Designation: ~~A554 – 14~~ A554 – 15

Standard Specification for Welded Stainless Steel Mechanical Tubing[1]

This standard is issued under the fixed designation A554; 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 covers welded austenitic and ferritic stainless steel mechanical tubing intended for use in ornamental, structural, exhaust, and other applications where appearance, mechanical properties, or corrosion resistance is needed. The grades covered are listed in Table 1.

1.2 This specification covers as-welded or cold-reduced mechanical tubing in sizes to 16 in. (406.4 mm) outside dimension, and in wall thicknesses 0.020 in. (0.51 mm) and over.

1.3 Tubes shall be furnished in one of the following shapes as specified by the purchaser: round, square, rectangular, or special.

1.4 Supplementary requirements of an optional nature are provided and when desired shall be so stated in the order.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A790/A790M Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
2.2 *Military Standards:*
MIL-STD-129 Marking for Shipment and Storage[3]
MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage[3]
2.3 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)[3]
2.4 *SAE Standard:*
SAE J 1086 Numbering Metals and Alloys[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A941.

4. Ordering Information

4.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:
4.1.1 Quantity (feet, mass, or number of pieces),
4.1.2 Name of material (welded stainless steel mechanical tubing),
4.1.3 Form (round, square, rectangular, special, see 1.3),

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[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 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.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

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

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

TABLE 1 Chemical Requirements

UNS #	Grade	Composition, %										
		~~Carbon, max~~	Manganese, ~~max~~	~~Phosphorus, max~~	~~Sulfur, max~~	~~Silicon, max~~	Nickel	Chromium	Molybdenum	Titanium	Columbium ~~+ Tantalum~~	Nitrogen
					Austenitic							
	MT-301	0.15	2.00	0.045	0.030	1.00	6.0–8.0	16.0–18.0	...	...	...	
	MT-302	0.15	2.00	0.045	0.030	1.00	8.0–10.0	17.0–19.0	...	...	...	
	MT-304	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...	
	~~MT-304L~~	~~0.035~~[A]	~~2.00~~	~~0.045~~	~~0.030~~	~~1.00~~	~~8.0–13.0~~	~~18.0–20.0~~	~~...~~	~~...~~	~~...~~	
	MT-305	0.12	2.00	0.045	0.030	1.00	10.0–13.0	17.0–19.0	...	...	...	
	MT-309S	0.08	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	...	...	. . .	
	~~MT-309S-Cb~~	~~0.08~~	~~2.00~~	~~0.045~~	~~0.030~~	~~1.00~~	~~12.0–15.0~~	~~22.0–24.0~~	~~...~~	~~...~~	[B]	
	MT-310S	0.08	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0	...	...	...	
	MT-316	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.0–3.0	...	...	
	~~MT-316L~~	~~0.035~~[A]	~~2.00~~	~~0.045~~	~~0.030~~	~~1.00~~	~~10.0–15.0~~	~~16.0–18.0~~	~~2.0–3.0~~	~~...~~	~~...~~	
	MT-317	0.08	2.00	0.045	0.030	1.00	11.0–14.0	18.0–20.0	3.0–4.0	...	...	
	~~MT-321~~	~~0.08~~	~~2.00~~	~~0.045~~	~~0.030~~	~~1.00~~	~~9.0–13.0~~	~~17.0–20.0~~	~~...~~	[C]	~~...~~	
	MT-330	0.15	2.00	0.040	0.030	1.00	33.0–36.0	14.0–16.0	...	...	...	
	~~MT-347~~	~~0.08~~	~~2.00~~	~~0.045~~	~~0.030~~	~~1.00~~	~~9.0–13.0~~	~~17.0–20.0~~	~~...~~	~~...~~	[B]	
					Ferritic							
	MT-429	0.12	1.00	0.040	0.030	1.00	0.50 max	14.0–16.0	...	...	...	
	MT-430	0.12	1.00	0.040	0.030	1.00	0.50 max	16.0–18.0	...	...	...	
	MT-430-Ti	0.10	1.00	0.040	0.030	1.00	0.075 max	16.0–19.5	...	5 × C min, 0.75 max	...	
~~S40900~~	~~409~~[D]											
S40910		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	Ti 6X (C+N) min, 0.050 max	Cb 0.17	0.030
S40920		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	Ti 8X (C+N) min, Ti 0.15–0.50	Cb 0.10	0.030
S40930		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	(Ti+Cb) [0.08+8 × (C+N)] min, 0.75 max; Ti 0.05 min	...	0.030
S43400	434	0.120	1.00	0.040	0.030	1.00	...	16.0–18.0	0.75–1.25	...	...	...
S43600	436	0.120	1.00	0.040	0.030	1.00	...	16.0–18.0	0.75–1.25	...	Cb 5 × C min 0.080 max	...
S43035	439	0.030	1.00	0.040	0.030	1.00	0.50	17.0–19.0	...	Ti [0.20+4(C+N)] min, 1.10 max; Al 0.015	...	0.030
~~S41003~~	[E]	~~0.030~~	~~1.50~~	~~0.040~~	~~0.030~~	~~1.00~~	~~1.50~~	~~10.5–12.5~~	~~...~~	~~...~~	~~...~~	~~0.030~~
S44400	444	0.025	1.00	0.040	0.030	1.00	1.00	17.5–19.5	1.75–2.50	(Ti+Cb) [0.20+4(C+N)] min 0.80 max		0.035
S41008	410S	0.080	1.00	0.040	0.030	1.00	0.60	11.5–13.5	...	...	...	...
~~S44100~~	[F]	~~0.030~~	~~1.00~~	~~0.040~~	~~0.030~~	~~1.00~~	~~1.00~~	~~17.5–19.5~~	~~...~~	~~0.1–0.5~~	~~Cb 0.3+ (9× C) min, 0.9 max~~	~~...~~

