

# **ASTM - A479/A479M**

## **SPECIFICATION FOR STAINLESS STEEL BARS AND SHAPES FOR USE IN BOILERS AND OTHER PRESSURE VESSELS**

This specification covers hot- and cold-finished bars of stainless steel, including rounds, squares, and hexagons, and hot-rolled or extruded shapes such as angles, tees, and channels for use in boiler and pressure vessel construction.

### **A. Heat Treatment :-**

1. The heat treatments shown in this section are to be followed unless otherwise specified in the applicable product specification.
2. Austenitic Grades:
  - i. Except for strain-hardened grades, hot rolled grades, and UNS N08020, all austenitic stainless steels shall be furnished in the solution annealed condition in accordance with Table 1, with subsequent light cold drawing for cold finishing and straightening permitted.
  - ii. Except as indicated in Table 1, the austenitic grades shall be annealed, at the option of the manufacturer, by a separate annealing treatment or by process annealing.
    - a. The separate annealing treatment shall consist of heating the material to the minimum annealing temperature for the grade as listed in Table 1, holding for a sufficient time to permit grain boundary carbides to enter into solution, and cooling rapidly enough to prevent unacceptable grain boundary carbide precipitation.
    - b. Process annealing shall consist of completing hot working above the minimum annealing temperature required for each grade as indicated in Table 1, and cooling rapidly enough to prevent unacceptable grain boundary carbide precipitation.
  - iii. For the stabilized grades, Types 321, 321H, 347, 347H, 348, and 348H, the manufacturer is permitted, if necessary, to use a lower temperature resolution anneal or a stabilization anneal after a high temperature anneal in order to maximize resistance to intergranular corrosion.
  - iv. Strain-Hardened Austenitic Grades :- When a particular austenitic grade is desired with increased mechanical properties, the purchaser is permitted to specify a strain hardened condition. This condition is produced by solution annealing the product in accordance with point A.2.i, followed by strain hardening sufficient to meet the required mechanical properties.
  - v. Hot-Rolled Austenitic Grades :- Individual product specifications are permitted to define requirements for particular hot-rolled austenitic grades without annealing.
  - vi. Except when strain-hardened, UNS N08020 shall be furnished in the stabilized annealed condition in accordance with Table 1, with subsequent light cold drawing for cold finishing and straightening permitted.
3. Austenitic-Ferritic (Duplex) Grades:
  - i. The austenitic-ferritic (duplex) grades shall be furnished in the solution annealed condition in accordance with Table 1, with subsequent light cold drawing for cold finishing and straightening permitted.

- ii. Except as indicated in Table 1, the duplex grades shall be annealed, at the option of the manufacturer, by a separate annealing treatment or by process annealing.
4. Ferritic Grades:
- i. Ferritic grades shall be annealed to meet their respective mechanical testing requirements as shown in the applicable product specification.
5. Martensitic Grades:
- i. All martensitic grades shall be supplied in either the annealed condition or in the tempered condition as specified by the purchaser. Tempered material shall be normalized, or shall be liquid quenched from 1700°F [925°C], minimum, followed by tempering in accordance with point A.5.ii, point A.5.iii or point A.5.iv.
  - ii. Types 403 and 410 tempered material shall be held at the tempering temperature for at least 1 h/in. (25.4 mm) of cross section as follows:
    - Condition 1—1250°F [675°C] minimum, 1400°F [760°C] maximum.
    - Condition 2—1100°F [595°C] minimum, 1400°F [760°C] maximum.
    - Condition 3—1050°F [565°C] minimum, 1400°F [760°C] maximum.
  - iii. Types XM-30, 414, and 431 tempered materials shall be held at 1100°F [595°C], minimum for at least 1 h/in. [25 mm] of cross section. Maximum tempering temperature shall be 1400°F [760°C].
  - iv. S41500 shall be heated to 1750°F [955°C] minimum, air cooled to 200°F [95°C] or lower prior to any optional intermediate temper and prior to the final temper. The final temper shall be between 1050°F [565°C] and 1150°F [620°C].

