

QQ-T-830a**MARCH 1, 1961****SUPERSEDING****Fed. Spec. QQ-T-830****September 15, 1958****(See section 6.)****FEDERAL SPECIFICATION****TUBE, STEEL, (CARBON, MECHANICAL;
SEAMLESS AND WELDED)**

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope.—This specification covers carbon steel mechanical tube for general application purposes and structural application (see 6.1).

1.2 Classification.

1.2.1 Types of steel. — Unless otherwise specified in the invitation for bids, contract or order, the steel is to be furnished as killed, semi-killed, rimmed or capped at the option of the producer providing the steel meets all the requirements of this specification (see 6.1).

1.2.2 Types of tube.—The tube is to be furnished in the following types, as specified in the invitation for bids, contract, or order (see 6.1):

Seamless.

Electric resistance welded.

Fusion welded.

Furnace butt-welded.

1.2.3 Conditions of tube.—The tube is to be furnished in the following conditions, as specified in the invitation for bids, contract, or order (see 6.1).

HR—As hot-rolled (seamless only).

W—As welded (electric-resistance welded, fusion welded and furnace butt-welded only).

CD—As cold-drawn (without final thermal treatment).

CDSR—Cold-drawn and stress relieved (finish anneal).

ANL—Annealed (sub-critical).

NORM—Normalized, or normalized and tempered (see 6.1.1).

QT—Quenched and tempered (see 6.1.2).

1.2.4 Shapes of tube.—The tube is to be furnished in the following shapes, as specified in the invitation for bids, contract or order.

Round.

Square.

Rectangular.

Special shapes (hexagonal, octagonal, "D"-shaped, or as negotiated by the contractor and procuring agency).

2. APPLICABLE SPECIFICATIONS AND STANDARDS

2.1 The following standards, of the issues in effect on date of invitation for bids, form a part of this specification.

Federal Standards:

Fed. Std. No. 48—Tolerances for Steel and Iron Wrought Products.

Fed. Std. No. 102—Preservation, Packaging, and Packing levels.

QQ-1-2: 02

Fed. Std. No. 123—Marking for Domestic Shipment (Civilian Agencies).

Fed. Test Method Std. No. 151—Metals, Test Methods.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications, Standards, and Handbooks and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, Seattle, and Washington, D. C.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications, Standards, and Handbooks from established distribution points in their agencies.)

Military Standards:

MIL-STD-163 — Steel Mill Products
Preparation for Shipment and Storage.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Chemical composition.—Chemical composition of tube shall be specified by ordering numbered standard carbon steels shown in tables I, II, and III and shall meet the chemical composition specified. Table I lists the standard low carbon steels used exclusively for seamless and welded tube. Table II lists the standard carbon steel used for seamless tube, and table III for welded tube.

3.1.1 Ladle analysis.—The contractor shall furnish a ladle analysis of each heat or lot of steel showing the percentages of the elements present. The ladle analysis for seamless tube

shall meet the requirements of tables I and II and for welded tube, the requirements of tables I and III.

3.1.2 Check analysis.—Check analysis shall be made on all tube specified to steel numbers over 1026 and SAE 1026. The chemical compositions shall meet the requirements of tables II and III subject to the tolerances as shown in tables IV and V.

3.1.2.1 Check analysis may be waived by the Government when it can be determined that the tube is produced from a heat of steel that is identical to that tested on a previous lot and found acceptable.

3.2 Mechanical properties. — Mechanical properties may be specified for tube specified in the annealed, normalized, normalized and tempered, or quenched and tempered conditions. When tube is specified to mechanical properties the requirements shall be as specified in the invitation for bids, contract or order.

3.2.1 Tensile properties.—When specified in the invitation for bids, contract, or order, the tube shall meet the tensile properties as specified by the procuring agency when tested in accordance with 4.6.2.2.1 (see 6.2).

3.2.2 Hardness properties.—When specified in the invitation for bids, contract, or order, the tube shall meet the hardness properties as specified by the procuring agency when tested in accordance with 4.6.2.2.2.

3.3 Heat treatment.—When tube is specified annealed, normalized, normalized and tempered or quenched and tempered to mechanical properties (see 6.1.1 and 6.1.2), the contractor may determine the detail procedure for heat treatment to meet the specified mechanical properties.

3.4 Flattening requirements.—When specified in the invitation for bids, contract, or order, the tube covered in table I in the annealed or normalized condition shall with-

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stand the flattening test of 4.6.2.3 without cracking. Except when physical requirements or hardness tests are specified, grades referred to in table I in the as hot-rolled or as-welded condition shall withstand the flattening test without cracking. In addition, welded tube required to be subjected to the flattening test shall not open in the weld or show evidence of lamination, or incomplete penetration of the weld during the flattening test. Superficial surface ruptures shall not be considered as cracks.

3.5 Dimensions and tolerances.

3.5.1 Dimensions. — Dimensions for tube shall be as specified in the invitation for bids, contract, or order (see 6.1.4).

