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Used in USDOE-NE standards

Standard Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service[1]

This standard is issued under the fixed designation A 376/A 376M; 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.

1. Scope*

1.1 This specification[2] covers seamless austenitic steel pipe intended for high-temperature central-station service. Among the grades covered are five H grades and two nitrogen grades (304N and 316N) that are specifically intended for high-temperature service.

1.2 Optional supplementary requirements (S1 through S10) are provided. These supplementary requirements specify additional tests that will be made only when stated in the order, together with the number of such tests required.

1.3 Grades TP321 and TP321H have lower strength requirements for nominal wall thicknesses greater than ⅜ in. [9.5 mm].

1.4 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.

NOTE 1—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]

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

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

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

E 112 Test Methods for Determining Average Grain Size

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing

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

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

2.2 *Other Standards:*

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A 941.

4. Ordering Information

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

4.1.1 Quantity (feet, centimetres, or number of lengths),

4.1.2 Name of material (seamless austenitic steel pipe),

4.1.3 Grade (Table 1),

4.1.4 Size (nominal size, or outside diameter and schedule number or average wall thickness),

4.1.5 Lengths (specific or random), (Permissible Variations in Length Section of Specification A 999/A 999M),

4.1.6 End finish (Ends Section of Specification A 999/A 999M),

4.1.7 Optional requirements (Section 9) (see Hydrostatic Test Requirements Section and the Permissible Variation in Weight for Seamless Pipe Section for weighing individual lengths, of Specification A 999/A 999M), (see 10.6, repairing by welding; 14.3, die stamping),

4.1.8 Test report required (Certification Section of Specification A 999/A 999M),

4.1.9 Specification designation, and

4.1.10 Special requirements or any supplementary requirements selected, or both.

[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-376 in Section II of that Code.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518.

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

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TABLE 1 Chemical Requirements

Grade	UNS Designation	Composition,%												
		Carbon	Manganese, max	Phosphorus, max	Sulfur, max	Silicon, max	Nickel	Chromium	Molybdenum	Titanium	Columbium	Tantalum	Nitrogen[A]	Others
TP304	S30400	0.08 max	2.00	0.045	0.030	0.75	8.0–11.0	18.0–20.0	...	...	...	...	...	...
TP304H	S30409	0.04–0.10	2.00	0.045	0.030	0.75	8.0–11.0	18.0–20.0	...	...	...	...	...	...
TP304N	S30451	0.08 max	2.00	0.045	0.030	0.75	8.0–11.0	18.0–20.0	...	...	...	...	0.10–0.16	...
TP304LN	S30453	0.035 max	2.00	0.045	0.030	0.75	8.0–11.0	18.0–20.0	...	...	...	...	0.10–0.16	...
TP316	S31600	0.08 max	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	...	...	...	...
TP316H	S31609	0.04–0.10	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	...	...	...	...
TP316N	S31651	0.08 max	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	...	...	0.10–0.16	...
TP316LN	S31653	0.035 max	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	...	...	0.10–0.16	...
TP321	S32100	0.08 max	2.00	0.045	0.030	0.75	9.0–13.0	17.0–19.0	...	[B]	...	...	...	...
TP321H	S32109	0.04–0.10	2.00	0.045	0.030	0.75	9.0–13.0	17.0–19.0	...	[C]	...	...	...	...
TP347	S34700	0.08 max	2.00	0.045	0.030	0.75	9.0–13.0	17.0–19.0	...	...	[D]	...	...	...
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	0.75	9.0–13.0	17.0–19.0	...	...	[E]	...	...	...
TP348[F]	S34800	0.08 max	2.00	0.045	0.030	0.75	9.0–13.0	17.0–19.0	...	...	[D]	0.10	...	Co 0.20 max
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–19.0			[E]	0.10		
16-8-2H	S16800	0.05–0.10	2.00	0.045	0.030	0.75	7.5–9.5	14.5–16.5	1.50–2.00	...	...	...	...	...
...	S31725	0.030 max	2.00	0.045	0.030	0.75	13.5–17.5	18.0–20.0	4.0–5.0	...	...	...	0.20 max	Cu 0.75 max
...	S31726	0.030 max	2.00	0.045	0.030	0.75	14.5–17.5	17.0–20.0	4.0–5.0	...	...	...	0.10–0.20	Cu 0.75 max
...	S34565	0.030 max	5.0–7.0	0.030	0.010	1.0	16.0–18.0	23.0–25.0	4.0–5.0	...	...	...	0.040–0.060	Cb 0.10 max

[A] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[B] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[C] The titanium content shall be not less than four times the carbon content and not more than 0.70 %.
[D] The columbium content shall be not less than ten times the carbon content and not more than 1.10 %.
[E] The columbium content shall be not less than eight times the carbon content and not more than 1.10 %.
[F] This grade is intended for special purpose applications.

