

# LAND

## AMETEK®

### *STEEL CASTING AND HOT ROLLING* APPLICATION NOTE



Successful steel production requires accurate measurements across a wide range of temperatures, under a variety of different conditions. AMETEK Land is an experienced supplier of solutions to the steel industry, delivering dedicated solutions for key applications, and flexible instrumentation that can be customised for specific processes. Our products support process control, higher quality, lower emissions, and greater safety across the industry.



# CRITICAL TEMPERATURE MEASUREMENTS FOR HIGH-QUALITY STEEL

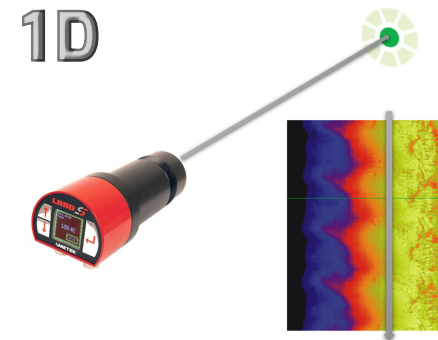
Accurate temperature measurement is essential for the production of high-quality steel. AMETEK Land's non-contact infrared thermometers, scanners, and imagers provide accurate, non-invasive measurements required at all critical positions through the tundish, continuous casting, and hot rolling mill processes. From specialised spray chamber probes, reheat furnace thermal imaging, to rugged understrip pyrometer systems, we offer choices

of single-point thermometers, scanners, and process thermal imagers for all industry applications. AMETEK Land has innovative and application-oriented solutions for your temperature measurement needs, including many unique sensor developments based on requests by our customers. We focus our experience on designing new, innovative devices and systems that help our customers achieve the highest levels of productivity and quality.

By concentrating on reliability and performance, we have created some of the most capable technologies in the world. We understand that you must have confidence that the measurements will provide accurate information during 24/7 operation in very rough, heavy industrial environments over long periods of time.

# KEY MEASUREMENT SOLUTIONS

## FIXED SPOT NON-CONTACT THERMOMETERS

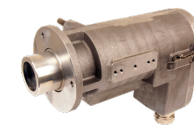


Also called infrared pyrometers, these devices have been widely used in steel mills for more than 60 years. Installed at a distance, they partly detect the infrared radiation that is emitted by the target object surface. Their non-contact operation allows them to operate out of harm's way. Additionally, because they do not touch the surface, they can accurately measure moving objects, whereas a thermocouple would be affected by friction, generating heat and eroding the thermocouple. Pyrometers and scanners also feature extremely fast response speeds, within milliseconds, this makes them very useful for measuring fast-moving strip or rod.

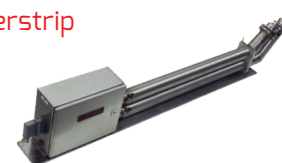
SPOT



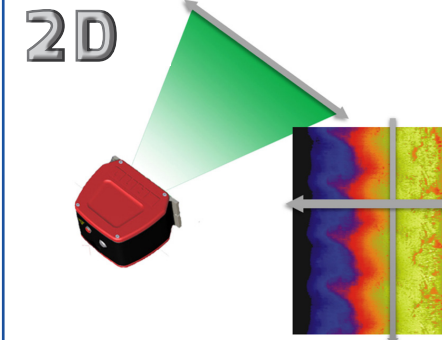
SPOT industrial enclosure



Understrip



## LINESCANNERS

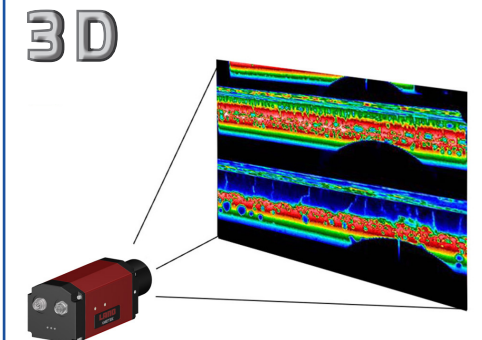


An infrared linescanner uses the periodic deflection of the optical beam path of a single, very fast, highly accurate point detector in the form of a scan line to record the temperature profile of a measuring object. For moving targets, such as when rolling steel, this results in a high-resolution surface temperature measurement. For processes requiring non-contact temperature measurement in which a very high homogeneity of the measurement over the measuring line/area is required, a linescanner is preferable in performance to even a radiometrically verified thermographic camera.

LSP-HD



## FIXED THERMAL IMAGERS



Modern markets demand higher quality, and companies expect improved profitability. Complete temperature measurement process thermal imagers provide a comprehensive picture of the product's temperature distribution. With this information, more precise process control is possible, resulting in improved quality of products, and increased customer satisfaction.

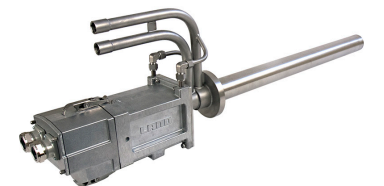
LWIR-640



NIR-656 and NIR-2K



MWIR-B-640

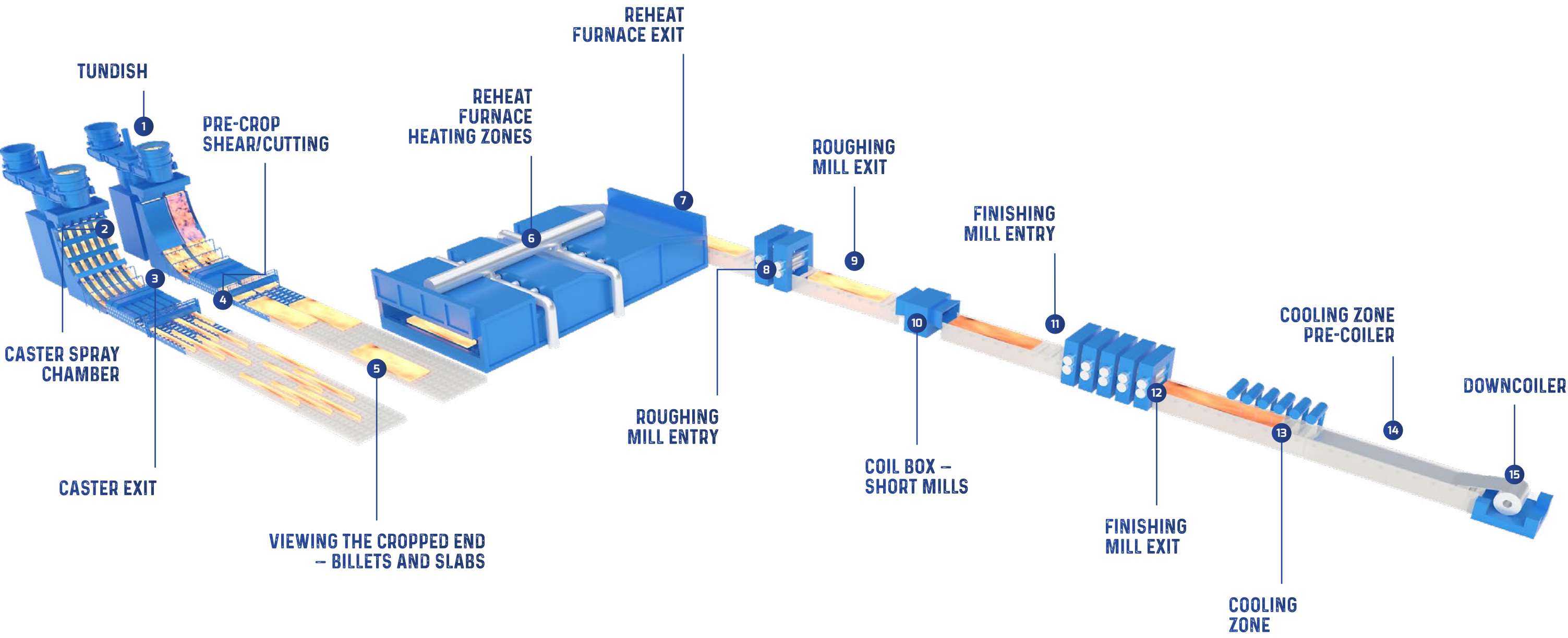




# STEEL PRODUCTION – FROM TUNDISH TO COILER



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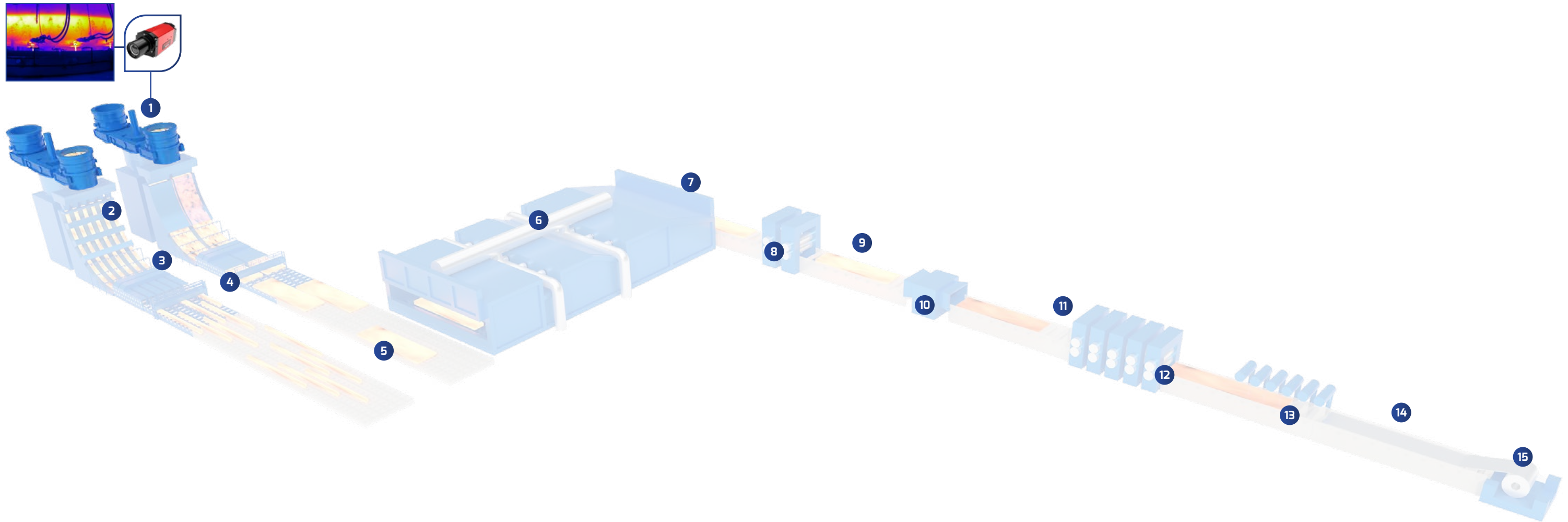


