MIL-P-17553A(OS)
22 June 1976
SUPERSEDING
MIL-G-17553(NOrd)
23 March 1953

MILITARY SPECIFICATION

* PACKING, PREFORMED, O-RING, SYNTHETIC RUBBER

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all departments and agencies of the Department of Defense.

1. SCOPE

*1.1 This specification covers synthetic rubber O-ring preformed packing used to provide both a high-pressure and a low-pressure seal within rockets. Only one type, grade, class, and composition of rubber as described in this specification will be acceptable. (See 6.1.)

*2. APPLICABLE DOCUMENTS

*2.1 Issues of documents. The following documents of the issues in effect on date of invitation for bids or request for proposals form a part of this specification to the extent specified herein. In the event of conflict between this specification and other documents referenced herein, the requirements of this specification shall apply.

SPECIFICATIONS

Military

*MIL-P-4816	Packing, Preformed, Rubber, Packing; Packaging of
MIL-P-5516	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160° F

STANDARDS

Federal

*FED-STD-601	Rubber, Sampling and Testing

FSC 5330

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

*3.1 Preproduction sample. A preproduction sample of 100 O-rings and three hardness test discs (see 4.5.12) shall be submitted to an activity designated in the contract or purchase order. All of the molds and as many of the mold cavities as possible which the manufacturer intends to use during production shall be represented by the 100 O-rings.

3.2 Material. The material composition of the O-rings furnished under this specification shall be in strict accordance with the requirements of the applicable drawings. (See 6.2.)

*3.3 Dimensions. Dimensions and tolerances of the O-rings shall conform to the drawings specified in the contract or purchase order. All dimensions shall apply to the O-rings in free state, i.e., not stretched or compressed. Measurements may be made by comparator, shadowgraph, or other acceptable methods of sufficient accuracy for the tolerances involved.

*3.4 Physical properties. The physical properties of the O-rings shall conform to the requirements of table I. The nominal value for specific gravity and tensile stress at 100 percent elongation shall be the average of the values observed for each of these properties during preproduction lot tests. The variation of these properties from their nominal values during production (inspection tests) shall be as specified in table I.

3.5 Molding process. The molding process for O-rings furnished under this specification shall be in accordance with the requirements of the applicable drawings. (See 6.2.)

Table I. Physical properties requirements.

Property	Requirement
Swelling after 96 hours immersion in distilled water at 158° F	8% max.
Compression modulus at 10% deflection, initial	2 lb/linear in. min. 10 lb/linear in. max.
Compression modulus at 10% deflection, after aging at 10% deflection for 96 hours at 158° F (based on initial dia.)	2 lb/linear in. min.
Compression set after aging at 10% deflection for 96 hours at 158° F	70% max.
Compression set after conditioning at 10% deflection for 96 hours at -20° F	70% max.
Ultimate elongation, initial	150% min.
Change of ultimate elongation after aging for 96 hours at 158° F	-15% max.
Tensile strength, initial	1500 psi min.
Change of tensile strength after aging for 96 hours at 158° F	-15% max.
Permanent set	5% max.
Cut resistance, initial	100 lb min.
Change of cut resistance after aging 96 hours at 158° F	-15% max.
*Specific gravity, variation from preproduction lot value	±0.2 points
Hardness, shore durometer	75 ± 5 points
*Tensile stress (modulus), psi at 100% elongation, variation from preproduction lot value	25%

3.6 Freedom from material defects.

3.6.1 Surface defects. The O-rings shall be free from surface defects in accordance with the applicable drawings specified in the contract or order.

3.6.2 Internal defects. The O-rings shall be free from internal defects that would cause failure of the O-rings to meet the requirements of table I.

*3.7 Surface finish and trimming. The method used to trim the mold flash shall not remove the original molded finish of the O-ring over an area wider than the maximum permissible flash thickness specified on the applicable drawing. The finish of the O-rings shall be free from blemish, flash, cuts, and roughness.

3.8 Workmanship. Workmanship shall be consistent with the highest grade commercial practice in manufacturing this kind of equipment.

3.9 Identification of O-rings. O-rings shall be identified in relation to the O-ring manufacturer and in accordance with this specification by color coding. The identification shall be in accordance with MIL-P-5516 except as follows.

*3.9.1 Every code assigned shall include a green dot to signify conformance to this specification. The green dot and the dot(s) for manufacturer's identification shall be adjacent and shall read in a clockwise direction, with the green dot signifying conformance to this specification first.

