

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS-P-5516

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Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160°F

NOTICE

This document has been taken directly from U.S. Military Specification MIL-P-5516C and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-P-5516C. Any part numbers established by the original specification remain unchanged.

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1. SCOPE:

1.1 This specification covers two classes of preformed packings for use where resistance to hydraulic fluid conforming to specification MIL-H-5606 is required at temperatures from -65° to 160°F.

1.2 Classification:

Packings shall be made from the following classes of synthetic rubber as specified (see 6.2).

Class A - Low Flexibility

Class B - High Flexibility

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2. APPLICABLE DOCUMENTS:

The following publications, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

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

MIL-P-4861	Packing, Preformed, Rubber, Packing, Packaging of
MIL-H-5440	Hydraulic Systems, Aircraft Types I and V, Design Installation, and Data Requirements For
MIL-P-5514	Packing, Installation and Gland Design, Hydraulic, General Requirements For
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-H-6083	Hydraulic Fluid, Petroleum Base Preservative
MIL-S-18729	Steel Plate, Sheet, and Strip, Alloy, 4130, Aircraft Quality
MIL-STD-10	Surface Roughness, Waviness, and Lay
MIL-STD-831	Test Reports, Preparation of
MS 24690	Packing, Preformed, High Pressure Air Valve
MS 28772	Packing, O-Ring, Shock Strut
QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
QQ-B-626	Brass, Leaded and Nonleaded: Rods, Shapes, Forgings, and Flat Products with Finished Edges (Bar, Flat Wire and Strip)
QQ-B-750	Bronze, Phosphor, Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections
FED-STD-601	Rubber: Sampling and Testing
FED-STD-791	Lubricants, Liquid Fuels, and Related Products; Methods of Testing
AN6225	Packing: V-Ring Hydraulic
AN6227	Packing: O-Ring Hydraulic
AN6228	Adapter: V-Ring Female Hydraulic Packing
AN6229	Adapter: V-Ring, Male, Hydraulic Packing
AN6230	Gasket: O-Ring Hydraulic
AN6238	Gasket: Replaceable Reservoir Type Filter Element
ANA Bulletin No. 438	Age Controls for Synthetic Rubber Parts

2.2 ASTM Publications:

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

ASTM D 91 Method of Test for Precipitation Number of Lubricating Oils

ASTM D 1329 Tentative Method of Test for Evaluating Low Temperature Characteristics of Rubber and Rubber-Like Materials by a Temperature-Retracton Procedure (TR Test)

3. REQUIREMENTS:

3.1 Qualification:

The packings furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein and has been listed on or approved for listing on the applicable qualified products list.

3.2 Material:

The packings shall be manufactured from a synthetic rubber which is compatible with hydraulic fluid conforming to specification MIL-H-5606. The synthetic rubber shall contain no substances which will adversely affect the properties of the fluid or the packings.

3.3 Design and construction:

3.3.1 Dimensions: Dimensions and tolerances shall be as specified on AN6225, AN6227, AN6229, AN6230, AN6238, MS24690, and MS 28772 or in the contract (see 6.2).

3.3.2 Splicing: Splicing of cured rubber shall not be used in the manufacture of the packings. Splicing of uncured stock is allowable.

3.4 Physical properties:

Physical properties of the synthetic rubber shall conform to Table I.

3.4.1 The maximum permissible variations in original physical properties during actual production from those values established during qualification tests shall be within the limits specified in Table II, but must stay within the limits specified in Table I.

3.5 Finish:

Mold flash shall be removed from the packings in such a manner that they conform to the requirements specified herein and on applicable standards. All surfaces of the packings shall be reasonably free from defects, blemishes, or irregularities. Reasonable shall be defined as allowing minor pits, raised spots, or tool marks which shall not be greater than 0.003 inch in height or depth from the packing surface.

3.6 Performance:

- 3.6.1 Leakage and breakout: Packings shall not exceed specified values when tested as described in section 4. There shall be no evidence of wear, extrusion, disintegration, or excessive permanent set.
- 3.6.2 Cycling: Packings shall withstand the operations specified in section 4. Leakage shall not exceed values specified in section 4. After test, the packings shall be serviceable with no evidence of cracking, flaking, excessive wear, or other malfunctioning.
- 3.6.3 Fatigue: All o-ring type packings when tested in section 4 shall perform without fatigue failure.

TABLE I. - Original physical properties

Property	Class A	Class B
Specific gravity	As determined ¹	As determined ¹
Hardness at 24° ± 3° C.(75° ± 5°F) shore A durometer, minimum	88	68
Tensile strength, psi	As determined	As determined ¹
Elongation, ultimate, percent	As determined	As determined ¹
Tensile stress (modulus), psi at 100 percent elongation	Not required	As determined ¹
Permanent set, percent	As determined at 50 percent elongation	Not greater than 4 percent at 150 percent elongation
Temperature retraction, 50 percent elongation and 10 percent return		As determined ¹
Tear resistance of AN6227-28 O-rings, minimum of 2 pounds		As determined ¹
Permissible change in original physical properties after oil and air aging		
Tensile strength, change percent	As determined	As determined ²
Elongation change, percent	As determined	As determined ²
Hardness change, points, Shore A durometer	As determined (See 4.5.2)	As determined (See 4.5.2)
Permanent set (list actual value)	As determined	As determined ²
Volumetric change upon aging in hydraulic oil, percent ²	0 to +5 percent ²	0 to +10 percent for O-ring ²
Corrosion adhesion	None ²	None ²
Temperature retraction 50 percent elongation and 10 percent return		-45 F or lower ²

¹Tests are to be made on AN6227 or AN62230 O-rings or AN6225 V-rings, as applicable. All other tests are to be performed on platen sheets or hardness samples, as applicable. (Hardness shall not be determined from actual packing rings).

²Tests are to be made on AN6227 or AN6230 O-rings, and on AN6225 V-rings, as applicable.

TABLE II. Maximum production permissible variations in physical properties from contractors' qualification values (see service approval report for limiting production values for a given compound)

Property	Class A	Class B
Specific gravity, points	$\pm 0.02^1$	$\pm 0.02^1$
Hardness, shore A durometer at $24^\circ \pm 3^\circ\text{C}$. ($75^\circ \pm 5^\circ\text{F}$), points	$\pm 3^2$	$\pm 3^2$
Tensile strength, percent	± 15	± 15
Elongation, percent	± 20	± 20
Modulus, pounds, percent	Not required	± 25
Permanent set, percent	± 20	± 20
Temperature retraction 50 percent elongation and 10 percent return.		$\pm 3^\circ\text{F}$
Corrosion and adhesion	Slight corrosion on steel	Slight corrosion on steel
Volume change	Swell determined from Qualification test value ± 2 (see example, ³ but must stay within limits specified in Table I.	

