ASSAB 88

UDDEHOLM SLEIPNER

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
ASSAB DF-3	ARNE	O1	1.2510	SKS 3
ASSAB XW-10	RIGOR	A2	1.2363	SKD 12
ASSAB XW-42	SVERKER 21	D2	1.2379	(SKD 11)
CALMAX / CARMO	CALMAX / CARMO		1.2358	
VIKING	VIKING / CHIPPER		(1.2631)	
CALDIE	CALDIE			
ASSAB 88	SLEIPNER			
ASSAB PM 23 SUPERCLEAN	VANADIS 23 SUPERCLEAN	(M3:2)	1.3395	(SKH 53)
ASSAB PM 30 SUPERCLEAN	VANADIS 30 SUPERCLEAN	(M3:2 + Co)	1.3294	SKH 40
ASSAB PM 60 SUPERCLEAN	VANADIS 60 SUPERCLEAN		(1.3292)	
VANADIS 4 EXTRA SUPERCLEAN	VANADIS 4 EXTRA SUPERCLEAN			
VANADIS 8 SUPERCLEAN	VANADIS 8 SUPERCLEAN			
VANCRON SUPERCLEAN	VANCRON SUPERCLEAN			
ELMAX SUPERCLEAN	ELMAX SUPERCLEAN			
VANAX SUPERCLEAN	VANAX SUPERCLEAN			
ASSAB 518		P20	1.2311	
ASSAB 618 T		(P20)	(1.2738)	
ASSAB 618 / 618 HH		(P20)	1.2738	
ASSAB 718 SUPREME / 718 HH	IMPAX SUPREME / IMPAX HH	(P20)	1.2738	
NIMAX / NIMAX ESR	NIMAX / NIMAX ESR			
VIDAR 1 ESR	VIDAR 1 ESR	H11	1.2343	SKD 6
UNIMAX	UNIMAX			
CORRAX	CORRAX			
ASSAB 2083		420	1.2083	SUS 420J2
STAVAX ESR	STAVAX ESR	(420)	(1.2083)	(SUS 420J2)
MIRRAX ESR	MIRRAX ESR	(420)		
MIRRAX 40	MIRRAX 40	(420)		
TYRAX ESR	TYRAX ESR			
POLMAX	POLMAX	(420)	(1.2083)	(SUS 420J2)
ROYALLOY	ROYALLOY	(420 F)		
COOLMOULD	COOLMOULD			
ASSAB 2714			1.2714	SKT 4
ASSAB 2344		H13	1.2344	SKD 61
ASSAB 8407 2M	ORVAR 2M	H13	1.2344	SKD 61
ASSAB 8407 SUPREME	ORVAR SUPREME	H13 Premium	1.2344	SKD 61
DIEVAR	DIEVAR			
QRO 90 SUPREME	QRO 90 SUPREME			
FORMVAR	FORMVAR			

( ) - modified grade

Edition 20200403

ASSAB 88

THE CHANGING TOOLING ENVIRONMENT

The tooling environment is changing to adapt to the changing market environment. Lead time is one aspect of this change and they are getting shorter and shorter. This ultimately means that more emphasis has to be placed on tool reliability in service and on time to manufacture the tooling.

The production materials used nowadays are placing more demands on the tools and the tool steel used to manufacture them. For example, advanced high strength steel materials now being used for automotive parts place extra demands on resistance to chipping and cracking, compressive strength and wear resistance.

THE MODERN GENERAL COLD WORK TOOL STEEL

The classical 12 % Cr-steel such as AISI D2 or W.-Nr. 1.2379 are still the backbone of cold work tooling but their limitations are becoming more and more apparent in the changing production environment.

ASSAB 88 is a 8 % Cr-steel from ASSAB. Its property profile has been carefully balanced and the result is a very versatile tool steel which overcomes the limitations of the 12% Cr-steel.

