Designation: A 688/A 688M – 08

Standard Specification for Welded Austenitic Stainless Steel Feedwater Heater Tubes[1]

This standard is issued under the fixed designation A 688/A 688M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification[2] covers welded austenitic stainless steel feedwater heater tubes including those bent, if specified, into the form of U-tubes for application in tubular feed-water heaters.

1.2 The tubing sizes covered shall be ⅝ to 1 in. [15.9 to 25.4 mm] inclusive outside diameter, and average or minimum wall thicknesses of 0.028 in. [0.7 mm] and heavier.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A 1016/A 1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E 527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[4]

3. Terminology

3.1 *Definitions Of Terms*—For definitions of terms used in this specification, refer to Terminology A 941.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material under this specification. Such requirements may include, but are not limited to, the following:

4.1.1 Quantity (length or number of pieces),

4.1.2 Material description,

4.1.3 Dimensions—Outside diameter, wall thickness (minimum or average wall), and length,

4.1.4 Grade (chemical composition) (Table 1),

4.1.5 U-bend requirements, if order specifies bending, U-bend schedules or drawings shall accompany the order,

4.1.6 Optional requirements—Purchaser shall specify if annealing of the U-bends is required or whether tubes are to be hydrotested or air tested (see 11.6)

4.1.7 Supplementary requirements—Purchaser shall specify on the purchase order if material is to be eddy current tested in accordance with Supplementary Requirements S1 or S2, and if special test reports are required under Supplementary Requirement S3, and,

4.1.8 Any special requirements.

5. General Requirements

5.1 Material furnished to this specification shall conform to the applicable requirements of the latest published edition of Specification A 1016/A 1016M unless otherwise provided herein.

6. Materials and Manufacture

6.1 The tube shall be made from flat-rolled steel by an automatic welding process with no addition of filler metal.

6.2 Subsequent to welding and prior to final heat treatment, the tubes shall be cold worked either in both the weld and base metal, or in the weld metal only. The method of cold work may

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-688 in Section II of that Code.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

***A Summary of Changes section appears at the end of this standard.**

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TABLE 1 Chemical Requirements

Element	Grade.....	TP 304	TP 304L	TP 304LN	TP 316	TP 316L	TP 316LN	TP XM-29	TP 304N	TP 316N	. . .	. . .	. . .	. . .
	UNS Designation[A]....	S30400	S30403	S30453	S31600	S31603	S31653	S24000	S30451	S31651	N08367	N08926	S31254	S32654
		Composition, %												
Carbon, max		0.08	0.035	0.035	0.08	0.035	0.035	0.060	0.08	0.08	0.030	0.020	0.020	0.020
Manganese, max[B]		2.00	2.00	2.00	2.00	2.00	2.00	11.50–14.50	2.00	2.00	2.00	2.00	1.00	2.0–4.0
Phosphorus, max		0.040	0.040	0.040	0.040	0.040	0.040	0.060	0.040	0.040	0.040	0.03	0.030	0.030
Sulfur, max		0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.01	0.010	0.005
Silicon, max		0.75	0.75	0.75	0.75	0.75	0.75	1.00	0.75	0.75	1.00	0.5	0.80	0.50
Nickel		8.00–11.00	8.00–13.00	8.00–13.00	10.00–14.00	10.00–15.00	10.00–15.00	2.25–3.75	8.00–11.0	10.00–14.00	23.50–25.50	24.00–26.00	17.5–18.5	21.0–23.0
Chromium		18.00–20.00	18.00–20.00	18.00–20.00	16.00–18.00	16.00–18.00	16.00–18.00	17.00–19.00	18.0–20.0	16.0–18.0	20.00–22.00	19.00–21.00	19.5–20.5	24.0–25.0
Molybdenum		...	...	...	2.00–3.00	2.00–3.00	2.00–3.00	...	...	2.00–3.00	6.00–7.00	6.0–7.0	6.0–6.5	7.0–8.0
Nitrogen[C]		...	...	0.10–0.16	...	...	0.10–0.16	0.20–0.40	0.10–0.16	0.10–0.16	0.18–0.25	0.15–0.25	0.18–0.22	0.45–0.55
Copper		. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.75 max	0.5–1.5	0.50–1.00	0.30–0.60

