

# QRO<sup>®</sup> 90 SUPREME

Hot work tool steel

COLD WORK

PLASTIC MOULDING

HOT WORK

HIGH PERFORMANCE STEEL



 **UDDEHOLM**

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose.

## General

QRO 90 Supreme is a high-performance, chromium-molybdenum-vanadium alloyed hot-work tool steel which is characterized by:

- Excellent high temperature strength and hot hardness
- Very good temper resistance
- Unique resistance to thermal fatigue
- Excellent thermal conductivity
- Good toughness and ductility in longitudinal and transverse directions
- Uniform machinability
- Good heat treatment properties

Typical analysis %	C 0,38	Si 0,30	Mn 0,75	Cr 2,6	Mo 2,25	V 0,9
Standard specification	None. Product is covered by patent world wide					
Delivery condition	Soft annealed to approx. 180 HB					
Color code	Orange/light brown					

### IMPROVED TOOLING PERFORMANCE

QRO 90 Supreme is a specially premium hot work steel developed by Uddeholm to provide better performance in high temperature tooling. The name "Supreme" implies that by special manufacturing techniques, including electro-slag remelting the steel attains high purity and good mechanical properties. This together with the optimum balance of alloying elements in QRO 90 Supreme gives a properties profile which is unique among hot work die steels. The combination of high temperature strength, temper resistance and thermal conductivity exhibited by QRO 90 Supreme is unparalleled.

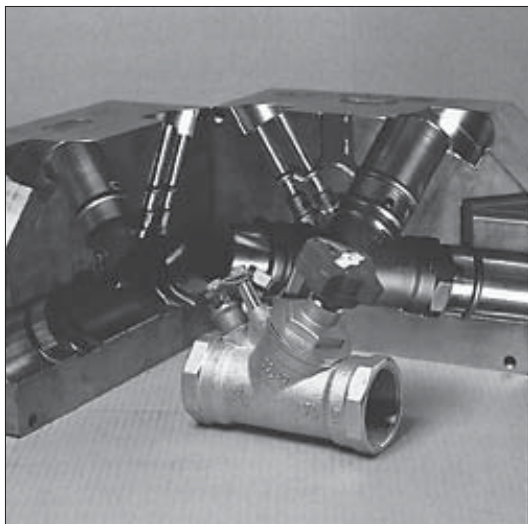


Photo: Bo Dahlgren

Thus QRO 90 Supreme has given improved service life in die casting and extrusion of nonferrous metals and forging and extrusion of steel.

## Applications

### DIE CASTING DIES AND ASSOCIATED TOOLING

QRO 90 Supreme will normally out-perform other standard hot work steels in both aluminum, brass and copper die casting. Its excellent high temperature strength ensures suppression of heat checking and prolonged die life.

Furthermore its high thermal conductivity gives the opportunity to reduce the cycle time and improve productivity.

QRO 90 Supreme can be used for parts where resistance against heat checking, erosion and bending is required. Typical applications are cores, core pins, inserts, small- to medium-sized dies, shot sleeves, moving parts for aluminum, brass and copper die casting.

### EXTRUSION DIES AND EXTRUSION TOOLING

In aluminum extrusion QRO 90 Supreme is recommended for dies when the extruded tonnage is likely to exceed the die life for a standard tool steel e.g.:

- Dies for simple profiles to be produced in long series requiring more than one die
- Dies for complicated or thin walled profiles
- Hollow dies
- Dies for difficult-to-extrude alloys

For extrusion tooling components e.g. liners, dummy blocks, mandrels and stems QRO 90 Supreme gives an improved tool life compared to AISI H13 in aluminum and steel extrusion.

In brass and copper extrusion QRO 90 Supreme has given improved tool life for dummy blocks and die holders compared to AISI H13.

Similar improvements have also been made with liners in QRO 90 Supreme for brass extrusion.

### FORGING DIES

QRO 90 Supreme has given many outstanding results for pressforging of steel, and brass, particularly in small- and medium-sized dies. The product is also eminently suitable for progressive forging, upset forging, extrusion forging, powder forging and all processes where heavy water cooling is used.

# Properties

All specimens are taken from the centre of a 14" x 5" (356 x 127 mm) bar. Unless otherwise is indicated all specimens were hardened 30 minutes at 1885°F (1030°C), quenched in air and tempered 2 + 2h at 1190°F (645°C). The hardness were 45 ± 1 HRC.

## PHYSICAL DATA

Hardened and tempered to 45 HRC.  
Data at room and elevated temperatures.

