

MIL-T-16286E (SH)
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 SUPERSEDING
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 (See 6.7)

MILITARY SPECIFICATION

TUBE, STEEL, SEAMLESS, MARINE

BOILER APPLICATION

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 requirements for various classes of seamless steel tubes for use as water tubes and superheater tubes in high pressure steam generators.

1.2 Classification. Tubes shall be one of the following classes as specified (see 6.2.1 and 6.5):

- Class a - Low carbon steel
- Class c - 18 percent chromium - 8 percent nickel austenitic corrosion-resisting steel (stabilized)
- Class d - Carbon - 1/2 percent molybdenum steel
- Class e - 2-1/4 percent chromium - 1 percent molybdenum steel
- Class g - Medium carbon steel

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

FEDERAL

- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-C-650 - Crates, Wood, Open and Covered.

MILITARY

- MIL-P-116 - Preservation-Packaging, Methods of.

STANDARDS

FEDERAL

- FED-STD-151 - Metals, Test Methods.
- FED-STD-183 - Continuous Identification Marking of Iron and Steel Products.

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-271 - Nondestructive Testing Requirements for Metals.

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.

MIL-T-16286E(SH)

(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)

- A262 - Susceptibility to Intergranular Attack in Stainless Steel.
- E8 - Tension Testing of Metallic Materials.
- E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
- E213 - Ultrasonic Inspection of Metal Pipe and Tubing for Longitudinal Discontinuities.
- E309 - Eddy-Current Testing of Steel Tubular Products with Magnetic Saturation.
- E426 - Electromagnetic (Eddy-Current) Testing of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys.

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

NATIONAL CLASSIFICATION BOARD

National Motor Freight Classification Classes and Rules.

(Application for copies should be addressed to the ATA Tariff Section, 1616 P Street, N.W., Washington, DC 20036.)

UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, G. F. Earl, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

(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 Material. Chemical composition shall be as specified in table I. Tubes, except class c and e, shall be made from billets of killed steel. Primary melting of steel for class c and e tube may incorporate separate degassing or refining and may be followed by secondary melting, using either electroslag remelting or vacuum-arc remelting. Steel for classes a, d, and g tubes shall be made by the open hearth, basic oxygen or electric furnace process. Steel for classes c and e shall be made by the electric furnace process. Reclaimed materials shall be used to the maximum extent possible.

TABLE I. Chemical composition.

Classes (see 1.2)	Carbon	Manga- nese	Silicon	Chromium	Molybde- num	Sulfur (max)	Phospho- rus (max)	Nickel
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
a	0.06-0.18	0.27-0.63	0.25 max	-----	-----	0.058	0.048	-----
cl/	.08 max	2.00 max	.75 max	17.0-20.0	-----	.030	.040	9.0-13.0
d	.10-0.20	0.30-0.80	.10-0.50	-----	0.44-0.65	.045	.045	-----
e	.15 max	.30-0.60	.50 max	1.90-2.60	.87-1.13	.030	.030	-----
g	.27 max	.193 max	.10 min	-----	-----	.058	.048	-----

¹/Chemical composition of class c stainless steel, grade TP-321 and TP-347 (see 6.5) are identical except for the stabilization elements as specified below:

- (a) Grade TP-321 shall have a titanium content of not less than five times the carbon content and not more than 0.60 percent.

MIL-T-16286E(SH)

(b) Grade TP-347 shall have a niobium (columbium) plus tantalum content of not less than eight times the carbon content and not more than 1.00 percent.

3.2 Manufacture. Tubes shall be made by any process or processes which will produce seamless tubes conforming to this specification, except as specified herein.

3.3 Heat treatment. Tubes shall be heat treated following the hot finishing or cold drawing operation.

3.3.1 Class a and d tubes shall be heat treated at a temperature of 1200°F or higher.

3.3.2 Class c tubes shall be solution annealed at a minimum of 2000°F followed by quenching in water or rapidly cooling by other means. Following the solution anneal, the tubes shall be given a stress relief anneal for stabilization within the temperature range of 1500°F to 1650°F.

3.3.3 Class e tubes shall be full annealed, isothermal annealed, or normalized and tempered. Tempering temperature shall be 1250°F or higher. Normalizing may be accomplished by cooling in air or in a cooling chamber of a controlled atmosphere furnace.

3.3.4 Class g tubes shall be given a subcritical anneal, a full anneal or a normalizing heat treatment after the final drawing process.