3.10 Age limitation. The O-ring manufacturer shall not deliver O-rings which are more than 12 months old (as determined by date of manufacture) to any Government service or manufacturer for stocking or installation purposes.

4. QUALITY ASSURANCE PROVISIONS

*4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his

own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

*4.1.1 Sampling. Sampling plans and procedures for inspection shall be in accordance with the provisions of MIL-STD-105 except where otherwise specified herein.

*4.1.2 Lots. The term "lot" shall mean "inspection lot," i.e., a collection of units of product submitted by an O-ring manufacturer for Government inspection. The number of units of product in inspection lots (see 4.1.1.1) may differ from the quantity designated in the contract, or order, as a lot for production, shipment, or other purpose.

4.1.2.1 Lots for inspection tests. After entering general production, O-rings submitted under this specification shall be subjected to batch control tests, production tests, and control tests. A lot for batch control tests shall consist of all the material constituting one mixed batch, i.e., the quantity of material run through a mill or mixer at one time. A lot for production tests shall consist of all the O-rings produced in 1 day. A lot for control tests shall consist of all the O-rings produced in a period of not more than 1 week.

*4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Preproduction inspection (see 4.3)
b. Quality conformance inspection (see 4.4).

*4.3 Preproduction inspection. Samples submitted in accordance with 3.1 shall be subjected to all the tests listed in table II to determine compliance with the requirements of section 3. Noncompliance shall be cause for the rejection of the preproduction samples.

*4.4 Quality conformance inspection. Quality conformance inspection shall consist of the following examinations and tests.

TABLE II. Preproduction and control tests.

Test	No. of specimens	Test paragraph
Swelling in distilled water	3	4.5.1
Compression modulus at 10% defection, initial (82° ± 5° F)	4	4.5.2
Compression modulus at 10% defection, after aging at 158° F	4	4.5.3
Compression set after aging at 158° F	4	4.5.4
Compression set after aging at -20° F	4	4.5.5
Tensile stress (modulus) at 100% elongation	6	4.5.6
Tensile strength, initial (82° ± 5° F)	6	4.5.7
Ultimate elongation, initial (82° ± 5° F)	6	4.5.7
Tensile strength, after aging at 158° F	6	4.5.8
Ultimate elongation, after aging at 158° F	6	4.5.8
Permanent set	3	4.5.9
Cut resistance, initial (82° ± 5° F)	6	4.5.10
Cut resistance, after aging at 158° F	6	4.5.11
Hardness	3	4.5.12
Specific gravity	6	4.5.13

4.4.1 Batch control tests. Batch control tests shall consist of the tests listed in table III. The test specimens shall be as specified in 4.5.12 and 4.5.13. If any of the specimens fail to meet the requirements of 3.3, the batch which it represents shall be rejected.

TABLE III. Batch control tests.

Test	No. of specimens	Test paragraph
Hardness	3	4.5.12
Specific gravity	6	4.5.13

4.4.2 Production tests. The production tests shall consist of the tests listed in table IV. If any of the specimens fail to meet the requirements of 3.3, the lot, consisting of that day's production, shall be rejected.

TABLE IV. Production tests.

Test	No. of specimens	Test paragraph
Compression modulus at 10% deflection, initial	4	4.5.2
Tensile stress (modulus) at 100% elongation	6	4.5.6
Tensile strength, initial	6	4.5.7
Ultimate elongation, initial	6	4.5.7
Specific gravity	6	4.5.13

4.4.3 Control tests. The control tests (see 4.1.2.1) shall consist of the tests listed in table II. One retest shall be allowed for the failure of a specimen to meet any one of the requirements as specified in 3.3. Failure on retest shall result in withdrawal of approval for general production.

*4.5 Test methods.

4.5.1 Swelling in distilled water.

4.5.1.1 Apparatus. The apparatus required for this test shall consist of a Jolly balance, test tube, distilled water, and a water bath.

4.5.1.2 Procedure. The volume of the O-ring shall be calculated by weighings in air and then in water using a Jolly balance or other suitable apparatus. These measurements shall be made in a room maintained

at a temperature of 82° ± 5° Fahrenheit (F). Place the O-ring in a test tube and cover with 100 milliliters (ml) of distilled water; loosely cork and place the test tube in a water bath at 158° ± 2° F for 96 hours. At the end of the immersion period remove the test tube from the water bath and allow the contents to cool for 30 minutes in the constant temperature room. Redetermine the volume of the O-ring by means of the Jolly balance.

