

INCH-POUND

MIL-DTL-18866J
w/AMENDMENT 2
20 January 2017
SUPERSEDING
MIL-DTL-18866J
w/AMENDMENT 1
7 June 2016

DETAIL SPECIFICATION

FITTINGS, HYDRAULIC TUBE, FLARED,
37 DEGREE AND FLARELESS,
GENERAL SPECIFICATION FOR

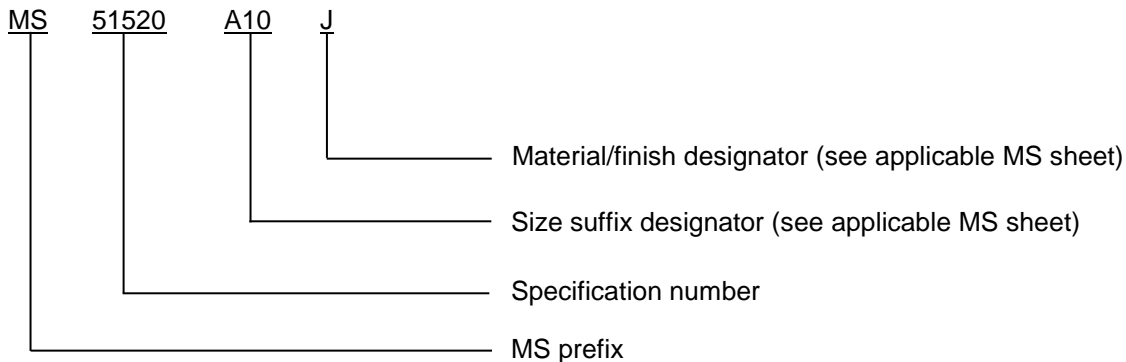
Reactivated after 20 January 2017 and may be used for
new and existing designs and acquisitions.

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

1. SCOPE

1.1 Scope. This specification covers 37° flared and flareless steel tube fittings, 1500 and 3000 pounds per square inch (psi) maximum design pressure, -65°F to 250°F temperature range, for use in hydraulic or air systems.

1.2 Part or Identifying Number (PIN). The PIN consists of the letters "MS", the specification number, a letter and number for fitting size, and a letter for material/finish designator. See other MS sheets for PIN variations.



2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 or 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 or 4 of this specification, whether or not they are listed.

Comments, suggestions, or questions on this document should be addressed to: DLA Land and Maritime, Columbus, Attn: VAI, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to FluidFlow@dla.mil. Since contact information can change you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 4730



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w/AMENDMENT 22.2 Government documents.

2.2.1 Specifications standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

- QQ-N-281 - Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections

FEDERAL STANDARDS

- FED-STD-H28 - Screw Thread Standards for Federal Services

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-C-15726 - Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod, and Wire
 MIL-DTL-16232 - Phosphate Coating, Heavy, Manganese or Zinc Base
 MIL-T-1368 - Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded
 MIL-T-8504 - Tubing, Steel, Corrosion-Resistant (304), Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
 MIL-T-16420 - Tube, Copper-Nickel Alloy, Seamless and Welded
 MS51825 - Sleeves, Clinches, Tube Fitting, Flareless Type, Hydraulic
 MS51889 - Washer, Back-Up, 37 Degree Flared and Flareless Type, Hydraulic

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-889 - Dissimilar Metals

(See supplement 1 for list of specification sheets.)

(Copies of these documents are available online at <http://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

- ASTM A29/A29M - Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
 ASTM A182/A182M - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
 ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes
 ASTM A479/A479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

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| ASTM A564/A564M | - | Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| ASTM A576 | - | Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality |
| ASTM A582/A582M | - | Standard Specification for Free-Machining Stainless Steel Bars |
| ASTM A693 | - | Standard Specification for Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip |
| ASTM B117 | - | Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B163 | - | Standard Specification for Seamless Nickel and Nickel Alloy Condenser and Heat- Exchanger Tubes |
| ASTM B164 | - | Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire |
| ASTM B165 | - | Standard Specification of Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube |
| ASTM B166 | - | Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696) and Nickel- Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Rod, Bar, and Wire |
| ASTM B338 | - | Standard Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers |
| ASTM B487 | - | Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section |
| ASTM B499 | - | Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals |
| ASTM B564 | - | Standard Specification for Nickel Alloy Forgings |
| ASTM B567 | - | Standard Test Method for Measurement of Coating Thickness by the Beta Backscatter Method |
| ASTM B568 | - | Standard Test Method for Measurement of Coating Thickness by X-Ray Spectrometry |
| ASTM B633 | - | Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM B695 | - | Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM B748 | - | Standard Test Method for Measurement of Thickness of Metallic Coatings by Measurement of Cross Section with a Scanning Electron Microscope |
| ASTM E18 | - | Standard Test Methods for Rockwell Hardness of Metallic Materials |
| ASTM E60 | - | Standard Practice for Analysis of Metals, Ores, and Related Materials by Spectrophotometry |
| ASTM E384 | - | Standard Test Method for Microindentation Hardness of Materials |
| ASTM F1136/F1136M- | - | Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners |

(Copies of these documents are available online at <http://www.astm.org> or from ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | | |
|-----------|---|---|
| ISO 17025 | - | General requirements for the competence of testing and calibration laboratories |
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(Copies of these documents are available online at <http://www.iso.ch> or from the International Organization for Standardization American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.)

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NCSL INTERNATIONAL

NCSL Z540.3 - Requirements for the Calibration of Measuring and Test Equipment

(Copies of these documents are available online at <http://www.ncsli.org> or from NCSL International 2995 Wilderness Place, Suite 107 Boulder, Colorado 80301-5404.)

