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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 7277C

Issued 1 JUL 1956
Revised 1 APR 1991

Superseding AMS 7277B

Submitted for recognition as an American National Standard

RINGS, SEALING, SYNTHETIC RUBBER
Phosphate Ester Hydraulic Fluid Resistant, Butyl Type
70 - 85

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of October 16, 1980. It is recommended that this specification not be specified for new designs.

This cover sheet should be attached to the "B" revision of the subject specification.

Noncurrent refers to those parts which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division does not recommend these as standard parts for future use in new designs. Each of these "Noncurrent" specifications is available from SAE upon request.

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This specification has been "CANCELLED" by the Aerospace Materials Division, SAE, as of October 16, 1990. By this action, subject specification number and its title will be deleted from the active specification index of Aerospace Material Specifications.

This specification is under the jurisdiction of AMS Committee "CE".

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400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 7277B

Issued 7- 1-56
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RINGS, SEALING, SYNTHETIC RUBBER
Phosphate Ester Hydraulic Fluid Resistant, Butyl Type
70 - 85

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This cover sheet should be attached to the "B" revision of the subject specification.

AEROSPACE
MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

AMS7277B

Superseding AMS 7277A

Issued 7-1-56

Revised 4-15-67

RINGS, SEALING, SYNTHETIC RUBBER
Phosphate Ester Hydraulic Fluid Resistant, Butyl Type
70 - 85

1. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

2. FORM: Molded rings.

3. APPLICATION: Sealing rings for use in phosphate ester base fire resistant hydraulic fluids at temperature as low as -55 C (-67 F).

4. TECHNICAL REQUIREMENTS:

4.1 General:

4.1.1 Corrosion: The product shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service. Discoloration of metal shall not be considered objectionable.

4.1.2 Adhesion: The product shall be removable from an assembly without tearing or leaving deposits of rubber due to adhesion when exposed to conditions normally encountered in service.

4.2 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with the issue of specified ASTM methods listed in the latest issue of AMS 2350, insofar as practicable. Tensile strength testing is not required on rings which are too small to permit assembly on rollers for testing and are, after cutting, too short to permit testing as a single strand. Eliminating tensile testing does not eliminate testing for elongation; elongation test can be made by stretching a ring over a mandrel of a size which will stretch the ring sufficiently to produce the required elongation when figured on the ID of the ring.

4.2.1 As Received:

4.2.1.1	Hardness, Durometer "A" or equiv.	70 - 85	
4.2.1.2	Tensile Strength, psi, min	1200	See 4.2.1.5
4.2.1.3	Elongation, %, min	200	See 4.2.1.5
4.2.1.4	Tensile Stress at 100% Elongation, psi, min	400	See 4.2.1.5 and 4.2.1.6

4.2.1.5 Use ASTM D1414 for "O" rings; use ASTM D412 for other rings.

4.2.1.6 Stretch specimen three times to 100% elongation prior to conducting the test.

4.2.2	Phosphate Ester Fluid Resistance: (Immediate Deteriorated Properties)		ASTM D471 Medium: SAE Phosphate Ester Standard Test Fluid No. 1A (See Note 1) Temperature: 70 C ± 1 (158 F ± 1.8) Time: 168 hr
4.2.2.1	Hardness Change, Durometer "A" or equiv.	-20 to 0	
4.2.2.2	Tensile Strength Change, %, max (based on area before immersion)	-25	

4.2.2.3	Elongation Change, %, max	-35	
4.2.2.4	Volume Change, %	0 to +15	
4.2.2.5	Decomposition	None	
4.2.2.6	Surface Tackiness	None	

4.2.2.7 If impracticable to determine tensile strength of rings 0.5 in. and less nominal ID after oil immersion, the rings shall withstand, without cracking, closing flat.