Temperature	68°F (20°C)	750°F (400°C)	1110°F (600°C)
Density lbs/in <sup>3</sup> kg/m <sup>3</sup>	0,281 7 800	0,277 7 700	0,274 7 600
Modulus of elasticity psi N/mm <sup>2</sup>	30,5 x 10 <sup>6</sup> 210 000	26,1 x 10 <sup>6</sup> 180 000	20,3 x 10 <sup>6</sup> 140 000
Coefficient of thermal expansion per °F from 68°F °C from 20°C	—	7,0 x 10 <sup>-6</sup> 12,6 x 10 <sup>-6</sup>	7,3 x 10 <sup>-6</sup> 13,2 x 10 <sup>-6</sup>
Thermal conductivity Btu in/(ft <sup>2</sup> h°F) W/m °C	—	230 33	230 33

## MECHANICAL PROPERTIES

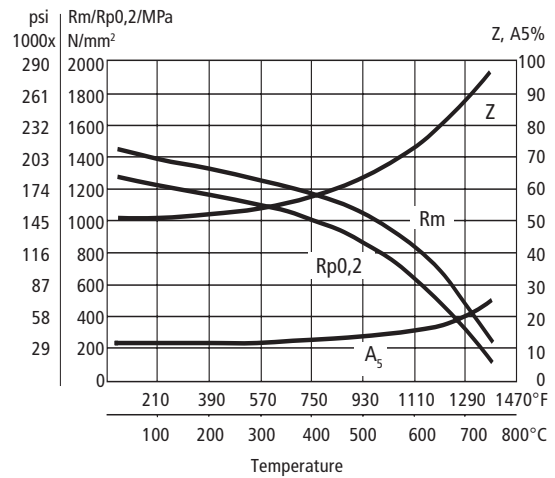
Approximate tensile strength at room temperature.

Hardness	48 HRC	45 HRC	40 HRC
Tensile strength Rm	1620 N/mm <sup>2</sup> 165 kp/mm <sup>2</sup> 105 tsi 235 000 psi	1470 N/mm <sup>2</sup> 150 kp/mm <sup>2</sup> 95 tsi 213 000 psi	1250 N/mm <sup>2</sup> 128 kp/mm <sup>2</sup> 81 tsi 181 000 psi
Yield strength Rp0,2	1400 N/mm <sup>2</sup> 143 kp/mm <sup>2</sup> 91 tsi 203 000 psi	1270 N/mm <sup>2</sup> 130 kp/mm <sup>2</sup> 82 tsi 184 000 psi	1100 N/mm <sup>2</sup> 112 kp/mm <sup>2</sup> 71 tsi 160 000 psi

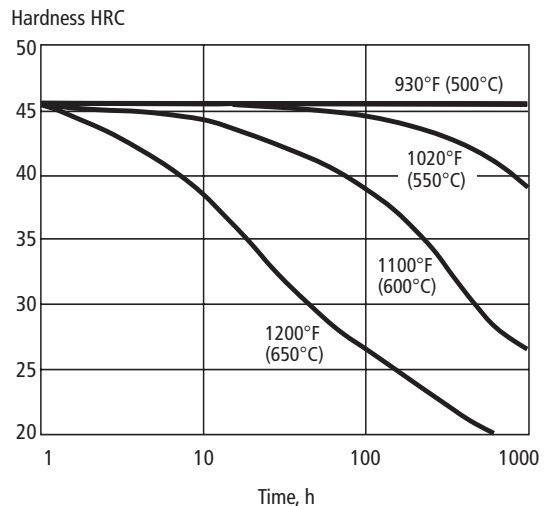


## Approximate strength at elevated temperatures

Longitudinal direction

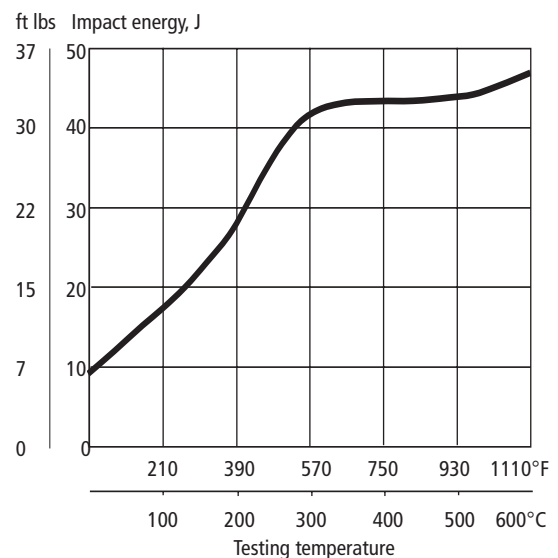


## Effect of time at high temperatures on hardness



## Effect of testing temperature on impact energy

Charpy V specimens, short transverse direction.



