CarTech® No. 883 Tool Steel

Identification

UNS Number

- T20813

AISI Number

- Type H13

Type Analysis

Single figures are nominal except where noted.

Carbon	0.41 %	**Manganese**	0.35 %
Silicon	1.00 %	**Chromium**	5.35 %
Molybdenum	1.40 %	**Vanadium**	0.90 %
Iron	Balance		

General Information

Description

CarTech No. 883 tool steel is a 5% chromium, hot work tool steel designed particularly for applications requiring extreme toughness combined with good red hardness. It will provide an extra margin of safety in tools subject to hammer blows and those tools containing deep recesses and sharp corners.

While CarTech No. 883 die steel has been designed primarily as a hot work tool steel, it has found many applications in cold work tools where extra toughness is required at the sacrifice of some wear resistance.

Applications

CarTech No. 883 tool steel has been used for hot working tools requiring the greatest possible toughness. Typical applications have included:

Aluminum extrusion dies
Bolt dies
Bulldozer dies
Die casting dies
Forging dies
Forming punches
Heavy duty compression tools
Hot forging tools with deep recesses and sharp corners
Hot piercing punches
Vastoning dies

If necessary, hot work tools made from this alloy can be water cooled in service without danger of cracking or heat checking.

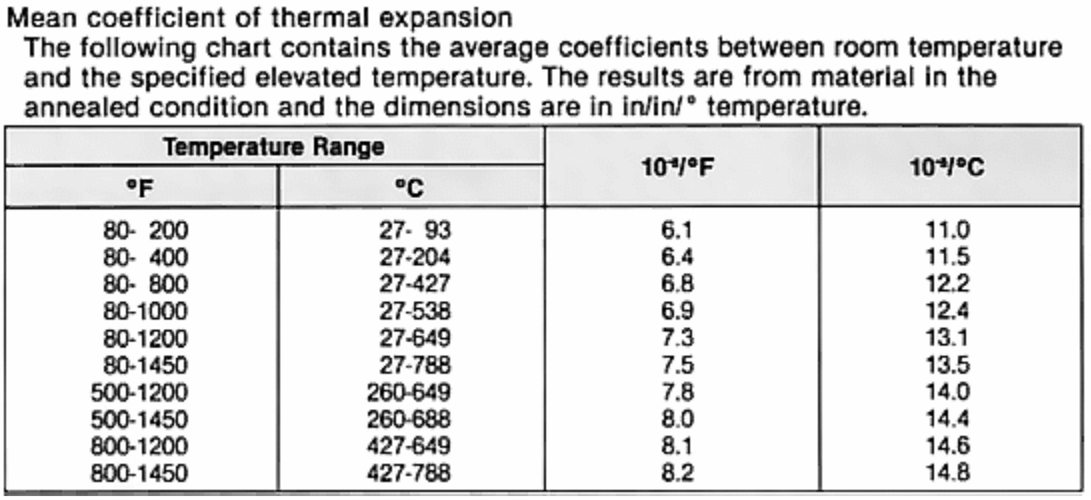
Because of the extreme toughness of No. 883 tool steel, it could also be considered for cold work applications where other steels have failed by breaking.

Properties

Physical Properties

Specific Gravity	7.77	
Density	0.2800	lb/in³
Mean Specific Heat	0.1100	Btu/lb/°F

Mean CTE		
80 to 200°F	6.10	x 10^{-6} in/in/°F
80 to 400°F	6.40	x 10^{-6} in/in/°F
80 to 800°F	6.80	x 10^{-6} in/in/°F
80 to 1000°F	6.90	x 10^{-6} in/in/°F
80 to 1200°F	7.30	x 10^{-6} in/in/°F
80 to 1450°F	7.50	x 10^{-6} in/in/°F
500 to 1200°F	7.80	x 10^{-6} in/in/°F
500 to 1450°F	8.00	x 10^{-6} in/in/°F
800 to 1200°F	8.10	x 10^{-6} in/in/°F
800 to 1450°F	8.20	x 10^{-6} in/in/°F

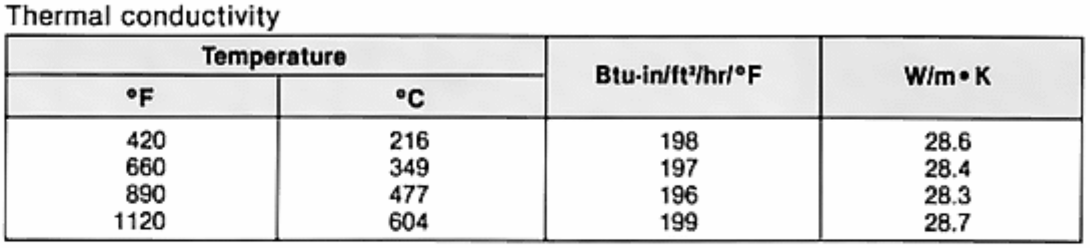


Mean coefficient of thermal expansion

The following chart contains the average coefficients between room temperature and the specified elevated temperature. The results are from material in the annealed condition and the dimensions are in in/in/° temperature.

