TYRAX ESR

UDDEHOLM TYRAX ESR

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
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 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			

20220824

( ) - modified grade

Edition 20230724

TYRAX ESR

Tyrax ESR is a premium high hardness and corrosion resistant plastic mould steel. It is designed with very high ductility/toughness and is easy and fast to polish to the highest surface finish levels. This grade is suited for moulding of high performance plastics often filled with glass fibre reinforcements and corrosive additives like flame retardants. It is also perfect for lens applications where the surface finish is important.

GENERAL

Tyrax ESR is a premium high hardness and corrosion resistant plastic mould steel with the following properties:

- Good corrosion resistance
- Excellent polishability
- Good wear resistance
- Good machinability
- High hardness 55-58 HRC for resistance against indentations
- Excellent ductility and toughness
- Good dimensional stability at heat treatment and in service
- Even microstructure and small grain size
- Good hardenability

Tyrax ESR is delivered in soft annealed condition to approximate 190 HB. Tyrax ESR is produced using the Electro-Slag-Remelting (ESR) technique, resulting in very low inclusion content.

Typical analysis %	C 0.4	Si 0.2	Mn 0.5	Cr 12.0	Mo 2.3	V 0.5	N +
Delivery condition	Soft annealed to approx. 190 HB.						

APPLICATIONS

Tyrax ESR is suitable for long run production moulds, for reinforced plastics and for compression moulding. Engineering applications like plasticizing screws are also an option. Tyrax ESR can be used in corrosive conditions as moulds subjected to humid working/ storage conditions or for production of corrosive plastics. Its high toughness/ductility makes it suitable for complex moulds. Tyrax ESR is also suitable when high gloss surface finish is required.

- High performance plastics filled with glass fibres and corrosive additives
- Corrosive plastics like PVC
- High surface finish, i.e. for production of optical parts

PROPERTIES

PHYSICAL PROPERTIES

DATA AT ROOM AND ELEVATED TEMPERATURES

Temperature	20 °C	200 °C	400 °C
Density, kg/m^3	7 750	-	-
Modulus of elasticity MPa	216 000		
Coefficient of thermal expansion /°C from 20°C	-	11.3 x 10^{-6}	12.0 x 10^{-6}
Thermal conductivity* W/m °C	-	23.5	24.6
Specific heat capacity J/kg°C	460	-	-

* Thermal conductivity is very difficult to measure. The scatter can be as high as ±15%.

TENSILE STRENGTH AT ROOM TEMPERATURE

The tensile strength values are to be considered as approximate. The test samples have been hardened at 1050-1080°C, gas quenched in a vacuum furnace and tempered twice at 530°C for two hours to the given hardness. All specimens have been taken from a bar with the dimension 254x102 mm.

Hardness	56 HRC	58 HRC
Tensile strength, R_m MPa	2 060	2 260
Yield point Rp0.2 MPa	1 460	1 610

COMPRESSIVE STRENGTH

Approximately compressive strength is shown in the table below. The test samples have been hardened at 1050°C, gas quenched in a vacuum furnace and tempered twice at 525°C for two hours to the given hardness.

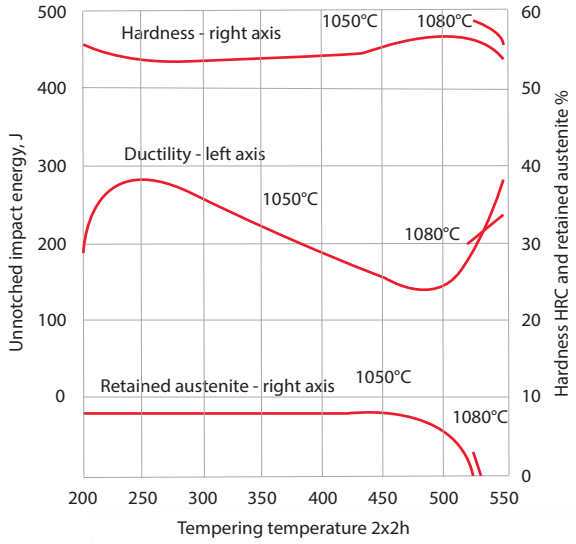
Hardness HRC	Compressive yield strength, Rc0.2 (MPa)
56	1820