TABLE 1 Chemical Requirements[A]

UNS #[J]	Grade	Composition, %												
		Carbon	Manganese,	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Titanium	Columbium	Nitrogen	Copper	Other
						Austenitic								
	MT-301	0.15	2.00	0.045	0.030	1.00	6.0–8.0	16.0–18.0	...	...	...			
	MT-302	0.15	2.00	0.045	0.030	1.00	8.0–10.0	17.0–19.0	...	...	...			
	MT-304	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...			
	MT-304L	0.035[B]	2.00	0.045	0.030	1.00	8.0–13.0	18.0–20.0	...	...	...			
	MT-305	0.12	2.00	0.045	0.030	1.00	10.0–13.0	17.0–19.0	...	...	...			
	MT-309S	0.08	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	...	...	. . .			
	MT-309S-Cb	0.08	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	...	...	[C]			
	MT-310S	0.08	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0	...	...	...			
	MT-316	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.0–3.0	...	...			
	MT-316L	0.035[B]	2.00	0.045	0.030	1.00	10.0–15.0	16.0–18.0	2.0–3.0	...	...			
	MT-317	0.08	2.00	0.045	0.030	1.00	11.0–14.0	18.0–20.0	3.0–4.0	...	...			
	MT-321	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	[D]	...			
	MT-330	0.15	2.00	0.040	0.030	1.00	33.0–36.0	14.0–16.0	...	...	...			
	MT-347	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	...	[C]			
						Ferritic								
	MT-429	0.12	1.00	0.040	0.030	1.00	0.50 max	14.0–16.0	...	...	...			
	MT-430	0.12	1.00	0.040	0.030	1.00	0.50 max	16.0–18.0	...	...	...			
	MT-430-Ti	0.10	1.00	0.040	0.030	1.00	0.075 max	16.0–19.5	...	5 × C min, 0.75 max	...			
S40900	409[E]													
S40910		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	Ti 6X (C+N) min, 0.050 max	Cb 0.17	0.030		
S40920		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	Ti 8X (C+N) min, Ti 0.15–0.50	Cb 0.10	0.030		
S40930		0.030	1.00	0.040	0.020	1.00	0.50	10.5–11.7	...	(Ti+Cb) [0.08+8 × (C+N)] min, 0.75 max; Ti 0.05 min	...	0.030		
S43400	434	0.120	1.00	0.040	0.030	1.00	...	16.0–18.0	0.75–1.25	...	...	...		
S43600	436	0.120	1.00	0.040	0.030	1.00	...	16.0–18.0	0.75–1.25	...	Cb 5 × C min 0.080 max	...		
S43035	439	0.030	1.00	0.040	0.030	1.00	0.50	17.0–19.0	...	Ti [0.20+4(C+N)] min, 1.10 max; Al 0.015	...	0.030		
S41003	[F]	0.030	1.50	0.040	0.030	1.00	1.50	10.5–12.5	...	...	...	0.030		
S44400	444	0.025	1.00	0.040	0.030	1.00	1.00	17.5–19.5	1.75–2.50	(Ti+Cb) [0.20+4(C+N)] min 0.80 max		0.035		
S41008	410S	0.080	1.00	0.040	0.030	1.00	0.60	11.5–13.5	...	...	...	...		
S44100	[G]	0.030	1.00	0.040	0.030	1.00	1.00	17.5–19.5	...	0.1–0.5	Cb 0.3+ (9× C) min, 0.9 max	...		
						Austenitic-Ferritic								
S31803		0.030	2.00	0.030	0.020	1.00	4.5–6.5	21.0–23.0	2.5–3.5	...	...	0.08–0.20	...	...
S32003		0.030	2.00	0.030	0.020	1.00	3.0–4.0	19.5–22.5	1.50–2.00	...	...	0.14–0.20	...	...
S32101		0.040	4.0–6.0	0.040	0.030	1.00	1.35–1.70	21.0–22.0	0.10–0.80	...	...	0.20–0.25	0.10–0.80	...
S32202		0.030	2.00	0.040	0.010	1.00	1.00–2.80	21.5–24.0	0.45 max	...	...	0.18–0.26	...	...
S32205	2205[K]	0.030	2.00	0.030	0.020	1.00	4.5–6.5	22.0–23.0	3.0–3.5	...	...	0.14–0.20	...	...

