BÖHLER

PLASTIC
MOULD STEEL

PLASTIC MOULD STEEL

BÖHLER M238

BÖHLER M238
HIGH HARD

voestalpine BÖHLER Edelstahl GmbH & Co KG
www.voestalpine.com/bohler-edelstahl

voestalpine
ONE STEP AHEAD.

BEST PROPERTIES

THE CLASSIC.

BÖHLER M238 is a hardened and tempered, not corrosion resistant plastic mould steel. Because of the Ni-addition there is no hardness decrease in the center of large sizes (up to 600 mm / 23.62 inch). A special melting technology offers good machinability.

This material is also offered by BÖHLER in the **"High-Hard"-version**, with a significant better wear resistance and edge-stability for improved tool life.

Maximal offered sizes:
BÖHLER M238: 1250 x 610 mm (49.21 x 24.02 inch)
BÖHLER M238 HH: 1050 x 410 mm (41.34 x 16.14 inch)

BÖHLER M238 Hardened and tempered: 290 – 330 HB

BÖHLER M238 HIGH HARD Hardened and tempered: 355 – 395 HB

Field of applications

» Large moulds (over 600 mm / 23.62 inch) for plastic processing
» Mould carrier frames for the plastic moulds
» Components for general mechanical engineering and tool manufacture

Chemical composition (average %)

C	Si	Mn	Cr	Ni	Mo	N	Additions
0.38	0.30	1.50	2.00	1.10	0.20	–	–

DIN-standard: 1.2738 / 40CrMnNiMo8-6-4

CONDITION OF SUPPLY

Hardened and tempered to 290 – 330 HB or as product-version "High-Hard" with 355 – 395 HB. General, no heat treatment required. If heat treatment is carried out for special purposes, e.g. for obtaining an increase in strength, the following instructions should be observed.

ADVANTAGES

One steel grade for all requirements:

» BÖHLER M238: 290 – 330 HB, max. thickness up to 600 mm (23.62 inch)
» BÖHLER M238 HH: 355 – 395 HB, max. thickness up to 400 mm (15.75 inch)

The economic and technological advantages of BÖHLER M238 and BÖHLER M238 HH at a glance:

Higher quality, longer service life and increased safety

» Uniformly high strength at dimension up to 600 mm (23.62 inch) thickness (HH version up to 400 mm / 15.75 inch)
» Optimum mechanical properties
» High toughness

Higher economy in production and still higher tool quality

» Good machinabilty
» Good electrical discharge machining properties
» Good polishability, especially for the version "High-Hard"
» Good photoetching properties

PRODUCTIVITY INCREASE

» Improved machinability allowing higher cutting speed and faster feed. This means a higher number of moulds per unit of time on your machine tools.
» Good polishability, photoetching properties and discharge machining properties help to save machining time.
» High toughness increase the service times of the moulds, i. e. a higher number of plastic components can be produced per mould.

SAFETY

» Good electrical discharge machining properties reducing the risk of cracking during production.
» Absence of heat treatment eliminator the risk of material having to be rejected.
» Good surface finish of the plastic products thanks to optimum polishability and photoetching properties.
» Favourable chip shape involving high safety of mould production in CNC machining centres.
» Good toughness ensuring high cracking resistance of the moulds in service.

MORE EFFICIENT AND MORE SAFETY

COST REDUCTION BY:

» Improved machinability, shorter machining times, reduction of tool costs.
» Condition of supply is hardened and tempered (= operating condition), no heat treatment and cost-intensive subsequent machining operations.

Additional advantages of our hardened and tempered plastic mould steel BÖHLER M238:

» High through hardenability.
» Suited for all nitriding processes serving to improve wear resistance.
» Suited for hard chromium plating and for every type of galvanic surface treatment serving to optimise hardness and corrosion resistance.
» Suited for PVD coating; excellent adhesion conditions for the TiN-layer.
» For special applications, the material can be subjected to case hardening.