IMPACT TOUGHNESS

Tyrax ESR has much higher toughness/ductility compared to other stainless tool steel of W.-Nr. 1.2083/AISI 420 type.
Approximate room temperature impact strength as measured by samples removed from the centre of a forged block, tested in the short transverse direction is shown below.
Original bar dimension: 250x80 mm
Specimen size: 7 x 10 x 55 mm unnotched.
Hardened at 1050°C and 1080°C for 30 minutes. Quenched in a vacuum furnace. Tempered 2 x 2h.

INFLUENCE OF TEMPERING TEMPERATURE ON UNNOTCHED IMPACT TOUGHNESS

All tests has been carried out at room temperature.



CORROSION RESISTANCE

Tyrax ESR shows the best corrosion resistance when tempered at a low temperature and polished to a mirror finish. Tyrax ESR is resistant to corrosive attack by water, water vapour, weak organic acids, dilute solutions of nitrates, carbonates and other salts.

A tool made from Tyrax ESR will have good resistance to rusting and staining due to humid working and storage conditions and when moulding corrosive plastics under normal production conditions.

HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 860 °C. Then cool in 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, holding time 2 hours. Cool slowly to 500 °C, then freely in air.

HARDENING AND HARDNENABILITY

Preheating temperature: 600 – 850°C. Recommended austenitising temperature is 1050-1080°C, holding time 30 minutes.

RECOMMENDED QUENCHING MEDIA

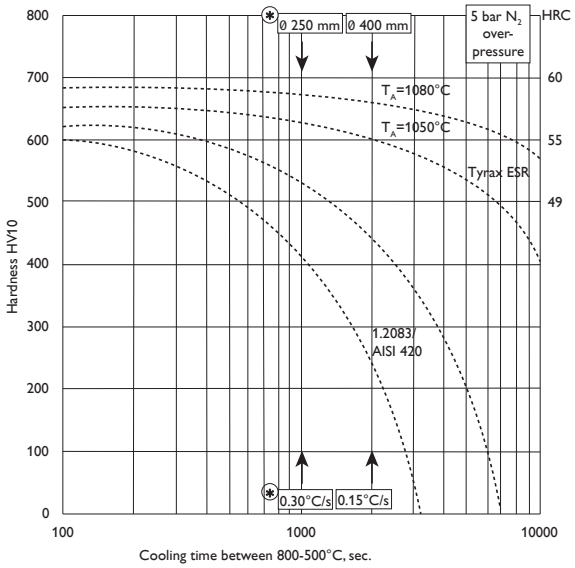
- vacuum furnace (high speed gas with sufficient overpressure)
- fluidised bed or salt bath at 250-550°C then cool in air blast
- High speed gas/circulating atmosphere

In order to obtain optimum properties, the cooling rate should be as fast as possible while maintaining an acceptable level of distortion. When heating in a vacuum furnace, a minumum of 4-5 bar overpressure is recommended. Temper immediately when the tool reaches 50-70°C.

Tyrax ESR has a much better hardenability than the W.-Nr. 1.2083/AISI 420 type of material so the high hardness will be retained even in the centre of large dimensions. The very good hardenability will also have a decisive effect on other properties such as toughness and corrosion resistance.

