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## Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe<sup>1</sup>

This standard is issued under the fixed designation A 814/A 814M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers two classes of flanged and cold-bending quality cold-worked straight-seam single or double welded austenitic steel pipe intended for high-temperature and general corrosive services.

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 304, 304L, and 347 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  $-425^{\circ}\text{F}$  [ $-250^{\circ}\text{C}$ ] without qualification by impact tests. Other AISI stainless steel grades are usually accepted for service temperatures as low as  $-325^{\circ}\text{F}$  [ $-200^{\circ}\text{C}$ ] 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  $-50^{\circ}\text{F}$  [ $-45^{\circ}\text{C}$ ].

1.2 Grades TP304H, TP304N, TP316H, TP316N, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP316, TP321, TP347, and TP348, and are intended for high-temperature service.

1.3 Two classes of pipe are covered as follows:

1.3.1 *Class SW*—Pipe, single-welded with no addition of filler metal and

1.3.2 *Class DW*—Pipe, double-welded with no addition of filler metal.

1.4 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, one or more of these may be specified in the order.

1.5 Table 1 lists the dimensions of cold-worked single- or double-welded stainless steel pipe. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

### 2. Referenced Documents

#### 2.1 *ASTM Standards:*<sup>2</sup>

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

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

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe

E 112 Test Methods for Determining Average Grain Size

E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

E 527 Practice for Numbering Metals and Alloys (UNS)

#### 2.2 *ANSI Standards:*

~~B1.20.1 Pipe Threads, General Purpose~~

~~B36.10 Welded and Seamless Wrought Steel Pipe~~

<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 A01.10 on Stainless and Alloy Steel Tubular Products.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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.

**TABLE 1 Pipe Dimensions<sup>A</sup>**

NOTE 1—For pipe sizes not listed and for pipe ordered to the “M” designation of this specification, the dimensions and tolerances shall be by agreement between the purchaser and producer.

| NPS No. | Outside Diameter | Outside Diameter Tolerance | Schedule | Wall      |           |
|---------|------------------|----------------------------|----------|-----------|-----------|
|         |                  |                            |          | Thickness | Tolerance |
| 1/8     | 0.405            | +0.004<br>-0.002           | 10       | 0.049     | ±0.004    |
|         |                  |                            | 40       | 0.068     | ±0.005    |
|         |                  |                            | 80       | 0.095     | ±0.006    |
| 1/4     | 0.540            | +0.005<br>-0.003           | 10       | 0.065     | ±0.005    |
|         |                  |                            | 40       | 0.088     | ±0.006    |
|         |                  |                            | 80       | 0.119     | ±0.009    |
| 3/8     | 0.675            | +0.006<br>-0.004           | 10       | 0.065     | ±0.005    |
|         |                  |                            | 40       | 0.091     | ±0.006    |
|         |                  |                            | 80       | 0.126     | ±0.010    |
| 1/2     | 0.840            | +0.007<br>-0.005           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.083     | ±0.006    |
|         |                  |                            | 40       | 0.109     | ±0.009    |
|         |                  |                            | 80       | 0.147     | ±0.011    |
| 3/4     | 1.060            | +0.010<br>-0.007           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.083     | ±0.006    |
|         |                  |                            | 40       | 0.113     | ±0.009    |
|         |                  |                            | 80       | 0.154     | ±0.011    |
| 1       | 1.315            | +0.010<br>-0.007           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.109     | ±0.009    |
|         |                  |                            | 40       | 0.133     | ±0.011    |
|         |                  |                            | 80       | 0.179     | ±0.014    |
| 1 1/4   | 1.660            | +0.012<br>-0.0080          | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.109     | ±0.009    |
|         |                  |                            | 40       | 0.140     | ±0.011    |
|         |                  |                            | 80       | 0.191     | ±0.014    |
| 1 1/2   | 1.900            | +0.015<br>-0.008           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.109     | ±0.009    |
|         |                  |                            | 40       | 0.145     | ±0.011    |
|         |                  |                            | 80       | 0.200     | ±0.015    |
| 2       | 2.375            | +0.018<br>-0.008           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.109     | ±0.009    |
|         |                  |                            | 40       | 0.154     | ±0.011    |
|         |                  |                            | 80       | 0.218     | ±0.015    |
| 2 1/2   | 2.875            | +0.020<br>-0.009           | 5        | 0.065     | ±0.005    |
|         |                  |                            | 10       | 0.120     | ±0.010    |
|         |                  |                            | 40       | 0.203     | ±0.015    |
|         |                  |                            | 80       | 0.276     | ±0.020    |
| 3       | 3.500            | +0.025<br>-0.010           | 5        | 0.083     | ±0.006    |
|         |                  |                            | 10       | 0.120     | ±0.010    |
|         |                  |                            | 40       | 0.216     | ±0.015    |
|         |                  |                            | 80       | 0.300     | ±0.020    |
| 3 1/2   | 4.000            | +0.025<br>-0.010           | 5        | 0.083     | ±0.006    |
|         |                  |                            | 10       | 0.120     | ±0.010    |
|         |                  |                            | 40       | 0.226     | ±0.018    |
|         |                  |                            | 80       | 0.318     | ±0.020    |
| 4       | 4.500            | +0.025<br>-0.010           | 5        | 0.083     | ±0.006    |
|         |                  |                            | 10       | 0.120     | ±0.010    |
|         |                  |                            | 40       | 0.237     | ±0.019    |
|         |                  |                            | 80       | 0.337     | ±0.020    |

