Uddeholm Vanadis® 60 SuperClean

UDDEHOLM
a voestalpine company

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Uddeholm Vanadis 60 SuperClean is a high alloyed powder metallurgical high speed steel suitable for very demanding cold work applications and for cutting tools. The high carbon and alloying content, Co, Mo, W and V, gives an extremely high compressive strength, 69 HRC, combined with a very good abrasive wear resistance.

For cutting tool applications Uddeholm Vanadis 60 SuperClean offers a unique combination of high wear resistance, hot hardness and good toughness compared to all other HSS.

The P/M process ensures a good machinability and grindability together with a good dimensional stability during heat treatment.

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

Edition 10, 04.2019

CERTIFIED
ISO 9001 · OHSAS 18001
ISO 14001 · ISO 50001

APPLICATIONS

Uddeholm Vanadis 60 SuperClean is a high alloyed high performance PM high speed steel with an addition of cobalt.

Uddeholm Vanadis 60 SuperClean is particularly suitable for cold work tooling where highest wear resistance and highest compressive strength are required at the same time.

GENERAL

Uddeholm Vanadis 60 SuperClean is a W-Mo-V-Co alloyed PM high speed steel characterized by:

- Highest wear resistance
- Maximum compressive strength
- Good through hardening properties
- Good toughness
- Good dimensional stability on heat treatment
- Very good temper resistance.

Typical analysis %	C 2,3	Cr 4,2	Mo 7,0	W 6,5	V 6,5	Co 10,5
Standard specification	~W.-Nr. 1.3292					
Delivery condition	Soft annealed, max. 340 HB					
Colour code	Gold					

Uddeholm Vanadis 60 SuperClean is a super highly alloyed PM high speed steel with a high cobalt and vanadium content.

PROPERTIES

SPECIAL PROPERTIES

Uddeholm Vanadis 60 SuperClean could be hardened to a very high hardness and compressive strength. Uddeholm Vanadis 60 SuperClean has further the same good dimensional stability during heat treatment as the other Uddeholm Vanadis SuperClean grades. The toughness is despite the very high alloying content very good. The machinability is lower compared to lower alloyed HSS. The grindability of Uddeholm Vanadis 60 Super-Clean is equal or better than other high alloyed HSS, but somewhat lower than for Uddeholm Vanadis 30. SuperClean Uddeholm Vanadis 60 SuperClean has a very high hot hardness.

PHYSICAL PROPERTIES

Temperature		20°C (68°F)	400°C (750°F)	600°C (1112°F)
Density kg/m^3	(1)	7960	7860	7810
lbs/in^3	(1)	0,286	0,283	0,281
Modulus of elasticity MPa	(2)	250 000	222 000	200 000
ksi	(2)	36 x 10^3	32 x 10^3	20 x 10^3
Thermal conductivity W/m•°C	(2)	21	25	24
Btu in/(ft^2 h°F)	(2)	145	173	166
Specific heat J/kg °C	(2)	420	510	600
Btu/lb °F	(2)	0,10	0,12	0,14

(1) = for the soft annealed condition.
(2) = for the hardened and tempered condition.

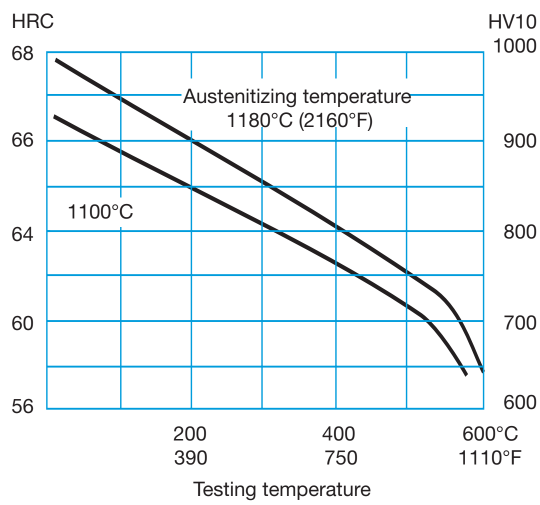
COEFFICIENT OF THERMAL EXPANSION

Hardened and tempered condition.

