Alloys & Tool Steel

Bar and Plate Products

WARNING: These products can potentially expose you to chemicals including Nickel, Chromium, Lead, Cobalt, Mercury and Beryllium, which are known to the state of California to cause cancer and/or birth defects or other reproductive harm. For more information, visit **www.P65Warnings.ca.gov**

Toolox®44

Pre-hardened Steel 45 HRC with ESR Properties

Toolox® 44 is a highly engineered quench & tempered pre-hardened tool and machine steel with measured and guaranteed mechanical properties. Toolox® 44 is delivered ready to use, no heat treating required, saving you valuable production time, reducing risks and lowering overall costs.

Toolox® has ESR properties. The casting process along with the low carbon concept gives a high degree of cleanliness and a homogenious structure.

The high hardness, in combination with excellent toughness, ensures lower tool wear. Toolox® 44 is two to three times tougher than comparable steels of similar hardness.
Additional product features include:

- Easy to machine with good dimensional stability
- High strength and toughness at esevated temperatures
- Excellent for etching, polishing and EDM
- Low residual stresses, no stress relieving required
- Excellent substrate for surface treatments

Typical Applications

Cold Work Tooling, Machine Components, Wear Components, Guide Rails, Plastic Molds, Rubber Molds, Press Forming, Dies (Forging, Die Cast)

Typical Analysis	Toolox® 44
Carbon (C)	0.32%
Silicon (Si)	0.60 - 1.10%
Manganese (Mn)	0.80%
Chromium (Cr)	1.35%
Molybdenum (Mo)	0.80%
Vanadium	0.14%

Mechanical Properties	+20°C	+200°C	+300°C	+400°C	+500°C
Hardness (HBW)	450				
Hardness (HRC)	~45				
Yield Strength $R_{P0.2}$ (MPa)	1,300	1,150	1,120	1,060	930
Tensile Strength RM (MPa)	1,450	1,380			
Elongation, A5, (%)	13	10			
Impact toughness, Charpy-V (J)	30	60	80	80	

Note: Toolox®44 is not intended for further heat treatment. If Toolox® 44 is heated above 590° after delivery from Alro, no guarantees for the properties of the steel are given.

Thickness (inches)	Weight (lbs./sqft)
5/8	25.524
3/4	30.629
7/8	35.735
1	49.008
1-1/2	69.428

Thickness (inches)	Weight (lbs./sqft)
2	89.848
2-1/2	110.628
3	130.688
4	164.585
5	209.100

ETD 150®

E.T.D. 150® is produced from AISI medium carbon 4100 series alloy steel. The heats to be used for e.t.d. 150® are controlled to contain nitrogen in quantities normally associated with steel produced by the electric furnace process. Only one additive, such as tellurium, selenium, or sulfur is also added to improve machinability.

Like Fatigue-Proof®, it is another Niagara LaSalle high strength material made by using specially designed dies. It eliminates heat treating and secondary operations such as straightening, finish grinding, cleaning, and inspections. e.t.d.® 150® can be roll threaded, knurled and plated. Suitable for induction hardening, e.t.d.® 150® is also electromagnetically tested using eddy currents and pretested for machinability through Niagara LaSalle's unique testing procedure.

Typical Analysis*	ETD 150®
Carbon (C)	0.40 Min
Manganese (Mn)	0.70 / 1.10
Silicon (Si)	0.15 / 0.35
Chromium (Cr)	0.80 / 1.20
Molybdenum (Mo)	0.15 / 0.25

Mechanical Properties

Tensile Strength.....**150,000 psi (Min)
Yield Strength (.2% offset)..... 130,000psi (Min)
Elongation ..... 5% Min
Reduction of Area..... 20% Min
Machinability.....75% of 1212 (approx)
Rockwell C Hardness ..... **32 (Min)
Brinell Hardness ..... **302 (Min)

ETD 150® contains additives for improving machinability. These may be Tellurium, Selenium, Sulphur (.06 max), or others, separately or in combination.

****In the event of disagreement between hardness and tensile strength, the tensile strength shall govern.***

ETD 150® Rounds

Stock Lengths: 12 foot

Size (inches)	Weight (lbs./foot)	Weight (lbs./12 ft.)
1/2	0.670	8.04
9/16	0.850	10.20
5/8	1.040	12.48
11/16	1.260	15.12
3/4	1.500	18.00
13/16	1.760	21.12
7/8	2.040	24.48
1	2.670	32.04
1-1/16	3.014	36.17
1-1/8	3.379	40.55
1-3/16	3.770	45.24
1-1/4	4.170	50.04
1-3/8	5.050	60.60
1-1/2	6.010	72.12
1-5/8	7.050	84.60
1-3/4	8.170	98.04
1-7/8	9.390	112.68
2	10.680	128.16
2-1/8	12.06	144.72
2-1/4	13.52	162.24
2-3/8	15.06	180.72
2-1/2	16.69	200.28
2-5/8	18.40	220.80
2-3/4	20.19	242.28
2-7/8	22.07	264.84
3	24.03	288.36
3-1/4	28.21	338.52
3-3/8	30.42	365.04
3-1/2	32.71	392.49

AISI 4140/41L40 - Annealed

HR / CF (Also available in DCF)

This medium carbon alloy grade is widely used for many general purpose parts requiring high tensile strength and toughness. 4140 contains chromium and molybdenum as alloying elements and may be heat treated over a wide range to give the combined advantages of proper hardness, strength and ductility. In conditions where localized hardness may be required, this steel is readily flame or induction hardened.

Typical Analysis	AISI 4140 / 41L40
Carbon (C)	0.38 / 0.43
Manganese (Mn)	0.75 / 1.00
Silicon (Si)	0.15 / 0.30
Molybdenum (Mo)	0.15 / 0.25
Chromium (Cr)	0.80 / 1.10
Phosphorus (P)	0.035 MAX
Sulphur (S)	0.040 MAX
*Lead	0.15 / 0.35

Applies only to 4140 leaded alloy steel bars.

AISI 4140 - Annealed Flats & Squares

HR (Cut From Plate) (Also available in DCF)

Size (inches)	Weight (lbs./foot)
3/8 x	
3/8	0.594
1/2	0.765
5/8	0.935
3/4	1.105
1	1.446
1-1/4	1.786
1-1/2	2.126
1-3/4	2.467
2	2.807
2-1/4	3.147
2-1/2	3.488
2-3/4	3.827
3	4.168
3-1/2	4.849
4	5.530
6	8.252
1/2 x	
1/2	1.004
5/8	1.227
3/4	1.451
1	1.897
1-1/4	2.344
1-1/2	2.791
1-3/4	3.237
2	3.684
2-1/4	4.131
2-1/2	4.577
2-3/4	5.024
3	5.471
3-1/2	6.364
4	7.257
4-1/2	8.151
5	9.044
6	10.831
7	12.618
8	14.404
10	17.978
12	21.551
16	28.697
20	35.844
24	42.991
5/8 x	
5/8	1.520
3/4	1.796
1	2.349
1-1/4	2.902
1-1/2	3.455
1-3/4	4.008
2	4.561

Size (inches)	Weight (lbs./foot)
5/8 x	
2-1/4	5.114
2-1/2	5.667
2-3/4	6.220
3	6.773
3-1/2	7.879
4	8.985
4-1/2	10.092
5	11.198
6	13.410
8	17.834
10	22.257
12	26.682
16	35.530
20	44.378
24	53.227
3/4 x	
3/4	2.141
1	2.801
1-1/4	3.460
1-1/2	4.120
1-3/4	4.779
2	5.438
2-1/4	6.098
2-1/2	6.757
2-3/4	7.417
3	8.076
3-1/2	9.395
4	10.713
4-1/2	12.032
5	13.351
6	15.988
8	21.263
10	26.538
12	31.813
16	42.363
20	52.913
24	63.463
1 x	
1	3.704
1-1/8	4.141
1-1/4	4.577
1-1/2	5.449
1-3/4	6.321
2	7.193
2-1/4	8.065
2-1/2	8.937
2-3/4	9.809
3	10.681
3-1/2	12.425

Size (inches)	Weight (lbs./foot)
1 x	
4	14.169
4-1/2	15.914
5	17.658
6	21.146
8	28.123
10	35.099
12	42.076
16	56.028
20	69.981
24	83.934
1-1/4 x	
1-1/4	5.692
1-1/2	6.778
1-3/4	7.862
2	8.947
2-1/4	10.032
2-1/2	11.117
2-3/4	12.201
3	13.286
3-1/2	15.456
4	17.625
4-1/2	19.795
5	21.964
6	26.304
8	34.982
10	43.660
12	52.338
16	69.694
20	87.050
24	104.406
1-1/2 x	
1-1/2	8.106
2	10.702
2-1/4	11.999
2-1/2	13.296
2-3/4	14.594
3	15.891
3-1/2	18.486
4	21.081
4-1/2	23.676
5	26.271
6	31.461
8	41.841
10	52.221
12	62.600
16	83.359
20	104.119
24	124.878

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate.
Weights above include nominal oversize tolerance. Actual weights may vary.

Continued on next page

AISI 4140 - Annealed Flats & Squares

HR (Cut from plate) (Also available in DCF)

Size (inches)	Weight (lbs./foot)
1-3/4 x	
1-3/4	10.945
2	12.456
2-1/2	15.476
3	18.497
4	24.537
4-1/2	27.557
5	30.578
6	36.619
8	48.700
10	60.781
12	72.862
16	97.025
20	121.188
24	145.350
2 x	
2	14.210
2-1/4	15.933
2-1/2	17.656
2-3/4	19.379
3	21.102
3-1/2	24.547
4	27.993
4-1/2	31.438
5	34.885
6	41.776
8	55.559
9	62.451
10	69.342
12	83.125
16	110.690
20	138.257
24	165.822
2-1/4 x	
2-1/4	17.900
2-1/2	19.836

Size (inches)	Weight (lbs./foot)
2-1/4 x	
2-3/4	21.771
3	23.707
3-1/2	27.578
4	31.449
4-1/2	35.320
5	39.191
5-1/2	43.063
6	46.934
8	62.418
10	77.903
12	93.387
16	124.357
20	155.326
24	165.823
2-1/2 x	
2-1/2	22.015
2-3/4	24.164
3	26.312
3-1/2	30.609
4	34.905
4-1/2	39.202
5	43.498
5-1/2	47.795
6	52.091
8	69.277
10	86.464
12	103.650
16	138.022
20	172.394
24	206.767
3 x	
3	31.522
3-1/2	36.670
4	41.817
4-1/2	46.964

Size (inches)	Weight (lbs./foot)
3 x	
5	52.112
6	62.406
8	82.996
10	103.585
12	124.174
16	165.353
20	206.532
24	247.711
3-1/2 x	
3-1/2	42.730
4	48.525
4-1/2	54.523
5	60.521
5-1/2	66.723
6	72.518
8	96.510
10	120.502
12	144.495
16	192.480
20	240.465
24	288.451
4 x	
4	55.408
4-1/2	62.257
5	69.106
5-1/2	75.955
6	82.804
8	110.199
10	137.595
12	164.991
16	219.782
20	274.574
24	329.366

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Sizes not listed above can be cut from plate.

AISI 4140 - Annealed Rounds

HR (Also available in DCF)

Diameter (inches)	Weight (lbs./foot)
5/8	1.044
3/4	1.500
7/8	2.040
1	2.676
1-1/8	3.384
1-1/4	4.176
1-3/8	5.052
1-1/2	6.012
1-5/8	7.056
1-3/4	8.172
1-7/8	9.384
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2-1/2	16.896
2-5/8	18.724
2-3/4	20.533
2-7/8	22.426
3	24.409
3-1/8	26.463
3-1/4	28.872
3-3/8	31.111

Diameter (inches)	Weight (lbs./foot)
3-1/2	33.434
3-5/8	36.070
3-3/4	38.568
4	43.814
4-1/4	49.394
4-1/2	55.309
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/4	145.202
7-1/2	155.224
7-3/4	165.580
8	176.275
8-1/4	187.296
8-1/2	199.737
8-3/4	211.463

Diameter (inches)	Weight (lbs./foot)
9	223.522
9-1/4	235.501
9-1/2	248.207
9-3/4	263.735
10	277.171
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
12-1/2*	429.889
13*	466.624
13-1/2*	502.591
14*	539.893
14-1/2*	578.531
15*	618.503
15-1/2*	659.811
16*	702.454
17*	791.746
18*	886.378
19*	986.351
20*	1091.664
22*	1318.314
24*	1566.326

** Sizes above 12" are 16-20' randoms, forged and roughturned.*
Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 20 foot

AISI 4140 Rounds - Q&T

Typical Analysis	AISI 4140
Carbon (C)	0.37 / 0.49
Manganese (Mn)	0.65 / 1.10
Silicon (Si)	0.15 / 0.35
Molybdenum (Mo)	0.15 / 0.25
Chromium (Cr)	0.75 / 1.20
Sulphur (S)	.040 MAX
Phosphorus (P)	.035 MAX
Tensile Strength	approx. 110,000 lbs psi
Yield Point	approx. 85,000 lbs psi
Brinell Hardness	269 - 321
Rockwell C	28 - 34
Elongation in 2"	16%
Reduction in Area	50%

AISI 4140 - Rounds

HR Q&T

Diameter (inches)	Weight (lbs./foot)
3/4	1.500
7/8	2.040
1	2.670
1-1/8	3.379
1-1/4	4.170
1-3/8	5.048
1-1/2	6.010
1-5/8	7.050
1-3/4	8.180
1-7/8	9.387
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2-1/2	16.896
2-5/8	18.724
2-3/4	20.533
2-7/8	22.426
3	24.645
3-1/4	28.872
3-1/2	33.434
3-3/4	38.568

Diameter (inches)	Weight (lbs./foot)
4	43.814
4-1/4	49.394
4-1/2	55.309
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/4	145.202
7-1/2	155.224
7-3/4	165.580
8	176.275
8-1/4	187.296
8-1/2	199.737
9	223.522
9-1/2	248.207

Diameter (inches)	Weight (lbs./foot)
10	277.171
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
13	466.624
13-1/2	502.591
14	539.893
14-1/2	578.531
15	618.503
15-1/2	659.811
16	702.454
18	886.378
20	1091.664
22	1318.314
23	1435.275
24	1566.326
26	1826.400

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 20 foot randoms, Bars over 10-1/2" diameter are forged.

AISI 4140 and 41L40* Annealed Rounds

Cold Finished

Diameter (inches)	Weight (lbs./foot)
3/16	0.100
1/4	0.170
5/16	0.261
3/8	0.380
7/16	0.510
1/2	0.668
9/16	0.845
5/8	1.043
11/16	1.261
3/4	1.500
13/16	1.763
7/8	2.044
15/16	2.347
1	2.670
1-1/16	3.010

Diameter (inches)	Weight (lbs./foot)
1-1/8	3.379
1-3/16	3.770
1-1/4	4.172
1-5/16	4.600
1-3/8	5.048
1-7/16	5.517
1-1/2	6.008
1-9/16	6.519
1-5/8	7.050
1-3/4	8.177
1-7/8	9.387
1-15/16	10.023
2	10.680
2-1/8	12.057
2-1/4	13.517

Diameter (inches)	Weight (lbs./foot)
2-3/8	15.060
2-1/2	16.688
2-9/16	17.532
2-5/8	18.398
2-3/4	20.192
2-7/8	22.069
3	24.030
3-1/4	28.202
3-1/2	32.708
3-3/4	37.547
4	42.720
4-1/4	48.227
4-1/2	54.068
5	66.750

Refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 12 foot (20 foot available in most sizes).
**41L40 is a superior free machining direct hardening alloy (Lead of .15/.35).*

AISI 4140/4142 Q&T Rounds

Cold Finish T&P

4140/4142 CF Q&T SR is a general purpose alloy used where substantial strength, toughness and hardness are required. Through tempering, quenching and the cold-finishing process, the end result is improved strength and ductility, improved toughness, better fatigue resistance and superior surface condition.

4140 CF Q&T SR Rounds are also calcium-treated for improved machinability and fully stress relieved after drawing so that distortion during machining is held to a minimum.

