

Steel

# perform<sup>®</sup>

Product information for high-strength thermomechanically hot-rolled strip and sheet



thyssenkrupp

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## Brief profile

perform<sup>®</sup> from thyssenkrupp is a low-carbon, microalloyed steel which is thermomechanically rolled. It is available as uncoated wide hot strip and cut-to-length sheet in the sizes listed in the section "Available dimensions". Orders can also be placed for microalloyed steels to DIN EN 10149-2.

perform<sup>®</sup> steels are characterized by a low carbon content, microalloying with niobium, vanadium and/or titanium and very low levels of tramp elements such as sulfur. The combination of microalloying and the special thermomechanical rolling process gives perform<sup>®</sup> steels outstanding cold formability and weldability. The extremely fine-grain microstructure additionally results in very good toughness levels with a low risk of cold cracking.

thyssenkrupp supplies perform<sup>®</sup> steels in various yield strengths from 300 to 700 MPa. A Lasercut variant is also available in the grades perform<sup>®</sup> 315 / 355 / 380 / 420 LC as cut-to-length sheet in thicknesses up to 20 mm.

perform<sup>®</sup> steels are primarily used for complex part geometries such as vehicle frames, axle structures, BIW beams and pillars, special profiles and shaped parts in car and commercial vehicle construction.

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## Available steel grades

Steel grade	Reference grade DIN EN 10149-2
perform® 300 <sup>1)</sup>	–
perform® 315	S315MC
perform® 340 <sup>1)</sup>	–
perform® 355	S355MC
perform® 380 <sup>1)</sup>	–
perform® 420	S420MC
perform® 460	S460MC
perform® 500	S500MC
perform® 550	S550MC
perform® 600	S600MC
perform® 650	S650MC
perform® 700	S700MC

<sup>1)</sup>Based on DIN EN 10149-2.

## Comments

By arrangement the grades perform® 300 to 650 can be supplied with Class 1 galvanizing properties.

Wide hot strip can be ordered in pickled or non-pickled condition and with mill or trimmed edges. Pickled material is dry available or with light, normal or heavily oiling.

Cut-to-length sheet is supplied with a maximum flatness tolerance in accordance with DIN EN 10029, table 4. Lower flatness tolerances in accordance with DIN EN 10029, table 5 can be agreed separately when ordering.

By special arrangement, cut-to-length sheet can be supplied in pickled and oiled condition or in blasted and primed condition.

## Technical characteristics

### Mechanical properties

Test direction parallel to rolling direction	Yield strength	Tensile strength	Elongation		Notch impact energy <sup>2)</sup>	
	R <sub>eH</sub> [MPa] min.	R <sub>m</sub> [MPa]	A [%] min.	A <sub>80</sub> [%] min.	KV [J] at a test temperature of -20 °C	KV [J] at a test temperature of -40 °C
<b>Steel grade</b>						
perform® 300	300	380–500	25	21		27
perform® 315	315	390–510	24	20		27
perform® 340	340	420–540	23	19		27
perform® 355	355	430–550	23	19		27
perform® 380	380	450–590	21	17		27 <sup>3)</sup>
perform® 420	420	480–620	19	16	40	27 <sup>3)</sup>
perform® 460	460	520–670	17	14		27 <sup>3)</sup>
perform® 500	500	550–700	14	12		27 <sup>3)</sup>
perform® 550	550	600–760	14	12		4)
perform® 600	600	650–820	13	11		4)
perform® 650	650 <sup>1)</sup>	700–880	12	10		4)
perform® 700	700 <sup>1)</sup>	750–950	12	10		4)

<sup>1)</sup> For thicknesses > 8 mm yield strengths may be 20 MPa lower.

<sup>2)</sup> The notch impact energy is optional. The test temperature, -20 °C or -40 °C, has to be agreed when ordering.

<sup>3)</sup> For thicknesses > 12 mm on request.

<sup>4)</sup> Notch impact energy at a test temperature of -40 °C on request.

### Chemical composition

Mass fractions in ladle analysis	C [%] max.	Si [%] max.	Mn [%] max.	P [%] max.	S [%] <sup>1)</sup> max.	Nb [%] <sup>2)</sup> max.	V [%] <sup>2)</sup> max.	Ti [%] <sup>2)</sup> max.	Mo [%] max.	B [%] max.
<b>Steel grade</b>										
perform® 300	0.10	0.50	1.30	0.025	0.010	0.09	0.20	0.15	–	–
perform® 315	0.10	0.50	1.30	0.025	0.010	0.09	0.20	0.15	–	–
perform® 340	0.10	0.50	1.50	0.025	0.010	0.09	0.20	0.15	–	–
perform® 355	0.10	0.50	1.50	0.025	0.010	0.09	0.20	0.15	–	–
perform® 380	0.10	0.50	1.50	0.025	0.010	0.09	0.20	0.15	–	–
perform® 420	0.10	0.50	1.60	0.025	0.010	0.09	0.20	0.15	–	–
perform® 460	0.10	0.50	1.60	0.025	0.010	0.09	0.20	0.15	–	–
perform® 500	0.10	0.50	1.70	0.025	0.006	0.09	0.20	0.15	–	–
perform® 550	0.10	0.50	1.80	0.025	0.006	0.09	0.20	0.15	–	–
perform® 600	0.10	0.50	1.90	0.025	0.006	0.09	0.20	0.22	0.50	0.005
perform® 650	0.10	0.60	2.00	0.025	0.006	0.09	0.20	0.22	0.50	0.005
perform® 700	0.10	0.60	2.10	0.025	0.006	0.09	0.20	0.22	0.50	0.005

<sup>1)</sup> A sulfur content of max. 0.006% can be agreed when ordering.

<sup>2)</sup> The sum of the alloying components Nb, V and Ti must not exceed 0.22%.

## Information on use and processing

### Forming

Microalloyed steels are particularly suitable for structural and crash-relevant parts, e.g. beams. The choice of grade for a particular strength level should take into account the anticipated forming loads so that individual advantages can be optimally exploited and the steels can also be used for difficult forming operations.

The typical r- and n-values for microalloyed steels do not make them suitable for a particular kind of forming operation. They are equally suitable for stretch-forming and deep-drawing.

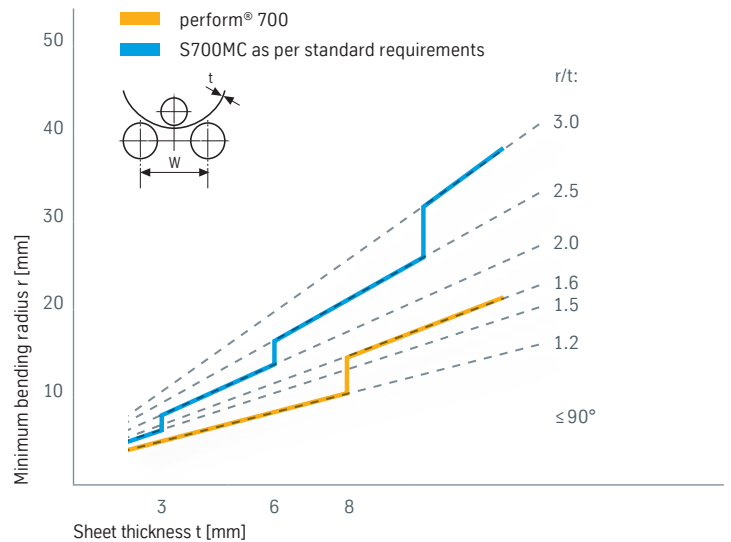
### Bending and press braking

With their particularly fine-grain microstructure and high cleanliness levels, perform® steels offer optimum forming behavior. They are also suitable for multi-stage forming processes. The drawing limit ratios differ very little from those of mild steels.

