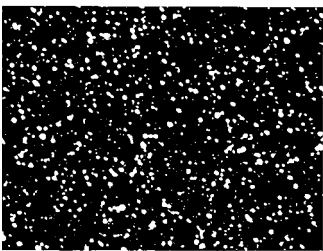


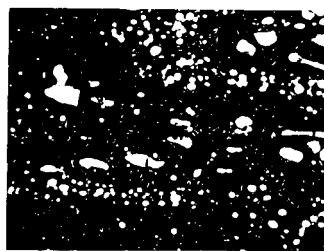
# CRUCIBLE

CPM 9V is made by the Crucible Particle Metallurgy process. Its composition is a modification of CPM 10V with lower carbon and vanadium to improve toughness and heat check resistance. These enhanced properties permit CPM 9V to perform well in problem applications where high carbon, high chromium tool steels, such as CPM 10V or the high speed steels, lack sufficient toughness or heat check resistance, or where lower alloy tool steels and hot work tool steels lack sufficient wear resistance.

The CPM process produces very homogeneous, high quality steel characterized by superior dimensional stability, grindability, and toughness compared to steels produced by conventional processes.

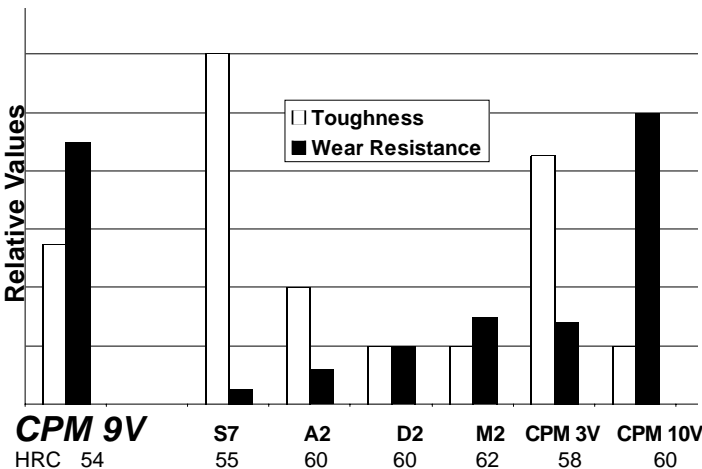


CPM Steel



Conventional Steel

## Tool Steel Comparagraph



## Typical Applications

- |                    |                   |
|--------------------|-------------------|
| Forming Rolls      | Punches           |
| Rolling Mill Rolls | Dies              |
| Header Tooling     | Slitter Knives    |
| Extrusion Tooling  | Shear Blades      |
| Pelletizer Blades  | Granulator Blades |
- Plasticizing Components: Non-return Valves and Screws

Note: These are some typical applications. Your specific application should not be undertaken without independent study and evaluation for suitability.

# Crucible... The Tool Steel Pros®

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# DATA SHEET

## CRUCIBLE CPM® 9V®

Issue #7

<b>Carbon</b>	<b>1.90%</b>
<b>Chromium</b>	<b>5.25%</b>
<b>Vanadium</b>	<b>9.10%</b>
<b>Molybdenum</b>	<b>1.30%</b>

## Physical Properties

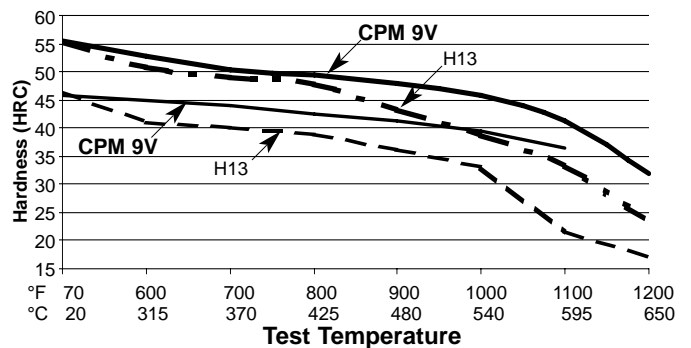
<b>Elastic Modulus</b>	32 X 10 <sup>6</sup> psi	(221 GPa)
<b>Density</b>	.269 lbs./in <sup>3</sup>	(7.455 g/cm <sup>3</sup> )
<b>Thermal Conductivity</b>		
	BTU/hr-ft-°F	W/m-°K      cal/cm-s-°C
72°F    22°C	11.83	20.48      4.89 X 10 <sup>-2</sup>
212°F   100°C	12.48	21.60      5.16 X 10 <sup>-2</sup>
392°F   200°C	13.35	23.10      5.52 X 10 <sup>-2</sup>
572°F   300°C	14.59	25.25      6.03 X 10 <sup>-2</sup>
932°F   500°C	14.91	25.81      6.16 X 10 <sup>-2</sup>
1004°F 540°C	15.07	26.08      6.23 X 10 <sup>-2</sup>

## Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70 - 200	(20 - 90)	6.15X10 <sup>-6</sup>	(11.07X10 <sup>-6</sup> )
70 - 400	(20 - 200)	6.21X10 <sup>-6</sup>	(11.18X10 <sup>-6</sup> )
70 - 800	(20 - 430)	6.45X10 <sup>-6</sup>	(11.61X10 <sup>-6</sup> )
70 -1200	(20 - 650)	6.59X10 <sup>-6</sup>	(11.86X10 <sup>-6</sup> )

## Mechanical Properties

### Hot Hardness vs. H13 (Hardness at Indicated Temperature)



### Heat Check Resistance (Warm Work Applications)

Grade	Hardness HRC	Number of Cycles <sup>(A)</sup>
D2	50	3,000
10V	51	5,000
9V	48	15,000
H13	48	20,000
H19	50	60,000

(A) One cycle consists of immersing the test specimen in 1250°F molten lead for 4 sec., cooling in 180°F water for 2 sec. followed by 8 sec. of air cooling.

## Machinability and Grindability

In the annealed condition, the machinability of CPM 9V is comparable to that of M2. Similar grinding equipment and practices used for high speed steels are recommended. "SG" type alumina wheels or CBN wheels have generally given the best performance with CPM steels.

## Thermal Treatments

**Critical Temperature:** 1590°F (865°C)

**Forging:** 2000-2100°F (1095-1150°) Do not forge below 1700°F (930°C). Slow Cool.

**Annealing:** Heat to 1650°F (900°C), hold 2 hours, slow cool no faster than 30°F (15°C) per hour to 1000°F (540°C), then furnace cool or cool in still air to room temperature.

**Annealed Hardness:** About BHN 223-255

### Stress Relieving

**Annealed Parts:** Heat to 1100-1300°F (595-700°C), hold 2 hours, then furnace cool or cool in still air.

**Hardened Parts:** Heat to 25-30°F (15°C) below original tempering temperature, hold 2 hours, then furnace cool or cool in still air.

**Straightening:** Best done warm 400-800°F (200-430°C)

### Hardening

**Preheat:** Heat to 1550-1600°F (845-870°C) Equalize.

Second pre-heat stage at 1850-1900°F (1010-1040°C) suggested for vacuum or atmosphere hardening.

**Austenitize:** 1850-2150°F (1025-1175°C), hold time at temperature 30-45 minutes.

**Quench:** Air or positive pressure quench (2 bar minimum) to below 125°F (50°C), or salt or interrupted oil quench to about 1000°F (540°C), then air cool to below 125°F (50°C). Salt bath treatment, if practical, will ensure maximum attainable toughness for a given hardening treatment. Vacuum or atmosphere quench rate through 1850-1300°F (1010-705°C) range is critical to achieve optimum heat treat response.

**Temper:** Double temper at 1000°F (540°C) minimum.

2 hours minimum each time. (See Table)

**Size Change:** +0.01%

**Recommended Heat Treatment:** For the best combination of toughness and wear resistance, austenitize 9V at 2050°F (1120°C), hold 30-45 minutes, and quench. Temper 3 times at 1025°F (550°C).

**Aim hardness: 54-56 HRC.** Higher austenitizing temperatures can be used to obtain higher hardness, at a slight decrease in impact resistance. The lower austenitizing temperatures provide the best impact toughness.

### Surface Treatments

Because of its high tempering temperatures (>1000°F) CPM 9V is suitable for nitriding, PVD coating or similar surface treatments. CVD coating processes generally exceed the critical temperature and may result in non-predictable dimensional changes.