4.5.2 Compression modulus at 10 percent deflection, initial (82° ± 5° F).

4.5.2.1 Apparatus. The apparatus for obtaining the load deflection characteristics of the O-ring is shown schematically by figure 1. The apparatus shall consist of the following: a bearing plate with central hole, supported by a tripod with leveling screws; a pressure plate supporting at its center, by ball-and-socket arrangement, a weight pen; a split-ring specimen positioning device for centering the O-ring under the pressure plate; and a dial micrometer graduated in mils, supported on a bracket attached to the bearing plate, for measuring the downward movement of the pressure plate. The metal surfaces contacting the test specimen shall have a surface finish of 63 microinches or smoother.

4.5.2.2 Procedure. The initial cross-sectional diameter (D) of the O-ring shall be measured, in the axial direction, using a micrometer having a pressure foot of 0.25 ± 0.01 inch in diameter and exerting a total force of 3.0 ± 0.1 ounce. The thickness of the pressure plate (T) shall be measured with a machinist's micrometer. The dial micrometer on the compression apparatus shall be set to zero while its foot is resting on the bearing plate. The O-ring shall be well lubricated with silicone grease (Dow-Corning DC-11) and centered between the pressure plate and bearing plate by means of the positioning device. The percent compression (C) of the O-ring, under the weight of the pressure plate and the empty weight pan, shall be calculated from the height of the O-ring plus the pressure plate as indicated on the dial micrometer (H):

$$C = \frac{D + T - H}{D} \times 100$$

Weights shall then be added to the weight pan in increments of 5 pounds until an added load of 20 pounds has been reached, thereafter the weights shall be added in 10-pound increments until a deflection of at least 10 percent has been reached. Deflection readings shall be taken exactly 30 seconds after each weight is added. The next load increment shall be added immediately following each load reading. Calculations shall be made for each load by use of the foregoing equation. The percent compression shall be plotted against loads per lineal inch (calculated from circumference at center of cross section) and the load to cause 10 percent deflection shall be determined from the curve by interpolation.

