UDDEHOLM STAVAX® SUPREME

UDDEHOLM

Classified according to EU Directive 1999/45/EC
For further information see our "Material Safety Data Sheets".

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The latest revised edition of this brochure is the English version, which is always published on our web site www.uddeholm.com

SS-EN ISO 9001
SS-EN ISO 14001

General

Demands placed on plastic mould tooling are increasing. Such conditions require mould steels that possess a unique combination of toughness, corrosion resistance and the ability to reach uniform hardness levels throughout large cross sections. Uddeholm Stavax Supreme has proven to be the right choice for these applications. Uddeholm Stavax Supreme is a new premium grade stainless tool steel with the following properties:

- good corrosion resistance
- excellent through-hardening properties
- good ductility and toughness
- good wear resistance
- excellent polishability

The combination of these properties provides a steel with outstanding production performance. The practical benefits of *good corrosion resistance* in a plastic mould can be summarized as follows:

- Lower mould maintenance costs.
  The surface of cavity impressions retain their original finish over an extended service life. Moulds stored or operated in humid conditions require no special protection.
- Lower production costs.
  Since water-cooling channels are less like to be affected by corrosion (unlike conventional mould steels), heat transfer characteristics, and therefore cooling efficiency, are constant throughout the mould life, ensuring consistent cycle times.

These benefits, coupled with the high wear resistance of Uddeholm Stavax Supreme, offer the moulder low-maintenance, long-life moulds for the greatest overall tooling economy.

Note! Uddeholm Stavax Supreme is produced using the Electro-Slag-Remelting (ESR) technique. The result is a mould steel with a very low inclusion level providing for excellent polishability characteristics.

Composition	Cr-Ni-Mo-V alloyed
Standard specification	AISI 420 modified
Delivery condition	Annealed to approx. 250 HB.
Colour code	Black/Orange with white line across

Applications

Although Uddeholm Stavax Supreme is recommended for all types of moulds, its special properties make it particularly suitable for moulds with the following demands:

- Corrosion/staining resistance, i.e. for moulding of corrosive materials, e.g. PVC, acetates, and for moulds subjected to humid working/storage conditions.
- High surface finish, i.e. for the production of optical parts, such as camera and sunglasses lenses, and for medical components, e.g. syringes, analysis vials etc..
- Toughness/ductility, i.e. for complex moulds
- Outstanding through-hardening characteristics i.e. high-hardenability, important for larger moulds.

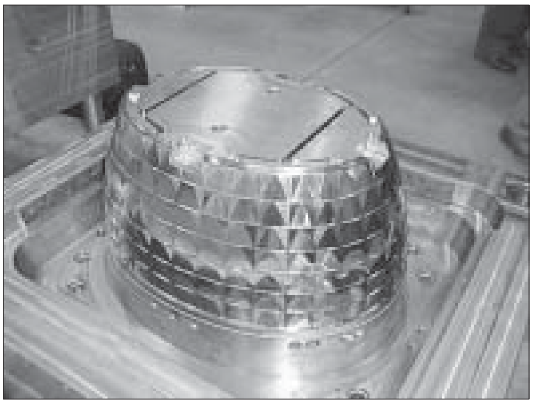
Properties

Physical data

Hardened and tempered to 50 HRC. Data at room and elevated temperatures.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density, kg/m³ lbs/in³	7 740 0,280	–	–
Modulus of elasticity MPa psi	210 000 30,5 x 10⁶	200 000 29 x 10⁶	180 000 26,1 x 10⁶
Coefficient of thermal expansion /°C from 20°C /°F from 68°F	–	11,1 x 10⁻⁶ 6,1 x 10⁻⁶	11,7 x 10⁻⁶ 6,7 x 10⁻⁶
Thermal conductivity* W/m °C Btu in/(ft²h °F)	–	20 139	24 166
Specific heat, J/kg °C Btu/lb, °F	460 0,110	–	–

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



Mould for production of street-light cover.

Tensile strength at room temperature

The tensile strength values are to be considered as only approximate. The test samples have been hardened in air from 1020°C (1870°F) and tempered twice to the given hardness.

All specimens have been taken from a bar with the dimension 407 x 203 mm (16" x 8").

Hardness	50 HRC	45 HRC
Tensile strength R_m MPa psi	 1 780 2,58 x 10^5	 1 500 2,18 x 10^5
Yield point $R_{p0,2}$ MPa psi	 1 290 1,87 x 10^5	 1 200 1,74 x 10^5

Impact toughness

Uddeholm Stavax Supreme has much higher toughness/ ductility compared to other stainless tool steels of W.-Nr. 1.2083/AISI 420 type.

For maximum toughness and ductility use low temperature tempering and for maximum abrasive wear resistance use high temperature tempering.

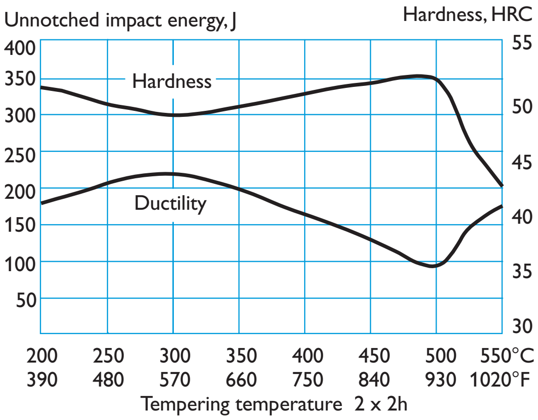
Approximate room temperature impact strength as measured by samples removed from the center of a forged block, tested in the short transverse direction is shown below.

Original bar dimension: 508 x 306 mm (20" x 12")

Specimen size: 7 x 10 x 55 mm (0,27" x 0,4" x 2,2") unnotched.

Hardened at 1020°C (1870°F) for 30 minutes. Quenched in air. Tempered 2 x 2h.

THE INFLUENCE OF TEMPERING TEMPERATURE ON THE ROOM TEMPERATURE UNNOTCHED IMPACT TOUGHNESS



Corrosion resistance

A tool made from Uddeholm Stavax Supreme has a very good corrosion resistance and will resist corrosive environments better than other stainless tool steels of the W.-Nr. 1.2083/ AISI 420 type.

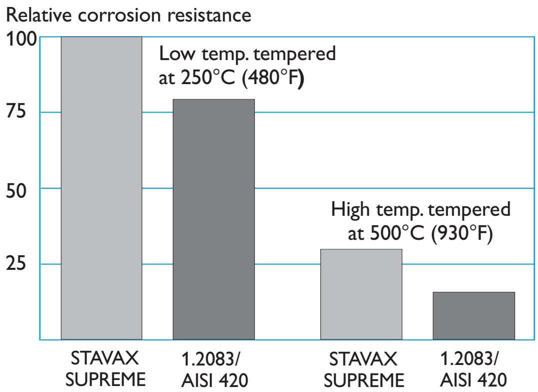
Uddeholm Stavax Supreme shows the best corrosion resistance when tempered at a low temperature and polished to a mirror finish.

