

CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE



# Industrial Thermal Imaging for Process Applications

Ben Wileman

16 November 2018

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

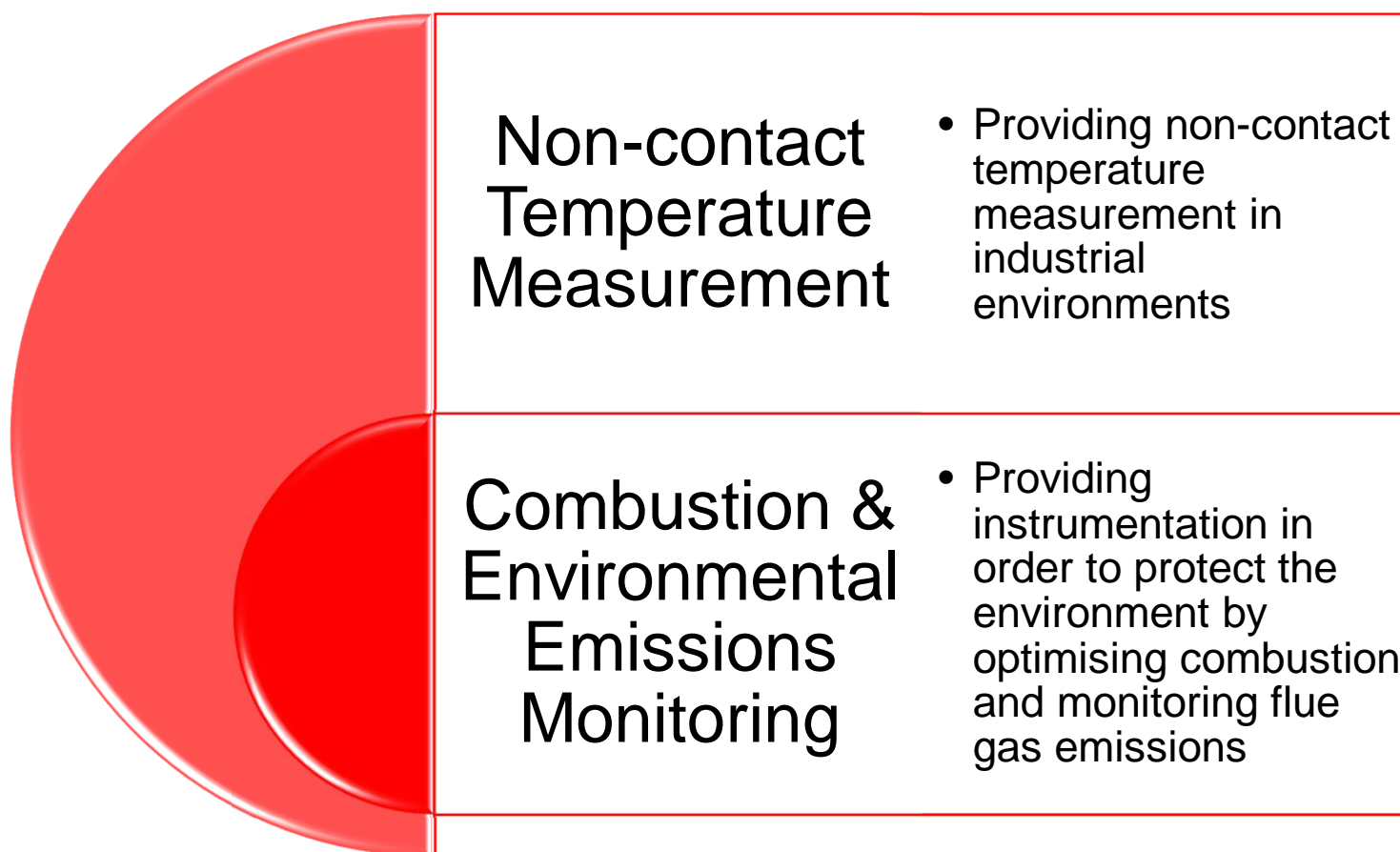
[WWW.LANDINST.COM](http://WWW.LANDINST.COM)

