For safety and efficiency, it is essential to monitor the steel level as the ladle is filled with molten metal. This is accomplished by measurements of the ladle freeboard, the area of the ladle between the top edge and the surface of the molten metal inside it. Measuring the freeboard is key to:

- Monitoring plant safety, reducing risks to plant personnel and equipment
- Determining the amount of molten metal being delivered to the next phase of production, increasing predictability
- Maximising the fill ratio of the ladles, lowering costs

The heat and fumes at the measurement location makes visual determination of the level difficult. AMETEK Land’s thermal imaging solution can “see” through the obscuring smoke for a clear view of the steel level.
In the steelmaking process, 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). Underfilling the ladle is inefficient, while overfilling is extremely hazardous. Accidents caused by overfilling can fatally injure plant personnel, and can also cause serious damage to equipment, leading to costly downtime. In addition, any incidents will increase the insurance premiums for the plant, raising the cost of operations. Some manufacturers also need to leave different amounts of freeboard depending on the downstream processing planned, which is usually steel grade dependent.

Measuring the fill level through observation is very difficult because of the high-temperature environment around the ladle. Smoke and fumes rise from the ladle, obscuring the view of the steel level, and it is also dangerous for an operator to attempt to get above the ladle to see the level. Traditional solutions for this measurement involve the use of visual cameras, and weighing the ladles. These each have disadvantages:

**VISUAL CAMERAS**

The amount of smoke and various gases present in the application environment makes it impossible to rely on these cameras for an accurate measurement. It is difficult to see the measurement zone, as the view is often obscured. These cameras also rely on the operator's skill and level of attention, which can be inconsistent and unreliable.

**WEIGHING THE LADLES**

Simply taking the difference between the weight of the empty ladle and the weight of the ladle when it contains steel provides an indication of the amount of steel present. However, scale can build up on the ladle over time, affecting the measurement, so the result is not entirely reliable.
MAKING MEASUREMENTS IN HOSTILE CONDITIONS

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 involved, and will be harmed by the heat.

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

Using a wavelength of 3.91µm, the thermal image is able to "see" through most gas and smoke for a consistent view of the freeboard.

It can be configured to monitor multiple areas of interest, triggering an alarm when each one is filled. This provides an easy, accurate detection of the level of the molten metal.

THE MEASUREMENT PROBLEM

APP NOTE
A typical steel plant ladle capable of holding 180 tonnes (200 US tons) of steel has an outside diameter of about 4m (13 ft) and is approximately 5m (16 ft) high. Some ladles can hold up to 300 tonnes (330 US tons) of molten steel.

The amount of gases and smoke present makes visual cameras and sight near impossible to trust.

INTELLIGENT IMAGING

FTI-E 391

FTI-E 391 is built to survive harsh steel mill environments
THE AMETEK LAND SOLUTION: FTI-E 391

THE FTI-E 391 FREEBOARD LEVEL SYSTEM CONSISTS OF AN INDUSTRIAL THERMAL IMAGING CAMERA, POWER SUPPLY, CABLES, COMPUTER WORKSTATION AND SOFTWARE.

Using radiometric infrared technology, the sensor has a 30 Hz frame rate and operates at an optimised 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.

The FTI-E system connects together using standard CAT6 Ethernet cabling and components. This greatly reduces the cost of cables and installation.

AMETEK Land software allows up to four FTI-E 391 cameras installed in different locations to operate and display simultaneously. These cameras measure across a range from 600 to 1600 °C (1112 to 2912 °F), so are able to easily distinguish between the molten steel and the ladle bricks.

A live thermal view of the ladle is displayed as it nears complete filling. Additional network clients can view images simultaneously.

The thermal images produced allow temperatures to be measured within an accuracy of 1%.

Four areas of interest can be positioned, rising up to the top of the ladle. As each zone fills up, an alarm contact will close. This allows full automation of the filling operations.
A TYPICAL SYSTEM INCLUDES A RUGGED ENCLOSURE MOUNTING WITH WATER AND AIR COOLING, PSU CABINET, 10M CAMERA CABLE, LAPTOP WITH LIPS SOFTWARE AND THE FTI-E SERVER. THE RESULT IS A ROBUST SOLUTION, ABLE TO WITHSTAND HARSH STEEL MILL ENVIRONMENTS, THAT CAN EASILY SEE THE LEVEL INSIDE THE LADLE AS IT NEARS THE END OF FILLING.

Schematic showing up to one FTI-E 391 systems networked to one workstation and one optional client display.

Interior view of steel ladle

Four zones of interest can be configured
LAND IMAGE PROCESSING SYSTEM (LIPS) SOFTWARE

LIPS is a Windows-based software system specifically designed for thermal analysis of data from AMETEK Land’s thermal imager ranges.

Offering powerful, flexible image processing for a wide range of industrial measurement applications, it is able to monitor and control multiple imagers at full frame rate.

LIPS provides extensive control and analytical functions for process control, including point or area temperature measurements. This makes it ideal for automated control of ladle filling by monitoring the hot steel reaching the areas of interest.
ADVANTAGES OF THE AMETEK LAND SOLUTION:

- A RELIABLE SOLUTION THAT WORKS EVERY TIME
- ROBUST DESIGN TO WITHSTAND THE HARSH CONDITIONS OF THE STEEL MILL
- ALARMS AND TEMPERATURE MEASUREMENT SUPPORT BETTER PROCESS CONTROL
- STRONG RETURN ON INVESTMENT

**FEATURES**

- High-resolution thermal images at 30 frames per second
- 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
- Easy to install and use

The FTI-E 391 in optional industrial housing
SUMMARY

Temperature measurements at the freeboard section of the ladle provide a reliable way to monitor the level of molten steel during filling.

Underfilling is highly inefficient, while overfilling is potentially extremely hazardous, but striking the right balance is made challenging by the hot, smoky conditions surrounding the ladle.

AMETEK Land offers a rugged thermal imaging solution which delivers accurate monitoring of the rising steel level, supporting automated control while overcoming the difficulties posed by the steel mill environment.

AMETEK LAND SOLUTION FOR TEMPERATURE MEASUREMENTS OF THE LADLE FREEBOARD DURING STEEL PRODUCTION

FTI-E 391

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

AMETEK Land’s global service network provides unparalleled after-sales services to ensure you get the best performance and value from your AMETEK Land products. Our dedicated service centre teams and on-site engineers are trained to deliver the highest standard of commissioning, maintenance and after-sales support.

AMETEK Land’s AMECare Performance Services ensure peak performance and maximum return on investment over the life of your equipment.

We will deliver this by:
• Proactively maintaining your equipment to maximize availability.
• Optimizing solutions to meet your unique applications.
• Enhancing user skills by providing access to product and application experts.

DOWNLOAD THE BROCHURE NOW: WWW.AMETEK-LAND.COM