces shall be in accordance with the relevant test procedure and comply with paragraph 3.1.5.1 Test Standards Equivalency.

If not otherwise stated, mechanical properties in delivery state and after heat or fluid immersion are to be tested at +23 °C and with the same test methods.

3.1.1.1 Print Designations for Micro-hardness Method. The part print shall indicate which hardness method using the word surface or cross section in parentheses after the numerical range. Slab measurements require no designation after the numerical range.

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3.1.2 Conditioning. Conditioning shall be as specified in the relevant Test Procedure.

3.1.2.1 Elastomer Test Specimens Preparation. Specimens used to develop all table properties are die cut specimens from ASTM D3182 sheet stock molded to the same conditions as for actual products, with post cure if applicable. Precondition slabs at 50% relative humidity (RH) and 23 °C for at least 16 h before testing. As an option, specimens from non-post cure compounds may be used from production molds. Report cure time and temperature conditions for all molded specimens.

3.1.3 Equipment. Conforming to the relevant Test Procedure.

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

3.1.5 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this document shall be determined correctly with respect to their physical definition.

3.1.5.1 Test Standards Equivalency. For reasons of cost and convenience, this document lists equivalent industry standards. Equivalency, as it applies to this document, is stated in ASTM D4968, Appendix A2. Documents may have some minor form differences, but otherwise will give "identical" results to those actions performed as a result of following the ISO standard and "vice versa." Only use the equivalent standards listed in Table 2. This also means the approved compounds are equivalent.

3.1.6 Facilities. Conform to the relevant Test Procedures.

3.1.6.1 GM North America Powertrain Only. All data must be generated by an ISO 17025, ISO/TS 16949 or GM accredited laboratory.

3.1.7 Deviations. Only improvements (e.g., increase in test time, harsher test media, etc.) or corrections (e.g., publication error, missing information, etc.) from the requirements of this standard are permitted, provided they have been agreed upon between tester and requester. Use of test procedure/condition deviations are considered temporary (up to six (6) months) until a consensus is reached and revisions made to this document by the sponsor. No specification limit deviation or test exemption(s) to accommodate material compliance to this standard is permitted on the production print or any relevant documentation by source or end user. All issues must be worked out through revision of this standard.

3.1.7.1 Exceptions to these requirements are not permitted on GM purchased part drawings. An example of an illegal deviation is:

Material: GMW14751 except age resistance to SAE J2236 change in elongation is -60% maximum.

In this example, SAE J2236 is a definition and cannot be modified.

3.2 Material and Performance Requirements.

3.2.1 Minimum Lot Testing. Material and performance properties are summarized in Table 2. For full approval of a sealing, compliance to the requirements of Table 2 is needed. A minimum of three production lots of compound shall be tested to each of the requirements for Design or Product Validation Testing.

3.2.2 Audit/Inspection Testing. If not defined otherwise, the following testing should be done for production audit testing beyond the approved supplier process plan. Three samples of material shall be tested to each of the requirements for Audit/Inspection Testing.

All tests per Table 2, except those at or more than 336 h and Joint Sealing Function.

3.2.3 Product Validation Testing/Audit/Inspection Testing. If not defined otherwise, the following testing should be done for production audit testing: Material properties to Table 3.

3.2.4 Table 2 properties for Type B o-rings represent cross section diameters of 1 mm to 3.5 mm. See 3.1.1.

3.2.4.1 O-ring Test Conditions. Only compounds used for o-rings require testing to o-ring conditions. Table 2 properties for Type B o-rings are from the SAE AS568-214 dimensions.

- Test Spool Diameter: 12.7 mm.
- Test Pull Rate: 254.0 mm per minute.

3.2.5 Rubber Adhesion to Carrier (Edge Molded Design). Rubber must be secure to the carrier over the entire contact length. On a fully cured part, attempts to remove the rubber using pliers or other gripping tools in a 90 degree or 180 degree pull (to the carrier) shall result in tearing of the rubber. A cut (up to 12 mm) between the rubber and carrier is permitted to facilitate gripping of the rubber. A clean adhesive failure (rubber to carrier) is not acceptable. Non-destructive test alternative using an interference fit, post die for small openings, or a straight segment rule die that deflects or bends the edge bonded rubber is permitted. For open segment tests,