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Designation: A403/A403M - 13a A403/A403M - 14

# Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings<sup>1</sup>

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 ( $\varepsilon$ ) 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.<sup>2</sup>

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.

#### 2. Referenced Documents

2.1 ASTM Standards:<sup>3</sup>

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 Practice for Liquid Penetrant Examination for General Industry

2.2 ASME Standards: <sup>4</sup>

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

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

2.3 MSS Standards: <sup>5</sup>

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

<sup>&</sup>lt;sup>1</sup> 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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<sup>&</sup>lt;sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-403 in Section II of that Code.

<sup>&</sup>lt;sup>3</sup> 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.

<sup>&</sup>lt;sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three<u>Two</u> Park Ave., New York, NY 10016-5990, http://www.asme.org.

<sup>&</sup>lt;sup>5</sup> 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.



#### **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-79 Socket-Welding Reducer Inserts

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: <sup>4</sup>

Section VIII Division I, I Pressure Vessels

Section IX, IX Welding Qualifications

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

4.2 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,

<sup>&</sup>lt;sup>6</sup> Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

<sup>&</sup>lt;sup>7</sup> Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

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# **TABLE 2** Chemical Requirements

WPXM-19     CRXM       WP20CB     CR20       WP6XN     CR62       WP6XN     CR6X       WP700     CR70       WPNIC     CRNM       WPNIC10     CRNM       WPNIC11     CRNM       WPNIC11     CRNM       WPNIC11     CRNM       WPNIC11     CRNM       WP904L     CR90       WP1925     CR19       WP304     CR30       WP316     CR31       WP316     CR31       WP316     CR31       WP317     CR31       WP3172     CR33       WPS31726     <	R700	R UNS Des- ignation S20910 N08020 N08367 N08700 N08800 N08810 N08811	C <sup>B</sup> 0.06 0.07 0.030 0.04 0.10 0.05- 0.10	Mn <sup><i>B</i></sup> 4.0–6.0 2.00 2.00 2.00 1.50	P <sup>B</sup> 0.045 0.045 0.040 0.040 0.045	S <sup>B</sup> 0.030 0.035 0.030 0.030	1.00	Ni 11.5–13.5 32.0–38.0		Mo 1.50-3.00	Ti 	N <sup>C</sup> 0.20– 0.40	Others D
NP20CB     CR20       NP6XN     CR6X       NP700     CR70       NPNIC     CRNI       NPNIC10     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NP904L     CR90       NP1925     CR19       NP304     CR30       NP304     CR31       NP316     CR31       NP316     CR31       NP317     CR31       NP3172     CR33       NPS31726     CR53       NPS31727     CR53       NPS31728     <	R20CB R6XN R700 RNIC RNIC10 RNIC11 R904L R1925	N08020 N08367 N08700 N08800 N08810	0.07 0.030 0.04 0.10	2.00 2.00 2.00	0.045 0.040 0.040	0.035	1.00						D
NP6XN     CR6X       NP700     CR70       NPNIC     CRNI       NPNIC10     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NPNIC11     CRNI       NP1925     CR19       NP1925N     CR19       NP304     CR30       NP305     CR31       NP315     CR31       NP316     CR31       NP317     CR31       NP3172     CR33       NPS31727     CR53       NPS31727     CR53       NPS31720     CR33       NPS31721     CR32       NP3212 <td>R6XN R700 RNIC RNIC10 RNIC11 R904L R1925</td> <td>N08367 N08700 N08800 N08810</td> <td>0.030 0.04 0.10</td> <td>2.00 2.00</td> <td>0.040 0.040</td> <td>0.030</td> <td></td> <td>32.0–38.0</td> <td>19.0–21.0</td> <td>0.00.0.00</td> <td></td> <td></td> <td></td>	R6XN R700 RNIC RNIC10 RNIC11 R904L R1925	N08367 N08700 N08800 N08810	0.030 0.04 0.10	2.00 2.00	0.040 0.040	0.030		32.0–38.0	19.0–21.0	0.00.0.00			
VP700     CR70       VPNIC     CRNI       VPNIC10     CRNI       VPNIC11     CRNI       VP904L     CR90       VP304     CR30       VP304     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR31       VP315     CR31       VP316     CR31       VP316L     CR31       VP317     CR31       VPS31725     CR53       VPS31726     CR53       VPS31727     CR53       VPS31720     CR53       VPS31721     CR32	R700 RNIC RNIC10 RNIC11 R904L R1925	N08700 N08800 N08810	0.04 0.10	2.00	0.040		1.00			2.00–3.00			Cu 3.0-4.0 Cb 8XC min, 1.00 max
VPNIC10     CRNI       VPNIC11     CRNI       VPNIC11     CRNI       VP1925     CR19       VP1925     CR19       VP1925N     CR19       VP304L     CR30       VP304L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP317C     CR33       VP3172C     CR53       VPS31726     CR53       VPS31727     CR53       VPS31720     CR53       VP3211     CR32       VPS3228     CR53       VPS34565     CR53       VPS34565     CR53	RNIC10 RNIC11 R904L R1925	N08810		1.50	0.045		1.00	23.5–25.5 24.0–26.0		6.0–7.0 4.3–5.0		0.18–0.25	Cu 0.75 Cu0.50 Cb 8XC min
VPNIC11     CRNI       VP904L     CR90       VP1925     CR19       VP1925N     CR19       VP304     CR30       VP304     CR31       VP316     CR31       VP316     CR31       VP316     CR31       VP316     CR31       VP317     CR31       VP3172     CR33       VPS31726     CR53       VPS31727     CR53       VPS31730     CR32       VPS321720     CR32       VPS3212     CR33       VPS34565     CR53       VPS34565	RNIC11 R904L R1925		0.05- 0.10			0.015	1.00	30.0–35.0	19.0–23.0	0.1	5–0.60		Al 0.15–0.60 Cu 0.75 Fe 39.5 min
VP904L     CR90       VP1925     CR19       VP1925N     CR19       VP304     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304H     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP317     CR31       VP317     CR31       VP317Z     CR33       VPS31725     CR53       VPS31727     CR53       VPS31730     CR32       VPS321053     CR53       VPS3212     CR32       VPS33228     CR53       VPS34565     CR53       VPS347     CR34	R904L R1925	N08811		1.50	0.045	0.015	1.00	30.0–35.0	19.0–23.0	0.1	5–0.60		Al 0.15–0.60 Cu 0.75 Fe 39.5 min
