

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE

MAM 2232A

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Superseding MAM 2232

TOLERANCES, METRIC Carbon Steel, Sheet, Strip, and Plate

1. SCOPE:

This specification covers established metric manufacturing tolerances applicable to carbon steel sheet, strip, and plate ordered to metric dimensions. 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. Tolerances for product sizes not listed herein shall be as agreed upon by purchaser and vendor.

1.1 AMS 2232 is the inch/pound version of this MAM.

2. THICKNESS:

Tolerances apply to measurements made at any point on widths less than 25 mm, at any point not less than 10 mm from a cut edge, or not less than 20 mm from a mill edge on widths 25 mm and over, and at a point 10 to 20 mm from the longitudinal edge of rectangular sheared plates. Regardless of whether thickness tolerances for sheet and strip are specified equally or unequally, plus and minus, the total tolerance shall be equal to the arithmetic sum of the tabular plus and minus tolerances (twice the tabular tolerances when specified equally plus and minus).

2.1 Cold Rolled Sheet, Coils and Cut Lengths (See 2.1.1):

See Table 1.

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TABLE 1 - Thickness Tolerances, Millimeter, Plus and Minus
for Width Ranges, Millimeters

Specified Thickness Millimeters	Over 50 to 300, incl	Over 300 to 1800, incl	Over 1800 to 2000, incl	Over 2000
Up to 0.4, incl	0.05	0.05	--	--
Over 0.4 to 1.0, incl	0.08	0.08	0.08	0.15
Over 1.0 to 1.2, incl	0.10	0.10	0.10	0.15
Over 1.2 to 2.5, incl	0.12	0.12	0.15	0.18
Over 2.5 to 4.0, incl	--	0.15	0.18	0.20

2.1.1 Tolerances in Table 1 for nominal widths of 50 to 300 mm, inclusive, in nominal thicknesses of (R) 0.4 to 2.1 mm, inclusive, apply to product slit from wider sheet.

2.2 Hot Rolled Sheets:

2.2.1 Coils and Cut Lengths: See Table 2.

TABLE 2 - Thickness Tolerances, Millimeter, Plus and Minus
for Width Ranges, Millimeters

Specified Thickness Millimeters	Over 300 to 600, incl	Over 600 to 1200, incl	Over 1200 to 1500, incl	Over 1500 to 1800, incl	Over 1800
Up to 2.0, incl	0.15	0.15	0.18	0.18	0.18
Over 2.0 to 2.5, incl	0.15	0.18	0.18	0.20	0.20
Over 2.5 to 4.0, incl	0.18	0.20	0.20	0.20	0.20
Over 4.0 to 5.5, incl	0.20	0.22	0.25	0.28	0.30
Over 5.5 to 6.0, incl	0.28	0.30	0.30	0.32	0.38

2.2.2 Coils Only: See Table 3.

TABLE 3 - Thickness Tolerances, Millimeter, Plus and Minus
for Width Ranges, Millimeters

Specified Thickness Millimeters	Over 300 to 600, incl	Over 600 to 1200, incl	Over 1200 to 1500, incl	Over 1500 to 1800, incl	Over 1800
Over 6.0 to 8.0, incl	0.25	0.28	0.30	0.32	0.38
Over 8.0 to 9.5, incl	0.30	0.30	0.32	0.38	0.40
Over 9.5 to 12.5, incl	0.35	0.35	0.35	0.40	0.45

2.2.3 Tolerances in Table 2 and Table 3 do not apply to the uncropped ends of mill edge coils.

2.3 Cold Rolled Strip, Coils and Cut Lengths:

See Table 4.

