Designation: A403/A403M – 20

Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings[1]

This standard is issued under the fixed designation A403/A403M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers wrought stainless steel fittings for pressure piping applications.[2]

1.2 Several grades of austenitic stainless steel alloys are included in this specification Grades are designated with a prefix, WP or CR, based on the applicable ASME or MSS dimensional and rating standards, respectively.

1.3 For each of the WP stainless grades, several classes of fittings are covered, to indicate whether seamless or welded construction was utilized. Class designations are also utilized to indicate the nondestructive test method and extent of nondestructive examination (NDE). Table 1 is a general summary of the fitting classes applicable to all WP grades of stainless steel covered by this specification. There are no classes for the CR grades. Specific requirements are covered elsewhere.

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

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

1.6 This specification does not apply to cast steel fittings. Austenitic stainless steel castings are covered in Specifications A351/A351M, A743/A743M, and A744/A744M.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts

A743/A743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

A744/A744M Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A960/A960M Specification for Common Requirements for Wrought Steel Piping Fittings

E112 Test Methods for Determining Average Grain Size

E165/E165M Practice for Liquid Penetrant Testing for General Industry

2.2 *ASME Standards:* [4]

ASME B16.9 Factory-Made Wrought Steel Butt-Welding Fittings

ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded

2.3 *MSS Standards:* [5]

MSS SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions

MSS SP-43 Standard Practice for Light Weight Stainless Steel Butt-Welding Fittings

MSS SP-79 Socket-Welding Reducer Inserts

[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] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-403 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 American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[5] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, http://www.mss-hq.com.

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

TABLE 1 Fitting Classes for WP Grades

Class	Construction	Nondestructive Examination
S	Seamless	None
W	Welded	Radiography or Ultrasonic
WX	Welded	Radiography
WU	Welded	Ultrasonic

MSS-SP-83 Steel Pipe Unions, Socket-Welding and Threaded
MSS SP-95 Swage(d) Nipples and Bull Plugs
MSS-SP-97 Integrally Reinforced Forged Branch Outlet Fittings—Socket Welding, Threaded and Buttwelding Ends

2.4 *ASME Boiler and Pressure Vessel Code:* [4]
Section III
Section VIII Division I
Section IX

2.5 *AWS Standards:* [6]
A 5.4 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes
A 5.9 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes
A 5.11 Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding
A5.14 Specification for Nickel and Nickel-Alloy Bare Welding Rods and Electrodes

2.6 *ASNT:* [7]
SNT-TC-1A (1984) Recommended Practice for Nondestructive Testing Personnel Qualification and Certification

3. Common Requirements and Ordering Information

3.1 Material furnished to this specification shall conform to the requirements of Specification A960/A960M including any supplementary requirements that are indicated in the purchase order. Failure to comply with the common requirements of Specification A960/A960M constitutes nonconformance with this specification. In case of conflict between this specification and Specification A960/A960M, this specification shall prevail.

3.2 Specification A960/A960M identifies the ordering information that should be complied with when purchasing material to this specification.

4. Material

4.1 The material for fittings shall consist of forgings, bars, plates, or seamless or welded tubular products that conform to the chemical requirements in Table 2. See Table 3 for a list of common names.

4.2 The steel shall be melted by one of the following processes:

4.2.1 Electric furnace (with separate degassing and refining optional),

4.2.2 Vacuum furnace, or

4.2.3 One of the former followed by vacuum or electroslag-consumable remelting.

4.3 If secondary melting is employed, the heat shall be defined as all ingots remelted from a primary heat.

4.4 *Grain Size*—Annealed Alloys UNS N08810 and UNS N08811 shall conform to an average grain size of ASTM No. 5 or coarser.

5. Manufacture

5.1 *Forming*—Forging or shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining, or by a combination of two or more of these operations. The forming procedure shall be so applied that it will not produce injurious defects in the fittings.

