Designation: B 333 – 98

Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip[1]

This standard is issued under the fixed designation B 333; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification[2] covers plate, sheet, and strip of nickel-molybdenum alloys (UNS N10001, N10665, N10675, N10629, and N10624)* as shown in Table 1, for use in general corrosive service.

1.2 The following products are covered under this specification:

1.2.1 *Sheet and Strip*—Hot or cold rolled, solution annealed, and descaled unless solution anneal is performed in an atmosphere yielding a bright finish.

1.2.2 *Plate*—Hot or cold rolled, solution annealed, and descaled.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys[3]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[6]

E 112 Test Methods for Determining the Average Grain Size[4]

TABLE 1 Chemical Requirements

Element	Composition Limits, %				
	Alloy N10001	Alloy N10665	Alloy N10675	Alloy N10629	Alloy N10624
Nickel	remainder[A]	remainder[A]	65.0 min	remainder[A]	Bal
Molybdenum	26.0–30.0	26.0–30.0	27.0–32.0	26.0–30.0	21.0-25.0
Iron	4.0–6.0	2.0 max	1.0–3.0	1.0–6.0	5.0-8.0
Chromium	1.0 max	1.0 max	1.0–3.0	0.5–1.5	6.0-10.0
Carbon, max	0.05	0.02	0.01	0.01	0.01
Silicon, max	1.0	0.10	0.10	0.05	0.10
Cobalt, max	2.5	1.00	3.0	2.5	1.0
Manganese, max	1.0	1.0	3.0	1.5	1.0
Phosphorus, max	0.04	0.04	0.030	0.04	0.025
Sulfur, max	0.03	0.03	0.010	0.01	0.01
Vanadium	0.2–0.4	...	0.20 max	...	...
Nickel plus Molybdenum	...	...	94.0–98.0		...
Aluminum	...	...	0.50 max	0.1–0.5	0.5
Columbium (Nb), max	...	...	0.20		...
Copper, max	...	...	0.20	0.5	0.5
Tantalum, max	...	...	0.20		...
Titanium, max	...	...	0.20		...
Tungsten, max	...	...	3.0		...
Zirconium, max	...	...	0.10		...
Magnesium, max	...	...	...	...	...

[A] See 12.1.1

E 140 Hardness Conversion Tables for Metals[4]

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys[6]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *cold-rolled plate*—material 3⁄16 to 3⁄8 in. (4.76 to 9.52 mm), inclusive, in thickness.

3.1.2 *hot-rolled plate*—material 3⁄16 in. (4.76 mm) and over in thickness.

3.1.3 *plate*—material 3⁄16 in. (4.76 mm) and over in thickness.

3.1.4 *sheet and strip*—material under 3⁄16 in. (4.76 mm) in thickness.

[1] This specification is under the jurisdiction of ASTM Committee B-2 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

Current edition approved Oct. 10, 1998. Published November 1998. Originally published as B 333 – 58 T. Last previous edition B 333 – 95a.

* New designation established in accordance with ASTM E 527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-333 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 02.04.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] *Annual Book of ASTM Standards*, Vol 03.05.

4. Ordering Information

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

4.1.1 *Alloy*—Table 1,

4.1.2 *Dimensions*—Thickness (in decimals of an inch), width, and length (inch or fractions of an inch),

4.1.3 *Optional Requirement*—Plate; how the plate is to be cut (see 7.8.1 and Table 6),

4.1.4 *Certification*—State if certification or a report of test results is required (Section 15),

4.1.5 *Purchase Inspection*—State which tests or inspections are to be witnessed (Section 13), and

4.1.6 *Samples for Product (Check) Analysis*—State whether samples shall be furnished (9.2.2).

5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 1.

5.2 If a product (check) analysis is made by the purchaser, the material shall conform to the requirements specified in Table 1 subject to the permissible tolerances in B 880.

6. Mechanical Properties and Other Requirements

6.1 *Tensile Properties*—The material shall conform to the room temperature tensile properties prescribed in Table 2.