## COMPANY HISTORY

- **Established 1947 in Sheffield by Tom Land**
- **Industry Firsts**
  - Commercial infrared thermometer using silicon photodiode
  - Portable single lens reflex infrared thermometer
  - ISO9000 certified infrared thermometer manufacturer
  - Production in-flight infrared thermometer
  - Utility gas turbine infrared thermometer
- **2006 Acquired by AMETEK, Inc**
  - Transformed from traditional, family run business into modern, global enterprise



## PRODUCT FAMILIES

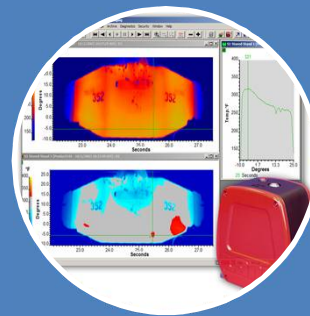


## NON-CONTACT TEMPERATURE MEASUREMENT



### Single point solutions

- Spot Thermometers
- Portables
- Fixed
- Application solutions



### Process imaging solutions

- Process Imaging
- Line Scanning
- Fixed Thermal Imaging
- Application solutions



## PORTABLE NON-CONTACT THERMOMETERS

- **Cyclops 100L**  
A general purpose, high precision, portable infrared thermometer, designed for accurate measurement of temperatures in the range 550 to 3000° C/1022 to 5432° F.
- **Cyclops 055L Meltmaster**  
The unique features of the Cyclops Meltmaster make it the ideal instrument for accurate non- contact temperature measurements of liquid metals in the foundry
- **Cyclops 390L Furnace Pro**
- **Cyclops 160L**





## EXAMPLE APPLICATION SOLUTIONS

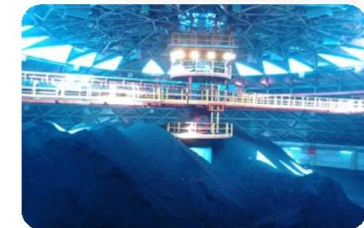
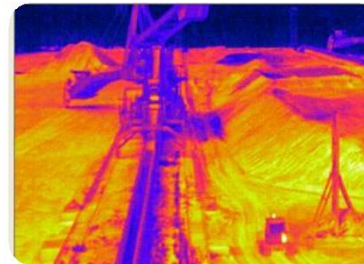
### Critical Vessel Monitoring

- eg Gasification or Gas to Liquid Vessels
- Monitor skin temperature of vessels
- Extend refractory life and reduce maintenance
  - Reliable alarm and long term trending without need for modification to the process vessel
- Increase site safety
- Dedicated archive and DCS integration



### Flammable Material Storage

- eg coal, pet-coke or sulphur
- Monitoring the material surface for hot spots
- Alerting the operator before the situation becomes critical
- Feedback to fire prevention systems





CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE

# Gasification Vessel Monitoring

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

[WWW.LANDINST.COM](http://WWW.LANDINST.COM)

## Why Measure Vessel Skin Temperature?

- In the event of refractory damage hot gases push into gaps of the refractory lining. This damage will increase hour by hour.
- If it is not recognized early it will cause further breakdown of the refractory and eventually catastrophic failure causing:
  - damage to plant
  - injury to personnel
  - costly unplanned shutdowns



## Measurement of Vessel Skin Temperature

- Early vessels used tubes filled with Eutectic salt
  - Melted at an alarm temperature
  - Flow would signal an alarm
- Reactor Sensor Cable (eg Fibre Optic, Thermistor, etc.)
  - Filled tubes bonded to the vessel surface (welded railing, nuts and bolts, altering compounds)
  - Connected via transmitters to a hot spot alarm system
- Infrared Thermal Cameras
  - Adopted exclusively for new plants by North American & European Engineering Companies
  - Retro-fitted to existing plants – replacing existing cable systems

