Designation: A 988/A 988M – 98 (Reapproved 2002)ε1

Standard Specification for Hot Isostatically-Pressed Stainless Steel Flanges, Fittings, Valves, and Parts for High Temperature Service[1]

This standard is issued under the fixed designation A 988/A 988M; 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.

ε1 NOTE—The title was changed to a dual designation editorially to reflect the existing measurements in the standard in September 2004.

1. Scope

1.1 This specification covers hot isostatically-pressed, powder metal, stainless steel piping components for use in pressure systems. Included are flanges, fittings, valves, and similar parts made to specified dimensions or to dimensional standards, such as in ASME specification B16.5.

1.2 Several grades of martensitic, austenitic, and austenitic-ferritic stainless steels are included in this specification.

1.3 Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order.

1.4 This specification is expressed in both inch-pound units and in SI units. Unless the order specifies the applicable "M" specification designation (SI units), however, the material shall be furnished to inch-pound units.

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

1.6 The following safety hazards caveat pertains only to test methods portions 8.1, 8.2, 9.5-9.7, and Section 10 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels[2]

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings[3]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[2]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[2]

A 923 Test Methods for Detecting Detrimental Intermetallic Phase in Wrought Duplex Austenitic/Ferritic Stainless Steels[2]

E 112 Test Methods for Determining the Average Grain Size[4]

E 165 Test Method for Liquid Penetrant Examination[5]

E 340 Test Method for Macroetching Metals and Alloys[4]

E 606 Practice for Strain-Controlled Fatigue Testing[4]

G 48 Test Method for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution[6]

2.2 *MSS Standard:*

SP 25 Standard Marking System for Valves, Fittings, Flanges, and Unions[7]

2.3 *ASME Specifications and Boiler and Pressure Vessel Codes:*

B16.5 Dimensional Standards for Steel Pipe Flanges and Flanged Fittings [8]

2.4 *ASME Specification IX Welding Qualifications:*

SFA-5.4 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes[8]

SFA-5.9 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes[8]

SFA-5.11 Specification for Nickel and Nickel-Alloy Covered Welding Electrodes[8]

[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 A01.22 on Steel Forgings and Wrought Fittings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] *Annual Book of ASTM Standards*, Vol 03.03.

[6] *Annual Book of ASTM Standards*, Vol 03.02.

[7] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602.

[8] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *can*, *n*—the container used to encapsulate the powder during the pressure consolidation process; it is partially or fully removed from the final part.

3.1.2 *compact*, *n*—the consolidated powder from one can. It may be used to make one or more parts.

3.1.3 *consolidation*, *n*—the bonding of adjacent powder particles in a compact under pressure by heating to a temperature below the melting point of the powder.

3.1.4 *fill stem*, *n*—the part of the compact used to fill the can. It is not integral usually to the part produced.

3.1.5 *hot isostatic-pressing*, *n*—a process for simultaneously heating and forming a compact in which the powder is contained in a sealed formable enclosure usually made from metal and the so-contained powder is subjected to equal pressure from all directions at a temperature high enough to permit plastic deformation and consolidation of the powder particles to take place.

3.1.6 *lot*, *n*—a number of parts made from a single powder blend following the same manufacturing practice.

3.1.7 *part*, *n*—a single item coming from a compact, either prior to or after machining.

3.1.8 *powder blend*, *n*—a homogeneous mixture of powder from one or more heats of the same grade.

3.1.9 *rough part*, *n*—the part prior to final machining.

4. Ordering Information

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

4.1.1 Quantity (weight or number of parts),

4.1.2 Name of material or UNS number,

4.1.3 ASTM designation and year of issue,

4.1.4 Dimensions (tolerances and surface finishes should be included),

4.1.5 Microstructure examination if required (5.1.4),

4.1.6 Inspection (15.1),

4.1.7 Whether rough part or finished machined (8.2.2),

4.1.8 Supplementary requirements, if any,

4.1.9 Additional requirements (see 7.2 and 17.1), and

4.1.10 Requirement, if any, that the manufacturer shall submit drawings for approval showing the shape of the rough part before machining and the exact location of test specimen material (see 9.3).