The predominant forming technique for cold forming steels is press brake bending. In most cases, bending with a defined inside radius in a die is limited by the rigid design of the die. The higher the strength of the steel, the greater the minimum press brake bending radius.

Graphic 1 shows the press brake bending radii for perform® 700 compared with grade S700MC as per standard requirements independent of direction.

Graphic 1: Press brake bending radii



perform® 700 is significantly better for press brake bending compared to the comparative grade according to DIN EN 10149-2.

### Minimum bending radii during cold forming

Recommended smallest bend radius for nominal thicknesses t in [mm]<sup>1)</sup>

t ≤ 3    3 < t ≤ 6    6 < t ≤ 8    8 < t ≤ 10    t > 10

#### Thermo-mechanically rolled steel for cold forming

##### Steel grade

perform® 700	1.2 t	1.2 t	1.2 t	1.6 t	1.6 t
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##### Reference grade DIN EN 10149-2

S700MC	1.5 t	2.0 t	2.5 t	2.5 t	3.0 t
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<sup>1)</sup> Values for bending angles ≤ 90°.

## Shearing, blanking, machining

perform® steels can be sheared and blanked without difficulty. In general the quality of the cut edges and consequently the cutting process are of great importance. Defect-free cut edges are essential to achieve the stated inside bending radii.

To achieve smooth material flow, grinding the cut edges in the bending zone and measures such as lubrication have proven effective.

The behavior of perform® steels during drilling, turning and milling is similar to that of conventional cold forming steels. Normal tools can be used for high-strength grades provided the cutting parameters are adapted accordingly.

## Thermal cutting

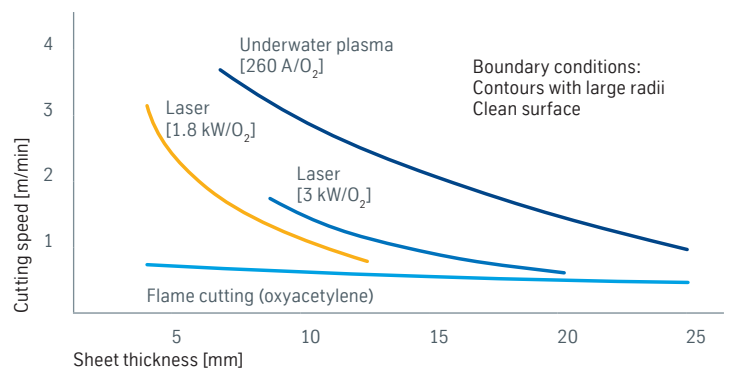
The following thermal cutting processes can be used with perform® steels:

- Plasma cutting
- Laser beam cutting
- Flame cutting

The plasma and laser beam techniques offer major advantages in terms of cost-efficiency and workpiece distortion. Plasma cutting permits the highest cutting speeds, as shown in Graphic 2, albeit with certain limitations with regard to cut edge quality.

Depending on sheet thickness and laser power, laser beam cutting offers significantly higher cutting speeds than flame cutting. Other advantages include a very narrow heat-affected zone, low distortion and high dimensional accuracy. Graphic 2 shows thermal cutting speeds for ferritic steels.

Graphic 2: Cutting speed



The LaserCut grades perform® LC with yield strengths of 315 to 420 MPa are particularly suitable for laser beam cutting. The good surface quality and flatness and low residual stresses of these materials permit excellent cut quality even at relatively high cutting speeds.

## Joining

Microalloyed steels display good weldability for both similar and dissimilar joints with other common steel grades on condition that the welding parameters are matched to the material.

### Resistance spot welding

Resistance spot welding is widely used in automotive body making. Sheets in thicknesses of less than 3 mm in particular can be joined cost-efficiently and reliably by this method in mass production, although in general this calls for adjustments to welding current, welding time and electrode force. Particularly important is the influence of electrode force and welding time on the welding range. With increasing sheet thickness and strength, higher electrode forces and longer current flow times are generally required to achieve an adequate welding range. Alternatively the use of multiple-pulse welding based on SEP12202 can have a favorable effect on the welding range.

The welding range depends not only on the grade, surface and thickness of the sheet; process parameters such as current type (AC 50 Hz / DC 1,000 Hz) and electrode geometry are also important. The welding ranges of conventional high-strength steels largely overlap. In addition to the good weldability of the individual steel grades, by setting similar parameters it is thus also possible to achieve good weldability for combinations of a broad range of materials available from the steel industry.