## The importance of early hot spot detection

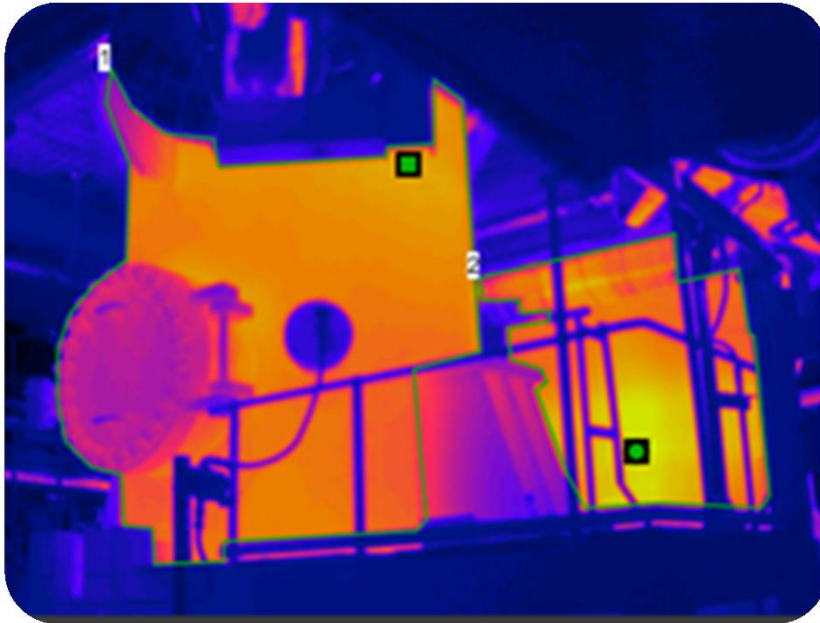
- Example: Accident at Terre Haute, Indiana – April 2008



- Vessel expanded causing a leak at the flange
- Two operators sent to tighten the bolts
- Explosion occurred killing both

## The importance of early hot spot detection

- Example: Accident at Terre Haute, Indiana – April 2008



- After the accident the plant SG Solutions have installed an IR camera solution

## Why the switch to infrared?

- Allows early recognition of possible damage
- Chance to adjust the process to avoid further damage
- Increase refractory life
- Avoid catastrophic failure
- Avoid damage to plant
- Protect personnel from injury
- Eliminate costly unplanned shutdowns
- Decrease maintenance and material costs of the plant
- Safely extend the refractory maintenance period
  - Allows plant to confidently extended maintenance period based on measurement rather than “experience.”

## Why the switch to infrared?

- It is fit for purpose
  - Vessel skin design temperature is 460 ° C
  - Vessel skin typical operating temperature is 280 ° C
  - Infrared thermal camera has measurement range of 0 – 500 ° C
  
- Inherently long operational lifetime
  - Infrared thermal cameras operate for more than 10-years
  - Almost no maintenance
  - No loss of performance over time
  - High reliability and availability
  - Can be used as reliable safety system signal

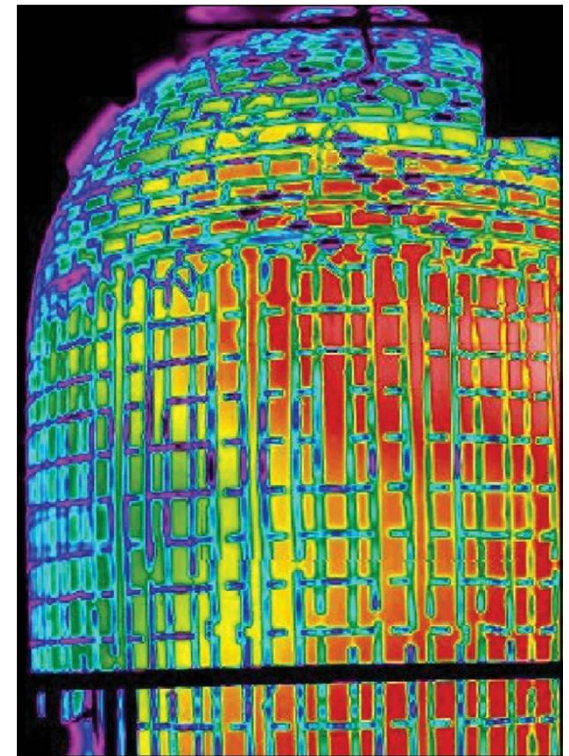


## Why the switch to infrared?

- Simple installation
  - No mechanical modifications required during engineering
  - No vessel preparation such as welding of railings
  - Cameras are positioned away from the vessel
  - No need to access the vessel
  - Easy installation of IR computer system with automatic operation
  