VP1925     CR19       VP1925N     CR19       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304N     CR30       VP304N     CR30       VP304N     CR30       VP304LN     CR30       VP304C     CR30       VP304C     CR30       VP304C     CR30       VP304LN     CR30       VP304C     CR31       VP316     CR31       VP316L     CR31       VP316N     CR31       VP316N     CR31       VP316N     CR31       VP317C     CR33       VPS31725     CRS3       VPS31726     CR33       VPS31727     CR33       VPS31730     CR33       VPS31726     CR33       VPS31726     CR33       VPS31727     CR33       VPS31728     CR33       VPS31720     CR33  V	R1925		0.60- 0.10	1.50	0.040	0.015	1.00	30.0–35.0	19.0–23.0	0.1	5–0.60		Al 0.15–0.60 Cu 0.75 Fe 39.5 min
VP1925     CR19       VP1925N     CR19       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304L     CR30       VP304N     CR30       VP304N     CR30       VP304N     CR30       VP304LN     CR30       VP304C     CR30       VP304C     CR30       VP304C     CR30       VP304LN     CR30       VP304C     CR31       VP316     CR31       VP316L     CR31       VP316N     CR31       VP316N     CR31       VP316N     CR31       VP316N     CR31       VP317C     CR33       VPS31725     CRS3       VPS31727     CR33       VPS31720     CR33       VPS3121     CR32       VPS3228     CR53       VPS34565     CR53       VPS347     CR34	R1925	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
VP1925N     CR19       VP304     CR30       VP304L     CR30       VP304H     CR30       VP304H     CR30       VP304H     CR30       VP304N     CR30       VP304N     CR30       VP304N     CR30       VP304N     CR30       VP304LN     CR30       VP304C     CR31       VP304C     CR33       VP316     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP317L     CR31       VP317Z     CR33       VPS31725     CRS3       VPS31726     CRS3       VPS31727     CRS3       VPS31730     CR33       VPS321     CR32       VPS33228     CRS3       VPS34565     CRS3       VPS34565     CRS3		N08925	0.020	1.00	0.045	0.030		24.0-26.0		6.0–7.0	-		Cu 0.8-1.5
VP304     CR30       VP304L     CR30       VP304H     CR30       VP304H     CR30       VP304H     CR30       VP304N     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP305     CR31       VP316     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP317     CR31       VP317     CR31       VPS31725     CRS3       VPS31726     CRS3       VPS31727     CRS3       VPS31730     CR32       VP321     CR32       VP33228     CR53       VPS33228     CR53       VPS34565     CR53       VPS347     CR34		N08926	0.020	2.00	0.030	0.010		24.0-26.0		6.0–7.0			Cu 0.5-1.5
VP304H     CR30       VP304N     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP304LN     CR30       VP309     CR30       VP310S     CR31       VP316L     CR31       VP317     CR31       VPS31725     CR53       VPS31726     CR53       VPS31727     CRS3       VPS31720     CR32       VP321     CR32       VP33228     CR53       VPS34565     CR53       VPS34565     CR53       VP347     CR34	R304	S30400	0.08	2.00	0.045	0.030		8.0-11.0	18.0-20.0				
VP304N     CR30       VP304LN     CR30       VP309     CR30       VP310S     CR31       VP310S     CR31       VP310S     CR31       VP31254     CR53       VP316     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316L     CR31       VP316LN     CR31       VP317     CR31       VP317     CR33       VPS31725     CR53       VPS31726     CR53       VPS31727     CR53       VPS31720     CR53       VPS31721     CR32       VP3211     CR32       VPS3228     CR53       VPS34565     CR53       VPS34565     CR53       VPS347     CR34	R304L	S30403	0.030 <sup>E</sup>	2.00	0.045	0.030	1.00	8.0-12.0	18.0-20.0				
WP304LN     CR30       WP309     CR30       WP310S     CR31       WP316     CR31       WP316     CR31       WP316     CR31       WP316     CR31       WP316     CR31       WP316     CR31       WP316N     CR31       WP316N     CR31       WP316LN     CR31       WP317C     CR33       WP3172     CR33       WPS31726     CRS3       WPS31727     CRS3       WPS31728     CRS3       WPS31729     CR33       WPS31720     CR33       WPS3121     CR32       WPS3228     CR33       WPS34565     CRS3       WPS34565     CRS3       WPS347     CR34	R304H	S30409	0.04-0.10	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0				
WP309     CR30       WP310S     CR31       WP311254     CRS3       WP316     CR31       WP316L     CR31       WP316L     CR31       WP316H     CR31       WP316H     CR31       WP316L     CR31       WP316L     CR31       WP316L     CR31       WP317     CR31       WP317L     CR33       WP317Z     CRS3       WPS31725     CRS3       WPS31727     CRS3       WPS31720     CRS3       WPS31721     CR32       VPS32053     CR53       WP321     CR32       WPS33228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS347     CR34	R304N	S30451	0.08	2.00	0.045	0.030	1.00	8.0-11.0	18.0–20.0			0.10-	
VP310S     CR31       VPS1254     CRS3       VP316     CR31       VP316L     CR31       VP316H     CR31       VP316H     CR31       VP316H     CR31       VP316N     CR31       VP316LN     CR31       VP317     CR31       VP317     CR31       VPS31725     CRS3       VPS31726     CRS3       VPS31727     CRS3       VPS31728     CRS3       VPS31729     CRS3       VPS31720     CRS3       VPS31721     CR32       VP321     CR32       VPS3218     CRS3       VPS33228     CRS3       VPS34565     CRS3       VPS34565     CRS3       VPS47     CR34	R304LN	S30453	0.030	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0			0.16 0.10– 0.16	