A VERSATILE TOOL STEEL

The property profile of ASSAB 88 is more versatile and superior to that of 12 % Cr-steel. The machinability, grindability and hardenability are much better and it is easier to make small repair welds. This means that ASSAB 88 is the right choice for faster toolmaking. The significantly better chipping resistance also result in better tool performance and easier maintenance.

GENERAL

ASSAB 88 is a chromium-molybdenum-vanadium alloyed tool steel which is characterised by:

- Good wear resistance
- Good chipping resistance
- High compressive strength
- High hardness (>60 HRC) after high temperature tempering
- Good through-hardening properties
- Good stability in hardening
- Good resistance to tempering back
- Good WEDM properties
- Good machinability and grindability
- Good surface treatment properties

Typical analysis %	C 0.9	Si 0.9	Mn 0.5	Cr 7.8	Mo 2.5	V 0.5
Standard specification	None					
Delivery condition	Soft annealed to approx. 235 HB					

APPLICATIONS

ASSAB 88 is a general purpose steel for cold work tooling. It has a mixed abrasive wear profile and a good resistance to chipping. Furthermore, a high hardness (>60 HRC) can be obtained after high temperature tempering. This means that surface treatment such as nitriding or PVD can be made on a high strength substrate. It also means that complicated shapes with hardness levels >60 HRC can be wire EDM'd from blocks with relatively thick cross-sections with a much reduced risk of cracking.

ASSAB 88 is recommended for medium run tooling applications where a resistance to mixed or abrasive wear and a good resistance to chipping are required.

TYPICAL APPLICATIONS

- Blanking and fine blanking
- Shearing
- Forming
- Coining
- Cold forging
- Cold extrusion
- Thread rolling
- Drawing and deep drawing
- Powder pressing

PROPERTIES

PHYSICAL DATA

Hardened and tempered to 62 HRC. Data at room and elevated temperatures.

Temperature	20 °C	200 °C	400 °C
Density kg/m³	7 730	7 680	7 620
Modulus of elasticity MPa	205 000	190 000	180 000
Coefficient of thermal expansion - after low temperature tempering (60HRC) per °C from 20 °C - after high temperature tempering per °C from 20 °C	- -	12.7×10^{-6} 11.6×10^{-6}	- 12.4×10^{-6}
Thermal conductivity W/m °C	-	20	25
Specific heat J/kg °C	460	-	-

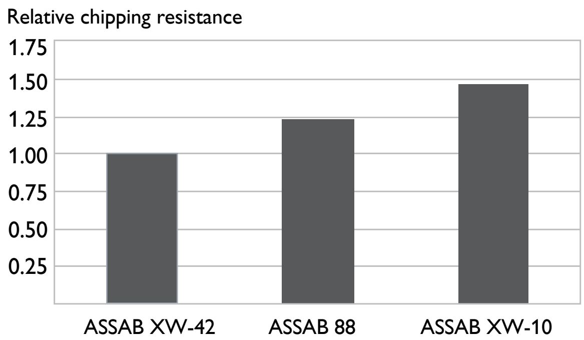
COMPRESSIVE STRENGTH

The figures should be considered as approximate.

Hardness HRC	Compressive yield strength $R_{c0.2}$ (MPa)
50	1 700
55	2 050
60	2 350
62	2 500
64	2 650

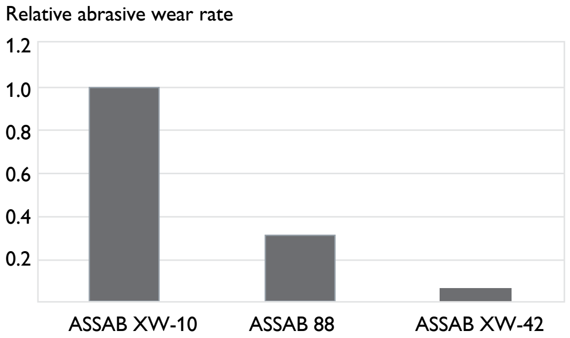
CHIPPING RESISTANCE

Relative chipping resistance for ASSAB XW-42, ASSAB 88 and ASSAB XW-10 at the same hardness level.