TABLE 1 Chemical Requirements

UNS Designation	Grade	Composition, %										
		Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Nickel	Chromium	Molybdenum	Columbium plus Tantalum	Tantalum, max	Titanium
		Martensitic Stainless Steels										
S41000	13 chromium	0.15 max	1.00 max	0.040	0.030	1.00 max		11.5–13.5	. . .	. . .	. . .	. . .
S41026	13 chromium 0.5 molybdenum	0.15 max	1.00 max	0.02	0.02	1.0 max	1.00–2.00	11.5–13.5	0.40–0.60	Other Elements Cu 0.50 max		
S41500	13 chromium, 4 nickel	0.05 max	0.50–1.00	0.030	0.030	0.60 max	3.5–5.5	11.5–14.0	0.50–1.00	. . .	. . .	. . .
S42390	12 chromium, 1.0 molybdenum, modified with vanadium	0.18–0.25	1.00 max	0.030	0.030	1.00 max	0.30–0.80	11.5–12.5	0.80–1.20	Other Elements N 0.03–0.08 V 0.25–0.35 Cb 0.08–0.15		
		Austenitic Stainless Steels										
S30400[A]	18 chromium, 8 nickel	0.08 max	2.00 max	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .
S30403[A]	18 chromium, 8 nickel, low carbon	0.035 max	2.00 max	0.045	0.030	1.00 max	8.0–13.0	18.0–20.0	. . .	. . .	. . .	. . .
S30451[B]	18 chromium, 8 nickel, modified with nitrogen	0.08 max	2.00 max	0.045	0.030	1.00 max	18.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .
S30453	18 chromium, 8 nickel, modified with nitrogen	0.030 max	2.00 max	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .
S31600[A]	18 chromium, 8 nickel, modified with molybdenum	0.08 max	2.00 max	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .
S31603[A]	18 chromium, 8 nickel, modified with molybdenum, low carbon	0.030 max	2.00 max	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .

TABLE 1 *Continued*

UNS Designation	Grade	Composition, % Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Nickel	Chromium	Molybdenum	Columbium plus Tantalum	Tantalum, max	Titanium
S31651[B]	18 chromium, 8 nickel, modified with molybdenum and nitrogen	0.08 max	2.00 max	0.045	0.030	1.00 max	10.0–13.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .
S31653[B]	18 chromium, 8 nickel, modified with molybdenum and nitrogen	0.030 max	2.00 max	0.045	0.030	1.00 max	10.0–13.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .
S31700	19 chromium, 13 nickel 3.5 molybdenum	0.08 max	2.00 max	0.045	0.030	1.00 max	11.0–15.0	18.0-20.0	3.0–4.0	. . .	. . .	. . .
S31703	19 chromium, 13 nickel, 3.5 molybdenum	0.030 max	2.00 max	0.045	0.030	1.00 max	11.0–15.0	18.0–20.0	3.0–4.0	. . .	. . .	. . .
S21904	20 chromium, 6 nickel, 9 manganese	0.04 max	8.0–10.0	0.045	0.030	1.00 max	5.5–7.5	19.0–21.5	. . .	. . .	Other Elements N 0.15–0.40	
S31254	20 chromium, 18 nickel, 6 molybdenum, low carbon	0.020 max	1.00 max	0.030	0.010	0.80 max	17.5–18.5	19.5–20.5	6.0–6.5	. . .	Other Elements Cu 0.50-1.00 N 0.18-0.22	
S31725	19 chromium, 15 nickel, 4 molybdenum	0.030 max	2.00 max	0.045	0.030	1.00 max	13.5–17.5	18.0–20.0	4.0–5.0	. . .	Other elements N 0.20 max	
S31726	19 chromium, 15 nickel, 4 molybdenum	0.030 max	2.00 max	0.045	0.030	1.00 max	14.5–17.5	17.0–20.0	4.0–5.0	. . .	Other Elements N 0.10–0.20	
N08367	22 chromium, 25 nickel, 6.5 molybdenum, low carbon	0.030 max	2.00 max	0.040	0.030	1.00 max	23.50–25.50	20.0–22.0	6.0–7.0		Other Elements N 0.18–0.25 Cu 0.75 max	
S32654	25 chromium, 22 nickel, 7 molybdenum, low carbon	0.020 max	2.0–4.0	0.030	0.005	0.50 max	21.0–23.0	24.0–25.0	7.0–8.0		Other Elements N 0.45–0.55 Cu 0.30–0.60	
						Austenitic-Ferritic Stainless Steels						
S31803	22 chromium, 5.5 nickel, modified with nitrogen	0.030 max	2.00 max	0.030	0.020	1.00 max	4.5–6.5	21.0–23.0	2.5–3.5	. . .	Other Elements N 0.08–0.20	
S32205	22 chromium, 5.5 nickel, modified with high nitrogen	0.030 max	2.00 max	0.030	0.020	1.00 max	4.5–6.5	22.0–23.0	3.0–3.5		Other Elements Cu 0.75 max N 0.14-0.20	
S32950	26 chromium, 3.5 nickel, 1.0 molybdenum	0.030 max	2.00 max	0.035	0.010	0.60 max	3.5–5.2	26.0–29.0	1.00–2.50	. . .	Other Elements N 0.15-0.35	
S32750	25 chromium, 7 nickel, 4 molybdenum, modified with nitrogen	0.030 max	1.20 max	0.035	0.020 max	0.80 max	6.0-8.0	24.0–26.0	3.0-5.0	. . .	Other Elements N 0.24–0.32 Cu 0.50 max	
S39274	25 chromium, 7 nickel, modified with nitrogen and tungsten	0.030 max	1.0 max	0.030 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	2.50–3.50	. . .	Other Elements N 0.24–0.32 Cu 0.20–0.80 W 1.50–2.50	
S32760[C]	25 chromium, 7 nickel, 3.5 molybdenum, modified with nitrogen and tungsten	0.030 max	1.00 max	0.030	0.010	1.00 max	6.0–8.0	24.0–26.0	3.0–4.0	. . .	Other Elements N 0.20–0.30 Cu 0.50–1.00 W 0.50–1.00	
S39277	25 chromium, 7 nickel, 3.7 molybdenum	0.025 max	0.80 max	0.025	0.002	0.80 max	6.5–8.0	24.0–26.0	3.0–4.0	. . .	Other Elements Cu 1.20–2.00 W 0.80–1.20 N 0.23–0.33	

[A] S30400, S30403, S31600, and S31603 shall have a maximum nitrogen content of 0.10 %.

[B] S30451, S31651, S30453, S31653 shall have a nitrogen content of 0.10 to 0.16 %.

^{C} % Cr + 3.3 × % Mo + 16 × % N > 40 min.

5. Materials and Manufacture

5.1 *Manufacturing Practice*:

5.1.1 Compacts shall be manufactured by placing a single powder blend into a can, evacuating the can, and sealing it. The can material shall be selected to ensure that it has no deleterious effect on the final product. The entire assembly shall be heated at a temperature and placed under sufficient pressure for a sufficient period of time to ensure that the final consolidated part meets the density requirements of 8.1.1.1. One or more parts shall be machined from a single compact.

5.1.2 The powder shall be prealloyed and made by a melting method capable of producing the specified chemical composition, such as but not limited to, air or vacuum induction melting, followed by gas atomization.

5.1.3 When powder from more than one heat of the same grade is used to make a blend, the heats shall be mixed thoroughly to ensure homogeneity.

5.1.4 The compact shall be sectioned and the microstructure examined to check for porosity and other internal imperfections. It shall meet the requirements of 8.1.2. The sample shall be taken from the fill stem or from a location in a part as agreed upon by the manufacturer and purchaser.

5.1.5 Unless otherwise specified in the purchase order, the manufacturer shall remove the can material from the surfaces of the consolidated compacts by chemical or mechanical methods such as by pickling or machining. This may be done before or after heat treatment at the option of the manufacturer (see Note 1).

NOTE 1—Often, it is advantageous to leave the can material in place until after heat treatment or further thermal processing of the consolidated compact.

6. Chemical Composition

6.1 The steel, both as a blend and as a part, shall conform to the requirements for chemical composition prescribed in Table 1. Test Methods, Practices, and Terminology of A 751 shall apply.

