Uddeholm Mirrax™ ESR
Premium Mold Steel
Enhanced 400 Series Stainless

Tooling Preparation	Review tool for sharp corners, strong angularity of the tooling, thin to thick transition areas and other aspects of the tool preparation which could affect heat treatment performance. Inspect for welding marks, braze joints, grinding burns, or Electro Discharge Machining indications. If steel has been welded, reanneal the steel per the MIRRAX ESR Data Sheet Guidelines. A minimum 3/16 inch (.1875 inch) radii should be considered on internal radii prior to heat treatment, to permit the best quench rate for the process.	
Heat Treatment	**Vacuum: min 4-5 bar overpressure is recommended or similar cooling rate**	**High Speed Gas/Circulating Atmosphere**
Preheating Temperature	1. Bring up to 1200°F, equalize 2. Heat up to 1550°F, equalize 3. Heat up to 1700°F, equalize Step 3 required for blocks > 8" cross section	1. Bring up to 1100-1200°F, equalize 2. Heat up to 1500-1650°F, equalize 3. Heat up to 1700°F, equalize Step 3 required for blocks > 8" cross section
Hardening Temperature Austenitizing	1830–1880°F (Normally 1870°F) For tooling greater than 8" in cross section 1830°F is recommended. Holding time after the tool or part has fully heated through at the hardening temperature: minimum 30 minutes, maximum 1 hour. Alternatively hold 20 minutes for first 1" and then 15 minutes for each additional inch of wall thickness.	
Quenching*	**Alt. 1** Inert gas, positive pressure; direct quench **Alt. 2** Inert gas, positive pressure; interrupted quench at 660 to 930°F	**Alt. 1** Oil 150°F until the die is black, then air cooling. **Alt. 2** Circulated inert gas. **Alt. 3** Circulated air.
	*Temper immediately after quenching when the tool or part reaches 150°F. • For maximum dimensional stability sub-zero treatment can be applied immediately after quench. Avoid intricate shapes due to the risk of cracking.	
Tempering **(minimum two times)** Avoid high hardening temperature (1880°F) in combination with low (<480°F) tempering temperature. Tempering at high temperatures (>1020°F) may be necessary to relieve residual stresses for large/complex tools.	Hardening Temperature: 1870°F **Tempering Temperature** / **Hardness** 970 °F — 49-51 HRC 1020 °F — 42-44 HRC 1150 °F — 36-38 HRC 1200 °F — 33-35 HRC Time: 1 hour per inch of wall thickness, or hold at temperature a minimum of two hours once tool comes to temperature. Check hardness in between tempers.	
	▪ Tempering at 480-570°F results in the best combination of toughness, hardness and corrosion resistance. However for very large molds, complicated designs, or for minimum size change a high tempering temperature is recommended. Consult Uddeholm before using.	
Stress Temper performed on hardened tools after EDM, welding or during preventative maintenance	Check hardness to confirm tool status. **Temperature:** Shall be 50°F below the lowest tempering temperature. **Time:** Soak 30 minutes per inch of maximum section with a minimum of 2 hours once tool comes to temperature. Cool in still air for simple shapes. For complex shapes, furnace cool to 800°F, then air cool. Caution: Stress tempering in an unprotected atmosphere will oxidize the tool. For hot work applications, this can prove beneficial to protect the tooling surface during operation. However, in other applications where surface finish condition is a concern, consult your heat treater on options for protective atmospheres or finish the surface after stress tempering.	
IMPORTANT: ALLOW FOR SIZE CHANGE	Expect shrinkage of the dimensions when performing low temperature tempers (when tempered below 950°F). When tempering above 950°F, expect growth. Manufacture with enough machining allowance to compensate for dimensional changes. Use 0.003 inch/inch/maximum dimension overall as a guideline provided that a stress relief is performed between rough and semi-finished machining. Please see the Mirrax ESR Data Sheet for further details.	

Additional Information: Soft annealing should be done prior to re-hardening. Protect the steel and heat through to 1365°F. Then cool in the furnace at 30°F per hour to 1020°F then freely in air.

UDDEHOLM
a voestalpine company

USA/Canada: 1-800-METAL20
Mexico: +52 442-349-7946
Website: www.uddeholm.com