HARDNESS AS A FUNCTION OF COOLING RATE

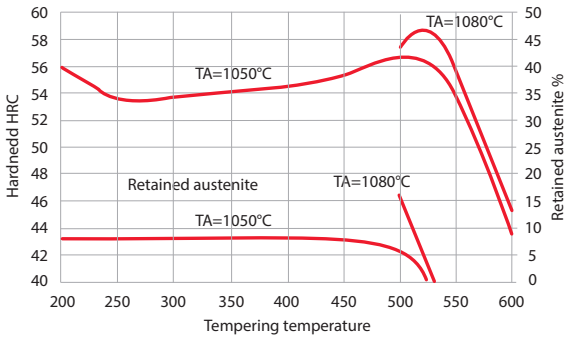
During hardening at 1050°C and 1080°C.



* Cooling rate in the centre of two dimensions is indicated.

TEMPERING

Tempering temperature should be selected depending on aimed hardness according to the graphs shown below. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature is 200 °C. Holding time at tempering is 2 hour.



The tempering curve is obtained after heat treatment of samples with a size of 15 x 15 x 40 mm, cooling in a vacuum furnace.

Note: Tempering at 200-250°C results in the best combination of toughness, hardness and corrosion resistance. However for complicated design it is recommended to use a high temperature tempering (lowest 525°C) to reduce residual stresses and retained austenite to a minimum.

Hardening at 1080°C will give a hardness up to 58 HRC when tempering at 530°C, still with good ductility.

In special cases a hardening temperature of 1100°C may be used. Hardness is increased up to 60 HRC when tempering at 525-530°C. 1100°C is only recommended when toughness is of secondary importance.

Tyrax ESR may also be used at a normal AISI 420 hardness of 52 HRC using 1020°C as hardening temperature and tempering twice at 250°C for two hours, giving <2% retained austenite.

DIMENSIONAL CHANGES

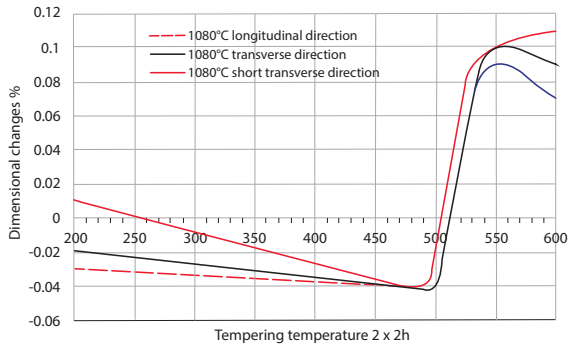
Dimensional changes have been measured after hardening and tempering.

Austenitising: 1080°C/30 min. cooling in vacuum furnace at 0.64°C/sec. between 800°C and 500°C.

Tempering: 2 x 2 h at various temperatures

Sample size: 100 x 40 x 20 mm.

A machining allowance of 0.15 % is recommended for Tyrax ESR.