Note 1. SAE Phosphate Ester Standard Test Fluid No. 1A is a standardized batch of test fluid which has been set aside by the manufacturer for use in AMS tests. It may be obtained for test purposes from:

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Society of Automotive Engineers, Inc.
485 Lexington Avenue
New York, New York 10017

4.2.3	Dry Heat Resistance:		ASTM D573 Temperature: 70 C ± 1 (158 F ± 1.8) Time: 168 hr
4.2.3.1	Hardness Change, Durometer "A" or equiv.	0 to +10	
4.2.3.2	Tensile Strength Change, %, max	-20	
4.2.3.3	Elongation Change, %, max	-35	
4.2.3.4	Bend (flat)	No cracking or checking	
4.2.4	Compression Set:		ASTM D395, Method B Temperature: 70 C ± 1 (158 F ± 1.8) Time: 22 hr
4.2.4.1	Per cent of original deflection, max	50	
4.2.4.2	Per cent of original thickness, max	12	See 4.2.4.3 and 4.2.4.4

4.2.4.3 These values are applicable to rings having a nominal cross sectional diameter of 0.139 in. and larger.

4.2.4.4 Rings over 2 in. nominal ID may be cut for testing. The cut specimen shall be not less than 1 in. in length.

4.2.5	Low Temperature Brittleness:	No cracking	See 4.2.5.1

4.2.5.1 The specimen for rings 2 in. and less nominal ID shall be a complete ring; the specimen for rings over 2 in. nominal ID shall be a piece 3 in. long cut from a ring. The specimen shall be aged in Phosphate Ester Test Fluid No. 1A for 72 hr at 70 C ± 1 (158 F ± 1.8), cooled in an unstressed position to -55 C ± 1 (-67 F ± 1.8), and held at that temperature for 5 hours. At the end of the refrigeration time, the specimen shall be bent as follows: The complete ring specimen shall be ovalized until the minor axis is equal to 50% of the original ID; the 3 in. specimen shall be bent around to form a circle.

4.2.6 Performance Tests: The product shall be capable of meeting the following performance tests, which shall be conducted in triplicate in the sequence listed. There shall be no evidence of wear, permanent set, or extrusion of the seals, or corrosion, sticking, or bad discoloration of the adapters or metals adjacent to the packings during or after the entire performance tests. Leakage shall be recorded.

4.2.6.1 Test Specimens: Shall be O-rings having the dimension shown for test ring size No. 3 in Table I mounted between two chrome-tanned leather back-up rings having an OD of 1-7/8 in. ± 1/64, cross-sectional width of 0.188 in. +0.010, -0.005, and thickness of 0.094 in. ± 0.010. Fluid shall be SAE Phosphate Ester Standard Test Fluid No. 1A.

4.2.6.2 Apparatus: Hydraulic piston and cylinder assembly designed for 3000 psi use, together with the required actuating mechanism, hydraulic pressure source, and thermal controls and equipment. The cylinder bore diameter shall be 1.876 in. ± 0.001 with taper not greater than 0.001 in. per ft and out-of-round not greater than 0.005 in. total indicator reading; piston groove diameter shall be 1.502 in. +0.002, -0.000; total diametral clearance shall be 0.007 in. ± 0.005; groove length shall be 0.410 in. +0.005, - 0.000; top of corner radius shall be 0.002 - 0.008 in.; surface finish of grooves shall be not less than 4 nor more than 32 microinches; and surface roughness of cylinder bore over which packing slides shall be 8 - 16 microinches. The assembly shall be set for a 4-1/2 in. stroke and adjustable in cycle rate from 0 - 40 cycles per minute. The assembly shall be mounted in a thermal chamber with a temperature range of -55 to +70 C (-67 to +158 F) and capable of control to ±1 C (± 1.8 F). Suitable differential pressure (for hydraulically actuated equipment) or strain gauge (for mechanically actuated equipment) measuring apparatus shall be provided for determining relative packing break-out and running friction values.

4.2.6.3 High Temperature Performance Test Procedure: Packing specimens and backup rings shall be installed in groove and assembly filled with fluid at no pressure. Assembly shall be maintained at 70 C ± 1 (158 F ± 1.8) for 6 days prior to performance tests. Assembly shall be disassembled at the end of this time and packings and all metals in contact with packings shall be inspected for adhesion, gum, residues, permanent set or swelling of packing, and discoloration or corrosion of metals. After reassembly, the pressure in the entire system shall be raised to 3000 psi with the piston near one end of cylinder, but not bottomed, and the necessary valve adjustments made to prevent motion. The temperature shall be raised within 1 hr to 70 C ± 1 (158 F ± 1.8) and the assembly held at this temperature and pressure for 24 hours. On completion of this period the following cyclic and static tests shall be performed in the order listed and at the temperature specified. Total leakage during the following sequence shall not exceed 7 drops (approximately 0.35 ml) from each packing gland.