3.4 Finish. Tubes shall be free from mill scale. A tight furnace oxide, not to exceed 0.001 inch (maximum), is acceptable. Slight surface imperfections may be removed by grinding, provided the wall thickness is not reduced below the minimum specified wall thickness and the ground areas are well faired into the remaining portion of the tube. The grinding medium shall be 180 grit or finer. Special precautions shall be taken with class c tubes to insure that the grinding medium has only been used previously on class c tubing material and contains no foreign metallic particles.

3.5 Mechanical properties. Tubes shall conform to the mechanical properties specified in table II.

TABLE II. Mechanical properties.

Class	Yield point (min) ^{1/}	Ultimate tensile strength (min)	Elongation in 2 inches (min)
	Lb/in ²	Lb/in ²	Percent
a	^{2/}	^{2/}	^{3/} ^{2/} 35
c	30,000	75,000	^{3/} 30
d	30,000	55,000	^{3/} 30
e	30,000	60,000	^{3/} 30
g	37,000	60,000	^{3/} 30

^{1/} When no definite yield point is exhibited, yield strength shall be determined at an extension under load of 0.005 inch per inch gage length or a 0.2 percent offset yield strength shall be used.

^{2/} Tension test for class a tubes not required. For purposes of design, the following mechanical properties may be assumed for class a tubes:

- (a) Yield point, minimum, lb/in²: 26,000.
- (b) Ultimate tensile strength, minimum, lb/in²: 47,000.
- (c) Elongation in 2 inches, minimum percent: 35.

^{3/} These values apply to full section test specimens and longitudinal strip tests 5/16 inch and thicker. In the case of strip tests of thickness less than 5/16 inch, the minimum elongation shall be determined by the following formulas, as applicable:

- (a) Class c: $E=56t + 17.50$.
- (b) Classes d, e, and g: $E=48t + 15.00$.

Where:

E = elongation in 2 inches in percent, and
t = actual thickness of specimen in inches.

3.5.1 Hardness. Hardness of tubes shall not exceed the maximum hardnesses of table III.

MIL-T-16286E(SH)

TABLE III. Hardness requirements.

<u>Classes</u>	<u>Minimum 1/</u>	<u>Maximum</u>
a	No requirement	Rockwell B-77
c	Rockwell B-70	Rockwell B-90
d	Rockwell B-65	Rockwell B-80
e	Rockwell B-68	Rockwell B-85
g	Rockwell B-68	Rockwell B-79

1/ Minimum requirements provided for information only.

3.5.2 Intergranular corrosion. Class c tubes shall be free from precipitated carbides which result in intergranular corrosion.

3.6 Dimensional characteristics.

3.6.1 Wall thickness. Variations from the wall thickness specified (see 6.2.1) shall not exceed the amounts shown in table IV.

TABLE IV. Permissible variations in wall thickness. 1/

Wall thickness inches		Hot finished tubes		Cold drawn tubes	
		Outside diameter, inches		Outside diameter, inches	
		4 and under	Over 4	1-1/2 and under	Over 1-1/2
		Variation in wall thickness, percent			
0.095 and under	Over Under	40 0	--- ---	20 0	22 0
Over 0.095 to 0.150, inclusive	Over Under	35 0	35 0	20 0	22 0
Over 0.150 to 0.180, inclusive	Over Under	33 0	33 0	20 0	22 0
Over 0.180	Over Under	28 0	28 0	20 0	22 0

1/ Wall thickness readings shall be taken with either pointed or ball type micrometers or by other means of comparable accuracy. Wall thickness readings shall not include the thickness of existing tight furnace oxide permitted in 3.4.

3.6.2 Length. The length shall be not less than but may be 0.188 inch (3/16 inch) more than that specified (see 6.2.1).

3.6.3 Outside diameter. The outside diameter shall conform to the sizes specified (see 6.2.1), within the tolerances shown in table V.

TABLE V. Outside diameter tolerances.

