

MIL-T-16420K(SH)
 14 April 1978
 SUPERSEDING
 MIL-T-16420J(SHIPS)
 4 March 1965
 (See 6.6)

MILITARY SPECIFICATION

TUBE, COPPER-NICKEL ALLOY, SEAMLESS AND WELDED

(COPPER ALLOY NUMBERS 715 AND 706)

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers two compositions of round copper-nickel alloy tube for basic piping systems on surface ships and submarines as referenced in MIL-STD-777 and MIL-STD-438. Tube and pipe sizes permit the use of Naval fittings designed for brazed or welded connections.

1.2 Classification. Tube shall be of the following compositions, tempers, types, classes, and grades, as specified (see 6.1):

Composition:

70-30 copper-nickel (copper alloy no. 715).
 90-10 copper-nickel (copper alloy no. 706).

Temper:

Annealed.
 Light drawn (alloy 706 only).

Type:

I - Seamless.
 II - Welded.

Class:

50 (50 pounds per square inch (lb/in²) maximum working pressure - type II only).
 200 (200 lb/in² maximum working pressure).
 700 (700 lb/in² maximum working pressure).
 1650 (1650 lb/in² maximum working pressure).
 3300 (3300 lb/in² maximum working pressure - type I only).
 6000 (6000 lb/in² maximum working pressure - type I only).
 Special (tube which does not conform to tables III or IV with respect to calculated wall-to-outside diameter ratio).

Grade:

1 - Material supplied without heat identification.
 2 - Material supplied with heat identification.

1.2.1 Class 50 tube shall be furnished in alloy 706 only. Class 200 shall be furnished in either alloy 715 or 706, and the remainder of the classes in alloy 715 only.

1.2.2 Nonstandard (special class) tube shall be classified on the basis of its maximum calculated working pressure and identified with the next lower nominal pressure class listed in 1.2. Special class tube shall be specified by its nominal class number and "special".

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

- MIL-C-3993 - Copper and Copper-Base Alloy Mill Products; Packaging of:
- MIL-C-15726 - Copper-Nickel Alloy, Rod, Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate) and Forgings.
- MIL-I-45208 - Inspection System Requirements.

STANDARDS

FEDERAL

- FED-STD-151 - Metals; Test Methods.
- FED-STD-185 - Identification Marking of Copper and Copper Base Alloy Mill Products.

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-271 - Nondestructive Testing Requirements for Metals.
- MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.

PUBLICATIONS

MILITARY

- NAVSEA 0900-LP-003-9000 - Radiographic Standards for Production and Repair Welds.

(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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A342 - Permeability of Feebly Magnetic Materials.
- E8 - Tension Testing of Metallic Materials.
- E29 - Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant in Specified Limiting Values.
- E340 - Methods for Macroetching Metals and Alloys.

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- B31.1 - Power Piping.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Manufacture.

3.1.1 Type I tube. Type I tube may be hot or cold worked, or both, and shall be weld-free. Tube shall be finished by such cold working or machining to size and annealing as may be necessary to meet the properties specified herein. Sizing of ends to meet dimensional requirements is prohibited. Fully annealed tube shall be completely recrystallized and shall be either fully annealed clean or annealed and acid cleaned. When light drawn alloy 706 tube is furnished, the tube shall be cold drawn after final anneal and pickle.

3.1.2 Type II tube. Type II tube shall be preformed from copper-nickel alloy flat products conforming to MIL-C-15726 and seam welded along a single longitudinal axis. Internal and external flash shall be removed by scarfing and there shall be no crevice in the weld seam visible to the unaided eye. Tube produced from fully annealed sheet, strip, or plate shall be of the temper resulting from forming and welding operations provided it meets the mechanical property requirements of 3.3 otherwise, the tube shall be reannealed clean or reannealed and acid-pickled. Light drawn tube (alloy 706 only) shall be cold drawn after final anneal and pickle to conform to the specified temper.

3.1.3 Contaminants, such as sulfur or sulfur-containing compounds from lubricants used in forming, machining, or other processing, or from marking materials used for in-process identification, shall be removed prior to any heat treatment of the material.

3.2 Chemical composition. Chemical composition shall conform to table I.

TABLE I. Chemical composition.

| Element | Copper alloy No. 706 | Copper alloy No. 715 |
|--|---|-------------------------|
| | Percent maximum (unless shown as a range or minimum) | |
| Copper (including silver), minimum | 66.5 | 65.0 |
| Nickel (including cobalt) | 9.0 - 11.0 | 29.0 - 33.0 |
| Iron | 1.0 - 1.8 | 0.40 - 1.0 |
| Manganese | 1.0 | 1.0 |
| Zinc | 0.50 | 0.50 |
| Lead | 0.02 | 0.02 |
| Phosphorus | 0.02 | 0.02 |
| Sulfur | 0.02 | 0.02 |
| Carbon | 0.05 | 0.05 |
| Copper plus elements with specific limits, minimum | 99.5 | 99.5 |

3.3 Mechanical requirements.

3.3.1 Tensile properties. Tensile properties shall conform to table II.

TABLE II. Tensile properties.

| Copper alloy No. and temper | Outside diameter inches | Tensile strength, lb/in ² (min.) | Yield strength at 0.5 percent offset or extension under- load lb/in ² (min.) | Elongation in 2 inches or 4D, percent (min.) |
|-----------------------------------|-------------------------------|---|--|--|
| 715 fully annealed | Up to 4-1/2, | 50,000 | 18,000 | 30 |
| | inclusive Over 4-1/2 | | | |
| 706 fully annealed | Up to 4-1/2, | 38,000 | 15,000 | 30 |
| | inclusive Over 4-1/2 | | | |
| 706 light drawn | ----- | 45,000 | 35,000 | 15 |

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‡ 3.3.2 Expansion or flattening. Annealed tube shall be capable of being expanded or flattened at room temperature without developing cracks or flaws visible to the unaided eye when tested as specified in 4.4.2.2. Light drawn tube shall not be required to withstand the flattening test.

3.4 Nondestructive requirements.

‡ 3.4.1 Hydrostatic pressure. Class 50 and 200 tube which is not required to be ultrasonically inspected in accordance with 3.4.3 and, when specified (see 6.1), tube subject to ultrasonic inspection shall be hydrostatically tested as specified in 4.4.3. Each tube shall be perfectly tight under test pressure and show no bulges, cracks, flaws, porous places, or other defects.

3.4.2 Radiographic (type II tube). Seam weld shall be radiographed and shall meet the requirements of NAVSEA 0900-LP-003-9000 for class 1 production welds when tested as specified in 4.4.8.

‡ 3.4.3 Ultrasonic. Each finished tube, as required by 3.4.3.1 through 3.4.3.3, shall be inspected ultrasonically by the shear wave (angle-beam) technique specified in 4.4.9. This inspection shall be conducted in two opposite circumferential directions. When specified (see 6.1), an alternate nondestructive test method may be substituted by the manufacturer at the option of the procuring activity. The method shall be capable of detecting inside and outside surface defects, and subsurface defects, equivalent to or smaller than those specified in 4.4.9.3.

