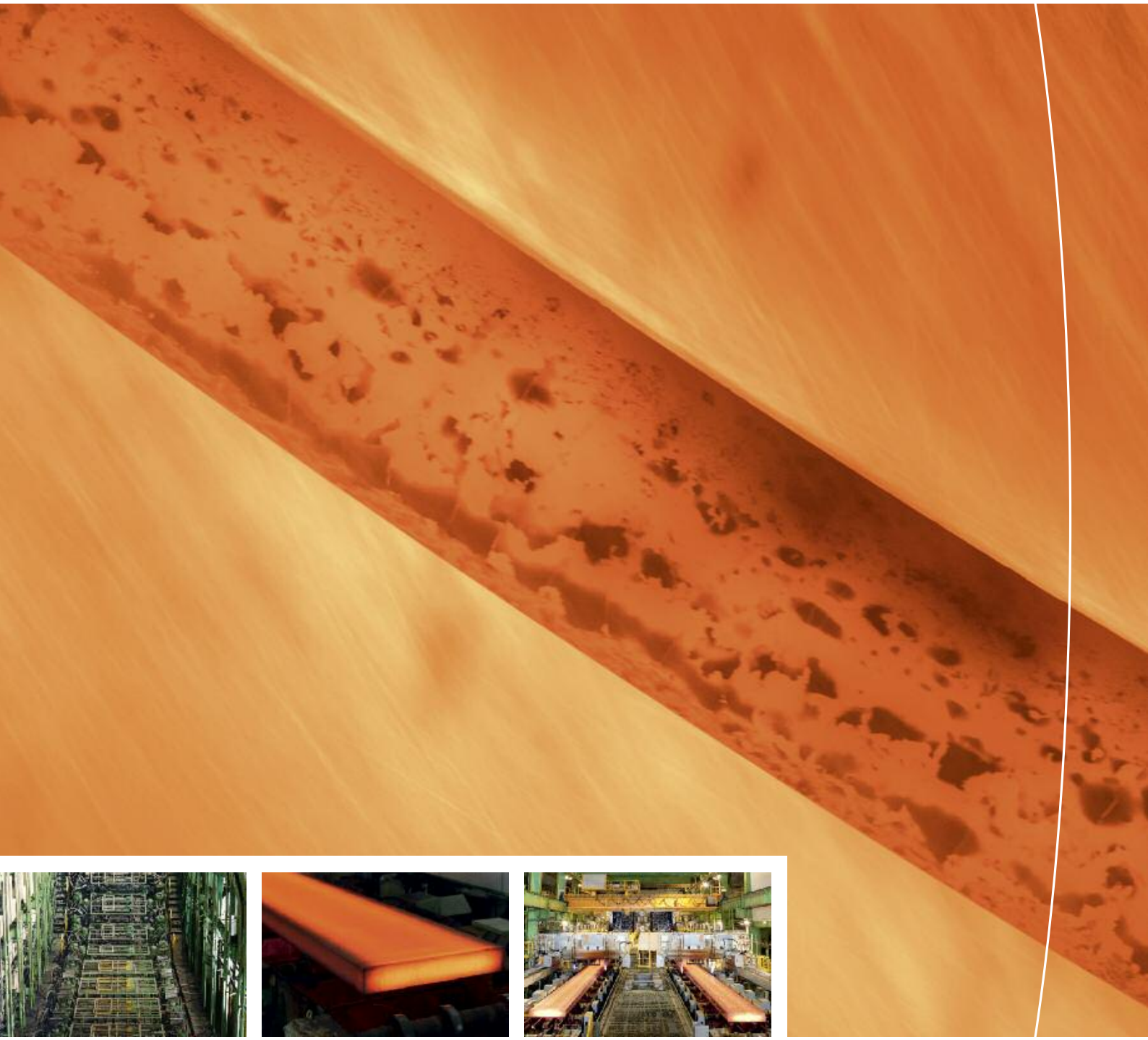
