



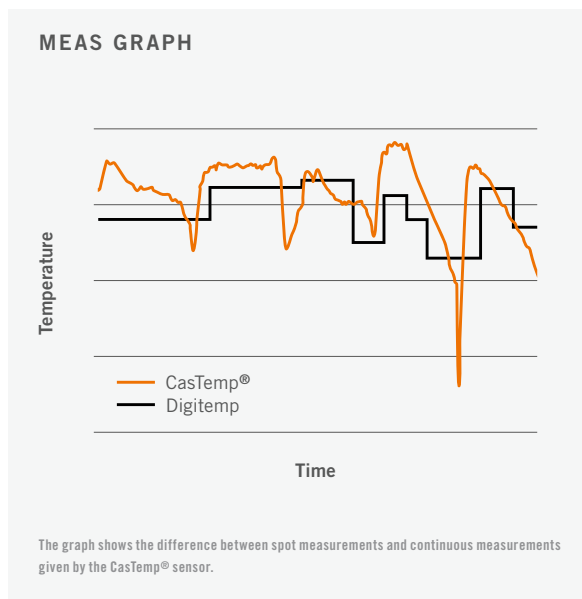
**CastTemp®**  
Continuous temperature measurement  
in liquid steel

# The CasTemp® system

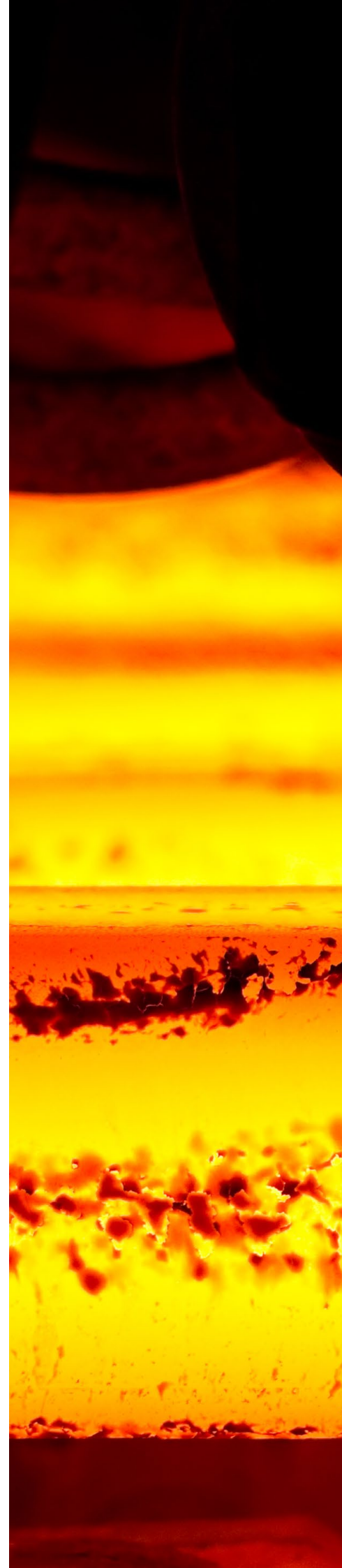
The CasTemp® system is used to safely, reliably, and continuously measure the temperature of liquid steel in the tundish. It has been designed to withstand the environment within a steel plant and is the global standard for continuously measuring temperature.