Temperature range		Coefficient	
°C	°F	°C from 20°C	°F from 68°F
20–100	68–212	9.6 x 10^{-6}	5.3 x 10^{-6}
20–200	68–392	9.8 x 10^{-6}	5.4 x 10^{-6}
20–300	68–572	10.1 x 10^{-6}	5.6 x 10^{-6}
20–400	68–752	10.4 x 10^{-6}	5.8 x 10^{-6}
20–500	68–932	10.7 x 10^{-6}	5.9 x 10^{-6}
20–550	68–1022	10.8 x 10^{-6}	6.0 x 10^{-6}

HIGH TEMPERATURE PROPERTIES

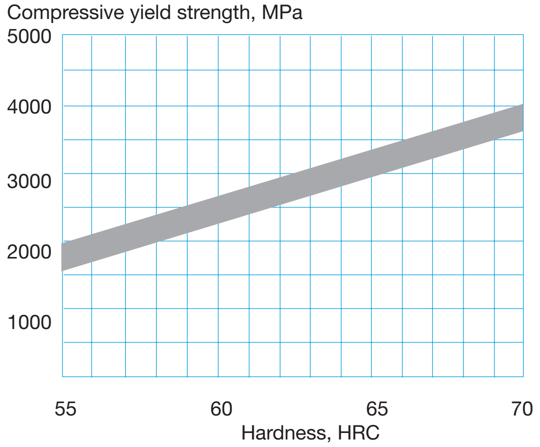
UDDEHOLM VANADIS 60 SUPERCLEAN HOT HARDNESS



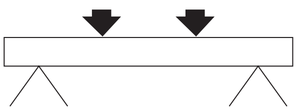
COMPRESSIVE YIELD STRENGTH

Specimen: Hourglass shaped with 10 mm (0.39 in.) Ø waist.

APPROXIMATE COMPRESSIVE YIELD STRENGTH VERSUS HARDNESS AT ROOM TEMPERATURE



BEND STRENGTH AND DEFLECTION



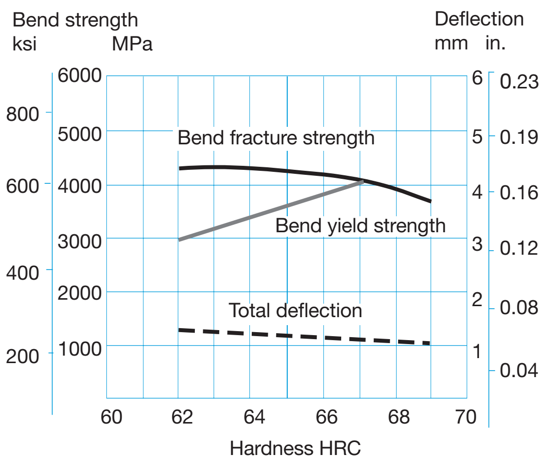
Four-point bend testing.

Specimen size: 5 mm (0,2 in.) Ø

Loading rate: 5 mm/min. (0,2 in./min.)

Austenitizing temperature: 1100–1210°C (2010–2210°F)

Tempering: 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



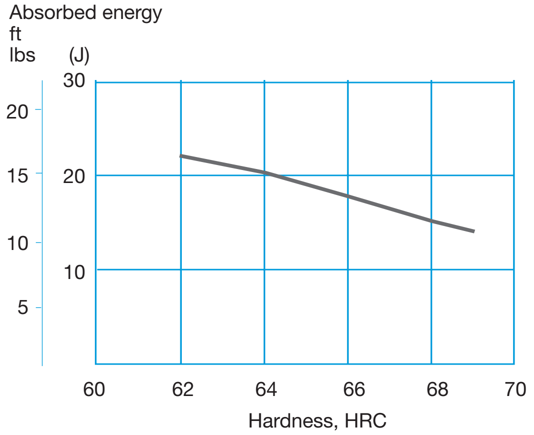
IMPACT STRENGTH

Specimen size: 7 x 10 x 55 mm (0.28 x 0.39 x 2.17 in.)