Size Outside diameter (inches)	Cold drawn tubes Tolerances	
	Over (inches)	Under (inches)
Under 1	0.004	0.004
1 to 1-1/2 inclusive	.006	.006
Over 1-1/2 to 2 exclusive	.008	.008
2 to 2-1/2 exclusive	.010	.010
2-1/2 to 3 exclusive	.012	.012
3 to 4 exclusive	.015	.015
Over 4 to 7-1/2 inclusive	.015	.025
Over 7-1/2 to 9 inclusive	.015	.045

MIL-T-16286E(SH)

TABLE V. Outside diameter tolerances. (Continued)

Size Outside diameter (inches)	Hot finished tubes	
	Tolerances	
	Over (inches)	Under (inches)
4 and under	1/64	1/32
Over 4 to 7-1/2 inclusive	1/64	3/64
Over 7-1/2 to 9 inclusive	1/64	1/16

3.7 Flaring and flattening.

3.7.1 Flaring. When subjected to the flaring test specified in 4.4.4, the test specimen after flaring shall show no tears or ruptures in the test area, the depth of which exceeds 10 percent of the specified minimum wall thickness. The depth of tears or ruptures shall be verified by 10X magnification and a calibrated reticle.

3.7.2 Flattening. When subjected to the flattening test specified in 4.4.5, the specimen after the first flattening step shall show no tears or cracks on the inside, outside or end surfaces.

3.8 Eddy current, hydrostatic pressure, and ultrasonic.

3.8.1 Hydrostatic pressure. Each length of tube shall be subjected to a hydrostatic pressure test as specified in 4.4.6 and shall show no evidence of leaks. Tubes shall be subjected to a hydrostatic pressure test, preferably, prior to eddy current or ultrasonic testing.

3.8.2 Eddy current and ultrasonic. Each length of tube with specified minimum wall thickness of 0.120 inch and below shall be subjected to an eddy current test as specified in 4.4.7. Each length of tube with a specified minimum wall thickness greater than 0.120 inch shall be subjected to an ultrasonic test as specified in 4.4.7. No tube shall produce a signal equal to or greater than the calibration notch.

3.9 Lot identification number. For each lot of tubes as defined in 4.2.2, the manufacturer shall assign a lot identification number which shall be marked on the tubes as specified in 3.10.1.

3.10 Identification marking. Tubes supplied shall be marked on each end or continuously marked for identification in accordance with FED-STD-183.

3.10.1 Marking information. Each tube 1 inch and over in outside diameter and over 3 feet in length shall be clearly and legibly marked by painting or stenciling the following information at intervals not greater than 3 feet:

- (a) Name, trademark or brand name of the manufacturer.
- (b) Specification number (MIL-T-16286).
- (c) Class letter.
- (d) Outside diameter, wall thickness and length.
- (e) Contract number.
- (f) Lot identification number (see 3.9).
- (g) Heat number.
- (h) Date of manufacture (month/year), numerically, date to be preceded by letter Q (e.g. Q-1-77).

3.10.2 Tags and wire. Tubes less than 1 inch in outside diameter or less than 3 feet in length shall have the markings specified in 3.10.1 clearly shown on two oil proof tags securely attached to each tube or bundle of tubes. Tags and securing wire for tubing shall not be made of galvanized material.

3.10.3 The marking fluid shall not be harmful to the tube and shall not rub off or smear in normal handling. The fluid shall not be affected by solvents used in subsequent cleaning and preservation operations by the contractor. For class c tubes, the marking fluid shall not contain any harmful metal, or metal salts, such as zinc, lead or copper which cause corrosive attack on heating.

MIL-T-16286E(SH)

3.11 Workmanship. Tubes shall be of proper dimension with ends cut square, free of burrs, and shall not deviate from straightness by more than 0.060 inch in 3 feet of length. Tubes shall be free from laminations, scale, and rust. A tight furnace oxide, not to exceed 0.001 inch (maximum), is acceptable. Tube surfaces shall conform to 3.4 and shall not contain defects such as laps, seams, tears, cracks, grooves, scratches, indentations, abrasions or pits with depths equal to, or greater than, 10 percent of the specified minimum wall thickness or which reduce the wall thickness below the specified minimum wall thickness. Where defects are encountered, distribution shall be random so as not to provide a potential circumferential or longitudinal failure path.

3.12 Certificate of compliance. For each lot of tubes (see 4.2.2), the manufacturer shall provide in each tube bundle (see 5.2.1) a certificate of compliance (see 4.6).

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 in accordance with the data ordering documents included in the contract or order (see 6.2.2).

4.2 Sampling for quality conformance inspection.

4.2.1 Sample unit. The sample unit shall be that length of tubing drawn from a single billet or tube hollow.

4.2.2 Lot. For purposes of sampling, a lot shall consist of tubes or sample units of the same class and of the same outside diameter and wall thickness, manufactured from the same heat of steel and presented for inspection at the same time, and heat treated under the same conditions as to temperature and time in a single charge in a batch type furnace or heat treated under the same conditions during an 8 hour period in a continuous furnace.