¹If basic specific gravity is 1.30, then limits can be 1.28 to 1.32.

²Shore hardness on production samples shall be not less than 85 for class A material, nor 65 for class B material with this tolerance applied.

³Example: If qualification swell of O-ring is +1 percent, then limits can be 0 to 3 percent; if +5 percent, then limits can be 3 to 7 percent; or if +8 percent, then limits can be 6 to 10 percent.

3.6.4 Crush: Class B materials shall be capable of withstanding high compressive loads without cracking, or otherwise disintegration, when tested in accordance with section 4.

3.7 Identification of Product:

The following general marking shall be used.

3.7.1 O-ring packings shall be identified in relation to the manufacturer and in conformance to this specification by a proper label on the package.

TABLE III. - Test samples required for Qualification tests
Physical Property Test

Tests	AN6225 V-ring		AN6227 O-ring		
	-20	-25	-19	-23	-28
Unaged samples (table I):					
Specific gravity	Use untested rings listed below for this test				
Tensile strength and elongation				3	3
Tensile stress (modulus)				2	2
Permanent set			2		
Temperature retraction 50/10				1	
Tear resistance of O-ring packings					2
Corrosion and adhesion	5		5		
Air-aged (table I):					
Tensile strength and elongation				3	3
Permanent set			2		
Oil-aged (table I):					
Tensile strength and elongation				3	3
Permanent set			2		
Temperature retraction 50/10				2	
Volumetric change	6	6		6	6
Subtotal (physicals)	11	6	11	20	19

Performance and Endurance Tests

Endurance (unaged)	2	4	1	3	2
Performance and endurance (aged)	4	4	2	4	2
Fatigue (new, air, and oil-aged)			6	6	6
Crush test (new, air, and oil-aged)			12		
Subtotal (Performance)	6	8	21	13	10
Additional samples required by Federal Test Method Standard No. 601.			18	18	18
Total (all tests)	17	14	50	51	47

3.7.2 V-ring packings shall have the manufacturer's trademark and the applicable size dash number molded into the surface of the inner Vee close to the apex of the angle. If any other marking is used, it shall be specially approved by the procuring activity. If raised figures are used, the height shall not exceed 0.010 inch.

3.8 Age:

Unless otherwise specified the age limitations for the finished product shall conform to ANA Bulletin No. 438.

3.9 Workmanship:

Workmanship and finish shall be in accordance with the highest grade practice in manufacturing this kind of product. Manufacturing practices shall be such that the physical properties of the finished product shall be uniform through the cross section of the packing.

3.9.1 O-ring packings may be off-register due to mold misalignment to the limit of the ring dimensions still being within specified tolerances, and ring finish being as specified.

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, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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.

4.2 Classification of tests:

The inspection and testing of packings shall be as follows:

- (a) Qualification tests (see 4.3).
- (b) Acceptance tests (see 4.4).

4.3 Qualification tests.

4.3.1 Sampling instructions: The Qualification test samples shall consist of the following:

(a) Class A material

17 AN6225-20

14 AN6225-25

3 Platen press sheets (0.075" x at least 4 3/4" x 4 3/4")

3 ASTM hardness test disks, 1/4 inch thick by 1 inch diameter

(b) Class B material

50 AN 6227-19

51 AN6227-23

47 AN6227-28

3 ASTM hardness test disks, 1/4 inch thick by 1 inch diameter

4.3.1.1 Platen press sheets and discs shall have the same compounding and equivalent cure as the accompanying packings, and the packings shall represent the manufacturer's production product, particularly with respect to stock preparation, mold design and finish, and molding technique. Proper identification shall be applied to each packing using expected production marking compound and technique and color.

4.3.2 Tests: The qualification tests shall consist of all the following tests:

Class A

- | | |
|--|--------------------------|
| (a) Examination of product | (4.4.1) |
| (b) Specific gravity (new only) | (4.5.1.6) |
| (c) Shore durometer hardness (new, air and oil aged) | (4.5.1.1) |
| (d) Tensile strength (new, air and oil aged) | (4.5.1.2) |
| (e) Ultimate elongation (new, air and oil aged) | (4.5.1.2) |
| (f) Permanent set (new, air and oil aged) | (4.5.1.2 and
4.5.1.4) |
| (g) Corrosion and adhesion (new only) | (4.5.4) |
| (h) Volume change (oil aged only) | (4.5.2.2) |
| (i) High and low temperature performance | (4.5.5.1 and
4.5.5.2) |
| (j) Endurance cycling tests | (4.5.6.1 and
4.5.6.2) |

4.3.2 (Continued):

Class B

The packings in this class shall be subjected to the same tests as class A. In addition, the following tests shall be made:

- | | |
|------------------------------|--------------------------|
| (a) Ultimate elongation | (4.5.1.3) |
| (b) Tensile strength | (4.5.1.3) |
| (c) Tensile stress (modulus) | (4.5.1.3) |
| (d) Tear resistance | (4.5.1.7) |
| (e) Fatigue test | (4.5.6.3) |
| (f) Crush test | (4.5.6.4) |
| (g) Permanent set | (4.5.1.3 and
4.5.1.5) |
| (h) Temperature retraction | (4.5.3) |

4.4 Acceptance tests:

- | | |
|------------------------------|---------|
| (a) Examination of product | (4.4.1) |
| (b) Batch tests | (4.4.2) |
| (c) Finished product tests | (4.4.3) |
| (d) Process monitoring tests | (4.4.4) |

4.4.1 Examination of product: Each packing and gasket shall be carefully examined to determine conformance to the applicable drawings, workmanship, finish, marking and applicable standards.

4.4.1.1 Dimensions: Packings shall be checked for cross-sectional dimensions and inside and outside diameters. All dimensions shall conform to the applicable standards as specified in 3.3.1, "Shape and dimensions." The cross section and stack height of V-ring packings shall be checked in "go" and "no go" templates similar to the type indicated in figure 1. Diameters and concentricity of V-rings shall be checked as shown in figure 2, sheets 1 and 2. The general type of gage shown in figures 1 and 2 may be used in applicable form on other types of packing.

4.4.2 Batch tests: The batch shall consist of the quantity of material compounded at any one time and ready for molding and curing into the finished product. Acceptance of the batch shall in no case be construed as a guaranty of the acceptance of the finished product.