Specimen type: Unnotched

Tempering 3 x 1 h at 560°C (1040°F)

APPROXIMATE ROOM TEMPERATURE IMPACT STRENGTH AT DIFFERENT HARDNESS LEVELS



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 850–900°C (1560–1650°F). Then cool in the furnace at 10°C/h (20°F/h) to 700°C (1290°F), then freely in air.

STRESS RELIEVING

After rough machining the tool should be heated through to 600–700°C (1110–1290°F), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

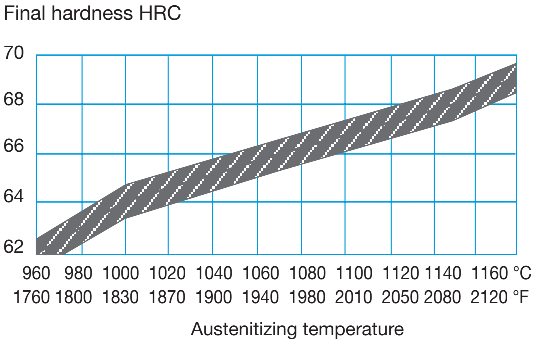
TEMPERING

Pre-heating temperature: 450–500°C (840–930°F) and 850–900°C (1560–1650°F).

Austenitizing temperature: 1100–1180°C, according to the desired final hardness, see diagram below.

The tool should be protected against decarburization and oxidation during hardening.

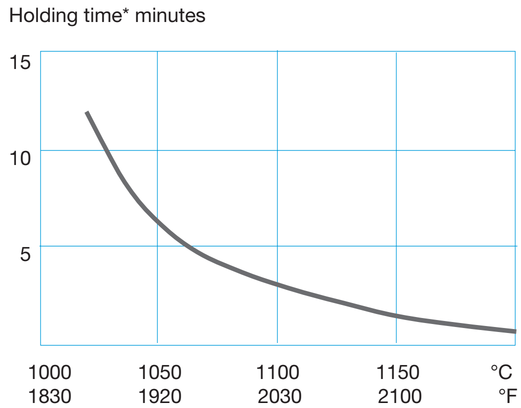
HARDNESS AFTER TEMPERING 3 TIMES FOR 1 HOUR AT 560°C (1040°F)



Hardness for different austenitizing temperatures after tempering 3 times for 1 hour at 560°C (1040°F) ±1 HRC.

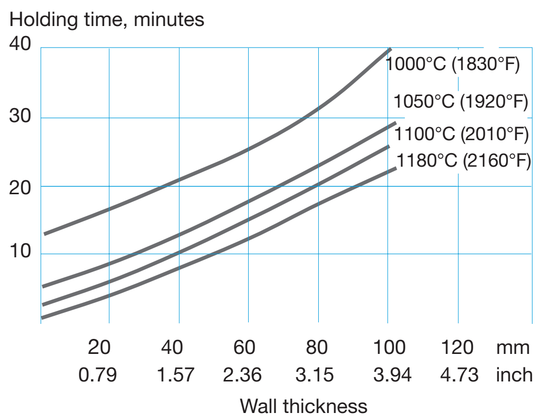
HRC	°C	°F
62	960	1760
64	1000	1832
66	1070	1960
68	1150	2102
69	1180	2156

