

## Tolerances for Dimensions and Allowances for Machining and Decarburization

Tool steels are produced on a variety of hammers, rolling mills, and other production units necessitated by the numerous sizes, sections, finishes and type compositions required.

Accuracy of dimensions is influenced by many factors such as whether the steel is hammered or rolled, the composition of steel, the size of the order, the mill design, heating practice, reduction between passes, roll wear, and roll pressure. The cumulative effect of those, as well as other factors, precludes production to exact specified size and requires that provisions be made for variations.

The accompanying tolerance tables indicate the expectancy of dimensional variations. The tables are a compilation of available industry experience on short runs which commonly occur in the manufacture of tool steels or specialty steels. Closer tolerances generally can be met on a hot rolled item manufactured in a quantity sufficient to enable the producer to make mill adjustments after the start of a run.

Table 1  
Hot Rolled Bars  
**Rounds,\* Squares, Octagons,  
Quarter Octagons, Hexagons**  
Size Tolerances

Specified Sizes, In.	Size Tolerances, In.	
	Under	Over
To 1/2, incl.	.005	.012
Over 1/2 to 1, incl.	.005	.016
Over 1 to 1 1/2, incl.	.006	.020
Over 1 1/2 to 2, incl.	.008	.025
Over 2 to 2 1/2, incl.	.010	.030
Over 2 1/2 to 3, incl.	.010	.040
Over 3 to 4, incl.	.012	.050
Over 4 to 5 1/2, incl.	.015	.060
Over 5 1/2 to 6 1/2, incl.	.018	.100
Over 6 1/2 to 8, incl.	.020	.150

\* For high speed steel rounds free of scale and decarburization, see Table 2.

Table 2  
Round Bars, High Speed Steels  
Free of Scale and Decarburization  
Diameter Tolerances

Specified Diameter, In.	Diameter Tolerances, In.	
	Under	Over
1/4 to 5/8, excl.	.0015	.0015
5/8 to 3 1/16, excl.	.000	.004
3 1/16 to 4 1/16, excl.	.000	.006
4 1/16 to 7, excl.	.000	.031

Table 3  
Hot Rolled Flats  
Width and Thickness Tolerances

Width Tolerances

Specified Widths, In.	Width Tolerances, In.	
	Under	Over
To 1, incl.	.016	.031
Over 1 to 3, incl.	.031	.047
Over 3 to 5, incl.	.047	.063
Over 5 to 6	.063	.094

# Crucible Tool Steel and Specialty Alloy Selector

## Thickness Tolerances

### Thickness Tolerances for Thicknesses Given, In.

Specified Widths, In.	To $\frac{1}{4}$ , incl.	
	Under	Over
To 1, incl.	.006	.010
Over 1 to 2, incl.	.006	.014
Over 2 to 3, incl.	.006	.018
Over 3 to 4, incl.	.008	.020
Over 4 to 5, incl.	.010	.020
Over 5 to 6, incl.	.012	.020
Specified Widths, In.	Over $\frac{1}{4}$ to $\frac{1}{2}$ , incl.	
	Under	Over
To 1, incl.	.008	.012
Over 1 to 2, incl.	.008	.016
Over 2 to 3, incl.	.008	.020
Over 3 to 4, incl.	.010	.022
Over 4 to 5, incl.	.012	.024
Over 5 to 6, incl.	.014	.030
Specified Widths, In.	Over $\frac{1}{2}$ to 1, incl.	
	Under	Over
To 1, incl.	.010	.016
Over 1 to 2, incl.	.010	.020
Over 2 to 3, incl.	.010	.024
Over 3 to 4, incl.	.013	.024
Over 4 to 5, incl.	.015	.030
Over 5 to 6, incl.	.018	.030
Specified Widths, In.	Over 1 to 2, incl.	
	Under	Over
To 1, incl.	—	—
Over 1 to 2, incl.	.020	.024
Over 2 to 3, incl.	.020	.027
Over 3 to 4, incl.	.024	.030
Over 4 to 5, incl.	.027	.035
Over 5 to 6, incl.	.030	.035

