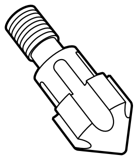
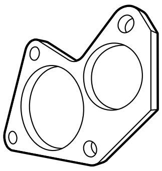
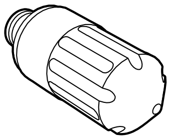
TOOLING ALLOYS
DATA SHEET Z-A11LV PM™

CERTIFIED TO ISO 9001

CHEMICAL COMPOSITION

Carbon	1.80 %
Chromium	5.25 %
Vanadium	9.00 %
Molybdenum	1.30 %
Manganese	0.50 %
Silicon	0.90 %

DESCRIPTION

Z-A11LV PM™ is the low vanadium and carbon version of Z-A11 PM™ powder metal tool steel. This difference in composition results in significantly enhanced toughness and thermal fatigue properties. Although it has reduced attainable hardness, the grade retains superior wear resistance compared to most standard tool steel grades. The unique combination of properties make it suitable for select cold and warm work tooling applications that involve heavy abrasion along with high risk of chipping and cracking. It is typically used at hardness less than RC58, and Z-A11 PM should be considered for use if higher hardness is deemed necessary. The powder metallurgy processing utilized provides well known benefits including more consistent machinability, grindability, heat treat response, and dimensional stability when compared to conventionally produced, high alloy grades.

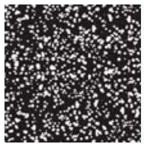
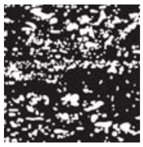
TYPICAL APPLICATIONS

_ plasticizing components
_ extrusion tooling
_ rolling mill rolls
_ shear blades
_granulator and pelletizer blades
_ forming rolls and punches and dies

PHYSICAL PROPERTIES

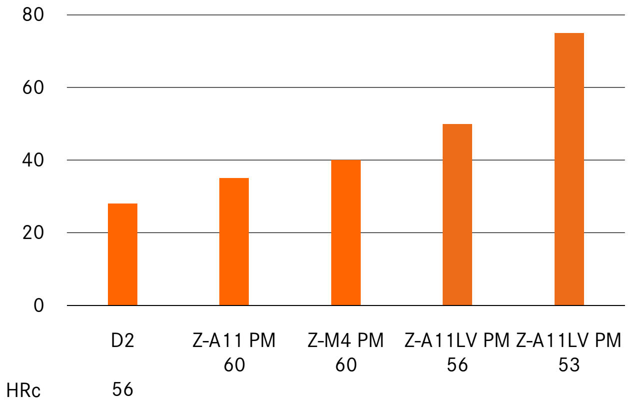
Modulus of elasticity E [psi x 10^6]	32
Density [lb/in³]	0.269
Coefficient of thermal expansion [in/in/ °F] Over a temperature range of 70 - 400°F 70 - 800°F 70 - 1200°F	 6.21×10^{-6} 6.45×10^{-6} 6.59×10^{-6}

POWDER METALLURGICAL AND CONVENTIONAL MICROSTRUCTURE

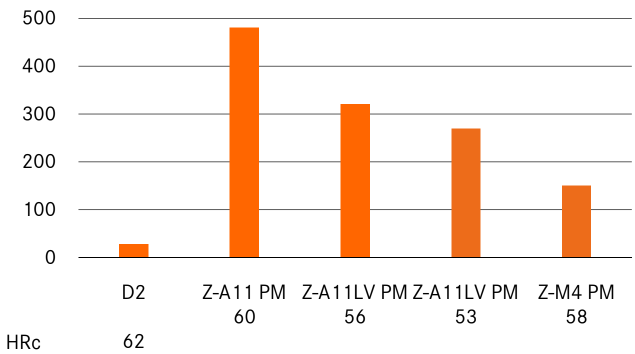



The uniform distribution of carbides in the powder-metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

RELATIVE TOUGHNESS



RELATIVE WEAR RESISTANCE



THERMAL PROCESSING

ANNEALING
Heat uniformly in a protective atmosphere (or vacuum) to 1650°F (900°C) and soak for 2 hours. Slow cool 30°F (15°C) per hour until 1000°F (540°C). Parts can then be cooled in air or furnace as desired. Hardness expected is BHN 223-255.

STRESS RELIEVING (SOFT)
Heat uniformly to 1100-1300°F (595-700°C), soak for 2 hours, and cool in air or furnace.

HARDENING
Vacuum, salt, or protective atmosphere methods are generally used. Care must be taken to prevent decarburization.

Preheat: Heat to 1550-1600°F (845-870°C) until temperature is equalized. Additional preheat steps including 1250-1300°F (680-700°C) and 1850-1900°F (1010-1040°C) are suggested when using programmed control during vacuum processing.

Austenitizing: Temperatures in the range of 1950°F (1040°C) to 2100°F (1150°C) are commonly used with the specific temperature and soak time determined by the hardness required. Higher hardening temperatures will provide maximum wear resistance and hardness while temperatures lower in the range will provide increased toughness. Refer to chart for further information.

Quenching: Methods include use of high pressure gas (minimum 5 bar preferred), salt bath, or oil. Quench rate through the temperature range of 1900°F (1040°C) to 1300°F (700°C) is critical to the development of optimum structure and properties. Part temperature can then be equalized at 1000-1100°F (540-595°C) after which cooling can continue to below 150°F (66°C) or “hand warm”. Step quenching in this manner will help to minimize distortion in larger section sizes.

