

MIL-P-5510C  
4 August 1977

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SUPERSEDING  
MIL-P-5510B  
10 October 1962

## MILITARY SPECIFICATION

### PACKING, PREFORMED, STRAIGHT THREAD TUBE FITTING BOSS, TYPE I HYDRAULIC (-65° TO 160°F)

This specification is approved for use by all Departments  
and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 This specification covers requirements for the material, design, testing and packaging of straight thread tube fitting boss packings.

1.2 Packings covered by this specification are nonmetallic elastomeric material of one grade.

#### 2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids form a part of this specification to the extent specified herein:

#### SPECIFICATIONS

##### Federal

QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
QQ-A-250/11	Aluminum Alloy 6061, Plate and Sheet
QQ-A-250/12	Aluminum Alloy 7075, Plate and Sheet
QQ-S-763	Steel Bar, Shapes, and Forgings - Corrosion Resisting (440C Stainless Steel)
QQ-S-764	Steel Bar, Corrosion Resistant Free Machining (303 Stainless Steel)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: AFML/MXA, WPAFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 5330

**MIL-P-5510C****Military**

MIL-P-4861	Packing, Preformed, Rubber, Packaging of
MIL-F-5506	Fittings, Method of Testing Tube
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance
MIL-H-6083	Hydraulic Fluid Petroleum Base, Preservative
MIL-S-18729	Steel Plate, Sheet, and Strip, Alloy 4130 Aircraft Quality

**STANDARDS****Military**

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-413	Visual Inspection Guide for Rubber O-Rings
MIL-STD-831	Test Reports, Preparation of
MS21344	Fittings-Installation of Flared Tube, Straight Thread Connectors Design Standard For
MS28778	Packing, Preformed, Straight Thread Tube Fitting Boss
MS33656	Fitting End, Standard Dimensions for Flared Tube Connection and Gasket Seal
MS33649	Bosses Fluid Connection, Internal Straight Thread

**Air Force-Navy Aeronautical**

AN814	Plug and Bleeder-Screw-Thread
AN937	Cross-Internal Screw Thread

(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.)

**2.2 Other Publications.** The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

**AMERICAN NATIONAL STANDARDS INSTITUTE**

ANSI B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
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(Application for copies should be addressed to American National Standards Institute, 1430 Broadway, New York, New York 10018.)

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## AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D297	Chemical Analysis of Rubber Products
ASTM D395	Compression Set of Vulcanized Rubber
ASTM D412	Tension Testing of Vulcanized Rubber
ASTM D471	Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids
ASTM D573	Accelerated Aging of Vulcanized Rubber by the Oven Method
ASTM D1329	Evaluating Low-Temperature Characteristics of Rubber and Rubber-Like Materials by a Temperature-Retracton Procedure (TR Test)
ASTM D1414	Rubber O-Rings
ASTM D2240	Indentation Hardness of Rubber and Plastic by Means of a Durometer

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

## 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.

3.1.1 General. The material used shall be suitable as a compression-type seal on straight-threaded, flared-tube connection fittings assembled in MS33656 and MS33649 bosses in accordance with MS21344 and used with MIL-H-5606 hydraulic fluid in hydraulic systems or with air in pneumatic systems. The material shall contain no substances which, when in contact with surrounding components, will adversely affect the components or packings as indicated by tests described in Section 4. The material shall be homogenous to ensure consistent swell, strength, and hardness characteristics throughout the entire batch. Natural rubber shall not be used.

3.1.1.1 Physical Properties. Properties of the materials shall conform to the requirements specified in Table I.

3.1.1.2 Tolerances. The maximum permissible variations in original physical properties during actual production from the values established in the Government test report for qualification testing shall be as specified in Table II. In no case shall the production test values be less than the minimum or exceed the maximum specified in Table I.

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3.2 Shape and Dimensions. Detail shapes, dimensions and tolerances, and markings shall conform to MS28778 and the requirements given herein.

TABLE I. PHYSICAL PROPERTY REQUIREMENTS

Property	Requirement	Test Method	Number of Specimens Each Test	Reference Section 4.6
<u>Original (Unaged)</u>				
Specific gravity	1.25 - 1.45	ASTM D1414 ASTM D297	3	4.6.3
Hardness at 25°C $\pm$ 2 (75° F $\pm$ 1.8) (1)				
Shore A Durometer	88 min.	ASTM D2240	1	4.6.1
Tensile Strength, psi(2)	1450 min.	ASTM D1414 ASTM D412	3 to 5	4.6.2
Elongation, ultimate, percent (2)	80 min.			4.6.2
Tensile stress (Modulus) at 50 percent elongation, psi(2)	500 min.			4.6.2
Temperature retraction, TR-10 (50 percent elongation and 10 percent return)	-43°C (-45°F) max.	ASTM D1414 ASTM D1329	2	4.6.4
Corrosion and adhesion	none		12	4.6.9
<u>Permissible Change in Original Physical Properties after Aging</u>				
Air aged 168 hr at 70°C $\pm$ 1 (158°F $\pm$ 1.8) (3)		ASTM D573		4.6.6
Hardness change, points	0 to +5	ASTM D2240	1	
Tensile strength change, percent	-10 max.	ASTM D1414 ASTM D412	3 to 5	

