QUENCHING MEDIA—
Quench as quickly as possible. Cooling must be uniform and rate must be adequate to avoid transformation products; however, risk of excessive distortion and/or quench cracking must be considered.
• Circulating air/atmosphere
• Positive gas pressure in vacuum furnace
• Martempering bath or fluidized bed at ~390°F (200°C) or 840-1020°F (450-550°C) for 1-100 minutes, then cool in air
• Warm oil
Note: Temper the tool as soon as its temperature reaches 120-160°F (50-70°C).

TEMPERING—
Choose the tempering temperature according to the hardness required by referencing the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 360°F (180°C). Holding time at temperature minimum 2 hours. Do not temper in the range 800-1020°F (425-550°C).

AISI H13 DATA
AISI H13 is a chromium-molybdenum-vanadium alloyed steel which is characterized by:
• Good resistance to abrasion at both low and high temperatures
• High level of toughness and ductility
• Uniform and high level of machinability and polishability
• Good high-temperature strength and resistance to thermal fatigue
• Excellent through-hardening properties
• Very limited distortion during hardening

<table>
<thead>
<tr>
<th>Typical analysis %</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.39</td>
<td>1.0</td>
<td>0.4</td>
<td>5.3</td>
<td>1.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Delivery condition: Soft annealed approx. 185 HB
Color code: Orange/Violet

APPLICATIONS
Dies, backers, dieholders, liners, dummy blocks, stems. Severe cold punching, scrap shears, hot shearing, shrink rings (e.g. for hard metal dies), wear resisting parts.

HEAT TREATMENT

SOFT ANNEALING—
Protect the steel and heat through to 1560°F (850°C). Then cool in the furnace at 20°F (10°C) per hour to 1200°F (650°C), then freely in air.

STRESS RELIEVING—
After rough machining the tool should be heated through to 1200°F (650°C), holding time of 2 hours. Cool slowly to 930°F (500°C), then freely in air.

HARDENING—
Preheating temperature: 1100-1560°F (600-850°C) Austenitizing temperature: 1800-1900°F (980-1030°C) normally 1870°F (1020°C). Protect the part against decarburization and oxidation during hardening.

Tempering within the range 800-1020°F (425-550°C) is not normally recommended due to the reduction in toughness properties.
MACHINING

MILLING—

• Face and Square Shoulder Milling

<table>
<thead>
<tr>
<th>Cutting data parameters</th>
<th>Milling with carbide</th>
<th>Milling with HSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rough milling</td>
<td>Fine milling</td>
</tr>
<tr>
<td>Cutting speed ($V_c$)</td>
<td>f.p.m.</td>
<td>m/min</td>
</tr>
<tr>
<td>Feed ($f$)</td>
<td>inch/tooth</td>
<td>0.008-0.016</td>
</tr>
<tr>
<td>mm/tooth</td>
<td>0.2-0.4</td>
<td>0.1-0.2</td>
</tr>
<tr>
<td>Depth of cut ($a_p$)</td>
<td>inch</td>
<td>0.08-0.20</td>
</tr>
<tr>
<td>mm</td>
<td>2-5</td>
<td>2</td>
</tr>
<tr>
<td>Carbide designation</td>
<td>US</td>
<td>C5-C6</td>
</tr>
<tr>
<td>ISO</td>
<td>P20-P40</td>
<td>P10-P20</td>
</tr>
</tbody>
</table>

End Milling

<table>
<thead>
<tr>
<th>Cutting data parameters</th>
<th>Type of milling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solid carbide</td>
</tr>
<tr>
<td>Cutting speed ($V_c$)</td>
<td>f.p.m.</td>
</tr>
<tr>
<td>Feed ($f$)</td>
<td>inch/tooth</td>
</tr>
<tr>
<td>mm/tooth</td>
<td>0.005-0.20</td>
</tr>
<tr>
<td>Carbide designation</td>
<td>US</td>
</tr>
<tr>
<td>ISO</td>
<td>K10, P40</td>
</tr>
</tbody>
</table>

1) For coated HSS end mill $v_c$~150 f.p.m./min. (45 m/min.)
2) Depending on radial depth of cut and cutter diameter.

Cylindrical grind.
Internal grinding
Profile grinding

WELDING—

Good results when welding tool steel can be achieved if proper precautions are taken regarding elevated temperature, joint preparation, choice of consumables and welding procedure.

FURTHER INFORMATION

CANADIAN LOCATIONS—
Kitchener, Ontario +1 (519) 748-5317
Rexdale, Ontario +1 (905) 799-7474

U.S. LOCATIONS—
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Blaine, Minnesota +1 (763) 585-9020
Cleveland, Ohio +1 (216) 362-8440
Meadville, Pennsylvania +1 (814) 337-6164