



Standard Specification for Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Pipe¹

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1. Scope*

1.1 This specification covers nickel (UNS N02200) and low carbon nickel (UNS N02201 and UNS N04400) in the form of welded and annealed or welded and stress relieved pipe intended for general corrosive service and for mechanical applications.

1.2 This specification covers outside diameter and nominal wall pipe in Schedules 5S, 10S, and 40S through 30-in. nominal pipe size shown in ANSI B 36.19 (see Table 1). Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 The following precautionary caveat pertains only to the test methods portion, Section 12, of this specification: *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- E 8 Test Methods for Tension Testing of Metallic Materials
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing
- E 571 Practice for Electromagnetic (Eddy-Current) Examination of Nickel and Nickel Alloy Tubular Products

2.2 ANSI Standards:³

- B 1.20.1 Pipe Threads
- B 36.10 Welded and Seamless Wrought Steel Pipe
- B 36.19 Stainless Steel Pipe
- 2.3 ASME Boiler and Pressure Vessel Code⁴
Section IX Welding and Brazing Qualifications

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

- 3.1.1 Alloy name or UNS number,
- 3.1.2 ASTM designation and date of issue,
- 3.1.3 Condition (temper) (Table 2),
- 3.1.4 Dimensions:

3.1.4.1 Nominal pipe size or outside diameter and schedule number or nominal wall thickness (Table 1),

3.1.4.2 Length (specific or random),

3.1.5 Quantity—feet or metres, or number of pieces,

3.1.6 Certification—State if certification is required (Section 15),

3.1.7 Samples for Product (Check) Analysis—State whether samples for product (check) analysis should be furnished (9.2),

3.1.8 Purchaser Inspection—If the purchaser wishes to witness tests or inspection of material at the place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (Section 13),

3.1.9 Nondestructive Tests (see 6.4)—Specify either Test Category 1 or 2. If Test Category 1 is required, specify if either a hydrostatic, eddy-current or ultrasonic test is to apply. If Test Category 2 is required, specify if either an eddy-current or ultrasonic test is to apply. See Section S1.

3.1.10 Supplementary Requirements.

4. Materials and Manufacture

4.1 Pipe shall be made from flat-rolled alloy by an automatic welding process with no addition of filler metal. Subsequent to welding and prior to final heat treatment, the pipe shall

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² 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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

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

TABLE 1 Dimensions of Welded Pipe

NOTE 1—The following table is a partial reprint of Table 1 of ANSI B 36.19.

NOTE 2—The decimal thicknesses listed for the respective pipe size represent their nominal wall dimensions.

Nominal Pipe Size, in.	Outside Diameter		Nominal Wall Thickness							
			Schedule 5S ^A		Schedule 10S ^A		Schedule 40S		Schedule 80S	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
1/8	0.405	10.29	...	...	0.049	1.245	0.068	1.727	0.095	2.41
1/4	0.540	13.72	...	...	0.065	1.651	0.088	2.235	0.119	3.02
3/8	0.675	17.15	...	...	0.065	1.651	0.091	2.311	0.126	3.20
1/2	0.840	21.34	0.065	1.651	0.083	2.108	0.109	2.768	0.147	3.73
3/4	1.050	26.67	0.065	1.651	0.083	2.108	0.113	2.870	0.154	3.91
1	1.315	33.40	0.065	1.651	0.109	2.768	0.133	3.378	0.179	4.55
1 1/4	1.660	42.16	0.065	1.651	0.109	2.768	0.140	3.556	0.191	4.85
1 1/2	1.900	48.26	0.065	1.651	0.109	2.768	0.145	3.683	0.200	5.08
2	2.375	60.33	0.065	1.651	0.109	2.768	0.154	3.912	0.218	5.54
2 1/2	2.875	73.03	0.083	2.108	0.120	3.048	0.203	5.156	0.276	7.01
3	3.500	88.90	0.083	2.108	0.120	3.048	0.216	5.486	0.300	7.62
3 1/2	4.000	101.6	0.083	2.108	0.120	3.048	0.226	5.740	0.318	8.08
4	4.500	114.3	0.083	2.108	0.120	3.048	0.237	6.020	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 ANSI B 1.20.1.

^B These do not conform to ANSI B 36.10.

