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Used in USDOE-NE standards

# Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes[1]

This standard is issued under the fixed designation A312/A312M; 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[2] covers seamless, straight-seam welded, and heavily cold worked welded austenitic stainless steel pipe intended for high-temperature and general corrosive service.

NOTE 1—When the impact test criterion for a low-temperature service would be 15 ft·lbf [20 J] energy absorption or 15 mils [0.38 mm] lateral expansion, some of the austenitic stainless steel grades covered by this specification are accepted by certain pressure vessel or piping codes without the necessity of making the actual test. For example, Grades TP304, TP304L, and TP347 are accepted by the ASME Pressure Vessel Code, Section VIII Division 1, and by the Chemical Plant and Refinery Piping Code, ANSI B31.3, for service at temperatures as low as −425 °F [−250 °C] without qualification by impact tests. Other AISI stainless steel grades are usually accepted for service temperatures as low as −325 °F [−200 °C] without impact testing. Impact testing may, under certain circumstances, be required. For example, materials with chromium or nickel content outside the AISI ranges, and for material with carbon content exceeding 0.10 %, are required to be impact tested under the rules of ASME Section VIII Division 1 when service temperatures are lower than −50 °F [−45 °C].

1.2 Grades TP304H, TP309H, TP309HCb, TP310H, TP310HCb, TP316H, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP309Cb, TP309S, TP310Cb, TP310S, TP316, TP321, TP347, and TP348, and are intended for service at temperatures where creep and stress rupture properties are important.

1.3 Optional supplementary requirements are provided for pipe where a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, it is permitted to specify in the order one or more of these supplementary requirements.

1.4 Table X1.1 lists the standardized dimensions of welded and seamless stainless steel pipe as shown in ANSI B36.19. These dimensions are also applicable to heavily cold worked pipe. Pipe having other dimensions is permitted to be ordered and furnished provided such pipe complies with all other requirements of this specification.

1.5 Grades TP321 and TP321H have lower strength requirements for pipe manufactured by the seamless process in nominal wall thicknesses greater than ⅜ in. [9.5 mm].

1.6 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. The inch-pound units shall apply unless the "M" designation of this specification is specified in the order.

NOTE 2—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as "nominal diameter," "size," and "nominal size."

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E112 Test Methods for Determining Average Grain Size

E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-312 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.

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

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E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ANSI Standards:*[4]

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 *ASME Standard:*

ASME Boiler and Pressure Vessel Code : Section VIII[5]

2.4 *AWS Standard:*

A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes[6]

2.5 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[7]

## 3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Specification A999/A999M and Terminology A941 are applicable to this specification.

## 4. Ordering Information

4.1 Orders for material to this specification shall conform to the requirements of the current edition of Specification A999/A999M.

## 5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A999/A999M unless otherwise provided herein.

## 6. Materials and Manufacture

6.1 *Manufacture:*

6.1.1 The pipe shall be manufactured by one of the following processes:

6.1.2 *Seamless (SML) pipe* shall be made by a process that does not involve welding at any stage of production.

6.1.3 *Welded (WLD) pipe* shall be made using an automatic welding process with no addition of filler metal during the welding process.

6.1.4 *Heavily cold-worked (HCW) pipe* shall be made by applying cold working of not less than 35 % reduction in thickness of both wall and weld to a welded pipe prior to the final anneal. No filler shall be used in making the weld. Prior to cold working, the weld shall be 100 % radiographically inspected in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest revision, Paragraph UW-51.

6.1.5 Welded pipe and HCW pipe of NPS 14 and smaller shall have a single longitudinal weld. Welded pipe and HCW pipe of a size larger than NPS 14 shall have a single longitudinal weld or shall be produced by forming and welding two longitudinal sections of flat stock when approved by the purchaser. All weld tests, examinations, inspections, or treatments shall be performed on each weld seam.

6.1.6 At the option of the manufacturer, pipe shall be either hot finished or cold finished.

6.1.7 The pipe shall be free of scale and contaminating exogenous iron particles. Pickling, blasting, or surface finishing is not mandatory when pipe is bright annealed. The purchaser is permitted to require that a passivating treatment be applied to the finished pipe.

6.2 *Heat Treatment*—All pipe shall be furnished in the heat-treated condition in accordance with the requirements of Table 2. Alternatively, for seamless pipe, immediately following hot forming while the temperature of the pipes is not less than the minimum solution treatment temperature specified in Table 2, pipes shall be individually quenched in water or rapidly cooled by other means (direct quenched).

## 7. Chemical Composition

7.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1.

## 8. Product Analysis

8.1 At the request of the purchaser, an analysis of one billet or one length of flat-rolled stock from each heat, or two pipes from each lot shall be made by the manufacturer. A lot of pipe shall consist of the following number of lengths of the same size and wall thickness from any one heat of steel:

| NPS Designator | Lengths of Pipe in Lot |
|---|---|
| Under 2 | 400 or fraction thereof |
| 2 to 5 | 200 or fraction thereof |
| 6 and over | 100 or fraction thereof |

8.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Section 7.