# STEEL PRODUCTION – FROM TUNDISH TO COILER



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	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640



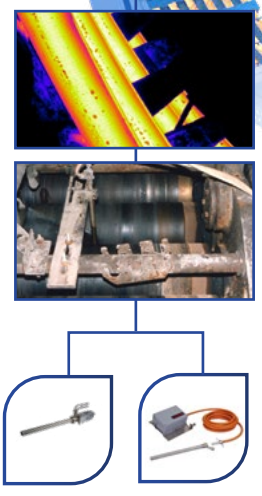
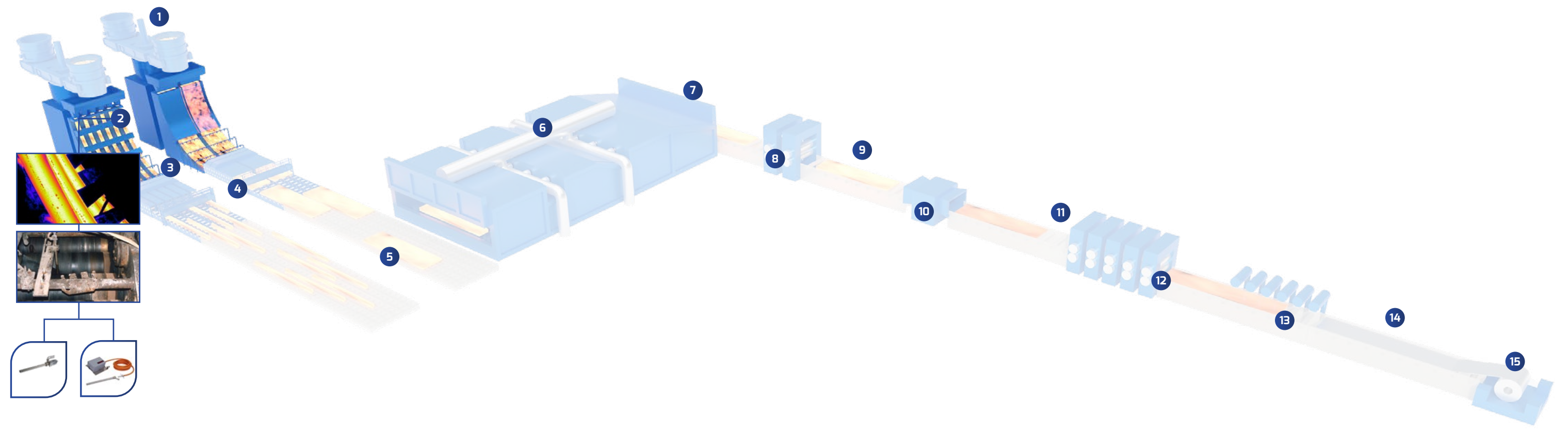


# STEEL PRODUCTION – FROM TUNDISH TO COILER



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	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber



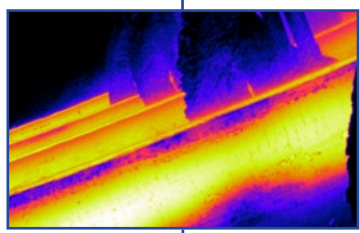
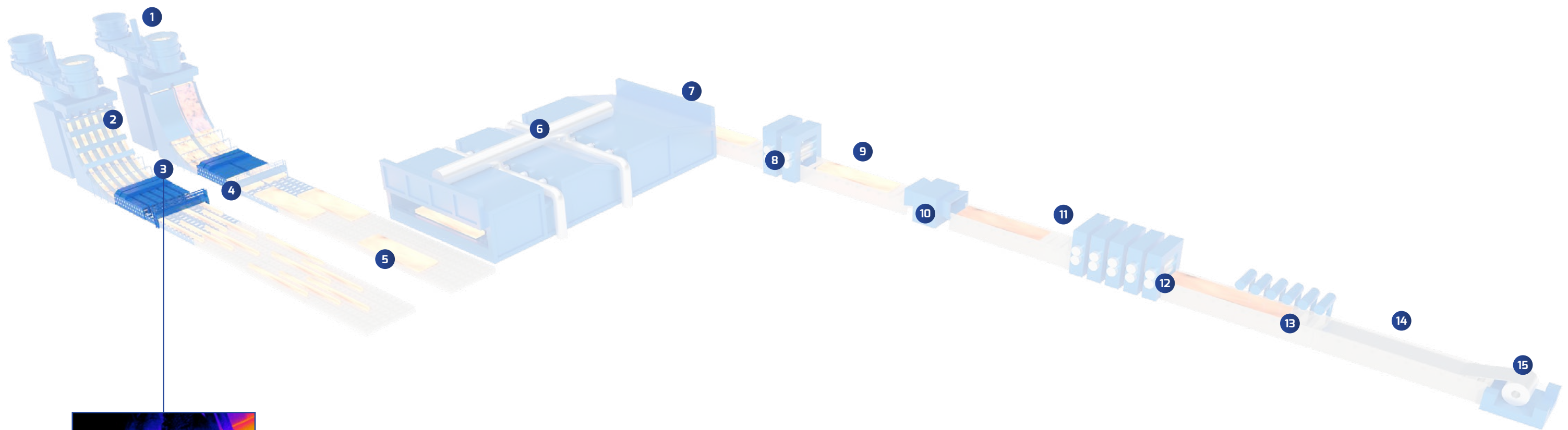


# STEEL PRODUCTION – FROM TUNDISH TO COILER



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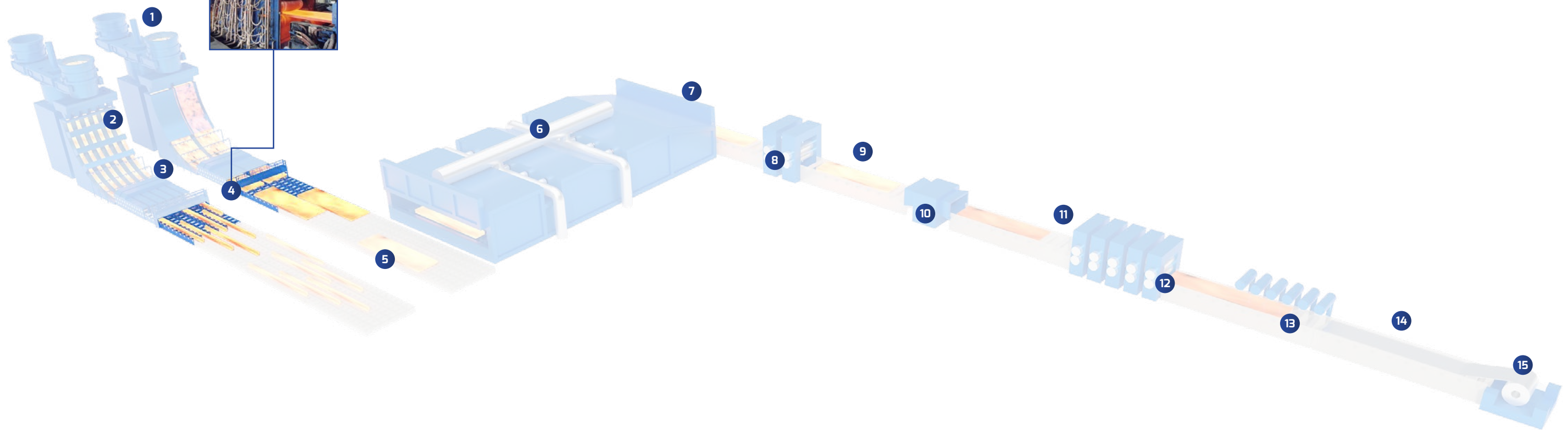
MEASUREMENT POINT	KEY PRODUCTS
1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K





# STEEL PRODUCTION – FROM TUNDISH TO COILER

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	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K

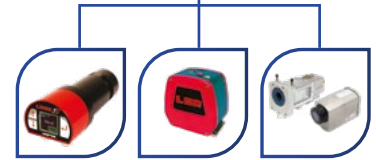
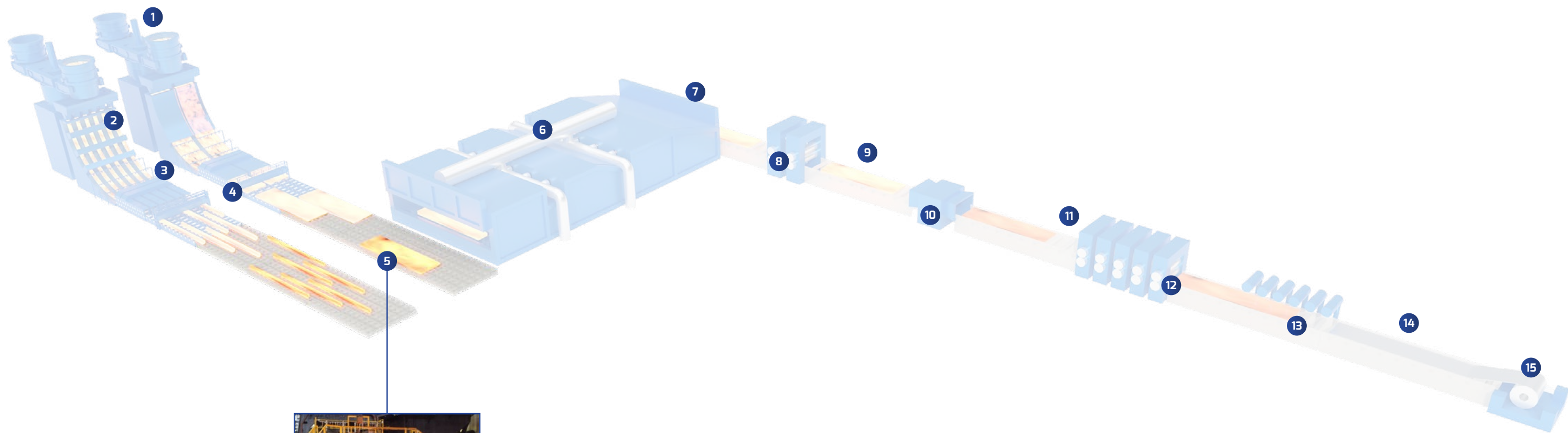