5.2 All fittings shall be heat treated in accordance with Section 6.

5.3 Grade WP fittings ordered as Class S shall be of seamless construction and shall meet all requirements of ASME B16.9, ASME B16.11, MSS SP-79, MSS SP-83, MSS SP-95, or MSS SP-97.

5.4 Grade WP fittings ordered as Class W shall meet the requirements of ASME B16.9 and:

5.4.1 Shall have all pipe welds made by mill or the fitting manufacturer with the addition of filler metal radiographically examined throughout the entire length in accordance with the Code requirements stated in 5.5, and,

5.4.2 Radiographic inspection is not required on single longitudinal seam welds made by the starting pipe manufacturer if made without the addition of filler metal; and

5.4.3 Radiographic inspection is not required on longitudinal seam fusion welds made by the fitting manufacturer when all of the following conditions have been met:

5.4.3.1 No addition of filler metal,

5.4.3.2 Only one welding pass per weld seam, and,

5.4.3.3 Fusion welding from one side only.

5.4.4 In place of radiographic examination, welds made by the fitting manufacturer may be ultrasonically examined in accordance with the Code requirements stated in 5.6.

5.5 Grade WP fittings ordered as Class WX shall meet the requirements of ASME B16.9 and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, radiographically examined throughout their entire length in accordance with Paragraph UW-51 of Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code.

5.6 Grade WP fittings ordered as Class WU shall meet the requirements of ASME B16.9 and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, ultrasonically examined throughout their entire length in accordance with Appendix 12 of Section VIII, Division 1 of ASME Boiler and Pressure Vessel Code.

5.7 The radiography or ultrasonic examination of welds for this class of fittings may be done at the option of the manufacturer, either prior to or after forming.

[6] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

[7] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

TABLE 2 Chemical Requirements

NOTE 1—Where an ellipsis (...) appears in this table, there is no requirement and the element need neither be analyzed for or reported.