8.3 If the analysis of one of the tests specified in 8.1 does not conform to the requirements specified in Section 7, an analysis of each billet or pipe from the same heat or lot may be made, and all billets or pipe conforming to the requirements shall be accepted.

## 9. Permitted Variations in Wall Thickness

9.1 In addition to the implicit limitation of wall thickness for seamless pipe imposed by the limitation on weight in Specification A999/A999M, the wall thickness for seamless and welded pipe at any point shall be within the tolerances specified in Table 3, except that for welded pipe the weld area shall not be limited by the "Over" tolerance. The wall thickness and outside diameter for inspection for compliance with this requirement for pipe ordered by NPS and schedule number is shown in Table X1.1.

## 10. Tensile Requirements

10.1 The tensile properties of the material shall conform to the requirements prescribed in Table 4.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

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

[7] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

**TABLE 1 Chemical Requirements**

| | Composition, %[B] |
|---|---|

**TABLE 1** *Continued*

| Composition, %[B] |
|---|

**TABLE 1** *Continued*

| Composition, %[B] |
|---|
| [redacted] |

**TABLE 1** *Continued*

| | Composition, %[B] |
|---|---|
| | |

[A] New designation established in accordance with Practice E527 and SAE J1086.
[B] Maximum, unless otherwise indicated. Where elipses (...) appear in this table, there is no requirement and analysis for the element need not be determined or reported.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] 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. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).
[E] For welded pipe, the phosphorus maximum shall be 0.045 %.
[F] Ti 5 × (C+N) min, 0.70 max.
[G] The niobium content shall be not less than ten times the carbon content and not more than 1.00 %.
[H] The niobium content shall be not less than eight times the carbon content and not more than 1.0 %.
[I] Grade S34751 shall have a niobium content of not less than 15 times the carbon content.
[J] Iron shall be determined arithmetically by difference of 100 minus the sum of the other specified elements.
[K] Al + Ti shall be 0.85 % min; 1.20 % max.
[L] Niobium (Nb) + Tantalum = 8 × Carbon min, 1.00 max.

**TABLE 2 Annealing Requirements**

| Grade or UNS Designation[A] | Heat Treating Temperature[B] | Cooling/Testing Requirements |
|---|---|---|
| All grades not individually listed below: | 1900 °F [1040 °C] | C |
| TP321H, TP347H, TP348H | | |
| Cold finished | 2000 °F [1100 °C] | D |
| Hot finished | 1925 °F [1050 °C] | D |
| TP304H, TP316H | | |
| Cold finished | 1900 °F [1040 °C] | D |
| Hot finished | 1900 °F [1040 °C] | D |
| TP309H, TP309HCb, TP310H, TP310HCb | 1900 °F [1040 °C] | D |
| S30600 | 2010–2140 °F [1100–1170 °C] | D |
| S30601 | 2010–2140 °F [1100–1170 °C] | D |
| S30815, S31272 | 1920 °F [1050 °C] | D |
| S31035 | 2160–2280 °F [1180–1250 °C] | D |
| S31254, S32654 | 2100 °F [1150 °C] | D |
| S31266 | 2100 °F [1150 °C] | D |
| S31277 | 2050 °F [1120 °C] | D |
| S31727, S32053 | 1975–2155 °F [1080–1180 °C] | D |
| S33228 | 2050–2160 °F [1120–1180 °C] | D |
| S34565 | 2050–2140 °F [1120–1170 °C] | D |
| S35315 | 2010 °F [1100 °C] | D |
| S38815 | 1950 °F [1065 °C] | D |
| N08367 | 2025 °F [1110 °C] | D |
| N08020 | 1700–1850 °F [925–1010 °C] | D |
| N08028 | 2000 °F [1100 °C] | D |
| N08029 | 2000 °F [1100 °C] | D |
| N08810 | 2050 °F [1120 °C] | D |
| N08811 | 2100 °F [1150 °C] | D |
| N08904 | 2000 °F [1100 °C] | D |
| N08925, N08926 | 2010–2100 °F [1100–1150 °C] | D |

[A] New designation established in accordance with Practice E527 and SAE J1086.
[B] Minimum, unless otherwise stated.
[C] Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent re-precipitation of carbides, as demonstrable by the capability of pipes, heat treated by either separate solution annealing or by direct quenching, of passing Practices A262, Practice E. The manufacturer is not required to run the test unless it is specified on the purchase order (see Supplementary Requirement S7). Note that Practices A262 requires the test to be performed on sensitized specimens in the low-carbon and stabilized types and on specimens representative of the as-shipped condition for other types. In the case of low-carbon types containing 3 % or more molybdenum, the applicability of the sensitizing treatment prior to testing shall be a matter for negotiation between the seller and the purchaser.
[D] Quenched in water or rapidly cooled by other means.

## 11. Mechanical Tests, Grain Size Determinations, and Weld Decay Tests Required

11.1 *Mechanical Testing Lot Definition*—The term *lot* for mechanical tests shall be as follows:

11.1.1 Where the final heat treated condition is obtained, consistent with the requirements of 6.2, in a continuous furnace, by quenching after hot forming or in a batch-type furnace equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or lesser range, the term *lot* for mechanical tests shall apply to all pipes of the same specified outside diameter and specified wall thickness (or schedule) that are produced from the same heat of steel and subjected to the same finishing treatment within the same operating period.