SAE INTERNATIONAL

SAE-AMS-C-81562 - Coatings, Cadmium, Tin-Cadmium and Zinc (Mechanically Deposited)

SAE-AMS-P-5510 - O-Ring, Preformed, Straight Thread Tube Fitting Boss, Type I Hydraulic (-65 to 160 °F)

SAE-AMS-QQ-P-416 - Plating, Cadmium (Electrodeposited)

SAE-AMS2417 - Plating, Zinc-Nickel Alloy

SAE-AMS2451/5 - Plating, Brush, Chromium Hard Deposit, Trivalent

SAE-AMS2451/9 - Plating, Brush, Zinc-Nickel Low Hydrogen Embrittlement

SAE-AMS2486 - Conversion Coating of Titanium Alloys Fluoride-Phosphate Type

SAE-AMS2488 - Anodic Treatment - Titanium and Titanium Alloys Solution pH 13 or Higher

SAE-AMS2700 - Passivation of Corrosion Resistant Steels

SAE-AMS4928 - Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes 6Al - 4V Annealed - UNS R56400

SAE-AMS4945 - Titanium Alloy Tubing, Seamless, Hydraulic 3Al - 2.5V, Controlled Contractile Strain Ratio Cold Worked, Stress Relieved - UNS R56320

SAE-AMS5567 - Steel, Corrosion Resistant, Seamless or Welded Hydraulic Tubing 19Cr - 10Ni (304) Solution Heat Treated - UNS S30400

SAE-AMS5604 - Steel, Corrosion Resistant, Sheet, Strip, and Plate 16.5Cr - 4.0Ni - 4.0Cu - 0.30Cb Solution Heat Treated, Precipitation Hardenable - UNS S17400

SAE-AMS5639 - Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing, and Rings 19Cr - 10Ni Solution Heat Treated - UNS S30400

SAE-AMS5643 - Steel, Corrosion-Resistant, Bars, Wire, Forgings, Mechanical Tubing, and Rings 16Cr - 4.0Ni - 0.30Cb (Nb) - 4.0Cu Solution Heat Treated, Precipitation Hardenable - UNS S17400

SAE-AMS5645 - Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings 18Cr - 10Ni - 0.40Ti (321) Solution Heat Treated - UNS S32100

SAE-AMS5647 - Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing, and Rings 19Cr - 9.5Ni Solution Heat Treated - UNS S30403

SAE-AMS5743 - Steel, Corrosion and Heat-Resistant, Bars and Forgings 15.5Cr - 4.5Ni - 2.9Mo - 0.10N Solution Heat Treated, Sub-Zero Cooled, Equalized, and Over-Tempered - UNS S35500

SAE-AMS6370 - Steel, Bars, Forgings, and Rings 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130) - UNS G41300

SAE-AMS6382 - Steel, Bars, Forgings, and Rings 0.95Cr - 0.20Mo (0.38 - 0.43C) (SAE 4140) Annealed - UNS G41400

SAE-AS28778 - Ring, Straight Thread Tube Fitting Box Molded from AMS-P-5510 Rubber

SAE-J403 - Chemical Compositions of SAE Carbon Steels

SAE-J514 - Hydraulic Tube Fittings

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| SAE-J515 | - | Specification for O-Ring Materials Used with Hydraulic Connectors |
| SAE-J524 | - | Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring |
| SAE-J1926-1 | - | Connections for General Use and Fluid Power Ports and Stud Ends with ASME B1.1 Threads and O-Ring Sealing Part 1: Threaded Port with O-Ring Seal in Truncated Housing |

(Copies of these documents are available online at <http://www.sae.org> or from the SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), samples shall be subjected to first article inspection in accordance with 4.3.

3.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.4 Materials. Materials shall be as specified herein and shall conform to all applicable specification sheets. When a definite material is not specified, a material shall be used which will enable the fitting or sleeve to meet the requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of acceptance of the finished product.

3.4.1 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.4.1.1 Used, rebuilt, or remanufactured components. No used, rebuilt, or remanufactured components, pieces, or parts shall be incorporated in the fittings.

3.4.1.2 Dissimilar metals. When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. Dissimilar metals such as brass, copper or steel (except corrosion-resisting steel) shall not be used in intimate contact with aluminum or aluminum alloy. Corrosion-resisting steel shall be passivated in accordance with SAE-AMS2700. Protective measures for dissimilar metals shall be in accordance with MIL-STD-889.

3.4.1.3 Ozone depleting substances (ODS). Class I and II ozone depleting substances (ODS) shall not be used in MIL-DTL-18866 or any referenced procedures.

3.4.3 Fitting materials. Fitting materials shall be as specified in [table I](#).

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| Material | Form | Specification | Alloy |
|---|----------------------------|--------------------------------------|---|
| Carbon steel (flared ferrules) | Bar | SAE-J403 ASTM A576 | 1008, 1010, 1015, 1213, 12L14, or 1215 |
| | | ASTM A29/A29M ASTM A576 | 1141 |
| Carbon steel (flareless ferrules) | Bar | SAE-J403 | 1010, 12L14, or 1215 |
| Carbon steel for fitting bodies and nuts | Bar | N/A | Any carbon steel <u>1/</u> |
| Carbon steel for fitting bodies | Forgings | ASTM A29/A29M or SAE-J403 | 1045, 1214, 1215 <u>1/</u> |
| Chrome-molybdenum steel | Bars | SAE-AMS6370 | 4130 |
| | Forgings | SAE-AMS6382 | |
| | | SAE-AMS6370 | |
| Corrosion resistant steel (CRES) | Bars and forgings | ASTM A276/A276M ASTM A479/A479M | 304, 304L, 316, 316L, or 321 |
| | | ASTM A564/A564M | XM-12 (15-5 PH) UNS S15500 or 630 (17-4 PH) UNS S17400 |
| | | SAE-AMS5639 | UNS S30400 |
| | | SAE-AMS5645 | UNS S32100 |
| | | SAE-AMS5647 | UNS S30403 |
| | | SAE-AMS5743 | UNS S35500 |
| | Bar | ASTM A582/A582M | UNS S30300 |
| | Forging | ASTM A182/A182M | 316, 316L |
| | CRES for flareless sleeves | Bar, tube, sheet, strip, or plate | SAE-AMS5604 |
| SAE-AMS5643 | | | |
| ASTM A693 | | | |
| Copper-nickel alloy | Bar | MIL-C-15726 | C71500 |
| Nickel-copper alloy | Bar | ASTM B164 QQ-N-281 | UNS N04400 |
| High-chromium nickel alloy | Bar | ASTM B166 | UNS N06690 |
| | Forgings | ASTM B564 | |
| Titanium <u>2/</u> | Bars | SAE-AMS4928 | 6Al-4V annealed |
| | Forgings | | |