VPS31254     CRS3       VP316     CR31       VP316L     CR31       VP316H     CR31       VP316N     CR31       VP316L     CR31       VP316N     CR31       VP316LN     CR31       VP316LN     CR31       VP317     CR31       VP317     CR33       VPS31725     CRS3       VPS31726     CRS3       VPS31727     CRS3       VPS31730     CR33       VP321     CR32       VPS322053     CR53       VPS33228     CRS3       VPS34565     CRS3       VPS34565     CRS3       VPS347     CR34	R309	S30900	0.20	2.00	0.045	0.030	1.00	12.0-15.0	22.0-24.0				
NP316     CR31       NP316L     CR31       NP316H     CR31       NP316N     CR31       NP316N     CR31       NP316LN     CR31       NP316LN     CR31       NP317     CR31       NP317     CR31       NPS31725     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31720     CRS3       NPS31721     CR32       NP321     CR32       NPS33228     CRS3       NPS34565     CRS3       NPS34565     CRS3       NPS347     CR34	R310S	S31008	0.08	2.00	0.045	0.030	1.00	19.0-22.0	24.0-26.0				
VP316L     CR31       VP316H     CR31       VP316N     CR31       VP316LN     CR31       VP316LN     CR31       VP317     CR31       VP317     CR31       VP317     CR31       VP317     CR31       VP317     CR31       VPS31725     CRS3       VPS31726     CRS3       VPS31727     CRS3       VPS31730     CR33       VP321     CR32       VPS3228     CRS3       VPS34565     CRS3       VPS34565     CRS3       VPS34565     CRS3	RS31254	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
WP316H     CR31       WP316N     CR31       WP316LN     CR31       WP316LN     CR31       WP317     CR31       WP317     CR31       WP317L     CR31       WP317L     CR31       WP317L     CR33       WPS31725     CRS3       WPS31726     CRS3       WPS31727     CRS3       WPS31730     CR32       WP321     CR32       WPS33228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS34565     CRS3		S31600	0.08	2.00	0.045	0.030		10.0-14.0		2.00-3.00			
WP316N     CR31       WP316LN     CR31       WP317     CR31       WP317L     CR31       WP317L     CR31       WP317L     CR31       WP317L     CR31       WPS31725     CRS3       WPS31726     CRS3       WPS31726     CRS3       WPS31727     CRS3       WPS31730     CRS3       WPS32053     CRS3       WPS321     CR32       WPS3228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS347     CR34		S31603	0.030 <sup>E</sup>	2.00	0.045	0.030		10.0–14.0 <sup>F</sup>		2.00-3.00			
WP316LN     CR31       NP317     CR31       NP317L     CR31       NPS31725     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31730     CRS3       NPS32053     CRS3       NPS311720     CRS3       NPS31720     CRS3       NPS32053     CRS3       NPS321     CR32       NPS321H     CR32       NPS33228     CRS3       NPS34565     CRS3       NPS34565     CRS3		S31609	0.04–0.10	2.00	0.045	0.030		10.0-14.0		2.00-3.00			
NP317     CR31       NP317L     CR31       NP317Z     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31727     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31720     CRS3       NPS31721     CR32       NP321     CR32       NP321H     CR32       NPS33228     CRS3       NPS34565     CRS3       NPS34565     CRS3       NPS347     CR34	R316N	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-	
NP317L     CR31       NPS31725     CRS3       NPS31726     CRS3       NPS31727     CRS3       NPS31720     CRS3       NPS31730     CRS3       NPS31721     CRS3       NPS32053     CRS3       NP321     CR32       NP3221H     CR32       NPS33228     CRS3       NPS34565     CRS3       NPS34565     CRS3       NP347     CR34	R316LN	S31653	0.030	2.00	0.045	0.030	1.00	10.0–13.0	16.0–18.0	2.00-3.00		0.16 0.10– 0.16	
WPS31725     CRS3       WPS31726     CRS3       WPS31727     CRS3       WPS31730     CRS3       WPS32053     CRS3       WPS21     CR32       WPS322053     CR33       WPS21     CR32       WPS322053     CRS3       WPS21     CR32       WPS3258     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS47     CR34	R317	S31700	0.08	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0			
WPS31726     CRS3       WPS31727     CRS3       WPS31730     CRS3       WPS32053     CRS3       WPS321     CR32       WPS321H     CR32       WPS3228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS347     CR34	R317L cite	S31703	0.030	2.00 0/010	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0	-0f0/2	stm-a4(	)3-a403m-14
WPS31727     CRS3       MPS31730     CRS3       WPS32053     CRS3       WPS321     CR32       WP321     CR32       WP3221H     CR32       WPS3228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WPS347     CR34	RS31725	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	
WPS31730     CRS3       WPS32053     CR32       WP321     CR32       WP321H     CR32       WPS3228     CRS3       WPS34565     CRS3       WPS34565     CRS3       WP347     CR34	RS31726		0.030	2.00	0.045	0.030		13.5–17.5		4.0–5.0		0.10– 0.20	
NPS32053     CRS3       NP321     CR32       NP321H     CR32       NP321H     CR33       NPS33228     CRS3       NPS34565     CRS3       NP347     CR34	RS31727 RS31730		0.030	1.00	0.030 0.040	0.030		14.5–16.5 15.0–16.5		3.8–4.5 3.0–4.0		0.15– 0.21 0.045	Cu 2.8–4.0 Cu 4.0–5.0
NP321H CR32 NPS33228 CRS3 NPS34565 CRS3 NP347 CR34	RS32053	S32053	0.030	1.00	0.030	0.010	1.00	24.0-26.0	22.0-24.0	5.0-6.0	<u></u> 	0.17	
WPS33228 CRS3 WPS34565 CRS3 WP347 CR34		S32100	0.08	2.00	0.045	0.030		9.0-12.0	17.0-19.0		G H		
NPS34565 CRS3 NP347 CR34		S32109	0.04-0.10 0.04-0.08	2.00	0.045	0.030		9.0-12.0	17.0-19.0				Co 0 05 0 10
WP347 CR34					0.020	0.015		31.0–33.0					Ce 0.05–0.10 Al 0.025 Cb 0.6–1.0
	RS34565		0.030	5.0-7.0	0.030	0.010		16.0–18.0		4.0–5.0		0.40- 0.60	Cb 0.10
		S34700	0.08	2.00	0.045	0.030		9.0-12.0	17.0-19.0				J
	R347H R347LN	S34709 S34751	0.04–0.10 0.005– 0.020	2.00 2.00	0.045 0.045	0.030 0.030		9.0–12.0 9.0–13.0	17.0–19.0 17.0–19.0				Cb 0.20–0.50, <sup><i>K</i></sup> N 0.06–0.10 <sup><i>C</i></sup>
WP348 CR34	R348	S34800	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0				Cb+Ta=10×(C)-1.1 Ta 0.10
WP348H CR34		S34809	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0				Co 0.20 Cb+Ta=8×(C)-1.10 Ta 0.10
	പാ40ല												Co 0.20
WPS38815 CRS3		S38815	0.030	2.00	0.040	0.020	5.5-6.5	5 13.0-17.0	13.0-15.0	0.75-1.50			Cu 0.75-1.50 Al 0.30

