ASSAB DF-3

UDDEHOLM ARNE

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 20210908

GENERAL

ASSAB DF-3 is a general purpose oil-hardening tool steel suitable for a wide variety of cold work applications. Its main characteristics include:

- Good machinability
- Good dimensional stability during hardening
- 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.

ASSAB DF-3 can be supplied in various surface executions including hot rolled, pre-machined, fine machined and precision ground. It is also available in the form of hollow bar.

Typical analysis %	C 0.95	Si 0.3	Mn 1.1	Cr 0.6	W 0.6	V 0.1
Standard specification	AISI O1, WNr. 1.2510, SKS 3					
Delivery condition	Soft annealed to max 230 HB.					

APPLICATIONS

BLANKING, CUTTING, FORMING AND OTHER APPLICATIONS

Application	Material thickness, mm	Hardness, HRC
Tools for: Blanking, punching, piercing, cropping, shearing, trimming, clipping	up to 3 mm	60-62
	3-6 mm	56-60
	6-10 mm	54-56
Short cold shears		56-60
Clipping, timming tools for forgings	Hot	58-60
	Cold	56-58
Tools for: Bending, raising, drawing, rim-rolling, spinning and flow-forming		56 - 62
Small coining dies		56 - 60
Gauges, measuring tools Turning centres Guide bushes, ejector pins, small to medium-sized drills and taps Small gear wheels, pistons, nozzles, cams		58 - 62

PROPERTIES

PHYSICAL PROPERTIES

Hardened and tempered to 62 HRC.

Temperature	20 °C	200 °C	400 °C
Density kg/m^3	7 850	7 750	7 700
Modulus of elasticity MPa	190 000	185 000	170 000
Coefficient of thermal expansion per °C from 20 °C	-	12.6 x 10^{-6}	13.1 x 10^{-6}
Thermal conductivity W/m °C	32	33	34
Specific heat J/kg °C	460	-	-

HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 780 °C. Then cool in furnace at 15 °C per hour to 650 °C, then freely in air.

STRESS RELIEVING

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

HARDENING

Pre-heating temperature: 600–700°C.
Austenitising temperature: 790–850°C.

Temperature °C	Soaking time* minutes	Hardness before tempering HRC
800	30	65±2
825	20	65±2
850	15	65±2

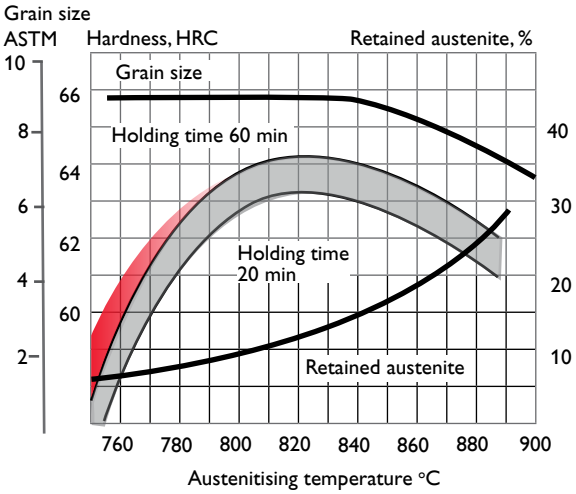
* Soaking time = time at hardening temperature after the tool is fully heated through

Protect the part against decarburisation and oxidation during hardening.

QUENCHING MEDIA

- Warm oil, approx. 80°C
- Martempering bath or fluidised bed at 180 - 225°C, then cooling in air

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



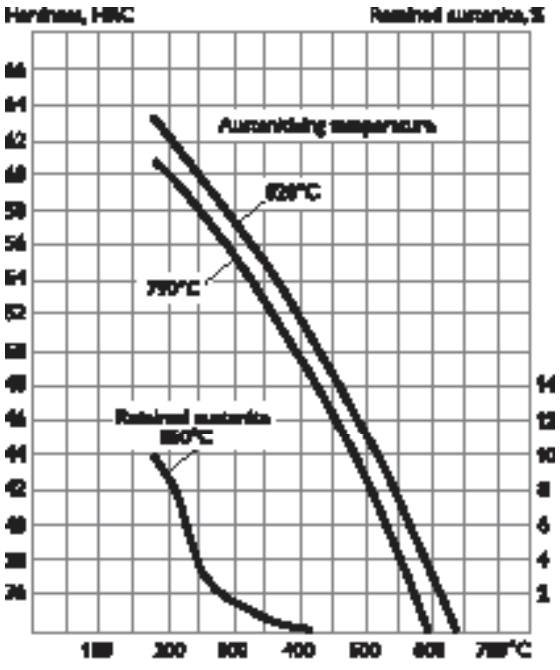
TEMPERING

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. The lowest tempering temperature which should be used is 180°C. The minimum holding time at temperature is 2 hours.