5. General Requirements

5.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A 999/A 999M unless otherwise provided herein.

6. Materials and Manufacture

6.1 *Manufacture*—At the manufacturer's option, pipe may be either hot finished or cold finished, with a suitable finishing treatment, where necessary.

6.2 *Heat Treatment*:

6.2.1 All pipe shall be furnished in the heat-treated condition unless the order specifically states that no final heat treatment shall be applied. When the order is furnished without final heat treatment, each pipe shall be stenciled "HT-O."

6.2.2 As an alternate to final heat treatment in a continuous furnace or batch-type furnace, immediately following hot forming while the temperature of the pipes is not less than the specified minimum solution treatment temperature, pipes may be individually quenched in water or rapidly cooled by other means.

6.2.3 *Grades TP304, TP304N, TP304LN, TP316, TP316N, TP316LN, TP321, TP347, TP348, 16-8-2H, S 31725, and S 31726* —Unless otherwise stated in the order, heat treatment shall consist of heating to a minimum temperature of 1900 °F [1040 °C] and quenching in water or rapidly cooling by other means.

6.2.3.1 The purchaser may specify controlled structural or special service characteristics which shall be used as a guide for the most suitable heat treatment. If the final heat treatment is at a temperature under 1900 °F [1040 °C], each pipe shall be stenciled with the final heat treatment temperature in degrees Fahrenheit or Celsius after the suffix "HT."

6.2.4 *Grades TP304H, TP316H, TP321H, TP347H, TP348H, and 16-8-2H*—If cold working is involved in processing, the minimum solution-treating temperature for Grades TP321H, TP347H, and TP348H shall be 2000 °F [1100 °C], for Grades TP304H and TP316H, 1900 °F [1040 °C], and for Grade 16-8-2H, 1800 °F [980 °C]. If the material is hot-rolled, the minimum solution-treating temperatures for Grades TP321H, TP347H, and TP348H shall be 1925 °F [1050 °C], for Grades TP304H and TP316H, 1900 °F [1040 °C], and for Grade 16-8-2H, 1800 °F [980 °C].

6.2.5 *Grade S34565*—Heat treatment shall consist of heating to a temperature in the range of 2050 °F [1120 °C] minimum and 2140 °F [1170 °C] maximum, and quenching in water or rapidly cooling by other means.

6.3 A solution annealing temperature above 1950 °F [1065 °C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in TP321, TP321H, TP347, TP347H, TP348, and TP348H. When specified by the purchaser, a lower temperature stabilization or re-solution anneal shall be used subsequent to the initial high temperature solution anneal (see Supplementary Requirement S9).

6.4 The grain size of grades 304H, 316H, 321H, 347H, and 348H as determined in accordance with Test Methods E 112, shall be No. 7 or coarser.

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 from each heat or two pipes from each lot (Note 2) shall be made by the manufacturer. A lot of pipe shall consist of the following:

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NPS Designator	Lengths of Pipe in Lot
Under NPS 2	400 or fraction thereof
NPS 2 to NPS 5, incl	200 or fraction thereof
Over NPS 5	100 or fraction thereof

NOTE 2—A lot shall consist of the number of lengths specified in 8.1 of the same size and wall thickness from any one heat of steel.

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 Table 1.

8.3 If the analysis of one of the tests specified in Section 9 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. Tensile Requirements

9.1 The material shall conform to the requirements as to tensile properties prescribed in Table 2.

10. Workmanship, Finish, and Appearance

10.1 The pipe manufacturer shall explore a sufficient number of visual surface imperfections to provide reasonable assurance that they have been properly evaluated with respect to depth. Exploration of all surface imperfections is not required but may be necessary to assure compliance with 10.2.