**Table 1**

Designation/Type	Temperature <sup>A</sup>	Cooling/Testing Requirements	Permitted Annealing <sup>B</sup>	
			Separate	Process
Austenitic (Chromium-Nickel) (Chromium-Nickel-Manganese)				
All austenitic grades except as listed below	1900°F [1040°C]	C	x	x <sup>D</sup>
All Cr-Ni-Mn grades, 302, S30215, S30452, S30600, S30615, 308, S30815, S30880, 309, 309S, 310, 310S, 314, 317, S31725, S31726, S32615, S38100	1900°F [1040°C]	E	x	x <sup>D</sup>
309Cb, 310Cb, 316Cb, 316Ti, 321, 347, 348	1900°F [1040°C]	E	x	
304H, 309H, 310H, 316H	1900°F [1040°C]	E	x	
321H, 347H, 348H :				
Hot-worked	1925°F [1050°C]	E	x	

Cold-worked	2000°F [1095°C]	E	x	
S32100	1900°F [1040°C]	E	x	x <sup>F</sup>
S31254, S32050	2100°F [1150°C]	E	x	
S31727, S32053	1975° to 2155°F [1080° to 1180°C]	E	x	
S33228	2050° to 2140°F [1120° to 1170°C]	E	x	
S34565	2050° to 2140°F [1120° to 1170°C]	E	x	
S35315	2010°F [1100°C]	E	x	
N08367	2025°F [1105°C]	E	x	
N08700	2000°F [1095°C]	E	x	
N08020	1700 to 1850°F [930 to 1010°C]	E	x	
N08810	2050°F [1120°C]	E	x	
N08811	2100°F [1150°C]	E	x	
N08904	2000°F [1095°C]	E	x	
N08925, N08926	2010 to 2100°F [1100 to 1150°C]	E	x	
Austenitic-Ferritic (Duplex)				
S31803	1900°F [1040°C]	E	x	x <sup>F</sup>
S32101	1870°F [1020°C]	E	x	x <sup>F</sup>
S32202	1800 to 1975°F [980 to 1080°C]	E	x	x <sup>F</sup>
S32205	1900°F [1040°C]	G	x	x <sup>F</sup>
S32506	1870° to 2050°F [1020° to 1120°C]	E	x	x <sup>F</sup>
S32550	1900°F [1040°C]	E	x	x <sup>F</sup>
S82441	1830°F [1000°C]	E	x	x <sup>F</sup>
S32760	2010°F [1100°C]	E	x	x <sup>F</sup>
S32906	1830° to 2100°F [1000° to 1150°C]	E	x	x <sup>F</sup>
S32950	1850°±25°F [1010°±15°C]	E	x	x <sup>F</sup>

<sup>A</sup> Minimum annealing temperature unless otherwise specified.

<sup>B</sup> Permitted annealing procedure, see point A.2.ii.

<sup>C</sup> Quenched in water or rapidly cooled by other means at a rate sufficient to prevent reprecipitation of carbides, as demonstrable by the capability of passing Practice E of Practices A262. Performance of the test is not required unless specified in the purchase order.

<sup>D</sup> Minimum temperature at which hot rolling is completed shall be 1850°F [1010°C].

<sup>E</sup> Quenched in water or rapidly cooled by other means.

<sup>F</sup> Minimum temperature at which hot rolling is completed shall be the minimum temperature for separate annealing. <sup>G</sup> Quenched in water.