TABLE 4 - Thickness Tolerances, Millimeter, Plus and Minus
for Width Ranges, Millimeters

Specified Thickness Millimeters	Up to 75, incl	Over 75 to 150, incl	Over 150 to 300, incl	Over 300 to 450, incl	Over 450 to 600, incl
Up to 0.2, incl	0.015	0.015	--	--	--
Over 0.2 to 0.3, incl	0.02	0.02	--	--	--
Over 0.3 to 0.5, incl	0.02	0.02	0.03	0.04	0.04
Over 0.5 to 0.6, incl	0.03	0.03	0.04	0.04	0.04
Over 0.6 to 0.9, incl	0.04	0.04	0.05	0.05	0.05
Over 0.9 to 1.0, incl	0.05	0.05	0.05	0.05	0.05
Over 1.0 to 1.5, incl	0.05	0.07	0.07	0.08	0.08
Over 1.5 to 2.0, incl	0.05	0.07	0.07	0.09	0.09
Over 2.0 to 4.0, incl	0.05	0.08	0.08	0.12	0.13
Over 4.0 to 5.0, incl	0.09	0.10	0.10	0.13	0.13
Over 5.0 to 6.0, incl	0.10	0.12	0.12	0.14	0.14

2.4 Hot Rolled Strip; Coils and Cut Lengths (See 2.4.1):

See Table 5.

TABLE 5 - Thickness Tolerances, Millimeter, Plus and Minus
for Width Ranges, Millimeters

Specified Thickness Millimeters	Up to 100, incl	Over 100 to 200, incl	Over 200 to 300, incl
Up to 1.5, incl	0.08	0.08	0.10
Over 1.5 to 3.0, incl	0.10	0.13	0.13
Over 3.0 to 4.5, incl	0.13	0.13	0.13
Over 4.5 to 5.0, incl	0.15	0.15	0.15
Over 5.0 to 6.0, incl	--	--	0.15

2.4.1 Tolerances in Table 5 do not include crown; the tolerances shown in Table 6 are in addition to those shown in Table 5.

2.5 Crown (See 2.4.1):

Strip may be thicker at the center than at a point 10 mm from the edge by the amounts shown in Table 6.

TABLE 6 - Crown Tolerances, Millimeter
for Width Ranges, Millimeters

Specified Thickness Millimeters	Up to 100, incl	Over 100 to 200, incl	Over 200 to 300, incl
Up to 3.0, incl	0.05	0.10	0.10
Over 3.0 to 4.5, incl	0.05	0.08	0.08
Over 4.5 to 6.0, incl	0.03	0.05	0.08
Over 6.0 to 9.5, incl	--	--	0.05

2.6 Rectangular Sheared Plates:

Minus tolerance for all sizes shall be 0.25 mm; plus tolerance shall be as shown in Table 7.

TABLE 7 - Thickness Tolerances, Millimeters, Plus Only
for Width Ranges, Millimeters

Specified Thickness Millimeters	Up to 1200, incl	Over 1200 to 1500, excl	1500 to 1800, excl	1800 to 2100, excl	2100 to 2400, excl	2400 to 2700, excl	2700 to 3000, incl
Up to 6.5, excl	0.4	0.4	0.5	0.5	0.6	0.7	0.8
6.5 to 8.0, excl	0.4	0.5	0.5	0.6	0.7	0.8	0.9
8.0 to 9.5, excl	0.5	0.5	0.6	0.6	0.7	0.8	0.9
9.5 to 11.0, excl	0.5	0.6	0.6	0.7	0.8	0.9	1.0
11.0 to 12.5, excl	0.6	0.6	0.7	0.7	0.8	0.9	1.0
12.5 to 16.0, excl	0.6	0.7	0.7	0.8	0.9	1.0	1.0
16.0 to 19.0, excl	0.7	0.7	0.8	0.8	0.9	1.0	1.1
19.0 to 25.0, excl	0.8	0.8	0.9	0.9	1.0	1.1	1.2
25.0 to 31.0, excl	1.0	1.1	1.2	1.2	1.2	1.3	1.4
31.0 to 37.5, excl	1.3	1.3	1.4	1.4	1.4	1.6	1.7
37.5 to 44.0, excl	1.5	1.5	1.6	1.6	1.6	1.8	2.0
44.0 to 50.0, incl	1.7	1.7	1.8	1.9	1.9	2.2	2.4

2.6.1 For thickness measured at any location other than that specified in Section 2, the permissible maximum plus tolerance shall be increased by 75%.

3. WIDTH:

- 3.1 Cold Rolled Sheet Over 300 mm in Width and Hot Rolled, Cut Edge Sheet, Not Resquared, Coils and Cut Lengths:

See Table 8.