Temperature Range		10^{-6}/°F	10^{-6}/°C
°F	°C		
80- 200	27- 93	6.1	11.0
80- 400	27-204	6.4	11.5
80- 800	27-427	6.8	12.2
80-1000	27-538	6.9	12.4
80-1200	27-649	7.3	13.1
80-1450	27-788	7.5	13.5
500-1200	260-649	7.8	14.0
500-1450	260-688	8.0	14.4
800-1200	427-649	8.1	14.6
800-1450	427-788	8.2	14.8

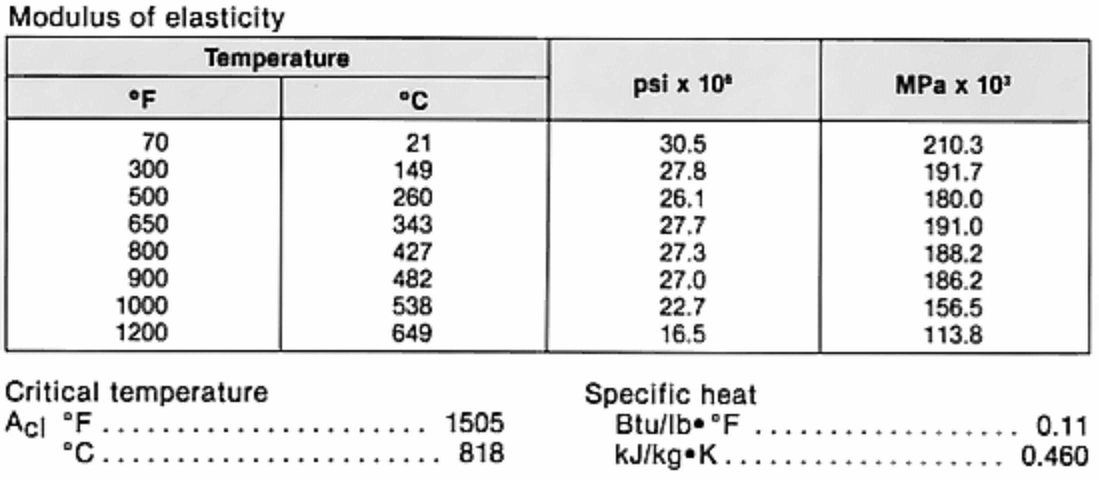
Thermal Conductivity		
420°F	198.0	BTU-in/hr/ft²/°F
660°F	197.0	BTU-in/hr/ft²/°F
890°F	196.0	BTU-in/hr/ft²/°F
1120°F	199.0	BTU-in/hr/ft²/°F



Thermal conductivity

Temperature		Btu-in/ft²/hr/°F	W/m • K
°F	°C		
420	216	198	28.6
660	349	197	28.4
890	477	196	28.3
1120	604	199	28.7

Modulus of Elasticity (E)		
70°F	30.5	x 10^{3} ksi
300°F	27.8	x 10^{3} ksi
500°F	26.1	x 10^{3} ksi
649°F	27.7	x 10^{3} ksi
801°F	27.3	x 10^{3} ksi
900°F	27.0	x 10^{3} ksi
1000°F	22.7	x 10^{3} ksi
1200°F	16.5	x 10^{3} ksi



Modulus of elasticity

Temperature		psi x 10^6	MPa x 10^3
°F	°C		
70	21	30.5	210.3
300	149	27.8	191.7
500	260	26.1	180.0
650	343	27.7	191.0
800	427	27.3	188.2
900	482	27.0	186.2
1000	538	22.7	156.5
1200	649	16.5	113.8

