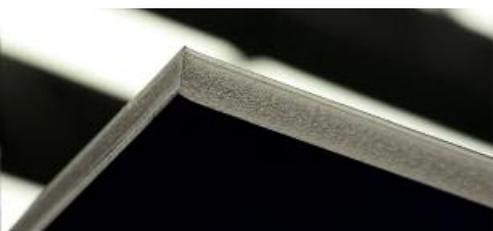


## HIGH TECH FOR HIGH-STRENGTH PLATE

Heavy plate production at MMK



# TECHNOLOGY FROM ONE SOURCE

## THE CUSTOMER

Magnitogorsk Iron & Steel (MMK), with a raw steel production volume of more than 11 million t per year, ranks among Russia's largest steel producers. Founded in 1932, the company based in Magnitogorsk in the southern Urals today covers the entire process chain of iron and steel making – from ore through to strip processing.

## THE PROJECT

Keen to supply equally high quality in the heavy plate sector, MMK decided to build a modern complex featuring new secondary metallurgy plants, a continuous caster, and a 5.0-m heavy plate mill – all supplied by SMS Siemag. This order was one of the largest in the corporate history of SMS Siemag, and it effectively demonstrated our expertise in all aspects of heavy plate production.

## THE TECHNOLOGY

Reflecting the new facility's broad range, the plants we supplied are designed to produce and process pipe and tube grades as well as other challenging steels. The secondary metallurgy plants make high-purity steel containing a minimum of unwanted alloying elements. The vertical-bending continuous caster manufactures high-quality slabs of top internal and surface quality. Next in line is the heavy plate mill that turns out plate with exact mechanical and technological properties to close geometric tolerances.

SMS Siemag supplied both the continuous caster and the heavy plate mill with our complete X-Pact® electrics and automation package. Receiving all the equipment from one source means our customer benefited from systems perfectly meshed with each other right from the start. Furthermore, there was just one contact for MMK in all projects, leading to much simpler project management and reduced interfaces.



Secondary metallurgy.



Continuous casting.

## CONTENTS

<b>TECHNOLOGY FROM ONE SOURCE</b>	<b>2</b>	<b>MILL STAND</b>	<b>16</b>
<b>SECONDARY METALLURGY</b>	<b>4</b>	<b>PLATE COOLING</b>	<b>20</b>
<b>CONTINUOUS CASTER</b>	<b>6</b>	<b>HOT PLATE LEVELER</b>	<b>22</b>
<b>HEAVY PLATE MILL</b>	<b>8</b>	<b>COOLING BED</b>	<b>24</b>
<b>ELECTRICAL AND AUTOMATION SYSTEMS</b>	<b>10</b>	<b>SHEARING LINE</b>	<b>26</b>
<b>PRE-INSTALLATION AND PLUG &amp; WORK</b>	<b>12</b>	<b>COLD PLATE LEVELER</b>	<b>28</b>
<b>FAST RUNUP, EXCELLENT QUALITY</b>	<b>14</b>	<b>HEAT TREATMENT LINE</b>	<b>30</b>



Hot rolling.



Ideal basis for success: close cooperation between MMK and SMS Siemag.

# SECONDARY METALLURGY

## Steel for the highest requirements

Equipped with the secondary metallurgy plants from SMS Mevac, MMK can offer a broad range right up to sophisticated heavy plate steels for large pipes and shipbuilding. SMS Mevac supplied a 370-t swivel ladle furnace with a 56-MVA transformer, a 370-t duplex RH-TOP plant, a ladle treatment station (LTS) and various auxiliary equipment such as the steam generator and dedusting system.

Special about the ladle furnace treatment is its focus on extreme reduction of sulfur in the liquid pig iron to contents of under 10 ppm.

The 370-t duplex RH-TOP plant achieves ultra-low hydrogen contents and can also produce minimum carbon values if required. Apart from a complex alloying plant, the duplex-RH-TOP plant at MMK features an automated temperature and sample taking system. The steam jet vacuum system is one of the world's largest of its type. Equally remarkable is the vessel lifting system because it can move masses weighing more than 1,000 t.

