



## Powder metallurgy Tool Steel

# A11 PM

### CHEMICAL COMPOSITION

C	Cr	Mo	W	Co	V
2.45	5.25	1.3	-	-	9.75

### STANDARDS

- USA: AISI A11

### DELIVERY HARDNESS

Soft annealed max. 280 HB  
 Cold drawn max. 320 HB  
 Cold rolled max. 320 HB

### DESCRIPTION

A11 PM is a high vanadium grade for wearing applications

### APPLICATIONS

- Knives
- Wear parts
- Cold work

### FORM SUPPLIED

- Coils
- Coarse Round bars
- Flat and square bars
- Sheets
- Discs
- Pieces cut from sheets

Available surface conditions: peeled, rough machined, cold rolled, hot rolled.

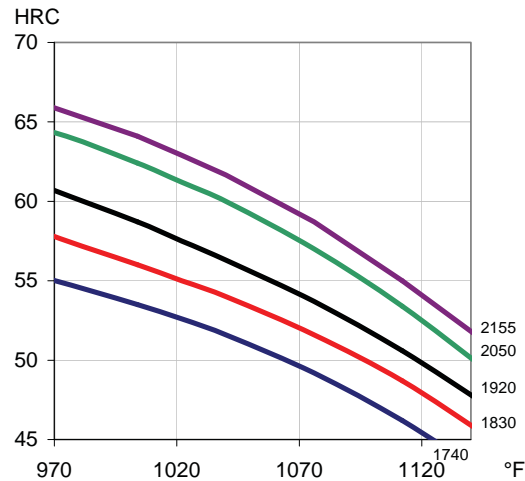
### HEAT TREATMENT

- Soft annealing in a protective atmosphere at 1560-1650°F for 3 hours, followed by slow cooling at 20°F/h down to 1290°F, then air cooling.
- Stress-relieving at 1110°F to 1290°F for approximately 2 hours, slow cooling down to 930°F.
- Hardening in a protective atmosphere with pre-heating in 2 steps at 840-930°F and 1560-1650°F and austenitising at a temperature

suitable for chosen working hardness. Cooling down to 100-120°F.

- Tempering at 1040°F three times for at least 1 hour each time. Cooling to room temperature (77°F) between temperings.

### GUIDELINES FOR HARDENING



Hardness after hardening, quenching and tempering 3x1 hour

### PROCESSING

A11 PM can be worked as follows :

- machining (grinding, turning, milling)
- polishing
- plastic forming
- electrical discharge machining
- welding (special procedure including preheating and filler materials of base material composition).

### GRINDING

During grinding, local heating of the surface, which may alter the temper, must be avoided. Grinding wheel manufacturers can furnish advice on the choice of grinding wheels.

### SURFACE TREATMENT

The steel grade is a good substrate material for PVD and CVD coating. If nitriding is requested a small zone of 2-15 μm is recommended. The steel grade can also be steam-tempered if so desired.



# PROPERTIES

## PHYSICAL PROPERTIES

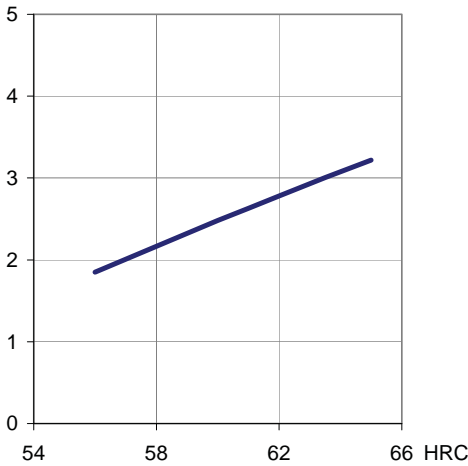
	Temperature		
	70°F	750°F	1110°F
Density lb/in <sup>3</sup> (1)	0.27	0.26	0.26
Modulus of elasticity psi (2)	3.2x10 <sup>7</sup>	2.8 x10 <sup>7</sup>	2.5 x10 <sup>7</sup>
Thermal expansion ratio, per °F (2)	-	6,6x10 <sup>-6</sup>	6,8x10 <sup>-6</sup>
Thermal conductivity Btu/ft h °F (2)	12	14	15
Specific heat Btu/lb °F (2)	0.10	0.12	0.14

(1)=Soft annealed

(2)= Hardened 2155°F and tempered 1040°F, 3 x1 hour

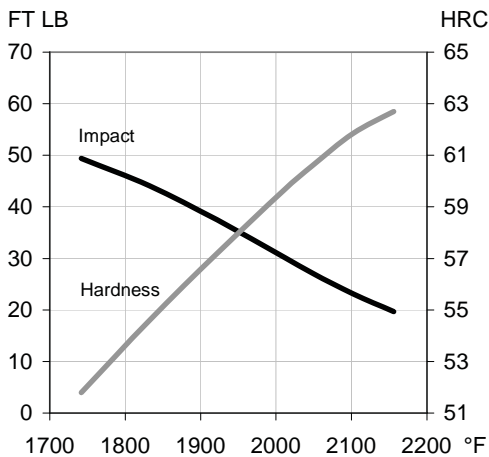
## COMPRESSION YIELD STRESS

Rc 0.2  
kN/mm<sup>2</sup>



Test piece : hour glass with 2/5 inch Ø waist

## IMPACT STRENGTH



Hardening temperature in °F

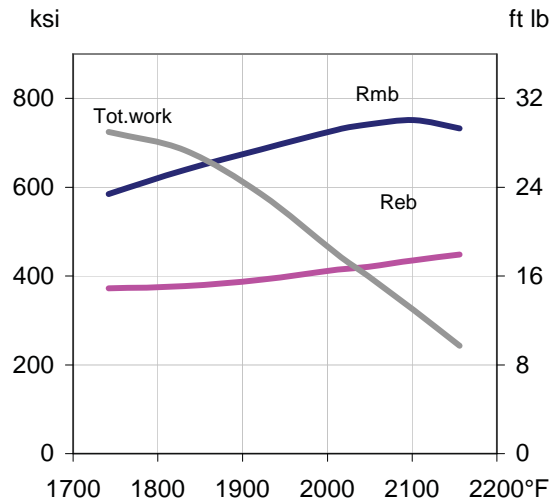
Original dimensions 1/3x1/2 mm

Tempering 3 x 1 hour at 1040° F

Unnotched test piece 9/32 x13/32 x 25/32 inch

## 4-POINT BEND STRENGTH

04/05



Hardening temperature in °F

Original dimensions Ø 0.3 inch

Tempering 3 x 1 hour at 1040°F

Dimension of test piece Ø1/5 inch

NB: High quality surface

Rmb = Ultimate bend strength in ksi

Reb = Bend yield strength in ksi

Tot. work = Total work in ft lb

## COMPARATIVE PROPERTIES