[A] New designation established in accordance with Practice E 527 and SAE J1086.
[B] Maximum, unless otherwise noted.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.

be specified by the purchaser. When cold drawn, the purchaser may specify the minimum amount of reduction in cross-sectional area or wall thickness, or both.

6.3 Many surface contaminants may have detrimental effects on high temperature properties or corrosion resistance of tubing. Contamination by copper, lead, mercury, zinc, chlorides, or sulfur may be detrimental to stainless steels. The manufacturer shall employ techniques that minimize surface contamination by these elements.

7. Cleaning Before Annealing

7.1 All lubricants of coatings used in the manufacture of straight-length tube or in the bending shall be removed from all surfaces prior to any annealing treatments. U-bends on which a lubricant had been applied to the inside surface during bending shall have the cleanness of their inside surface confirmed by blowing close fitting acetone-soaked felt plugs through 10 % of the tubes of each bend radius. Dry, oil-free, air or inert gas shall be used to blow the plugs through the tubes. If the plugs blown through any tube shows more than a light gray discoloration, all tubes that have had a lubricant applied to the inside surface during bending shall be recleaned. After recleaning 10 % of the tubes of each bend radius whose inside surface had been subjected to bending lubricants shall be retested.

8. Heat Treatment

8.1 All finished straight tubing or straight tubing ready for U-bending shall be furnished in the solution-annealed condition. The annealing procedure, except for N08367, S31254, S32654, and N08926, shall consist of heating the material to a minimum temperature of 1900 °F [1040 °C] followed by a rapid cooling to below 700 °F [370 °C]. The cooling rate shall be sufficiently rapid to prevent harmful carbide precipitation as determined in Section 13.

8.2 UNS N08367 shall be solution annealed at 2025 °F [1107 °C] minimum followed by rapid quenching.

8.3 N08926 shall be heat-treated at a minimum temperature of 2010 °F [1100 °C] followed by quenching in water or rapidly cooling by other means.

8.4 S31254 and S32654 shall be solution annealed at 2100 °F [1150 °C] minimum followed by rapid quenching.

8.5 If heat treatment of U-bends is specified, it shall satisfy the annealing procedure described above, and shall be done as follows:

8.5.1 The heat treatment shall be applied to the U-bend area plus approximately 6 in. [150 mm] of each leg beyond the tangent point of the U-bend.

8.5.2 If the heat treatment specified in 8.5 is accomplished by resistance-heating methods wherein electrodes are clamped to the tubes, the clamped areas shall be visually examined for arc burns. Burn indications shall be cause for rejection unless they can be removed by local polishing without encroaching upon minimum wall thickness.

8.5.3 Temperature control shall be accomplished through the use of optical or emission pyrometers, or both. No temperature-indicating crayons, lacquers, or pellets shall be used.

8.5.4 The inside of the tube shall be purged with a protective or an inert gas atmosphere during heating and cooling to below 700 °F [370 °C] to prevent scaling of the inside surface. The atmosphere should be noncarburizing.

9. Surface Condition

9.1 The straight tubes, after final annealing, shall be pickled using a solution of nitric and hydrofluoric acids followed by flushing and rinsing in water. If bright annealing is performed, this requirement does not apply.

9.2 A light oxide scale on the outside surface of U-bend area shall be permitted for tubes which have been electric-resistance heat treated after bending.

10. Chemical Composition

10.1 *Product Analysis*:

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10.1.1 When requested in the purchase order, a product analysis shall be made by the supplier from one tube or coil of steel per heat. The chemical composition shall conform to the requirements shown in Table 1.