# STEEL PRODUCTION – FROM TUNDISH TO COILER



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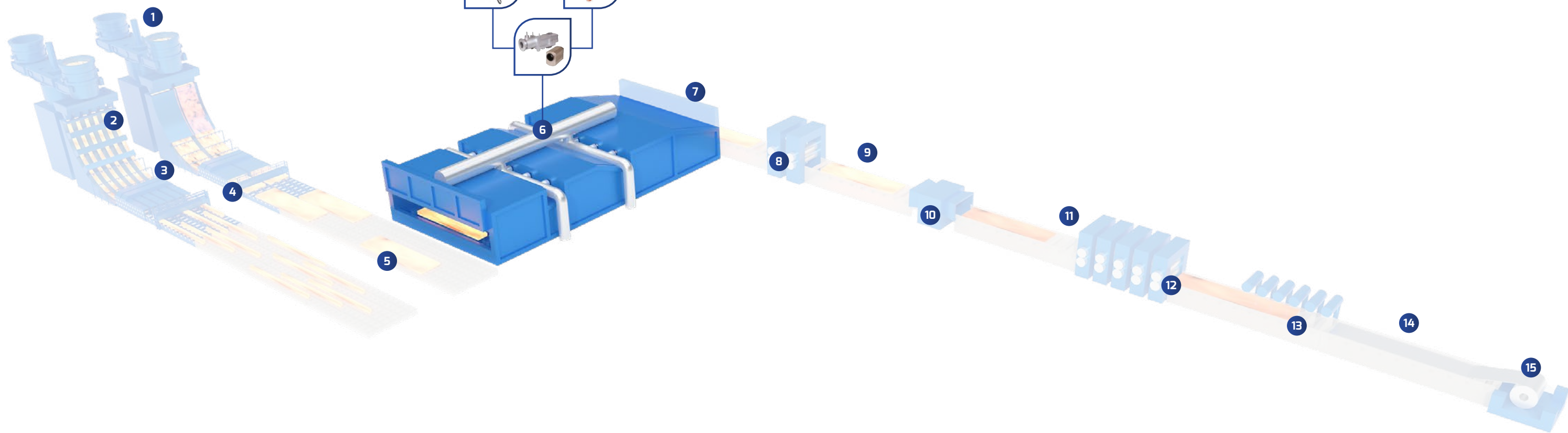
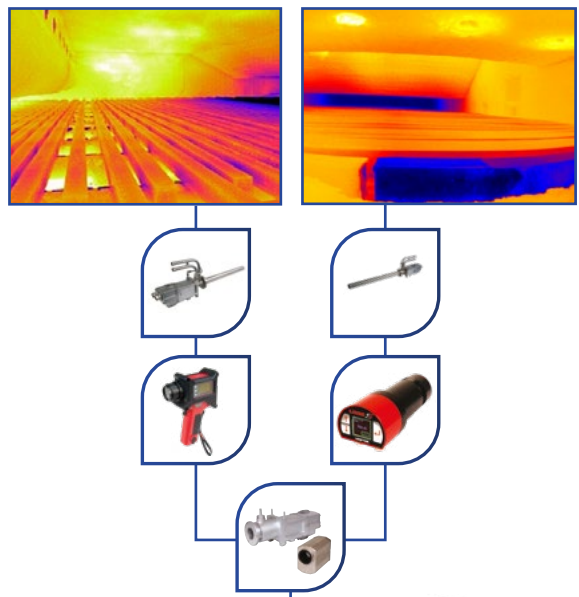
MEASUREMENT POINT	KEY PRODUCTS
1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4 Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5 Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K





# STEEL PRODUCTION – FROM TUNDISH TO COILER

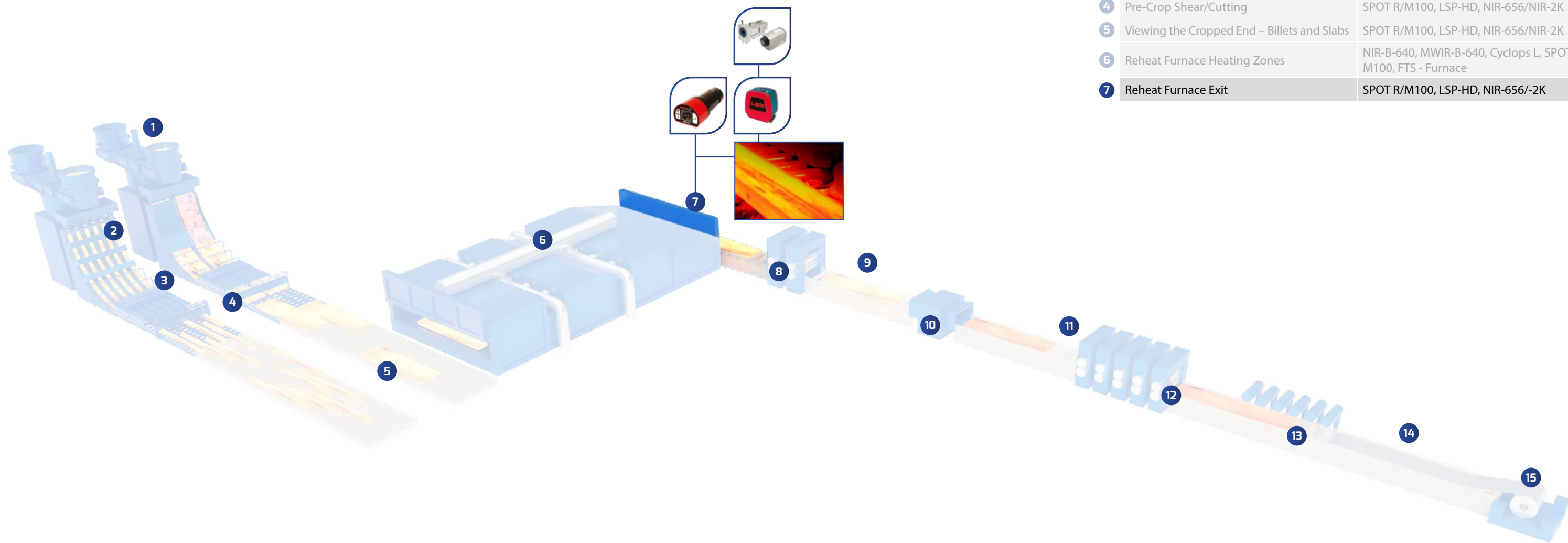
  

MEASUREMENT POINT	KEY PRODUCTS
1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4 Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5 Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6 Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace

# STEEL PRODUCTION – FROM TUNDISH TO COILER

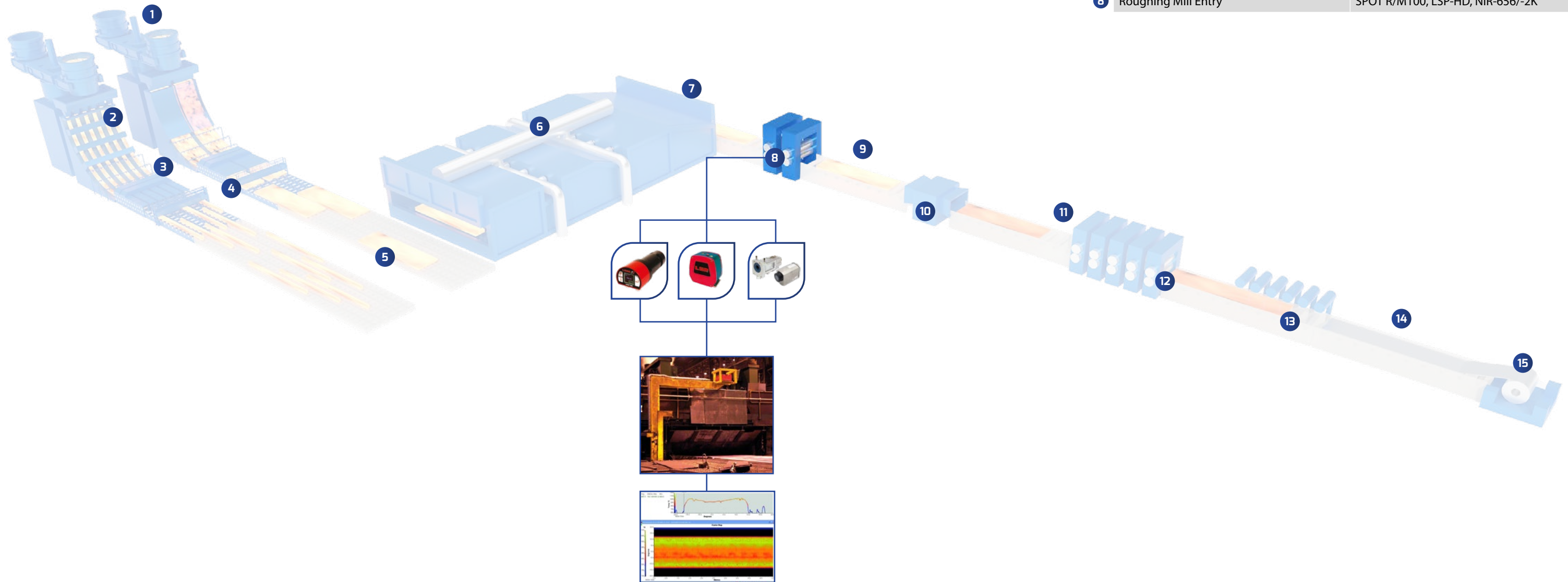
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1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4 Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5 Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6 Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7 Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K