10.2 Surface imperfections that penetrate more than 12½ % of the nominal wall thickness or encroach on the minimum wall thickness shall be considered defects. Pipe with such defects shall be given one of the following dispositions:

10.2.1 The defect may be removed by grinding provided that the remaining wall thickness is within specified limits.

10.2.2 Repaired in accordance with the repair welding provisions of 10.6.

10.2.3 The section of pipe containing the defect may be cut off within the limits of requirements on length.

TABLE 2 Tensile Requirements

Grade	Tensile[A] strength, min, ksi [MPa]	Yield strength min, ksi [MPa]	Elongation in 2 in. or 50 mm (or 4D) min, %	
			Longitudinal	Transverse
TP304, TP304H, TP304LN, TP316, TP316H, TP316LN, TP347, TP347H, TP348, TP348H, 16-8-2H, S31725	75 [515]	30 [205]	35	25
TP304N, TP316N, S31726	80 [550]	35 [240]	35	25
S34565	115 [790]	60 [415]	35	30
TP321, 321H				
≤⅜ ″	75 [515]	30 [205]	35	25
>⅜ ″[B]	70 [480]	25 [170]	35	25

[A] For grade TP304, NPS8 or larger, and in schedules 140 and heavier, the required minimum tensile strength shall be 70 ksi [480 MPa].

[B] Prior to the issuance of A 376/A 376M – 88, the tensile and yield strength values were 75 [520] and 30 [210] respectively, for nominal wall greater than ⅜ in. [9.5 mm].

10.2.4 Rejected.

10.3 To provide a workmanlike finish and basis for evaluating conformance with 10.2, the pipe manufacturer shall remove by grinding the following:

10.3.1 Mechanical marks, abrasions (see Note 3), and pits, any of which imperfections are deeper than 1/16 in. [1.6 mm].

NOTE 3—Marks and abrasions are defined as cable marks, dinges, guide marks, roll marks, ball scratches, scores, die marks, and so forth.

10.3.2 Visual imperfections commonly referred to as scabs, seams, laps, tears, or slivers found by exploration in accordance with 10.1 to be deeper than 5 % of the nominal wall thickness.

10.4 At the purchaser's discretion, pipe shall be subject to rejection if surface imperfections acceptable under 10.2 are not scattered, but appear over a large area in excess of what is considered a workmanlike finish. Disposition of such pipe shall be a matter of agreement between the manufacturer and the purchaser.

10.5 When imperfections or defects are removed by grinding, a smooth curved surface shall be maintained, and the wall thickness shall not be decreased below that permitted by this specification. The outside diameter at the point of grinding may be reduced by the amount so removed.

10.5.1 Wall thickness measurements shall be made with a mechanical caliper or with a properly calibrated nondestructive testing device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical caliper shall govern.

10.6 Weld repair shall be permitted only subject to the approval of the purchaser and in accordance with Specification A 999/A 999M.

10.7 The finished pipe shall be reasonably straight.

10.8 The pipe shall be free of scale and contaminating iron particles. Pickling, blasting, or surface finishing is not mandatory when pipe is bright annealed. The purchaser may request that a passivating treatment be applied.

11. Hydrostatic or Nondestructive Electric Test

11.1 Each pipe shall be subjected to the Nondestructive Electric Test or the Hydrostatic Test. Unless specified by the purchaser, either test may be used at the option of the producer.

11.2 *Hydrostatic Test*— Each length of finished pipe shall be subjected to the hydrostatic test in accordance with Specification A 999/A 999M, unless specifically exempted under the provisions of 11.3 and 11.4.

11.3 For pipe sizes NPS 24 and over, the purchaser, with the agreement of the manufacturer, may complete the hydrostatic test requirement with the system pressure test, which may be lower or higher than the specification test pressure, but in no case shall the test pressure be lower than the system design pressure. Each length of pipe furnished without the completed manufacturer's hydrostatic test shall include with the mandatory marking the letters "NH."

11.4 *Nondestructive Examination*—Each pipe shall be examined with a nondestructive test in accordance with Practice E 213 or Practice E 426. Unless specifically called out by the purchaser, the selection of the nondestructive electric test will be at the option of the manufacturer. The range of pipe sizes

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that may be examined by each method shall be subject to the limitations in the scope of the respective practices.