# Heat treatment– general recommendations

## SOFT ANNEALING

Protect the steel and heat through to 1500°F (820°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 2 hours. Cool slowly to 930°F (500°C), then freely in air.

## HARDENING

*Pre-heating temperature:* 1110–1560°F (600–850°C) normally in two pre-heating steps.

*Austenitizing temperature:* 1870–1920°F (1020–1050°C).

Temperature		Soaking* time minutes	Hardness before tempering
°F	°C		
1870	1020	30	51±2 HRC
1920	1050	15	52±2 HRC

\* Soaking time = time at hardening temperature after the tool is fully heated through.

*Protect the part against decarburization and oxidation during hardening.*

## QUENCHING MEDIA

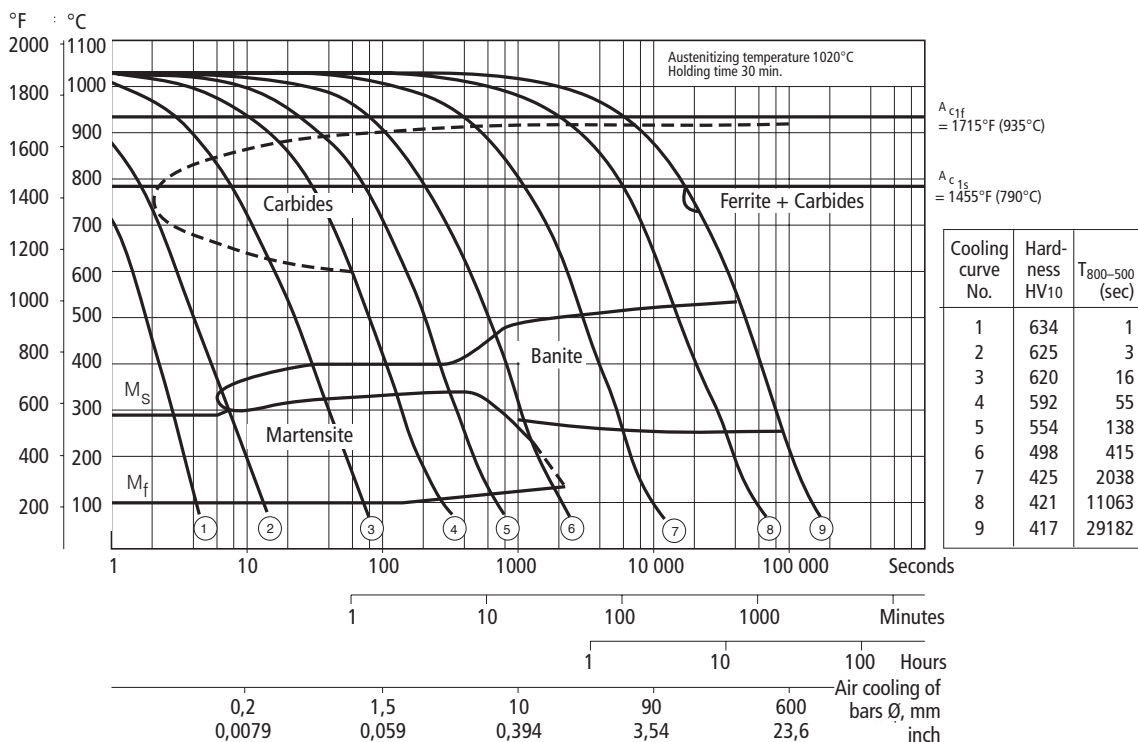
- High speed gas/circulating atmosphere
- Vacuum (high speed gas with sufficient positive pressure). An interrupted quench is recommended
- Martempering bath or fluidized bed at 1020°F (550°C)
- Martempering bath or fluidized bed at approx. 360–430°F (180–220°C)
- Warm oil

*Note 1:* Temper the tool as soon as its temperature reaches 120–160°F (50–70°C).