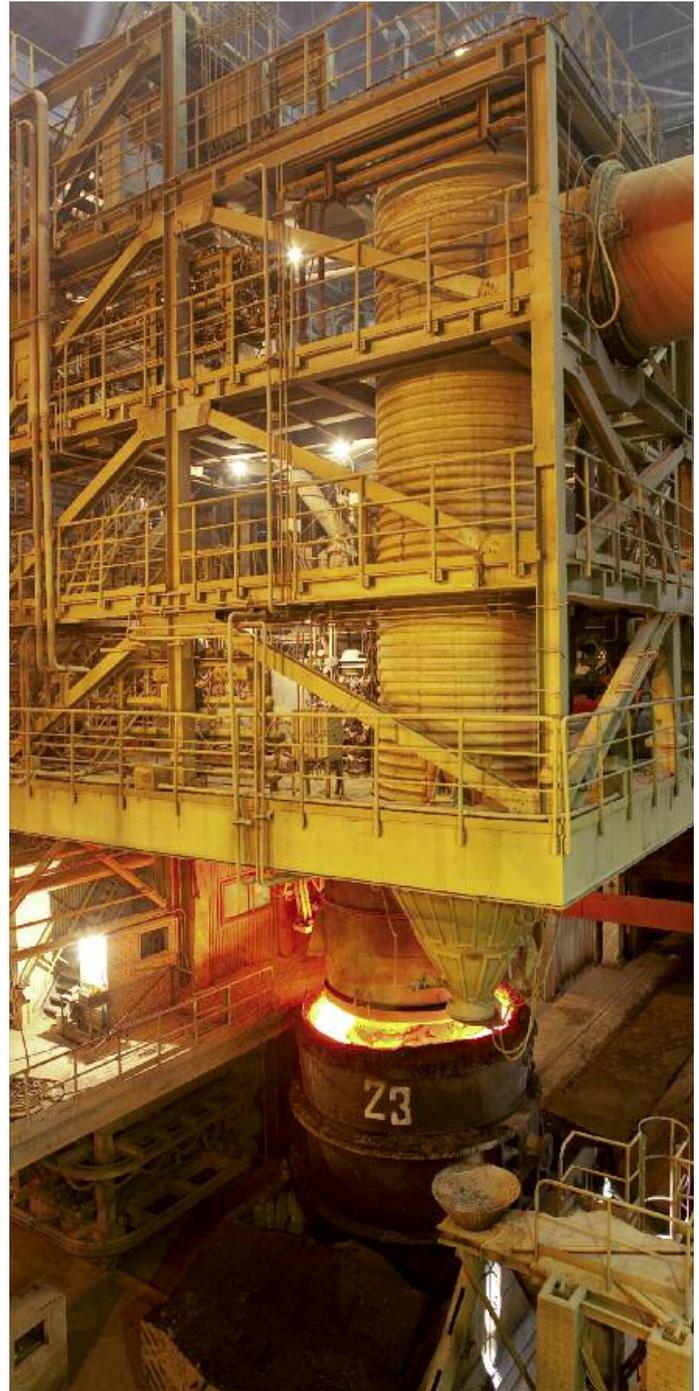
### TECHNICAL DATA

#### Swivel ladle furnace

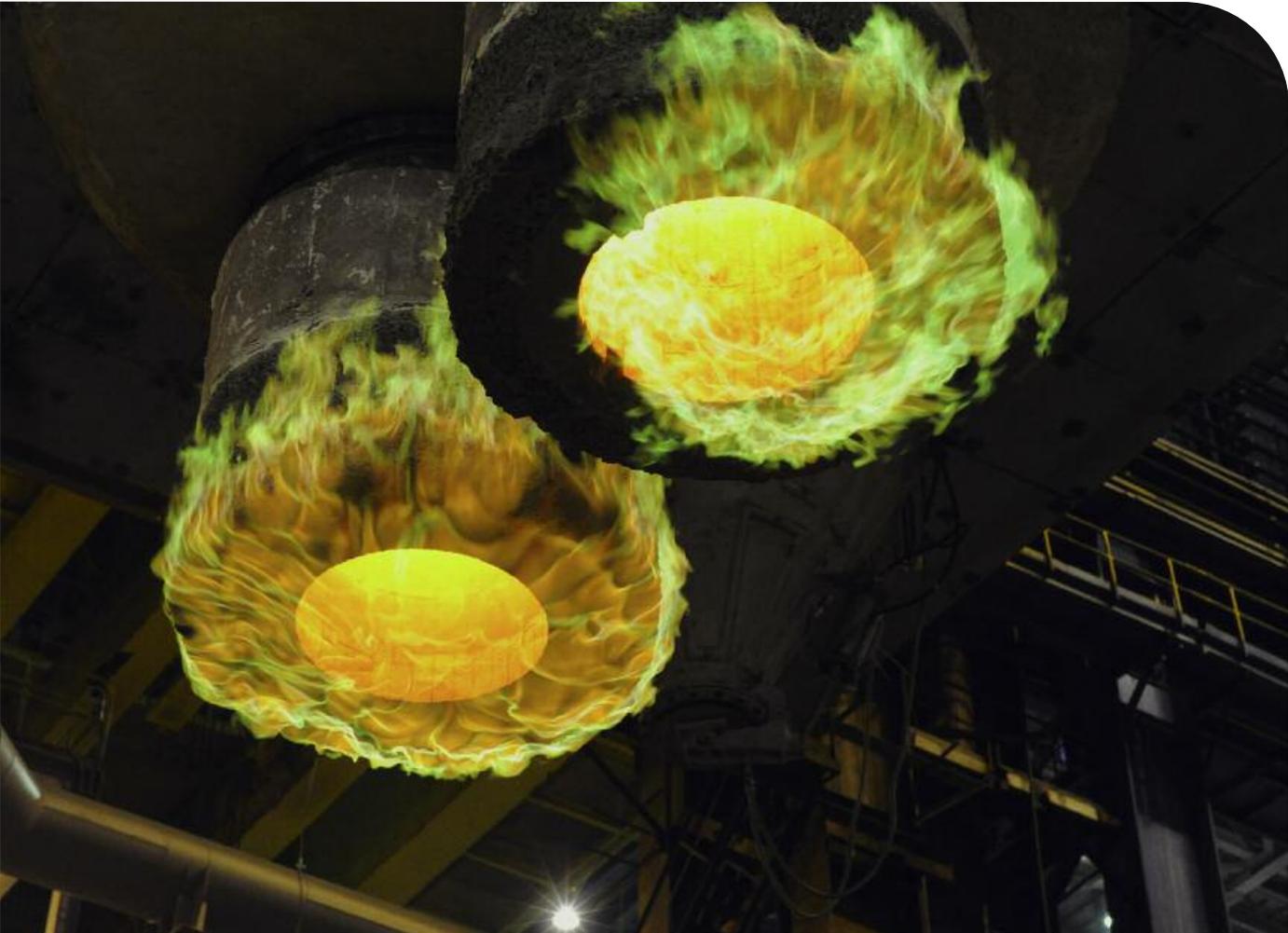
- Ladle size: 370 t
- Annual production: 2 million t
- Commissioning: 2010

#### Duplex-RH-TOP plant

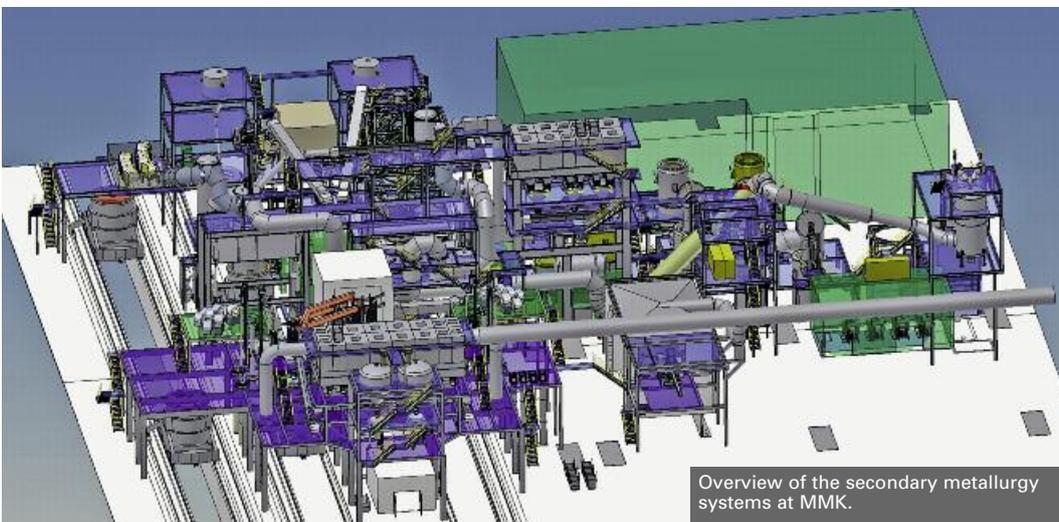
- Ladle size: 370 t
- Annual production: 2 million t
- Commissioning: 2010



RH-TOP plant.



Immersion tubes of the RH plant.



Overview of the secondary metallurgy systems at MMK.

# CONTINUOUS CASTER

## How to produce quality slabs

Depending on the formats required, the slab continuous caster supplied by SMS Siemag is designed for an annual production of 1.65 million t of quality slabs. The maximum slab cross-section is 300 millimeters thick and 2,700 millimeters wide, one of the largest formats made in Russia.

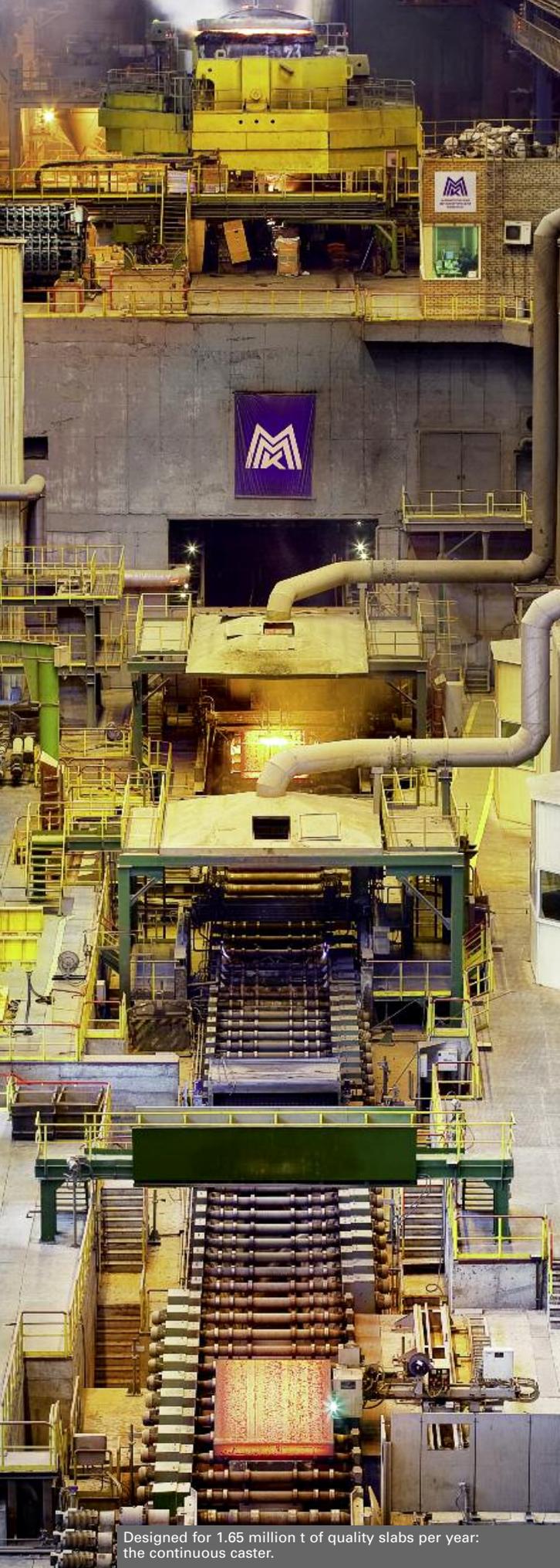
Included in our scope of supply and services were the mechanical systems complete with slab transport equipment, electrical and hydraulic components, the entire X-Pact® electrics and automation, and the drive technology.

What particularly stands out is the turret: Capable of lifting a load of 2 times 535 t, it's the largest S-shaped ladle turret built by SMS Siemag anywhere in the world.

Various ISC® (Intelligent Slab Casting) modules make it possible to produce top-quality slabs while ensuring the caster is extremely reliable and flexible. The resonance oscillation system with variable stroke frequency, stroke height, and curve shape ensures consistently good slab surfaces. Also ready for use here is a Mold Monitoring System (MMS) that maps the mold temperature and enables early detection of break-out risks. Adding to the plant's efficiency are hydraulically controlled cyberlink segments and dual-medium cooling. Furthermore, our Dynamic Soft Reduction and Dynamic Cooling Model packages are installed.