ABRASIVE WEAR RESISTANCE

Relative abrasive wear resistance for ASSAB XW-42, ASSAB 88 and ASSAB XW-10 at the same hardness level (low value means better wear resistance).



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 850 °C. Then cool in the furnace at 10 °C per hour to 650 °C, then freely in air.

STRESS RELIEVING

After rough machining, the tool should be heated through to 650 °C and held for 2 hours. Cool slowly to 500 °C, then freely in air.

HARDENING

Preheating temperature: 600 – 650 °C and 850 – 900 °C.

Austenitising temperature: 950 – 1080 °C, but usually 1030 – 1050 °C.

Holding time: 30 minutes

Note: Holding time = time at hardening temperature after the tool is fully heated through. A holding time of less than recommended time will result in loss of hardness.

Protect the part against decarburisation and oxidation during hardening.

QUENCHING MEDIA

- Vacuum (high speed gas with sufficient overpressure minimum 2 bar)
- Martempering bath or fluidised bed at approx. 200 – 550 °C
- Forced air/gas

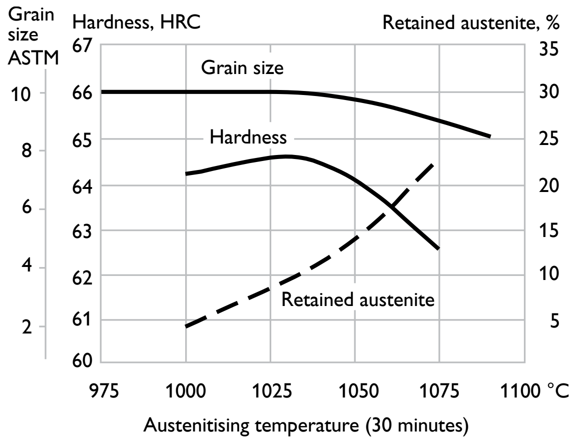
Note: Temper the tool as soon as its temperature reaches 50 – 70 °C.

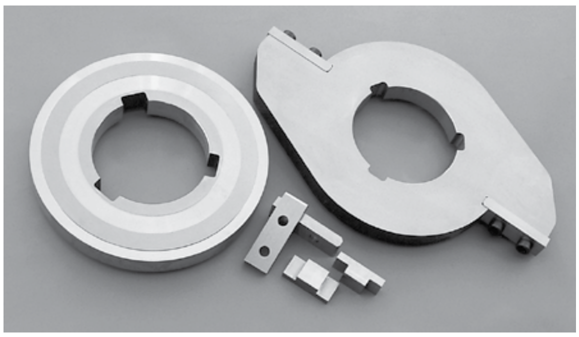
In order to obtain the optimum properties for the tool, the cooling rate should be as fast as possible with regards to acceptable distortion.

A slow quench rate will result in loss of hardness compared with the given tempering curves.

Martempering should be followed by forced air cooling if wall thickness is exceeding 50 mm.