<sup>A</sup> See Section <u>1415</u> for marking requirements.
<sup>B</sup> Maximum, unless otherwise indicated.
<sup>C</sup> The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
<sup>D</sup> Columbium 0.10–0.30 %; Vanadium, 0.10–0.30 %.

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<sup>E</sup> 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.

<sup>F</sup> On pierced tubing, the nickel may be 11.0–16.0 %.

<sup>G</sup> 5X(C+N) min-0.70 max.

<sup>H</sup> 4X(C+N) min-0.70 max.

<sup>1</sup> The columbium content shall be not less than ten times the carbon content and not more than 1.10 %.

<sup>J</sup> The columbium content shall be not less than eight times the carbon content and not more than 1.10 %.

<sup>*K*</sup>The columbium content shall be not less than 15 times the carbon content.

Grade WP <sup>A</sup> Grade CR <sup>A</sup> UNS Designation     Type <sup>B</sup> WPXM-19     CRXM-19     S20910     XM-19 <sup>C</sup> WP20CB     CR20CB     N08020        WP6XN     CR6KN     N08267        WP700     CR700     N08700        WPNIC10     CRNIC     N08800     800 <sup>C</sup> WPNIC10     CRNIC1     N08810     800 <sup>LC</sup> WPNIC10     CRNIC11     N08811        WP904L     CR904L     N08926        WP304     CR304H     S30400     304L       WP304L     CR304H     S30409     304H       WP304L     CR304H     S30409     304H       WP304L     CR304H     S30409     304H       WP304L     CR304H     S30409     304H       WP305     CR310S     S31600     316       WP305     CR310S     S31600     316       WP316L     CR316H     S31603     316H       WP316L     CR317L     S31725     317		TABLE 3 Common Names				
WP20CB     CR20CB     N08020        WP6XN     CR6XN     N083670        WP700     CR700     N08800     800 <sup>-6</sup> WPNIC10     CRNIC10     N08810     800H <sup>6</sup> WPNIC10     CRNIC11     N08811        WPNIC10     CRNIC11     N08925        WP304     CR304     S30400     304       WP304     CR304     S30451     304N       WP304     CR316     S31600     316       WP305     CR316     S31600     316       WP316     CR316     S31603     316H       WP316     CR3172     S31726     317LM <sup>6</sup> WP317 <th></th> <th>Grade WP<sup>A</sup></th> <th>Grade CR<sup>A</sup></th> <th>UNS Designation</th> <th>Type<sup>B</sup></th> <th></th>		Grade WP <sup>A</sup>	Grade CR <sup>A</sup>	UNS Designation	Type <sup>B</sup>	
WP20CB     CR20CB     N08020        WP6XN     CR6XN     N083670        WP700     CR700     N08800     800 <sup>-6</sup> WPNIC10     CRNIC10     N08810     800H <sup>6</sup> WPNIC10     CRNIC11     N08811        WPNIC10     CRNIC11     N08925        WP304     CR304     S30400     304       WP304     CR304     S30451     304N       WP304     CR316     S31600     316       WP305     CR316     S31600     316       WP316     CR316     S31603     316H       WP316     CR3172     S31726     317LM <sup>6</sup> WP317 <td></td> <td>WPXM-19</td> <td>CRXM-19</td> <td>S20910</td> <td></td> <td></td>		WPXM-19	CRXM-19	S20910		
WP6XN     CR6XN     N08367       WP700     CR700     N08700        WPNIC     CRNIC     N08800     8004       WPNIC10     CRNIC1     N08810     8004       WPNIC11     CRNIC11     N08811        WP904     CR904L     N08904     904L <sup>C</sup> WP1925     CR1925     N08926        WP304     CR304L     S30400     304L       WP304L     CR304L     S30403     304L       WP304     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304L     CR304L     S30453     304LN       WP304L     CR3108     S31603     316L       WP316     CR316     S31600     316       WP316     CR316     S31603     316L       WP316     CR316L     S31603     316L       WP316     CR3172     S31703     317L       WP3172 <td< td=""><td></td><td>WP20CB</td><td></td><td></td><td></td><td></td></td<>		WP20CB				
WP700     CR700     N08700        WPNIC     CRNIC10     N08800     800 <sup>-C</sup> WPNIC10     CRNIC10     N08801     800H <sup>0</sup> WPNIC11     CRNIC11     N08811        WP904L     CR904L     N08904     904L <sup>C</sup> WP1925     CR1925N     N08925        WP304     CR304     S30400     304       WP304L     CR304H     S30409     304H       WP304L     CR304H     S30409     304H       WP304L     CR304H     S30409     304H       WP304N     CR304H     S30451     304N       WP304S     CR304H     S30453     304L       WP304N     CR304H     S31609     310S       WP305     CR310S     S31008     310S       WP310B     CR316H     S31603     316H       WP316N     CR316H     S31603     317L       WP317     CR317ZS     S31726     317LM <sup>o</sup> WP3172     CRS31725     S31726     317LM <sup>o</sup> <						
WPNIC     CRNIC     N08800     800 <sup>C</sup> WPNIC110     CRNIC10     N08811        WPNIC11     CRNIC11     N08904     904L <sup>C</sup> WP1925     CR1925     N08925        WP304L     CR304L     S30400     304       WP304     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304L     CR304L     S30403     304L       WP304LN     CR304L     S30403     304LN       WP304LN     CR304LN     S30453     304LN       WP304L     CR31254     S3108     310S       WP316     CR316     S31603     316L       WP316L     CR316L     S31603     316L       WP316L     CR317L     S31703     317L       WP317L     CR31725     S31727     S17LMC <sup>C</sup> WP331725     CRS31725     S31727     S17L						
WPNIC10   CRNIC10   N08810   800H <sup>C</sup> WPNIC11   CRNIC11   N08811      WP904L   CR904L   N08904   904L <sup>C</sup> WP1925   CR1925   N08925      WP304   CR304   S30400   304     WP304   CR304   S30403   304L     WP304H   CR304H   S30403   304H     WP304UN   CR304N   S30453   304LN     WP304L   CR304N   S30453   304LN     WP304UN   CR304N   S30453   304LN     WP304   CR304N   S30453   304LN     WP305   CR315S   S31008   310S     WP316L   CR316S   S31600   316     WP316L   CR316N   S31651   316H     WP317D   CR3172   S31703   317L     WP3172   CR31725   S31725   317LM <sup>C</sup> WP3172   CR31726   S31726   317LM <sup>C</sup> WP331725   CRS31726   S31726   317LM <sup>C</sup> WP331727   CRS31727   S31727   W						