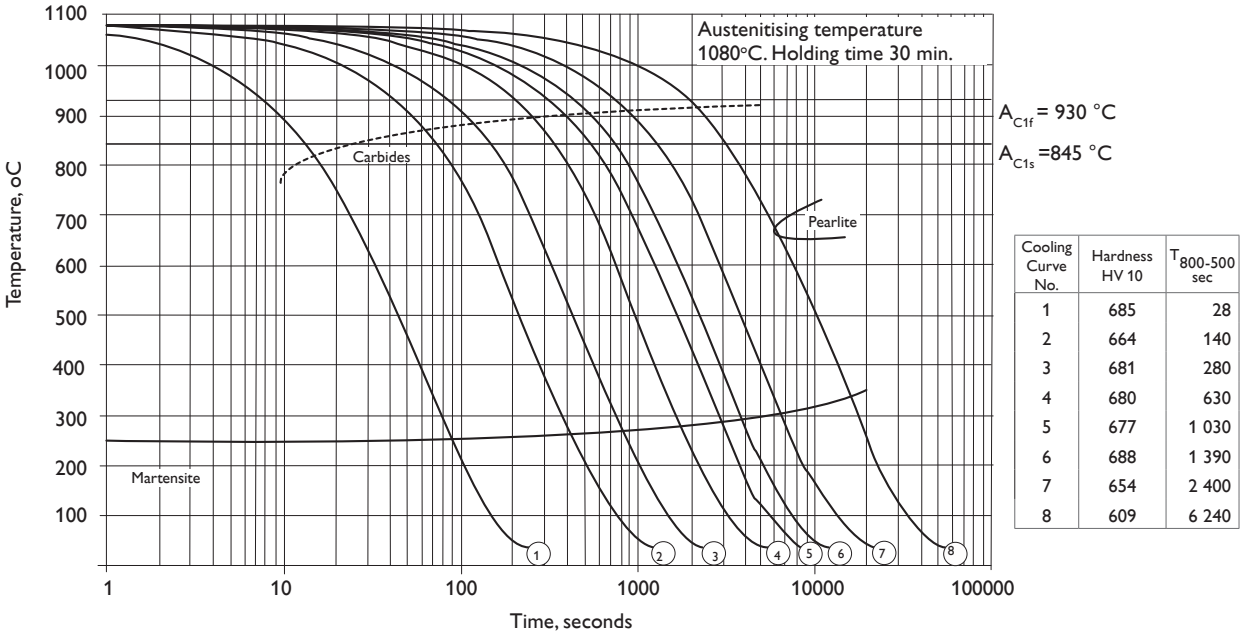
SUB-ZERO TREATMENT

Cryo-treatment in liquid nitrogen (-120°C to -196°C) may be carried out for tools with high demands on dimensional stability after heat treatment. This treatment should be performed before tempering. Intricate shapes should however be avoided because of the risk of cracking. Cryo-treatment is especially interesting before low temperature tempering as the content of retained austenite will be eliminated/ very low resulting in increased hardness and wear resistance. Corrosion resistance is improved using low temperature tempering at 200°C to 480°C compared to tempering at temperatures 525°C or higher.

Hardening 1080°C / 30min / cryo-treatment at -196°C	Tempering 200°C/2x2h
Hardness	58.5 HRC
Retained austenite	<2%

CCT-GRAPH

Austenitising temperature 1080 °C. Holding time 30 minutes.



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	685	28
2	664	140
3	681	280
4	680	630
5	677	1 030
6	688	1 390
7	654	2 400
8	609	6 240

CUTTING DATA RECOMMENDATIONS

The cutting data below should be considered as guidelines only. These guidelines must be adapted to local machining conditions.

The recommendations, in following tables, are valid for Tyrax ESR in soft annealed condition approx. 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	140 – 190	190 – 240	15 - 20
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

