MELTING STOCK FOR CAST COLD WORK TOOLS

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.

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

Edition 1, 09.2009

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

CONTENTS

General

Uddeholm Granshot is a foundry melt stock for production of cast tools and dies. The use of granules means that no further metallurgy is needed. After melting of the granulates in a high frequency furnace the molten metal is ready for immediate casting without further processing.

Uddeholm Granshot are manufactured utilizing the Uddeholm patented water granulation process. When the molten metal is transported to the granulation tank, poured onto the refractory target and dispersed as molten droplets into the water bath. After dewatering the granulate is completely dried and then passed through a surface deoxidation unit.

Advantages

- Reduced handling costs
- Reduced material consumption
- Reduced power consumption
- Exact and certified chemical composition
- Consistent quality
- No charge for laboratory analyses
- High yield of charge material as well as castings
- High flexibility
- Clean steel with a low inclusion content

The melting procedure

Granshot material can be charged directly into the furnace. The granules generally melt very quickly. When using a furnace with a lower capacity, the following procedures might be considered:

- Charge the granules into a hot furnace
- Keep if possible a small part of the molten steel from the previous heat in the furnace and charge the granules into it
- If no previous charge material can be used, it is beneficial to use some return scrap of larger size together with the granules
- Make sure that there is no build up of a bridged material on the surface
- Always keep a liquid "eye" open into which the granules are charged

Melting of metal with a high melting point should be done with necessary care to avoid any risk of burns. Always make sure that the material is completely dry before it is charged into the furnace.

Packaging

Uddeholm Granshot is packed in new steel drums. The drums are fastened onto pallets.

The drum volume is 200 l and holds a maximum of 830 kg granules. The steel grade, charge number and weight are specified on each drum.

Uddeholm Granshot™ program

Increasing the alloy content – especially carbon – increases the risk of cracking during the casting process and also cracking of the tool in service. This means that the size of the cast tool that can be produced decreases with increasing Granshot alloy content. Other important operations such as weldability, machinability, flame- and induction hardenability become

more difficult to perform or may even be impaired as the alloy content increases. On the other hand, hardness, compressive strength, wear resistance and coatability improve with increasing alloy content. This means that a carefully balanced product programme is necessary in order to take all these factors into account.

There are four different grades in the Uddeholm Granshot programme. These range from the rather low alloyed Uddeholm Fermo Granshot up to the high alloyed 12% Cr-steel Uddeholm Sverker 21 Granshot.

Uddeholm grade	Analysis %					
	C	Si	Mn	Cr	Mo	V
Fermo Granshot	0.48	0.40	0.80	1.40	-	-
Carmo Granshot	0.60	0.35	0.80	4.50	0.50	0.25
Caldie Granshot	0.73	0.20	0.50	5.00	2.30	0.50
Sverker 21 Granshot	1.55	0.30	0.35	11.70	0.75	0.75

Guidelines for the maximum cast tool weight

The possibility to produce large cast tools is restricted by the increasing carbon and alloy content. In addition it is restricted by the geometrical complexity of the tool.

The following estimated maximum cast tool weights for the different Granshot grades can be used as a guideline.

Uddeholm grade	Maximum weight (kg)
Fermo Granshot	10 000
Carmo Granshot	5 000
Caldie Granshot	2000
Sverker 21 Granshot	250

After casting, some type of heat treatment procedure is recommended. The time between shake out of the casting and heat treatment is important. The time spans for the different grades are given below. The more carbon and alloy elements in the cast steel the shorter the time span is in order to avoid cracking of the cast tool.

Uddeholm grade	Time span shake out – heat treatment
Fermo Granshot	within a couple of days
Carmo Granshot	within a day
Caldie Granshot	within half a day
Sverker 21 Granshot	within half a day

Depending of tool size and capacity of available heat treatment facilities either soft annealing, normalizing or hardening should be carried out. If flame-/ induction-/laser-hardening of active cutting edges or forming parts is planned, the most appropriate heat treatment is normally prehardening to 250–300 HB.

Properties profiles (relative comparisons)

Uddeholm grade	Wear resistance	Cracking resistance	Weldability	Flame-/induction hardenability	Hardness/ Compressive strength
Fermo Granshot					
Carmo Granshot					
Caldie Granshot					
Sverker 21 Granshot					

The longer the bar the better.