1/ Other low to medium carbon steels may be used provided they meet the working , proof and burst requirements of SAE-J514, except the working pressures shall be as specified in 3.6.1.

2/ Titanium shall not be used in oxygen or potable water systems.

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3.4.4 Finish.

3.4.4.1 Steel fitting finish (except corrosion resistant steel).

- a. Cadmium plating. Cadmium plating in accordance with SAE-AMS-C-81562, type II, class 3 or SAE-AMS-QQ-P-416, type II, class 2. Fluid passages, other openings and internal threads shall not be subject to the plating thickness requirement and may have bare areas provided they are protected with a light film of oil. Cadmium shall not be used in oxygen or potable water systems.
- b. Zinc plating's.
 - (1) Zinc plating shall be in accordance with ASTM B633; type III or V Fe/Zn 8, or ASTM B695, type II, class 8. Zinc plating's specified in ASTM B633 or ASTM B695 shall meet the 96-hour salt spray test. Not for use in aircraft, requires Program Office approval for all applications.
 - (2) Zinc-aluminum in accordance with ASTM F1136/F1136M, grade 3, NC.
 - (3) Zinc phosphate. Zinc phosphate shall be in accordance with MIL-DTL-16232, type Z.
 - (4) Zinc nickel shall be in accordance with SAE-AMS2417, type 2, grade B. The zinc-nickel alloy plate shall contain 12% to 16% nickel. The coating thickness shall be 315 μ inches (8 μ m) minimum coating thickness.

3.4.4.2 Corrosion resistant steel (CRES). CRES shall be passivated in accordance with SAE-AMS2700, method 1, type 6 or 7.

3.4.4.3 Titanium. Titanium shall be anodized in accordance with SAE-AMS2488, type 2 or fluoride phosphated in accordance with SAE-AMS2486.

3.4.5 Finish salt spray test. All plating's shall be capable of meeting the 96 hour salt spray test in accordance with 4.6.5. The fittings shall show no evidence of red corrosion after 96 hours of salt spray. Fluid passages, other openings, and internal threads shall not be subject to the plating thickness requirement and may have bare areas provided they are protected with a light film of oil. The following exceptions shall apply:

- a. Phosphate coated fittings shall be subjected to all tests as specified in MIL-DTL-16232, Class 1, except for the salt spray test. The salt spray test is required only to verify the phosphating process or changes thereto.
- b. CRES passivated fittings shall be subjected only to the copper sulfate tests as specified in SAE-AMS2700, method 102. Fittings passing this test shall be returned to stock for usage after each fitting is thoroughly rinsed in deionized water and thoroughly dried.

3.4.6 Trivalent Wrenchability. When the finish has been damaged due to poor wrenchability, the surface of the connector shall be touched up using one of the brush plating processes below as appropriate to primary finish. The term "trivalent wrenchability" is used to evaluate the ability of the finish to withstand abrasion from an excessive amount of wrenching

- a. Brush plating of hard chromium by electrodeposition shall be in accordance with SAE-AMS-2451/5.
- b. Brush plating of medium-hardness, low stress nickel by electrodeposition shall be in accordance with SAE-AMS-2451/9.

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3.4.7 Cadmium is not recommended. Carbon steel material with cadmium plating shall only be used when other materials and finishes specified in this document cannot meet performance requirements (see 6.5). Cadmium shall not be used in oxygen or potable water systems.

3.4.8 Plating thickness verification (cadmium and zinc plating's). Plating thickness shall be measured in accordance with 4.6.2 and shall meet the requirements of 3.4.4.1.

3.5 Hardness (steel).

3.5.1 Finished corrosion-resisting steel parts. Unless otherwise specified in the contract or order (see 6.2), the minimum hardness for finished corrosion-resisting steel parts, other than flareless sleeves (see 3.4.3) shall be Rockwell B80 and the maximum hardness shall be Rockwell C32.

3.5.2 Sleeves, flareless, carbon steel. Unless otherwise specified in the contract or order (see 6.2), carbon steel flareless sleeves shall be case hardened to a depth of .0010 to .0019 inch (25.4µm to 48.3µm). The hardness of the core shall not exceed Rockwell B99.5.

3.5.3 Sleeves, flareless, corrosion-resisting steel. Unless otherwise specified in the contract or order, corrosion-resisting steel flareless sleeves shall be treated in such a manner as to produce a minimum through-hardness of Rockwell C41.8 or 423 KHN (Knoop) (see 6.2).