TABLE 8 - Width Tolerances

Specified Width Millimeters	Tolerance, Millimeters Plus Only
Over 300 to 600, incl	3
Over 600 to 1200, incl	5
Over 1200 to 1500, incl	6
Over 1500 to 1800, incl	8
Over 1800	10

- 3.1.1 For hot rolled sheet, tolerances apply only to thicknesses 6 mm and under.

- 3.2 Cold Rolled Sheet 50 to 300 mm in Width, Produced by Slitting Wider Sheet, Not Resquared, Coils and Cut Lengths:

See Table 9.

TABLE 9 - Width Tolerances

Specified Width Millimeters	Tolerance, Millimeters Plus and Minus
Over 50 to 100, incl	0.3
Over 100 to 200, incl	0.4
Over 200 to 300, incl	0.8

3.3 Cold Rolled Strip, Coils and Cut Lengths:

3.3.1 Mill Edge: See Table 10.

TABLE 10 - Width Tolerances

Specified Width Millimeters	Tolerance, Millimeters Plus and Minus
Up to 50, incl	0.8
Over 50 to 100, incl	1.2
Over 100 to 200, incl	1.6
Over 200 to 400, incl	2.5
Over 400 to 500, incl	3.0
Over 500 to 600, incl	4.0

3.3.2 Slit Edge: See Table 11.

TABLE 11 - Width Tolerances, Millimeter, Plus and Minus
for Thickness Ranges, Millimeters

Specified Width Millimeters	Up to 1.5, incl	Over 1.5 to 2.5, incl	Over 2.5 to 4.5, incl	Over 4.5 to 6.0, incl
Up to 100, incl	0.13	0.20	0.25	0.40
Over 100 to 200, incl	0.13	0.25	0.40	0.50
Over 200 to 300, incl	0.25	0.25	0.40	0.50
Over 300 to 450, incl	0.40	0.40	0.50	0.80
Over 450 to 600, incl	0.50	0.50	0.50	0.80

3.4 Hot Rolled Strip, Coils and Cut Lengths (See 3.4.1):

See Table 12.

TABLE 12 - Width Tolerances, Millimeters, Plus and Minus
for Thickness Ranges, Millimeters

Specified Width Millimeters	Mill Edge or Square Edge	Slit or Cut Edge	
		Up to 2.5, incl	Slit or Cut Edge Over 2.5
Up to 50, incl	0.8	0.2	0.4
Over 50 to 100, incl	1.2	0.2	0.4
Over 100 to 200, incl	1.6	0.3	0.4
Over 200 to 300, incl	2.4	0.4	0.4

3.4.1 Tolerances for strip over 6 to 12.5 mm in specified thickness with mill edge or square edge apply only to coiled strip.

3.5 Hot Rolled Plate:

3.5.1 Sheared Plate: Minus tolerance shall be 6.5 mm for all sizes; plus tolerance shall be as shown in Table 13.

TABLE 13 - Width Tolerances, Millimeters, Plus Only
for Thickness Ranges, Millimeters