11.4.1 The following information is for the benefit of the user of this specification:

11.4.1.1 The reference standards defined in 11.10.1 through 11.10.4 are convenient standards for calibration of nondestructive testing equipment. The dimensions of these standards should not be construed as the minimum size imperfection detectable by such equipment.

11.4.1.2 The ultrasonic testing (UT) can be performed to detect both longitudinally and circumferentially oriented defects. It should be recognized that different techniques should be employed to detect differently oriented imperfections. The examination may not detect short, deep, defects.

11.4.1.3 The eddy-current testing (ET) referenced in Practice E 426 has the capability of detecting significant discontinuities, especially the short abrupt type.

11.4.1.4 A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular product.

11.5 *Time of Examination*—Nondestructive testing for specification acceptance shall be performed after all mechanical processing, heat treatments, and straightening operations. This requirement does not preclude additional testing at earlier stages in the processing.

11.6 *Surface Condition*:

11.6.1 All surfaces shall be free of scale, dirt, grease, paint, or other foreign material that could interfere with interpretation of test results. The methods used for cleaning and preparing the surfaces for examination shall not be detrimental to the base metal or the surface finish.

11.6.2 Excessive surface roughness or deep scratches can produce signals that interfere with the test.

11.7 *Extent of Examination*:

11.7.1 The relative motion of the pipe and the transducer(s), coil(s), or sensor(s) shall be such that the entire pipe surface is scanned, except as in 6.2.

11.7.2 The existence of end effects is recognized, and the extent of such effects shall be determined by the manufacturer, and, if requested, shall be reported to the purchaser. Other nondestructive tests may be applied to the end areas, subject to agreement between the purchaser and the manufacturer.

11.8 *Operator Qualifications*—The test unit operator shall be certified in accordance with SNT-TC-1A, or an equivalent recognized and documented standard.

11.9 *Test Conditions*:

11.9.1 For eddy-current testing, the excitation coil frequency shall be chosen to ensure adequate penetration yet provide good signal-to-noise ratio.

11.9.2 The maximum eddy-current coil frequency used shall be as follows:

On specified walls up to 0.050 in.—100 KHz max
On specified walls up to 0.150 in.—50 KHz max
On specified walls up to 0.150 in.—10 KHz max

11.9.3 *Ultrasonic*—For examination by the ultrasonic method, the minimum nominal transducer frequency shall be 2.00 MHz and the maximum nominal transducer size shall be 1.5 in.

11.9.3.1 If the equipment contains a reject notice filter setting, this shall remain off during calibration and testing unless linearity can be demonstrated at that setting.

11.10 *Reference Standards*:

11.10.1 Reference standards of convenient length shall be prepared from a length of pipe of the same grade, size (NPS, or outside diameter and schedule or wall thickness), surface finish, and heat treatment condition as the pipe to be examined.

11.10.2 *For Ultrasonic Testing*, the reference ID and OD notches shall be any one of the three common notch shapes shown in Practice E 213, at the option of the manufacturer. The depth of each notch shall not exceed 12½ % of the specified nominal wall thickness of the pipe or 0.004 in., whichever is greater. The width of the notch shall not exceed twice the depth. Notches shall be placed on both the OD and ID surfaces.

11.10.3 *For Eddy-Current Testing*, the reference standard shall contain, at the option of the manufacturer, any one of the following discontinuities:

11.10.3.1 *Drilled Hole*—The reference standard shall contain three or more holes, equally spaced circumferentially around the pipe and longitudinally separated by a sufficient distance to allow distinct identification of the signal from each hole. The holes shall be drilled radially and completely through the pipe wall, with care being taken to avoid distortion of the pipe while drilling. One hole shall be drilled in the weld, if visible. Alternately, the producer of welded pipe may choose to drill one hole in the weld and run the calibration standard through the test coils three times with the weld turned at 120° on each pass. The hole diameter shall vary with NPS as follows:

NPS Designator	Hole Diameter
	0.039 in. (1 mm)
above ½ to 1¼	0.055 in. (1.4 mm)
above 1¼ to 2	0.071 in. (1.8 mm)
above 2 to 5	0.087 in. (2.2 mm)
above 5	0.106 in. (2.7 mm)

11.10.3.2 *Transverse Tangential Notch*—Using a round tool or file with a ¼-in. (6.4-mm) diameter, a notch shall be filed or milled tangential to the surface and transverse to the longitudinal axis of the pipe. Said notch shall have a depth not exceeding 12½ % of the specified nominal wall thickness of the pipe or 0.004 in. (0.102 mm), whichever is greater.