- 4.4.2.1 Test specimens: Test specimens shall be molded from each batch and finished with the same state of cure as the finished product. Test specimens for the purpose of batch testing shall consist of one compression molded hardness specimen (1/4 inch thick and 1 inch diameter minimum) and three dumbell specimens cut with a No. III or No. VII die, conforming to Federal Test Method Standard No. 601, Method 4111, obtained from one 0.075 inch thick platen sheet.
- 4.4.2.2 Tests: The tests shall consist of those tests specified under "Test Methods" (4.5) for the following properties:
- | | |
|--------------------------------|-----------------------|
| (a) Hardness | (4.5.1.1) |
| (b) Specific gravity | (4.5.1.6) |
| *(c) Tensile strength | (4.5.1.2 and 4.5.1.3) |
| *(d) Ultimate elongation | (4.5.1.2 and 4.5.1.3) |
| *(e) Modulus @ 100% elongation | (4.5.1.2 and 4.5.1.3) |
- *(To be used for monitoring only since values for dumbells were not established at qualification -- not cause for rejection in this case. Values shall be recorded as part of the inspection records.)
- 4.4.2.3 Rejection and retest: Failure of any of the test specimens to conform to the acceptance requirements of this specification shall be cause for rejection of the batch represented. A batch that has been rejected may be reworked to correct the deficiencies and re-submitted for acceptance.
- 4.4.3 Finished product tests: Tests shall be performed on unaged specimens from each day's production of the specific sizes for which physical property values were established at qualification. These specimens shall be provided by the manufacturer, molded concurrently with other production parts. Variation in physical properties shall not exceed those specified in Table II and those contained in the Service and Qualification Approval Report.
- 4.4.3.1 Test specimens: For Class A material, one platen sheet (0.075" x at least 4 3/4" x 4 3/4") shall be molded concurrently with other production parts using the same production techniques. For class B material, six AN6227-23 or six AN6227-28 O-rings shall be selected at random from each day's production or molded concurrently with other production parts using the same production techniques.
- 4.4.3.2 Tests: The tests shall consist of those tests specified under "Test Methods" (4.5) for the following properties:
- | |
|-------------------------|
| (a) Specific gravity |
| (b) Tensile strength |
| (c) Ultimate elongation |
| (d) Modulus @ 100% |

- 4.4.3.3 Rejection and retest: Failure of any of the test specimens to conform to the acceptance requirements of this specification shall require a retesting of an additional set of test specimens. In the event of failure of any specimens in the retest, the finished products represented by the specimens shall be withheld from acceptance until the extent and cause of failure has been determined and correction verified by additional tests.
- 4.4.4 Process monitoring test: Tests shall be performed at six month intervals on unaged specimens of the specific sizes for which physical property values were established at qualification. These specimens shall be provided by the manufacturer, molded concurrently with other production parts.
- 4.4.4.1 Test specimens: For Class A material, eight AN6225-20 V-rings and two 0.075 inch thick dumbbells and for Class B material, ten AN6227-19 and seven AN6227-23 O-rings shall be selected at random from production or shall be molded concurrently with other production parts using the same production techniques.
- 4.4.4.2 Tests: The tests shall consist of those tests specified under "Test Methods" (4.5) for the following properties, using the number and sizes of specimens indicated:
- Class A Material
- (a) Permanent set
 - (b) Corrosion and adhesion
 - (c) Volume change
- Class B Material
- (a) Permanent set
 - (b) Temperature retraction
 - (c) Corrosion and adhesion
 - (d) Volume change
 - (e) Crush
 - (f) Fatigue
- 4.4.4.3 Rejection and retest: Failure of any of the test specimens to conform to the process evaluation requirements of this specification shall require a retesting of an additional set of specimens. In the event of failure of any of the test specimens in the retest no finished products on hand or later production shall be accepted until the extent and cause of failure have been determined, corrected and action taken to preclude recurrence. After correction, all of the tests in 4.4.3.2 will be repeated. Full particulars concerning the failure and action taken to correct the deficiencies shall be recorded as part of the inspection records.
- 4.4.4.4 Test conditions: The test fluid shall be an oil which has been listed or approved for listing on QPL-5606 with 26 - 28% swell of standard synthetic rubber. The oil and samples to be aged shall be put into a non-pressurized closed container or a reflux-type condenser to prevent distillation of the volatile matter in the field. A new batch of fluid shall be used for each aging test. In all cases, the ratio of quantity of fluids to the weight of the seals being aged shall be 20 ml of fluid for every gram of seals. Seals shall be loosely separated in the fluids.

4.5 Test methods:

4.5.1 Original physical properties of material: The physical properties listed below shall be determined as specified in Federal Test Method Standard No. 601, table I herein, and as noted. During qualification tests only, the manufacturer shall report all values for each sample tested as well as the average value for each size:

- (a) Hardness: Method 3021
- (b) Tensile strength: Method 4111
- (c) Ultimate elongation: Method 4121
- (d) Tensile stress (modulus): Method 4131
- (e) Permanent set: See 4.5.1.4 or 4.5.1.5
- (f) Specific gravity: Method 14011
- (g) Tear resistance: See 4.5.1.7

4.5.1.1 Hardness: Hardness of both class A and class B compounds shall be determined as specified in 4.5.1, except that test samples shall be compression molded 1/4 inch thick, and shall be no smaller than 1 inch in diameter. Two 1/8 inch sheets shall not be used. Hardness checks shall not be made on actual packings.

4.5.1.2 Class A material specimens: Tensile strength, ultimate elongation, tensile stress (modulus), and permanent set, of class A material only, shall be made on standard dumbbell specimen made of 0.075 inch platen sheets. (See 4.5.1)

4.5.1.3 Class B material specimens: Tensile strength, ultimate elongation, tensile stress (modulus) and permanent set, for class B materials, shall be made on actual qualification samples of AN6227 rings. Quantities and sizes of samples tested shall be in accordance with table III. The acceptance test samples can not be sizes other than those listed in Table III. All pull-type tests (tensile, elongation, etc.) on continuous-type rings shall be made in a Scott test machine, or equivalent, equipped with driven (rotating) Scott ring spool tester attachment. Gage marks for determination of elongation, etc., shall be taken from center punch marks in the center of each spool. The distance between spool centers shall be set to a proper value to give approximately zero elongation in the ring at the start of each separate pull test. During the test, the spools shall separate at a speed of 20 inches per minute.

4.5.1.4 Class A material permanent set: Permanent set test for Class A material shall be made by stretching the dumbbell specimen at the rate of 2 inches per minute to an elongation of 50 percent, holding for 10 minutes, releasing the load, and measure set after 10 minutes' rest.

