LAND

AMETEK®

COAL HANDLING SAFETY APPLICATION NOTE

STRENGTHENING PLANT SAFETY IN COAL GRINDING MILLS AND STORAGE SILOS WITH CARBON MONOXIDE MONITORING

Risks of unwanted combustion – potentially causing injury, damage and downtime – occur everywhere that coal is handled, processed or stored.

Safe coal handling practices are designed to ensure that the fuel remains intact throughout its journey from the mine until the point at which it is ignited in the boiler.

It takes as little as 1.4 kg (3 lbs) of pulverised coal in 28 m^3 (1,000 ft^3) of air to form an explosive mixture. Since a large boiler burns over 40 kg (88 lbs) or more of coal per second, the safe burning of pulverised coal necessitates strict adherence to planned operating procedures.

FIRE RISKS IN MILLS AND SILOS

APP NOTE

CO gas detection offers a fast, sensitive means to detect the presence of oxidising coal.

All coals oxidise during storage, but sub-bituminous coals (such as Power River Basin) due to their friability and porosity are especially prone to spontaneous combustion. The increasing use of sub-bituminous coals throughout the world has increased the risks of grinding mill incidents and silo fires.

Good operating procedures, such as inventory turnover, nitrogen inerting or using chemicals reduce the risk of auto-ignition, however mill and silo fires may still occur.

Though the probability of a fire remains low, the expense and liability impact of a combustion event mandates proper CO monitoring is needed to alert plant operating personnel that a fire may be about to start in their processing vessels.

HIGH RISK AT MILL START-UP AND SHUTDOWN

The greatest risk of spontaneous heating and subsequent fire occurs when the mill is shut down under load, as this leaves a large amount of pulverised fuel inside a hot mill.

The large surface area of the pulverised coal and the high temperature inside the mill lead to rapid oxidation of the coal. This results in further heat build-up and the potential for a fire.

If the mill is restarted without first removing the hot coal, an explosion can occur when particles are suspended and exposed to the in-rushing combustion air.

Even in routine mill shutdowns, there is a danger that any residual coal left within the mill will oxidise, and may explode as the mill is restarted.

The Millwatch system is installed near the classifier and can detect the CO emitted from any hot inclusions within the residual coal. With many baseload plants now being frequently dispatched, the risk of a catastrophic event mounts.

DETECTING OXIDATION IN MILLS AND SILOS

Several methods are available to detect the presence of oxidation within the mill or silo.

Thermocouples are widely used to detect the heat build-up from oxidation or early-stage fire, but they have limited sensitivity and cannot monitor the whole volume of the mill or silo.

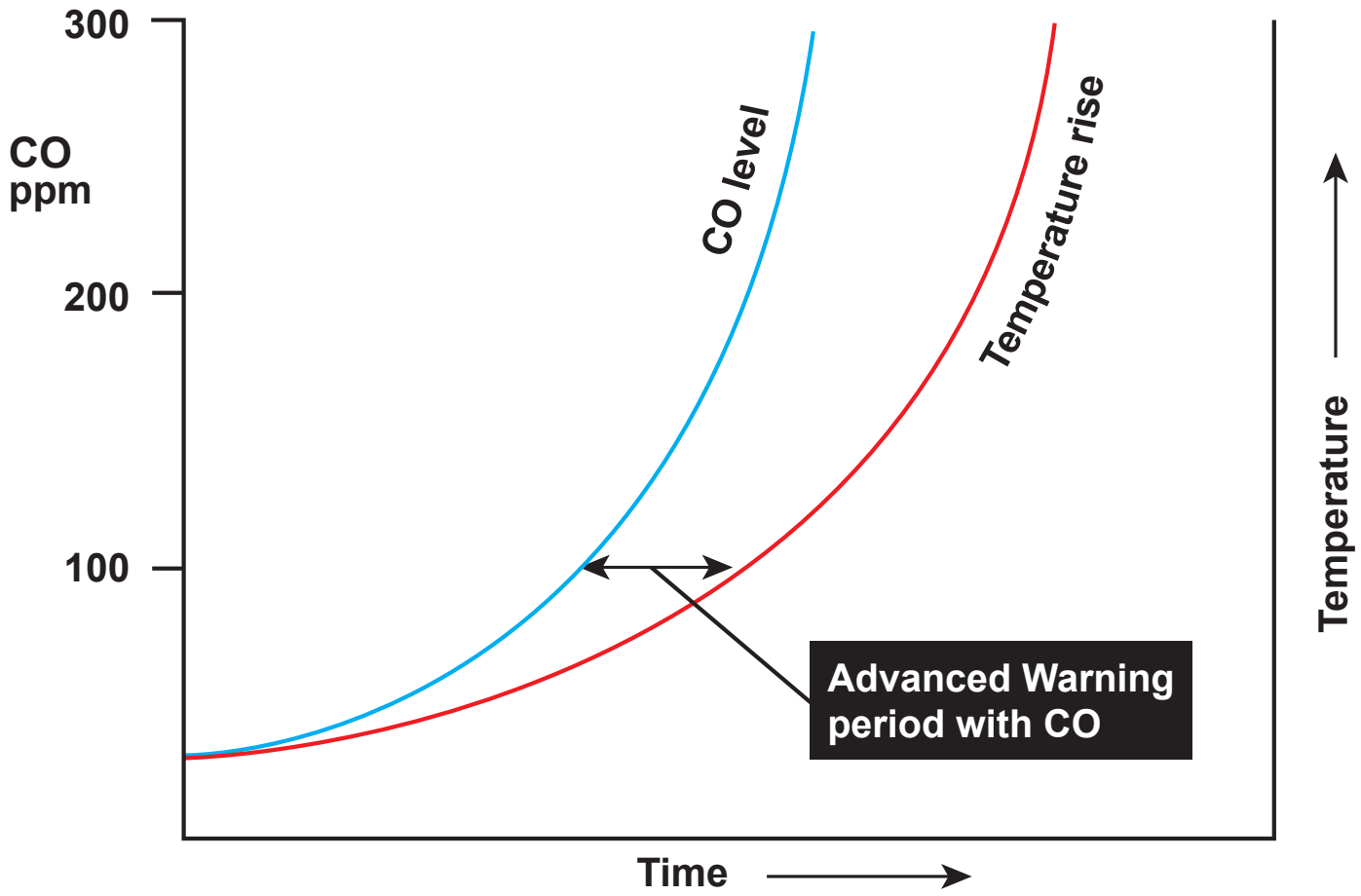
It also takes time for sufficient heat to build up within the vessels to generate a detectable increase in temperature.

