Designation: B474/B474M – 15

Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe[1]

This standard is issued under the fixed designation B474/B474M; 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 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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

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 (UNS N04400) Plate, Sheet, and Strip

B162 Specification for Nickel Plate, Sheet, and Strip

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

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

B424 Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825, UNS N08221, and UNS N06845) Plate, Sheet, and Strip

B435 Specification for UNS N06002, UNS N06230, UNS N12160, and UNS R30556 Plate, Sheet, and Strip

B443 Specification for Nickel-Chromium-Molybdenum-Columbium Alloy(UNS N06625) and Nickel-Chromium-Molybdenum-SiliconAlloy (UNS N06219) Plate, Sheet, and Strip

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

B536 Specification for Nickel-Iron-Chromium-Silicon Alloys (UNS N08330 and N08332) Plate, Sheet, and Strip

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

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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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.

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

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 [177-1232][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.

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 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 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

[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.

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 ⅛ 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

TABLE 2 Pipe and Weld Filler Materials

Alloy	UNS Designation	ASTM Plate Specification	Filler Metal Clsssification and UNS Designation[A] for Applicable AWS Specification					
			A5.11		A5.9		A5.14	
			Class	UNS	Class	UNS	Class	UNS
200	N02200	B162	ENi-1	W82141	...	...	ERNi-1	N02061
201	N02201	B162	...	...	...	...	...	...
400	N04400	B127	ENiCu-7	W84190	...	...	ERNiCu-7	N04060
X	N06002	B435	ENiCrMo-2	W86002	...	...	ERNiCrMo-2	N06002
C22[B]	N06022	B575	ENiCrMo-10	W86022	...	...	ERNiCrMo-10	N06022
C2000[B]	N06200	B575	ENiCrMo-17[C]	W86200[C]	...	...	ERNiCrMo-17[C]	N06200[C]
C30[B]	N06030	B582	ENiCrMo-11	W86030	...	...	ERNiCrMo-11	N06030
230[B]	N06230	B435	ENiCrWMo-1[C]	W86231[C]	...	...	ERNiCrWMo-1	N06231
600	N06600	B168	N/A[D]	...	...	...	ERNiCr-3	N06082
601	N06601	B168	[E]	...	...	...	[E]	
625	N06625	B443	ENiCrMo-3	W86112	...	...	ERNiCrMo-3	N06625
G3	N06985	B582	ENiCrMo-9	W86985	...	...	ERNiCrMo-9	N06985
20CB	N08020	B463	...	...	ER320	N08021	...	...
...	...	...	...	...	ER320LR	N08022	...	...
825	N08825	B424	ENiCrMo-3[F]	W86112	...	...	ERNiCrMo-3[F]	N06625
C276	N10276	B575	ENiCrMo-4	W80276	...	...	ERNiCrMo-4	N10276
B2	N10665	B333	ENiMo-7	W80665	...	...	ERNiMo-7	N10665
B3[B]	N10675	B333	ENiMo-10	W80875	...	...	ERNiMo-10	N10675

[A] New designation established in accordance with ASTM E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).
[B] Registered Trademark of Haynes International.
[C] Approved by AWS but not published.
[D] No AWS classification existed at the time of this writing—consult material manufacturer for recommended filler metal.
[E] Filler metal used is highly dependent on intended service temperature—consult material manufacturer for specific filler metal for end use temperature.
[F] Recommended filler metal—this material is highly dependent on intended service temperature for best filler metal selection—consult material manufacturer for specific filler metal given the end use temperature.