In the graph below values from potentiodynamic polarization curves have been evaluated to show the difference in general corrosion resistance between Uddeholm Stavax Supreme and W.-Nr.1.2083/AISI 420 measured at low- and high temperature tempering.

Specimen size: 20 x 15 x 3 mm (0,8" x 0,6" x 0,1")

Hardened at 1020°C (1870°F) for 30 minutes. Quenched in air. Tempered 2 x 2h.

THE INFLUENCE OF MOULD STEEL AND TEMPERING TEMPERATURE ON CORROSION RESISTANCE



Heat Treatment

Soft annealing

Protect the steel and heat through to 740°C (1365°F). Then cool in the furnace at 15°C (30°F) per hour to 550°C (1020°F), then freely in air.

Stress-relieving

After rough machining the tool should be heated through to 650°C (1200°C), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

Hardening

Preheating temperature: 600–920°C (1110–1690°F) Normally a minimum of two preheating steps.
Austenitizing temperature: 1000–1025°C (1830–1880°F) but usually 1020°C (1870°F). For very large moulds 1000°C (1830°F) is recommended.

Temperature °C	Temperature °F	Holding time* minutes	Hardness before tempering
1020	1870	30	55±2 HRC
1000	1830	30	54±2 HRC

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

Protect the part against decarburization and oxidation during hardening.

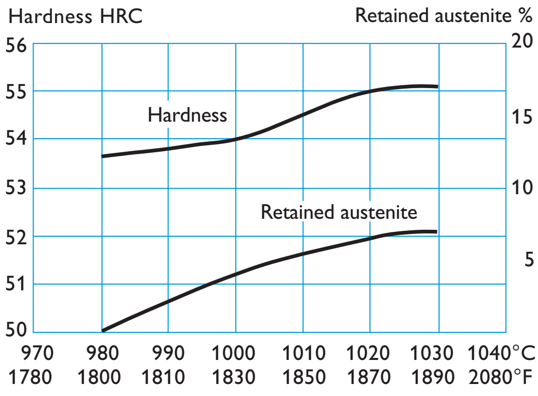
Quenching media and hardenability

- Vacuum, cooling in gas with sufficient overpressure
- Fluidized bed or salt bath at 350–500°C (660–930°F) 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, min. 4–5 bar overpressure is recommended.

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

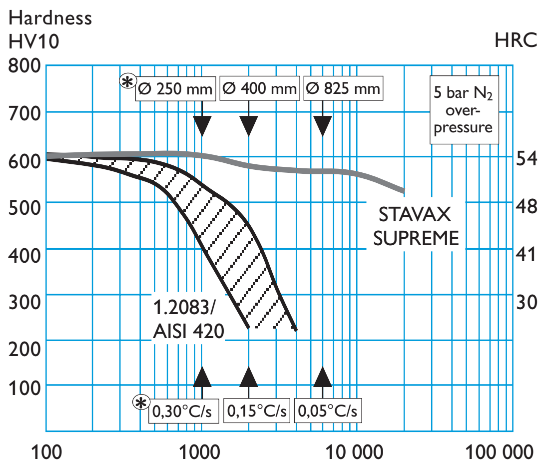
HARDNESS AND RETAINED AUSTENITE AS A FUNCTION OF THE AUSTENITIZING TEMPERATURE



When hardening larger dimensions of W.-Nr. 1.2083 /AISI 420 type of material, the relatively poor hardenability will provide a low hardness and an undesirable microstructure over the cross section. In some parts of the mould the corrosion resistance and the toughness will be lowered.

Uddeholm Stavax Supreme 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 center 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



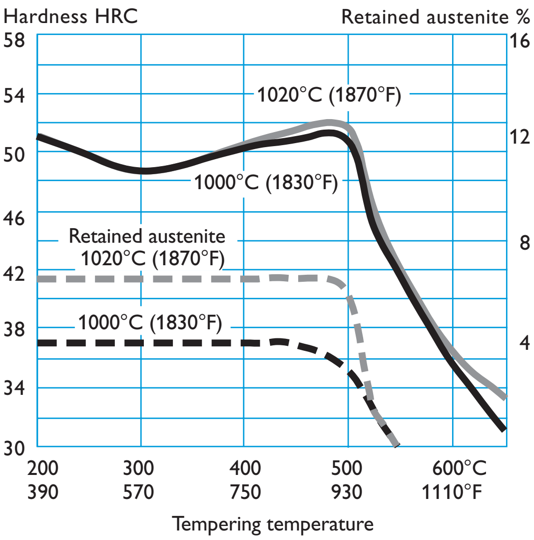
Cooling time between 800–500°C (1470–930°F), sec
*Cooling rate in the centre of three dimensions is indicated

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 250°C (480°F). Holding time at temperature minimum 2 hours.

TEMPERING GRAPH

The tempering curves are approximate.



Note: Tempering at 250–300°C (480–570°F) results in the best combination of toughness, hardness and corrosion resistance. However, for very large moulds and/or a complicated design it is recommended to use a high tempering temperature to reduce the residual stresses to a minimum.

Further information is given in the leaflet "Heat Treatment Recommendations for Uddeholm Stavax Supreme".

Dimensional changes

The dimensional changes during hardening and tempering vary depending on temperatures, type of equipment and cooling media used during heat treatment.

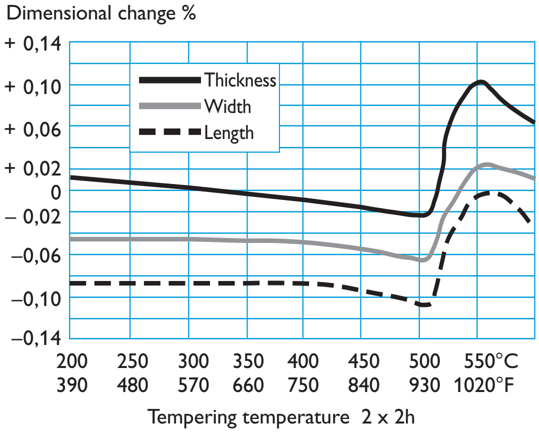
The size and geometry of the tool will also affect distortion and dimensional change. Therefore the tool should always be manufactured with enough machining allowance to compensate for dimensional changes. Use 0,20% as a guideline for Uddeholm Stavax Supreme provided that a stress relief is performed between rough and semifished machining as recommended.