3.5.2 Tolerances.

3.5.2.1 Round tube.—The dimensional tolerance requirements of Federal Standard No. 48 shall apply for all round tube. The applicable references to this standard are indicated in table VI. Cross-sectional dimensional tolerances or straightness tolerances for certain sizes and conditions of tubing are not covered by this standard and must be negotiated between the procuring agency and producer (see 6.1.4).

3.5.2.1.1 Unless otherwise specified in the invitation for bids, contract, or order, tube shall be furnished in mill lengths of five feet or over. When specific lengths or lengths expressed as multiples of specific units are ordered, the tube shall be furnished to the required length with tolerances as indicated in table VI (see 6.1.5).

3.5.2.2 Square and rectangular tube.

3.5.2.2.1 Size and wall thickness tolerances. —The outside dimensions and wall thickness of square and rectangular cold-finished tube shall be as shown in tables VII and VIII for unannealed and finished annealed tube. The tolerances for rectangular tube are based on the larger external-diameter dimension on a

ratio of the longer side to the shorter side not exceeding $2\frac{1}{2}$ to 1. The wall thickness tolerances shall not apply at the corners. Size and wall-thickness tolerances for other conditions shall be negotiated between the producer and the procuring agency.

3.5.2.2.2 Corner radii.—Unless otherwise specified in the invitation for bids, contract, or order, corners of square and rectangular tube shall be slightly rounded inside and rounded outside, consistent with wall thickness. The outside corners may be slightly flattened. The corners of sections processed by Turk's-head rolls do not have constant radii. The radii of corners for square and rectangular cold finished seamless and butt-weld tube shall be approximately in accordance with table IX and for square and rectangular hot-rolled or cold-rolled electric-resistance tube shall be approximately in accordance with table X.

3.5.2.2.3 Length.—Unless otherwise specified in the invitation for bids, contract, or order, tube shall be furnished in mill lengths of 5 feet or over. When specified in the invitation for bids, contract, or order, tube shall be furnished to exact lengths or lengths expressed as multiples of specific units (see 6.1.5). Tolerances from specified lengths shall be in accordance with tables XI and XII.

3.5.2.2.4 Twist tolerance.—Twist tolerance for square and rectangular tube shall be as shown in tables XIII and XIV when measured in accordance with 4.5.2.1.

3.5.2.2.5 Straightness tolerance.—Straightness tolerance for square and rectangular tube shall be 0.060 inch in any 3 feet.

3.5.2.2.6 Squareness tolerance.—Squareness tolerance for the side of square and rectangular tube shall be determined as follows:

Plus or minus $b = c \times 0.006$ inch.

b = tolerance for out of square.

c = largest external dimension across flats.

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3.5.2.3 Special shaped tubing.—All tolerances on dimensions, straightness and twist shall be negotiated between the contractor and the procuring agency.

3.6 Identification marking.—When specified in the invitation for bids, contract or order, tube $\frac{1}{2}$ inch or over outside diameter or largest dimensions shall be identified individually on one end of the tube. Tube under $\frac{1}{2}$ -inch-outside diameter or largest dimension shall be bundled and a tag bearing the required identification marking shall be securely fastened to each bundle. The following shall be marked on the tube or tag:

- (a) Specification number.
- (b) Steel designation, condition, and heat number.
- (c) Manufacturer's name or trademark.

3.7 Workmanship.—Seamless and welded tube shall be free from pipes, cracks, and tears and, in addition, welded tube shall be free from burnt spots and incomplete penetration of the weld. Seamless tube shall have no welds and welded tube shall have no welds other than one longitudinal weld necessary for manufacture. Seamless or welded tube shall not have any defects which due to their nature, degree, or extent detrimentally affect the suitability of the tube for the specified end use (see 6.1).

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 The supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order.

4.2 Classification of inspection.

4.2.1 Acceptance inspection.—All examination and testing specified in this specification

shall be classified as acceptance inspection and shall be to determine conformance to the requirements of this specification to serve as a basis for acceptance of the material covered by this specification.

4.3 Lot.—Unless otherwise specified in the invitation for bids, contract, or order, a lot shall consist of tube, manufactured in production, submitted for inspection at the same time, of the same type, the same heat, the same condition, the same size and wall thickness, and when heat treated subjected to the same heat treatment.

4.4 Sampling.

4.4.1 Chemical composition (Government check analysis).—One sample shall be taken from each heat. The sample shall be selected in accordance with methods 111 or 112 of Federal Test Method Standard No. 151. The sample shall be forwarded to a Government or Government approved laboratory as designated by the procuring agency.

4.4.2 Mechanical properties.

4.4.2.1 Tension and hardness tests.—When specified, the number of samples for tensile or hardness tests from each lot shall be in accordance with table XV. In addition, in the case of quenched and tempered tube if more than one quenching charge is represented in a tempering charge each quenching charge shall be represented in the samples selected for testing.

