

# EARLE M. JORGENSEN COMPANY 

REFERENCE BOOK

ALLOY•ALUMINUM•BRASS•BRONZE CARBON • CAST IRON•CHROME • NICKEL STAINLESS • SUPER ALLOY • TITANIUM BAR • PIPE • PLATE • SHEET • TUBE

## SECTION 0

## TOLERANCES AND MACHINING ALLOWANCES

SIZE AND STRAIGHTNESS TOLERANCES
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| TOLERANCES |  |  |  |
| :---: | :---: | :---: | :---: |
| HOT ROLLED CARBON AND ALLOY BARS |  |  |  |
| SIZE TOLERANCES - ROUNDS AND SOUARES |  |  |  |
| Specified Size | Size Tol | Inches | Out-of-Round |
| Inches | Over | Under | or Square, In. |
| To 5/16 incl. | 0.005 | 0.005 | 0.008 |
| Over $5 / 16$ to 7/16 incl. | 0.006 | 0.006 | 0.009 |
| Over $7 / 16$ to $5 / 8 \mathrm{incl}$. | 0.007 | 0.007 | 0.010 |
| Over $5 / 8$ to $7 / 8 \mathrm{incl}$. | 0.008 | 0.008 | 0.012 |
| Over $7 / 8$ to 1 incl. | 0.009 | 0.009 | 0.013 |
| Over 1 to $1^{1 / 8} \mathrm{incl}$. | 0.010 | 0.010 | 0.015 |
| Over $11 / 8$ to $11 / 4 \mathrm{incl}$. | 0.011 | 0.011 | 0.016 |
| Over $11 / 4$ to $13 / 8 \mathrm{incl}$. | 0.012 | 0.012 | 0.018 |
| Over $13 / 8$ to $11 / 2 \mathrm{incl}$. | 0.014 | 0.014 | 0.021 |
| Over $11 / 2$ to 2 incl . | 1/64 | 1/64 | 0.023 |
| Over 2 to $2^{1 / 2}$ incl. | $1 / 32$ | 0 | 0.023 |
| Over $2^{11 / 2}$ to $3^{1 / 2} 2 \mathrm{incl}$. | 3/64 | 0 | 0.035 |
| Over $31 / 2$ to $41 / 2 \mathrm{incl}$. | 1/16 | 0 | 0.046 |
| Over $4^{11 / 2}$ to $5^{1 / 2} 2 \mathrm{incl}$. | 5/64 | 0 | 0.058 |
| Over $5^{112}$ to $61 / 2 \mathrm{incl}$. | 1/8 | 0 | 0.070 |
| Over $6^{11 / 2}$ to $8^{1 / 4} \mathrm{incl}$. | 5/32 | 0 | 0.085 |
| Over $81 / 4$ to $91 / 2 \mathrm{incl}$. | 3/16 | 0 | 0.100 |
| Over $91 / 2$ to 10 incl . | $1 / 4$ | 0 | 0.120 |

Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the samecross-section. Out-of-square is the difference in the two dimensions at the same cross-section of a square bar, each dimension being the distance between opposite sides.

## SIZE TOLERANCES - HEXAGONS

| Specified Size Between Opposite Sides, Inches | Size Tolerance, Inches |  | Out-of-Round or Square, In |
| :---: | :---: | :---: | :---: |
|  | Over | Under |  |
| To $1 / 2 \mathrm{incl}$. | 0.007 | 0.007 | 0.011 |
| Over $1 / 2$ to 1 incl . | 0.010 | 0.010 | 0.015 |
| Over 1 to $11 / 2 \mathrm{incl}$. | 0.021 | 0.013 | 0.025 |
| Over $11 / 2$ to 2 incl. | $1 / 32$ | 1/64 | $1 / 32$ |
| Over 2 to $2^{1 / 2}$ incl. | 3/64 | 1/64 | 3/64 |
| Over $2^{11 / 2}$ to $3^{1 / 2}$ incl. | 1/16 | 1/64 | 1/16 |

Out-of-hexagon section is the greatest difference between any two dimensions at the same cross-section between opposite faces.

## SIZE TOLERANCES - FLATS

| Specified Width Inches | Thickness Tolerance, for Thickness Given, Over and Under, Inches |  |  |  |  |  |  | Width Tolerance Inches |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & .203 \text { to } \\ & .230, \\ & \text { excl. } \end{aligned}$ | .230 to 1/4, excl. | $\begin{aligned} & 1 / 4 \text { to } \\ & 1 / 2, \\ & \text { incl. } \end{aligned}$ | Over $1 / 2$ to 1 , incl. | Over <br> 1 <br> to 2, <br> incl. | Over 2 to 3, incl. | $\begin{aligned} & \text { Over } \\ & 3 \end{aligned}$ | Over | Under |
| To 1 incl. | 0.007 | 0.007 | 0.008 | 0.010 | - | - | - | 1/64 | 1/64 |
| Over 1 to 2 incl. | 0.007 | 0.007 | 0.012 | 0.015 | 1/32 | - | - | 1/32 | 1/32 |
| Over 2 to 4 incl. | 0.008 | 0.008 | 0.015 | 0.020 | 1/32 | 3/64 | 3/64 | 1/16 | 1/32 |
| Over 4 to 6 incl. | 0.009 | 0.009 | 0.015 | 0.020 | 1/32 | 3/64 | 3/64 | $3 / 32$ | 1/16 |
| Over 6 to 8 incl. | * | 0.015 | 0.016 | 0.025 | 1/32 | 3/64 | 1/16 | 1/8 | 3/32 |

*Flats over 6" to 8", incl. in width are not available as hot rolled carbon steel bars in thickness over 0.230 .