10.1.2 A product analysis tolerance of Specification A 480/A 480M shall apply. The product analysis tolerance is not applicable to the carbon content for material with a specified maximum carbon of 0.04 % or less.

10.1.3 If the original test for product analysis fails, retests of two additional lengths of flat-rolled stock or tubes shall be made. Both retests, for the elements in question, shall meet the requirements of this specification; otherwise all remaining material in the heat or lot shall be rejected, or at the option of the producer, each length of flat-rolled stock or tube may be individually tested for acceptance. Lengths of flat-rolled stock or tubes that do not meet the requirements of this specification shall be rejected.

11. Mechanical Requirements

11.1 *Tensile Properties*:

11.1.1 The material shall conform to the tensile properties shown in Table 2.

11.1.2 One tension test shall be made on a specimen for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes.

11.2 *Hardness*:

11.2.1 Grade TP XM-29 and N08367 tubes shall have a hardness number not exceeding 100 HRB or its equivalent. Tubes of all other grades shall have a hardness number not exceeding 90 HRB or its equivalent. This hardness requirement is not to apply to the bend area of U-bend tubes which are not heat treated after bending.

11.2.2 Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot.

11.3 *Reverse Bend Test*:

11.3.1 One reverse bend test shall be made on a specimen from each 1500 ft [460 m] of finished tubing.

11.3.2 A section 4 in. [100 mm] minimum in length shall be split longitudinally 90° on each side of the weld. The sample shall then be opened and bent around a mandrel with a maximum thickness of four times the wall thickness, with the mandrel parallel to the weld and against the original outside surface of the tube. The weld shall be at the point of maximum bend. There shall be no evidence of cracks, or of overlaps resulting from the reduction in thickness of the weld area by cold working. When the geometry or size of the tubing make it difficult to test the sample as a single piece, the sample may be sectioned into smaller pieces provided a minimum of 4 in. of weld is subjected to reverse bending.

NOTE 1—The reverse bend test is not applicable when specified wall is 10 % or more of the specified outside diameter, or the wall thickness is 0.134 in. [3.4 mm] or greater, or the outside diameter size is less than 0.375 in. [9.5 mm]. Under these conditions, the reverse flattening test of Specification A 1016/A 1016M shall apply.

11.4 *Flattening Test*—Flattening tests shall be made on specimens from each end of one finished tube, not the one used for the flange test, from each lot.

11.5 *Flange Test*—Flange tests shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot.

11.6 *Pressure Test*:

11.6.1 Each straight tube or each U-tube after completion of the bending and post-bending heat treatment, shall be pressure tested in accordance with one of the following paragraphs as specified by the purchaser.

11.6.1.1 *Hydrostatic Test*—Each tube shall be given an internal hydrostatic test in accordance with Specification A 1016/A 1016M, except that the test pressure and hold time, when other than that stated in Specification A 1016/A 1016M, shall be agreed upon between purchaser and manufacturer.

11.6.1.2 *Air Underwater Test*—Each tube shall be air underwater tested in accordance with Specification A 1016/A 1016M.

11.7 *Lot Definitions*:

11.7.1 For flattening and flange requirements, the term "lot" applies to 125 tube groupings, prior to cutting to length, of the same nominal size and wall thickness, produced from the same heat of steel and annealed in a continuous furnace.

11.7.2 For tension and hardness, the term "lot" applies to all tubes, prior to cutting to length, of the same nominal diameter and wall thickness, produced from the same heat of steel and annealed in a continuous furnace at the same temperature, time at temperature, and furnace speed.

12. Nondestructive Test (Electric Test)

12.1 Each straight tube shall be tested after the finish heat treatment by passing it through a nondestructive tester capable of detecting defects on the entire cross section of the tube, in accordance with Specification A 1016/A 1016M.