WPNC11   CRNIC11   N08811      WP904L   CR904L   N08905      WP1925   CR1925N   N08926      WP304   CR304   S30400   304L     WP304L   CR304H   S30403   304L     WP304L   CR304H   S30403   304L     WP304L   CR304H   S30451   304LN     WP304LN   CR304LN   S30451   304LN     WP304L   CR304N   S30451   304LN     WP305   CR310S   S31008   316L     WP310S   CR316   S31600   316     WP316L   CR316L   S31603   316L     WP316L   CR316L   S31603   316L     WP316L   CR316L   S31653   316L     WP317L   CR317L   S31703   317L     WP317L   CR317Z   S31725   317LM°2     WPS3172C   CRS31726   S31727      WPS31727   CRS31727   S31703   317LM°2     WPS31727   CRS31726   S32263   S32063						
WP904L   CR904L   N08924   904L <sup>C</sup> WP1925   CR1925   N08925      WP304   CR304   S30400   304     WP304L   CR304L   S30403   304L     WP304H   CR304H   S30409   304L     WP304H   CR304H   S30453   304LN     WP304L   CR304N   S30453   304LN     WP304L   CR304   S31058   3105     WP304L   CR304   S31030   316     WP305   CR31254   S31023   316L     WP316   CR316   S31600   316     WP316L   CR316H   S31603   316L     WP316L   CR316N   S31631   316L     WP316L   CR316N   S31651   316N     WP317   CR317L   S31726   317LM <sup>C</sup> WP3172   CR31725   S31726   317LM <sup>C</sup> WP3172   CRS31727   S31726   317LM <sup>C</sup> WP3172   CRS31727   S31726   317LM <sup>C</sup> WPS31725   CRS31726   S31726   317LM <sup>C</sup> <						
WP1925   CR1925   N08925      WP1925N   CR1925N   N08926      WP304   CR304   S30400   304     WP304L   CR304L   S30403   304L     WP304H   CR304H   S30409   304H     WP304N   CR304N   S30453   304LN     WP304LN   CR304N   S30453   304LN     WP305   CR310S   S31008   310S     WP3105   CR31254   S31603   316     WP316   CR316L   S31600   316     WP316   CR316H   S31603   316L     WP316L   CR316H   S31603   316L     WP316L   CR316H   S31603   316L     WP316L   CR3172   S31700   317L     WP316L   CR3172   S31720   317LM°     WP317   CR3172   S31720   317LM°     WPS31727   CRS31726   S31720   317LM°     WPS31730   CR32053   S32053      WPS31730   CR32053   S32053      WPS317						
WP1925N   CR1925N   N08926      WP304   CR304   S30400   304     WP304H   CR304L   S30403   304L     WP304H   CR304H   S30409   304H     WP304N   CR304N   S30451   304N     WP304N   CR304N   S30453   304LN     WP309   CR309   S30900   309     WP316   CR31254   S31008   310S     WP316   CR316L   S31600   316L     WP316H   CR316H   S31603   316L     WP316H   CR316L   S31603   316L     WP316L   CR316L   S31603   316L     WP316H   CR316L   S31603   316L     WP3172   CR31725   S31725   317LM°     WP3172   CRS31725   S31725   317LM°     WPS31725   CRS31726   S31730      WPS31726   CRS31730   S31730      WPS31730   CR32053   S32053      WPS31727   CRS31726   S31730      WPS						
WP304   CR304   S30400   304     WP304L   CR304L   S30403   304L     WP304H   CR304N   S30403   304H     WP304N   CR304N   S30451   304N     WP304LN   CR304LN   S30453   304LN     WP309   CR309   S30900   309     WP310S   CR316S   S31008   310S     WP316L   CR316L   S31603   316     WP316H   CR316H   S31603   316L     WP316H   CR316H   S31603   316L     WP316H   CR316H   S31603   316L     WP316H   CR316H   S31603   316L     WP317L   CR3177   S31700   317L     WP317L   CR31725   S31725   317LM <sup>o</sup> WP331725   CRS31727   S31727      WP331730   CRS31727   S31727      WP321   CR3214   S32100   321     WP332865   CRS33228   S33228      WP334565   CRS3465   S34700   347     WP3347<						
WP304L   CR304L   S30403   304L     WP304H   CR304H   S30409   304H     WP304H   CR304N   S30451   304N     WP304LN   CR304LN   S30453   304LN     WP309   CR309   S30900   309     WP310S   CR310S   S31008   310S     WP316L   CR316   S31600   316     WP316H   CR316L   S31603   316H     WP316N   CR316LN   S31653   316H     WP316N   CR316LN   S31653   316H     WP316N   CR317   S31703   317L     WP317L   CR317   S31703   317L     WPS31725   CRS31725   S31726   317LM <sup>or</sup> WPS31727   CRS31730   S31726   317LM <sup>or</sup> WPS31726   CRS31730   S32100   321     WPS32053   CRS32053   S32206      WPS32126   CRS31730   S31726      WPS31727   CRS31730   S31726      WPS31727   CRS31730   S32100   321  <						
WP304H   CR304H   S30409   304H     WP304N   CR304N   S30451   304N     WP304LN   CR304N   S30451   304LN     WP304LN   CR309   S30900   309     WP309   CR309   S30900   309     WP310S   CR310S   S31008   310S     WP316L   CR316   S31600   316     WP316L   CR316L   S31603   316L     WP317L   CR3172   S31700   317L     WP317Z   CRS31725   S31726   317LM°     WPS31725   CRS31726   S31727   S31726     WPS31730   CR31730   S31730   S31730     WPS32053   CR32053   S32053   S32109     WPS31720   CR3214   S32100   321     WPS						
WP304N     CR304N     S30451     304N       WP304LN     CR304LN     S30453     304LN       WP309     CR309     S30900     309       WP310S     CR310S     S31008     310S       WP316L     CR316     S3160     316       WP316L     CR316L     S31609     316H       WP316L     CR316L     S31609     316H       WP316L     CR316L     S31609     316H       WP316L     CR316L     S31609     316H       WP316L     CR316L     S31603     316L       WP316N     CR317L     S31700     317L       WP317L     CR317Z5     S31725     317LM°       WPS31726     CRS31726     S31726     317LM°       WPS31730     CRS31727     S31720     317LM°       WPS31730     CRS31727     S31720        WPS31730     CRS31726     S32053        WPS31730     CRS3228     S32053        WPS31730     CRS3228     S32109     321H <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
WP304LN   CR304LN   S30453   304LN     WP309   CR309   S30900   309     WP310S   CR310S   S31008   310S     WP310S   CR310S   S31254   S31254   S31254     WP316   CR316   S31600   316     WP316L   CR316L   S31600   316L     WP316N   CR316L   S31651   316L     WP316N   CR316L   S31653   316L     WP317L   CR317L   S31700   317L     WP3172   CRS31725   S31725   317LM°     WPS31725   CRS31726   S31726   317LM°     WPS31727   CRS31726   S31726   317LM°     WPS31726   CRS31726   S31720   317LM°     WPS31727   CRS31726   S31720   317LM°     WPS31728   CRS31726   S32100   321     WPS321   CRS3174   S32100   321     WPS3328   CRS3228   S32100   321     WPS34565   CRS3228   S32100   321     WPS34565   CRS3328   S34565   .						
