



Designation: B474/B474M – 19 (Reapproved 2023)

Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe¹

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1. Scope

1.1 This specification covers electric fusion welded pipe suitable for high-temperature or corrosive service as listed in **Table 1**. (Although no restrictions are placed on the sizes of pipe that may be furnished under this specification, commercial practice is commonly limited to sizes not less than 8 in. [203 mm] nominal diameter.)

1.2 Five classes of pipe are covered as follows:

1.2.1 *Class 1*—Pipe shall be double welded by processes employing filler metal in all passes and shall be completely radiographed.

1.2.2 *Class 2*—Pipe shall be double welded by processes employing filler metal in all passes. No radiography is required.

1.2.3 *Class 3*—Pipe shall be single welded by processes employing filler metal in all passes and shall be completely radiographed.

1.2.4 *Class 4*—Same as Class 3 except that the weld pass exposed to the inside pipe surface may be made without the addition of filler metal.

1.2.5 *Class 5*—Pipe shall be double welded by processes employing filler metal in all passes and shall be spot radiographed.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *This standard does not purport to address all of the safety concerns, 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 Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health,*

and environmental practices, and determine the applicability of regulatory limitations prior to use.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

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

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

B127 Specification for Nickel-Copper Alloy Plate, Sheet, and Strip

B162 Specification for Nickel Plate, Sheet, and Strip

B168 Specification for Nickel-Chromium-Aluminum Alloys (UNS N06699), Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674), and

B333 Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip

B424 Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloys Plate, Sheet, and Strip

B435 Specification for Heat and Corrosion Resistant High Temperature Alloy Plate, Sheet, and Strip

B443 Specification for Nickel-Chromium-Molybdenum-Columbium Alloy and Nickel-Chromium-Molybdenum-Silicon Alloy Plate, Sheet, and Strip

B463 Specification for UNS N08020 Alloy Plate, Sheet, and Strip

B536 Specification for Nickel-Iron-Chromium-Silicon Alloys Plate, Sheet, and Strip

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Designation established in accordance with ASTM E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

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.

TABLE 1 Recommended Heat Treatment

Alloy	UNS Designation	PWHT ^{A,B} Deg. F. [Deg. C]	Quench
200 (Ni)	N02200	1650-1700 [900 to 928]	Rapid Air/water
201 (Low C)	N02201	1650-1700 [900 to 928]	Rapid Air/water
400 (Ni-Cu)	N04400	1650-1700 [900 to 928]	Rapid Air/water
X (Ni-Cr-Mo-Fe)	N06002	2150 [1177] ^C	Rapid Air/water
C22 ^D (Low C-Ni-Mo-Cr)	N06022	2050-[1120] ^C	Rapid Air/water
G30 ^D (Ni-Cr-Fe-Mo-Cu)	N06030	2150 [1177] ^C	Rapid Air/water
C2000 ^D (Ni-Cr-Mo-Cu)	N06200	2075-2125 [1135-1163] ^B	Rapid Air/water
230 ^D (Ni-Cr-W-Mo)	N06230	2150-2250 [1177-1232] ^B	Rapid Air/water
600 (Ni-Cr-Fe)	N06600	1800-1850 [983 to 1010]	Rapid Air/water
601 (Ni-Cr-Fe-Al)	N06601	1600-1650 [874 to 900] ^E	Rapid Air/water
625 (Ni-Cr-Mo-Cb) Grade 1	N06625	1600 [871] ^C	Rapid Air/water
625 (Ni-Cr-Mo-Cb) Grade 2	N06625	2000 [1093] ^C	Rapid Air/water
G3 ^D (Ni-Cr-Fe-Mo-Cu)	N06985	2100-2150 [1147 to 1177] ^B	Rapid Air/water
Alloy 20 (Cr-Ni-Fe-Mo-Cu-Cb)	N08020	1700-1850 [927 to 1010]	Rapid Air/water
825 (Ni-Fe-Cr-Mo-Cu)	N08825	1700-1800 [930 to 980] ^E	Rapid Air/water
C276 (Low C-Ni-Mo-Cr)	N10276	2050 [1121] ^C	Rapid Air/water
B2 (Ni-Mo)	N10665	1950 [1065] ^C	Rapid Air/water
B3 ^D (Ni-Mo)	N10675	1950 [1065] ^C	Rapid Air/water

^A Recommended temperatures—Different temperatures may be selected by either the purchaser or the manufacturer.