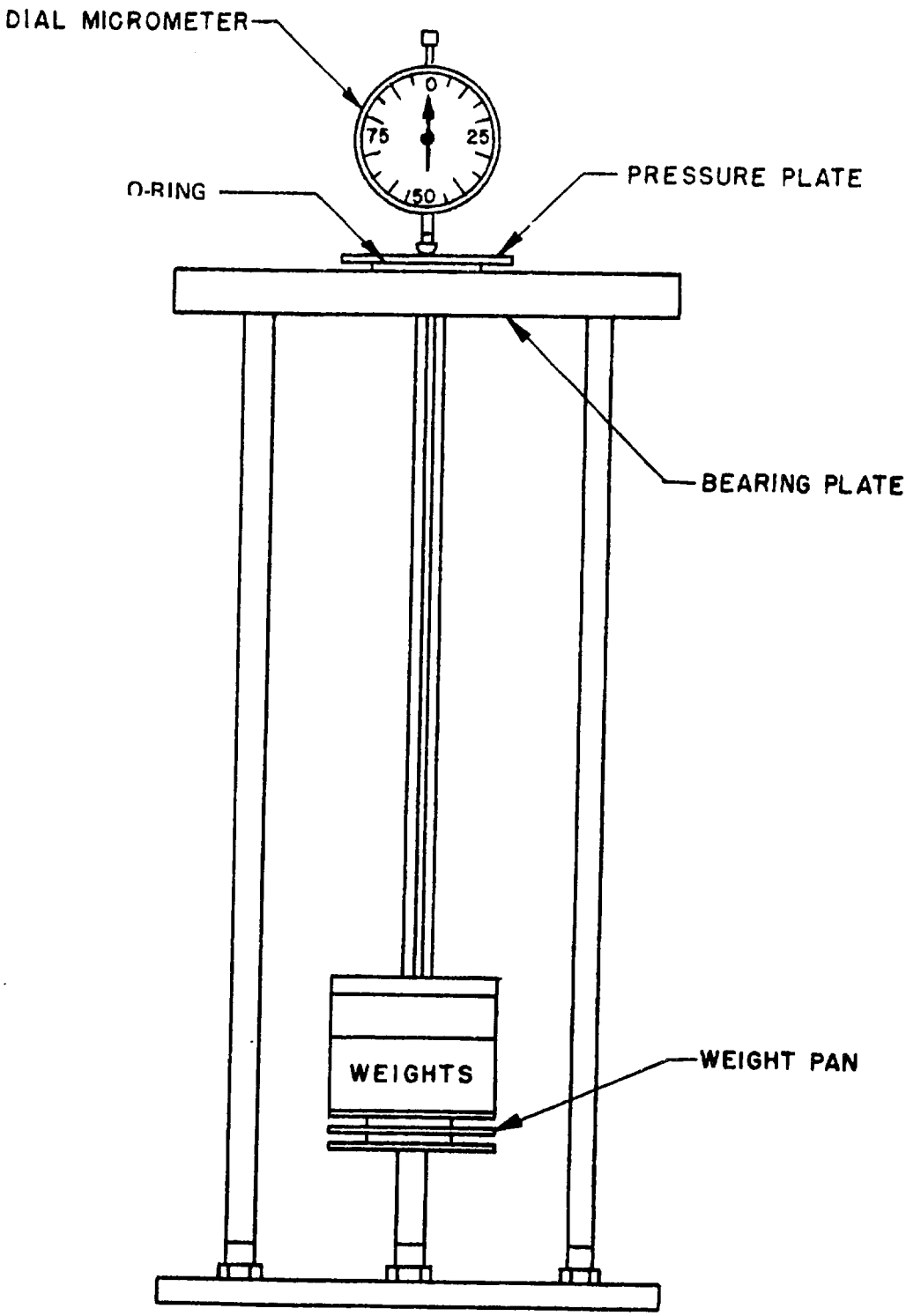

FIGURE 1. Apparatus for compression modulus tests.

4.5.3 Compression modulus at 10 percent deflection, after aging at 158° F.

4.5.3.1 Apparatus. The compression device shall consist of two or more flat steel plates between which the O-ring is to be compressed. The metal surfaces which will be in contact with the O-ring shall have a surface finish of 63 microinches or smoother. Steel spacers shall be placed on two sides (diametrically opposed) of the O-ring to control its thickness to a compression of 10 percent. The plates shall be bolted together at all four corners for compression and holding the O-ring.

4.5.3.2 Procedure. Measure the cross-sectional diameter (D) of the O-ring, in the axial direction, using a dial micrometer having a presser foot 0.25 ± 0.01 inch in diameter and exerting a total force of 3.0 ± 0.1 ounce. Coat the O-ring with silicone grease (DC-11) and center it on one of the plates. Place a sufficient number of steel spacers on both sides of the O-ring to equal 90.0 ± 0.2 percent of its cross-sectional diameter. The other plate shall be placed on top of the O-ring and the bolts shall be tightened so that the plates are drawn together uniformly until they are in contact with the spacers. Place the assembled test apparatus in a circulating air oven at 158° ± 2° F for 96 hours. At the end of this period, the assembly shall be removed from the oven, the O-ring released and allowed to recover for 30 minutes at 70° to 90° F. The thickness (A) of the O-ring shall be measured in the direction of compression using the dial micrometer. This value shall be used for computing the compression set as specified in 4.5.4. Then the compression modulus shall be determined as specified in 4.5.2 using the cross-sectional diameter (D) of the O-ring prior to aging as the basis for determining the percent compression.

4.5.4 Compression set after aging at 158° F. Compression set(s) after aging at 10 percent deflection for 96 hours at 158° F shall be calculated using the following equation:

$$S = \frac{D - A}{(0.1)(D)} \times 100$$

The values for the initial diameter (D) of the O-ring and for the thickness (A) of the O-ring after aging shall be as determined in 4.5.3.

4.5.5 Compression set after aging at -20° F.

4.5.5.1 Procedure. The O-ring shall be measured, coated with silicone grease, and compressed to a deflection of 10 percent in the compression device as specified in 4.5.3. The assembled test apparatus shall be immersed in a solution of 50 percent methanol and 50 percent water (by volume) at -20° ± 2° F. After 96 hours, the O-ring shall be released from the assembly while still under the cooling medium and shall be allowed to recover at -20° ± 2° F for approximately 30 minutes. The O-ring shall then be removed from the solution and its thickness in the direction of compression measured using the dial micrometer. The compression set shall then be calculated using the formula specified in 4.5.4.

4.5.6 Tensile stress (modulus) at 100 percent elongation (82° ± 5° F). The test for tensile stress shall be in accordance with the procedures outlined in MIL-P-5516, class B materials, except that elongation shall be calculated from the equation given in 4.5.7.