4.2.3 Sampling for visual and dimensional examination. From each lot of finished tubes (tubes cut to the specified length) samples shall be selected in accordance with the procedures of MIL-STD-105. The acceptable quality level (AQL) expressed as percent defective and inspection levels shall be as follows:

	General inspection level	AQL percent
Visual examination	II	1.5
Dimensional examination	II	1.5

4.2.4 Sampling for chemical analysis. One specimen shall be taken from each of two sample units, billets or tube hollows from each lot for chemical analysis.

4.2.5 Sampling for tension test. One specimen shall be taken from each of two sample units from each lot of classes c, d, e and g tubes for tension testing following the straightening process.

4.2.6 Sampling for hardness test. One specimen shall be taken from each of two sample units from each lot of classes a, c, d, e, and g tubes following the straightening process. Tension test specimens shall be used for hardness testing except for class a tubes for which no tension test is required.

4.2.7 Sampling for flaring and flattening tests. Random samples from the sample units (from which proper test specimens shall be prepared), following the straightening process, shall be selected from each lot in accordance with level III of MIL-STD-105 for an AQL equal to 1.5 percent.

MIL-T-16286E(SH)

4.2.8 Sampling for intergranular corrosion test. One specimen from each of two sample units from each lot of class c tubes shall be tested as specified in 4.4.8 for intergranular corrosion.

4.3 Visual and dimensional examination. Each sample unit selected in accordance with 4.2.3 shall be visually examined and dimensions, as specified herein, measured to verify conformance with this specification. Any sample unit that deviates from a specific tolerance shall not be offered for delivery. If the number of nonconforming sample units exceeds the acceptance number specified, the entire lot shall be rejected or 100 percent examined to remove all nonconforming tubes. Any deviation from a specific tolerance shall constitute a defect. Classification of defects is contained in table VI.

TABLE VI. Classification of defects.

Attributes	Defects
Design and construction (see 3.6.1, 3.6.2, and 3.6.3)	Tubes not the proper class as specified in contract or order. Wall thickness, length, and outside diameter not as specified; variation exceeds the allowable limits.
Workmanship (see 3.11)	Not free from mill scale as specified. Contains unallowable surface imperfections. Out of straightness tolerance.
Marking identification (see 3.10 through 3.10.3)	Missing, incomplete, not legible or not continuous as specified. Marking fluid harmful to tube or smears in normal handling.
Packaging (see 5.2)	Not as required.

4.4 Tests.

4.4.1 Chemical analysis. Millings, drillings, or chips from each specimen selected for test as specified in 4.2.4 shall be separately analyzed in accordance with the wet chemical method 111 or the spectrographic method 112 of FED-STD-151 to ensure compliance with table I. Drillings shall be taken from several points around each specimen. Broken tensile test specimen may be used for obtaining millings, drillings, or chips. Material to be analyzed shall be free from dirt, scale, grit, oil and other foreign matter and shall consist of not less than 2 ounces. If any analysis fails to conform with table I, the lot shall be rejected.

4.4.2 Tension test. Longitudinal tension test specimens selected as specified in 4.2.5 shall be tested in full section up to the capacity of the testing machine; beyond this limit, strip specimens are permitted. The test specimens shall be in accordance with the applicable test specimen of ASTM E8. When no definite yield point is exhibited, yield strength shall be determined at an extension under load of 0.005 inch per inch of gage length or the yield strength shall be determined at an offset of 0.2 percent of the gage length. If any specimen fails to conform to table II, the entire lot shall be rejected.

4.4.3 Hardness test. Hardness testing for classes a, c, d, e, and g tubes shall be performed in accordance with ASTM E18 on test specimens selected as specified in 4.2.6 to ensure compliance with the requirements of table III. If any specimen exceeds the maximum hardness value of table III, the entire lot shall be rejected.

4.4.4 Flaring test. A specimen between 2 and 4 inches in length shall be cut from one end of each sample selected as specified in 4.2.7 and subjected to a flaring test. Test specimen ends shall be smooth. Each test specimen shall withstand flaring with a flaring tool until the specimen at the mouth of the flare has been expanded uniformly to the requirements of table VII. The flaring tool shall have a 60 degree included angle, a minimum hardness of Rockwell C-50 and a surface finish of 32 micro-inches rms or better. The rate of

MIL-T-16286E(SH)

flaring shall be slow and uniform. The afterflared specimen shall meet the requirements of 3.7.1. If the flaring test specimen results do not meet the acceptance/rejection criteria of MIL-STD-105, the entire lot shall be rejected subject to the resubmittal provision of 4.5.2.