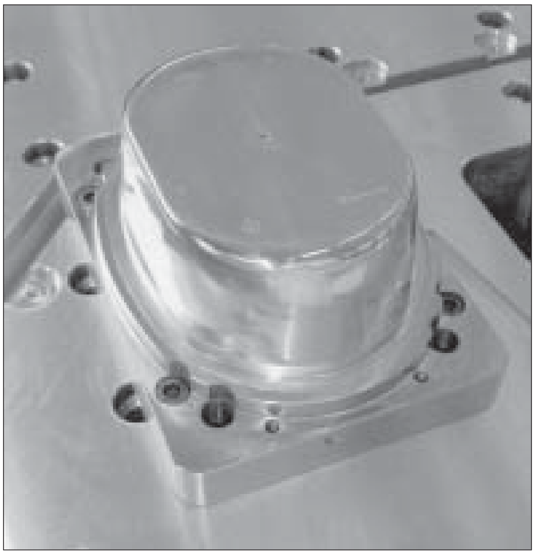
Expect shrinkage rather than growth when using low temperature tempering as shown in the graph below.

Dimensional changes were measured for a sample of Uddeholm Stavax Supreme with a size of 100 x 100 x 100 mm (3,9" x 3,9" x 3,9") heat treated under the following conditions:

Austenitizing: 1020°C (1870°F)/30 min., cooling in vacuum furnace with gas at 1,1°C/s (1,8°F/s) between 800°C (1470°F) and 500°C (930°F).
Tempering: 2 x 2 h at various temperatures.

DIMENSIONAL CHANGES DURING HARDENING AND TEMPERING IN LENGTH, WIDTH AND THICKNESS DIRECTION





Mould for production of big ice cream container.

Machining recommendations

The cutting data below are to be considered as guidelines and may require adjustments based on equipment, selection of cutting tools, etc. More information can be found in the Uddeholm publication "Cutting data recommendation".

The recommendations, in following tables, are valid for Uddeholm Stavax Supreme hardness approx. 250 HB.

Turning

Cutting data parameter	Turning with carbide Rough turning	 Fine turning	Turning with high speed steel Fine turning
Cutting speed (v_c) m/min f.p.m.	 160–210 525–690	 210–260 690–850	 18–23 59–75
Feed (f) mm/r i.p.r.	 0,2–0,4 0,008–0,016	 0,05–0,2 0,002–0,008	 0,05–0,3 0,002–0,01
Depth of cut (a_p) mm inch	 2–4 0,08–0,16	 0,5–2 0,02–0,08	 0,5–3 0,02–0,1
Carbide designation ISO	P20–P30 Coated carbide	P10 Coated carbide or cermet	–

Drilling

HIGH SPEED STEEL TWIST DRILLS

Drill diameter mm	 inch	Cutting speed (v_c) m/min	 f.p.m.	Feed (f) mm/r	 i.p.r.
–5	–3/16	14–16*	46–52*	0,05–0,15	0,002–0,006
5–10	3/16–3/8	14–16*	46–52*	0,15–0,20	0,006–0,008
10–15	3/8–5/8	14–16*	46–52*	0,20–0,25	0,008–0,010
15–20	5/8–3/4	14–16*	46–52*	0,25–0,30	0,010–0,014

* For coated HSS drill v_c =22–24 m/min. (72–79 f.p.m.)

CARBIDE DRILL

Cutting data parameter	Type of drill Indexable insert	 Solid carbide	 Brazed carbide[1]
Cutting speed, (v_c) m/min f.p.m.	 210–230 689–755	 80–100 262–328	 70–80 230–262
Feed, (f) mm/r i.p.r.	 0,03–0,10[2] 0,0012–0,004	 0,10–0,25[2] 0,004–0,01	 0,15–0,25[2] 0,006–0,01

[1] Drills with internal cooling channels and brazed tip
[2] Depending on drill diameter

Milling

FACE AND SQUARE SHOULDER FACE MILLING

Cutting data parameter	Milling with carbide Rough milling	 Fine milling
Cutting speed (v_c) m/min f.p.m.	 160–240 525–787	 240–280 787–919
Feed (f_z) mm/tooth in/tooth	 0,2–0,4 0,008–0,016	 0,1–0,2 0,004–0,008
Depth of cut (a_p) mm inch	 2–4 0,08–0,16	 0,5–2 0,02–0,08
Carbide designation ISO	P20–P40 Coated carbide	P10–P20 Coated carbide or cermet

END MILLING

Cutting data parameter	Type of end mill Solid carbide	 Carbide indexable insert	 High speed steel
Cutting speed (v_c) m/min f.p.m.	 120–150 390–500	 160–220 525–722	 25–30[1] 82–100
Feed (f_z) mm/tooth in/tooth	 0,01–0,20[2] 0,0004–0,008	 0,06–0,20[2] 0,002–0,008	 0,01–0,3[2] 0,0004–0,01
Carbide designation ISO	–	P20–P30	–

[1] For coated HSS end mill v_c = 45–50 m/min. (150–165 f.p.m.)
[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 Uddeholm publication "Grinding of tool steel"

Type of grinding	Wheel recommendation Delivery condition	 Hardened condition
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 techniques are used. Precautions such as preheating, heat treatment, post weld heat treatment, joint preparation, selection of consumables, etc. are required.

For best result after polishing and photo-etching use consumables with a matching chemical composition to the mould steel.

Welding method	TIG
Working temperature	200–250°C (390–480°F)
Welding consumables	STAVAX TIG-WELD
Hardness after welding	54–56 HRC
Heat treatment after welding:	
Hardened condition	Temper at 10–20°C (50–70°F) below the original tempering temperature.
Delivery condition	Heat treat to 700°C (1290°F) for 5 hours. Then cool freely in air.

Further information is given in the Uddeholm brochure "Welding of Tool Steel" or nearest Uddeholm sales office.

Polishing

Uddeholm Stavax Supreme has a very good polishability in the hardened and tempered condition.

A slightly different technique, in comparison with other Uddeholm mould steels, should be used. The main principle is to use smaller steps at the fine-grinding/polishing stages and not to start polishing on too rough of a surface. It is also important to stop the polishing operation *immediately after* the last scratch from the former grit size has been removed.

More detailed information on polishing techniques is given in the brochure "Polishing of tool steel".

Photo-etching

Uddeholm Stavax Supreme has a very low inclusion content and a homogeneous microstructure. The high cleanliness level provides for good photo-etching/texturing characteristics.

The special photo-etching process that might be necessary because of Uddeholm Stavax Supreme's good corrosion resistance is familiar to all the leading photo-etching companies.

Further information is given in the Uddeholm brochure "Photo-etching of tool steel".

