



Designation: ~~B333-98~~ Designation: **B 333 – 03 (Reapproved 2008)**

Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip¹

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 specification² 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.~~

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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 Material Safety Data Sheet (MSDS) 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: B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys*³

E8 Test Methods for Tension Testing of Metallic Materials B 906 Specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys Plate, Sheet, and Strip

E18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁴ 112 Test Methods for Determining Average Grain Size

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

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

E112 Test Methods for Determining the Average Grain Size⁴

E140 Hardness Conversion Tables for Metals⁴

E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys⁶ 140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *cold-rolled plate* cold-rolled plate, *n*—material $\frac{3}{16}$ to $\frac{3}{8}$ in. (4.76 to 9.52 mm), inclusive, in thickness.

3.1.2 *hot-rolled plate* hot-rolled plate, *n*—material $\frac{3}{16}$ in. (4.76 mm) and over in thickness.

3.1.3 *plate* plate, *n*—material $\frac{3}{16}$ in. (4.76 mm) and over in thickness.

¹ This specification is under the jurisdiction of ASTM Committee B-2B02 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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* 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 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 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 Specification B 90642.1-1.

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 E 140.

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

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of Specification B 906 unless otherwise provided herein.

5. Ordering Information

5.1 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:

5.1.1 Alloy—Table 1,

5.1.2

- 5.1.2 *Dimensions*—Thickness (in decimals of an inch), width, and length (inch or fractions of an inch),
- 4.1.3
- 5.1.3 *Optional Requirement*—Plate; how the plate is to be cut (see 7.8.1 and Table 6);
- 4.1.4 *Plate; how the plate is to be cut (Specification B 906, Table A2.3)*
- 5.1.4 *Certification*—State if certification or a report of test results is required (Section 15);
- 4.1.5 *State if certification or a report of test results is required (Specification B 906, Section 21),*
- 5.1.5 *Purchase Inspection*—State which tests or inspections are to be witnessed (Section 13), and
- 4.1.6 *State which tests or inspections are to be witnessed (Specification B 906, Section 18), and*
- 5.1.6 *Samples for Product (Check) Analysis*—State whether samples shall be furnished (9.2.2).

5.—State whether samples should be furnished (Specification B 906, Section 7.2.2).

6. Chemical Composition

- 5.1.1 **6.1** The material shall conform to the composition limits specified in Table 1.
- 5.2 **6.2** 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 and Specification B 906.

6.

7. Mechanical Properties and Other Requirements

- 6.1
- 7.1 *Tensile Properties*—The material shall conform to the room temperature tensile properties prescribed in Table 2.
- 6.2
- 7.2 *Hardness*—The hardness values given in Table 2 are informative only.
- 6.3
- 7.3 *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.

TABLE 2 3 Mech Grain Size Propz forty R Anneqiralemd Shenets

Alloy	Thickness, in. (mm)	ASTensM Mile Strenogth, rain-m Sin, psi (MPa)	Yield-Str Numbengthr, (0.2-% Offset), min, psi (MPa)x	ElonAverage C Din-2 in.ameter, m or 4D ^A m (in,-%
0.125 (3.175) and under	3.0	Sheet and Strip		
N10001	Under 3/16 (4.76)	115 000 (795)	50 000 (345)	45
Over 0.125 (3.175)	1.5	000 (795)	50 000 (345)	45
N10665	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40
N10675	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40
N10629	Under 3/16 (4.76)	110 000 (760)	51 000 (350)	40
N10624	Under 3/16 (4.76)	104 000 (720)	46 000 (320)	40
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
N10001	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	100 000 (690)	84)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
N10675	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	110 000 (760)	51 000 (350)	40
N10629	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	110 000 (760)	51 000 (350)	40
N10624	3/16 to 2 1/2 in. (4.76 to 63.5 mm), incl	104 000 (720)	46 000 (320)	40

^AD refers to the diameter of the tension specimen.
^BHardness 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.

7.

8. Dimensions, Mass, and Permissible Variations

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