- Highly Accurate
  - Accurate single temperature measurements to  $\pm 2^{\circ} \text{C}$  or  $\pm 2\%$
  - True temperature from a measurement spot of less than 16 cm<sup>2</sup>
  - Accurate hot spot detection and alarming
  - Storage and trending of historical data

## Issues with traditional methods

- No detection of early refractory damage
  - Average temperature measurement over large area – typically >250 cm<sup>2</sup>
- Poor Reliability
  - Tubes or sensor cable can lose contact to vessel shell, no detection possible
  - Mechanical damage during installation can cause false hot spot alarms
- Short Operational Lifetime
  - Typically sensor cable must be replaced after 3-years of operation
- Operation requirement exceeds recommended use specification for Sensor Cable
  - Sensor cable design temperature is 140 ° C
  - Sensor cable peak temperature is >200 ° C for less than 15 minutes

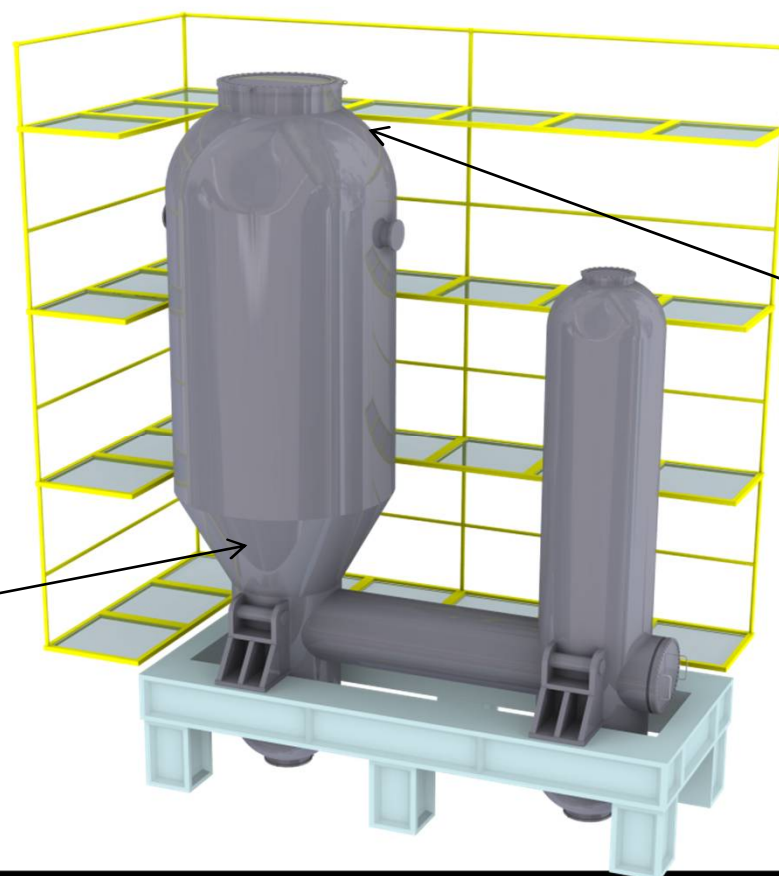


## CRITICAL VESSEL – A TYPICAL INSTALLATION

Multiple cameras to ensure complete coverage



Critical Cone  
Area  
(up to 4 cameras)



Critical Dome  
Area  
(up to 4 cameras)

