Technical Datasheet

CarTech® A6 Tool Steel

Identification

UNS Number

• T30106

AISI Number

• Type A6

Type Analysis

Single figures are nominal except where noted.

Carbon	0.70 %	**Manganese**	2.00 %
Silicon	0.30 %	**Chromium**	1.00 %
Molybdenum	1.35 %	**Iron**	Balance

General Information

Description

CarTech A6 tool steel combines the deep hardening and minimum size change characteristics of air hardening tool steels with the simplicity of low temperature heat treatment possible in many oil hardening tool steels.

This tool steel has been used in applications where optimum freedom from size change is desired, or when the sections are very large.

Vega tool steel is available as a DeCarb-Free product. DCF bars have been cold finished in the mill, eliminating the need for bar bark removal.

Applications

Typical applications for CarTech A6 tool steel have included:

Large blanking dies
Large forming dies
Trimming dies
Notching dies
Feed fingers
Heavy duty punches
Coining dies
Retaining rings
Rim rolls
Master hubs
Shear blades
Precision tools
Spindles
Bending tools
Mandrels
Stripper plates
Plastic molds

Properties

Physical Properties

Specific Gravity	7.85	
Density	0.2900	lb/in³

Mean CTE	
68 to 212°F	6.57 x 10^{-6} in/in/°F
68 to 392°F	6.91 x 10^{-6} in/in/°F
68 to 572°F	7.32 x 10^{-6} in/in/°F
68 to 752°F	7.59 x 10^{-6} in/in/°F
68 to 932°F	7.86 x 10^{-6} in/in/°F
68 to 1112°F	8.01 x 10^{-6} in/in/°F
68 to 1292°F	8.19 x 10^{-6} in/in/°F

Mean coefficient of thermal expansion

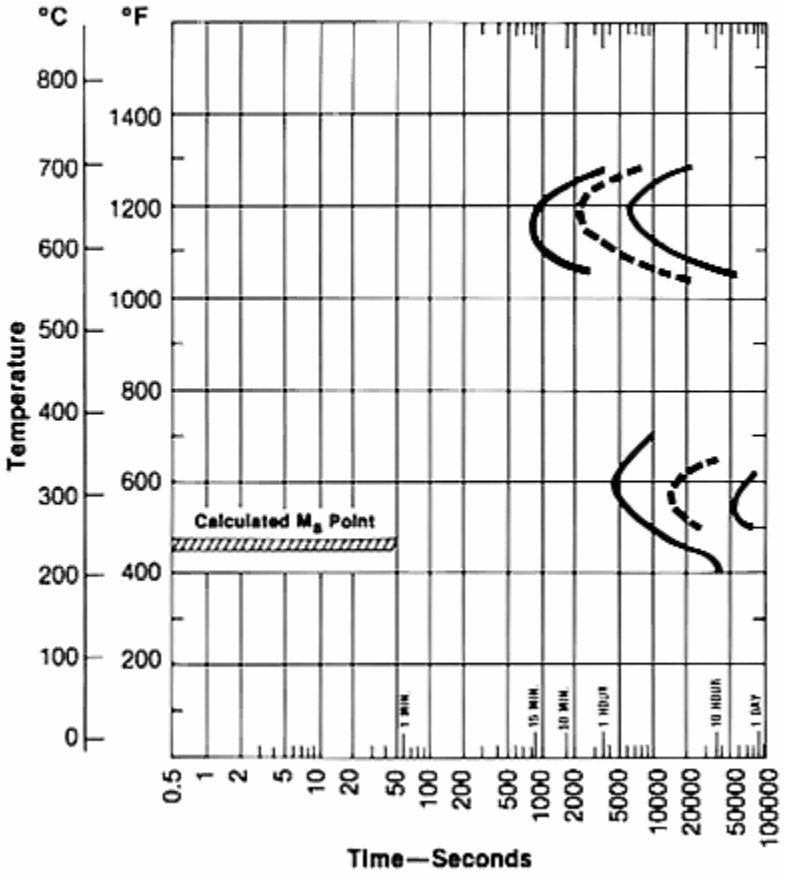
The following figures are the average coefficients between room temperature and the specified elevated temperature. They represent material in the annealed condition and the dimensions are in in/in°C temperature.