HARDNESS, RETAINED AUSTENITE AND GRAIN SIZE AS FUNCTION OF AUSTENISING TEMPERATURE



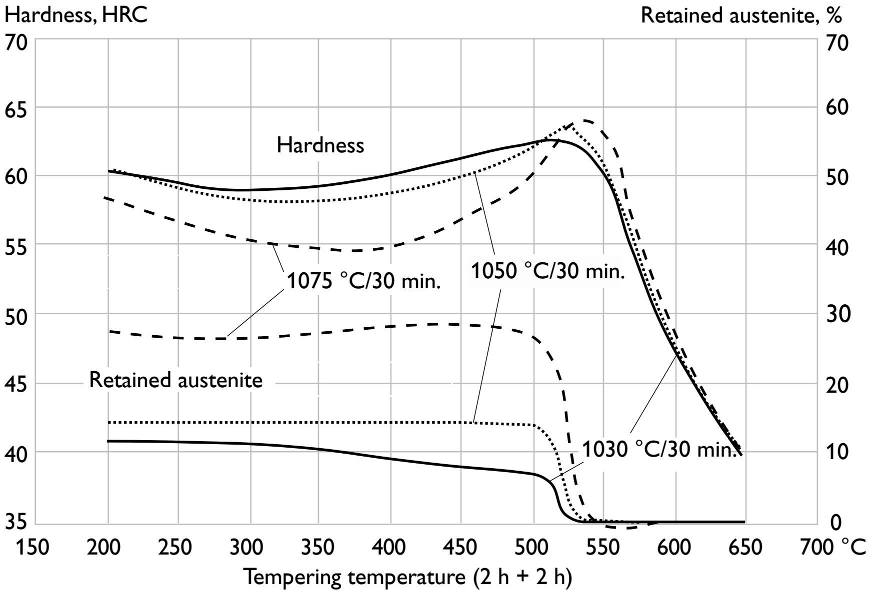


TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper at least twice with intermediate cooling to room temperature. For highest dimensional stability and ductility, a minimum temperature of 540 °C and three tempers is strongly recommended.

Tempering at a lower temperature than 540 °C may increase the hardness and compressive strength to some extent but also impair cracking resistance and dimensional stability. However, if lowering the tempering temperature, do not temper below 520 °C.

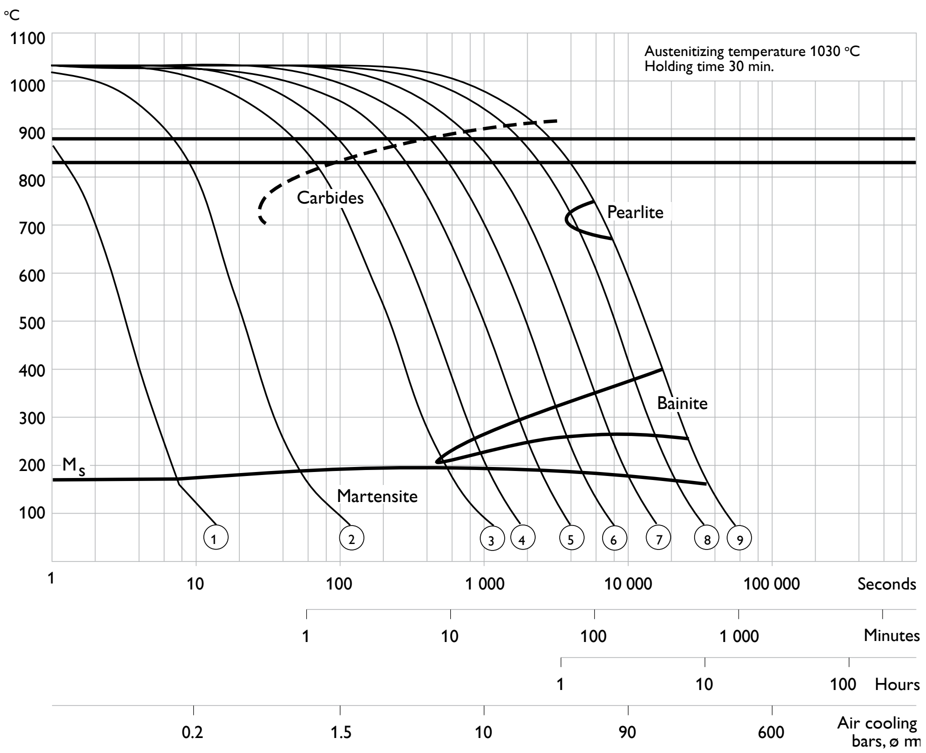
When tempering twice the minimum holding time at temperature is 2 hours. When tempering three times the minimum holding time is 1 hour.