**TABLE 3 Permitted Variations in Wall Thickness**

| NPS Designator | Tolerance, % from Nominal Over | Tolerance, % from Nominal Under |
|---|---|---|
| ⅛ to 2½ incl., all t/D ratios | 20.0 | 12.5 |
| 3 to 18 incl., t/D up to 5 % incl. | 22.5 | 12.5 |
| 3 to 18 incl., t/D > 5 % | 15.0 | 12.5 |
| 20 and larger, welded, all t/D ratios | 17.5 | 12.5 |
| 20 and larger, seamless, t/D up to 5 % incl. | 22.5 | 12.5 |
| 20 and larger, seamless, t/D > 5 % | 15.0 | 12.5 |

*where:*

$t$ = Nominal Wall Thickness
$D$ = Ordered Outside Diameter

11.1.2 Where the final heat treated condition is obtained, consistent with the requirements of 6.2, in a batch-type furnace not equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or lesser range, the term *lot* shall apply to the larger of: (*a*) each 200 ft [60 m] or fraction thereof and (*b*) those pipes heat treated in the same furnace batch charge for pipes of the same specified outside diameter and specified wall thickness (or schedule) that are produced from the same heat of steel and are subjected to the same finishing temperature within the same operating period.

11.2 *Transverse or Longitudinal Tension Test*—One tension test shall be made on a specimen for lots of not more than 100 pipes. Tension tests shall be made on specimens from two tubes for lots of more than 100 pipes.

11.3 *Flattening Test*—For material heat treated in a continuous furnace, by quenching after hot forming or in a batch-type furnace equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or lesser range, flattening tests shall be made on a sufficient number of pipe to constitute 5 % of the lot, but in no case less than 2 lengths of pipe. For material heat treated in a batch-type furnace not equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or lesser range, flattening tests shall be made on 5 % of the pipe from each heat treated lot.

11.3.1 For welded pipe a transverse-guided face bend test of the weld may be conducted instead of a flattening test in accordance with the method outlined in the steel tubular product supplement of Test Methods and Definitions A370. For welded pipe with a specified wall thickness over ⅜ in., two side bend tests may be made instead of the face bend test. The ductility of the weld shall be considered acceptable when there is no evidence of cracks in the weld or between the weld and the base metal after bending. Test specimens from 5 % of the lot shall be taken from the pipe or test plates of the same material as the pipe, the test plates being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

11.4 *Grain Size*—Grain size determinations, in accordance with Test Methods E112, shall be made on the grades listed in Table 5. Grain size determinations shall be made on each heat

**TABLE 4 Tensile Requirements**

| Grade | UNS Designation | Tensile Strength, min ksi [MPa] | Yield Strength, min ksi [MPa] |
|---|---|---|---|
| TP201 | S20100 | 75 [515] | 38 [260] |
| TP201LN | S20153 | 95 [655] | 45 [310] |
| . . . | S20400 | 95 [635] | 48 [330] |
| TPXM-19 | S20910 | 100 [690] | 55 [380] |
| TPXM-10 | S21900 | 90 [620] | 50 [345] |
| TPXM-11 | S21904 | 90 [620] | 50 [345] |
| TPXM-29 | S24000 | 100 [690] | 55 [380] |
| TP304 | S30400 | 75 [515] | 30 [205] |
| TP304L | S30403 | 70 [485] | 25 [170] |
| TP304H | S30409 | 75 [515] | 30 [205] |
| . . . | S30415 | 87 [600] | 42 [290] |
| TP304N | S30451 | 80 [550] | 35 [240] |
| TP304LN | S30453 | 75 [515] | 30 [205] |
| . . . | S30600 | 78 [540] | 35 [240] |
| . . . | S30601 | 78 [540] | 37 [255] |
| . . . | S30615 | 90 [620] | 40 [275] |
| . . . | S30815 | 87 [600] | 45 [310] |
| TP309S | S30908 | 75 [515] | 30 [205] |
| TP309H | S30909 | 75 [515] | 30 [205] |
| TP309Cb | S30940 | 75 [515] | 30 [205] |
| TP309HCb | S30941 | 75 [515] | 30 [205] |
| . . . | S31002 | 73 [500] | 30 [205] |
| TP310S | S31008 | 75 [515] | 30 [205] |
| TP310H | S31009 | 75 [515] | 30 [205] |
| | S31035 | 95 [655] | 45 [310] |
| TP310Cb | S31040 | 75 [515] | 30 [205] |
| TP310HCb | S31041 | 75 [515] | 30 [205] |
| . . . | S31050: | | |
| t ≤ 0.25 in. | | 84 [580] | 39 [270] |
| t > 0.25 in. | | 78 [540] | 37 [255] |
| . . . | S31254: | | |
| t ≤ 0.187 in. [5.00 mm] | | 98 [675] | 45 [310] |
| t > 0.187 in. [5.00 mm] | | 95 [655] | 45 [310] |
| . . . | S31266 | 109 [750] | 61 [420] |
| . . . | S31272 | 65 [450] | 29 [200] |
| . . . | S31277 | 112 [770] | 52 [360] |
| TP316 | S31600 | 75 [515] | 30 [205] |
| TP316L | S31603 | 70 [485] | 25 [170] |
| TP316H | S31609 | 75 [515] | 30 [205] |
| . . . | S31635 | 75 [515] | 30 [205] |
| TP316N | S31651 | 80 [550] | 35 [240] |
| TP316LN | S31653 | 75 [515] | 30 [205] |
| . . . | S31655 | 92 [635] | 45 [310] |
| TP317 | S31700 | 75 [515] | 30 [205] |
| TP317L | S31703 | 75 [515] | 30 [205] |
| . . . | S31725 | 75 [515] | 30 [205] |
| . . . | S31726 | 80 [550] | 35 [240] |
| . . . | S31727 | 80 [550] | 36 [245] |
| . . . | S31730 | 70 [480] | 25 [175] |
| . . . | S32053 | 93 [640] | 43 [295] |
| TP321 | S32100: | | |
| *Welded* | | 75 [515] | 30 [205] |
| *Seamless:* | | | |
| ≤ ⅜ in. | | 75 [515] | 30 [205] |
| > ⅜ in. | | 70 [485] | 25 [170] |
| TP321H | S32109: | | |
| *Welded* | | 75 [515] | 30 [205] |
| *Seamless:* | | | |
| ≤ ⅜ in. | | 75 [515] | 30 [205] |
| > ⅜ in. | | 70 [480] | 25 [170] |
| . . . | S32615 | 80 [550] | 32 [220] |
| . . . | S32654 | 109 [750] | 62 [430] |
| . . . | S33228 | 73 [500] | 27 [185] |
| . . . | S34565 | 115 [795] | 60 [415] |
| TP347 | S34700 | 75 [515] | 30 [205] |
| TP347H | S34709 | 75 [515] | 30 [205] |
| TP347LN | S34751 | 75 [515] | 30 [205] |
| TP348 | S34800 | 75 [515] | 30 [205] |
| TP348H | S34809 | 75 [515] | 30 [205] |
| . . . | S35045 | 70 [485] | 25 [170] |
| . . . | S35315 | | |
| *Welded* | | 94 [650] | 39 [270] |
| *Seamless* | | 87 [600] | 38 [260] |