Uddeholm Fermo Granshot

General

The chemical composition of Uddeholm Fermo Granshot corresponds to the wrought cold work tool steel Uddeholm Fermo. The cast steel can be used in tools and dies for blanking and forming of soft sheet materials for outer panel or structural car body parts. It is possible to get a tool surface hardness of 56 ±2 HRC by flame-/induction-/laser-hardening without any water quenching. It is also easy to perform repair welding without having to preheat.

Liquidus temperature: 1481°C (2698°F)
Solidus temperature: 1408°C (2566°F)

Heat Treatment

Soft annealing

Protect the steel and heat trough to 780°C (1440°F and hold for two hours. After this cool in furnace at 10°C per hour to 650°C (20°F per hour to 1200°F), then freely in air.

Hardening

For through hardening the following temperatures and times are recommended:
Pre-heating temperature: 600–700°C (1110–1290°F).
Austenitizing temperature: 840–880°C (1540–1620°F). There is a risk of grain growth at high austenitizing temperatures.

The tool should be protected against decarburization during hardening.

Quenching

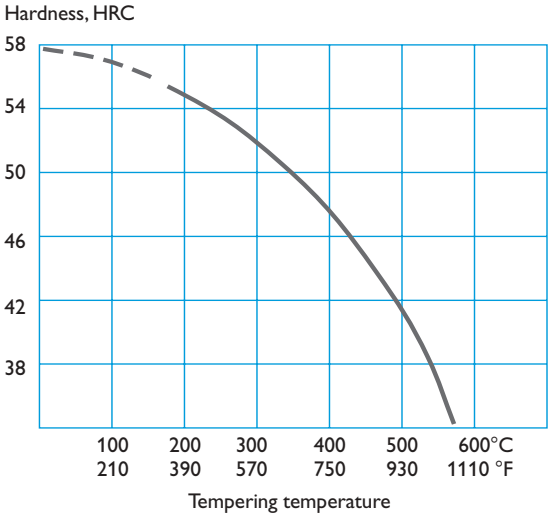
- High speed gas/circulating atmosphere
- Saltbath 200–550°C (390–1020°F)
- Fluidized bed 200–550°C (390–1020°F)

Note 1: Quenching should not be interrupted until the part has cooled down to 50–70°C (120–160°F).
Note 2 : Temper immediately after quenching.
Note 3: Quenching in oil is not recommended.

Tempering

The tempering temperature for the required hardness may be determined by means of the tempering graph. Temper twice. Lowest temperature: 200°C (390°F). Holding time at temperature: min. 2 hours.

TEMPERING GRAPH –
SURFACE HARDNESES AFTER TEMPERING



Prehardening

The prehardening treatment consist of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 15°C per minute (30°F per minute) or more down to 50–70°C (120–160°F).
3. Temper two times at 650°C (1200°F), hardness level ~270 HB.

Normalizing

If the size of the tool makes it impossible to perform a proper prehardening sequence or if the risk for hardening cracks is very high, normalizing is an alternative treatment in order to refine the as-cast microstructure.

The normalizing treatment consist of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 300°C per hour (570°F per hour) down to 50–70°C (120–160°F).
3. Tempering in the temperature range 650–700°C (1200–1290°F) in order to fine tune the hardness.

Welding recommendations

Preheating

200–250°C (390–480°F)

Minor repairs on edges can be made at room temperature with the TIG-method providing caution is taken with the heat input.

FILLER MATERIAL

Consumables		Hardness as welded
TIG-welding	MMA-welding	
UTP A73G2 UTP ADUR 600	UTP 73G2 UTP A67S	53–56 HRC 55–58 HRC

For large repairs weld the initial layers with a soft filler material of the austenitic stainless type AWS E312 or AWS ER312.

POST TREATMENT

Welding in the soft annealed condition – soft anneal afterwards.

Welding in the hardened, prehardened or normalized conditions – temper at 10–20°C (20–40°F) below the last used tempering temperature. The holding time is two hours.

The Granshot granulation process.

Uddeholm Carmo Granshot

General

The chemical composition of Uddeholm Carmo Granshot corresponds to the wrought cold work tool steel Uddeholm Carmo.