Above tempering curves are obtained after heat treatment of samples with a size of 15 x 15 x 40 mm, cooling in forced air. Lower hardness can be expected after heat treatment of tools and dies due to factors like actual tool size and heat treatment parameters.

CCT GRAPH

Austenitising temperature 1030 °C. Holding time 30 minutes.



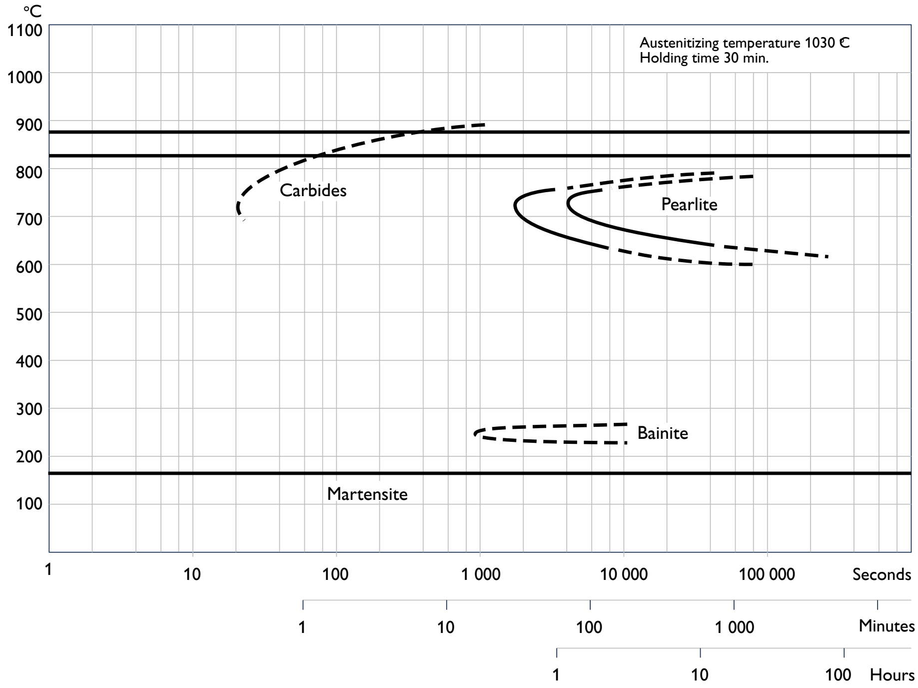
A_{C1f} = 880 °C

A_{C1s} = 830 °C

Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	824	2
2	824	11
3	813	140
4	813	280
5	813	630
6	813	1 241
7	724	2 482
8	649	5 215
9	572	8 360

TTT GRAPH

Austenitising temperature 1030 °C. Holding time 30 minutes.



A_{C1f} = 880 °C

A_{C1s} = 830 °C

Temp. °C	Time h	Hardness HV 10
800	31.0	498
750	3.1	266
725	1.6	309
700	3.0	304
650	19.6	239
600	23.3	724
300	7.0	813
250	16.3	803
200	23.4	813

DIMENSIONAL CHANGES

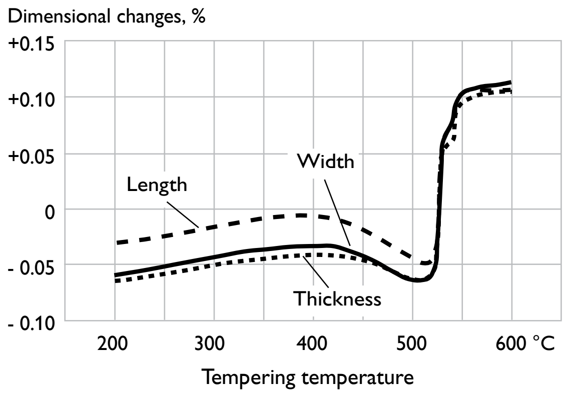
The dimensional changes have been measured after austenitising and tempering.