RECOMMENDED HOLDING TIME



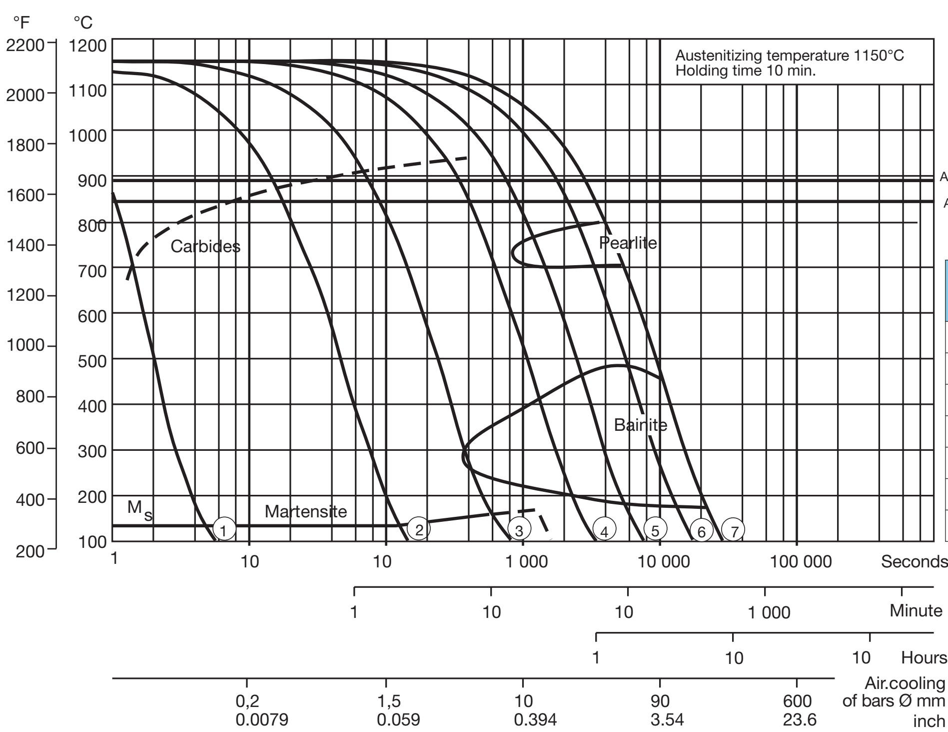
* Holding time = time at austenitizing temperature after the tool is fully heated through.

TOTAL SOAKING TIME IN A SALT BATH AFTER PRE-HEATING IN TWO STAGES AT 450°C (840°F) AND 850°C (1560°F)



CCT-GRAPH (CONTINUOUS COOLING)

Austenitizing temperature 1150°C (1920°F). Holding time 10 minutes.



Graph no.	Hardness HV10	T800-500 (sec)
1	946	1
2	946	28
3	946	140
4	772	630
5	620	1390
6	498	3205
7	450	5215

QUENCHING MEDIA

- Martempering bath at approx. 540°C (1004°F)
- Vacuum furnace with high speed gas at sufficient overpressure

Note. 1: Quenching should be continued until the temperature of the tool reaches approx. 25°C (77°F). The tool should then be tempered immediately.

Note. 2: In order to obtain a high toughness, the cooling speed in the core should be at least 10°C/sec. (20°F/sec.). This is valid for cooling from the austenitizing temperature down to approx. 540°C (1004°F). After temperature equalization between the surface and core, the cooling rate of approx. 5°C/ sec. (10°F/sec.) can be used. The above cooling cycle results in less distortion and residual stresses.

TEMPERING

For cold work applications tempering should always be carried out at 560°C (1040°F) irrespective of the austenitizing temperature. Temper three times for one hour at full temperature. The tool should be cooled to room temperature between the tempers. The retained austenite content will be less than 1% after this tempering cycle.

DIMENSIONAL CHANGES

Dimensional changes after hardening and tempering.

Heat treatment: austenitizing between 1050–1130°C (1920–2070°F) and tempering 3 x 1 h at 560°C (1040°F).

Specimen size: 80 x 80 x 80 mm (2.91 x 2.91 x 2.91 in.) and 100 x 100 x 25 mm (3.94 x 3.94 x 0.99 in.).

Dimensional changes: growth in length. width and thickness: +0.03% to +0.13%.

SUB-ZERO TREATMENT

Pieces requiring maximum dimensional stability can be sub-zero treated as follows:

Immediately after quenching the piece should be sub-zero treated followed by tempering. Uddeholm Vanadis 60 SuperClean is commonly sub-zero treated between -150 and -196°C (- and -°F), although occasionally -70 to -80°C (-95 and 110°F) are used due to constraints of the sub-zero medium and equipment available. A treatment time of 1–3 hours at temperature will give a hardness increase of 1–3 HRC.

Avoid intricate shapes as there is a risk of cracking.

