M-1 High Speed Steel

M-1 High Speed Steel was the first of the family of Molybdenum High Speed Steels. The first commercial heat was melted in 1931 by Universal- Cyclops Steel Corporation. Since that time **M-1** and the other molybdenum high speed steels have constantly increased in use and application, and it has been proven that these steels make tools of equal or better cutting properties that the equivalent tungsten steels.

M-1 is one of the least expensive high speed steels, and should be considered for all general purpose applications, if good heat treating facilities are available. This grade is susceptible to decarburization unless hardened from a salt bath or controlled atmosphere furnace.

Chemical Composition

Carbon	**0.80**
Manganese	**0.30**
Silicon	**0.30**
Molybdenum	**8.50**
Tungsten	**1.50**
Chromium	**4.00**
Vanadium	**1.15**

Typical Applications

General purpose high speed steel suitable for drills, taps, reamers, cutters, hobs, punches, lathe and planer tools.

Physical Properties

Critical temperature - (on heating) 1510°F

Specific Gravity - 8.00

Coefficient of Thermal Expansion

100 - 500°F	5.61 x 10^{-6} in/in/°F
100 - 800°F	6.32
100-1000°F	6.66
100-1200°F	6.86
100-1500°F	7.07

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Forging

Heating for forging must be done slowly and uniformly, with care being taken not to put cold steel into a hot furnace. Soak through at 1700-1800°F and then heat to 1900-2000°F for initial forging. Do not forge below 1600-1700°F, and when forging is completed, cool slowly in lime, mica, dry ashes or furnace.

Annealing

Heat slowly to 1500-1550°F, hold until the entire mass is heated through, and cool slowly in the furnace (30°F or hour) to about 1000°F, after which the cooling rate may be increased. Suitable precautions must be taken to prevent excessive carburization or decarburization.

Strain Relieving

When desirable to relieve the strains of machining, heat slowly to 1150-1250°F, allow to equalize, and then cool in still air.

Preheat for Hardening

Warm slightly before charging into preheat furnace, which should be operating at 1350-1500°F.

Hardening

After thorough preheating, transfer to the hardening furnace, operating at 2100-2200°F, depending upon the degree of hardening required for the application, and the size of the tool.

Quenching

Cool in air, oil, or molten salt bath operating at 1000-1100°F. In the case of oil quenching, it is usually good practice to interrupt the quench by removing the tool after it has reached about 1000°F, and allow the cooling to continue in still air. Where a salt bath is used, the tool should be held only long enough to equalize at the bath temperature, and then should removed and cooled in air. Any necessary straightening should be done while cooling in the range of 850-450°F. Tools should be allowed to cool to 150°F, or to where they can be held in the bare hand, and then tempered immediately.

Tempering

The tempering temperature may be varied according to the desired hardness, but is usually in the range of 1000-1100°F. Double tempering is always recommended. The response to tempering is shown in the following chart.

Hardening Temp. **Double Temp.**	**2100°F**	**2150°F**	**2200°F**
800°F	61.0RC	61.5RC	62.0RC
850°F	61.5	62.0	62.5
900°F	62.0	63.0	63.5
950°F	62.5	64.0	65.0
1000°F	63.0	65.0	65.5
1025°F	62.5	64.5	65.5
1050°F	62.0	64.0	65.0
1100°F	61.0	62.5	63.5
1150°F	57.0	58.0	59.5
1200°F	50.5	53.0	55.0

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