Austenitising: 1030 °C/30 min, cooling in vacuum furnace at 0.75 °C/s between 800 °C and 500 °C

Tempering: 2 x 2 h at various temperatures

Specimen size: 100 x 100 x 100 mm

DIMENSIONAL CHANGES AS FUNCTION OF TEMPERING TEMPERATURE



SUB-ZERO TREATMENT

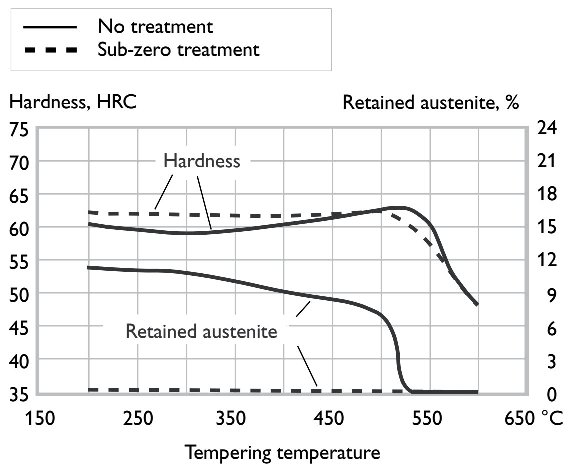
Pieces requiring maximum dimensional stability in service should be sub-zero treated.

Sub-zero treatment reduces the amount of retained austenite and changes the hardness as shown in the diagram below.

Austenitising: 1030 °C /30 min

Tempering: 2 x 2 h at various temperatures

HARDNESS AND RETAINED AUSTENITE AS FUNCTION OF TEMPERING TEMPERATURE AND SUB-ZERO TREATMENT



SURFACE TREATMENT

Some cold work tool steel are given a surface treatment in order to reduce friction and increase wear resistance. The most commonly used treatments are nitriding and surface coating with wear resistant layers produced via PVD or CVD.

The high hardness and good resistance to chipping together with a good dimensional stability make ASSAB 88 suitable as a substrate steel for various surface coatings.

NITRIDING AND NITROCARBURISING

Nitriding and nitrocarburising result in a hard surface layer which is very resistant to wear and galling. The surface hardness after nitriding is approximately 1100 $HV_{0.2kg}$. The thickness of the layer should be chosen to suit the application in question.

PVD

Physical vapour deposition, PVD, is a method of applying a wear-resistant coating at temperatures between 200–500 °C.

CVD

Chemical vapour deposition, CVD, is used for applying wear-resistant surface coatings at a temperature of around 1000 °C. It is recommended that the tools are separately hardened and tempered in a vacuum furnace after surface treatment.

MACHINING RECOMMENDATIONS

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions.

Condition: Soft annealed condition ~235 HB

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (v_C), m/min	100 – 150	150 – 200	17 – 22
Feed (f) mm/rev	0.2 – 0.4	0.05 – 0.2	0.05 – 0.3
Depth of cut (a_p) mm	2 – 4	0.5 – 2	0.5 – 3
Carbide designation ISO	K20, P20 Coated carbide	K10, P15 Coated carbide	–

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_C) m/min	110 – 180	180 – 220
Feed (f_z) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 5	< 2
Carbide designation ISO	K20, P20 Coated carbide	P10 – P20 Coated carbide

END MILLING

Cutting data parameters	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_C), m/min	80 – 120	100 – 140	13 – 18 [1)]
Feed (f_z) mm/tooth	0.03 – 0.20 [2)]	0.08 – 0.20 [2)]	0.05 – 0.35 [2)]
Carbide designation ISO	–	P15 – P40	–

1) For coated High Speed Steel end mill, v_C~ 30 – 35 m/min
2) Depending on radial depth of cut and cutter diameter

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (v_C) m/min	Feed (f) mm/r
≤5	13 – 18*	0.05 – 0.10
5 – 10	13 – 18*	0.10 – 0.20
10 – 15	13 – 18*	0.20 – 0.25
15 – 20	13 – 18*	0.25 – 0.30

* For coated high speed steel drill, v_C ~ 25 – 35 m/min

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (v_C), m/min	140 – 160	80 – 100	45 – 55
Feed (f) mm/r	0.05 – 0.15 [2]	0.10 – 0.25 [3]	0.15 – 0.25 [4]

1) Drill with replaceable or brazed carbide tip
2) Feed rate for drill diameter 20–40 mm
3) Feed rate for drill diameter 5–20 mm
4) Feed rate for drill diameter 10–20 mm

GRINDING

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

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

WELDING

Good results when welding tool steel can be achieved if proper precautions are taken during the welding operation.