‡ 3.4.3.1 Nominal class tube (type I). Alloy 715 tube (class 700, 1650, 3300, and 6000) and, when specified (see 6.1), alloy 715 and 706 tube (class 200) shall be continuously scanned ultrasonically in accordance with MIL-STD-271 and shall pass the acceptance criteria specified in 4.4.9.8.

‡ 3.4.3.2 Nominal class tube (type II). Alloy 715 tube (class 700 and 1650) and, when specified (see 6.1), alloy 715 tube (class 200) and alloy 706 tube (class 50 and 200) shall be continuously scanned ultrasonically in accordance with MIL-STD-271, except at the weld seam, and shall pass the acceptance criteria specified in 4.4.9.8. When required (see 6.1), flat products from which the tubes are fabricated shall be of ultrasonic test quality in accordance with MIL-C-15726.

‡ 3.4.3.3 Special class tube (type I and II). Based on its nominal class (see 1.2.2), nonstandard tube shall be capable of meeting the ultrasonic requirements specified in 3.4.3.1 or 3.4.3.2.

‡ 3.4.3.4 Laminations. Tube required to meet the ultrasonic requirements specified in 3.4.3 shall be examined for laminar discontinuities by ultrasonic gaging for compliance with the wall thickness requirements of 3.8.2. Laminar discontinuities shall be considered as reductions of wall thickness.

3.5 Etch. Seamless tube shall be weld-free when etch tested as specified in 4.4.4. The test is required when the tube is procured from a mill which manufactures both welded and seamless tube and when the mill does not mark the tube in accordance with 3.10 at the fabricating site.

‡ 3.6 Magnetic permeability (alloy 706 only). When specified (see 6.1), magnetic permeability of tube tested in accordance with 4.4.5 shall not exceed 1.05 $\mu\mu$.

3.7 Dimensions and weights. Size of tube required shall be as specified (see 6.1). Unless otherwise specified in the contract or order, the standard dimensions and weights shall be as shown in table III or IV.

3.7.1 Nonstandard sizes. When tube is ordered to dimensions other than those in table III or IV, the maximum working pressure shall be determined by the procuring activity in accordance with equations 4 and 4A of ANSI B31.1. The additional thickness allowance, A, shall be 0.050 inch to compensate for corrosion/erosion or for thinning of the wall due to threading.

3.8 Tolerances.

3.8.1 Overweight. Maximum tolerance permitted for overweight of any lot of tube is 10 percent, assuming Copper-nickel alloy 715 or 706 weighs 0.323 pounds per cubic inch.

‡ 3.8.2 Wall thickness. When determined as specified in 4.4.7, the tube wall at any point shall be not less than the thickness required in table III or IV. Maximum tolerance on wall thickness per tube shall not exceed an overweight allowance of 13 percent of the calculated weight.

TABLE III. Dimensions and weights of copper-alloy number 715 tube (type I and type II unless otherwise indicated).

| Outside diameter Inches | Class 200 | | Class 700 | | Class 1650 | | Class 3300 | | Class 6000 | |
|----------------------------|-------------------------------|-----------------------------------|-------------------------------|-----------------------------------|-------------------------------|-----------------------------------|-------------------------------|-----------------------------------|-------------------------------|-----------------------------------|
| | Wall thickness (min.) Inch | Wt./ft. calcu- lated Pounds | Wall thickness (min.) Inch | Wt./ft. calcu- lated Pounds | Wall thickness (min.) Inch | Wt./ft. calcu- lated Pounds | Wall thickness (min.) Inch | Wt./ft. calcu- lated Pounds | Wall thickness (min.) Inch | Wt./ft. calcu- lated Pounds |
| 0.125 | ---- | ---- | ---- | ---- | ---- | ---- | 0.028 | 0.033 | 0.028 | 0.033 |
| .250 | 2/0.035 | 0.092 | ---- | ---- | ---- | ---- | .035 | .092 | .058 | .136 |
| .375 | ---- | ---- | ---- | ---- | ---- | ---- | .049 | .194 | .083 | .295 |
| .405 | ---- | ---- | ---- | ---- | ---- | ---- | .058 | .245 | .095 | .359 |
| .500 | 2/ | .198 | 0.065 | 0.344 | 0.035 | 0.198 | .072 | .375 | .120 | .555 |
| .540 | ---- | .376 | .065 | .376 | .042 | .255 | .072 | .410 | .120 | .614 |
| .675 | ---- | .483 | .072 | .529 | .049 | .373 | .095 | .671 | .148 | .950 |
| .750 | ---- | ---- | ---- | ---- | .058 | .489 | .109 | .851 | .165 | 1.18 |
| .840 | ---- | .614 | .072 | .673 | .058 | .552 | .120 | 1.05 | .203 | 1.57 |
| 1.000 | ---- | .780 | ---- | .977 | .072 | .814 | .134 | 1.41 | .220 | 2.09 |
| 1.050 | ---- | ---- | .083 | ---- | .083 | .977 | .148 | 1.63 | .238 | 2.35 |
| 1.250 | ---- | ---- | ---- | ---- | .095 | 1.14 | .165 | 2.18 | .284 | 3.34 |
| 1.315 | ---- | .990 | .095 | 1.41 | .095 | 1.41 | .180 | 2.49 | .300 | 3.71 |
| 1.500 | ---- | ---- | ---- | ---- | .109 | 1.85 | .203 | 3.21 | .340 | 4.80 |
| 1.660 | ---- | 1.39 | .095 | 1.81 | .120 | 2.25 | .220 | 3.86 | .380 | 5.92 |
| 1.900 | ---- | 1.60 | .109 | 2.38 | .134 | 2.88 | .250 | 5.02 | .425 | 7.63 |
| 2.000 | ---- | ---- | ---- | ---- | .148 | 3.34 | .284 | 5.93 | .454 | 8.55 |
| 2.375 | ---- | 2.32 | .120 | 3.30 | .165 | 4.14 | .340 | 8.43 | .520 | 11.7 |
| 2.500 | ---- | ---- | ---- | ---- | .180 | 5.09 | .340 | 8.94 | .547 | 13.0 |
| 2.875 | ---- | 2.82 | .134 | 4.47 | .203 | 6.60 | .380 | 11.5 | .630 | 17.2 |
| 3.500 | ---- | 3.94 | .165 | 6.70 | .250 | 9.89 | .458 | 17.0 | .760 | 25.3 |
| 4.000 | ---- | 4.52 | .180 | 8.37 | .284 | 12.8 | ---- | ---- | ---- | ---- |
| 4.500 | ---- | 5.83 | .203 | 10.6 | .340 | 17.2 | ---- | ---- | ---- | ---- |
| 5.000 | ---- | 7.13 | .203 | 11.9 | .380 | 21.4 | ---- | ---- | ---- | ---- |
| 5.563 | ---- | 8.28 | .220 | 14.1 | .425 | 26.6 | ---- | ---- | ---- | ---- |
| 6.625 | ---- | 10.6 | .259 | 20.1 | .457 | 34.3 | ---- | ---- | ---- | ---- |
| 7.625 | ---- | 12.2 | .284 | 25.4 | .526 | 45.5 | ---- | ---- | ---- | ---- |
| 8.625 | ---- | 15.3 | .340 | 34.3 | .595 | 58.2 | ---- | ---- | ---- | ---- |
| 9.625 | ---- | 21.5 | .340 | 38.4 | .664 | 72.5 | ---- | ---- | ---- | ---- |
| 10.750 | ---- | 24.1 | .380 | 48.0 | .741 | 90.3 | ---- | ---- | ---- | ---- |
| 12.750 | ---- | 38.1 | .454 | 68.0 | .879 | 127 | ---- | ---- | ---- | ---- |
| 14.000 | ---- | ---- | .473 | 77.9 | ---- | ---- | ---- | ---- | ---- | ---- |
| 15.000 | ---- | ---- | .503 | 88.8 | ---- | ---- | ---- | ---- | ---- | ---- |
| 16.000 | ---- | ---- | .534 | 101 | ---- | ---- | ---- | ---- | ---- | ---- |

2/ Tube with outside diameters 0.125 inch through 2.875 inches available in type I only.