All systems, including the continuous caster, work with X-Pact® electrics and automation.



Designed for 1.65 million t of quality slabs per year: the continuous caster.

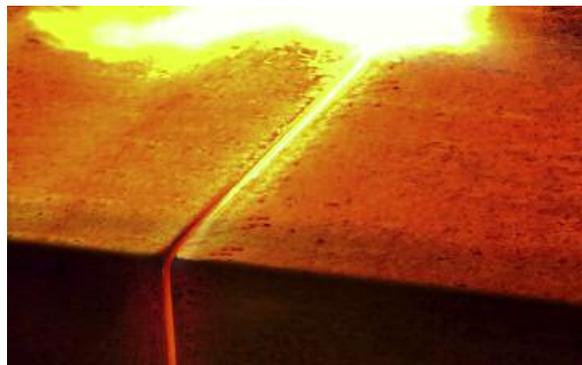
## TECHNICAL DATA

### Continuous caster

- Type: 1-strand vertical bending plant
- Ladle size: 380 t
- Metallurgical length: 34.2 m
- Machine radius: 11.0 m
- Number of segments: 15
- Commissioning: 2009
- Annual production: 1.65 million t
- Slab dimensions: 190 / 250 / 300 mm x 1,400 - 2,700 mm



The ladle turret is the largest built by SMS Siemag so far.



Quality slabs for heavy plate production.

# 5.0-M HEAVY PLATE MILL



## 200,000 SQUARE METERS OF HIGH-TECH

The MMK heavy plate mill is pure SMS Siemag technology. That's because the entire technological equipment, from the mill stands to the plate adjusting line, comes from us. This also applies to the reheating furnaces, the heat treatment line, and the roll workshop – all supplied by SMS Siemag.

We integrated the single-stand 5.0-m heavy plate mill into the existing MMK complex in Magnitogorsk, where it occupies an area of 1,080 meters by 200 meters.

The plant is designed for an annual production of 1.5 million t of plates up to 4.800 mm wide and between 8 and 160 mm thick.

Now, with the new heavy plate mill, MMK specializes in the production of high-strength plate and in particular pipe grades. That's why thermo-mechanical rolling is especially important. What happens here is that final rolling in the non-recrystallizing temperature range followed by controlled cooling in the plate cooling section precisely set the mechanical properties such as strength and ductility, also achieving a fine-grain microstructure. It's also possible to reduce the proportion of expensive alloying elements, which cuts costs and improves weldability.

## TECHNICAL DATA

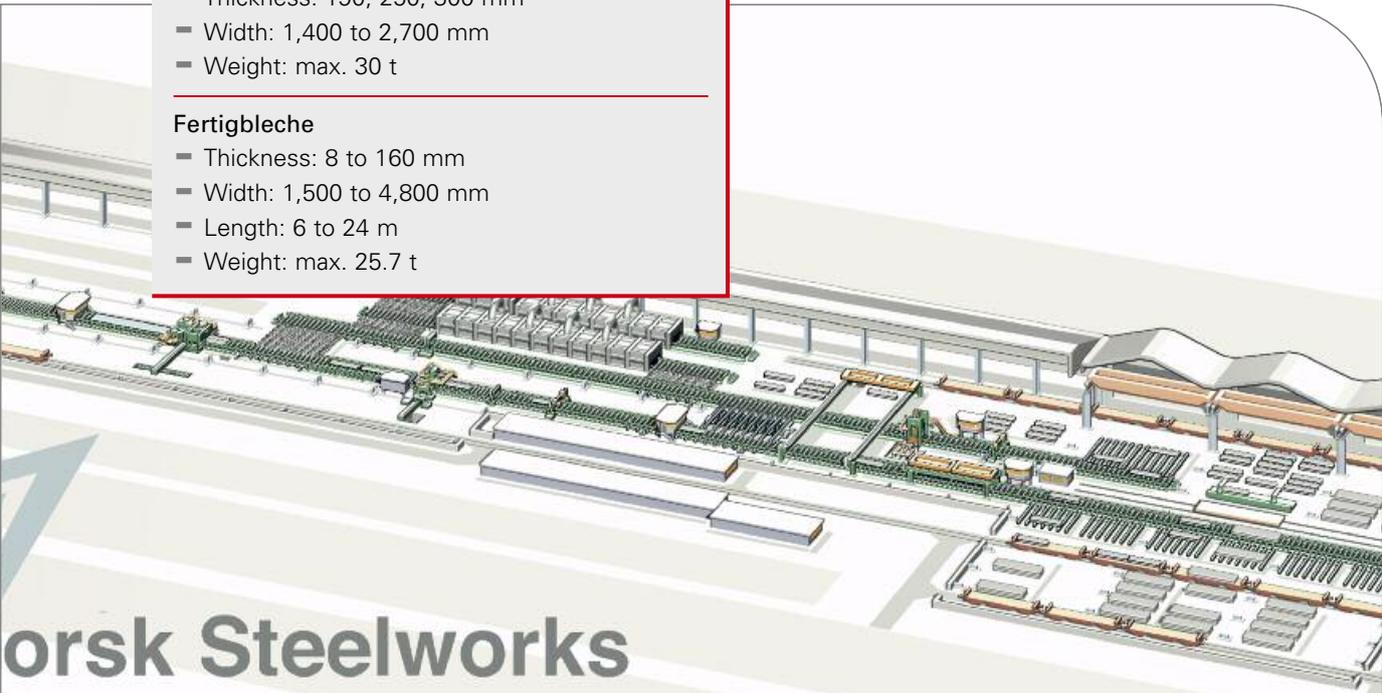
Commissioning: July 2009  
 Annual capacity: 1.5 million t  
 Steel grades: pipe grades (up to X120),  
 pressure vessel steel, bridge construction steel,  
 shipbuilding steel

### Slabs

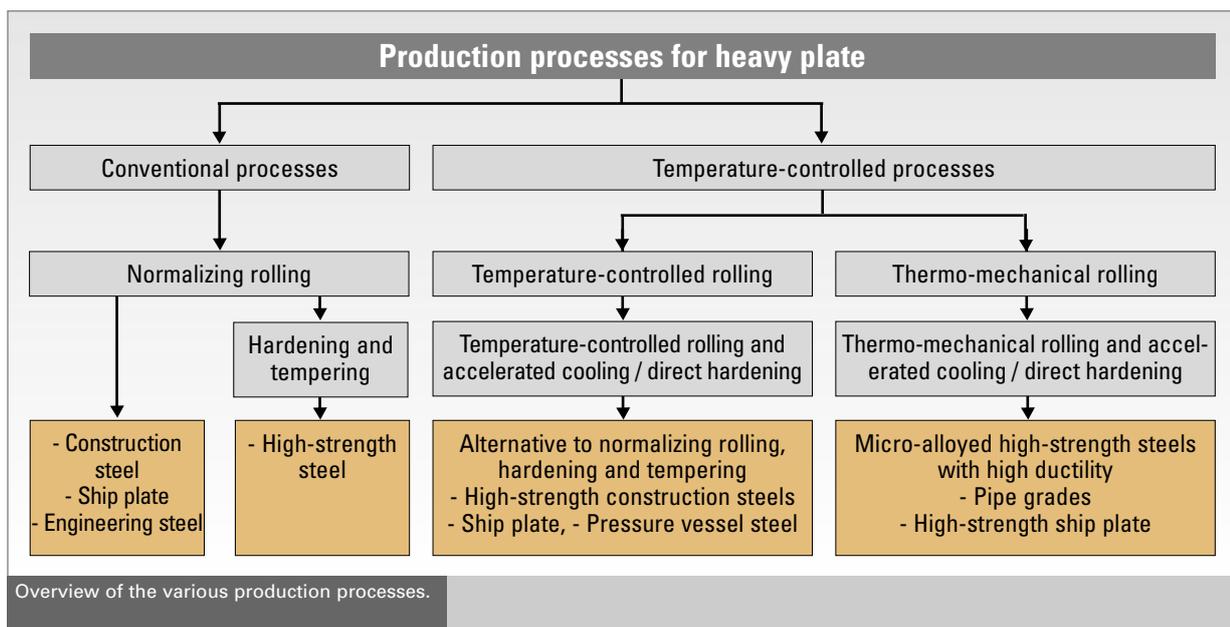
- Thickness: 190, 250, 300 mm
- Width: 1,400 to 2,700 mm
- Weight: max. 30 t

