

LAND

AMETEK®

*MOLTEN METAL ESCAPES
AND BREAKOUTS*

APPLICATION NOTE

TEMPERATURE MEASUREMENTS TO PREVENT MOLTEN METAL ESCAPES AND BREAKOUTS

The escape or breakout of molten metal is a highly important safety consideration in all metal manufacturing industries, particularly steelmaking.

The extremely high temperatures involved make any breakout of molten metal extremely hazardous. However, if the metal mixes with water, it can instantly vaporise the water, causing a potentially explosive reaction.

Temperature measurement systems can provide a warning of when breakouts are likely to occur. Hotspots on the outside of ladles indicate the early stages of a damaged or thinning refractory lining. By detecting these hotspots on the surface of vessels and torpedo cars, they can identify points where the refractory lining is at its weakest.

Temperature measurement systems can also warn when overfilling is likely to occur, helping to avoid metal escaping over the top of a vessel or ladle.

TORPEDO CARS

Typically, integrated steel mills use torpedo cars on rails to transport molten metal from the blast furnace to the steelworks. Each car has a torpedo-shaped ladle that can carry up to 250 tonnes of liquid metal.

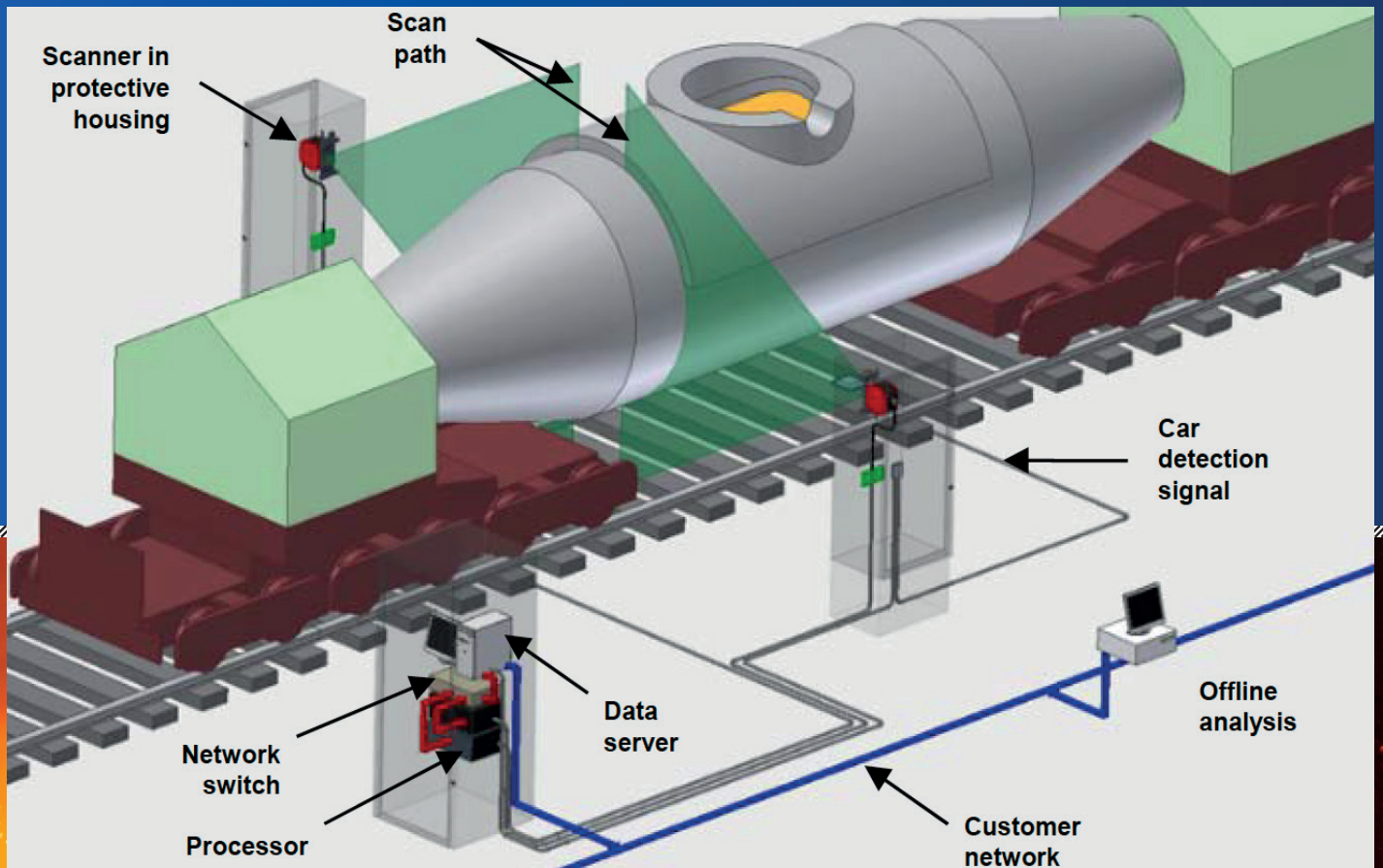
The ladle is lined with refractory brick to keep the contents in a liquid state