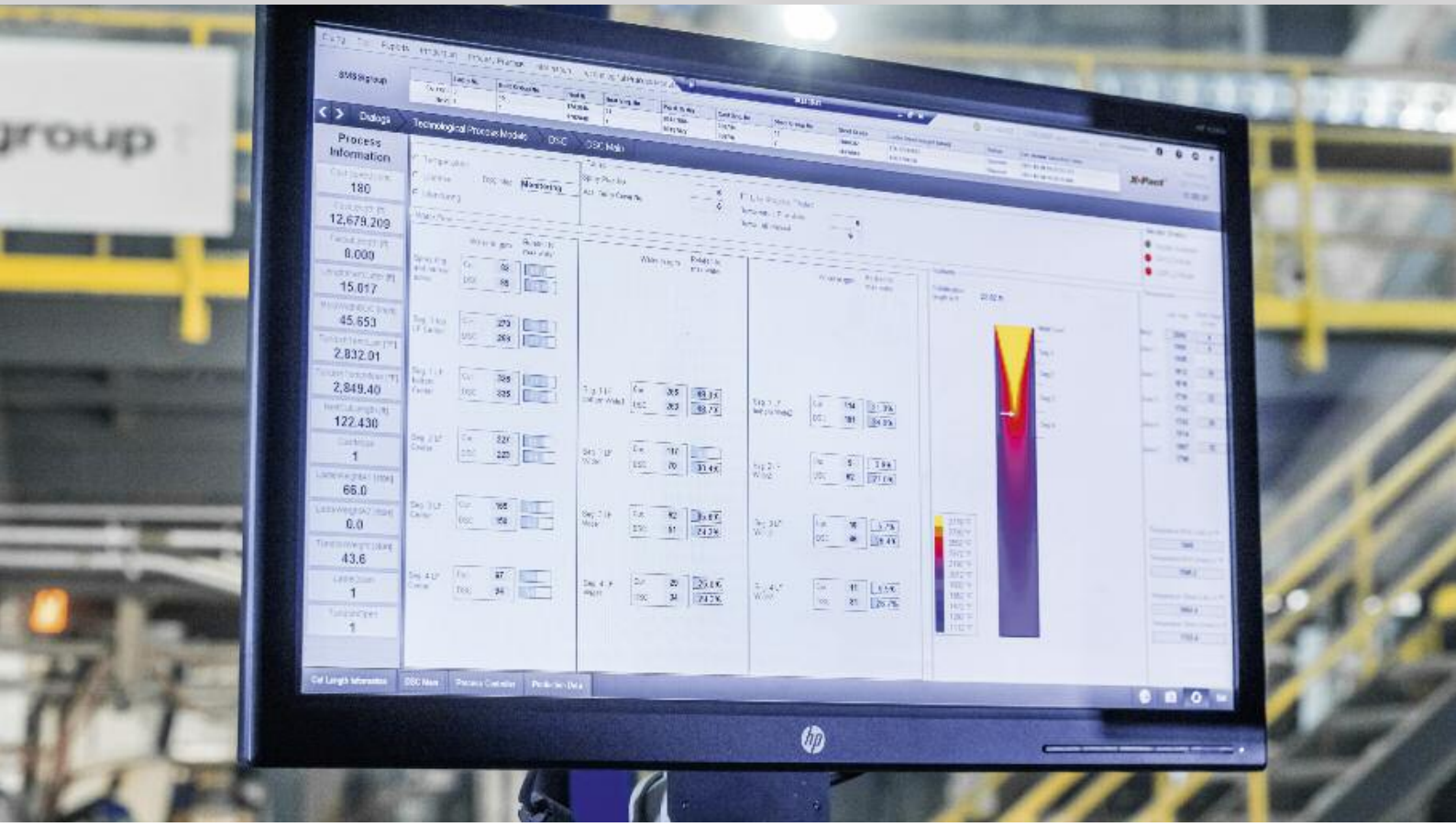
SMS group