## STRAIGHTNESS TOLERANCES

## ROUNDS, SQUARES, HEXAGONS, OCTAGONS, FLATS, SPRING FLATS

## Standard <br> $\frac{1 / 4 \text { inch in any } 5 \text { feet, or } 1 / 4 \times \frac{\text { number of feet of length }}{5} \text { inches }}{5}$ Special <br> $\frac{1 / 8 \text { inch in any } 5 \text { feet, or } 1 / 8 \times \frac{\text { number of feet of length }}{5} \text { inches }}{}$

Because of warpage, straightness tolerances do not apply to bars if any subsequent heating operation has been performed after straightening.

## COLD FINISHED CARBON BARS

Minus Tolerances in Inches
(No Plus Tolerances Apply)

| Specified Size Inches | Maximum of Carbon Range 0.28\% or less | Maximum of Carbon Range Over 0.28\% to 0.55\% incl. | Stress or Strain Relieved After Cold Finishing (Max. of Carbon Range to $.55 \%$ incl.) | Maximum of Carbon <br> Range Over .55\% <br> or <br> Quenched and Tempered Before Cold Finishing |
| :---: | :---: | :---: | :---: | :---: |

ROUNDS - COLD DRAWN OR TURNED AND POLISHED ${ }^{1}$

| Up to $1 \frac{1}{1} / 2$ Incl. | 0.002 | 0.003 | 0.004 | 0.005 |
| :--- | :--- | :--- | :--- | :--- |
| Over $11 / 2$ to $2^{1 / 2}$ incl. | 0.003 | 0.004 | 0.005 | 0.006 |
| Over $2^{112}$ to 4 incl. | 0.004 | 0.005 | 0.006 | 0.007 |
| Over 4 to 6 incl. | 0.005 | 0.006 | 0.007 | 0.008 |
| Over 6 to 8 incl. | 0.006 | 0.007 | 0.008 | 0.009 |
| Over 8 to 9 incl. | 0.007 | 0.008 | 0.009 | 0.010 |
| Over 9 | 0.008 | 0.009 | 0.010 | 0.011 |

ROUNDS - TURNED, GROUND AND POLISHED AND COLD DRAWN, GROUND AND POLISHED

| Up to $1 \frac{1}{2}$ Incl. | 0.001 | 0.001 | 0.001 | 0.001 |
| :--- | ---: | ---: | ---: | ---: |
| Over $1 \frac{1}{2}$ to $2^{1 / 2}$ incl. | 0.0015 | 0.0015 | 0.0015 | 0.0015 |
| $2^{1 / 2}$ to 3 incl. | 0.002 | 0.002 | 0.002 | 0.002 |
| Over 3 to 4 incl. | 0.003 | 0.003 | 0.003 | 0.003 |

HEXAGONS - COLD DRAWN ${ }^{1}$

| Up to $3 / 4$ incl. | 0.002 | 0.003 | 0.004 | 0.006 |
| :--- | :--- | :--- | :--- | :--- |
| Over $3 / 4$ to $1 \frac{1}{2}$ incl. | 0.003 | 0.004 | 0.005 | 0.007 |
| Over $11 / 2$ to $2^{11 / 2}$ incl. | 0.004 | 0.005 | 0.006 | 0.008 |
| Over $2^{1 / 2}$ to $3^{1 / 8}$ incl. | 0.005 | 0.006 | 0.007 | 0.009 |

## SQUARES - COLD DRAWN ${ }^{1}$

| Up to $3 / 4$ incl. | 0.002 | 0.004 | 0.005 | 0.007 |
| :--- | :---: | :---: | :---: | :---: |
| Over $3 / 4$ to $1 \frac{1}{2} 2$ incl. | 0.003 | 0.005 | 0.006 | 0.008 |
| Over $1 \frac{1}{2}$ to $2^{1 / 2}$ incl. | 0.004 | 0.006 | 0.007 | 0.009 |
| Over $21 / 2$ to 4 incl. | 0.005 | 0.008 | 0.009 | 0.011 |
| Over $21 / 2$ to $31 / 8$ incl. | 0.010 | - | - | - |

FLATS - COLD DRAWN OR COLD ROLLED ${ }^{1}$
Tolerances apply to thickness as well as width ${ }^{2}$

| Width in Inches |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: |
| Up to $3 / 4$ Incl. | 0.003 | 0.004 | 0.006 | 0.008 |
| Over $3 / 4$ to $11 / 2$ incl. | 0.004 | 0.005 | 0.008 | 0.010 |
| Over $1 / 12$ to 3 incl. | 0.005 | 0.006 | 0.010 | 0.012 |
| Over 3 to 4 incl. | 0.006 | 0.008 | 0.011 | 0.016 |
| Over 4 to 6 incl. | 0.008 | 0.010 | 0.012 | 0.020 |
| Over 6 | 0.013 | 0.015 | - | - |

'Tolerances apply to bars that have been annealed, spheroidize annealed, normalized, normalized and tempered, or quenched and tempered before cold finishing. Tolerances shown do not apply to bars that are annealed, spheroidize annealed, normalized, normalized and tempered, or quenched and tempered after cold finishing.
${ }^{2}$ Width governs the tolerances for both width and thickness of flats. For example, when the maximum of carbon range is $0.28 \%$ or less, for a flat 2 " wide and 1 " thick, the width tolerance is 0.005 " and the thickness tolerance is the same.