### MIG arc brazing

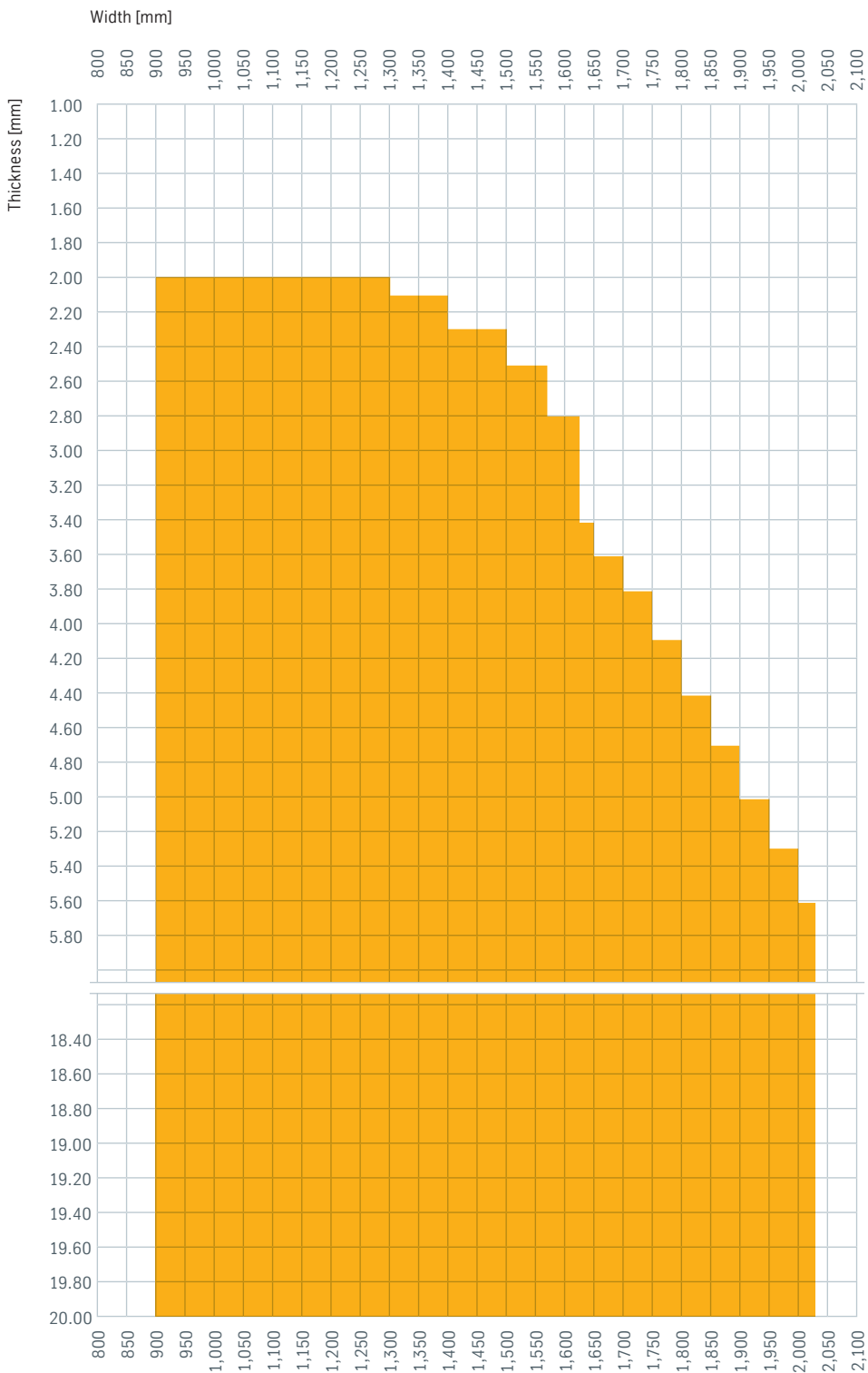
The data sheet DVS 09382 "Arc brazing" describes the brazing of steels with tensile strengths up to approx. 500 MPa. As the material described has a higher tensile strength, it is advisable to check the suitability of parts for brazing.

### Fatigue strength and crash behavior

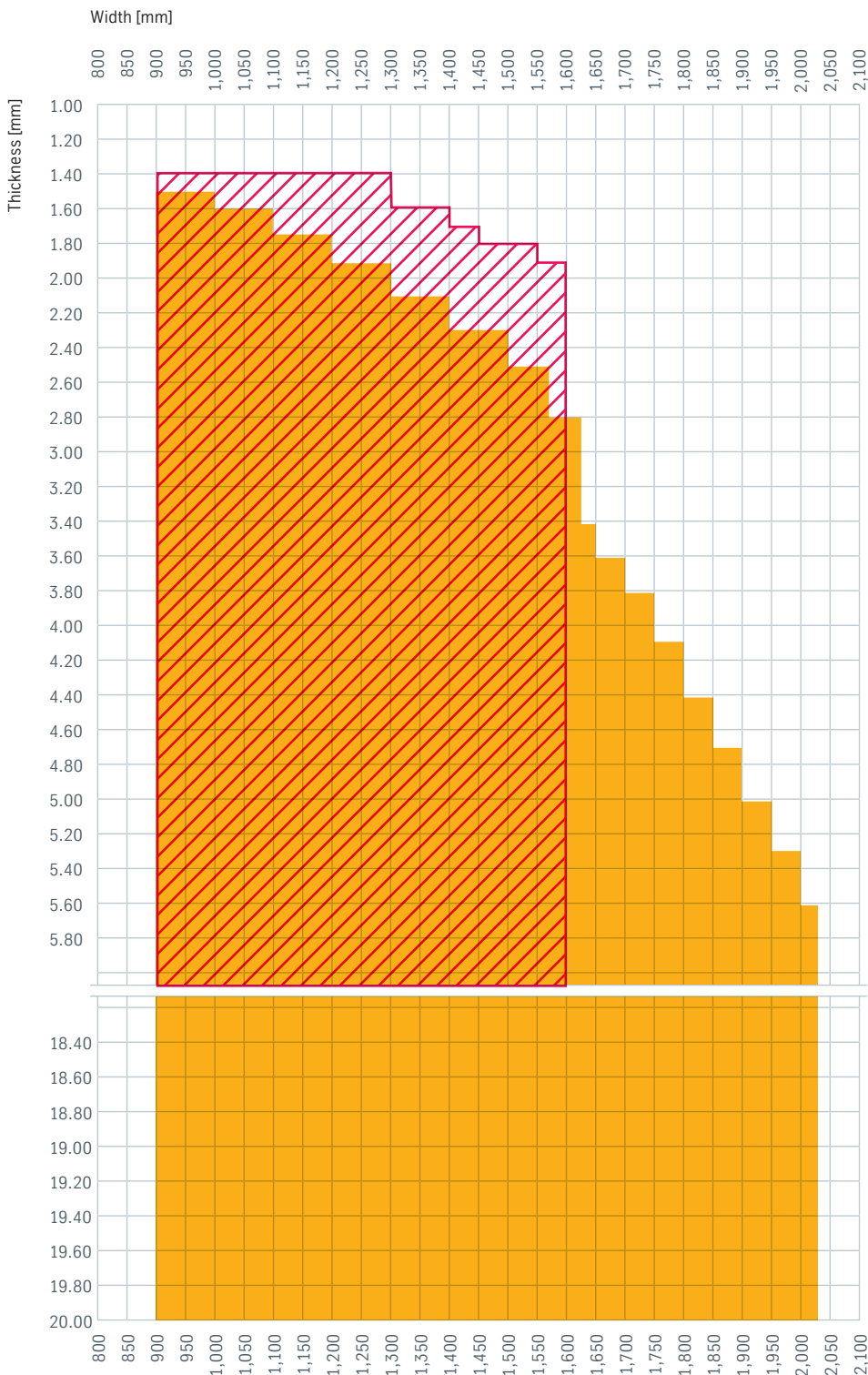
Microalloyed steels guarantee higher minimum yield and tensile strengths than deep-drawing steels. These parameters allow reliable and practical evaluation of fatigue strength. Microalloyed steels are available in various strengths. The higher the yield strength and tensile strength, the higher the fatigue strength. Formability tends to decrease with increasing strength, so designers and production planners need to find the optimum solution. Microalloyed steels are traditionally used for stamped and welded parts and structural components. Thanks to their high residual elongation they demonstrate very robust crash behavior. However, compared with dual-phase and retained-austenite grades they display lower work hardening and possibly lower yield strength, which reduces their energy absorption capacity.