### Fertigbleche

- Thickness: 8 to 160 mm
- Width: 1,500 to 4,800 mm
- Length: 6 to 24 m
- Weight: max. 25.7 t



orsk Steelworks



# ELECTRICAL AND AUTOMATION SYSTEMS

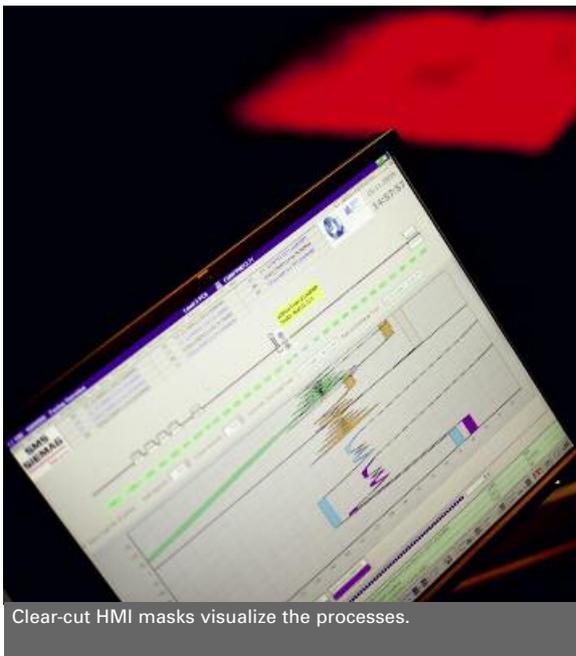
## Holistic systems expertise

The heavy plate mill is controlled using X-Pact® electrics and automation from SMS Siemag. Included in the supply package were the technological measuring systems, instruments, sensory systems, Level 1 and Level 2 systems with process models, and the HMI for the entire plant. SMS Siemag also supplied the complete drive technology with transformers, converters, main and auxiliary drives as well as the roller table motors.

Crucial for productivity and product quality are the technological process models. This means above all Pass Schedule Calculation (PSC), Profile and Flatness Control (PFC) and the cooling and leveling models.

They work by applying mathematical-physical models that precisely describe the various processes. Material tracking makes the logistics within the plant, from the rolling mill to the finishing line, perfectly transparent. Combined with the pass schedule model as well as the profile and flatness control, it facilitates thermo-mechanical rolling in multi-plate operation with groups of up to six plates. That ensures high productivity.

New on the scene was the rolling mill control desk developed for MMK. It stands out for its excellent ergonomic design. The HMI systems are arranged to match the operator's view, giving him a production-oriented representation of the process showing all the relevant systems.



Clear-cut HMI masks visualize the processes.



X-Pact® electrics and automation from SMS Siemag.



The ergonomically designed control desk enables an unrestricted view of the rolling process.

# PRE-INSTALLATION AND PLUG & WORK

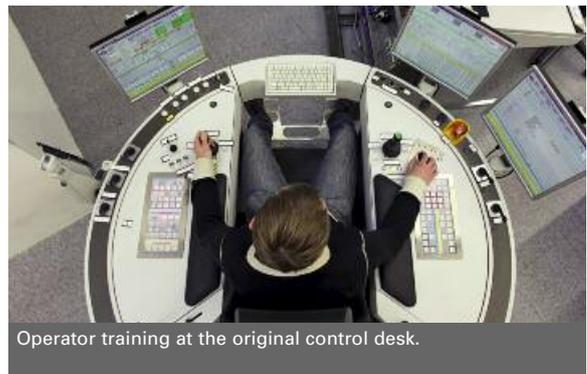
## for fast and reliable commissioning

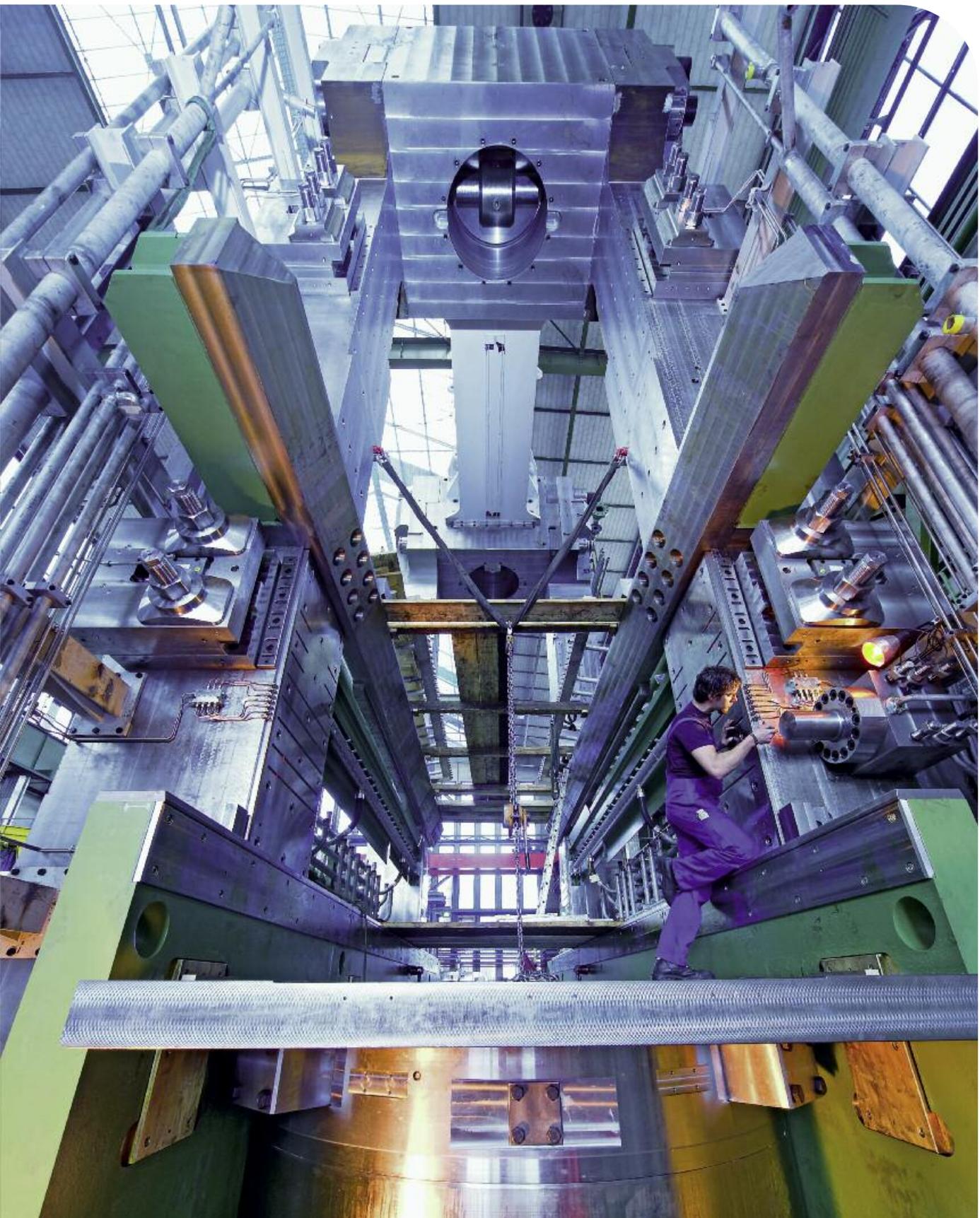
What makes plants from SMS Siemag stand out is fast and efficient commissioning, plus good performance right from day one. There are many reasons for this: meticulous, tried-and-tested design of all components, top-quality manufacturing standards, and pre-testing of the mechanical and automation systems.

We manufactured the core components such as the CVC® shifting systems, the hydraulic controls, and the drive spindles at our Hilchenbach location. This production shop is equipped with a powerful machine stock consisting of more than 70 modern machine tools. It's capable of almost complete pre-assembly of even giant mill stands such as that for MMK, guaranteeing hitch-free delivery.

To smooth the commissioning process, we tested the X-Pact® automation with our unique Plug & Work process before shipment to the customer. The heart of Plug & Work is simulation of the production process. Essential for running these simulations is that we set up the customer-specific plant models including the kinematic and dynamic parameters of the plant behavior as well as the sensor systems. That creates a model which maps reality as precisely as possible. Then we use the simulation to test and optimize the operational procedures of the plant.

Furthermore, Plug & Work provided the perfect opportunity to train the MMK operating personnel in preparation for their future work on the plant. Aided by the simulations, they were able to control production virtually and to learn what the plant can do, how it works, and how to operate it in realistic working situations.