## B. Chemical Composition :-

1. Chemical composition shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in Table 2.

**Table 2<sup>B</sup>**

UNS Designation <sup>A</sup>	Type	C	Mn	P	S	Si	Cr	Ni	N	Mo	Other Elements <sup>C</sup>
Austenitic Grades											
N08020	Alloy 20	0.07	2	0.045	0.035	1	19.0–21.0	32.0–38.0	...	2.00–3.00	Cu 3.0–4.0; Cb 8xC–1.00
N08367	...	0.03	2	0.04	0.03	1	20.0–22.0	23.5–25.5	0.18–0.25	6.0–7.0	Cu 0.75
N08800	800	0.1	1.5	0.045	0.015	1	19.0–23.0	30.0–35.0	...	...	Fe <sup>J</sup> 39.5 min.; Cu 0.75 Al 0.15–0.60; Ti 0.15–0.60
N08810	800H	0.05–0.10	1.5	0.045	0.015	1	19.0–23.0	30.0–35.0	...	...	Fe <sup>J</sup> 39.5 min.; Cu 0.75; Al 0.15–0.60; Ti 0.15–0.60
N08811	...	0.06–0.10	1.5	0.045	0.015	1	19.0–23.0	30.0–35.0	...	...	Fe <sup>J</sup> 39.5 min.; Cu 0.75; Al <sup>K</sup> 0.25–0.60; Ti <sup>K</sup> 0.25–0.60
N08700	...	0.04	2	0.04	0.03	1	19.0–23.0	24.0–26.0	...	4.3–5.0	Cu 0.50; Cb [8xC–0.40]
N08904	904L	0.02	2	0.045	0.035	1	19.0–23.0	23.0–28.0	0.1	4.0–5.0	Cu 1.0–2.0
N08925	...	0.02	1	0.045	0.03	0.5	19.0–21.0	24.0–26.0	0.10–0.20	6.0–7.0	Cu 0.80–1.50
N08926	...	0.02	2	0.03	0.01	0.5	19.0–21.0	24.0–26.0	0.15–0.25	6.0–7.0	Cu 0.50–1.50
S20161	...	0.15	4.0–6.0	0.045	0.03	3.0–4.0	15.0–18.0	4.0–6.0	0.08–0.20	...	...
S20910	XM-19	0.06	4.0–6.0	0.045	0.03	1	20.5–23.5	11.5–13.5	0.20–0.40	1.50–3.00	Cb 0.10–0.30; V 0.10–0.30

S21600	XM-17	0.08	7.5–9.0	0.045	0.03	1	17.5–20.5	5.0–7.0	0.25–0.50	2.00–3.00	...
S21603	XM-18	0.03	7.5–9.0	0.045	0.03	1	17.5–20.5	5.0–7.0	0.25–0.50	2.00–3.00	...
S21800	...	0.1	7.0–9.0	0.06	0.03	3.5–4.5	16.0–18.0	8.0–9.0	0.08–0.18	...	...
S21904	XM-11	0.04	8.0–10.0	0.045	0.03	1	19.0–21.5	5.5–7.5	0.15–0.40		
S24000	XM-29	0.08	11.5–14.5	0.06	0.03	1	17.0–19.0	2.3–3.7	0.20–0.40	...	...
S30200	302	0.15	2	0.045	0.03	1	17.0–19.0	8.0–10.0	0.1	...	...
S30400	304	0.08 <sup>D</sup>	2	0.045	0.03	1	18.0–20.0	8.0–10.5	...	...	...
S30403	304L	0.03	2	0.045	0.03	1	18.0–20.0	8.0–12.0	...	...	...
S30409	304H	0.04–0.10	2	0.045	0.03	1	18.0–20.0	8.0–10.5	...	...	...
S30451	304N	0.08	2	0.045	0.03	1	18.0–20.0	8.0–12.0	0.10–0.16	...	...
S30453	304LN	0.03	2	0.045	0.03	1	18.0–20.0	8.0–11.0	0.10–0.16	...	...