4.4.3 Flattening.—When flattening tests are specified by the procuring agency, one sample shall be selected for each 5,000 feet of tube or fraction thereof per lot or for each 20,000 pounds or fraction thereof per lot, whichever occurs first.

4.4.4 Visual and dimensional.

4.4.4.1 Workmanship and dimension.—A representative number of sample units shall be selected in each lot for visual examination

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for workmanship and dimension examination. Sample units selected for workmanship examination may be used for dimensional examination.

4.4.4.2 Identification marking.—A representative number of sample units shall be selected for visual examination of identification marking. Identification marking is customarily accomplished after acceptance of the lot for workmanship and dimensional examination and for testing.

4.4.4.3 Preparation for shipment. — A representative number of sample units shall be selected to determine compliance with section 5.

4.5 Examination.

4.5.1 Visual.

4.5.1.1 Workmanship. — Sample units selected in accordance with 4.4.5.1 shall be examined for compliance with the workmanship requirements (see 3.7).

4.5.1.2 Identification marking. — Sample units selected in accordance with 4.4.5.2 shall be examined for compliance with the identification marking requirements (see 3.6).

4.5.1.3 Preparation for shipment.—Sample units shall be examined to determine that the preservation, packaging, packing and marking for shipment comply with the requirements of section 5.

4.5.2 Dimensions and tolerances.—The dimensions and tolerances shall be measured or gaged to determine compliance with the dimension and tolerance requirements (see 3.5).

4.5.2.1 Twist tolerance.—The twist tolerance (see 3.5.2.2.4) in square and rectangular tube shall be measured by holding one end of the square or rectangular tube on a surface plate with the bottom side parallel to the surface plate and noting the height at

either corner of the opposite end of the same side above the surface plate.

4.6 Tests.

4.6.1 Test specimens.

4.6.1.1 Chemical composition.—Specimens for spectrochemical analysis shall be prepared in accordance with method 112 of Federal Test Method Standard No. 151.

4.6.1.2 Mechanical properties.

4.6.1.2.1 Tension tests. — Specimens for tensile tests shall represent the full section of the tube when practicable. When testing in full section is not practicable the test specimens shall be type T1 through T4, as appropriate, of method 211 of Federal Test Method Standard No. 151. For heavy walled tubing, type F1 and F2 may be used.

4.6.1.2.2 Hardness tests.—The test specimen for hardness tests shall be a section cut from the full section of the tube or the full section of the tube may be used.

4.6.1.3 Flattening test. — The specimen from seamless tube shall be at least 2½ inches in length; specimens for electric-resistance-welded, fusion-welded and furnace-butt-welded tube shall be 4 to 6 inches in length.

4.6.2 Test procedures.

4.6.2.1 Chemical composition. — Analysis for chemical composition on samples selected in accordance with 4.4.1 and test specimens for spectrochemical analysis prepared in accordance with 4.6.1.1 shall be conducted in accordance with methods 111 and 112 of Federal Test Method Standard No. 151. Reference analysis, in case of dispute, shall be conducted by method 111.

4.6.2.2 Mechanical properties.

4.6.2.2.1 Tension tests. — Specimens prepared in accordance with 4.6.1.2.1 shall be

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tested in accordance with method 211 of Federal Test Method Standard No. 151.

4.6.2.2.1 Yield strength.—Yield strength shall be determined by either the offset method or the extension-under-load method of method 211 of Federal Test Method Standard No. 151. When the offset method is used the limiting set shall be 0.20 percent (0.002 inch per inch of gage length). The limiting extension-under-load shall be calculated as follows:

$$X = \frac{Y}{E} + 0.002$$

where

X = limiting extension-under-load, inches per inch of gage length.

Y = specified yield strength, pounds per square inch.

E = 30,000,000, pounds per square inch.

4.6.2.2.2 Hardness tests.—Specimens prepared in accordance with 4.6.1.2.2 shall be tested in accordance with method 243 of Federal Test Method Standard No. 151. Specimens tested in full section shall be adequately protected from possible deflection of the tubular section under the testing load.

4.6.2.3 Flattening tests.—Specimens prepared in accordance with 4.6.1.3 shall be flattened between parallel plates to the extent indicated in 4.6.2.3.1, 4.6.2.3.2, and 4.6.2.3.3 according to the type of tube specified.

4.6.2.3.1 Seamless tube.—No cracks other than superficial surface ruptures shall appear in the metal until the distance between the two parallel plates shall be not greater than the distance calculated from the following formula:

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

where:

H = distance between flattening plates in inches.

t = mean wall thickness of tube in inches.

D = outside diameter of the tube in inches.

e = constant, equal to 0.09.