Pre-assembly of the entire mill stand in the SMS Siemag workshop.

# FAST RUN-UP, EXCELLENT QUALITY

Right on schedule, the new MMK heavy plate mill went on line in July 2009. The successful start was followed by a rapid run-up with an early focus on pipe grades.

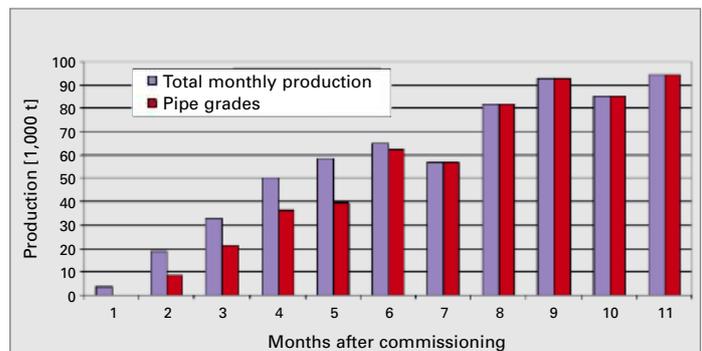
Producing high-strength pipe grades got under way just five weeks after the first plate was rolled. As early as the seventh month after commissioning, MMK was exclusively making thermo-mechanically rolled plate for oil and gas pipelines. MMK produced up to 90 % of this material in multi-plate mode, around half of them in groups of four to six plates.

Thanks to CVC® plus technology, the steelmaker achieved precise, reproducible plate geometry even under difficult conditions. That included highly challenging rolling campaigns to produce the plates of identical width and thickness typically used for pipe production. Here, MMK attained consistent, extremely narrow tolerances of profile and flatness. Straight away, during commissioning, the results far exceeded current market requirements of plate geometry.

Equipped with the new heavy plate mill, MMK also entered the shipbuilding, automotive, heavy machinery, and boiler construction markets. It didn't take long before the ship plates were certified by major quality testers such as the Russian Sea Register (RS), Det Norske Veritas, or Germanischer Lloyd.



Multi-plate rolling with up to six plates was standard after just a few months.



Right from the start, MMK focused on pipe grades.



Control desk for the transport beds.



Plate transport by rail.

# THE MILL STAND

## The heart of the heavy plate mill

Once the slabs have been heated in two reheating furnaces, a high-pressure descaler with a maximum pressure of 200 bar removes the primary scale. The upper spraying beams are height-adjustable so that all slabs can be effectively descaled from the ideal distance.

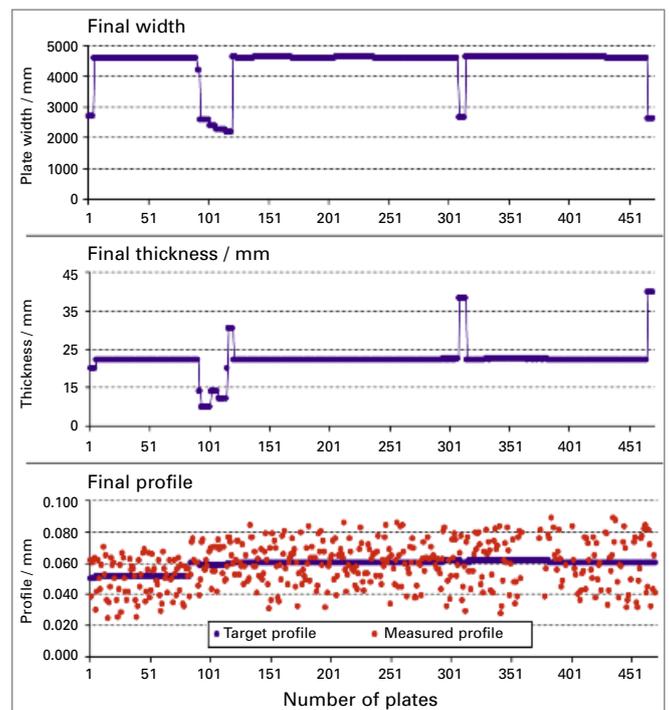
The rolling line consists of a four-high mill stand with an edging stand on the exit side. Capable of applying a rolling force of 120 MN, the horizontal stand ranks among the world's most powerful. It's the first heavy plate mill stand in Russia to feature CVC® plus technology and is also equipped with hydraulic adjustment and work roll bending. Two 12,000-kW motors drive the work rolls. Adding to the strength of the plant are robust SMS Siemag flat-neck spindles that reliably transfer even extreme rolling torques.

Central to the CVC® plus technology is the combination of work roll bending, axial shifting of the work rolls with special CVC® plus grinding, and the PFC (Profile and Flatness Control) technological process model. The PFC model adjusts the shift position and bending force from pass to pass, taking into account the rolling force. Due to the optimal setting of the roll gap, the plant can achieve higher reductions, optimal pass numbers, and very narrow geometrical tolerances of even thin and wide plates.

To be capable of handling rolling forces of up to 120 MN, the backup rolls are held in oilfilm roll-neck bearings. They ensure optimal running accuracy of the rolls coupled with excellent operational reliability.



The flat-neck spindles feature length compensation for shifting the work rolls with the CVC® system.



Even in extreme rolling campaigns, MMK achieves very narrow geometric tolerances with CVC® plus.



The entry side of the 5.0-m mill stand.



Descaling the slab after heating.

The mill housings consist of several parts, with the housing posts and yokes firmly joined together with tension rods. It's a multi-part design because this makes it easier to cast the housing, shortens delivery times, and facilitates transport. Simultaneously, controlled pre-stressing of the tension rods reduces necking during rolling.

There is a vertical edging stand on the exit side of the finishing stand to achieve good width accuracy of the plates. This applies a rolling force of 5,000 kN. A special "short stroke" of the edger ensures good right-angularity at the plate ends, increasing the plant's yield.



Work-roll changing is fully automated with a locomotive.

Work-roll changing is fully automatic and takes just a few minutes. The work rolls are transported by locomotive between the rolling hall and the roll workshop.

## TECHNICAL DATA

### Reheating furnaces

- Walking-beam furnaces
- Heating with: natural gas or coke oven gas
- Slab temperature: max. 1,250 °C
- Furnace capacity: 175 t/h

### Primary descaler

- Operating pressure: approx. 200 bar

### Finishing stand

- Work rolls: 1,210 / 1,110 x 5,300 mm
- Backup rolls: 2,300 / 2,100 x 4,950 mm
- Rolling force: 120,000 kN
- Main drive:
  - Type: twin drive
  - Nominal power: 2 x 12,000 kW
  - Rated torque: 2 x 1,910 kNm
- Technical characteristics
  - Multi-part housing design
  - CVC® plus
  - Hydraulic adjustment
  - Oilfilm bearings
  - Flat-neck spindles with length compensation

### Edging stand

- Diameter: 1,000 / 900 mm
- Barrel length: 600 mm
- Edging force: 5,000 kN
- Width reduction: max. 50 mm
- Main drive: 2 x 1,250 kW
- Technical characteristics
  - Hydraulic adjustment

### X-Pact® electrics and automation

with Pass Schedule Calculation (PSC) and Profile and Flatness Control (PFC)



The edging stand on the exit side improves width accuracy.



The control station with control desk for the stand and the operating unit up to the cooling section.

# PLATE COOLING

## High cooling rates, exact cooling strategies

The plate cooling section at MMK is a combination of spray and laminar cooling with a pre-leveler in the entry area. This gives MMK the capacity for very high cooling rates as well as a particularly large range of cooling strategies, which allows the company to gradually develop its product spectrum, above all in the area of high-strength steels.

The upstream 5-roll leveling machine improves the evenness of the plates before they enter the cooling section. That's how the pre-leveler contributes to a uniform cooling result over the entire plate length and width.

The 30-meter cooling line consists of the high-pressure spray cooling and the laminar zone. Fitted with special nozzles, the spray cooling achieves very high cooling rates and is therefore ideal for DQ (Direct Quenching) as well as ACC (Accelerated Cooling). Important here is to ensure – even during very rapid cooling – that the plate is even. Therefore there are squeeze rolls between the cooling beams to regulate the plate travel as well as the water flow. That leads to perfect temperature distribution and cooling efficiency. The water quantities in both cooling zones can be controlled freely and separately for precise management of the cooling process. To balance out temperature differences, the plant features width masking as well as front and back end masking.