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S30600	...	0.018	2	0.02	0.02	3.7–4.3	17.0–18.5	14.0–15.5		0.2	Cu 0.50
S30815	...	0.05–0.10	0.8	0.04	0.03	1.4–2.0	20.0–22.0	10.0–12.0	0.14–0.20	...	Ce 0.03–0.08
S30908	309S	0.08	2	0.045	0.03	1	22.0–24.0	12.0–15.0	...	...	...
S30909	309H	0.04–0.10	2	0.045	0.03	1	22.0–24.0	12.0–15.0	...	...	...
S30940	309Cb	0.08	2	0.045	0.03	1	22.0–24.0	12.0–16.0	...	...	Cb [10×C- 1.10]
S30880	ER308 <sup>E</sup>	0.08	1.00–2.50	0.03	0.03	0.25–0.6	19.5–22.0	9.0–11.0	...	...	...
S31008	310S	0.08	2	0.045	0.03	1	24.0–26.0	19.0–22.0	...	...	...
S31009	310H	0.04–0.10	2	0.045	0.03	1	24.0–26.0	19.0–22.0	...	...	...
S31040	310Cb	0.08	2	0.045	0.03	1	24.0–26.0	19.0–22.0	...	...	Cb [10×C-1.10]
S31050	...	0.025	2	0.02	0.015	0.4	24.0–26.0	20.5–23.5	0.09–0.15	1.60–2.60	...
S31254	...	0.02	1	0.03	0.01	0.8	19.5–20.5	17.5–18.5	0.18–0.25	6.0–6.5	Cu 0.50–1.00
S31600	316	0.08 <sup>C</sup>	2	0.045	0.03	1	16.0–18.0	10.0–14.0	...	2.00–3.00	...
S31603	316L	0.03	2	0.045	0.03	1	16.0–18.0	10.0–14.0	...	2.00–3.00	...
S31609	316H	0.04–0.10	2	0.045	0.03	1	16.0–18.0	10.0–14.0	...	2.00–3.00	...
S31635	316Ti	0.08	2	0.045	0.03	1	16.0–18.0	10.0–14.0	0.1	2.00–3.00	Ti [5×(C+N)- 0.70]
S31640	316Cb	0.08	2	0.045	0.03	1	16.0–18.0	10.0–14.0	0.1	2.00–3.00	Cb [10×C- 1.10]
S31651	316N	0.08	2	0.045	0.03	1	16.0–18.0	10.0–14.0	0.10–0.16	2.00–3.00	...
S31653	316LN	0.03	2	0.045	0.03	1	16.0–18.0	10.0–14.0	0.10–0.16	2.00–3.00	...
S31700	317	0.08	2	0.045	0.03	1	18.0–20.0	11.0–15.0	...	3.0–4.0	...
S31725	...	0.03	2	0.045	0.03	1	18.0–20.0	13.5–17.5	0.2	4.0–5.0	...
S31726	...	0.03	2	0.045	0.03	1	17.0–20.0	14.5–17.5	0.10–0.20	4.0–5.0	...
S31727	...	0.03	1	0.03	0.03	1	17.5–19.0	14.5–16.5	0.15–0.21	3.8–4.5	Cu 2.8–4.0
S32050	...	0.03	1.5	0.035	0.02	1	22.0–24.0	20.0–23.0	0.21–0.32	6.0–6.8	Cu 0.40
S32053	...	0.03	1	0.03	0.01	1	22.0–24.0	24.0–26.0	0.17–0.22	5.0–6.0	...
S32100	321	0.08 <sup>D</sup>	2	0.045	0.03	1	17.0–19.0	9.0–12.0	...	...	Ti [5×(C+N) - 0.70 <sup>F</sup> ]
S32109	321H	0.04–0.10	2	0.045	0.03	1	17.0–19.0	9.0–12.0	...	...	Ti [5×(C+N) - 0.70 <sup>F</sup> ]

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							17.0–19.0	9.0–12.0			
							17.0–19.0	9.0–12.0			
S32615	...	0.07	2	0.045	0.03	4.8–6.0	16.5–19.5	19.0–22.0	...	0.30–1.50	Cu 1.50–2.50
S32654	...	0.02	2.0–4.0	0.03	0.005	0.5	24.0–25.0	21.0–23.0	0.45–0.55	7.0–8.0	Cu 0.30–0.60
S33228	...	0.04–0.08	1	0.02	0.015	0.3	26.0–28.0	31.0–33.0	...	...	Cb 0.60–1.00; Ce 0.05–0.10; Al 0.025
S34565	...	0.03	5.0–7.0	0.03	0.01	1	23.0–25.0	16.0–18.0	0.40–0.60	4.0–5.0	Cb 0.10
S34700	347	0.08 <sup>D</sup>	2	0.045	0.03	—	—	1 ...	—	—	Cb [10×C–1.10]
S34709	347H	0.04–0.10	2	0.045	0.03	—	—	1 ...	—	—	Cb [8×C–1.10]
S34800	348	0.08 <sup>D</sup>	2	0.045	0.03	1	17.0–19.0	9.0–12.0	...	...	(Cb+Ta) [10×C–1.10]; Ta 0.10; Co 0.20
S34809	348H	0.04–0.10	2	0.045	0.03	1	17.0–19.0	9.0–12.0	...	...	(Cb + Ta) [8×C–1.10]; Co 0.20; Ta 0.10
S35315	...	0.04–0.08	2	0.04	0.03	1.2–2.0	24.0–26.0	34.0–36.0	0.12–0.18	...	Ce 0.03–0.08
S38815	...	0.03	2	0.04	0.02	5.5–6.5	13.0–15.0	15.0–17.0	...	0.75–1.50	Al 0.30; Cu 0.75–1.50
Austenitic-Ferritic Grades											
S31803	...	0.03	2	0.03	0.02	1	21.0–23.0	4.5–6.5	0.08–0.20	2.5–3.5	...
S32101	...	0.04	4.0–6.0	0.04	0.03	1	21.0–22.0	1.35–1.70	0.20–0.25	0.10–0.80	Cu 0.10–0.80
S32202	...	0.03	2	0.04	0.01	1	21.5–24.0	1.00–2.80	0.18–0.26	0.45	...
S32205	...	0.03	2	0.03	0.02	1	22.0–23.0	4.5–6.5	0.14–0.20	3.0–3.5	...
S32506	...	0.03	1	0.04	0.015	0.9	24.0–26.0	5.5–7.2	0.08–0.20	3.0–3.5	W 0.05–0.30
S32550	...	0.04	1.5	0.04	0.03	1	24.0–27.0	4.5–6.5	0.10–0.25	2.9–3.9	Cu 1.50–2.50
S32750	...	0.03	1.2	0.035	0.02	0.8	24.0–26.0	6.0–8.0	0.24–0.32	3.0–5.0	Cu 0.50