11.10.3.3 *Longitudinal Notch*—A notch 0.031 in. or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the pipe, to have a depth not exceeding 12½ % of the specified wall thickness of the pipe or 0.004 in., whichever is greater. The length of the notch shall be compatible with the testing method.

11.10.3.4 More or smaller reference discontinuities, or both, may be used by agreement between the purchaser and the manufacturer.

11.11 *Standardization Procedure*:

11.11.1 The test apparatus shall be standardized at the beginning and end of each series of pipes of the same size (NPS or diameter and schedule or wall thickness), grade and

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heat treatment condition, and at intervals not exceeding 4 h. More frequent standardization may be performed at the manufacturer's option or may be required upon agreement between the purchaser and the manufacturer.

11.11.2 The test apparatus shall also be standardized after any change in test system settings; change of operator; equipment repair; or interruption due to power loss, process shutdown, or when a problem is suspected.

11.11.3 The reference standard shall be passed through the test apparatus at the same speed and test system settings as the pipe to be tested.

11.11.4 The signal-to-noise ratio for the reference standard shall be 2½ to 1 or greater. Extraneous signals caused by identifiable causes such as dings, scratches, dents, straightener marks, and so forth, shall not be considered noise. The rejection amplitude shall be adjusted to be at least 50 % of full scale of the readout display.

11.11.5 If upon any standardization, the rejection amplitude has decreased by 29 % (3 dB) of peak height from the last standardization, the pipe since the last calibration shall be rejected. The test system settings may be changed, or the transducer(s), coil(s) or sensor(s) adjusted, and the unit restandardized, but all pipe tested since the last acceptable standardization must be retested for acceptance.

11.12 *Evaluation of Imperfections*:

11.12.1 Pipes producing a signal equal to or greater than the lowest signal produced by the reference standard(s) shall be identified and separated from the acceptable pipes. The area producing the signal may be reexamined.

11.12.2 Such pipes shall be rejected if the test signal was produced by imperfections that cannot be identified or was produced by cracks or crack-like imperfections. These pipes may be repaired in accordance with Sections 13 and 14. To be accepted, a repaired pipe must pass the same nondestructive test by which it was rejected, and it must meet the minimum wall thickness requirements of this specification.

11.12.3 If the test signals were produced by visual imperfections such as:

(1) Scratches,
(2) Surface roughness,
(3) Dings,
(4) Straightener marks,
(5) Cutting chips,
(6) Steel die stamps,
(7) Stop marks, or
(8) Pipe reducer ripple.

The pipe may be accepted based on visual examination provided the imperfection is less than 0.004 in. (0.1 mm) or 12½ % of the specified wall thickness (whichever is greater).

11.12.4 Rejected pipe may be reconditioned and retested providing the wall thickness is not decreased to less than that required by this or the product specification. The outside diameter at the point of grinding may be reduced by the amount so removed. To be accepted, retested pipe shall meet the test requirement.

11.12.5 If the imperfection is explored to the extent that it can be identified as non-rejectable, the pipe may be accepted without further test providing the imperfection does not encroach on the minimum wall thickness.

12. Mechanical Tests Required

12.1 *Transverse or Longitudinal Tension Test*—The tension test shall be performed on 1 % of the pipe from each lot.

NOTE 4—The term "lot" applies to all pipe of the same nominal size and wall thickness (or schedule) which is produced from the same heat of steel and subjected to the same finishing treatment in a continuous furnace or by directly obtaining the heat treated condition by quenching after hot forming. When final heat treatment is in a batch-type furnace, the lot shall include only that pipe which is heat treated in the same furnace charge.

12.2 *Flattening Test*—For pipe heat treated in a batch-type furnace, the flattening test shall be made on 5 % of the pipe from each heat-treated lot (see Note 4). When heat treated by the continuous process or when treated condition is obtained directly by quenching after hot forming, this test shall be made on a sufficient number of pipe to constitute 5 % of the lot (Note 4) but in no case less than two pipes.

13. Certification

13.1 In addition to the certification required by Specification A 999/A 999M, the certification for pipe furnished to this specification shall identify each length of pipe which is furnished without the manufacturer's completed hydrostatic test, in accordance with 11.3.