Additional advantages of BÖHLER M238 HH:

» Improved edge-stability and therefore reduction of edge-wear of mould-closing-surfaces
» Increased number of products of each mould due to increased wear resistance
» Improved and faster polishability of moulds

BEST USAGE PROPERTIES

HEAT TREATMENT

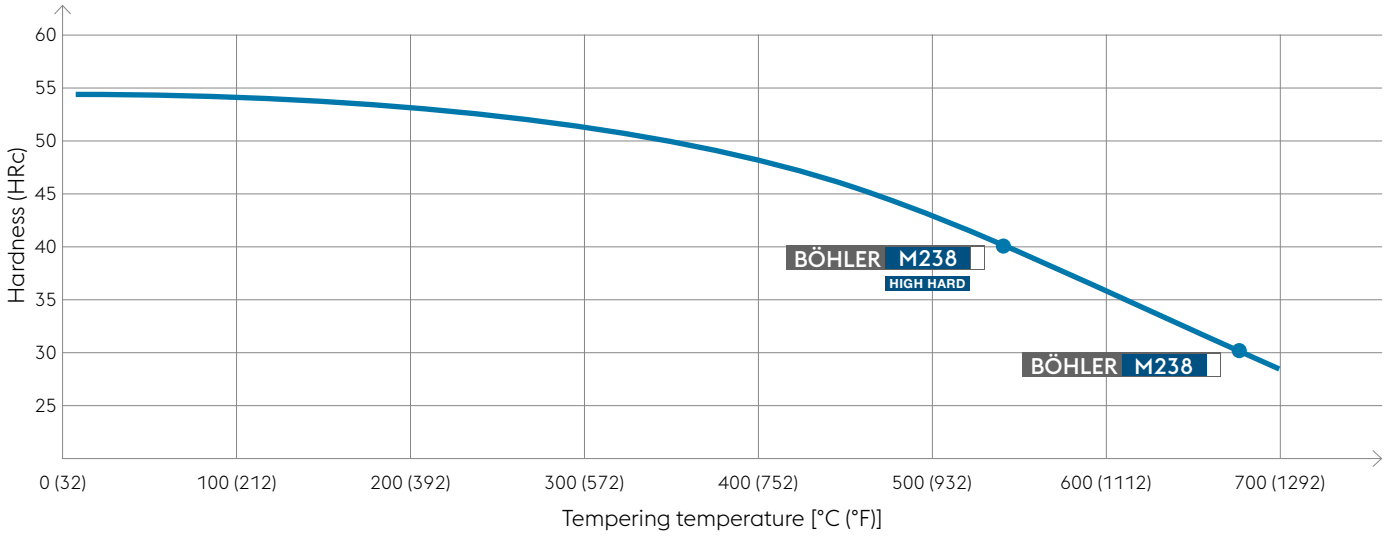
Stress relieving:
» BÖHLER M238: appr. 500 °C (932 °F)
» BÖHLER M238 HH: appr. 450 °C (842 °F)
In hardened and tempered condition approx. 30 to 50 °C (86 to 122 °F) below the tempering temperature / after through heating, hold at temperature in neutral atmosphere for 1 to 2 hours / slow cooling in furnance.

Hardening:
» 840 to 860 °C (1544 – 1580 °F) / oil,
After through soaking, hold for 15 – 30 minutes.
» Obtainable hardness: approx. 54 HRC

TEMPERING

» Slow heating to tempering temperature immediately after hardening
» Time in furnace 1 hour for each 20 mm (0.79 inch) of workpiece thickness, but at least 2 hours / cooling in air.
» We recommend the tempering twice.
» For information on the average hardness figures obtained after tempering please refer to the tempering chart.

Tempering chart



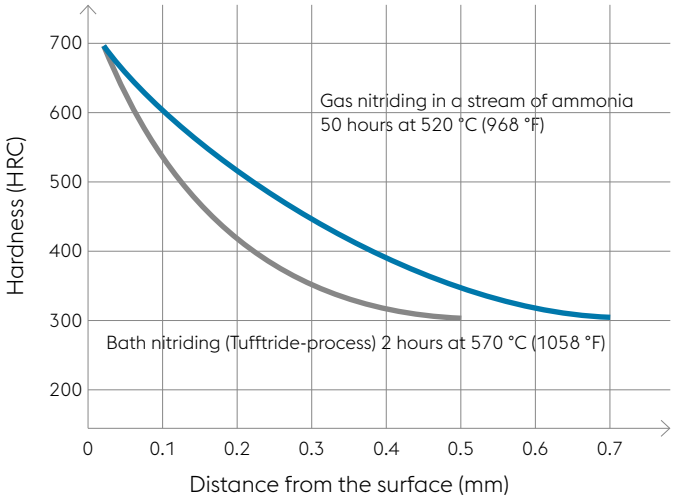
Hardening temperature: 850 °C (1562 °F)
Specimen size: square 50 mm (1.97 inch)