## COLD FINISHED ALLOY BARS

Minus Tolerances in Inches
(No Plus Tolerances Apply)

| Specified Size Inches | Maximum of Carbon Range . $028 \%$ or less As Cold Finished and without any Thermal Treatment | Maximum of Carbon Range Over 0.28\% to $0.55 \%$ incl. As Cold Finished and without any Thermal Treatment | Maximum of Carbon Range up to 0.55\% incl. Annealed or Stress Relieved after Cold Finishing | Maximum of Carbon Range over $0.55 \%$, or all Carbons Quenched and Tempered or Normalized and Tempered before Cold Finishing, or all Carbons Stress Relieved after Cold Finishing |
| :---: | :---: | :---: | :---: | :---: |

ROUNDS - COLD DRAWN OR TURNED AND POLISHED

| Up to $1 \frac{1}{1 / 2}$ incl. | 0.003 | 0.004 | 0.005 | 0.006 |
| :--- | :--- | :--- | :--- | :--- |
| Over $1^{1 / 2}$ to $2 \frac{1}{2}$ incl. | 0.004 | 0.005 | 0.006 | 0.007 |
| Over $2^{1 ⁄ 2}$ to 4 incl. | 0.005 | 0.006 | 0.007 | 0.008 |
| Over 4 to 6 incl. | 0.006 | 0.007 | 0.008 | 0.008 |
| Over 6 to 8 incl. | 0.007 | 0.008 | 0.009 | 0.010 |
| Over 8 to 9 incl. | 0.008 | 0.009 | 0.010 | 0.011 |
| Over 9 | 0.009 | 0.010 | 0.011 | 0.012 |

## ROUNDS - TURNED, GROUND AND POLISHED AND COLD DRAWN, GROUND AND POLISHED

| Up to $1 \frac{1}{2}$ incl. | 0.001 | 0.001 | 0.001 | 0.001 |
| :--- | ---: | ---: | ---: | ---: |
| Over $1 \frac{1}{1 / 2}$ to $2^{1 / 2}$ incl. | 0.0015 | 0.0015 | 0.0015 | 0.0015 |
| $2^{1 / 2}$ to 3 incl. | 0.002 | 0.002 | 0.002 | 0.002 |
| Over 3 to 4 incl. | 0.003 | 0.003 | 0.003 | 0.003 |

HEXAGONS

| Up to $3 / 4$ incl. | 0.003 | 0.004 | 0.005 | 0.007 |
| :--- | :---: | :---: | :---: | :---: |
| Over $3 / 4$ to $1 \frac{1}{1 / 2}$ incl. | 0.004 | 0.005 | 0.006 | 0.008 |
| Over $1^{11 / 2}$ to $2^{1 / 2}$ incl. | 0.005 | 0.006 | 0.007 | 0.009 |
| Over $2^{11 / 2}$ to $3^{1 / 1}$ incl. | 0.006 | 0.007 | 0.008 | 0.010 |
| Over $3^{1 / 8}$ to 4 incl. | 0.006 | - | - | - |

## SQUARES

| Up to $3 / 4$ incl. | 0.003 | 0.005 | 0.006 | 0.008 |
| :--- | :--- | :--- | :--- | :--- |
| Over $3 / 4$ to $1 \frac{1}{2}$ incl. | 0.004 | 0.006 | 0.007 | 0.009 |
| Over $1 \frac{1}{2}$ to $2^{1 / 2}$ incl. | 0.005 | 0.007 | 0.008 | 0.010 |
| Over $21 / 2$ to 4 incl. | 0.007 | 0.009 | 0.010 | 0.012 |

FLATS
Tolerances apply to thickness as well as width ${ }^{1}$

| Up to $3 / 4$ incl. | 0.004 | 0.005 | 0.007 | 0.009 |
| :--- | :---: | :---: | :---: | :---: |
| Over $3 / 4$ to $1 \frac{1}{2} 2$ incl. | 0.005 | 0.006 | 0.009 | 0.011 |
| Over $1 \frac{1}{2}$ to 3 incl. | 0.006 | 0.007 | 0.011 | 0.013 |
| Over 3 to 4 incl. | 0.007 | 0.009 | 0.012 | 0.017 |
| Over 4 to 6 incl. | 0.009 | 0.011 | 0.013 | 0.021 |
| Over 6 | 0.014 | - | - | - |

${ }^{1}$ Width governs the tolerances for both width and thickness of flats. For example, when the maximum of carbon range is $0.28 \%$ or less, for a flat 2 " wide and 1 " thick, the width tolerance is 0.006 " and the thickness tolerance is the same, namely 0.006".

## STAINLESS BARS

SIZE TOLERANCES - HOT ROLLED ROUNDS AND SQUARES

| Specified Size <br> Inches | Size Tolerance, Inches |  | Out-of-Round <br> Out-of Square |
| :--- | :---: | :---: | :---: |
|  |  |  |  |

${ }^{1}$ Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross-section. Out-of-square is the difference in the two dimensions at the same cross-section of a square bar, each dimension being the distance between opposite faces.
${ }^{2}$ Round sections in the size range of $1 / 4$ " to approximately $5 / 8$ " diameter are commonly produced on rod mills in coils. Tolerances on the product made this way have not been established.