^B Set temperatures, ± 25 °F [± 14 °C].

^C Minimum set temperature.

^D Registered Trademark of Haynes International.

^E Heat treatment is highly dependent on intended service temperature — consult material manufacturer for specific heat treatments for end use temperature.

B575 Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, Low-Carbon Nickel-Chromium-Molybdenum-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Tungsten, and Low-Carbon Nickel-Molybdenum-Chromium Alloy Plate, Sheet, and Strip

B582 Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip

B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

B899 Terminology Relating to Non-ferrous Metals and Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

2.2 *American Society of Mechanical Engineers Standard*.³

ASME Boiler and Pressure Vessel Code, Section IX and Section VIII, Div. 1

2.3 *American Welding Society Standards*.⁴

A5.4 Corrosion-Resisting Chromium and Chromium Nickel Steel Covered Welding Electrodes

A5.9 Corrosion-Resisting Chromium and Chromium Nickel Steel Welding Rods and Bare Electrodes

A5.11 Nickel and Nickel Alloy Covered Welded Electrodes

A5.14 Nickel and Nickel Alloy Bare Welding Rods and Electrodes

3. Terminology

3.1 Terms defined in Terminology **B899** shall apply unless otherwise defined in this standard.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Examples of such requirements include, but are not limited to, the following:

- 4.1.1 Quantity (feet, metres, or number of lengths),
- 4.1.2 Name of material or UNS number (electric-fusion-welded pipe),
- 4.1.3 Alloy (**Table 1**),
- 4.1.4 Class (see **1.2**),
- 4.1.5 Size (outside diameter and minimum wall thickness),
- 4.1.6 Length (specific or random),
- 4.1.7 ASTM designation and year of issue,
- 4.1.8 Authorization for repair of plate defects by welding without prior approval if such is intended (see **9.4**),
- 4.1.9 Circumferential weld permissibility (see **8.3.2**), and
- 4.1.10 Supplementary requirements.

5. Materials and Manufacture

5.1 *Materials*—The plate material shall conform to the requirements of the appropriate raw material specification listed in **2.1**.

5.2 *Welding*:

5.2.1 The joints shall be full penetration double-welded or single-welded butt joints employing fusion welding processes as defined under “Definitions,” ASME Boiler and Pressure Vessel Code, Section IX. This specification makes no provision for any difference in weld quality requirements regardless of the weld joint type employed (single or double) in making the weld. Where backing rings or strips are employed, the ring or strip material shall be of the same P-number (Table QW-422 of

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁴ Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.

Section IX) as the plate being joined. Backing rings or strips shall be completely removed after welding, prior to any required radiography, and the exposed weld surface shall be examined visually for conformance to the requirements of 5.2.3. Welds made by procedures employing backing strips or rings which remain in place are prohibited. Welding procedures and welding operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

5.2.2 Except as provided in 5.2.2.1 and 5.2.2.2, welds shall be made in their entirety by processes involving the deposition of filler metal.

5.2.2.1 For Class 4 pipe employing multiple passes, the root-pass may be completed without the addition of filler metal.

5.2.2.2 For Class 4 pipe, the weld surface exposed inside the pipe may result from a single pass made from the inside of the pipe without the addition of filler metal.

5.2.2.3 All single-welded pipe shall be completely radiographed.

5.2.3 The weld surface on either side of the weld shall be flush with the base plate or shall have a reasonably uniform crown, not to exceed $\frac{1}{8}$ in. [3.2 mm]. Any weld reinforcement may be removed at the manufacturer's option or by agreement between the manufacturer and purchaser. The contour of the reinforcement shall be reasonably smooth and free of irregularities. The deposited metal shall be fused uniformly into the plate surface. No concavity of contour is permitted unless the resulting thickness of weld metal is equal to or greater than the minimum thickness of the adjacent base metal.