# STEEL PRODUCTION – FROM TUNDISH TO COILER



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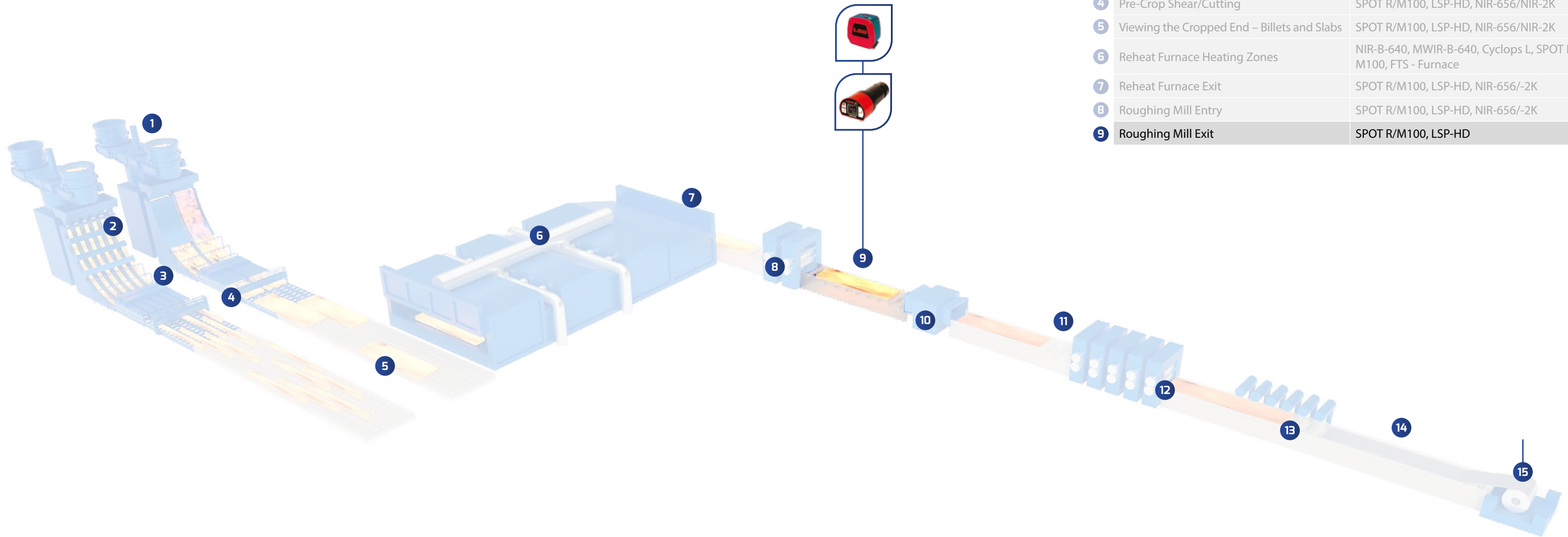


	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5	Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6	Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7	Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8	Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K

# STEEL PRODUCTION – FROM TUNDISH TO COILER



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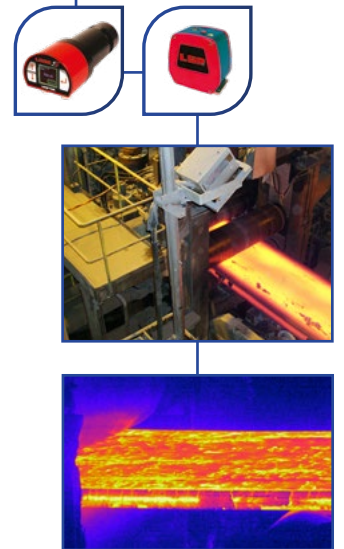
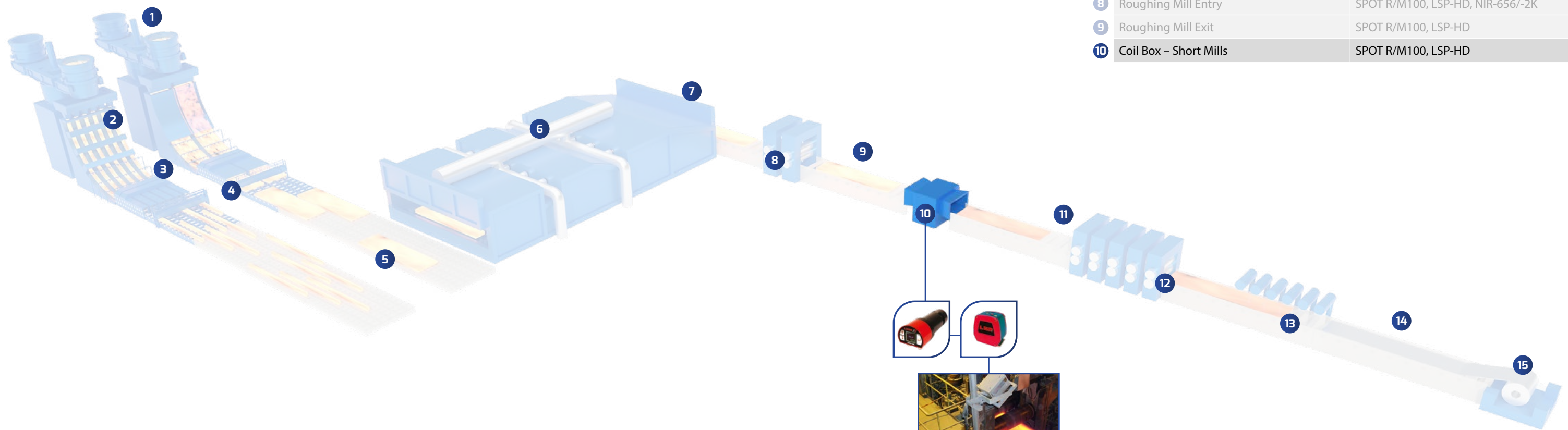


	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5	Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6	Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7	Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8	Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9	Roughing Mill Exit	SPOT R/M100, LSP-HD



# STEEL PRODUCTION – FROM TUNDISH TO COILER

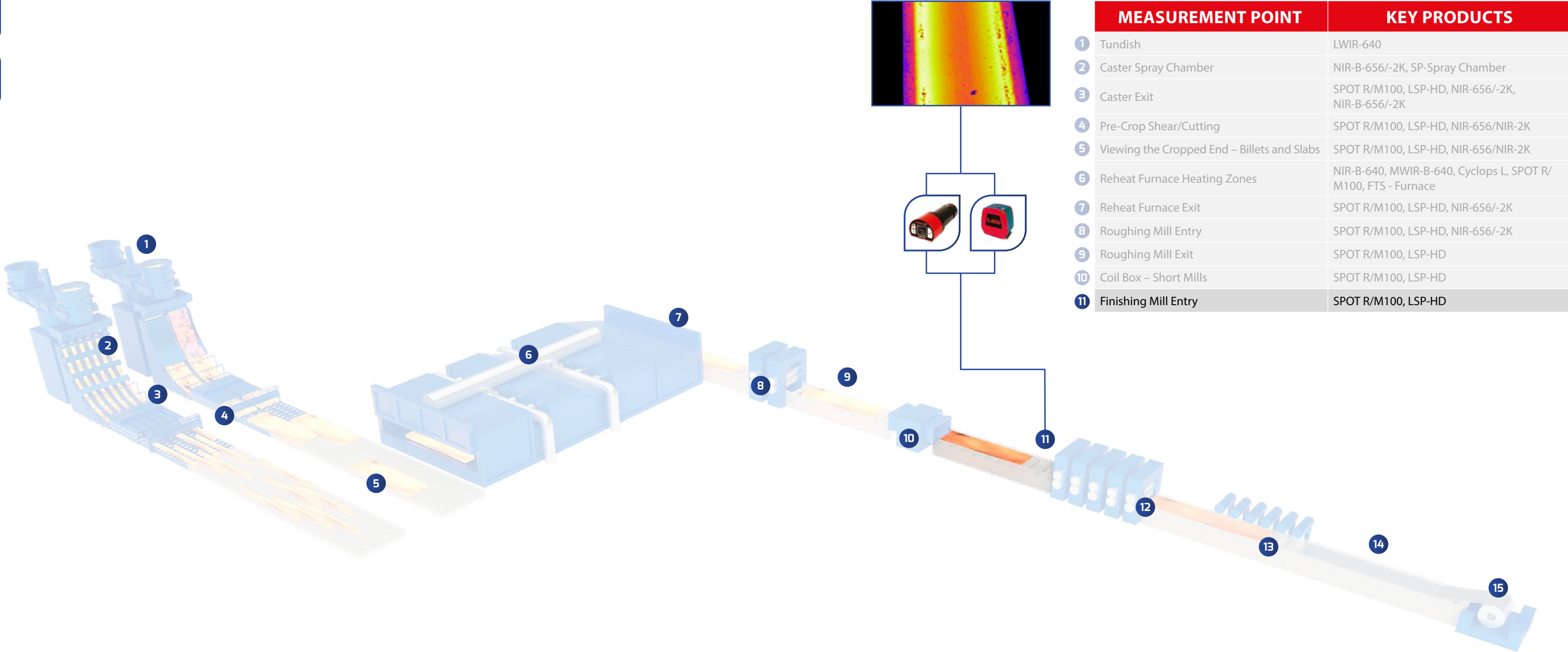



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1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5	Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6	Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7	Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8	Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9	Roughing Mill Exit	SPOT R/M100, LSP-HD
10	Coil Box – Short Mills	SPOT R/M100, LSP-HD

