



Designation: B 691 – 02

Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire¹

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1. Scope

1.1 This specification covers iron-nickel-chromium-molybdenum alloys (UNS N08366 and UNS N08367)* in the form of hot-finished and cold-finished rounds, squares, hexagons, octagons, and rectangles.

1.2 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 following safety hazards caveat pertains only to the test methods portion, Section 12, of this specification: *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 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

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

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 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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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* New designation established in accordance with ASTM E 527 and SAE J1086, Practice for Numbering Metals and Alloys.

² *Annual Book of ASTM Standards*, Vol 03.06.

3.1.1 The terms rod, bar, and wire, as used in this specification, are described as follows:

3.1.1.1 *bar*—hot-finished or cold-finished material of round, square, hexagon, octagon, or rectangular solid section in straight lengths.

3.1.1.2 *rod*—hot-finished material of round, square, hexagon, octagon, or rectangular solid section furnished in coils for subsequent cold drawing into finished products.

3.1.1.3 *wire*—cold-finished material of round, square, hexagon, octagon, or rectangle solid section furnished in coils.

4. Ordering Information

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

4.1.1 Quantity (feet, metres, or number of pieces),

4.1.2 Form (rod, bar, wire),

4.1.3 Name of material or UNS number,

4.1.4 Finish (see 8.2),

4.1.5 Dimensions, including length,

4.1.6 Certification, if required (Section 15),

4.1.7 Purchaser's inspection, if required (Section 13),

4.1.8 ASTM designation and year of issue, and

4.1.9 Samples for product analysis, if required.

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 permissible variations for product (check) analysis in Specification **B 880**.

6. Mechanical Properties and Other Requirements

6.1 The material shall conform to the mechanical property requirements specified in **Table 2**.

TABLE 1 Chemical Requirements

Element	Composition Limits, %	
	N08366	N08367
Carbon	0.035 max	0.030 max
Manganese	2.00 max	2.00 max
Silicon	1.00 max	1.00 max
Phosphorus	0.040 max	0.040 max
Sulfur	0.030 max	0.030 max
Chromium	20.00 to 22.00	20.00 to 22.00
Nickel	23.50 to 25.50	23.50 to 25.50
Molybdenum	6.00 to 7.00	6.00 to 7.00
Nitrogen	...	0.18 to 0.25
Iron ^A	remainder	remainder
Copper	...	0.75 max

^A Iron shall be determined arithmetically by difference.

TABLE 2 Mechanical Properties

	Cold-Finished-Annealed and Hot-Finished-Annealed (All Sizes)		Forging Quality (All Sizes)	
	N08366	N08367	N08366	N08367
	Tensile strength, min, ksi (MPa)	75 (517)	95 (655)	^A
Yield strength, 0.2 % offset, min, ksi (MPa)	30 (206)	45 (310)	^A	^A
Elongation in 2 in. or 50 mm, or 4D, min, %	30	30	^A	^A

^A No tensile properties are required on forging quality.

7. Dimensions and Permissible Variations

7.1 Size:

7.1.1 *Rounds*—The permissible variations in size of cold-finished round shall be as given in **Table 3**. For hot-finished round bars and rod, they shall be as given in **Table 4**.

7.1.2 *Squares*—The permissible variations in size of cold-finished square bars shall be as given in **Table 5**. For hot-finished square bars and rods, they shall be as given in **Table 4**.

7.1.3 *Hexagons and Octagons*—The permissible variations in size of cold-finished hexagons and octagons shall be as

TABLE 3 Permissible Variations in Diameter Cold-Finished Round Bars and Wire

Specified Diameter, in. (mm)	Diameter tolerance, in. (mm) ^{A,B,C}
	Plus and Minus
0.0030 (0.076) to 0.0048 (0.122), excl	0.0001 (0.003)
0.0048 (0.122) to 0.0080 (0.203), excl	0.0002 (0.005)
0.0080 (0.203) to 0.0120 (0.305), excl	0.0003 (0.008)
0.0120 (0.305) to 0.0240 (0.610), excl	0.0004 (0.010)
0.0240 (0.610) to 0.0330 (0.838), excl	0.0005 (0.013)
0.0330 (0.838) to 0.0440 (1.118), excl	0.0008 (0.020)
0.0440 (1.118) to 0.3125 (7.938), excl	0.001 (0.03)
0.3125 (7.938) to 0.5000 (12.700), excl	0.0015 (0.038)
0.5000 (12.700) to 1.000 (25.4), excl	0.002 (0.05)
1.000 (25.4) to 1.500 (38.1), excl	0.0025 (0.06)
1.500 (38.1) to 4.000 (101.6), incl	0.003 (0.08)