CUTTING DATA RECOMMENDATIONS

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendations"

Condition: Soft annealed ~320 HB

TURNING

Cutting data parameters	Turning with carbide Rough turning	Turning with carbide Fine turning	Turning with high speed steel Fine turning
Cutting speed (v_c) m/min f.p.m.	60–90 200–300	90–110 300–365	6–10 20–33
Feed (f) mm/r i.p.r.	0.20–0.40 0.008–0.016	0.05–0.20 0.002–0.008	0.05–0.30 0.002–0.012
Depth of cut (a_p) mm inch	2–4 0.08–0.16	0.5–2 0.02–0.08	0.5–3 0.02–0.12
Carbide designation ISO	K20, P20 Coated carbide* or cermet*	K15, P10 Coated carbide* or cermet*	–

* Preferably a wear resistant CVD coated carbide grade

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Drill diameter inch	Cutting speed (v_c) m/min	Cutting speed (v_c) f.p.m.	Feed (f) mm/r	Feed (f) i.p.r.
–5	3/16	6–8*	20–26*	0.05–0.15	0.002–0.006
5–10	3/16–3/8	6–8*	20–26*	0.15–0.20	0.006–0.008
10–15	3/8–5/8	6–8*	20–26*	0.20–0.25	0.008–0.010
15–20	5/8–3/4	6–8*	20–26*	0.25–0.35	0.010–0.012

* For coated high speed steel drill v_c = 12–14 m/min

CARBIDE DRILL

Cutting data parameters	Type of drill: Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed (v_c) m/min f.p.m.	80–100 265–335	40–60 130–200	20–30 65–100
Feed (f) mm/r i.p.r.	0.08–0.14[2] 0.003–0.006[2]	0.10–0.15[3] 0.004–0.006[3]	0.10–0.20[4] 0.004–0.008[4]

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20–40 mm (0.8"–1.6")
[3] Feed rate for drill diameter 5–20 mm (0.2"–0.8")
[4] Feed rate for drill diameter 10–20 mm (0.4"–0.8")

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide Rough milling	Milling with carbide Fine milling
Cutting speed (v_c) m/min f.p.m.	40–60 130–200	60–80 200–265
Feed (f_z) mm/tooth inch/tooth	0.20–0.30 0.008–0.012	0.10–0.20 0.004–0.008
Depth of cut (a_p) mm inch	2–4 0.08–0.16	1–2 0.04–0.08
Carbide designation ISO	K20, P20 Coated carbide* carbide*	K15, P10 Coated or cermet*

* Preferably a wear resistant CVD coated carbide grade

END MILLING

Cutting data parameters	Type of mill: Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) m/min f.p.m.	30–40 100–130	40–60 130–200	10–14[1] 30–50[1]
Feed (f_z) mm/tooth inch/tooth	0.01–0.20[2] 0.0004–0.008[2]	0.06–0.20[2] 0.002–0.008[2]	0.01–0.30[2] 0.0004–0.012[2]
Carbide designation ISO	–	K15, P10–P20 Coated carbide[3] or cermet[3]	–

[1] A coated high speed steel end mill
[2] Depending on radial depth of cut and cutter diameter
[3] Preferably a wear resistant CVD coated carbide grade