# STEEL PRODUCTION – FROM TUNDISH TO COILER



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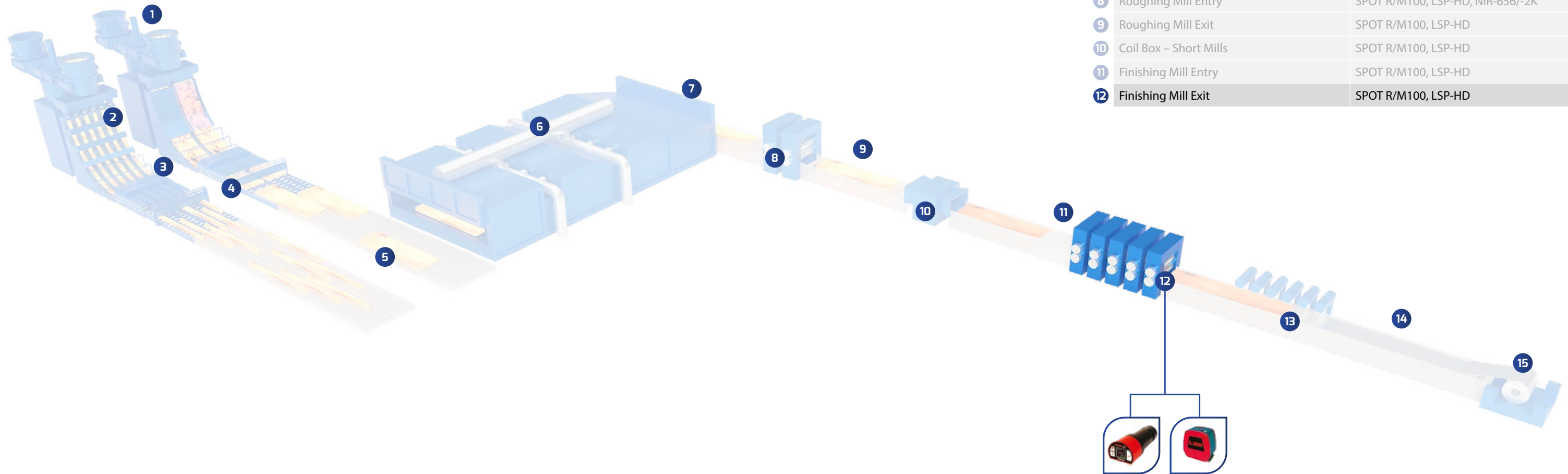




# STEEL PRODUCTION – FROM TUNDISH TO COILER



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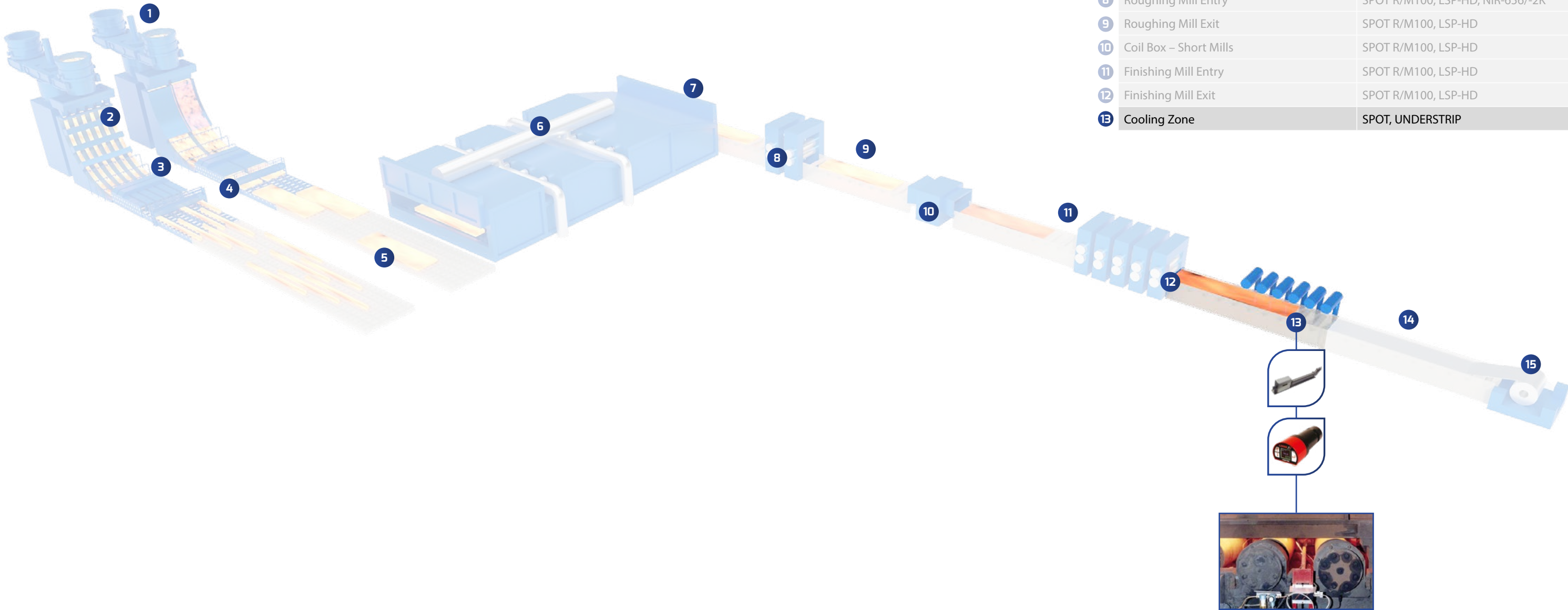


	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5	Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6	Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7	Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8	Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9	Roughing Mill Exit	SPOT R/M100, LSP-HD
10	Coil Box – Short Mills	SPOT R/M100, LSP-HD
11	Finishing Mill Entry	SPOT R/M100, LSP-HD
12	Finishing Mill Exit	SPOT R/M100, LSP-HD

# STEEL PRODUCTION – FROM TUNDISH TO COILER



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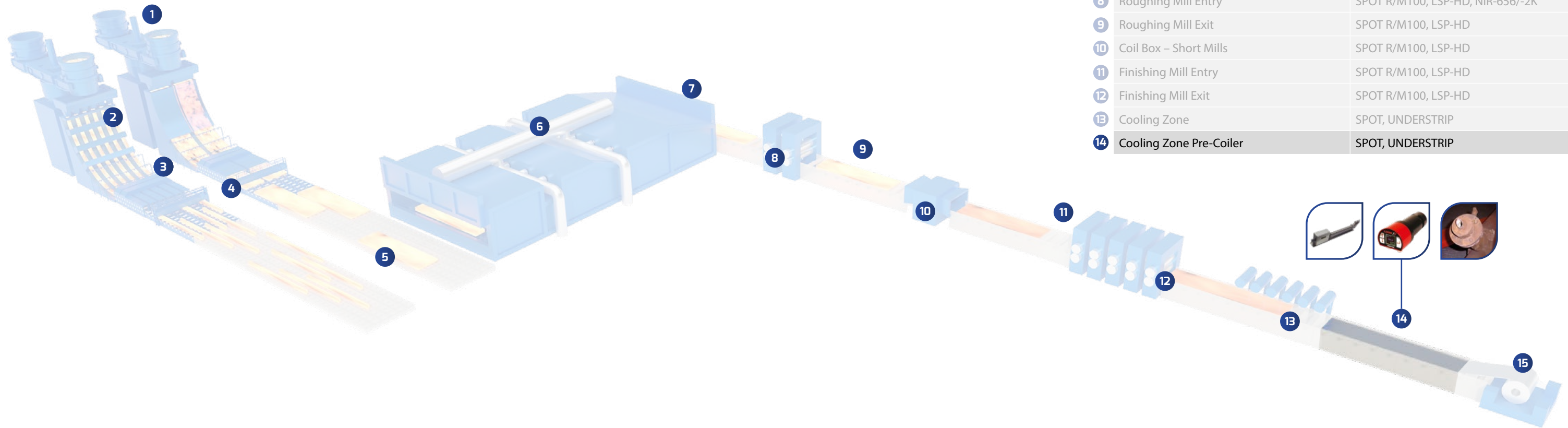
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1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
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7 Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8 Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9 Roughing Mill Exit	SPOT R/M100, LSP-HD
10 Coil Box – Short Mills	SPOT R/M100, LSP-HD
11 Finishing Mill Entry	SPOT R/M100, LSP-HD
12 Finishing Mill Exit	SPOT R/M100, LSP-HD
13 Cooling Zone	SPOT, UNDERSTRIP