TABLE VII. Flaring test requirement data.

Ratio of inside diameter to outside diameter l/d	Minimum expansion of inside diameter, percent	
	Classes a,c,d, and g	Class e
0.9	21	15
.8	22	17
.7	25	19
.6	30	23
.5	39	28
.4	51	38
.3	68	50

l/d Actual ratio of specimen to be taken to the nearest ratio given. Inside and outside diameter values to be used with table VII shall be actual specimen dimensions.

4.4.5 Flattening test. A specimen not less than 2-1/2 inches in length shall be cut from each sample selected as specified in 4.2.7. Specimen selected for flattening shall have no visible surface imperfections prior to conducting the first step of the flattening test. Surface imperfections may be removed as permitted by 3.4 prior to conducting the flattening test. The specimens shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility, no cracks or tears on the inside, outside, or end surfaces shall occur until the distance between the plates is less than the value of H calculated as follows:

$$H = \frac{(1 + e)t}{e + t/d}$$

Where: H = Distance between flattening plates in inches.

t = Specified minimum wall thickness of tube in inches.

d = Specified outside diameter of tube in inches.

e = Deformation per unit length:

For classes a, c and d: $e = 0.09$

For class e: $e = 0.08$

For class g: $e = 0.07$.

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the tube meet. Evidence of inclusions or laminated material that is revealed during the entire flattening test shall be cause for rejection. If the flattening test specimen results do not meet the acceptance/rejection criteria of MIL-STD-105, the entire lot shall be rejected subject to the resubmittal provision of 4.5.2.

4.4.6 Hydrostatic test. Each tube (see 3.8.1) shall be subjected to the hydrostatic test pressure specified in table VIII for a minimum of 5 seconds. If any tube shows leaks during the hydrostatic test, it shall be rejected.

TABLE VIII. Hydrostatic test pressures.

Classes	Outside diameter inches	Test pressures lb/in ²
a,c,d,e and g	Under 1	1000
a	1 to 1-1/2 exclusive	1500
a	1-1/2 to 2 exclusive	2000
c,d,e and g	1 to 2 exclusive	2000
a,c,d,e and g	2 to 3 exclusive	2500
a,c,d,e and g	3 to 5 exclusive	3500
a,c,d,e and g	5 and over	4500

MIL-T-16286E(SH)

4.4.7 Nondestructive electric test. Each length of class a, d, e, and g tubes shall be tested in accordance with ASTM E309 or ASTM E213. Class c tubes shall be tested in accordance with ASTM E426 or E213. The following calibration standards in 4.4.7.1 and 4.4.7.2 shall be used for all classes of tubes to establish a minimum sensitivity level for rejection. Tube lengths producing a signal equal to or greater than the calibration notch shall be rejected.

4.4.7.1 Eddy current. The calibration standard shall contain a notch that does not exceed 10 percent of the minimum specified wall thickness in depth, 0.031 inch (max.) in width or one inch in length. The notch shall be positioned on the outside diameter of the tube in a longitudinal direction or on the inside diameter of the tube in a transverse direction. The calibration standard shall be made from defect free material of the same type, specified minimum wall thickness, and specified outside diameter as the tube to be tested.

4.4.7.2 Ultrasonic. The calibration standard shall contain two longitudinal notches, one on the inside surface and one on the outside surface, sufficiently separated, that readily distinguishable, individual indications are obtainable from each notch. Each notch shall be a minimum of 1 inch away from the end of the calibration standard. The notches shall have a depth not greater than 10 percent of the specified minimum wall thickness, a width no greater than 2X (twice) the depth and a length not exceeding 1 inch. The notches shall be in a radial plane parallel to the tube axis. The test shall be performed in two circumferential directions. The calibration standard shall be made from defect free material of the same type, specified minimum wall thickness, and specified outside diameter as the tube to be tested. Ultrasonic inspection shall be in accordance with MIL-STD-271.