SURFACE TREATMENT

Nitriding

» All nitriding processes are applicable.
» Temperature for "High-Hard" condition only max. 480 °C (896 °F).

Nitriding for BÖHLER M238, standard hardness



Flame and induction hardening

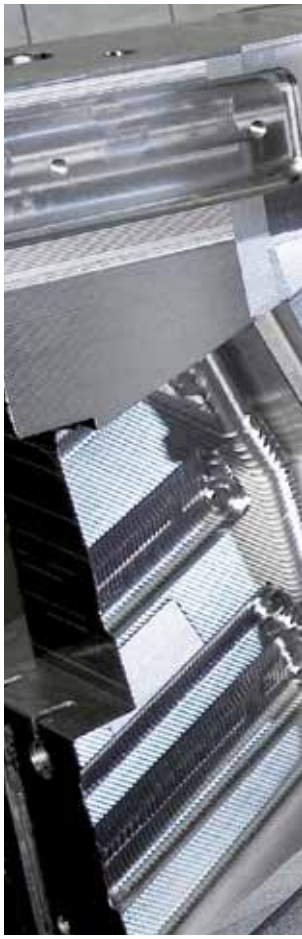
» Flame or induction hardening is possible.
» Obtainable hardness: approx. 50 HRC
» Tempering immediately after hardening is recommended.

Case hardening

» Case hardening can be employed for special applications.
» Carburisation: 880 to 980 °C (1616 – 1796 °F).
» Hardening: as indicated before.
» Tempering: average surface hardness after tempering
200 °C (392 °F) = 62 HRC
300 °C (572 °F) = 59 HRC
400 °C (752 °F) = 55 HRC

Physical properties

	20 68	100 212	200 392	300 572	400 752	500 932	°C °F
Specific heat capacity	465 0.110	491 0.117	525 0.125	557 0.133	595 0.142	649 0.155	J/kg.K Btu/lb.°F
Thermal expansion between 20 °C (68 °F) and ... °C	– –	11.88 6.60	12.44 6.91	13.00 7.22	13.45 7.47	13.85 7.69	10^{-6}m/m.K 10^{-6}in/in.°F
Density	7.81 0.282	7.78 0.281	7.76 0.280	7.73 0.279	7.69 0.278	7.66 0.277	kg/dm^3 lbs/in^3
Modulus of elasticity	212 30.75	207 30.02	201 29.15	194 28.14	186 26.97	176 25.53	10^3 MPa 10^3 ksi
Thermal conductivity	35.2 20.34	35.7 20.63	35.9 20.74	35.6 20.57	34.8 20.11	33.6 19.41	W/m.K Btu/ft h.°F