4.5.7 Ultimate elongation and tensile strength at 82° ± 5° F. The same O-rings used in the test of 4.5.6 shall be subjected to the tensile strength and ultimate elongation test in accordance with the procedure outlined in MIL-P-5516, class B materials, with the exception that the ultimate elongation shall be calculated from the following equation:

$$UE = \frac{(a - b)}{2b + c} \times 200$$

where:

a = distance between center punch marks at instant of break
b = distance between center punch marks before stretching
c = circumference of spool
UE = ultimate elongation in percent.

4.5.8 Ultimate elongation and tensile strength after aging at 158° F. The O-rings shall be subjected to accelerated air aging in accordance with MIL-P-5516, class B materials, with the exception that the aging period shall be 96 hours. The O-ring shall then be subjected to the ultimate elongation and tensile strength test specified in 4.5.7.

*4.5.9 Permanent set, initial (82° ± 5° F). The O-ring shall be subjected to the permanent set test in accordance with the procedure outlined in MIL-P-5516, class B materials, except that the O-ring shall be stretched to an inside diameter equal to 150 percent of the original diameter.

4.5.10 Cut resistance, initial.

4.5.10.1 Apparatus. The apparatus for determining the cut resistance of the O-ring shall consist of a hardened steel anvil and a wedged shaped cutter with an included angle of 22°. A steel music wire 0.046 inch in diameter shall be imbedded at the apex of the cutter. The cutter shall be secured to the cross head of a universal tester.

4.5.10.2 Procedure. The O-ring shall be cut into three segments and lubricated with silicone grease (DC-11) and placed on the anvil beneath the cutter described in 4.5.10.1. Lower the cutter on the O-ring segments at a rate of 0.1 inch per minute. Cutting of the segments is evidenced by a sharp decrease in the indicated load of the test machine. The temperature of the O-ring for the test shall be 82° ± 5° F.

4.5.11 Cut resistance, after aging for 96 hours at 158° F.

4.5.11.1 Apparatus. The apparatus shall be as specified in 4.5.10.1.

4.5.11.2 Procedure. Each O-ring shall be cut into three segments and aged in an oven for 96 hours at 158° F. After aging, and before testing, the segments shall be conditioned for 16 to 24 hours at 82° ± 5° F. Place the segments of the O-ring on the anvil beneath the cutter and proceed with the test as described in 4.5.10.2. The results of the cutting test shall be expressed in pounds load to cut one O-ring section.

*4.5.12 Hardness. Hardness shall be determined at 76° ± 6° F by the durometer test method as outlined in FED-STD-601. This test shall be performed on hardness test discs which shall be 1/4-inch thick by 1 inch minimum in diameter. The discs shall be compression molded and shall have the formulation specified in 3.2 and a cure equivalent to that in 3.5. They shall not be plied up to the required thickness.

4.5.13 Specific gravity. For the purpose of this specification, specific gravity shall be the ratio of the density of the finished O-ring at 25° Celsius (C) to the density of the same volume of water at 4° C.

4.5.14 Examination of product. Each O-ring shall be carefully examined to determine conformance to the applicable drawings, workmanship, finish trimming, and identification.

*5. PACKAGING

*5.1 Preservation-packaging and packing. Preservation-packaging and packing of the O-rings shall be level A, B, or C, as specified (see 6.2), and in accordance with MIL-P-4861.

*5.2 Marking. In addition to any special markings required in the contract or purchase order, unit packages, intermediate packages, and shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The O-rings covered by this specification are used for retaining the gases in prescribed rocket chambers and for excluding moisture and other foreign material. The rubber compound referred to in 3.2 is required where compatibility with rocket propellant powder and silicone lubricant are desired and where a low-moisture absorption is essential.

*6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification
b. Preproduction test activity (see 3.1)
c. Applicable drawings (see 3.2)
d. Level of preservation-packaging and packing (see 5.1)
e. Special marking, if required (see 5.2).

*6.3 The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodian:
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Preparing activity:
Navy - OS
(Project No. 5330-N055)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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DOCUMENT IDENTIFIER AND TITLE

MIL-P-17553A(OS), Packing, Preformed, O-Ring, Synthetic Rubber

NAME OF ORGANIZATION AND ADDRESS	CONTRACT NUMBER
	MATERIAL PROCURED UNDER A ☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

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