AEROSPACE MATERIAL SPECIFICATION

AMS2231™	REV. L

Issued 1945-05
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Revised 2024-12

Superseding AMS2231K

(R) Tolerances
Carbon Steel Bars

RATIONALE

AMS2231L is the result of a Five-Year Review and update. SI units have been added for information throughout.

1. SCOPE

This specification covers established inch/pound manufacturing tolerances applicable to carbon steel bars ordered to inch/pound dimensions. These tolerances apply to all conditions, unless otherwise noted. The term “excl” applies only to the higher figure of the specified range.

1.1 No clear-cut demarcation is available to differentiate between bar and wire products; therefore, definitions of wire products are not included.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS7766 Terms Used in Aerospace Metals Specifications

2.2 Definitions

Terms used in AMS are defined in AS7766.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2231L/

3. DIAMETER OR THICKNESS

3.1 Cold Finished

3.1.1 Cold Drawn

Table 1 includes tolerances for bars that 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.

3.1.1.1 Width governs the tolerances for both width and thickness of flats. For example, when the maximum carbon range is up to 0.28%, inclusive, for a flat 2.000 inch (50.80 mm) wide and 1.000 inch (25.40 mm) thick, the width tolerance is 0.005 inch (0.13 mm) and the thickness tolerance is the same, namely, 0.005 inch (0.13 mm).

Table 1 - Cold drawn, diameter, thickness, or width tolerances, minus only

Table 1A - Rounds, inch/pound units

Specified Diameter Inches	Up to 0.28 Carbon Incl Inches	Over 0.28 to 0.55 Carbon Incl Inches	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Inches	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Inches
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

Table 1B - Rounds, SI units

Specified Diameter Millimeters	Up to 0.28 Carbon Incl Millimeters	Over 0.28 to 0.55 Carbon Incl Millimeters	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Millimeters	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Millimeters
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

Table 1C - Hexagons, inch/pound units

Specified Thickness Inches	Up to 0.28 Carbon Incl Inches	Over 0.28 to 0.55 Carbon Incl Inches	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Inches	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Inches
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
Over 3.125 to 4.000, incl	0.005	0.008	--	--

Table 1D - Hexagons, SI units

Specified Thickness Millimeters	Up to 0.28 Carbon Incl Millimeters	Over 0.28 to 0.55 Carbon Incl Millimeters	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Millimeters	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Millimeters
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
Over 79.38 to 101.60, incl	0.13	0.20	--	--

Table 1E - Squares and flats, inch/pound units

Specified Thickness or Width Inches	Up to 0.28 Carbon Incl Inches	Over 0.28 to 0.55 Carbon Incl Inches	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Inches	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Inches
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 1F - Squares and flats, SI units

Specified Thickness or Width Millimeters	Up to 0.28 Carbon Incl Millimeters	Over 0.28 to 0.55 Carbon Incl Millimeters	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Millimeters	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Millimeters
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	--	--

3.1.2 Cold Finished

Table 2 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 2A - Turned and polished, diameter tolerances, minus only, inch/pound units

Specified Diameter Inches	Up to 0.28 Carbon Incl Inches	Over 0.28 to 0.55 Carbon Incl Inches	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Inches	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Inches
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 2B - Turned and polished, diameter tolerances, minus only, SI units

Specified Diameter Millimeters	Up to 0.28 Carbon Incl Millimeters	Over 0.28 to 0.55 Carbon Incl Millimeters	Up to 0.55 Carbon Incl Stress Relieved or Annealed After Cold Finishing Millimeters	Over 0.55 Carbon, With or Without Stress Relieving or Annealing After Cold Finishing, and All Carbons Quenched and Tempered or Normalized and Tempered Before Cold Finishing Millimeters
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

3.1.3 Cold Drawn, Ground, and Polished Rounds

Table 3 includes tolerances for round bars that are cold drawn, ground, and polished.

Table 3A - Diameter tolerances, inch/pound units

Specified Diameter Inches	Tolerance Inches 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 3B - Diameter tolerances, SI units

Specified Diameter Millimeters	Tolerance Millimeters Minus Only
Up to 38.10, incl	0.02
Over 38.10 to 63.50, excl	0.038
63.50 to 76.20, incl	0.05
Over 76.20 to 101.6, incl	0.08

3.1.4 Turned, Ground, and Polished Rounds

Table 4 includes tolerances for round bars that are turned, ground, and polished.