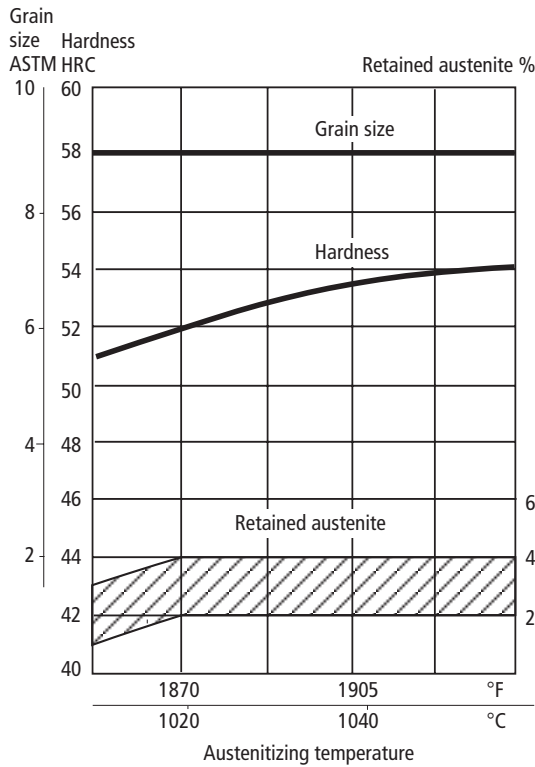
*Note 2:* In order to obtain the optimum properties for the tool, the cooling rate should be fast but not at a level that gives excessive distortion or cracks.

## CCT graph

Austenitizing temperature 1870°F (1020°C). Holding time 30 minutes.



*Hardness, grain size and retained austenite as functions of austenitizing temperature*

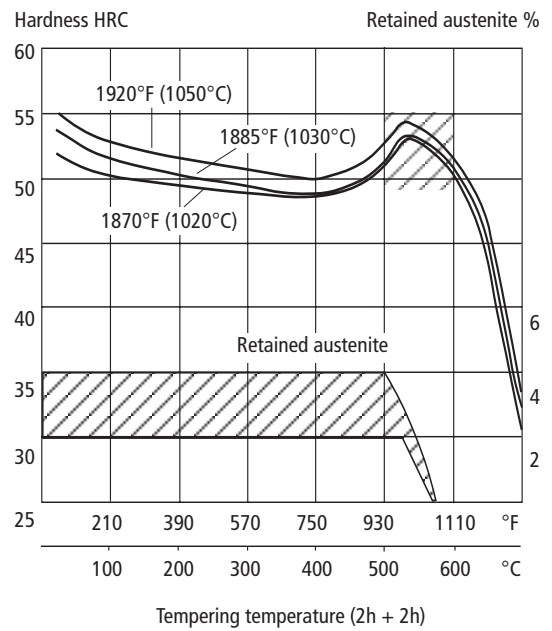


**TEMPERING**

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper minimum twice with intermediate cooling to room temperature. Lowest tempering temperature 1110°F (600°C). Holding time at temperature minimum 2 hours. To avoid “temper brittleness” do not temper in the range 930–1110°F (500–600°C).

*Tempering graph*

Air cooling of specimens 1" x 1" x 1 1/2" (25 x 25 x 40 mm). Larger sections, which contain bainite after hardening, are characterized by a lower initial hardness and displacement of the secondary-hardening peak to higher temperatures. During overtempering, however, the curves are more or less identical from about 45 HRC down, irrespective of section size.



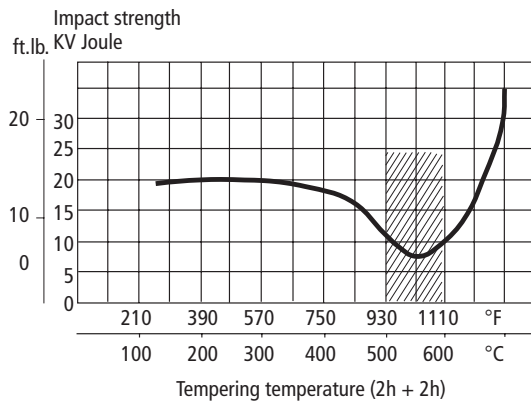
Core pins in QRO 90 HT (prehardened QRO 90 Supreme)



Shot sleeves in QRO 90 Supreme

*Approximate impact strength at different tempering temperatures*

Longitudinal specimens, heat treated after machining.



Tempering within the range 930–1110°F (500–600°C) is normally not recommended due to the reduction in toughness properties.

**DIMENSIONAL CHANGES DURING HARDENING AND TEMPERING**

During hardening and tempering the die is exposed to thermal as well as transformation stresses. This will inevitably result in dimensional changes and in the work case distortion. It is therefore recommended to always leave a machining allowance after machining before the die is hardened and tempered. Normally the size in the largest direction will shrink and the size in the smallest direction might increase but this is also a matter of the die size, the die design as well as the cooling rate after hardening.