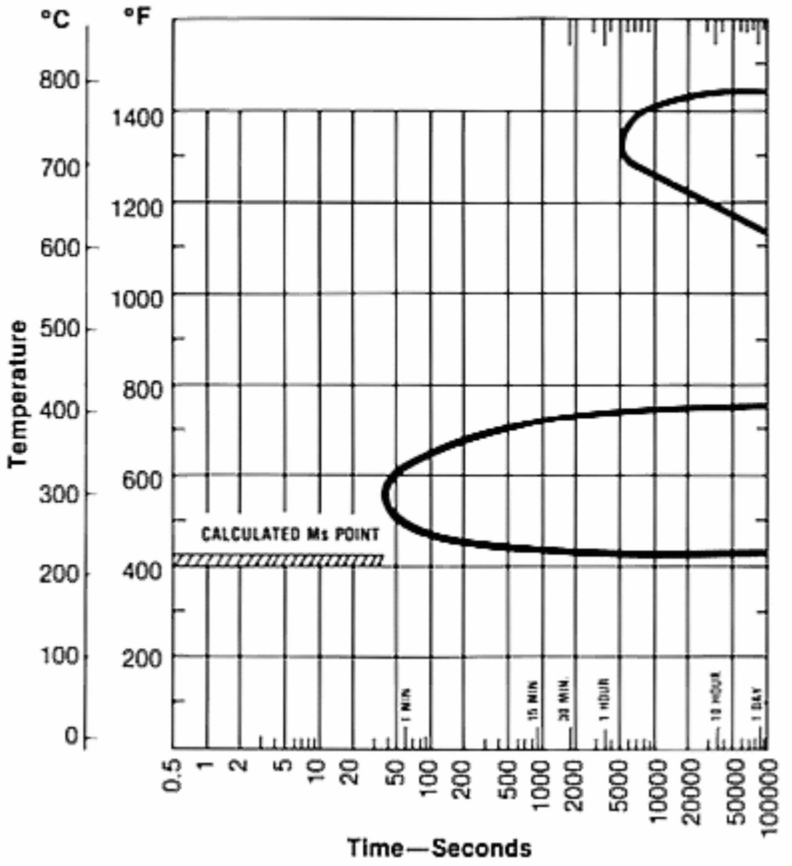
Critical temperature

A_{cl}	°F	1505
	°C	818

Specific heat

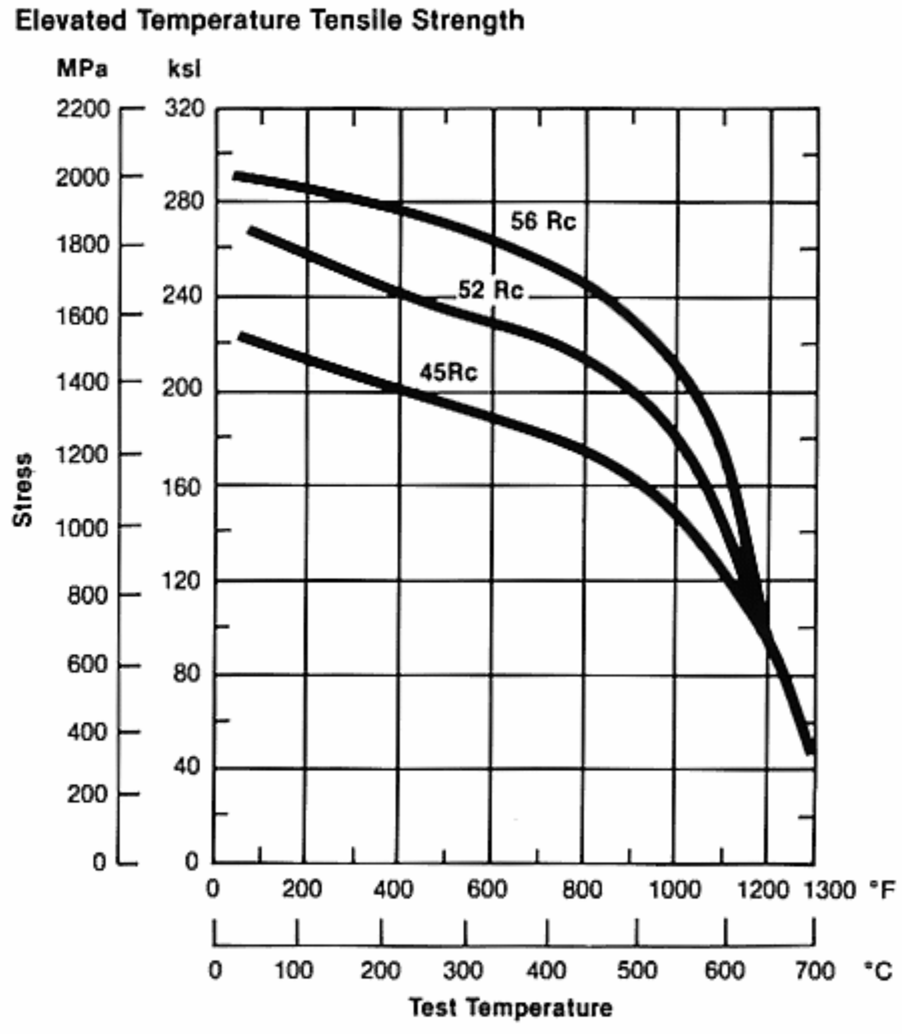
Btu/lb•°F	0.11
kJ/kg•K	0.460

Isothermal transformation diagram
Austenitizing temperature—1850°F (1010°C)

