SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS-P-5315A

Issued MAR 1998
Revised JUL 2001

Superseding AMS-P-5315

(R)

Butadiene - Acrylonitrile (NBR) Rubber For Fuel-Resistant Seals 60 to 70

1. SCOPE:

1.1 This specification covers a butadiene - acrylonitrile (NBR) rubber in the manufacture of molded seals.

1.2 Application:

These products have been used typically at temperatures from -65 °F (-54 °C) to +180 °F (+182 °C). where resistance to fuel is required, but usage is not limited to such applications. Each application should be considered individually.

1.3 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of hazardous materials and to take necessary precautionary measures to ensure health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2817	Packaging and Identification, Preformed Packings
AMS 4027	Aluminum Alloy, Sheet and Plate, 1.0Mg - 0.6Si - 0.28Cu - 0.20Cr, (6061; -T6 Sheet, -T651 Plate), Solution and Precipitation Heat Treated
AMS 4037	Aluminum Alloy, Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn, (2024; -T3 Flat Sheet, -T351 Plate), Solution Heat Treated
AMS 4045	Aluminum Alloy Sheet and Plate, 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr, (7075; -T6 Sheet, -T651 Plate, Solution and Precipitation Heat Treated
AMS 5513	Steel, Corrosion Resistant, Sheet, Strip, and Plate, 19Cr - 9.2Ni, (SAE 30304), Solution Heat Treated
AMS 5630	Steel, Corrosion Resistant; Bars, Wire, and Forgings, 17Cr - 0.52Mo (0.95-1.20C) (SAE 51440C)
AMS 6350	Steel Sheet, Strip, and Plate, 0.95Cr - 0.20Mo (0.28-0.33C), (SAE 4130)
AS871	Manufacturing and Inspection Standard for Preformed Packings (O-Rings)
AS29513	Packing, Preformed, Hydrocarbon Fuel Resistant, O-Ring
PD2000	Procedures for an Industry Managed Product Qualification Program

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 297	Rubber Products - Chemical Analysis
ASTM D 395	Rubber Property - Compression Set
ASTM D 412	Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	Rubber Property - Effect of Liquids
ASTM D 1329	Rubber Property - Retraction at Lower Temperatures (TR Test)
ASTM D 1414	Rubber O-Rings
ASTM D 2240	Rubber Property - Durometer Hardness
ASTM D 3677	Rubber - Identification by Infrared Spectrophotometry
ASTM E 1131	Compositional Analysis by Thermogravimetry

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, www.dsp.dla.mil.

MIL-PRF-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Operation
MS 29512	Packing, Preformed, Hydrocarbon Fuel Resistant, Lube Fitting, O-Ring

2.4 ANSI Publications:

Available from ANSI, 1430 Broadway, New York, NY 10018.

ANSI B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be a compound, based on a butadiene-acrylonitrile (NBR) elastomer, suitably cured to produce sealing rings meeting the requirements of 3.2.

3.2 Properties:

The product shall conform to the requirements shown in Table 1; tests shall be performed, except as otherwise specified herein, in accordance with ASTM D 1414, insofar as practicable.

TABLE 1 - Properties

	Property	Requirement	Test Method
3.2.1	Specific Gravity	Preproduction Value ±0.02	ASTM D 297
3.2.2	Hardness, Durometer A or equivalent	65 ± 5	ASTM D 2240
3.2.3	Tensile Strength, min	1000 psi (6.90 MPa)	ASTM D 412
3.2.4	Elongation, min	200%	ASTM D 412
3.2.5	Volume Change	0 to 10	ASTM D 471 Ref. Fuel A
3.2.6	Volume Change	0 to 50	ASTM D 471 Ref. Fuel B
3.2.7	Compression Set, %	0 to 50	ASTM D 395, Method B Temperature: 158 °F ± 2 (70 °C ± 1) Time: 70 hours ± 0.5
3.2.8	Temperature Retraction TR_{10} point, max	-50 °F (-46 °C)	ASTM D 1329
3.2.9	Dry Neckdown Test	Pass	4.5.1
3.2.10	Wet Neckdown Test	Pass	4.5.2
3.2.11	Corrosion and Adhesion	Slight Corrosion Allowed on AMS 6350 Steel, on Other Metals	4.5.3 None

TABLE 1 - Properties (Continued)

	Property	Requirement	Test Method
3.2.12	Fourier Transform Infrared (FTIR)	Record	ASTM D 3677
3.2.13	Thermal Gravimetric Analysis (TGA)	Record	ASTM E 1131

3.3 Qualification:

3.3.1 Seals that qualify are placed on a qualified product list (QPL) maintained by the QPL agency. To qualify, seals shall meet the required specified in 3.1 and 3.2 and performed in accordance with provisions of 8.2.