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TABLE I. CONTINUED

Property	Requirement	Test Method	Number of Samples Each Test	Reference Section 4.6
<u>Permissible Change in Original Physical Properties after Aging (Continued)</u>				
Elongation change, percent of original	-15 max.			
Compression set 25 percent compression	35 max.	ASTM D1414 Method B of ASTM D395	3	4.6.5
Oil aged 168 hr at 70°C $\pm$ 1 (158°F $\pm$ 1.8) in MIL-R-5606 (3)		ASTM D1414 ASTM D471		4.6.7
Hardness change, points	-5 to +5	ASTM D2240	1	
Tensile strength change, percent	-15 max.	ASTM D1414-6 ASTM D412	3 to 5	
Elongation change, percent of original	-20 max.			
Temperature retraction	-39.5°C (-39°F) max.		2	
Compression set 25 percent compression	25 max.	ASTM D1414-9 Method B of ASTM D395	3	4.6.8
Volume change, percent <sup>(4)</sup>	+1 to +8	ASTM D1414-12 ASTM D471	3	

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NOTES:

1. Hardness tests before and after aging shall be made on ASTM hardness disc 0.25 inc. (6 mm) thick by 1.0 in. (25.4 mm) diameter. The specimen shall not be composed of plies of thinner pieces. Hardness shall not be determined from actual packings.
2. Tensile strength, ultimate elongation, and tensile stress are determined on the same test specimens; therefore, only 3 or 5 specimens are required for the determination of these three properties.
3. Volumetric change may be determined on oil aged samples prior to tension tests.
4. All tests except Shore A Durometer hardness to be conducted on MS28778-16 packings.

TABLE II. MAXIMUM PERMISSIBLE PRODUCTION VARIATIONS IN PHYSICAL PROPERTIES FROM CONTRACTOR'S QUALIFICATION VALUES (See Service Approval Report for Limiting Production Values for a given compound)

PROPERTY	Maximum Permissible Production Variation
Specific Gravity	$\pm 0.02$
Hardness, Shore A	$\pm 5^{(1)}$
Tensile Strength, percent	$\pm 15$
Elongation, percent	$\pm 20$
Tensile Stress, (Modulus), percent	$\pm 20$
Volume Change, percent	$\pm 2^{(2)}$
Corrosion and Adhesion	None
Temperature Retraction	$\pm 2^{\circ}\text{C}$ ( $\pm 3.6^{\circ}\text{F}$ )

NOTES:

1. Shore hardness on production samples shall not be less than 85 with this tolerance applied.
2. Swell determined from Qualification Test Value  $\pm 2$ , but must not shrink.
- 3.3 Identification. All o-rings shall be individually packaged in accordance with MIL-P-4861. Each envelope shall have the following information printed on the outside:

Federal Stock Number  
Military Part Number  
Material Specification  
Manufacturer's Name  
Manufacturer's Compound Number  
Manufacturer's Batch Number  
Contract Number  
Cure Date

- 3.4 Workmanship.

3.4.1 Workmanship and finish shall be in accordance with the best commercial practice.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. 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 MS28778 packings shall be classified as follows:

- (a) Qualification tests (4.3)
- (b) Quality conformance inspection (4.4)

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#### 4.3 Qualification tests.

##### 4.3.1 Test sample.

4.3.1.1 Qualification test samples include the following:

- (a) 50 MS28778-16 Packings
- (b) 3 ASTM Hardness Discs

4.3.1.2 The hardness 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 compound, processing, mold design, molding techniques, and finish.

4.3.2 Tests. The qualification tests shall consist of all the tests specified in 4.5.

#### 4.4 Quality conformance inspection.

4.4.1 Sampling for inspection. Sampling for quality conformance inspection shall be in accordance with MIL-STD-105, except where otherwise indicated herein. Quality conformance tests are required for all production lots of material.

4.4.1.1 Lot. A lot shall consist of all material of the same identity cured in the same production run, from the same batch, and submitted at the same time for inspection.

4.4.1.2 Batch. A batch shall be the quantity of material compounded on a mill or mixer at one time.

4.4.2 Quality conformance test samples. The test samples shall be size -16 O-rings conforming to MS28778. Hardness discs shall be used for hardness determinations.

4.4.3 Inspection of materials and components. The supplier is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with referenced subsidiary specifications and standards to the extent specified, or if none, in accordance with this specification (See 4.1). In the event of conflict, this specification shall govern. Inspection records shall be kept complete and available to the procuring activity at all times.