## Available dimensions

### Wide hot strip perform® 300



perform® 315



uncoated  
scalur® S315MC¹

scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

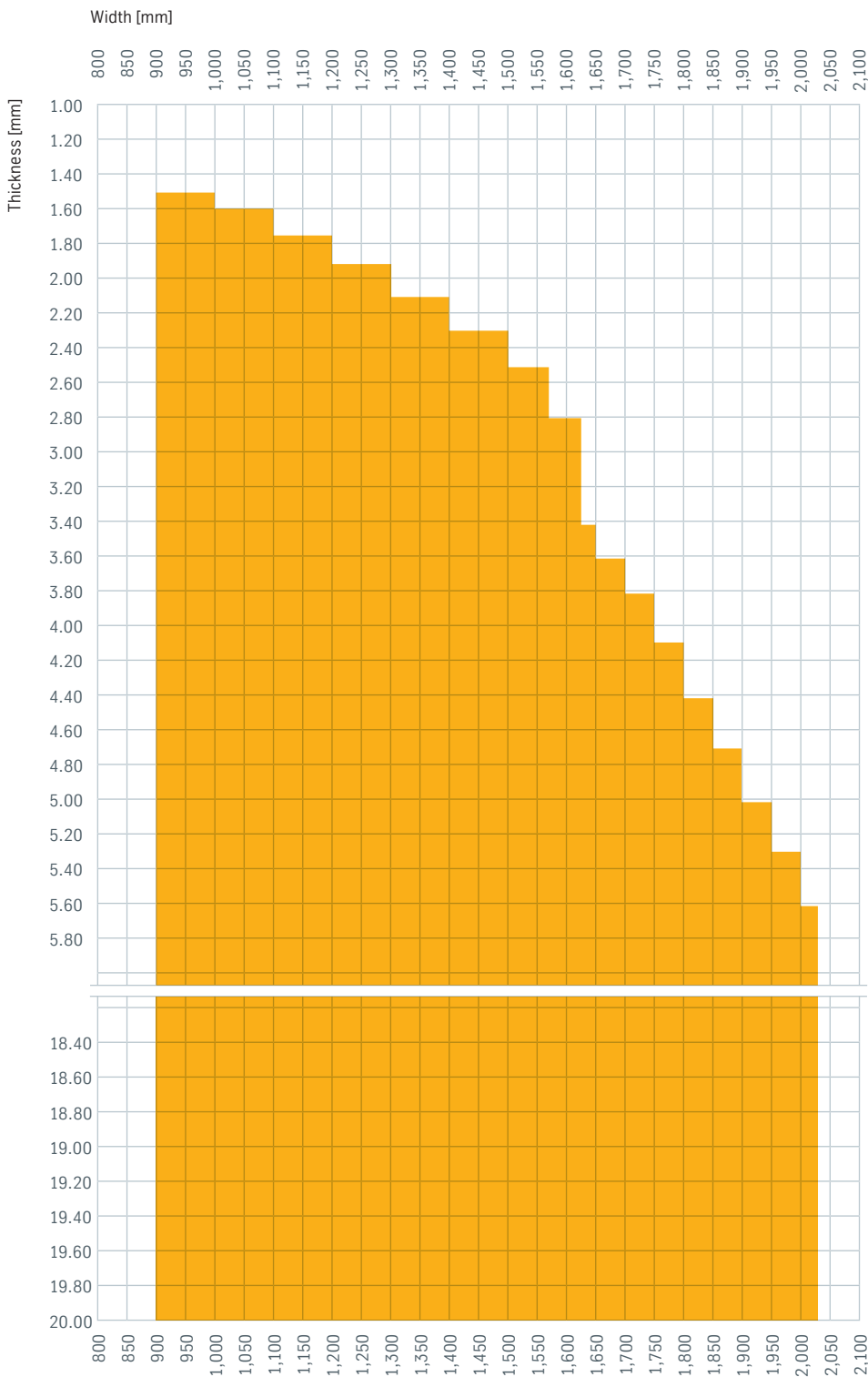
¹) Max. width:  
1,600 mm for thicknesses up to 9.00 mm

Widths < 900 mm and other sizes on request.

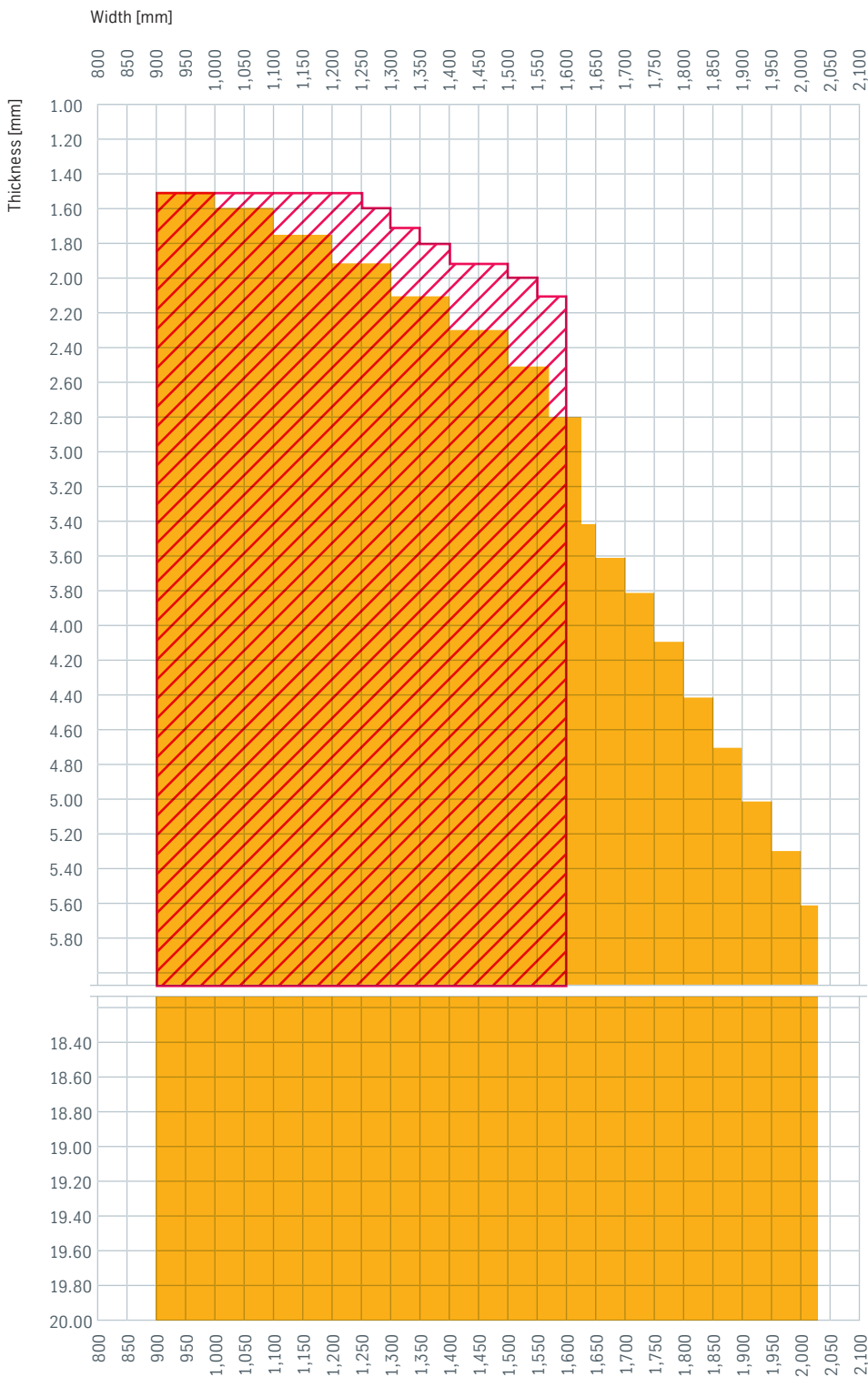
Tolerances to EN 10051 or narrower by arrangement.