**TABLE 4** *Continued*

| Grade | UNS Designation | Tensile Strength, min ksi [MPa] | Yield Strength, min ksi [MPa] |
|---|---|---|---|
| TPXM-15 | S38100 | 75 [515] | 30 [205] |
| . . . | S38815 | 78 [540] | 37 [255] |
| Alloy 20 | N08020 | 80 [550] | 35 [240] |
| | N08028 | 73 [500] | 31 [214] |
| | N08029 | 73 [500] | 31 [214] |
| . . . | N08367: | | |
| t ≤ 0.187 | | 100 [690] | 45 [310] |
| t > 0.187 | | 95 [655] | 45 [310] |
| 800 | N08800 | | |
| | cold-worked | 75 [515] | 30 [205] |
| | annealed | | |
| | hot finished annealed | 65 [450] | 25 [170] |
| 800H | N08810 | 65 [450] | 25 [170] |
| | N08811 | 65 [450] | 25 [170] |
| . . . | N08904 | 71 [490] | 31 [215] |
| . . . | N08925 | 87 [600] | 43 [295] |
| . . . | N08926 | 94 [650] | 43 [295] |

| Elongation in 2 in. or 50 mm (or 4*D*), min, % | Longi-tudinal | Trans-verse |
|---|---|---|
| All Grades except S31050 and S32615 | 35 | 25 |
| S32615, S31050 | 25 | . . . |
| S31277, N08925, N08028, N08029 | 40 | . . . |
| N08367, N08020, N08800, N08810, N08811 | 30 | . . . |

**TABLE 5 Grain Size Requirements**

| Grade | UNS Designation | Grain Size |
|---|---|---|
| . . . | N08810 | 5 or coarser |
| . . . | N08811 | 5 or coarser |
| TP304H | S30409 | 7 or coarser |
| TP309H | S30909 | 6 or coarser |
| TP309HCb | S30940 | 6 or coarser |
| TP310H | S31009 | 6 or coarser |
| . . . | S31035 | 7 or coarser |
| TP310HCb | S31041 | 6 or coarser |
| TP316H | S31609 | 7 or coarser |
| TP321H | S32109 | 7 or coarser |
| . . . | S32615 | 3 or finer |
| TP347H | S34709 | 7 or coarser |
| TP348H | S34809 | 7 or coarser |

treatment lot, as defined in 11.1, for the same number of pipes as prescribed for the flattening test in 11.3. The grain size results shall conform to the requirements prescribed in Table 5.

11.5 HCW pipe shall be capable of passing the weld decay tests listed in Supplementary S9 with a weld metal to base metal loss ratio of 0.90 to 1.1. The test is not required to be performed unless S9 is specified in the purchase order.

## 12. Hydrostatic or Nondestructive Electric Test

12.1 Each pipe shall be subjected to the nondestructive electric test or the hydrostatic test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

12.2 The hydrostatic test shall be in accordance with Specification A999/A999M, unless specifically exempted under the provisions of 12.3.