5.2.4 Weld defects shall be repaired by removal to sound metal and rewelding. Subsequent heat treatment and inspection (that is, visual, radiographic and dye penetrant) shall be as required on the original welds.

5.3 Heat Treatment:

5.3.1 The pipe furnished under this specification, shall be heat treated in accordance with Table 1. See Table 1 for recommended practice.

5.3.2 The purchase order shall specify one of the following conditions if the heat-treated condition specified by Table 1 is not desired by the purchaser.

5.3.2.1 A final heat treatment other than that specified in Table 1—Each pipe supplied under this requirement shall be stenciled with the final heat-treatment temperature in degrees Fahrenheit or degrees Celsius after the suffix “HT.”

5.3.2.2 No final heat-treatment of pipe fabricated of plate that has been heat treated at temperatures required by this specification—Each pipe supplied under this requirement shall be stenciled with the suffix “HT-O.”

5.3.2.3 No final heat-treatment of pipe fabricated of plate that has not been heat treated at temperatures required by this specification—Each pipe supplied under this requirement shall be stenciled with the suffix “HT-SO.”

6. Chemical Composition

6.1 *Product Analysis of Plate*—The pipe manufacturer shall make an analysis of each mill heat of plate material. The product analysis so determined shall meet the requirements of the plate specification to which the material was ordered.

6.2 *Product Analysis of Weld*—The pipe manufacturer shall make an analysis of the finished deposited weld material from each lot of pipe. The chemical composition of the weld deposit shall fall within the chemical composition limits of the applicable AWS filler metal specification for the corresponding grade shown in Table 2 (or higher alloyed filler metal when approved by the purchaser) or shall conform to the chemical composition specified for the plate specification to which the material was ordered, or shall, subject to the purchaser approval, be a filler metal more highly alloyed than the base metal when needed for corrosion resistance or other properties. Use of a filler metal other than that listed in Table 2 shall be reported and the filler metal identified on the pipe manufacturer's certificate of test. The composite analysis variations from Table 2 limits, that are caused by the dilution of the weld metal with the base metal, shall be agreed upon between purchaser and manufacturer.

6.3 A lot for product analysis shall consist of one heat.

7. Mechanical and Other Properties

7.1 Mechanical Properties:

7.1.1 The mechanical properties of the plate shall be in accordance with the plate specification to which it was ordered. Tension tests made by the plate manufacturer shall qualify the plate material.

7.1.2 Transverse tension tests taken across the welded joint shall have a tensile strength not less than the specified minimum tensile strength of the plate.

7.1.3 A lot for mechanical testing shall consist of all material from the same heat (which may include more than one plate/slab/lot number), nominal size (excepting length) and heat treatment. When final heat treatment is in a batch-type furnace, a lot shall include only those pipes of the same size and the same heat (which may include more than one plate/slab/lot number) that are heat-treated in the same furnace charge. When heat treatment is in a continuous furnace, a lot shall include all pipe of the same size and heat (which may include more than one plate/slab/lot number), heat-treated in the same furnace at the same temperature, time at temperature, and furnace speed during one production run. At no time shall a lot consist of more than 20 000 lb [9070 kg].

7.1.4 Samples of the material to provide test specimens for mechanical and other properties shall be taken from such locations in each lot as to be representative of that lot. Test specimens shall be taken from material in the final condition. It is permissible for the test specimens to be taken from a test plate of the same material as the pipe, the test plate being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal weld seam, including any/all post weld heat treatments.

7.2 Transverse Guided Weld Bend Test Requirements:

7.2.1 Two bend test specimens shall be taken transversely from the weld area of the pipe or test plate. Except as provided in 7.2.2, one shall be subject to a face guided-bend test and the second to a 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 against the plunger.