For QRO 90 Supreme it is recommended to leave a machining allowance of 0,3 per cent of the dimension in length, width and thickness.

**NITRIDING AND NITROCARBURIZING**

Nitriding and nitrocarburizing result in a hard surface layer which is very resistant to wear and erosion. The nitrided layer is, however, brittle and may crack or spall when exposed to mechanical or thermal shock, the risk increasing with layer thickness. Before nitriding, the tool should be hardened and tempered at a temperature minimum 50–90°F (25–50°C) above the nitriding temperature.

Nitriding in ammonia gas at 950°F (510°C) or plasma nitriding in a 75% hydrogen/25% nitrogen mixture at 895°F (480°C) both result in a surface hardness of about 1000 HV<sub>0,2</sub>. In general, plasma nitriding is the preferred method because of better

control over nitrogen potential; in particular, formation of the so-called white layer, which is not recommended for hot-work service, can readily be avoided. However, careful gas nitriding can give perfectly acceptable results.

QRO 90 Supreme can also be nitrocarburized in either gas or salt bath. The surface hardness after nitrocarburizing is 800–900 HV<sub>0,2</sub>.

**DEPTH OF NITRIDING**

Process	Time	Depth	
		inch	mm
Gas nitriding at 950°F (510°C)	10 h	0,0063	0,16
	30 h	0,0106	0,27
Plasma nitriding at 895°F (480°C)	10h	0,0070	0,18
	30 h	0,0106	0,27
Nitrocarburizing – in gas at 1075°F (580°C)	2,5 h	0,0078	0,20

Nitriding to case depths >0,012 inch (0,3 mm) is not recommended for hot-work applications. It should be noted that QRO 90 Supreme exhibits better nitridability than AISI H13. For this reason, the nitriding times for QRO 90 Supreme should be shortened in relation to H13, otherwise there is considerable risk that the case depth will be too great.

QRO 90 Supreme can be nitrided in the soft-annealed condition. The hardness and depth of case will, however, be reduced somewhat in this case.



# Machining recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendations".

## TURNING

Cutting data parameters	Turning with carbide		Turning with HSS Fine turning
	Rough turning	Fine turning	
Cutting speed ( $v_c$ ) f.p.m. m/min	656–820 200–250	820–984 250–300	82–98 25–30
Feed ( $f$ ) i.p.r. mm/r	0,008–0,016 0,2–0,4	0,002–0,008 0,05–0,2	0,002–0,01 0,05–0,3
Depth of cut ( $a_p$ ) inch mm	0,08–0,16 2–4	0,02–0,08 0,5–2	0,02–0,08 0,5–2
Carbide designation US ISO	C6–C5 P20–P30 Coated carbide	C7–C6 P10–P20 Coated carbide or cermet	– –

## DRILLING

### High speed steel twist drill

Drill diameter		Cutting speed $v_c$		Feed $f$	
inch	mm	f.p.m.	m/min.	i.p.r.	mm/r
–3/16	– 5	52–59*	16–18*	0,002–0,006	0,05–0,15
3/16–3/8	5–10	52–59*	16–18*	0,006–0,008	0,15–0,20
3/8–5/8	10–15	52–59*	16–18*	0,008–0,010	0,20–0,25
5/8–3/4	15–20	52–59*	16–18*	0,010–0,014	0,25–0,35

\* For coated HSS drill  $v_c = 92–98$  f.p.m. (28–30 m/min.).

### Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide <sup>1)</sup>
Cutting speed, $v_c$ f.p.m. m/min	722–787 220–240	427–525 130–160	262–361 80–110
Feed, $f$ i.p.r. mm/r	0,002–0,01 <sup>2)</sup> 0,05–0,25 <sup>2)</sup>	0,004–0,01 <sup>2)</sup> 0,1–0,25 <sup>2)</sup>	0,006–0,01 <sup>2)</sup> 0,15–0,25 <sup>2)</sup>

<sup>1)</sup> Drill with internal cooling channels and brazed carbide tip.

<sup>2)</sup> Depending on drill diameter.