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4.4.4 Inspection of the end item. Examination of the end item shall be in accordance with the classification of defects, inspection levels, and acceptable quality levels (AQL's) set forth herein. The lot size, for the purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of O-rings.

4.4.4.1 Examination for defects in appearance and workmanship. The examination shall be in accordance with MIL-STD-413. The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 1.5.

4.4.4.2 Examination for dimensional defects. The examination shall be made to the tolerances specified in MS28778. The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 0.65.

4.4.4.3 Examination for defects in preparation for delivery. An examination shall be made to determine that the packaging, packing, and markings comply with section 5. The sample unit for this examination shall be one shipping container fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects.

<u>Examine</u>	<u>Defect</u>
Packaging	Not the level specified. Not packaged as specified or required. Packaging material, closures not as specified.
Packing	Not level specified; not in accordance with contract requirements. Container not as specified, closures not accomplished by specified or required methods or materials. Any nonconforming component, component missing, damaged or otherwise defective, affecting serviceability. Inadequate application of components, such as incomplete closure of case liners, containing flaps loose or inadequate strapping, bulged or distorted containers.

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Count	Less than specified or indicated quantity.
Weight	Gross weight exceeds specified requirements.
Markings	Interior or exterior markings, as applicable, omitted, illegible, incorrect, incomplete or not in accordance with contract requirements. Date of cure, storage instruction missing.

The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 2.5.

4.4.5 Quality conformance tests. The following tests shall be conducted on each lot of material (See 4.4.2):

Original

Specific gravity  
Hardness  
Tensile strength  
Elongation  
Tensile stress

4.4.5.1 Rejection criteria. A lot shall be rejected upon the failure of any sample to meet the test requirements specified herein. A lot that has been rejected may be reworked to correct the deficiencies and resubmitted for acceptance.

4.5 Process Monitoring Test.

4.5.1 Tests shall be performed at two month intervals on 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.

4.5.2 Test specimens. Packings shall be size -16, selected at random from production or molded concurrently with other production parts using the same production techniques.

4.5.3 Tests. The tests shall consist of those tests specified under "Test Methods" for the following properties, using the number and sizes of specimens indicated.

(a) Original  
Hardness  
Tensile strength  
Elongation  
Tensile stress

## (b) Physical properties after oil aging

Hardness change

Volume change

Tensile strength change

Elongation change

(c) Compression set 25 percent compression 168 hr  
at  $70^{\circ}\text{C} \pm 1$  ( $158^{\circ}\text{F} \pm 1.8$ ) in air

4.5.4 Rejection and Retest. When specimens selected from a production run fail to meet the specification requirements in 4.5.3, 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 4.5.3 shall be repeated.

4.6 Test Methods.

4.6.1 Hardness tests. Hardness tests shall be conducted on aged and unaged specimens in accordance with ASTM D2240. The specimen shall be an ASTM hardness test disc, 0.25 inch (6.4 mm) thick and not less than 1.00 inch (25.4 mm) in diameter with cure equivalent to production packings.

4.6.2 Tension tests. Tensile strength, ultimate elongation, and tensile stress at 50 percent elongation shall be in accordance with ASTM D1414-6 and ASTM-D412.

4.6.3 Specific gravity tests. Specific gravity tests shall be conducted in accordance with ASTM D1414-1 and ASTM D297-15.1.2. The sample shall consist of three MS28778-16 packings.

4.6.4 Temperature retraction (TR). The "TR" value shall be determined by the method described in ASTM D1414-10 and ASTM D1329. The specimen shall be an MS28778-16 packing cut to form one single strand which can be mounted in the clamps of the apparatus.

4.6.5 Compression set in air oven. Compression set in air shall be conducted in accordance with ASTM D1414-8, Reference Method B of ASTM D395. The amount of compression shall be 25 percent, the time 168 hours and the temperature  $70^{\circ}\text{C} \pm 1$  ( $158^{\circ}\text{F} \pm 1.8$ ). The specimens shall be MS28778-16 packings two shall be used for each test.

4.6.6 Properties after aging in air oven. Air aging shall be conducted according to ASTM D573, the time shall be 168 hours and the temperature shall be  $70^{\circ}\text{C} \pm 1$  ( $158^{\circ}\text{F} \pm 1.8$ ). Changes in tensile strength and

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ultimate elongation shall be determination by the method described in 4.5.2. The test specimen shall be an MS28778-16 packing. Change in hardness shall be determined by the method specified in 4.6.1. The specimen shall be an ASTM hardness disc.

