M1 ESR - Technical Data

General Descriptions:

M1 ESR is made using the ESR melting practice.
It is a Molybdenum-tungsten high speed steel and is a tough general purpose high speed steel with high cutting efficiency and excellent finishing properties.

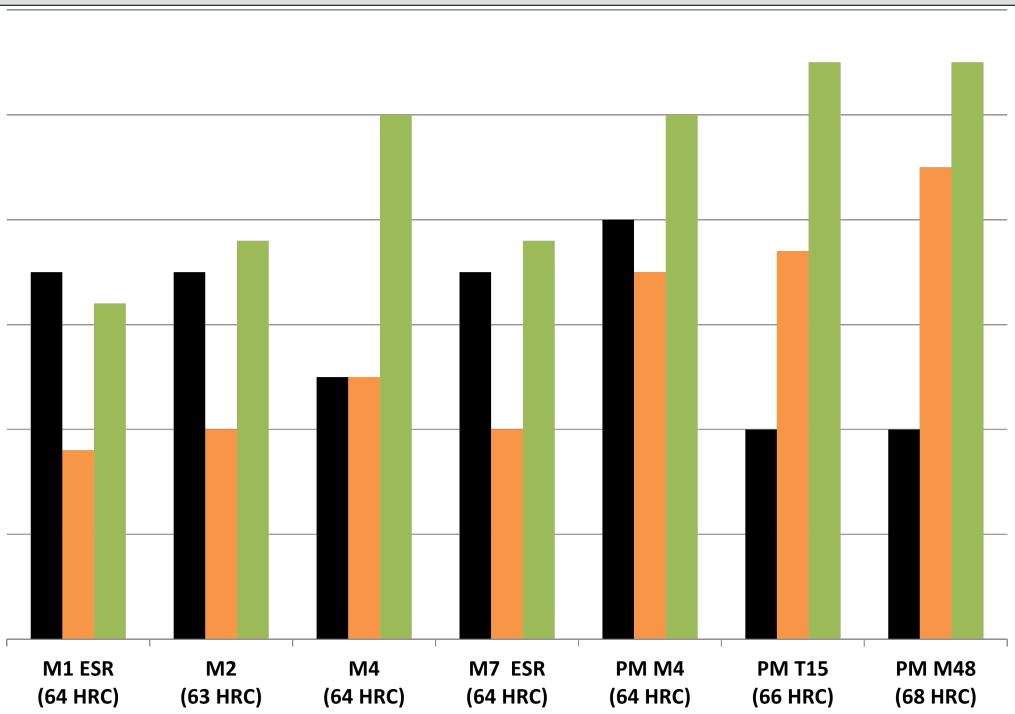
Examples of applications:

Chasers, reamers, drills, taps, end mills, thread rolling dies, punches and tool bits.

Chemical Composition

Carbon	Manganese	Silicon	Chromium	Vanadium	Tungsten	Molybdenum
0.78-0.88%	0.15-0.40%	0.20-0.40%	3.50-4.00%	1.00-1.35%	1.40-2.10%	8.20-9.20%

Comparison Chart



Typical Heat Treat Response

Tempering Temp °F	Hardness HRC 2100 °F	2150 °F	2200 °F
1000	64.5	65.6	66.0
1025	64.3	65.5	66.0
1050	63.8	64.9	65.5
1075	62.6	63.9	64.8
1100	61.0	62.5	63.5
1125	59.5	61.0	62.0
1150	57.0	58.7	60.5

Size Changes During Hardening

Hardening Temp °F	Tempering Temp	HRC	Longitudinal Size Change %
2175 °F	1025 °F	65	+0.24

Surface Treatment

M1 can be nitrided or titanium-nitride coated.
If the CVD TiN treatment is used,
care is required in vacuum hardening.

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Heat Treatment

Forging

2075 °F. Do not forge below 1700 °F.
Slow cool after forging.

Annealing

1600 °F, hold 2 hours, slow cool 25°F/hr max. to 1000 °F, then air or furnace cool.
Annealed hardness BHN 217/235.

Stress Relieving

1100-1300 °F, hold 2 hours and air or furnace cool.

Hardening

Salt Baths or Vacuum Furnace preferred.

High Heat (Austenitizing)

Preheat to 1500-1550 °F - let parts equalize.
2100-2200 °F, soak 2 to 5 minutes.
For vacuum hardening, use the high side of the high heat range and soak times.

Quench

Salt or vacuum quench to 1000-1100°F, equalize, then air cool to 150 °F.
Temper immediately.The vacuum quench rate to below 1000 °F is critical to achieve proper results.

Tempering

Tempering at 1000 °F or higher is recommended.
Temper at least two times at recommended temperatures.
2 hours per temper, cool to room temperature between tempers.

Physical Properties

Modulus of Elasticity	30 x 10^6 psi (207 GPa)	**Density**	T0.286 lb/in^3
Annealed Hardness	BHN 217/235	**Machinability**	65% of O1