12.3 For pipe whose dimensions equal or exceed NPS10, the purchaser, with the agreement of the manufacturer, is permitted to waive the hydrostatic test requirement when in lieu of such test the purchaser performs a system test. Each length of pipe furnished without the completed manufacturer's hydrostatic test shall include with the mandatory markings the letters "NH."

12.4 The nondestructive electric test shall be in accordance with Specification A999/A999M.

## 13. Lengths

13.1 Pipe lengths shall be in accordance with the following regular practice:

13.1.1 Unless otherwise agreed upon, all sizes from NPS ⅛ to and including NPS 8 are available in a length up to 24 ft with the permitted range of 15 to 24 ft. Short lengths are acceptable and the number and minimum length shall be agreed upon between the manufacturer and the purchaser.

13.1.2 If definite cut lengths are desired, the lengths required shall be specified in the order. No pipe shall be under the specified length and no pipe shall be more than ¼ in. [6 mm] over the specified length.

13.1.3 No jointers are permitted unless otherwise specified.

## 14. Workmanship, Finish, and Appearance

14.1 The finished pipes shall be reasonably straight and shall have a workmanlike finish. Removal of imperfections by grinding is permitted, provided the wall thicknesses are not decreased to less than that permitted in the Permissible Variations in Wall Thickness section of Specification A999/A999M.

## 15. Repair by Welding

15.1 For welded pipe whose diameter equals or exceeds NPS 6, and whose nominal wall thickness equals or exceeds 0.200, it is permitted to make weld repairs to the weld seam with the addition of compatible filler metal using the same procedures specified for plate defects in the section on Repair by Welding of Specification A999/A999M.

15.2 Weld repairs of the weld seam shall not exceed 20 % of the seam length.

15.3 Weld repairs shall be made only with the gas tungsten-arc welding process using the same classification of bare filler rod qualified to the most current AWS Specification A5.9 as the grade of stainless steel pipe being repaired and as shown in Table 6. Alternatively, subject to approval by the purchaser, weld repairs shall be made only with the gas tungsten-arc welding process using a filler metal more highly alloyed than the base metal when needed for corrosion resistance or other properties.

15.4 Pipes that have had weld seam repairs with filler metal shall be uniquely identified and shall be so stated and identified on the certificate of tests. When filler metal other than that listed in Table 6 is used, the filler metal shall be identified on the certificate of tests.

**TABLE 6 Pipe and Filler Metal Specification**

| Pipe | | Filler Metal | |
|---|---|---|---|
| Grade | UNS Designation | AWS A5.9 Class | UNS Designation |
| TP201 | S20100 | . . . | . . . . . |
| TP201LN | S20153 | . . . | . . . . . |
| TP304 | S30400 | ER308 | S30800, W30840 |
| TP304L | S30403 | ER308L | S30883, W30843 |
| TP304N | S30451 | ER308 | S30880, W30840 |
| TP304LN | S30453 | ER308L | S30883, W30843 |
| TP304H | S30409 | ER308 | S30880, W30840 |
| . . . | S30601 | . . . | . . . |
| TP309Cb | S30940 | . . . | . . . . . |
| TP309S | S30908 | . . . | . . . . . |
| TP310Cb | S31040 | . . . | . . . . . |
| TP310S | S31008 | . . . | . . . . . |
| . . . | S31266 | ERNiCrMo-4 | N10276 |
| | | ERNiCrMo-10 | N06022 |
| | | ERNiCrMo-13 | N06059 |
| | | ERNiCrMo-14 | N06686 |
| | | ERNiCrMo-17 | N06200 |
| | S31272 | . . . | . . . . . |
| TP316 | S31600 | ER316 | S31680, W31640 |
| TP316L | S31603 | ER316L | S31683, W31643 |
| TP316N | S31651 | ER316 | S31680, W31640 |
| TP316LN | S31653 | ER316L | S31683, W31643 |
| . . . | S31655 | . . . | . . . . . |
| TP316H | S31609 | ER316H | S31680, W31640 |
| . . . | S31730 | ERNiCr-3, or ERNiCrMo-3, or ERNiCrMo-4 | N06082, N06625, N10276 |
| TP321 | S32100 | ER321 | S32180, W32140 |
| | | ER347 | S34780, W34740 |
| TP347 | S34700 | ER347 | S34780, W34740 |
| TP348 | S34800 | ER347 | S34780, W34740 |
| TPXM-19 | S22100 | ER209 | S20980, W32240 |
| TPXM-29 | S28300 | ER240 | S23980, W32440 |
| . . . | N08367 | . . . | N06625 |
| Alloy 20 | N08020 | ER320 | N08021 |
| | | ER320LR | N08022 |
| | N08028 | ER383 | N08028 |
| | N08029 | ERNiCrMo-3[A] | N06625 |
| | | ERNiCrMo-13[A] | N06059 |
| . . . | S20400 | ER209 | S20980, W32240 |
| 800 | N08800 | ERNiCr-3[A] | N06082 |
| 800H | N08810 | ERNiCr-3[A] | N06082 |
| | N08811 | ERNiCr-3[A] | N06082 |
| . . . | N08925 | . . . | N06625 |
| . . . | N08926 | . . . | N06625 |

[A]AWS A5.14 Class.