4.6.2.3.2 Electric-resistance-welded and fusion-welded tube.—The weld shall be located 90 degrees from the line of the direction of the applied force. No cracks, other than superficial surface ruptures, shall appear in the weld until the distance between the flattening plates is less than two-thirds of the outside diameter of the tube. Likewise no cracks, other than superficial surface ruptures, shall appear in the metal of the tube other than in the weld until the distance between the flattening plates is less than one-third of the outside diameter of the tube (see 6.5).

4.6.2.3.3 Furnace-butt-welded tube.—The weld shall be located 45 degrees from the line of the direction of applied force. No cracks, other than superficial surface ruptures, shall appear in the weld until the distance between the flattening plates is less than three-fourths of the outside diameter of the tube. Likewise, no cracks, other than superficial surface ruptures, shall appear in the metal of the tube other than the weld metal until the distance between the flattening plates is less than three-fifths of the outside diameter of the tube.

4.7 Rejection.

4.7.1 Examination.—If the representative sample for visual and dimensional examination is rejectable, the lot represented by the sample shall be rejected.

4.7.2 Tests.—A lot shall be rejected for failure to comply with any of the test requirements when tested in accordance with 4.6.

4.8 Re-examination and retests.

4.8.1 Re-examination.—Lots rejected on the basis of visual or dimensional defects may

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be resubmitted for examination upon approval of the procuring agency provided that the contractor shall remove all nonconforming units from the lot.

4.8.2 Retests.—Retests shall be permitted in accordance with Federal Test Method Standard No. 151.

5. PREPARATION FOR DELIVERY

5.1 For civil agencies, the definitions and applications of the levels of packaging and packing shall be in accordance with Federal Standard No. 102.

5.2 Preservation and packaging (military).—Tube shall be preserved and packaged in accordance with levels A, B, or C as specified (see 6.1).

5.2.1 Levels A or B.—Preservation and packaging of tube shall be in accordance with the applicable requirements of Military Standard MIL-STD-163.

5.2.2 Level C.—Preservation and packaging of tube shall be in accordance with commercial practice.

5.3 Packing.—Tube shall be packed in accordance with levels A, B, or C, as specified (see 6.1).

5.3.1 Levels A or B.—Packing shall be in accordance with the applicable requirements of Military Standard MIL-STD-163.

5.3.2 Level C.—Packing of tube shall be in accordance with commercial practice adequate to ensure carrier acceptance and safe delivery at the lowest rate.

5.4 Marking for shipment.

5.4.1 Marking for shipment for civilian agencies shall be in accordance with Federal Standard No. 123 and for military agencies in accordance with Military Standard MIL-STD-163.

(a) Title, number, and date of this specification.

6. NOTES

6.1 Ordering data.—Purchasers should exercise any desired options offered herein, and procurement documents should specify the following:

(b) End use of tube should be noted in invitation for bids, contract, or order (see 1.1).

(c) Type of steel, if specified (see 1.2.1).

(d) Type and condition of tube (see 1.2.2 and 1.2.3).

(e) Shape of tube (see 1.2.4).

(f) Composition of tube (see 3.1).

(g) Mechanical properties, if required (see 3.2).

(h) Flattening requirements, if specified (see 3.4).

(i) Sizes and tolerances (see 3.6).

(j) Level of preservation, packaging and packing required (see section 5).

6.1.1 Normalized tube.—When normalized tube is required, the procuring agency should not specify whether the tubing is to be normalized or normalized-and-tempered. Customarily, tube is normalized when the nominal carbon content is less than 0.35 percent and is normalized-and-tempered when the carbon content is 0.35 percent or more. The choice between the two treatments is normally left to the contractor.

6.1.2 Quenched-and-tempered tube.—Hot rolled quenched-and-tempered tube and cold-drawn quenched-and-tempered tube are not commercially available in all sizes. When such tubing is desired, the procuring agency should consult with prospective sources on availability and economy of choice. When quenched-and-tempered tube is specified, whether seamless or welded, hot rolled or cold-drawn, the applicable tolerances for cross-sectional dimensions must be negotiated between the procuring agency and the contractor.

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6.1.3 Forming quality requirements. — When tube is ordered to be of special quality for forming operations, the procuring agency should specify the number and types of tests to determine the formability of the material, or other standards of acceptance. If the procuring agency specifies an actual forming operation or forming of the part for which the material is intended, the procuring agency shall furnish a drawing of the part to be formed. When the choice of quality is affected by the end use of the tube, or the forming operation to be performed, the procuring agency should state such information in adequate detail.

6.1.4 Specifying cross-sectional dimensions and tolerances. — It is possible to specify cross-sectional tube dimensions by inside diameter, outside diameter, and wall thickness. But when specifying cross-sectional dimensions to definite tolerances, only combinations of any two dimensions are specified, not all three. Cross-sectional tolerances closer than those covered by this specification are available in certain combinations of outside diameter and wall thickness. Such tolerances must be negotiated between the procuring agency and the contractor.