4.5.1.5 Class B material permanent set: Permanent set tests for Class B material shall be made on AN6227-19 O-rings as specified in table III, by measuring the ID and then stretching over a tapered cone until the ID of the seal has been stretched 150 percent of original diameter. (Example: If ID of specimen measures 0.990 inch, the ring shall be stretched to 1.485 inches, thus making a new ID of 2.475 inches.) Ring shall be held in this stretched state for 10 minutes, removed from the cone, and the new ID determined after 10 minutes' rest. Permanent set shall be calculated from the as-measured ID before and after the test. Any breaking or cracking of the test samples shall be cause for rejection.

- 4.5.1.6 Specific gravity: Specific gravity for both class A and B materials shall be determined on the finished AN6225, AN6227, or AN6230 rings, as applicable.
- 4.5.1.7 Tear resistance of O-ring packings: Tear resistance shall be determined on class B compound AN6227-28 O-ring packings only for qualification tests. The test shall be conducted on at least two samples. (See table III). In conducting the test, the ring shall be split on the centerline of the cross section in the manner indicated on figure 4, and the tear test made in two planes, one with the mold seam and the second at right angles to the mold seam. A Scott test machine, or equivalent, may be used. Tear values recorded in the tear test shall be obtained with a rate of 2 inches per minute motion of the lower jaw of the machine (table I).
- 4.5.2 Physical properties after aging:
- 4.5.2.1 Change in tensile strength, elongation, permanent set, and hardness: Air aging of samples (see tables I and III) shall be conducted as specified in Federal Test Method Standard No. 601, Method 7221. Oil aging shall be accomplished by immersing in Specification MIL-H-5606 hydraulic oil, for a period of 7 days at $70^{\circ} \pm 1^{\circ}\text{C}$ ($158^{\circ} \pm 2^{\circ}\text{F}$). The tensile strength, elongation, permanent set, and hardness shall be determined on the aged specimens in accordance with 4.5.1. The percentage difference between aged and unaged values for tensile strength and elongation (table I), and the actual values for change in hardness and permanent set (table I) shall be recorded.
- 4.5.2.2 Volumetric change: Swelling shall be determined as specified in Federal Test Method Standard No. 601, Method 6211, except that for both class A and class B materials, the specimens shall be qualification sample packings or gaskets of the sizes and quantities listed in table III. The period of immersion shall be 7 days. The fluid shall be hydraulic oil conforming to Specification MIL-H-5606, as specified in 4.4.4.4, maintained at a temperature of $70^{\circ} \pm 1^{\circ}\text{C}$ ($158^{\circ} \pm 2^{\circ}\text{F}$). The volumetric change shall not exceed the value specified in table I.
- 4.5.3 Temperature retraction:
- 4.5.3.1 Unaged: This test shall be in accordance with ASTM D1329, except that AN6227-23 O-ring samples shall be used and 4 or 6 samples may be tested. The rate of warming shall be $1/2^{\circ}\text{C}$. (1°F) per minute. The temperature retraction 50/10 reading of these unaged seals shall be determined and recorded. A suggested temperature retraction apparatus is shown in figure 3.
- 4.5.3.2 Aged: To determine the change in temperature retraction after aging, the test specified in 4.5.3.1 shall be repeated on applicable specimens. Two AN6227-23 rings shall be aged for 7 days in Specification MIL-H-5606 fluid at a temperature of $70^{\circ} \pm 1^{\circ}\text{C}$ ($158^{\circ} \pm 2^{\circ}\text{F}$). An O-ring compound having a temperature retraction 50/10 value of -43°C (-45°F) or colder, shall be subjected to a cold performance test.
- 4.5.3.3 Aging: Aging of the two AN6227-23 rings for the temperature retraction tests shall be accomplished by placing the rings in a small 4 ounce screw-top jar and covering them with 56 ml of Specification MIL-H-5606 oil. A screw-type lid shall be placed snugly on the jar and the jar shall be put into an aging oven with the fluid temperature maintained at $158^{\circ} \pm 2^{\circ}\text{F}$ for 7 days.

4.5.4 Corrosion and adhesion: Packings or gaskets of the type required for qualification tests (in quantities and sizes specified in table III, shall be prepared for corrosion testing by inserting sufficient quantities of the seals in a desiccator or similar humidity chamber maintained at 92 percent minimum relative humidity and at $75^{\circ} \pm 5^{\circ}\text{F}$, temperature for 72 hours minimum. Metallic plates of the metals listed below shall be polished to a surface roughness of 5 to 15 microinches rms finish. The edges shall also be polished to reduce the formation of edge corrosion. Plates shall be washed with precipitation naphtha, as specified in Method 3101 of Federal Test Method Standard No. 791, ASTM Method No. D 91, or similar degreasing agent. The metals used shall be as follows:

- (a) Aluminum alloy: Specification QQ-A-250/4
- (b) Brass: Specification QQ-B-626, composition 2
- (c) Phosphor bronze: Specification QQ-P-750
- (d) Steel: Specification MIL-S-18729, condition N

The humidified seals and the metallic plates shall be immersed in Specification MIL-H-6083 type I fluid and drained to the drip point. The seals and plates shall then be so laid together in a stack that at least two seals contact each specified metal. The stack shall be held together with a pressure of 20 to 30 pounds and placed in a desiccator which is maintained at not less than 92 percent relative humidity at $24^{\circ} \pm 3^{\circ}\text{C}$. ($75^{\circ} \pm 5^{\circ}\text{F}$). (Di-potassium acid phosphate, K_2HPO_4 , when placed in distilled water in sufficient quantity to produce a concentrated solution, will maintain approximately 92 percent humidity in a sealed desiccator at 20°C . (68°F) temperature). Time of immersion for this portion of test shall be 96 hours minimum for all acceptance tests and 14 days minimum for all qualification test analyses. No more than 15 minutes should elapse between the time the test samples are removed from the prehumidifying chamber and placed in the stacked condition in the second humidity chamber. At the termination of this test, the procedure outlined below shall be followed:

- (1) The surfaces of the plates which were in contact with the seals shall be inspected for discoloration, deposits, pitting, etc. If any exists, the surfaces of the plates shall be washed in precipitation naphtha. Deposits determined as rubber compounds or elements therefrom, which can be removed by this process and which do not occur on the separate control plates, shall be construed as adhesion.
- (2) Any pits or eroded marks remaining after this process shall be construed to be corrosion. Discoloration or staining (marks which do not physically affect the surface of the plates and which easily wash or buff off) shall not be considered detrimental. If any doubt should arise about the presence of pitting, erosion, or corrosion on the metal plates, a microscope of approximately 10- to 15-power magnification shall be used to determine the actual condition.