6.2 *Hardness*—The hardness values given in Table 2 are informative only.

6.3 *Grain Size for Sheet and Strip*—Sheet and strip shall conform to the grain sizes as illustrated in Plate 1 of Test Methods E 112. The requirements shall be as indicated in Table 3.

7. Dimensions, Mass, and Permissible Variations

7.1 *Weight*—For calculations of mass or weight, the following densities shall be used:

TABLE 3 Grain Size for Annealed Sheet

Thickness, in. (mm)	ASTM Micrograin Size Number, max	Average Grain Diameter, max, mm (in.)
0.125 (3.175) and under	3.0	0.127 (0.0050)
Over 0.125 (3.175)	1.5	0.214 (0.0084)

TABLE 4 Permissible Variations in Thickness of Plate[A]

Specified Thickness, in. (mm)	Permissible Variations in Thickness, in. (mm)[B,C]	
	+	–
3/16 to 7/32 (4.762 to 5.556), incl	0.021 (0.53)	0.010 (0.25)
Over 7/32 to 1/4 (5.556 to 6.350), incl	0.024 (0.61)	0.010 (0.25)
Over 1/4 to 3/8 (6.350 to 9.525), incl	0.027 (0.69)	0.010 (0.25)
Over 3/8 to 1/2 (9.525 to 12.70), incl	0.030 (0.76)	0.010 (0.25)
Over 1/2 to 5/8 (12.70 to 15.88), incl	0.035 (0.89)	0.010 (0.25)
Over 5/8 to 3/4 (15.88 to 19.05), incl	0.040 (1.02)	0.010 (0.25)
Over 3/4 to 7/8 (19.05 to 22.25), incl	0.045 (1.14)	0.010 (0.25)
Over 7/8 to 1 (22.25 to 25.4), incl	0.050 (1.27)	0.010 (0.25)
Over 1 to 2 1/2 (25.4 to 63.5), incl	5[D]	0.010 (0.25)

[A] Applicable to plate 48 in. (1.22 m) and under in width.
[B] Measured 3/8 in. (9.525 mm) or more from any edge.
[C] Buffing or grinding for removal of light surface imperfections shall be permitted. The depth of such buffed or ground areas shall not exceed the minimum tolerance thickness.
[D] Expressed as percent of thickness.

Alloy	Density lb/in.^{3}	Density (g/cm^3)
N10001	0.334	(9.24)
N10665	0.333	(9.22)
N10675	0.333	(9.22)
N10629	0.333	(9.22)
N10624	0.322	(8.9)

7.2 *Thickness*:

7.2.1 *Plate*—The permissible variations in thickness of plate shall be as prescribed in Table 4.

TABLE 2 Mechanical Property Requirements

Alloy	Thickness, in. (mm)	Tensile Strength, min, psi (MPa)	Yield Strength (0.2 % Offset), min, psi (MPa)	Elongation in 2 in. (50.8 mm) or 4D[A] min, %	Rockwell Hardness,[B] max
		Sheet and Strip			
N10001	Under 3/16 (4.76)	115 000 (795)	50 000 (345)	45	100 HRB
N10665	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40	100 HRB
N10675	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40	100 HRB
N10629	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40	100 HRB
N10624	Under 3/16 (4.76)	104 000 (720)	46 000 (320)	40	100 HRB
		Plate			
N10001	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	100 000 (690)	45 000 (310)	40	100 HRB
N10665	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	110 000 (760)	51 000 (350)	40	100 HRB
N10675	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	110 000 (760)	51 000 (350)	40	100 HRB
N10629	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	110 000 (760)	51 000 (350)	40	100 HRB
N10624	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	104 000 (720)	46 000 (320)	40	100 HRB

[A] D refers to the diameter of the tension specimen.
[B] Hardness values are shown for information purposes only and are not to be used as a basis for rejection or acceptance. For approximate hardness conversions, see Hardness Conversion Tables E140.