## MILLING

### Face and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed ( $v_c$ ) f.p.m. m/min	590–853 180–260	853–984 260–300
Feed ( $f_z$ ) inch/tooth mm/tooth	0,008–0,016 0,2–0,4	0,004–0,008 0,1–0,2
Depth of cut ( $a_p$ ) inch mm	0,08–0,2 2–5	–0,08 –2
Carbide designation US ISO	C6–C5 P20–P40 Coated carbide	C7–C6 P10–P20 Coated carbide or cermet

### End milling

Cutting data parameters	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed ( $v_c$ ) f.p.m. m/min	525–656 160–200	558–755 170–230	115–131 <sup>1)</sup> 35–40 <sup>1)</sup>
Feed ( $f_z$ ) inch/tooth mm/tooth	0,001–0,008 <sup>2)</sup> 0,03–0,2 <sup>2)</sup>	0,003–0,008 <sup>2)</sup> 0,08–0,2 <sup>2)</sup>	0,002–0,014 <sup>2)</sup> 0,05–0,35 <sup>2)</sup>
Carbide designation US ISO	– –	C6–C5 P20–P30	– –

<sup>1)</sup> For coated HSS end mill  $v_c = 180–197$  f.p.m. (55–60 m/min.)

<sup>2)</sup> Depending on radial depth of cut and cutter diameter.

## GRINDING

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm publication "Grinding of Tool Steel".

### Wheel recommendation

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	A 46 HV
Face grinding segments	A 24GV	A 36 GV
Cylindrical grinding	A 46 LV	A 60 KV
Internal grinding	A 46 JV	A 60 IV
Profile grinding	A 100 LV	A 120 JV

## Electrical-discharge machining

If spark-erosion is performed in the hardened and tempered condition, the white re-cast layer should be removed mechanically e.g. by grinding or stoning. The tool should then be given an additional temper at approx. 50°F (25°C) below the previous tempering temperature.

## Welding

Welding of tool steel can be performed with good results if proper precautions are taken regarding elevated temperature, joint preparation, choice of consumables and welding procedure.

Welding method	TIG	MMA
Working temperature	620–710°F (325–375°C)	620–710°F (325–375°C)
Filler metals	QRO 90 TIG-WELD	QRO 90 WELD
Post welding cooling	35–70°F/h (20–40°C/h) for the first 2–3 hours and then freely in air.	
Hardness after welding	50–55 HRC	50–55 HRC
<b>Heat treatment after welding</b>		
Hardened condition	Temper at 20–40°F (10–20°C) below the original tempering temp.	
Soft annealed condition	Soft-anneal the material at 1500°F (820°C) in protected atmosphere. Then cool in the furnace at 20°F (10°C) per hour to 1200°F (650°C) then freely in air.	

More detailed information can be found in the Uddeholm brochure "Welding of tool steel".



Dummy blocks in QRO 90 Supreme

## Hard-chromium plating

After plating, parts should be tempered at 360°F (180°C) for 4 hours to avoid the risk of hydrogen embrittlement.

## Further information

Please contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steels.



## UDDEHOLM EUROPE

### AUSTRIA

UDDEHOLM  
Hansaallee 321  
D-40549 Düsseldorf  
Telephone: +49 211 535 10  
Telefax: +49 211 535 12 80

### BELGIUM

UDDEHOLM N.V.  
Waterstraat 4  
B-9160 Lokeren  
Telephone: +32 9 349 11 00  
Telefax: +32 9 349 11 11

### CROATIA

BOHLER UDDEHOLM Zagreb  
d.o.o za trgovinu  
Zitnjak b.b  
10000 Zagreb  
Telephone: +385 1 2459 301  
Telefax: +385 1 2406 790

### CZECHIA

BOHLER UDDEHOLM CZ s.r.o.  
Division Uddeholm  
U silnice 949  
161 00 Praha 6 Ruzyně  
Czech Republic  
Telephone: +420 233 029 850,8  
Telefax: +420 233 029 859

### DENMARK

UDDEHOLM A/S  
Kokmose 8, Bramdrupdam  
DK-6000 Kolding  
Telephone: +45 75 51 70 66  
Telefax: +45 75 51 70 44

### ESTONIA

UDDEHOLM TOOLING AB  
Silikatsiidi 7  
EE-0012 Tallinn  
Telephone: +372 655 9180  
Telefax: +372 655 9181

### FINLAND

OY UDDEHOLM AB  
Ritakujja 1, PL 57,  
FIN-01741 VANTAA  
Telephone: +358 9 290 490  
Telefax: +358 9 2904 9249

### FRANCE

UDDEHOLM S.A.  
12 Rue Mercier, Z.I. de Mitry-Compans  
F-77297 Mitry Mory Cedex  
Telephone: +33 (0)1 60 93 80 10  
Telefax: +33 (0)1 60 93 80 01