4.5.5 Performance tests: The following performance tests shall be conducted in the sequence listed. All packings shall be installed in the applicable glands of a test cylinder similar to figure 5, and the cylinder filled with hydraulic oil conforming to Specification MIL-H-5606 at no pressure. The cylinder with packings installed shall be maintained at $70^{\circ} \pm 1^{\circ}\text{C}$ ($158^{\circ} \pm 2^{\circ}\text{F}$) for 6 days prior to performance tests. All packings and the metals in contact with the packings shall be inspected at termination of this period for sticky or gummy residue, permanent set, or swelling of the packings and discoloration or corrosion of the metals. These data shall be recorded for use in conjunction with later results of the test for evaluation of performance.

4.5.5.1 High-temperature performance:

4.5.5.1.1 High-temperature leakage: At completion of the preceding preparation, the packings shall be installed in a controlled temperature chamber as indicated in figure 6 (only the apparatus indicated within the upper left-hand corner of figure 6 is applicable to this test). The hydraulic fluid used for testing shall be the type conforming to Specification MIL-H-5606. The pressure in the entire system shall be raised to 1,500 psi with the piston near one end of the cylinder, but not bottomed, and necessary valves adjusted to prevent motion. The temperature in the test box shall be raised to 71°C (160°F) minimum within a period of 60 minutes, and shall remain at this temperature and pressure for 24 hours. Upon completion of the 24-hour period, the following cycling and static operations shall be accomplished in the order listed. (The specified temperature shall be maintained throughout the test.)

- (a) High-pressure cycling: At least 10 cycles of operation at a 1,500 psi pressure shall be made by opening the proper valves between the cylinder and the accumulator and bleeding pressure from the opposite end of the cylinder to the reservoir.
- (b) Low-pressure cycling: At least 10 cycles of operation at low pressure shall be made by opening the proper valves between the cylinder and the reservoir and bleeding just enough pressure from the accumulator to cycle the cylinder at slow motion. The pressure shall be recorded.
- (c) Low-pressure static: The hydraulic pressure in the test cylinder shall be lowered to 5 to 10 psi pressure and the installation allowed to set for 1 hour to determine low-pressure static leakage.

The total leakage during entire test shall not exceed three drops (approximately 0.15 cc) from each packing gland. The leakage shall be recorded.

4.5.5.1.2 High-temperature breakout: Upon completion of the high temperature leakage test, the hydraulic pressure in the entire system shall be again pumped up to 1,500 psi. With the piston held static and a 1,500 psi pressure maintained, the temperature in the box shall be maintained at 71°C (160°F) minimum for 3 hours after which time the source of heat shall be turned off and the entire apparatus allowed to cool to room temperature over approximately a 20-hour period. Pressure shall not fall below 1,000 psi during this 20-hour period. A no-load breakout test shall then be performed by closing the valve between the accumulator and cylinder, exhausting the pressure in each end of the test cylinder simultaneously, and recording the lowest pressure necessary to start motion of the piston. The pressure required for breakout shall not exceed

4.5.5.1.2 (Continued):

40 psi for O-ring and 30 psi for V-ring packings. Leakage during the period of this portion of the test shall not exceed two drops (approximately 0.10 cc) per gland. Breakout pressure and leakage shall be recorded.

4.5.5.2 Low-temperature performance:

4.5.5.2.1 Leakage at low temperature: The same apparatus and packing rings used in previous tests shall be charged to 1,500 psi at room temperature, the accumulator pressure isolated from the test cylinder by closing the valves between the cylinder and accumulator and the cylinder pressure allowed to fall to 5 to 10 psi. Temperature shall be lowered to the range of -54° to -57°C. (-65° to -70°F) within 1 hour and held for at least 72 hours. The following cycling and static operations shall then be performed in the order specified, using fluid no warmer than -54°C (-65°F):

- (a) Low-pressure cycling: At the end of this time, the piston shall be cycled at no-load pressure for at least 10 cycles by opening the proper valves between the cylinder and reservoir and bleeding sufficient pressure from the accumulator to move the piston at the minimum pressure not to exceed 50 psi. The pressure shall be recorded. (The pressure in the cylinder shall not be permitted to exceed 50 psi at any time during these 10 cycles, as by bottoming the piston, etc.).
- (b) High-pressure cycling: The piston shall be cycled under high-pressure operation for at least 10 cycles by opening the proper valves between the cylinder and accumulator and bleeding pressure from the opposite end of the cylinder to the reservoir. Minimum cycling pressure permitted during this test is 1,500 psi.
- (c) High-pressure static: With the valves closed between the cylinder and the reservoir, the valves between accumulator and cylinder shall be opened to allow a static pressure of 1,500 psi minimum to both sides of piston without causing motion. The apparatus shall be allowed to set for 1 hour. Pressure shall then be reduced to zero psi and the apparatus allowed to warm up to room temperature over an 18-hour period.

NOTE: At the start of (a), (b), and (c), the piston rod shall be forcefully moved from side to side in each of two planes, 90° apart.

Leakage during this entire test shall not exceed 20 drops (approximately 1.0 cc) per gland. Leakage for V-rings during the entire test shall not exceed 10 cc per gland. 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 after or during the entire performance tests. The leakage shall be recorded.

4.5.6 Endurance tests:

- 4.5.6.1 Cycling tests of aged ring: The same packings as were used in the performance test (4.5.5) shall be reinstalled in a test cylinder conforming to figure 7. The cylinder shall be installed in a test apparatus conforming to figure 6 (only the portion of the figure 6 deleting temperature apparatus is applicable to this test). This test machine 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 to 14.7 psi absolute pressure). Test conditions shall be as follows:

Oil: Specification MIL-H-5606

Temperature: $49^{\circ} \pm 6^{\circ}\text{C}$ ($120^{\circ} \pm 10^{\circ}\text{F}$).

Stroke: 4-inch minimum

Operating pressure: 1,100 to 1,500 psi driving, and 1,500 psi minimum loading.

Rate of cycling: 30 cycles per minute minimum, total 70,000 cycles minimum with thick (nonbreathing) cylinders used.