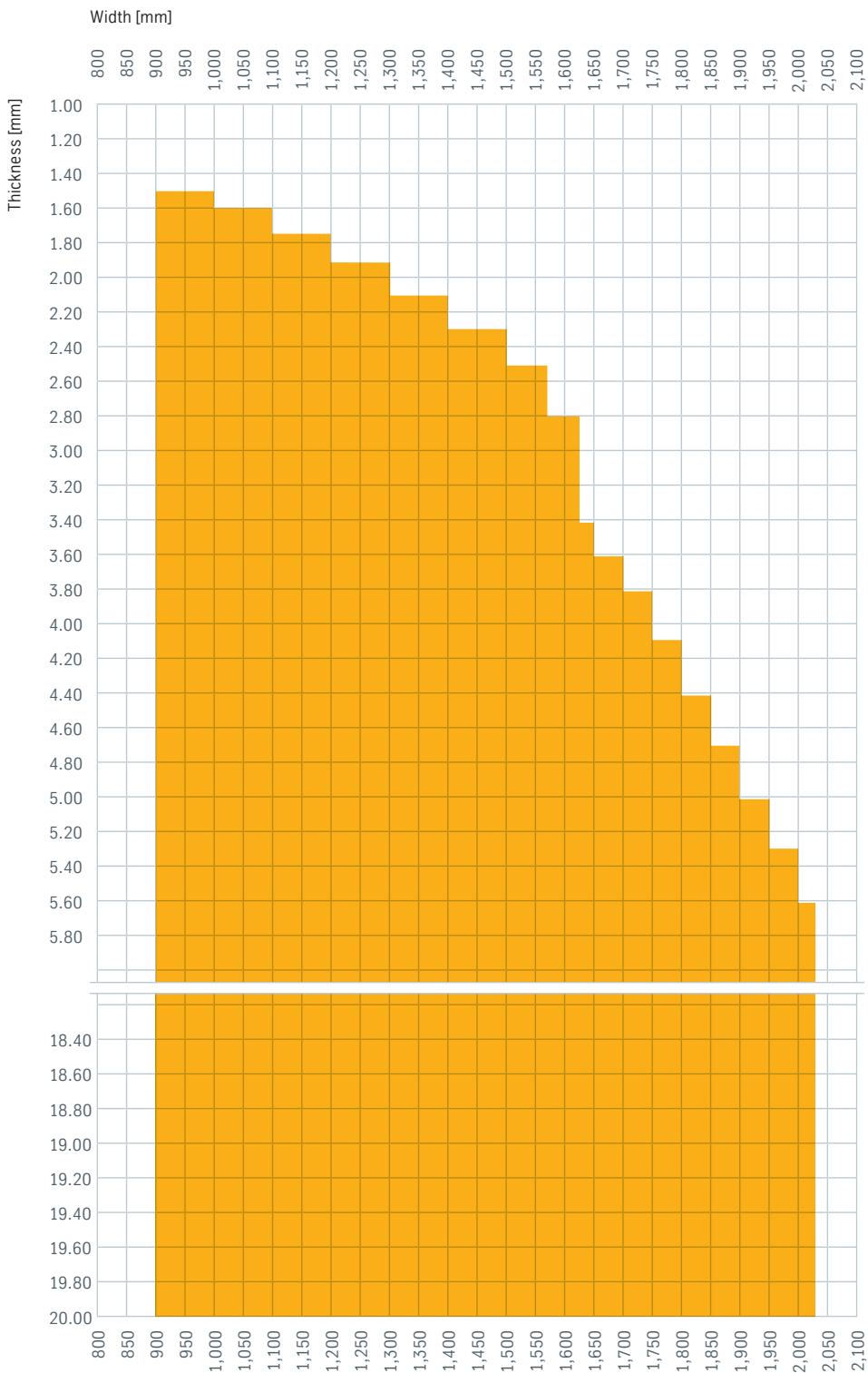
perform® 340



perform® 355



perform® 380

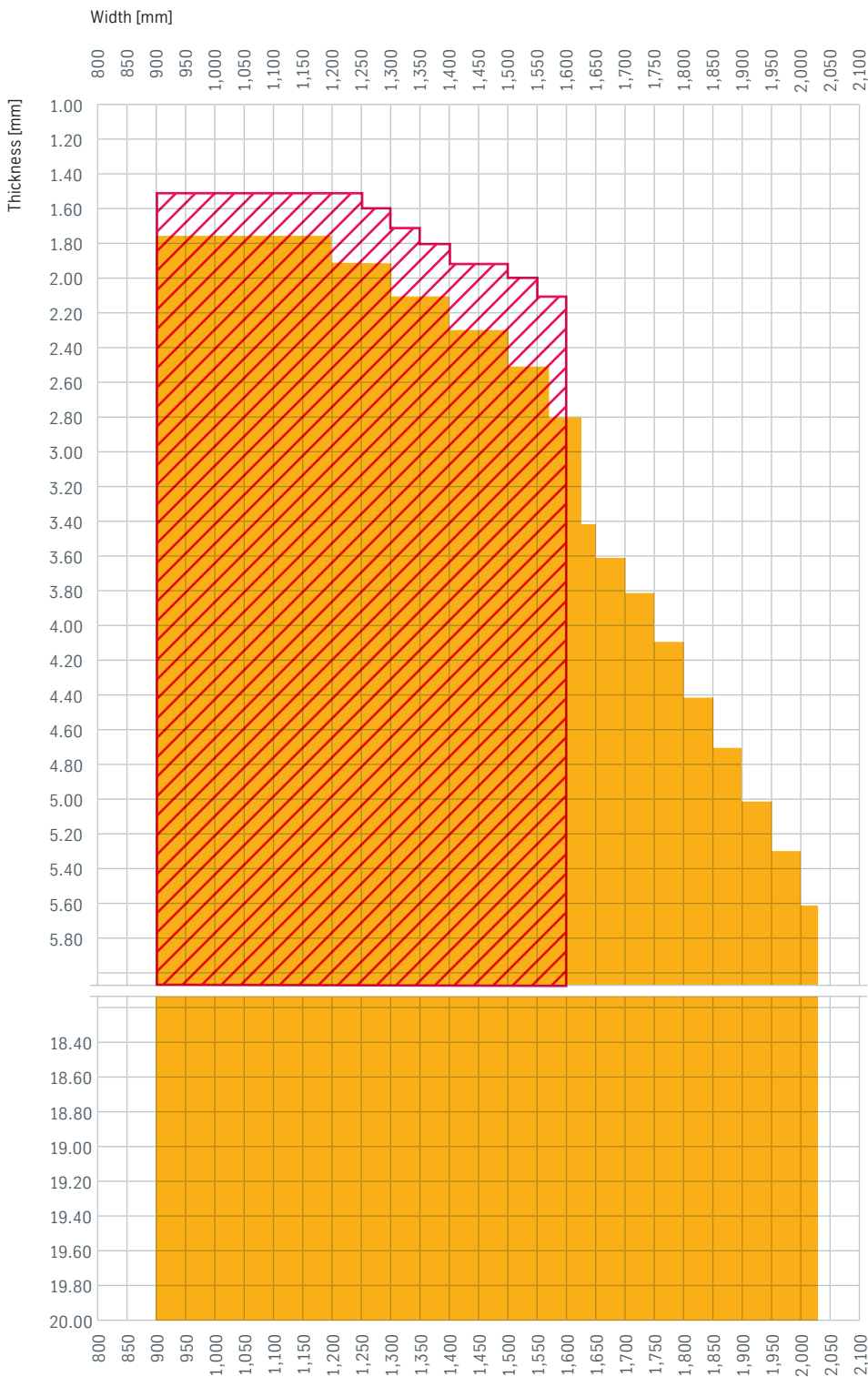


uncoated