^A Diameter tolerances are over and under as shown in the above table. Also, rounds can be produced to tolerances all over and nothing under, or all under and nothing over, or any combination of over and under, if the total spread in diameter tolerance for a specified diameter is not less than the total spread shown in the table.

^B The maximum out-of-round tolerance for round wire is one-half of the total size tolerance shown in the above table.

^C When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table for sizes 0.0240 in. (0.610 mm) and over.

given in **Table 5**. For hot-finished bar and rod hexagons and octagons they shall be as given in **Table 6**.

7.1.4 *Flats (Rectangles)*—The permissible variations in width and thickness of cold-finished flats shall be as given in **Table 7** for bars and for wire in **Table 8**. For hot-finished flat bars and rods, the tolerances for width and thickness shall be as given in **Table 9**.

7.2 *Out-of-Round*—Hot-finished rounds and cold-finished rounds (except forging quality), all sizes, in straight lengths, shall not be out-of-round by more than shown in **Table 4** and **Table 3**.

7.3 *Corners*—Cold-finished squares, rectangles, hexagons and octagons will have equal angles and sharp corners.

7.4 *Machining Allowances*—When the surfaces of hot-finished material are to be machined, the allowances given in **Table 10** are recommended for normal machining operations.

7.5 Length:

7.5.1 Unless multiple, nominal, or cut lengths are specified, random mill lengths shall be furnished.

7.5.2 When bars are ordered in multiple lengths, ¼ in. (6.4 mm) will be allowed for each multiple cut, unless otherwise specified.

7.5.3 The permissible variations in length of hot or cold-finished bars shall be as specified in **Table 11** or **Table 12** depending upon whether or not the material is specified to be machine-cut after straightening.

7.6 Ends:

7.6.1 Bars ordered to random or nominal lengths will be furnished with either cropped or saw-cut ends.

7.6.2 Bars ordered to cut lengths will be furnished with square saw-cut or machine cut ends.

7.7 Straightness:

7.7.1 The permissible variations in straightness of cold-finished bars shall be as specified in **Table 13**.

7.7.2 The permissible variations in straightness of hot-finished bars shall be as specified in **Table 13**.

8. Workmanship, Finish, and Appearance

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

8.2 Finishes available include hot-rolled, hot rolled-annealed-descaled, cold-drawn, ground, turned, and machined.

9. Sampling

9.1 Lot Definition:

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

9.1.2 Lots for mechanical testing shall consist of the material from one heat, in the same condition (temper), and of the same specified size (excepting length) and cross-section.

9.2 Test Material Selection:

9.2.1 Sampling for Chemical Analysis:

9.2.1.1 An analysis of each lot shall be made by the manufacturer from a representative sample obtained during the pouring of the heat or subsequent processing.

9.2.1.2 If samples for product (check) analysis are specified, a representative sample shall be taken from each lot of finished material.

TABLE 4 Permissible Variations in Size of Hot-Finished Round and Square Bars and Rods