3.6 Design.

3.6.1 Design and construction. Fittings, when properly assembled, shall insure a leak-proof full-flow connection up to 3000 psi (20.7MPa) working pressure or 6000 psi (41 MPa) proof pressure for sizes -2 through -16 (1/8 through 1 inch) and 1500 psi (10 MPa) working pressure or 3000 psi (21 MPa) proof pressure for sizes -20 through -32 (1-1/4 through 2 inch). Working pressure is the established recommended pressure based on a safety factor of 4 to 1. However, fittings may have an increased working pressure based on any or all of the following factors: reduced tube size, increased tube wall thickness and reduced safety factor. The -4 (1/4-inch) fittings may have an increased working pressure up to 5000 psi (35 MPa) maximum. Prior to such use, supporting test data shall be approved by both the procuring agency and the manufacturer.

3.6.2 Design and dimensions. Fittings shall be in accordance with the applicable MS sheets, see supplement 1. If a specification does not exist the fitting or sleeve shall be in accordance with SAE-J514 (see 3.1).

3.6.2.1 Surface finish. Unless otherwise specified all sealing surfaces shall be smooth, except that annular tool marks up to 100 micro-inch (2.54 µm) maximum, peak to valley, will be permissible.

3.6.2.2 Boss. Straight thread O-ring bosses, for swivel and adjustable fittings, shall be in accordance with SAE-J1926-1, part 1.

3.6.2.3 O-Rings. When O-rings are required, they shall be in accordance with SAE-AMS-P-5510 (reference SAE-AS28778 for PIN's) or SAE-J515, type 1.

3.6.2.4 Shape and form restrictions. Abrupt reductions of section shall be avoided. Small external sections adjoining relatively heavy body sections shall be shaded into the heavier sections by means of ample fillets. There shall be no sharp corners or inadequate fillets, excessive undercuts, or excessive grooves at the junction of such small sections with large sections of fittings.

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3.6.2.5 Drill offset. On straight fittings where the fluid passage is drilled from each end, the offset between the drilled holes at the meeting point of the drills shall not exceed .015 inch (0.38 mm). It shall be possible to pass through the fluid passage a ball whose minimum diameter is .020 inch (0.51mm) less than the minimum diameter specified for the passage. On angle fittings, the cross-sectional area at the junction of the fluid passage shall be not smaller than the cross-sectional area of the smaller passage.

3.6.2.6 Wall thickness. The wall thickness at any point on the fitting shall be not less than the thickness established by the dimensions, tolerances and eccentricities for the inside and outside diameters specified in the applicable detail specification sheets (MS sheets) given herein (see 1.2).

3.6.2.7 Straight threads. Straight threads shall conform to the Unified Screw Thread Standard, Class 2A and 2B, in accordance with the screw thread standards in accordance with FED-STD-H28.

3.6.2.8 Taper pipe threads. Taper pipe threads shall conform to the American National Standard Pipe Thread (Dry Seal - NPTF) in accordance with FED-STD-H28.

3.6.2.9 Sleeve design. Flareless sleeves shall be in accordance with MS51825 style A or B, as specified (see 6.2).

3.6.3 Back-up washers. MS51889 back-up washers shall be furnished on all adjustable fittings. Washers are to be installed on fittings by the manufacturer.

3.7 Marking.

3.7.1 Identification of product. Fittings shall be marked as specified in 3.7.2 and 3.7.3. Stamped markings shall be applied in a location not detrimental to the function of the fittings prior to the application of the corrosion-protective finish specified in 3.4.4.

3.7.2 Trademark. Unless otherwise specified, all fittings shall be stamped with manufacturer's name or trademark, except for sleeves which shall be stamped at the option of the manufacturer (see 6.2).

3.7.3 Additional marking. If specified, all fittings made from corrosion-resisting steel, except sleeves, shall be permanently stamped with the composition number of steel (see 6.2).

3.7.4 Sleeve marking. All flareless sleeves made from corrosion-resisting steel shall be marked with a light knurl on the perimeter of the largest O.D.

3.8 Lubrication. During assembly, an anti-friction compound, oil or petroleum lubricant may be used on the sleeves and threads of carbon steel and of corrosion-resisting steel fittings. A dry film lubricant, a lubricious coating, may be added to the threads of corrosion-resisting steel nuts.

3.9 Cleanliness. All fittings and sleeves shall be free of oil, grease, dirt, moisture, cleaning solvents and foreign materials both internally and externally.

3.10 Workmanship. Workmanship shall conform to the best commercial practice to produce high quality fittings. Fittings shall be free from all hanging burrs, loose scale and slivers which might become dislodged in usage and all other defects which might affect their performance. The fittings and sleeves shall be examined for the following defects as specified in table II.

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| Examination | Requirement paragraph |
|--|-----------------------|
| Type, size, termination, style, or configuration not in conformance with the applicable individual specification sheet. | 3.1 |
| Shape and form reduction abrupt: Small external Visual sections not shaded into heavy body section by fillets: fittings have sharp corners; inadequate fillets; excessive undercuts or grooves (3.4.3) | 3.6.2.3 |
| Bores drilled from each end exceed specified tolerance at drill meeting point; size of fluid passage of angle fittings, not as specified. | 3.6.2.4 |
| Wall thickness of fittings, less than dimensions and tolerances specified | 3.6.2.5 |
| Machined surface finish | 3.6.2.1 |
| Material not as specified | 3.4.3 |
| Threads not as specified | 3.6.2.6, 3.6.2.7 |
| Sealing surface, not as specified | 3.6.2 |
| Finish not as specified | 3.6.2 |
| Contractor does not have documentation available for identification of material | 3.4.3 |
| Contractor does not have documentation available for identification of finishes or treatment | 3.4.5 |
| Dissimilar metals are not treated or effectively insulated from each other | 3.4.1.2 |
| Used, rebuilt or remanufactured components, pieces, or parts incorporated in the fittings. | 3.4.1.1 |
| Nuts, or washers missing or not as specified | 3.1 and 3.6.3 |
| Marking missing, illegible, or not as specified | 3.7 |

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.3).
- b. Conformance inspection (see 4.4).