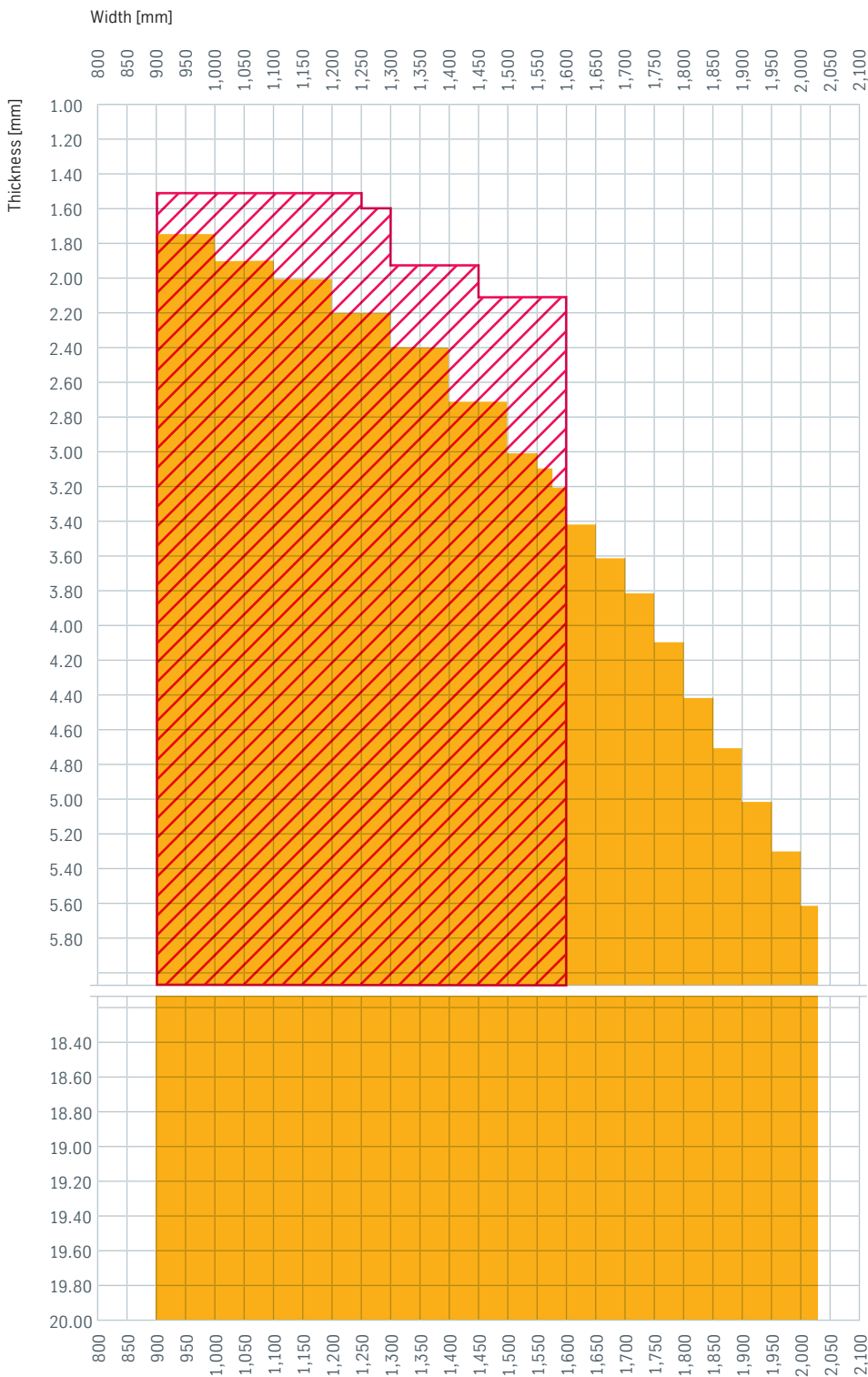
Widths < 900 mm and other sizes on request.

Tolerances to EN 10051 or narrower by arrangement.