Uddeholm Carmo is developed together with the automotive industry with the aim to become an universal tool steel grade for car body dies. The cast steel can be used in tools and dies for blanking and forming of soft and semi hard sheet materials (≤600 Mpa tensile strength) for outer panel or structural car body parts. It is possible to get a tool surface hardness of 58 ±2 HRC by flame-/induction-/laser-hardening without any water quenching. It's also easy to perform repair welding without need of preheating. Weld rods with the same chemical composition as the base material are available in order to further facilitate the tool maintenance process.

Liquidus temperature: 1468°C (2674°F)
Solidus temperature: 1379°C (2514°F)

Heat Treatment

Soft annealing

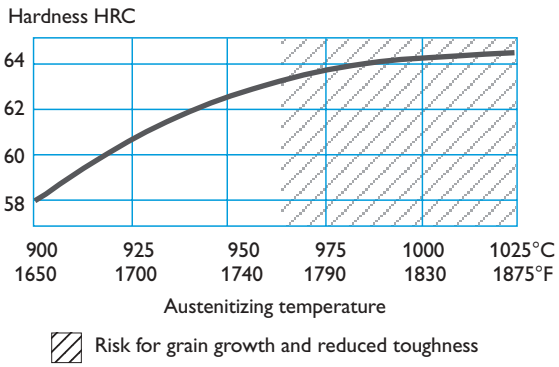
Protect the steel and heat trough to 860°C (1580°F) and hold for two hours. After this cool in the furnace at 20°C per hour to 770°C (40°F per hour to 1420°F), then 10°C per hour to 650°C (20°F per hour to 1200°F), then freely in air.

Hardening

For through hardening the following temperatures and times are recommended:
Pre-heating temperature: 600–700°C (1110-1290°F).
Austenitizing temperature: 950–970°C (1740–1780°F), normally 960°C (1760°F).
Holding time: 30–45 minutes.

The tool should be protected against decarburization during hardening.

HARDNESS AS A FUNCTION OF AUSTENITIZING TEMPERATURE



Quenching

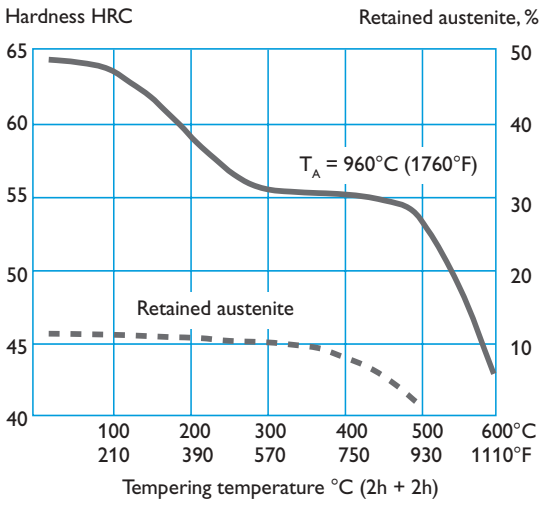
- High speed gas/circulating atmosphere
- Saltbath 200–550°C (390–1020°F)
- Fluidized bed 200–550°C (390–1020°F)

Note 1: Quenching should not be interrupted until the part has cooled down to 50–70°C (120–160°F).
Note 2 : Temper immediately after quenching.
Note 3: Quenching in oil is not recommended.

Tempering

The tempering temperature for the required hardness may be determined by means of the tempering graph. Temper twice. Lowest temperature: 200°C (390°F). Holding time at temperature: min. 2 hours.

TEMPERING GRAPH – SURFACE HARDNESS AFTER TEMPERING



Prehardening

The prehardening treatment consist of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 15°C per minute (30°F per minute) or more down to 50–70°C (120–160°F).
3. Temper two times at 685°C (1265°F), hardness level ~270 HB.

Normalizing

If the size of the tool makes it impossible to perform a proper prehardening sequence or if the risk for hardening cracks is very high, normalizing is an alternative treatment in order to refine the as-cast microstructure.

The normalizing treatment consists of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 300°C per hour (570°F per hour) down to 50–70°C (120–160°F).
3. Tempering in the temperature range 650–700°C (1200–1290°F) in order to fine tune the hardness.

Welding recommendations

Preheating

200–250°C (390–480°F).
Minor repairs on edges can be made at room temperature with the TIG-method providing caution is taken with the heat input.