Specified Width Millimeters	Specified Length Millimeters	Up to 9.5, excl	9.5 to 16.0, excl	16.0 to 25.0, excl	25.0 to 37.5, incl
Up to 1500, excl	Up	9.5	11.0	12.5	16.0
1500 to 2100, excl	to	11.0	12.5	16.0	19.0
2100 to 2700, excl	3000,	12.5	16.0	19.0	25.0
2700 and over	excl	16.0	19.0	22.0	28.0
Up to 1500, excl	3000	9.5	12.5	16.0	19.0
1500 to 2100, excl	to	12.5	16.0	19.0	22.0
2100 to 2700, excl	6000,	14.0	18.0	20.0	25.0
2700 and over	excl	16.0	19.0	22.0	28.0
Up to 1500, excl	6000	9.5	12.5	16.0	19.0
1500 to 2100, excl	to	12.5	16.0	19.0	22.0
2100 to 2700, excl	9000,	14.0	18.0	22.0	25.0
2700 and over	excl	16.0	22.0	25.0	31.0
Up to 1500, excl	9000	11.0	12.5	16.0	19.0
1500 to 2100, excl	to	12.5	16.0	19.0	22.0
2100 to 2700, excl	12,000,	14.0	19.0	22.0	25.0
2700 and over	excl	19.0	22.0	25.0	31.0
Up to 1500, excl	12,000	11.0	12.5	16.0	19.0
1500 to 2100, excl	to	12.5	16.0	19.0	22.0
2100 to 2700, excl	15,000,	16.0	19.0	22.0	25.0
2700 and over	excl	19.0	22.0	25.0	31.0
Up to 1500, excl	15,000	12.5	16.0	19.0	22.0
1500 to 2100, excl	to	16.0	19.0	22.0	25.0
2100 to 2700, excl	18,000,	16.0	19.0	22.0	28.0
2700 and over	excl	22.0	25.0	28.0	31.0
Up to 1500, excl	18,000	14.0	19.0	22.0	25.0
1500 to 2100, excl	and	19.0	22.0	25.0	28.0
2100 to 2700, excl	over	19.0	22.0	25.0	31.0
2700 and over		25.0	28.0	31.0	35.0

3.5.2 Gas Cut Rectangular Plate, Thicknesses Up to 50 mm, Exclusive: See Table 14.

TABLE 14 - Width Tolerance

Specified Width Millimeters	Tolerance, Millimeters, Plus and Minus
All	12.5

3.5.2.1 Tolerances may be taken all minus or divided unequally plus and minus, if so specified.

3.5.2.2 Plates with universal rolled edges are commonly cut to length only.

3.5.3 Universal Mill Plate: Minus tolerance shall be 3.5 millimeters. Plus tolerance shall be as shown in Table 15.

TABLE 15 - Width Tolerances, Millimeters, Plus Only
for Thickness Ranges, Millimeters

Specified Width Millimeters	Up to 10 excl	10 to 16, excl	16 to 25, excl	25 to 50, excl
Up to 500, excl	3.5	3.5	5.0	6.5
500 to 900, excl	5.0	6.5	8.0	9.5
900 and over	8.0	9.5	11.0	12.5

3.5.4 Mill Edge Plates in Coils and Cut Lengths for Plates Produced on Strip Mills: See Table 16.

TABLE 16 - Width Tolerances

Specified Width Millimeters	Tolerance, Millimeters Plus and Minus
Up to 350, excl	11.0
350 to 425, excl	12.5
425 to 475, excl	14.0
475 to 525, excl	16.0
525 to 600, excl	17.5
600 to 650, excl	20.5
650 to 700, excl	23.5
700 to 875, excl	28.5
875 to 1250, excl	31.5
1250 to 1500, excl	37.5

3.5.4.1 Tolerances in Table 16 do not apply to the uncropped ends of mill edge plate in coils.

4. LENGTH:

4.1 Cold Rolled Sheet, Cut Lengths, Not Resquared:

See Table 17.

TABLE 17 - Length Tolerances

Specified Length Millimeters	Tolerance, Millimeters Plus Only
Over 300 to 1500, incl	6
Over 1500 to 3000, incl	20
Over 3000 to 6000, incl	35
Over 6000	45

4.1.1 Tolerances in Table 17 for widths 50 to 300 mm, inclusive, apply to product produced by slitting from wider sheet.

4.2 Hot Rolled Sheet, Cut Lengths, Not Resquared:

See Table 18.

TABLE 18 - Length Tolerances

Specified Length Millimeters	Tolerance, Millimeters Plus Only
Over 300 to 600, incl	6
Over 600 to 900, incl	8
Over 900 to 1500, incl	12
Over 1500 to 3000, incl	20
Over 3000 to 4000, incl	25
Over 4000 to 5000, incl	35
Over 5000 to 6000, incl	40
Over 6000	45

4.3 Cold Rolled Strip:

See Table 19.

TABLE 19 - Tolerances, Millimeters, Plus Only
for Width Ranges, Millimeters

Specified Length Millimeters	Up to 300, incl	Over 300 to 600, incl
600 to 1500, incl	10	15
Over 1500 to 3000, incl	15	20
Over 3000	20	25

4.4 Hot Rolled Strip:

See Table 20.