6.1.5 Multiple length allowance. — When tubing is ordered in lengths expressed as multiples of specific units, the amounts required for any loss in parting the units should be included. The customary amount allowed per unit is shown in table XVI.

6.2 Mechanical properties. — The several mechanical properties given for selected carbon steel tube compositions are included for information purpose only and are not to be considered as mechanical properties requirements unless so specified in the invitation for bids, contract, or order. The mechanical

properties shown in table XVII are for carbon steel round mechanical tubing only.

6.3 This document supersedes Federal Specification, QQ-T-830, Tube, Steel, Carbon, Mechanical, Round; Seamless and Welded, dated 15 September 1958, and incorporates the requirements of Military Specification MIL-T-52089 (Ord), Tube, Steel, Carbon, Mechanical, Shapes Other Than Round; Seamless and Welded, dated 12 January 1960.

6.4 Definitions and other information. — Department of Defense Supply and Logistics Handbook Standardization H-8, Steel and Wrought Iron Products may be consulted for guidance, general information, and definitions of terms used in this specification. The Handbook is not intended for use in procurement but is limited to information purposes only.

6.5 The flattening test for electric-resistance-welded and fusion-welded tube is more severe for small outside diameter thick wall tube than the seamless tube flattening test.

Notice. — When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded, by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

CUSTODIANS:

Army—Ord
Navy—Wepe
Air Force—ARDC.

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TABLE I.—Standard carbon steels exclusively for seamless and welded mechanical tube

Identification number ^{2/}	Alloying elements, percent ^{1/}					
	C		Mn		P	S
	Min.	Max.	Min.	Max.	Max.	Max.
MT ^{3/} 1010	0.05	0.15	0.30	0.60	0.040	0.050
MT 1015	.10	.20	.30	.60	.040	.050
MT X 1015	.10	.20	.60	.90	.040	.050
MT 1020	.15	.25	.30	.60	.040	.050
MT X 1020	.15	.25	.70	.00	.040	.050

^{1/} The percentages for carbon content apply to check analysis; all other percentages apply to ladle analysis and are subject to the applicable check analysis tolerances shown in tables IV and V.

^{2/} Purchasers specifying these steels shall use the proper prefix letters in addition to the identification number.

^{3/} MT stands for mechanical tubing.

TABLE II.—Standard carbon steels for seamless tube¹

Identification number	Alloying elements, percent ^{2/} , ^{3/}							
	Carbon		Manganese		Phosphorous		Sulphur	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1022	0.18	0.23	0.70	1.00	—	0.040	—	0.050
1025	.22	.28	.30	.60	—	.040	—	.050
1026	.22	.28	.60	.90	—	.040	—	.050
1030	.28	.34	.60	.90	—	.040	—	.050
1035	.32	.38	.60	.90	—	.040	—	.050
1040	.37	.44	.60	.90	—	.040	—	.050
1045	.43	.50	.60	.90	—	.040	—	.050
1050	.48	.55	.60	.90	—	.040	—	.050
1118	.14	.20	1.30	1.60	—	.040	0.08	.13
1137	.32	.39	1.35	1.65	—	.040	.08	.13

^{1/} Chemical ranges and limits based on ladle analysis.

^{2/} Silicon, when required, shall be specified with the following ranges and limits: for steel number 1022, 0.10 percent maximum, or ranges 0.10 to 0.20, or 0.15 to 0.30 percent as applicable; for steel numbers 1025 to 1050 ranges of 0.10 to 0.20, or 0.15 to 0.30 percent, as applicable; for steel number 1118 and 1137 inclusive, 0.10 percent maximum, or ranges of 0.10 to 0.20, or 0.15 to 0.30 percent as applicable.

^{3/} Copper may also be specified, when required. Copper is generally specified to a minimum of 0.20 percent.

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TABLE III.—Standard carbon steels for welded tube¹

Identification number SAE ^{2/}	Alloying elements, percent ^{3/} , ^{4/}							
	Carbon		Manganese		Phosphorous		Sulphur	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1022	0.17	0.24	0.70	1.00	---	0.040	---	0.050
1025	.21	.28	.30	0.60	---	.040	---	.050
1026	.21	.28	.60	.90	---	.040	---	.050
1030	.27	.35	.60	.90	---	.040	---	.050
1035	.31	.39	.60	.90	---	.040	---	.050
1040	.36	.45	.60	.90	---	.040	---	.050
1045	.42	.51	.60	.90	---	.040	---	.050
1050	.47	.56	.60	.90	---	.040	---	.050

^{1/} Chemical ranges and limits based on ladle analysis.

^{2/} Purchasers ordering these compositions must specify the prefix designation SAE with the identification number.

^{3/} Silicon, when required, shall be specified in accordance with the following ranges and limits: for steel numbers SAE 1022 and 0.1 percent maximum, or ranges of 0.10 to 0.20, or 0.15 to 0.30 percent, as applicable; for steel numbers SAE 1025 to 1050, ranges of 0.10 to 0.20, or 0.15 to 0.30 percent, as applicable.