2/ Intended for hydraulic service, no corrosion allowance included.

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TABLE IV. Dimensions and weights of copper alloy number 706 tube
(type I and type II unless otherwise indicated).

| Outside diameter | Class 50 - type II | | Class 200 ^{1/} | |
|------------------|-----------------------|--------------------|-------------------------|--------------------|
| | Wall thickness (min.) | Wt./ft. calculated | Wall thickness (min.) | Wt./ft. calculated |
| Inches | Inch | Pounds | Inch | Pounds |
| 0.250 | ---- | ---- | ^{2/} 0.035 | 0.092 |
| .500 | ---- | ---- | ^{2/} .035 | .198 |
| .540 | ---- | ---- | .065 | .376 |
| .675 | ---- | ---- | .065 | .483 |
| .840 | ---- | ---- | .065 | .613 |
| 1.050 | ---- | ---- | .065 | .779 |
| 1.315 | ---- | ---- | .065 | .989 |
| 1.660 | ---- | ---- | .072 | 1.39 |
| 1.900 | ---- | ---- | .072 | 1.60 |
| 2.375 | ---- | ---- | .083 | 2.32 |
| 2.875 | ---- | ---- | .083 | 2.82 |
| 3.500 | ---- | ---- | .095 | 3.94 |
| 4.000 | ---- | ---- | .095 | 4.51 |
| 4.500 | ---- | ---- | .109 | 5.83 |
| 5.000 | ---- | ---- | .120 | 7.12 |
| 5.563 | ---- | ---- | .125 | 8.28 |
| 6.625 | ---- | ---- | .134 | 10.6 |
| 7.625 | ---- | ---- | .140 | 12.2 |
| 8.625 | ---- | ---- | .151 | 15.3 |
| 9.625 | ---- | ---- | .187 | 21.5 |
| 10.750 | 0.134 | 17.3 | .187 | 24.0 |
| 12.750 | .156 | 23.9 | .250 | 38.0 |
| 14.000 | .165 | 27.8 | ---- | ---- |
| 15.000 | ---- | ---- | ---- | ---- |
| 16.000 | .165 | 31.8 | ---- | ---- |
| 18.000 | .180 | 39.1 | ---- | ---- |
| 20.000 | .180 | 43.5 | ---- | ---- |
| 22.000 | .180 | 47.8 | ---- | ---- |
| 22.750 | .180 | 49.5 | ---- | ---- |
| 30.000 | .250 | 90.5 | ---- | ---- |
| 40.000 | .312 | 150.7 | ---- | ---- |

^{1/} Tube with outside diameters 0.250 inch through 2.875 inches available in type I only.^{2/} Intended for hydraulic service, no corrosion allowance included.3.8.3 Average outside diameter. Permissible variations in average outside diameter of tube shall be as specified in table V.TABLE V. Average outside diameter tube tolerances.^{1/}

| Outside diameter | Permissible variation | |
|----------------------------|-----------------------|--------|
| | Plus | Minus |
| Inches | Inch | Inch |
| 0.250 to 0.675, incl. | 0.0 | 0.0050 |
| Over 0.675 to 1.050, incl. | .0 | .0060 |
| Over 1.050 to 1.900, incl. | .0 | .0080 |
| Over 1.900 to 2.875, incl. | .0 | .010 |
| Over 2.875 to 4.000, incl. | .0 | .012 |
| For 4.500 | .0 | .015 |
| For 5.000 | .0 | .016 |
| For 5.563 | .0 | .017 |
| For 6.625 | .0 | .020 |
| For 7.625 | .0 | .023 |
| For 8.625 | .0 | .026 |

See footnote at end of table.

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TABLE V. Average outside diameter tube tolerances.^{1/} (Continued)

| Outside diameter | Permissible variation | |
|------------------|-----------------------|-----------|
| | Plus | Minus |
| Inches | Inch | Inch |
| For 9.625 | 0.0 | 0.026 |
| For 10.750 | .0 | .030 |
| For 12.750 | .0 | .035 |
| Over 12.750 | .0 | 1 percent |

^{1/} The average outside diameter of a tube is the average of the maximum and minimum outside diameters as determined at any cross-section of the tube.

3.8.4 Weld seam (type II tube). Outside weld reinforcement shall be smooth for the full length of the tube. Inside weld may be flush with the inside surface or have a uniform reinforcing crown not to exceed the tolerances of table VI.

TABLE VI. Weld seam tolerances (type II tube).

| Wall thickness | Thickness of weld crown on inside diameter (max.) |
|----------------|---|
| Inch | Inch |
| Under 0.250 | 1/32 |
| 0.250 to 0.500 | 1/16 |
| 0.500 and over | 3/32 |

3.8.5 Length.

3.8.5.1 Unless otherwise specified (see 6.1), type I tube shall be furnished in mill lengths and type II tube shall be furnished in lengths of 12 to 24 feet with a tolerance of plus or minus 6 inches. When specified (see 6.1), or on the drawings, tubes shall be furnished in specific lengths or to any particular schedule of lengths agreed upon between manufacturer and the procuring activity.

3.8.5.2 Mill lengths. Mill lengths shall have a maximum length of 25 feet with a permissible variation of plus 1 inch. The shortest permissible lengths and the minimum percent by weight of the longer lengths in any lot or shipment shall be as specified in table VII. When agreed upon between the manufacturer and the procuring activity, lengths greater than 25 feet may be supplied as mill lengths.

3.8.5.2.1 Specific lengths. Where tubes are ordered to specific (exact) lengths, the tolerances specified in table VIII shall apply.