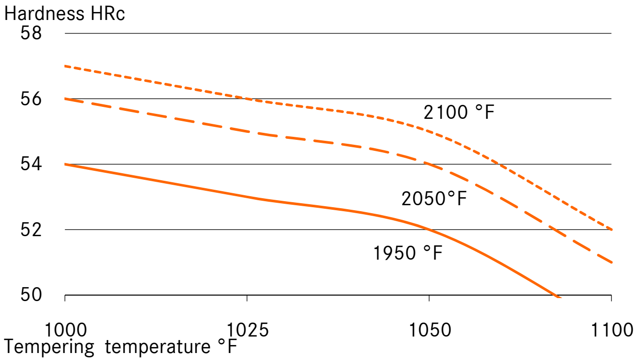
TEMPERING
Tempering should be performed immediately after quenching. Temperatures in the range of 1000°F (540°C) to 1100°F (595°C) are generally used depending on the hardness required. Heat uniformly to the selected temperature and soak for 2 hours. Double tempering is absolutely necessary while triple tempering is highly recommended when hardening at 2100°F (1150°F) and over. Tempering temperatures of less than 1000°F (540°C) should not be used and care must be taken to cool parts fully to room temperature (hand warm) between each temper.

STRESS RELIEVING (HARD)
Heat to 25°F (15°C) less than the temperature of the last temper and soak for 1 hour.

CRITICAL TEMPERATURE
1590°F (865°C).

SIZE CHANGE DURING HARDENING
+.0002 in/in (at HRc 55)

TEMPERING DIAGRAM



HEAT TREATMENT INSTRUCTIONS

1st preheat	1250-1300°F
2nd preheat	1550-1600°F
Hardening	as specified in table
Tempering	2+2+2 hours at 1000°F minimum

Preferred quench method is high pressure inert gas (minimum 5 bar) or molten salt at 1025°F.

Required hardness HRc	**Austenitizing soak temp °F**	**Austenitizing soak time** [min]*	**Tempering temperature[°F]****
48-50 (max toughness)	1950	30	1075
50-52	1950	30	1050
52-54	1950	30	1025
54-56	2050	20	1025
55-57 (max wear)	2100	15	1025

* Process variation and part section size can affect results. Soak times should be based on actual part temperatures. Use of load thermocouples is highly recommended during batch processing.

** An increase in tempering temperature by 25°F can be used to reduce hardness 1 to 2 points HRc. Tempering temperatures less than 1000°F should not be used.

STRAIGHTENING
Should be done warm (or during quench) using temperatures in the range of 400°F (200°C) to 800°F (430°C).

SURFACE TREATMENT
This grade is an excellent substrate material for use with the various commercially available PVD coating processes. Conventional nitriding (.001” maximum depth) and steam tempering can also be used. Coating vendors should be consulted to select the optimum process for a given application.

Care must be exercised during CVD and other surface treatment processes that can alter the original heat treatment of the tool.

MACHINING DATA

TURNING

Cutting parameter	Turning with cemented carbide medium turning	 finish turning	HSS
Cutting speed (V_C) m/min.	70–100	100–120	8–10
Feed (f) mm/U	0.2–0.4	0.05–0.2	0.05–0.3
Cutting depth (a_p) mm	2–4	0.05–2	0.5–3
Tools according ISO	P 10–P 20*	P 10*	–

* Use wear resistant coated cemented carbide, e.g. Coromant 4015 or Seco TP 100.

MILLING

FACE- AND EDGEMILLING

Cutting parameter	Milling with cemented carbide medium turning	 finish turning	HSS
Cutting speed (V_C) m/min.	50–70	70–100	15
Feed (f) mm/U	0.2–0.3	0.1–0.2	0.1
Cutting depth (a_p) mm	2–4	1–2	1–2
Tools according ISO	K 15*	K 15*	–

* Use wear resistant coated cemented carbide, e.g. Coromant 4015 or Seco TP 100.

END MILLING

Cutting parameter	Solid carbide	Milling cutter w. indexable tips	Coated HSS
Cutting speed (V_C) m/min.	25–35	60–80	12*
Feed (f) mm/U	0.01–0.20**	0.06–0.20**	0.01–0.30**
Tools according ISO	K 20	P 25***	–

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.
** depends on radial depth of cut and on milling cutter - diameter
*** Use wear resistant coated cemented carbide, e.g. Coromant 3015 or SECO T15M.

DRILLING

SPIRAL DRILL MADE OF HSS

Driller-∅ mm	Cutting speed (V_C) m/min.	Feed (f) mm/U
0–5	5–8*	0.05–0.15
5–10	5–8*	0.15–0.25
10–15	5–8*	0.25–0.35
15–20	8–8*	0.35–0.40

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.

CARBIDE METAL DRILLER

Cutting parameter	Drill type Insert drill	Solid carbide tip	Coolant bore driller with carbide tip*
Cutting speed (V_C) m/min.	70–90	40	35
Feed (f) mm/U	0.08–0.14**	0.10–0.15**	0.10–0.20**

* driller with coolant bores and a soldered on carbide tip
** depends on driller-diameter

GRINDING

Grinding method	soft annealed	hardened
Surface grinding, straight grinding wheels	A 13 HV	B 107 R75 B3* 3SG 46 GVS** A 46 GV
Surface grinding	A 24 GV	3SG 36 HVS**
Cylindrical grinding	A 60JV	B126 R75 B3* 3SG 60 KVS** A 60 IV
Internal grinding	A 46 JV	B126 R75 B3* 3SG 80 KVS** A 60 HV
Profile grinding	A 100 LV	B126 R100 B6* 5SG 80 KVS** A 120 JV

* for these applications we recommend CBN-wheels
** grinding wheel from the company Norton Co.

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