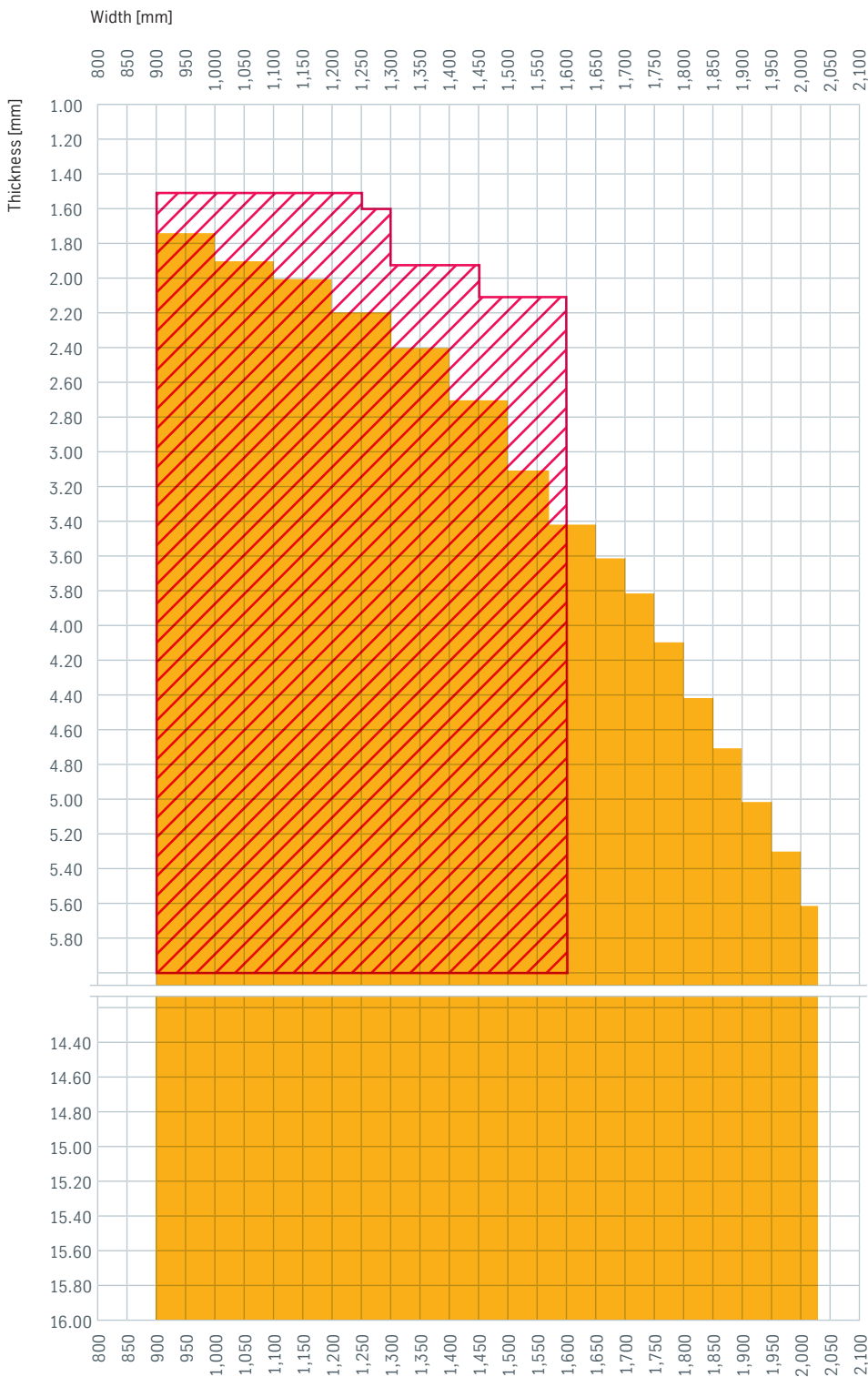
perform® 420



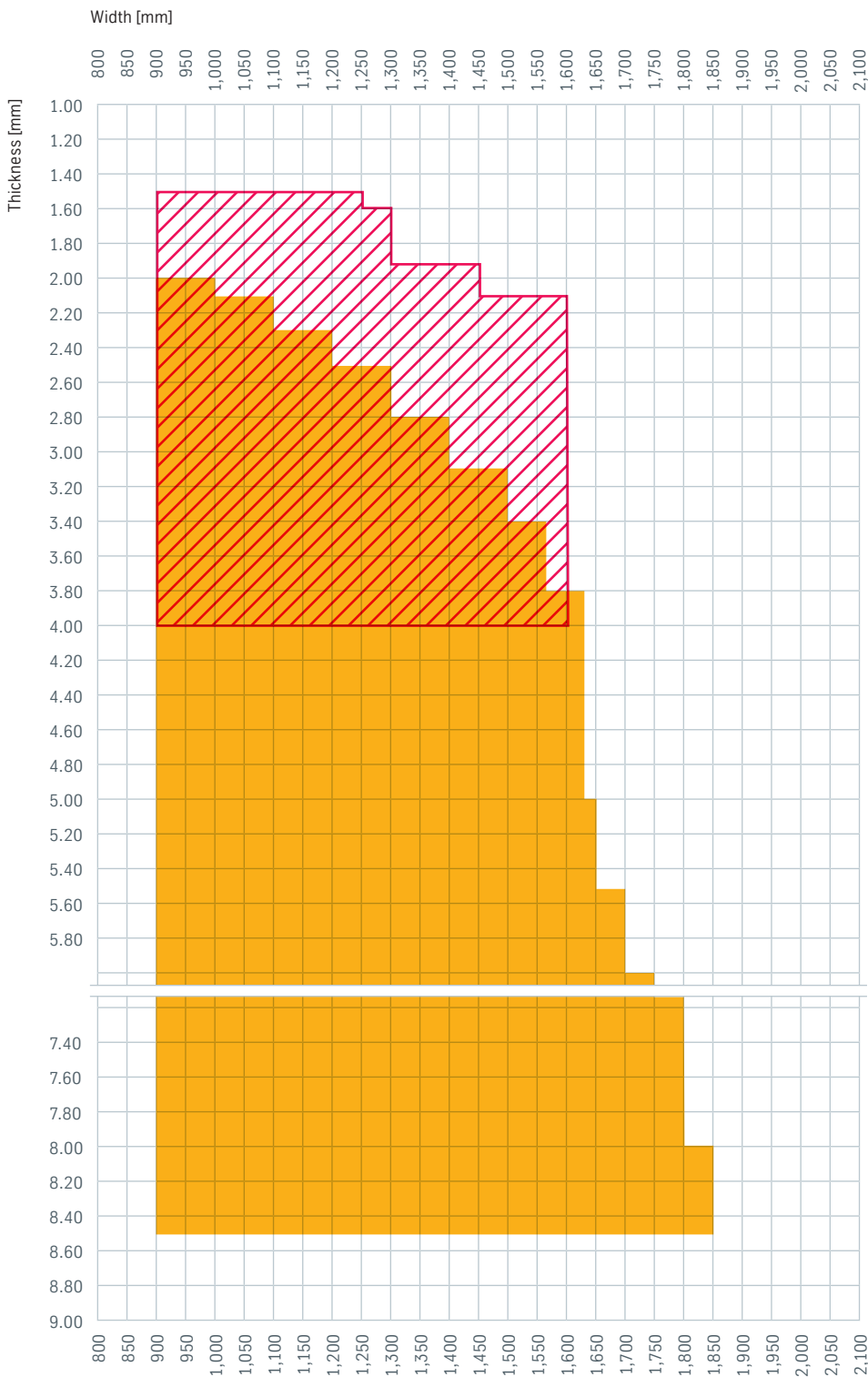
perform® 460



perform® 500



perform® 550



uncoated  
 scalur® S550MC

scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

Widths < 900 mm and other sizes on request.

Tolerances to EN 10051 or narrower by arrangement.

perform® 600



uncoated<sup>1)</sup>  
 scalur® S600MC

scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

<sup>1)</sup> Max. width: 1,620 mm for thicknesses up to 8.00 mm

Widths < 900 mm and other sizes on request.