**Table 4**  
**Forged Bars**  
**Rounds, Squares, Octagons, Hexagons**  
**Size Tolerances**

<b>Specified Sizes, In.</b>	<b>Size Tolerances, In.</b>	
	<b>Under</b>	<b>Over</b>
Over 1 to 2, incl.	.030	.060
Over 2 to 3, incl.	.030	.080
Over 3 to 5, incl.	.060	.125
Over 5 to 7, incl.	.125	.187
Over 7 to 10	.187	.312

*Note:* Refer to Table 2 for diameter tolerances on rounds of high speed steels free of scale and decarburization.

**Table 5**  
**Forged Flats**  
**Width Tolerances**

<b>Specified Widths, In.</b>	<b>Width Tolerances, In.</b>	
	<b>Under</b>	<b>Over</b>
Over 1 to 3, incl.	.031	.078
Over 3 to 5, incl.	.062	.125
Over 5 to 7, incl.	.125	.187
Over 7 to 9	.187	.312

**Thickness Tolerances**

**Thickness Tolerances for Thicknesses Given, In.**

<b>Specified Widths, In.</b>	<b>To 1, Incl.</b>	
	<b>Under</b>	<b>Over</b>
Over 1 to 3, incl.	.016	.031
Over 3 to 5, incl.	.031	.062
Over 5 to 7, incl.	.047	.094
Over 7 to 9	.062	.125

<b>Specified Widths, In.</b>	<b>Over 1 to 3, Incl.</b>	
	<b>Under</b>	<b>Over</b>
Over 1 to 3, incl.	.031	.078
Over 3 to 5, incl.	.047	.094
Over 5 to 7, incl.	.062	.125
Over 7 to 9	.078	.156

Specified Widths, In.	Over 3 to 5, Incl.	
	Under	Over
Over 1 to 3, incl.	—	—
Over 3 to 5, incl.	.062	.125
Over 5 to 7, incl.	.078	.156
Over 7 to 9	.094	.187

Specified Widths, In.	Over 5 to 7, Incl.	
	Under	Over
Over 1 to 3, incl.	—	—
Over 3 to 5, incl.	—	—
Over 5 to 7, incl.	.125	.187
Over 7 to 9	.156	.219

Specified Widths, In.	Over 7 to 10, Incl.	
	Under	Over
Over 1 to 3, incl.	—	—
Over 3 to 5, incl.	—	—
Over 5 to 7, incl.	—	—
Over 7 to 9	.187	.312

Table 6  
 Straightened  
 Hot Rolled Annealed Bars or  
 Cold Finished Bars

Straightness Tolerances

This table does not apply to flat bars having a width to thickness ratio of 6 to 1 or greater.

Measurement is taken on the concave side of the bar with a straight edge. Bars are furnished to the following straightness tolerances.

*Hot rolled bars:*

1/8 inch in any 5 feet, but may not exceed

$$1/8 \text{ inch} \times \frac{\text{no. of feet in length}}{5}$$

The foregoing formula applies also to bars under 5 feet in length.

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*Cold finished bars:*

1/16 inch in any 5 feet, but may not exceed

$$1/16 \text{ inch} \times \frac{\text{no. of feet in length}}{5}$$

The foregoing formula applies also to bars under 5 feet in length.