## 16. Certification

16.1 In addition to the information required by Specification A999/A999M, the certification shall state whether or not the material was hydrostatically tested. If the material was nondestructively tested, the certification shall so state and shall state which standard practice was followed and what reference discontinuities were used.

## 17. Marking

17.1 In addition to the marking specified in Specification A999/A999M, the marking shall include the NPS (nominal pipe size) or outside diameter and schedule number or average wall thickness, heat number, and NH when hydrotesting is not performed and ET when eddy-current testing is performed or UT when ultrasonic testing is performed. The marking shall also include the manufacturer's private identifying mark, the marking requirement of 12.3, if applicable, and whether

seamless (SML), welded (WLD), or heavily cold-worked (HCW). For Grades TP304H, TP316H, TP321H, TP347H, TP348H, and S30815, the marking shall also include the heat number and heat-treatment lot identification. If specified in the purchase order, the marking for pipe larger than NPS 4 shall include the weight.

## 18. Government Procurement

18.1 *Scale Free Pipe for Government Procurement:*

18.1.1 When specified in the contract or order, the following requirements shall be considered in the inquiry, contract or order, for agencies of the U.S. Government where scale free pipe or tube is required. These requirements shall take precedence if there is a conflict between these requirements and the product specifications.

18.1.2 The requirements of Specification A999/A999M for pipe and Specification A1016/A1016M for tubes shall be applicable when pipe or tube is ordered to this specification.

18.1.3 Pipe and tube shall be one of the following grades as specified herein:

| Grade | UNS Designation |
|---|---|
| TP304 | S30400 |
| TP304L | S30403 |
| TP304N | S30451 |
| TP316 | S31600 |
| TP316L | S31603 |
| TP316N | S31651 |
| TP317 | S31700 |
| TP317L | S31703 |
| TP321 | S32100 |
| TP347 | S34700 |

18.1.4 *Part Number:*

*Example:* ASTM A312/A312MPipe 304 NPS 12 SCH 40S SMLS

| | |
|---|---|
| Specification Number | ASTM A312 |
| Pipe | P |
| Grade | 304 |
| NPS | 12 |
| Wall | 0.375 |
| SMLS OR WELDED | SML |

18.1.4.1

| | |
|---|---|
| Specification Number | ASTM A312 |
| Tube | T |
| Grade | 304 |
| Outside Diameter | 0.250 |
| Wall | 0.035 |
| SMLS OR WELDED | WLD |

18.1.5 *Ordering Information*—Orders for material under this specification shall include the following in addition to the requirements of Section 4:

18.1.5.1 Pipe or tube,

18.1.5.2 Part number,

18.1.5.3 Ultrasonic inspection, if required,

18.1.5.4 If shear wave test is to be conducted in two opposite circumferential directions,

18.1.5.5 Intergranular corrosion test, and

18.1.5.6 Level of preservation and packing required.

## 19. Keywords

19.1 austenitic stainless steel; seamless steel pipe; stainless steel pipe; steel pipe; welded steel pipe

# SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified in the purchase order. The purchaser may specify a different frequency of test or analysis than is provided in the supplementary requirement. Subject to agreement between the purchaser and manufacturer, retest and retreatment provisions of these supplementary requirements may also be modified.

## S1. Product Analysis

S1.1 For all pipe NPS 5 and larger in nominal size there shall be one product analysis made of a representative sample from one piece for each ten lengths or fraction thereof from each heat of steel.

S1.2 For pipe smaller than NPS 5 there shall be one product analysis made from ten lengths per heat of steel or from 10 % of the number of lengths per heat of steel, whichever number is smaller.

S1.3 Individual lengths failing to conform to the chemical requirements specified in Section 7 shall be rejected.

## S2. Transverse Tension Tests

S2.1 There shall be one transverse tension test made from one end of 10 % of the lengths furnished per heat of steel. This requirement is applicable only to pipe NPS 8 and larger.

S2.2 If a specimen from any length fails to conform to the tensile properties specified that length shall be rejected.

## S3. Flattening Test

S3.1 The flattening test of Specification A999/A999M shall be made on a specimen from one end or both ends of each pipe. Crop ends may be used. If this supplementary requirement is specified, the number of tests per pipe shall also be specified. If a specimen from any length fails because of lack of ductility prior to satisfactory completion of the first step of the flattening test requirement, that pipe shall be rejected subject to retreatment in accordance with Specification A999/A999M and satisfactory retest. If a specimen from any length of pipe fails because of a lack of soundness that length shall be rejected, unless subsequent retesting indicates that the remaining length is sound.

## S4. Etching Tests

S4.1 The steel shall be homogeneous as shown by etching tests conducted in accordance with the appropriate portions of Method E381. Etching tests shall be made on a cross section from one end or both ends of each pipe and shall show sound

and reasonably uniform material free of injurious laminations, cracks, and similar objectionable defects. If this supplementary requirement is specified, the number of tests per pipe required shall also be specified. If a specimen from any length shows objectionable defects, the length shall be rejected, subject to removal of the defective end and subsequent retests indicating the remainder of the length to be sound and reasonably uniform material.