TABLE 20 - Length Tolerances, Millimeters, Plus Only
for Width Ranges, Millimeters

Specified Length Millimeters	Up to 100, incl	Over 100 to 200, incl	Over 200 to 300, incl
Up to 1500, incl	10	10	15
Over 1500 to 3000, incl	10	15	20
Over 3000 to 6000, incl	15	15	25
Over 6000 to 9000, incl	20	20	30
Over 9000 to 12,000, incl	25	25	40
Over 12,000	40	40	45

4.5 Hot Rolled Plate:

4.5.1 Sheared Plate, Universal Mill Plate, and Mill Edge Plate: Minus tolerance shall be 6.5 mm for all sizes. Plus tolerances shall be as shown in Table 21 except as specified in 4.5.1.1.

TABLE 21 - Length Tolerances, Millimeters, Plus Only
for Thickness Ranges, Millimeters

Specified Length Millimeters	Specified Width Millimeters	Up to 9.5, excl	9.5 to 16.0, excl	16.0 to 25.0, excl	25.0 to 50.0, incl
Up to 3000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	12.5 16.0 19.0 22.0	16.0 17.0 22.0 25.0	19.0 22.0 25.0 28.0	25.0 25.0 28.0 32.0
3000 to 6000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	19.0 19.0 22.0 25.0	22.0 22.0 23.5 28.0	25.0 25.0 28.0 31.0	28.0 31.0 34.5 34.5
6000 to 9000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	25.0 25.0 25.0 28.0	28.0 28.0 28.0 31.0	31.0 31.0 34.5 34.5	37.5 37.5 37.5 44.0
9000 to 12,000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	28.0 31.0 31.0 34.5	31.0 34.5 34.5 37.5	34.5 37.5 37.5 40.5	40.5 40.5 47.0 47.0
12,000 to 15,000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	31.0 34.5 34.5 37.5	37.5 37.5 37.5 40.5	40.5 40.5 40.5 44.0	47.0 47.0 47.0 47.0
15,000 to 18,000, excl	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	44.0 44.0 44.0 44.0	47.0 47.0 47.0 50.0	47.0 47.0 47.0 56.5	56.5 56.5 56.5 62.5
18,000 and over	Up to 1500, excl 1500 to 2100, excl 2100 to 2700, excl 2700 and over	50.0 50.0 50.0 50.0	53.0 53.0 53.0 53.0	56.5 56.5 56.5 62.5	69.0 69.0 69.0 75.0

4.5.1.1 For sheared plate, the tolerances in Table 21 apply only to specified thicknesses 37.5 mm and under.

4.5.2 Gas Cut Rectangular Plates, Thicknesses Up to 50 Millimeters, Exclusive: See Table 22.

TABLE 22 - Length Tolerances

Specified Length Millimeters	Tolerance, Millimeters, Plus Only
All	12.5

4.5.2.1 Tolerances may be taken all minus or divided plus and minus if so specified.

4.5.2.2 Plates with universal rolled edges are commonly cut to length only.

5. CAMBER (Lateral Bow):

5.1 Sheet:

Camber (lateral bow) is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge.

5.1.1 Cold Rolled Sheet Over 300 mm Wide and Hot Rolled Sheet, Not Resquared, Cut Lengths: See Table 23.

TABLE 23 - Camber

Specified Cut Length Millimeters	Tolerance Millimeters
Up to 1200, incl	4
Over 1200 to 1800, incl	5
Over 1800 to 2400, incl	6
Over 2400 to 3000, incl	8
Over 3000 to 3700, incl	10
Over 3700 to 4300, incl	13
Over 4300 to 4900, incl	16
Over 4900 to 5500, incl	19
Over 5500 to 6000, incl	22
Over 6000 to 9000, incl	32
Over 9000 to 12,200, incl	38

5.1.2 Cold Rolled Sheet Over 300 mm Wide and Hot Rolled Sheet in Coils: 25 mm in any 6000 millimeters.