Specified size, in. (mm)	Permissible Variations from Specified Size, in. (mm)		Out-of-Round ^A or Out-of-Square, ^B in. (mm)
	Plus	Minus	
1/4 (6.4) to 5/16 (7.9), incl	0.005 (0.13)	0.005 (0.13)	0.008 (0.20)
Over 5/16 (7.9) to 7/16 (11.1), incl	0.006 (0.15)	0.006 (0.15)	0.009 (0.23)
Over 7/16 (11.1) to 5/8 (15.9), incl	0.007 (0.18)	0.007 (0.18)	0.010 (0.25)
Over 5/8 (15.9) to 7/8 (22.2), incl	0.008 (0.20)	0.008 (0.20)	0.012 (0.30)
Over 7/8 (22.2) to 1 (25.4), incl	0.009 (0.23)	0.009 (0.23)	0.013 (0.33)
Over 1 (25.4) to 1 1/8 (28.6), incl	0.010 (0.25)	0.010 (0.25)	0.015 (0.38)
Over 1 1/8 (28.6) to 1 1/4 (31.8), incl	0.011 (0.28)	0.011 (0.28)	0.016 (0.41)
Over 1 1/4 (31.8) to 1 3/8 (34.9), incl	0.012 (0.30)	0.012 (0.30)	0.018 (0.46)
Over 1 3/8 (34.9) to 1 1/2 (38.1), incl	0.014 (0.36)	0.014 (0.36)	0.021 (0.53)
Over 1 1/2 (38.1) to 2 (50.8), incl	1/64 (0.4)	1/64 (0.4)	0.023 (0.58)
Over 2 (50.8) to 2 1/2 (63.5), incl	1/32 (0.8)	0	0.023 (0.58)
Over 2 1/2 (63.5) to 3 1/2 (88.9), incl	3/64 (1.2)	0	0.035 (0.89)
Over 3 1/2 (88.9) to 4 1/2 (114.3), incl	1/16 (1.6)	0	0.046 (1.17)
Over 4 1/2 (114.3) to 5 1/2 (139.7), incl	5/64 (2.0)	0	0.058 (1.47)
Over 5 1/2 (139.7) to 6 1/2 (165.1), incl	1/8 (3.2)	0	0.070 (1.78)
Over 6 1/2 (165.1) to 8 (203.2), incl	5/32 (4.0)	0	0.085 (2.16)

^A Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section.

^B Out-of-square section is the difference in the two dimensions at the same cross section of a square bar, each dimension being the distance between opposite faces.

TABLE 5 Permissible Variations in Distance Between Parallel Surfaces of Cold Finished Hexagonal, Octagonal, and Square Bars and Wire

Specified Size, in. (mm)	Permissible Variations from Specified Size, in. (mm) ^A	
	Plus	Minus
0.125 (3.18) to 0.3125 (7.938), excl	0	0.002 (0.05)
0.3125 (7.938) to 0.500 (12.70), excl	0	0.003 (0.08)
0.500 (12.70) to 1.000 (25.40), incl	0	0.004 (0.10)
Over 1 (25.40) to 2 (50.80), incl	0	0.006 (0.15)
Over 2 (50.80) to 3 (76.20), incl	0	0.008 (0.20)
Over 3 (76.20)	0	0.010 (0.25)

^A When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.

TABLE 6 Permissible Variations in Size of Hot-Finished Hexagonal and Octagonal Bars and Rods

Specified Sizes Measured Between Opposite Sides, in. (mm)	Permissible Variations from Specified Size, in. (mm)		Maximum Difference, in. (mm), 3 Measurements for Hexagons Only
	Plus	Minus	
1/4 to 1/2 (6.4 to 12.7), incl	0.007 (0.18)	0.007 (0.18)	0.011 (0.28)
Over 1/2 to 1 (12.7) to (25.4), incl	0.010 (0.25)	0.010 (0.25)	0.015 (0.38)
Over 1 (25.4) to 1 1/2 (38.1), incl	0.021 (0.53)	0.021 (0.53)	0.025 (0.64)
Over 1 1/2 (38.1) to 2 (50.8), incl	1/32 (0.8)	1/32 (0.8)	1/32 (0.8)
Over 2 (50.8) to 2 1/2 (63.5), incl	3/64 (1.2)	3/64 (1.2)	3/64 (1.2)
Over 2 1/2 (63.5) to 3 1/2 (88.9), incl	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)

9.2.2 *Sampling for Mechanical Testing*—Samples of the material to provide test specimens for mechanical testing shall be taken from such locations in each lot (see 9.1.2) as to be representative of that lot.

10. Number of Tests and Retests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Mechanical Tests and Tension Tests*—One test per lot.

10.3 *Retests*—If the specimen used in the mechanical test of any lot fails to meet the specified requirements, an additional

specimen shall be taken from a different sample piece and tested. The results of this test specimen shall meet the specified requirements.

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.

11.2 All rod and bar shall be tested in full cross-section size when possible. When a full cross-section size test cannot