TABLE VII. Schedule of mill lengths (type I only).

| Outside diameter | Class 200 | | | | Class 700 | | | |
|------------------|-----------------------|---------------|-----------------------|--|-----------------------|---------------|-----------------------|--|
| | Wall thickness (min.) | Length (min.) | Longer lengths (max.) | Percent by weight of longer lengths (min.) | Wall thickness (min.) | Length (min.) | Longer lengths (max.) | Percent by weight of longer lengths (min.) |
| Inches | Inch | Feet | Feet | | Inch | Feet | Feet | |
| 0.125 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| .250 | 0.035 | 12 | 25 | 80 | --- | ---- | -- | -- |
| .375 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| .405 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| .500 | .035 | 12 | 25 | 80 | 0.065 | 12 | 25 | 80 |
| .540 | .065 | 12 | 25 | 80 | .065 | 12 | 25 | 80 |
| .675 | .065 | 12 | 25 | 80 | .072 | 12 | 25 | 80 |
| .750 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| .840 | .065 | 12 | 25 | 80 | .072 | 12 | 25 | 80 |
| 1.000 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| 1.050 | .065 | 12 | 25 | 80 | .083 | 12 | 25 | 80 |
| 1.250 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| 1.315 | .065 | 12 | 25 | 80 | .095 | 12 | 25 | 80 |
| 1.500 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| 1.660 | .072 | 12 | 25 | 80 | .095 | 12 | 25 | 70 |
| 1.900 | .072 | 12 | 25 | 70 | .109 | 12 | 25 | 70 |
| 2.000 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| 2.375 | .083 | 12 | 25 | 65 | .120 | 12 | 25 | 60 |
| 2.500 | --- | ---- | -- | -- | --- | ---- | -- | -- |
| 2.875 | .083 | 12 | 25 | 60 | .134 | 10 | 25 | 50 |
| 3.500 | .095 | 12 | 25 | 55 | .165 | 10 | 25 | 40 |
| 4.000 | .095 | 12 | 25 | 50 | .180 | 10 | 18 | 40 |
| 4.500 | .109 | 12 | 25 | 40 | .203 | 10 | 16 | 40 |
| 5.000 | .120 | 10 | 18 | 40 | .203 | 10 | 16 | 30 |
| 5.563 | .125 | 10 | 18 | 40 | .220 | 10 | 16 | 30 |
| 6.625 | .134 | 10 | 16 | 35 | .259 | 8 | 14 | 20 |
| 7.625 | .140 | 10 | 14 | 25 | .284 | 6 | 10 | 10 |
| 8.625 | .151 | 8 | 12 | 20 | .340 | 4 | 8 | -- |
| 9.625 | .187 | 5 | 10 | 10 | .340 | 3-1/2 | 7 | -- |
| 10.750 | .187 | 5-1/2 | 8 | -- | .380 | 3-1/2 | 7 | -- |
| 12.750 | .250 | 3-1/2 | 6 | -- | .454 | 3-1/2 | 7 | -- |

TABLE VII. Schedule of mill lengths (type I only) - Continued.

| Outside diameter | Class 1650 | | | | Class 3300 | | | | Class 6000 | | | |
|------------------|-----------------------|---------------|-----------------------|--|-----------------------|---------------|-----------------------|--|-----------------------|---------------|-----------------------|--|
| | Wall thickness (min.) | Length (min.) | Longer lengths (max.) | Percent by weight of longer lengths (min.) | Wall thickness (min.) | Length (min.) | Longer lengths (max.) | Percent by weight of longer lengths (min.) | Wall thickness (min.) | Length (min.) | Longer lengths (max.) | Percent by weight of longer lengths (min.) |
| Inches | Inch | Feet | Feet | | Inch | Feet | Feet | | Inch | Feet | Feet | |
| 0.125 | --- | --- | --- | --- | 0.028 | 12 | 25 | 70 | 0.028 | 12 | 25 | 70 |
| .250 | --- | --- | --- | --- | .035 | 12 | 25 | 70 | .058 | 12 | 25 | 70 |
| .375 | --- | --- | --- | --- | .049 | 12 | 25 | 70 | .083 | 12 | 25 | 70 |
| .405 | --- | --- | --- | --- | .058 | 12 | 25 | 70 | .095 | 12 | 25 | 70 |
| .500 | 0 035 | 12 | 25 | 80 | .072 | 12 | 25 | 70 | .120 | 12 | 25 | 70 |
| .540 | .042 | 12 | 25 | 80 | .072 | 12 | 25 | 70 | .120 | 12 | 25 | 70 |
| .675 | .049 | 12 | 25 | 80 | .095 | 12 | 25 | 70 | .148 | 12 | 25 | 65 |
| .750 | .058 | 12 | 25 | 80 | .109 | 12 | 25 | 70 | .165 | 12 | 25 | 60 |
| .840 | .058 | 12 | 25 | 80 | .120 | 12 | 25 | 60 | .203 | 10 | 25 | 50 |
| 1.000 | .072 | 12 | 25 | 80 | .134 | 12 | 25 | 60 | .220 | 10 | 18 | 50 |
| 1.050 | .083 | 12 | 25 | 80 | .148 | 12 | 25 | 60 | .238 | 10 | 18 | 40 |
| 1.250 | .095 | 12 | 25 | 70 | .165 | 12 | 25 | 60 | .284 | 10 | 18 | 40 |
| 1.315 | .095 | 12 | 25 | 70 | .180 | 10 | 18 | 55 | .300 | 8 | 16 | 30 |
| 1.500 | .09 | 12 | 25 | 65 | .203 | 10 | 18 | 50 | .340 | 8 | 16 | 30 |
| 1.660 | .20 | 10 | 18 | 50 | .220 | 10 | 18 | 45 | .380 | 8 | 14 | 30 |
| 1.900 | .34 | 10 | 18 | 40 | .250 | 10 | 18 | 40 | .425 | 5 | 11 | 30 |
| 2.000 | .148 | 10 | 18 | 40 | .284 | 8 | 16 | 30 | .454 | 4 | 8 | 30 |
| 2.375 | .165 | 10 | 18 | 40 | .340 | 8 | 16 | 30 | .5201 | 4 | 8 | 30 |
| 2.500 | .180 | 9 | 18 | 40 | .340 | 8 | 16 | 20 | .5474 | 3 | 5 | 30 |
| 2.875 | .203 | 9 | 18 | 40 | .380 | 8 | 14 | 20 | --- | --- | --- | --- |
| 3.500 | .250 | 8 | 16 | 40 | .4575 | 7 | 10 | --- | --- | --- | --- | --- |
| 4.000 | .284 | 8 | 14 | 30 | --- | --- | --- | --- | --- | --- | --- | --- |
| 4.500 | .340 | 6 | 12 | 30 | --- | --- | --- | --- | --- | --- | --- | --- |
| 5.000 | .380 | 5 | 8 | 20 | --- | --- | --- | --- | --- | --- | --- | --- |
| 5.563 | .425 | 4 | 7 | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 6.625 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7.625 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8.625 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9.625 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10.750 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12.750 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

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TABLE VIII. Specific length tolerances.^{1/}

| Length | For outside diameters up to 1 inch, inclusive | For outside diameters over 1 to 4 inches, inclusive | For outside diameters over 4 inches |
|--------------------------------|---|---|-------------------------------------|
| | Inch | Inch | Inch |
| Up to 6 inches, incl. | 1/32 | 1/16 | --- |
| Over 6 inches to 2 feet, incl. | 1/16 | 3/32 | 1/8 |
| Over 2 feet to 6 feet, incl. | 3/32 | 1/8 | 1/4 |
| Over 6 feet to 14 feet, incl. | 1/4 | 1/4 | 1/4 |
| Over 14 feet | 1/2 | 1/2 | 1/2 |

^{1/} Tolerances are all plus; if all minus tolerances are required, use the same values. If tolerances plus or minus are required, halve the values given.

3.8.6 Squareness of cut. Departure from squareness of the end of any tube shall not exceed 0.010 inch for tube up to and including 5/8-inch outside diameter, and 0.016 inch per inch of diameter for tube over 5/8-inch outside diameter.