3.3.2 Recertification of qualification is required every three years.

3.3.3 Qualification testing, review of test results, approval, reapproval, and recertification of qualification for QPL listing shall be in accordance with PD2000 or equivalent and the instructions from the responsible QPL agency.

3.3.4 Seals furnished to this specification will be listed or approved for listing on the qualified products list (QPL) in accordance with the provisions of 8.2 and 8.3.

3.4 Quality:

Seals, as received by purchaser, shall be uniform in quality and condition, smooth, as free from foreign material as commercially practicable, and free from internal imperfections detrimental to usage of the seals. Surface imperfections shall be no greater than that permitted by AS871 for minor defects.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

The manufacturer shall supply all samples and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the rings conform to the specified requirements.

4.2 Classification of tests:

4.2.1 Acceptance Tests: The following requirements are acceptance tests and shall be performed on suitably molded and cured seals from each lot.

Specific Gravity (3.2.1)
Hardness (3.2.2)
Tensile Strength (3.2.3)
Elongation (3.2.4)
Volume Change, Ref. Fuel A (3.2.5)
Volume Change, Ref. Fuel B (3.2.6)
Dry Neckdown Test (3.2.9).

4.2.2 Periodic Tests: The following requirements are periodic tests and shall be performed yearly on suitably molded and cured seals.

Specific Gravity (3.2.1)
Hardness (3.2.2)
Tensile Strength (3.2.3)
Elongation (3.2.4)
Volume Change, Ref. Fuel A (3.2.5)
Volume Change, Ref. Fuel B (3.2.6)
Compression Set (3.2.7)
Temperature Retraction (3.2.8)
Wet Neckdown Test (3.2.10)
Corrosion and Adhesion (3.2.11)
Fourier Transform Infrared (3.2.12)
Thermal Gravimetric Analysis (3.2.13).

4.2.3 Qualification Tests: All technical requirements are qualification tests and shall be performed prior to shipment of seals to the purchaser, when a change in ingredients and/or processing requires reapproval, and when purchaser deems confirmatory testing to be required.

4.2.3.1 Material Traceability and Compound Confirmation: To provide full traceability of the compound being qualified and to ensure that the compound and the state of cure do not change during production, an FTIR spectra of a randomly chosen qualification part shall be obtained per ASTM D 3677. This spectra, appropriately dated and recorded, shall remain part of the permanent record for the qualified compound. Copies of this record shall be available for reference. In addition a TGA curve will be obtained for the same sample per ASTM E 1131. This curve, showing compositional analysis, shall also be appropriately dated and recorded and shall remain part of the permanent record for the qualified compound.

4.3 Sampling and Testing:

4.3.1 For Acceptance Tests: Sufficient seals shall be selected at random from each lot to perform all required tests; the number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all seals of the same size from the same batch of compound processed in one continuous run and presented for vendor's inspection at one time.

4.3.1.2 A batch shall be the quantity of compound run through a mill or mixer at one time.

4.3.1.3 A statistical sampling plan acceptable to purchaser may be used in lieu of sampling as in 4.3.1 and the report of 4.6 shall state that such plan was used. Sample size for visual and dimensional requirements shall be as shown in Table 2; sample unit shall be one molded part and acceptance based on zero defects.

TABLE 2 - Visual and Dimensional Inspection

Lot Size	Sample Size
2 to 8	Entire Lot
9 to 90	8
91 to 150	12
151 to 280	19
281 to 500	21
501 to 1200	27
1201 to 3200	35
3201 to 10,000	38
10,001 to 35,000	46
35,001 to 150,000	56
150,001 and Over	65

4.3.2 For Periodic Tests: Shall be as in 4.3.1 for the lot from which the samples are taken. All values shall be within the numerical limits specified in Table 1 and within the permissible production variation specified in Table 3.