Tolerances to EN 10051 or narrower by arrangement.



perform® 650



uncoated<sup>1)</sup>  
 scalur® S650MC

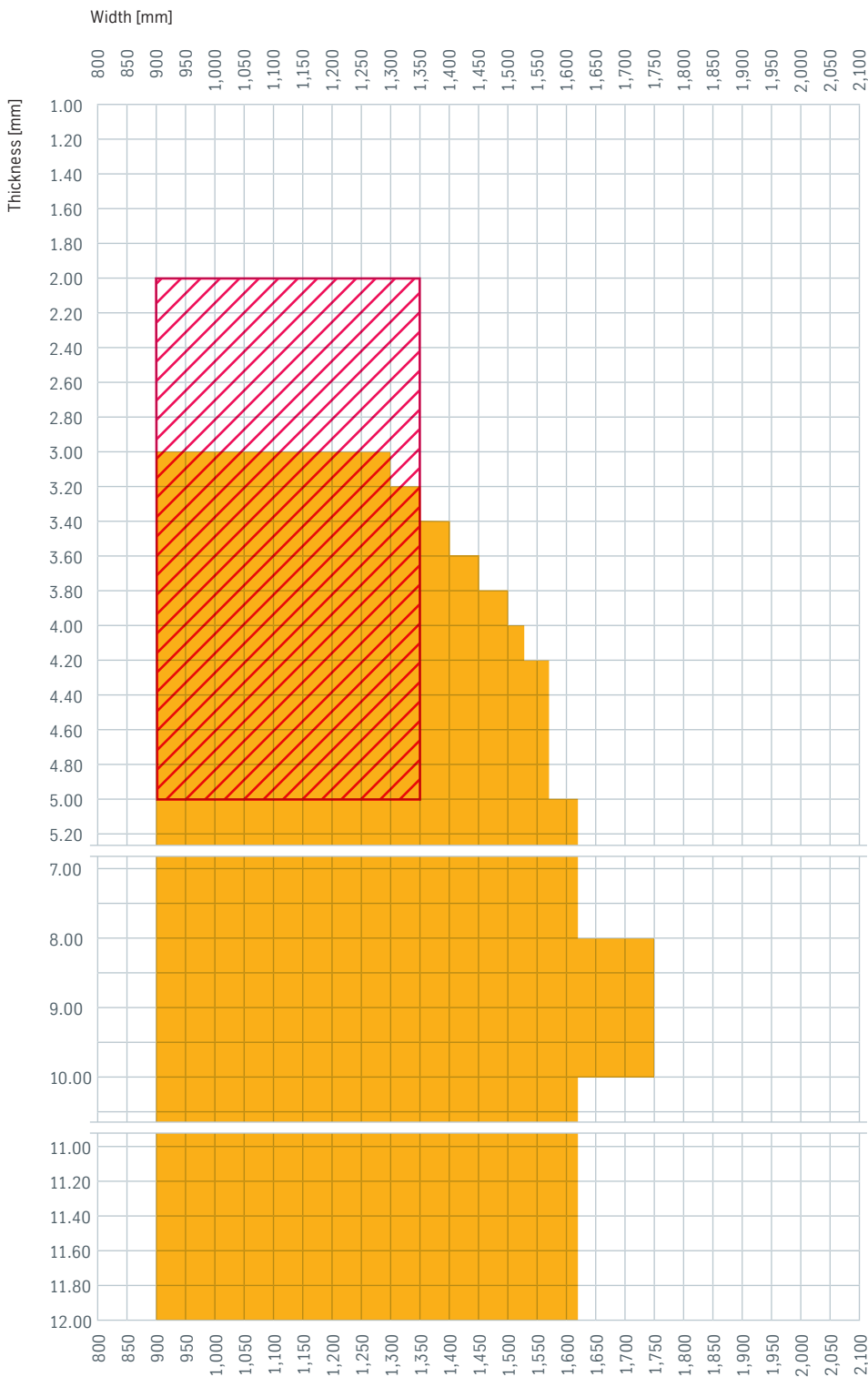
scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

<sup>1)</sup> Max. width: 1,620 mm for thicknesses up to 8.00 mm

Widths < 900 mm and other sizes on request.

Tolerances to EN 10051 or narrower by arrangement.

perform® 700



scalur® is a pickled hot-rolled strip from thyssenkrupp with very close thickness tolerances. For more information please refer to the product information on scalur®.

Widths < 900 mm and other sizes on request.

Tolerances to EN 10051 or narrower by arrangement.

## Cut-to-length sheet

perform® 315, perform® 355, perform® 380, perform® 420, perform® 460,  
perform® 500, perform® 550, perform® 600, perform® 650, perform® 700

	Thickness* [mm]		Width* [mm]	
	from_to		max.	
<b>Steel grade</b>				
	3.00–3.39		≤ 1,600	
perform® 315	3.40–3.99		≤ 1,730	
perform® 355	4.00–4.59		≤ 1,880	
perform® 380	4.60–9.99		≤ 2,000	
perform® 420	10.00–15.00		≤ 2,000	
	15.01–20.00		≤ 1,720	

	Thickness* [mm]		Width* [mm]	
	from_to		max.	
<b>Steel grade</b>				
	3.00–3.39		≤ 1,270	
	3.40–3.59		≤ 1,380	
	3.60–3.79		≤ 1,430	
perform® 550	3.80–3.99		≤ 1,480	
	4.00–4.99		≤ 1,530	
	5.00–12.00		≤ 1,630	

	Thickness* [mm]		Width* [mm]	
	from_to		max.	
<b>Steel grade</b>				
	3.00–3.39		≤ 1,620	
	3.40–3.99		≤ 1,720	
perform® 460	4.00–4.59		≤ 1,870	
perform® 500	4.60–15.00		≤ 2,000	
	15.01–20.00		≤ 1,700	

	Thickness* [mm]		Width* [mm]	
	from_to		max.	
<b>Steel grade</b>				
	3.00–3.79		≤ 1,500	
	3.80–4.19		≤ 1,530	
perform® 600	4.20–4.99		≤ 1,570	
perform® 650	5.00–7.99		≤ 1,620	
perform® 700	8.00–10.00		≤ 1,750	
	10.01–12.00		≤ 1,620	

Minimum width: 820 mm, trimmed

Length: 1,000 to 16,000 mm

Other sizes on request.

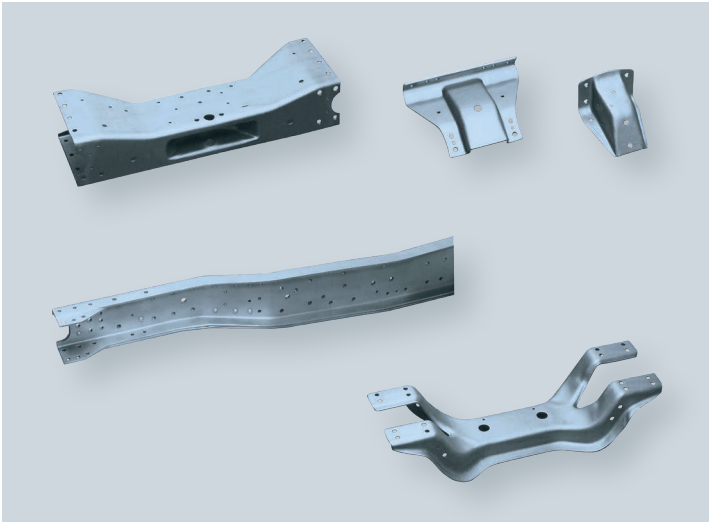
Tolerances to EN 10051 or narrower by arrangement.

\* Not all thickness and width combinations are possible.

## Sample applications



Trailer design.



Complex part geometries.

Special mill grades are supplied subject to the special conditions of thyssenkrupp. Other delivery conditions not specified here will be based on the applicable specifications. The specifications used will be those valid on the date of issue of this product information brochure.

### General information

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