13. Corrosion Resisting Properties

13.1 One full section sample 1 in. [25.4 mm] long from the center of a sample tube of the smallest radius bend which is

TABLE 2 Tensile Requirements

Grade	304, 316	304L, 316L	XM-29	304N, 316N	304LN, 316LN	. . .	. . .	. . .	. . .	. . .	. . .
UNS Designation	S30400, S31600	S30403, S31603	S24000	S30451, S31651	S30453, S31653	N08367 t ≤ 0.187	N08367 t > 0.187	N08926	S31254 t ≤ 0.187	S31254 t > 0.187	S32654
Tensile strength, min ksi [MPa]	75 [515]	70 [485]	100 [690]	80 [550]	75 [515]	100 [690]	95 [655]	94 [650]	100 [690]	95 [655]	120 [825]
Yield strength, min ksi [MPa]	30 [205]	25 [175]	55 [380]	35 [240]	30 [205]	45 [310]	45 [310]	43 [295]	45 [310]	45 [310]	65 [450]
Elongation in 2 in. or 50 mm, min, %	35	35	35	35	35	30	30	35	35	35	40

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heat treated shall be tested in the heat treated condition in accordance with Practices A 262.

13.2 One full-section sample 1 in. [25.4 mm] long from each lot of straight tubes shall be tested in the finished condition in accordance with Practices A 262.

13.3 The appearance of any fissures or cracks in the test specimen when evaluated in accordance with Practices A 262 indicating the presence of intergranular attack, shall be cause for rejection of that lot.

13.4 Lot definitions: For corrosion test requirements, the term "lot" applies to all tubes, prior to cutting to length, of the same nominal diameter and wall thickness, produced from the same heat of steel and annealed in a continuous furnace at the same temperature, time at temperature, and furnace speed.

14. Permissible Variations in Dimensions (Fig. 1)

14.1 Permissible variations from the specified outside diameter shall be in accordance with Specification A 1016/A 1016M. Those tolerances do not apply to the bent portion of the U-tubes. At the bent portion of a U-tube for $R = 2 \times D$ or greater, neither the major nor minor diameter of the tube shall deviate from the nominal diameter prior to bending by more than 10 %. If less than $2 \times D$ is specified, tolerances could be greater.

14.2 *Permissible Variations from the Specified Wall Thickness*:

14.2.1 Permissible variations from the specified minimum wall thickness shall not exceed +20 % − 0.

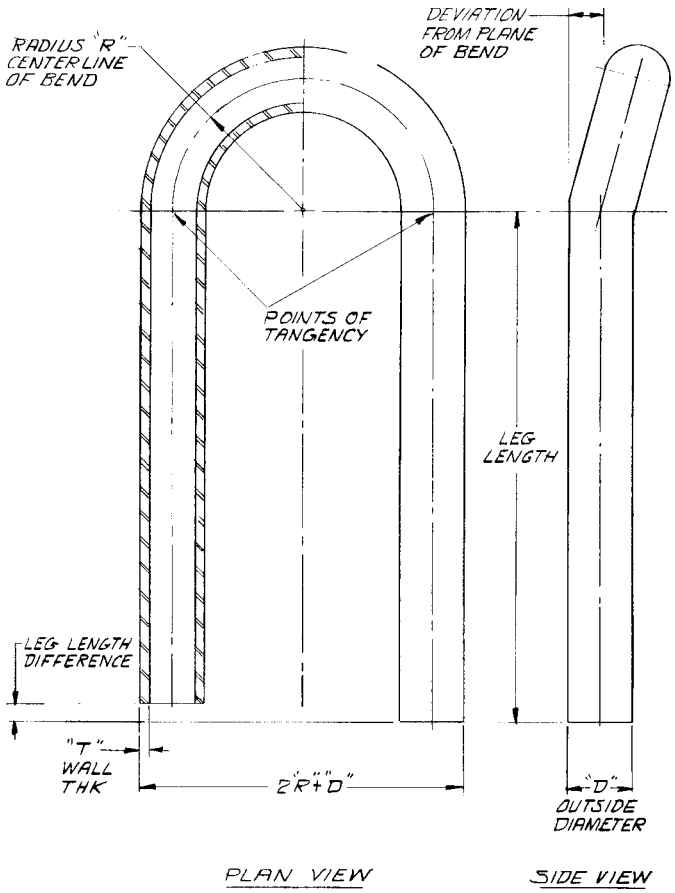


FIG. 1 Plane Bend for U-Tube

14.2.2 Permissible variations from the specified average wall thickness are ±10 % of the nominal wall thickness.

14.2.3 The wall thickness of the tube in the U-bent section shall not be less than value determined by the equation:

$$t_f = \frac{4RT}{4R + D}$$

where:

t_f = wall thickness after bending, in. [mm],
T = minimum wall thickness of 14.2.1 or 14.2.2, in. [mm],
R = centerline bend radius, in. [mm], and
D = nominal outside tube diameter, in. [mm].

14.3 *Permissible Variations from the Specified Length*:

14.3.1 *Straight Lengths*—The maximum permissible variations for lengths 24 ft [7.3 m] and shorter shall be +⅛ in. [3 mm], –0; for lengths longer than 24 ft [7.3 mm], an additional over tolerance of +⅛ in. [3 mm] for each 10 ft [3 m], or fraction thereof, shall be permitted up to a maximum of +½ in. [13 mm].

14.3.2 *U-Bends*—In the case of U-tubes, the length of the tube legs as measured from the point of tangency of the bend and the tube leg to the end of the tube leg, shall not be less than specified, but may exceed the specified values by the amount given in Table 3. The difference in lengths of the tube legs shall not be greater than ⅛ in. unless otherwise specified.

14.4 The end of any tube may depart from square by not more than the amount given in Table 4.

14.5 The leg spacing measured between the points of tangency of the bend to the legs shall not vary from the value (2 R − specified tube outside diameter) by more than 1/16 in. [1.5 mm] where R is the center-line bend radius.

14.6 The bent portion of the U-tube shall be substantially uniform in curvature, and not to exceed ± 1/16 in. [1.5 mm] of the nominal center-line radius.

14.7 Permissible deviation from the plane of bend (Fig. 1) shall not exceed 1/16 in. [1.5 mm] as measured from the points of tangency.

15. Workmanship, Finish, and Appearance

15.1 Tubing purchased to this specification is intended for use in heat exchangers, and will be inserted through close-fitting holes in baffles or support plates, or both, spaced along the tube length. The tube ends will also be inserted into very close-fitting holes in a tubesheet and expanded and may be welded therein. The tubes shall be able to stand expanding and bending without showing cracks and flaws, and shall be finished reasonably straight and suitable for the intended purpose.

15.2 The residual chloride salt contamination of the inside and outside surface of the tubing at the time of packing for shipment from the mill shall not exceed a concentration of 1

TABLE 3 Tube Leg Length Tolerance

Leg Length, ft [m]	Plus Tolerance, in. [mm]
Up to 20 [6], incl	1/8 [3.2]
Over 20 to 30 [6 to 9], incl	5/32 [4.0]
Over 30 to 40 [9 to 12.2], incl	3/16 [4.8]

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TABLE 4 Squareness of Ends Tolerance

Tube OD, in. [mm]	Tolerance, in. [mm]
⅝ [15.9], incl	0.010 [0.25]
Over ⅝ to 1 in. [15.9 to 25.4], incl	0.016 [0.4]

mg/ft^2 [10.7 mg/m^2] of tube surface. One tube in each five hundred pieces shall be checked immediately prior to packing for shipment for chloride salt contamination by a procedure agreed upon by the manufacturer and purchaser.

16. Inspection

16.1 The inspector representing the purchaser shall have entry, at all times, to those areas where inspection and testing is being performed on the purchaser's ordered material. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All required tests and inspections shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted so as not to interfere unnecessarily with the operation of the works.