- The joints should be prepared properly.
- Repair welds should be made at elevated temperature. Make the two first layers with the same electrode diameter and/or current.
- Always keep the arc length as short as possible. The electrode should be angled at 90° to the joint sides to minimise undercut. In addition, the electrode should be held at an angle of 75 – 80° to the direction of forward travel.
- For large repairs, weld the initial layers with a soft filler material (buffering layer).

FILLER MATERIAL

TIG WELDING CONSUMABLES

Filler Material	Hardness after welding
Type AWS ER312	300 HB (for buffering layers)
UTP A67S	55 – 58 HRC
UTP A696	60 – 64 HRC
Casto Tig 45303W *	60 – 64 HRC
Caldie Tig-Weld	58 – 62 HRC

* Should not be used for more than 4 layers because of the increased risk of cracking

MMA (SMAW) WELDING CONSUMABLES

Filler Material	Hardness after welding
Type AWS ER312	300 HB (for buffering layers)
Castolin EutecTrode 2	54 – 60 HRC
UTP 67S	55 – 58 HRC
UTP 69	60 – 64 HRC
Castolin EutecTrode 6	60 – 64 HRC
Caldie Weld	58 – 62 HRC

PREHEATING TEMPERATURE

The temperature of the tool during the entire welding process should be maintained at an even level.

	Soft annealed	Hardened
Hardness	230 HB	60 – 62 HRC
Preheating temperature	250 °C	250 °C
Max. interpass-temperature	400 °C	400 °C

HEAT TREATMENT AFTER WELDING

	Soft annealed	Hardened
Hardness	230 HB	60 – 62 HRC
Cooling rate	20 – 40 °C/h for the first 2 hours then freely in air	
Heat treatment	Soft anneal Harden Temper	Temper 10 – 20 °C below the latest tempering temperature

FLAME HARDENING

Use oxy-acetylene equipment with a capacity of 800 – 1250 l/h. Oxygen pressure 2.5 bar, acetylene pressure 1.5 bar. Adjust to give neutral flame.
Temperature: 980 – 1020 °C. Cool freely in air.

The hardness at the surface will be 58 – 62 HRC and 41 HRC at a depth of 3 – 3.5 mm.

ELECTRICAL DISCHARGE MACHINING — EDM

If EDM is performed in the hardened and tempered condition, finish with a fine-sparking, i.e. low current, high frequency.

For optimal performance the EDM'd surface should be ground/polished to completely remove the EDM layer and the tool re-tempered at approx. 25 °C below the original tempering temperature.

When EDM'ing larger sizes or complicated shapes ASSAB 88 should be tempered at high temperature, above 500 °C, during the heat treatment to lower the residual stress level and thereby reducing the risk of potential cracking in connection with the EDM.

Further information

For further information, i.e., steel selection, heat treatment, application and availability, please contact our ASSAB office nearest to you.