Table 7  
Hot Rolled or Forged Bars  
and Billets

Tolerances for Machine Cut Lengths

Specified Sizes Apply to Rds., Sqs., Hexs., Octagons and Widths of Flats, In.	Tolerances for Specified Length, 14 Ft. Max., In.	
	Under	Over
To 9, incl.	3/8	0
Over 9 to 12, incl.	1/2	0
Over 12 to 18, incl.	3/4	0
Over 18 to 20	1	0

Table 8  
Drill Rod  
Rounds, Polished or Ground  
Size Tolerances

Size Range, In.	Standard Manufacturing Tolerance, In. Plus and Minus	Closer Tolerance, In. Plus and Minus
Up to .124, incl.	.0003	.0002
.125 to .499, incl.	.0005	.00025
.500 to 1.500, incl.	.001	.0005

Table 9  
Drill Rod  
Shapes Other Than Rounds, Cold Drawn  
Size Tolerances

Size Range, In.	Tolerance, In. Plus and Minus
Up to 1/4, excl.	.0005
1/4 to 3/4, excl.	.001
3/4 to 1, incl.	.0015

Table 10  
Centerless Ground Bars  
**Rounds**  
Diameter Tolerances

Diameter Range, In.	Tolerance, In.	
	Under	Over
$1/4$ to $1/2$ excl.	.0015	.0015
$1/2$ to $3 1/16$ excl.	.002	.002

Table 11  
Cold Drawn Bars  
**Rounds, Octagons, Quarter Octagons  
and Hexagons**  
Size Tolerances

Size Range, In.	Tolerance, In. Plus and Minus
$1/4$ to $1/2$ , excl.	.002
$1/2$ to 1, excl.	.0025
1 to $2 3/4$ , incl.	.003

Table 12  
Cold Drawn Bars  
**Squares and Flats**  
Size Tolerances

Size Range, In.	Tolerance, In. Plus and Minus
$1/4$ to $3/4$ , incl.	.002
Over $3/4$ to $1 1/2$ , incl.	.003
Over $1 1/2$ to 3, incl.	.004

Table 13  
Forgings  
**Allowances for Machining; Tolerances Over  
Allowances**

Unmachined tool steel forgings are furnished to size and surface allowances for machining and tolerances over allowances. Experience indicates that the allowances and tolerances in the tabulation below are satisfactory for many applications. When

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width and thickness differ, each dimension carries its individual allowance and tolerance in accordance with the tabulation; also, the ID and OD take their respective allowances and tolerances.

When forgings are ordered, the purchaser should state whether the sizes are the forged or the finished sizes. Minimum ordered forged sizes should be the finished sizes plus allowances for machining; and the ordered forged sizes are subject to applicable tolerances.

Finished Size Diameter or Distance Between Parallel Faces, or Both	Allowance For Machining Over Finished Size	Tolerance Over the Allowance	
		Plus	Minus
Up to 3, incl.	1/8	1/8	0
Over 3 to 5, incl.	3/16	3/16	0
Over 5 to 7, incl.	5/16	5/16	0
Over 7 to 12, incl.	3/8	3/8	0
Over 12 to 18, incl.	1/2	1/2	0

Ring forgings: for the OD, use the same allowances and tolerances shown in the above tabulation; for the ID, double the tolerances shown in the above tabulation.

Tables 14-17  
 Minimum Allowances for  
 Machining and Maximum  
 Decarburization Limits

Machining Allowances is the Total Stock Removal recommended for the purpose of preparing a tool surface free from decarburization, scale seams, or any other imperfections which might adversely affect the heat treatment or properties of the steel.

Decarburization is the loss of carbon at the surface of tool steel bars, forgings and other forms resulting from oxidation at exposed surfaces during heating for production operations.

Table 14  
 Minimum Allowances for Machining  
 and  
 Maximum Decarburization Limits  
**Rounds, Hexagons and Octagons**

Minimum Allowances for Machining  
 Minimum Allowance Per Side for Machining Prior  
 to Heat Treatment, Inch

