



AEROSPACE MATERIAL

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SPECIFICATION

AMS 2231F

Superseding 2231E

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TOLERANCES Carbon Steel Bars

1. **SCOPE:** This specification covers established manufacturing tolerances applicable to carbon steel bars. These tolerances apply to all conditions, unless otherwise noted. The term "excl" is used to apply only to the higher figure of the specified range.
 - 1.1 No clear cut demarcation is available to differentiate between bar and wire products, so no definitions of these products are included.
2. **DIAMETER OR THICKNESS:**
 - 2.1 **Cold Finished:**
 - 2.1.1 **Cold Drawn:** Table I includes tolerances for bars that, before cold finishing, have been annealed, spheroidize annealed, normalized, normalized and tempered, or quenched and tempered before cold finishing. This table does not include tolerances for bars that, after cold finishing, are spheroidize annealed, normalized, normalized and tempered, or quenched and tempered.
 - 2.1.1.1 Width governs the tolerances for both width and thickness of flats. For example, when the maximum of carbon range is up to 0.28, incl, for a flat 2.000 in. (50.80 mm) wide and 1.000 in. (25.40 mm) thick, the width tolerance is 0.005 in. (0.13 mm) and the thickness tolerance is the same, namely, 0.005 in. (0.13 mm).

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TABLE I

Tolerance, Inch, Minus Only
Maximum of Carbon Range, %

Nominal Diameter or Thickness Inches	Up to 0.28, incl	Over 0.28 to 0.55, incl	Up to 0.55, incl, Stress Relieved or Annealed After Cold Finishing	Over 0.55, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Nor- malized and Tempered Before Cold Finishing
ROUNDS				
Up to 1.500, incl	0.002	0.003	0.004	0.005
Over 1.500 to 2.500, incl	0.003	0.004	0.005	0.006
Over 2.500 to 4.000, incl	0.004	0.005	0.006	0.007
HEXAGONS				
Up to 0.750, incl	0.002	0.003	0.004	0.006
Over 0.750 to 1.500, incl	0.003	0.004	0.005	0.007
Over 1.500 to 2.500, incl	0.004	0.005	0.006	0.008
Over 2.500 to 3.125, incl	0.005	0.006	0.007	0.009
SQUARES				
Up to 0.750, incl	0.002	0.004	0.005	0.007
Over 0.750 to 1.500, incl	0.003	0.005	0.006	0.008
Over 1.500 to 2.500, incl	0.004	0.006	0.007	0.009
Over 2.500 to 4.000, incl	0.006	0.008	0.009	0.011
FLATS				
Up to 0.750, incl	0.003	0.004	0.006	0.008
Over 0.750 to 1.500, incl	0.004	0.005	0.008	0.010
Over 1.500 to 3.000, incl	0.005	0.006	0.010	0.012
Over 3.000 to 4.000, incl	0.006	0.008	0.011	0.016
Over 4.000 to 6.000, incl	0.008	0.010	0.012	0.020
Over 6.000	0.013	0.015	--	--

TABLE I (SI)