6.1.1 Each blend of powder shall be analyzed by the manufacturer to determine the percentage of elements prescribed in Table 1. This analysis shall be made using a representative sample of the powder. The blend shall conform to the chemical composition requirements prescribed in Table 1.

6.1.2 When required by the purchaser, the chemical composition of a sample from one part from each lot of parts shall be determined by the manufacturer. The composition of the sample shall conform to the chemical requirements prescribed in Table 1.

6.2 Addition of lead, selenium, or other elements for the purpose of rendering the material free-machining shall not be permitted.

6.3 The steel shall not contain an unspecified element other than nitrogen, for the ordered grade, to the extent that the steel conforms to the requirements of another grade for which that element is a specified element having a required minimum content.

7. Heat Treatment

7.1 Except as provided in 7.2, the final heat treatment of all parts shall be in compliance with the requirements of Table 2. After hot isostatic-pressing and prior to final heat treatment, the compacts may be annealed, at the option of the producer, either as a part of the consolidation process or as a separate operation.

7.2 When agreed upon by the purchaser, liquid quenching may be applied to the martensitic stainless steels in place of the furnace cool or air cool specified in Table 2, provided that such quenching is followed by tempering in the temperature ranges as required in Table 2. Martensitic parts that are liquid quenched and tempered shall be marked "QT."

7.3 The final heat treatment shall be performed before or after machining at the option of the producer.

7.4 See Section S15 if a particular heat treatment method is specified by the purchaser in the order.

8. Structural Integrity Requirements

8.1 *Microporosity*—The parts shall be free of microporosity as demonstrated by measurement of density as provided in 8.1.1 or by microstructural examination as provided in 8.1.2.

8.1.1 *Density Measurement*:

8.1.1.1 The density measurement shall be used for acceptance of material but not for rejection of material. The measured density for each material shall exceed 99 % of the density typical of that grade when wrought and in the same heat treated condition as the sample. Material that fails to meet this acceptance criterion may be tested at the option of the producer, for microporosity in accordance with the microstructural examination as provided in 8.1.2.

8.1.1.2 Density shall be determined for one sample from each production lot by measuring the difference in weight of the sample when weighed in air and when weighed in water and multiplying this difference by the density of water (Archimede's principle). The equipment used shall be capable of determining density within ±0.004 lb/in.^{3}(0.10 g/cm^3).

8.1.1.3 At the option of the producer, the density shall be compared to the room temperature density typical of wrought steels of the same class of grades, 0.28 lb/in.^{3}(7.8 g/cm^3) for martensitic and austenitic-ferritic grades, and 0.29 lb/in.^{3}(8.0 g/cm^3) for austenitic grades, or to the density of a wrought reference sample of the same grade heat treated in accordance with the requirements of Table 2 (see Note 2).

NOTE 2—The actual density of stainless steel varies slightly with composition and heat treatment. For this reason, small differences in the measured density from the typical density for a class of grades may be the result of differences in alloy content, heat treatment, or microporosity. When density values are measured that are less than the density typical of a class of grades, it is appropriate to examine the sample for microporosity by the more specific metallographic examination procedures.

8.1.2 *Microstructural Examination*:

8.1.2.1 The microstructure when examined at 20-50×, 100-200×, and 1000-2000× shall be reasonably uniform and shall be free of voids, laps, cracks, and porosity.