SIZE TOLERANCES - COLD FINISHED ROUNDS (Drawn, Smooth Turned, Ground, or Ground and Polished)

| Specified Size <br> Inches | Over | Under |
| :--- | ---: | ---: |
| .044 to $5 / 16$ excl. | 0.001 | 0.001 |
| $5 / 16$ to $1 / 2$ excl. | 0.0015 | 0.0015 |
| $1 / 2$ to 1 excl. | 0.002 | 0.002 |
| 1 to $11 / 2 \mathrm{excl}$. | 0.0025 | 0.0025 |
| $11 / 2$ to 4 incl. | 0.003 | 0.003 |
| $4^{1 / 8}$ to $41 / 2 \mathrm{incl}$. | 0.005 | 0.005 |
| $4^{9} / 16$ to 6 incl. | 0.008 | 0.008 |

SIZE TOLERANCES - COLD FINISHED HEXAGONS, SQUARES

| Specified Size <br> Inches | Hexagons |  | Squares |  |
| :--- | :---: | :---: | :---: | :---: |
|  | Over | Under | Over | Under |
| $1 / 8$ to $5 / 16$ excl. | 0 | 0.002 | 0 | 0.002 |
| $5 / 16$ to $1 / 2$ excl. | 0 | 0.003 | 0 | 0.003 |
| $1 / 2$ to 1 incl. | 0 | 0.004 | 0 | 0.004 |
| Over 1 to 2 incl. | 0 | 0.006 | 0 | 0.006 |
| Over 2 to 3 incl. | 0 | 0.008 | 0 | 0.008 |
| Over 3 to 4 incl. | 0 | 0.010 | 0 | 0.010 |

When it is necessary to heat treat or heat treat and pickle after cold finishing, because of special hardness or mechanical property requirements, tolerances are commonly double those shown above.

## STRAIGHTNESS TOLERANCES

 ROUNDS, SOUARES, HEXAGONS, OCTAGONS, FLATS, SPRING FLATSMeasurement is taken on the concave side of the bar with a straight edge.

## Hot Finished

$\frac{H}{1 / 8}$ inch in any 5 feet, but may not exceed $1 / 8 \times \frac{\text { no. of feet of length }}{5}$ inches Cold Finished


TOLERANCES
ALUMINUM TOLERANCES
ROD, BAR, AND WIRE

| ROUNDS |  | HEXAGONS |  |
| :---: | :---: | :---: | :---: |
| Diameter <br> in Inches | Tolerance <br> in Inches | Diameter <br> In Inches | Tolerance <br> In Inches |
| Standard Screw Machine Stock | Standard Screw Machine Stock |  |  |
| $0.125-0.500$ | $\pm 0.0015$ | $0.125-0.500$ | $\pm 0.0020$ |
| $0.501-1.000$ | $\pm 0.0020$ | $0.501-1.000$ | $\pm 0.0025$ |
| $1.001-1.500$ | $\pm 0.0025$ | $1.001-1.500$ | $\pm 0.0030$ |
| $1.501-2.000$ | $\pm 0.0040$ | $1.501-2.000$ | $\pm 0.0050$ |
| $2.001-3.000$ | $\pm 0.0060$ | $2.001-3.000$ | $\pm 0.0080$ |
| $3.001-3.375$ | $\pm 0.0080$ |  |  |


| Drawn Round Wire |  | Drawn Hexagonal Wire |  |
| :--- | :---: | :---: | :---: |
| $0.0126-$ | 0.0201 | $\pm 0.0005$ | $0.0202-$ |
| $0.0202-$ | 0.0359 | $\pm 0.0005$ | 0.0359 |
| $0.036-0.064$ | $\pm 0.0010$ | $0.036-0.064$ | $\pm 0.0015$ |
| $0.065-0.374$ | $\pm 0.0015$ | $0.065-0.374$ | $\pm 0.0020$ |
|  |  |  |  |
| Cold Finished Rod |  | Cold Finished Hexagonal Bar |  |
| $0.375-0.500$ | $\pm 0.0015$ | $0.375-0.500$ | $\pm 0.0020$ |
| $0.501-1.000$ | $\pm 0.0020$ | $0.501-1.000$ | $\pm 0.0025$ |
| $1.001-1.500$ | $\pm 0.0025$ | $1.001-1.500$ | $\pm 0.0030$ |
| $1.501-2.000$ | $\pm 0.0040$ | $1.501-2.000$ | $\pm 0.0050$ |
| $2.001-3.000$ | $\pm 0.0060$ | $2.001-3.000$ | $\pm 0.0080$ |


| Rolled Rod |  | Rolled Hexagon Bar |  |
| :---: | :---: | :---: | :---: |
| $1.501-2.000$ | $\pm 0.006$ | $1.501-2.000$ | $\pm 0.016$ |
| $2.001-3.000$ | $\pm 0.008$ | $2.001-3.000$ | $\pm 0.020$ |
| $3.001-3.499$ | $\pm 0.012$ |  |  |
| $3.500-5.000$ | $+0.031,-0.016$ |  |  |
| $5.001-8.000$ | $+0.062,-0.031$ |  |  |

EXTRUDED ROUNDS, SQUARES, AND RECTANGLES

| Cross-Sectional <br> Dimensions Inches | Tolerance <br> in Inches | Cross-Sectional <br> Dimensions Inches | Tolerance <br> in Inches |
| :--- | :---: | :---: | :---: |
| Under | 0.125 | $\pm 0.006$ | 1.0 to under 1.5 |
| 0.125 to under 0.250 | $\pm 0.007$ | 1.5 to under2.0 | $\pm 0.012$ |
| 0.250 to under 0.500 | $\pm 0.008$ | 2.0 to under 4.0 | $\pm 0.014$ |
| 0.500 to under 0.750 | $\pm 0.009$ | 4.0 to under6.0 | $\pm 0.024$ |
| 0.750 to under 1.0 | $\pm 0.010$ | 6.0 to under8.0 | $\pm 0.034$ |
|  |  | 8.0 to under10.0 | $\pm 0.044$ |