17. Rejection

17.1 Each length of tubing received from the manufacturer may be inspected by the purchaser, and, if it does not meet the requirements of the specification based on the inspection and test method outlined in the specification, the tubing may be rejected and the manufacturer shall be notified. Disposition of rejected tubing shall be a matter of agreement between the manufacturer and the purchaser.

17.2 Material that fails in any of the forming operations or in the process of installation and is found to be defective, shall be set aside, and the manufacturer shall be notified. Disposition of such material shall be a matter for agreement between the manufacturer and the purchaser.

18. Certification

18.1 A test report, signed by an authorized employee or representative of the manufacturer, shall be furnished to the purchaser to indicate the specification and grade, the results of the heat analysis, hardness and tensile properties. Product analysis will be reported only when requested on the purchase order as provided in 4.1.7.

19. Product Marking

19.1 All tubes shall be marked with the heat number.

19.2 Containers and packages shall be marked or tagged to show the purchaser's order number, the manufacturer's order number, specification, grade, size and gage of tubing, number of pieces contained in the package, and item number (if appropriate).

20. Packaging

20.1 All tubing shall be packaged and blocked in such a manner as to prevent damage in ordinary handling and transportation. The boxes shall be constructed in such a manner that no nails, staples, screws, or similar fasteners are required to close and secure the box after the tubes have been placed in the box. The box shall be lined with plastic sheet or vapor barrier materials so as to prevent chloride contamination of the tube during handling, transportation, and storage.

20.2 The U-bent tubes shall be arranged in boxes so that the smaller radius bends may be removed without disturbing larger radius bends. Tubes for an item number shall be boxed together.

21. Keywords

21.1 austenitic stainless steel; feedwater heater tubes; stainless steel tube; steel tube; welded steel tube

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement or requirements may become a part of the specification when specified in the inquiry or invitation to bid, and purchase order or contract. These requirements shall not be considered, unless specified in the order, in which event the necessary tests shall be made by the manufacturer prior to the bending or shipment of the tubing.

S1. Nondestructive Eddy-Current Test

S1.1 Each tube in the finished condition, except for bending if that is required, shall be tested by passing it through an electric nondestructive tester capable of detecting defects on the entire cross section of the tube. Suitable instrumentation shall be used to clearly distinguish the artificial defects. The outside and inside surfaces of the tubes shall be free of loose scale, metallic particles, or other material which would tend to restrict signals or create electrical noise. The tubing shall be inspected by feeding it longitudinally through an inspection coil or coils with a diameter suitable for the diameter of tubing to be inspected. The instrument calibration shall be accomplished with a reference standard prepared from an appropriate length of selected tubing of the same size, grade, and physical condition as the material to be inspected. The standard shall be fed through the coil at the same speed at which the inspection of the tubing is performed.

S1.2 The factors listed in S1.3 shall be selected or adjusted, or both, in accordance with the instrument manufacturer's instructions, for the particular instrument involved as required to achieve optimum instrument distinction between the reference defects and plain portions of the tube.

S1.3 The following as well as other factors involved shall not be used in such a manner that they detract from the overall ability of the instrument to detect defects: test frequency, direct-current saturation level, filter networks, phase-analysis circuits, coil diameter, and instrument gain.

S1.4 The reference standard shall consist of a defect-free sample of the same size, alloy, and condition (temper) as that being tested, and shall contain longitudinal and circumferential

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notches on the outside diameter establishing the rejection level of the tubing to be tested. Inside diameter notches, both longitudinal and transverse, shall also be a part of the reference standard. These inside notches may be larger than the outside notches, and are intended for use only to assure instrument phase settings capable of yielding optimum inside surface sensitivity.

S1.4.1 All notches shall be produced by EDM methods. The outside diameter notches shall be of the dimensions shown in Table S1.1 and Fig. S1.1.

