Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 7311D
Superseding AMS 7311C

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PISTON RINGS, CENTRIFUGALLY CAST IRON
0.50Mo - 0.50Cu

1. SCOPE:

1.1 Type: This specification covers piston rings made of centrifugally-cast, alloyed iron.

1.2 Application: Primarily for use as top compression rings in aircraft piston engines. Rings usually require chromium plating for compatibility with the cylinder barrel material.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A247 - Evaluating the Microstructure of Graphite in Iron Castings
ASTM A327 - Impact Testing of Cast Iron
ASTM E8 - Tension Testing of Metallic Materials
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E351 - Chemical Analysis of Cast - All Types

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E351, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Total Carbon	2.85	3.50
Manganese	0.50	1.00
Silicon	1.00	1.65
Phosphorus	--	0.30
Sulfur	--	0.12
Molybdenum	0.35	0.65
Copper	0.35	0.65

3.2 Fabrication: Rings shall be machined from centrifugally cast sleeves which have been annealed, hardened, and tempered.

3.2.1 Finish: Sides of rings shall be ground or lapped. Periphery shall be turned smooth.

3.3 Properties: Shall be as follows, determined on specimens prepared as in 4.3.2:

3.3.1 Test Specimens:

3.3.1.1 Tensile Strength: Shall be not lower than 88,000 psi (607 MPa), determined in accordance with ASTM E8.

3.3.1.2 Modulus of Elasticity: Shall be not lower than 20,000,000 psi (138 GPa), determined in flexure by applying a steadily increasing load to the 0.260 in. (6.60 mm) face of the specimen.

3.3.1.3 Izod Impact Value: Shall be not lower than 10 ft-lb (13.6 N·m), determined in accordance with ASTM A327 with the weight striking the 0.260 in. (6.60 mm) face of the specimen.

3.3.1.4 Hardness: Shall be 24 - 30 HRC or equivalent, determined in accordance with ASTM E18.

3.3.2 Finished Rings: Shall conform to the following requirements:

3.3.2.1 Hardness: Shall be 24 - 30 HRC or equivalent, determined in accordance with ASTM E18.

3.3.2.2 Microstructure: Shall consist of a tempered, partly-spheroidized martensitic matrix with evenly-distributed, isolated particles of cementite, evaluated in accordance with ASTM A247. Graphite shall be present for the most part as temper carbon nodules; primary graphite shall exist only as small, isolated areas. Free ferrite shall be absent.

3.3.2.3 Circularity: The diameter through the gap shall exceed the diameter 90 deg (1.57 rad) from the gap by not less than 0.0025 in. per inch (0.0025 mm/mm) of nominal ring diameter when finished ring is held around its periphery by a flexible steel band 0.0045 - 0.0055 in. (0.114 - 0.140 mm) thick and of width approximately equal to that of the ring and whose inside circumference is equal to the nominal outside circumference of ring ±0.003 in. (±0.008 mm).

3.3.2.4 Light-Tightness of Periphery: When finished ring is placed in a circular gage whose ID is equal to the nominal OD of ring ±0.0005 in. (±0.013 mm), the portion of periphery on each side of the gap equal to 20% of the nominal OD of the ring shall be light-tight. The space between the balance of ring periphery and ID of gage shall be not greater than 0.0005 in. (0.013 mm) at any point and not less than 85% of the periphery of the ring shall be light-tight. Intermittent or fuzzy light shall be considered the same as light-tight.

3.3.2.5 Flatness: When weight of not more than 0.50 lb per inch (8.9 g/mm) of nominal OD of ring is applied to a ring supported in a gage having the same nominal diameter +0.001 in. (+0.03 mm), -0.000, and having the same interior angle as the nominal angle between side face and periphery of ring, the ring shall show, by light gage, bluing, or other acceptable method, at least line contact around not less than 85% of the side face of the ring. This contact may be anywhere between the inside and outside circumference and may vary between these limits on any one ring. This contact shall indicate that ring faces are not wavy.

3.3.2.6 Heat Stability: Finished rings, heated at 600°F ± 10 (315.6°C ± 5.6) for 60 min. ± 5 and cooled to room temperature while confined in a retaining ring having ID equal to the nominal OD of ring ± 0.001 in. (± 0.03 mm), shall retain not less than 90% of the original free gap opening.

3.4 Quality: Rings shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to their performance.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of rings shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the rings conform to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance or routine control tests.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Composition: At least one sample from each melt. If composition is determined on the melt, a chilled pencil-type specimen is preferred for carbon determinations but other types of samples of proven accuracy may be used. If composition is determined on sleeves, a solid sample cut from the sleeve shall be used.

4.3.2 Mechanical Properties: At least one specimen from each lot of sleeves. A lot shall be all sleeves cast in a period of eight consecutive hours and heat treated in a single furnace charge. Blanks for specimens shall be cut longitudinally from representative sleeves after final heat treatment. Tensile test specimens shall be machined to have a cross section not smaller than the cross section of the finished ring. Modulus of elasticity and impact test specimens shall be machined to rectangular cross section 0.260 in. ± 0.005 (6.60 mm ± 0.13) wide and 0.140 in. ± 0.005 (3.56 mm ± 0.13) thick.

4.3.3 Hardness: Specimens shall be those on which tensile strength or modulus of elasticity is determined and not less than one ring of each part number in each shipment.

4.3.4 Microstructure, Circularity, Light-Tightness, and Flatness: As agreed upon by purchaser and vendor.

4.3.5 Heat Stability: One ring from each shipment.

4.4 Approval:

4.4.1 Sample rings shall be approved by purchaser before rings for production use are supplied, unless such approval be waived.

4.4.2 Vendor shall use manufacturing procedures, processes, and methods of inspection on production rings which are essentially the same as those used on the approved sample rings. If necessary to make any change in manufacturing procedures or processes which could affect quality or properties of the rings, vendor shall submit for reapproval of the process a detailed statement of the revised operations and, when requested, sample rings. No production rings fabricated by the revised procedure shall be shipped prior to receipt of reapproval.

4.5 Reports:

4.5.1 The vendor, before the first shipment, shall furnish for each purchase order, three copies of a statement that the rings will conform to the chemical composition and properties specified. This report shall include the purchase order number, material specification number and its revision letter, and part number.

4.5.2 The vendor shall furnish to the purchaser one copy of a weekly cumulative report showing the chemical composition and mechanical properties of typical sleeves cast during the period.