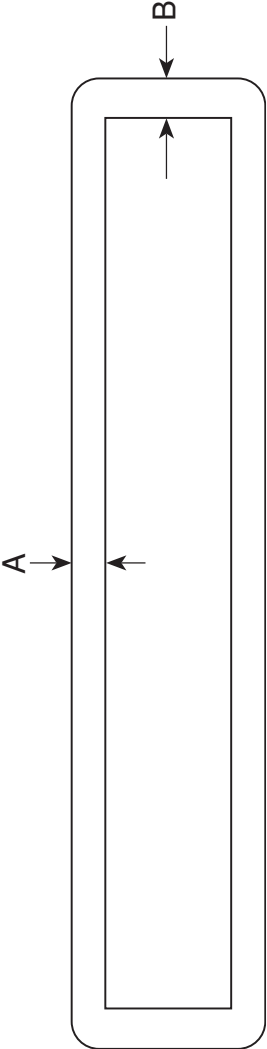
Ordered Size, Inches	Hot Rolled	Forged	Rounds Rough Turned	Cold Drawn
Up to 1/2, incl.	.016	—	—	.016
Over 1/2 to 1, incl.	.031	—	—	.031
Over 1 to 2, incl.	.048	.072	—	.048
Over 2 to 3, incl.	.063	.094	.020	.063
Over 3 to 4, incl.	.088	.120	.024	.088
Over 4 to 5, incl.	.112	.145	.032	—
Over 5 to 6, incl.	.150	.170	.040	—
Over 6 to 8, incl.	.200	.200	.048	—

Maximum Decarburization Limits  
 80 Per cent of above allowances per side.

Note: Rounds 1/4 in. and over of high speed steel are normally furnished free of scale and decarburization.

Table 15  
Minimum Allowances for Machining and  
Maximum Decarburization Limits

Hot Rolled Square and Flat Bars



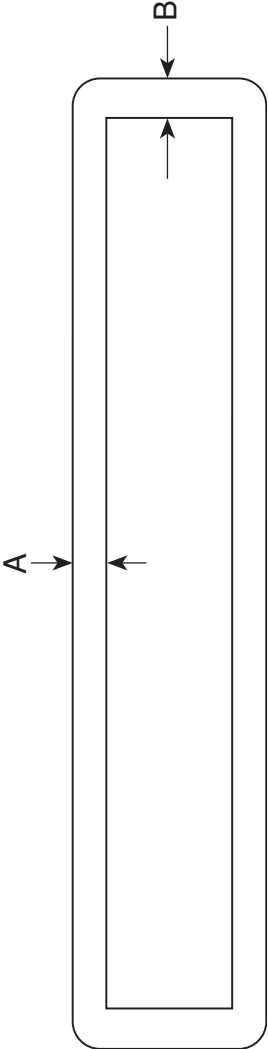
## Minimum Allowance Per Side for Machining Prior to Heat Treatment, Inch

Thickness, Inches	Ordered Width, Inches											
	0 to 1/2 incl.	Over 1/2 to 1 incl.	Over 1 to 2 incl.	Over 2 to 3 incl.	Over 3 to 4 incl.	Over 4 to 5 incl.	Over 5 to 6 incl.	Over 6 to 7 incl.	Over 7 to 8 incl.	Over 8 to 9 incl.	Over 9 to 12 incl.	
0 to 1/2, incl.	A	.025	.030	.035	.040	.044	.050	.055	.060	.060	.060	
	B	.025	.040	.048	.055	.068	.078	.082	.098	.102	.120	
Over 1/2 to 1, i incl.	A	—	.045	.044	.050	.055	.065	.070	.075	.075	.075	
	B	—	.045	.058	.070	.080	.102	.112	.122	.128	.135	
Over 1 to 2, incl.	A	—	.065	.065	.070	.070	.075	.075	.080	.085	.090	
	B	—	.065	.070	.075	.090	.108	.122	.140	.148	.152	
Over 2 to 3, incl.	A	—	—	.080	.080	.085	.085	.090	.090	.100	.100	
	B	—	—	.080	.090	.102	.118	.138	.152	.162	.170	
Over 3 to 4, incl.	A	—	—	—	.100	.100	.108	.115	.118	.125	.125	
	B	—	—	—	.100	.112	.125	.150	.165	.165	.170	