Sec. 0

TOLERANCES
ALUMINUM THICKNESS TOLERANCES FLAT SHEET - COILED SHEET - PLATE

Inches - Plus or Minus

| $\begin{aligned} & 2036 \\ & 3004 \\ & 5052 \end{aligned}$ | $\begin{aligned} & 5083 \\ & 5086 \\ & 5154 \end{aligned}$ |  | $\begin{aligned} & 5252 \\ & 5254 \\ & 5454 \end{aligned}$ | $\begin{aligned} & 5456 \\ & 5652 \\ & 6061 \end{aligned}$ |  | Brazing Sheet 11,12,23,24 Also Alclad Alloys |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 'Specified | Specified Widths in Inches |  |  |  |  |  |  |  |
| Thickness In Inches | 39.37 and Under | $\begin{aligned} & \text { Over } \\ & 39.37- \\ & 59.06 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 59.06 \\ & 78.74 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & \mathbf{7 8 . 7 4 -} \\ & 98.43 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 98.43- \\ & 118.11 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 118.11- \\ & 137.80 \end{aligned}$ | $\begin{gathered} \text { Over } \\ 137.80- \\ 157.48 \end{gathered}$ | $\left\lvert\, \begin{gathered} \text { Over } \\ 157.48- \\ 177.17 \end{gathered}\right.$ |
| 0.006-0.010 | . 0010 | . 0020 | - | - | - | - | - | - |
| 0.011-0.016 | . 0015 | . 0025 | - | - | - | - | - | - |
| 0.017-0.025 | . 0020 | . 0030 | - | - | - | - | - | - |
| 0.026-0.032 | . 0020 | . 0035 | . 0045 | - | - | - | - | - |
| 0.033-0.039 | . 0025 | . 0035 | . 0055 | . 007 | - | - | - | - |
| 0.040-0.047 | . 0030 | . 0040 | . 006 | . 008 | . 010 | . 011 | - | - |
| 0.048-0.063 | . 0030 | . 0045 | . 007 | . 009 | . 011 | . 013 | - |  |
| 0.064-0.079 | . 0035 | . 0055 | . 007 | . 010 | . 013 | . 015 | - |  |
| 0.080-0.098 | . 0035 | . 006 | . 008 | . 011 | . 015 | . 018 | - | - |
| 0.099-0.126 | . 0045 | . 007 | . 010 | . 013 | . 016 | . 020 | - | - |
| 0.127-0.158 | . 0055 | . 008 | . 012 | . 015 | . 018 | . 022 | - | - |
| 0.159-0.197 | . 007 | . 010 | . 015 | . 018 | . 022 | . 026 | - | - |
| 0.198-0.248 | . 009 | . 012 | . 017 | . 021 | . 025 | . 029 | - | - |
| 0.249-0.315 | . 012 | . 015 | . 019 | . 024 | . 029 | . 033 | . 041 | . 051 |
| 0.316-0.394 | . 017 | . 018 | . 022 | . 028 | . 033 | . 039 | . 047 | . 059 |
| 0.395-0.630 | . 023 | . 023 | . 028 | . 033 | . 039 | . 047 | . 059 | . 070 |
| 0.631-0.984 | . 031 | . 031 | . 037 | . 043 | . 051 | . 060 | . 070 | . 085 |
| 0.985-1.575 | . 039 | . 039 | . 047 | . 055 | . 065 | . 075 | . 090 | . 105 |
| 1.576-2.362 | . 055 | . 055 | . 060 | . 070 | . 090 | . 100 | . 115 | - |
| 2.363-3.150 | . 075 | . 075 | . 085 | . 100 | . 110 | . 125 | - |  |
| 3.160-3.937 | . 100 | . 100 | . 115 | . 130 | . 150 | . 160 | - | - |
| 3.938-6.299 | . 130 | . 130 | . 145 | . 165 | - | - | - | - |
| 1060 | $\begin{aligned} & 3003 \\ & 3005 \\ & 3105 \end{aligned}$ |  | $\begin{aligned} & 5005 \\ & 5050 \\ & 5457 \end{aligned}$ |  |  | ```5657 1100 Reflector Sheet Also Alclad Alloys``` |  |  |
| 1100 |  |  |  |  |  |  |  |  |
| 1350 |  |  |  |  |  |  |  |  |
| 0.006-0.010 | . 0010 | . 0015 | - | - | - | - | - | - |
| 0.011-0.016 | . 0010 | . 0020 | - |  | - | - | - | - |
| 0.017-0.025 | . 0015 | . 0020 | . 0030 | . 0035 | - | - | - | - |
| 0.026-0.032 | . 0020 | . 0025 | . 0035 | . 0040 | - | - | - | - |
| 0.033-0.039 | . 0020 | . 0030 | . 0035 | . 0045 | . 006 | - | - | - |
| 0.040-0.047 | . 0025 | . 0035 | . 0045 | . 0055 | . 007 | - | - | - |
| 0.048-0.063 | . 0030 | . 0035 | . 0055 | . 006 | . 007 | . 009 | - | - |
| 0.064-0.079 | . 0035 | . 0040 | . 006 | . 007 | . 008 | . 010 | - | - |
| 0.080-0.098 | . 0035 | . 0045 | . 007 | . 008 | . 010 | . 011 | - | - |
| 0.099-0.126 | . 0045 | . 0055 | . 007 | . 010 | . 011 | . 013 | - | - |
| 0.127-0.158 | . 0055 | . 007 | . 009 | . 011 | . 013 | . 015 | - | - |
| 0.159-0.197 | . 007 | . 009 | . 011 | . 013 | . 015 | . 018 | - |  |
| 0.198-0.248 | . 009 | . 011 | . 013 | . 015 | . 018 | . 022 | . 027 | - |
| 0.249-0.315 | . 012 | . 014 | . 015 | . 018 | . 022 | . 027 | . 036 | . 047 |
| 0.316-0.394 | . 017 | . 017 | . 020 | . 023 | . 027 | . 033 | . 041 | . 051 |
| 0.395-0.630 | . 023 | . 023 | . 027 | . 032 | . 037 | . 043 | . 053 | . 065 |
| 0.631-0.984 | . 031 | . 031 | . 037 | . 043 | . 051 | . 060 | . 070 | . 085 |
| 0.985-1.575 | . 039 | . 039 | . 047 | . 055 | . 065 | . 075 | . 090 | . 105 |
| 1.576-2.362 | . 055 | . 055 | . 060 | . 070 | . 090 | . 100 | . 115 | - |
| 2.363-3.150 | . 075 | . 075 | . 085 | . 100 | . 110 | . 125 | - | - |
| 3.160-3.937 | . 100 | . 100 | . 115 | . 130 | . 150 | . 160 | - | - |
| 3.938-6.299 | . 130 | . 130 | . 145 | . 165 | - | - | - | - |