and to protect the outer steel shell of the torpedo car against failure.

It is important to monitor the shell temperatures using the same method each time the car passes the monitoring location. In this way, a history of hotspot progression can be developed.

There is a temptation for steel manufacturers to allow the refractory linings to thin, thus increasing the volume of iron that can be carried. However, this increases the risk of failure.

Constant and repeatable thermal mapping of the shell allows early detection of areas that need repair.



A TYPICAL TORPEDO CAR SCANNING SYSTEM

A MONITORING SOLUTION FOR TORPEDO CARS

The AMETEK Land Torpedo Car Monitoring System uses LSP-HD scanners installed on each side of the track, producing highly detailed thermal images of each side of the car from a short distance, which usual thermal imagers cannot deliver. This enables the safety system to view very small surface details.

The scanners are housed in climate-controlled enclosures with air purges and electrical interfaces. Industry-standard fast ethernet provides rapid communication to the control room.

As each car passes a measurement station, ID tags on the car provide a

unique car number and temperature data to the monitoring software. The direction of movement is also detected.

The wide 80° vertical scan angle of the scanners and the 1,000 temperature points in each scan produce extremely high-resolution thermal images, providing comprehensive monitoring of the torpedo car.

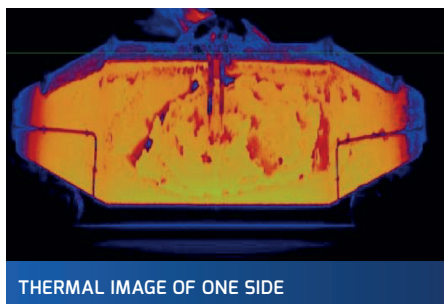
An image file is automatically saved for each side of every car. The complete view is then divided into a number of areas (50, for example).

For each area, the maximum and average temperature is transferred to

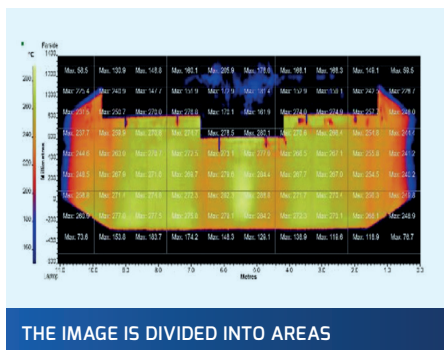
a historical database, which provides long-term trending of individual areas on the torpedo car.

The database and stored images are accessible via PCs on the company network. Data can also be transferred to the plant network for further analysis and storage.

Data obtained from a torpedo car can be presented in the form of a complete thermal image. Temperatures above the target region are indicated in red, and indicate an issue with the refractory lining.



THEMAL IMAGE OF ONE SIDE



THE IMAGE IS DIVIDED INTO AREAS

MAIN FEATURES AND BENEFITS

Early detection of cracks in refractory helps avoid metal breakouts

Early detection of changes in temperature profile

Hot spot detection, analysis and tracking

Increased plant safety

- Reduce and prevent breakouts
- Less risk to operators as manual field work is reduced by automatic inspection

Easy-to-use, fully automated solution

Historical thermal image database

Analysis of long-term trends

Improved confidence in refractory condition

Planned refractory relining maintenance schedule

Automatic ladle/torpedo car detection and recognition

TORPEDO CAR TAGGING

A SOFIS surface acoustic wave identification system is used for non-contact identification of ID tags located on mobile objects.

The SOFIS reading device has a computer-controlled, high-frequency transmitter and receiver unit. It reads the tag number and direction of

travel in the IDF tag and conveys this to the Landscan WCA software.