AISI 4140 Quench & Tempered Rounds

Cold Finish T&P

Diameter (inches)	Length (feet)	Weight (lbs./foot)
3/8	12	.375
1/2	12	.667
5/8	12	1.042
3/4	12	1.501
7/8	20	2.044
1	20	2.670
1-1/8	20	3.379
1-3/16	20	3.765
1-1/4	20	4.171
1-3/8	20	5.047
1-7/16	20	5.510
1-1/2	20	6.007
1-5/8	20	7.050
1-3/4	20	8.176
1-7/8	20	9.387
1-15/16	20	10.020
2	20	10.680

Diameter (inches)	Length (feet)	Weight (lbs./foot)
2-3/16	20	12.776
2-1/4	20	13.516
2-7/16	20	15.863
2-1/2	20	16.687
2-11/16	20	19.277
2-3/4	20	20.191
2-15/16	20	23.031
3	20	24.030
3-1/4	20	28.202
3-7/16	20	31.541
3-1/2	20	32.707
3-15/16	20	41.384
4	20	42.720
4-7/16	20	52.564
4-1/2	20	54.080
5	20	66.750
6	20	96.120

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Stock Lengths: 12 foot randoms.

AISI 4140 Annealed Squares

Cold Finish

Size (inches)	Weight (lbs./foot)
3/8	0.478
1/2	0.850
5/8	1.328
3/4	1.913
7/8	2.603

Size (inches)	Weight (lbs./foot)
1	3.400
1-1/8	4.303
1-1/4	5.313
1-1/2	7.650

Size (inches)	Weight (lbs./foot)
1-3/4	10.413
2	13.600
2-1/2	21.250
3	30.600

AISI 4140 Annealed Hexagons

Cold Finish

Size (inches)	Weight (lbs./foot)
3/8	0.413
7/16	0.563
1/2	0.735
9/16	0.930
5/8	1.148
11/16	1.300
3/4	1.654
13/16	1.953
7/8	2.251

Size (inches)	Weight (lbs./foot)
15/16	2.584
1	2.940
1-1/16	3.324
1-1/8	3.721
1-1/4	4.594
1-3/8	5.558
1-7/16	6.085
1-1/2	6.625

Size (inches)	Weight (lbs./foot)
1-5/8	7.763
1-3/4	9.004
1-7/8	10.350
2	11.780
2-1/4	14.910
2-1/2	18.400
2-3/4	22.220
3	26.500

Please refer to pages 8-32 thru 8-33 for alloy tolerances.

Stock Lengths: 12 foot randoms

AISI 4140 Annealed Flats

Cold Finish

Size (inches)	Weight (lbs./foot)
1/4 x	
1-1/2	1.28
2	1.70
3	2.55
3/8 x	
1	1.28
1-1/4	1.59
1-1/2	1.91
2	2.55
3	3.83
3-1/2	4.46
4	5.10
1/2 x	
1	1.70
1-1/2	2.55
2	3.40
2-1/2	4.25
3	5.10
4	6.80
4-1/2	7.65
5	8.50
6	10.20
5/8 x	
1	2.13
2	4.25
2-1/2	5.31
3	6.77
4	8.50
5	10.63
6	12.75

Size (inches)	Weight (lbs./foot)
3/4 x	
1	2.55
1-1/4	3.19
1-1/2	3.83
2	5.10
2-1/2	6.38
3	7.65
4	10.20
5	12.75
6	15.30
1 x	
1-1/4	4.25
1-1/2	5.10
1-3/4	5.95
2	6.80
2-1/2	8.50
3	10.20
3-1/2	11.90
4	13.60
5	17.00
6	20.40
7	23.80
8	27.20
1-1/4 x	
1-1/2	6.38
2	8.50
2-1/4	9.56
3	12.75
3-1/2	14.88
4	17.00
4-1/2	19.13

Size (inches)	Weight (lbs./foot)
1-1/4 x	
5	21.25
6	25.50
1-1/2 x	
2	10.20
2-1/2	12.75
3	15.30
3-1/2	17.84
4	20.40
5	25.50
6	30.60
2 x	
2-1/2	17.00
3	20.40
3-1/2	23.80
4	27.20
5	34.00
6	40.80
2-1/2 x	
4	34.00
3 x	
4	40.80
5	51.00

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

AISI 4140/4142 (MOD) DCF

Medium Carbon Alloy, Pre-Hardened (Cut From Plate)

Also available in HR

4140/4142 is a fine pre-hardened alloy steel, ready for use and is machinable in its hardened state 260/321 Brinell for thickness under 3" and 241/321 Brinell for 3" and over.

Typical Applications

Strippers, Holder Blocks, Mold Bases, Ejectors, Back Up and Support Tooling, Fixtures, Jigs, Molds, Cams, and many more applications where time and money are important considerations.

Typical Analysis	AISI 4140/4142 (MOD)
Carbon (C)	0.36 / 0.46
Manganese (Mn)	0.70 / 1.70
Silicon (Si)	0.15 / 0.45
Molybdenum (Mo)	0.15 / 0.35
Chromium (Cr)	0.75 / 1.20
Phosphorus (P)	0.035 max.
Sulphur (S)	0.040 max.
Nickel (Ni)	0.50 max.
Tempering	
Tempering temperature	
Approx. tempered hardness, Rockwell C	26-34
Wear Resistance	Medium
Toughness	Very High
Resistance to Softening Effect of Elevated	
Temperature	Low
Depth of Hardening	Medium
Machinability	Medium
Grindability	High

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

AISI 4140/4142 (MOD) - Flats & Squares

Pre-Hardened DCF, HR Pre-Hardened, Annealed DCF and HR Annealed (Cut from Plate)

Size (inches)	Weight (lbs./foot)
1/4 x	
1/2	0.540
5/8	0.657
3/4	0.774
1	1.008
1-1/8	1.125
1-1/4	1.242
1-1/2	1.476
1-3/4	1.710
2	1.944
2-1/4	2.178
2-1/2	2.412
2-3/4	2.646
3	2.880
3-1/2	3.348
3-3/4	3.582
4	3.816
4-1/2	4.284
5	4.751
6	5.687
7	6.623
8	7.559
9	8.495
10	9.431
12	13.533
16	17.998
20	22.463
24	26.928
32	35.858
3/8 x	
3/8	0.615
1/2	0.785
5/8	0.956
3/4	1.126
1	1.466
1-1/4	1.806
1-1/2	2.147
1-3/4	2.487
2	2.827
2-1/4	3.168
2-1/2	3.508
2-3/4	3.848
3	4.189
3-1/2	4.869
4	5.550
6	8.272
7	9.634
8	10.995
10	13.718

Size (inches)	Weight (lbs./foot)
3/8 x	
12	18.691
16	24.858
20	31.024
24	37.191
32	49.524
1/2 x	
1/2	1.031
5/8	1.254
3/4	1.478
1	1.924
1-1/4	2.371
1-1/2	2.818
1-3/4	3.264
2	3.711
2-1/4	4.158
2-1/2	4.604
2-3/4	5.051
3	5.498
3-1/2	6.391
4	7.284
5	9.071
6	10.858
6-1/2	11.751
7	12.644
8	14.431
9	16.218
10	18.004
12	23.849
14	27.783
16	31.717
18	35.651
20	39.585
24	47.453
32	63.190
5/8 x 5/8	1.553
3/4	1.829
1	2.382
1-1/4	2.935
1-1/2	3.488
1-3/4	4.041
2	4.594
2-1/4	5.148
2-1/2	5.701
2-3/4	6.254
3	6.807
3-1/2	7.913
4	9.019

Size (inches)	Weight (lbs./foot)
5/8 x	
4-1/2	10.125
5	11.231
6	13.443
8	17.867
10	22.291
12	29.006
16	38.576
20	48.146
24	57.715
32	76.855
3/4x	
3/4	2.181
1	2.841
1-1/4	3.500
1-1/2	4.159
1-3/4	4.819
2	5.478
2-1/4	6.137
2-1/2	6.797
2-3/4	7.456
3	8.116
3-1/2	9.434
4	10.753
5	13.390
6	16.028
8	21.303
10	26.578
12	34.164
16	45.435
20	56.706
24	67.978
32	90.521
7/8x	
7/8	2.916
1	3.299
1-1/4	4.064
1-1/2	4.830
1-3/4	5.596
2	6.362
2-1/4	7.127
2-1/2	7.893
2-3/4	8.659
3	9.424
3-1/2	10.956
4	12.487
4-1/2	14.019
5	15.550

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Note, sizes not listed above can be cut from plate.

Continued on next page

AISI 4140/4142 (MOD) - Flats & Squares

Pre-Hardened DCF, HR Pre-Hardened, Annealed DCF and HR Annealed (Cut from Plate)

Size (inches)	Weight (lbs./foot)
7/8 x	
6	18.613
8	24.739
10	30.865
12	39.321
16	52.294
20	65.267
24	78.240
32	104.186
1 x 1	3.757
1-1/4	4.629
1-1/2	5.501
1-3/4	6.373
2	7.245
2-1/4	8.117
2-1/2	8.989
2-3/4	9.861
3	10.733
3-1/2	12.478
4	14.222
4-1/2	15.966
5	17.710
6	21.198
7	24.687
8	28.175
9	31.663
10	35.151
12	44.479
16	59.153
20	73.828
24	88.503
32	117.852
1-1/8 x	
1-1/4	5.193
1-1/2	6.172
2	8.129
2-1/2	10.086
3	12.042
3-1/2	13.999
4	15.956
5	19.870
6	23.783
8	31.611
10	39.438
1-1/8 x 12	49.636
16	66.012
20	82.389
24	98.765
32	131.517

Size (inches)	Weight (lbs./foot)
1-1/4 x	
1-1/4	5.758
1-1/2	6.843
1-3/4	7.927
2	9.012
2-1/4	10.097
2-1/2	11.182
2-3/4	12.267
3	13.351
3-1/2	15.521
4	17.690
4-1/2	19.860
5	22.030
6	26.369
8	35.047
10	43.725
12	54.794
16	72.872
20	90.949
24	109.027
32	145.183
1-3/8 x 1-3/8	6.918
1-1/2	7.514
1-3/4	8.705
2	9.896
2-1/4	11.087
2-1/2	12.278
2-3/4	13.469
3	14.660
3-1/2	17.043
4	19.425
5	24.189
6	28.954
8	38.483
10	48.012
12	59.951
16	79.731
20	99.510
24	119.290
32	158.848
1-1/2 x 1-1/2	8.184
1-3/4	9.482
2	10.779
2-1/4	12.077
2-1/2	13.374
2-3/4	14.672
3	15.969
3-1/2	18.564
4	21.159

Size (inches)	Weight (lbs./foot)
1-1/2 x	
4-1/2	23.754
5	26.349
6	31.539
8	41.919
10	52.298
12	65.109
16	86.590
20	108.071
24	129.552
32	172.514
1-3/4 x	
1-3/4	11.036
2	12.546
3	18.587
3-1/2	21.608
4	24.628
4-1/2	27.648
5	30.669
6	36.709
8	48.791
10	60.872
12	75.424
16	100.308
20	125.192
24	150.077
32	199.845
2 x	
2	14.314
2-1/4	16.036
2-1/2	17.759
2-3/4	19.482
3	21.205
3-1/2	24.651
4	28.097
4-1/2	31.542
5	34.988
6	41.880
8	55.662
10	69.445
12	85.739
16	114.027
20	142.314
24	170.601
32	227.176

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate.

Continued on next page

AISI 4140/4142 (MOD) - Flats & Squares

Pre-Hardened DCF, HR Pre-Hardened, Annealed DCF and HR Annealed (Cut from Plate)

Size (inches)		Weight (lbs./foot)
2-1/4 x	2-1/4	18.016
	2-1/2	19.952
	3	23.823
	3-1/2	27.694
	4	31.565
	5	39.308
	6	47.050
	8	62.534
	10	78.019
	12	96.054
	16	127.745
	20	159.435
	24	191.126
	32	254.507
2-1/2 x	2-1/2	22.144
	2-3/4	24.293
	3	26.441
	3.5	30.737
	4	35.034
	5	43.627
	6	52.220
	8	69.406
	10	86.592
	12	106.369
	16	141.463
	20	176.557
	24	211.651
	32	281.838
2-3/4 x	2-3/4	26.698
	3	29.059
	4	38.503
	5	47.947
	6	57.390
	8	76.278
	10	95.166
	12	116.684
	16	155.181
	20	193.678
	24	232.175
	32	309.169

Size (inches)		Weight (lbs./foot)
3 x	3	31.677
	3-1/2	36.824
	4	41.971
	5	52.266
	6	62.561
	8	83.150
	10	103.739
	12	127.000
	16	168.900
	20	210.800
	24	252.700
	32	336.500
3-1/2 x	3-1/2	42.911
	4	48.909
	5	60.905
	6	72.901
	8	96.894
	10	120.887
	12	147.630
	16	196.336
	20	245.043
	24	293.749
	32	391.163
4 x	4	55.846
	5	69.544
	6	83.242
	8	110.638
	10	138.034
	12	168.260
	16	223.773
	20	279.286
	24	334.799
	32	445.825
4-1/2 x	4-1/2	70.745
	5	78.445
	6	93.844
	8	124.643
	10	155.442
	12	186.241
	16	247.839
	20	309.437
	24	371.035
	32	494.231

Size (inches)		Weight (lbs./foot)
5 x	5	88.550
	6	105.832
	8	140.394
	10	174.957
	12	209.520
	16	278.646
	20	347.772
	24	416.898
	32	555.149
5-1/2 x	5-1/2	106.761
6 x	6	126.673
	8	168.042
	10	209.411
	12	250.781
	16	333.519
	24	498.996
	32	664.474
7 x	7	171.602
	8	195.690
	10	243.865
	12	292.041
	16	388.392
	20	484.744
	24	581.095
	32	773.798
8 x	8	223.337
	10	278.319
	12	333.301
	16	443.266
	20	553.230
	24	663.194
	32	883.122

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Note, sizes not listed above can be cut from plate.

AISI 4140 - As Rolled Plate

Also available in Annealed & Pre-Hardened

4140 Hot Rolled - As Rolled is available to be saw cut or flame cut to custom sizes.

Thickness (inches)	Weight (lbs./sqft)
1/2	20.42
5/8	25.53
3/4	30.60
7/8	35.735
1	40.80
1-1/4	51.10
1-1/2	61.30
1-5/8	66.40
1-3/4	71.47
1-7/8	76.575
2	81.70
2-1/4	91.90
2-1/2	102.10

Thickness (inches)	Weight (lbs./sqft)
2-3/4	112.30
3	122.50
3-1/4	132.73
3-1/2	142.90
3-3/4	153.15
4	163.30
4-1/4	173.57
4-1/2	183.78
4-3/4	193.99
5	204.20
5-1/4	214.40
5-1/2	224.62
5-3/4	234.83

Thickness (inches)	Weight (lbs./sqft)
6	245.04
6-1/4	255.25
6-1/2	265.45
6-3/4	275.67
7	285.88
7-1/2	306.30
8	326.72
8-1/4	336.93
8-1/2	347.14
8-3/4	357.35
9	367.56

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

AISI 4150 Hot Rolled Annealed

4150 grade is a medium-carbon, chromium-molybdenum steel. 4150 is also capable of good strength and wear resistance, has excellent toughness, good ductility and has the ability to resist stress and creep at prolonged high temperatures. In the annealed condition, machinability is improved.

Typical Analysis	AISI 4150
Carbon (C)	0.48 / 0.53
Manganese (Mn)	0.75 / 1.00
Phosphorus (P)	0.035 max
Sulphur (S)	0.02 / 0.04
Chromium (Cr)	0.80 / 1.10
Molybdenum (Mo)	0.15 / 0.25
Silicon (Si)	0.15 / 0.35
Nickel (Ni)	0.25 max
Copper (Cu)	0.35 max
Vanadium (V)	0.10 max
Aluminum (Al)	0.020 to 0.050
Microstructure - Steel to have a predominately lamellar pearlite structure for optimum machinability.	

AISI 4150 Hot Rolled Annealed Rounds

Diameter (inches)	Weight (lbs./foot)	Diameter (inches)	Weight (lbs./foot)	Diameter (inches)	Weight (lbs./foot)
2	10.680	3-3/4	38.568	6-3/4	126.162
2-1/8	12.234	4	43.814	7	135.515
2-1/4	13.704	4-1/8	46.562	7-1/4	145.202
2-3/8	15.258	4-1/4	49.394	7-1/2	155.224
2 -1/2	16.896	4-1/2	55.309	7-3/4	165.580
2-5/8	18.724	4-3/4	61.859	8	176.275
2-3/4	20.533	5	68.459	8-1/4	187.296
2-7/8	22.426	5-1/4	75.393	8-1/2	199.737
3	24.645	5-1/2	82.661	8-3/4	211.463
3-1/8	26.717	5-3/4	91.359	9	223.522
3-1/4	28.872	6	99.343	9-1/4	235.501
3-1/2	33.434	6-1/4	107.662	9-1/2	248.207
3-5/8	36.070	6-1/2	116.315	10	277.171

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Stock Lengths: 20 foot randoms

AISI 4150R Q&T SR Hot Rolled

(Resulphurized, Hot Rolled, Quenched and Tempered, Stress Relieved)

4150R HR Q&T SR is a free-machining alloy steel that provides an outstanding combination of heat treated properties and superior machinability. This alloy steel is manufactured under close quality control for uniformity to an ASTM grain size of 5 to 8. It is especially suitable for service applications where substantial strength, toughness and hardness are required.