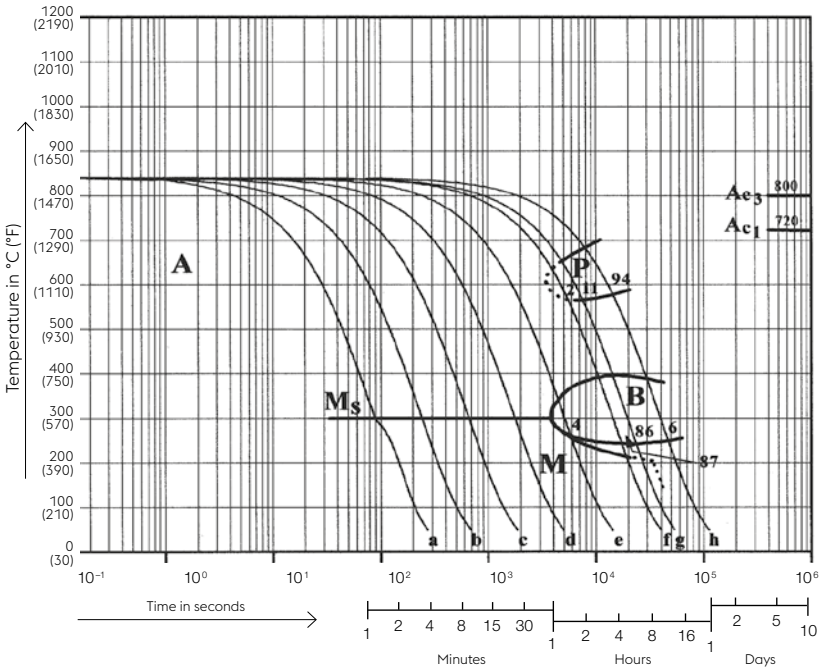


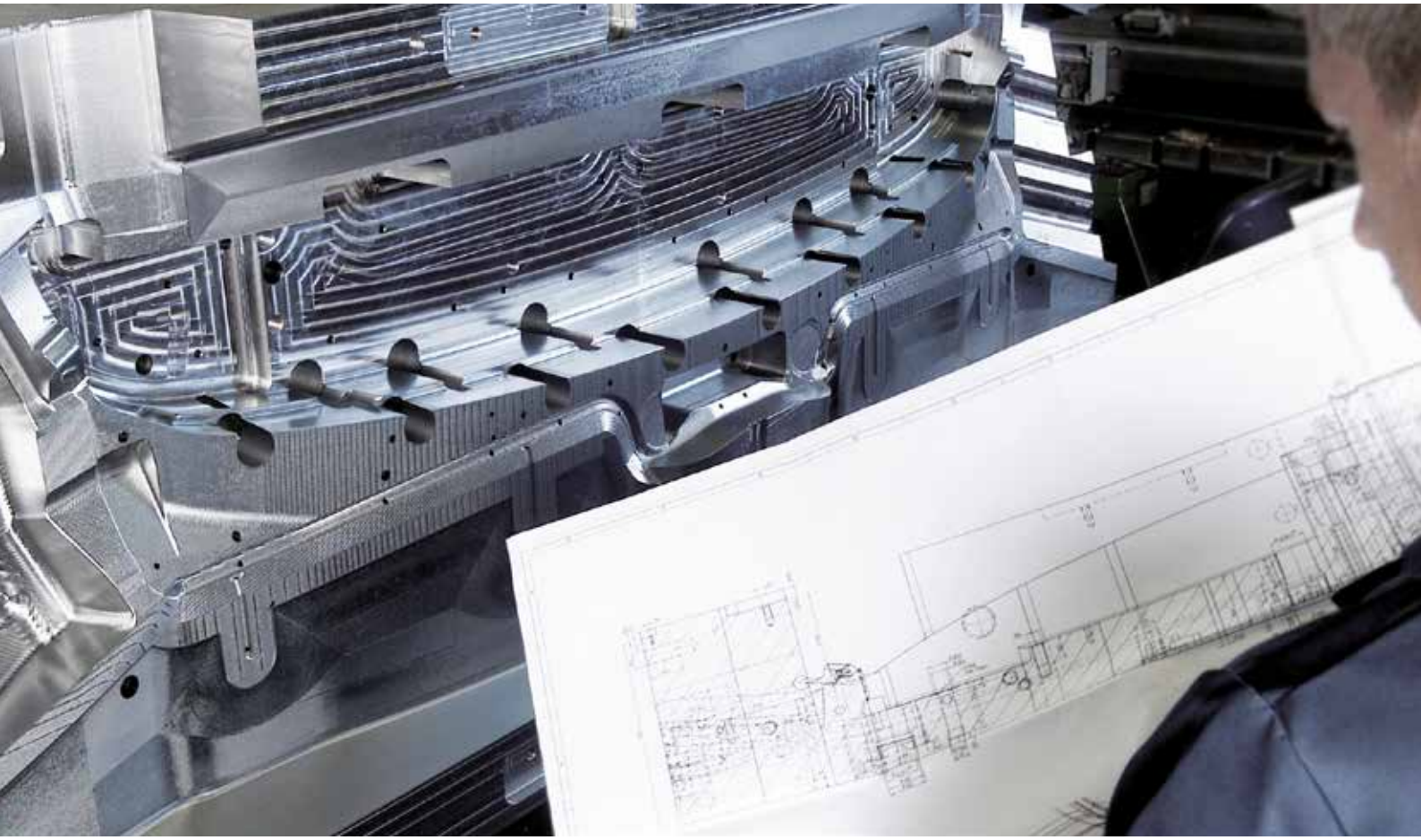
HEAT TREATMENT RECOMMENDATIONS

Continuous cooling CCT curves

Austenitizing temperature: 840 °C (1544 °F)
Holding time: 15 minutes

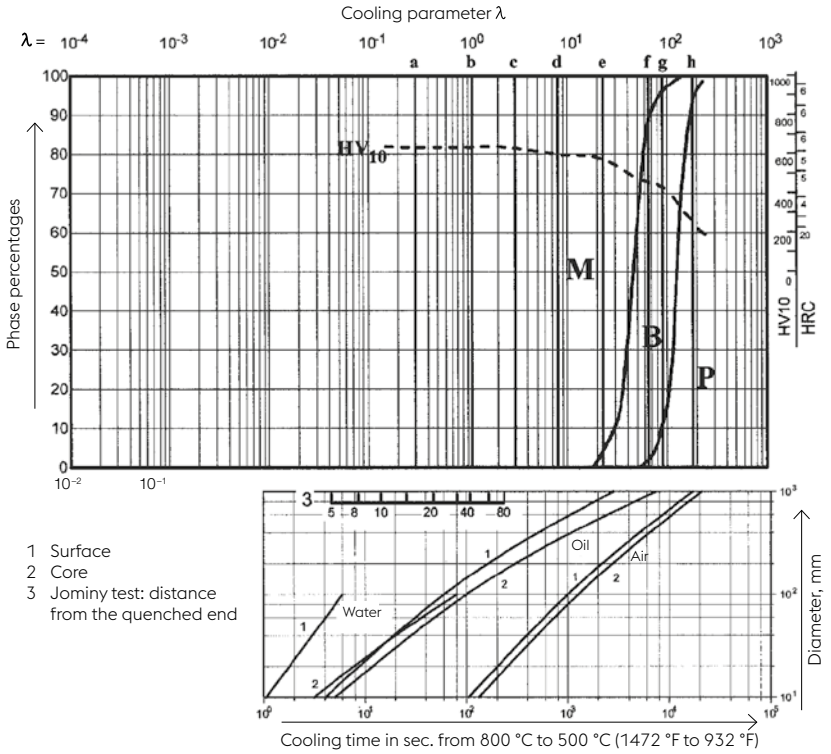
Sample	λ	HV_{10}
a	0.30	634
b	1.10	632
c	3.00	620
d	8.00	599
e	23.00	572
f	65.00	455
g	90.00	433
h	180.00	254





Quantitative phase diagram

A Austenite
B Bainite
M Martensite
P Perlite



1 Surface
2 Core
3 Jominy test: distance from the quenched end

WELDING

Minor machining defects can be remedied and cavity modifications carried out in the hardened and tempered condition approx. 1000 N/mm^2 (300 HB) under observance of the given guidelines. Buildups on large surfaces are possible only in the annealed condition and call for another hardening and tempering treatment.

In all cases we recommend manual electric arc welding by use of BÖHLER FOX CM2 Kb electrodes or TIG welding by use of BÖHLER CM2-IG welding wire. The deposit is machinable.

