

# Uddeholm Arne®

## Welding recommendations

### GENERAL

Uddeholm Arne general-purpose oil-hardening tool steel is a versatile manganese-chromium-tungsten steel suitable for a wide variety of cold-work applications. Its main characteristics include a good machinability, a good dimensional stability in hardening and a good combination of high surface hardness and toughness after hardening and tempering. These characteristics combine to give a steel suitable for the manufacture of tooling with good tool life and production economy.

Good results when welding can be achieved if proper precautions are taken (joint preparation, choice of consumables and welding procedure).

### RECOMMENDED FILLER MATERIAL

Welding Method	Gas Tungsten Arc Welding GTAW (TIG)	Gas Metal Arc Welding GMAW (MIG/MAG)	Shielded Metal Arc Welding SMAW (MMA)	Laser	Comments
Filler material	Caldie TIG Weld Calmax / Carmo TIG Weld	Calmax / Carmo MIG Weld	Calmax / Carmo Weld	Tyrax Laser Weld	
	Type AWS ER 312 AWS ER NiCrMo-3		E 29 9 R		Use soft filler material for buffering layer
Hardness as welded	58 - 62 HRC	58 - 62 HRC	58 - 62 HRC	55 - 60 HRC	

### DIMENSIONS FILLER MATERIAL

Type	TIG			MIG	MMA	Laser
Dia. Ø mm	1.6	2.4	3.2	1.2	2.5	0.2 - 0.6
Dia. Ø Inch	1/16	3/32	3/32	3/64	3/32	0.008 - 0.024
Caldie TIG Weld	X	X	X			
Calmax / Carmo TIG Weld	X					
Calmax / Carmo MIG Weld				X		
Calmax / Carmo Weld					X	
Tyrax Laser Weld						X

### PARAMETERS

Condition	Soft Annealed 190 HB	Hardened 56 - 60 HRC	Comment
Preheating Temperature	225°C ± 25°C 440°F ± 50°F	225°C ± 25°C 440°F ± 50°F	The temperature should be kept constant during the welding operation. Start with buffering layers if not all cracks are removed
Interpass temperature	Max 150°C, 270°F above preheating temperature	Max 150°C, 270°F above preheating temperature	The temperature of the tool in the vicinity of the weld. When passed, the tool will have a risk for distortion, soft zones or cracking in and around the weld (the HAZ).
Cooling rate	20 - 40°, 35 - 70°F C/h The first 2 hours then freely in air <70°C, 160°F		
Post treatment	Soft anneal Harden Temper	Temper at 25°C / 50°F below previous tempering temperature	Holding time when tempering, 2h. The temperature depends on the last used tempering temperature. When soft annealing and hardening, see heat treatment specification in Uddeholm Arne product brochure.*

\* Note. We have seen that in many cases a high temperature tempering, 2h, of ~750°C (1380°F) functions instead of a complete soft annealing when welding in soft annealed material.

## PROCEDURES

- Clean weld area.
- Preheat material to  $225^{\circ}\text{C} \pm 25^{\circ}\text{C}$  /  $440^{\circ}\text{F} \pm 50^{\circ}\text{F}$  and maintain temperature during welding.
- Do not let the temperature in the vicinity of the weld (the HAZ) increase more than  $150^{\circ}\text{C}$  /  $270^{\circ}\text{F}$  above the preheating temperature. There is a risk of lowering (softening) the hardness of the base material or/and cracking in the HAZ. Use temple sticks or other temperature-measuring devices.
- For finishing layers use consumables which give suitable hardness.
- Wait a few minutes between each layer of strings, both for soft and hard filler, in order to let the layer equalize and minimize stresses, if possible use pre-heating furnace. Peen to minimize stresses.
- If possible, change welding direction  $180^{\circ}$  between each layer.
- Cool slowly after welding,  $20 - 40^{\circ}\text{C}/\text{h}$ ,  $35 - 70^{\circ}\text{F}/\text{h}$  for the first two hours and then freely in air  $< 70^{\circ}\text{C}$  /  $160^{\circ}\text{F}$ .
- Temper at  $25^{\circ}\text{C}$  /  $50^{\circ}\text{F}$  below previous tempering temperature, two hours at full temperature. Lowest tempering temperature is  $200^{\circ}\text{C}$  /  $390^{\circ}\text{F}$
- Tools welded in the annealed condition must undergo a full soft annealing immediately after welding. Allow tool to cool to room temperature before soft annealing. If a complete soft annealing cannot be done, which we recommend, a high temperature tempering at  $750^{\circ}\text{C}$  /  $1380^{\circ}\text{F}$  could be used. Be aware of that the working properties of the material will be somewhat reduced, if the high temperature tempering is used instead of the soft annealing.

Use these guideline recommendations along with  
“Welding of Uddeholm Tool Steel” for complete instructions.