Experience shows that thermocouples do not pre-emptively provide a reliable indication that a hazardous condition is developing.

Carbon monoxide (CO) gas detection offers a fast, sensitive means to detect the presence of oxidising coal, as the oxidation process inevitably produces large amounts of CO and is a precursor to an actual fire.

The most important reasons to choose CO measurement for these applications are the availability of very sensitive CO sensors (detection limit 2 parts per million (ppm)), quick response time and the ability to extractively sample large volumes of the grinding mill or storage silos using mounted sample probes.

HOW IT WORKS | FIRE ADVANCED WARNING - CO VS TEMPERATURE



CO monitoring is fast, specific and sensitive, and can be calibrated to determine alarm levels that reliably identify a hazardous condition, while minimising the occurrence of false alarms.

Optical techniques and diffusion based CO detectors systems can be useful, but are slower detection systems which respond too late to the developing hazard.

MILLWATCH/SILOWATCH

FOR

EARLY WARNING OF POTENTIAL FIRE

IN MILLS AND SILOS

DETERMINING ALARM LEVELS

One of the biggest challenges in configuring a Millwatch system is the determination of suitable alarm levels. A CO concentration greater than 250 ppm can be seen during mill start-up, but in normal operation the CO concentration is in the region of 10 ppm.

Millwatch analysers offer two independent alarm points, so an alarm level can be set at 300 ppm during start-up, and at 50 ppm for normal operation.

Each plant's operating parameters will eventually determine the proper levels of the dual alarms to provide the proper notifications while minimising nuisance alarms. This is a simple change of alarm levels on the Millwatch system.

Of course, these alarms levels can trigger the plant's suppression system as a system response.

STANDARD START UP

NORMAL OPERATION

MILLWATCH OFFERS INDEPENDENT ALARM POINTS

CASE STUDIES

HOW THE MILLWATCH SYSTEM PROVED ITS VALUE TO INDUSTRY

CASE STUDY ONE | HOUSHI POWER PLANT, CHINA

Houshi Power Plant is a 4200 MW electricity generating plant in China's Fujian province, which supplies electricity to the city of Zhangzhou and the surrounding area.

There are seven electricity generating units at the site, each of which is rated for 600 MW. In 2011, the plant operators decided to add CO monitors to the five coal mills in Unit 1, supplementing their existing temperature and fire sensors.