FILLER MATERIAL

Consumables		Hardness
TIG-welding	MMA-welding	as welded
CALMAX/CARMO TIG WELD	CALMAX/ CARMO WELD	58–61 HRC
UTP A73G2	UTP 73G2	53–56 HRC
UTP ADUR 600	UTP A67S	55–58 HRC

For large repairs weld the initial layers with a soft filler material of the austenitic stainless type AWS E312 or AWS ER312.

POST TREATMENT

Welding in the soft annealed condition – soft anneal afterwards.

Welding in the hardened, prehardened or normalized conditions – temper at 10–20°C (20–40°F) below the last used tempering temperature. The holding time is two hours.

Machined Uddeholm Carmo Granshot ready for laser hardening.

Uddeholm Caldie Granshot

The chemical composition of Uddeholm Caldie Granshot corresponds to the wrought cold work tool steel Uddeholm Caldie. The basic idea behind Uddeholm Caldie is to have a tool steel to cope with new and challenging work materials such as AHSS (Advanced High Strength Steel). The steel can be used in tools and dies for blanking and forming AHSS and other demanding materials requiring high compressive strength and where surface coatings are necessary. It is possible to get a tool hardness of 61 ±2 HRC by flame-/ induction-/ laser-hardening, without having to water quench. It's also easy to perform repair welding without need of preheating. Weld rods with the same chemical composition as the base material are available in order to further facilitate the tool maintenance process.

Liquidus temperature: 1453°C (2647°F)
Solidus temperature: 1347°C (2457°F)

Heat Treatment

Soft annealing

Protect the steel and heat trough to 820°C (1510°F) and hold for two hours. After this cool in the furnace at 10°C per hour to 650°C (20°F per hour to 1200°F), then freely in air.

Hardening

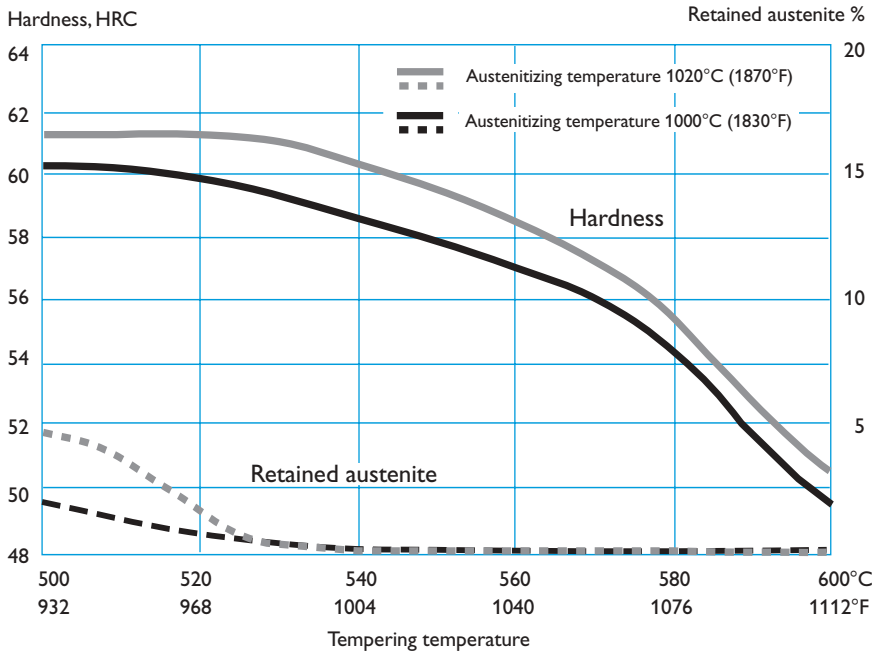
For through hardening the following temperatures and times are recommended:
Pre-heating temperature: 600–650°C (1110–1200°F). In case of larger dimensions a third preheating step at 930°C (1700°F) is recommended.
Austenitizing temperature: 1000–1025°C (1830–1875°F), normally 1020°C (1870°F), in case of bigger dimensions 1000°C (1830°F). Holding time: 30 min.

The tool should be protected against decarburization during hardening.

Tempering

The tempering temperature for the required hardness may be determined by means of the tempering graph. Temper twice. Lowest temperature: 525°C (980°F). Holding time at temperature: min. 2 hours.