4.6.7 Properties after oil aging. Oil aging shall be conducted according to the method described in ASTM D1414-12 and ASTM D471. The oil shall be MIL-H-5606 hydraulic fluid, the temperature  $70^{\circ}\text{C} \pm 1$  ( $158^{\circ}\text{F} \pm 1.8$ ) for a period of 168 hours. The specimens and test methods shall be as specified in the paragraphs referenced below.

4.6.7.1 Change in hardness shall be determined by the method specified in 4.6.1. The test specimen shall be an ASTM hardness disc.

4.6.7.2 Volume change shall be determined by the method described in ASTM D1414-12 and ASTM D471. The test specimen shall be MS28778-16 packings and three shall be used for each test.

4.6.7.3 Change in tensile strength and ultimate elongation shall be determined by the method specified in 4.6.2. The specimen shall be MS28778-16.

4.6.7.4 Temperature retraction shall be determined by the method specified in 4.6.4. The specimen shall be MS28778-16.

4.6.8 Compression set in oil. The aging conditions shall be conducted according to the method specified in 4.6.7. The specimens shall be two MS28778-16 packings. The compression shall be 25 percent of the measured cross section and the compression set test shall be conducted according to the method described in ASTM D1414-9, Method B of ASTM D395.

4.6.9 Corrosion and adhesion.

4.6.9.1 MS28778-16 packings, two for each plate, shall be prepared for corrosion testing by inserting sufficient quantities of the packings in a desiccator or similar humidity chamber maintained at 92 percent minimum relative humidity and  $25^{\circ}\text{C} \pm 2$  ( $77^{\circ}\text{F} \pm 3.6$ ) for at least 72 hours.

4.6.9.2 Plates of the metals listed below shall be polished to a surface roughness of 4 to 16 RHR in accordance with ANSI B46.1. The edges shall also be polished to reduce the formation of edge corrosion. The plates shall be washed with toluene, aliphatic naphtha, or similar degreasing agent that will produce a clean dry surface free from film. The metals used shall be as follows:

QQ-A-250/4	Aluminum Alloy 2024
QQ-A-250/11	Aluminum Alloy 6061
QQ-A-250/12	Aluminum Alloy 7075
QQ-S-763	440C Stainless Steel
QQ-S-764	303 Stainless Steel (Free machining)
MIL-S-18729	4130 Steel, Aircraft Quality

4.6.9.3 The humidified packings and metallic plates shall be immersed in MIL-H-6083, Type I, fluid and drained to the drip point. The packings and plates shall then be so laid together in a stack so that at least two packings 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  $25^{\circ}\text{C} \pm 2$  ( $77^{\circ}\text{F} \pm 3.6$ ). This relative humidity may be produced by the use of a salt of sufficient concentration in solution with distilled water. Time of humidity exposure shall be 14 days. No more than 15 minutes should elapse between the time the samples are removed from the prehumidifying chamber and placed in the stacked condition in the second humidity chamber.

4.6.9.4 At the termination of this test, the procedures outlined below shall be followed:

- (a) The surface of the plates which were in contact with the seals shall be inspected for discoloration, deposits, pitting, or other evidence of corrosion or adhesion. If any exist, the surfaces of the plates shall be washed in aliphatic naphtha. Deposits determined as rubber compounds or elements therefrom, which can be removed by this process and which do not occur on other surfaces of the plates, shall be construed as adhesion.
- (b) 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 from the packings, a microscope of approximately 10- to 15-power magnification shall be used to determine the actual condition.

4.7 Inspection of preparation for delivery. The preservation, packing, and marking shall be examined and tested to determine conformance with the requirements of Section 5 of this specification and as required by specifications referenced therein.

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## 5. PACKAGING

5.1 Preservation, Packaging, Packing, and Marking. Preservation, packaging, and packing for the two levels of packaging, the three levels of packing, and marking shall be in accordance with MIL-P-4861.

## 6. NOTES

6.1 Intended use. Packings covered by this specification are intended for use in aircraft Type I hydraulic and pneumatic systems (-65° to 160°F) to seal standard fitting of the MS33656 and MS33649 bosses as indicated in MS21344. These packings are not intended for use in any other application unless otherwise specified by Air Force or Navy, or both, as applicable.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, revision letter, and date of this specification.
- (b) MS part number of the packing required.
- (c) Applicable Federal Stock Number.
- (d) Levels of preservation, packaging, and packing.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved 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 requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the 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 in the Air Force Materials Laboratory, Attn: MXE, Wright-Patterson AFB, Ohio 45433 and information pertaining to qualification of products may be obtained from that activity.

6.3.1 Test report. Three copies of a test report prepared in accordance with MIL-STD-831 should be furnished to the activity responsible for qualification prior to qualification evaluation accompanied by the required number of packings to perform all the qualification tests specified herein. The report should contain a tabulation of the physical property values obtained during prequalification tests.

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**Custodians**

Army - WC

Navy - AS

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**Preparing Activity**

Air Force - 11

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