Further information

Please contact your local Uddeholm office for further information on the selection, heat treatment and application of Uddeholm tool steels, including the publication "Steels for moulds".

The Tool Steel Process

The starting material for our tool steel is carefully selected from high quality recyclable steel. Together with ferroalloys and slag formers the recyclable steel is melted in an electric arc furnace. The melt is then tapped into a ladle.

The de-slagger removes oxygen-rich slag and after the deoxidation, alloying and heating of the steel bath are carried out in the ladle furnace. Vacuum degassing removes elements such as hydrogen, nitrogen and sulphur.

ESR PLANT

In uphill casting the prepared moulds are filled with a controlled flow of molten steel from the ladle. From this, the steel can go directly to our rolling mill or to the forging press, but also to our ESR furnace where our most sophisticated steel grades are melted once again in electro slag remelting process. This is done by melting a consumable electrode immersed in an overheated slag bath. Controlled solidification in the steel bath results in an ingot of high homogeneity with a solidification structure thereby free from macro segregation. Melting under a protective atmosphere gives an even better steel cleanliness.

HOT WORKING

From the ESR plant, the steel goes to the rolling mill or to our forging press to be formed in to round or flat bars.

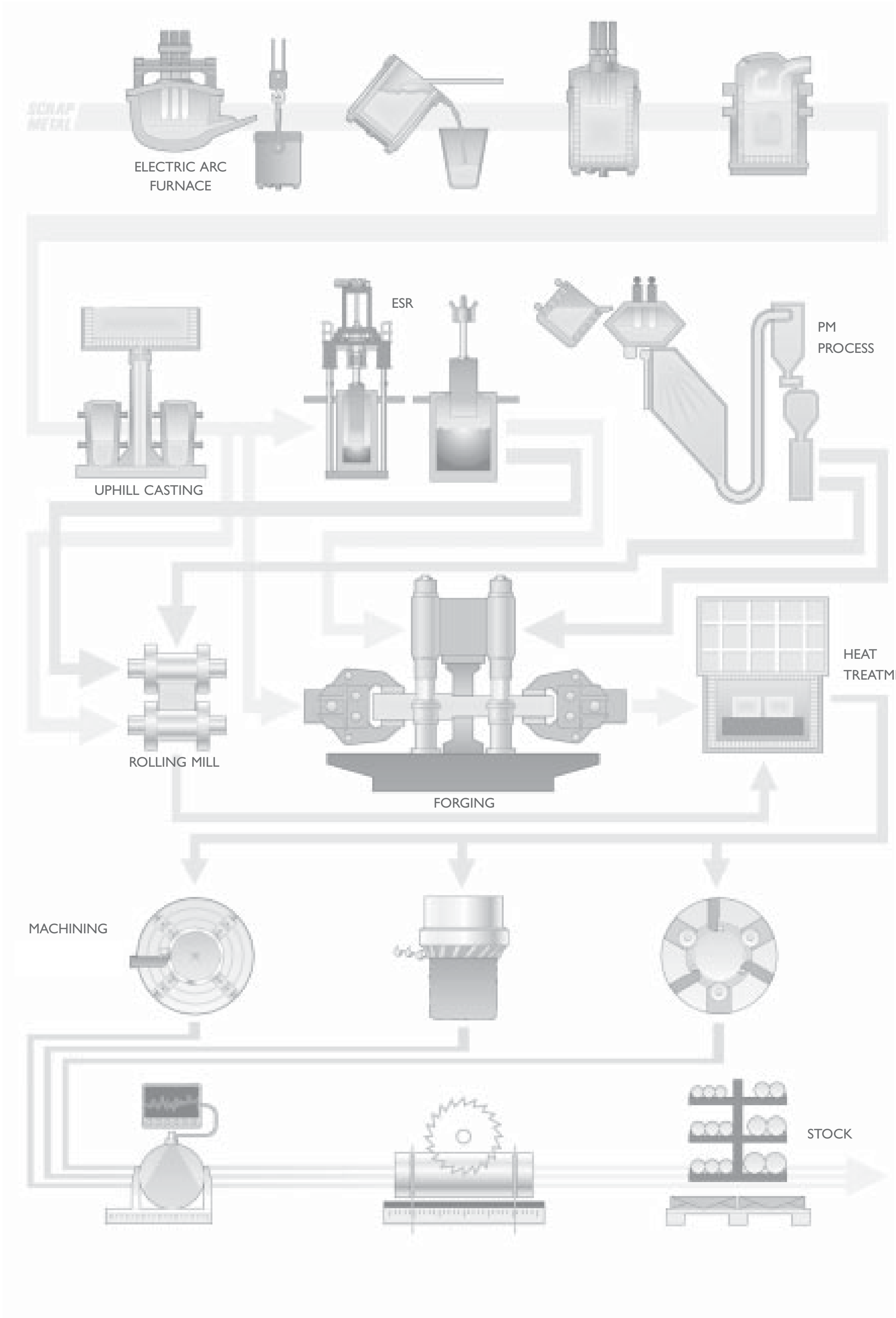
Similar to our ESR steels, other high quality steel grades including the powder metal steels and spray formed steels, go to the rolling mill or the forging press before all of the different bar material is subjected to a heat treatment operation; either a soft annealing or hardening and tempering. This operation provides the steel with the right balance between hardness and toughness.

MACHINING

Before the material is finished and put into stock we also rough machine the bar profiles to required size and exact tolerances.

In the lathe machining of large dimensions, the steel bar rotates against a stationary cutting tool. In peeling of smaller dimensions, the cutting tools revolve around the bar.

We also saw the ends, and also remove any defects the bar may contain. Through our surface inspection, ultrasonic inspection and auto inspection of the bars we will safeguard and guarantee the quality of the tool steel.