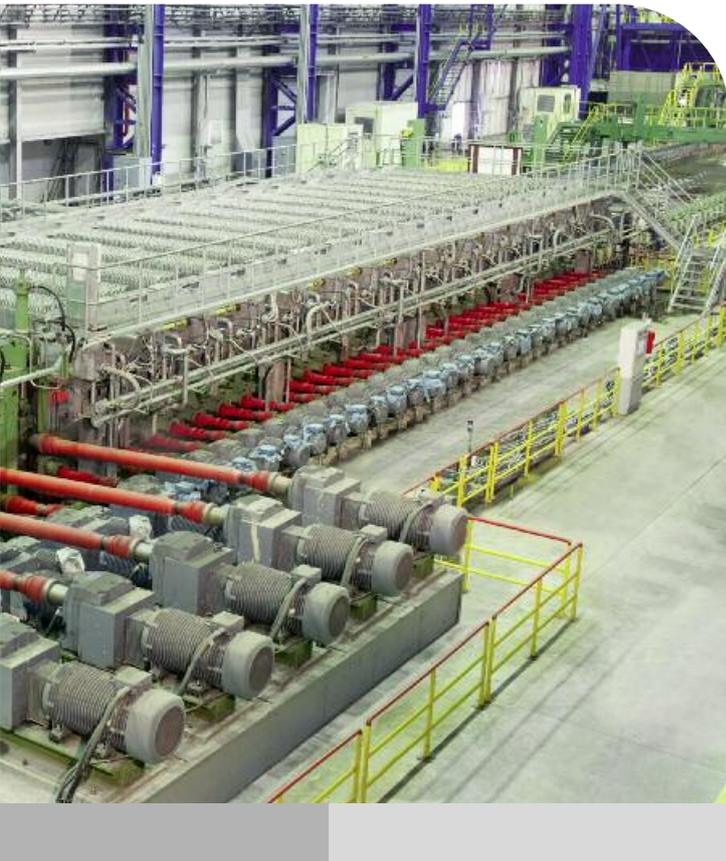
The course of cooling is controlled by our X-Pact® process model, set according to an exact description of the cooling process. That's where the cooling model comes in. It applies true-to-life material models and algorithms to formulate temperature equations, in this way precisely determining the temperature distribution and microstructure components, and ultimately the mechanical properties.



The combined spray and laminar cooling, a highly flexible metallurgical tool.



The 5-roll pre-leveler contributes to homogeneous cooling results.



## TECHNICAL DATA

### Pre-leveler

- Number of leveling rolls: 5
- Leveling force: 17 MN

### Spray cooling

- Type: Spray nozzle cooling
- Length: 6.4 m
- Water pressure: max. 5 bar
- Cooling beams: 4 upper and 4 lower (double beams)
- Control units: 4 upper and 4 lower
- Number of squeeze rolls 5 upper and 5 lower

### Laminar cooling

- Type: U-pipe cooling
- Length: 24 m
- Water pressure: approx. 0.8 bar
- Cooling beams: 15 upper (double beams), 30 lower
- Control units: 15 upper and 15 lower
- Technical characteristics
  - Individually controlled cooling ramps
  - Squeeze rolls in spray cooling zone
  - Width masking
  - Front and back end masking

X-Pact® electrics and automation including cooling model



The laminar cooling plant.



The cooling system and mill stand must form a unit for thermo-mechanical rolling.

# HOT PLATE LEVELER

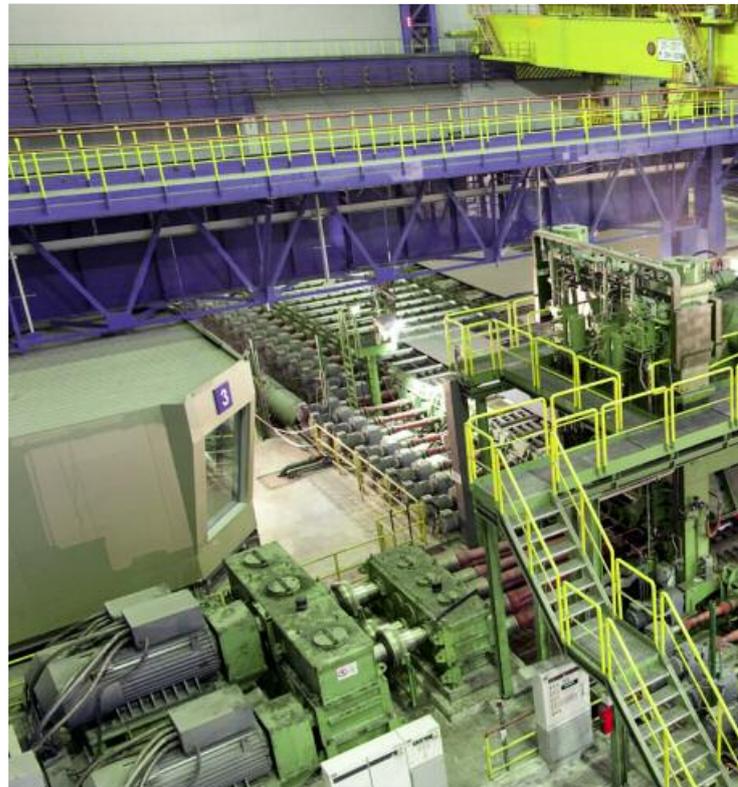
## High leveling forces for even plates

The hot-plate leveler evens out irregularities by shaping the plates between offset leveling rolls. This 9-roll machine with a leveling force of 40 MN is designed to cope with high stresses, so it can level even directly hardened plates fed in at low temperatures in one pass. There is a wide scope of application because the leveling range spans plate thicknesses of 10 to 100 millimeters.

The upper pressure frame of the leveler is adjusted purely hydraulically. It's possible to level each plate individually: by tilting and inclining the upper roll set and separately setting the feed and runout rolls in the bottom roll set.

Potentially, problems can arise from high leveling forces that cause elastic distortion in the machine that alters the leveling gap and the gap profile. Compensating this distortion is vital for a good leveling result. A so-called hinged frame does this by counter-bending the leveling rolls. The parallel share of the machine's expansion and compression distortions is conveyed as an additional target value to the main adjusting system.

Then the X-Pact® leveling model calculates the optimal leveling strategy for each plate. Ranking among key parameters for the calculation are the mechanical properties of the material, the current plate temperature, and the plate dimensions.



The hot plate leveler with drives and control station.



The operating side.



Control station of the hot plate leveler.

## PRODUCT DATA

- Plate thickness: 10 to 100 mm
- Plate width: 1,500 to 4,900 mm
- Plate length: max. 52 m
- Yield strength: max. 1,000 N/mm<sup>2</sup>

## TECHNICAL DATA

- Leveling rolls: 9
- Leveling roll diameter: 360 mm
- Leveling force: 40,000 kN
- Leveling rate: max. 2.5 m/s
- Main drive: 3 x 650 kW

## TECHNICAL CHARACTERISTICS

- Purely hydraulic adjustment
- Individual adjustment of the feed and runout rolls
- Bending system
- Inner cooling of the leveling rolls
- X-Pact® electrics and automation including leveling model



Leveling rolls.

# COOLING BED

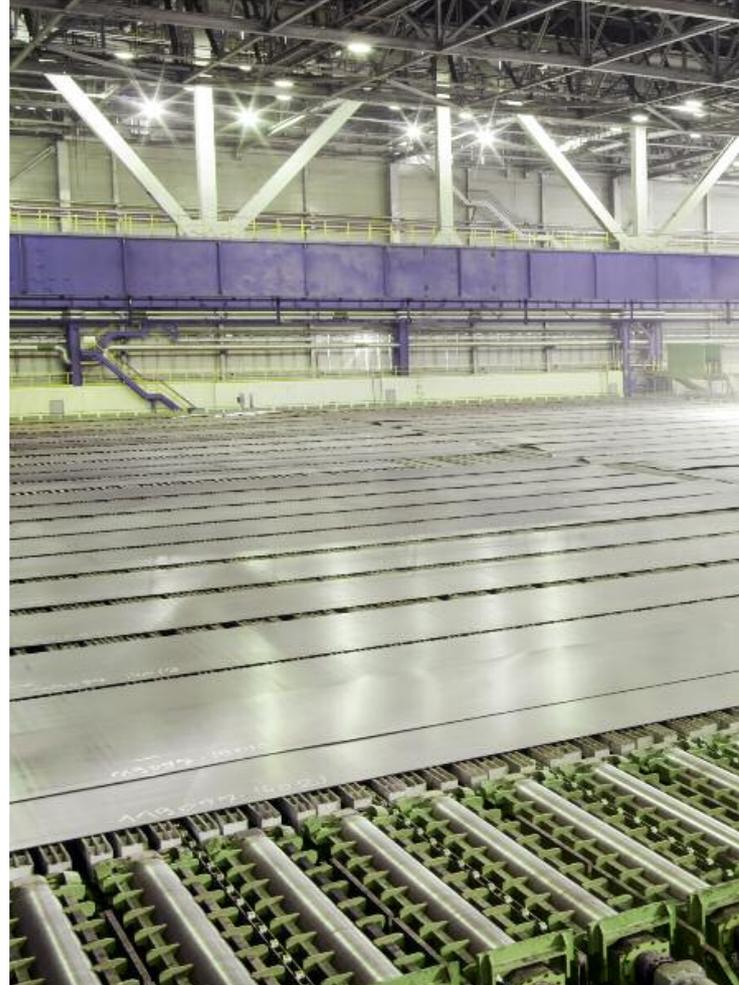
## Cooling and plate inspection

The walking beam cooling bed covers a total area of some 4,400 m<sup>2</sup>. This is where the plates cool slowly from a maximum of 1,000 °C to a temperature of some 100 °C.