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S32760 <sup>G</sup>	...	0.03	1	0.03	0.01	1	24.0–26.0	6.0–8.0	0.20–0.30	3.0–4.0	Cu 0.50–1.00; W 0.50–1.00
S32906	...	0.03	0.80–1.50	0.03	0.03	0.5	28.0–30.0	5.8–7.5	0.30–0.40	1.50–2.60	Cu 0.80
S32950	...	0.03	2	0.035	0.01	0.6	26.0–29.0	3.5–5.2	0.15–0.35	1.00–2.50	...
S39277	...	0.025	0.8	0.025	0.002	0.8	24.0–26.0	6.5–8.0	0.23–0.33	3.0–4.0	Cu 1.20–2.00 W 0.80–1.20
S82441	...	0.03	2.5–4.0	0.035	0.005	0.7	23.0–25.0	3.0–4.5	0.20–0.30	1.00–2.00	Cu 0.10–0.80

Ferritic Grades

S40500	405	0.08	1	0.04	0.03	1	11.5–14.5	0.5	...	...	Al 0.10–0.30
S43000	430	0.12	1	0.04	0.03	1	16.0–18.0	...	...	...	...
S43035	439	0.07	1	0.04	0.03	1	17.0–19.0	0.5	0.04	...	Ti [(0.20 + 4×(C+N)) – 1.10]; Al 0.15
S44400	444	0.025	1	0.04	0.03	1	17.5–19.5	1	0.035	1.75–2.50	(Ti+Cb) [(0.20 + 4×(C+N)) – 0.80]
S44627	XM-27	0.010 <sup>H</sup>	0.4	0.02	0.02	0.4	25.0–27.5	0.5	0.015 <sup>H</sup>	0.75–1.50	Cu 0.20; Cb 0.05–0.20; (Ni+Cu) 0.50
S44700	...	0.01	0.3	0.025	0.02	0.2	28.0–30.0	0.15	0.02	3.5–4.2	(C+N) 0.025; Cu 0.15
S44800	...	0.01	0.3	0.025	0.02	0.2	28.0–30.0	2.00–2.50	0.02	3.5–4.2	(C+N) 0.025; Cu 0.15

Martensitic Grades

S40300	403						11.5–13.0			0.15	1	0.04
	0.03	0.5 ...	...	...	...	...	11.5–13.5	...	...	...	...	...
S41000	410	0.15	1	0.04	0.03	1	...	...	...	...	...	...
S41040	XM-30	0.18	1	0.04	0.03	1	11.5–13.5	...	...	...	...	Cb 0.05–0.30
S41400	414	0.15	1	0.04	0.03	1	11.5–13.5	1.25–2.50	...	...	...	...
S41425	...	0.05	0.50–1.00	0.02	0.005	0.5	12.0–15.0	4.0–7.0	0.06–0.12	1.50–2.00	...	Cu 0.30
S41500	<sup>I</sup>	0.05	0.50–1.00	0.03	0.03	0.6	11.5–14.0	3.5–5.5	...	0.50–1.00	...	...
S43100	431	0.2	1	0.04	0.03	1	15.0–17.0	1.25–2.50	...	...	...	...