TABLE 2 Mechanical Properties of Pipe and Tube

Condition and Size	Tensile Strength, min, psi (MPa)			Yield Strength (0.2 % offset), min, psi (MPa)			Elongation in 2 in. or 50 mm (or 4D), min, %		
	Nickel	Low- Carbon Nickel	UNS N04400	Nickel	Low- Carbon Nickel	UNS N04400	Nickel	Low- Carbon Nickel	UNS N04400
Annealed									
5 in. (127 mm) and under outside di- ameter	55 000 (380)	50 000 (345)	70 000 (480)	15 000 (105)	12 000 (80)	28 000 (195)	35	35	35
Over 5 in. (127 mm) in outside diameter	55 000 (380)	50 000 (345)	70 000 (480)	12 000 (80)	10 000 (70)	25 000 (170)	40	40	35
Stress-relieved									
All sizes	65 000 (450)	60 000 (415)	85 000 (585)	40 000 (275)	30 000 (205)	55 000 (380)	15	15	15

be cold worked to assure that optimum corrosion resistance in the weld area and base metal will be developed during heat treatment.

4.2 Pipe shall be furnished with a scale free finish. When bright annealing is used, descaling is not necessary.

5. Chemical Composition

5.1 The material shall conform to the requirements as to chemical composition prescribed in Table 3.

5.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Table 3.

6. Mechanical Properties and Other Requirements

6.1 *Mechanical Properties*—The material shall conform to the requirements for mechanical properties prescribed in Table 2.

TABLE 3 Chemical Requirements

Element	Composition, %			Product (Check) Analysis Variations, under min or over max, of the Specified Limit of Element
	Nickel (UNS N02200)	Low-Carbon Nickel (UNS N02201)	Nickel-Copper (UNS N04400)	
Nickel, min	99.0	99.0	63.0	0.60
Copper, max	0.25	0.25	28.0–34.0	0.03
Iron, max	0.40	0.40	2.5	0.03
Manganese, max	0.35	0.35	2.0	0.03
Carbon, max	0.15	...	0.3	0.01
Carbon, max	...	0.02	...	0.005
Silicon, max	0.35	0.35	0.5	0.03
Sulfur, max	0.01	0.01	0.024	0.003

6.2 *Flattening Test Requirements*—Flattening test specimens made in accordance with 12.3 shall show no cracks or breaks on the inside, outside, or end surfaces.

6.3 *Transverse Guided Bend Test*—See 12.6.3 for acceptance criteria.

6.4 *Nondestructive Tests:*

6.4.1 Pipe shall be subjected to the nondestructive tests outlined in the following test categories.

6.4.1.1 *Category 1*—Hydrostatic, eddy-current, or ultrasonic test at the manufacturer’s option unless the purchaser specifies in accordance with 3.1.9.

6.4.1.2 *Category 2*—Hydrostatic plus eddy-current or ultrasonic test at the manufacturer’s option unless the purchaser specifies in accordance with 3.1.9.

6.4.1.3 The manufacturer shall have the option to use Test Category 1 or 2 if the purchaser does not specify the test category options in accordance with 3.1.9.

6.4.2 *Hydrostatic Test*—When tested in accordance with the requirements of 12.4, any pipe that leaks shall be rejected. Any leaking area may be cut out and the pipe retested.

6.4.3 *Acceptance and Rejection*—Pipe producing a signal equal to or greater than the calibration imperfection shall be subject to rejection.

6.4.3.1 Test signals produced by imperfections that cannot be identified or produced by cracks or crack-like imperfections shall result in rejection of the pipe subject to rework and retest. To be accepted, the pipe must pass the same electric test to which it was originally subjected provided that the dimensional requirements are met.

6.4.3.2 If the imperfection is judged as injurious, the pipe shall be rejected but may be reconditioned and retested providing the dimensional requirements are met. To be accepted, retested pipe shall meet the original electric test requirements.

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

7. Dimensions and Permissible Variations

7.1 The outside diameter shall not exceed the permissible variations prescribed in Table 4.

7.1.1 Pipe having a specified wall thickness that is 3 % or less of the outside diameter cannot be straightened properly without a certain amount of ovality resulting in the diameter. The limits to this ovality are stated in Footnote B of Table 4.