TABLE 2 Heat Treating Requirements

UNS No.	Heat Treat Type	Austenitizing/Solutioning Temperature °F (°C)[A]	Cooling Media	Quenching, Cool to Below °F (°C)	Tempering Temperature, min° F (°C)
Martensitic Stainless Steels					
S41000 Class 1	anneal	not specified	furnace cool	[B]	[B]
	normalize and temper	not specified	air cool	400 (205)	1325 (725)
	temper	not required	[B]	[B]	1325 (725)
S41000 Class 2	anneal	not specified	furnace cool	[B]	[B]
	normalize and temper	not specified	air cool	400 (205)	1250 (675)
	temper	not required	[B]	[B]	1250 (675)
S41000 Class 3	anneal	not specified	furnace cool	[B]	[B]
	normalize and temper	not specified	air cool	400 (205)	1100 (595)
S41000 Class 4	anneal	not specified	furnace cool	[B]	[B]
	normalize and temper	not specified	air cool	400 (205)	1000(540)
S41026	anneal	1750 (955)	furnace cool	[B]	[B]
	normalize and temper	1750 (955)	air cool	400 (205)	1150 (620)
S41500	normalize and temper	1850 (1010)	air cool	200 (95)	1040-1120 (560-600)
S42390	normalize and temper	1860–1960 (1015–1070)	air cool	200 (95)	1350–1440 (730–780)
Austenitic Stainless Steels					
S30400	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S30403	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S30451	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S30453	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31600	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31603	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31651	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31653	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31700	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31703	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S21904	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31254	solution treat and quench	2100 (1150)	liquid	500 (260)	[B]
S31725	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
S31726	solution treat and quench	1900 (1040)	liquid	500 (260)	[B]
N08367	solution treat and quench	2025 (1105)	liquid	500 (260)	[B]
S32654	solution treat and quench	2050–2160 (1120–1180)	liquid	500 (260)	[B]
Austenitic-Ferritic Stainless Steels					
S31803	solution treat and quench	1870 (1020)	liquid	500 (260)	[B]
S32205	solution treat and quench	1870 (1020)	liquid	500 (260)	[B]
S32950	solution treat and quench	1825-1875 (995-1025)[C]	liquid	500 (260)	[B]
S32750	solution treat and quench	1880 (1025)	liquid	500 (260)	[B]
S39274	solution treat and quench	1920–2060 (1050–1125)	liquid	500 (260)	[B]
S32760	solution treat and quench	2010–2085 (1100–1140)	liquid	500 (260)	[B]
S39277	solution treat and quench	1940 (1060)	liquid	175 (80)	[B]

[A] Minimum unless temperature range is listed.
[B] Not applicable.
[C] 30 min/in. of thickness.

8.1.2.2 One sample from each production lot shall be examined. The sample shall be taken after hot-isostatic pressing or after final heat treatment. The microstructure shall meet the requirements of 8.1.2.1.

8.1.2.3 If the sample fails to meet the requirements for acceptance, each part in the lot may be retested, and those that pass may be accepted.

8.2 *Hydrostatic Tests*—After they have been machined, pressure-containing parts shall be tested to the hydrostatic shell test pressures prescribed in ASME B16.5 for the applicable steel rating for which the part is designed and shall show no leaks. Parts ordered under these specifications for working pressures other than those listed in the ASME B16.5 ratings shall be tested to such pressures as may be agreed upon between the manufacturer and purchaser.

8.2.1 No hydrostatic test is required for welding neck or other flanges.

8.2.2 The compact manufacturer is not required to perform pressure tests on rough parts that are to be finish machined by others. The fabricator of the finished part is not required to pressure test parts that are designed to be pressure containing only after assembly by welding into a larger structure. The manufacturer of the compacts, however, shall be responsible, as required in 16.1 for the satisfactory performance of the parts under the final test required in 8.2

9. Mechanical Properties

9.1 The material shall conform to the requirements for mechanical properties prescribed in Table 3 at room temperature.

9.2 Mechanical test specimens shall be obtained from production parts or from the fill stems. Mechanical test specimens shall be taken from material that has received the same heat treatment as the parts that they represent. If repair welding is required (see Section 15), the test specimens prior to testing shall accompany the repaired parts if a post weld treatment is done.

9.3 For normalized and tempered, or quenched and tempered parts, the central axis of the test specimen shall correspond to the ¼ T plane or deeper position, where T is the