SCRAP METAL
ELECTRIC ARC FURNACE
ESR
PM PROCESS
UPHILL CASTING
HEAT TREATMENT
ROLLING MILL
FORGING
MACHINING
STOCK

Europe

Austria

Representative office
UDDEHOLM
Albstraße 10
DE-73765 Neuhausen
Telephone: +49 7158 9865-0
www.uddeholm.de

Belgium

UDDEHOLM
Europark Oost 7
B-9100 Sint-Niklaas
Telephone: +32 3 780 56 20
www.uddeholm.be

Croatia

BÖHLER UDDEHOLM Zagreb
d.o.o za trgovinu
Zitnjak b.b
10000 Zagreb
Telephone: +385 1 2459 301
Telefax: +385 1 2406 790
www.bohler-uddeholm.hr

Czech Republic

BÖHLER UDDEHOLM CZ s.r.o.
Division Uddeholm
U Silnice 949
161 00 Praha 6, Ruzyne
Telephone: +420 233 029 850,8
www.uddeholm.cz

Denmark

UDDEHOLM A/S
Kokmose 8, Bramdrupdam
DK-6000 Kolding
Telephone: +45 75 51 70 66
www.uddeholm.dk

Estonia

UDDEHOLM TOOLING AB
Silikatsiidi 7
EE-11216 Tallinn
Telephone: +372 655 9180
www.uddeholm.ee

Finland

OY UDDEHOLM AB
Ritakuja 1, PL 57
FI-01741 VANTAA
Telephone: +358 9 290 490
www.uddeholm.fi

France

Head office
UDDEHOLM
Z.I. de Mitry-Compans, 12 rue Mercier,
FR-77297 Mitry Mory Cedex
Telephone: +33 (0)1 60 93 80 10
www.uddeholm.fr

Branch offices
UDDEHOLM S.A.
77bis, rue de Vesoul
La Nef aux Métiers
FR-25000 Besançon
Telephone: +33 (0)381 53 12 19

LE POINT ACIERS
UDDEHOLM - Aciers à outils
Z.I. du Recou, Avenue de Champlevert
FR-69520 GRIGNY
Telephone: +33 (0)4 72 49 95 61

LE POINT ACIERS
UDDEHOLM - Aciers à outils
Z.I. Nord 27, rue François Rochaix
FR-01100 OYONNAX
Telephone: +33 (0)4 74 73 48 66

Germany

Head office
UDDEHOLM
Hansaallee 321
DE-40549 Düsseldorf
Telephone: +49 211 5351-0
www.uddeholm.de

Branch offices
UDDEHOLM
Falkenstraße 21
DE-65812 Bad Soden/TS
Telephone: +49 6196 6596-0

UDDEHOLM
Albstraße 10
DE-73765 Neuhausen
Telephone: +49 7158 9865-0

UDDEHOLM
Friederikenstraße 14b
DE-06493 Harzgerode
Telephone: +49 39484 727 267

Great Britain

UDDEHOLM DIVISION
BOHLER-UDDEHOLM (UK) LIMITED
European Business Park
Taylors Lane, Oldbury
GB-West Midlands B69 2BN
Telephone: +44 121 552 5511
Telefax: +44 121 544 2911
www.uddeholm.co.uk

Greece

STASSINOPOULOS-UDDEHOLM
STEEL TRADING S.A.
20, Athinon Street
GR-Piraeus 18540
Telephone: +30 210 4172 109
www.uddeholm.gr

SKLERO S.A.
Heat Treatment and Trading of Steel
Uddeholm Tool Steels
Industrial Area of Thessaloniki
P.O. Box 1123
GR-57022 Sindos, Thessaloniki
Telephone: +30 2310 79 76 46
www.sklero.gr

Hungary

UDDEHOLM TOOLING/BOK
Dunaharaszti, Jedlik Ányos út 25
HU-2331 Dunaharaszti 1. Pf. 110
Telephone/fax:+36 24 492 690
www.uddeholm.hu

Ireland

Head office:
UDDEHOLM DIVISION
BOHLER-UDDEHOLM (UK) LIMITED
European Business Park
Taylors Lane, Oldbury
UK-West Midlands B69 2BN
Telephone: +44 121 552 5511
Telefax: +44 121 544 2911
www.uddeholm.co.uk
Dublin:
Telephone: +353 1845 1401

Italy

UDDEHOLM
Divisione della Bohler Uddeholm
Italia S.p.A.
Via Palizzi, 90
IT-20157 Milano
Telephone: +39 02 39 49 211
www.uddeholm.it

Latvia

UDDEHOLM TOOLING LATVIA SIA
Piedrujas Street 7
LV-1035 Riga
Telephone: +371 7 702133
Telefax: +371 7 185079

Lithuania

UDDEHOLM TOOLING AB
BE PLIENAS IR METALAI
T. Masiulio 18B
LT-52459 Kaunas
Telephone: +370 37 370613, -669
www.besteel.lt

The Netherlands

UDDEHOLM
Isolatorweg 30
NL-1014 AS Amsterdam
Telephone: +31 20 581 71 11
www.uddeholm.nl

Norway

UDDEHOLM A/S
Jernkroken 18
Postboks 85, Kalbakken
NO-0902 Oslo
Telephone: +47 22 91 80 00
www.uddeholm.no

Poland

BOHLER UDDEHOLM POLSKA
Sp. z.o.o./Co. Ltd.
ul. Kolejowa 291, Dziekanów Polski,
PL-05-092 Lomianki
Telephone: +48 22 429 2260, -203, -204
www.uddeholm.pl

Portugal

F RAMADA Aços e Industrias S.A.
P.O. Box 10
PT-3881 Ovar Codex
Telephone: +351 256 580580
www.ramada.pt

Romania

BÖHLER-UDDEHOLM Romania SRL
Atomistilor Str. No 96-102
077125 - com. Magurele, Jud. Ilfov.
Telephone: +40 214 575007
Telefax: +40 214 574212

Russia

UDDEHOLM TOOLING CIS
9A, Lipovaya Alleya, Office 509
RU-197183 Saint Petersburg
Telephone: +7 812 6006194
www.uddeholm.ru

Slovakia

Bohler-Uddeholm Slovakia s.r.o.
divizia UDDEHOLM
Čsl.Armády 5622/5
SK-036 01 Martin
Telephone: +421 (0)434 212 030
www.uddeholm.sk

Slovenia

Representative office
UDDEHOLM
Divisione della Bohler Uddeholm
Italia S.p.A.
Via Palizzi, 90
IT-20157 Milano
Telephone: +39 02 39 49 211
www.uddeholm.it

Spain

Head office
UDDEHOLM
Guifré 690-692
ES-08918 Badalona, Barcelona
Telephone: +34 93 460 1227
www.acerosuddeholm.com

Branch office
UDDEHOLM
Barrio San Martín de Arteaga,132
Pol.Ind. Torrelarragoiti
ES-48170 Zamudio (Bizkaia)
Telephone: +34 94 452 13 03

Sweden

Head office
UDDEHOLM TOOLING SVENSKA AB
Aminogatan 25
SE-431 53 Mölndal
Telephone: +46 31 67 98 50
www.uddeholm.se

Branch offices
UDDEHOLM TOOLING SVENSKA AB
Box 45
SE-334 21 Anderstorp
Telephone: +46 371 160 15

UDDEHOLM TOOLING SVENSKA AB
Box 148
SE-631 03 Eskilstuna
Telephone: +46 16 15 79 00

UDDEHOLM TOOLING SVENSKA AB
Aminogatan 25
SE-431 53 Mölndal
Telephone: +46 31 67 98 70