Tolerance, Millimeter, Minus Only
Maximum of Carbon Range, %

Nominal Diameter or Thickness Millimeters	Up to 0.28, incl	Over 0.28 to 0.55, incl	Up to 0.55, incl, Stress Relieved or Annealed After Cold Finishing	Over 0.55, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Nor- malized and Tempered Before Cold Finishing
ROUNDS				
Up to 38.10, incl	0.05	0.08	0.10	0.13
Over 38.10 to 63.50, incl	0.08	0.10	0.13	0.15
Over 63.50 to 101.60, incl	0.10	0.13	0.15	0.18
HEXAGONS				
Up to 19.05, incl	0.05	0.08	0.10	0.15
Over 19.05 to 38.10, incl	0.08	0.10	0.13	0.18
Over 38.10 to 63.50, incl	0.10	0.13	0.15	0.20
Over 63.50 to 79.38, incl	0.13	0.15	0.18	0.23
SQUARES				
Up to 19.05, incl	0.05	0.10	0.13	0.18
Over 19.05 to 38.10, incl	0.08	0.13	0.15	0.20
Over 38.10 to 63.50, incl	0.10	0.15	0.18	0.23
Over 63.50 to 101.60, incl	0.15	0.20	0.23	0.28
FLATS				
Up to 19.05, incl	0.08	0.10	0.15	0.20
Over 19.05 to 38.10, incl	0.10	0.13	0.20	0.25
Over 38.10 to 76.20, incl	0.13	0.15	0.25	0.30
Over 76.20 to 101.60, incl	0.15	0.20	0.28	0.41
Over 101.60 to 152.40, incl	0.20	0.25	0.30	0.51
Over 152.40	0.33	0.38	--	--

- 2.1.2 Turned and Polished Rounds: Table II includes tolerances for bars that, before cold finishing, have been annealed, spheroidize annealed, normalized, normalized and tempered, or quenched and tempered. This table does not include tolerances for bars that, after cold finishing, are spheroidize annealed, normalized, normalized and tempered, or quenched and tempered.

TABLE II

Tolerance, Inch, Minus Only
Maximum of Carbon Range, %

Nominal Diameter Inches	Up to 0.28, incl	Over 0.28 to 0.55, incl	Up to 0.55, incl, Stress Relieved or Annealed After Cold Finishing	Over 0.55, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Nor- malized and Tempered Before Cold Finishing
Up to 1.500, incl	0.002	0.003	0.004	0.005
Over 1.500 to 2.500, incl	0.003	0.004	0.005	0.006
Over 2.500 to 4.000, incl	0.004	0.005	0.006	0.007
Over 4.000 to 6.000, incl	0.005	0.006	0.007	0.008
Over 6.000 to 8.000, incl	0.006	0.007	0.008	0.009
Over 8.000 to 9.000, incl	0.007	0.008	0.009	0.010
Over 9.000	0.008	0.009	0.010	0.011

TABLE II (SI)

Tolerance, Millimeter, Minus Only
Maximum of Carbon Range, %

Nominal Diameter Millimeters	Up to 0.28, incl	Over 0.28 to 0.55, incl	Up to 0.55, incl, Stress Relieved or Annealed After Cold Finishing	Over 0.55, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Nor- malized and Tempered Before Cold Finishing
Up to 38.10, incl	0.05	0.08	0.10	0.13
Over 38.10 to 63.50, incl	0.08	0.10	0.13	0.15
Over 63.50 to 101.60, incl	0.10	0.13	0.15	0.18
Over 101.60 to 152.40, incl	0.13	0.15	0.18	0.20
Over 152.40 to 203.20, incl	0.15	0.18	0.20	0.23
Over 203.20 to 228.60, incl	0.18	0.20	0.23	0.25
Over 228.60	0.20	0.23	0.25	0.28

2.1.3 Cold Drawn, Ground, and Polished Rounds:TABLE III

Nominal Diameter Inches	Tolerance, Inch Minus Only
Up to 1.500, incl	0.001
Over 1.500 to 2.500, excl	0.0015
2.500 to 3.000, incl	0.002
Over 3.000 to 4.000, incl	0.003

TABLE III (SI)

Nominal Diameter Millimeters	Tolerance, Millimeter Minus Only
Up to 38.10, incl	0.03
Over 38.10 to 63.50, excl	0.04
63.50 to 76.20, incl	0.05
Over 76.20 to 101.60, incl	0.08

2.1.4 Turned, Ground, and Polished Rounds:

- 2.1.4.1 For nonresulfurized steels (steels specified to maximum sulfur limits under 0.08%) or for steels thermally treated, the tolerances for sizes over 4.000 in. (101.60 mm) nominal diameters are increased by 0.001 in. (0.03 mm).