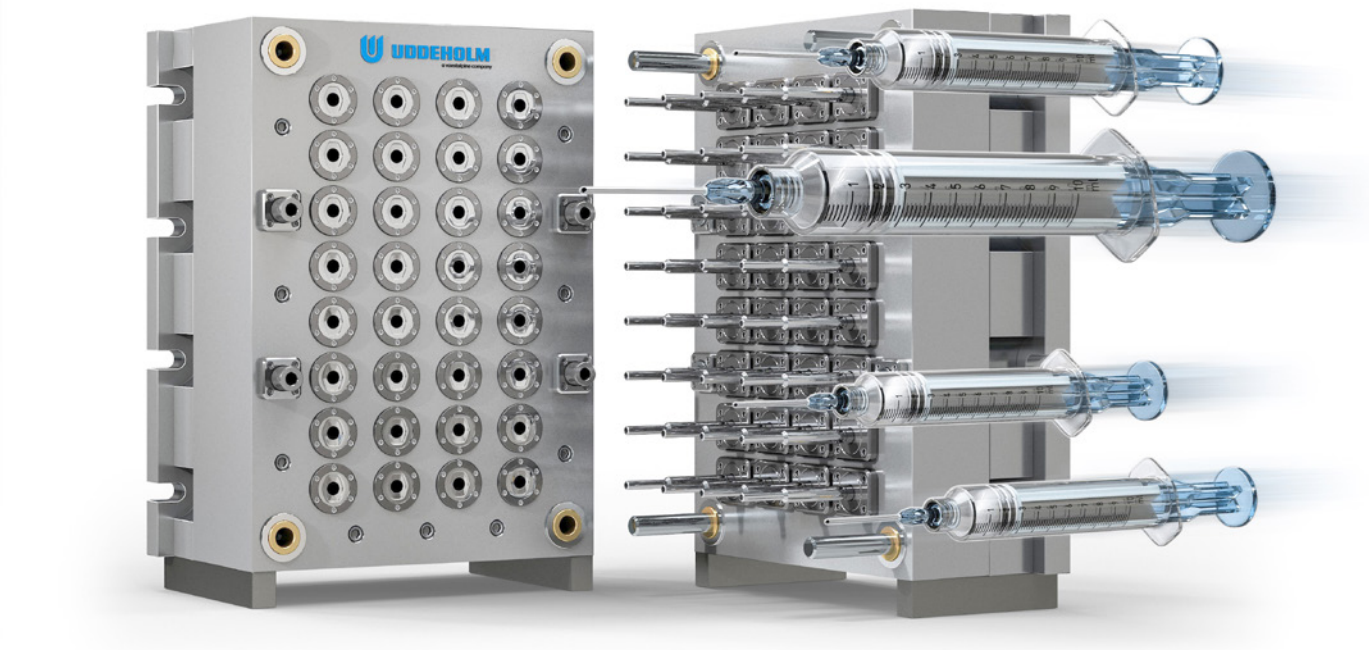
Drill diameter mm	Cutting speed (v_c) m/min	Feed (f) mm/r
≤ 5	12 – 16 *	0.05 – 0.15
5 – 10	12 – 16 *	0.15 – 0.20
10 – 15	12 – 16 *	0.20 – 0.25
15 – 20	12 – 16 *	0.25 – 0.35

* For coated HSS drill v_c = 22 - 24 m/min.

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (v_c), m/min	160 – 200	80 – 100	60 – 90
Feed (f) mm/r	0.03 – 0.10 [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



MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min	120 – 170	170 – 210
Feed (f_z) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 4	0.5 - 2
Carbide designation ISO	P30 – P40 Coated carbide	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	120 – 150	110 – 150	20 – 25 [1]
Feed (f_z) mm/tooth	0.01 – 0.20 [2]	0.06 – 0.20 [2]	0.01 – 0.30 [2]
Carbide designation ISO	–	P30 – P40	–

[1] For coated HSS end mill vc 35-40 m/min

[2] 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 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 IV
Profile grinding	A 100 LV	A 120 KV

POLISHING

Tyrax ESR has excellent polishability in the hardened and tempered condition. It can be polished up to the highest levels of surface finish in very few steps.
More detailed information on polishing, please refer to “Polishing of Tool Steel”.

WELDING

Good results can be obtained if proper precautions are taken before, during and after the welding operation. Joint preparation, preheating, interpass temperature, post weld heat treatment and handling of consumables are all crucial for the end result.

Use consumables with the same chemical composition as the tool steel for optimal results after polishing or photo etching.

Welding method	TIG
Preheating temperature*	330 °C ± 25 °C
Welding consumables	TYRAX TIG Weld
Maximum interpass temperature	480 °C
Post welding cooling rate	20 - 40 °C/h for the first 2 hours and then freely in air.
Hardness after welding	56 - 58 HRC
Heat treatment after welding	
Hardened condition	Temper 25°C below the original tempering temperature.
Soft annealed condition	Soft-anneal the material at 860 °C in protected atmosphere. The subsequent cooling should be carried out in the furnace at 10°C/h to 650 °C then freely in air.