TEMPERING GRAPH



Quenching

- High speed gas/circulating atmosphere
- Vacuum furnace (high speed gas with sufficient overpressure)
- Martempering bath at 500–550°C (930–1020°F)
- Martempering bath at 200–350°C (390–660°F)

Note 1: Quenching should not be interrupted until the part has cooled down to 50–70°C (120–160°F).
Note 2 : Temper immediately after quenching.

Prehardening

The prehardening treatment consist of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 15°C per minute (60°F per minute) or more down to 50–70°C (120–160°F).
3. Temper two times at 750°C (1380°F), hardness level ~270 HB.

Normalizing

If the size of the tool makes it impossible to perform a proper prehardening sequence or if the risk for hardening cracks is very high, normalizing is an alternative treatment in order to refine the as-cast microstructure.

The normalizing treatment consist of three steps.

1. Austenitizing at 950°C (1740°F), holding time 30 minutes.
2. Quenching with a cooling speed around 300°C per hour (570°F per hour) down to 50–70°C (120–160°F).
3. Tempering in the temperature range 650–700°C (1200–1290°F) in order to fine tune the hardness.

Welding recommendations

Preheating

200–250°C (390–480°F).
Minor repairs on edges can be made at room temperature with the TIG-method providing caution is taken with the heat input.

FILLERMATERIAL

Consumables		Hardness
TIG-welding	MMA-welding	as welded
CALDIE TIG WELD	CALDIEWELD	58–62 HRC
UTP A73G2	UTP 73G2	53–56 HRC
UTP ADUR 600	UTP A67S	55–58 HRC
UTP A696	UTP A69	60–64 HRC

For large repairs weld the initial layers with a soft filler material of the austenitic stainless type AWS E312 or AWS ER312.

POST TREATMENT

Welding in the soft annealed condition – soft anneal afterwards.

Welding in the hardened, prehardened or normalized conditions – temper at 10–20°C (20–40°F) below the last used tempering temperature. The holding time is two hours.

Uddeholm Sverker 21 Granshot

General

The chemical composition of Uddeholm Sverker 21 Granshot corresponds to the wrought cold work tool steel Uddeholm Sverker 21. This type of tool steel is the most common grade for cold work tooling and Uddeholm Sverker 21 fulfils the AISI D2 specification and is very close to the W.-Nr. 1.2379 specification. The cast steel can be used in tools and dies for forming of soft and medium hard sheet materials for outer panel or structural car body parts with high demands on wear resistance and compressive strength. The high carbon and alloy content of this grade limits its use for large or complex shaped tooling.

Liquidus temperature: 1398°C (2548°F)
Solidus temperature: 1231°C (2248°F)

Heat Treatment

Soft annealing

Protect the steel and heat trough to 850°C (1560°F) and hold for two hours. After this cool in the furnace at 10°C per hour to 650°C (20°F per hour to 1200°F), then freely in air.

Hardening

For through hardening the following temperatures and times are recommended:
Pre-heating temperature: 600–750°C (1110–1380°F).
Austenitizing temperature: 990–1050°C (1810–1920°F), normally 1020°C (1870°F). Holding time: 30 minutes.

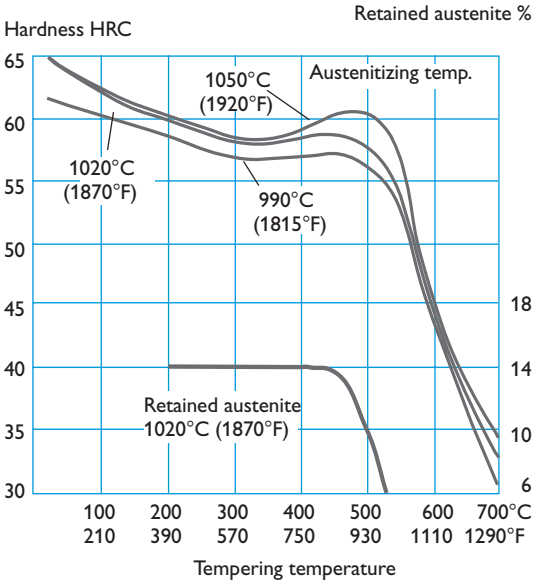
Quenching

- High speed gas/circulating atmosphere
- Vacuum furnace (high speed gas with sufficient overpressure)
- Martempering bath at 180–500°C (360–930°F), then in air

Tempering

The tempering temperature for the required hardness may be determined by means of the tempering graph. Temper twice. Lowest temperature: 180°C (360°F). Holding time at temperature: minimum 2 hours.

