

# P & D HIGH SPEED STEEL (AISI M1)

**M-1 P & D** is a lower carbon modification of the standard M1 analysis. The lower carbon content greatly enhances the toughness at the expense of some loss of cutting properties. For this reason, the grade is strongly recommended for punch and die applications, and others requiring high abrasives resistance and toughness properties.

## TYPICAL APPLICATIONS

Cavity punches, piercing punches, nut and trim dies, pipe taps.

## PHYSICAL PROPERTIES

**Critical temperature-(on heating) 1525°F**  
**Specific Gravity - 8.00**  
**Coefficient of Thermal Expansion**

<b>100 - 500°F</b>	<b>5.85 x 10-6 in/in/°F</b>
<b>100 - 800°F</b>	<b>6.75</b>
<b>100 - 1000°F</b>	<b>6.93</b>
<b>100 - 1200°F</b>	<b>6.99</b>
<b>100 - 1500°F</b>	<b>7.13</b>

## THERMAL PRACTICE

**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 per hour) to about 1000°F, after which the cooling rate may be increased. Suitable precautions must be taken to prevent excessive carburization or decarburization.

## TYPE ANALYSIS

<b>Carbon.....</b>	<b>.74</b>
<b>Manganese.....</b>	<b>.30</b>
<b>Silicon.....</b>	<b>.30</b>
<b>Molybdenum.....</b>	<b>8.50</b>
<b>Tungsten.....</b>	<b>1.50</b>
<b>Chromium.....</b>	<b>4.00</b>
<b>Vanadium.....</b>	<b>1.15</b>

**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 1350-1550°F.

**HARDENING** - After through 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 a 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 be 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.

<b>Hardening Temperature</b>	<b>2100°F</b>	<b>2150°F</b>	<b>2200°F</b>
<b>Doubled Temp.</b>			
<b>700 °F</b>	<b>58.0RC</b>	<b>59.0RC</b>	<b>59.5RC</b>
<b>750°F</b>	<b>58.5</b>	<b>59.5</b>	<b>60.0</b>
<b>800°F</b>	<b>59.0</b>	<b>60.5</b>	<b>61.0</b>
<b>850°F</b>	<b>60.0</b>	<b>61.0</b>	<b>61.5</b>
<b>900°F</b>	<b>60.5</b>	<b>62.5</b>	<b>63.0</b>
<b>950°F</b>	<b>62.0</b>	<b>63.5</b>	<b>64.0</b>
<b>1000°F</b>	<b>63.0</b>	<b>64.0</b>	<b>64.5</b>
<b>1050°F</b>	<b>61.5</b>	<b>63.0</b>	<b>64.0</b>
<b>1100°F</b>	<b>60.5</b>	<b>62.0</b>	<b>62.5</b>

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