<sup>A</sup> All dimensions in inches.

### B36.19 Stainless Steel Pipe

#### 2.3 ASME Boiler and Pressure Vessel Code:<sup>3</sup>

Section VIII Division 1, Pressure Vessels

#### 2.4

#### 2.3 SAE Standard:<sup>4</sup>

SAE J 1086 Practice for Numbering Metals and Alloys (UNS)

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>3</sup> Available from American Society of Mechanical Engineers, ASME International Headquarters, Three Park Avenue, New York, NY 10016-5990.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>4</sup> Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

### 3. Ordering Information

3.1 Orders for material under this specification should include the following as required, to describe the desired material adequately:

- 3.1.1 Quantity (feet, centimetres, or number of lengths),
- 3.1.2 Name of material (austenitic steel pipe),
- 3.1.3 Class (1.3). If not specified by the purchaser, the producer shall have the option to furnish either single-welded (SW) or double-welded (DW) pipe,
- 3.1.4 Grade (Table 2),
- 3.1.5 Size (NPS or outside diameter and schedule number or average wall thickness),
- 3.1.6 Length (specific or random) (Section 10),
- 3.1.7 End finish (Section on Ends of Specification A 999/A 999M),
- 3.1.8 Optional requirements (Section 9), (Supplementary Requirements S1 to S8),
- 3.1.9 Test report required (Section on Certification of Specification A 999/A 999M),
- 3.1.10 Specification designation, and
- 3.1.11 Special requirements or exceptions to the specification.

### 4. Materials and Manufacture

#### 4.1 *Manufacture:*

4.1.1 The pipe shall be made by a machine-welding or an automatic-welding process, welding from one or both sides and producing full penetration welds with no addition of filler metal in the welding operation.

4.1.2 Weld repairs, with the addition of compatible filler metal, may be made to the weld joint in accordance with the requirements of the section on Repair by Welding of Specification A 999/A 999M.

4.1.3 Prior to final heat treatment of the pipe, the weld bead must be cold-worked by methods such as forging, planishing, drawing, swaging or bead rolling so as to obtain a flush condition on the inside and outside of the pipe. Undercuts shall be limited to shallow rounded depressions of less than 0.005 in. [0.127 mm] deep on either the inside or outside surface of the pipe with no encroachment of the minimum permitted wall thickness.

4.1.4 The pipe shall be pickled free of scale. When bright annealing is used, pickling is not necessary.

#### 4.2 *Heat Treatment:*

~~4.2.1 All pipe shall be furnished in the heat-treated condition. The heat-treatment procedure, except for H grades N 08367 and S 31254, shall consist of heating the pipe to a minimum temperature of 1900°F [1040°C] and quenching in water or rapidly cooling by other means.~~

~~4.2.2 All H grades shall be furnished in the solution-treated condition. The minimum solution treating temperature for Grades TP321H, TP347H, and TP348H shall be 2000°F [1100°C] and for Grades TP304H and TP316H, 1900°F [1040°C]. If the H grade is hot-rolled, the minimum solution treating temperatures for Grades TP321H, TP347H, and TP348H shall be 1925°F [1050°C] and for Grades TP304H and TP316H, 1900°F [1040°C].~~

4.2.1 All pipe shall be furnished in the heat-treated condition. The heat-treatment procedure, except for H grades, S30815, N 08367 and S 31254, shall consist of heating the pipe to a minimum temperature of 1900 °F [1040 °C] and quenching in water or rapidly cooling by other means.