3.8.7 Roundness. Provided that the tube conforms to all other dimensional requirements specified herein, it will be acceptable if when examined at the mill, the difference between the major and minor outside diameters at any one cross-section does not exceed the percentages of the nominal outside diameter specified in table IX.

TABLE IX. Roundness tolerances.

| Ratio of minimum wall thickness to nominal outside diameter | Roundness tolerance as percent of nominal outside diameter |
|---|--|
| 0.01 to 0.03, incl. | 3.0 |
| Over 0.03 | 2.0 |

3.8.8 Straightness. When examined at the mill, fully annealed tube shall be sufficiently straight so as to make it suitable for normal applications. Straightness tolerances applicable to light drawn alloy 706, type I tube, 1/4 to 3-1/2 inches in outside diameter, inclusive, shall be in accordance with table X.

TABLE X. Straightness tolerances for light drawn alloy 706 tube, type I.

| Length, feet ^{1/} | Maximum curvature (depth of arc), inch |
|----------------------------|--|
| Over 3 to 6, incl. | 3/16 |
| Over 6 to 8, incl. | 5/16 |
| Over 8 to 10, incl. | 1/2 |

^{1/} For lengths greater than 10 feet, the maximum curvature shall not exceed 1/2 inch in any 10-foot portion of the total length.

3.9 Removal of defects. Removal of surface defects shall be accomplished by grinding, machining, or filing with a clean file, provided the wall thickness is not reduced below the minimum specified in 3.8.2 and the ground areas are well-faired into the rest of the tube. A well-faired area is considered one in which the bottom radius of the ground area equals at least 3 times the depth of the defect. If grinding is used to remove the surface defect, the grinding medium shall be 120 or finer iron-free alumina grit. Grinding shall be limited to the use of either resin or rubber bonded wheels.

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‡ 3.10 Identification marking. When specified (see 6.1), each tube shall be marked in accordance with FED-STD-185 with the following identification:

- (a) Manufacturer's name, trademark, or symbol.
- (b) Alloy designation.
- (c) Lot number.
- (d) Temper, type, class, grade, and heat number (for grade 2 tube).
- (e) Dimensions (outside diameter and wall thickness).
- (f) Specification number.

‡ 3.10.1 Marking by means of vibratory tool, electrochemical etching, or by paint or ink stenciling is acceptable, provided the following conditions are met:

- (a) Vibratory marking tools shall be fitted with a carbide marking point, or equivalent, and shall be adjusted to provide a legible, shallow, rounded impression not exceeding 0.010 inch in depth. The marking tool tip minimum radius shall be 0.005 inch.
- (b) Electrolyte used for electrochemical etching shall not contain in excess of 250 parts per million (p/m) each of total halogens, sulfur, and lead.
- (c) Marking fluids shall not contain mercury or halogens in excess of 200 p/m, sulfur in excess of 250 p/m, phosphorus, and any low melting point elements in other than trace amounts (less than 100 p/m).
- (d) No marking shall reduce the wall thickness of the tube below the specified minimum tolerance.
- (e) Tube with nominal wall thickness less than 1/8 inch and light drawn alloy 706 tube shall be marked only by electrochemical etch. Electric arc marking and die stamping of any kind is prohibited.

3.11 Visual and dimensional examination. Tube shall pass the visual and dimensional examination specified in 4.3.1 and 4.3.2.

3.12 Workmanship. Surface of all tubes shall be smooth, clean, and free of cracks, laminations, laps, seams, scale and other injurious defects to the maximum extent possible as revealed by visual examination. Tube shall be of proper dimensions with ends cut square and free of burrs and shall have a surface roughness not greater than 125 microinch, center line average. Surface imperfections such as handling marks, straightening marks, light mandrel, and die or roll marks will not be considered injurious defects provided the imperfections do not reduce the wall thickness below the minimum specified in 3.8.2. Permissible defects in finished tube shall be randomly distributed over the tube surface.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

‡ 4.1.1 Inspection system. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208 (see 6.1).

4.2 Quality conformance inspection.

4.2.1 Inspection lot.

‡ 4.2.1.1 Grade 1. A lot shall consist of the quantities of the tube of the same alloy, type, class, and size specified in table XI and offered for delivery at the same time.

‡ 4.2.1.2 Grade 2. A lot shall consist of the quantities of tube of the same alloy, type, class, and size specified in table XI, offered for delivery at the same time and identifiable by mill records as originating from one or more heats, as necessary, which conform to the chemical requirements in table I.

TABLE XI. Inspection lot.

| Outside diameter | Lot size (maximum) |
|--------------------------|--------------------|
| Inches | Feet |
| Up to 1/2, incl. | 10,000 |
| Over 1/2 to 1-1/2, incl. | 5,000 |
| Over 1-1/2 to 4, incl. | 3,000 |
| Over 4 to 5-9/16, incl. | 2,500 |
| 6-5/8 | 2,000 |
| 7-5/8 | 1,800 |
| 8-5/8 | 1,500 |
| 9-5/8 | 1,200 |
| 10-3/4 | 800 |
| 12-3/4 | 600 |
| Over 12-3/4 | 500 |

4.2.2 Sampling for quality conformance inspection. For purposes of the tests specified in this specification, samples shall be selected in a manner which correctly represents the material furnished.

4.2.2.1 Sampling for destructive tests. The number of samples shall be selected in accordance with table XII for the destructive tests specified in 4.4.2.1, 4.4.2.2, 4.4.4, and 4.4.5.

TABLE XII. Sampling for destructive tests.

| Size of lot (feet) | Number of samples tested |
|--------------------|--------------------------|
| Up to 50 | 1 |
| 51 to 1,600 | 2 |
| 1,601 to 4,000 | 3 |
| 4,001 to 10,000 | 5 |
| 10,001 to 25,000 | 8 |
| 25,001 to 62,500 | 13 |

4.2.2.2 Sampling for visual examination. For class 50 and 200, a representative sample of tubes shall be selected from each inspection lot in accordance with MIL-STD-105 and shall be visually examined as specified in 4.3.1.

4.2.2.2.1 For classes 700, 1650, 3300, and 6000, all tubes shall be visually examined as specified in 4.3.1.

4.2.2.3 Sampling for dimensional examination. For class 50 and 200, a representative sample of tubes shall be selected from each inspection lot in accordance with MIL-STD-105 and shall be measured as specified in 4.3.2. The samples selected for dimensional examination may be the same as those selected for visual examination. For classes 700, 1650, 3300, and 6000, all tubes shall be measured as specified in 4.3.2.

4.2.2.4 Sampling for chemical analysis.

4.2.2.4.1 Grade 1. Two ounces of clean chips selected in accordance with method 111 of FED-STD-151 or a 2-ounce solid sample selected and prepared in accordance with method 112 of FED-STD-151 shall be taken from two tubes selected at random from each lot for the analysis specified in 4.4.1. For the purpose of chemical analysis for phosphorus and sulfur content, each heat or ingot from each pour shall be sampled.