4.4.8 Intergranular corrosion test. Each of the specimens of class c tubes selected in accordance with 4.2.8 shall be prepared and tested in accordance with ASTM A262 Practice E (Copper-Copper Sulfate-Sulfuric Acid Test) except the rapid screening test shall not be used. If the test results of either specimens do not meet the requirements of 3.5.2, the entire lot shall be rejected.

4.5 Rejection.

4.5.1 Sample units and finished tubes. If any specimens fail to conform to the requirements of 4.2.3 and 4.2.7 (although the test results for the lot meet the acceptance criteria), those individual sample units or finished tubes represented by the specimens tested shall not be offered for delivery.

4.5.2 Tube lots. Tube lots rejected for nonconformance to the tensile, hardness, intergranular corrosion, flaring or flattening tests caused by improper heat treatment may reheat treated and retested for conformance by performing the tests specified in 4.4.2 through 4.4.5 and 4.4.8. When retesting reheat treated lots for the case where the original sample units have already been cut into individual tube lengths, the specimens for testing may be taken from individual tubes vice the sample units as defined in 4.2.1. Sample sizes for specimens shall be as specified in 4.2.5 through 4.2.8. Acceptance of the reheat treated lot shall be based on the retests meeting the requirements of 3.5, 3.5.1, 3.5.2, 3.7.1, 3.7.2 and 3.11. No more than two reheat treatments will be permitted.

4.6 Test reports. The manufacturer shall provide in each tube bundle a certificate of compliance for that lot of tubes which contains the results of the following tests:

- (a) Chemical analysis (see 4.4.1).
- (b) Tension test (see 4.4.2).
- (c) Hardness test (see 4.4.3).
- (d) Flaring test (see 4.4.4).
- (e) Flattening test (see 4.4.5).
- (f) Hydrostatic pressure test (see 4.4.6).
- (g) Nondestructive electric test (as applicable) (see 4.4.7).
- (h) Certification of heat treatment (see 3.3).
- (i) Intergranular corrosion test for class C tubing only (see 4.4.8).

To be acceptable, the certificate of compliance shall contain the actual test data and shall be validated by a representative of the manufacturer. It shall also include the marking information specified in 3.10.1.

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

MIL-T-16286E(SH)

5. PREPARATION FOR DELIVERY

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

5.1 Preservation-packaging. Preservation-packaging shall be level A or C as specified (see 6.2.1).

5.1.1 Level A. Cleaning, drying, preservation-packaging shall conform to the applicable processes, procedures and methods of MIL-P-116 and as specified herein:

- (a) Class a, d, e, and g tubes shall be coated inside and out with type P-19 preservative to meet the requirements of method I.
- (b) Class c tubes shall be unit protected to meet the requirements of method III.

Tube wrapping shall be as specified in 5.2 for the level of packing required.

5.1.2 Level C. Preservation-packaging shall afford protection against corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The contractor's normal preservation and packaging methods may be utilized when such meets the requirements of this level.

5.2 Packing. Packing shall be level A, B or C, as specified (see 6.2.1).

5.2.1 General requirements. Tubes shall be segregated by class, size, and lot, and shall be packed in accordance with the level specified using tube bundle sizes as follows:

- (a) Tubes with a 2 inch outside diameter and under shall be bundled in rows of 4 high in quantities of 30 tubes per bundle.
- (b) Tubes over 2 inches in outside diameter shall be bundled in rows of 3 high in quantities of 11 tubes per bundle.

5.2.2 Level A. Tubes preserved-packaged as specified (see 6.2.1) and in the quantity required (see 5.2.1) shall be packed in cleated bundles and strapped to a skid base in accordance with figure 1. Prior to fabricating the cleated bundle, the quantity of tubes shall be completely wrapped, including the ends of the load, with a double wrap of grease-proof-waterproof barrier material. The wrapped tubes shall be steel strapped over nominal 2 inch by 4 inch or 2 inch by 6 inch wood cleats positioned approximately 2 feet from each end of the bundle. Unit loads (bundles) exceeding 10 feet in length shall be provided with additional cleat band(s) located equidistant or not more than 72 inches from the end cleats. A girthwise coated or galvanized flat steel strap 1.25 inches by 0.035 inch or equivalent round steel wire shall be tension tied over each cleat band. Galvanized corner protectors shall be required over end grain of cleats when round wire strapping is used. Cleats may be staggered to permit stacking. The ends of the unit load shall be completely covered with barrier material as specified herein, overwrapped with burlap (weight basis 7.5 ounces per 40 inch width), and further protected with wood caps. Wrapping shall be secured in place with two parallel bands of steel strapping. The steel strapping shall be as specified herein.