4.2.6.3.1 Initial High Pressure Break-Out: Following the 24 hr standby period, and with the assembly at 70 C ± 1 (158 F ± 1.8) and 3000 psi hydraulic pressure, slowly apply sufficient force (hydraulic or mechanical) to initiate movement of the piston. The pressure required for break-out of hydraulically actuated mechanisms shall not exceed 40 psi, and the break-out force for mechanically actuated equipment shall not exceed 110 pounds.

4.2.6.3.2 High Pressure Cycling: Not less than 10 cycles of operation at 3000 psi shall be made. The differential pressure required to maintain movement at 20 cpm for hydraulically actuated mechanisms shall not exceed 20 psi, and for mechanically actuated equipment the force required shall not exceed 55 pounds.

4.2.6.3.3 Low Pressure Cycling: The piston shall be actuated not less than 10 times at no-load pressure. For hydraulically actuated mechanisms, use sufficient differential pressure to maintain movement at 20 cycles per minute. Mechanically actuated equipment should be set at 20 cpm and 10 psi piston packing pressure. Record differential pressure (hydraulically actuated mechanisms) or force (mechanically actuated equipment) required to maintain movement of the piston.

4.2.6.3.4 Low Pressure Static: The hydraulic pressure in the test assembly shall be lowered to 5 - 10 psi and the installation allowed to set 1 hour. After the standby period, record the differential pressure (hydraulically actuated mechanisms) or force against the piston (mechanically actuated equipment) required to initiate movement of the piston.

4.2.6.3.5 Final High Pressure Break-Out: After completion of the preceding test sequence, the hydraulic pressure in the test assembly shall be raised to 3000 psi with the piston near one end of the cylinder, but not bottomed, and maintained at that pressure for 3 hr at 70 C ± 1 (158 F ± 1.8). The test assembly shall then be allowed to cool to room temperature over a 20 hr period. Pressure shall not fall below 2000 psi during this period. Pressure shall then be relieved from the test assembly without permitting the piston to move, and a non-load break-out friction test performed. The pressure required for break-out of hydraulically actuated mechanisms shall not exceed 40 psi, and the break-out force for mechanically actuated equipment shall not exceed 110 pounds. Leakage during this portion of the test shall not exceed 2 drops (approximately 0.10 ml) per gland.

4.2.6.4 Low Temperature Performance Test Procedure: The same apparatus and packing rings used in previous tests shall be charged to 3000 psi for 3 min. to position the rings within the packing gland. The pressure shall then be lowered to 5 - 10 psi and the test assembly lowered within 1 hr to -55 C ± 1 (-67 F ± 1.8) and maintained at that temperature for not less than 24 hours. The following cycling and static tests shall then be performed in the order specified, using fluid no warmer than -55 C (-67 F). Leakage during the entire sequence of low temperature performance tests shall not exceed 20 drops (approximately 1 ml) per gland.

4.2.6.4.1 Low Pressure Break-Out: Following the 24 hr standby period, and with the assembly at -55 C (-67 F) and 5 - 10 psi, slowly apply sufficient force (hydraulic or mechanical) to initiate movement of the piston. Differential break-out pressure for hydraulically actuated mechanisms shall not exceed 80 psi. No more than 220 lb break-out force shall be required for mechanically actuated piston.

4.2.6.4.2 Low Pressure Cycling: The piston shall be actuated not less than 10 times at no load pressure. Differential pressure required to maintain 20 cpm movement of hydraulically actuated mechanisms shall not exceed 100 psi. Force required to maintan 20 cpm with mechanically actuated pistons shall not exceed 275 pounds. (See Note 2)

4.2.6.4.3 High Pressure Break-Out: After completing the preceding test sequence, the hydraulic pressure in the test assembly shall be maintained at 3000 psi with the piston near one end of the cylinder, but not bottomed, and maintained at that pressure for 1 hour. Following completion of the 1 hr standby period, sufficient force (hydraulic or mechanical) shall be applied to initiate movement of the piston. The pressure required for break-out of hydraulically actuated mechanisms shall not exceed 120 psi, and the break-out force for mechanically actuated equipment shall not exceed 330 pounds. Pressure shall then be reduced to 0 psi and the apparatus allowed to warm to room temperature over an 18 hr period (See Note 2).