# STEEL PRODUCTION – FROM TUNDISH TO COILER



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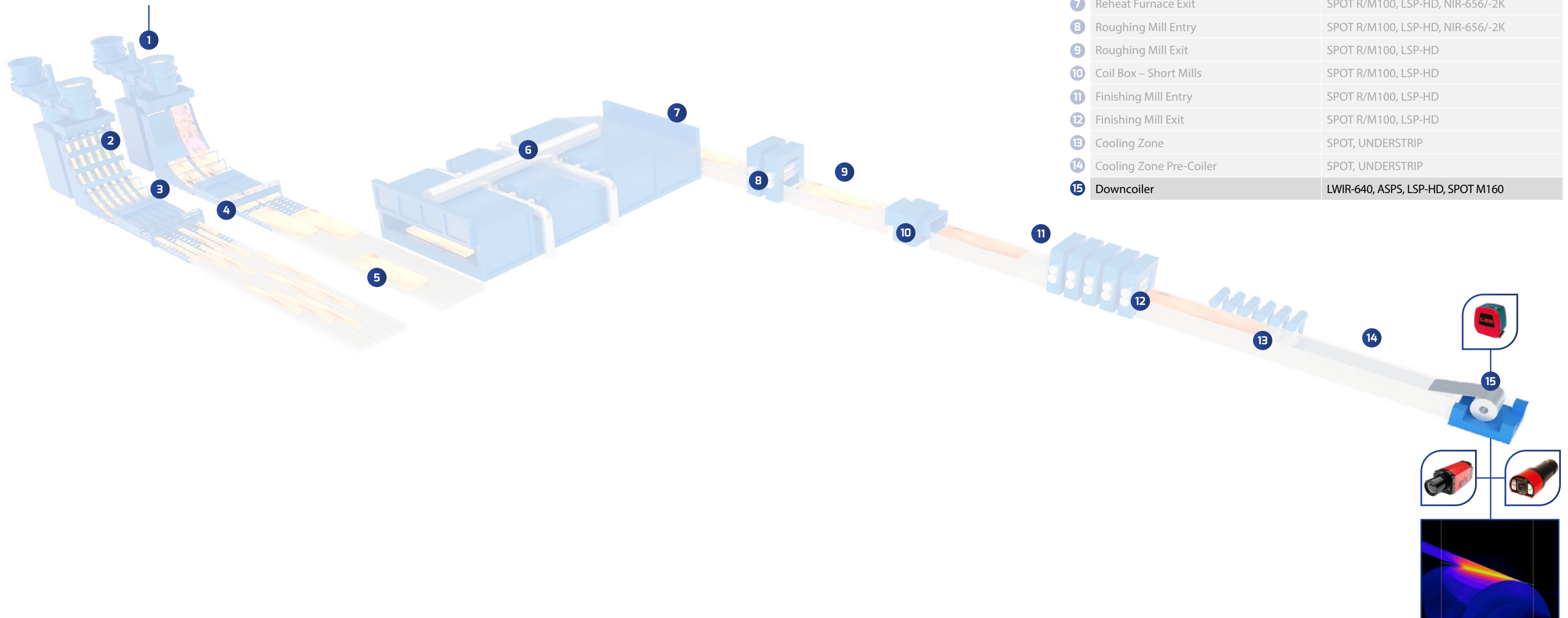


MEASUREMENT POINT	KEY PRODUCTS
1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4 Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5 Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6 Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7 Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8 Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9 Roughing Mill Exit	SPOT R/M100, LSP-HD
10 Coil Box – Short Mills	SPOT R/M100, LSP-HD
11 Finishing Mill Entry	SPOT R/M100, LSP-HD
12 Finishing Mill Exit	SPOT R/M100, LSP-HD
13 Cooling Zone	SPOT, UNDERSTRIP
14 Cooling Zone Pre-Coiler	SPOT, UNDERSTRIP

# STEEL PRODUCTION – FROM TUNDISH TO COILER



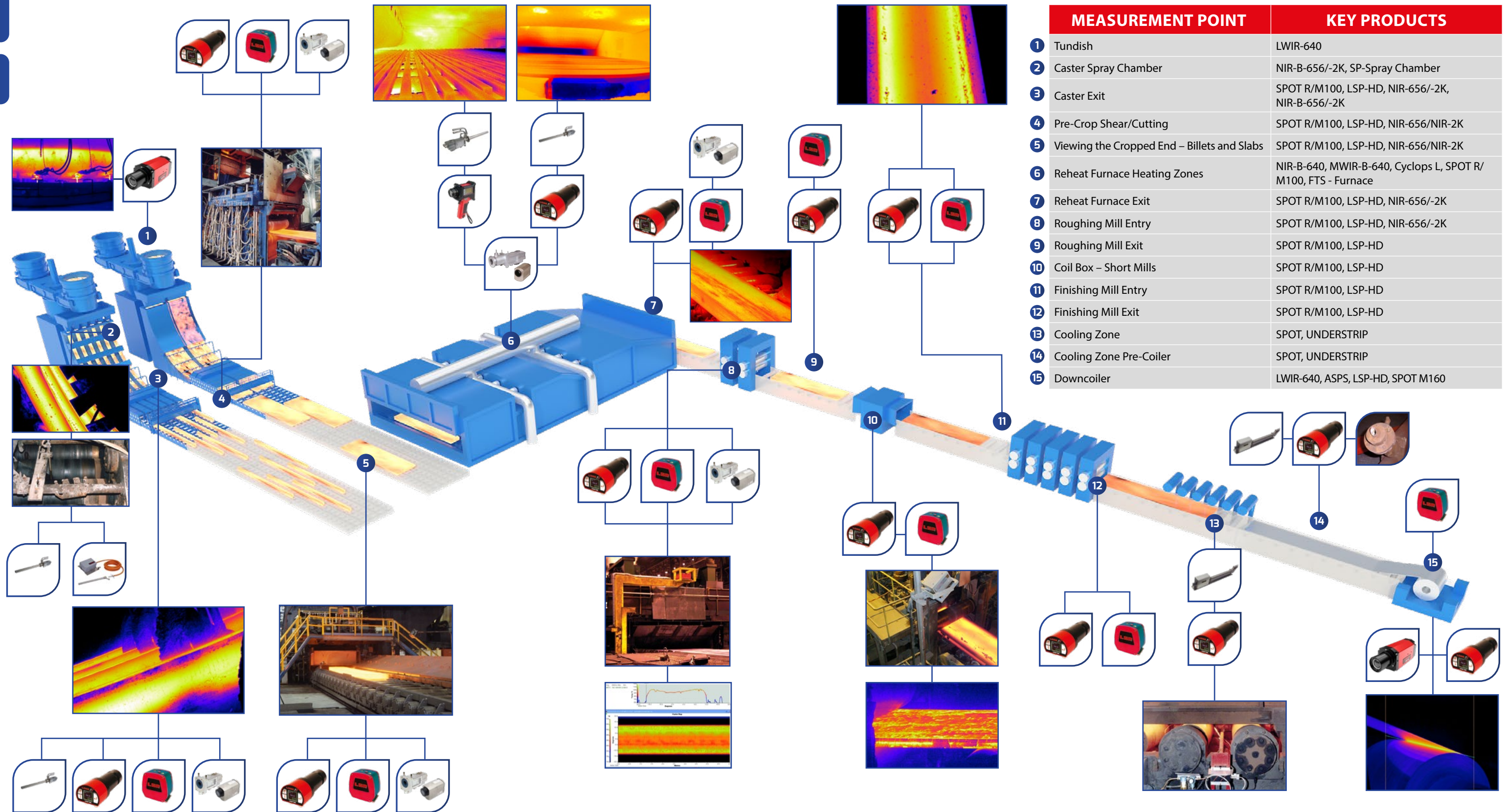
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MEASUREMENT POINT	KEY PRODUCTS
1 Tundish	LWIR-640
2 Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3 Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4 Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5 Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6 Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7 Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8 Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9 Roughing Mill Exit	SPOT R/M100, LSP-HD
10 Coil Box – Short Mills	SPOT R/M100, LSP-HD
11 Finishing Mill Entry	SPOT R/M100, LSP-HD
12 Finishing Mill Exit	SPOT R/M100, LSP-HD
13 Cooling Zone	SPOT, UNDERSTRIP
14 Cooling Zone Pre-Coiler	SPOT, UNDERSTRIP
15 Downcoiler	LWIR-640, ASPS, LSP-HD, SPOT M160



# STEEL PRODUCTION – FROM TUNDISH TO COILER



	MEASUREMENT POINT	KEY PRODUCTS
1	Tundish	LWIR-640
2	Caster Spray Chamber	NIR-B-656/-2K, SP-Spray Chamber
3	Caster Exit	SPOT R/M100, LSP-HD, NIR-656/-2K, NIR-B-656/-2K
4	Pre-Crop Shear/Cutting	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
5	Viewing the Cropped End – Billets and Slabs	SPOT R/M100, LSP-HD, NIR-656/NIR-2K
6	Reheat Furnace Heating Zones	NIR-B-640, MWIR-B-640, Cyclops L, SPOT R/M100, FTS - Furnace
7	Reheat Furnace Exit	SPOT R/M100, LSP-HD, NIR-656/-2K
8	Roughing Mill Entry	SPOT R/M100, LSP-HD, NIR-656/-2K
9	Roughing Mill Exit	SPOT R/M100, LSP-HD
10	Coil Box – Short Mills	SPOT R/M100, LSP-HD
11	Finishing Mill Entry	SPOT R/M100, LSP-HD
12	Finishing Mill Exit	SPOT R/M100, LSP-HD
13	Cooling Zone	SPOT, UNDERSTRIP
14	Cooling Zone Pre-Coiler	SPOT, UNDERSTRIP
15	Downcoiler	LWIR-640, ASPS, LSP-HD, SPOT M160



# CONTINUOUS CASTING

# THE REHEAT FURNACE

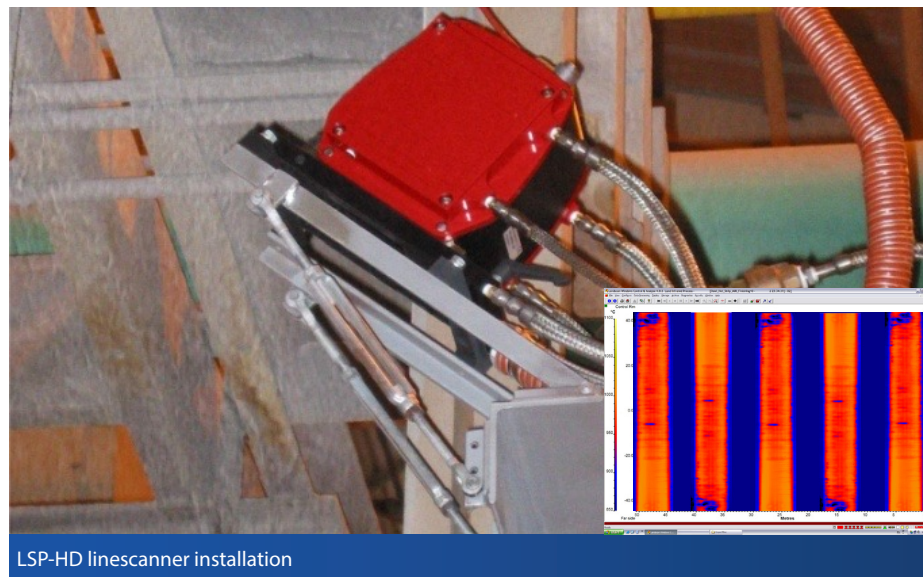
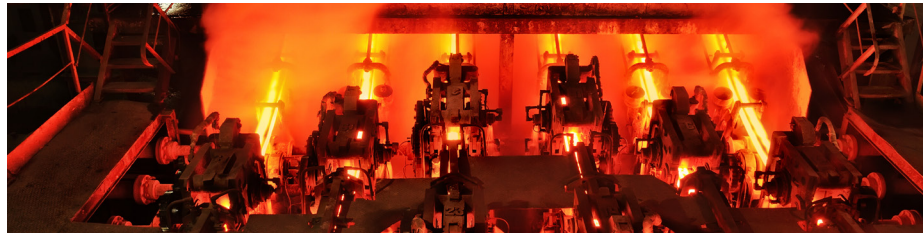
Molten steel is continuously cast into slabs or billets. As it leaves the mould, it passes through the spray chamber, where it is gradually cooled and solidified with water sprays or mist. Conditions in the spray chamber are very hostile to thermometers, so a specialised product is needed to ensure reliable operation without constant maintenance.