^{4/} Copper may also be specified when required. Copper is generally specified to a minimum of 0.20 percent.

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TABLE IV.—Check analysis tolerances for carbon steel seamless tube¹

Alloying element	Specified range or limit, percent	Allowable tolerance ^{2/} percent
Carbon ^{3/}	(Up to 0.25 incl. (Over 0.25 to 0.55 incl. (Over 0.55	0.02 0.03 0.04
Manganese	(Up to 0.90 incl. (Over 0.90 to 1.65 incl.	0.03 0.06
Phosphorus ^{3/}	(Up to 0.05 incl. ^{4/} (Up to 0.12 incl. ^{6/}	0.008 ^{5/} 0.01 ^{5/}
Sulphur ^{3/}	Up to 0.06 incl.	0.008 ^{5/}
Silicon	(Up to 0.35 incl. (Over 0.35 to 0.60 incl.	0.02 0.05
Copper ^{7/}	Up to 0.20 (min) incl.	0.02 ^{8/}

^{1/}Applicable to the compositions listed in tables I and II.^{2/}Over the maximum limit or under the minimum limit.^{3/}Unless misapplication is clearly indicated, check analysis is not specified for carbon, phosphorus and sulphur in rimmed or capped steels, nor for phosphorus and sulphur in rephosphorized or resulphurized steels.^{4/}Applies to basic steel.^{5/}Variation permitted over the maximum only.^{6/}Applies to acid Bessemer steel.^{7/}Applies to copper-bearing steel.^{8/}Variation permitted under the minimum only.

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TABLE V.—Check analysis tolerances for carbon steel welded tube¹

Alloying element	Specified range or limit, percent	Allowable tolerance ^{2/} , percent	
		Under min.	Over max.
Carbon ^{3/}	(Up to 0.15	0.02	0.03
	(Over 0.15 to 0.40 incl.	0.03	0.04
	(Over 0.40 to 0.80 incl.	0.03	0.05
Manganese	(Up to 0.60 incl.	0.03	0.03
	(Over 0.60 to 1.15 incl.	0.04	0.04
	(Over 1.15 to 1.65 incl.	0.05	0.05
Phosphorus ^{3/}	(^{4/})	—	0.01 ^{4/}
Sulphur ^{3/}	(^{4/})	—	0.01 ^{4/}
Silicon	(Up to 0.30 incl.	0.02	0.02
	(Over 0.30 to 0.60 incl.	0.05	0.05
Copper ^{5/}	Up to 0.20(min.) incl.	0.02 ^{6/}	—

^{1/} Applicable to the compositions listed in tables I and III.^{2/} Over the maximum limit and under the minimum limit.^{3/} Unless misapplication is clearly indicated, check analysis is not specified for carbon, phosphorus, and sulphur in rimmed or capped steels, nor for phosphorus and sulphur in rephosphorized or resulphurized steels.^{4/} Variation permitted over the maximum only.^{5/} Applies to copper-bearing steel.^{6/} Variation permitted under the minimum only.

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TABLE VI.—Dimensional tolerance references to Federal Standard No. 48

Dimensional tolerance	Federal Standard No. 48 Paragraph references			
	Seamless tubing		Welded tubing	
	Hot-rolled	Cold-drawn ^{1/}	Hot-rolled	Cold-drawn ^{1/}
Outside diameter	16ab5	16ab6	16ab7 16ab5 ^{2/}	16ab9 16ab6 ^{2/}
Inside diameter	—	16ab6	16ab7	16ab9 16ab6 ^{2/}
Wall thickness	16ab5	16ab6	16ab8 16ab5 ^{2/}	16ab10 16ab6 ^{2/}
Straightness	16abl2	16abl2	16abl2	16abl2
Length ^{3/}	16ab3	16ab3	16ab3	16ab3

^{1/} While normally only two cross-section dimensions may be specified as subject to definite tolerances (6.1.4), when seamless tubing and furnace butt-welded tubing in the as-cold-drawn or cold-drawn-and-stress-relieved conditions are ordered to outside diameter and inside diameter, the following rule applies: Wall thickness at any point shall not vary by more than ± 10 per cent from the mean wall thickness as calculated from the mean of the maximum and minimum permissible outside and inside diameters. If the tolerances for outside and inside diameters are not of equal value, then special attention must be given to determination of the mean wall thickness.

^{2/} Applicable to furnace butt-welded tubing only.

^{3/} Section of paragraph 16ab3 under heading "Mechanical Tubing, Round".