TABLE 1 *Continued*

UNS #[J]	Grade	Composition, %												
		Carbon	Manganese,	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Titanium	Columbium	Nitrogen	Copper	Other
S32304	2304[K]	0.030	2.50	0.040	0.040	1.00	3.0–5.5	21.5–24.5	0.05–0.60	...	...	0.05–0.20	0.05–0.60	...
S32550	255[K]	0.04	1.50	0.040	0.030	1.00	4.5–6.5	24.0–27.0	2.9–3.9	...	...	0.10–0.25	1.50–2.50	...
S32750[H]	2507[K]	0.030	1.20	0.035	0.020	0.80	6.0–8.0	24.0–26.0	3.0–5.0	...	...	0.24–0.32	0.5	...
S32760[I]		0.030	1.00	0.030	0.010	1.00	6.0–8.0	24.0–26.0	3.0–4.0	...	...	0.20–0.30	0.50–1.00	W 0.50–1.00
S81921		0.030	2.00–4.00	0.040	0.030	1.00	2.00–4.00	19.0–22.0	1.00–2.00	...	...	0.14–0.20	...	...
S82011		0.030	2.0–3.0	0.040	0.020	1.00	1.00–2.00	20.5–23.5	0.10–1.00	...	...	0.15–0.27	0.50	...
S82441		0.030	2.5–4.0	0.035	0.005	0.70	3.0–4.5	23.0–25.0	1.00–2.00	...	...	0.20–0.30	0.10–0.80	...

[A] Maximum, unless a range or minimum is indicated. Where ellipses (...) appear in this table, there is no minimum and analysis for the element need not be determined or reported.

[B] For small diameter or thin walls, or both, where many drawing passes are required, a carbon content of 0.040 % max is necessary in grades MT-304L and MT-316L. Small outside diameter tubes are defined as those less than 0.500 in. (12.7 mm) in outside diameter and light wall tubes as those less than 0.049 in. (1.24 mm) in average wall thickness.

[C] The columbium ~~plus tantalum~~ content shall be not less than ten times the carbon content and not more than 1.00 %.

[D] The titanium content shall be not less than five times the carbon content and not more than 0.60 %.

[E] S40900 (Type 409) has been replaced by S40910, S40920, and S40930. Unless otherwise specified in the ordering information, an order specifying S40900 or Type 409, shall be satisfied by any one of S40910, S40920, or S40930 at the option of the seller. Material meeting the requirements of S40910, S40920, or S40930 may, by agreement between purchaser and manufacturer, be certified as S40900.

[F] S41003 chemical composition relates to Type 412, which is not currently an AISI or SAE number.

[G] S44100 chemical composition relates to Type 441, which is not currently an AISI or SAE number.

[H] % Cr + 3.3 × %Mo + 16 × %N = 41 min.