TEMPERING GRAPH

The tempering graphs are valid for small samples. The hardness received is also dependent on the tool size.



Tempering temperature (2 x 2 h)

MARTEMPERING

Tools at austenitising temperature are immersed in the martempering bath for the time indicated, then cooled in air to not lower than 100°C. Temper immediately as with oil quenching.

Austenitising Temperature °C	Temperature [1] °C	Holding time [2] minutes	Surface hardness [3]
825	225	max. 5	64±2 HRC
825	200	max. 10	63±2 HRC
825	180	max. 20	62±2 HRC
850	225	max. 10	62±2 HRC

[1] Temperature of martempering bath
[2] Holding time in martempering bath
[3] Obtained by martempering but prior to tempering

MACHINING ALLOWANCE TO COMPENSATE FOR DIMENSIONAL CHANGES

The dimensional changes during hardening and tempering vary depending on temperature, type of equipment and cooling media used during heat treatment.
The size and geometric shape of the tool are also of essential importance. During toolmaking, provide adequate machining allowance to compensate for distortion. Use 0.25% as a guideline for ASSAB DF-3. Any distortion arising from hardening and tempering can then be adjusted during finish machining.

SUB-ZERO TREATMENT AND AGEING

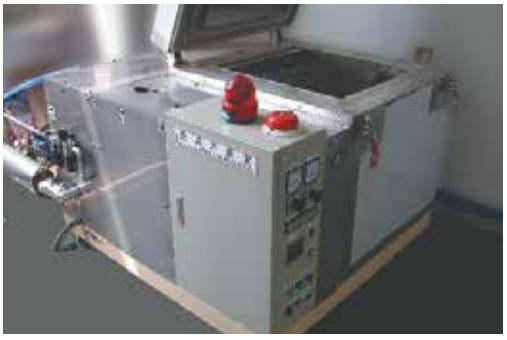
Pieces requiring maximum dimensional stability should be sub-zero treated and/or artificially aged, as volume changes may occur in the course of time. This applies to, for examples, measuring tools like gauges and certain structural components.

SUB-ZERO TREATMENT

Immediately after quenching the piece should be sub-zero treated to between -70 and -80°C, soaking time 3 - 4 hours, followed by tempering or ageing. Sub-zero treatment will give a hardness increase of 1 - 3 HRC. Avoid intricate shapes as there will be risk of cracking.

AGEING

Tempering after quenching is replaced by ageing at 110 - 140°C. Holding time 25 - 100 hours.



Sub-zero treatment chamber.

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 ~190 HB

TURNING

Cutting data parameters	Turning with carbide		Turning with High speed steel Fine turning
	Rough turning	Fine turning	
Cutting speed (v_c), m/min	160 – 210	210 – 260	20 - 25
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	P20 - P30 Coated carbide	P10 Coated carbide or cermet	-

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (v_c) m/min	Feed (f) mm/r
≤ 5	15 – 17 *	0.08 – 0.20
5 – 10	15 – 17 *	0.20 – 0.30
10 – 15	15 – 17 *	0.30 – 0.35
15 – 20	15 – 17 *	0.35 – 0.40

* For coated HSS drill v_c = 26 - 28 m/min.

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (v_c), m/min	200 – 220	110 – 140	70 – 90
Feed (f) mm/r	0.05 – 0.25 [2]	0.10 – 0.25 [2]	0.15 – 0.25 [2]

[1] Drill with replaceable or brazed carbide tip

[2] Depending on drill diameter

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c), m/min	170 – 250	250 – 290
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	P20 - P40 Coated carbide	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), m/min	150 – 190	160 – 220	25 – 30 [1]
Feed (f_z) mm/tooth	0.03 – 0.20 [2]	0.08 – 0.20 [2]	0.05 – 0.35 [2]
Carbide designation ISO	K20, P40 Coated carbide	P20 – P30 Coated carbide	–

[1] For coated HSS end mill Vc = 45 – 50 m/min.

[2] Depending on radial depth of cut and cutter diameter

GRINDING

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 IV
Profile grinding	A 100 LV	A 120 JV

WELDING

There is a general tendency for tool steel to crack after welding. When welding is required, take proper precautions with regards to joint preparation, filler material selection, preheating, welding procedure and postweld heat treatment to ensure good welding results. If the tool is to be polished or photo-etched, it is necessary to work with an electrode type of matching composition.