Typical Analysis	AISI 4150R
Carbon (C)	0.47 / 0.55
Manganese (Mn)	0.75 / 1.35
Silicon (Si)	0.15 / 0.30
Molybdenum (Mo)	0.15 / 0.25
Chromium (Cr)	0.70 / 1.10
Sulphur (S)	0.06 / 0.10
Phosphorus (P)	0.035 max.
Tensile Strength	approx. 110,000 lbs psi
Yield Point	approx. 85,000 lbs psi
Brinell Hardness	269 - 321
Rockwell C	28 - 34
Elongation in 2"	16%
Reduction in Area	51%
Rounds 11" and up are not resulphurized.	
Flats and Squares Hot rolled, heat treated, machine straightened, stress relieved. BHN 269/321	

AISI 4150R Q&T SR Hot Rolled Rounds

Diameter (inches)	Weight (lbs./foot)
3/4	1.500
7/8	2.040
1	2.676
1-1/8	3.384
1-1/4	4.176
1-3/8	5.052
1-1/2	6.012
1-5/8	7.056
1-3/4	8.172
1-7/8	9.384
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2 -1/2	16.896
2-5/8	18.724
2-3/4	20.533
2-7/8	22.426
3	24.645
3-1/8	26.717
3-1/4	28.872
3-1/2	33.434

Diameter (inches)	Weight (lbs./foot)
3-5/8	36.070
3-3/4	38.568
4	43.814
4-1/8	46.562
4-1/4	49.394
4-1/2	55.309
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/4	145.202
7-1/2	155.224
7-3/4	165.580
8	176.275
8-1/4	187.296
8-1/2	199.737

Diameter (inches)	Weight (lbs./foot)
8-3/4	211.463
9	223.522
9-1/4	235.501
9-1/2	248.207
10	277.171
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
12-1/2	429.889
13	466.624
13-1/2	502.591
14	539.893
14-1/2	573.511
15	618.503
16	702.454
17	791.746
18	886.378
19	986.351
20	1091.664
22	1318.314

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

Rounds 12" and up are not resulphurized. Stock lengths 20' randoms

4150 Dybar - (MOD) RS Hot Rolled

4150 Dybar is a special quality alloy steel that has been resulphurized for considerations for machining. Modifications have been made to the chemical composition for increased hardenability. This steel is made by a single slab electric furnace process to a silicon fully killed practice and resulphurized to set limits.

Typical Analysis	AISI 4150
Carbon (C)	0.47 / 0.55
Manganese (Mn)	0.95 / 1.30
Silicon (Si)	0.20 / 0.35
Molybdenum (Mo)	0.15 / 0.25
Chromium (Cr)	0.60 / 0.90
Vanadium (V)	0.10 max.
Sulphur (S)	0.06 / 0.10
Phosphorus (P)	0.025 max.
Nickel (Ni)	0.25 max.
Columbium	0.015 / 0.035

4150 Dybar - (MOD) RS HR Flats & Squares

Size (inches)	Weight (lbs./foot)
5/8 x	
2-1/2	5.471
3	6.566
4-1/2	9.848
1 x	
2-1/2	8.755
3-1/2	12.250
4-1/2	15.759
1-1/8 x	
2-1/2	9.848
3-1/2	13.788
4-1/2	17.728
5	19.698
8	31.550
1-1/4 x	
2-1/2	10.943
3-1/2	15.321
4	17.510
4-1/2	19.698
5	21.887
7	30.670

Size (inches)	Weight (lbs./foot)
1-1/2 x	
2-1/2	13.132
3	15.759
3-1/2	18.385
4	21.012
4-1/2	23.638
5	26.265
6	31.518
7	36.810
8	42.024
1-3/4 x	
3-1/4	19.940
2 x 2-1/2	17.510
3	21.012
3-1/2	24.514
4	28.016
4-1/2	31.518
5	35.050
6	42.060
8	56.080

Size (inches)	Weight (lbs./foot)
2-1/2 x	
2-1/2	21.887
3	26.265
3-1/2	30.642
4	35.020
4-1/2	39.397
6	52.530
3 x	
3	31.518
4	42.024
5	52.530
6	63.036
3-1/2 x	
3-1/2	42.899
4 x	
4	56.040
8	112.170
4-5/8 x 4-5/8	74.065
5-1/8 x 5-1/8	93.666
5-5/8 x 5-5/8	112.652
6-1/8 x 6-1/8	133.085

Please refer to pages 8-32 thru 8-34 for alloy tolerances.

AISI 4340

Annealed, Hot Rolled

4340 is a highly alloyed steel with high nickel and chromium content which assures deep hardening when oil quenched, with high strength characteristics throughout the section. Used for heavily stressed parts operating under strenuous conditions.

Typical Analysis	AISI 4340
Carbon (C)	0.38 / 0.43
Manganese (Mn)	0.60 / 0.80
Silicon (Si)	0.15 / 0.35
Molybdenum (Mo)	0.20 / 0.30
Chromium (Cr)	0.70 / 0.90
Nickel (Ni)	1.65 / 2.00
Sulphur (S)	0.040 max.
Phosphorus (P)	0.035 max.

AISI 4340

Q&T (For Reference Only), Hot Rolled

Typical Analysis	AISI 4340
Carbon (C)	0.38 / 0.43
Manganese (Mn)	0.60 / 0.80
Silicon (Si)	0.15 / 0.35
Molybdenum (Mo)	0.20 / 0.30
Chromium (Cr)	0.70 / 0.90
Nickel (Ni)	1.65 / 2.00
Sulphur (S)	0.040 max.
Phosphorus (P)	0.035 max.
Tensile Strength	approx. 130,000 lbs psi
Yield Point	approx. 100,000 lbs psi
Brinell Hardness	285 - 352
Elongation in 2"	approx. 14%
Reduction in Area	approx. 35%

Note: Mechanical Properties for Q&T are for reference only!

AISI 4340 - HR Q&T Rounds

Diameter (inches)	Weight (lbs./foot)
1	2.670
1-1/8	3.379
1-1/4	4.170
1-3/8	5.048
1-1/2	6.010
1-5/8	7.050
1-3/4	8.180
1-7/8	9.387
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2-1/2	16.896
2-5/8	18.724
2-3/4	20.533
2-7/8	22.426
3	24.645
3-1/8	26.717
3-1/4	28.872

Diameter (inches)	Weight (lbs./foot)
3-1/2	33.434
3-3/4	38.568
4	43.814
4-1/4	49.394
4-1/2	55.309
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/4	145.202
7-1/2	155.224
7-3/4	165.580
8	176.275

Diameter (inches)	Weight (lbs./foot)
8-1/4	187.296
8-1/2	199.737
9	223.522
9-1/2	248.207
10	277.171
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
13	466.624
14	539.893
15	618.503
16	702.454
17	791.746
18	886.378
19	986.351
20	1091.664

Rounds over 12" are Forged, Rough Turned, Q&T

AISI 4340 - Annealed Rounds

Diameter (inches)	Weight (lbs./foot)
3/4	1.500
7/8	2.040
1	2.676
1-1/8	3.384
1-1/4	4.176
1-3/8	5.052
1-1/2	6.012
1-5/8	7.056
1-3/4	8.172
1-7/8	9.384
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2-1/2	16.896
2-3/4	20.533
3	24.645
3-1/4	28.872
3-1/2	33.434

Diameter (inches)	Weight (lbs./foot)
3-3/4	38.568
4	43.814
4-1/8	46.562
4-1/4	49.394
4-1/2	55.309
4-5/8	58.685
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/2	155.224
8	176.275
8-1/4	187.296

Diameter (inches)	Weight (lbs./foot)
8-1/2	199.737
9	223.522
9-1/4	235.501
9-1/2	248.207
10	277.171
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
12-1/2	429.889
13	466.624
13-1/2	502.591
14	539.893
15	618.503
16	702.454
17	791.746
18	886.378
20	1091.664

Rounds 1/2" - 11" are Hot Rolled Annealed. Rounds over 11" are Forged, Rough Turned, Annealed.
Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 20 foot randoms

AISI 4340
Annealed Aircraft Quality (AQ) Rounds

AISI	4340 CFA-AQ	4340 HRA-AQ
ASTM	A108, A331	A322, A304, E381
AMS	6415	6415

Diameter (inches)	Weight (lbs./foot)	4340 CFA-AQ	4340 HRA-AQ
1/2	.668	●	
3/4	1.500	●	
1	2.676	●	
1-1/4	4.176	●	
1-1/2	6.012	●	
1-3/4	8.172	●	
2	10.680	●	
2-1/4	13.704	●	
2-1/2	16.896	●	
2-3/4	20.533	●	
3	24.645	●	●
3-1/4	28.872		●
3-1/2	33.434		●
3-3/4	38.568		●
4	43.814		●
4-1/4	49.394		●
4-1/2	55.309		●
4-3/4	61.859		●
5	68.459		●
5-1/2	82.661		●
6	99.343		●
6-1/2	116.315		●
7	135.515		●
7-1/2	155.224		●
8	176.275		●
8-1/2	199.737		●
9	223.522		●
9-1/2	248.207		●
10	277.171		●

AISI 6150 - Annealed, HR/DCF

An electric furnace melt of chrome vanadium steel possessing the following characteristics: oil-hardening, high resistance to vibratory stress, standard deformation, medium hardness, high torque strength and bright polish.

Typical Applications

Arbors, Heavy Machinery Parts, Gears, Shafts, High Strength Studs and Spindles.

Typical Analysis	AISI 6150
Carbon (C)	0.48 / 0.53
Manganese (Mn)	0.70 / 0.90
Silicon (Si)	0.15 / 0.30
Phosphorus (P)	0.035 max.
Sulphur (S)	0.040 max.
Molybdenum (Mo)	
Chromium (Cr)	0.80 / 1.10
Vanadium (V)	0.15 min.
Cobalt (Co)	
Forging (a) Start forging at Do not forge below	1750 - 2150ºF (950 - 1175ºC) 1600º F (870ºC)
Normalizing (b)	1650 - 1700ºF (899 - 927ºC)
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1525 - 1575ºF (828 - 855ºC) 179 - 217
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 1500 - 1550ºF (816 - 843ºC) O (I)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 400ºF (204ºC) 56 - 58
Wear Resistance	Medium
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	Low
Depth of Hardening	Medium
Machinability	Medium
Grindability	High
Distortion in Heat Treating	Medium
Safety in Hardening	Low
Resistance to Carburization	Medium

AISI 6150 - Annealed Flats & Squares

DCF (Cut From Plate)

Size (inches)	Weight (lbs./foot)
1/2 x	
1/2	1.031
5/8	1.254
3/4	1.478
1	1.924
1-1/4	2.371
1-1/2	2.818
1-3/4	3.264
2	3.711
2-1/4	4.158
2-1/2	4.604
2-3/4	5.051
3	5.498
3-1/2	6.391
4	7.284
5	9.071
6	10.858
8	14.431
10	18.004
12	23.849
16	31.717
20	39.585
24	47.453
5/8 x	
5/8	1.553
3/4	1.829
1	2.382
1-1/4	2.935
1-1/2	3.488
1-3/4	4.041
2	4.594
2-1/4	5.148
2-1/2	5.701
2-3/4	6.254
3	6.807
3-1/2	7.913
4	9.019
4-1/2	10.125
5	11.231
5-1/2	12.337
6	13.443
7	15.655
8	17.867
9	20.079
10	22.291
12	29.006
16	38.576
20	48.146
24	57.715
32	76.855

Size (inches)	Weight (lbs./foot)
3/4 x	
3/4	2.181
1	2.841
1-1/4	3.500
1-1/2	4.159
1-3/4	4.819
2	5.478
2-1/4	6.137
2-1/2	6.797
2-3/4	7.456
3	8.116
3-1/2	9.434
4	10.753
5	13.390
6	16.028
8	21.303
10	26.578
12	34.164
16	45.435
20	56.706
24	67.978
32	90.521
1 x	
1	3.757
1-1/4	4.629
1-1/2	5.501
1-3/4	6.373
2	7.245
2-1/4	8.117
2-1/2	8.989
2-3/4	9.861
3	10.733
3-1/2	12.478
4	14.222
4-1/2	15.966
5	17.710
6	21.198
7	24.687
8	28.175
10	35.151
12	44.479
16	59.153
20	73.828
24	88.503
32	117.852
1-1/8x	
2-1/2	10.086
4-1/2	17.913
1-1/4 x	
1-1/4	5.758
1-1/2	6.843
1-3/4	7.927

Size (inches)	Weight (lbs./foot)
1-1/4 x	
2	9.012
2-1/4	10.097
2-1/2	11.182
2-3/4	12.267
3	13.351
3-1/2	15.521
4	17.690
4-1/2	19.860
5	22.030
6	26.369
8	35.047
10	43.725
12	54.794
16	72.872
20	90.949
24	109.027
32	145.183
1-3/8 x	
1-3/8	6.918
1-1/2	7.514
1-3/4	8.705
2	9.896
2-1/4	11.087
2-1/2	12.278
2-3/4	13.469
3	14.660
3-1/2	17.043
4	19.425
5	24.189
6	28.954
8	38.483
10	48.012
12	59.951
16	79.731
20	99.510
24	119.290
32	158.848
1-1/2 x	
1-1/2	8.184
1-3/4	9.290
2	10.587
2-1/4	11.885
2-1/2	13.182
2-3/4	14.480
3	15.803
3-1/2	18.372
4	20.967
4-1/2	23.562
5	26.157
6	31.347

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate.

Continued on next page

AISI 6150 - Annealed Flats & Squares

DCF (Cut From Plate)

Size (inches)	Weight (lbs./foot)
1-1/2 x	
8	41.727
10	52.106
12	65.109
16	83.246
20	104.005
24	127.765
32	166.284
1-3/4 x	
1-3/4	11.036
2	12.546
3	18.587
3-1/2	21.608
4	24.628
4-1/2	27.648
5	30.669
5-1/2	33.689
6	36.709
7	42.750
8	48.791
9	54.831
10	60.872
12	75.424
16	100.308
20	125.192
24	150.077
32	199.845
2 x	
2	14.314
2-1/4	16.036
2-1/2	17.759
2-3/4	19.482
3	21.205
3-1/2	24.651
4	28.097
4-1/2	31.542
5	34.988
6	41.880
8	55.662
10	69.445
12	85.739
16	114.027
20	142.314
24	170.601
32	227.176

Size (inches)	Weight (lbs./foot)
2-1/2 x	
2-1/2	22.144
2-3/4	24.293
3	26.441
3-1/2	30.737
4	35.034
5	43.627
6	52.220
8	69.406
10	86.592
12	106.369
16	141.463
20	176.557
24	211.651
3 x	
3	31.677
3-1/2	36.824
4	41.971
5	52.266
6	62.561
8	83.150
10	103.739
12	127.000
14	147.950
16	168.900
20	210.800
24	252.700
32	336.500
3-1/2 x	
3-1/2	42.911
4	48.909
5	60.905
6	72.901
8	96.894
10	120.887
12	147.630
16	196.336
20	245.043
24	293.749
32	391.163

Size (inches)	Weight (lbs./foot)
4 x	
4	55.846
5	69.544
6	83.242
8	110.638
10	138.034
12	168.260
14	196.016
16	223.773
20	279.286
24	334.799
32	445.825
4-1/2 x	
4-1/2	72.041
5	79.831
6	95.411
8	126.571
10	157.730
12	188.890
16	251.209
20	313.529
24	375.848
32	500.487
5 x	
5	88.550
6	105.832
8	140.394
10	174.957
12	209.520
16	278.646
20	347.772
24	416.898
32	555.149
6 x	
6	126.673
8	168.042
10	209.411
12	250.781
16	333.519
20	416.258
24	498.996
32	664.474

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate.