X-Pact®

X-Pact® Solid Control

3D temperature control for an optimized cooling strategy





The challenge

The requirements to the quality of the products of a continuous casting machine have grown continuously during the last decades. In parallel, the request for higher yields have increased at the same time as well.

Thus, the metallurgist is always in dilemma between production and quality. There is usually no time to test various setup possibilities. Two of the major settings the metallurgist has to deal with are secondary cooling and soft-reduction.

An optimized cooling strategy during the whole casting process for different steel grades is mandatory for optimal quality of the product. Additional, surface cracks and edge cracks are to avoid as well as the requirement for highest slab exit temperatures for hot charging.

Soft-reduction requires to know the exact position of the solidification point within the strand. An un-accurate calculation would result in a wrong setup of the segments and in downgrading of the product.

The SMS group solution

The SMS group developed the X-Pact® Solid Control which is a metallurgical process model for dynamic temperature control with semi-three-dimensional temperature calculation. The system includes optimization of a steel grade based cooling strategy, evaluation of surface and edge crack risk to optimize product quality and assures a high slab exit temperature.

The system includes a “Process” and a “Technology” package. The “Process” package will be integrated into the plant automation; the “Technology” package serves to support the metallurgist to

- monitor the current product
- replay previous casts for analyzing quality issues
- develop/optimize metallurgical setups for new/exiting grades and is divided into a “Basic” and an “Advanced” part.

Key features

- Avoids edge & corner cracks in straightening area
- Assures homogenous solidification front
- Minimizes surface cracks
- Generates best inner quality by best possible soft reduction rates
- Assists to best surface quality
- Creates highest slab quality, fewer returns – less complains

Modernization

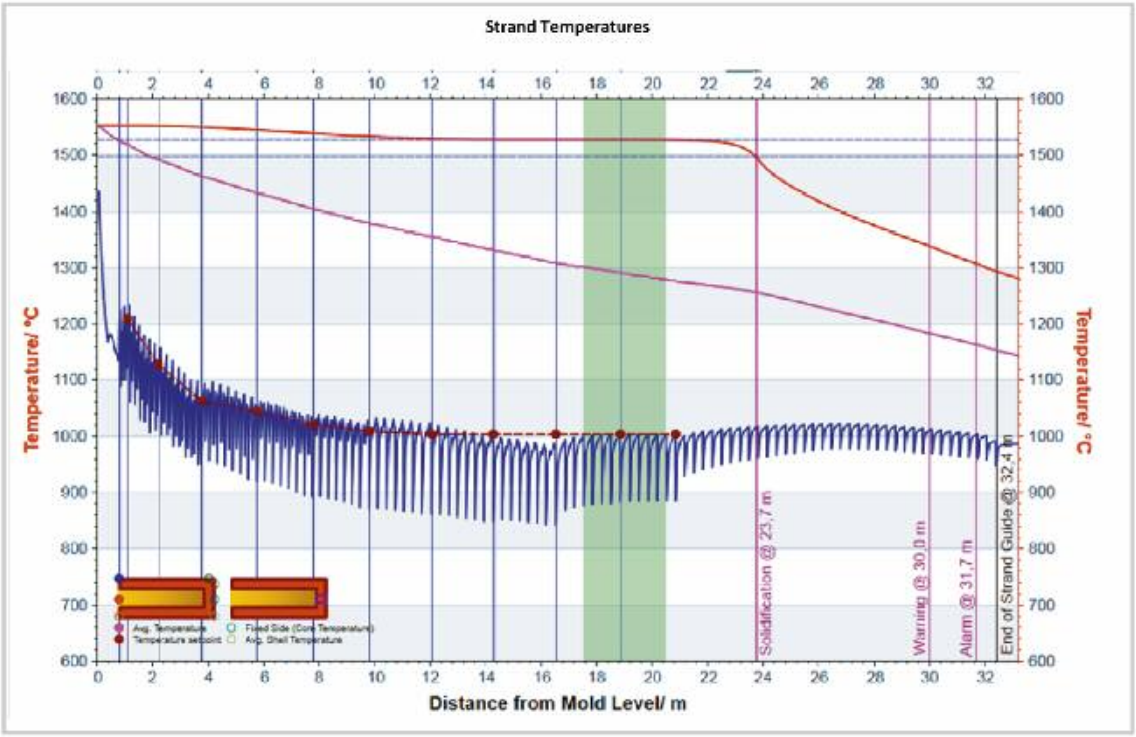
The X-Pact® Solid Control can be integrated into any existing plant.

Process Package

The “Process Package” contains the most important functions to optimize the secondary cooling. The corresponding user interface contains only the process relevant information to avoid an overload for the operator.

Common	Temperature / Lifetime Control	Adjusts the water volumes of the secondary cooling system according to a given reference surface temperature curve or based on strand age.
	Observer	Contains the observation of the solidification point. First a warning and then an alarm message will be generated in case the solidification point exceeds limits.
	Softreduction Speed	Calculates the required casting speed to bring a defined solid fraction at a certain position for best softreduction results.
	Max Cast Speed	Recommends the maximal possible grade dependent casting speed at the actual situation.
	Grade Tracker	Tracks different steel grades through the strand guidance. The secondary cooling will be adapted step wise, as soon the new grade enters a new cooling zone.
	Max Slab Exit Temperature	Maximizes the slab temperature at exit of strand guidance (only for CSP® Casters).
Solidification	Solid Front	Calculates the solidification front of the strand center across the slab width. Considers the width dependent factors of the secondary cooling.
	Isotherms of Strand Temperatures	Represents the calculated strand temperatures by a colored image in the form of a cut through the strand center as well as by a top view.
	Softreduction Preset	Calculates the solid fraction positions and sends them to the subordinated hydraulic segment adjustment. Possible, recommended and actual soft reduction area will be shown in the user interface.

