



# AEROSPACE MATERIAL SPECIFICATION

**AMS2231****REV. K**

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Superseding AMS2231J

Tolerances  
Carbon Steel Bars

## RATIONALE

AMS2231K results from a Five Year Review and update.

### 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. DIAMETER OR THICKNESS

#### 2.1 Cold Finished

##### 2.1.1 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.

2.1.1.1 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 wide and 1.000 inch thick, the width tolerance is 0.005 inch and the thickness tolerance is the same, namely, 0.005 inch.

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**TABLE 1 – Diameter, Thickness, or Width Tolerances, Inch, Minus Only for Maximum of Carbon Range, %****Table 1A – Rounds**

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

**Table 1B – Hexagons**

| Specified Thickness<br>Inches | Up to<br>0.28 Carbon,<br>incl | Over 0.28<br>to 0.55 Carbon,<br>incl | Up to 0.55 Carbon,<br>incl, Stress<br>Relieved or<br>Annealed After<br>Cold Finishing | Over 0.55 Carbon,<br>With or Without Stress<br>Relieving or Annealing<br>After Cold Finishing,<br>and All Carbons<br>Quenched and Tempered<br>or Normalized and<br>Tempered Before Cold<br>Finishing |
|-------------------------------|-------------------------------|--------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 1C – Squares and flats**

| Specified Thickness or<br>Width<br>Inches | Up to<br>0.28 Carbon,<br>incl | Over 0.28<br>to 0.55 Carbon,<br>incl | Up to 0.55 Carbon,<br>incl, Stress<br>Relieved or<br>Annealed After<br>Cold Finishing | Over 0.55 Carbon,<br>With or Without Stress<br>Relieving or Annealing<br>After Cold Finishing,<br>and All Carbons<br>Quenched and Tempered<br>or Normalized and<br>Tempered Before Cold<br>Finishing |
|-------------------------------------------|-------------------------------|--------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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                                | --                                                                                    | --                                                                                                                                                                                                   |

### 2.1.2 Turned and Polished Rounds

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 2 – Diameter tolerances, inch, minus only for maximum of carbon range, %**

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

### 2.1.3 Cold Drawn, Ground, and Polished Rounds

See Table 3.

**Table 3 – Diameter tolerances**

| Specified Diameter<br>Inches | Tolerance, Inch<br>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                         |

### 2.1.4 Turned, Ground, and Polished Rounds

See Table 4.

**Table 4 – Diameter tolerances**

| Specified Diameter<br>Inches | Tolerance, Inch<br>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)           |

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 inches in specified diameter are increased by 0.001 inch.

## 2.2 Hot Finished

### 2.2.1 Rounds and Squares

See Table 5. 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 5 - Diameter or thickness tolerances**

| Specified<br>Diameter or Thickness<br>Inches | Tolerance, Inch<br>Plus | Tolerance, Inch<br>Minus | Out-of-Round<br>or Out-of-Square<br>Inch |
|----------------------------------------------|-------------------------|--------------------------|------------------------------------------|
| 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                                    |

## 2.2.2 Square-Edge and Round-Edge Flats

See Table 6 and Table 7.

**Table 6 – Thickness tolerance, inch, plus and minus for thickness ranges, inch**

| Specified Width<br>Inches | 0.203<br>to<br>0.230,<br>excl | 0.230<br>to<br>0.250,<br>excl | 0.250<br>to<br>0.500,<br>incl | Over<br>0.500<br>to<br>1.000,<br>incl | Over<br>1.000<br>to<br>2.000,<br>incl | Over<br>2.000<br>to<br>3.000,<br>incl | Over<br>3.000 |
|---------------------------|-------------------------------|-------------------------------|-------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------|
| 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 7 - Width tolerance**

| Specified Width<br>Inches | Tolerance<br>Inch, Plus | Tolerance<br>Inch, 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                    |

## 3. WIDTH

Included in Section 2.

## 4. LENGTH

No requirements for AMS.