S1.5 All tubing shall meet this specification. The instrument calibration shall be verified at the start of testing, after any shut down of the test equipment, after any test equipment adjustment, or at least every ½ h of continuous production testing or both. Tubes generating a signal above the outside diameter calibration standard sensitivity level shall be rejected.

S1.6 Tubes may be reconditioned and retested provided reconditioning does not adversely effect the minimum wall thickness or other properties of the tube specification requirements. Upon agreement between purchaser and manufacturer, the referee method, employing ultrasonic testing, may be employed for retesting tubes rejected by the eddy-current test. The calibration standard for this test shall be identical to that required for the eddy-current test.

S2. Nondestructive Eddy-Current Testing (Select Commercial Grade)

S2.1 The manufacturer shall test the tubing using the procedure outlined in Supplementary Requirement S1, except for the notch standards, which shall be as indicated in Table S2.1.

TABLE S1.1 Notch Depth

OD, in. [mm]	Wall, in. [mm]	Depth,[A] in. [mm]	Length, max, in. [mm]	Width, max
⅝ to 1 [15.9 to 25.4], incl	0.028 [0.7] and heavier	0.0045 [0.11] or 10 % of wall thickness whichever is greater	0.375 [9.5]	wall thickness but not greater than 0.062 in. [1.6 mm]

[A] The tolerance of notch depth shall be ± 8 % or ± 0.0005 in. [0.01 mm], whichever is greater. Refer to Fig. S1.1 for notch location orientation and length of calibration standard.

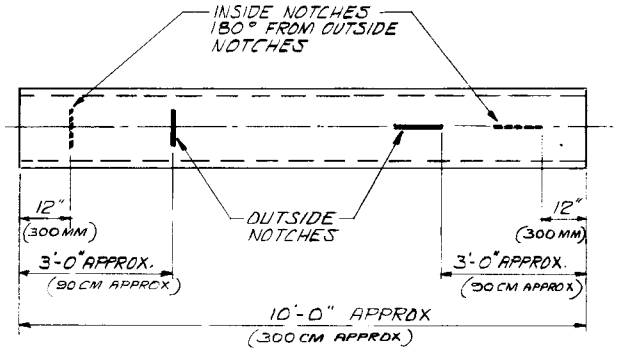


FIG. S1.1 Eddy-Current Test Standard

TABLE S2.1 Notch Depth for Select Commercial Grade

OD, in. [mm]	Wall, in. [mm]	Depth,[A] in. [mm]	Length, max, in. [mm]	Width, max
⅝ to 1 [15.9 to 25.4], incl	0.035 [0.9] and heavier	0.0045 [0.11] or 10 % of wall thickness, whichever is greater	0.375 [9.5]	3 times notch depth
⅝ to 1 [15.9 to 25.4], incl	less than 0.035 [0.9]	0.0045 [0.11] or 10 % of wall thickness, whichever is greater	0.375 [9.5]	wall thickness

[A] The tolerance of notch depth shall be ± 8 % or ± 0.0005 in. [0.1 mm], whichever is greater. Refer to Fig. S1.1 for notch location orientation and length of calibration standard.

S3. Report

S3.1 A report shall be furnished by the manufacturer to include a record of all tests performed to qualify material to this specification. This record shall include numbers of tests performed and qualitative or quantitative results as is applicable.

S4. Intergranular Corrosion Tests

S4.1 When specified, material shall pass intergranular corrosion tests conducted by the manufacturer in accordance with Practices A 262, Practice E.

NOTE S4.1—Practice E requires testing on the sensitized condition for low carbon grades, and on the as-shipped condition for other grades.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 688/A 688M – 07, which may impact the use of this specification. (Approved March 1, 2008)

(*1*) Added notch tolerances to Table S2.1.

(*2*) Moved lot definitions from notes to the body of the specification.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 688/A 688M – 04, which may impact the use of this specification. (Approved November 1, 2007)

(*1*) Revised hardness maximum of N08367 from B90 to B100 in 11.2.1.

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