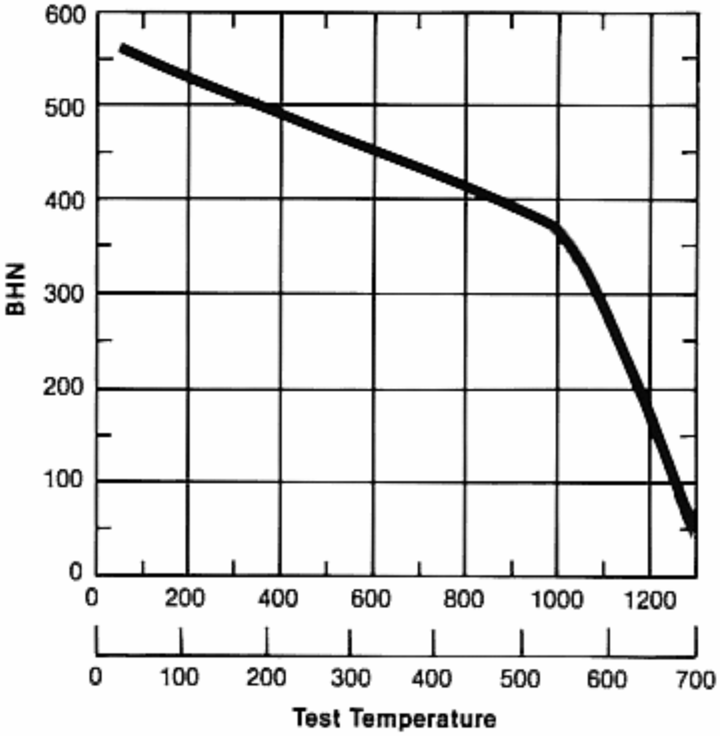


Critical Temperature (AC1)	1505 °F

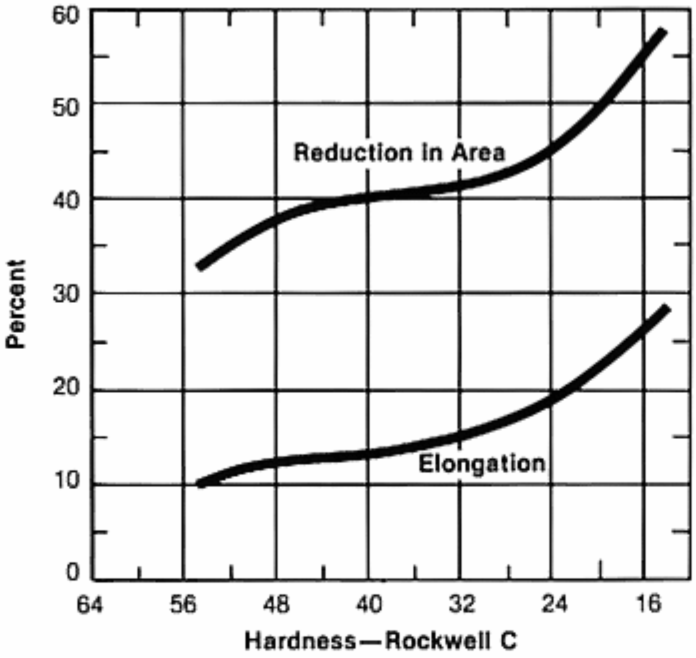
Typical Mechanical Properties

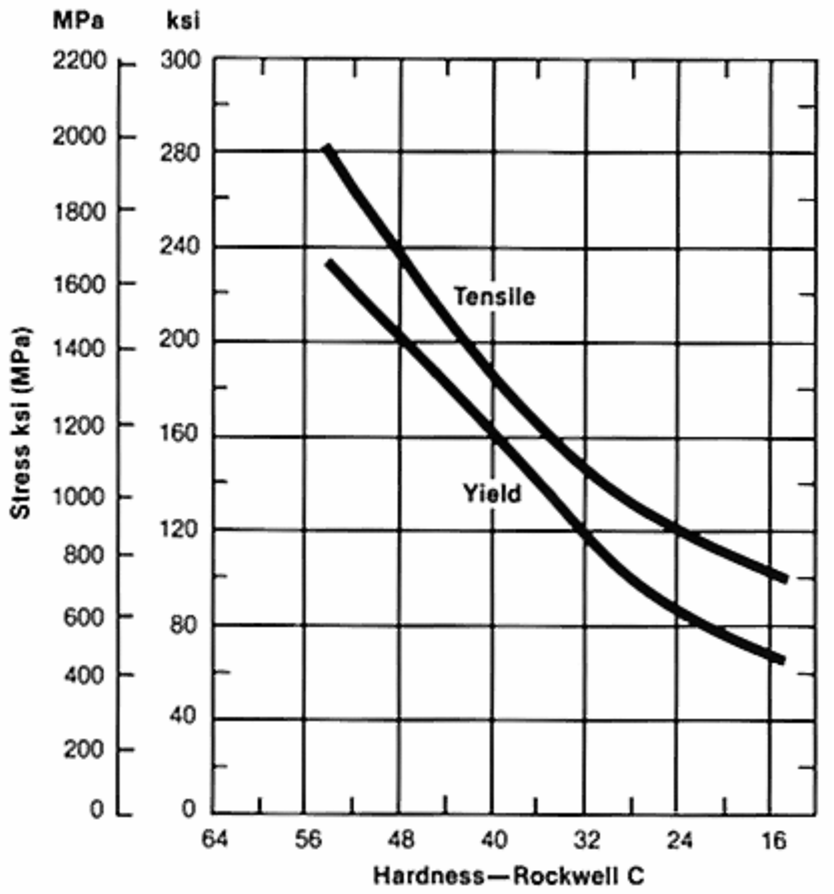


Hot Brinell Hardness

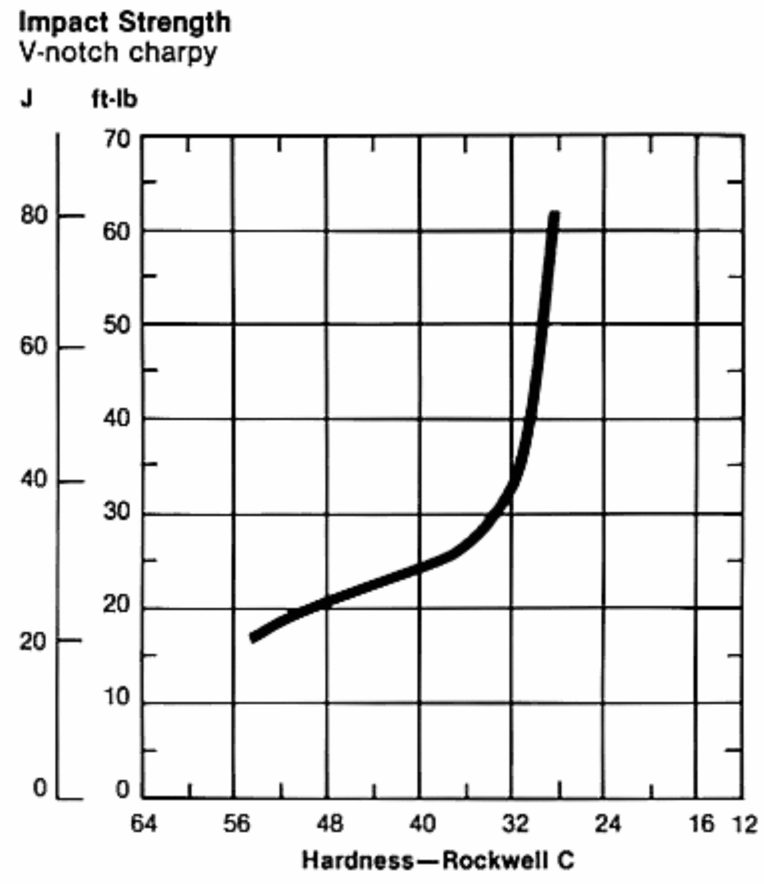


Reduction in Area and Elongation





Tensile and Yield Strength



Heat Treatment

Decarburization

Like other high carbon tool steels, No. 883 tool steel is subject to decarburization during thermal processing. Precautions must be taken to control this condition. Modern furnaces are available which provide environments designed to minimize decarburization.

Normalizing

Normalizing is not recommended for No. 883 tool steel and is not necessary after furnace cooling as indicated above.

Annealing

No. 883 tool steel should be packed in a suitable container, using a neutral packing compound, or placed in a controlled atmosphere furnace.

Heat uniformly to 1150/1600°F (843/871°C), then cool very slowly in the furnace at a rate of not more than 30°F (16.7°C) per hour until the furnace is black. The furnace may then be turned off and allowed to cool naturally. This will produce a maximum hardness of Brinell 241.

Hardening

No. 883 tool steel may be air treated or quenched in oil to harden.

For air treating, heat the furnace to 1850/1875°F (1010/1024°C), then place the tool right in the hot furnace near the thermocouple. Let the tool heat naturally until it uniformly matches the color of the thermocouple. Soak 20 minutes plus an additional 5 minutes per inch of thickness, then air cool.