WP309   CR309   \$30900   309     WP310S   CR310S   \$31008   310S     WP31254   CRS31254   \$31254      WP316   CR316   \$31600   316     WP316L   CR316L   S31603   316L     WP316H   CR316L   S31609   316L     WP316L   CR316L   S31653   316L     WP316L   CR316L   S31653   316L     WP316L   CR316L   S31653   316L     WP316L   CR317   S31700   317L     WP317   CR3172   S31726   317LM <sup>C</sup> WP3172   CRS31725   S31726   317LM <sup>C</sup> WPS31726   CRS31726   S31726   317LM <sup>C</sup> WPS31727   CRS31726   S31726   317LM <sup>C</sup> WPS32112   CR321   S32100   321     WP321H   CR321   S32100   321     WP33228   CRS3328   S3228      WP347   CR334565   S34565      WP347   CR347   S34700   347     WP3						
WP310S   CR310S   S31008   310S     WPS31254   CRS31254   S31254      WP316   CR316   S31600   316L     WP316L   CR316L   S31603   316L     WP316H   CR316H   S31603   316H     WP316H   CR316H   S31603   316H     WP316L   CR316LN   S31651   316N     WP317L   CR317L   S31700   317L     WP317Z5   CRS31725   S31725   317LM°C     WPS31726   CRS31726   S31720   317L     WPS31727   CRS31727   S31700   317L     WPS31726   CRS31726   S31730   S31700     WPS31727   CRS31727   S31700   317L     WPS31728   CRS32053   S32053      WPS31730   CRS32053   S32053      WP321H   CR321H   S3200   321H     WP33228   CRS33228       WP3347   CR347   S34700   347     WP3471   CR347H   S34709   347H						
WPS31254   CRS31254   S31254      WP316   CR316   S31600   316     WP3161   CR3161   S31609   3161     WP3161   CR3161   S31609   3161     WP3161   CR316N   S31651   316N     WP3161   CR3161   S31609   3161     WP3161   CR316N   S31653   316LN     WP3161   CR3172   S31700   317     WP3171   CR3172   S31700   317L     WP31725   CRS31725   S31725   317LM°     WPS31726   CRS31726   S31727   317LM°     WPS31726   CRS31726   S31726   317LM°     WPS31727   CRS31726   S31730      WPS32053   CRS32053   S32053      WP3211   CR3224   S32100   3211     WP33228   CRS33228   S34565      WPS34565   CRS34565   S34565      WP347   CR347   S34700   347     WP3471N   CR347H   S34709   347H						
WP316   CR316   S31600   316     WP316L   CR316L   S31603   316L     WP316H   CR316H   S31609   316H     WP316EN   CR316N   S31651   316L     WP316EN   CR316LN   S31651   316LN     WP317   CR317   S31700   317L     WP3172   CRS31725   S31725   317LM°     WPS31725   CRS31725   S31725   317LM°     WPS31727   CRS31727   S31700   317LM°     WPS31726   CRS31727   S31726   317LM°     WPS31727   CRS31730   S31720   317LM°     WPS32053   CRS32053   S32053      WPS32053   CRS3228   S32109   321H     WPS3228   CRS3228   S3228      WP321H   CR321   S32109   321H     WP334565   CRS34565   S34565      WP347   CR347   S34700   347     WP347H   CR347H   S34709   347LN     WP348   CR348   S34800   348H						
WP316L   CR316L   S31603   S1603   S16L     WP316H   CR316H   S31609   S16H     WP316N   CR316N   S31651   S16N     WP316L   CR316L   S31651   S16N     WP316L   CR316L   S31653   S16L     WP316L   CR316L   S31653   S16L     WP317L   CR317   S31700   S17     WP317Z   CRS31725   S31725   S1725     WPS31726   CRS31726   S31726   S17LMC <sup>C</sup> WPS31727   CRS31726   S31726   S17LMN <sup>C</sup> WPS31727   CRS31730   S31730      WPS31730   CRS32053   S32053      WP321   CR321   S32100   321     WP321H   CR321H   S32109   321H     WP33228   CRS33228   S33228      WP347   CR347   S34700   347     WP3471   CR347   S34700   347     WP3471   CR3471   S34709   347H     WP347LN   CR3471   S34709   347H <						
WP316H   CR316H   S31609   316H     WP316N   CR316N   S31651   316N     WP316LN   CR316LN   S31653   16LN     WP317   CR317L   S31700   317L     WP317   CR317L   S31703   317L     WP31725   CRS31725   S31725   317LMC <sup>o</sup> WPS31726   CRS31726   S31726   317LMN <sup>o</sup> WPS31727   CRS31726   S31726   317LMN <sup>o</sup> WPS31727   CRS31730   S31730      WPS32053   CRS32053   S32053      WP3214   CR321   S32100   321     WPS31726   CRS3228   S33228      WP321H   CR321H   S32109   321H     WP332055   CRS33228   S33228      WP347   CR347   S34700   347     WP347LN   CR347H   S34709   347H     WP347LN   CR347LN   S34751   347LN     WP348   CR348   S34800   348H     WP348H   CR348H   S34809   348H						
WP316N   CR316N   S31651   316N     WP316LN   CR316LN   S31653   116LN     WP317L   CR317   S31700   317L     WP3172   CR317L   S31703   317L     WPS31725   CRS31725   S31725   317LM°     WPS31726   CRS31726   S31726   317LM°     WPS31720   CRS31726   S31726   317LM°     WPS31730   CRS31730   S31730      WP3211   CR321   S32053      WP321H   CR321   S322053      WPS31655   CRS3228   S33228      WP3214   CR321   S34700   347     WP3347   CR347   S34700   347     WP347   CR347   S34700   347     WP347LN   CR347LN   S34751   347LN     WP348   CR348   S34800   348     WP348H   CR348H   S34809   348H						
WP316LN   CR316LN   S31653   316LN     WP317   CR317   S31700   317     WP317L   CR317L   S31700   317L     WP317L   CR317L   S31703   317L     WPS31725   CRS31725   S31725   317LMC <sup>C</sup> WPS31726   CRS31726   S31726   317LMC <sup>C</sup> WPS31726   CRS31726   S31727      WPS31730   CRS31730   S32053      WPS31730   CRS32053   S32053      WPS3121   CR321   S32100   321     WPS3228   CRS3228   S33228      WPS34565   CRS34565   S34565      WPS3474   CR347   S34709   347     WP3471   CR3471   S34709   347     WP3472LN   CR347LN   S34709   347     WP347LN   CR347   S34709   347     WP347LN   CR347   S34709   347     WP347LN   CR347   S34709   347     WP348   CR348   S34800   348						