TEMPERING GRAPH



Prehardening

The prehardening treatment consist of three steps.

1. Austenitizing according to the hardening procedure.
2. Quenching with a cooling speed around 15°C per minute (30°F per minute) or more down to 50–70°C (120–160°F).
3. Temper two times at 750°C (1380°F), hardness level ~270 HB.

Automotive tool part cast via polystyrene model and Uddeholm Carmo Granshots, weight 750 kg.

Normalizing

If the size of the tool makes it impossible to perform a proper prehardening sequence or if the risk for hardening cracks is very high, normalizing is an alternative treatment in order to refine the as-cast microstructure.

The normalizing treatment consist of three steps.

1. Austenitizing at 1000°C (1830°F), holding time 30 minutes.
2. Quenching with a cooling speed around 300°C per hour (570°F per hour) down to 50–70°C (120–160°F).
3. Tempering in the temperature range 650–750°C (1200–1380°F) in order to fine tune the hardness.

Welding recommendations

Preheating

200–250°C (390–480°F).
Minor repairs on edges can be made at room temperature with the TIG-method providing caution is taken with the heat input.

FILLERMATERIAL

Consumables		Hardness
TIG-welding	MMA-welding	as welded
UTP A73G2 UTP ADUR 600 UTP A696	UTP 73G2 UTP A67S UTP A69	53–56 HRC 55–58 HRC 60–64 HRC

For large repairs weld the initial layers with a soft filler material of the austenitic stainless type AWS E312 or AWS ER312.

POST TREATMENT

Welding in the soft annealed condition – soft anneal afterwards.

Welding in the hardened, prehardened or normalized conditions – temper at 10–20°C (20–40°F) below the last used tempering temperature. The holding time is two hours.

Machining recommendations

In general the machining properties of a gran-shot casting are similar to wrought material of the same steel grade and hardness. Consequently, the machining recommendations for the corresponding wrought material steel grade can be used. However, please note the following information.

Surface property

A cast material does not have the same properties as that of a wrought or premachined material. When machining the surface of a cast material, the cutting parameters have to be adjusted accordingly as described below.

- The surface might have an oxide layer that will cause more abrasive wear on the cutting edge. This will typically cause notch wear on the cutting edge. If this is the major wear mechanism use a more wear resistant carbide grade with an edge geometry intended for rough machining. Reduce cutting speed and feed rate.
- The surface might have defects as cracks, cavities or pores that will cause more chipping of the cutting edge. If this is the major wear mechanism use a tougher carbide grade with an edge geometry intended for rough machining. Reduce cutting speed and feed rate.
- The surface might have a decarburized layer. This layer could cause more adhesive (sticky) wear, which could create a built up edge on the cutting tool. If this is the major wear mechanisms use a tougher carbide grade with somewhat sharper edge geometry. Increase cutting speed.

Alloy segregations

- A cast alloy has more segregations than wrought material. This can lead to a different machinability at different locations on the casting.

Network of excellence

UDDEHOLM is present on every continent. This ensures you high-quality Swedish tool steel and local support wherever you are. ASSAB is our wholly-owned subsidiary and exclusive sales channel, representing Uddeholm in various parts of the world. Together we secure our position as the world's leading supplier of tooling materials.

ASSAB
www.assab.com

UDDEHOLM
www.uddeholm.com

UDDEHOLM 0900901500 / TRYCKERI KNAPPEN 20090252

UDDEHOLM is the world's leading supplier of tooling materials. This is a position we have reached by improving our customers' everyday business. Long tradition combined with research and product development equips Uddeholm to solve any tooling problem that may arise. It is a challenging process, but the goal is clear – to be your number one partner and tool steel provider.

Our presence on every continent guarantees you the same high quality wherever you are. ASSAB is our wholly-owned subsidiary and exclusive sales channel, representing Uddeholm in various parts of the world. Together we secure our position as the world's leading supplier of tooling materials. We act worldwide, so there is always an Uddeholm or ASSAB representative close at hand to give local advice and support. For us it is all a matter of trust – in long-term partnerships as well as in developing new products. Trust is something you earn, every day.

For more information, please visit www.uddeholm.com, www.assab.com or your local website.

ASSAB

UDDEHOLM