TABLE 3 - Permissible Production Variation in Properties from Qualification Values

Property	Variation
Specific Gravity, points	±0.02 points
Hardness, Durometer points	± 5 points
Tensile Strength	±15 percent
Elongation, percent	±20 percent
Volume Change in Ref. Fuel A	±2 units of percent
Volume Change in Ref. Fuel B	±3 units of percent
Compression Set, percent	±5 units of percent
Temperature Retraction, °F (°C)	±2 °F (±1 °C)
Wet Neckdown Test	Pass
Corrosion and Adhesion	None
Fourier Transform Infrared	Report
Thermal Gravimetric Analysis	Report

4.3.3 For Qualification Tests: Samples shall consist of 50 MS 29513-214 seals and 6 hardness discs. Samples shall be identified as follows and forwarded to the activity responsible for testing as designated in the letter of authorization from the qualifying activity:

Butadiene - Acrylonitrile (NBR) Rubber, For Fuel-Resistant Seals, 60 to 70
AMS-P-5315A
Manufacturer's Identification
Name of Manufacturer
Lot Number
Date of Manufacture
Submitted by (Name) (Date) for qualification tests in accordance with AMS-P-5315A under authorization (reference authorizing letter).

4.4 Approval:

4.4.1 Manufacturer shall establish, for each size of seal, parameters for the process control factors, which will produce seals meeting the technical requirements of this specification. These shall constitute the approved procedures and shall be used to manufacturing production of seals. If necessary to make any change in parameters for the process control factors, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing. When requested, sample seals shall be submitted in accordance with the provisions of 3.3.4. Seals manufactured using a revised procedure shall not be shipped prior to reapproval of qualification in writing.

4.4.2 Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection in production which are essentially the same as those used on the approved sample.

4.4.2.1 Control factors for producing seals include, but are not limited to, the following:

Compound ingredients and proportions thereof with established limits
Sequence of mixing compound ingredients
Type of mixing equipment
Method and equipment for preparing preforms
Basic molding procedure (compression, transfer, injection)
Curing time and pressure; variations of ±10% are permissible
Finishing methods
Methods of inspection.

4.4.2.2 Any of the above process control factors for which parameters are considered proprietary by the manufacturer may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Test methods:

4.5.1 Dry Neckdown Test: Test rings shall be stretched to 100% elongation and held in this condition by a suitable jig. The stretched samples shall demonstrate uniform cross section without local constrictions or other irregularities.

4.5.2 Wet Neckdown Test: Test rings shall be soaked for 16 to 24 hour in ASTM Reference Fuel B at 68 to 86 °F (20 to 30 °C), removed from the fuel, and visually examined within 15 minutes. The sample shall demonstrate uniform swell without distortion, angularity, or other local deviation from a uniform section.

4.5.3 Corrosion and Adhesion: Size -214 O-rings, two for each metallic plate below and using whole uncut rings, shall be prepared for corrosion testing by inserting sufficient quantities of the seals in a desiccator or similar humidity chamber maintained at relative humidity not lower than 92% and 77 °F ± 5 (25 °C ± 3) for not less than 72 hours. Plates of the metals listed below shall be polished to a surface texture of 4 to 16 microinches (0.1 to 0.4 µm), determined in accordance with ANSI B 46.1. The edges shall also be polished to reduce the formation of edge corrosion. The plates shall be washed with toluene, aliphatic naphtha, or similar degreasing agent that will produce a clean dry surface free from film. The metals used shall be as follows:

AMS 4027 Aluminum Alloy
AMS 4037 Aluminum Alloy
AMS 4045 Aluminum Alloy
AMS 5513 Corrosion Resistant Steel
AMS 5630 Corrosion Resistant Steel
AMS 6350 Low-Alloy Steel

4.5.3.1 The humidified rings and the metallic plates shall be immersed in MIL-H-6083, Type I, fluid and drained to the drip point. The rings and plates shall be laid together in a stack so that at least two whole rings contact each specified metal. The stack shall be held together with a pressure of 20 to 30 pounds force (89 to 133 N) and placed in a desiccator maintained at relative humidity not lower than 92% at 77 °F ± 5 (25 °C ± 3). This relative humidity may be produced by the use of a salt of sufficient concentration in solution with distilled water. No more than 15 minutes should be required for assembling the test samples. Time of humidity exposure for this portion of test shall be 14 days. At the termination of this test, the procedures outlined below shall be followed:

4.5.3.1.1 The surfaces of the plates, which were in contact with the seals, shall be inspected for discoloration, deposits, pitting, or other evidence of corrosion or adhesion. If any exist, the surfaces of the plates shall be washed in aliphatic naphtha. Deposits determined as rubber compounds or elements therefrom, which can be removed by this process and which do not occur on other surfaces of the same plates, shall be construed as adhesion.