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4.2.2.4.2 Grade 2. For continuous ingot casting facilities, two tubes shall be selected, one tube from the first pour and one tube from the last pour of each heat to produce the lot. If there is one pour, or one tube in a lot, only one tube shall be required. For semi-continuous ingot casting facilities, one sample shall be obtained from the heat during pouring or subsequent processing. In the latter case, a lot for chemical analysis shall be defined as all material from the same heat. Phosphorus and sulfur shall be determined on the heat or ingot, but are not required to be determined on the finished product.

4.2.2.5 Radiography (type II tube). The entire seam weld of all class 700 and 1650 tube shall be radiographed. For each lot of class 50 and 200 tube, the weld seam shall be radiographed every 50 feet of the overall welding seam length.

4.3 Examination.

4.3.1 Visual. Each sample tube or all tubes, as applicable, selected in accordance with 4.2.2.2 shall be visually examined in accordance with table XIII to verify conformance with this specification.

4.3.2 Dimensional. Each sample tube or all tubes, as applicable, selected in accordance with 4.2.2.3 shall be dimensionally measured in accordance with table XIII to verify conformance with this specification.

TABLE XIII. Classification of defects in accordance with the definitions of MIL-STD-105.

| Categories | Defects |
|------------|---|
| Major: | |
| 101 | Class (lb/in ² working pressure) not as specified. |
| 102 | Type (seamless or welded) not as specified. |
| 103 | Material not processed as required; surface not smooth, not of uniform thickness, not free from welds (type I), injurious seams, grooving, indentations, pits, cracks or scale. |
| 104 | Outside diameter not as specified; variation exceeds the allowable limits. |
| 105 | Wall thickness at any point less than the specified minimum. |
| 106 | Length not within specified limits. |
| 107 | Tube not commercially straight. |
| 108 | Ends not cut square or free from burrs. |
| 109 | Grooves, scratches, indentations, and pits exceed allowable limits. |
| 110 | Marking, specification number, or manufacturer's coding and identification designation missing, incorrect, illegible or not printed and recurringly located as specified. |
| Minor: | |
| 201 | Packing not as required. |

4.3.3 Removal of defects. When conditioning operations are required in accordance with 3.9, the conditioned areas shall be reinspected by the nondestructive inspection technique used in originally detecting the defect. Repair by welding is permissible for type II tube only and shall be in accordance with MIL-STD-278.

4.4 Test procedures.

4.4.1 Chemical analysis. A test sample shall be taken from each tube or ingot specified in 4.2.2.4 for chemical analysis. Either the wet chemical method 111 or the spectrographic method 112 of FED-STD-151 may be used. In case of dispute, the wet chemical method shall be the basis for acceptance. If any sample fails to meet the requirements of table I, this shall be cause for rejection of the lot represented by the sample.

4.4.2 Test for mechanical properties.

4.4.2.1 Tension test. A tension test specimen shall be cut from one end of each sample selected in accordance with 4.2.2.1 and shall be prepared and tested in accordance with ASTM E8 for conformance with 3.3.1.

4.4.2.2 Expansion or flattening test. Test sections shall be cut from one end of each tube selected as specified in 4.2.2.1. For the expansion test, the tube shall be expanded on a hardened and ground, tapered, steel pin having an included angle of 60 degrees to 30 percent of its inside diameter. As an alternative to the expansion test for tube over 4 inches in outside diameter, a section 4 inches in length shall be cut from the end of the lengths for a flattening test. This 4-inch test specimen shall be flattened so that a gage set at three times the wall thickness will pass over the tube freely throughout the flattened part. Type II tube test specimens shall be flattened with the weld area located in the bend. In making the flattening test, the tube shall be slowly flattened by one stroke of the press.

4.4.2.3 Acceptance criteria. Failure of one or more specimens tested in accordance with 4.4.2.1 and 4.4.2.2 to meet requirements of 3.3 shall be cause for rejection of the lot from which the specimen was selected, subject to the provisions of the section on rejection and retests of FED-STD-151.

4.4.3 Hydrostatic pressure test. Each tube shall be tested in the condition to be offered for acceptance. Tube of standard dimensions shall be subjected at room temperature to an internal pressure not less than 150 percent or greater than 165 percent of the maximum working pressure as specified in 1.2. The pressure to be used for tube of nonstandard dimensions (special class) shall be as specified by the procuring activity (see 6.1). Defective tubes shall not be offered for delivery.

4.4.4 Etch test. A specimen consisting of an annular ring shall be cut from an end of each tube sample selected as specified in 4.2.2.1. The specimen shall be metallographically polished and etched in accordance with ASTM E340. Any specimen found to be welded shall be rejected, together with the entire lot it represents.

4.4.5 Magnetic permeability test. A specimen from one end of each tube sample selected as specified in 4.2.2.1 shall be tested in accordance with ASTM A342. Failure of one or more specimens to meet the requirement of 3.6 shall be cause for rejection of the lot from which the specimen was selected, subject to the provisions of the section on rejection and retests of FED-STD-151.

4.4.6 Weight. Each lot of tube as defined in 4.2.1 shall be weighed to insure that the tubes comply with the requirements specified in 3.8.1.

4.4.7 Laminations and gage. Conformance to the wall thickness requirements of 3.8.2 shall be determined by circumferential measurements on both ends of the tube unless ultrasonic gaging is required by 3.4.3.4. Ultrasonic gaging for thickness and laminations shall be carried out circumferentially at 18-inch intervals or less along the entire length of the tube by the compression wave technique in accordance with MIL-STD-271. Each sample, or all tubes as applicable, that do not meet the requirements of 3.8.2 shall be rejected.

4.4.8 Radiography. Tube specified in 4.2.2.5 shall be radiographed in accordance with MIL-STD-271. When defects in excess of those permitted by 3.4.2 are found in class 50 and 200 tube, an additional spot shall be radiographed on each side of the original spot. If these locations are acceptable, the original area shall be repaired and reradiographed for inspection. Excessive defects in class 700 and 1650 tube shall be weld repaired and reradiographed for inspection without exploring additional sites on either side of a defective area.

4.4.9 Ultrasonic inspection. For tube having an outside diameter of 5.563 inches or less, ultrasonic inspection shall be in accordance with the applicable sections of MIL-STD-271 except as specified in 4.4.9.1 through 4.4.9.8. For tube having an outside diameter larger than 5.563 inches, ultrasonic inspection shall be in accordance with the applicable sections of MIL-STD-271.

4.4.9.1 Instruments. Instrument to be used in the inspection system shall have a minimum bandwidth of plus or minus 10 percent (measured at the 3 decibels (dB) down points) from the nominal 5 megahertz (MHz) operating frequency. Instrument bandwidth may be verified by the manufacturer's certification.