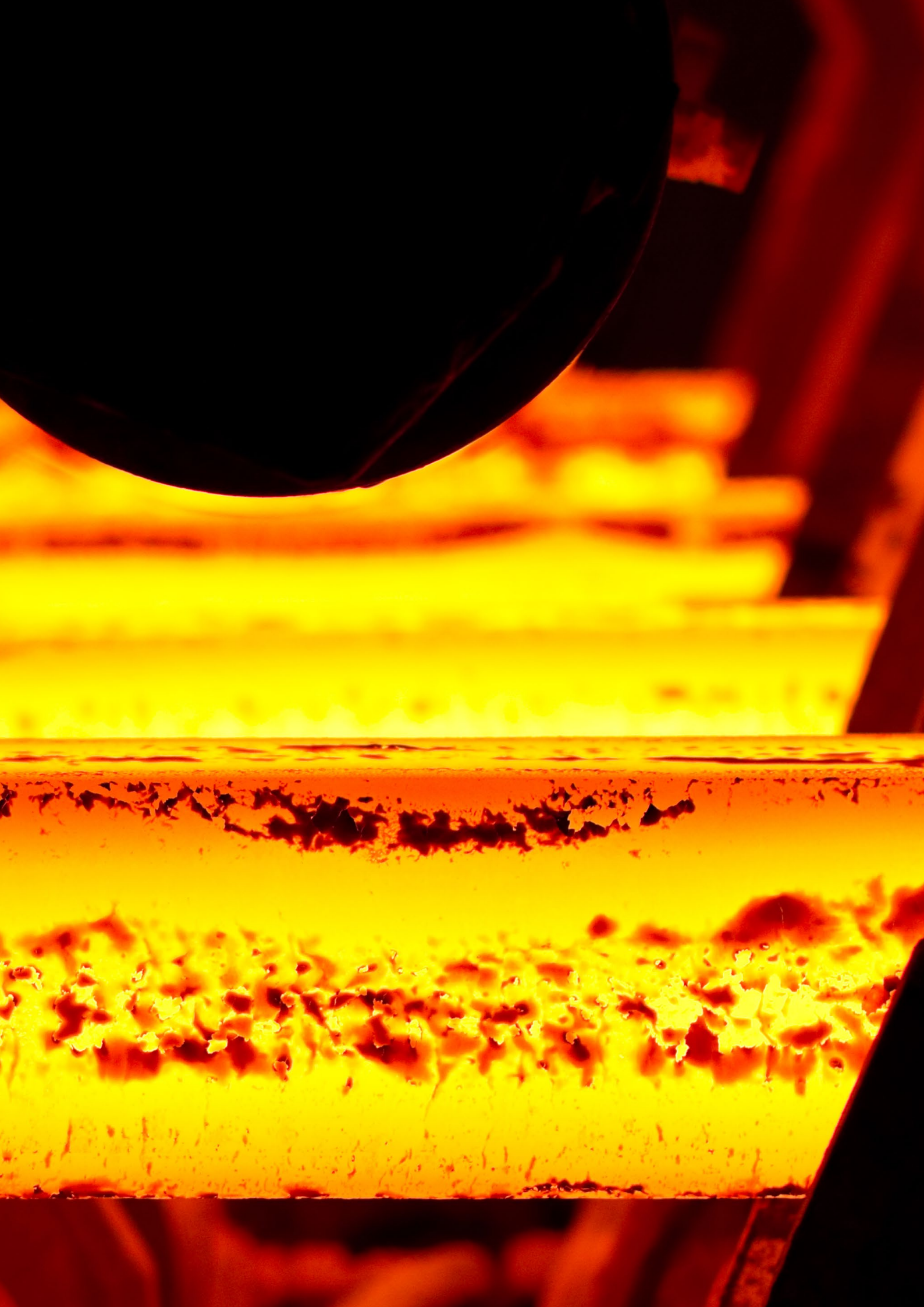
## The benefits of CasTemp® are:

- improved safety by removing the possibility of the operator being exposed to liquid steel
- continuous temperature readings throughout the whole casting sequence including preheat
- a fast response because the sensor is fully submerged in liquid steel
- improved output by optimizing the speed of casting
- reduced temperature-related breakouts and freezeoffs
- avoids contact with corrosive slag easy to install and set up
- accurate measurements during ladle changes



CasTemp® measuring graph





## The system

The following shows the essential parts of the CasTemp<sup>®</sup> measurement system