Standby period: Internal pressure of 1,500 psi shall be applied statistically for at least a 17-hour period after every second days' cycling. Standby pressure shall be 5 to 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

- 4.5.6.1.1 Leakage during entire cycling test, including standby, shall not exceed an average of 1cc per 1,000 cycles of operation (approximately 2 drops per 100 cycles) per gland. Leakage over the last 5,000 cycles of operation shall not exceed 10 cc. The leakage shall be recorded.
- 4.5.6.2 Cycling tests of new rings: A second set of new packing rings (as molded with no aging) shall be installed in a life test cylinder in accordance with figure 7, as used in the cycling tests of aged rings and cycled under identical conditions of pressure, temperate, stroke and speed of cycling, standby, and total number of cycles, except that the O-ring adapters shall be V-grooves as noted in figure 7. All test data shall be recorded.
- 4.5.6.2.1 Leakage of the new rings shall not exceed the rate allowed under endurance cycling of aged packings. The leakage shall be recorded.
- 4.5.6.2.2 The right is reserved by the Services to conduct cycling tests on air-aged rings in rectangular grooves and on oil-aged rings in V-grooves if additional data is considered necessary by the Services to evaluate the manufacturer's product.
- 4.5.6.3 Fatigue test of O-ring packings and gaskets: Two unaged O-rings each of sizes AN6227-19, -23, and -28, shall be tested in a fatigue machine as described in figure 8, and the conditions set up herein. The rings shall be installed in the fatigue machine on the proper size grooves as noted in figure 8, with the nominal ID of the O-ring stretched 15 percent. The driving roll shall rotate at $1,750 \pm 50$ rpm. All rings shall last 12 hours of rotation in the machine without signs of

4.5.6.3 (Continued):

cracking, flaking, wear, or other deterioration, or failure. The rotation need not be continuous, but the 15 percent stretch should not be maintained during extended periods of no rotation, and the maximum test time specified should be the summation of only those periods of time in which rotation takes place. If failure is due to method of testing, a repeat test may be conducted on those size and type samples which fail the test. Two samples shall be used for each failed sample when conducting the repeat test. Repeat testing shall not be allowed if failure resulted from inadequate product quality. The test data shall be recorded.

4.5.6.4 Crush test: Nine AN6227-19 O-rings, as applicable, shall be chosen for this test. Three rings shall be aged in oil; and three rings shall be aged in air for a period of 7 days at $70^{\circ} \pm 1^{\circ}\text{C}$ ($158^{\circ} \pm 2^{\circ}\text{F}$). The oil to be used shall be designated by the Services and shall conform to Specification MIL-H-5606. The six aged and three unaged rings shall each be twisted (inside out) one-half turn about the cross section and laid between rigid iron or steel plates with a surface finish of 32 to 63 micro-inches in accordance with Standard MIL-STD-10. This may be obtained by sandblasting a commercial grind finish, as indicated in figure 9. The air-aged rings shall be laid together in one layer, the oil aged in a second layer, and the unaged rings in a third layer. The stack shall then be subjected to a constant axial compression load of 16,800 pounds, or 5,600 pounds for each ring in a layer (number of layers does not affect the applied load) for the AN6227-19 O-ring stack. The stack shall be left in the compressed state for 20 hours and then each ring removed and inspected immediately for cracking or disintegration. The rings shall be laid away at room temperature in a free condition and the permanent set of seal cross section determined at the end of 6 hours. All specimens shall have no cracking or disintegration evident. The cross-sectional dimensions of all tested specimens shall have attained at least 80 percent at the thinnest section based on its "as-manufactured" size. This can be measured with a thin metal template.

4.5.6.4.1 Quality control crush tests: Quality control tests shall be conducted in accordance with the above, except that new unaged rings only shall be tested.

4.6 Packing, packaging, and marking:

The inspector shall ascertain that the packing, packaging, and marking of the seals conform to this specification.

5. PREPARATION FOR DELIVERY:

5.1 Packaging, packing and marking:

Packaging, packing, and marking for the three levels of packaging and packing shall be in accordance with Specification MIL-P-4861 (see 6.2).

6. NOTES:

6.1 Intended use:

This specification covers packings and gaskets intended for use at a temperature range of -65° to 160°F in hydraulic systems in accordance with Specification MIL-P-5514, MIL-H-5440, and shock absorbers. These rings should not be used in conjunction with any hydraulic fluid other than that conforming to Specification MIL-H-5606, unless otherwise specified by the procuring activity.

6.1.1 V-ring, class A packings, and O-ring, class B packings, are intended for use in shock absorber struts, actuating cylinders, valves, and in all parts of hydraulic mechanisms with operating pressure of from 0 to 1,500 psi, except that O-rings can be used at higher pressures in accordance with Specification MIL-P-5514.

6.1.2 U-cup-type packings of class B material for use in hydraulic systems, brake cylinders, brake valves, and other similar mechanisms must be made of suitable compounds and tested by the user of the cups to the applicable requirements of this specification, except that tests will be made in the individual units for which the cups were designed, under normal operating pressures and representative conditions, including extreme temperature requirements.

6.1.3 D-ring-type packings are intended for use in landing gear shock strut as rod seal only.

6.1.4 Gaskets are intended for use in effecting static seals. (See Specification MIL-P-5514).

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) MS or AN part number of the packing or gasket to be furnished.
- (c) Class of material.
- (d) Selection of applicable levels of packaging, and packing (see 5.1).

6.3 Drawing requirements.

6.3.1 Volumetric swell data: Within 60 days after a packing manufacturer's compound has been approved by the Government, a reprintable graph in Vandyke form should be submitted to the Services showing the result of an 18-day volumetric swell test in Specification MIL-H-5606 fluid at a temperature of 70 ± 1 C (158 ± 2 F). Samples checked should include three packing rings from each cross-sectional size group on the applicable standard packing drawing AN6225 or AN6227. Samples of each size should be placed in a sufficiently large vessel and completely covered with fluid. Once every 24 hours throughout the first 8 days, except 1 day (for Sunday) provided this excepted day does not fall on the seventh day, and once every 48 to 72 hours thereafter until the 18-day minimum is reached, each sample should be removed and the volumetric change determined and recorded. No sample should be out of the fluid for longer than 1/2 hour during this check, and the time of determining the check should be the same during each day of the 18-day

6.3.1 (Continued):

period. The average volumetric change of the three samples of each size tested should be shown in graph form on the same sheet plotted against time in days and volumetric change in percentage. Each line should be identified in relation to the size and type of packing. The graph should also contain the manufacturer's name, compound number, make of fluid used, and should be not greater in size than standard form 8 1/2 by 11 inches.