They determined that AMETEK Land's Millwatch analysers were best suited to the task. The analysers have a long track record, with hundreds of installations worldwide, and include a number of desirable features:

- RUGGED SAMPLE PROBES WITH AUTOMATIC BLOWBACK TO MAINTAIN A GOOD SAMPLE FLOW
- AUTOMATIC CALIBRATION TO VERIFY CORRECT OPERATION OF THE ANALYSERS
- CONTINUOUS MEASUREMENT OF EACH SAMPLE POINT, WITH NO MULTIPLEXING AND A RESPONSE TIME BELOW 60 SECONDS

This last feature was deemed especially important, as hazardous conditions can develop within a few minutes, and a multiplexed system sampling six measurement points , or each point every 10 to 15 minutes, would be much too slow.

The Millwatch system proved its value in 2013 when it showed rapidly rising CO levels in the outlet of one of the coal mills.

It would have taken at least 15 minutes for the temperature and fire detection systems to respond and indicate a problem, so the Millwatch analysers allowed corrective action to be taken significantly earlier than would otherwise have been possible.

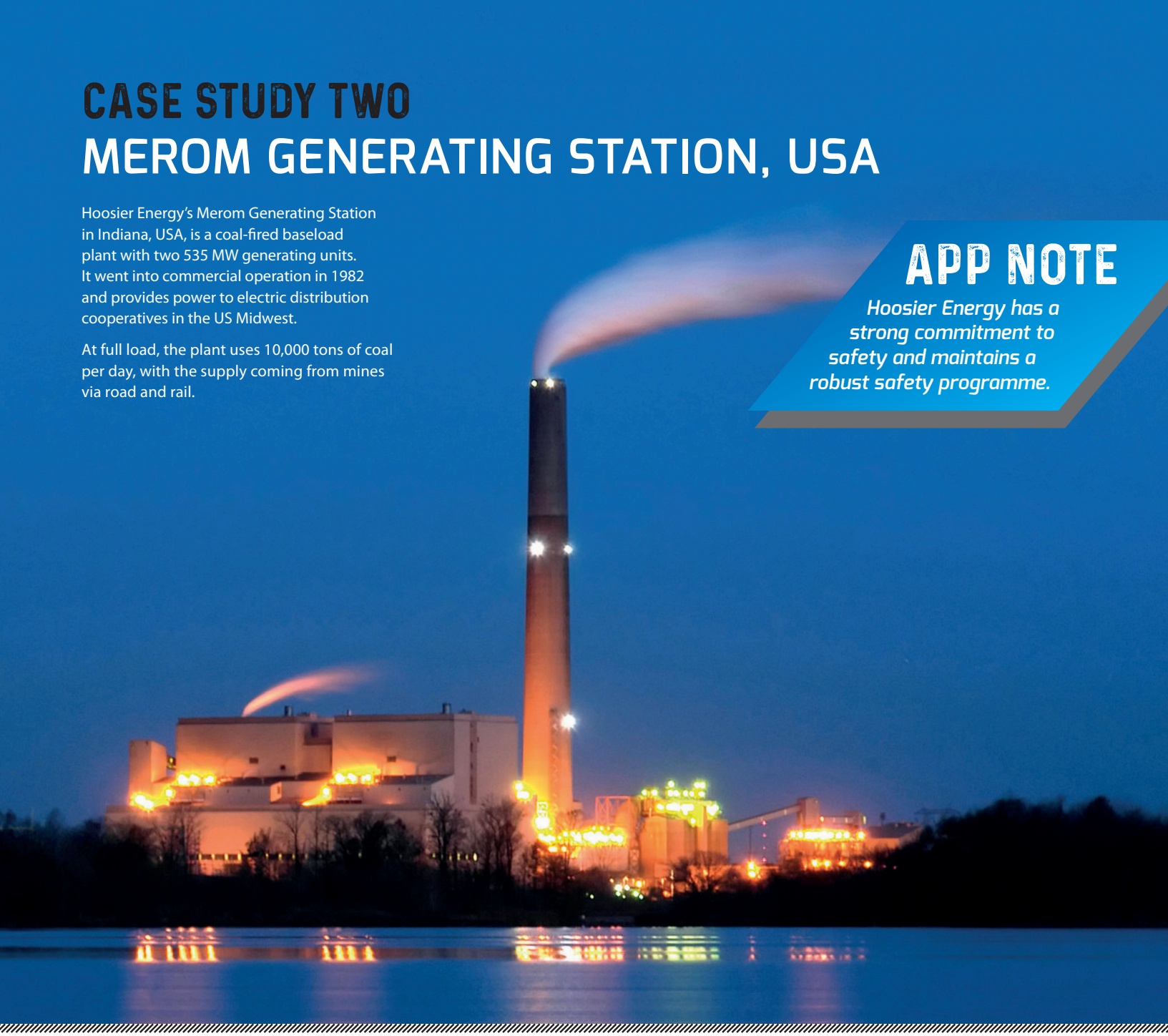
CASE STUDY TWO
MEROM GENERATING STATION, USA

Hoosier Energy's Merom Generating Station in Indiana, USA, is a coal-fired baseload plant with two 535 MW generating units. It went into commercial operation in 1982 and provides power to electric distribution cooperatives in the US Midwest.