TABLE 4 Permissible Variations in Outside Diameter

NPS Designator	Permissible Variations in Outside Diameter			
	Over		Under	
	in.	mm	in.	mm
1/8 to 1 1/2, incl	1/64 (0.015)	0.4	1/32 (0.031)	0.8
Over 1 1/2 to 4, incl	1/32 (0.031)	0.8	1/32 (0.031)	0.8
Over 4 to 8, incl	1/16 (0.062)	1.6	1/32 (0.031)	0.8
Over 8 to 12, incl	3/32 (0.093)	2.4	1/32 (0.031)	0.8
Over 18 to 26, incl	1/8 (0.125)	3.2	1/32 (0.031)	0.8
Over 26 to 34, incl	5/32 (0.156)	4.0	1/32 (0.031)	0.8
Over 34 to 48, incl	3/16 (0.187)	4.8	1/32 (0.031)	0.8

7.2 The wall thickness shall not vary from nominal by more than $\pm 12\frac{1}{2}$ %.

7.3 *Straightness*—Material shall be reasonably straight and free of bends or kinks.

7.4 *Length*—Variations from the specified length shall not exceed the amounts prescribed in Table 5.

8. Workmanship, Finish, and Appearance

8.1 The material shall be uniform in quality and temper, smooth, commercially straight, and free of injurious imperfections.

9. Sampling

9.1 *Lots of Chemical Analysis and Mechanical Testing.*

9.1.1 A lot for chemical analysis shall consist of one heat.

9.1.2 A lot for mechanical properties and flattening or transverse guided bend testing shall consist of all material from the same heat, nominal size (excepting length), and condition (temper).

9.2 *Test Material Selection.*

9.2.1 *Chemical Analysis*—Representative samples shall be taken during pouring or subsequent processing.

9.2.1.1 Product (check) analysis shall be wholly the responsibility of the purchaser.

TABLE 5 Permissible Variations in Length^A

Outside Diameter, in. (mm)	Cut Length, in. (mm)	
	Over	Under
Under 2 (50.8)	1/8 (3.18)	0
2 (50.8) and over	3/16 (4.75)	0

^A These permissible variations in length apply to pipe before bending. They apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft, an additional over-tolerance of 1/8 in. (3.18 mm) for each 10 ft (3.0 m) or fraction thereof shall be permissible up to a maximum additional over-tolerance of 1/2 in. (12.7 mm).

9.2.2 *Mechanical Properties and Flattening Testing*—Samples of the material to provide test specimens shall be taken from such locations in each lot as to be representative of that lot.

10. Number of Tests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Mechanical Properties*—One test per lot.

10.3 *Flattening or Transverse Guided Bend Test*—One test per lot.

10.4 *Nondestructive*—Each piece in each lot.

11. Specimen Preparation

11.1 Tension test specimens shall be taken from material in the final condition (temper) and tested in the direction of fabrication.

11.1.1 Whenever possible, all pipe shall be tested in full-tubular size. When testing in full-tubular size is not possible, longitudinal strip specimens shall be used. In the event of disagreement when full-tubular testing is not possible, a longitudinal strip specimen with reduced gage length in accordance with Test Methods E 8 shall be used.

12. Test Methods

12.1 The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods.

Test	ASTM Designation
Chemical Analysis	E 39
Tension	E 8
Rounding procedure	E 29

12.2 For purposes of determining compliance with the limits in this specification, an observed value or a calculated value shall be rounded in accordance with the rounding method of Practice E 29:

Test	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerances (when expressed in decimals).	nearest unit in the last right-hand place of figures of the specified limit.
Tensile strength and yield strength.	nearest 1000 psi (6.9 MPa)
Elongation	nearest 1 %

12.3 *Flattening Test*—Pipe shall be capable of withstanding, without cracking, flattening under a load applied gradually at room temperature until the distance between the platens is five times the wall thickness. The weld shall be positioned 90 % from the direction of the applied flattening force.

12.4 *Hydrostatic Test*—Each pipe shall be tested at a pressure calculated by the following equation:

$$P = 2St/D \quad (1)$$

where:

- P = hydrostatic test pressure, psi (or MPa),
- t = specified wall thickness, in. (or mm),
- D = specified outside diameter, in. (or mm), and
- S = allowable fiber stress for material in the condition furnished, as follows:

	Nickel	Low Carbon Nickel	Nickel-Copper (Allowable Fiber Stress)
Annealed			
5 in. (127 mm) outside diameter and under	10 000 psi (70 MPa)	8000 psi (55 MPa)	17 500 psi (120 MPa)
Over 5 in. outside diameter	8000 psi (55 MPa)	6700 psi (45 MPa)	16 700 psi (115 MPa)
	Nickel	Low Carbon Nickel	Nickel-Copper (Allowable Fiber Stress)
Stress Relieved:			
All sizes	16 200 psi (110 MPa)	15 000 psi (105 MPa)	21 200 psi (145 MPa)

12.4.1 The test pressure shall be held for a minimum of 5s.

12.4.2 Visual examination shall be made when the pipe is under pressure. The full length of the pipe must be examined for leaks. If any pipe shows leaks during the hydrostatic test, it shall be rejected.