Grade[A]			Composition, %										
Grade WP	Grade CR	UNS Designation	Carbon[B]	Manganese[B]	Phosphorous[B]	Sulphur[B]	Silicon[B]	Nickel	Chromium	Molybdenum	Titanium	Nitrogen[C]	Others
WPXM-19	CRXM-19	S20910	0.06	4.0–6.0	0.045	0.030	1.00	11.5–13.5	20.5–23.5	1.50–3.00	...	0.20–0.40	[E]
WP20CB	CR20CB	N08020	0.07	2.00	0.045	0.035	1.00	32.0–38.0	19.0–21.0	2.00–3.00	...		Cu 3.0–4.0 Nb[D] 8XC min, 1.00 max
WP6XN	CR6XN	N08367	0.030	2.00	0.040	0.030	1.00	23.5–25.5	20.0–22.0	6.0–7.0	...	0.18–0.25	Cu 0.75
WP700	CR700	N08700	0.04	2.00	0.040	0.030	1.00	24.0–26.0	19.0–23.0	4.3–5.0			Cu 0.50 Nb[D] 8XC min
WPNIC	CRNIC	N08800	0.10	1.50	0.045	0.015	1.00	30.0–35.0	19.0–23.0	...	0.15–0.60	...	Al 0.15–0.60 Cu 0.75 Fe 39.5 min
WPNIC10	CRNIC10	N08810	0.05–0.10	1.50	0.045	0.015	1.00	30.0–35.0	19.0–23.0	...	0.15–0.60	...	Al 0.15–0.60 Cu 0.75 Fe 39.5 min
WPNIC11	CRNIC11	N08811	0.06–0.10	1.50	0.040	0.015	1.00	30.0–35.0	19.0–23.0	...	0.25–0.60[M]	...	Al 0.25–0.60[M] Cu 0.75 Fe 39.5 min
WP904L	CR904L	N08904	0.020	2.00	0.045	0.035	1.00	23.0–28.0	19.0–23.0	4.0–5.0	...	0.10	Cu 1.0–2.0
WP1925	CR1925	N08925	0.020	1.00	0.045	0.030	0.50	24.0–26.0	19.0–21.0	6.0–7.0		0.10–0.20	Cu 0.8–1.5
WP1925N	CR1925N	N08926	0.020	2.00	0.030	0.010	0.50	24.0–26.0	19.0–21.0	6.0–7.0	...	0.15–0.25	Cu 0.5–1.5
WP304	CR304	S30400	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...	...
WP304L	CR304L	S30403	0.030[F]	2.00	0.045	0.030	1.00	8.0–12.0	18.0–20.0	...	...	...	...
WP304H	CR304H	S30409	0.04–0.10	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...	...
WP304N	CR304N	S30451	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	0.10–0.16	...
WP304LN	CR304LN	S30453	0.030	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	0.10–0.16	...
WP309	CR309	S30900	0.20	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	...	...	...	...
WP310S	CR310S	S31008	0.08	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0	...	...	...	...
WP310H	CR310H	S31009	0.04–0.10	2.00	0.045	0.030	1.00	19.00–22.0	24.0–26.0	...	...	...	...
WPS31254	CRS31254	S31254	0.020	1.00	0.030	0.010	0.80	17.5–18.5	19.5–20.5	6.0–6.5	...	0.18–0.25	Cu 0.50–1.00
WPS31266	CRS31266	S31266	0.030	2.00–4.00	0.035	0.020	1.00	21.00–24.00	23.00–25.00	5.2–6.2	...	0.35–0.60	Cu 1.00–2.50 W 1.50–2.50
WP316	CR316	S31600	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...
WP316L	CR316L	S31603	0.030[F]	2.00	0.045	0.030	1.00	10.0–14.0[G]	16.0–18.0	2.00–3.00	...	...	...
WP316H	CR316H	S31609	0.04–0.10	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...
WP316N	CR316N	S31651	0.08	2.00	0.045	0.030	1.00	10.0–13.0	16.0–18.0	2.00–3.00	...	0.10–0.16	...
WP316LN	CR316LN	S31653	0.030	2.00	0.045	0.030	1.00	10.0–13.0	16.0–18.0	2.00–3.00	...	0.10–0.16	...
WP317	CR317	S31700	0.08	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...
WP317L	CR317L	S31703	0.030	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...
WPS31725	CRS31725	S31725	0.030	2.00	0.045	0.030	1.00	13.5–17.5	18.0–20.0	4.0–5.0	...	0.20	...
WPS31726	CRS31726	S31726	0.030	2.00	0.045	0.030	1.00	13.5–17.5	17.0–20.0	4.0–5.0	...	0.10–0.20	...
WPS31727	CRS31727	S31727	0.030	1.00	0.030	0.030	1.00	14.5–16.5	17.5–19.0	3.8–4.5	...	0.15–0.21	Cu 2.8–4.0
WPS31730	CRS31730	S31730	0.030	2.00	0.040	0.010	1.00	15.0–16.5	17.0–19.0	3.0–4.0	...	0.045	Cu 4.0–5.0
WPS32053	CRS32053	S32053	0.030	1.00	0.030	0.010	1.00	24.0–26.0	22.0–24.0	5.0–6.0	...	0.17–0.22	...
WP321	CR321	S32100	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	...	[H]	...	...
WP321H	CR321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	...	[I]	...	...
WPS33228	CRS33228	S33228	0.04–0.08	1.00	0.020	0.015	0.30	31.0–33.0	26.0–28.0	...	...	...	Ce 0.05–0.10