At full load, the plant uses 10,000 tons of coal per day, with the supply coming from mines via road and rail.

APP NOTE

Hoosier Energy has a strong commitment to safety and maintains a robust safety programme.



Hoosier Energy has a strong commitment to safety and maintains a robust safety programme, endeavouring to operate with the utmost regard for the health and wellbeing of its employees and the public.

Each generating unit at Merom Station has three Riley Power double-ended ball tube mills. Each mill can provide 65 tons per hour of pulverised coal to the boiler, or a total of 195 tons per hour, per boiler.

Because the ball-tube mills have outlets at each end, with a classifier on each outlet, two sample points were needed on each mill. For enhanced reliability, a redundant configuration was chosen with two sample points on each classifier, giving four samples per mill.

With three mills per generating unit, 12 sample points were needed per generating unit, or six twin-stream Millwatch analysers. Redundant measurements reduce the likelihood that a potentially hazardous condition will remain undetected. Even if one sensor were to malfunction, the other can still trigger an alarm condition.

Even though the inside of the mills is a hazardous area, the sample probes are simple devices with no electrical connections, so no special precautions were needed. It was understood the mill environment is very abrasive, however the probe assemblies have abrasion shields which prevent the stainless steel filters from being damaged by the high concentration of coal dust. An installation location at the classifier outlet was preferred, since this allowed the abrasion shield to face the flow of coal dust and protect the filter. Blowback controllers were installed close to the classifiers, but outside the hazardous area.

Along with the CO monitors, in-situ oxygen probes were installed on each classifier, to determine the oxygen concentration since the mills are steam-inerted.

The Millwatch CO analysers were installed at the same level as the classifiers, which meant the sample lines could be kept short and the response time minimised. The chosen location also gave easy access for maintenance.

ENHANCED SAFETY

Commissioning took place during an outage in May 2011. Since that time, there have been a several high CO alarms, but no mill explosions – a satisfactory achievement for a baseload station. The Millwatch analysers have proven to be extremely reliable, while providing continuous measurements and yet requiring no more than routine maintenance.

On the 8th of December 2013, the Millwatch analysers demonstrated their value. With Unit 2 running at full load, one of the mills tripped and the operators observed a rapid increase in CO readings, even though there was no indication of a temperature rise.

Within a few minutes, the CO level was above the alarm threshold, and the operators decided to activate the inerting system. The boiler continued to operate using coal from the remaining mills, with output dropping to 60% of its rated value.

The CO level in the affected mill started dropping after 15 minutes, and within 45 minutes it was below 10 ppm. The mill was restarted two hours after the high CO alarm was detected, and returned to full operation in 3½ hours.

The Millwatch CO analysers detected a potentially dangerous condition and allowed it to be dealt with quickly, with no damage to plant or personnel.

APP NOTE

The Millwatch analysers are extremely reliable, requiring no more than routine maintenance.