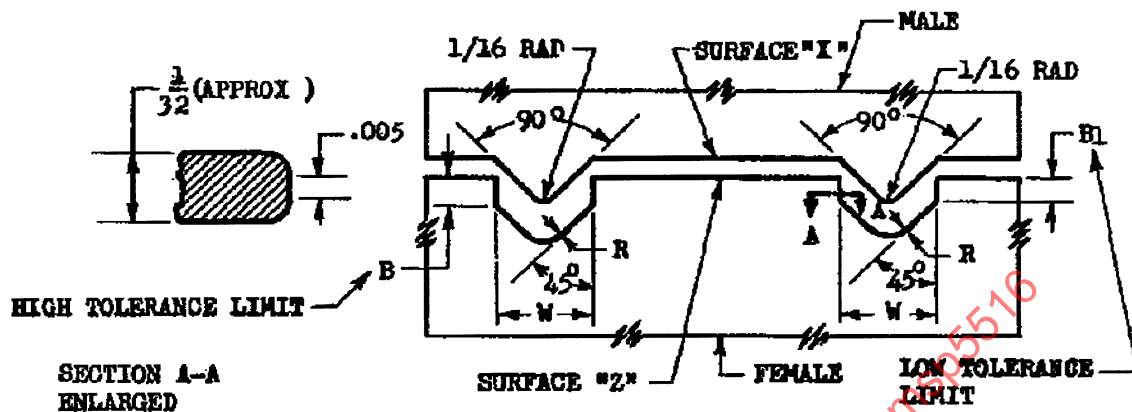
6.4 Qualification:

With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products list is the San Antonio Air Materiel Area, Service Engineering Division, ATTN: MME, Kelly AFB, Texas 78241, and information pertaining to qualification of products may be obtained from that activity.

6.4.1 Test report test samples, and test data. The following shall be furnished to the activity responsible for qualification:

- (a) Test report: Three copies of a test report prepared in accordance with MIL-STD-831. The report shall contain a tabulation of the physical property values obtained during qualification tests. The report shall contain a complete set of photographs showing the packing as mounted for each test and showing details of any failures encountered. Diagrams of test setups shall be provided when not self-explanatory by the photographs.
- (b) A comprehensive description of the manufacturer's performance and endurance test machines, indicating all discrepancies between that machine and the one indicated herein, including gland dimensions, materials, and design, stroke, speed of cycling, fluid temperatures, operating pressures, etc. Exact gland dimensions should be given for each test cylinder.

PREPARED UNDER THE JURISDICTION OF AMS COMMITTEE "CE"



FOR "V" RING PACKING AN6225 DASH NO.	W INCH	R INCH	B INCH	B1 INCH
1 TO 7 INCLUSIVE	.1875	.0625	.093	.073
8 TO 24 INCLUSIVE	.2500	.0625	.093	.073
25 TO 35 INCLUSIVE	.3125	.1093	.150	.130
36 TO 47 INCLUSIVE	.3750	.1250	.166	.146
48 TO 55 INCLUSIVE	.4375	.1563	.207	.187
56 TO 80 INCLUSIVE	.5000	.1563	.207	.187

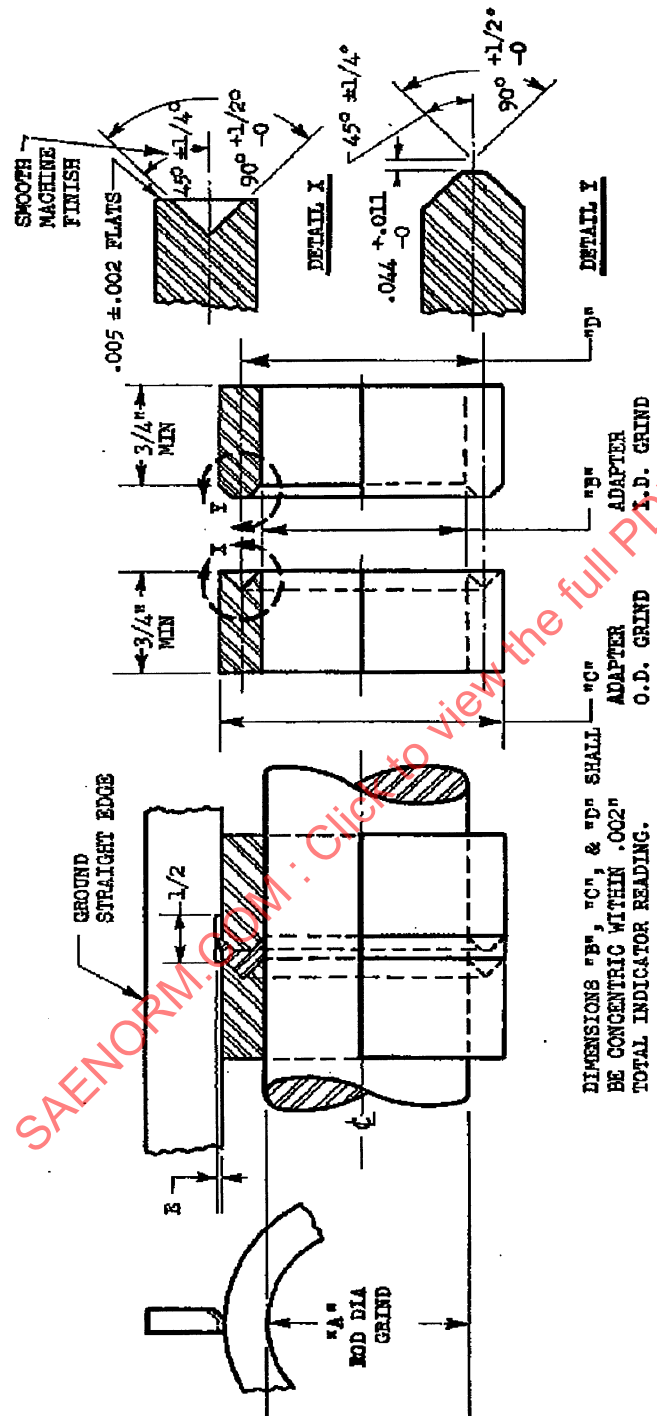
EXAMINATION CHARACTERISTICS WITH APPLICABLE PACKING IN TEMPLATES.

1. SMALLEST PERMISSIBLE STACK HEIGHT INDICATED WHEN SURFACES X AND Z OF LOW TOLERANCE TEMPLATES COME TOGETHER AND ANGLE SURFACES OF BOTH TEMPLATES AND PACKING RING ARE IN CONTACT WITHIN ALLOWABLE ANGULARITY LIMITS OF AN6225.
2. WHEN ANGLE SURFACES OF BOTH TEMPLATE AND PACKING RING ARE IN CONTACT, BUT SURFACES X AND Z ARE APART, REVERT TO HIGH LIMIT TOLERANCE TEMPLATE.
3. HIGHEST PERMISSIBLE STACK HEIGHT INDICATED WHEN SURFACES X AND Z OF HIGH TOLERANCE TEMPLATES COME TOGETHER AND ANGLE SURFACES OF BOTH TEMPLATES AND PACKING RING ARE IN CONTACT WITHIN ALLOWABLE ANGULARITY LIMITS OF AN6225.