In addition to the high temperatures resulting from casting molten metal, any temperature measurement devices will be exposed to high-pressure water sprays, water vapour and high vibration, which may potentially influence the measurement.

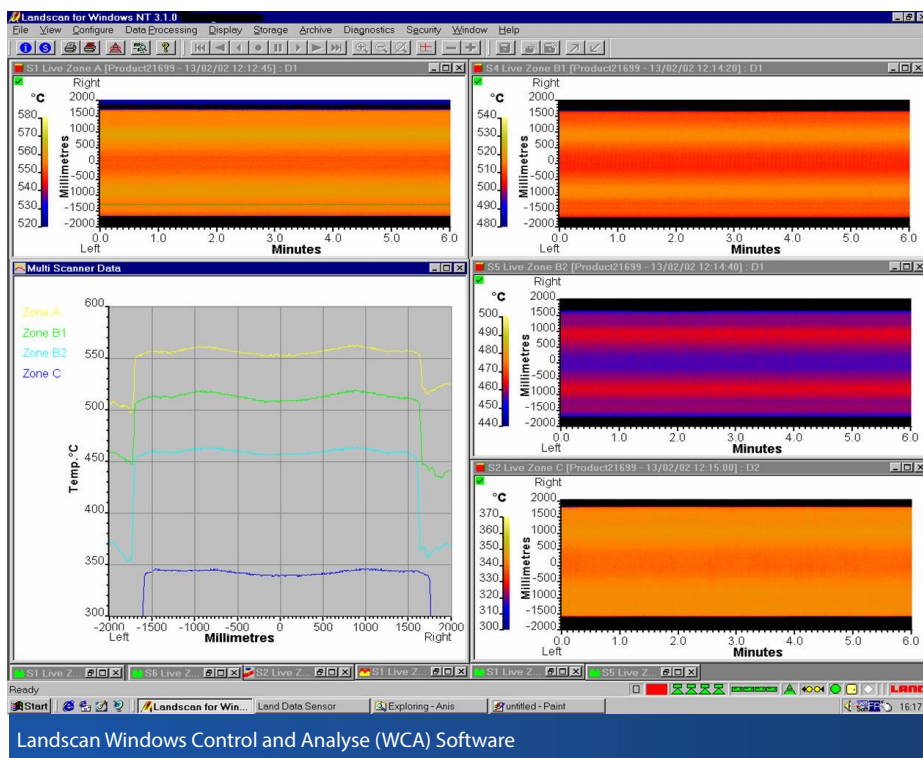
Requiring minimal maintenance, the SP spray chamber thermometer provides the measurements required to optimise cooling patterns in the chamber, influencing both product quality and process efficiency. It also helps avoid possible cracks or costly breakouts which, in addition to being a safety hazard, can cause equipment damage and operational downtime.

As the strand exits the casting stage, it passes through a straightening section before being cut to size and soaked. A temperature measurement at this stage, by a pyrometer, scanner, or imager, provides information about the cooling uniformity in the spray chamber, and about the temperature profile of the hot strand. Measurement at this location can prevent loss of containment if the slab centre is still liquid.

LSP-HD



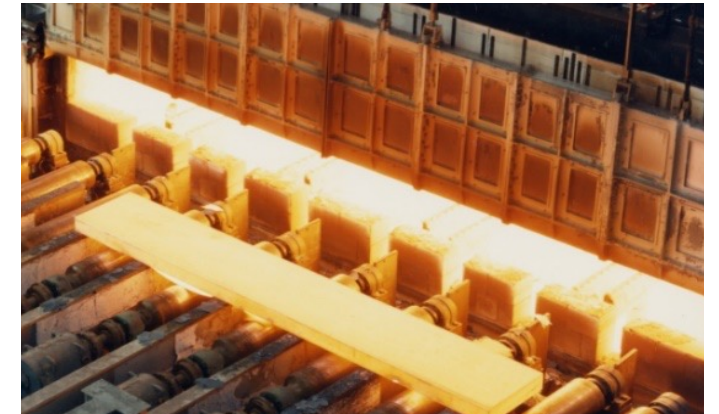
LSP-HD linescanner installation



Landscan Windows Control and Analyse (WCA) Software

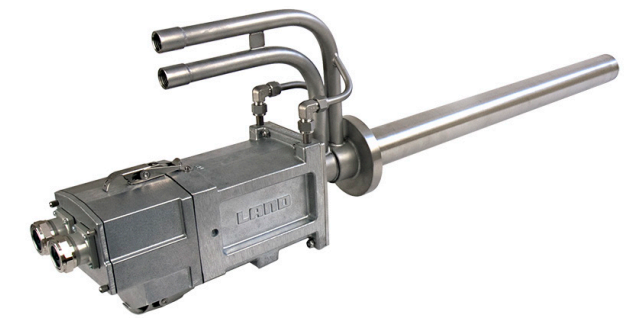


Borescope monitoring of the furnace interior



Temperature uniformity is an important consideration

MWIR-B-640



The reheat furnace brings the cooled-down steel back to the correct temperature for rolling. Temperature measurements in the reheat furnaces allow for optimised heating trajectories, providing considerable energy savings. Monitoring also ensures temperature uniformity and consistent product quality, reducing energy wastage.

Controlling the reheat furnace is key to reducing the costs of fuel and time needed for this stage. It also offers the final opportunity of checking the steel temperature before it enters the rolling mill. However, reflections from higher background temperature roof and walls in the furnace can affect the measurement. AMETEK Land's MWIR-B-640 and NIR-B process thermal imagers feature automatic background temperature

measurement and reflection compensation abilities, to achieve the highest possible temperature reading accuracies and complete furnace process monitoring, 24/7.

Borescope thermal imaging systems can be easily installed via a narrow-diameter hole through the furnace wall. The lens tip provides fields of view up to 95 horizontal degrees and offers a high resolution (up to 1968 x 1476 pixels) thermal image. Temperatures can be measured anywhere within the scene. Unlike simpler devices, the furnace imager design provides accurate temperature measurements anywhere, from the centre of the thermal image all the way out to the corners of the image in addition to a continuous real view into the furnace scene.

The MWIR-B-640 enables a continuous and clear view, even through smoke, yellow shiny flames, and furnace atmospheres, which is not possible with visual furnace camera systems. With a clear view through smoke and furnace gases, the MWIR-B-640 allows highly accurate and fully radiometric temperature measurement image data to be taken, stored, and trended over the lifetime of the furnace/boiler.

A certificate of conformity accompanies each imager, showing the calibration uniformity at various points across the imager scene. In this way, multiple objects or areas in the scene can be defined and simultaneously provide accurate temperature readings.



# HOT ROLLING MILLS

Hot rolling is used to reduce the thickness of steel to a uniform thinner level or/and forming it into profile shapes. The process involves heating the steel above its recrystallisation temperature, so the process includes heating, cooling, and rolling stages. Temperature measurements are vital throughout the hot rolling process at different stages to ensure product quality and uniformity, and to increase production yields.

Accurate non-contact temperature measurements are made, for example, after the descaler, at the roughing and

finishing stands and after the laminar cooling section before the coiler.

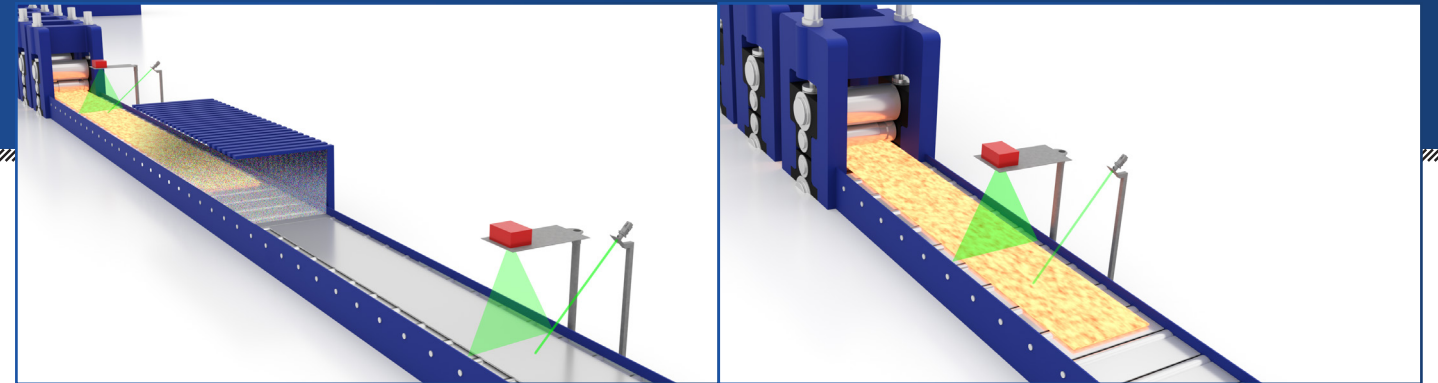
The use of scanners or pyrometers enables the end-user to verify and control the overall edge to edge temperature uniformity.