<sup>A</sup> New designations established in accordance with Practice E527 and SAE J 1086 published jointly by ASTM and SAE. See ASTM DS–56C, available from ASTM Headquarters.

<sup>B</sup> Maximum unless otherwise indicated.



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<sup>C</sup> Except as required for specific alloy type, molybdenum, titanium, nickel, cobalt, tantalum, nitrogen, and copper need not be reported but shall not be present in other than residual amounts, the intent being to prohibit substitution of one alloy type for another due to absence of control of the above named elements in certain alloys. <sup>D</sup> See Supplementary Requirement H.1.

<sup>E</sup> American Welding Society designation.

<sup>F</sup> Nitrogen content is to be reported for this grade.

<sup>G</sup>  $\%Cr + 3.3 \times \%Mo + 16 \times \%N \geq 40$ .

<sup>H</sup> Product analysis tolerance over the maximum limit for carbon and nitrogen to be 0.002 %.

<sup>I</sup> Wrought version of CA6NM.

<sup>J</sup> Iron shall be determined arithmetically by difference of 100 minus the sum of specified elements. <sup>K</sup> (Al+Ti) 0.85–1.20.

### C. Grain Size for Austenitic Grades :-

1. All austenitic grades shall be tested for average grain size by Test Methods E112.

Designation/Type	Grain Size
304H, 309H, 310H, and 316H	6 or coarser
321H, 347H, and 348H	7 or coarser
S32615	3 or finer
N08810 and N08811	5 or coarser

### D. Mechanical Properties Requirements :-

1. The material shall conform to the mechanical property requirements specified in Table 3.
2. The yield strength shall be determined by the offset (0.2 %) method.
3. Martensitic grades shall be capable of meeting the hardness requirements after heat treating as specified in Table 4.

**Table 3**

UNS Designation	Type	Condition	Tensile Strength, min, ksi [Mpa]	Yield Strength, <sup>A</sup> min, ksi [MPa]	Elongation in 2 in. [50 mm] or 4D, min, %	Reduction of Area, min, % <sup>B,C</sup>	Brinell Hardness, max
Austenitic Grades							
N08020	Alloy 20	stabilized-annealed	80 [550]	35 [240]	30 <sup>D</sup>	50	
	Up to 2 in. [50.8 mm], incl	strain-hardened	90 [620]	60 [415]	15	40	
N08367	...	annealed	95 [655]	45 [310]	30	...	241
N08800	800	annealed	75 [515]	30 [205]	30	...	192
N08810	800H	annealed	65 [450]	25 [170]	30	...	192
N08811	...	annealed	65 [450]	25 [170]	30	...	192
N08700	...	annealed	80 [550]	35 [240]	30	50	...
N08904	904L	annealed	71 [490]	31 [220]	35	...	...
N08925	...	annealed	87 [600]	43 [295]	40	...	217
N08926	...	annealed	94 [650]	43 [295]	35	...	256
S20161	...	annealed	125 [860]	50 [345]	40	40	311
S20910	XM-19	annealed	100 [690]	55 [380]	35	55	293
	Up to 2 in. [50.8 mm], incl	hot-rolled	135 [930]	105 [725]	20	50	...
	Over 2 to 3 in. [50.8 to 76.2 mm], incl	hot-rolled	115 [795]	75 [515]	25	50	...
	Over 3 to 8 in. [76.2 to 203.2mm], incl	hot-rolled	100 [690]	60 [415]	30	50	...
	Up to 1(1/2) in. [38.1 mm], incl	strain-hardened	145 [1000]	125 [860]	12	40	...
	Over 1(1/2) to 2(1/4) in. [38.1 to 57.2 mm], incl	strain-hardened	120 [825]	105 [725]	15	45	...
S21600, S21603	XM-17, XM-18	annealed	90 [620]	50 [345]	40	50	212
S21800	...	annealed	95 [655]	50 [345]	35	55	241
S21904	XM-11	annealed	90 [620]	50 [345]	45	60	...
S24000	XM-29	annealed	100 [690]	55 [380]	30	50	...