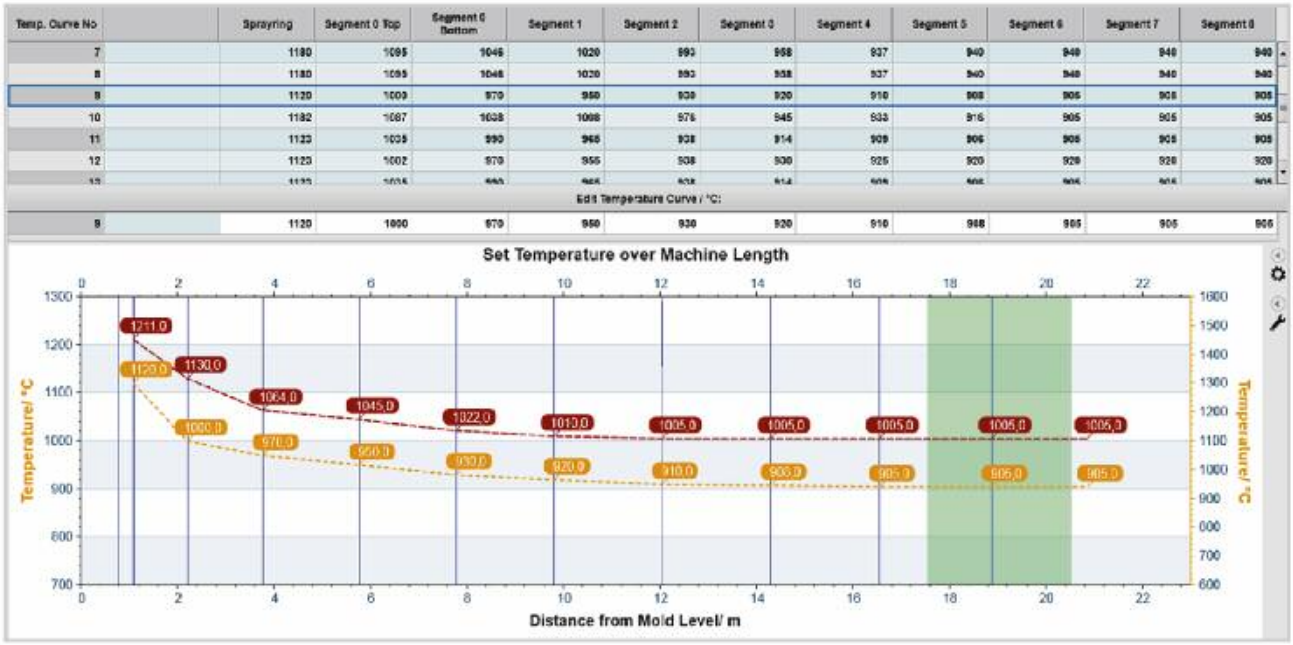
All calculations are based on a single-nozzle resolution. For quality assurance, certain data are provided at defined positions (e.g., edge temperatures, solid portions, or strain).



Basic Technology Package

The “Basic Technology Package” includes the most important calculations for the optimal guidance of the process in the bending & straightening area, a "Material Information Center" and several "Assistants" for metallurgical support.