By ensuring an even temperature balance across the strip, you ensure uniform grain size and shapes and prevent camber issues.

The use of non-contact temperature measurement after the laminar cooling section allows for advanced cooling control methods like edge masking to be implemented.

Sophisticated and rugged Understrip pyrometer systems provide high quality temperature measurements when the top side of the strip may be obscured by black water.

AMETEK Land manufactures and supplies a complete range of non-contact temperature measuring systems designed specifically for hot metal rolling applications all over the world. All are designed to the highest standards of quality and reliability, to ensure continuous, accurate results in the harsh operating conditions of the hot mill for many years.



The LSP-HD linescanner in the hot rolling mill

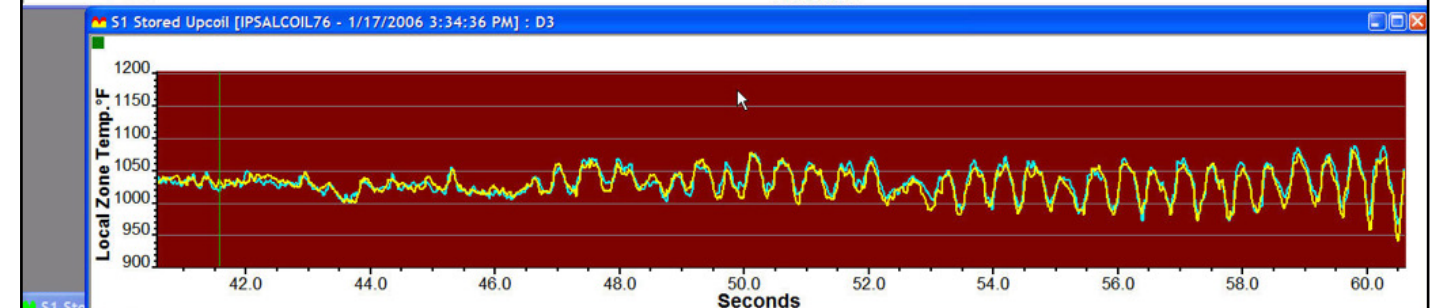
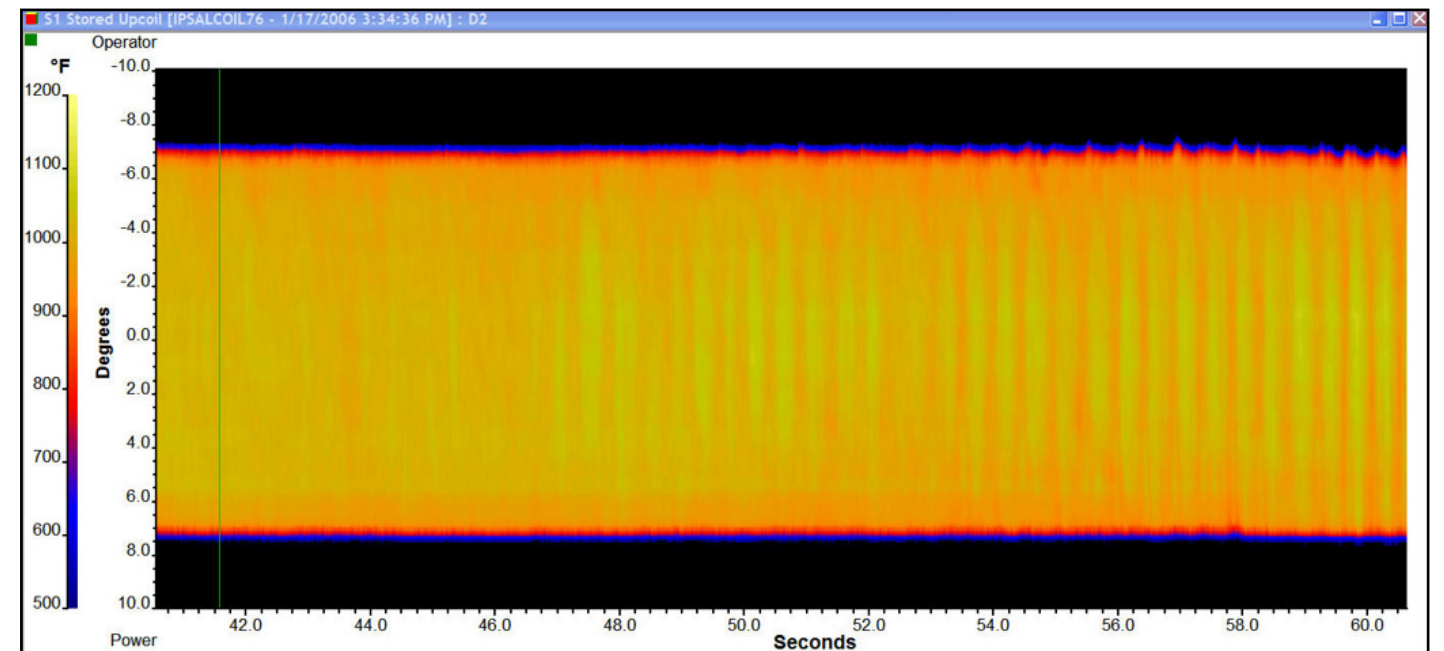
LSP-HD



SPOT



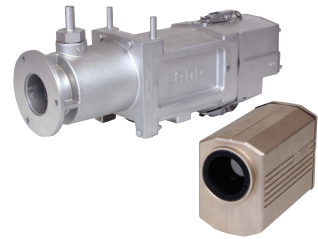
The hot rolling process



Linescanner measurements viewed with Landscan WCA software



## FTS - FURNACE



### FIXED SPOT THERMOMETERS

A range of high-precision, single spot infrared and fibre-optic pyrometers, providing exceptional flexibility across a wide range of temperatures, operating wavelengths, and applications.

**Temperature measurement range:** Model specific, from 500 to 2000 °C / 932 to 3632 °F

## SPOT



### FIXED SPOT THERMOMETERS

A family of fully-featured, high-performance pyrometers for fixed non-contact infrared spot temperature measurements. Available in range of operating wavelengths, temperature ranges and process requirements, including fibre-optic versions.

**Temperature measurement range:** Model specific, from 50 to 1800 °C / 122 to 3272 °F

## ASPS



### FIXED THERMAL IMAGERS

An application-specific version of our proven thermal imaging system, designed for temperature monitoring of metal strip and cold rolling strip processing using the wedge method.

**Temperature measurement range:** 0 to 1000 °C / 32 to 1832 °F

## LWIR-640

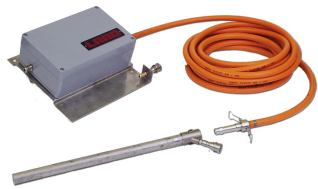


### FIXED THERMAL IMAGERS

A long-wavelength thermal imager providing a full temperature measurement range of 0 to 1000 °C (32 to 1832 °F) in two ranges with a choice of different optics and fields of view.

**Temperature measurement range:** 0 to 1000 °C / 32 to 1832 °F

## SP - SPRAY CHAMBER



### FIXED SPOT THERMOMETERS

A fibre-optic infrared thermometer system, custom-designed for temperature measurements in the hostile environment of the continuous caster spray chamber.

**Temperature measurement range:** 600 to 2600 °C / 1112 to 4712 °F

## UNDERSTRIP

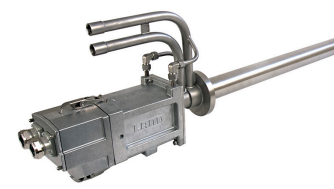


### FIXED SPOT THERMOMETERS

A fibre-optic temperature measurement system designed to provide continuous, accurate monitoring of the scale-free metal surface under the steel mill roller table. Single device or redundant systems are available.

**Temperature measurement range:** 300 to 2600 °C / 572 to 4712 °F

## MWIR-B-640



### FIXED THERMAL IMAGERS

A highly accurate radiometric infrared borescope imaging camera with spectral filtering for continuous temperature measurement and furnace profiling applications.

**Temperature measurement ranges:** 300 to 1800 °C / 572 to 3272 °F

## NIR-B-640 & NIR-B-656/-2K



### FIXED THERMAL IMAGERS

Short wavelength radiometric infrared borescope imaging cameras and systems designed for a wide range of continuous process monitoring and control applications.

**Temperature measurement ranges:** 600 to 1800 °C / 1112 to 3272 °F

## CYCLOPS L



### PORTABLE THERMOMETERS

A range of premium quality, highly accurate hand-held instruments, these ergonomic non-contact thermometers provide easy, accurate point-and-measure temperature readings.

**Temperature measurement range:** Model specific, from 200 to 3000 °C / 392 to 5432 °F

## LSP-HD



### LINESCANNERS

Compact and sophisticated high-accuracy infrared linescanner, designed to produce advanced thermal profiles and resulting images (maps).

**Temperature measurement range:** 20 to 1700 °C / 68 to 3092 °F

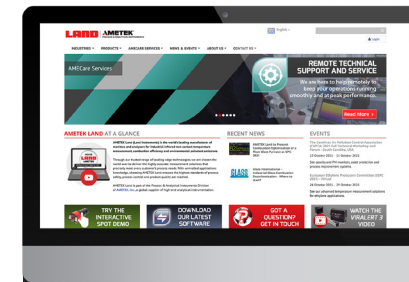
## NIR-656 & NIR-2K



### FIXED THERMAL IMAGERS

A range of high-precision thermal imagers producing high-temperature measurements in a wide range of applications.

**Temperature measurement ranges:** 600 to 1800 °C / 1112 to 3272 °F



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[WWW.AMETEK-LAND.COM](http://WWW.AMETEK-LAND.COM)

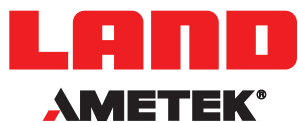
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