TABLE 2 *Continued*

Grade[A]			Composition, %										
Grade WP	Grade CR	UNS Designation	Carbon[B]	Manganese[B]	Phosphorous[B]	Sulphur[B]	Silicon[B]	Nickel	Chromium	Molybdenum	Titanium	Nitrogen[C]	Others
													Al 0.025 Nb[D] 0.6–1.0
WPS34565	CRS34565	S34565	0.030	5.0–7.0	0.030	0.010	1.00	16.0–18.0	23.0–25.0	4.0–5.0	. . .	0.40–0.60	Nb[D] 0.10
WP347	CR347	S34700	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	[J]
WP347H	CR347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	[K]
WP347LN	CR347LN	S34751	0.005–0.020	2.00	0.045	0.030	1.00	9.0–13.0	17.0–19.0	. . .	. . .	. . .	Nb[D] 0.20–0.50,[L] N 0.06–0.10[C]
WPS34752	CRS34752	S34752	0.005–0.020	2.00	0.035	0.010	0.60	10.0–13.0	17.0–19.0	0.20–1.20	. . .	0.06–0.12[C]	Cu 2.50-3.50 Nb[D] 0.20-0.50[L] B 0.001-0.005
WP348	CR348	S34800	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	Nb[D] +Ta=10×(C)–1.10 Ta 0.10 Co 0.20
WP348H	CR348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	Nb[D] +Ta=8×(C)–1.10 Ta 0.10 Co 0.20
WPS38815	CRS38815	S38815	0.030	2.00	0.040	0.020	5.5–6.5	15.0–17.0	13.0–15.0	0.75–1.50	. . .	. . .	Cu 0.75–1.50 Al 0.30

[A] See Section 15 for marking requirements.
[B] Maximum, unless otherwise indicated.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] Niobium and columbium are interchangeable names for the same element and both names are acceptable for use in A01.22 specifications.
[E] Niobium (columbium) 0.10–0.30 %; Vanadium, 0.10–0.30 %.
[F] For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP304L and TP316L. 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.
[G] On pierced tubing, the nickel may be 11.0–16.0 %.
[H] 5X(C+N) min–0.70 max.
[I] 4X(C+N) min–0.70 max.
[J] The niobium (columbium) content shall be not less than ten times the carbon content and not more than 1.10 %.
[K] The niobium (columbium) content shall be not less than eight times the carbon content and not more than 1.10 %.
[L] The niobium (columbium) content shall be not less than 15 times the carbon content.
[M] Al + Ti shall be 0.85 % min: 1.20 % max.

TABLE 3 Common Names

Grade WP[A]	Grade CR[A]	UNS Designation	Type[B]
WPXM-19	CRXM-19	S20910	XM-19[C]
WP20CB	CR20CB	N08020	. . .
WP6XN	CR6XN	N08367	. . .
WP700	CR700	N08700	. . .
WPNIC	CRNIC	N08800	800[C]
WPNIC10	CRNIC10	N08810	800H[C]
WPNIC11	CRNIC11	N08811	. . .
WP904L	CR904L	N08904	904L[C]
WP1925	CR1925	N08925	. . .
WP1925N	CR1925N	N08926	. . .
WP304	CR304	S30400	304
WP304L	CR304L	S30403	304L
WP304H	CR304H	S30409	304H
WP304N	CR304N	S30451	304N
WP304LN	CR304LN	S30453	304LN
WP309	CR309	S30900	309
WP310S	CR310S	S31008	310S
WP310H	CR310H	S31009	310H
WPS31254	CRS31254	S31254	. . .
WPS31266	CRS31266	S31266	. . .
WP316	CR316	S31600	316
WP316L	CR316L	S31603	316L
WP316H	CR316H	S31609	316H
WP316N	CR316N	S31651	316N
WP316LN	CR316LN	S31653	316LN
WP317	CR317	S31700	317
WP317L	CR317L	S31703	317L
WPS31725	CRS31725	S31725	317LM[C]
WPS31726	CRS31726	S31726	317LMN[C]
WPS31727	CRS31727	S31727	. . .
WPS31730	CRS31730	S31730	. . .
WPS32053	CRS32053	S32053	. . .
WP321	CR321	S32100	321
WP321H	CR321H	S32109	321H
WPS33228	CRS33228	S33228	. . .
WPS34565	CRS34565	S34565	. . .
WP347	CR347	S34700	347
WP347H	CR347H	S34709	347H
WP347LN	CR347LN	S34751	347LN
WPS34752	CRS34752	S34752	. . .
WP348	CR348	S34800	348
WP348H	CR348H	S34809	348H
WPS38815	CRS38815	S38815	. . .