WP317   CR317   S31700   317     WP317L   CR317L   S31703   317L     WP317L   CR31725   S31725   317LMC     WPS31726   CRS31726   S31726   317LMC     WPS31726   CRS31726   S31726   317LMC     WPS31726   CRS31726   S31726   317LMNC     WPS31727   CRS31720       WPS32053   CRS32053   S32053      WPS321   CR321   S32100   321     WPS3228   CRS3228   S33228      WPS34565   CRS34565   S34565      WPS34565   CRS34565   S34700   347     WP3471   CR3471   S34709   347LN     WP347LN   CR347LN   S34709   347LN     WP347LN   CR347   S34709   347LN     WP347LN   CR347   S34709   347LN     WP347LN   CR348   S34800   348     WP348   CR348   S34809   348H						
WP317L   CR317L   S31703   317L     WPS31725   CRS31725   S31725   317LMC     WPS31726   CRS31726   S31726   317LMC     WPS31726   CRS31726   S31726   317LMC     WPS31726   CRS31726   S31727      WPS31727   CRS31720   S31730      WPS31730   CRS32053   S32053      WPS321   CR321   S32100   321     WP321   CR321H   S32109   321H     WPS33228   CRS33228   S33228      WPS34565   CRS34565   S34565      WP3471   CR347   S34700   347     WP347LN   CR347LN   S34709   347LN     WP347LN   CR347LN   S34709   347LN     WP347LN   CR347LN   S34709   347LN     WP347LN   CR347LN   S34709   347LN     WP347LN   CR348   S34800   348     WP348   CR348   S34809   348H     WP348H   CR348H   S34809   348H <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
WPS31725   CRS31725   S31725   S317LMC     WPS31726   CRS31726   S31726   S31726     WPS31727   CRS31726   S31727   S17LMNC     WPS31730   CRS31730   S31730      WPS32053   CRS32053   S32053      WPS211   CR321   A403/A40   S32100   321     WPS31726   CRS3228   S33228      WPS34565   CRS34565   S34565      WPS34565   CRS3477   S34700   347     WP347   CR347   S34709   347H     WP347LN   CR347LN   S34703   347LN     WP348   CR348   S34800   348     WP348H   CR348H   S34809   348H				S31700	317	
WPS31726   CRS31726   S31726   317LMN <sup>C</sup> WPS31727   CRS31727   S31727      WPS31730   CRS31730   S31730      WPS32053   CRS32053   S32053      WPS21   CR321   A403/A40   S32100   321     WPS31727   CRS31726   S32109   3214     WPS21H   CR321H   S3228   S33228      WPS34565   CRS34565   S34565      WPS34565   CRS34565   S34700   347     WP347   CR347   S34709   347H     WP347LN   CR347LN   S34751   347LN     WP348   CR348   S34800   348     WP348H   CR348H   S34809   348H		WP317L	CR317L	S31703		
WPS31727     CRS31727     S31727        WPS31730     CRS31730     S31730        WPS2053     CRS32053     S32053        WP321     CR321     A403/A40     S32100     321       ards.itch.al/catal     WPS32055     CRS3228     S32100     321       WPS314     CR321     A403/A40     S32100     321       WPS32055     CRS3228     CRS3228     S3228     321       WPS34565     CRS34565     S34565        WP347     CR347     S34700     347       WP347H     CR347H     S34709     347H       WP347LN     CR347LN     S34751     347LN       WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H		WPS31725	CRS31725	S31725	317LM <sup>C</sup>	
WPS31730 WPS32053     CRS31730 CRS32053     S31730 S32053        WPS3210     CR321     A403/A40     S32100     321       Iards.iteh.ai/catal     WP321H WPS3228     CR321     A403/A40     S32100     321       WPS3228     CRS3228     CRS3228     S3228     S3228     S3228       WPS35228     CRS34565     S34565     S34565     S34565       WP347     CR347     S34700     347       WP347H     CR347H     S34709     347H       WP347LN     CR347LN     S34751     347LN       WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H		WPS31726	CRS31726	S31726	317LMN <sup>C</sup>	
WPS31730 WPS32053     CRS31730 CRS32053     S31730 S32053        wP321     CR321     A403/A40     S32100     321       wP321     CR321     A403/A40     S32100     321       wP321     CR321     S32053      S32100     321       wP321     CR321     S32100     321     S32100     321       wPS31730     CR3228     S3228     S322100     321     S32100     321       wPS33228     CRS3228     S3228     S329     S3		WPS31727	CRS31727	S31727		
WPS32053   CRS32053   S32053      WP321   CR321   A403/A40   S32100   321     Iards.iteh.al/catal   WP321H   CR321H   S32100   321H     WPS3228   CRS33228   S32209   9033-2   321H     WPS3228   CRS33228   S3228   S3228   S3228     WPS33228   CRS34565   S34565      WPS475   CRS347   S34700   347     WP3471   CR3471   S34709   347H     WP347LN   CR347LN   S34751   347LN     WP348   CR348   S34800   348     WP348H   CR348H   S34809   348H		WPS31730	CRS31730	S31730		
WP321     CR321     A403/A40     S32100     321       Iards.iteh.ai/cata     WP321H     CR321H     S32109     2321H     2003 - 2321H     2004 - 2000 <td>-</td> <td>WPS32053</td> <td>CRS32053</td> <td>S32053</td> <td></td> <td></td>	-	WPS32053	CRS32053	S32053		
dards.iteh.ai/catak WP321H WPS33228 CR321H CR333228 cb8-4151 S32109 S33228 S321H 3cb9e0f0/astm-a403-a403 WPS34565 CRS34565 S34565 WP347 CR347 S34700 347 WP347H CR347H S34709 347H WP347LN CR347LN S34751 347LN WP348 CR348 S34800 348 WP348H CR348H S34809 348H		WP321	CR321 A403			
MPS33228     CRS33228     CRS33228     CRS33228     CRS33228       WPS34565     CRS34565     S34565        WP347     CR347     S34700     347       WP347H     CR347H     S34709     347H       WP347LN     CR347LN     S34751     347LN       WP348     CR348H     S34800     348       WP348H     CR348H     S34809     348H					00111	
WPS34565     CRS34565     S34565        WP347     CR347     S34700     347       WP347H     CR347H     S34709     347H       WP347LN     CR347LN     S34751     347LN       WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H					33-28323eb9e010/astm-a	
WP347CR347S34700347WP347HCR347HS34709347HWP347LNCR347LNS34751347LNWP348CR348S34800348WP348HCR348HS34809348H						
WP347H     CR347H     S34709     347H       WP347LN     CR347LN     S34751     347LN       WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H						
WP347LN     CR347LN     S34751     347LN       WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H						
WP348     CR348     S34800     348       WP348H     CR348H     S34809     348H						
WP348H CR348H S34809 348H						
WPS38815 CRS38815 S38815		WPS38815	CRS38815	S34809 S38815		