AISI 6150 - Annealed HR Rounds

Diameter (inches)	Weight (lbs./foot)
1	2.676
1-1/8	3.384
1-1/4	4.176
1-3/8	5.052
1-1/2	6.012
1-5/8	7.056
1-3/4	8.180
1-7/8	9.390
2	10.680
2-1/8	12.230
2-1/4	13.704
2-1/2	16.896
2-5/8	18.724
2-3/4	20.533
3	24.409
3-1/4	28.606
3-1/2	33.143

Diameter (inches)	Weight (lbs./foot)
3-3/4	38.175
4	43.394
4-1/4	48.939
4-1/2	54.822
4-3/4	61.243
5	67.804
5-1/4	74.699
5-1/2	81.928
5-3/4	90.203
6	98.146
6-1/4	103.390
6-1/2	114.985
6-3/4	123.078
7	133.771
7-1/4	143.397
7-1/2	153.348
7-3/4	163.633

Diameter (inches)	Weight (lbs./foot)
8	174.251
8-1/4	185.204
8-1/2	197.178
8-3/4	208.818
9	220.816
9-1/4	235.501
9-1/2	248.207
10*	277.171
10-1/2*	305.044
11*	334.253
11-1/2*	364.796
12*	396.675
13*	466.624
14*	539.893
15*	618.503
16*	702.454

**** Over 10" is forged***

Diameter tolerance may vary depending on sourcing.
Stock Lengths: 20 foot randoms

AISI 8620/86L20

Carefully controlled proportions of chromium, nickel and molybdenum are responsible for the extensive use of 8620 as a carburizing alloy steel. Valuable features of this grade include extreme surface hardenability and internal strength.

Typical Analysis	AISI 8620 / 86L20
Carbon (C)	0.18 / 0.23
Manganese (Mn)	0.70 / 0.90
Silicon (Si)	0.15 / 0.30
Nickel (Ni)	0.40 / 0.70
Molybdenum (Mo)	0.15 / 0.25
Chromium (Cr)	0.40 / 0.60
Phosphorus (P)	0.035 MAX
Sulphur (S)	0.040 MAX
*Lead	0.15 / 0.35
Heat Treatment	
Carburize temperature	1700ºF (927ºC)
(Allow to cool in carburizing box)	
Reheat temperature	1550ºF (843ºC
Quenching medium	O (I)
Tensile Strength	92,000 lbs. PSI
Yield Point	64,000 lbs. PSI
Brinell Hardness	192
Rockwell B	92
Elongation in 2"	25%
Reduction in Area	58%
Machinability	58%

Applies only to 8620 leaded alloy steel bars.

AISI 8620 Flats and Squares

HR (Cut From Plate)

Size (inches)	Weight (lbs./foot)
3/8 x	
3/8	0.594
1/2	0.765
5/8	0.935
3/4	1.105
1	1.446
1-1/4	1.786
1-1/2	2.126
1-3/4	2.467
2	2.807
2-1/4	3.147
2-1/2	3.488
2-3/4	3.827
3	4.168
3-1/2	4.849
4	5.530
6	8.252
1/2 x	
1/2	1.004
5/8	1.227
3/4	1.451
1	1.897
1-1/4	2.344
1-1/2	2.791
1-3/4	3.237
2	3.684
2-1/4	4.131
2-1/2	4.577
2-3/4	5.024
3	5.471
3-1/2	6.364
4	7.257
4-1/2	8.151
5	9.044
6	10.831
7	12.618
8	14.404
10	17.978
12	21.551
16	28.697
20	35.844
24	42.991
5/8 x	
5/8	1.520
3/4	1.796
1	2.349
1-1/4	2.902
1-1/2	3.455
1-3/4	4.008
2	4.561

Size (inches)	Weight (lbs./foot)
5/8 x	
2-1/4	5.114
2-1/2	5.667
2-3/4	6.220
3	6.773
3-1/2	7.879
4	8.985
4-1/2	10.092
5	11.198
6	13.410
8	17.834
10	22.257
12	26.682
16	35.530
20	44.378
24	53.227
3/4 x	
3/4	2.141
1	2.801
1-1/4	3.460
1-1/2	4.120
1-3/4	4.779
2	5.438
2-1/4	6.098
2-1/2	6.757
2-3/4	7.417
3	8.076
3-1/2	9.395
4	10.713
4-1/2	12.032
5	13.351
6	15.988
8	21.263
10	26.538
12	31.813
16	42.363
20	52.913
24	63.463
1 x	
1	3.704
1-1/8	4.141
1-1/4	4.577
1-1/2	5.449
1-3/4	6.321
2	7.193
2-1/4	8.065
2-1/2	8.937
2-3/4	9.809
3	10.681
3-1/2	12.425

Size (inches)	Weight (lbs./foot)
1 x	
4	14.169
4-1/2	15.914
5	17.658
6	21.146
8	28.123
10	35.099
12	42.076
16	56.028
20	69.981
24	83.934
1-1/4 x	
1-1/4	5.692
1-1/2	6.778
1-3/4	7.862
2	8.947
2-1/4	10.032
2-1/2	11.117
2-3/4	12.201
3	13.286
3-1/2	15.456
4	17.625
4-1/2	19.795
5	21.964
6	26.304
8	34.982
10	43.660
12	52.338
16	69.694
20	87.050
24	104.406
1-1/2 x	
1-1/2	8.106
2	10.702
2-1/4	11.999
2-1/2	13.296
2-3/4	14.594
3	15.891
3-1/2	18.486
4	21.081
4-1/2	23.676
5	26.271
6	31.461
8	41.841
10	52.221
12	62.600
16	83.359
20	104.119
24	124.878

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate, please inquire.
Weights above include nominal oversize tolerance. Actual weights may vary.

Continued on next page

AISI 8620 Flats and Squares

HR (Cut From Plate)

Size (inches)	Weight (lbs./foot)
1-3/4 x	
1-3/4	10.945
2	12.456
2-1/2	15.476
3	18.497
4	24.537
4-1/2	27.557
5	30.578
6	36.619
8	48.700
10	60.781
12	72.862
16	97.025
20	121.188
24	145.350
2 x	
2	14.210
2-1/4	15.933
2-1/2	17.656
2-3/4	19.379
3	21.102
3-1/2	24.547
4	27.993
4-1/2	31.438
5	34.885
6	41.776
8	55.559
9	62.451
10	69.342
12	83.125
16	110.690
20	138.257
24	165.822

Size (inches)	Weight (lbs./foot)
2-1/4 x	
2-1/4	17.900
2-1/2	19.836
2-3/4	21.771
3	23.707
3-1/2	27.578
4	31.449
4-1/2	35.320
5	39.191
5-1/2	43.063
6	46.934
8	62.418
10	77.903
12	93.387
16	124.357
20	155.326
24	165.823
2-1/2 x	
2-1/2	22.015
2-3/4	24.164
3	26.312
3-1/2	30.609
4	34.905
4-1/2	39.202
5	43.498
5-1/2	47.795
6	52.091
8	69.277
10	86.464
12	103.650
16	138.022
20	172.394
24	206.767

Size (inches)		Weight (lbs./foot)
3 x	3	31.522
	3-1/2	36.670
	4	41.817
	4-1/2	46.964
	5	52.112
	6	62.406
	8	82.996
	10	103.585
	12	124.174
	16	165.353
	20	206.532
	24	247.711
3-1/2 x		
	3-1/2	42.730
	4	48.525
	4-1/2	54.523
	5	60.521
	5-1/2	66.723
	6	72.518
	8	96.510
	10	120.502
	12	144.495
	16	192.480
	20	240.465
	24	288.451
4 x	4	55.408
	4-1/2	62.257
	5	69.106
	5-1/2	75.955
	6	82.804
	8	110.199
	10	137.595
	12	164.991
	16	219.782
	20	274.574
	24	329.366

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Note, sizes not listed above can be cut from plate.

AISI 8620 HR Rounds

Diameter (inches)	Weight (lbs./foot)
5/8	1.044
3/4	1.500
7/8	2.040
1	2.676
1-1/16	3.01
1-1/8	3.384
1-3/16	3.76
1-1/4	4.176
1-5/16	4.60
1-3/8	5.052
1-7/16	5.52
1-1/2	6.012
1-5/8	7.056
1-3/4	8.172
1-7/8	9.384
2	10.680
2-1/8	12.234
2-1/4	13.704
2-3/8	15.258
2-1/2	16.896
2-5/8	18.724
2-3/4	20.533
2-7/8	22.426
3	24.645

Diameter (inches)	Weight (lbs./foot)
3-1/8	26.717
3-1/4	28.872
3-1/2	33.434
3-5/8	36.070
3-3/4	38.568
4	43.814
4-1/8	46.562
4-1/4	49.394
4-1/2	55.309
4-3/4	61.859
5	68.459
5-1/4	75.393
5-1/2	82.661
5-3/4	91.359
6	99.343
6-1/4	107.662
6-1/2	116.315
6-3/4	126.162
7	135.515
7-1/4	145.202
7-1/2	155.224
7-3/4	165.580
8	176.271
8-1/4	187.296

Diameter (inches)	Weight (lbs./foot)
8-1/2	199.737
8-3/4	211.463
9	223.522
9-1/4	235.501
9-1/2	248.207
9-3/4	253.812
10	277.171
10-1/4	290.941
10-1/2	305.044
11	334.253
11-1/2	364.796
12	396.675
12-1/2	429.889
13	466.624
14	539.893
15	618.503
16	702.454
17	791.746
18	886.378
19	986.351
20	1091.664
22	1318.314
24	1566.326
26	1835.701

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 18 - 20 foot randoms

AISI 8620 CF Rounds

Diameter (inches)	Weight (lbs./foot)
1/4	0.167
5/16	0.261
3/8	0.375
7/16	0.511
1/2	0.668
9/16	0.845
5/8	1.043
11/16	1.262
3/4	1.502
13/16	1.763
7/8	2.044
15/16	2.347
1	2.670
1-1/16	3.014
1-1/8	3.379

Diameter (inches)	Weight (lbs./foot)
1-3/16	3.765
1-1/4	4.172
1-5/16	4.599
1-3/8	5.048
1-7/16	5.517
1-1/2	6.008
1-5/8	7.050
1-3/4	8.177
1-7/8	9.387
2	10.680
2-1/8	12.057
2-1/4	13.517
2-3/8	15.060
2-1/2	16.688
2-5/8	18.398

Diameter (inches)	Weight (lbs./foot)
2-3/4	20.192
2-7/8	22.069
3	24.030
3-1/8	26.074
3-1/4	28.202
3-3/8	30.413
3-1/2	32.708
3-3/4	37.547
4	42.720
4-1/4	48.227
4-1/2	54.068
4-3/4	60.242
5	66.750
6	96.120

Please refer to pages 8-32 thru 8-34 for alloy tolerances.
Stock Lengths: 12 foot (20 foot also available in most sizes).

AISI 86L20 CF Rounds

Diameter (inches)	Weight (lbs./foot)
3/8	0.38
1/2	0.67
9/16	0.85
5/8	1.04
3/4	1.50
13/16	1.76
7/8	2.04
15/16	2.35
1	2.67
1-1/8	3.38

Diameter (inches)	Weight (lbs./foot)
1-1/4	4.17
1-5/16	4.60
1-3/8	5.05
1-7/16	5.52
1-1/2	6.01
1-5/8	7.05
1-3/4	8.18
1-7/8	9.39
2	10.68
2-1/8	12.06

Diameter (inches)	Weight (lbs./foot)
2-1/4	13.52
2-3/8	15.06
2-1/2	16.69
2-5/8	18.40
2-3/4	20.19
3	24.03
3-1/4	28.20
3-1/2	32.71

AISI 8620 HR Plate

Thickness (inches)	Weight (lbs./sqft)
1/2	20.4
3/4	30.6
1	40.8
1-1/8	45.9
1-1/4	51.0
1-1/2	61.2
1-3/4	71.47

Thickness (inches)	Weight (lbs./sqft)
2	81.6
2-1/4	91.89
2-1/2	102.0
2-3/4	112.31
3	122.4
3-1/2	142.9
4	163.3

Refer to pages 8-32 thru 8-34 for alloy tolerances.

AISI 52100

AISI 52100 is a moderately deep hardening alloy having high resistance to wear, medium toughness, and low resistance to softening at high temperatures.

Typical Analysis	AISI 52100
Carbon (C)	0.98 / 1.10
Manganese (Mn)	0.25/ 0.45
Silicon (Si)	0.15 - 0.30
Chromium (Cr)	1.30 / 1.60
Phosphorus (P)	0.025 MAX
Sulphur (S)	0.025 MAX
Physical Properties	
Contact Alro for specific certification.	

AISI 52100 Rounds

Spheroidize Annealed, B.Q.

Diameter (inches)	Weight (lbs./foot)
3/8	0.380
1/2	0.667
5/8	1.042
3/4	1.501
13/16	1.760
7/8	2.044
1	2.670
1-1/8	3.379
1-1/4	4.171
1-3/8	5.047
1-1/2	6.007
1-5/8	7.050
1-3/4	8.176
1-13/16	8.780
1-7/8	9.386

Diameter (inches)	Weight (lbs./foot)
2	10.680
2-1/4	13.512
2-3/8	15.060
2-1/2	16.687
2-5/8	18.400
2-3/4	20.191
3	24.030
3-1/4	28.201
3-1/2	32.710
3-3/4	37.547
4	42.720
4-1/4	48.230
4-1/2	54.067
4-3/4	60.240
5	66.750

Diameter (inches)	Weight (lbs./foot)
5-1/4	73.590
5-1/2	80.767
6	96.120
6-1/4	104.296
6-1/2	112.807
6-3/4	123.078
7	130.830
7-1/2	150.187
8	170.880
8-1/2	197.178
9	220.816
10	277.171
11	334.253
12	396.675

Diameter tolerance may vary depending on sourcing.

Hot Rolled Alloy Bars

Size Tolerances and Out-of-Round or Out-of Square Tolerances

Hot Rolled Alloy Bars Round, Square and Round-Cornered Square			
Specified Sizes (inches)	Size Tolerances (inches)		Out-of-Round or Out-of-Square Section (inches)
	Over	Under	
Up thru 5/16	0.005	0.005	0.008
Over 5/16 thru 7/16	0.006	0.006	0.009
Over 7/16 thru 5/8	0.007	0.007	0.010
Over 5/8 thru 7/8	0.008	0.008	0.012
Over 7/8 thru 1	0.009	0.009	0.013
Over 1 thru 1-1/8	0.010	0.010	0.015
Over 1-1/8 thru 1-1/4	0.011	0.011	0.016
Over 1-1/4 thru 1-3/8	0.012	0.012	0.018
Over 1-3/8 thru 1-1/2	0.014	0.014	0.021
Over 1-1/2 thru 2	1/64	1/64	0.023
Over 2 thru 2-1/2	1/32	0	0.023
Over 2-1/2 thru 3-1/2	3/64	0	0.035
Over 3-1/2 thru 4-1/2	1/16	0	0.046
Over 4-1/2 thru 5-1/2	5/64	0	0.058
Over 5-1/2 thru 6-1/2	1/8	0	0.070
Over 6-1/2 thru 8-1/4	5/32	0	0.085
Over 8-1/4 thru 9-1/2	3/16	0	0.100
Over 9-1/2	1/4	0	0.120

Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same transverse cross section. Out-of-square section is the difference in perpendicular distance between opposite faces, measured at the same transverse cross section.

Size Tolerances - Rounds

Turned & Ground/Turned, Ground & Polished		
Diameter Range (inches)	Not Heat Treated All Carbons	Heat Treated All Carbons
Up thru 1-1/2	+0 - 0.001	+0 - 0.001
Over 1-1/2 thru 2-1/2	+0 - 0.0015	+0 - 0.0015
Over 2-1/2 thru 3	+0 - 0.002	+0 - 0.002
Over 3 thru 4	+0 - 0.003	+0 - 0.003
Over 4 thru 6	+0 - 0.004	+0 - 0.005
Over 6	+0 - 0.005	+0 - 0.006

Straightness *Tolerances - Steel Bars

Hot Rolled Bars

Straightness is a perishable tolerance; therefore, reasonable care in handling and storage should be taken to avoid bending the bars. Deviation from straightness is measured by placing the bar on a level table so that the arc or deviation from straightness is horizontal, and the depth of the arc is measured with a steel scale and a straight edge. A tightly-stretched string can be used as a substitute for a steel scale.