Note 2. At the start of 4.2.6.4.2 and 4.2.6.4.3, the piston rod shall be forcefully moved from side to side in each of two planes 90 deg apart.

4.2.7 Endurance Tests: The product shall be capable of meeting the following test requirements.

4.2.7.1 Test Specimens: Shall be O-rings and back-up rings identical to those required for performance tests in 4.2.6.

4.2.7.2 Apparatus: Shall be similar to that required for performance tests in 4.2.6. Hydraulically actuated mechanisms shall be so constructed that during the filling stroke of the inboard end of the cylinder (at which time the piston rod is retracting), the fluid pressure shall be atmospheric or less (5 - 14.7 psi absolute pressure). Mechanically actuated equipment shall be so constructed that impulse pressure of 3000 psi at a rate of 25,000 psi per sec will be applied at mid-stroke as the piston is retracting and remain at 3000 psi for 1/2 cycle, being reduced to 20 - 50 psi absolute pressure as the piston reaches mid-stroke in the opposite direction.

4.2.7.3 Aged Ring Cycling Test Procedure: The same O-rings and back-up rings as were used in 4.2.6 shall be reinstalled in the test cylinder. Test conditions shall be as follows:

Fluid: SAE Phosphate Ester Test Fluid No. 1A
Temperature: 50 C ± 3 (122 F ± 5.4)
Stroke: 4 in., min
Operating Pressure, Hydraulically actuated mechanisms:
2600 - 3000 psi driving and 3000 psi min loading
Operating Pressure, Mechanically actuated equipment:
1/2 cycle at 3000 psi, 1/2 cycle at 20 - 50 psi, absolute pressure. Pressure to change at mid-stroke.

Rate of Cycling: 30 cycles per minute, minimum. Total cycles, 40,000 min with thin-walled type cylinders, or 70,000 min if thick (non-breathing) cylinders are used.

Standby Period: Internal pressure of 3000 psi shall be applied for not less than 17 hr after every second day's cycling. Standby pressure shall be 5 - 10 psi during all other periods. In no case, however, shall more than 10,000 cycles be made between two standby periods.

All test data shall be recorded.

4.2.7.3.1 Acceptable leakage rates will vary according to the particular test apparatus used. In no case shall average leakage during the entire cycling test, including standby, exceed 1.25 ml per 1000 cycles of operation (approximately 5 drops per 200 cycles) per gland. Leakage over the last 5,000 cycles of operation shall not exceed 10 ml per gland. The leakage shall be recorded.

4.2.7.4 New Ring Cycling Test Procedure: New packings (as molded with no aging) shall be installed in the test cylinder and cycled in the same manner in the same grooves as specified in 4.2.7.3. All test data shall be recorded.

4.2.7.4.1 Leakage of the new rings shall not exceed the rate allowed in 4.2.7.3.1. Leakage shall be recorded.

4.2.8 Fatigue Tests: The product shall be capable of meeting the following tests which shall be conducted on at least 2 air aged, 2 fluid aged, and 2 unaged rings of each size specified in 4.2.8.1. Aged conditions shall be 7 days at 70 C ± 1 (158 F ± 1.8). Fluid shall be Phosphate Ester Test Fluid No. 1A. All new (unaged) O-rings shall withstand 24 hr and all aged O-rings shall withstand 16 hr of rotation in the machine without failure and without signs of cracking, flaking, wear, or other deterioration. Test data shall be recorded.

4.2.8.1 Test Specimens: Shall be as listed in Table I, unless otherwise specified.

4.2.8.2 Apparatus: O-rings shall be mounted in the apparatus shown in Fig. 1. The driven mandrel shall be mounted on movable slides such that a 15% stretch can be maintained on the rings. The driving mandrel shall rotate at 1750 rpm ± 50.

4.2.8.3 Fatigue Test Procedure: The 6 rings of each size may be installed in the apparatus and evaluated simultaneously. The rotation need not be continuous, but the 15% stretch should not be maintained during extended periods of no rotation, and the maximum test time specified should be a summation of only those periods of time in which rotation takes place.