For oil treating, follow the same procedure, but drop the temperature to 1825/1850°F (996/1010°C).

Control of decarburization can be achieved by using any one of the several modern heat treating furnaces designed for this purpose. If endothermic atmospheres are used, a dew point between 40/55°F (4/13°C) is suggested.

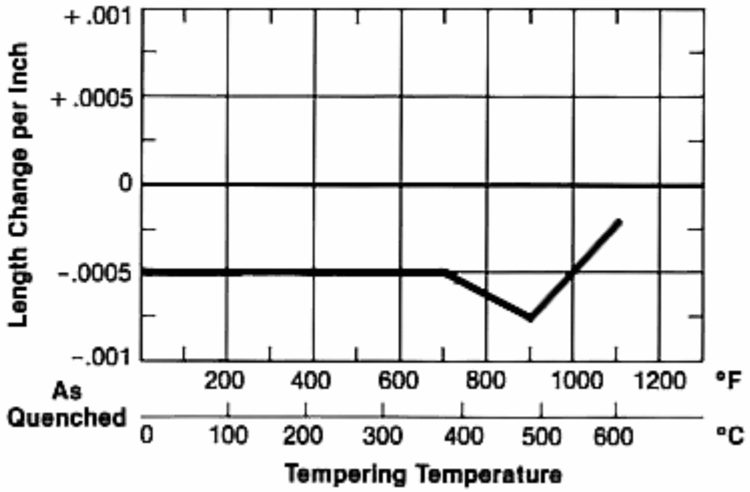
In older type, manually operated exothermic atmosphere furnaces, an oxidizing atmosphere is required. Excess oxygen of about 2 to 4% is preferred. If no atmosphere is available, the tool should be pack hardened or wrapped in stainless steel to protect its surface.

Deformation (Size Change) in Hardening

The accompanying hyperlink entitled "Size Change of No. 883 Tool Steel" shows typical length changes of No. 883 tool steel when it has been properly hardened and tempered. Note that the length change information is presented in inches per inch of original length. The hyperlink shows that this alloy can be expected to shrink slightly when heat treated. Shrinkage of approximately 0.0005 inches/inch occur when tempered at 1000°F (538°C). Tool steels hold size best when quenched from the proper hardening temperature. If overheated, they tend to show shrinkage after tempering.

Size Change of No. 883 Tool Steel

Austenitize—1875°F (1024°C), oil quenched and tempered 1 hour at indicated temperature