UDDEHOLM TOOLING SVENSKA AB
Nya Tanneforsvägen 96
SE-582 42 Linköping
Telephone: +46 13 15 19 90

UDDEHOLM TOOLING SVENSKA AB
Derbyvägen 22
SE-212 35 Malmö
Telephone: +46 40 22 32 05

UDDEHOLM TOOLING SVENSKA AB
Honnörsgatan 16A
SE-352 36 Växjö
Telephone: +46 470 457 90

Switzerland

HERTSCH & CIE AG
General Wille Strasse 19
CH-8027 Zürich
Telephone: +41 44 208 16 66
www.hertsch.ch

Turkey

Head office
ASSAB Korkmaz Celik A.S.
Organize Sanayi Bölgesi
2. Cadde No: 26 Y. Dudullu
Umraniye-Istanbul Turkey
Telephone: +90 216 420 1926-121/124
www.assabkorkmaz.com

America

Argentina
ACEROS BOEHLER UDDEHOLM S.A
Mozart 40
1619-Centro Industrial Garin
Garin-Prov.
AR-Buenos Aires
Telephone: +54 332 7444 440
www.uddeholm.com.ar

Brazil
AÇOS BOHLER-UDDEHOLM DO BRASIL LTDA– DIV. UDDEHOLM
Estrada Yae Massumoto, 353
CEP 09842-160
BR-Sao Bernardo do Campo - SP Brazil
Telephone: +55 11 4393 4560, 4554
www.uddeholm.com.br

Canada
Head Office & Warehouse
UDDEHOLM
2595 Meadowvale Blvd.
Mississauga, ON L5N 7Y3
Telephone: +1 905 812 9440
www.bucanada.com

Branch Warehouses
UDDEHOLM
3521 Rue Ashby
St. Laurent, QC H4R 2K3
Telephone: +1 514 333 8000

UDDEHOLM
730 Eaton Way - Unit #10
New Westminister, BC V3M 6J9
Telephone: +1 604 525 3354

Heat Treating
THERMO-TECH
2645 Meadowvale Blvd.
Mississauga, ON L5N 7Y4
Telephone: +1 905 812 9440

Colombia
AXXECOL S.A.
Carrera 35 No 13-20
Apartado Aereo 80718
CO-Bogota 6
Telephone: +57 1 2010700
www.axxecol.com

ASTECO S.A.
Carrera 54 No 35-12
Apartado Aereo 663
CO-Medellin
Telephone: +57 4 2320122
www.asteco.com

Dominican Republic
RAMCA, C. POR A.
Luis Puigbó Alegre, EPS P-2289
P O Box 02-5261
DO-Santo Domingo
Telephone: +1 809 682 4011
domrep@assab.com

Ecuador
IVAN BOHMAN C.A.
Apartado 1317
Km 6 1/2 Via a Daule
Guayaquil
Telephone: +593 42 254111

IVAN BOHMAN C.A.
Casilla Postal 17-01370
Quito
Telephone: +593 2 2248001

El Salvador
ACAVISA DE C.V.
25a. Avenida Sur 463
zona 1
Apartado Postal 439
SV-San Salvador
Telephone: +503 22 711700
www.acavisa.com

Guatemala
IMPORTADORA ESCANDINAVA
Apartado postal 2042
GT-Guatemala City
Telephone: +502 23 659270
guatemala@assab.com

Mexico
Head office
ACEROS BOHLER UDDEHOLM S.A. de C.V.
Calle Ocho No 2, Letra "C"
Fraccionamiento Industrial Alce Blanco
C.P. 52787 Naucalpan de Juarez
MX-Estado de Mexico
Telephone: +52 55 9172 0242
www.bu-mexico.com

Branch office
BOHLER-UDDEHOLM MONTERREY, NUEVO LEON
Lerdo de Tejada No.542
Colonia Las Villas
MX-66420 San Nicolas de Los Garza, N.L.
Telephone: +52 81 83 525239

Peru
C.I.P.E.S.A
Av. Oscar R. Benavides
(ante Colonial) No. 2066
PE-Lima 1
Telephone: +51 1 336 8673
peru@assab.com

U.S.A.
Head Office
UDDEHOLM
4902 Tollview Drive
Rolling Meadows IL 60008
Telephone: 1-847-577-2220
Sales phone: 1-800-638-2520
www.bucorp.com

Region East Warehouse
UDDEHOLM
220 Cherry Street
Shrewsbury MA 01545

Region Central Warehouse
UDDEHOLM
548 Clayton Ct.
Wood Dale IL 60191

Region West Warehouse
UDDEHOLM
9331 Santa Fe Springs Road
Santa Fe Springs, CA 90670

Venezuela
PRODUCTOS HUMAR C.A.
Multicentro Empresarial del Este,
Edf Libertador, Núcleo A.
Piso 9, Of. A-93, Chacao
VE-Caracas 1060
Telephone: +58 212 2655040
humar@assab.com

Other Countries in America
ASSAB INTERNATIONAL AB
Box 42
SE-171 11 Solna, Sweden
Telephone: +46 8 564 616 70
www.assab.se

Asia & Pacific

Australia
BOHLER UDDEHOLM Australia
129-135 McCredie Road
Guildford NSW 2161
Private Bag 14
AU-Sydney
Telephone: +61 2 9681 3100
www.buau.com.au

Bangladesh
ASSAB INTERNATIONAL AB
P.O. Box 17595
Jebel Ali
AE-Dubai
Telephone: +971 488 12165
www.assab.se

North China
Head office
ASSAB Tooling (Beijing) Co Ltd
No.10A Rong Jing Dong Jie
Beijing Economic Development Area
Beijing 100176, China
Telephone: +86 10 6786 5588
www.assabsteels.com

Branch offices
ASSAB Tooling (Beijing) Ltd
Dalian Branch
8 Huanghai Street, Haerbin Road
Economic & Technical Develop. District
Dalian 116600, China
Telephone: +86 411 8761 8080

ASSAB Qingdao Office
Room 2521, Kexin Mansion
No. 228 Liaoning Road, Shibei District
Qingdao 266012, China
Telephone: +86 532 8382 0930

ASSAB Tianjin Office
No.12 Puwangli Wanda Xincheng
Xinyibai Road, Beichen District
Tianjin 300402, China
Telephone: +86 22 2672 0006

Central China
Head office
ASSAB Tooling Technology (Shanghai) Co Ltd
No. 4088 Humin Road
Xinzhuang Industrial Zone
Shanghai 201108, China
Telephone: +86 21 5442 2345
www.assabsteels.com

Branch offices
ASSAB Tooling Technology (Ningbo) Co Ltd
No. 218 Longjiaoshan Road
Vehicle Part Industrial Park
Ningbo Economic & Technical Dev. Zone
Ningbo 315806, China
Telephone: +86 574 8680 7188