TABLE 3 Tensile and Hardness Requirements

UNS Designation	Tensile Strength, min, ksi (MPa)	Yield Strength, min, ksi (MPa)[A]	Elongation in 2 in. (50 mm) or 4*D*, min, %	Reduction of Area, min, %	Brinell Hardness Number
Martensitic Stainless Steels					
S41000 Class 1	70 (485)	40 (275)	18	35.0	143–187
S41000 Class 2	85 (585)	55 (380)	18	35.0	167–229
S41000 Class 3	110 (760)	85 (585)	15	35.0	235–302
S41000 Class 4	130 (895)	110 (760)	12	35.0	263–321
S41026	110-135 (760–930)	90 (620)	16	45.0	235–285
S41500	115 (790)	90 (620)	15	45.0	295 max
S42390	100–125 (690–862)	75 (517)	14.0	. . .	. . .
Austenitic Stainless Steels					
S30400	75 (515)[B]	30 (205)	30	50	. . .
S30403	70 (485)[C]	25 (170)	30	50	. . .
S30451	80 (550)	35 (240)	30	50	. . .
S30453	75 (515)[B]	30 (205)	30	50	. . .
S31600	75 (515)[B]	30 (205)	30	50	. . .
S31603	70 (485)[C]	25 (170)	30	50	. . .
S31651	80 (550)	35 (240)	30	50	. . .
S31653	75 (515)[B]	30 (205)	30	50	. . .
S31700	75 (515)[B]	30 (205)	30	50	. . .
S31703	70 (485)[C]	25 (170)	30	50	. . .
S21904	90 (620)	50 (345)	45	60	. . .
S31254	94 (650)	44 (300)	35	50	. . .
S30600	78 (540)	35 (240)	40.0	50.0	. . .
S31725	75 (525)	30 (205)	40.0	50.0	. . .
S31726	80 (550)	35 (240)	40.0	50.0	. . .
N08367	95 (655)	45 (310)	30.0	50.0	
S32654	109 (750)	62 (430)	40.0	. . .	250 max
Austenitic-Ferritic Stainless Steels					
S31803	90 (620)	65 (450)	25	45	. . .
S32205	90 (620)	65 (450)	25.0	. . .	293 max
S32950	100 (690)	70 (485)	15	. . .	. . .
S32750	116 (800)	80 (550)	15	. . .	310 max
S39274	116 (800)	80 (550)	15	30	310 max
S32760	109–130 (750–895)	80 (550)	25.0	45	. . .
S39277	118 (820)	85 (585)	25.0	50	. . .

[A] Determined by the 0.2 % offset method.
[B] For sections over 5 in. (130 mm) in thickness, the minimum tensile strength shall be 70 ksi (485 MPa).
[C] For sections over 5 in. (130 mm) in thickness, the minimum tensile strength shall be 65 ksi (450 MPa).

maximum heat treated thickness of the represented part. In addition, for quenched and tempered parts, the midlength of the test specimen shall be at least *T* from any second heat treated surface. When the section thickness does not permit this positioning, the test specimen shall be positioned as near as possible to the prescribed location, as agreed to by the purchaser and the supplier.

9.4 For all annealed stainless steels, the test specimen may be taken from any convenient location.

9.5 *Tension Tests*:

9.5.1 *Martensitic Stainless Steels*—One tension test shall be made for each production lot in each heat treatment charge. When the heat treating cycles are the same and the furnaces (either batch or continuous type) are controlled within ±25°F (±14°C) and equipped with recording pyrometers so that complete records of heat treatment are available, then only one tension test from each production lot of each type of part (see Note 3) and section size is required instead of one test from each production lot in each heat-treatment charge.

NOTE 3—"Type" in this case is used to describe the shape of the part such as a flange, elbow, tee, and so forth.

9.5.2 *Austenitic and Austenitic-Ferritic Stainless Steels*—One tension test shall be made for each production lot. The tension test specimen shall be made from material accompanying the parts in final heat treatment.

9.5.3 Testing shall be performed in accordance with Test Methods and Definitions A 370 using the largest feasible of the round specimens. The gage length for measuring elongation shall be four times the diameter of the test section.

9.6 *Hardness Tests*:

9.6.1 Except when only one part is produced, a minimum of two pieces/batch or continuous run as defined in 9.6.2 shall be hardness tested in accordance with Test Methods and Definitions A 370 to ensure that the parts are within the hardness limits given for each grade in Table 3. The purchaser may verify that the requirement has been met by testing at any location on the part provided such testing does not render the part useless.

9.6.2 When the reduced number of tension tests permitted by 9.5.1 is applied, additional hardness tests shall be made on