<sup>A</sup> Naming system developed and applied by ASTM International.

<sup>B</sup> Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute (AISI).

 $^{\ensuremath{\mathcal{C}}}$  Common name, not a trademark widely used, not associated with any one producer.

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.

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.

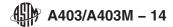
### 6. Heat Treatment

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 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 stabilization or resolution 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 resolution annealed.



#### **TABLE 4 Heat Treatment**

Grade WP <sup>A</sup>	Grade CR <sup>A</sup>	UNS Designation	Solution Anneal Temperature, min °F [°C	Quench Media
WPXM-19	CRXM-19	S20910	1900 [1040]	water or other rapid cool
WP20CB	CR20CB	N08020	1700–1850	water or other rapid cool
	01.2002		[927–1010]	
WP6XN	CR6XN	N08367	2025 [1107]	water or other rapid cool
WP700	CR700	N08700	2025–2100	water or other rapid cool
	000		[1107–1150]	
WPNIC	CRNIC	N08800	1800–1900	water or other rapid cool
		100000	[983–1038] <sup>C</sup>	
WPNIC10	CRNIC10	N08810	2100–2150	water or other rapid cool
	01111010		[1147–1177] <sup>C</sup>	
WPNIC11	CRNIC11	N08811	2100–2150	water or other rapid cool
WINIOTI	ormorr	100011	[1147–1177] <sup>C</sup>	water of other rapid coor
WP904L	CR904L	N08904	1985–2100	water or other rapid cool
WF904L	CH904L	100904	[1085–2100	water of other rapid coor
WP1925	CR1925	N08925		water or other repid cool
WP 1925	CR1925	1008925	1800–1900	water or other rapid cool
		Nooooo	[983–1038]	
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
WPS31254	CR31254	S31254	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	\$31703	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	water or other rapid cool
	onconter	001121	[1080–1180]	
WPS31730	CRS31730	S31730	1900 [1040]	water or other rapid cool
WPS32053	CRS32053	S32053	1975–2155	water or other rapid cool
WI 002000	011002000	0000000	[1080–1180]	water of other rapid coor
WP321	CR321	S32100	1900 [1040]	water or other rapid cool
WP321H	CR321H	S32100		water or other rapid cool
			1925 [1050]	
WPS33228	CRS33228	AS33228 A403/A40	2050-2160	water or other rapid cool
where tandard	Is iteh a CRS34565 standa	rds/sist/\$34565 eb8-4151	_49ed [1120–1180]	e0f0/astm-a403-a403m-14
WPS34565	CR534565	534565	2050-2140	water or other rapid cool
	00047	00.1700	[1120–1170]	
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
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

<sup>A</sup>Naming system developed and applied by ASTM International.

<sup>B</sup>Where a range of temperature is not listed, the single value shown shall be the minimum required temperature.

<sup>o</sup>Heat Treatment is highly dependent on intended service temperature; consult material manufacturer for specific heat treatments for end use temperature.

## 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 include variations of the chemical analysis requirements that are listed in the various specifications for starting materials (pipe, tube, plate, bar, and forgings) normally used in the manufacturing of fittings to this specification. Methods and practices relating to chemical analyses required by this specification shall be in accordance with Test Methods, Practices, and Terminology A751. Product analysis tolerances in accordance with Specification A960/A960M are applicable.

7.2 The steel shall not contain any unspecified elements for the ordered grade to the extent that it conforms to the requirements of another grade for which that element is a specified element having a required minimum content.

7.3 In fittings of welded construction, the alloy content (carbon, chromium, nickel, molybdenum, columbium, and tantalum) of the deposited weld metal shall conform to that required of the base metal or for equivalent weld metal as given in the AWS filler metal specification A 5.4 or A 5.9 (Type 348 weld metal is listed in AWS A 5.9 but not in AWS A 5.4). Exceptions are when welding