FURTHER INFORMATION

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

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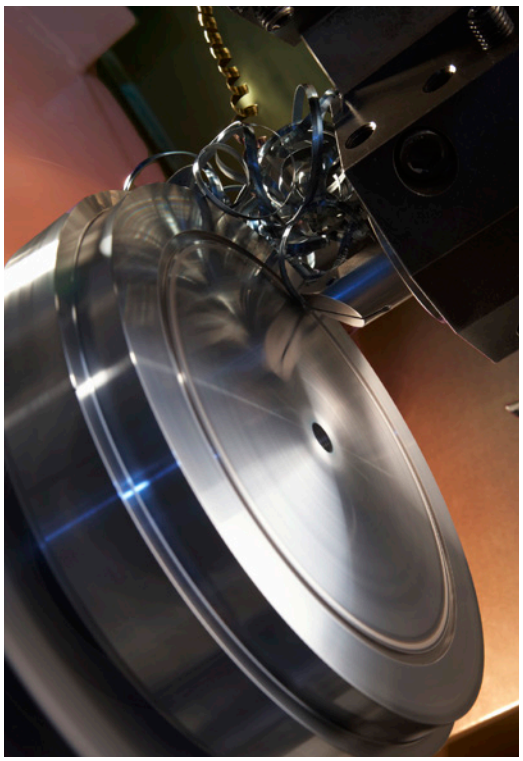
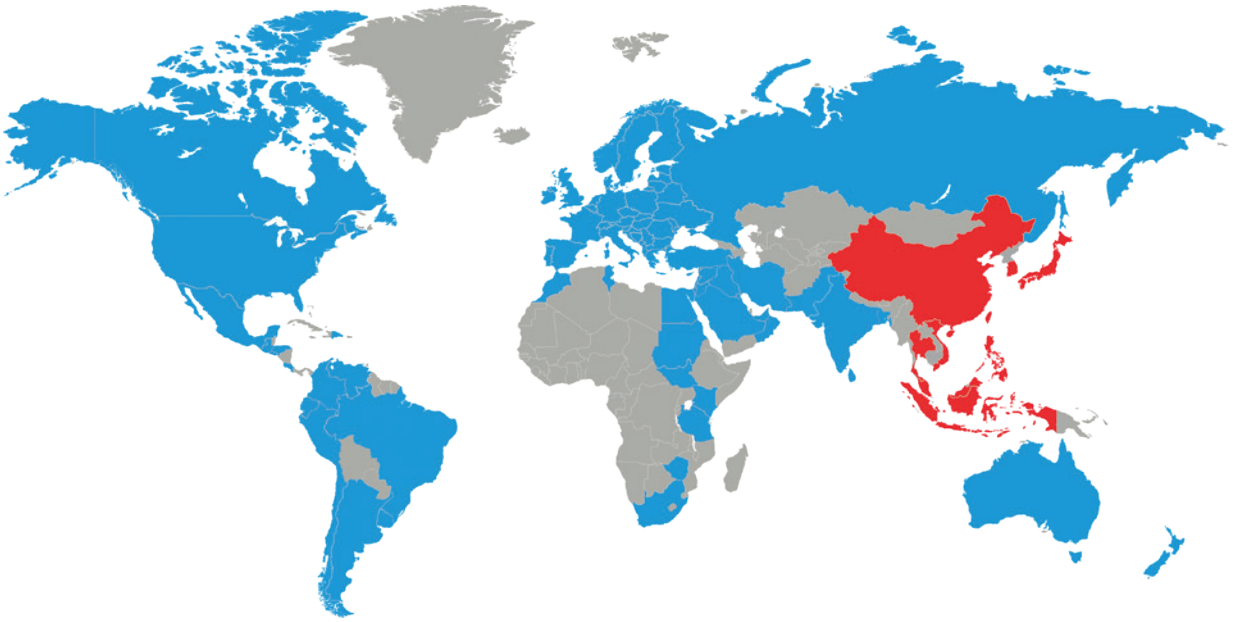


ASSAB is unmatched as a one-stop product and service provider that offers superior tooling solutions. In addition to the supply of tool steel and other special steel, our range of comprehensive value-added services, such as machining, heat treatment and coating services, span the entire supply chain 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
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