## S5. Radiographic Examination

S5.1 The entire length of weld in each double welded pipe shall be radiographically examined, using X-radiation, in accordance with Paragraph UW-51 of Section VIII Division 1 of the ASME Boiler and Pressure Vessel Code. In addition to the marking required by Section 13 each pipe shall be marked "RT" after the specification and grade. Requirements of S5 shall be required in the certification.

## S6. Stabilizing Heat Treatment

S6.1 Subsequent to the solution anneal required in 6.2, Grades TP309HCb, TP310HCb, TP321, TP321H, TP347, TP347H, TP348, and TP348H shall be given a stabilization heat treatment at a temperature lower than that used for the initial solution annealing heat treatment. The temperature of stabilization heat treatment shall be as agreed upon between the purchaser and vendor.

## S7. Intergranular Corrosion Test

S7.1 When specified, material shall pass intergranular corrosion tests conducted by the manufacturer in accordance with Practices A262, Practice E.

S7.1.1 Practice E requires testing on the sensitized condition for low carbon or stabilized grades, and on the as-shipped condition for other grades. The applicability of this test and the preparation of the sample for testing for grades containing greater than 3 % molybdenum shall be as agreed by the purchaser and manufacturer.

NOTE S7.1—Practice E requires testing on the sensitized condition for low carbon or stabilized grades, and on the as-shipped condition for other grades.

S7.2 A stabilization heat treatment in accordance with Supplementary Requirement S6 may be necessary and is permitted in order to meet this requirement for the grades containing titanium or columbium, particularly in their H versions.

## S8. Minimum Wall Pipe

S8.1 When specified by the purchaser, pipe shall be furnished on a minimum wall basis. The wall of such pipe shall not fall below the thickness specified. In addition to the marking required by Section 17, the pipe shall be marked S8.

## S9. Weld Decay Test

S9.1 When specified in the purchase order, one sample from each lot of pipe shall be subject to testing in a boiling solution of 50 % reagent grade hydrochloric acid and 50 % water.

S9.2 The sample, of approximately 2–in. [50–mm] length, shall be prepared from a production length of pipe. Depending on the size of the pipe, it is permitted to section the sample longitudinally to allow it to fit in the Erlenmeyer flask. As a minimum, the tested sample shall include the entire weld and adjacent area and the full length of base metal 180° across from the weld. All burrs and sharp edges shall be removed by light grinding. Dust and grease shall be removed by cleaning with soap and water or other suitable solvents.

S9.3 The hydrochloric acid solution shall be prepared by slowly adding reagent grade (approximately 37 %) hydrochloric acid to an equal volume of distilled water.

**Warning**—Protect eyes and use rubber gloves when handling acid. Mixing and testing shall be performed in a protective enclosure.

S9.4 The test container shall be a 1–L Erlenmeyer flask equipped with ground-glass joints and an Ahline condenser. The volume of the solution shall be approximately 700 mL.

S9.5 The thickness of the weld and the base metal 180° from the weld shall be measured near both ends of the sample. These measurements shall be made with a micrometer with an anvil shape suitable for measuring the thickness with an accuracy to at least 0.001 in. [0.025 mm].

S9.6 The sample sections, both weld and base metal, shall be immersed in the flask containing the solution. Boiling chips shall be added and the solution brought to a boil. Boiling shall be maintained through the duration of the test. The time of testing shall be that which is required to remove 40 to 60 % of the original base metal thickness (usually 2 h or less). If more than 60 % of the base metal thickness remains, it is permitted to terminate the test after 24 h.

S9.7 At the end of the test period, the samples shall be removed from the solution, rinsed with distilled water, and dried.

S9.8 The thickness measurements as in S9.5 shall be repeated. The anvil shape of the micrometer used shall be suitable for measuring the minimum remaining thickness with an accuracy to at least 0.001 in. [0.025 mm].

S9.9 The corrosion ratio, $R$, shall be calculated as follows:

$$R = (W_0 - W)/(B_0 - B)$$

*where:*

$W_0$ = average weld-metal thickness before the test,
$W$ = average weld-metal thickness after the test,
$B_0$ = average base-metal thickness before the test, and
$B$ = average base-metal thickness after the test,

S9.9.1 The corrosion ratio for HCW pipe shall be as specified in 11.5.

S9.9.2 The corrosion ratio shall be 1.25 or less, or as further restricted in the purchase order, when the weld decay test is specified for welded (WLD) pipe.

## APPENDIX

### (Nonmandatory Information)

### X1. DIMENSIONS OF WELDED AND SEAMLESS STAINLESS STEEL PIPE

X1.1 Table X1.1 is based on Table number 1 of the American National Standard for stainless steel pipe (ANSI B36.19).