ASSAB Tooling Technology (Chongqing) Co Ltd
Plant C, Automotive Industrial lPark
Chongqing Economic & Technological Development Zone
Chongqing 401120, China
Telephone: +86 23 6745 5698

South China
Head office
ASSAB Steels (HK) Ltd
Room 1701–1706
Tower 2 Grand Central Plaza
138 Shatin Rural Committee Road
Shatin NT - Hong Kong
Telephone: +852 2487 1991
www.assabsteels.com

Branch offices
ASSAB Tooling (Dongguan) Co Ltd
Northern District
Song Shan Lake Science & Technology Industrial Park
Dongguan 523808, China
Telephone: +86 769 2289 7888
www.assabsteels.com

ASSAB Tooling (Xiamen) Co Ltd
First Floor Universal Workshop
No. 30 Huli Zone
Xiamen 361006, China
Telephone: +86 592 562 4678

Hong Kong
ASSAB Steels (HK) Ltd
Room 1701-1706
Grand Central Plaza, Tower 2
138 Shatin Rural Committee Road
Shatin NT, Hong Kong
Telephone: +852 2487 1991
www.assabsteels.com

India
ASSAB Sripad Steels LTD
T 303 D.A.V. Complex
Mayur Vihar Ph I Extension
IN-Delhi-110 091
Telephone: +91 11 2271 2736
www.assabsripadsteels.com

ASSAB Sripad Steels LTD
709, Swastik Chambers
Sion-Trombay Road
Chembur
IN-Mumbai-400 071
Telephone: +91 22 2522-7110, -8133

ASSAB Sripad Steels LTD
Padmalaya Towers
Janaki Avenue
M.R.C. Nagar
IN-Chennai-600 028
Telephone: +91 44 2495 2371

Indonesia
Head office
PT ASSAB Steels Indonesia
Jl. Rawagelam III No. 5
Kawasan Industri Pulogadung
Jakarta 13930, Indonesia
Telephone: +62 21 461 1314
www.assabsteels.com

Branch offices
SURABAYA BRANCH
Jl. Berbek Industri 1/23
Surabaya Industrial Estate, Rungkut
Surabaya 60293, East Java, Indonesia
Telephone: +62 31 843 2277

MEDAN BRANCH
Komplek Griya Riatur Indah
Blok A No.138
Jl. T. Amir Hamzah
Halvetia Timur, Medan 20124
Telephone: +62 61 847 7935/6

BANDUNG BRANCH
Komp. Ruko Bumi Kencana
Jl. Titian Kencana Blok E
No.5 Bandung 40233
Telephone: +62 22 604 1364

TANGERANG BRANCH
Pusat Niaga Cibodas
Blok C No. 7 Tangerang
Telephone: +62 21 921 9596, 551 2732

SEMARANG BRANCH
Jl. Imam Bonjol No.155
R.208 Semarang 50124
Telephone: +62 358 8167

Iran

ASSAB INTERNATIONAL AB
P.O. Box 19395
IR-1517 TEHRAN
Telephone: +98 21 888 35392
www.assabiran.com

Israel

PACKER YADPAZ QUALITY STEELS Ltd
P.O. Box 686
Ha-Yarkon St. 7, Industrial Zone
IL-81106 YAVNE
Telephone: +972 8 932 8182
www.packer.co.il

Japan

UDDEHOLM KK
Atago East Building
3-16-11 Nishi Shinbashi
Minato-ku, Tokyo 105-0003, Japan
Telephone: + 81 3 5473 4641
www.assabsteels.com

Jordan

ENGINEERING WAY Est.
P.O. Box 874
Abu Alanda
JO-AMMAN 11592
Telephone: +962 6 4161962
engineeringway@assab.com

Malaysia

Head office

ASSAB Steels (Malaysia) Sdn Bhd
Lot 19, Jalan Perusahaan 2
Batu Caves Industrial Estate
68100 Batu Caves
Selangor Malaysia
Telephone: +60 3 6189 0022
www.assabsteels.com

Branch offices

BUTTERWORTH BRANCH
Plot 146a
Jalan Perindustrial Bukit Minyak 7
Kawasan Perindustrial Bukit Minyak
14000 Bukit Mertajam, SPT Penang
Telephone: +60 4 507 2020

JOHOR BRANCH
No. 8, Jalan Persiaran Teknologi
Taman Teknologi
81400 Senai
Johor DT, Malaysia
Telephone: +60 7 598 0011

New Zealand

VIKING STEELS
25 Beach Road, Otahuhu
P.O. Box 13-359, Onehunga
NZ-Auckland
Telephone: +64 9 270 1199
www.ssm.co.nz

Pakistan

ASSAB International AB
P.O. Box 17595
Jebel Ali
AE-Dubai
Telephone: +971 488 12165
www.assab.se

Philippines

ASSOCIATED SWEDISH STEELS PHILS Inc.
No. 3 E. Rodriguez Jr., Avenue
Bagong Ilog, Pasig City
Philippines
Telephone: +632 671 1953/2048
www.assabsteels.com

Republic of Korea

Head office

ASSAB Steels (Korea) Co Ltd
116B-8L, 687-8, Kojan-dong
Namdong-ku
Incheon 405-310, Korea
Telephone: +82 32 821 4300
www.assabsteels.com

Branch offices

BUSAN BRANCH
14B-5L, 1483-9, Songjeong-dong
Kangseo-ku, Busan 618-270, Korea
Telephone: +82 51 831 3315

DAEGU BRANCH
Room 27, 7-Dong2 F
Industry Materials Bldg.1629
Sangyeog-Dong, Buk-Ku
Korea-Daegu 702-710
Telephone: +82 53 604 5133

Lebanon

WARDE STEEL & METALS SARL MET
Charles Helou Av, Warde Bldg
P.O. Box 165886
LB-Beirut
Telephone: +961 1 447228
lebanon@assab.com

Saudi Arabia

ASSAB INTERNATIONAL AB
P.O. Box 255092
SA-Riyadh 11353
Telephone: +966 1 4466542
saudiarabia@assab.com

Singapore

Head office Pacific

ASSAB Pacific Pte Ltd
171, Chin Swee Road
No. 07-02, SAN Centre
SG-Singapore 169877
Telephone: +65 6534 5600
www.assabsteels.com

Jurong

ASSAB Steels Singapore (Pte) Ltd
18, Penjuru Close
SG-608616 Singapore
Telephone: +65 6862 2200

Sri Lanka

GERMANIA COLOMBO (Ptd) Ltd
451/A Kandy Road
LK-Kelaniya
Telephone: +94 11 2913556
www.iwsholdings.com