4.2.2 All H grades and S30815 shall be furnished in the solution-treated condition. The minimum solution treating temperature for Grades TP321H, TP347H, and TP348H shall be 2000 °F [1100 °C] and for Grades TP304H and TP316H, 1900 °F [1040 °C]. The minimum temperature for S30815 shall be 1920 °F [1050 °C].

4.2.3 The heat-treatment procedure for S 31254 shall consist of heating the pipe to a minimum temperature of 2100 °F [1150 °C] and quenching in water or rapidly cooling by other means.

~~4.2.4 UNS N 08367 should be solution annealed from 2025°F minimum followed by rapid quenching.~~

~~4.2.4 UNS N 08367 shall be solution annealed from 2025 °F minimum followed by rapid quenching.~~

4.3 H grades and S30815 shall have a minimum grain size of 7 or coarser when measured in accordance with Test Methods E 112.

### 5. Chemical Composition

5.1 The steel shall conform to the chemical composition prescribed in Table 2.

5.2 When specified on the purchase order, a product analysis shall be supplied from one tube or coil of steel per heat. The product analysis tolerance of Specification A 480/A 480M shall apply.

### 6. Tensile Requirements

6.1 The tensile properties of the material shall conform to the requirements prescribed in Table 3.

### 7. Permissible Variations in Dimensions

7.1 *Specified Diameter*—The diameter at any point in each length of pipe shall be within the tolerance specified in Table 1.

7.2 *Alignment (Camber)*—Using a 3-ft [1.0-m] straightedge placed so that both ends are in contact with the pipe, the camber shall not be more than 0.030-in. [0.8-mm].