RELATIVE COMPARISON OF ASSAB COLD WORK TOOL STEEL

MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS

ASSAB Grade	Hardness/ Resistance to plastic deformation	Machinability	Grindability	Dimension stability	Resistance to		Fatigue cracking resistance	
					Abrasive wear	Adhesive wear/Galling	Ductility/ resistance to chipping	Toughness/ gross cracking
Conventional cold work tool steel								
ASSAB DF-3								
ASSAB XW-10								
ASSAB XW-42								
Calmax								
Caldie (ESR)								
ASSAB 88								
Powder metallurgical tool steel								
Vanadis 4 Extra*								
Vanadis 8*								
Vancron*								
Powder metallurgical high speed steel								
ASSAB PM 23*								
ASSAB PM 30*								
ASSAB PM 60*								
Conventional high speed steel								
ASSAB M2								

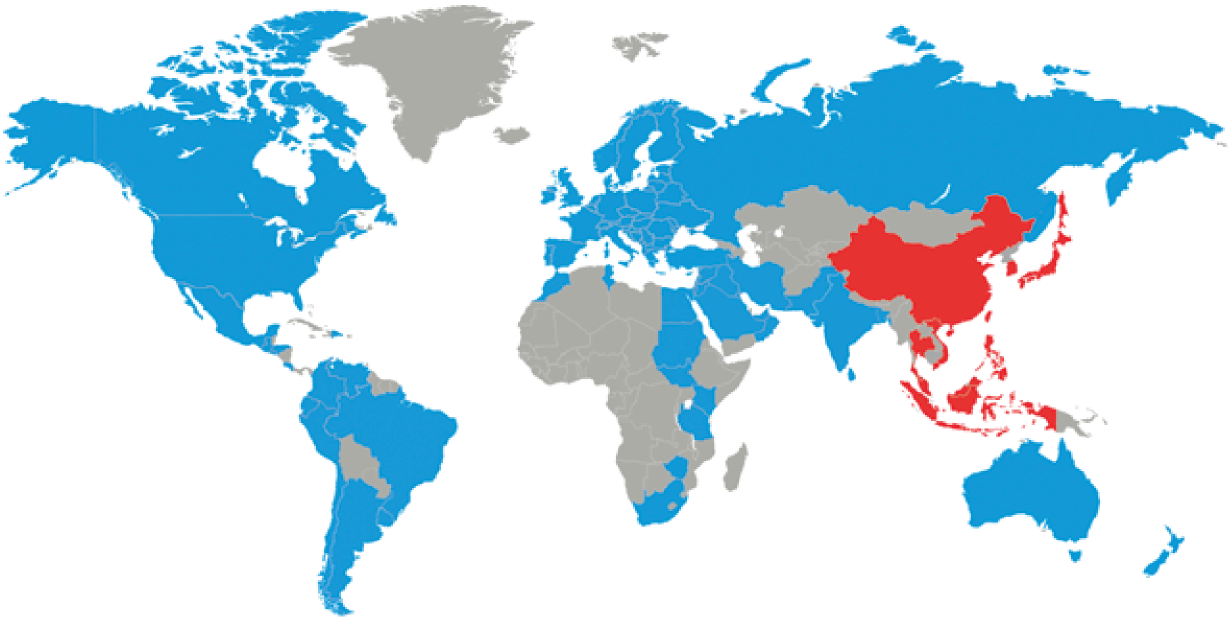
* ASSAB PM SuperClean Tool Steel

ASSAB

SUPERIOR TOOLING SOLUTIONS

A ONE-STOP SHOP

ASSAB is unmatched as a one-stop product and service provider that offers superior tooling solutions. In addition to the supply of tool steel and other special steel, our range of comprehensive value-added services, such as machining, heat treatment and coating services, span the entire supply chain to ensure convenience, accountability and optimal usage of steel for customers. We are committed to achieving solutions for our customers, with a constant eye on time-to-market and total tooling economy.



Choosing the right steel is of vital importance. ASSAB engineers and metallurgists are always ready to assist you in your choice of the optimum steel grade and the best treatment for each application. ASSAB not only supplies steel products with superior quality, we offer state-of-the-art machining, heat treatment and surface treatment services to enhance steel properties to meet your requirement in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

ASSAB and Uddeholm are present on every continent. This ensures you that high quality tool steel and local support are available wherever you are. Together we secure our position as the world's leading supplier of tooling materials.

For more information, please visit
www.assab.com

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