[A] Naming system developed and applied by ASTM International.
[B] Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute (AISI).
[C] Common name, not a trademark widely used, not associated with any one producer.

5.8 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

5.9 Grade CR fittings shall meet the requirements of MSS SP-43 and do not require nondestructive examination.

5.10 All fittings shall have the welders, welding operators, and welding procedures qualified under the provisions of Section IX of the ASME Boiler and Pressure Vessel Code except that starting pipe welds made without the addition of filler metal do not require such qualification.

5.11 All joints welded with filler metal shall be finished in accordance with the requirements of Paragraph UW-35 (a) of Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code.

5.12 Fittings machined from bar shall be restricted to NPS 4 or smaller. Elbows, return bends, tees, and header tees shall not be machined directly from bar stock.

5.12.1 All caps machined from bar shall be examined by liquid penetrant in accordance with Supplementary Requirement S52 in Specification A960/A960M.

5.13 Weld buildup is permitted to dimensionally correct unfilled areas produced during cold forming of stub ends. Radiographic examination of the weld buildup shall not be required provided that all the following steps are adhered to:

5.13.1 The weld procedure and welders or welding operators meet the requirements of 5.10.

5.13.2 Annealing is performed after welding and prior to machining.

5.13.3 All weld surfaces are liquid penetrant examined in accordance with Appendix 8 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

5.13.4 Repair of areas in the weld is permitted, but 5.13.1, 5.13.2, and 5.13.3 must be repeated.

5.14 Stub ends may be produced with the entire lap added as weld metal to a straight pipe section provided the welding satisfies the requirements of 5.10 for qualifications and Section 6 for post weld heat treatment.

5.14.1 *Grade WP Class W*—Radiographic inspection of the weld is required. See 5.4.

5.14.2 *Grade WP Class WX*—Radiographic inspection of all welds is required. See 5.5.

5.14.3 *Grade WP Class WU*—Ultrasonic inspection of all welds is required. See 5.6.

5.14.4 *Grade CR*—Nondestructive examination is not required. See 5.12.1.

5.15 Stub ends may be produced with the entire lap added by the welding of a ring, made from plate or bar of the same alloy grade and composition, to the outside of a straight section of pipe, provided the weld is double welded, is a full penetration joint, satisfies the requirements of 5.10 for qualifications and Section 6 for post weld heat treatment.

5.15.1 *Grade WP Class W*—Radiographic inspection of the welds, made with the addition of filler metal, is required (see 5.4).

5.15.2 *Grade WP Class WX*—Radiographic inspection of all welds, made with or without the addition of filler metal, is required (see 5.5).

5.15.3 *Grade WP Class WU*—Ultrasonic inspection of all welds, made with or without the addition of filler metal, is required (see 5.6).

5.15.4 Grade CR nondestructive examination is not required (see 5.9).

5.16 After final heat treatment, all “H-Grade” steel fittings shall have a grain size of 7 or coarser in accordance with Test Methods E112.

6. Heat Treatment

6.1 All fittings shall be furnished in the heat-treated condition. For H grades, separate solution heat treatments are required for solution annealing; in-process heat treatments are not permitted as a substitute for the separate solution annealing treatments. The heat-treat procedure, except for those grades listed in 6.2, shall consist of solution annealing the fittings at the temperatures listed for each grade in Table 4 until the