Downstream of the cooling bed is an inspection bed for surface inspection. Here, minor flaws are directly ground out. There is a plate turner in the center of the inspection bed so that the underside of the plate can also be checked. Next in line, an ultrasonic scanner examines the plates for internal flaws.

Right beside the hot plate leveler and the cooling bed, MMK has plenty of room to stack plates. Yet, when pipe-grade plates are stacked, the lower cooling rate means that effusion expels hydrogen atoms trapped in the microstructure. These would otherwise make the material brittle.

Thick plates, i.e. plates over 50 mm thick, roll off the line before the cooling bed.



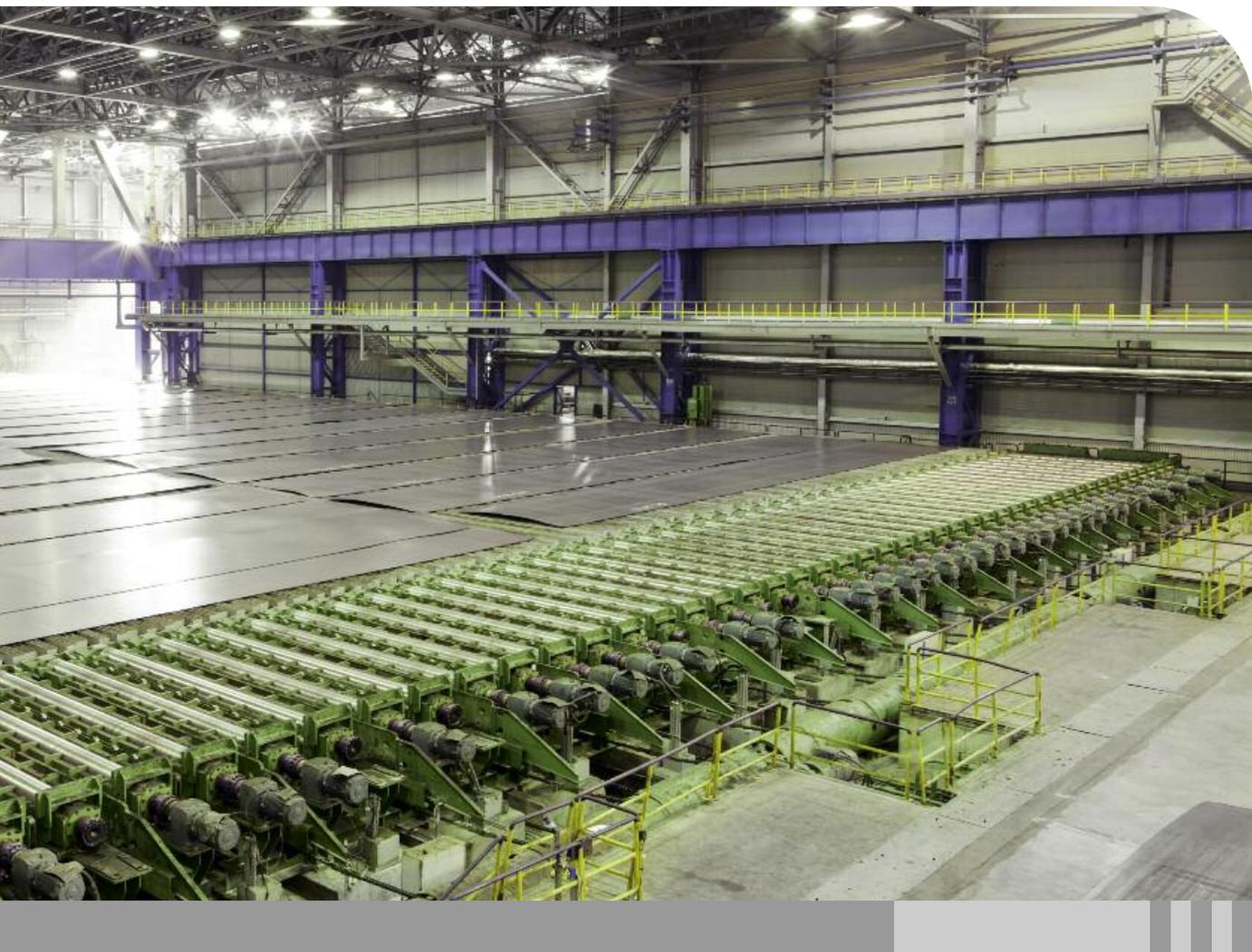
Walking beam cooling bed.



The walking beam mechanism transports the plates without damage.



Ultrasonic scanner and plate measuring system downstream of the cooling bed.



Plates between 50 and 160 mm thickness roll off the line before the cooling bed.

#### PRODUCT DATA

- Plate thickness: 8 to 50 mm
- Plate width: max. 4,900 mm
- Plate length: max. 52 m
- Plate temperature: max. 1,000 °C

#### TECHNICAL DATA

##### Cooling bed

- Type: Walking beam cooling bed
- Dimensions: 52 x 84 m
- Total capacity: 850 t

# SHEARING LINE

## Efficiency and precision

The four shears in the shearing line process high-strength plates up to a cold tensile strength of 1,200 N/mm<sup>2</sup> and a maximum thickness of 50 mm. Cropping, double trimming, slitting, and cut-to-length shears all work according to the rolling-cut principle that prevents plate distortion during cutting and guarantees clean cut edges. The cutting gap can be freely adjusted to suit the thickness and quality of the material. All the shears come with automatic scrap removal.

Immediately before the shearing line, a contour measuring device precisely measures the plates and checks them ultrasonically. Based on this data, the X-Pact® automation optimizes the cutting scheme, reducing scrap losses.

When they pass through the cropping shear, the plates are cropped at both ends to facilitate transport through the shearing line. Like the cut-to-length shear, the cropping shear is built in a closed stand design. That's because the high rigidity of this type additionally improves cutting accuracy and edge quality.

The double trimming and slitting shears are arranged in tandem. They trim the plate edges and divide them lengthways. Invaluable here is that narrow plates can be rolled at double widths, which increases the rolling mill's productivity. Combining the two shears makes sense as the plates only have to be positioned once. This involves magnetic aligning tools, then laser beams show the operating personnel the exact cutting lines. The cut-to-length shear cuts the trimmed plates to their finished lengths. Furthermore, it also removes test strips for analysis of the mechanical properties of the plate.



All shears work according to the rolling-cut principle.

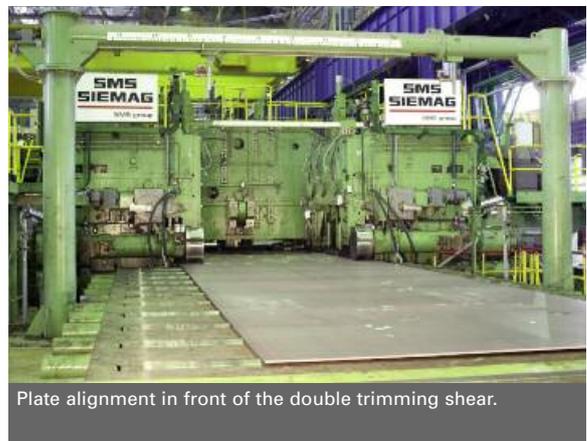
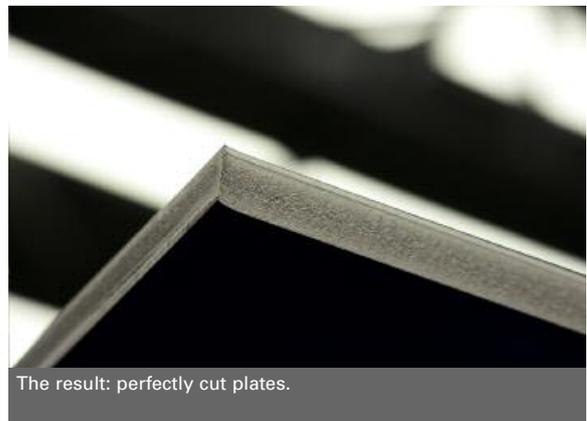


Plate alignment in front of the double trimming shear.