The reading device is comprised of an evaluation unit and an integrated antenna designed for railway applications, and is accommodated in a robust housing.

The ID tag consists of a surface acoustic wave chip and antenna in a protective housing.

Both the tag and reader are highly resistant to vibration and shock, and are suitable for use in the track ballast or for installation on the vehicle body.



LSP-HD 61

A compact, high-accuracy infrared linescanner, the LSP-HD is designed to provide advanced thermal images of moving processes.

Output from the linescanner heads is converted into a data string of 1000 readings per scan line, at a maximum frequency of 150 scan lines per second. Landscan WCA software provides all calculations required from each scan line.

The LSP-HD 61 is the model recommended for torpedo car monitoring, and operates in a temperature range from 50 to 400 °C (120 to 750 °F), with a wavelength between 3 and 5 μm , which excludes sun and weather influences on the measurement.

FEATURES

High-resolution optical system, providing a highly homogeneous thermal image

Industry-leading 150 Hz scan speed

Designed to operate in harsh industrial environments

Plug-and-play installation via a single Ethernet cable

BENEFITS

Full-width measurement identifies smallest temperature variations

Accurate thermal records

Real-time thermal display

Easy connection to control systems

Complete, integrated system from a single supplier

MOLTEN METAL LEVEL INDICATION IN LADLES

It is important to continuously measure the level of molten steel as the ladle is filled from the Electric Arc Furnace (EAF) or Basic Oxygen Furnace (BOF). This is partly to ensure greater efficiency by preventing underfilling. Overfilling, however, is extremely hazardous and can cause serious accidents that can fatally injure plant personnel.

Even if staff are unharmed, overfilling accidents can still damage equipment, leading to costly downtime. Any incidents will also increase insurance premiums for the plant, raising the cost of operations.

Visual cameras are unreliable for filling applications, because smoke and gas present in the application environment often obscure the view of the measurement zone. These cameras also rely on the operator's skill and level of attention, which can be inconsistent and unreliable.

The level of molten steel in the ladle can also be determined by weighing the ladle before and after filling. However, oxide scale can build up on the ladle over time, affecting the measurement, so the result is not entirely reliable. It also does not prevent overfilling, it just recognises that it has taken place.

Since the temperature of molten steel is much higher than that reached by the ladle refractory bricks, temperature measurements can be taken at key points on the freeboard to determine the depth of the steel.

The difficulty with this measurement technique is that the steel mill environment around the ladle during steel tapping is incredibly hostile. Most instrumentation is unable to operate accurately and reliably in the high temperatures and smoke involved, and will be harmed by the heat.

THE AMETEK LAND SOLUTION

AMETEK Land has developed a thermal imager solution that can operate in these difficult conditions while also providing an effective, reliable measurement.

Using a waveband in the Mid Wave Infrared (MWIR) range, the thermal imager is able to "see" through most gas and smoke for a consistent view of the freeboard, providing a much clearer image than other systems.

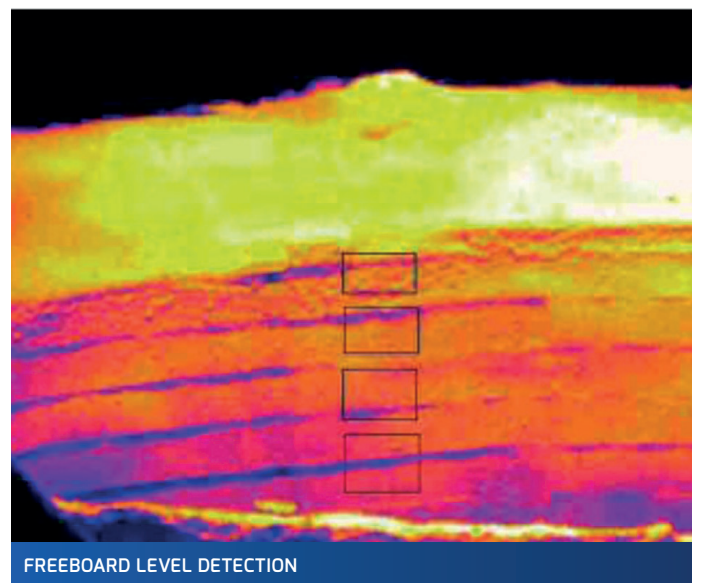
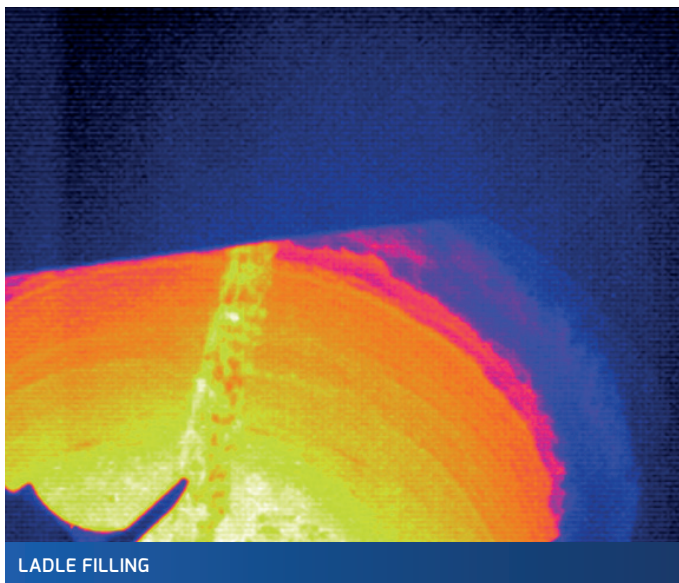
By configuring multiple measuring zones in the area of the refractory where the freeboard level appears, an alarm can be triggered when each one is filled. This provides an easy, accurate detection of the level of the molten metal, and prevents overfilling.