#### Branch office

UDDEHOLM S.A.  
77bis, rue de Vesoul  
La Nef aux Métiers  
F-25000 Besançon  
Telephone: +33 381 53 12 19  
Telefax: +33 381 53 13 20

### GERMANY

UDDEHOLM  
Hansaallee 321  
D-40549 Düsseldorf  
Telephone: +49 211 535 10  
Telefax: +49 211 535 12 80

#### Branch offices

UDDEHOLM  
Falkenstraße 21  
D-65812 Bad Soden/TS.  
Telephone: +49 6196 659 60  
Telefax: +49 6196 659 625

### UDDEHOLM

Albstraße 10  
D-73765 Neuhausen  
Telephone: +49 715 898 65-0  
Telefax: +49 715 898 65-25

### GREAT BRITAIN, IRELAND

UDDEHOLM UK LIMITED  
European Business Park  
Taylors Lane, Oldbury  
West Midlands B69 2BN  
Telephone: +44 121 552 55 11  
Telefax: +44 121 544 29 11  
Dublin Telephone: +353 1 45 14 01

### GREECE

UDDEHOLM STEEL TRADING  
COMPANY  
20, Athinon Street  
G-Piraeus 18540  
Telephone: +30 2 10 41 72 109/41 29 820  
Telefax: +30 2 10 41 72 767

### SKLERO S.A.

Steel Trading Comp. and  
Hardening Shop  
Frixou 11/Nikif. Ouranou  
G-54627 Thessaloniki  
Telephone: +30 31 51 46 77  
Telefax: +30 31 54 12 50

### HUNGARY

UDDEHOLM TOOLING/BOK  
Dunaharaszti, Jedlik Anyos út 25  
H-2331 Dunaharaszti 1.Pf. 110  
Telephone/Telefax: +36 24 492 690

### ITALY

UDDEHOLM Italia S.p.A.  
Via Palizzi, 90  
I-20157 Milano  
Telephone: +39 02 35 79 41  
Telefax: +39 02 390 024 82

### LATVIA

UDDEHOLM TOOLING AB  
Deglava street 50  
LV-1035 Riga  
Telephone: +371 7 701 983, -981, -982  
Telefax: +371 7 701 984

### LITHUANIA

UDDEHOLM TOOLING AB  
BE PLIENAS IR METALAI  
T. Masiulio 18b  
LT-3014 Kaunas  
Telephone: +370 37 370613, -669  
Telefax: +370 37 370300

### THE NETHERLANDS

UDDEHOLM B.V.  
Isolatorweg 30  
NL-1014 AS Amsterdam  
Telephone: +31 20 581 71 11  
Telefax: +31 20 684 86 13

### NORWAY

UDDEHOLM A/S  
Jernkroken 18  
Postboks 85, Kalbakken  
N-0902 Oslo  
Telephone: +47 22 91 80 00  
Telefax: +47 22 91 80 01

### POLAND

INTER STAL CENTRUM  
Sp. z. o.o./Co. Ltd.  
ul. Kolejowa 291, Dziekanów Polski  
PL-05-092 Lomianki  
Telephone: +48 22 429 2260  
Telefax: +48 22 429 2266

### PORTUGAL

F RAMADA Açoes e Industrias S.A.  
P.O. Box 10  
P-3881 Ovar Codex  
Telephone: +351 56 58 61 11  
Telefax: +351 56 58 60 24

### ROMANIA

BÖHLER Romania SRL  
Uddeholm Branch  
Str. Atomistilor Nr 14A  
077125 Magurele Jud Ilfov  
Telephone: +40 214 575007  
Telefax: +40 214 574212

### RUSSIA

UDDEHOLM TOOLING CIS  
25 A Bolshoy pr PS  
197198 St. Petersburg  
Telephone: +7 812 233 9683  
Telefax: +7 812 232 4679

### SLOVAKIA

UDDEHOLM Slovakia  
Nástrojové ocele, s.r.o  
KRÁČINY 2  
036 01 Martin  
Telephone: +421 842 4 300 823  
Telefax: +421 842 4 224 028

### SLOVENIA

UDDEHOLM Italia S.p.A.  
Via Palizzi, 90  
I-20157 Milano  
Telephone: +39 02 35 79 41  
Telefax: +39 02 390 024 82

### SPAIN

UDDEHOLM  
Guifré 690-692  
E-08918 Badalona, Barcelona  
Telephone: +34 93 460 1227  
Telefax: +34 93 460 0558