WELDING RECOMMENDATIONS

Welding guidelines:

- Nitrided and case hardening layers as well as surface cracks in the weld area to be completely ground out.
- The absence of cracks to be verified by dye penetrant testing; sharp edges and corners to be avoided in the weld area.
- bevel radii to be at least 3 mm (0.118 inch).
- prior to welding, the workpiece is to be preheated slowly and uniformly to 300 to 350 °C (572 – 662 °F), if possible in a preheating furnace.
- deep grooves resulting from crack removal to be filled by means of BÖHLER FOX DCMS Kb electrodes or BÖHLER DCMS-IG welding wire.
- buildup welding to be done with thin electrodes at low amperages and with low heat input depositing 2 – 3 cm (0.79 – 1.18 inch) long string beads, with slight weaving.
- Slight peening of each weld bead to reduce shrinkage stresses.
- Welding to be carried out without interruption under observance of the minimum preheating temperature of 300 °C (572 °F);
- After completion of the welding operations, the workpi ece is to be cooled slowly in the furnace or covered by thermoinsulating material; then it is to betempered at 550 to 600 °C (1022 – 1112 °F), "High-Hard" condition at 480 °C (896 °F).

For further information please ask for our "Welding in Tool Making" leaflet.

MACHINING RECOMMENDATIONS

Turning with sintered carbide

Depth of cut mm (inch)	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)	over 8 (.31)
Feed mm/rev. (inch/rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)	0.5 – 1.5 (.02 – .06)
BOEHLERIT-grade	SB10, SB20	SB10, SB20, EB10	SB30, EB20	SB30, SB40
ISO grade	P10, P20	P10, P20, M10	P30, M20	P30, P40
Cutting speed v_c (m/min) (f.p.m)				
Indexable inserts tool life: 15 min.	220 – 160 (740 – 525)	170 – 120 (560 – 390)	120 – 90 (390 – 295)	80 – 55 (260 – 180)
Brazed carbide tools tool life: 30 min.	160 – 120 (525 – 390)	145 – 95 (475 – 315)	100 – 70 (330 – 230)	80 – 45 (260 – 150)
Coated indexable inserts				
BOEHLERIT ROYAL 121	up to 220 (740)	up to 190 (625)	up to 140 (460)	up to 90 (295)
BOEHLERIT ROYAL 131	up to 150 (490)	up to 150 (490)	up to 110 (360)	up to 70 (230)
Tool angles for brazed carbide tools				
Rake angle	6° – 12°	6° – 12°	6° – 12°	
Clearance angle	6° – 8°	6° – 8°	6° – 8°	
Inclination angle	0°	-4°	-4°	

Turning with high speed steel

Depth of cut mm (inch)	0.5 (.02)	3 (.12)	6 (.24)
Feed mm/rev. (inch/rev.)	0.1 (.004)	0.4 (.016)	0.8 (.032)
HSS-grade BÖHLER/DIN	S700 / DIN S10-4-3-10		
Cutting speed v_c (m/min) (f.p.m)			
Tool life: 60 min.	30 – 20 (100 – 65)	25 – 15 (80 – 50)	28 – 10 (90 – 35)
Rake angle	14°	14°	14°
Clearance angle	8°	8°	8°
Inclination angle	-4°	-4°	-4°

Milling with inserted tooth cutter

Feed mm/tooth (inch/tooth)	up to 0.2 (.008)
Cutting speed v_c (m/min) (f.p.m)	
BOEHLERIT SBF/ISO P25	140 – 70 (460 – 230)
BOEHLERIT SB40/ISO P40	90 – 60 (295 – 195)
BOEHLERIT ROYAL 131/ISO P35	100 – 70 (330 – 230)

Drilling with sintered carbide

Drill diameter mm (inch)	3 – 8	8 – 20	20 – 40
Feed mm/rev. (inch/rev.)	0.02 – 0.05	0.05 – 0.12	0.12 – 0.18
BOEHLERIT/ISO grade	HB10 / K10		
Cutting speed v_c (m/min) (f.p.m)	55 – 40 (180 – 130)	55 – 40 (180 – 130)	55 – 40 (180 – 130)
Point angle	115° – 120°	115° – 120°	115° – 120°
Freiwinkel	5°	5°	5°

Condition H & T 290 – 330 HB
Figures are guidelines only

voestalpine BÖHLER Edelstahl GmbH & Co KG
Mariazeller Straße 25
8605 Kapfenberg, Austria
T. +43/50304/20-6046
F. +43/50304/60-7563
E. info@bohler-edelstahl.at
www.voestalpine.com/bohler-edelstahl

voestalpine
ONE STEP AHEAD.

M238EN – 04.2019