4.2 Inspection conditions. Unless otherwise specified, all required inspections shall be performed in accordance with the test conditions specified in 4.6.

4.2.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ISO 17025 and NCSL Z540.3 as applicable.

4.3 First article. First article inspection shall be performed at a laboratory acceptable to the Government on sample units produced with equipment and procedures used in production.

4.3.1 Samples for first article. Unless otherwise specified, after award of the contract or order, the manufacturer shall forward, from randomly selected samples, 3 fittings and sleeves. The samples shall be representative of the construction, workmanship, components, and materials to be used during production. When a manufacturer is in continuous production of fittings and sleeves from one contract to another or has demonstrated within the past 2 years the capability to meet the requirements of this

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specification, inspection of additional first article samples for a new contract may be waived at the discretion of the acquiring activity (see 6.2). Approval of the first article samples or the waiving of first article inspection does not preclude the requirements for performing conformance inspection. First article samples shall be furnished to the Government as directed by the contracting officer (see 6.2).

4.3.2 Inspection routine. Samples randomly selected from each lot (see 4.3.2.1) shall be subjected to the first article inspections specified in table III.

4.3.2.1 Lot. A lot shall consist of all fittings and sleeves of the same type, size, material, and manufactured under essentially the same conditions and submitted for acceptance at one time, see 6.2.

4.3.3 Failures. One or more failures shall be cause for refusal to grant first article approval.

4.3.4 Disposition of samples. First article samples shall be furnished to the Government as directed by the contracting officer (see 6.2). Unless otherwise specified, after award of the contract or order, the manufacturer shall forward, from randomly selected samples, 1 fitting. The sample shall be representative of the construction, workmanship, components, and materials to be used during production.

4.3.5 First article information. Upon completion of first article inspection, the Government activity responsible for conducting the inspection program (see 6.2), shall report the results of the inspection, with appropriate recommendation, to the contracting officer. Approval of the first article samples or the waiving of first article inspection does not preclude the requirements for performing conformance inspection.

4.3.6 Waivers or deviations to specification requirements. All waivers or deviations to specification requirements shall be coordinated through the preparing activity; DLA Land and Maritime, Attn: VAI, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Fluidflow@dla.mil.

TABLE III. First article inspections.

| Inspection | Inspection paragraph | Test paragraph | Number of samples |
|--|--|-------------------------|-------------------|
| Visual inspection | 3.1 , 3.6.2 , 3.7 , 3.9 , and 3.10 | 4.6.1 | All |
| Proof test | N/A | SAE-J514 | 2 minimum |
| Burst test | N/a | SAE-J514 | 2 minimum |
| Plating verification (cadmium or zinc) | 3.4.8 | 4.6.2 | 2 minimum |
| Hardness test | 3.5 | 4.6.3 | 2 minimum |
| Chemical analysis ^{2/} | 3.4.3 | 4.6.4 | 2 minimum |
| Corrosion resistance | 3.4.5 | 4.6.5 | 2 minimum |
| Tests for sleeves | | 4.6.6 | --- |
| Case depth and hardness test | 3.5 | 4.6.6.1 | 2 |
| Cut tests | --- | 4.6.6.2 | 2 |
| Tests of design capability | | 4.6.8.1 | --- |
| Design capability test - 37° flared | --- | 4.6.8.2 | 5 |
| Design capability test - flareless | --- | 4.6.8.3 | 5 |

^{1/} May be supplied by the plating manufacturer.

^{2/} This test shall be performed when specified by the acquiring activity (see 6.2).

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4.4 Conformance inspection.

4.4.1 Individual tests. Inspection of the product for delivery shall consist of subjecting each fitting or sleeve to the individual tests specified in [table IV](#). In those cases where there is a continuous production of fittings and sleeves and the manufacturer has an established statistical process control in place inspection may be used as specified in [4.4.2](#).

4.4.1.1 Individual test failures. Any item failing to meet the requirements of the individual tests shall be immediately removed from the lot. The entire lot shall be inspected for that particular defect and then the entire lot shall be re-inspected at the next higher inspection level. Any item failing to meet the requirements of the individual inspection, the entire lot shall not be rejected and not supplied to the contract.

4.4.2 Statistical process control criteria for continuous production. In those cases where there is a continuous production of fittings and sleeves, the data from each individual lot sampled can be accumulated to report an average outgoing quality in parts per million (PPM).

- a. Statistically valid sampling plans with Accept/Reject criteria of 0/1 (attribute, combined variable and attribute plans) (accept on zero defects/reject on one defect).
- b. Evidence of a controlled process that assures consistent production of conforming product.
- c. 100 percent inspection and/or continuous sampling inspection reverting to 100 percent inspection on or upon the occurrence of one defect.
- d. A part per million (PPM) quality reporting system that accumulates data from individual lots using "accept on zero" sampling plans to establish an outgoing quality assessment.
- e. Use of process capability index (Cp) and process performance index (Cpk).

TABLE IV. Individual inspection.

| Inspection | Requirement paragraph | Test method paragraph |
|-------------------|-----------------------|------------------------------|
| Visual inspection | 3.6.2 | 4.6.1 (a, b) |

4.4.3 Sampling tests. Fittings and sleeves, selected to form an inspection sample (see [4.4.3.1](#)), shall be subjected to the sampling tests specified in [table V](#).

TABLE V. Sampling inspection.

| Inspection | Requirement paragraph | Test method paragraph |
|-------------|-----------------------|------------------------|
| Cleanliness | 3.9 | 4.6.1e |
| Hardness | --- | 4.6.6 |

4.4.3.1 Inspection sample. An inspection sample shall consist of fitting or sleeves, of one size, randomly selected without regard to quality. Eight samples from a lot size of 3,000 fittings or sleeves or one sample from each smaller lot size of 375 fittings or sleeves shall be subjected to the sampling tests. If there has been some production but the number of fittings and sleeves produced has not reached 375 for a specific size within 3 years, the manufacturer shall perform sampling tests on fitting or sleeve of that size unless documented approval has been obtained from the acquiring activity.