S30200, S30400, S30409, S30453, S30880, S30908, S30909, S30940, S31008, S31009, S31040, S31600,	302, 304, 304H, 304LN, ER308, <sup>E</sup> 309S, 309H, 309Cb, 310S, 310H, 310Cb, 316, 316H,	annealed	75 [515] <sup>F</sup>	30 [205]	30	40	...
S31609, S31635, S31640, S31653, S31700, S32100, S32109, S34700, S34709, S34800, S34809, S30403, S31603	316Ti, 316Cb, 316LN, 317, 321, 321H, 347, 347H, 348, 348H						
	316, 316L 304, 304L	strain-hardened level 1	85 [585]	65 [450] <sup>G</sup>	30	60	...
	2 in. and under	strain-hardened level 2	95 [655]	75 [515]	25	40	...
	Over 2 to 2(1/2) in. [50.8 to 63.5 mm], incl	strain-hardened level 2	90 [620]	65 [450]	30	40	...
	Over 2(1/2) to 3 in. [63.5 to 76.2 mm], incl	strain-hardened level 2	80 [550]	55 [380]	30	40	...
S30403, S31603	304L, 316L	annealed	70 [485]	25 [170]	30	40	...
S30451, S31651	304N, 316N	annealed	80 [550]	35 [240]	30	40	...
S30600	...	annealed	78 [540]	35 [240]	40	...	...
S30815	...	annealed	87 [600]	45 [310]	40	50	...
S31050	0.25 in. [6 mm] and under	annealed	84 [580]	39 [270]	25	40	...
	Over 0.25 in. [6 mm]	annealed	78 [540]	37 [255]	25	40	...
S31254	...	annealed	95 [655]	44 [305]	35	50	...
S31725	...	annealed	75 [515]	30 [205]	40	...	...
S31726	...	annealed	80 [550]	35 [240]	40	...	...
S31727	...	annealed	80 [550]	36 [245]	35	...	217
S32050	...	annealed	98 [675]	48 [330]	40	...	...
S32053	...	annealed	93 [640]	43 [295]	40	...	217

S32615	...	annealed	80 [550]	32 [220]	25	40	...
S32654	...	annealed	109 [750]	62 [430]	40	40	250
S33228	...	annealed	73 [500]	27 [185]	30	...	...
S34565	...	annealed	115 [795]	60 [415]	35	40	230
S35315	...	annealed	94 [650]	39 [270]	40	...	...
S38815	...	annealed	78 [540]	37 [255]	30	...	...

Austenitic-Ferritic Grades

S31803	...	annealed	90 [620]	65 [450]	25	...	290
S32101	...	annealed	94 [650]	65 [450]	30	...	290
S32202	...	annealed	94 [650]	65 [450]	30	...	290
S32205	...	annealed	95 [655]	65 [450]	25	...	290
S32506	...	annealed	90 [620]	65 [450]	18	...	302
S32550	...	annealed	110 [760]	80 [550]	15	...	297
S32750	2 in. and under	annealed	116 [800]	80 [550]	15	...	310
	over 2 in.	annealed	110 [760]	75 [515]	15	...	310
S32760	...	annealed	109 [750]	80 [550]	25	...	300
S32906	...	annealed	109 [750]	80 [550]	25	...	310
S32950	...	annealed	100 [690]	70 [485]	15	...	297
S39277	...	annealed	118 [820]	85 [585]	25	50	293
S82441	Under 7/16 in. [11 mm]	annealed	107 [740]	78 [540]	25	...	290
S82441	7/16 in. and over [11 mm]	annealed	99 [680]	70 [480]	25	...	290

Ferritic Grades

S40500	405	annealed	60 [415]	25 [170]	20	45	207
S43000, S43035	430, 439	annealed	70 [485]	40 [275]	20 <sup>H</sup>	45 <sup>H</sup>	192
S44627	XM-27	annealed	65 [450]	40 [275]		45 <sup>H</sup>	217
S44401	...	annealed	60 [415]	45 [310]	20 <sup>I</sup>	45 <sup>I</sup>	217
S44700	...	annealed	70 [485]	55 [380]	20	40	...