**1 Well block**

Securely holds the probe in the lining of the tundish

**2 Embedding tool**

Correctly lines the well block up in the tundish

**3 Mortar**

Secures the sensor in the block

**4 Continuity checker**

Verifies that the sensor is working

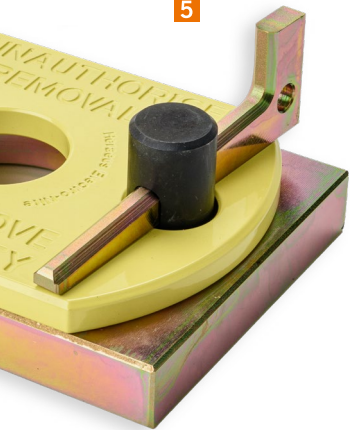
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**FIT AND FORGET**

The CasTemp<sup>®</sup> system gives an accurate measurement throughout the casting sequence and is positioned close to the steel outlet. It is a 'fit and forget' system that does not need any handling.

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**5 Application system**

Locks the tundish equipment in place

**6 CasTemp<sup>®</sup> instrument**

Processes and displays the measurements

**7 CasTemp<sup>®</sup> sensor**

Continuous immersion temperature sensor for molten metal

**8 QUBE CTW**

Battery-powered unit transmits measurement data via high-integrity connection

# Setup, Operation and Measuring

## Preparing the system

The CasTemp sensor is inserted through the sidewall of the tundish using a system specifically designed mounting system.

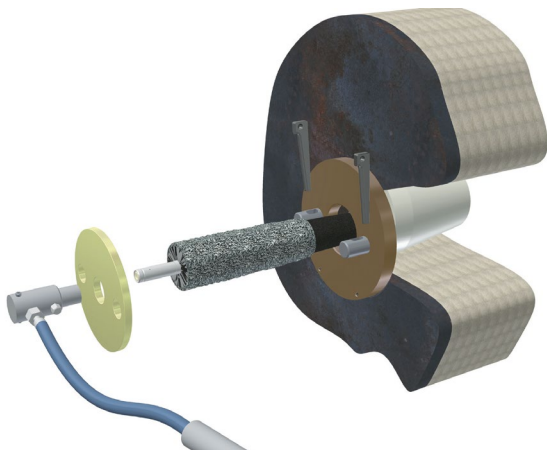
The sensor can be used in all types of tundish. The CasTemp® system is quick and easy to install.

## Using the CasTemp® Sensor

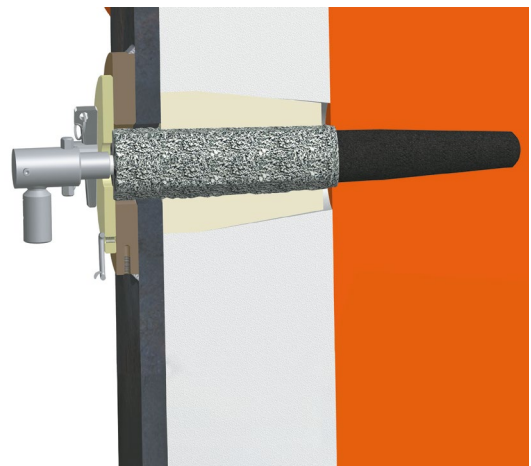
The sensor contains a type-B thermocouple housed in a robust refractory sheath, which can withstand thermal shock and gives a fast temperature response.

## Measuring

CasTemp® continuously measures the casting temperature throughout a casting sequence enabling closed-loop caster control.



Operation of the CasTemp® sensor



The CasTemp® retaining system

The system is not affected by the level of liquid steel or slag, or the machine being used.

Heraeus



Electro-Nite



CasTemp 



# CasTemp® Wireless instrument

The CasTemp® instrument is a robust instrument that can be placed close to the measurement point.