TABLE 4 Heat Treatment

Grade WP[A]	Grade CR[A]	UNS Designation	Solution Anneal Temperature, min °F [°C][B]	Quench Media
WPXM-19	CRXM-19	S20910	1900 [1040]	water or other rapid cool
WP20CB	CR20CB	N08020	1700–1850 [927–1010]	water or other rapid cool
WP6XN	CR6XN	N08367	2025 [1107]	water or other rapid cool
WP700	CR700	N08700	2025–2100 [1107–1150]	water or other rapid cool
WPNIC	CRNIC	N08800	1800–1900 [983–1038][C]	water or other rapid cool
WPNIC10	CRNIC10	N08810	2100–2150 [1147–1177][C]	water or other rapid cool
WPNIC11	CRNIC11	N08811	2100–2150 [1147–1177][C]	water or other rapid cool
WP904L	CR904L	N08904	1985–2100 [1085–1150]	water or other rapid cool
WP1925	CR1925	N08925	1800–1900 [983–1038]	water or other rapid cool
WP1925N	CR1925N	N08926	2150 [1177]	water or other rapid cool
WP304	CR304	S30400	1900 [1040]	water or other rapid cool
WP304L	CR304L	S30403	1900 [1040]	water or other rapid cool
WP304H	CR304H	S30409	1900 [1040]	water or other rapid cool
WP304N	CR304N	S30451	1900 [1040]	water or other rapid cool
WP304LN	CR304LN	S30453	1900 [1040]	water or other rapid cool
WP309	CR309	S30900	1900 [1040]	water or other rapid cool
WP310S	CR310S	S31008	1900 [1040]	water or other rapid cool
WP310H	CR310H	S31009	1900 [1040]	water or other rapid cool
WPS31254	CR31254	S31254	2100 [1150]	water or other rapid cool
WPS31266	CRS31266	S31266	2100 [1150]	water or other rapid cool
WP316	CR316	S31600	1900 [1040]	water or other rapid cool
WP316L	CR316L	S31603	1900 [1040]	water or other rapid cool
WP316H	CR316H	S31609	1900 [1040]	water or other rapid cool
WP316N	CR316N	S31651	1900 [1040]	water or other rapid cool
WP316LN	CR316LN	S31653	1900 [1040]	water or other rapid cool
WP317	CR317	S31700	1900 [1040]	water or other rapid cool
WP317L	CR317L	S31703	1900 [1040]	water or other rapid cool
WPS31725	CRS31725	S31725	1900 [1040]	water or other rapid cool
WPS31726	CRS31726	S31726	1900 [1040]	water or other rapid cool
WPS31727	CRS31727	S31727	1975–2155 [1080–1180]	water or other rapid cool
WPS31730	CRS31730	S31730	1900 [1040]	water or other rapid cool
WPS32053	CRS32053	S32053	1975–2155 [1080–1180]	water or other rapid cool
WP321	CR321	S32100	1900 [1040]	water or other rapid cool
WP321H	CR321H	S32109	1925 [1050]	water or other rapid cool
WPS33228	CRS33228	S33228	2050–2160 [1120–1180]	water or other rapid cool
WPS34565	CRS34565	S34565	2050–2140 [1120–1170]	water or other rapid cool
WP347	CR347	S34700	1900 [1040]	water or other rapid cool
WP347H	CR347H	S34709	1925 [1050]	water or other rapid cool
WP347LN	CR347LN	S34751	1900 [1040]	water or other rapid cool
WPS34752	CRS34752	S34752	1940-2140 [1060-1170]	water or other rapid cool
WP348	CR348	S34800	1900 [1040]	water or other rapid cool
WP348H	CR348H	S34809	1925 [1050]	water or other rapid cool
WPS38815	CRS38815	S38815	1950 [1065]	water or other rapid cool

[A]Naming system developed and applied by ASTM International.
[B]Where a range of temperature is not listed, the single value shown shall be the minimum required temperature.
[C]Heat Treatment is highly dependent on intended service temperature; consult material manufacturer for specific heat treatments for end use temperature.

chromium carbides go into solution, and then cooling at a sufficient rate to prevent reprecipitation.

6.2 A solution annealing temperature above 1950 °F [1065 °C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in 321, 321H, 347, and 347H. When specified by the purchaser a lower temperature stabilizing treatment or a second solution anneal shall be used subsequent to the initial high-temperature solution anneal (see Supplementary Requirement S2).

6.3 All welding shall be done prior to heat treatment.

6.4 Fittings machined directly from solution-annealed forgings and bar stock need not be annealed again.

7. Chemical Composition

7.1 The chemical composition of each cast or heat used shall be determined and shall conform to the requirements of the chemical composition for the respective grades of materials listed in Table 2. The ranges as shown have been expanded to