TABLE IV

Nominal Diameter Inches	Tolerance, Inch Minus Only
Up to 1.500, incl	0.001
Over 1.500 to 2.500, excl	0.0015
2.500 to 3.000, incl	0.002
Over 3.000 to 4.000, incl	0.003
Over 4.000 to 6.000, incl	0.004 (See 2.1.4.1)
Over 6.000	0.005 (See 2.1.4.1)

TABLE IV (SI)

Nominal Diameter Millimeters	Tolerance, Millimeter Minus Only
Up to 38.10, incl	0.03
Over 38.10 to 63.50, excl	0.038
Over 63.50 to 76.20, incl	0.05
Over 76.20 to 101.60, incl	0.08
Over 101.60 to 152.40, incl	0.10 (See 2.1.4.1)
Over 152.40	0.13 (See 2.1.4.1)

2.2 Hot Finished:2.2.1 Rounds and Squares:

- 2.2.1.1 Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section. Out-of-square section is the difference in the two dimensions at the same cross section of a square bar between opposite faces.

TABLE V

Nominal Diameter or Thickness Inches	<u>Tolerance, Inch</u>		Out-of-Round or Out-of-Square Inch
	Plus	Minus	
Up to 0.3125, incl	0.005	0.005	0.008
Over 0.3125 to 0.4375, incl	0.006	0.006	0.009
Over 0.4375 to 0.625, incl	0.007	0.007	0.010
Over 0.625 to 0.875, incl	0.008	0.008	0.012
Over 0.875 to 1.000, incl	0.009	0.009	0.013
Over 1.000 to 1.125, incl	0.010	0.010	0.015
Over 1.125 to 1.250, incl	0.011	0.011	0.016
Over 1.250 to 1.375, incl	0.012	0.012	0.018
Over 1.375 to 1.500, incl	0.014	0.014	0.021
Over 1.500 to 2.000, incl	0.016	0.016	0.023
Over 2.000 to 2.500, incl	0.031	0	0.023
Over 2.500 to 3.500, incl	0.047	0	0.035
Over 3.500 to 4.500, incl	0.063	0	0.046
Over 4.500 to 5.500, incl	0.078	0	0.058
Over 5.500 to 6.500, incl	0.125	0	0.070
Over 6.500 to 8.250, incl	0.156	0	0.085
Over 8.250 to 9.500, incl	0.188	0	0.100
Over 9.500 to 10.000, incl	0.250	0	0.120

TABLE V (SI)

Nominal Diameter or Thickness Millimeters	<u>Tolerance, Millimeters</u>		Out-of-Round or Out-of-Square Millimeters
	Plus	Minus	
Up to 7.938, incl	0.13	0.13	0.20
Over 7.938 to 11.112, incl	0.15	0.15	0.23
Over 11.112 to 15.88, incl	0.18	0.18	0.25
Over 15.88 to 22.22, incl	0.20	0.20	0.30
Over 22.22 to 25.40, incl	0.23	0.23	0.33
Over 25.40 to 28.58, incl	0.25	0.25	0.38
Over 28.58 to 31.75, incl	0.28	0.28	0.41
Over 31.75 to 34.98, incl	0.30	0.30	0.46
Over 34.98 to 38.10, incl	0.36	0.36	0.53
Over 38.10 to 50.80, incl	0.41	0.41	0.58
Over 50.80 to 63.50, incl	0.79	0	0.58
Over 63.50 to 88.90, incl	1.19	0	0.89
Over 88.90 to 114.30, incl	1.60	0	1.17
Over 114.30 to 139.70, incl	1.98	0	1.47
Over 139.70 to 165.10, incl	3.18	0	1.78
Over 165.10 to 209.55, incl	3.96	0	2.16
Over 209.55 to 241.30, incl	4.78	0	2.54
Over 241.30 to 254.00, incl	6.35	0	3.05