The AMETEK Land Freeboard Level System (FLS) consists of a thermal imaging camera designed for continuous use in very harsh industrial environments, power supply, cables, computer workstation and software.

Using radiometric infrared technology, the sensor has a 30 Hz frame rate and operates at an optimized wavelength where hot carbon dioxide and steam are transparent. This delivers a clear image which is easy to interpret and can be used to make decisions.

A live thermal view of the ladle is displayed as it nears complete filling, which also provides the operator with a continuous, clear view of the filling process. Additional network clients can view images simultaneously.

FREEBOARD LEVEL DETECTION





FREEBOARD LEVEL SYSTEM (FLS)

FEATURES

High-resolution thermal images at 30 frames per second

Clear image, even if smoke and vapour is available in the process

Designed for 24/7 operation in harsh environmental conditions

Recording and playback of moving processes

Real-time data analysis

Wide ambient temperature capability

BENEFITS

Optimised safety and product quality

Live information for accurate decision-making

Precise process control

Continuous and detailed observation of the filling process

Easy to install and use

MONITORING THE LADLE OUTER SURFACE

Ladles, like torpedo cars, typically have a steel outer surface and a refractory lining, and in the same way can suffer from wear and damage to the lining, leading to hotspots that can indicate a damaged refractory and/or a potential breakout.

AMETEK Land provides a thermal imaging solution for automatic, remote thermal monitoring of the outer surface of steel ladles as they pass through a single monitoring station.

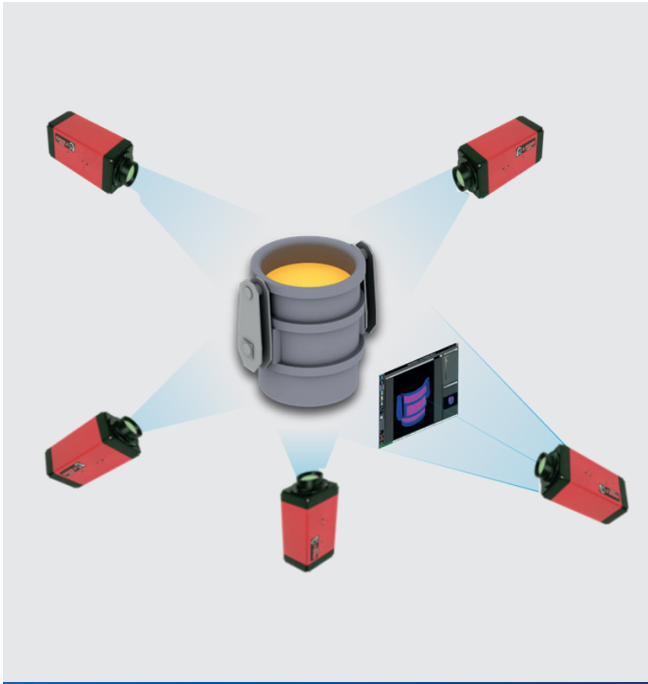
This system is comprised of three to five ARC thermal imaging cameras, depending on the site conditions and whether or not the bottom of the ladle also needs to be monitored. Each of these is mounted inside a water-cooled housing with an air-purged front window and adjustable mounting bracket. The industrial enclosure is designed to protect the camera in the harshest environments, ensuring continuous, reliable operation.