Table 4A - Diameter tolerances, inch/pound units

Specified Diameter Inches	Tolerance Inches 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 3.1.4.1)
Over 6.000	0.005 (see 3.1.4.1)

Table 4B - Diameter tolerances, SI Units

Specified Diameter Millimeters	Tolerance Millimeters Minus Only
Up to 38.10, incl	0.02
Over 38.10 to 63.50, excl	0.038
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 3.1.4.1)
Over 152.40	0.13 (see 3.1.4.1)

3.1.4.1 For non-resulfurized steels (steels specified to maximum sulfur limits under 0.08%) or for steels thermally treated, the tolerances for sizes over 4.000 inches (101.60 mm) in specified diameter are increased by 0.001 inch (0.02 mm).

3.2 Hot Finished

3.2.1 Rounds and Squares

Table 5 includes tolerances for hot-finished rounds and squares. Out-of-round is the difference between 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 5A - Diameter or thickness tolerances, inch/pound units

Specified Diameter or Thickness Inches	Tolerance Inches Plus	Tolerance Inches Minus	Out-of-Round or Out-of-Square Inches
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 5B - Diameter or thickness tolerances, SI units

Specified Diameter or Thickness Millimeters	Tolerance Millimeters Plus	Tolerance Millimeters Minus	Out-of-Round or Out-of-Square Millimeters
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 34.92, incl	0.30	0.30	0.46
Over 34.92 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	2.86	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 241.39 to 254.00, incl	6.35	0	3.05

3.2.2 Square-Edge and Round-Edge Flats

Tables 6 and 7 include tolerances for square-edge and round-edge flats.

Table 6A - Thickness tolerance, inch, plus and minus for thickness ranges, inch/pound units

Specified Width Inches	0.203 to 0.230 Excl Inches	0.230 to 0.250 Excl Inches	0.250 to 0.500 Incl Inches	Over 0.500 to 1.000 Incl Inches	Over 1.000 to 2.000 Incl Inches	Over 2.000 to 3.000 Incl Inches	Over 3.000 Inches
Up to 1.000, incl	0.007	0.007	0.008	0.010	--	--	--
Over 1.000 to 2.000, incl	0.007	0.007	0.012	0.015	0.031	--	--
Over 2.000 to 4.000, incl	0.008	0.008	0.015	0.020	0.031	0.047	0.047
Over 4.000 to 6.000, incl	0.009	0.009	0.015	0.020	0.031	0.047	0.047
Over 6.000 to 8.000, incl	--	0.015	0.016	0.025	0.031	0.047	--

Table 6B - Thickness tolerance, inch, plus and minus for thickness ranges, SI units

Specified Width Millimeters	5.16 to 0.5.84 Excl Millimeters	5.84 to 6.35 Excl Millimeters	6.35 to 12.70 Incl Millimeters	Over 12.70 to 25.40 Incl Millimeters	Over 25.40 to 50.80 Incl Millimeters	Over 50.80 to 76.20 Incl Millimeters	Over 76.20 Millimeters
Up to 25.40, incl	0.18	0.18	0.20	0.25	--	--	--
Over 25.40 to 50.80, incl	0.18	0.18	0.30	0.38	0.79	--	--
Over 50.80 to 101.60, incl	0.20	0.20	0.38	0.51	0.79	1.19	1.19
Over 101.60 to 152.40, incl	0.23	0.23	0.38	0.51	0.79	1.19	1.19
Over 152.40 to 203.20, incl	--	0.38	0.41	0.64	0.79	1.19	--

Table 7A - Width tolerance, inch/pound units

Specified Width Inches	Tolerance Inches Plus	Tolerance Inches Minus
Up to 1.000, incl	0.016	0.016
Over 1.000 to 2.000, incl	0.031	0.031
Over 2.000 to 4.000, incl	0.063	0.031
Over 4.000 to 6.000, incl	0.094	0.063
Over 6.000 to 8.000, incl	0.125	0.094

Table 7B - Width tolerance, SI units

Specified Width Millimeters	Tolerance Millimeters Plus	Tolerance Millimeters Minus
Up to 25.40, incl	0.41	0.41
Over 25.40 to 50.80, incl	0.79	0.79
Over 50.80 to 101.60, incl	1.60	0.79
Over 101.60 to 152.40, incl	2.39	1.60
Over 152.40 to 203.20, incl	3.18	2.39

3.3 Width

Width is included in the information provided in Section 3.