The result: perfectly cut plates.



Cropping shear as well as slitting and trimming shear (in the background).

## PRODUCT DATA

- Plate thickness: 8 to 50 mm
- Plate width (finished plate): max. 4,800 mm
- Plate length (initial plate): max. 52 m
- Plate length (finished plate): max. 24 m

## TECHNICAL DATA

### Cropping shear

- Shearing force: 16,000 kN
- Number of cuts: max. 18 strokes/min
- Main drive: 2 x 600 kW

### Double side trimmer

- Shearing force: 6,500 kN
- Number of cuts: max. 30 strokes/min
- Main drive: 4 x 350 kW

### Slitting shear

- Shearing force: 11,000 kN
- Number of cuts: max. 30 strokes/min
- Main drive: 2 x 400 kW

### Cut-to-length shear

- Shearing force: 16,000 kN
- Number of cuts: max. 24 strokes/min
- Main drive: 2 x 800 kW

## TECHNICAL CHARACTERISTICS

- Rolling-cut principle
- Closed shear stand (cropping and cut-to-length shear)
- Automatic scrap transport
- X-Pact® electrics and automation including cutting optimization

# COLD PLATE LEVELER

## Large leveling range for high-strength plates

Following cutting or heat treatment, MMK can level the plates again in the cold plate leveler. This optimizes them even further and minimizes residual internal stress. That's why the cold plate leveler from SMS Siemag features numerous options for adjusting the leveling gap.

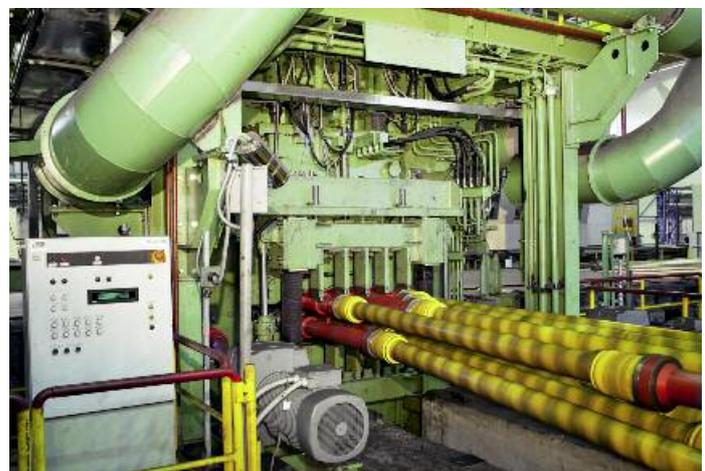
Each leveling roll in the patented 9/5-roll machine is controlled not only by the main hydraulic system, but also by a separate hydraulic roll adjuster and individual roll drive. The X-Pact® leveling model calculates the ideal bending curve for every plate to reduce residual stress. Wherever there is any edge or center waviness, the upper pressure frame swivels and tilts to support the leveling process. High leveling forces can bend the pressure frame, but a compensation mechanism balances this out to ensure a parallel leveling gap at all times.

Individual roll adjustment ensures that some of the rolls can be removed from the leveling process. That increases the roll separation and expands the machine's leveling area. Specifically, thin, high-strength plates are leveled in 9-roll mode, while the larger roll gap in 5+2-roll mode is ideal for leveling thicker plates. The plant switches between the two modes automatically and without time losses from one plate to the next.

The leveling model uses mathematical-physical mapping of the processes inside the plate and the machine. Based on the material properties such as yield strength, tensile strength, and elasticity as well as plate dimensions, it calculates the correct setting of the leveling rolls and the drive torques.



The cold plate leveler.



All the leveling rolls are individually driven.



## PRODUCT DATA

- Plate thickness: 8 to 50 mm
- Plate width: max. 4,800 mm
- Plate length: max. 24 m
- Plate temperature: max. 100 °C

## TECHNICAL DATA

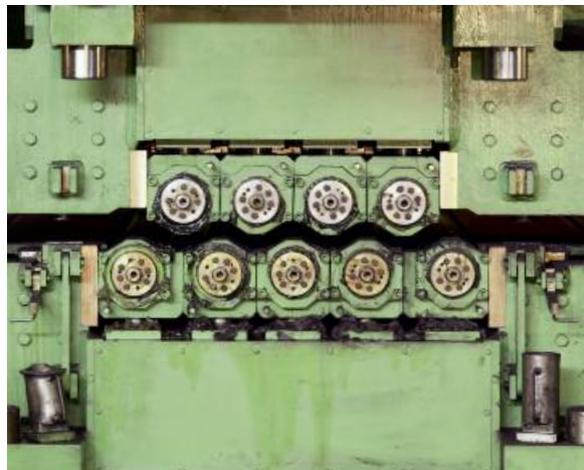
- Leveling rolls: 9
- Leveling modes: 9-roll and 5+2-roll modes
- Leveling roll diameter: 220 mm
- Leveling force: 35,000 kN
- Main drive: 9 x 180 kW
- Leveling rate: 60 m/min

## TECHNICAL CHARACTERISTICS

- Operation with 9 or 5+2 leveling rolls
- Purely hydraulic adjustment
- Individual adjustment of all leveling rolls
- Individual drive of all leveling rolls
- Bending system
- X-Pact® electrics and automation including leveling model



Operator workplace.



In 9-roll mode, the machine levels thin plates, and in 5+2-roll mode it levels thick plates.

# HEAT TREATMENT LINE

## Flexibility for top requirements

The heat treatment line consists of a furnace with a continuous quench to harden the plates, plus an annealing furnace for normalizing and tempering.

First in line is the roller hearth furnace which heats the plates, then comes the continuous quencher that completes the hardening stage. Quenching involves spraying vast amounts of water onto the plates through special nozzle systems to achieve extremely high cooling rates. The result? Plates that meet the highest demands of strength and toughness. The upper squeeze rolls control the water flow during cooling, ensuring homogeneous temperature reduction. Simultaneously, they prevent unevenness, especially of thin plates. There is the option after hardening of annealing to systematically determine the final properties of the product.

The temperatures in the annealing furnace during normalizing are between 920 and 960° C. Usually, a holding phase follows the heating. This heat treatment breaks up irregular and coarse microstructures to produce a uniform, fine-grained structure. The annealing furnace is 81 meters long and is heated with recuperative burners.



The thermal treatment line with the hardening furnace and quencher (left) and the normalizing furnace (right).



The quenching unit was supplied by Drever International, a subsidiary of SMS Siemag AG.



## PRODUCT DATA

- Capacity (hardening and tempering): 100,000 tpa
- Capacity (normalizing): 250,000 tpa
- Plate thickness: 8 to 60 mm
- Plate width: 1,500 to 4,650 mm
- Plate length: 6,000 to 20,000 mm
- Plate weight: max. 30 t

## TECHNICAL DATA

### Hardening furnace

- Type: Roller hearth furnace
- Length: approx. 24 m
- Burners: Recuperative burners in radiant tubes

### Quencher

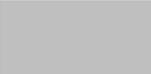
- Type: Continuous quencher
- Length: approx. 24 m
- Water quantity: 60 m<sup>3</sup>/min (high-pressure zone), 125 m<sup>3</sup>/min (low-pressure zone)

### Normalizing furnace

- Type: Roller hearth furnace
- Length: approx. 81 m
- Burners: Recuperative burners in radiant tubes



During heat treatment, systematic heating and cooling further adjust the microstructure.



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**MEETING** your **EXPECTATIONS**

"The information provided in this brochure contains a general description of the performance characteristics of the products concerned. The actual products may not always have these characteristics as described and, in particular, these may change as a result of further developments of the products. The provision of this information is not intended to have and will not have legal effect. An obligation to deliver products having particular characteristics shall only exist if expressly agreed in the terms of the contract."