**TABLE X1.1 Dimensions of Welded and Seamless Stainless Steel Pipe**

NOTE 1—The decimal thickness listed for the respective pipe sizes represents their nominal or average wall dimensions.

| NPS Designator | Outside Diameter | | Nominal Wall Thickness | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | in. | mm | Schedule 5S[A] | | Schedule 10S[A] | | Schedule 40S | | Schedule 80S | |
| | | | in. | mm | in. | mm | in. | mm | in. | mm |
| ⅛ | 0.405 | 10.29 | ... | ... | 0.049 | 1.24 | 0.068 | 1.73 | 0.095 | 2.41 |
| ¼ | 0.540 | 13.72 | ... | ... | 0.065 | 1.65 | 0.088 | 2.24 | 0.119 | 3.02 |
| ⅜ | 0.675 | 17.15 | ... | ... | 0.065 | 1.65 | 0.091 | 2.31 | 0.126 | 3.20 |
| ½ | 0.840 | 21.34 | 0.065 | 1.65 | 0.083 | 2.11 | 0.109 | 2.77 | 0.147 | 3.73 |
| ¾ | 1.050 | 26.67 | 0.065 | 1.65 | 0.083 | 2.11 | 0.113 | 2.87 | 0.154 | 3.91 |
| 1.0 | 1.315 | 33.40 | 0.065 | 1.65 | 0.109 | 2.77 | 0.133 | 3.38 | 0.179 | 4.55 |
| 1¼ | 1.660 | 42.16 | 0.065 | 1.65 | 0.109 | 2.77 | 0.140 | 3.56 | 0.191 | 4.85 |
| 1½ | 1.900 | 48.26 | 0.065 | 1.65 | 0.109 | 2.77 | 0.145 | 3.68 | 0.200 | 5.08 |
| 2 | 2.375 | 60.33 | 0.065 | 1.65 | 0.109 | 2.77 | 0.154 | 3.91 | 0.218 | 5.54 |
| 2½ | 2.875 | 73.03 | 0.083 | 2.11 | 0.120 | 3.05 | 0.203 | 5.16 | 0.276 | 7.01 |
| 3 | 3.500 | 88.90 | 0.083 | 2.11 | 0.120 | 3.05 | 0.216 | 5.49 | 0.300 | 7.62 |
| 3½ | 4.000 | 101.60 | 0.083 | 2.11 | 0.120 | 3.05 | 0.226 | 5.74 | 0.318 | 8.08 |
| 4 | 4.500 | 114.30 | 0.083 | 2.11 | 0.120 | 3.05 | 0.237 | 6.02 | 0.337 | 8.56 |
| 5 | 5.563 | 141.30 | 0.109 | 2.77 | 0.134 | 3.40 | 0.258 | 6.55 | 0.375 | 9.52 |
| 6 | 6.625 | 168.28 | 0.109 | 2.77 | 0.134 | 3.40 | 0.280 | 7.11 | 0.432 | 10.97 |
| 8 | 8.625 | 219.08 | 0.109 | 2.77 | 0.148 | 3.76 | 0.322 | 8.18 | 0.500 | 12.70 |
| 10 | 10.750 | 273.05 | 0.134 | 3.40 | 0.165 | 4.19 | 0.365 | 9.27 | 0.500[B] | 12.70[B] |
| 12 | 12.750 | 323.85 | 0.156 | 3.96 | 0.180 | 4.57 | 0.375[B] | 9.52[B] | 0.500[B] | 12.70[B] |
| 14 | 14.000 | 355.60 | 0.156 | 3.96 | 0.188[B] | 4.78[B] | ... | ... | ... | ... |
| 16 | 16.000 | 406.40 | 0.165 | 4.19 | 0.188[B] | 4.78[B] | ... | ... | ... | ... |
| 18 | 18.000 | 457.20 | 0.165 | 4.19 | 0.188[B] | 4.78[B] | ... | ... | ... | ... |
| 20 | 20.000 | 508.00 | 0.188 | 4.78 | 0.218[B] | 5.54[B] | ... | ... | ... | ... |
| 22 | 22.000 | 558.80 | 0.188 | 4.78 | 0.218[B] | 5.54[B] | ... | ... | ... | ... |
| 24 | 24.000 | 609.60 | 0.218 | 5.54 | 0.250 | 6.35 | ... | ... | ... | ... |
| 30 | 30.000 | 762.00 | 0.250 | 6.35 | 0.312 | 7.92 | ... | ... | ... | ... |

[A] Schedules 5S and 10S wall thicknesses do not permit threading in accordance with the American National Standard for Pipe Threads (ANSI B1.20.1).
[B] These do not conform to the American National Standard for Welded and Seamless Wrought Steel Pipe (ANSI B36.10–1979).

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A312/A312M-16, that may impact the use of this specification. (Approved September 1, 2016)

*(1)* Revised minimum nickel content to 10.0 % for nickel grades 316, 316H, 316N, and 316LN and eliminated Note E from chemistry table on these grades.

Committee A01 has identified the location of selected changes to this specification since the last issue, A312/A312M-15b, that may impact the use of this specification. (Approved January 1, 2016)

*(1)* Removed incorrect A999/A999M section number reference in 14.1 and replaced with appropriate section title in A999/A999M.

Committee A01 has identified the location of selected changes to this specification since the last issue, A312/A312M-15a, that may impact the use of this specification. (Approved November 1, 2015)

*(1)* Added UNS N08028 and N08029 to Table 1, Table 2, Table 4, and Table 6.

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