The large display makes sure that it can be read at a distance of up to 30 metres. It sends temperature data from the sensor to the control room and has a number of communications options, which are programmable. It eliminates the need for fixed cabling and results in improved safety and reliability and is designed with a simple connection protocol to ensure robust synchronization.

**The benefits are:**

- the CasTemp Wireless system is simple to install, set up, and operate
- it improves safety: no maintenance on cabling in restricted and dangerous locations
- operational and cost benefits:
  - Easy operator setup
  - No cabling/connectors from the sensor to instrumentation
  - Long-Life battery technology

**QUBE CTW**

The Qube CasTemp Wireless (CTW) is connected to the sensor and transmits measurement data to the CasTemp Wireless Instrument. QUBE CTW is battery-powered and is identified with a unique serial number, which ensures 1:1 pairing of the CasTemp sensor with the instrument.

**When in search mode, the measurement steps are typically:**

- Connect the QUBE CTW to the CasTemp sensor
- Note the unique serial number of the QUBE CTW
- Pair the QUBE CTW to the sensor

Pairing is confirmed both by the instrument display and the QUBE CTW LED sequence. The measurement continues automatically. Resetting or disconnecting the QUBE CTW results in “unpairing”.

The following shows a typical display of temperature measurement data on the CasTemp Wireless instrument:



CasTemp® Wireless instrument





CasTemp® Wireless instrument

### Pairing protocol

This has been designed to maximise measurement integrity in a simple-to-use and reliable way.

There may be several CasTemp Wireless systems in operation on a steel plant; and it is vital to direct the CasTemp sensor information to the correct process control system:

- The simple 1:1 pairing process involves and assures the operator
- Once “paired”, the QUBE CTW cannot be paired with other CasTemp Wireless instruments: it is a unique link
- The QUBE CTW remains linked to the CasTemp instrument until it is unpaired

**The simple-to-use 1:1 pairing protocol means that it is possible to build an economical system that is easy to operate and maintain.**

The optimal system uses one CasTemp instrument system for each tundish car, each monitoring its own QUBE CTW and enabling the measurement of preheat, casting, and post-cast liquidus temperatures without changing or resetting the QUBE CTW's.

### Communication

The CasTemp Wireless instrument links to the plant computer and has a number of programmable communication options:

- Remote Viewer application to view the instrument screen and download data files over a network connection
- Multiple Anybus protocols

# CasTemp® Superheat

Dynamic superheat control is essential for optimising the continuous casting process, requiring knowledge of the tundish temperature above liquidus. Good control of superheat will help ensure high quality production and productivity.

Liquid steel temperature is obtained using the CasTemp “through the wall” continuous temperature measurement, which is optimally sited near the tundish outlets. Therefore the liquidus has to be accurately

and consistently measured to ensure a viable dynamic superheat for casting operations, and future enhancements such as automated speed control. Liquidus is measured by the direct reading CasTip liquidus probe.

CasTemp Superheat is a development of the established CasTemp Wireless system and combines a QUBE CTW module and QUBE CasTip to deliver the CasTemp and CasTip measurements, providing an economical and reliable dynamic superheat value promising greater accuracy than existing methods.

The system is wireless and it is designed with a simple connection protocol to ensure robust synchronization built on the existing CasTemp Wireless system protocol.

A configurable user interface (UI) can be easily adapted to provide a digital superheat display suitable for shop floor operation, or graphical trending for use in the control room.



CasTip probe

#### The benefits are:

- dynamic superheat through casting of the ladle
- in built trending package
- no cabling/connectors from the sensor to instrumentation
- long-life battery technology
- advisory knowledge of superheat to the end of the ladle using forward prediction
- existing CasTemp® Wireless users can benefit through a software upgrade

#### Potential benefits that can be realized include:

- automated casting speed control can be implemented by users
- improved consistency of operator decisions offered through use of the trending and prediction package
- faster casting
- increased productivity
- improved steel product quality
- lower superheat in the ladle
- reduction in input energy costs

#### Liquidus Determination

A number of liquidus equations are in regular use and calculate the liquidus from the steel chemistry. As all equations start at the nominal melting point of pure iron, then error in liquidus temperature is magnified by incorrect coefficients as alloy content increases, in particular carbon.