[I] % Cr + 3.3 × %Mo + 16 × %N = 40 min.

[J] Designation established in accordance with Practice E527 and SAE J 1086.

[K] Common name, not a trademark, widely used, not associated with any one producer.

4.1.4 Dimensions:
4.1.4.1 Round-outside diameter and wall thickness for all conditions (Section 9). Alternatively, for cold-reduced condition, outside diameter and inside diameter or inside diameter and wall dimensions may be specified,
4.1.4.2 Square and rectangular outside dimensions and wall thickness (see 10.1),
4.1.4.3 Special (to be specified),
4.1.5 Length (mill lengths, cut lengths, or multiple lengths (see 9.3)),
4.1.6 Grade (Table 1),
4.1.7 Condition (see 7.1),
4.1.8 Inside diameter bead condition (see 7.2),
4.1.9 Surface finish (see Section 12),
4.1.10 Report of chemical analysis, if required (Section 8),
4.1.11 Individual supplementary requirements, if required,
4.1.12 End use,
4.1.13 Specification designation,
4.1.14 Special requirements,
4.1.15 Special marking (Section 15), and
4.1.16 Special packing (Section 16).

5. Process

5.1 The steel may be made by any process.

5.2 If a specific type of melting is required by the purchaser, it shall be stated on the purchase order.

5.3 The primary melting may incorporate separate degassing or refining and may be followed by secondary melting, such as electroslag remelting or vacuum-arc remelting. If secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

5.4 Steel may be cast in ingots or may be strand cast. When steel of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by an established procedure that positively separates the grades.

6. Materials and Manufacture

6.1 The tubes shall be made from flat-rolled steel by an automatic welding process without the addition of filler metal.

7. Condition

7.1 The tubes shall be furnished in any of the following conditions as specified:
7.1.1 As welded,
7.1.2 Welded and annealed,
7.1.3 Cold reduced,
7.1.4 Cold reduced and annealed.

7.2 The inside diameter bead shall be furnished in any of the following conditions as specified:
7.2.1 Bead not removed,
7.2.2 Bead controlled to 0.005 in. (0.13 mm) or 15 % of the specified wall thickness, whichever is greater, and
7.2.3 Bead removed.

7.3 Square and rectangular welded stainless tubing is supplied as cold worked unless otherwise specified.

8. Heat Analysis

8.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified. If secondary melting processes are employed, the heat analysis shall be obtained from one remelted ingot or the product of one remelted ingot of each primary melt. The chemical composition thus determined, or that determined from a product analysis made by the tubular product manufacturer, shall conform to requirements specified. When requested in the order or contract, a report of this analysis shall be furnished to the purchaser. (See Test Methods, Practices, and Terminology A751.)

9. Permissible Variations in Dimensions—Round Tubing

9.1 For all conditions except tubing with bead removed, Table 2 shall apply.

9.2 For tubing with bead removed, Table 3 shall apply.

9.3 *Lengths*—Tubing is normally furnished in mill lengths 5 ft (1.5 m) and over. Definite cut lengths are furnished when specified, to the length tolerances shown in Table 4. For tubing ordered in multiple lengths, it is common practice to allow a definite amount over for each multiple for the purchaser's cutting operation. Thus cutting allowance should be specified in the purchase order.

TABLE 2 Diameter, Wall,[A] and Ovality Tolerances (All Conditions Except Tubing with Bead Removed)

NOTE 1—Ovality is the difference between maximum and minimum outside diameters measured at any one cross section. There is no additional tolerance for ovality on tubes having a specified wall thickness of more than 3 % of the outside diameter.

NOTE 2—For sizes up to and including 5-in. (127.0-mm) outside diameter, an ovality tolerance of twice the tabular outside diameter tolerance spread shown is applied one half plus and one half minus to tubes having a specified wall thickness of 3 % or less of the specified outside diameter. The average of the maximum and minimum outside diameter readings should fall within the outside diameter tolerances as shown in this table.

NOTE 3—For sizes over 5-in. (127.0-mm) to and including 16-in. (406.4-mm) outside diameter, when the specified wall thickness is 3 % or less of the outside diameter, the ovality shall not exceed 1.5 % of the specified outside diameter.