Room Temperature		Average Coefficient	
68°F to	20°C to	10^{-6}/°F	10^{-6}/°C
212	100	6.57	11.8
392	200	6.91	12.4
572	300	7.32	13.2
752	400	7.59	13.7
932	500	7.86	14.1
1112	600	8.01	14.4
1292	700	8.19	14.7

Modulus of Elasticity (E)	29.0 x 10^{3} ksi

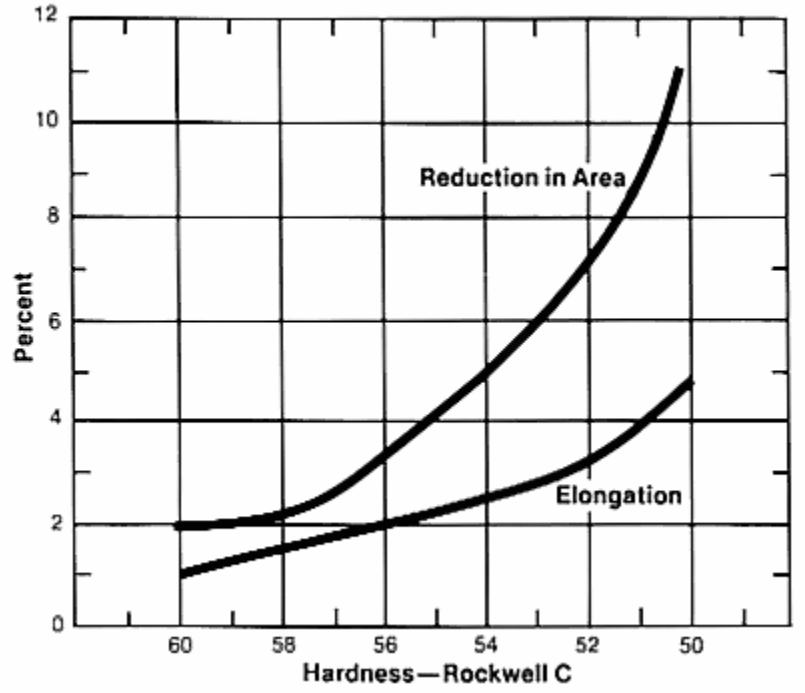
Isothermal transformation diagram

Austenitizing temperature—1550°F (843°C)