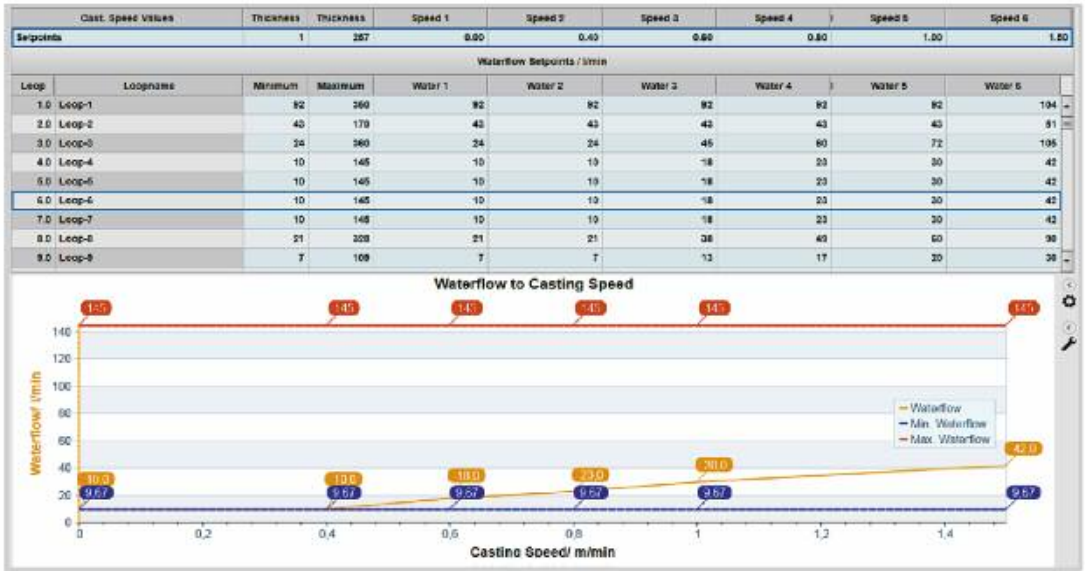
Bending & Straightening	Ductility Monitor	Monitors if the strand surface temperature is within a range of low ductility.
	Bulging Monitor	Monitors the bulging along the strand guidance and the strain at the phase boundary.
	Crack Monitor	Monitors the temperatures at the edges of the solidifying strand to evaluate the risk of edge cracks.
Material Information Center	Material Selection	Selection of material is done via chemical composition.
	Thermo-physical Properties	Calculation of thermos-physical properties (Enthalpy, Thermal Conductivity, etc.) based on chemical analysis.
	Scale	Calculates the scale growth as a function of time in air (for temperature, C-content & Si-content).
	Ductility and Strength	Contains a collection of several ductility curves and strength curves (extension possible).
	Classifier for Ductility and Strength	Allows an assignment of the current analysis to a reference material. This applies for ductility and strength.
Assistants	Temperature Curve Assist	Supports the metallurgist defining / optimizing reference temperature curves.
	Spray Pattern Assist	Supports the metallurgist defining / optimizing spray patterns.
	Segment Gap Assist	Supports the metallurgist by calculating the reference segment adjustment rates.
	Width Factor Assist	Supports the metallurgist by calculating the width depending factors for an optimized edge cooling and an homogeneous solidification front.



Advanced Technology Package

The “Advanced Technology Package” contains an extension of the “Basic Technology Package” and is required e. g. for production of crack sensitive grades (peritectic steels, micro-alloyed steels, steel with a high tendency to segregation).

Bending & Straightening	CEQ-Phase Monitor	Monitors the temperature depending phase curves. The curves will be compared with the temperature curves along the machine length.
	Lateral Expansion Monitor	Monitors the process-dependent lateral expansion and the resulting strand geometry within the strand guidance. Additionally it indicates the cold dimension of slab width at 25°C.
	Brittle Temperature Range	Monitors the thickness of the strand shell based on steel grade and casting parameters. In addition, the hot-crack-sensitive temperature range (Brittle Temperature Range) is indicated.
	Structure	Monitors the primary structure based on the “Columnar to Equiaxed Transition” model and the secondary structure based on the “Time Temperature Transformation” model.
Material Information Center — Extension	Chemical Equilibrium (CEQ)	Calculates the fractions of stable phases as a function of temperature based on the CALPHAD method.
	Micro-Segregation	Calculates the micro-segregation based on the Scheil-Gulliver model.
	Brittle Temperature Range (BTR)	Calculates the hot-crack-susceptible temperature range based on the Scheil-Gulliver model.
	Columnar to equiaxed transition (CET)	Calculates the morphology diagram for the transcristal (columnar) to the globulitic structure (equiaxed).
	Secondary Creep	Represents the elongation of secondary creep as a function of time as basis for the calculation of the lateral expansion across the machine length.
	Hot-Crack-Susceptibility	Calculates the thermal contraction in the BTR.
	Continuous Cooling Transformation (CCT)	Calculates the CCT-diagram to determine the secondary structure.
Defect Analyser	Allows localizing the origin of a crack to optimize the cooling in the corresponding area.	



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