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TABLE VII.—Tolerances, outside dimensions and wall thickness seamless and butt weld square and rectangular mechanical tube plus and minus, inch

Largest outside dimension across flats, inch	Wall thickness	Tolerances for outside dimensions, including convexity or concavity
To 3/4 incl.	0.065" and lighter	0.015
To 3/4 incl.	.065" and heavier	.010
Over 3/4 to 1-1/4 incl.	All thickness	.015
Over 1-1/4 to 2-1/2 incl.	All thickness	.020
Over 2-1/2 to 3-1/2 incl.	.065" and lighter	.030
Over 2-1/2 to 3-1/2 incl.	Over .065"	.025
Over 3-1/2 to 5-1/2 incl.	All thickness	.030
Over 5-1/2 to 7-1/2 incl.	All thickness	1%

Wall thickness: The tolerance is plus and minus 10 percent of nominal wall thickness.

TABLE VIII.—Tolerances, outside dimensions and wall thicknesses electric resistance welded square and rectangular mechanical tube plus and minus

Largest nominal outside dimension, inches	Wall thickness, inch	Outside tolerance at all sides at corners inch
3/16 to 5/8 incl.	0.020 to 0.083 incl.	0.004
Over 5/8 to 1-1/8 incl.	.025 to .156 incl.	.005
Over 1-1/8 to 1-1/2 incl.	.025 to .192 incl.	.006
Over 1-1/2 to 2 incl.	.032 to .192 incl.	.008
Over 2 to 3 incl.	.035 to .259 incl.	.010
Over 3 to 4 incl.	.049 to .259 incl.	.020
Over 4 to 6 incl.	.065 to .259 incl.	.020

Convexity and concavity: Shapes having two parallel sides are also measured in the center of the flat sides for convexity and concavity, this tolerance applies to the specific size determined at the corners, and is measured on the following basis:

Longest nominal outside dimension, inch	Tolerance plus and minus, inch
2-1/2 and under	.010
Over 2-1/2	.015

Wall thickness: The tolerance is plus and minus 10 percent of nominal wall thickness.

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TABLE IX.—Dimensions of corner radii for square and rectangular carbon steel seamless and butt-weld mechanical tube

Wall thickness, inches	Maximum radii of corners, inches
Over .020 to .049 incl.	3/32
Over .049 to .065 incl.	1/8
Over .065 to .083 incl.	9/64
Over .083 to .095 incl.	3/16
Over .095 to .109 incl.	13/64
Over .109 to .134 incl.	7/32
Over .134 to .156 incl.	1/4
Over .156 to .188 incl.	9/32
Over .188 to .250 incl.	11/32
Over .250 to .313 incl.	7/16
Over .313 to .375 incl.	1/2
Over .375 to .500 incl.	11/16
Over .500 to .625 incl.	27/32

TABLE X.—Dimensions of corner radii for square and rectangular carbon steel electric resistance welded mechanical tube

Square and rectangular made from tubes whose diameter ranges from	Wall thickness B.W. gage	Radius
1/2 to 1-1/2 incl.	22 (.028)	1/32" to 1/16"
1/2 to 2-1/2 incl.	20 (.035)	1/32" to 1/16"
1/2 to 4 incl.	18 (.049)	3/64" to 5/64"
1/2 to 4-1/8 incl.	16 (.065)	1/16" to 7/64"
3/4 to 4-1/8 incl.	14 (.083)	5/64" to 1/8"
Over 4-1/8 to 6 incl.	14 (.083)	3/16" to 5/16"
1 to 4-1/8 incl.	13 (.095)	3/32" to 5/32"
Over 4-1/8 to 6 incl.	13 (.095)	3/16" to 5/16"
1-1/4 to 4" incl.	12 (.109)	1/8" to 13/64"
Over 4" to 6 incl.	12 (.109)	3/16" to 5/16"
1-1/4 to 4 incl.	11 (.120)	1/8" to 7/32"
Over 4 to 6 incl.	11 (.120)	7/32" to 7/16"
2 to 4 incl.	10 (.134)	5/32" to 9/32"
Over 4 to 6 incl.	10 (.134)	7/32" to 7/16"
2 to 4 incl.	9 (.148)	3/16" to 5/16"
Over 4 to 6 incl.	9 (.148)	7/32" to 7/16"
2 to 6 incl.	8 (.165)	1/4" to 1/2"
2 to 6 incl.	7 (.180)	1/4" to 1/2"
2-1/2 to 4 incl.	6 (.203)	5/16" to 9/16"
Over 4" to 6" incl.	6 (.203)	5/16" to 9/16"
2-1/2" to 6" incl.	5 (.220)	3/8" to 5/8"
2-1/2" to 6" incl.	4 (.238)	3/8" to 5/8"
2-1/2" to 6" incl.	3 (.259)	3/8" to 5/8"

The above dimensions commonly apply to grade MT 1010 and grade MT 1015. Dimensions on higher carbon grades should be negotiated between the purchaser and producer.

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TABLE XI.—Length tolerances — seamless and butt weld tube

Lengths	Tolerances, inch	
	Plus	Minus
1/4 to 4 feet incl.	1/8	0.000
Over 4 to 12 feet incl.	3/16	0.000
Over 12 to 24 feet incl.	1/4	0.000

Over 24 feet, an additional 1/8 inch for each addition 10 feet, or fraction thereof.