Hot Rolled Bars	1/4" in any 5 ft.	or	$1/4 \times \frac{\text{no. of ft. of length}}{5}$ inches
Hot Rolled, Thermally Treated	1/4" in any 5 ft.	or	$1/4 \times \frac{\text{no. of ft. of length}}{5}$ inches

** There is not a published flatness or straightness tolerance for flat bars.*

Straightness *Tolerances - Steel Bars

Cold Finished Bars

Form Size (inches)	Length (feet)	Maximum Curvature (Depth of arc in inches)
Rounds		
Less than .28 Carbon		
Less than 5/8"	Less than 15'	1/8" in any 10' portion of the total length
Less than 5/8"	15' and over	1/8" in any 10' portion of the total length
5/8" and over	Less than 15'	1/16" in any 10' portion of the total length
5/8" and over	15' and over	1/8" in any 10' portion of the total length
.28 Carbon and over and all heat treated material		
Less than 5/8"	Less than 15'	3/16" in any 10' portion of the total length
Less than 5/8"	15' and over	5/16" in any 10' portion of the total length
5/8" and over	Less than 15'	1/8" in any 10' portion of the total length
5/8" and over	15' and over	3/16" in any 10' portion of the total length
Hexagons & Squares		
Less than .28 Carbon		
Less than 5/8"	Less than 15'	3/16" in any 10' portion of the total length
Less than 5/8"	15' and over	5/16" in any 10' portion of the total length
5/8" and over	Less than 15'	1/8" in any 10' portion of the total length
5/8" and over	15' and over	3/16" in any 10' portion of the total length
.28 Carbon and over and all heat treated material		
Less than 5/8"	Less than 15'	1/4" in any 10' portion of the total length
Less than 5/8"	15' and over	3/8" in any 10' portion of the total length
5/8" and over	Less than 15'	3/16" in any 10' portion of the total length
5/8" and over	15' and over	1/4" in any 10' portion of the total length

**** There is not a published flatness or straightness tolerance for flat bars.***

Thickness & Width Oversize Ranges

De-Carb Free Flats and Squares

Size (inches)	Width - Based on Thickness (inches)	Thickness (inches)
Through 4" thick	+.035 / +.077 oversize	+.015 / +.035 oversize
Rough Milled 4" thru <5"	+.062 / +.124 oversize	+.062 / +.125 oversize
Rough Milled 5" and over	+.062 / +.124 oversize	+.125 / +.250 oversize

Thickness Tolerances

4140 HRA and 8620 HR Flats

All widths range from .035 - .124 oversize

Thickness (inches)	Tolerance
3/8	+.03 -.01
1/2	+.03 -.01
5/8	+.04 -.01
3/4 and 7/8	+.04 -.01
1 to 1-7/8	+.07 -.01
2 to 2-3/4	+.11 -.01
3 to 3-3/4	+.13 -.01
4 to 4-1/2	+.15 -.01

Standard Manufacturing Tolerances

Cold Finished Alloy Bars (Undersize variation in inches)

Size & Shape	Carbon thru .28% Max.	Max. Carbon over .28% thru .55%	Max. Carbon over .55% or All Carbons Heat Treated	E.T.D. 150®
Rounds (Cold Drawn or Turned and Polished)				
Up thru 1-1/2	.003	.004	.006	.005
Over 1-1/2 thru 2-1/2	.004	.005	.007	.006
Over 2-1/2 thru 4	.005	.006	.008	.007
Over 4 thru 6	.006	.007	.009	---
Over 6 thru 8	.007	.008	.010	---
Over 8 thru 9	.008	.009	.011	---
Hexagons				
Up thru 3/4	.003	.004	.007	---
Over 3/4 thru 1-1/2	.004	.005	.008	---
Over 1-1/2 thru 2-1/2	.005	.006	.009	---
Over 2-1/2 thru 3-1/8	.006	.007	.010	---
Squares				
Up thru 3/4	.003	.005	.008	---
Over 3/4 thru 1-1/2	.004	.006	.009	---
Over 1-1/2 thru 2-1/2	.005	.007	.010	---
Over 2-1/2 thru 3-1/8	.007	.009	.012	---
Flats (Width)				
Up thru 3/4	.004	.006	.009	---
Over 3/4 thru 1-1/2	.005	.007	.011	---
Over 1-1/2 thru 3	.006	.008	.013	---
Over 3 thru 4	.007	.010	.017	---
Over 4 thru 6	.009	.012	.021	---
Over 6	.014	---	---	---

Note: Tolerances for flats apply to thickness as well as to width.

AISI A2 DCF

An air-hardening tool steel containing five percent chromium. Replaces the oil hardening (O1 type) when safer hardening, less distortion and increased wear-resistance are required. Provides an intermediate grade between the oil hardening and the high carbon, high chromium (D2) types.

Typical Applications

Large Blanking Dies, Thread Roller Dies, Long Punches, Rolls, Master Hubs, Trimming Dies, Forming Dies, Precision Tools, Gauges, Coining Dies, Extrusion Dies, Mandrels, Shear Blades and Slitters.

Typical Analysis	Type A2 (UNS T30102)
Carbon (C)	0.95 / 1.05
Manganese (Mn)	1.00 max.
Silicon (Si)	0.50 max.
Tungsten (W)	
Molybdenum (Mo)	0.90 / 1.40
Chromium (Cr)	4.75 / 5.50
Vanadium (V)	0.15 / 0.50
*Nickel (Ni)	0.30 max.
Forging (a) Start forging at	 1850 - 2000°F (1010 - 1093°C)
Do not forge below	1650°F (899°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour	 1550 - 1600°F (843 - 871°C) 40°F (22°C)
Typical annealed hardness, Brinell	201 - 235
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 1450 °F (788°C) 1700 - 1800°F (927 - 962°C) 20 - 45 (j) A (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 350 - 1000°F (177 - 538°C) 57 - 62
Wear Resistance	High
Toughness	Medium
Resistance to Softening Effect of Elevated Temperature	Medium to High
Depth of Hardening	Deep
Machinability	Medium
Grindability	Medium
Distortion in Heat Treating	Lowest
Safety in Hardening	Highest
Resistance to Decarburization	Medium

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI A6

A6 is an air-hardening, non-deforming tool steel that combines the deep hardening characteristics of air-hardening steels with the simplicity of low temperature heat treatment possible in many of the oil-hardening grades.

Typical Applications

Blanking Dies, Precision Tools, Forming Dies, Coining Dies, Master Hubs, Shear Blades, Plastic Molds, Spindles, Mandrels, Heavy Duty Punches.

Typical Analysis	Type A6 (UNS T30106)
Carbon (C)	0.65 / 0.75
Manganese (Mn)	1.80 / 2.50
Silicon (Si)	0.50 max.
Tungsten (W)	
Molybdenum (Mo)	0.90 / 1.40
Chromium (Cr)	0.90 /1.20
Vanadium (V)	
Cobalt (Co)	
*Nickel (Ni)	0.30 max.
Forging (a)	
Start forging at	1900 - 2050°F (1038 - 1213°C)
Do not forge below	1600°F (871°C)
Normalizing (b)	Do not normalize
Annealing (c)	
Temperature	1350 - 1375°F (732 - 746°C)
Rate of cooling, max. per hour	25°F (14°C)
Typical annealed hardness, Brinell	217 - 248
Hardening	
Rate of heating	Slowly
Preheat temperature	1200°F (649°C)
Hardening temperature	1525 - 1600°F (829 - 871°C)
Time at temperature, minutes	20 - 45 (j)
Quenching medium	A (l)
Tempering	
Tempering temperature	300 - 800°F (149 - 427°C)
Approx. tempered hardness, Rockwell C	54 - 60
Wear Resistance	Low to Medium
Toughness	Medium to High
Resistance to Softening Effect of Elevated Temperature	Medium
Depth of Hardening	Deep
Machinability	Low to Medium
Grindability	Medium
Distortion in Heat Treating	Lowest
Safety in Hardening	Highest
Resistance to Decarburization	Medium to High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI D2

D2 is an air-hardening, high carbon, high chromium tool steel with extremely high wear resisting properties. It is a very deep hardening steel and will be practically free from size change after proper treatment. The high percentage of chromium gives it mild corrosion-resisting properties in the hardened condition.

Typical Applications

Blanking Dies, Forming Dies, Coining Dies, Slitting Cutters, Heading Tools, Long Punches, Forming Rolls, Edging Rolls, Master Tools, Beading Rolls, Intricate Punches, Extrusion Dies, Drawing Dies, Lamination Dies, Thread Rolling Dies, Shear Blades, Burnishing Tools, Gauges, Knurls, Wear Parts.

Typical Analysis	Type D2 (UNS T30402)
Carbon (C)	1.40 / 1.60
Manganese (Mn)	0.60 max.
Silicon (Si)	0.60 max.
Tungsten (W)	
Molybdenum (Mo)	0.70 / 1.20
Chromium (Cr)	11.00 / 13.00
Vanadium (V)	1.10 max.
Cobalt (Co)	1.00 max.
*Nickel (Ni)	0.30 max.
Forging (a) Start forging at Do not forge below	 1850 - 2000°F (1010 - 1093°C) 1700°F (927°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1600 - 1650°F (871 - 899°C) 40°F (22°C) 217 - 255
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Very Slowly 1500°F (816°C) 1800 - 1875°F (982 - 1024°C) 15 - 45 (j) A (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 400 - 1000°F (204 - 538°C) 54 - 61
Wear Resistance	High to Very High
Toughness	Low
Resistance to Softening Effect of Elevated Temperature	Medium to High
Depth of Hardening	Deep
Machinability	Low
Grindability	Low
Distortion in Heat Treating	Lowest
Safety in Hardening	Highest
Resistance to Decarburization	Medium

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

DC53

DC53 is a general purpose, cold work die and mold steel whose strength and toughness approach those of high-speed steels.

Typical Applications

Forming Dies, Thread Rolling Dies, Cold Forging Dies, Gauges, Plastic Molds, Stepped Punch and Press Punching Dies.

Typical Analysis	Type DC53
Carbon (C)	0.95
Molybdenum (Mo)	2.00
Chromium (Cr)	8.00
Vanadium (V)	0.25
Cobalt (Co)	
*Nickel (Ni)	
Forging (a) Start forging at Do not forge below	 1100°C 900°C
Normalizing (b)	
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 830°C - 880°C 40°F (22°C) 255°
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 800°C - 850°C) 1020° C - 1040°C 15 - 45 Air, Gas
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 520 - 550°C 64 - 58
Wear Resistance	High to Very High
Toughness	High
Resistance to Softening Effect of Elevated Temperature	High
Depth of Hardening	Through Harden
Machinability	High
Grindability	High
Distortion in Heat Treating	Low
Safety in Hardening	High
Resistance to Decarburization	High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI 01

O1 is an oil-hardening, non-deforming tool steel which can be hardened at relatively low temperatures. Tools and dies made from O1 will have good wearing qualities since the tungsten and higher chromium content gives improved wear resistance over the straight manganese grades.

Typical Applications

Blanking Dies, Bushings, Forming Dies, Master Tools, Forming Rolls, Gauges, Trim Dies.

Typical Analysis	Type O1 (UNS T31501)
Carbon (C)	0.85 / 1.00
Manganese (Mn)	1.00 / 1.40
Silicon (Si)	0.50 max.
Tungsten (W)	0.40 / 0.60
Molybdenum (Mo)	
Chromium (Cr)	0.40 / 0.70
Vanadium (V)	0.30 max.
Cobalt (Co)	
*Nickel (Ni)	0.30 max.
Forging (a) Start forging at Do not forge below	 1800 - 1950°F (982 - 1066°C) 1550°F (843°C)
Normalizing (b)	1600°F (871 °C)
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1400 - 1450°F (760 - 788°C) 40°F (22°C) 183 - 212
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 1200°F (649°C) 1450 - 1500°F (788 - 816°C) 10 - 30 0 (I)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 350 - 500°F (177 - 260°C) 57 - 62
Wear Resistance	Medium
Toughness	Medium
Resistance to Softening Effect of Elevated Temperature	Low
Depth of Hardening	Medium
Machinability	High
Grindability	High
Distortion in Heat Treating	Low
Safety in Hardening	Medium to High
Resistance to Decarburization	High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI O6

O6 is an oil-hardening cold work steel which has outstanding machinability resulting from small particles of graphitic carbon uniformly distributed throughout the steel. These particles increase resistance to wear and galling in service. For an oil-hardening steel, 06 holds size well during heat treating.

Typical Applications

Blanking Dies, Piercing Dies, Drawing Dies, Pneumatic Hammers, Forming Dies, Spinning Tools, Punches, Stamps, Gauges, Wear Plates, Cams, Rotary Slitting Cutters.

Typical Analysis	Type O6 (UNS T31506)
Carbon (C)	1.25 / 1.55
Manganese (Mn)	0.30 / 1.10
Silicon (Si)	0.55 / 1.50
Tungsten (W)	
Molybdenum (Mo)	0.20 / 0.30
Chromium (Cr)	0.30 max
*Nickel (Ni)	0.30 max
Forging (a) Start forging at Do not forge below	 1800 - 1950°F (982 - 1066°C) 1500°F (816°C)
Normalizing (b)	1600°F (871 °C)
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1400 - 1450°F (766 - 788°C) 20°F (11°C) 183 - 217
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 1450 - 1500°F (788 - 816°C) 10 - 30 0 (I)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 350 - 600°F (177 - 316°C) 58 - 63
Wear Resistance	Medium
Toughness	Medium
Resistance to Softening Effect of Elevatated Temperature	Low
Depth of Hardening	Medium
Machinability	Highest
Grindability	High
Distortion in Heat Treating	Low
Safety in Hardening	Medium to High
Resistance to Decarburization	High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.
**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI L6

L6 is a tough, oil-hardening tool steel possessing a fine-grained structure and desirable shock resistance. L6 is also associated with high strength and good non-deforming characteristics.

Typical Applications

Forming Rolls, Spindles, Punches, Trim Dies, Blanking Dies, Embossing Dies, Forming Dies, and Shear Blades.

Typical Analysis	Type L6 (UNS T61206)
Carbon (C)	0.65 / 0.75
Manganese (Mn)	0.25 / 0.80
Silicon (Si)	0.50 max
Molybdenum (Mo)	0.50 max
Chromium (Cr)	0.60 / 1.20
Vanadium (V)	0.30 max
*Nickel (Ni)	1.25 / 2.00
Forging (a)	
Start forging at	1800 - 2000°F (982 - 1093°C)
Do not forge below	1550°F (843°C)
Normalizing (b)	1600°F (871 °C)
Annealing (c)	
Temperature	1400 - 1450°F (760 - 788°C)
Rate of cooling, max. per hour	40°F (22°C)
Typical annealed hardness, Brinell	183-255
Hardening	
Rate of heating	Slowly
Hardening temperature	1450 - 1550°F (788 - 843°C)
Time at temperature, minutes	10 - 30 (j)
Quenching medium	0 (l)
Tempering	
Tempering temperature	350 - 1000°F (177 - 538°C)
Approx. tempered hardness, Rockwell C	45 - 62
Wear Resistance	Medium
Toughness	Very High
Resistance to Softening Effect of Elevatated Temperature	Low
Depth of Hardening	Medium
Machinability	Medium
Grindability	High
Distortion in Heat Treating	Low
Safety in Hardening	Medium
Resistance to Decarburization	High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI S5

S5 is an oil-hardening silicon-manganese steel of medium carbon content especially adapted for punches, shear blades, chisels, and other shock resisting applications. S5 is therefore applicable where the properties of silicon-manganese steels are desired in combination with well-known advantages of oil-hardening steels. A reduced tendency to distort or crack in heat treatment is accordingly combined with high toughness in S5.

Typical Analysis	Type S5 (UNS T41905)
Carbon (C)	0.50 / 0.65
Manganese (Mn)	0.60 / 1.00
Silicon (Si)	1.75 / 2.25
Tungsten (W)	
Molybdenum (Mo)	0.20 / 1.35
Chromium (Cr)	0.35 max
Vanadium (V)	0.35 max
Cobalt (Co)	
Forging (a)	
Start forging at	1850 - 2050°F (1010 - 1121°C)
Do not forge below	1600°F (871°C)
Normalizing (b)	Do not normalize
Annealing (c)	
Temperature	1425 -1475°F (774 - 802°C)
Rate of cooling, max. per hour	25°F (14°C)
Typical annealed hardness, Brinell	192-229
Hardening	
Rate of heating	Slowly
Preheat Temperature	1400°F (760°C)
Hardening temperature	1600 - 1700°F (871 - 927°C)
Time at temperature, minutes	5 - 20
Quenching medium	0 (I)
Tempering	
Tempering temperature	350 - 800°F (177 - 427°C)
Approx. tempered hardness, Rockwell C	50 - 60
Wear Resistance	Low to Medium
Toughness	Highest
Resistance to Softening Effect of Elevated Temperature	Low
Depth of Hardening	Medium
Machinability	Medium to High
Grindability	Medium to High
Distortion in Heat Treating	Medium
Safety in Hardening	High
Resistance to Decarburization	Low

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.
**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI S7

AISI S7 is a general purpose air-hardening tool steel with high impact and shock resistance. It has good resistance to softening at moderately high temperatures. This combination of properties makes it suitable for many hot work and cold work applications. Excellent combination of high strength and toughness. Useful in moderate hot work as well as cold work work tooling. Added size stability when air hardened.