14. Product Marking

14.1 In addition to the marking prescribed in Specification A 999/A 999M, the marking shall include the ANSI schedule number, the heat number or manufacturer's number by which the heat can be identified, the marking requirements of 6.2, and, if applicable, NH when hydrotesting is not performed and ET when eddy-current testing is performed, or UT when ultrasonic testing is performed.

14.2 If the pipe conforms to any of the supplementary requirements specified in S1 through S10, compliance shall be so indicated by adding the symbol "S" directly followed by the number of the applicable supplementary requirement to the marking prescribed in 14.1.

14.3 No steel indentation stamping shall be done without the purchaser's consent.

15. Keywords

15.1 austenitic stainless steel; feedwater heater tubes; stainless steel tube; steel tube; welded steel tube

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SUPPLEMENTARY REQUIREMENTSFOR PIPE REQUIRING SPECIAL CONSIDERATION

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 Product analysis shall be made on each length of pipe. Individual lengths failing to conform to the chemical composition requirements shall be rejected.

S2. Transverse Tension Tests

S2.1 A transverse tension test shall be made on a specimen from one end or both ends of each pipe NPS 8 and over in nominal diameter. If this supplementary requirement is specified, the number of tests per pipe shall also be specified. If a specimen from any length fails to meet the required tensile properties (tensile, yield, and elongation), that length shall be rejected subject to retreatment in accordance with Specification A 999/A 999M and satisfactory retest.

S3. Flattening Test

S3.1 The flattening test of Specification A 999/A 999M 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 A 999/A 999M 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 E 381. 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 from 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. Photomicrographs

S5.1 Photomicrographs at 100 diameters may be made from one end of each piece of pipe furnished in sizes 6 in. [152 mm] and larger in the as-furnished condition. Such photomicrographs shall be suitably identified as to pipe size, wall thickness, piece number, and heat. Such photomicrographs are for information only, and shall show the actual metal structure of the pipe as finished.

S6. Ultrasonic Test

S6.1 Each piece of pipe may be ultrasonically tested to determine its soundness throughout the entire length of the pipe. Each piece shall be ultrasonically tested in a circumferential direction in such a manner that the entire piece is scanned by the ultrasonic beam. The calibration standard shall be prepared from a section of pipe which has two notches, one in the inside surface and one in the outside surface. The notches shall be at least 1½-in. [38-mm] long and have a depth of 3 % of the wall thickness, or 0.004 in. [0.1 mm], whichever is the greater. Any pipe showing an ultrasonic indication of greater amplitude than the amplitude of the indication from the calibration standard shall be subject to rejection.

S7. Hot Ductility Test for Indicating Weldability

S7.1 A high-temperature ductility test may be made upon each heat of material supplied in heavy-wall pipe sections. An appropriate specimen shall be heated to an initial temperature, cooled 100 °F [50 °C], then subjected to a tension test, and shall show a minimum reduction of area of 60 %. The initial temperature is that temperature 50 °F [30 °C] below the temperature at which material exhibits zero ductility. Rejection of material shall not be based upon this test.

S8. Retests

S8.1 Upon the purchaser's request, retests shall be made from sections of material removed from any part of the pipe. Failure to meet the requirements stated in this specification shall be cause for rejection.

S9. Stabilization Heat Treatment

S9.1 Subsequent to the solution anneal required in 6.4, Grades 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 at a temperature as agreed upon between the purchaser and vendor.

S10. Intergranular Corrosion Test

S10.1 When specified, material shall pass intergranular corrosion tests conducted by the manufacturer in accordance with Practices A 262, Practice E.

NOTE S10.1—Practice E requires testing on the sensitized condition for low carbon or stabilized grades, and on the as-shipped condition for other grades.

S10.2 A stabilization heat treatment in accordance with Supplementary Requirement S9 may be necessary and is permitted in order to meet this requirement for the grades containing titanium or columbium, particularly in their H versions.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 376/A 376M - 04, that may impact the use of this specification. (Approved March 1, 2006)

(*1*) Added grade TP348H.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 376/A 376M - 02a, that may impact the use of this specification. (Approved October 1, 2004)

(*1*) Modified paragraph 14.1 to remove hydrotest pressure and length from the product marking requirements.

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