${ }^{1}$ When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension.

TOLERANCES
ALUMINUM THICKNESS TOLERANCES FLAT SHEET - COILED SHEET - PLATE

Inches - Plus or Minus

| $\begin{aligned} & 2014 \\ & 2024 \\ & 2124 \end{aligned}$ | 22 | $\begin{aligned} & 7050 \\ & 7075 \\ & 7150 \end{aligned}$ |  | $\begin{aligned} & 7178 \\ & 7475 \\ & \text { Also Alclad Alloys } \end{aligned}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {'Specified }}$ | Specified Widths through 78.74 Inches |  |  |  |  |  |
| Thickness In Inches | 39.37 and Under | $\begin{gathered} \text { Over } \\ 39.37- \\ 4724 \end{gathered}$ | $\begin{aligned} & \text { Over } \\ & \mathbf{4 7 . 2 4} \\ & 55.12 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 55.12- \\ & 59.06 \end{aligned}$ | $\begin{gathered} \text { Over } \\ 59.06 \\ 70.87 \end{gathered}$ | $\begin{gathered} \text { Over } \\ \mathbf{7 0 . 8 7} \\ \mathbf{7 8 . 7 4} \end{gathered}$ |
| 0.006-0.010 | . 0010 | . 0020 | . 0020 | . 0020 | - | - |
| 0.011-0.016 | . 0015 | . 0025 | . 0025 | . 0025 | - | - |
| 0.017-0.025 | . 0015 | . 0025 | . 0025 | . 0025 | - |  |
| 0.026-0.032 | . 0015 | . 0015 | . 0020 | . 0030 | . 0030 |  |
| 0.033-0.039 | . 0015 | . 0015 | . 0020 | . 0030 | . 0030 | . 0035 |
| 0.040-0.047 | . 0020 | . 0020 | . 0020 | . 0030 | . 0030 | . 0035 |
| 0.048-0.063 | . 0020 | . 0020 | . 0030 | . 0030 | . 0030 | . 0035 |
| 0.064-0.079 | . 0020 | . 0020 | . 0030 | . 0035 | . 0035 | . 0035 |
| 0.080-0.098 | . 0020 | . 0020 | . 0035 | . 0040 | . 0040 | . 0045 |
| 0.099-0.126 | . 0035 | . 0035 | . 0035 | . 0045 | . 0045 | . 0045 |
| 0.127-0.158 | . 0040 | . 0040 | . 0045 | . 007 | . 007 | . 009 |
| 0.159-0.197 | . 0055 | . 007 | . 007 | . 009 | . 009 | . 011 |
| 0.198-0.248 | . 009 | . 012 | . 012 | . 012 | . 017 | . 017 |
| 0.249-0.315 | . 012 | . 015 | . 015 | . 015 | . 019 | . 019 |
| 0.316-0.394 | . 017 | . 018 | . 018 | . 018 | . 022 | . 022 |
| 0.395-0.630 | . 023 | . 023 | . 023 | . 023 | . 028 | . 028 |
| 0.631-0.984 | . 031 | . 031 | . 031 | . 031 | . 037 | . 037 |
| 0.985-1.575 | . 039 | . 039 | . 039 | . 039 | . 047 | . 047 |
| 1.576-2.362 | . 055 | . 055 | . 055 | . 055 | . 060 | . 060 |
| 2.363-3.150 | . 075 | . 075 | . 075 | . 075 | . 085 | . 085 |
| 3.160-3.937 | . 100 | . 100 | . 100 | . 100 | . 115 | . 115 |
| 3.938-6.299 | . 130 | . 130 | . 130 | . 130 | . 145 | . 145 |
|  | Specified Widths through 78.75 Inches |  |  |  |  |  |
|  | $\begin{gathered} \text { Over } \\ 78.74 \\ 86.61 \end{gathered}$ | $\begin{aligned} & \text { Over } \\ & \mathbf{8 6 . 6 1 -} \\ & \mathbf{9 8 . 4 3} \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 98.43- \\ & 118.11 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & 118.11 \\ & 137.80 \end{aligned}$ | $\begin{aligned} & \text { Over } \\ & \text { 137.80- } \\ & 157.48 \end{aligned}$ | $\begin{gathered} \text { Over } \\ 157.48- \\ 177.17 \end{gathered}$ |
| 0.033-0.039 | . 0035 | . 007 | - | - | - | - |
| 0.040-0.047 | . 0035 | . 008 | . 010 | . 011 | - | - |
| 0.048-0.063 | . 0035 | . 009 | . 011 | . 013 | - | - |
| 0.064-0.079 | . 0035 | . 010 | . 013 | . 015 | - | - |
| 0.080-0.098 | . 0045 | . 011 | . 015 | . 018 | - | - |
| 0.099-0.126 | . 0045 | . 013 | . 016 | . 020 | - | - |
| 0.127-0.158 | . 009 | . 015 | . 018 | . 022 | - | - |
| 0.159-0.197 | . 011 | . 018 | . 022 | . 026 | - | - |
| 0.198-0.248 | . 021 | . 021 | . 025 | . 029 | - |  |
| 0.249-0.315 | . 024 | . 024 | . 029 | . 033 | . 041 | . 051 |
| 0.316-0.394 | . 028 | . 028 | . 033 | . 039 | . 047 | . 059 |
| 0.395-0.630 | . 033 | . 033 | . 039 | . 047 | . 059 | . 070 |
| 0.631-0.984 | . 043 | . 043 | . 051 | . 060 | . 070 | . 085 |
| 0.985-1.575 | . 055 | . 055 | . 065 | . 075 | . 090 | . 105 |
| 1.576-2.362 | . 070 | . 070 | . 090 | . 100 | . 115 | - |
| 2.363-3.150 | . 100 | . 100 | . 110 | . 125 | - | - |
| 3.160-3.937 | . 130 | . 130 | . 115 | . 160 | - | - |
| 3.938-6.299 | . 165 | . 165 | - | - | - | - |