Typical Applications

Bull Riveters, Concrete Breakers (Moll Points), Riveting Dies, Powder Metal Dies, Notching Dies, Dowels, Drills, Drill Plates, Hubs, Plastic Mold Dies, Cold Forming Dies, Blanking Dies, Bending Dies, and Master Hobs.

Typical Analysis	Type S7 (UNS T41907)
Carbon (C)	0.45 / 0.55
Manganese (Mn)	0.20 / 0.80
Silicon (Si)	0.20 / 1.00
Tungsten (W)	
Molybdenum (Mo)	1.30 / 1.80
Chromium (Cr)	3.00 / 3.50
Vanadium (V)	0.30 max
Cobalt (Co)	
Forging (a) Start forging at Do not forge below	 1950 - 2050°F (1066 - 1121°C) 1700°F (927°C)
Normalizing (b)	Do not normalize
Annealing (C) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1500 - 1550°F (816 - 843°C) 25°F (14°C) 187-223
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly 1200 - 1300°F (649 - 704°C) 1700 - 1750°F (927 - 954°C) 15 - 45 (j) A or O (l)
Tempering Tempering temperature (Do not temper below 400°F) Approx. tempered hardness, Rockwell C	 400 - 1150°F (204 - 621°C) 45 - 57
Wear Resistance	Low to Medium
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	High
Depth of Hardening	Medium to Deep
Machinability	Medium to High
Grindability	Medium to High
Distortion in Heat Treating	A: Lowest /O: Low
Safety in Hardening	A: Highest /O: High
Resistance to Decarburization	Medium

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI S7 ESR

S7 ESR tool steel is specifically designed for use in molds and other applications where a highly polished or a very smooth finish is required. The ESR (Electro Slag Remelt) process removes most of the non-metallic inclusions in the steel. S7 ESR double melt's relatively low carbon level, fortified chemistry, ultra-clean, uniform, and homogeneous internal structure make it superior to the other conventionally manufactured shock-resisting tool steels. The following charts show microcleanliness ratings of ESR tool steels by ASTM E45, Method D:

Typical Microcleanliness	A	B	C	D
Thin	< 0.5	< 0.5	< 0.5	1.0
Heavy	< 0.5	< 0.5	< 0.5	1.0

Maximum Rated Microcleanliness	A	B	C	D
Thin	1.5	1.5	2.0	1.5
Heavy	1.0	1.0	1.0	1.0

The quality control of the S7 ESR process assures the exceptional cleanliness throughout by removing most harmful inclusions in the material (such as, oxides, nitrides and sulfides). The ESR steel produced will reflect a mirror like surface condition, subsequently reducing friction giving you easier ejection of parts, the elimination of minute scratches, and other stress-raisers that could lead to premature die failures.

The higher quality steel produced by special melt practices imparts a most important characteristic—freedom of inclusions and other imperfections. Other advantages include: cleanliness, stability, improved mechanical properties, structures relatively free from segregation resulting in less cracking, and quality assurance by ultrasonic testing of all ESR material produced.

Typical Analysis	Type S7 ESR
Carbon (C)	.50
Manganese (Mn)	.60
Silicon (Si)	.65
Molybdenum (Mo)	1.40
Chromium (Cr)	3.25

Annealing (C)

When properly annealed, this steel has a machinability rating of 95 as compared to a 1% carbon steel rated at 100.

Tempering

Tempering	Rockwell C
As Quenched	60
400°F	58
500°F	56
600°F	55
700°F	54
800°F	53
900°F	52
1000°F	51
1100°F	47
1200°F	38

1" specimen, 3 long were air-hardened from 1725°F.

Material may become brittle when tempered at less than 400°F.

Please refer to pg. 8-58 for Hardening information

** Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI P20

Prehardened

P20 is a chrome-moly tool steel made specifically to fill the requirements for the machined cavities and forces used in zinc die casting and plastic molding. It is delivered fully quenched and tempered to approximately Brinell 300. Other hardness levels may be obtained through additional heat treatment. P20 composition and structure provide excellent machining and polishing characteristics.

Typical Analysis	Type P20 (UNS T51620)
Carbon (C)	0.35
Manganese (Mn)	0.80
Silicon (Si)	0.50
Tungsten (W)	
Molybdenum (Mo)	0.45
Chromium (Cr)	1.70
Vanadium (V)	
Cobalt (Co)	
Nickel (Ni)	
Forging (a) Start forging at Do not forge below	 2000°F (1093°C) 1700°F (927°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1450-1500°F (788-816°C) 30°F per hour to 1000°F 207 max.
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly None 1500-1600°F (816-871°C) 60 min. per inch of thick. O (I)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 300-1200°F (149-649°C) 26-54
Wear Resistance	Low to Medium
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	High
Depth of Hardening	Medium to Deep
Machinability	Medium
Grindability	Medium
Distortion in Heat Treating	Low
Safety in Hardening	High
Resistance to Decarburization	High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI T420 Stainless ESR

AISI T420 ESR is an air or oil hardening mold steel having superior internal steel cleanliness combined with good resistance to corrosion. It is suitable for mold applications and is capable of providing an excellent polished surface. A special re-melting process called Electro Slag Refining or ESR provides a 420 type steel with the very low inclusion content required by mold makers who polish mold surfaces.

Typical Analysis	Type T420 (UNS S42000)
Carbon (C)	Over 0.15
Manganese (Mn)	1.00 max
Silicon (Si)	1.00 max
Tungsten (W)	0.03 max
Molybdenum (Mo)	0.03 max
Chromium (Cr)	12.00 / 14.00
Vanadium (V)	
Cobalt (Co)	
*Nickel (Ni)	
Forging (a) Start forging at Do not forge below	
Normalizing (b)	
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1600 - 1650°F (871 - 899°C) 192 - 241
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 1350 - 1450°F (735 - 788°C) 1850 - 1950°F (1110 - 1066°C) A (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 450 - 750°F (232 - 399°C) 49 - 53
Wear Resistance	Low
Toughness	Medium
Resistance to Softening Effect of Elevated Temperature	Good
Depth of Hardening	Medium
Machinability	Medium
Grindability	Good
Distortion in Heat Treating	Low
Safety in Hardening	High
Resistance to Decarburization	Medium

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.
**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI W2

W2 is a shallow hardening tool steel. Due to its vanadium content, the grain is superior in toughness and resistance to fatigue compared to straight carbon tool steels thereby making it desirable for many types of impact tools.

Typical Analysis	Type W2 (UNS T27302)
Carbon (C)	0.85 / 1.50
Manganese (Mn)	0.10 / 0.40
Silicon (Si)	0.10 / 0.40
Tungsten (W)	0.15 max
Molybdenum (Mo)	0.10 max
Chromium (Cr)	0.15 max
Vanadium (V)	0.15 / 0.35
Cobalt (Co)	
*Nickel (Ni)	0.20 max
Forging (a) Start forging at Do not forge below	 1800 - 1950°F (982 - 1066°C) 1500°F (816°C)
Normalizing (b)	1450 - 1700°F (d)
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1360 - 1450°F(d) (738 - 788°C) 40°F (22°C) 156 - 201
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Slowly (g) 1400 - 1550°F (e) (760 - 843°C) 10 - 30 B or W (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 350 - 650°F (177 - 343°C) 50 - 64
Wear Resistance	Low to Medium
Toughness	High (l)
Resistance to Softening Effect of Elevated Temperature	Low
Depth of Hardening	Shallow
Machinability	Highest
Grindability	Highest
Distortion in Heat Treating	High
Safety in Hardening	Low to Medium
Resistance to Decarburization	Highest

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

AISI H13

H13 is a 5% chromium hot work tool steel designed for applications that require extreme toughness combined with good red-hardness. H13 will allow an extra margin of safety in tools subject to heavy hammer blows, and those containing deep recesses or sharp corners. Although H13 was designed as a hot work steel, it has solved many cold work applications where extra toughness could be gained with some sacrifice of wear resistance.

Typical Applications

Aluminum Extrusion Dies, Die Casting Dies, Heavy Duty Compression Tools, Forming Punches, Hot Forging Dies, Shear Blades, Plastic Mold Dies, and Bolt Dies.

Typical Analysis	Type H13 (UNS T20813)
Carbon (C)	0.32 / 0.45
Manganese (Mn)	0.20 / 0.50
Silicon (Si)	0.80 / 1.20
Tungsten (W)	
Molybdenum (Mo)	1.10 / 1.75
Chromium (Cr)	4.75 / 5.50
Vanadium (V)	0.80 / 1.20
Cobalt (Co)	
*Nickel (Ni)	0.30 max
Forging (a) Start forging at Do not forge below	 1950 - 2100°F (1066 - 1149°C) 1650°F (899°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1550 - 1650°F (843 - 899°C) 40°F (22°C) 192 - 229
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching medium	 Moderately from preheat 1500°F (816°C) 1825 - 1900°F (996 - 1038°C) 15 - 40 (j) A (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 1000-1200°F (k) (538-649°C) 38-53
Wear Resistance	Medium
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	High
Depth of Hardening	Deep
Machinability	Medium to High
Grindability	Medium to High
Distortion in Heat Treating	Very Low
Safety in Hardening	Highest
Resistance to Decarburization	Medium to High

Please refer to pg. 8-58 for notes (a) to (o) incl., explanation of letter 0, A, S, B and W.

**Unless otherwise specified, nickel plus copper equal 0.75% max. for all tool steel types.*

Viscount 44®

Prehardened AISI Type H13 Typical Analysis

Viscount 44® is fully heat treated H13 hot work steel with carefully controlled and evenly dispersed sulphide additives. It is the same analysis type as Latrobe's popular VDC, but the free-machining sulphides improve the machinability to the point where die work at a hardness of Rockwell C 42-46 is practical. It is thus possible to bypass the risk of heat treatment involved in tool building.

Prehardening gives Viscount 44® a tremendous advantage when used for hot work dies because of the constant danger of size change or distortion during heat treatment. The product also eliminates costly finishing operations after heat treatment.

Using prehardened Viscount 44® for extrusion tools makes it possible to produce dies, backers, bolsters, dummy blocks, etc. in a few hours, allowing extremely short delivery schedules to be met. In addition, the use of prehardened Viscount 44® for extrusion dies ensures clean metal at the bearing surfaces free from any possible decarburization, carburization, scale, sub-scale or other deleterious conditions sometimes encountered when finished dies are heat treated.

Field tests show that Viscount 44®'s performance in aluminum, magnesium, and zinc die casting dies is at best the equivalent of regular H13. Particular examples have shown that over 100,000 shots can be obtained in large dies and over 200,000 shots in smaller dies.

Field reports also indicate excellent performance with Viscount 44® on forging dies, plastic molds, extrusion tools, and other hot work tools.

Typical Analysis	Viscount 44®
Carbon (C)	0.40
Manganese (Mn)	0.80
Silicon (Si)	1.00
Tungsten (W)	
Molybdenum (Mo)	1.35
Chromium (Cr)	5.25
Vanadium (V)	1.00
Cobalt (Co)	
Tempering Approx. tempered hardness, Rockwell C	42 - 46
Wear Resistance	Medium
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	High
Depth of Hardening	
Machinability	Low
Grindability	Medium
Distortion in Heat Treating	
Safety in Hardening	
Resistance to Decarburization	

DRM1

Hot and Warm Forging Die Steel

DRM1 tool steel features high hardness and high tough Matrix type high speed tool steel vastly surpasses hot work die steels. DRM1 improves hot and warm die life by its higher toughness than conventional grade.

Typical Applications

Used for hot and warm forging dies and punches.

Typical Analysis	Type DRM1
Carbon (C)	0.60
Manganese (Mn)	0.50
Silicon (Si)	0.20
Tungsten (W)	3.00
Molybdenum (Mo)	1.00
Chromium (Cr)	4.20
Vanadium (V)	1.50
Cobalt (Co)	2.00
Annealing (c) Temperature Slow cooling Typical annealed hardness, Brinell	 1472 - 1616°F (800 - 880°C) ≤ 235HB
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching	 Moderately from preheat 1742°F (950°C) 2012 - 2084°F (1100 - 1140°C) 20-30 per inch of thickness for material under 4" 10-20 per inch of thickness for material 4" and over OQ-Oil Quenching, GC-Gas Quenching in vacuum furnace, Salt Bath, Similar to conventional high speed steels
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	Minimal Double Temper AC-Air Cooling, 1022-1148°F (550-620°C) 56-58 HRC
Wear Resistance	Good
Toughness	Very High
Resistance to Softening Effect of Elevated Temperature	High
Machinability	Better and faster than conventional high speed steels
Grindability	Better and faster than conventional high speed steels

DRM2

Warm and Cold Forging Die Steel

DRM2 is a matrix type high speed tool steel available for warm and cold forging tools where critical performance is required. DRM2 prolongs service life due to its higher hardness and toughness than those of conventional grades.

Typical Applications

Used for warm and cold forging dies and punches.

Typical Analysis	Type DRM2
Carbon (C)	0.70
Tungsten (W)	1.00
Molybdenum (Mo)	2.40
Chromium (Cr)	5.50
Vanadium (V)	1.00
Annealing (c) Temperature Slow cooling Typical annealed hardness, Brinell	 1472 - 1616°F (800 - 880°C) ≤ 235HB
Hardening Rate of heating Preheat temperature Hardening temperature Time at temperature, minutes Quenching	 Moderately from preheat 1742°F (950°C) 1922 - 2012°F (1050 - 1100°C) 20-30 per inch of thickness for material under 4" 10-20 per inch of thickness for material 4" and over OQ-Oil Quenching, GC-Gas Quenching in vacuum furnace, Salt Bath, Similar to conventional high speed steels
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	Minimal Double Temper AC-Air Cooling, 1022 - 1148°F (550 - 620°C) 58 - 62 HRC
Wear Resistance	Good
Toughness	High
Resistance to Softening Effect of Elevated Temperature	High
Machinability	Better and faster than conventional high speed steels
Grindability	Better and faster than conventional high speed steels

DRM3

Cold Forging Die Steel

Conventional grade MH88 has been improved to DRM3. High hardness and tough DRM3 with excellent hardenability is suitable for high precision cold working tools.

Typical Applications

Used for hot and warm forging dies and punches.

Typical Analysis	Type DRM3
Carbon (C)	0.80
Manganese (Mn)	0.35
Silicon (Si)	0.70
Tungsten (W)	0.95
Molybdenum (Mo)	4.35
Chromium (Cr)	5.50
Vanadium (V)	1.20
Annealing (c)	
Temperature	1472 - 1616°F (800 - 880°C)
Slow cooling	
Typical annealed hardness, Brinell	≤ 235HB
Hardening	
Rate of heating	Moderately from preheat
Preheat Temperature	1742°F (950°C)
Hardening temperature	2012 - 2084°F (1100 - 1140°C)
Time at temperature, minutes	30 - 90
Quenching	OQ-Oil Quenching, GC-Gas Quenching in vacuum furnace, Salt Bath, Similar to conventional high speed steels
Tempering	Minimal Double Temper AC-Air Cooling,
Tempering temperature	1022-1148°F (550-620°C)
Approx. tempered hardness, Rockwell C	62-66 HRC
Wear Resistance	Very High
Toughness	Good
Resistance to Softening Effect of Elevated Temperature	High
Machinability	Better and faster than conventional high speed steels
Grindability	Better and faster than conventional high speed steels

AISI M2

M2 is a tungsten-molybdenum high-speed steel and is a popular grade for general purpose cutting and non-cutting applications. It has a wider heat-treating range than most of the molybdenum high-speed steels, coupled with a resistance to decarburization that is characteristic of tungsten types. M2 offers an excellent combination of red hardness, toughness, and wear resistance. M2 is available in a wide variety of shapes and sizes. As with all Alro Specialty Metal products, M2 is subjected to a variety of rigid quality control tests and inspection to ensure quality, uniformity, and reliability.

Typical Applications

Broaches, Boring Tools, Chasers, Cold Forming Rolls, Cold Heading Inserts, Drills, End Mills, Form Tools, Hobs, Lathe and Planer Tools, Punches, Milling Cutters, Taps, Reamers, and Saws.