Stress Relieving

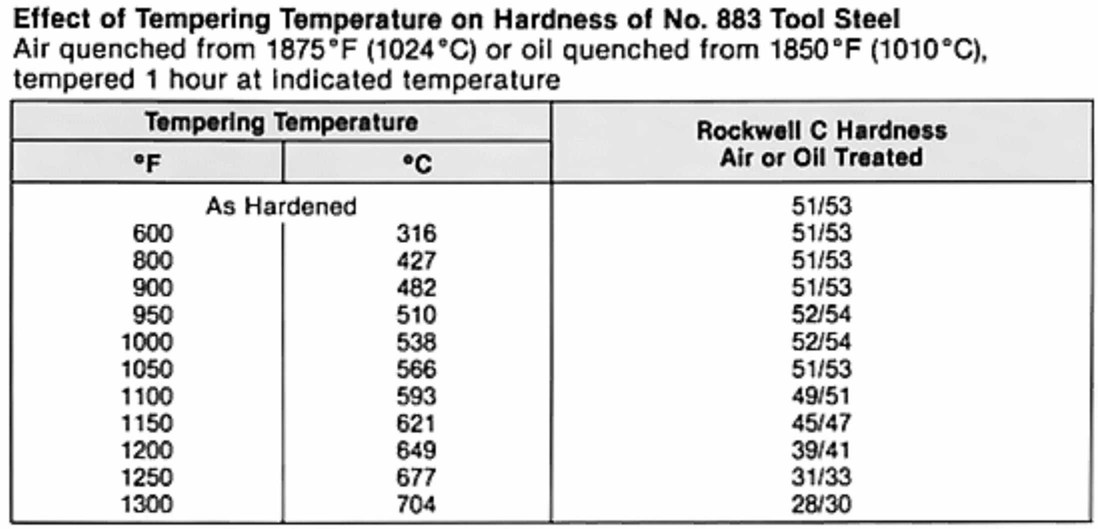
To relieve machining stresses for greater accuracy in hardening, first rough machine, then heat to a temperature of 1200/1250°F (649/677°C), hold for 1 hour at temperature, then slowly cool. Finish machine the parts following this treatment.

Tempering

Note in the hyperlink entitled "Effect of Tempering Temperature on Hardness" below that full hardness is maintained up to a tempering temperature of 1000°F (538°C). There is, therefore, no reason to temper No. 883 tool steel at a lower temperature.

For greater toughness, temper at a higher temperature.

Hot work tools should never be tempered at temperatures lower than the working temperature at which they will be used. It is also very important to preheat tools used in hot working applications.



Effect of Tempering Temperature on Hardness of No. 883 Tool Steel

Air quenched from 1875°F (1024°C) or oil quenched from 1850°F (1010°C), tempered 1 hour at indicated temperature

Tempering Temperature		Rockwell C Hardness Air or Oil Treated
°F	°C	
As Hardened		51/53
600	316	51/53
800	427	51/53
900	482	51/53
950	510	52/54
1000	538	52/54
1050	566	51/53
1100	593	49/51
1150	621	45/47
1200	649	39/41
1250	677	31/33
1300	704	28/30

Workability

Forging

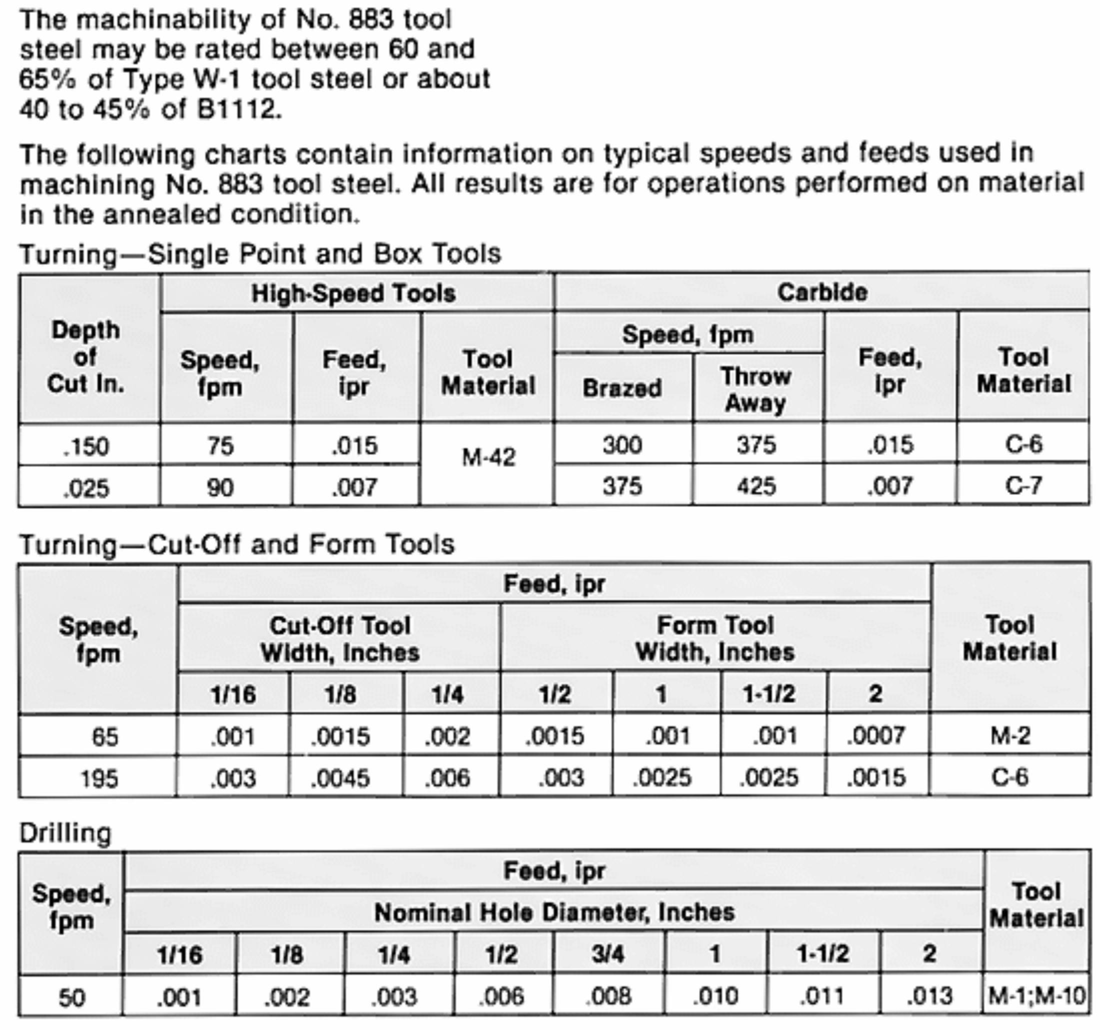
Heat slowly and uniformly to a temperature of 2000/2075°F (1093°/1135°C), then proceed to forge. Do not work the steel below 1650°F (899°C). Reheat as often as necessary to maintain proper forging temperature.