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- 4.4.9.2 Search units. Search units to be used in the inspection system shall provide an inspection frequency of 5 MHz plus or minus 10 percent. For longitudinal defect inspection, a cylindrically focused transducer shall be used. The active element shall not exceed 1/2 by 1 inches in size. It shall produce a sound beam having a width not greater than 3/16 inch when measured at a distance of 3 to 5 inches in water. The beam profile shall not deviate more than minus 2 dB from the peak amplitude along the axis and be at least 1/2-inch wide at the 2 dB down point. The beam profile and width shall be maintained within the 3- to 5-inch zone in water as shown on figure 1.
- 4.4.9.3 Reference standard. Calibration reference standard shall be made from a length of ultrasonically sound tube or pipe of the same type, wall thickness, and outside diameter as that to be tested as defined in MIL-STD-271. The standard shall meet the flatness requirement shown on figure 2 and shall have two longitudinal notches. One longitudinal notch shall be on the inside surface and one on the outside surface. The notch dimensions shall be within the tolerances shown on figure 2 and may be machined or electro-discharge-machined. The notches shall have a depth of 5 percent of the minimum wall as listed in table III or 0.005 inch, whichever is greater.
- 4.4.9.4 Couplant. Visible suspended foreign particles (solids or air) shall be excluded from the couplant used.
- 4.4.9.5 Calibration for inspection.
- 4.4.9.5.1 Circumferential. Scan until the notch indication on the inside diameter, shown as position 1 on figure 3 is clearly resolved. The reference calibration standard shall be moved until the indication from this notch reappears along the horizontal trace, shown as position 3 on figure 3. Scan until the notch indication from the outside diameter is produced at maximum amplitude, shown as position 2 on figure 3. The distance between the front surface signal and the leading edge of the gate shall be determined by the front surface noise level. The test angle shall be adjusted so that the signals shown as positions 1 and 2 on figure 3 achieve the nearest amplitude match. Electronic balancing shall not be used. The alarm or recorder shall be set at 50 percent of full screen height.
- 4.4.9.6 Recalibration. During acceptance testing, any realinement of the search unit with respect to the tube, or any change in search unit, couplant, instrument settings, or scanning speed from that used for calibration shall require recalibration. In addition, the calibration shall be rechecked at least once per 8-hour shift and at the completion of testing. If a recheck indicates that recalibration is required, all items tested since the last instrument check shall be reinspected.
- 4.4.9.7 Testing (scanning). The search unit position with respect to the tube axis shall be maintained within 1 percent of the nominal outside diameter of the tube or 0.010 inch, whichever is greater. Proper rotation and through speeds shall be used to insure 100 percent inspection coverage. The helix shall be adjusted such that the standard reference notches shall each be detected above the alarm level not less than two times during one traverse of the notch length. This scanning shall be done with the same couplant, search unit alignment and instrument settings as were used during calibration.
- 4.4.9.8 Acceptance criteria. Any portion of a tube which produces an indication equal to or greater than the reject levels established during calibration shall not be offered for delivery.
- 4.4.10 Numerical limits. For purposes of determining compliance with the specified limits for requirements of the properties listed in table XIV, an observed value or a calculated value shall be rounded-off as indicated in accordance with the rounding-off method of ASTM E29.

TABLE XIV. Rounding-off procedure for numerical limits.

| Property | Rounding-off unit for observed or calculated value |
|------------------------------------|---|
| Chemical composition | Nearest unit in the last right-hand place of figures of the specified limit |
| Tensile strength Yield strength | Nearest 1000 lb/in ² |
| Elongation | Nearest 1 percent |

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4.5 Certification of quality conformance inspection. A certification of quality conformance inspection shall be furnished with each lot of material offered for acceptance. The certification shall include actual numerical values, where applicable, of specified chemical, mechanical, metallographic, and nondestructive tests. It shall also include the results of initial tests as well as all retests of the material offered for acceptance, together with the reason retest was required, when acceptance of the lot is based on any of the following provisions of FED-STD-151:

- (a) Replacement of test specimens.
- (b) Retest of additional specimens from the lot.
- (c) Resubmittal of a rejected lot for test after rework or removal of nonconforming material.

4.5.1 The identification of melts, heats or lots, and the general requirements for test specimens shall be in accordance with the general section of FED-STD-151. In addition, the contractor shall report the melting source of the master melt if the contractor is not the melter of the master melt.

4.5.2 The minimum certification data required may be submitted in the format shown on figure 4.

4.6 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurement.)

5.1 Packaging, packing, and marking. Preparation for delivery shall be in accordance with the requirements of MIL-C-3993. Level C packaging, packing, and marking shall apply unless level A packaging and level A or B packing are required and specified (see 6.1). Marking shall be in accordance with MIL-C-3993.

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Composition, temper, type, class, and grade (see 1.2).
- (c) Whether hydrostatic testing is required for tube subject to ultrasonic inspection (see 3.4.1).
- (d) Whether an alternate nondestructive test method is proposed (see 3.4.3).
- (e) Whether ultrasonic test is required for class 50 and 200 tube (see 3.4.3.1, 3.4.3.2, and 3.4.3.3).
- (f) When ultrasonic test of flat product is required (see 3.4.3.2).
- (g) Whether magnetic permeability testing is required for alloy 706 tube (see 3.6).
- (h) Dimensions of standard tube required (see table III or IV and 3.7).
- (i) Dimensions of nonstandard tube and class required (see 3.8.1).
- (j) Length of tube or schedule of lengths required and whether exact or mill lengths (see 3.8.5.1).
- (k) Whether tube marking is required (see 3.10).
- (l) Quality assurance requirements (see 4.1.1).
- (m) Hydrostatic test pressure required (minimum and maximum) for special class tube (see 4.4.3).
- (n) Level of packaging and packing required, if other than as specified (see 5.1).
- (o) Maximum gross weight of container.

6.2 Light drawn alloy 706 tube is less subject to damage in handling than fully annealed tube; however, tube other than fully annealed may present problems in bending to radii less than 5 diameters and show excessive wall thinning at bends. Accordingly, light drawn tube should not be ordered for stock if fully annealed tube is available.

6.3 Tube should be purchased on a footage basis (per foot of length) in preference to weight.

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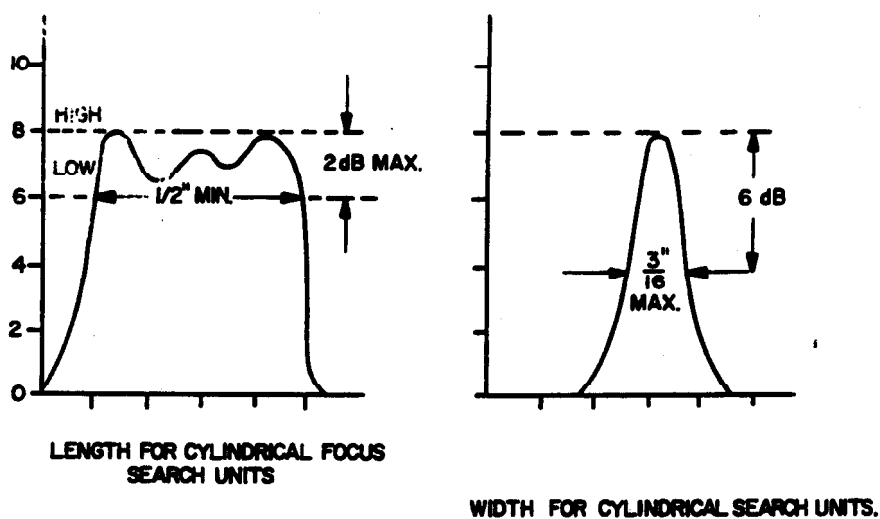
‡ 6.4 Type I tube meeting the tensile strength requirements of this specification is normally available in sizes up to and including 8-5/8 inches in outside diameter. For sizes which exceed this range, availability is limited to sources with a large size tube capability.