### Service Center Locations

Location	Phone	Toll Free	FAX
Auburn, MA	508-832-5353	800-365-1101	508-832-2217
Charlotte, NC	704-372-3073	800-365-1160	704-342-0985
Chicago, IL	630-378-0093	800-365-1151	630-378-1965
Cincinnati, OH	513-771-1310	800-365-1163	513-771-0119
Cleveland, OH	330-562-3131	800-365-1132	330-562-7818
Columbus, OH	614-262-4959	800-365-1131	614-262-7850
Dallas, TX	817-649-2800	800-365-1168	817-633-8142
Detroit, MI	248-528-0332	800-365-1133	248-528-1977
Grand Rapids, MI	616-554-9699	800-365-1137	616-554-9328
Huntsville, AL	256-772-0201	800-365-1161	256-772-3361
Indianapolis, IN	317-638-4501	800-365-1146	317-634-7375
Los Angeles, CA	714-632-1131	800-365-1179	714-632-1181

# Crucible Service Centers

A Division of Crucible Materials Corporation

## Heat Treat Response

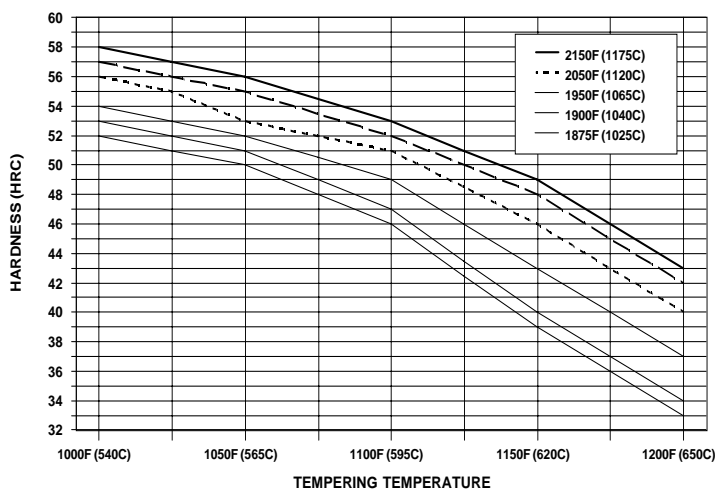
### Hardness HRC

Tempering Temperature	Austenitizing Temperature					
	1875°F (1025°C)	1900°F (1040°C)	1950°F (1065°C)	2050°F (1120°C)	2100°F (1150°C)	2150°F (1175°C)
As Quenched	53	54	56	58	59	61
1000°F (540°C)	52	53	54	56	57	58

Optimum for Maximum Toughness and Effective Stress Relieving						
1025°F (550°C)	51	52	53	55	56	57
1050°F (565°C)	50	51	52	53	55	56
1100°F (595°C)	46	47	49	51	52	53
1150°F (620°C)	39	40	43	46	48	49
1200°F (650°C)	33	34	37	40	42	43

Results may vary with hardening method and section size. Salt or oil quenching will give maximum response. Vacuum or atmosphere cooling may result in up to 1-2 HRC points lower.

Minimum Time at Aust. Temp.	60 min.	45 min.	30 min.	20 min.	15 min.	10 min.
Minimum Number of Tempers	2	2	2	2	3	3



### Toughness

Depending on the hardness requirement, lowering the hardening temperature (underhardening) increases toughness.

Hardening Temperature	Tempering Temperature	Hardness HRC	Charpy C-Notch ft-lb (J)	Bend Fracture Strength ksi (MPa)
2150°F (1175°C)	1025°F (550°C)	57	26 35	606 4177
2100°F (1150°C)	1025°F (550°C)	56	36 48	- -
2050°F (1120°C)	1000°F (540°C)	56	47 63	600 4136
1950°F (1065°C)	1100°F (595°C)	49	74 99	- -

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and heat treat conditions may cause deviations from these values. For additional data or metallurgical engineering assistance, consult your local Crucible Service Center.

Location	Phone	Toll Free	FAX
Meadville, PA	814-337-8804	800-365-0530	814-337-8808
Milwaukee, WI	262-781-6710	800-242-0948	262-781-6743
Minneapolis, MN	612-331-6320	800-365-1153	612-331-4137
St. Louis, MO	636-272-7220	877-201-4049	636-978-9559
<b>Canada</b>			
Wallaceburg, ONT	519-627-2245	800-265-5293	519-627-2247
<b>Mexico (SISA)</b>			
Monterrey, N.L.	52-818-351-7220		52-818-351-2981
Naucalpan, E de M	52-555-576-4011		52-555-360-1865

**CRUCIBLE SERVICE CENTERS DIVISIONAL HEADQUARTERS:**  
 Syracuse, NY 315-487-0800 800-365-1185 315-487-4028  
[www.crucibleservice.com](http://www.crucibleservice.com) email: [crucible@crucibleservice.com](mailto:crucible@crucibleservice.com)