${ }^{1}$ When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension.

## MACHINING ALLOWANCES

Experience has shown that it is advisable for purchasers of bars and tubing to make adequate allowances to remove surface imperfections and to specify sizes accordingly.
These allowances require consideration of mill manufacturing practices, the type of steel, the size and length of bars, the tolerances for size, out-of-roundness, and straightness, and the practice used to remove surface metal.
In order to minimize or eliminate the incidence of surface defects on finished parts, and in order to minimize thermal cracking from heat treatment, it is advisable that adequate allowance be made to permit stock removal of not less than the amounts show in the following tables. Also, the minimum recommended stock removal should be made before heat treatment to minimize thermal cracking.

## REGULAR QUALITY ALLOY STEEL HOT ROLLED BARS and SPECIAL QUALITY CARBON STEEL HOT ROLLED BARS

As recommended by the American Iron and Steel Institute

|  | Minimum Machining Allowance Per side (Per Cent of Specified Size) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Non-Resulphurized |  | Resulphurized |  |
|  | 2" and Under | Over <br> 2" | 2" and Under | Over 2" |
| Centerless Turned or Ground | 2.6\% | 1.6\% | 3.4\% | 2.4\% |
| Other than Centerless Turned or Ground | 1.6\% |  | 2.4\% |  |
| Sizes under $5 / 8$ " Diameter, Hex, Square or Thickness | 0.010" Min |  | 0.015" Min |  |

Turned on Centers: Since this operation is dependent upon length and straightness considerations, each item should be negotiated between consumer and supplier.

## TOOL STEEL HOT ROLLED BARS

As recommended by the American Iron and Steel Institute

| As recommended by the American Iron and Steel Institute |  |
| :---: | :---: |
| Nominal Diameter <br> of Bar (inches) | Minimum Machining Allowance <br> Per Side (inches) |
| Up to $1 / 2$ incl. | .016 |
| Over $1 / 2$ to 1 incl. | .031 |
| Over 1 to 2 incl. | .048 |
| Over 2 to 3 incl. | .063 |
| Over 3 to 4 incl. | .088 |
| Over 4 to 5 incl | .112 |
| Over 5 to 6 incl. | .150 |
| Over 6 to 8 incl. | .200 |

## COLD FINISHED ALLOY and CARBON BARS


#### Abstract

Cold Finished bars are produced to closer size tolerances than hot rolled bars and are subjected to more critical inspection standards. Their surface is generally considered to be free from the major types of defects of hot rolled bars such as slivers, scabs, and pronounced rolling defects.

They are not, however, free from such lesser surface discontinuities as light seams and laps and small pits. Decarburization present in hot rolled bars is also present in cold drawn bars since cold drawing does not remove any surface. For Cold Drawn Bars, the following allowances are recommended in order to minimize or eliminate surface discontinuities:


|  | Minimum Recommended Stock Removal from Surface (inches) |  |
| :---: | :---: | :---: |
|  | Up to 5/8" incl. | Over 5/8" for each 1/16" diameter |
| Grades with Free-Machining Additives | . 015 | . 0015 |
| Grades with no Free-Machining Additives | . 010 | . 001 |
| Leaded Grades | . 010 | . 001 |
| Examples: |  |  |
| 1" diameter, 1213, .024" removal from surface (.048" on diameter) |  |  |
| 1" diameter, 1018, .016" removal from surface (.032" on diameter) |  |  |
| 1" diameter, 86L20, .016" | moval from | 32" on diameter) |

For Cold Drawn, Ground, \& Polished Bars, the allowance recommended in order to minimize or eliminate surface discontinuities is $50 \%$ of the above.