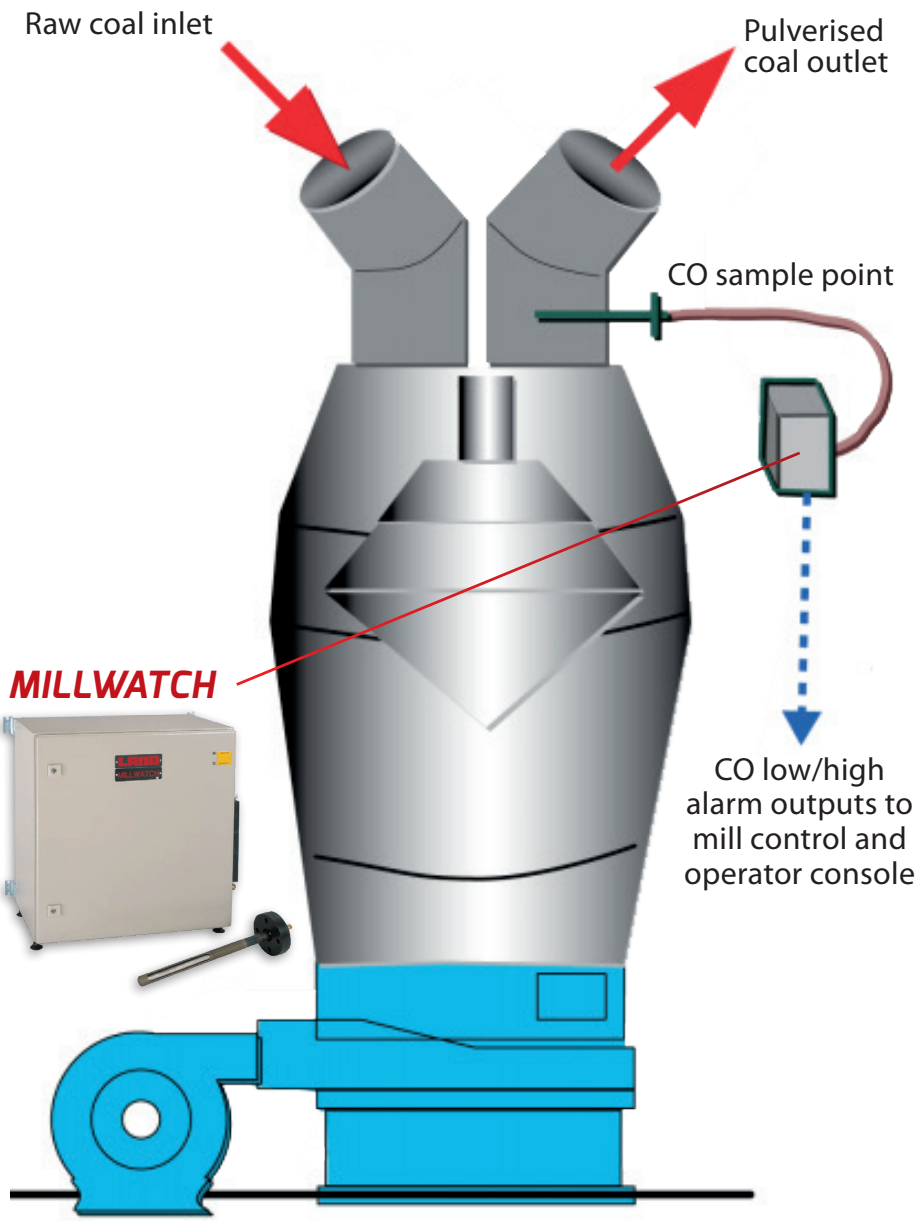
CONCLUSION

Carbon monoxide monitoring provides a rapid and reliable method for the detection of potentially dangerous coal oxidation within a mill, so that action can be taken to reduce the risk of a fire or explosion.

At both Houshi Power Plant and Hoosier Energy Merom Station, Millwatch analysers from AMETEK Land have provided good reliability and a high level of safety coverage, with no explosions in the mill since they were installed.

AMETEK LAND SOLUTIONS

TYPICAL MILLWATCH INSTALLATION



MILLWATCH AND SILOWATCH

Millwatch is designed to detect the rapid build-up of CO inside the grinding mill. By continuously extracting sample gases from the mill outlet, it continuously monitors the internal atmosphere, responding quickly to any significant increase in CO levels.

Silowatch is designed to detect the rapid build-up of CO inside storage silos.

Both systems are similar in design with added protective measures for the Millwatch system due to the abrasive atmosphere where they are installed.

Millwatch/Silowatch can independently support dual sample probes with no multiplexing which reduces the cost per measurement point. A system can also measure CO and O_2 which can be beneficial if the vessel is being inerted.

AMETEK Land also offers asset protection systems for monitoring conveyors and storage silos.

DOWNLOAD THE BROCHURE AT: WWW.AMETEK-LAND.COM/MILLWATCH

LAND
AMETEK

www.ametek-land.com
land.enquiry@ametek.com

Land Instruments International
Stubley Lane, Dronfield
S18 1DJ
United Kingdom
Tel: +44 (0) 1246 417691

AMETEK Land - Americas
150 Freeport Road,
Pittsburgh, Pennsylvania, 15238
United States of America
Tel: +1 (412) 826 4444

AMETEK Land China Service
Part A1 & A4, 2nd Floor Bldg. 1
No. 526 Fute 3rd Road East,
Pilot Free Trade Zone 200131
Shanghai, China
Tel: +86 21 5868 5111 ext 122

AMETEK Land India Service
Divyasree N R Enclave,Block A,
4th Floor, Site No 1, EPIP Industrial Area
Whitefield, Bangalore- 560066
Karnataka, India
Tel: +91 - 80 67823240

For a full list of international offices, please visit our website **www.ametek-land.com**

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Certificate No. CC-2041
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MARCOM0465 Coal Safety Application Note Rev 1