5.2.2.1 As an alternate to cleated bundles, tubes completely wrapped as specified in 5.2.2 may be packed in containers conforming to any one of the following specifications at the option of the contractor:

<u>Specification</u>	<u>Type, class or style</u>
PPP-B-601	Overseas type
PPP-B-621	Class 1
PPP-C-650	Style B

Container closure shall be as specified in the applicable container specification or appendix thereto. Boxes shall be modified by the addition of wood skids in accordance with the applicable box specification.

5.2.3 Level B. Tubes preserved-packaged as specified (see 6.2.1) and in the quantity required (see 5.2.1) shall be packed in cleated bundles (see figure 1) as shown for level B. The full length wrappings, skid base, and wood end protectors shall be omitted. Ends of the unit load shall be wrapped as specified under level A.

MIL-T-16286E(SH)

5.2.4 Level C. Tubes preserved and packaged as specified (see 6.2.1) and in the quantity required (see 5.2.1) shall be packed in container acceptable to the common carrier which will insure safe delivery at the destination in a satisfactory condition at the lowest applicable rate. Containers, packing and method of shipment shall comply with Uniform Freight or National Motor Freight Rules or Regulations or other carrier rules applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required herein (see 6.2.1) shipments shall be marked in accordance with MIL-STD-129.

5.4 Special requirements. The required certificate of compliance (see 3.12 and 4.6) shall be placed in a waterproof, greaseproof bag or envelope, identified as to contents, and placed in each bundle in such a manner to prevent loss or damage of the certificate during shipment and storage and be accessible without breaking the bundle (see figure 1, note 7).

6. NOTES

6.1 Intended use. Tubes covered by this specification are intended for the uses specified in 6.1.1 through 6.1.4.

6.1.1 Class a. Class a tubes are intended for use as water tubes in steam generators operating at a steam pressure not to exceed 750 lb/in². Class a tubes are considered equivalent to resistance-welded carbon steel boiler tubes covered by MIL-T-17188, class a, and may be used interchangeably in water tube applications. However, if seamless MIL-T-16286 class a tubes are specifically requested, MIL-T-17188 class a tubes shall not be supplied.

6.1.2 Class g. Class g tubes are intended for use as water tubes in steam generators.

6.1.3 Class c and e. Class c and class e tubes are intended for use as superheater tubes.

6.1.4 Class d. Class d tubes are intended for use as water tubes in steam generators only when approved by the procuring activity.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Class designation of tube (see 1.2).
- (c) Minimum wall thickness, length and outside diameter required (see 3.6.1, 3.6.2 and 3.6.3).
- (d) Levels of preservation, packaging and packing required (see 5.1 and 5.2).
- (e) Special marking required (see 5.3).

6.2.2 Data requirements. When this specification is used in a procurement which invokes the provision of the "Requirements for Data" of the Armed Services Procurement Regulations (ASPR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the ASPR are not invoked in a procurement, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

<u>Paragraph</u>	<u>Data requirements</u>	<u>Applicable DID</u>	<u>Option</u>
4.1.1	Inspection system program plan	DI-R-4803	-----

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

MIL-T-16286E(SH)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the procuring/purchasing activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item procured to this specification. This does not apply to specific data which may be required for each procurement regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 The various classes of tubes available under this specification are substantially different and the intended uses are for different applications; therefore, special care should be exercised in stocking to avoid loss of identification.

6.4 Certain provisions of this specification are the subject of international standardization agreement ABC-NAVY Standard 25. When amendment, revision, or cancellation of this specification is proposed which will effect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