## MACHINING ALLOWANCES (Continued)

|  | STAINLESS BAR <br>  <br>  <br> *Minimum Recommended Stock Removal |
| :--- | :---: |
| Cold Drawn; | Rounds - Hexagons - Squares |
| Up to \& Incl. $5 / 16 "$ | .003 per side except 440-C |
| Over $5 / 16 "$ | $1 \%$ of Diameter per Side |

## Centerless Ground:

All Ground **Defect Free** within the Standard Size Tolerances
Example: $1 \frac{1}{1 / 2 "}$ Rd. TOL is $\pm .003$
Material must not have any defect under -. 003

## Rough Turned:

All "R.T." sizes are produced on the plus side.
Material must be defect free on size.
Example: 5" Rd. HR-RT must be defect free at 5"

## HP-A\&P Flats \& Squares and Cold Drawn Flats

*Recommended Machining Allowances

| (B) Removal From Thickness | Each Surface Specified Thickness (D) |  |  |  | (Inches) |
| :--- | :---: | :---: | :---: | :---: | :---: |
| (A) <br> SPECIFIED | $\mathbf{1 / 8 - 1 / \mathbf { 2 } ^ { \prime \prime }}$ | $\mathbf{1 / 2 - 1 "}$ | $\mathbf{1 - 2 "}$ | $\mathbf{2 - 3 "}$ | REMOVAL FROM WIDTH- <br> RACH SURFACE |
| Up to 1" Incl. | .008 | .010 | - | - | .015 |
| Over 1-2" Incl. | .012 | .015 | .031 | - | .031 |
| Over 2-3" Incl. | .015 | .020 | .031 | .047 | .047 |
| Over 3-4" Incl. | .015 | .020 | .031 | .047 | .062 |
| Over 4-6" Incl. | .015 | .020 | .031 | - | .093 |

(A) Select the "Width" first and then read across to
(B) Select the reading - this is the stock removal for the thickness per side
(C) Continue across on same line for the readings for width
(D) As measured form the minimum of the tolerance
*THESE RECOMMENDATIONS ARE BASED ON EXPERIENCE AND DO NOT NECESSARILY CONSTITUTE A GUARANTEE OF CLEAN UP.

# AIRCRAFT QUALITY BARS AND MECHANICAL TUBING <br> Subject to Magnetic Particle (Magnaflux) Inspection 

Bars and Mechanical Tubing produced to meet Aircraft Quality Standards are usually used for critically stressed applications. Special steelmaking practices and techniques are employed to meet the rigid quality imposed by Aerospace Material Specification AMS 2301 for Alloy, and AMS 2303 for Stainless.

The following tables list the minimum recommended stock removal to minimize or eliminate injurious nonmetallic inclusions in accordance with AMS 2301 or AMS 2303.

## BARS

| HOT ROLLED SIZE (Inches) | COLD DRAWN SIZE (Inches) | MINIMUM REMOVAL PER SIDE (Inch) |
| :---: | :---: | :---: |
| $1 / 4$ to $1 / 2$, incl. | $1 / 4$ to $7 / 16$, incl. | . 030 |
| Over $1 / 2$ to $3 / 4$, incl. | Over $7 / 16$ to ${ }^{11 / 16, ~ i n c l . ~}$ | . 045 |
| Over $3 / 4$ to 1 , incl. | Over $11 / 16$ to $15 / 16$, incl. | . 060 |
| Over 1 to $11 / 2$, incl. | Over ${ }^{15 / 16}$ to $1^{7 / 16}$, incl. | . 075 |
| Over $11 / 2$ to 2 , incl. | Over $1^{7 / 166}$ to $115 / 16$, incl. | . 090 |
| Over 2 to $2^{1 / 2}$, incl. | Over $1^{15 / 16}$ to $2^{7 / 16}$, incl. | . 125 |
| Over $2^{1 / 2}$ to $3^{1 / 2}$, incl. | Over $2^{7 / 16}$ to $3^{3 / 8}$, incl. | . 156 |
| Over $3^{11 / 2}$ to $41 / 2$, incl. | Over $33 / 8$ to $43 / 8$, incl. | . 187 |
| Over $41 / 2$ to 6 , incl. |  | . 250 |

## MECHANICAL TUBING

Tubing with nominal wall thicknesses less than .250 " should have $10 \%$ of the wall thickness or .015 ", which ever is less, removed from the OD before heat treatment. Tubing with wall thicknesses .250 " and over should be machined to conform to the following minimum stock removal.

| Machined <br> Outside Diameter <br> (Inches) | Minimum Stock <br> Removal Per <br> Side |
| :--- | :---: |
| $2^{1 / 2}$ and under | .044 |
| Over $2^{11 / 2}$ to $31 / 2$, incl. | .046 |
| Over $3^{11 / 2}$ to $41 / 2$, incl. | .052 |
| Over $41 / 2$ to $51 / 2$ incl. | .057 |
| Over $5^{1 / 2}$ to $61 / 2$, incl. | .064 |
| Over $6^{1 / 2}$ to 8, incl. | .074 |
| Over 8 to 10, incl. | .087 |

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