GRINDING

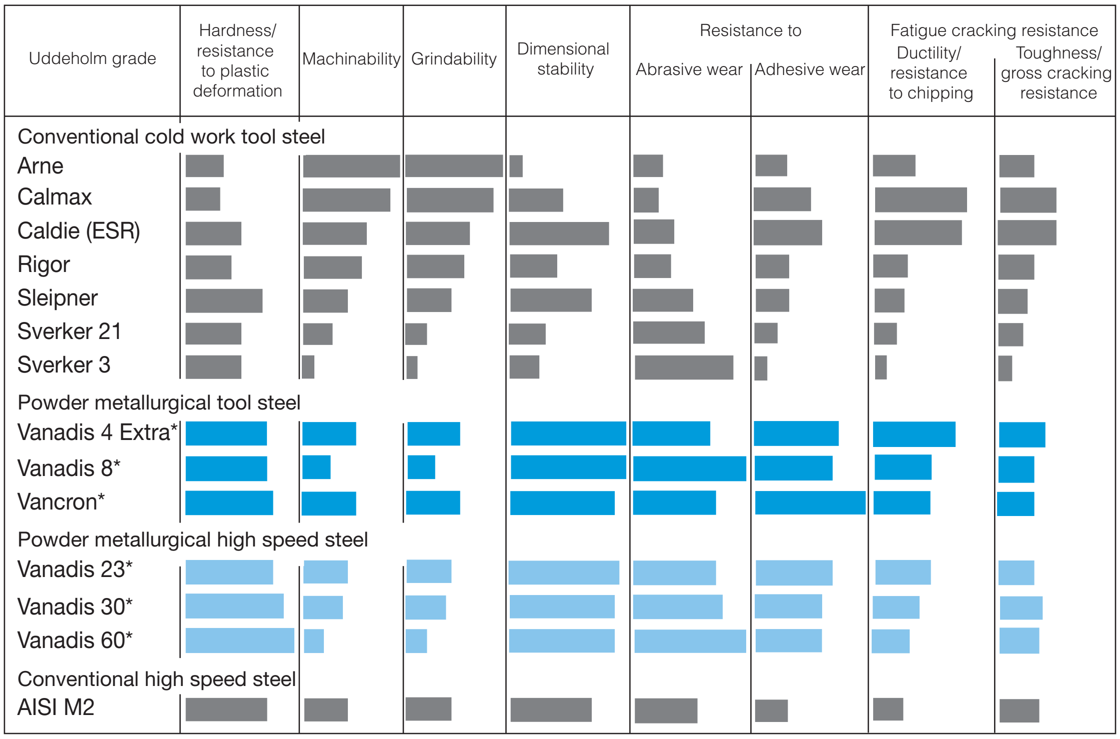
General grinding wheel recommendation is given below. More information can be found in the Uddeholm publication "Grinding of Tool Steel".

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B151 R50 B3[1] A 46 HV[2]
Face grinding (segments)	A 36 GV	B151 R50 B3[1] A 46 GV[2]
Cylindrical grinding	A 60 KV	B151 R50 B3[1] A 60 KV[2]
Internal grinding	A 60 JV	B151 R75 B3[1] A 60 IV[2]
Profile grinding	A 100 IV	B126 R100 B6[1] A 120 JV[2]

[1] If possible use CBN wheels for this application
[2] Preferably a wheel type containing sintered Al_2O_3 (seeded gel)

RELATIVE COMPARISON OF UDDEHOLM COLD WORK TOOL STEEL

MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS



* Uddeholm PM SuperClean tool steels

EDM

If EDM is performed in the hardened and tempered condition, finish with “fine-sparking”, i.e. low current, high frequency. For optimal performance the EDM’d surface should then be ground/polished and the tool retempered at approx. 535°C (995°F).

FURTHER INFORMATION

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

THE POWDER METALLURGY PROCESS

In the powder metallurgy process nitrogen gas is used to atomise the melted steel into small droplets, or grains. Each of these small grains solidifies quickly and there is little time for carbides to grow. These powder grains are then compacted to an ingot in a hot isostatic press (HIP) at high temperature and pressure. The ingot is then rolled or forged to steel bars by conventional methods.

The resulting structure is completely homogeneous steel with randomly distributed small carbides, harmless as sites for crack initiation but still protecting the tool from wear.

Large slag inclusions can take the role as sites for crack initiation instead. Therefore, the powder metallur-gical process has been further developed in stages to improve the cleanliness of the steel. Powder steel from Uddeholm is today of the third generation and is considered the cleanest powder metallurgy tool steel product on the market.