12.5 *Electric Test*—Each pipe shall be tested with an electric test in accordance with either Practice E 213 or E 571.

12.5.1 For eddy-current testing, the calibration pipe shall contain, at the option of the manufacturer, any one of the following discontinuities to establish a minimum sensitivity level for rejection. The discontinuity shall be placed in the weld if visible.

(a) *Drilled Hole*—A hole not larger than 0.031 in. (0.79 mm) in diameter shall be drilled radially and completely through the wall, care being taken to avoid distortion of the pipe while drilling.

(b) *Transverse Tangential Notch*—Using a round file or tool 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. This notch shall have a depth not exceeding 12½ % of the specified wall thickness of the pipe or 0.004 in. (0.102 mm), whichever is greater.

(c) *Longitudinal Notch*—A notch 0.031 in. (0.79 mm) or less in width shall be machined in a radial plan parallel to the pipe 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. (0.102 mm), whichever is greater. The length of the notch shall be compatible with the testing method.

12.5.2 For ultrasonic testing, the longitudinal calibration reference notches shall be at the option of the manufacturer, any one of the three common notch shapes in accordance with Practice E 213. The depth of the notch shall not exceed 12½ % of the specified wall thickness of the pipe or 0.004 in. (0.102 mm), whichever is greater. The notch shall be placed in the weld if visible.

12.6 *Transverse Guided Bend Test:*

12.6.1 At the option of the pipe manufacturer, the transverse guided bend test may be substituted in lieu of the flattening test. Two bend specimens shall be taken transversely from pipe or the test specimens may be taken from a test plate of the same material and heat as pipe, which is attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam. Except as provided in 12.6.2, one shall be subjected to a face guided bend and a second to root guided bend test. One specimen shall be bent with the inside surface of the pipe against the plunger and the other with the outside surface of the pipe against the plunger. Guided bend test specimens shall be

prepared and tested in accordance with **Section IX, Part QW160** of the ASME Boiler and Pressure Vessel Code and shall be one of the types shown in QW462.2 and QW462.31.3 of that code.

12.6.2 For specified wall thicknesses $\frac{3}{8}$ in. (9.5 mm) and over, but less than $\frac{3}{4}$ in. (19 mm) side bend tests may be made instead of the face and root bend tests. For specified wall thicknesses $\frac{3}{4}$ in. (19 mm) and over, both specimens shall be subjected to the side bend tests. Side bend specimens shall be bent so that one of the side surfaces becomes the convex surface of the bend specimen.

12.6.3 The bend test shall be acceptable if no cracks or other defects exceeding $\frac{1}{8}$ in. (3 mm) in any direction be present in the weld metal or between the weld and the pipe or plate metal after bending. Cracks which originate along the edges of the specimen during testing, and are less than $\frac{1}{4}$ in. (6.5 mm) measured in any direction shall not be considered.

13. Inspection

13.1 Inspection of the material shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

15. Certification

15.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Product Marking

16.1 The name or brand of the manufacturer, the name of the material or UNS number from which the pipe is made, the letters ASTM, the specification number, condition (temper), heat number, test category for pipe outside diameters 1.5 in. (38.1 mm) and under, and the nominal size shall be stenciled legibly on each pipe $\frac{1}{2}$ in. (12.7 mm) and over in outside diameter, provided the length is not under 3 ft (914 mm). The material marking shall be by any method that will not result in harmful contamination.

16.2 For pipe less than $\frac{1}{2}$ in. (12.7 mm) in diameter and pipe under 3 ft (914 mm) in length, the information in accordance with 16.1 shall be either stenciled or marked on a tag securely attached to the bundle or box in which the pipe is shipped.

17. Keywords

17.1 N02200; N02201; N04400; welded pipe

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified in the purchase order.

S1. Supplementary Requirements for Pipe Requiring Special Consideration

S1.1 The pipe may be furnished without cold working.

S1.2 The pipe may be furnished without a final heat treatment.

S1.3 Pipe over 0.125 in. (3.175 mm) wall thickness may be welded with the addition of matching filler metal.

SUMMARY OF CHANGES

Committee B02 has identified the location of selected changes to this standard since the last issue (B 725 – 93 (2003)^{e1}) that may impact the use of this standard.

(1) Added Transverse Guided Bend Test.

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