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4.5. Tube materials. To facilitate testing the tube shall be of like material of the body, nut, and sleeve.

- a. Seamless low carbon steel tubing shall be in accordance with SAE-J524.
- b. Corrosion resistant steel shall be in accordance with ASTM A269/A269M, SAE-AMS5567, or MIL-T-8504.
- c. Copper-nickel tubing in accordance with MIL-T-16420, class 200 (70/30).
- d. Nickel-copper alloy tube shall be in accordance with MIL-T-1368 or ASTM B165.
- e. High-chromium nickel alloy tube shall be in accordance with ASTM B163.
- f. Titanium alloy tubing in accordance with SAE-AMS4945 or ASTM B338.

4.6 Test methods.

4.6.1 Visual inspection. Tube fittings and sleeves shall be examined to ensure conformance with this specification. Continuous examination shall be performed to assure compliance with the following requirements:

- a. Specification sheets (see [3.1](#)).
- b. Design, construction and physical dimensions (see [3.6.2](#)).
- c. Materials (see [3.4.3](#)) and finishes (see [3.4.5](#)).
- d. Marking (see [3.7](#)).
- e. Cleanliness (see [3.9](#)).
- f. Workmanship (see [3.10](#)).

4.6.2 Verification of fitting plating thickness cadmium or zinc. Verification of under plating and finish plating shall be measured in accordance with ASTM B499, ASTM B567, or ASTM B568. A cross-sectioning method, such as that specified by ASTM B487 or ASTM B748, can also be used as a referee method to confirm the precision when thicknesses of 30 microns (0.76 μm) or above are used. The zinc plating thickness may also be measured in accordance with ASTM B633 or ASTM B695 as applicable. The following details shall apply:

- a. When applicable a minimum of five points shall be measured on the fitting surface. The fitting may be rotated, but measurement points shall be progressively further from the last point. Readings shall not be averaged. Measurements shall be as follows:
 - (1) One measurement shall be taken at a point on the front radius and rear radius.
 - (2) Three measurements shall be taken in the middle areas.

4.6.3 Hardness test (see [3.5](#)). 2 fittings minimum randomly selected in accordance with [4.3.2](#) shall be tested for hardness in accordance with ASTM E18 or ASTM E384 to determine conformance to [3.5](#).

4.6.4 Chemical analysis. When requested by the acquiring activity, certification showing conformance with the applicable material specification, see [table I](#), shall be made available. When specified, spectrochemical analysis shall be in accordance with ASTM E60 (see [6.2](#)).

4.6.5 Corrosion resistance (cadmium or zinc plated parts only) (see [3.4.5](#)). Corrosion resistance testing shall be in accordance with ASTM B117 and shall meet the requirements of [3.4.5](#).

4.6.6 Tests for sleeves. 2 samples minimum flareless sleeves, randomly selected in accordance with [4.3.2](#) shall be tested in accordance with [4.6.6.1](#) and [4.6.6.2](#).

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4.6.6.1 Case depth and hardness test. Case depth and hardness test shall be conducted as follows:

- a. Remove plating, grind and polish end of sleeve perpendicular to sleeve axis. In this manner, the cutting edge is removed.
- b. Immerse samples in etchant (2 percent Nital) for a sufficient length of time for the desired etch, about 8 to 10 seconds.
- c. Wash in hot water, immerse in alcohol and blow dry.
- d. Take at least three measurements at different points on the sleeve. The case depth and hardness shall be in accordance with [3.5](#).

4.6.6.2 Cut tests. Tubing selected in accordance with [4.5](#) shall be used for cut tests of sleeves and performance test for fittings. The following details shall apply:

- a. The sleeves shall be assembled to the tubing in accordance with [4.6.8.3a](#) and [table VII](#).
- b. After disassembly, each sleeve shall be driven back to expose the ring cut for examination.
- c. The cut shall completely encircle the periphery of the tube.
- d. There shall be no longitude or circumferential cracks on the sleeve before driving back.
- e. Circumferential crazing marks on the end of the sleeve in the neighborhood of the cutting edge are permitted.

4.6.8 Design capability testing of fittings.

4.6.8.1 Design certification. In order to provide a basis for certifying to the design requirements of [3.6](#), fitting manufacturers shall pressure test each of their product designs as outlined in [4.6.8.2](#) and [4.6.8.3](#).

4.6.8.2 Design capability test - 37° flared. When specified, a minimum of five 37° flared fittings of each size, shape and material, after being lubricated, shall be assembled with mating fittings in a manner similar to figures [1](#), [2](#), and [3](#) as applicable (see [6.2](#)). The following details shall apply:

- a. To facilitate testing the tube shall be of the like material of the body, nut, and sleeve, see [4.6](#).
- b. The tube nut shall be tightened to the minimum torque load specified in [table VI](#) for the applicable assembly size.
- c. The pipe threaded end, or straight thread with O-ring end fitting or straight thread fitting, whichever is applicable, shall be tightened to the point where leakage shall not occur, at a proof pressure of 6000 psi (41 MPa) for size -2 through -16 or a proof pressure of 3000 psi (21 MPa) for size -20 through -32. under this pressure, there shall be no leakage or distortion of the assembly.
- d. The assembly shall then be pressurized to the point at which leakage or rupture occurs and the results shall be recorded.