Small, simple forgings may be cooled slowly in lime. The best practice for large forgings is to place them in a heated furnace at approximately 1450°F (788°C), soak uniformly at this temperature, then shut off the heat and allow the material to cool slowly in the furnace. This is not an anneal. After the forging is cool, it must be annealed as indicated below.

Machinability

The machinability of No. 883 tool steel may be rated between 60 and 65% of Type W-1 tool steel or about 40 to 45% of B1112.

Following are typical feeds and speeds for No. 883 tool steel.



The machinability of No. 883 tool steel may be rated between 60 and 65% of Type W-1 tool steel or about 40 to 45% of B1112.

The following charts contain information on typical speeds and feeds used in machining No. 883 tool steel. All results are for operations performed on material in the annealed condition.

Turning—Single Point and Box Tools

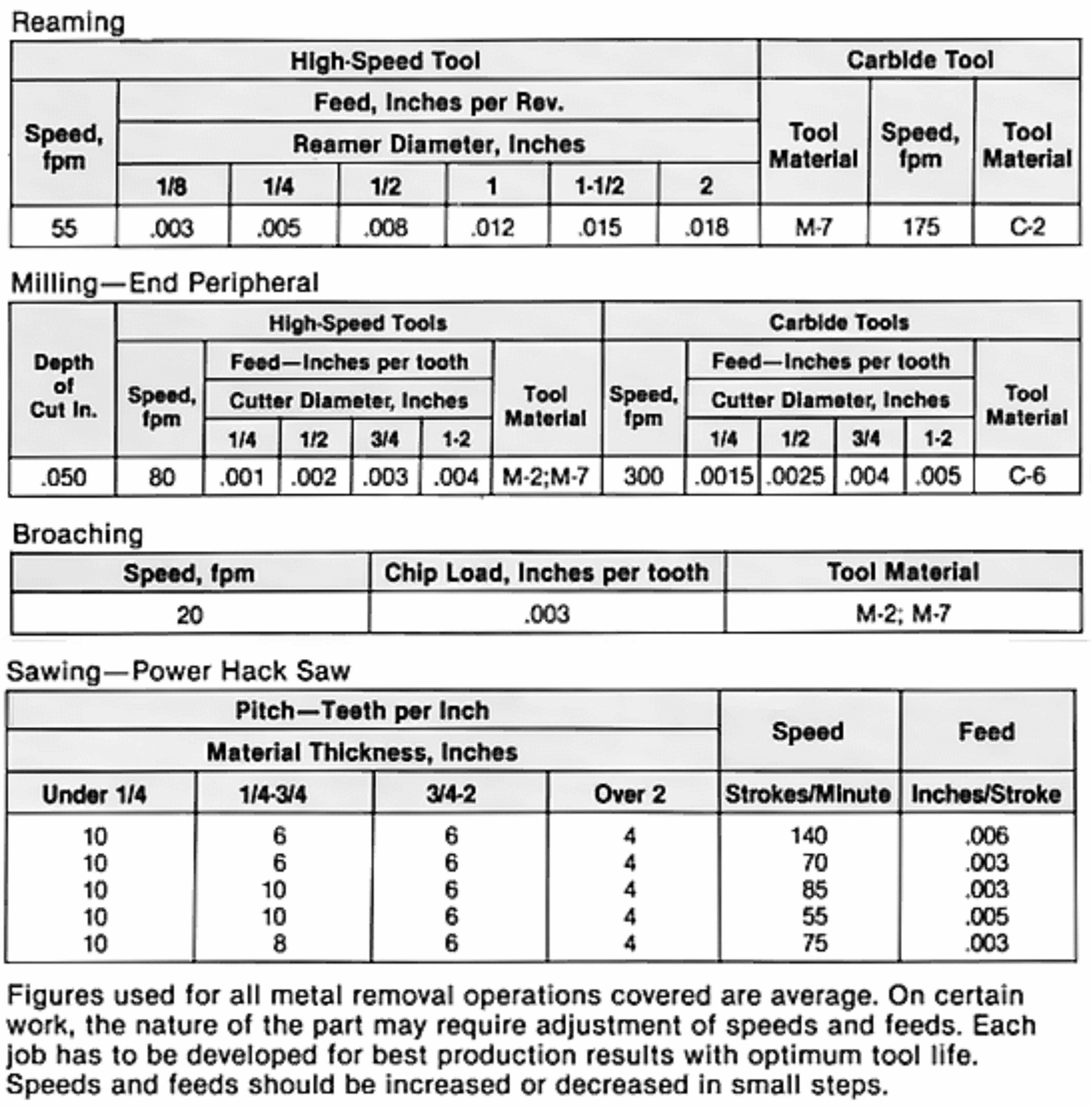
Depth of Cut In.	High-Speed Tools			Carbide			
	Speed, fpm	Feed, ipr	Tool Material	Speed, fpm		Feed, ipr	Tool Material
				Brazed	Throw Away		
.150	75	.015	M-42	300	375	.015	C-6
.025	90	.007		375	425	.007	C-7