Equations also differ in the constant chosen to represent the melting point of iron, so there can be inconsistency in prediction even at lower carbon contents. Many plants choose to define a single value for liquidus for a casting sequence, based upon grade chemistry, whilst others use sample analysis.

Whilst the grade liquidus value is stable, its accuracy on a given ladle is dependent upon the deviation of the casting analysis from the grade chemistry used in the calculation.

Liquidus obtained from sample analysis is dynamic and relevant to the ladle in question, but is subject to uncertainties caused by analytical technique, delay, sample quality and, indeed, sample identity. The accuracy of the liquidus is mainly determined by the selection of the equation, and its precision mainly by the variation of the alloy content values used in the calculation from the actual chemistry in the tundish.

**CasTip is a direct reading liquidus probe which records the liquidus arrest plateau during solidification of a captured sample. It is optimized for use in the tundish, and will deliver a stable plateau using thermocouple technology for interpretation by the CasTemp Wireless measurement instrument.**

# CasTemp® Superheat System Components



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**1 CasTemp Wireless instrument**

**2 QUBE CTW**

battery-powered unit transmits CasTemp continuous temperature measurement data to the CasTemp Wireless instrument

**3 CasTemp “through the wall” continuous measurement sensor**

**4 CasTip probe & holder**

immersion probe for liquidus determination attached to a standard pole and connected to the QUBE CasTip by an internal signal cable

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### Continuous Temperature Measurement

Obtaining an accurate liquid steel temperature trend is fundamental to the CasTemp Superheat system. This measured by CasTemp via the QUBE CTW module.

### Liquidus Measurement

CasTip is a direct reading liquidus probe which records the liquidus arrest plateau during solidification of a captured sample.

It is optimized for use in the tundish and will deliver a stable plateau using thermocouple technology for interpretation by the CasTemp Wireless measurement instrument.

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Measurement of liquidus by CasTip uses manual measurement techniques familiar to virtually all caster operations:

- Connect the CasTip Liquidus sensor to the pole and obtain green light on the QUBE CasTip
- Immerse the probe quickly through the slag layer and into the melt for approximately 4–6 seconds to capture the sample
- Remove the probe from the melt and allow up to 20 seconds for the liquidus arrest to complete
- Once completed it will show on the CasTemp Wireless screen
- All measurement operations are indicated by the signalization LED on the QUBE CasTip, and will be displayed on the CasTemp Wireless screen or Remote Viewer facility

### 5 CasTemp Wireless Instrument

### 6 QUBE CasTip

battery-powered unit transmits CasTip liquidus measurement data to the CasTemp wireless instrument

# CasTemp® Superheat System Components

## User Interface and trending

In CasTemp Superheat mode, the CasTemp Wireless instrument indicates the status of the respective QUBE measurement modules and their latest recorded temperature values. The screen can be configured to display either digital values, for easy reference on the caster floor, or a graphical interface.

Both displays can be duplicated on a PC based Remote Viewer facility located in the control room. The graphical interface displays the movement of the CasTemp tundish temperature over time and displays the liquidus recorded by CasTip.

A critical superheat limit can be user defined, and the system will monitor the progress of the trend towards this limit and on to end of cast, offering both an advisory prediction of superheat at end of cast and also an

advisory time when the critical limit will be reached if within the expected casting time.

This provides operators with an early warning of potential problems, and can be used to encourage consistency of decision making. The advisory forward prediction is automatically enabled on taking a CasTip liquidus measurement.

## System Requirements

CasTemp Superheat requires connection to level 1 or level 2 systems for optimal operation, though its benefits can be demonstrated without such connection.

## SUPERHEAT USER INTERFACE





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