TABLE XII.—Length tolerances — electric resistance welded steel tube

Lengths	Tolerances, inch
1 to 3 ft. incl.	Plus or minus 1/16"
Over 3 to 12 ft. incl.	Plus or minus 3/32"
Over 12 to 20 ft. incl.	Plus or minus 1/8"
Over 20 to 30 ft. incl.	Plus or minus 3/16"
Over 30 to 40 ft. incl.	Plus or minus 3/8"

TABLE XIII.—Twist tolerances electrical resistance welded carbon mechanical tube

Largest dimension inches	Twist tolerance in 3 feet, inch
Under 1/2	0.032
1/2 to 1-1/2 incl.	0.050
Over 1-1/2 to 2-1/2 incl.	0.062
Over 2-1/2 to 4 incl.	0.075
Over 4 to 5-1/2 incl.	0.087

TABLE XIV.—Twist tolerance — seamless and butt weld carbon mechanical tube

Largest dimension inches	Maximum twist in 3 feet, inches
Under 1/2	.050
1/2 to 1-1/2 incl.	.075
Over 1-1/2 to 2-1/2 incl.	.095
Over 2-1/2	.125

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TABLE XV.—Sampling for tension and hardness tests

Feet of tubing per lot	Number of samples per lot
Up to 5,000, incl.	2
Over 5,000 to 10,000, incl.	3
Over 10,000 to 20,000, incl.	4
Over 20,000 to 50,000, incl.	5
Over 50,000 additional or fraction thereof.	1 additional

TABLE XVI.—Customary allowance for parting units from multiple length

Ordered wall thickness, inch	Allowance per unit, inch
Up to 1/8, incl.	1/8
Over 1/8 to 1/2, incl.	3/16
Over 1/2	1/4

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TABLE XVII.—Several mechanical properties of selected carbon steel round tubing¹

Identifying steel No. 2/ ^{2/}	Type of tubing ^{3/}		Condition ^{4/}	Tensile strength, minimum	Yield strength, 0.2% offset, minimum	Elongation in 2 inches, ^{5/} minimum
	S	W		P.s.i.	F.s.i.	Percent
1020	X	-	HR	50,000	32,000	25
	-	X	W	50,000	38,000	20
	X	X	CD	70,000	60,000	5
	X	X	CDSR	65,000	50,000	10
	X	X	ANL	48,000	28,000	30
	X	X	NORM	55,000	34,000	22
1025	X	-	HR	55,000	35,000	25
	-	X	W	55,000	40,000	17
	X	X	CD	75,000	65,000	5
	X	X	CDSR	70,000	55,000	8
	X	X	ANL	53,000	30,000	25
	X	X	NORM	55,000	36,000	22
1035	X	-	HR	65,000	40,000	20
	-	X	W	65,000	50,000	15
	X	X	CD	85,000	75,000	5
	X	X	CDSR	75,000	65,000	8
	X	X	ANL	60,000	33,000	25
	X	X	NORM ^{6/}	65,000	40,000	20
1045	X	-	HR	75,000	45,000	1
	X	-	CD	90,000	80,000	5
	X	-	CDSR	80,000	70,000	8
	X	-	ANL	65,000	35,000	20
	X	-	NORM ^{6/}	75,000	48,000	14
1050	X	-	CDSR	82,000	70,000	6
	X	-	ANL	68,000	38,000	18
	X	-	NORM ^{6/}	78,000	50,000	12
1118	X	-	HR	55,000	35,000	25
	X	-	CD	75,000	60,000	5
	X	-	CDSR	70,000	55,000	8
	X	-	ANL	50,000	30,000	25
	X	-	NORM	55,000	35,000	20
1137	X	-	HR	70,000	40,000	20
	X	-	CD	80,000	65,000	5
	X	-	CDSR	75,000	60,000	8
	X	-	ANL	65,000	35,000	22
	X	-	NORM ^{6/}	70,000	45,000	15

^{1/}Applicable to seamless and welded carbon steel tubing with outside diameter within the range of 1/8 inch to 5 inches and wall thickness within the range of 0.025 inch to 0.250 inch.

^{2/}Mechanical properties are not shown for 1022 because no data is available, as 1022 steel is a carburizing grade normally supplied in a machinable condition without specified mechanical properties.

^{3/}S = seamless tubing and W = welded tubing.

^{4/}See 1.2.4 for definition of condition symbols.

^{5/}Values based on test of full section of tubing with wall thickness approximately 6 to 20 percent of outside diameter. Elongation test values may vary according to cross-sectional dimensions and size and type of specimen. Therefore, in specifying elongation values, characteristics of test specimen must be taken into consideration.

^{6/}Properties indicated are obtained by normalizing and tempering.

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SPECIFICATION		
ORGANIZATION (of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEM PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
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1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.		
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