Maximum Decarburization Limits  
80 Per cent of above allowances per side

Table 16  
Minimum Allowances for Machining and  
Maximum Decarburization Limits

Forged Square and Flat Bars



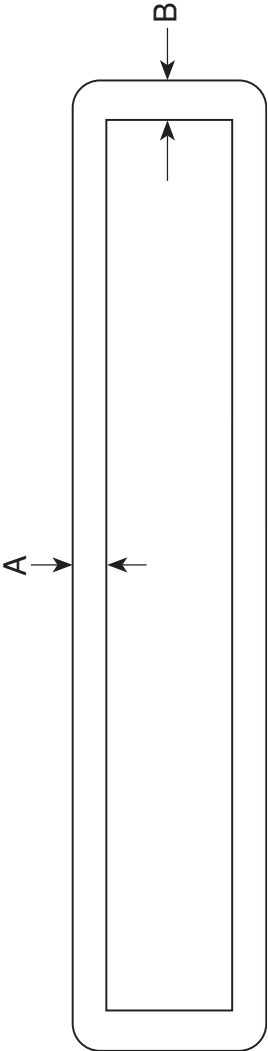
Minimum Allowance Per Side for Machining Prior to Heat Treatment, Inch

Thickness, Inches	Ordered Width, Inches									
	Over 1 to 2 incl.	Over 2 to 3 incl.	Over 3 to 4 incl.	Over 4 to 5 incl.	Over 5 to 6 incl.	Over 6 to 7 incl.	Over 7 to 8 incl.	Over 8 to 9 incl.	Over 9 to 10 incl.	Over
Over 1/2 to 1, incl.	A .048	.052	.060	.065	.070	.078	.082	.090	.100	.100
	B .060	.070	.088	.100	.118	.138	.165	.165	.165	.165
Over 1 to 2, incl.	A .072	.078	.082	.088	.092	.100	.105	.118	.133	.133
	B .072	.082	.098	.108	.125	.142	.165	.165	.165	.165
Over 2 to 3, incl.	A —	.100	.105	.110	.115	.122	.133	.143	.158	.158
	B —	.100	.115	.122	.133	.148	.170	.170	.170	.170
Over 3 to 4, incl.	A —	—	.128	.133	.140	.150	.165	.175	.198	.198
	B —	—	.128	.133	.140	.150	.165	.175	.198	.198
Over 4 to 5, incl.	A —	—	—	.158	.162	.172	.182	.195	.212	.212
	B —	—	—	.158	.162	.172	.182	.195	.212	.212
Over 5 to 6, incl.	A —	—	—	—	.188	.198	.208	.220	.235	.235
	B —	—	—	—	.188	.198	.208	.220	.235	.235
Over 6 to 8 incl.	A —	—	—	—	—	.220	.232	.232	.250	.250
	B —	—	—	—	—	.220	.232	.232	.250	.250
Over 8 to 10, incl.	A —	—	—	—	—	—	—	.250	.250	.250
	B —	—	—	—	—	—	—	.250	.250	.250

Maximum Decarburization Limits  
80 Per cent of above allowances per side

Table 17  
Minimum Allowances for Machining and  
Maximum Decarburization Limits

Cold Drawn Square and Flat Bars



## Minimum Allowance Per Side for Machining Prior to Heat Treatment, Inch

Thickness, Inches	Ordered Width, Inches									
	Over 0 to 1/2 incl.	Over 1/2 to 1 incl.	Over 1 to 2 incl.	Over 2 to 3 incl.	Over 3 to 4 incl.	Over 4 to 5 incl.	Over 5 to 5 incl.			
0 to 1/2, incl.	A	.048	.052	.060	.065	.070	.078	.082		
	B	.025	.032	.040	.048	.055	.068	.078		
Over 1/2 to 1, incl.	A	-	.045	.045	.044	.050	.055	-		
	B	-	.045	.052	.058	.070	.080	-		
Over 1 to 2, incl.	A	-	-	.065	.065	.070	-	-		
	B	-	-	.065	.070	.075	-	-		

## Maximum Decarburization Limits

80 Per cent of above allowances per side