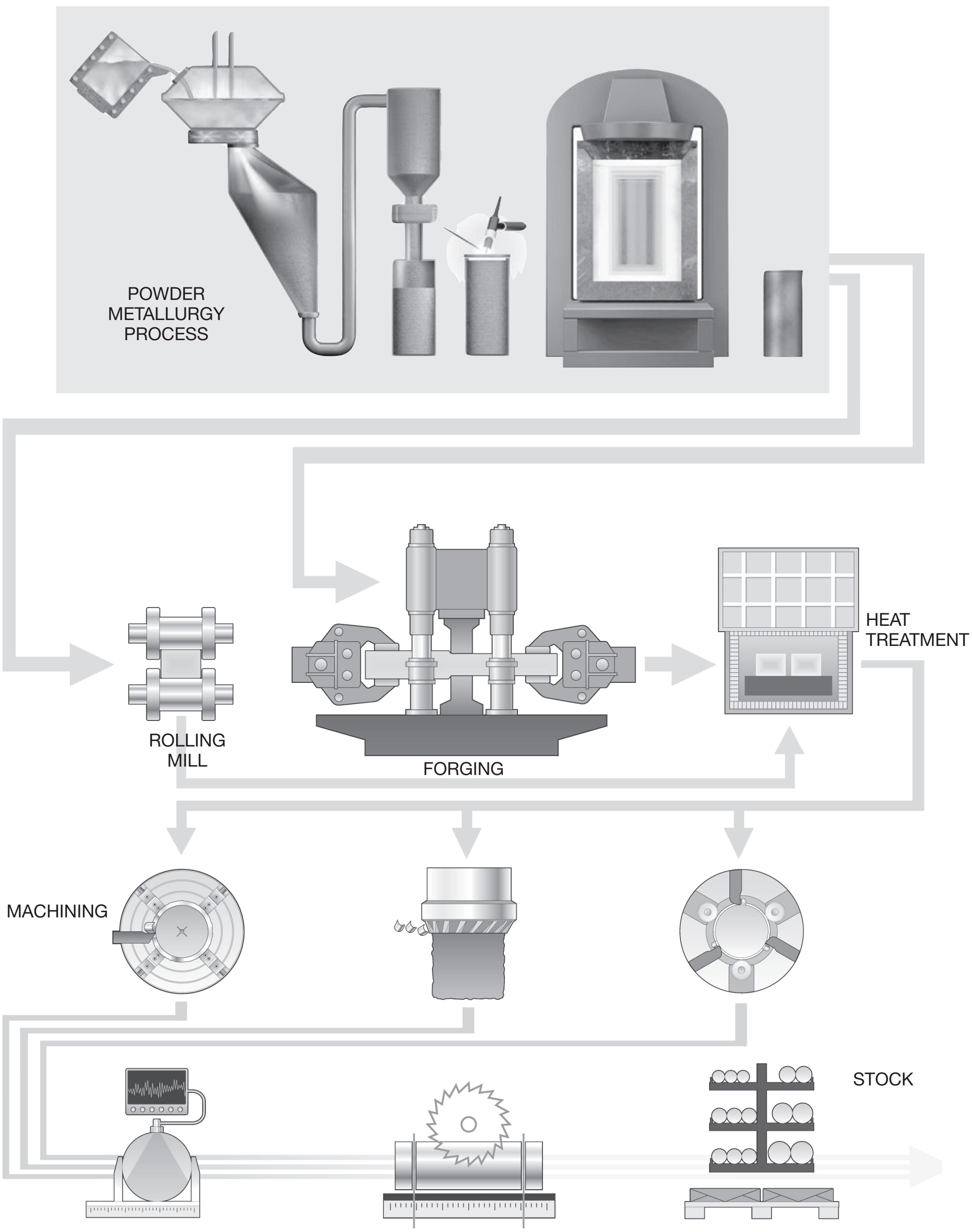
HEAT TREATMENT

Prior to delivery all of the different bar materials are subjected to a heat treatment operation, either as soft annealing or hardening and tempering. These operations provide 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.

To safeguard our quality and guarantee the integrity of the tool steel we perform both surface- and ultrasonic inspections on all bars. We then remove the bar ends and any defects found during the inspection.


POWDER
METALLURGY
PROCESS
ROLLING
MILL
FORGING
HEAT
TREATMENT
MACHINING
STOCK

Manufacturing solutions for generations to come

SHAPING THE WORLD®

We are shaping the world together with the global manufacturing industry. Uddeholm manufactures steel that shapes products used in our every day life. We do it sustainably, fair to people and the environment. Enabling us to continue shaping the world – today and for generations to come.

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