4.2.9 Chew Resistance Screening Tests: The product shall be capable of meeting the following tests, conducted on at least 12 rings in both the aged and unaged condition. Average chew resistance ratings shall be not less than 88 for the aged samples and not less than 92 for the unaged samples. Individual ratings lower than 70 in either the aged or unaged condition shall be cause for rejection of the material for O-ring packing use.

4.2.9.1 Test Specimens: O-rings having the dimensions shown for test ring size No. 1 in Table I mounted between two chrome-tanned leather back-up rings having an OD of 1-1/4 in. ± 1/64 and a cross-sectional width of 0.123 in. +0.010, -0.005. Fluid shall be SAE Phosphate Ester Test Fluid No. 1A.

4.2.9.2 Apparatus: Cylinder 2-1/4 in. long with 1.0057 - 1.0060 in. diameter bore designed to withstand 3000 psi operation with internal packing glands 1/4 in. from each end. Packing groove dimensions shall be as follows: Groove diameter, 1.243 in. ± 0.001; bottom corner radii, 1/32 in. ± 1/64; top and cylinder bore edge corner radii, 0.002 - 0.008 in.; gland length, 0.268 in. ± 0.005; groove wall surface finish, 8 - 32 micro-inches. Pressure entry port shall be midway between the packing glands. The entire cylinder assembly shall be mounted horizontally and supported by a mechanically aligned horizontal rod running through the cylinder bore. The rod shall be of AMS 6440 steel, heat treated to hardness not lower than Rockwell C 60, hard chromium plated in accordance with AMS 2406, and finish ground to 0.9987 - 0.9990 in. with a surface roughness of 8 - 16 microinches. The rod shall be mounted between two rigidly supported linear ball bushings, 6 in. apart, such that total side-to-side free play is no more than 0.0002 inch. Means shall be provided for actuating the rod through a 5/32 in. stroke at 300 cpm while maintaining the floating cylinder in a fixed position midway between the two linear ball bushings. Hydraulic pressure shall be provided for steady 3000 psi operation.

4.2.9.3 Chew Resistance Screening Test Procedure:

4.2.9.3.1 Unaged Samples: A new O-ring packing (as molded) shall be installed between two fluid-dipped leather back-up rings in the two packing glands of the floating cylinder. The cylinder shall then be assembled on the rod, between the two rod aligning bearings, and 3000 psi steady hydraulic pressure shall be applied to the test cylinder. The rod shall then be actuated for 5,000 complete cycles through a 5/32 in. stroke at a rate of 300 cpm. More than 5 ml average leakage, or failure of the packings to maintain 3000 psi for 5000 cycles, shall be cause for rejection of the material.

4.2.9.3.2 Aged Samples: Samples which have been immersed in a beaker of test fluid for 7 days at 70 C ± 1 (158 F ± 1.8) shall be installed between two fluid-dipped leather back-up rings and tested as in 4.2.9.3.1.

4.2.9.4 Rating Procedure: After removal from the test cylinder packing gland, each O-ring shall be dipped in isopropyl alcohol, dried, and cleaned of all loose or shredded rubber. A thin cross-sectional wafer (approximately 1/64 in. thick) shall then be cut from each ring at the point of maximum chew, and a similar wafer shall be cut from an untested ring, using a razor blade or similar sharp cutting instrument. The wafers shall be placed in a shadow-graph or similar projecting apparatus and viewed at a magnification of not less than 15 diameters and the cross-sectional area shall be determined using a planimeter or other suitable device. The chew resistance rating shall be the percentage of cross-sectional area of tested to untested rings.

5. QUALITY: The product shall be uniform in quality and condition, clean, smooth, and free from foreign materials and from imperfections detrimental to fabrication, appearance, or performance of parts.

6. REPORTS: Unless otherwise specified, the vendor shall furnish with each shipment three copies of a report stating that the parts conform to the requirements of this specification. This report shall include the purchase order number, material specification number, vendor's compound number, date of cure, part number, and quantity.

7. IDENTIFICATION: Each ring shall be identified by the manufacturer using a molded-in color code as specified by the purchaser and shall include a green dot or dash.

8. PACKAGING:

8.1 Packaging shall be accomplished in such a manner as to ensure that the product, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any normal hazard.