Welding method	TIG	MMA
Preheating temperature [1]	200 - 250 °C	200 - 250 °C
Filler material	AWS ER 312 (buffering layers) UTP A73G2 UTP A67S CastoTIG 5 [3]	AWS E 312 (buffering layers) ESAB OK 84.52 UTP 67S Castolin 2 Castolin N 102
Maximum interpass temperature [2]	400°C	400°C
Post weld cooling	20 - 40 °C/h the first 2 h then freely in air at <70°C	
Hardness after welding	AWS ER 312 (buffering layers) 300 HB UTP A73G2 53 - 56 HRC UTP A67S 55 - 58 HRC CastoTIG 5 60 - 64 HRC	AWS E 312 (buffering layers) 300 HB ESAB OK 84.52 53 - 54 HRC UTP 67S 55 - 58 HRC Castolin 2 / Castolin N 102 54 - 60 HRC
Heat treatment after welding:		
Hardened condition	Temper 10 - 20°C below the original tempering temperature.	
Soft annealed condition	Soft anneal according to the "Heat treatment" recommendation.	

[1] Preheating temperature must be established throughout the tool and must be maintained for the entire welding process, to prevent weld cracking. For hardened and tempered tool, the actual preheat temperature used is typically lower than the original tempering temperature to prevent a drop in hardness.

[2] The temperature of the tool in the weld area immediately before the second and subsequent pass of a multiple pass weld. When exceeded, there is a risk of distortion of the tool or soft zones around the weld.

[3] Should not be used for more than 4 layers because of the increased risk of cracking.

ELECTRICAL DISCHARGE MACHINING — EDM

If EDM is performed in the hardened and tempered condition, the EDM'd surface is covered with a resolidified layer (white layer) and a rehardened and untempered layer, both of which are very brittle and hence detrimental to the tool performance.

When a profile is produced by EDM, it is recommended to finish with "fine-sparking", i.e., low current, high frequency. For optimal performance, the EDM'd surface should be ground/polished to remove the white layer completely. The tool should then be retempered at approx. 25°C below the highest previous tempering temperature.

FURTHER INFORMATION

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

RELATIVE COMPARISON OF ASSAB COLD WORK TOOL STEEL

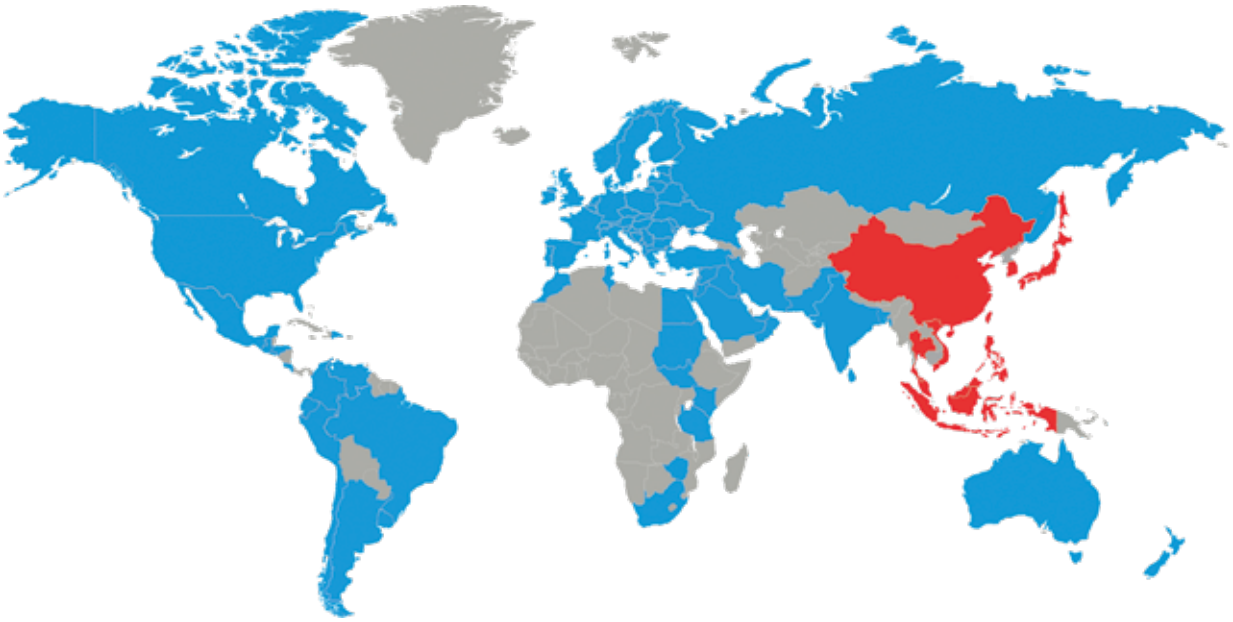
MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS

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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