#### Branch office

UDDEHOLM  
Barrio San Martin de Arteaga, 132  
Pol.Ind. Torrelarragoiti  
E-48170 Zamudio  
(Bizkaia)  
Telephone: +34 94 452 13 03  
Telefax: +34 94 452 13 58

### SWEDEN

UDDEHOLM TOOLING  
SVENSKA AB  
Aminogatan 25  
SE-431 53 Mölndal  
Telephone: +46 31 67 98 50  
Telefax: +46 31 27 02 94

### SWITZERLAND

HERTSCH & CIE AG  
General Wille Strasse 19  
CH-8027 Zürich  
Telephone: +41 1 208 16 66  
Telefax: +41 1 201 46 15

### UDDEHOLM

### NORTH AMERICA

### USA

UDDEHOLM  
4902 Tollview Drive  
Rolling Meadows IL 60008  
Telephone: +1 847 577 22 20  
Telefax: +1 847 577 80 28

### UDDEHOLM

548 Clayton Ct.,  
Wood Dale IL 60191  
Telephone: +1 630 350 10 00  
Telefax: +1 630 350 08 80

### UDDEHOLM

9331 Santa Fe Springs Road  
Santa Fe Springs, CA 90670  
Telephone: +1 562 946 65 03  
Telefax: +1 562 946 77 21

### UDDEHOLM

220 Cherry Street  
Shrewbury, MA 01545  
Telephone: +1 508 845 1066  
Telefax: +1 508 845 3471

### CANADA

UDDEHOLM LIMITED  
2595 Meadowvale Blvd.  
Mississauga, Ontario L5N 7Y3  
Telephone: +1 905 812 9440  
Telefax: +1 905 812 8659

### MEXICO

ACEROS BOHLER UDDEHOLM,  
S.A. de C.V.  
Calle 8 No 2, Letra "C"  
Fraccionamiento Industrial Alce Blanco  
C.P. 52787 Naucalpan de Juarez  
Estado de Mexico  
Telephone: +52 55 9172 0242  
Telefax: +52 55 5576 6837

### UDDEHOLM

Lerdo de Tejada No.542  
Colonia Las Villas  
66420 San Nicolas de Los Garza, N.L.  
Telephone: +52 8-352 5239  
Telefax: +52 8-352 5356

## UDDEHOLM SOUTH AMERICA

### ARGENTINA

UDDEHOLM S.A  
Mozart 40  
1619-Centro Industrial Garin  
Garin-Prov. Buenos Aires  
Telephone: +54 332 744 4440  
Telefax: +54 332 745 3222

### BRAZIL

UDDEHOLM ACOS ESPECIAIS Ltda.  
Estrada Yae Massumoto, 353  
CEP 09842-160  
Sao Bernardo do Campo - SP Brazil  
Telephone: +55 11 4393 4560, -4554  
Telefax: +55 11 4393 4561

## UDDEHOLM SOUTH AFRICA

UDDEHOLM Africa (Pty) Ltd.  
P.O. Box 539  
ZA-1600 Isando/Johannesburg  
Telephone: +27 11-974 2781  
Telefax: +27 11-392 2486

## UDDEHOLM AUSTRALIA

BOHLER-UDDEHOLM Australia  
129-135 McCredie Road  
Guildford NSW 2161  
Private Bag 14  
Telephone: +61 2 9681 3100  
Telefax: +61 2 9632 6161

#### Branch offices

Sydney, Melbourne, Adelaide,  
Brisbane, Perth, Newcastle,  
Launceston, Albury, Townsville

## ASSAB

### ASSAB INTERNATIONAL

Skytteholmsvägen 2  
P O Box 42  
SE-171 11 Solna  
Sweden  
Telephone: +46 8 564 616 70  
Telefax: +46 8 25 02 37

#### Subsidiaries

India, Iran, Turkey, United Arab  
Emirates

#### Distributors in

Africa, Latin America, Middle East

### ASSAB PACIFIC

ASSAB Pacific Pte. Ltd  
171, Chin Swee Road  
No. 07-02, San Centre  
Singapore 169877  
Telephone: +65 534 56 00  
Telefax: +65 534 06 55

#### Subsidiaries

China, Hong Kong, Indonesia, Japan,  
Korea, Malaysia, Philippine Islands,  
Singapore, Taiwan, Thailand

When the first idea pops into your head, throughout the development process to the release of the new product, we'll be your partner. As the world's leading supplier of tooling materials and related services, we can be trusted. Meet us under the Uddeholm and ASSAB brands, wherever in the world you have your business.



WWW.UDDEHOLM.COM

Edition: 4, 04.2003