OD Size, in. (mm)	Wall Thickness		OD, ±	
	in.	mm	in.	mm
Under ½ (12.7)	0.020 to 0.049	0.51 to 1.24	0.004	0.10
½ to 1 (12.7 to 25.4)	0.020 to 0.065	0.51 to 1.65	0.005	0.13
½ to 1 (12.7 to 25.4)	over 0.065 to 0.134	over 1.65 to 3.40	0.010	0.25
Over 1 to 1 ½ (25.4 to 38.1), incl	0.025 to 0.065	0.64 to 1.65	0.008	0.20
Over 1 to 1 ½ (25.4 to 38.1), incl	over 0.065 to 0.134	over 1.65 to 3.40	0.010	0.25
Over 1 ½ to 2 (38.1 to 50.8), incl	0.025 to 0.049	0.64 to 1.24	0.010	0.25
Over 1 ½ to 2 (38.1 to 50.8), incl	over 0.049 to 0.083	over 1.24 to 2.11	0.011	0.28
Over 1 ½ to 2 (38.1 to 50.8), incl	over 0.083 to 0.149	over 2.11 to 3.78	0.012	0.30
Over 2 to 2 ½ (50.8 to 63.5), incl	0.032 to 0.065	0.81 to 1.65	0.012	0.30
Over 2 to 2 ½ (50.8 to 63.5), incl	over 0.065 to 0.109	over 1.65 to 2.77	0.013	0.33
Over 2 to 2 ½ (50.8 to 63.5), incl	over 0.109 to 0.165	over 2.77 to 4.19	0.014	0.36
Over 2 ½ to 3 ½ (63.5 to 88.9), incl	0.032 to 0.165	0.81 to 4.19	0.014	0.36
Over 2 ½ to 3 ½ (63.5 to 88.9), incl	over 0.165	over 4.19	0.020	0.51
Over 3 ½ to 5 (88.9 to 127.0), incl	0.035 to 0.165	0.89 to 4.19	0.020	0.51
Over 3 ½ to 5 (88.9 to 127.0), incl	over 0.165	over 4.19	0.025	0.64
Over 5 to 7 ½ (127.0 to 190.5), incl	0.049 to 0.250	1.24 to 6.35	0.025	0.64
Over 5 to 7 ½ (127.0 to 190.5), incl	over 0.250	over 6.35	0.030	0.76
Over 7 ½ to 16 (190.5 to 406.4), incl	all	all	0.00125 in./in. or mm/mm of circumference	

[A] Wall tolerance ±10 % of specified wall thickness.

TABLE 3 Diameter, Wall,[A] and Ovality Tolerances for Tubing with Bead Removed

NOTE 1—Ovality is the difference between maximum and minimum outside diameters measured at any one cross section. There is no additional tolerance for ovality on tubes having a specified wall thickness of more than 3 % of the outside diameter.

NOTE 2—An ovality allowance of twice the outside diameter tolerance, shown in this table, is applied one half plus and one half minus to the outside diameter, for tubes having a specified wall thickness of 3 % or less of the specified outside diameter. The average of the maximum and minimum outside diameter readings should fall within the outside diameter tolerances of this table.

NOTE 3—Tubing may be specified to only two of the three following dimensions—outside diameter, inside diameter, or wall.

OD Size, in. (mm)	OD, ±		ID, ±	
	in.	mm	in.	mm
Up to 3/32 (2.4), excl	0.001	0.03	0.001	0.03
3/32 to 3/16 (2.4 to 4.8), excl	0.0015	0.038	0.0015	0.038
3/16 to ½ (4.8 to 12.7), excl	0.003	0.08	0.005	0.13
½ to 1 (12.7 to 25.4), excl	0.004	0.10	0.006	0.15
1 to 1½ (25.4 to 38.1), excl	0.005	0.13	0.007	0.18
1 ½ to 2 (38.1 to 50.8), excl	0.006	0.15	0.008	0.20
2 to 2 ½ (50.8 to 63.5), excl	0.007	0.18	0.010	0.25
2 ½ to 3 ½ (63.5 to 88.9), excl	0.010	0.25	0.014	0.36
3 ½ to 5 (88.9 to 127.0), incl	0.015	0.38	0.020	0.51
Over 5 to 16 (127.0 to 406.4), incl	0.00125 in./in. or mm/mm of circumference		0.0013 in./in. or mm/mm of circumference	

[A] Wall tolerance is ±10 % of specified wall thickness.