S44800	...	annealed	70 [485]	55 [380]	20	40	...
Martensitic Grades							
S40300, S41000	403, 410	annealed	70 [485]	40 [275]	20 <sup>I</sup>	45 <sup>I</sup>	223
		1	70 [485]	40 [275]	20 <sup>I</sup>	45 <sup>I</sup>	223
		2	110 [760]	85 [585]	15	45	269
		3	130 [895]	100 [690]	12	35	331
S41400	414	tempered	115 [795]	90 [620]	15	45	321
S41425	...	tempered	120 [825]	95 [655]	15	45	321
S41500	...	normalized and tempered	115 [795]	90 [620]	15	45	293
S43100	431 <sup>J</sup>	annealed	...	...	...	...	277
		tempered	115 [795]	90 [620]	15	45	321
S41040	XM-30	annealed	70 [485]	40 [275]	13 <sup>H</sup>	45 <sup>H</sup>	235
		quenched and tempered	125 [860]	100 [690]	13	45	302

<sup>A</sup> See Section D.

<sup>B</sup> Reduction of area does not apply on flat bars 3/16 in. [4.80 mm] and under in thickness, as this determination is not generally made in this product size.

<sup>C</sup> The material shall be capable of meeting the required reduction of area where listed, but actual measurement and reporting of the reduction of area are not required unless specified in the purchase order.

<sup>D</sup> Cold-finished shapes require only 15 %, minimum, elongation.

<sup>E</sup> American Welding Society designation.

<sup>F</sup> Tensile strength 70 ksi [485 MPa] min permitted for extruded shapes.

<sup>G</sup> For bars greater than 2 in. [51 mm], a cross section, 60 ksi [415 MPa] min, shall be permitted.

<sup>H</sup> Elongation in 2 in. or 50 mm of 12 % min and reduction of area of 35 % min permitted for cold-finished bars.

<sup>I</sup> Elongation in 2 in. of 12 % min and reduction of area of 35 % min permitted for cold-drawn or cold-rolled bars. <sup>J</sup> Annealed bars shall be capable of meeting the tempered condition requirements when heat treated.

**Table 4**

Type <sup>A</sup>	Heat Treatment Temperature <sup>B</sup> °F (°C), min	Quenchant	Hardness HRC, min
403	1750 [955]	Air	35

410	1750 [955]	Air	35
414	1750 [955]	Oil	42

<sup>A</sup> Samples for testing shall be in the form of a section not exceeding 3/8 in. [9.50 mm] in thickness. <sup>B</sup>

Temperature tolerance is  $\pm 25^{\circ}\text{F}$  [ $15^{\circ}\text{C}$ ].

#### **E. Corrosion Testing :-**

1. Austenitic stainless steels solution annealed by the alternative method shall be tested and pass the intergranular corrosion test.
2. Tests shall be performed in accordance with Practice E of Practices A262.

#### **F. Testing for Intermetallic Compounds.**

1. When specified by the purchaser in the purchase order, the manufacturer shall test the austenitic or austenitic-ferritic (duplex) stainless steel material in its final condition.

#### **G. Test Methods :-**

The properties enumerated in the applicable product specification shall be tested in accordance with the following ASTM methods:

1. Chemical Analysis—Test Methods, Practices, and Terminology A751.
2. Tension Tests—Test Methods and Definitions A370.
3. Stress Rupture—Test Methods E139.
4. Brinell Hardness—Test Methods and Definitions A370.
5. Rockwell Hardness—Test Methods and Definitions A370.
6. Intergranular Corrosion—Practice E of Practices A262.
7. Grain Size—Test Methods E112.
8. Charpy V-Notch Impact Test—Test Methods and Definitions A370.

#### **H. Supplementary Requirements:-**

1. Materials for High-Temperature Service :-
  - i. Unless an H grade has been ordered, this supplementary requirement shall be specified for ASME Code applications for service above 1000°F [540°C].
  - ii. The user is permitted to use an austenitic stainless steel as the corresponding H grade when the material meets all requirements of the H grade including chemistry, annealing temperature, and grain size.
  - iii. The user is permitted to use an L grade austenitic stainless steel for service above 1000°F [540°C], subject to the applicable allowable stress table of the ASME Code, when the material meets all requirements of this specification and the grain size is ASTM No. 7 or coarser as determined in accordance with Test Methods E112. The grain size shall be reported on a Certified Test Report.
2. Corrosion Tests :-

- i. Tests shall be performed in accordance with Practice E of Practices A262.
3. Material for High Cycle Fatigue Service.
4. Material for Optimum Resistance to Stress Corrosion Cracking.
5. Demonstration of the Absence of Detrimental Intermetallic Phase in Austenitic and Austenitic-Ferritic (Duplex) Grades.

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