Typical Analysis	Type M2 (UNS T11302)
Carbon (C)	0.78 / 0.88
Manganese (Mn)	0.15 / 0.88
Silicon (Si)	0.20 / 0.45
Tungsten (W)	5.50 / 6.75
Molybdenum (Mo)	4.50 / 5.50
Chromium (Cr)	3.75 / 4.50
Vanadium (V)	1.75 / 2.20
Nickel (Ni)	0.30 max
Forging (a) Start forging at Do not forge below	 1900 - 2100°F (1038 - 1149°C) 1700°F (927°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1600 - 1650°F (871 - 899°C) 40°F (22°C) 212 - 241
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 Rapidly from preheat 1350-1550°F (732-843°C) 2175-2250°F (h) (1191-1232°C) 2-5 O, A, or S (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 1000-1100°F (538-593°C) 60-65
Wear Resistance	Very High
Toughness	Low
Resistance to Softening Effect of Elevated Temperature	Very High
Depth of Hardening	Deep
Machinability	Medium
Grindability	Low
Distortion in Heat Treating	A or S: Low/O: Medium
Safety in Hardening	Medium
Resistance to Decarburization	High

AISI M3

M3 was developed after extensive studies of the effect of increased carbon and vanadium contents on the intermediate molybdenum-tungsten high-speed steels. The analysis was tried and proven on practically all high-speed steel applications. M3 offers the unusual combination of extremely high-edge strength at high hardness levels. With few exceptions, best life is accomplished with a minimum hardness of 65.5 Rockwell C. Experience indicates that the chemical balance achieved in M3 results in optimum combination of cutting ability, abrasion resistance, edge strength, red hardness, and long service life. M3 is more readily machined and offers less grinding resistance than higher vanadium types.

Typical Applications

Drills, Taps, End Mills, Reamers, Counterbores, Broaches, Hobs, Form Tools, Lathe and Planer Tools, Checking Tools, Milling Cutters, Slitting Saws, Punches, Drawing Dies, and Wood Working Knives.

Typical Analysis	Type M3 (UNS T11313)
Carbon (C)	1.00 - 1.10
Manganese (Mn)	0.15 - 0.40
Silicon (Si)	0.20 - 0.45
Tungsten (W)	5.00 - 6.75
Molybdenum (Mo)	4.75 - 6.50
Chromium (Cr)	3.75 - 4.50
Vanadium (V)	2.25 - 2.75
Nickel (Ni)	0.30 max
Forging (a) Start forging at Do not forge below	 1900 - 2100°F (1038 - 1149°C) 1700°F (927°C)
Normalizing (b)	Do not normalize
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1600 - 1650°F (871 - 899°C) 40°F (22°C) 223 - 255
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 Rapidly from preheat 1350 - 1550°F (732-843°C) 2200 - 2250°F (h) (1191 - 1232°C) 2 - 5 O, A, or S (l)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 1000-1100°F (538-593°C) 61 - 66
Wear Resistance	Highest
Toughness	Low
Resistance to Softening Effect of Elevated Temperature	Very High
Depth of Hardening	Deep
Machinability	Medium
Grindability	Very Low
Distortion in Heat Treating	A or S: Low/O: Medium
Safety in Hardening	Medium
Resistance to Decarburization	High

AISI M4 (PM)

M4 PM, a member of the molybdenum-tungsten family of high-speed steels, is a special purpose grade which utilizes its higher carbon and vanadium contents to develop excellent abrasion resistance. Produced conventionally, M4 is difficult to machine in the annealed condition and grind in the hardened condition. M4 PM is produced by the powder metallurgy process and allows an addition of .06/.08 sulfur which provides a uniform dispersion of small sulfides throughout the structure and enhances machinability. Coupled with finer carbides and structural uniformity, better grindability is also achieved. These factors, along with increased toughness, are ideally suited for heavy-duty cold-work applications.

Typical Applications

Blades, Broaches, Chasers, Die Inserts, Form Tools, Lathe and Planer Tools, Milling Cutters, Punches, Reamers, Slitter Knives, Spade Drills, and Taps.

Typical Analysis	Type M4 PM (UNS T11304)
Carbon (C)	1.30
Manganese (Mn)	0.30
Silicon (Si)	0.40
Tungsten (W)	5.50
Molybdenum (Mo)	4.50
Chromium (Cr)	4.50
Vanadium (V)	4.00
Sulphur (S)	0.07
Forging (a) Start forging at Do not forge below	
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1550 - 1600°F (843 - 871°C)
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 1450 - 1550°F (788 - 843°C) 2150 - 2250°F (h) (1176 - 1232°C) 10 - 30 O (I)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 1000 - 1100°F (538 - 593°C) 62 - 66
Wear Resistance	Highest
Toughness	Low
Resistance to Softening Effect of Elevated Temperature	Very High
Depth of Hardening	Deep
Machinability	Medium
Grindability	High
Distortion in Heat Treating	Low
Safety in Hardening	Medium
Resistance to Decarburization	Medium

AISI M42

M42 is a molybdenum-cobalt high-speed steel capable of being hardened to 70 Rockwell C. The carbon content is higher than in most high-speed steels, and with this balanced composition, contributes to wear resistance and hot hardness as well as the high hardness capability. M42 exhibits good grindability and relatively good toughness at high hardness levels. M42 is being used for the machining of heat treated materials (high hardness) and high temperature alloys.

Typical Applications

Broaches, Circular and Dovetail Form Tools, Drills, End Mills, Lathe Tools, Milling Cutters, Punches, Reamers, Slitting Saws, and Twist Drills.

Typical Analysis	Type M42 (UNS T11342)
Carbon (C)	1.05 - 1.15
Manganese (Mn)	0.15 - 0.40
Silicon (Si)	0.15 - 0.65
Tungsten (W)	1.15 - 1.85
Molybdenum (Mo)	9.00 - 10.00
Chromium (Cr)	3.50 - 4.25
Vanadium (V)	0.95 - 1.35
Cobalt (Co)	7.75 - 8.75
Nickel (Ni)	0.30 max
Forging (a)	
Start forging at	1900 - 2100°F (1038 - 1149°C)
Do not forge below	1700°F (927°C)
Annealing (c)	
Temperature	1600 - 1650°F (871 - 899°C)
Rate of cooling, max. per hour	40°F (22°C)
Typical annealed hardness, Brinell	235 - 269
Hardening	
Rate of heating	Rapidly from preheat
Preheat Temperature	1350 - 1550°F (733 - 843°C)
Hardening temperature	2125 - 2175°F (h)(o) (1163 - 1191°C)
Time at temperature, minutes	2 - 5
Quenching medium	O, A, or S (l)
Tempering	
Tempering temperature	950-1100°F (510-593°C)
Approx. tempered hardness, Rockwell C	65-70
Wear Resistance	Very High to Highest
Toughness	Low
Resistance to Softening Effect of Elevated Temperature	Highest
Depth of Hardening	Deep
Machinability	Medium
Grindability	Low
Distortion in Heat Treating	A or S: Low/O: Medium
Safety in Hardening	Low to Medium
Resistance to Decarburization	Low

AISI T15 (PM)

T15 PM is a tungsten high-speed steel designed for use in machining operations requiring heavy cuts, high speeds and feeds. Its primary use is in applications requiring the machining of high-hardness heat-treated materials such as high temperature alloys. The high carbon, vanadium, and cobalt contents contribute to good wear resistance, hot hardness and good hardness capabilities. T15 PM is produced by the powder metallurgy process which has resulted in improved quality from the standpoint of structural uniformity, response to heat treatment and grindability. These factors, along with increased toughness, are increased usage in the industry because of its recognized superior cutting ability.

Typical Applications

Broaches, Chasers, Form Tools, Heavy Duty Cutting Tools, High Production Blades, Milling Cutters, Reamers, and Taps.

Typical Analysis	Type T15 PM (UNS T12015)
Carbon (C)	1.55
Manganese (Mn)	0.30
Silicon (Si)	0.30
Tungsten (W)	12.25
Molybdenum (Mo)	
Chromium (Cr)	4.00
Vanadium (V)	5.00
Cobalt (Co)	5.00
Forging (a) Start forging at Do not forge below	
Annealing (c) Temperature Rate of cooling, max. per hour Typical annealed hardness, Brinell	 1600 - 1650°F (871 - 899°C)
Hardening Rate of heating Preheat Temperature Hardening temperature Time at temperature, minutes Quenching medium	 1450 - 1500°F (788 - 816°C) 2175 - 2225°F (h)(o) (1190 - 1218°C)
Tempering Tempering temperature Approx. tempered hardness, Rockwell C	 1000 - 1100°F (538 - 593°C) 66 - 68
Wear Resistance	Highest
Toughness	Low
Resistance to Softening Effect of	
Elevated Temperature	Very High
Depth of Hardening	Deep
Machinability	Medium
Grindability	High
Distortion in Heat Treating	Medium
Safety in Hardening	Medium
Resistance to Decarburization	Medium

Heat Treating Notes

(a) The temperature at which to start heat treating is given as a range, the higher side of which should be used for large sections and heavy or rapid reductions, and the lower side for smaller sections and lighter reduction. As the alloy content of steel increases, the time of soaking at forging temperature increases proportionately. Likewise, as the alloy content increases, it becomes necessary to cool slowly from the maximum heating temperature. With very high alloy steels, such as high-speed steels and air- hardening steels, this slow cooling is imperative in order to prevent cracking and to leave the steel in semi-soft condition. Either furnace cooling or burying in an insulating medium, such as lime, mica, or silocel is satisfactory.

(b) The length of time the steel is held after being uniformly heated through at the normalizing temperature varies from about 15 minutes for a small section to about one hour for large sizes. Cooling from the normalizing temperature is done in still air. The purpose of normalizing after forging is to refine the grain structure and to produce a uniform structure throughout the forging. Normalizing should not be confused with low temperature [about 1200°F (649°C)] annealing used for the relief of residual stresses resulting from heavy machining, bending, and forming.

(c) The annealing temperature is given as a range, the upper limit of which should be used for large sections and the lower limit for smaller sections. The length of time the steel is held after being uniformly heated through at the annealing temperature varies from about one hour for light sections and small furnace charges of carbon or low alloy tool steel to about four hours for heavy sections and large furnace charges of high alloy steel.

(d) Normalizing, annealing, and hardening temperatures of carbon tool steels are given as ranges as they vary with carbon content. The following temperatures are suggested:

Normalizing

0.60 to 0.75%	C: 1500°F (816°C)
0.75 to 0.90%	C: 1450°F (788°C)
0.90 to 1.10%	C: 1600°F (871°C)
1.10 to 1.40%	C: 1600 to 1700°F (871 to 927°C)

Annealing

0.60 to 0.90%	C: 1360 to 1400°F (738 to 760°C)
0.90 to 1.40%	C: 1400 to 1450°F (760 to 788°C)

(e) Varies with carbon content as follows:

0.60-0.80%	C: 1450-1550°F (788 to 843°C)
0.85-1.05%	C: 1425-1550°F (774 to 843°C)
1.10-1.40%	C: 1400-1525°F (760 to 829°C)

(f) Toughness decreases with increasing carbon content and depth of hardening.

(g) For large tools and tools having intricate sections, preheating at 1050-1200°F (566-649°C) is recommended.

(h) When high temperature heating is carried out in a salt bath, the range of temperatures should be about 25°F (14°C) lower than that shown.

(j) Times shown apply to open furnace heat treatment. For pack hardening a common rule is to heat for 1/2 hour per inch (25.4 mm) of cross section of the pack.

(k) Double tempering suggested for not less than one hour at temperature each temper.

(l) O: Oil quench
A: Air Cool
S: Salt bath quench
B: Brine quench
W: Water quench

(m) Triple tempering suggested for not less than one hour at temperature each temper.

(n) When high carbon material is involved, lowering of the hardening temperature an additional 25°F (14°C) is suggested. This is in addition to the 25°F (14°C) reduction involving salt bath hardening.

(o) Available in two silicon contents, nominally 0.33% and 0.55%. When 0.55% silicon is used, the maximum suggested hardening temperature is 2150°F (1177°C).

Tool Wrap

Tool Wrap is a revolutionary new approach to the heat treatment process. Here's how it works: wrap your parts in our special Tool Wrap as you would a package or a sandwich because Tool Wrap can be wrinkled, folded or cut with scissors (.002 thick T321 Stainless). Then place in your furnace and air cool as usual with the Tool Wrap on the material. Try Tool Wrap on all air hardening grades and hot work steels.

Consider the following advantages of Tool Wrap:

- ✓ No costly atmosphere or special controls needed.
- ✓ No time consuming Ni chrome box packing.
- ✓ Scale free heat treating.
- ✓ Hardened parts remain scale free, minimizing grinding.

Grade Availability		
Grade	**Thickness**	**Maximum Temperature**
321 Stainless	.002"	2000°F (1093°C)
309 Stainless	.002"	2240°F (1093°C)

Tool Wrap edges are extremely sharp, gloves should always be worn when working with Tool Wrap.

Tool Steel Flats and Squares (DCF)

Size (inches)		Weight (lbs./foot)
3/8 x	1/2	0.785
	3/4	1.126
	1	1.466
	1-1/4	1.806
	1-3/8	1.977
	1-1/2	2.147
	1-3/4	2.487
	2	2.827
	2-1/4	3.168
	2-1/2	3.508
	2-3/4	3.848
	3	4.189
	3-1/2	4.869
	3-3/4	5.210
	4	5.550
	4-1/2	6.231
	5	6.911
	6	8.272
	6-1/2	8.953
	7	9.634
	8	10.995
	9	12.356
	10	13.718
	12	18.691
1/2 x	1/2	1.031
	5/8	1.254
	3/4	1.478
	7/8	1.701

Size (inches)		Weight (lbs./foot)
1/2 x	1	1.924
	1-1/8	2.148
	1-1/4	2.371
	1-3/8	2.594
	1-1/2	2.818
	1-3/4	3.264
	1-7/8	3.488
	2	3.711
	2-1/4	4.158
	2-1/2	4.604
	2-3/4	5.051
	3	5.498
	3-1/4	5.944
	3-1/2	6.391
	4	7.284
	4-1/2	8.178
	5	9.071
	5-1/2	9.964
	6	10.858
	6-1/2	11.751
	7	12.644
	8	14.431
	9	16.218
	10	18.004
	12	23.849
	14	27.783
	16	31.717

Size (inches)		Weight (lbs./foot)
5/8 x	5/8	1.553
	3/4	1.829
	7/8	2.106
	1	2.382
	1-1/8	2.659
	1-1/4	2.935
	1-3/8	3.212
	1-1/2	3.488
	1-3/4	4.041
	2	4.594
	2-1/4	5.148
	2-1/2	5.701
	2-3/4	6.254
	3	6.807
	3-1/4	7.360
	3-1/2	7.913
	4	9.019
	4-1/2	10.125
	5	11.231
	5-1/2	12.337
	6	13.443
	6-1/2	14.549
	7	15.655
	8	17.867
	9	20.079
	10	22.291
	12	29.006

Tool Steel Flats and Squares (DCF)

Size (inches)		Weight (lbs./foot)
3/4 x	3/4	2.181
	7/8	2.511
	1	2.841
	1-1/8	3.170
	1-1/4	3.500
	1-3/8	3.830
	1-1/2	4.159
	1-3/4	4.819
	2	5.478
	2-1/4	6.137
	2-1/2	6.797
	2-3/4	7.456
	3	8.116
	3-1/4	8.775
	3-1/2	9.434
	4	10.753
	4-1/2	12.072
	5	13.390
	5-1/2	14.709
	6	16.028
	6-1/2	17.347
	7	18.665
	8	21.303
	9	23.940
	10	26.578
	12	34.164
	14	39.799
	16	45.435
	20	56.706
7/8 x	7/8	2.916
	1	3.299
	1-1/8	3.682
	1-1/4	4.064
	1-3/8	4.447
	1-1/2	4.830
	1-3/4	5.596
	2	6.362
	2-1/4	7.127
	2-1/2	7.893
	2-3/4	8.659
	3	9.424
	3-1/4	10.190
	3-1/2	10.956
	4	12.487
	4-1/2	14.019
	5	15.550
	5-1/2	17.082
	6	18.613

Size (inches)		Weight (lbs./foot)
7/8 x	7	21.676
	8	24.739
	9	27.802
	10	30.865
	12	39.321
1 x	1	3.757
	1-1/4	4.629
	1-3/8	5.065
	1-1/2	5.501
	1-3/4	6.373
	2	7.245
	2-1/4	8.117
	2-1/2	8.989
	2-3/4	9.861
	3	10.733
	3-1/2	12.478
	4	14.222
	4-1/2	15.966
	5	17.710
	5-1/2	19.454
	6	21.198
	6-1/2	22.942
	7	24.687
	8	28.175
	9	31.663
	10	35.151
	12	44.479
	14	51.816
	16	59.153
1-1/8 x	1-1/8	4.704
	1-1/4	5.193
	1-1/2	6.172
	1-3/4	7.150
	2	8.129
	2-1/4	9.107
	2-1/2	10.086
	2-3/4	11.064
	3	12.042
	3-1/2	13.999
	4	15.956
	4-1/2	17.913
	5	19.870
1-1/8 x	5-1/2	21.827
	6	23.783
	8	31.611
	10	39.438
	12	49.636

Size (inches)		Weight (lbs./foot)
1-1/4 x	1-1/4	5.758
	1-1/2	6.843
	1-3/4	7.927
	2	9.012
	2-1/4	10.097
	2-1/2	11.182
	2-3/4	12.267
	3	13.351
	3-1/2	15.521
	4	17.690
	4-1/2	19.860
	5	22.030
	5-1/2	24.199
	6	26.369
	7	30.708
	8	35.047
	9	39.386
	10	43.725
	12	54.794
	16	72.872
	20	90.949
	24	109.027
1-3/8 x	1-3/8	6.918
	1-1/2	7.514
	1-3/4	8.705
	2	9.896
	2-1/4	11.087
	2-1/2	12.278
	2-3/4	13.469
	3	14.660
	3-1/2	17.043
	4	19.425
	4-1/2	21.807
	5	24.189
	5-1/2	26.572
	6	28.954
	8	38.483
	9	43.247
	10	48.012
	12	59.951
1-1/2x	1-1/2	8.184
	1-3/4	9.482
	2	10.779
	2-1/4	12.077
	2-1/2	13.374
	2-3/4	14.672
	3	15.969

DCF Thickness and Width Oversize Ranges :

Width (based on thickness)	
Thru < 4" thick	+0.035 to +0.077 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.124 oversize
Rough Milled 5" and over	+0.062 to +0.124 oversize

Thickness	
Thru < 4" thick	+0.015 to +0.035 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.125 oversize
Rough Milled 5" and over	+0.125 to +0.250 oversize

Note: Actual weight may vary because of oversize tolerance. Sizes not listed above can be cut from plate. For Powdered Metal add 3% for weight.