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TABLE VI. Torque load for tightening 37° flared tube nut.

| Tubing O.D. | Torque Inch-pounds (Nm) | | Tubing O.D. | Torque inch-pounds (Nm) | |
|-------------|-------------------------|----------|-------------|-------------------------|------------|
| Inches | Min | Max | Inches | Min | Max |
| 1/8 | 75 (8) | 85 (10) | 3/4 | 855 (97) | 945 (107) |
| 3/16 | 95 (11) | 105 (12) | 7/8 | 1050 (119) | 1200 (136) |
| 1/4 | 135 (15) | 145 (16) | 1 | 1140 (129) | 1260 (142) |
| 5/16 | 170 (19) | 190 (21) | 1 1/4 | 1520 (172) | 1680 (190) |
| 3/8 | 215 (24) | 245 (28) | 1 1/2 | 1900 (215) | 2100 (237) |
| 1/2 | 430 (49) | 470 (53) | 2 | 2660 (301) | 2940 (332) |
| 5/8 | 620 (70) | 680 (77) | | | |

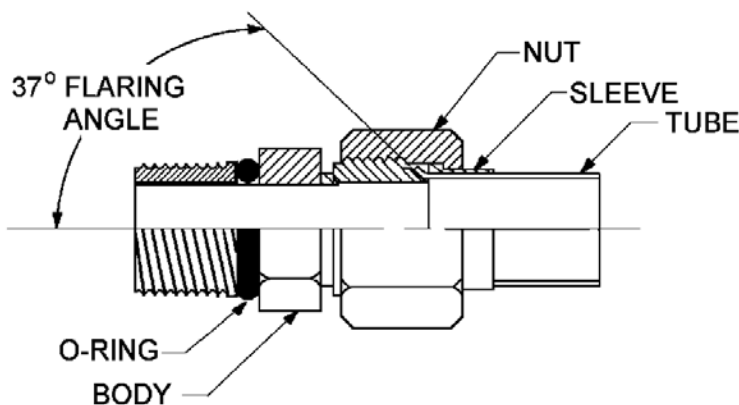


FIGURE 1. Typical flared fitting assembly showing body, O-ring, nut, sleeve and tube

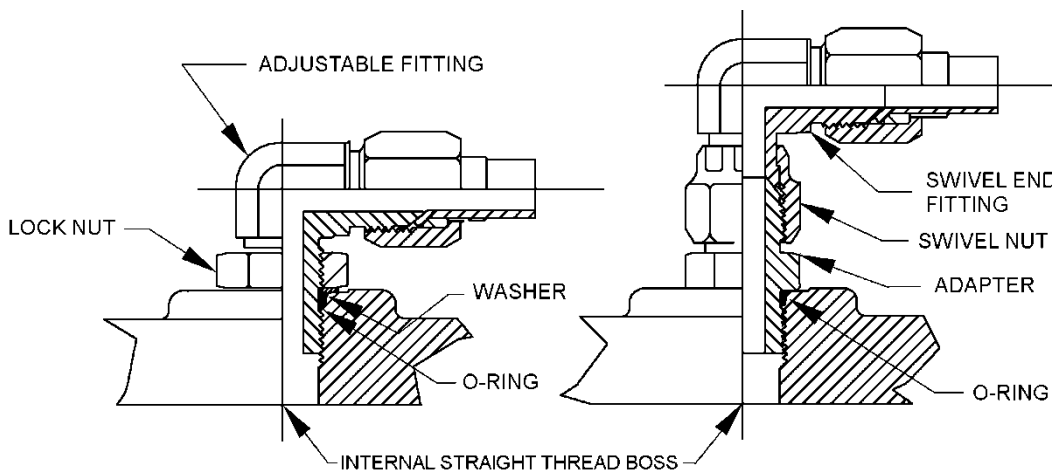


FIGURE 2. Adjustable fitting Typical installation.

FIGURE 3. Swivel and fitting typical installation.

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4.6.8.3 Design capability test - flareless. When specified, a minimum of five flareless fittings in each size, shape and material shall be assembled with mating fittings in a manner similar to figures 4, 5, and 6 as applicable (see 6.2). To facilitate testing the tube shall be of the like material of the body, nut, and sleeve, see 4.5. The following details shall apply:

- a. Sleeves shall be preset on tubing before assembly using a presetting machine, or the fitting, by tightening the nut to the number of turns specified in table VII, past the point of ring grip.
- b. After presetting the sleeve the nut shall be completely disengaged, inspect sleeve for proper bite, reassemble to fitting body wrenching the nut 1/6 to 1/4 turn, maximum, beyond the point where a sudden increase in torque is noted.
- c. The pipe threaded end, or straight thread with O-ring end fitting or straight thread fitting, whichever is applicable, shall be tightened to the point where leakage shall not occur, at a proof pressure of 6000 psi (41 MPa) for sizes -2 through -16 and proof pressure of 3000 psi (21 MPa) for sizes -20 through -32. Under this pressure, there shall be no leakage or distortion of the assembly.
- d. The assembly shall then be pressurized to the point at which leakage or rupture occurs and the results shall be recorded.

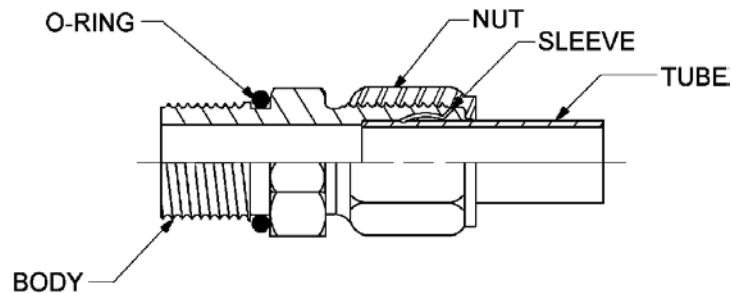


FIGURE 4. Typical flareless fitting assembly showing body, O-ring, nut, sleeve and tube.