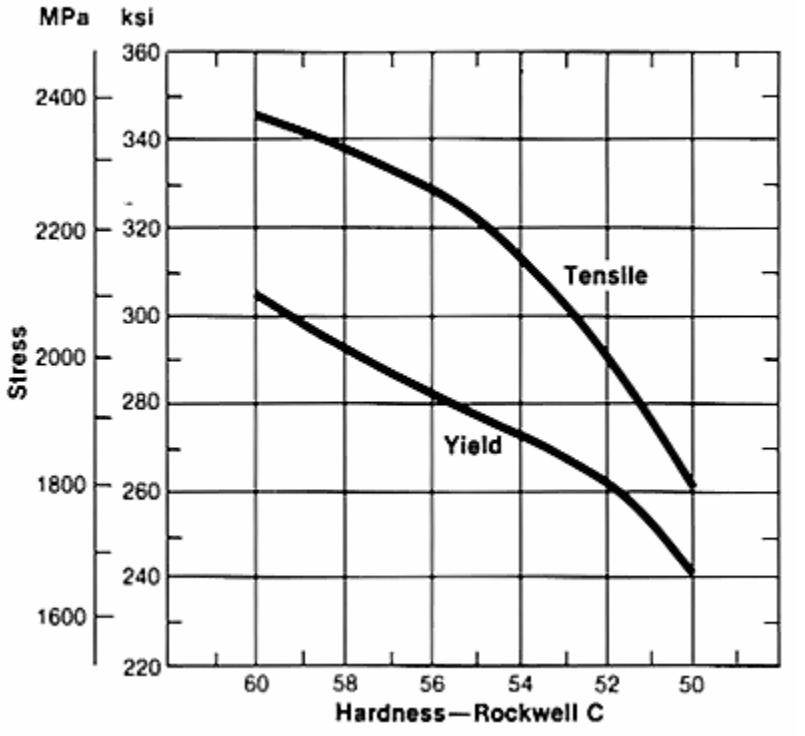


Typical Mechanical Properties

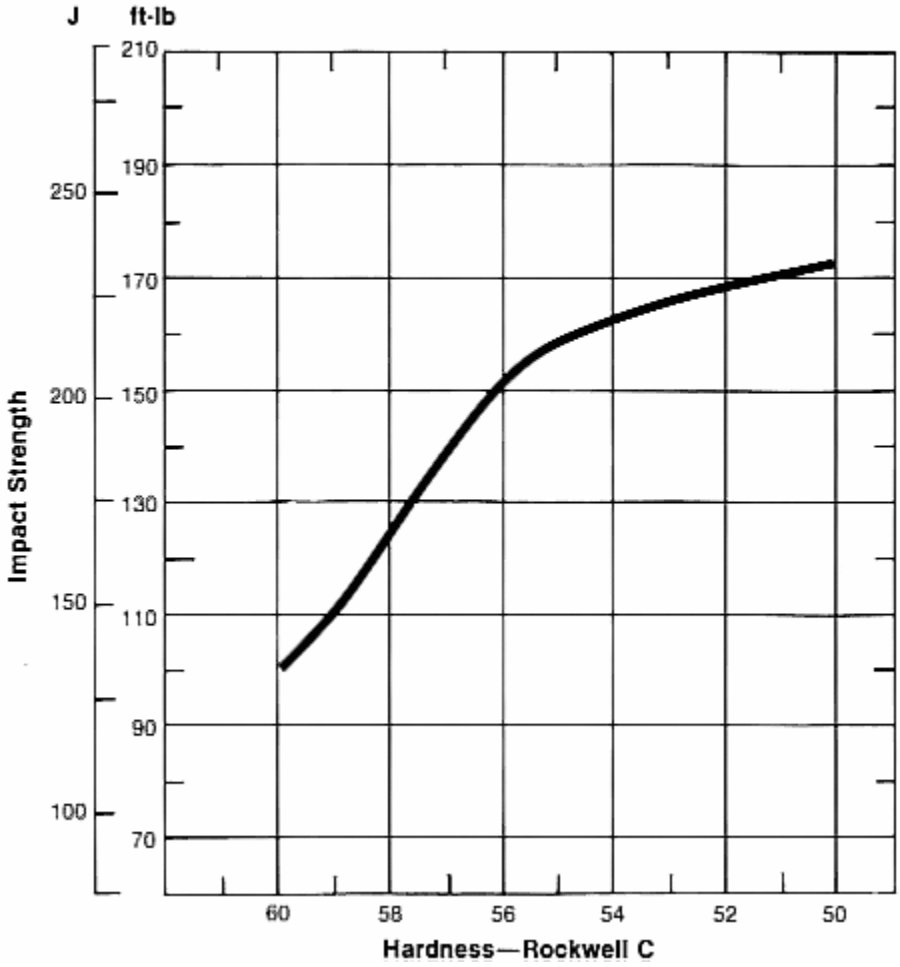
Reduction in Area and Elongation—Vega Tool Steel



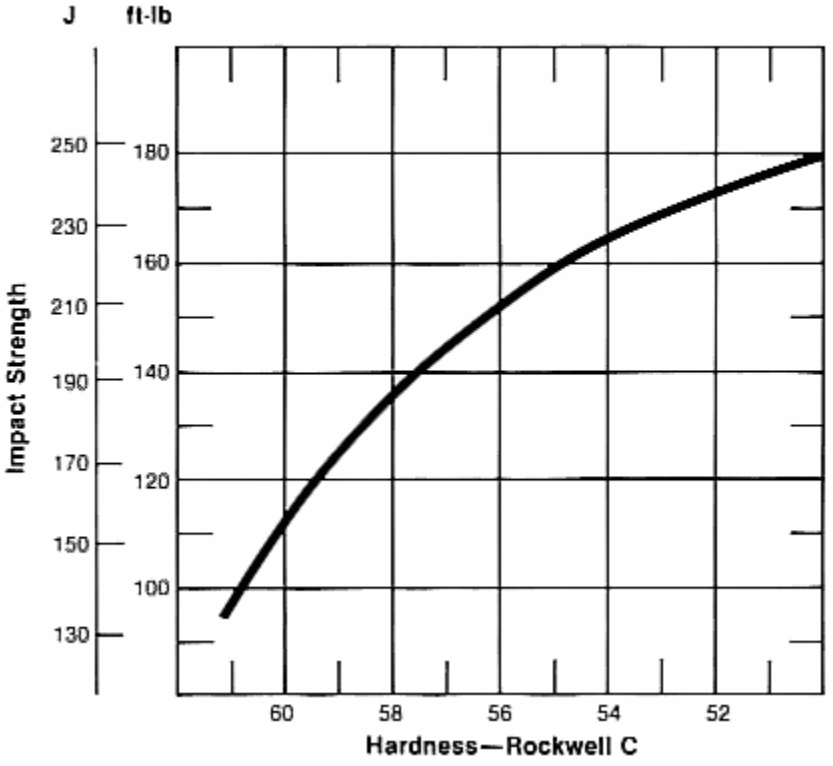
Tensile and Yield Strengths—Vega Tool Steel