NOTE: CARE SHOULD BE TAKEN TO NOT INJURE SEALING LIPS OF PACKING WITH TEMPLATES.

DIMENSIONS IN INCHES. TEMPLATE TOLERANCES, UNLESS OTHERWISE SPECIFIED, $\pm .001$, ANGLES $\pm 1/2$ DEGREE.

FIGURE1. Template for checking cross section of V-ring packings and stack height dimension



1. V-RING SHALL SLIDE ON MANDREL WITH NO LIGHT VISIBLE AROUND ID.
2. V-RING SHALL BE SEATED INTO FEMALE ADAPTER WITH NO DISTORTION OF LIPS (LACK OF CONCENTRICITY BETWEEN V-RING AND FEMALE ADAPTER SHALL NOT BE APPARENT.)
3. WITH BOTH MALE AND FEMALE ADAPTERS PRESSED AGAINST V-RING, BY LIGHT HAND PRESSURE, ON THE MANDREL, A POSITIVE PROJECTION OF THE LIP SHALL BE APPARENT ABOVE THE OD OF THE MALE AND FEMALE ADAPTERS AS SHOWN BY A STRAIGHT EDGE. THIS SHALL BE TRUE OVER ENTIRE 360° OF PERIPHERY.

FIGURE 2 (sheet 1 of 2). Tools and method for inspection of V-ring diameter

AN6225 V-RING DASH NO.	A +.0000 -.0005	B +.0005 -.0000	C +.00025	D +.0005	E MIN. REF.	AN6225 V-RING DASH NO.	A +.0000 -.0005	B +.0005 -.0000	C +.00025	D +.0005	E MIN. REF.
1	.121	.1215	.504	.3125	.0015	41	3.120	3.121	3.880	3.500	.0035
2	.1835	.184	.5665	.375	.0015	42	3.245	3.246	4.005	3.625	.0035
3	.246	.2465	.629	.4375	.0015	43	3.370	3.371	4.130	3.750	.0035
4	.3085	.309	.6915	.500	.0015	44	3.495	3.496	4.255	3.875	.0035
5	.371	.3715	.754	.5625	.0015	45	3.620	3.621	4.380	4.000	.0035
6	.4335	.434	.8165	.625	.0015	46	3.745	3.746	4.505	4.125	.0035
7	.496	.4965	.879	.6875	.0015	47	3.870	3.871	4.630	4.250	.0035
8	.5585	.559	.9415	.750	.0015	48	3.995	3.996	4.755	4.375	.0065
9	.621	.6215	1.004	.8125	.0015	49	4.120	4.121	4.880	4.500	.0065
10	.6835	.684	1.0665	.875	.0015	50	4.245	4.246	5.005	4.625	.0065
11	.746	.7465	1.129	.9375	.0015	51	4.370	4.371	5.130	4.750	.0065
12	.8085	.809	1.1915	1.000	.0015	52	4.495	4.496	5.255	4.875	.0065
13	.871	.8715	1.254	1.0625	.0015	53	4.620	4.621	5.380	5.000	.0065
14	.9335	.934	1.3165	1.125	.0015	54	4.745	4.746	5.505	5.125	.0065
15	.996	.9965	1.379	1.1875	.0015	55	4.870	4.871	5.630	5.250	.0065
16	1.0585	1.059	1.4415	1.250	.0015	56	4.995	4.996	5.755	5.375	.0065
17	1.121	1.1215	1.504	1.3125	.0015	57	5.120	5.121	5.880	5.500	.0065
18	1.1835	1.184	1.5665	1.375	.0015	58	5.245	5.246	6.005	5.625	.0065
19	1.246	1.2465	1.629	1.4375	.0015	59	5.370	5.371	6.130	5.750	.0065
20	1.3085	1.309	1.6915	1.500	.0015	60	5.495	5.496	6.255	5.875	.0065
21	1.371	1.3715	1.754	1.5625	.003	61	5.620	5.621	6.380	6.000	.0065
22	1.4335	1.434	1.8165	1.625	.003	62	5.745	5.746	6.505	6.125	.0065
23	1.496	1.4965	1.879	1.6875	.003	63	5.870	5.871	6.630	6.250	.0065
24	1.5585	1.559	1.9415	1.750	.003	64	5.995	5.996	6.755	6.375	.0065
25	1.621	1.6215	2.004	1.8125	.003	65	6.120	6.121	6.880	6.500	.0065
26	1.6835	1.684	2.0665	1.875	.003	66	6.245	6.246	7.005	6.625	.0065
27	1.746	1.7465	2.129	1.9375	.003	67	6.370	6.371	7.130	6.750	.0065
28	1.8085	1.809	2.1915	2.000	.003	68	6.495	6.496	7.255	6.875	.0065
29	1.871	1.8715	2.254	2.0625	.003	69	6.620	6.621	7.380	7.000	.0065
30	1.9335	1.934	2.3165	2.125	.003	70	6.745	6.746	7.505	7.125	.0065
31	1.996	1.9965	2.379	2.1875	.003	71	6.870	6.871	7.630	7.250	.0065
32	2.0585	2.059	2.4415	2.250	.003	72	6.995	6.996	7.755	7.375	.0065
33	2.121	2.1215	2.504	2.3125	.003	73	7.120	7.121	7.880	7.500	.0065
34	2.1835	2.184	2.5665	2.375	.003	74	7.245	7.246	8.005	7.625	.0065
35	2.246	2.2465	2.629	2.4375	.003	75	7.370	7.371	8.130	7.750	.0065
36	2.3085	2.309	2.6915	2.500	.003	76	7.495	7.496	8.255	7.875	.0065
37	2.371	2.3715	2.754	2.5625	.003	77	7.620	7.621	8.380	8.000	.0065
38	2.4335	2.434	2.8165	2.625	.003	78	7.745	7.746	8.505	8.125	.0065
39	2.496	2.4965	2.879	2.6875	.003	79	7.870	7.871	8.630	8.250	.0065
40	2.5585	2.559	2.9415	2.750	.003	80	7.995	7.996	8.755	8.375	.0065

FIGURE 2 (sheet 2 of 2). Tools and method for inspection of V-ring diameter