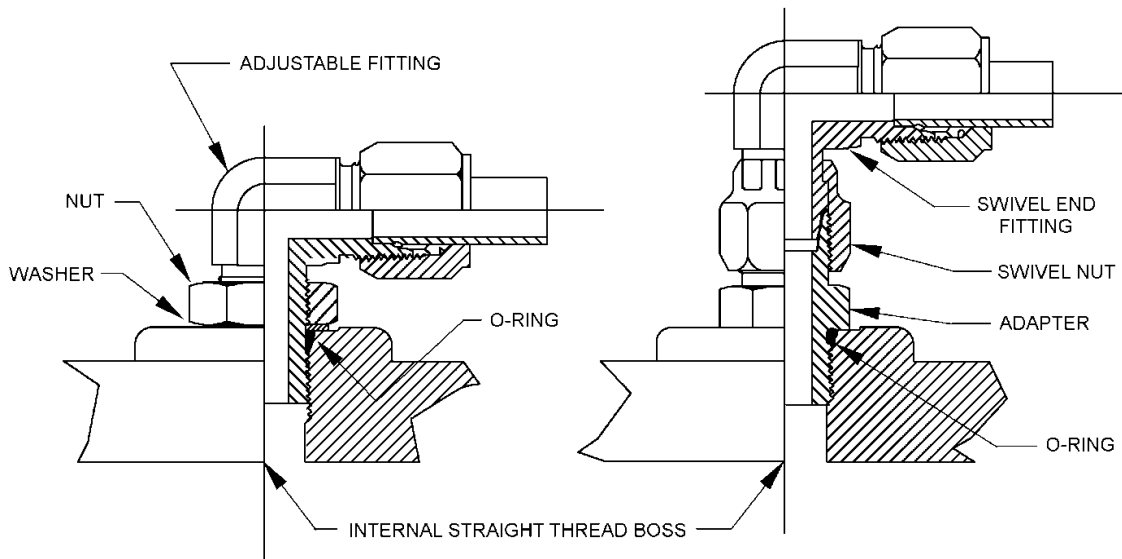


FIGURE 5. Adjustable fitting. Typical installation.

FIGURE 6. Swivel and fitting. Typical installation.

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4.6.8.4. Results of design capability. Results of design capability tests shall be maintained on file by the fitting manufacturers, available for review by the Government upon request.

TABLE VII. Preset - tube tightness limits.

| Tubing O.D inches | Number of turns | Tubing O.D inches | Number of turns |
|-------------------|-----------------|-------------------|-----------------|
| 1/8 | 1 1/16 | 3/4 | 1 |
| 3/16 | 1 1/16 | 7/8 | 1 |
| 1/4 | 1 1/16 | 1 | 5/6 |
| 5/16 | 1 1/16 | 1 1/4 | 1 |
| 3/8 | 1 1/16 | 1 1/2 | 1 |
| 1/2 | 1 1/16 | 2 | 1 |
| 5/8 | 1 | | |

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Service or Defense Agency, or within the Military Service's System Commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory).

6.1 Intended use. 37° flared fittings are intended for use with steel tubing in hydraulic systems. Flareless fittings are intended for use in hydraulic or air systems. Carbon steel sleeves may be used only with fully annealed 70-30 copper-nickel or carbon steel tubing. Corrosion-resisting steel sleeves may be used with fully annealed 70-30 copper-nickel, 70-30 copper-nickel-, corrosion-resisting steel or carbon steel tubing. These fittings are not intended for use in aircraft. The fittings are military unique because they can withstand 96 hours of salt spray testing, commercial equivalents cannot meet the test requirements.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. MS PIN (1.2).
- c. Hardness requirement, if different (3.5)
- d. Material certification and/or plating thickness (4.6.4 and 3.4.8).
- e. Style of flareless sleeve required (3.6.2.9).
- f. Marking (3.7)
- g. Additional marking (3.7.3).
- h. If first article is required (see 3.2).

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- i. Name and address of the first article inspection test facility to which first article samples are to be forwarded (see 4.2.1) and the name and address of the Government activity responsible for conducting the first article inspection program (see 6.3).
- j. Name and address of the Government activity responsible for receiving a production sample (see 4.3.5).
- k. Packaging requirements (see 5.1).

6.3 First article. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first article samples. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.3.1 Defense Logistics Agency (DLA) waiver of first article test. A waiver of a first article testing will only be considered by DLA when the contractor has delivered the same item within the last 3 years, has no unfavorable quality history, has not changed processes, or changed any subcontractors. DLA will not accept first article testing results outside the stated requirements.

6.4 Guidance on use of alternative parts with less hazardous or nonhazardous materials. This specification provides for a number of alternative platings and materials via the PIN. Users should select the PIN with the least hazardous material that meets the form, fit and function requirements of their application.

6.5 Cadmium plating replacements.

6.5.1 Zinc coatings. It is recommended that zinc coating be specified in place of cadmium plating whenever contact with salt atmosphere is not a problem.

6.5.2 Phosphate coatings. It is recommended that phosphate coating be specified when electrodeposited zinc or mechanically-deposited cadmium plating are not desired.

6.6 Subject term (key word) listing.

Adapters
Cadmium
Fluid
Hydraulic connector
Nickel
Pneumatic

6.7 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. 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.

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CONCLUDING MATERIAL

Custodians:

Army - AR
Navy - OS
Air Force - 99
DLA - CC

Preparing activity:
DLA - CC

(Project 4730-2017-001)

Review activities:

Army - AT, AV, GL, MI
Navy - AS, MC, SH, YD
Air Force - 71

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online data at <https://assist.dla.mil>.