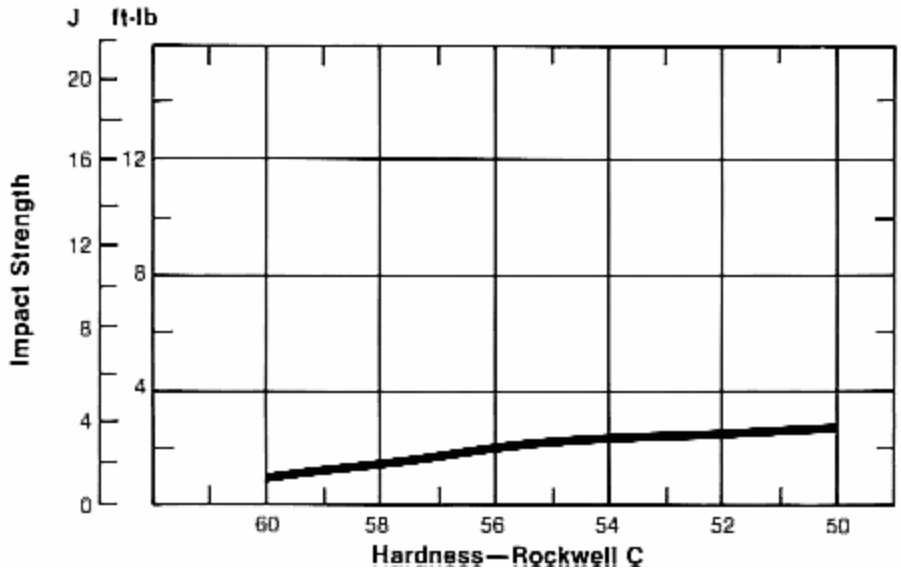
Unnotched Charpy Impact Strength—Vega Tool Steel



Unnotched Izod Impact Strength — Vega Tool Steel



V-Notched Charpy Impact—Vega Tool Steel



Heat Treatment

Decarburization

Like all high carbon steels, Vega tool steel is subject to decarburization during thermal processing and 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 Vega tool steel.

Annealing

For annealing, Vega tool steel should either be packed in a suitable container, using a neutral packing compound, or placed in a controlled atmosphere furnace.

Heat uniformly to 1350/1375°F (732/746°C) and cool very slowly in the furnace at a rate of not more than 20°F (11°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 235.

Hardening

First, heat the salt bath or furnace to 1525/1600°F (830/871°C), depending upon the size of the tool. Without preheating, place the tool in the hot furnace and let it heat "naturally" until it uniformly matches the color of the thermocouple in the furnace. Soak for 20 minutes at temperature, and an additional 5 minutes per inch of thickness, then remove from the furnace and cool in a free circulating air.

Using this practice, sections up to approximately 4" (101.6 mm) square will harden to about Rockwell C 61/63. Sections 8" (203.2 mm) square can be hardened as high as Rockwell C 60.

Control of decarburization can be accomplished by using any one of the several modern heat treating furnaces designed for this purpose. If endothermic atmospheres are used, a dew point between +30/40°F (-1.1/+4.4°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.

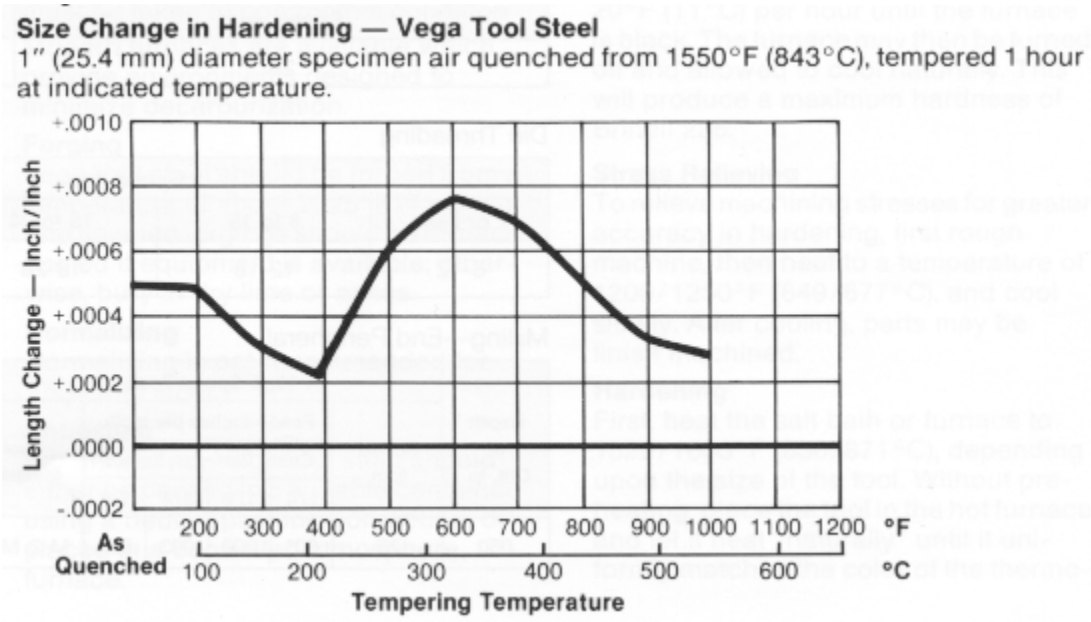
If no atmosphere is available, the tool should be pack hardened or wrapped in stainless steel foil to protect its surface.