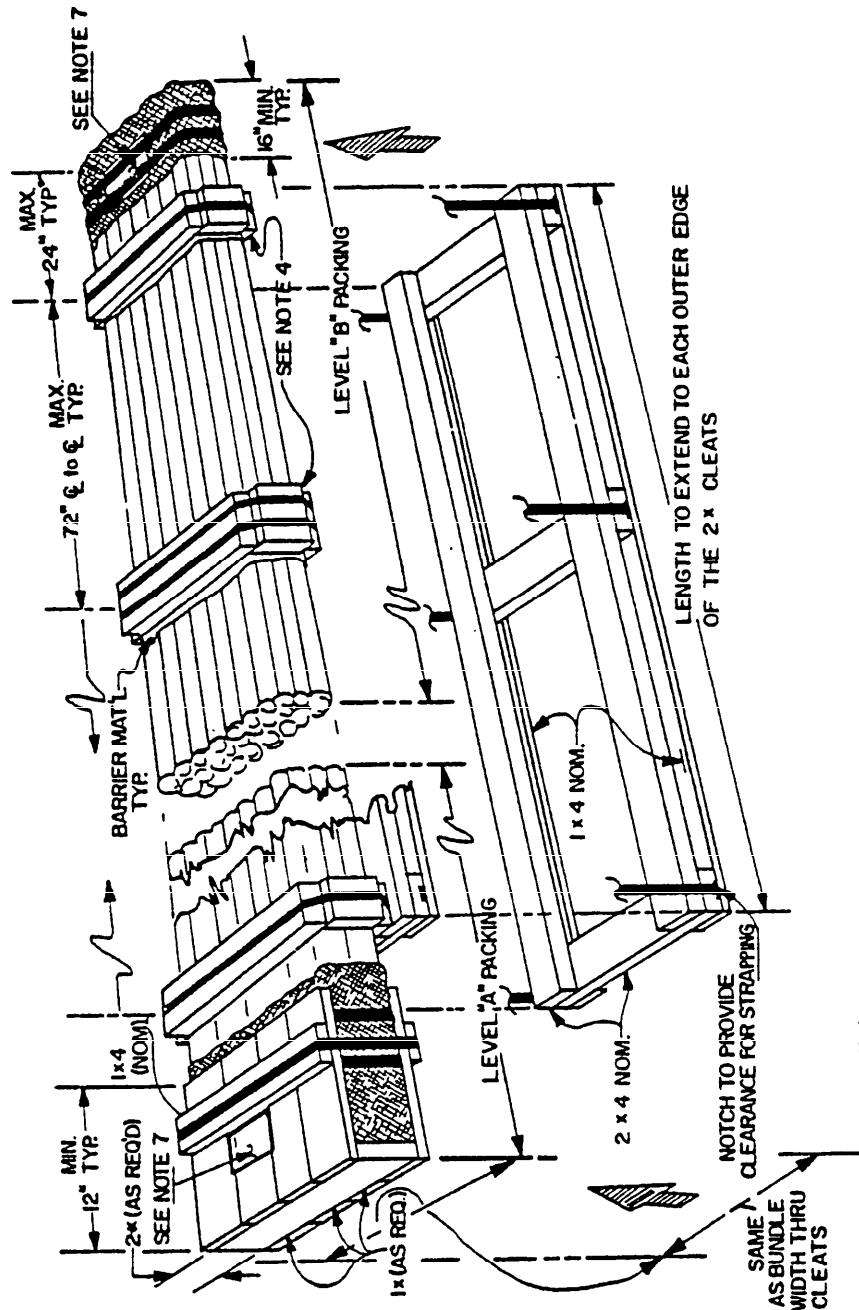
6.5 The chemical and mechanical property requirements of the tube classes under this specification are similar to those of ASTM as follows:

<u>Classes</u>	<u>ASTM</u>
a	A192
c	A213, grade TP 321, 347
d	A209, grade T1
e	A213, grade T22
g	A210, grade A1

6.6 Class f tubes of revision D have been deleted. They were intended for new construction and should not be carried in Naval stocks. Class e tubes will be used as replacement for class f tubes.

6.7 Changes from previous issue. The symbol "\$" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 4710-N429)



- Notes:
1. One end shown - other end opposite for the level of packing specified.
 2. Skid base for level A packing only.
 3. Bundles may be multi-stacked on one skid - not to exceed five bundles.
 4. Strapping on bundle cleats - one strap for 2x4, two straps for 2x6 lumber.
 5. Nails and nailing shall be as required in PPP-B-621 for the thickness of the lumber to be nailed.
 6. Skid base cross members shall be centered under each cleat of the bundle and steel strapped around the bundle.
 7. Locate the certificate of compliance (see 5.4) as shown for the level of packing specified. To secure the envelope, use staples for level A and pressure sensitive tape for level B.

FIGURE 1. Cleated bundle and skid system.

SH11227

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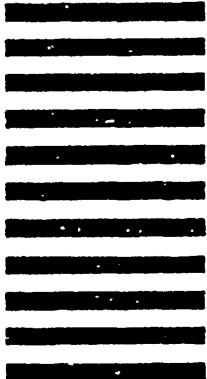
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