These cameras are connected via Ethernet to the control room, where data can be processed, analysed and stored in the Vessel Manager software suite.

The Vessel Manager software uses shape recognition and contour matching, so by using pre-programmed ladle shapes, each camera will automatically detect when a ladle passes through the monitoring station. Analysis is performed against a pre-set grid of up to 400 cells, each of which is examined for important temperature information.

A pre-installation site survey helps identify the optimum mounting location for the system. Thermal images of passing ladles are recorded during this survey, for the offline set-up and configuration of the system prior to installation.

A suitable location on the ladle surface is also identified at this time, allowing the attachment of steel labels which can be used by the system to identify the ladle number.



AMETEK LAND'S THERMAL IMAGING SOLUTION FOR LADLE SURFACES



ARC IMAGER

ARC IMAGER

FEATURES

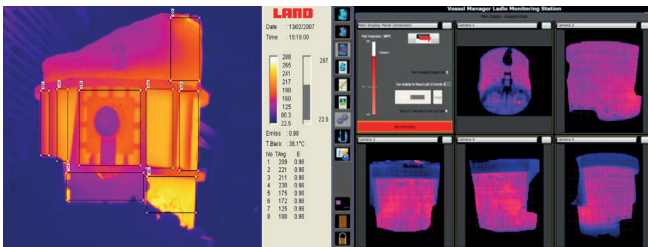
- High-resolution and robust radiometric thermal images
- Four lens options
- Wide ambient temperature range
- Viewer software as standard

BENEFITS

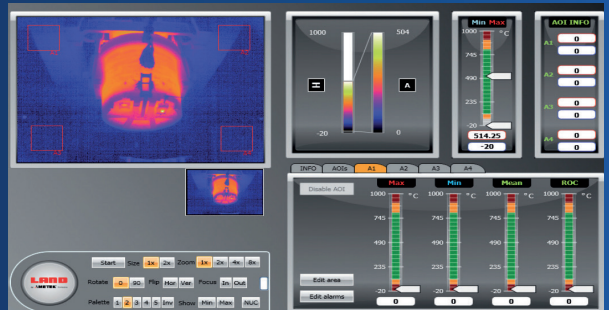
- Unsurpassed temperature accuracy
- View any target at any distance with outstanding clarity
- Suitable for installation in almost any climate
- User-friendly software control

MAIN FEATURES AND BENEFITS

- Early detection of cracks in refractory
- Early detection of changes in temperature profile
- Hot spot detection, analysis and tracking
- Increased site safety
 - Reduce breakouts
 - Less risk to operators as manual field work is reduced by automatic inspection
- Reduced maintenance
 - Increase lining lifespan
- Monitor process conditions
- Reliable alarm independent of operator – pre-alarm and hot alarm
- Redundant temperature measurements and hot spot detection available



THERMAL IMAGES ARE PROCESSED, ANALYSED AND STORED IN THE VESSEL MANAGER SOFTWARE SUITE



VIEWER SOFTWARE IS SUPPLIED AS STANDARD

AMETEK LAND SOLUTIONS FOR TEMPERATURE MEASUREMENTS TO PREVENT MOLTEN METAL ESCAPES AND BREAKOUTS



Our in-house service centres provide after-sales services to ensure you get the best performance from your system. This includes technical support, certification, calibration, commissioning, repairs, servicing, preventative maintenance and training. Our highly trained technicians can also attend your site to cover planned maintenance schedules and repair emergency breakdowns.

LSP-HD 61

A compact and robust infrared linescanner, designed to produce advanced thermal imaging in moving processes.



LINESCANNING

FLS

A high-resolution, accurate, fast, radiometric thermal imager designed to capture detailed information in harsh industrial environments.



PROCESS IMAGING

ARC IMAGER

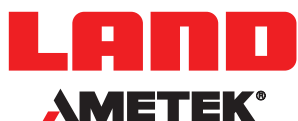
A rugged, compact radiometric thermal process imager providing unsurpassed temperature accuracy across a wide range of applications.



PROCESS IMAGING



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