Deformation (Size Change) in Hardening

Remember that tool steels hold size best when quenched from the proper hardening temperature. If overheated they tend to show shrinkage after tempering.

Vega tool steel can be expected to expand slightly (about 0.0002 inches/inch) when tempered in the 300 to 400°F (149 to 240°C) temperature range.

The hyperlink titled "Size Change in Hardening" illustrates typical length changes of Vega tool steel after having been properly hardened and tempered. Note that the length change information is presented in inches per inch of original length.



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), and cool slowly. After cooling, parts may be finish machined.

Tempering

The effect of various tempering temperatures on the hardness of Vega tool steel is shown in the hyperlink titled "Effect of Tempering Temperature".

The best combination of hardness and toughness is obtained by tempering Vega tool steel at about 350°F (177°C).

Effect of Tempering Temperature—Vega Tool Steel
4" (101.6 mm) square section air quenched from 1550°F (843°C) and tempered 1 hour at indicated temperature.

Tempering Temperature		Rockwell C Hardness
°F	°C	
As Hardened		61/62
200	93	61/62
300	149	60/61
350	177	59/60
400	204	58/59
500	260	56/57
600	316	55/56
700	371	54/55
800	427	52/53
900	482	50/51
1000	538	48/49

Workability

Forging

Vega tool steel should be forged from a temperature of about 2025°F (1107°C). The finished forgings should be furnace cooled if equipment is available; otherwise, bury in dry lime or ashes.

Machinability

The machinability of Vega tool steel may be rated between 60 to 65% of Type W-1 tool steel or about 40 to 45% of B1112.

Following are typical feeds and speeds for Vega tool steel.

The machinability of Vega tool steel may be rated between 60 to 65% of Type W-1 tool steel or about 40 to 45% of B1112.

The following charts include typical machining parameters used to machine Vega tool steel. The data listed should be used as a guide for initial machine setup only.

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-2	270	315	.015	C-6
.025	85	.007	M-3	315	380	.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	
60	.001	.0015	.002	.0015	.001	.001	.0007	M-2
205	.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	
45	.001	.001	.003	.005	.007	.008	.010	.012	M-1;M-10

Reaming

Speed, fpm	High-Speed Tool							Carbide Tool	
	Feed, Inches per Rev						Tool Material	Speed, fpm	Tool Material
	Reamer Diameter, Inches								
	1/8	1/4	1/2	1	1-1/2	2			
45	.003	.005	.008	.011	.015	.018	M-7	150	C-2

Tapping

Speed, fpm	Tool Material
25	M-1; M-7; M-10

Die Threading

Speed, fpm				Tool Material
7 or Less	8 to 15	16 to 24	25 and up, T.P.I.	
8-12	12-18	18-25	20-30	M-1; M-2; M-7; M-10

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	75	.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
15	.003	M-42

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 or 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 or feeds should be increased or decreased in small steps.

Other Information

Wear Resistance

The wear characteristics of Vega tool steel shown in the hyperlink entitled "Dry Sand/Rubber Wheel Abrasion Tests" were generated using ASTM-G65 Procedure A titled "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, therefore, that a lower number indicates better wear resistance.

Dry Sand/Rubber Wheel Abrasion Test—Vega Tool Steel
All specimens air hardened from 1550°F (843°C) and tempered for 1 hour.

Tempering Temperature		Rockwell C Hardness	Average Volume Loss ASTM
°F	°C		
As-Hardened		62/63	73.8
350	177	60.5	75.2
650	343	56	106.3
900	482	51	118.1
1100	593	45	130.7

Applicable Specifications

- ASTM A681
- QQ-T-570

Forms Manufactured

- Bar-Flats
- Bar-Rounds

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