**TABLE 2 Chemical Requirements**

| Grade    | UNS Designation <sup>A</sup> | Composition, %           |                             |                 |             |           |           |           |            |          |                         |               |                       |           |           |           |
|----------|------------------------------|--------------------------|-----------------------------|-----------------|-------------|-----------|-----------|-----------|------------|----------|-------------------------|---------------|-----------------------|-----------|-----------|-----------|
|          |                              | Carbon, max <sup>B</sup> | Manganese, max <sup>B</sup> | Phosphorus, max | Sulfur, max | Silicon   | Nickel    | Chromium  | Molybdenum | Titanium | Columbium plus Tantalum | Tantalum, max | Nitrogen <sup>C</sup> | Vanadium  | Copper    | Cerium    |
| TP 304   | S30400                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 8.0–11.0  | 18.0–20.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 304H  | S30409                       | 0.04–0.10                | 2.00                        | 0.045           | 0.030       | 1.00 max  | 8.0–11.0  | 18.0–20.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 304L  | S30403                       | 0.030 <sup>D</sup>       | 2.00                        | 0.045           | 0.030       | 1.00 max  | 8.0–13.0  | 18.0–20.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 304N  | S30451                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 8.0–11.0  | 18.0–20.0 | ...        | ...      | ...                     | ...           | 0.10–0.16             | ...       | ...       | ...       |
| TP 304LN | S30453                       | 0.030                    | 2.00                        | 0.045           | 0.030       | 1.00 max  | 8.0–11.0  | 18.0–20.0 | ...        | ...      | ...                     | ...           | 0.10–0.16             | ...       | ...       | ...       |
| TP 309Cb | S30940                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 12.0–16.0 | 22.0–24.0 | ...        | ...      | 10 × C min, 1.10 max    | ...           | ...                   | ...       | ...       | ...       |
| TP309S   | S30908                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 12.0–15.0 | 22.0–24.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 310Cb | S31040                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 19.0–22.0 | 24.0–26.0 | ...        | ...      | 10 × C min, 1.10 max    | ...           | ...                   | ...       | ...       | ...       |
| TP 310S  | S31008                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 19.0–22.0 | 24.0–26.0 | 0.75 max   | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 316   | S31600                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 10.0–14.0 | 16.0–18.0 | 2.00–3.00  | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 316H  | S31609                       | 0.04–0.10                | 2.00                        | 0.045           | 0.030       | 1.00 max  | 10.0–14.0 | 16.0–18.0 | 2.00–3.00  | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 316L  | S31603                       | 0.030 <sup>D</sup>       | 2.00                        | 0.045           | 0.030       | 1.00 max  | 10.0–14.0 | 16.0–18.0 | 2.00–3.00  | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 316N  | S31651                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 10.0–14.0 | 16.0–18.0 | 2.00–3.00  | ...      | ...                     | ...           | 0.10–0.16             | ...       | ...       | ...       |
| TP 316LN | S31653                       | 0.030                    | 2.00                        | 0.045           | 0.030       | 1.00 max  | 10.0–14.0 | 16.0–18.0 | 2.00–3.00  | ...      | ...                     | ...           | 0.10–0.16             | ...       | ...       | ...       |
| TP 317   | S31700                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 11.0–14.0 | 18.0–20.0 | 3.0–4.0    | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 317L  | S31703                       | 0.030                    | 2.00                        | 0.045           | 0.030       | 1.00 max  | 11.0–15.0 | 18.0–20.0 | 3.0–4.0    | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 321   | S32100                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 321H  | S32109                       | 0.04–0.10                | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP 347   | S34700                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | G                       | ...           | ...                   | ...       | ...       | ...       |
| TP347H   | S34709                       | 0.04–0.10                | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | H                       | ...           | ...                   | ...       | ...       | ...       |
| TP 348   | S34800                       | 0.08                     | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | G                       | 0.10          | ...                   | ...       | ...       | ...       |
| TP 348H  | S34809                       | 0.04–0.10                | 2.00                        | 0.045           | 0.030       | 1.00 max  | 9.00–13.0 | 17.0–19.0 | ...        | ...      | H                       | 0.10          | ...                   | ...       | ...       | ...       |
| TP XM-10 | S21900                       | 0.08                     | 8.0–10.0                    | 0.045           | 0.030       | 1.00 max  | 5.5–7.5   | 19.0–21.5 | ...        | ...      | ...                     | ...           | 0.15–0.40             | ...       | ...       | ...       |
| TP XM-11 | S21903                       | 0.04                     | 8.0–10.0                    | 0.045           | 0.030       | 1.00 max  | 5.5–7.5   | 19.0–21.5 | ...        | ...      | ...                     | ...           | 0.15–0.40             | ...       | ...       | ...       |
| TP XM-15 | S38100                       | 0.08                     | 2.00                        | 0.030           | 0.030       | 1.50–2.50 | 17.5–18.5 | 17.0–19.0 | ...        | ...      | ...                     | ...           | ...                   | ...       | ...       | ...       |
| TP XM-19 | S20910                       | 0.06                     | 4.0–6.0                     | 0.045           | 0.030       | 1.00 max  | 11.5–13.5 | 20.5–23.5 | 1.50–3.00  | ...      | 0.10–0.30               | ...           | 0.20–0.40             | 0.10–0.30 | ...       | ...       |
| TP XM-29 | S24000                       | 0.08                     | 11.5–14.5                   | 0.060           | 0.030       | 1.00 max  | 2.3–3.7   | 17.0–19.0 | ...        | ...      | ...                     | ...           | 0.20–0.40             | ...       | ...       | ...       |
| ...      | S31254                       | 0.020                    | 1.00                        | 0.030           | 0.010       | 0.80 max  | 17.5–18.5 | 19.5–20.5 | 6.0–6.5    | ...      | ...                     | ...           | 0.18–0.22             | ...       | 0.50–1.00 | ...       |
| ...      | S30815                       | 0.05–0.10                | 0.80                        | 0.040           | 0.030       | 1.40–2.00 | 10.0–12.0 | 20.0–22.0 | ...        | ...      | ...                     | ...           | 0.14–0.20             | ...       | ...       | 0.03–0.08 |
| ...      | N08367                       | 0.030                    | 2.00                        | 0.040           | 0.030       | 1.00 max  | 23.5–25.5 | 20.0–22.0 | 6.0–7.0    | ...      | ...                     | ...           | 0.18–0.25             | ...       | 0.75 max  | ...       |

<sup>A</sup> New designation established in accordance with ASTM E 527 and SAE J1086, and SAE J 1086.

<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> 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. [1.2 mm] in average wall thickness (0.044 in. [1 mm] in minimum wall thickness).

<sup>E</sup> The titanium content shall be not less than five times the carbon content and not more than 0.70 %.

<sup>F</sup> The titanium content shall be not less than four times the carbon content and not more than 0.70 %.

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

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