6.5 The chemical and mechanical property requirements of this specification are similar to ASTM B466 and B467, copper alloy no. 715 and 706.

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

Preparing activity:
Navy - SH
(Project 4710-N308)

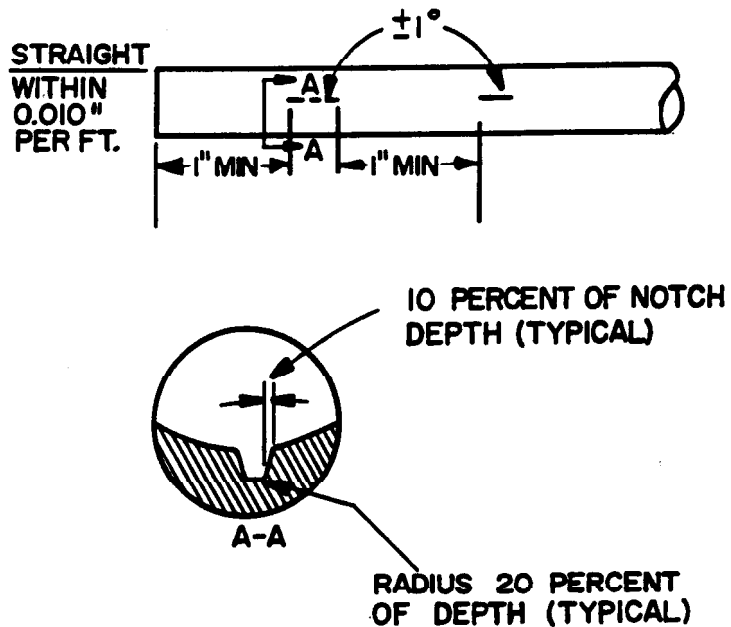
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FIGURE 1. Beam profile and width.

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Tolerance 1/Depth - 5 percent of minimum wall or 0.005 inch whichever is greater plus or minus 0.0005 inch 2/

Width - 2X nominal depth - maximum

Length - 1.0 inch plus or minus 1/16 inch

Alinement - Plus or minus 1 degree

1/ Measurement may be made by optical or replicating techniques.
Destructive means may be used on duplicate notches which have identical ultrasonic response.

2/ For wall thicknesses in excess of 0.100 inch the tolerance shall be plus or minus 0.001 inch.

FIGURE 2. Reference standard dimensions and tolerances.

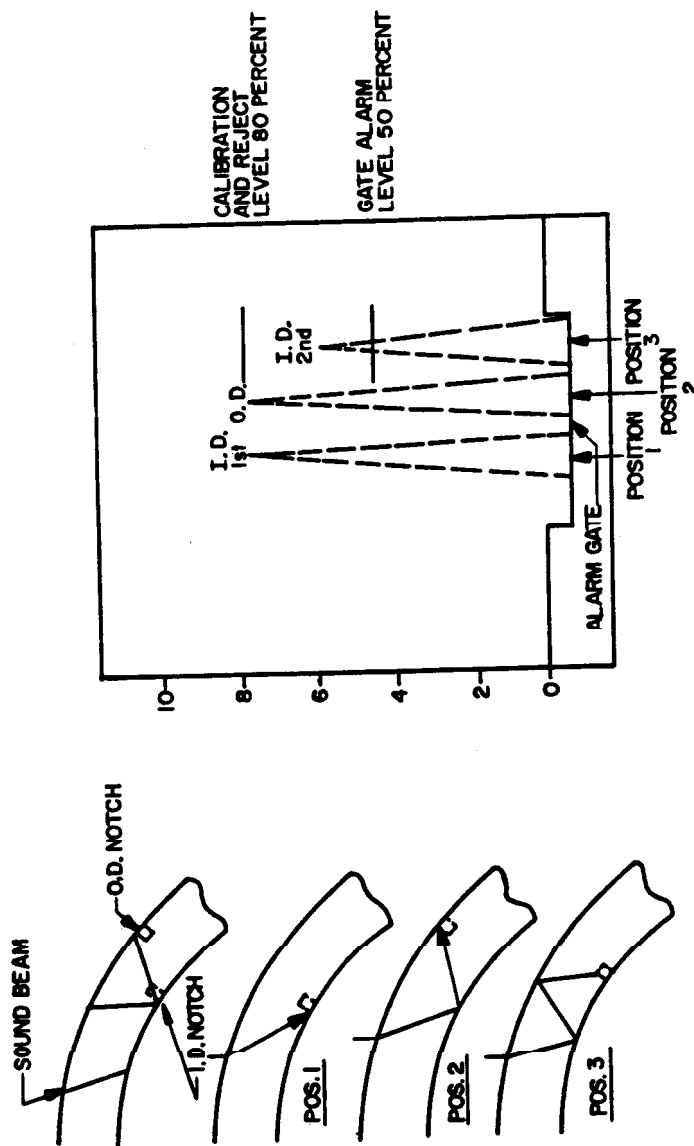


FIGURE 3. Calibration and flaw alarm/rejection/acceptance signal amplitude levels.

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Certification of Quality Conformance Inspection

1. Manufacturer or Distributor _____
2. Address _____
3. Date _____
4. Customer Name _____
5. Customer Order No. _____
6. Specification No. _____
7. Identification:
 Composition and Temper _____ Type _____ Grade _____
 Class _____ Melting Source _____
 Heat No. _____ Lot No. _____
8. Retests - For each test below, indicate if results are from retest. If results are from retest, attach supplementary sheet(s) giving reason(s) for retest and all results of initial tests.
9. Chemical Analysis:
 Copper _____
 Nickel _____
 Zinc _____
 Iron _____
 Lead _____
 Manganese _____
 Phosphorus _____
 Sulfur _____
 Carbon _____
 Copper Plus Elements with Specific Limits _____
10. Mechanical Properties Tests:
 Tensile Strength _____
 Yield Strength _____
 Elongation _____
 Flattening Test _____
11. Etch Test _____
12. Nondestructive Tests:
 Visual and Dimensional Examination _____
 Radiographic Inspection _____
 Ultrasonic Testing _____
 Hydrostatic Test _____
 Test Pressure _____
13. We hereby certify that the above material has been inspected and tested in accordance with the listed specification and is in conformance with all requirements. If type I tube is supplied, we also certify that it is seamless and free of any weld repair.

Signature of Responsible Company OfficialFIGURE 4. Certification of quality conformance inspection.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

| | |
|---|--|
| 1. DOCUMENT NUMBER | 2. DOCUMENT TITLE |
| 3a. NAME OF SUBMITTING ORGANIZATION | 4. TYPE OF ORGANIZATION (Mark one) |
| b. ADDRESS (Street, City, State, ZIP Code) | <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify): _____ |
| 5. PROBLEM AREAS | |
| a. Paragraph Number and Wording: b. Recommended Wording: c. Reason/Rationale for Recommendation: | |
| 6. REMARKS | |
| 7a. NAME OF SUBMITTER (Last, First, MI) - Optional | b. WORK TELEPHONE NUMBER (Include Area Code) - Optional |
| c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional | 8. DATE OF SUBMISSION (YYMMDD) |