Turning—Cut-Off and Form Tools

Speed, fpm	Feed, ipr							Tool Material
	Cut-Off Tool Width, Inches			Form Tool Width, Inches				
	1/16	1/8	1/4	1/2	1	1-1/2	2	
65	.001	.0015	.002	.0015	.001	.001	.0007	M-2
195	.003	.0045	.006	.003	.0025	.0025	.0015	C-6

Drilling

Speed, fpm	Feed, ipr								Tool Material
	Nominal Hole Diameter, Inches								
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
50	.001	.002	.003	.006	.008	.010	.011	.013	M-1;M-10



Reaming

High-Speed Tool							Carbide Tool		
Speed, fpm	Feed, Inches per Rev.						Tool Material	Speed, fpm	Tool Material
	Reamer Diameter, Inches								
	1/8	1/4	1/2	1	1-1/2	2			
55	.003	.005	.008	.012	.015	.018	M-7	175	C-2

Milling—End Peripheral

Depth of Cut In.	High-Speed Tools						Carbide Tools					
	Speed, fpm	Feed—Inches per tooth				Tool Material	Speed, fpm	Feed—Inches per tooth				Tool Material
		Cutter Diameter, Inches						Cutter Diameter, Inches				
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.050	80	.001	.002	.003	.004	M-2;M-7	300	.0015	.0025	.004	.005	C-6

Broaching

Speed, fpm	Chip Load, Inches per tooth	Tool Material
20	.003	M-2; M-7

Sawing—Power Hack Saw

Pitch—Teeth per Inch				Speed	Feed
Material Thickness, Inches					
Under 1/4	1/4-3/4	3/4-2	Over 2	Strokes/Minute	Inches/Stroke
10	6	6	4	140	.006
10	6	6	4	70	.003
10	10	6	4	85	.003
10	10	6	4	55	.005
10	8	6	4	75	.003

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased or decreased in small steps.

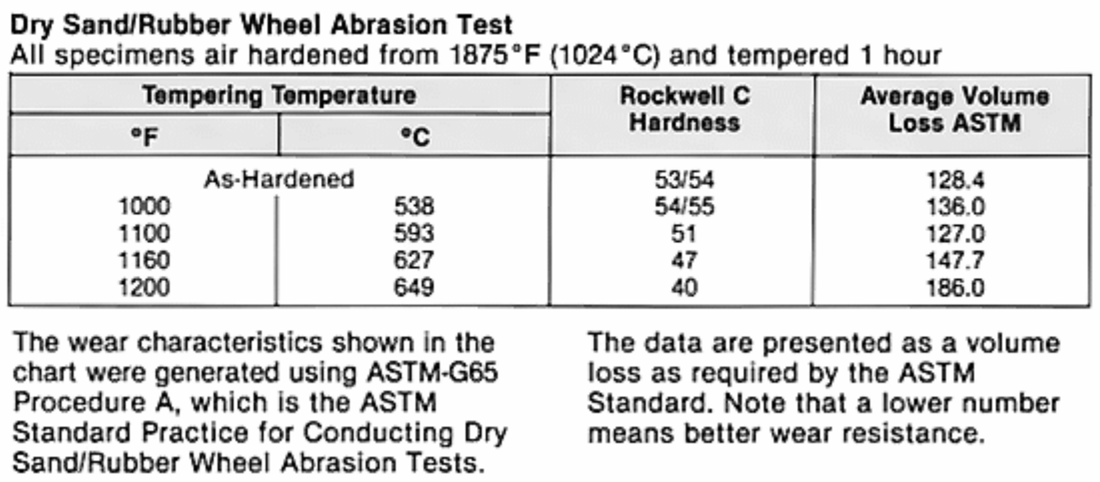
Additional Machinability Notes

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased or decreased in small steps.

Other Information

Wear Resistance

The wear characteristics shown in the hyperlink entitled "Dry Sand/Rubber Wheel Abrasion Test" were generated using ASTM-G65 Procedure A, which is the ASTM Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests. The data are presented as a volume loss as required by the ASTM Standard. Note that a lower number means better wear resistance.



Dry Sand/Rubber Wheel Abrasion Test

All specimens air hardened from 1875°F (1024°C) and tempered 1 hour

Tempering Temperature		Rockwell C Hardness	Average Volume Loss ASTM
°F	°C		
As-Hardened		53/54	128.4
1000	538	54/55	136.0
1100	593	51	127.0
1160	627	47	147.7
1200	649	40	186.0

The wear characteristics shown in the chart were generated using ASTM-G65 Procedure A, which is the ASTM Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.

The data are presented as a volume loss as required by the ASTM Standard. Note that a lower number means better wear resistance.

Applicable Specifications

- ASTM A681
- QQ-T-570

Forms Manufactured

- Bar-Rounds
- Wire-Shapes
- Billet

Technical Articles

- A New Guide for Selecting Ferrous Alloys, Tungsten Carbides and Ceramics for Tooling
- Forging Difficult Alloys: How to Get Better Results, Consistently

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