Tool Steel Flats and Squares (DCF)

Size (inches)		Weight (lbs./foot)
1-1/2x	3-1/2	18.564
	4	21.159
	4-1/2	23.754
	5	26.349
	5-1/2	28.944
	6	31.539
	7	36.729
	8	41.919
	9	47.109
	10	52.298
	12	65.109
	16	86.590
	20	108.071
	24	129.552
1-3/4x	1-3/4	11.036
	2	12.546
	2-1/4	14.057
	2-1/2	15.567
	2-3/4	17.077
	3	18.587
	3-1/2	21.608
	4	24.628
	4-1/2	27.648
	5	30.669
	5-1/2	33.689
	6	36.709
	7	42.750
	8	48.791
	9	54.831
	10	60.872
	12	75.424
2 x	2	14.314
	2-1/4	16.036
	2-1/2	17.759
	2-3/4	19.482
	3	21.205
	3-1/2	24.651
	4	28.097
	4-1/2	31.542
	5	34.988
	5-1/2	38.434
	6	41.880
	7	48.771
	8	55.662
	9	62.554
	10	69.445

Size (inches)		Weight (lbs./foot)
2 x	12	85.739
	16	114.027
	20	142.314
	24	170.601
2-1/4x	2-1/4	18.016
	2-1/2	19.952
	2-3/4	21.887
	3	23.823
	3-1/2	27.694
	4	31.565
	4-1/2	35.436
	5	39.308
	5-1/2	43.179
	6	47.050
	7	54.792
	8	62.534
	9	70.277
	10	78.019
	12	96.054
2-1/2x	2-1/2	22.144
	2-3/4	24.293
	3	26.441
	3-1/2	30.737
	4	35.034
	4-1/2	39.331
	5	43.627
	5-1/2	47.924
	6	52.220
	7	60.813
	8	69.406
	9	77.999
	10	86.592
2-1/2x	12	106.369
	16	141.463
	20	176.557
	24	211.651
2-3/4x	2-3/4	26.698
	3	29.059
	3-1/2	33.781
	4	38.503
	4-1/2	43.225
	5	47.947
	5-1/2	52.669
	6	57.390
	7	66.834
	8	76.278
	9	85.722

Size (inches)		Weight (lbs./foot)
2-3/4x	10	95.166
	12	116.684
	16	155.181
	20	193.678
	24	232.175
3 x	3	31.677
	3-1/2	36.824
	4	41.971
	4-1/2	47.119
	5	52.266
	5-1/2	57.413
	6	62.561
	7	72.855
	8	83.150
	9	93.445
	10	103.739
	12	127.000
	16	168.900
	20	210.800
3-1/2x	3-1/2	42.911
	4	48.909
	4-1/2	54.907
	5	60.905
	5-1/2	66.903
	6	72.901
	7	84.898
	8	96.894
	9	108.890
	10	120.887
	12	147.630
	16	196.336
	20	245.043
4 x	4	55.846
	4-1/2	62.695
	5	69.544
	5-1/2	76.393
	6	83.242
	7	96.940
	8	110.638
	9	124.336
	10	138.034
	12	168.260
	16	223.773
	20	279.286

DCF Thickness and Width Oversize Ranges :

Width (based on thickness)	
Thru < 4" thick	+0.035 to +0.077 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.124 oversize
Rough Milled 5" and over	+0.062 to +0.124 oversize

Thickness	
Thru < 4" thick	+0.015 to +0.035 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.125 oversize
Rough Milled 5" and over	+0.125 to +0.250 oversize

Note: Actual weight may vary because of oversize tolerance. Sizes not listed above can be cut from plate. For Powdered Metal add 3% for weight.

Tool Steel Flats and Squares (DCF)

Size (inches)		Weight (lbs./foot)
4-1/2 x	4-1/2	72.041
	5	79.831
	6	95.411
	8	126.571
	10	157.730

Size (inches)		Weight (lbs./foot)
5 x	5	88.550
	5-1/2	97.191
	6	105.832
	7	123.113
	8	140.394
	10	174.957
	12	209.520
5-1/2x	5-1/2	106.761
	6	116.252
	8	154.218
	10	192.184

Size (inches)		Weight (lbs./foot)
6 x	6	126.673
	7	147.357
	8	168.042
	10	209.411
	12	250.781

*** 10" thick plate is available in some grades. Please inquire.**

DCF Thickness and Width Oversize Ranges :

Width (based on thickness)	
Thru < 4" thick	+0.035 to +0.077 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.124 oversize
Rough Milled 5" and over	+0.062 to +0.124 oversize

Thickness	
Thru < 4" thick	+0.015 to +0.035 oversize
Rough Milled 4" thru < 5"	+0.062 to +0.125 oversize
Rough Milled 5" and over	+0.125 to +0.250 oversize

Note: Actual weight may vary because of oversize tolerance. Sizes not listed above can be cut from plate. For Powdered Metal add 3% for weight.

Carbon and Alloy Plate Tolerances

Tolerance Over Specified Thickness for Widths Given (inches)								
Specified Thickness (inches)	**Up thru 48"**	**>48" up to 60"**	**>60" up to 72"**	**>72" up to 84"**	**>84" up to 96"**	**>96" up to 108"**	**>108" up to 120"**	**>120" up to 132"**
Up thru 1/4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
>1/4 to 5/16	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
5/16 to 3/8	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
3/8 to 7/16	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
7/16 to 1/2	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
1/2 to 5/8	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
5/8 to 3/4	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
3/4 to 1	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05
1 to 2	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.10
2 to 3	0.09	0.09	0.09	0.10	0.10	0.11	0.12	0.13
3 to 4	0.11	0.11	0.11	0.11	0.11	0.13	0.14	0.14
4 to 6	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
6 to 10	0.23	0.24	0.24	0.24	0.24	0.24	0.24	0.24
10 to 12	0.29	0.29	0.33	0.33	0.33	0.33	0.33	0.33
12 to 15	0.29	0.29	0.35	0.35	0.35	0.35	0.35	0.35

Permissible variations in thickness for rectangular carbon, high strength, low alloy and alloy-steel plates, when ordered to thickness.
Note[1]: Permissible variation under specificed thickness - 0.01"
Note[2]: Thickness to be measured at 3/8" to 3/4" from longitudinal edge.
Note[3]: For thickness measured at any location other than that specified in Note[2], the permissible maximum over tolerance shall be increased by 75%, rounded to the nearest 0.01".

Tool Steel Rounds (DCF)

Diameter (inches)	Weight (lbs./foot)
1/4	.182
5/16	.285
3/8	.404
7/16	.545
1/2	.727
9/16	.912
5/8	1.117
11/16	1.344
3/4	1.591
7/8	2.157
1	2.799
1-1/8	3.525
1-1/4	4.335
1-3/8	5.225
1-1/2	6.206
1-5/8	7.408
1-3/4	8.564
1-7/8	9.803
2	11.125
2-1/8	12.531
2-1/4	14.021
2-3/8	15.595
2-1/2	17.252
2-5/8	18.993

Diameter (inches)	Weight (lbs./foot)
2-3/4	20.817
2-7/8	22.725
3	25.778
3-1/8	27.896
3-1/4	30.099
3-1/2	34.754
3-3/4	39.745
4	45.070
4-1/4	51.079
4-1/2	57.094
4-3/4	63.443
5	70.126
5-1/4	77.145
5-1/2	84.498
5-3/4	92.185
6	100.207
6-1/4	109.830
6-1/2	118.571
6-3/4	127.646
7	137.057
7-1/4	149.891
7-1/2	160.074
7-3/4	170.592
8	181.445

Diameter (inches)	Weight (lbs./foot)
8-1/2	204.154
8-3/4	211.460
9	228.202
9-1/2	253.589
10	280.423
10-1/2	308.492
11	337.900
11-1/2	368.646
12	400.928
12-1/2	434.359
13	469.130
13-1/2	505.238
14	543.372
14-1/2	582.182
15	622.331
16	706.644
17	796.311
18	891.333
19	991.709
20	1097.440
22	1324.964
24	1573.907
26	1844.266
28	2136.044

Notes: For Powdered Metal add 3% for weight.

DC53 rounds under 6-1/2" are hot rolled and oversized to finish at their normal size. Rounds 6-1/2" and over are rough turned and oversized to finish at their normal size. DC-53 is ordered to metric sizes and the weight (lbs./ft.) may vary compared to the imperial measurements.

M2 rounds are available in on-size diameters and oversize diameters. M2 rounds are available in 3/8" to 6" diameters.

Thickness & Width Oversize Ranges

De-Carb Free Flats and Squares

Size (inches)	Width - Based on Thickness (inches)	Thickness (inches)
Through 4" thick	+.035 / +.077 oversize	+.015 / +.035 oversize
Rough Milled 4" thru <5"	+.062 / +.124 oversize	+.062 / +.125 oversize
Rough Milled 5" and over	+.062 / +.124 oversize	+.125 / +.250 oversize

De-Carb Rounds, Typical Machining Allowances

	Nominal Size (inches)	Oversize Tolerance (inches)
Rough Turned Tolerances:	1/2 to under 3	+0.007 to +0.062
	3 thru 6	+0.020 to +0.186
(All rounds 3" diameter and over are supplied with a Rough Turned tolerance)	Over 6 thru 7	+0.060 to +0.250
	Over 7 thru 18	+0.090 to +0.375
	Over 18	+0.118 to +0.375

Machining and Decarburization Allowances

When ordering hot rolled bar stock, allowances must be made for machining in order to remove all decarburized surface. Decarburization is caused by heating for forging or rolling, and annealing. To obtain a uniform surface hardness and keep warpage to a minimum on finished tools, it is necessary to remove all the decarburization from all surfaces before hardening.

The minimum allowances for machining and the maximum decarburization limits for rounds, hexagons, octagons, and flats are given in the following tables.

Minimum Allowances Per Side for Machining Prior to Heat Treatment for Hot Rolled Rounds

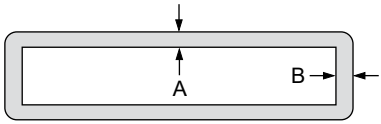
Ordered Size (inches)	Hot Rolled	Forged	Rounds Rough Turned
Up to 1/2, incl.	.016	—	—
Over 1/2 to 1, incl.	.031	—	—
Over 1 to 2, incl.	.048	.072	—
Over 2 to 3, incl.	.063	.094	.020
Over 3 to 4, incl.	.088	.120	.024
Over 4 to 5, incl.	.112	.145	.032
Over 5 to 6, incl.	.150	.170	.040
Over 6 to 8, incl.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

Hot Rolled

Machining and Decarburization Allowances

Maximum Decarburization Limits — 80% of allowances per side for machining

Minimum Allowances Per Side for Machining Prior to Heat Treatment for Hot-Rolled Square and Flat Bars



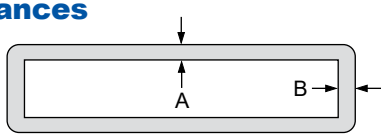
Specified Thickness (inches)		Specified Width (inches) 0 to 1/2 incl.	Over 1/2 to 1 incl.	Over 1 to 2 incl.	Over 2 to 3 incl.	Over 3 to 4 incl.	Over 4 to 5 incl.
0 to 1/2, incl.	A	.025	.025	.030	.035	.040	.045
	B	.025	.036	.044	.056	.068	.092
Over 1/2 to 1, incl.	A	---	.045	.045	.050	.055	.060
	B	---	.045	.052	.064	.080	.104
Over 1 to 2, incl.	A	---	---	.065	.065	.070	.070
	B	---	---	.065	.075	.084	.112
Over 2 to 3, incl.	A	---	---	---	.085	.085	.085
	B	---	---	---	.085	.102	.120
Over 3 to 4, incl.	A	---	---	---	---	.115	.115
	B	---	---	---	---	.115	.127
Over 4 to 5, incl.	A	---	---	---	---	---	.150
	B	---	---	---	---	---	.150
Over 5 to 6, incl.	A	---	---	---	---	---	---
	B	---	---	---	---	---	---
Over 6	A	---	---	---	---	---	---
	B	---	---	---	---	---	---

Specified Thickness (inches)		Specified Width (inches) 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.
0 to 1/2, incl.	A	.050	.055	.060	.060	.060
	B	.104	.120	.136	.144	.152
Over 1/2 to 1, incl.	A	.070	.070	.075	.075	.075
	B	.120	.136	.160	.160	.160
Over 1 to 2, incl.	A	.075	.075	.090	.095	.100
	B	.124	.144	.168	.180	.180
Over 2 to 3, incl.	A	.085	.090	.100	.100	.100
	B	.136	.160	.180	.190	.190
Over 3 to 4, incl.	A	.115	.115	.125	.125	.125
	B	.140	.180	.190	.190	.190
Over 4 to 5, incl.	A	.150	.150	.150	.150	.150
	B	.165	.180	.190	.190	.190
Over 5 to 6, incl.	A	.190	.190	.190	.190	.190
	B	.190	.190	.190	.190	.190
Over 6	A	---	.250	.250	.250	.250
	B	---	.250	.250	.250	.250

Hot Rolled

Machining and Decarburization Allowances

Minimum Allowances Per Side for Machining of Forged Squares and Flat Bars



Specified Thickness (inches)		Specified 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.
0 to 1/2, incl.	A	.030	.030	.035	.040	.045	.055
	B	.030	.048	.064	.080	.100	.120
Over 1/2 to 1, incl.	A	---	.060	.060	.065	.065	.075
	B	---	.060	.072	.084	.100	.120
Over 1 to 2, incl.	A	---	---	.090	.090	.090	.100
	B	---	---	.090	.100	.108	.124
Over 2 to 3, incl.	A	---	---	---	.120	.120	.125
	B	---	---	---	.120	.130	.140
Over 3 to 4, incl.	A	---	---	---	---	.150	.150
	B	---	---	---	---	.150	.150
Over 4 to 5, incl.	A	---	---	---	---	---	.180
	B	---	---	---	---	---	.180
Over 5 to 6, incl.	A	---	---	---	---	---	---
	B	---	---	---	---	---	---
Over 6	A	---	---	---	---	---	---
	B	---	---	---	---	---	---

Specified Thickness (inches)		Specified Width (inches) 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.
0 to 1/2, incl.	A	.065	.070	.075	---	---
	B	.144	.168	.200	---	---
Over 1/2 to 1, incl.	A	.080	.085	.090	.100	.110
	B	.144	.168	.200	.200	.200
Over 1 to 2, incl.	A	.110	.115	.125	.140	.150
	B	.148	.172	.200	.200	.200
Over 2 to 3, incl.	A	.130	.135	.150	.160	.175
	B	.148	.172	.200	.200	.200
Over 3 to 4, incl.	A	.160	.180	.190	.210	.225
	B	.160	.180	.190	.210	.225
Over 4 to 5, incl.	A	.180	.190	.210	.225	.250
	B	.180	.190	.210	.225	.250
Over 5 to 6, incl.	A	.210	.225	.225	.250	.250
	B	.210	.225	.225	.250	.250
Over 6	A	---	.250	.250	.250	.250
	B	---	.250	.250	.250	.250