Syria

WARDE STEEL & METALS SARL MET
Charles Helou Av, Warde Bldg
P.O. Box 165886
LB-Beirut
Telephone: +961 1 447228
lebanon@assab.com

Taiwan

Head office

ASSAB Steels (Taiwan) Co Ltd
No. 112 Wu Kung 1st Rd.
Wu Ku Industry Zone
TW-Taipei 248-87, Taiwan (R.O.C.)
Telephone: +886 2 2299 2849
www.assabsteels.com

Branch offices

NANTOU BRANCH
No. 10, Industry South 5th Road
Nan Kang Industry Zone
Nantou 540-66, Taiwan (R.O.C.)
Telephone: +886 49 225 1702

TAINAN BRANCH
No. 180, Yen He Street,
Yong Kang City
Tainan 710-82, Taiwan (R.O.C.)
Telephone: +886 6 242 6838

Thailand

ASSAB Steels (Thailand) Ltd
9/8 Soi Theedinthai,
Taeparak Road, Bangplee,
Samutprakarn 10540, Thailand
Telephone: +66 2 385 5937,
+66 2 757 5017
www.assabsteels.com

United Arab Emirates

ASSAB INTERNATIONAL AB
P.O. Box 17595
Jebel Ali
AE-Dubai
Telephone: +971 488 12165
www.assab.se

Vietnam

CAM Trading Steel Co Ltd
90/8 Block 5, Tan Thoi Nhat Ward
District 12, Ho Chi Minh City
Vietnam
Telephone: +84 8 5920 920
www.assabsteels.com

Other Asia

ASSAB INTERNATIONAL AB
Box 42
E-171 11 Solna, Sweden
Telephone: +46 8 564 616 70
www.assab.se

Africa

Egypt

UNITED FOR IMPORT AND INDUSTRIAL SUPPLIES
Montaser Project No 20
Flat No 14
Al Ahram Street-El Tabia
EG-Giza Cairo
Telephone: +20 2 7797751
www.assab.se

Kenya

SANDVIK Kenya Ltd
P.O. Box 18264
Post code 00500
KE-Nairobi
Telephone: +254 20 532 866
sandvik@africaonline.co.ke

South Africa

UDDEHOLM Africa (Pty.) Ltd.
P.O. Box 539
ZA-1600 Isando/Johannesburg
Telephone: +27 11 974 2781
www.bohler-uddeholm.co.za

Tunisia

MCM Distribution
4 Bis, Rue 8610 - Z.I.
2035 Chargula 1
TN-Tunis
Telephone: + 216 71 802479
www.mcm.com.tn

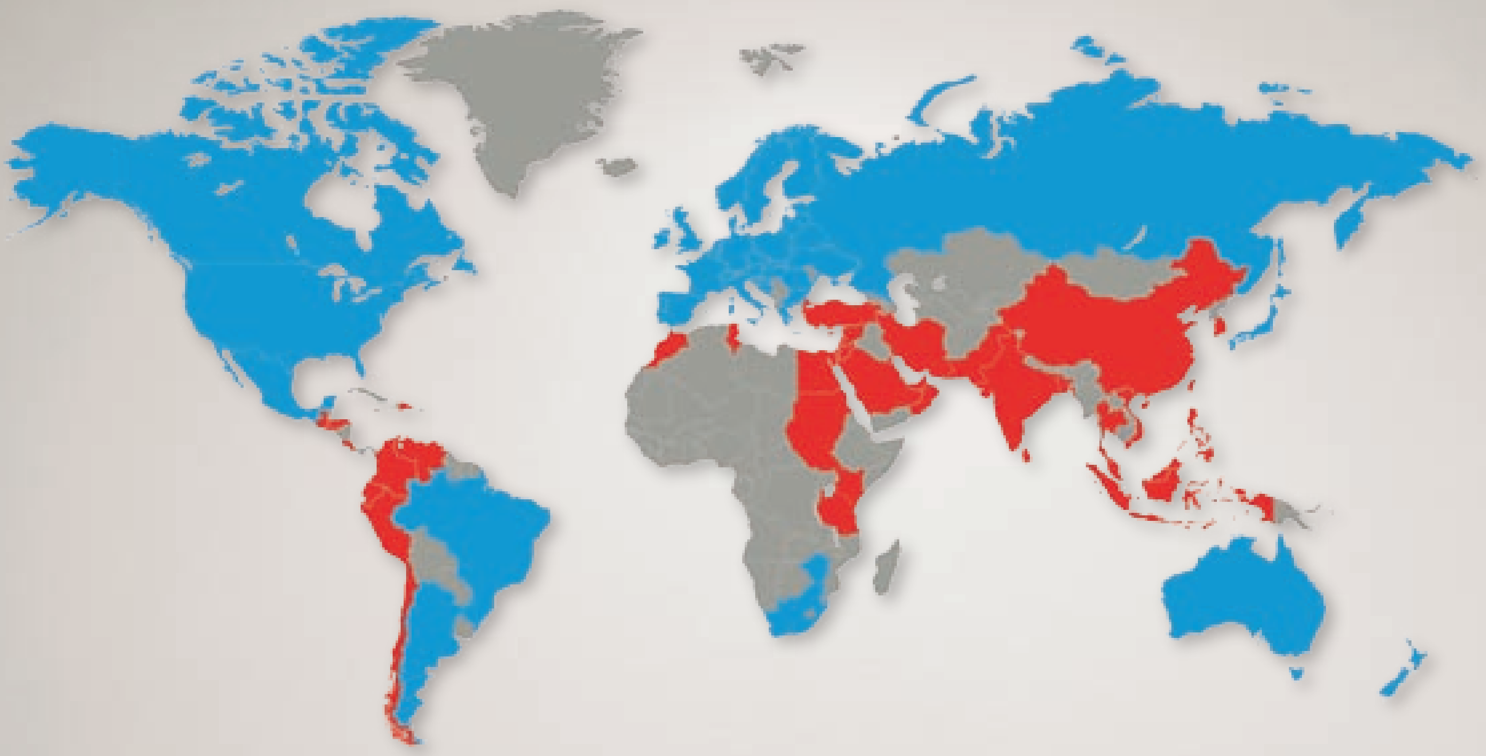
Zimbabwe

Representative office:

UDDEHOLM Africa (Pty.) Ltd.
P.O. Box 539
ZA-1600 Isando/Johannesburg
Telephone: +27 11 974 2781
www.bohler-uddeholm.co.za

Other African Countries

ASSAB INTERNATIONAL AB
Box 42
SE-171 11 Solna, Sweden
Telephone: +46 8 564 616 70
www.assab.se



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HAGFORS KLARTEXT U070402.300 / TRYCKERI KNAPPEN, KARLSTAD 20070467