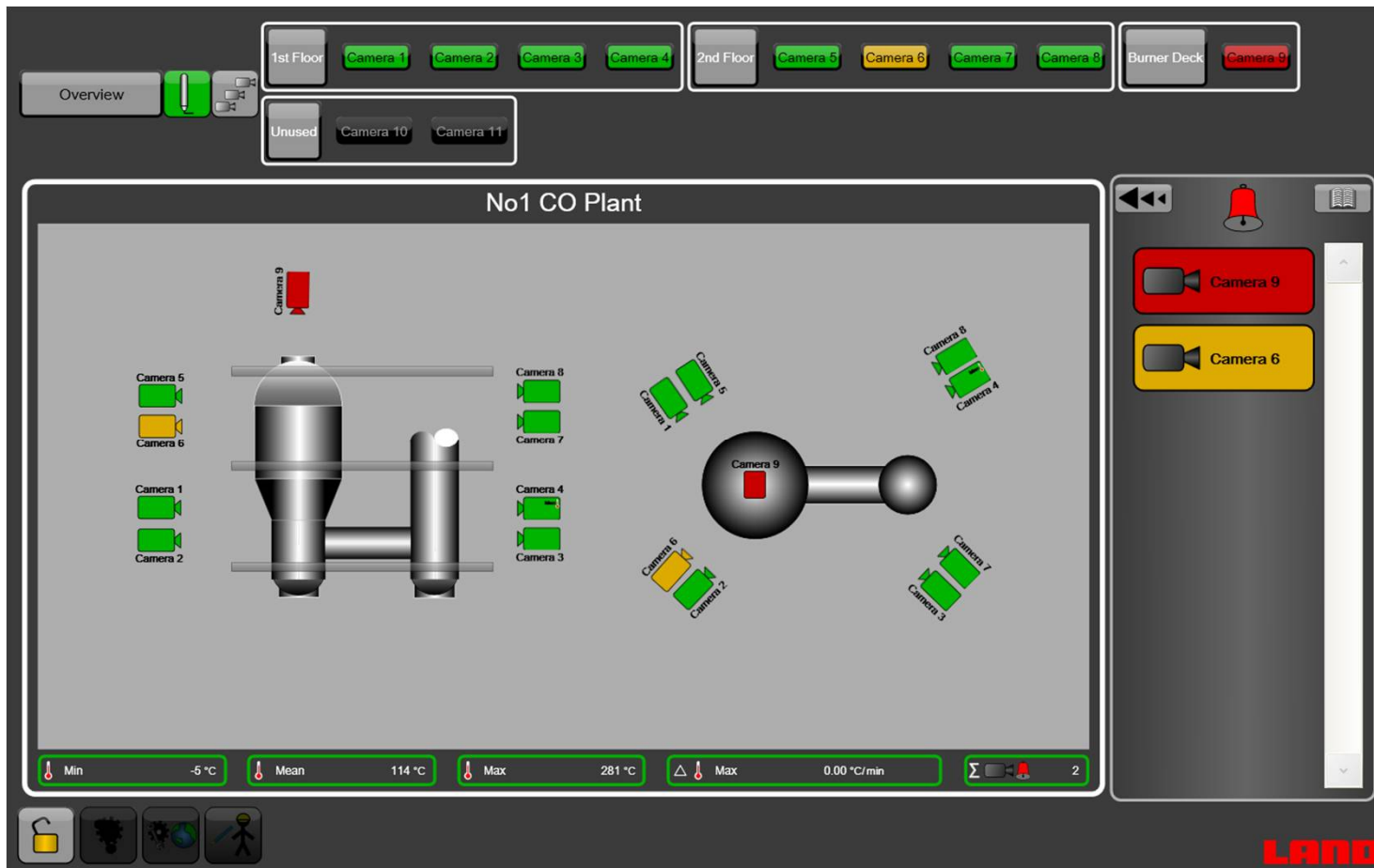
Additional cameras on  
the sidewalls

Images courtesy of Linde AG

# CRITICAL VESSEL – SOFTWARE FUNCTIONALITY



## CRITICAL VESSEL – SOFTWARE FUNCTIONALITY





## System Features

- Hotspot Tracking Mechanism
  - Inside an Area of Interest
  - Per Camera
  - Overall system
  
- Historian and Trending
  - Data stored every 1 minute during normal operation (user adjustable)
  - Data stored every 15 seconds during alarm condition (user adjustable)
  - Long term storage for up to 5-years data
  - Trending of all measured values over user defined time period
  
- System Status Monitoring
  - Critical for use as a safety system
  - Alarm if camera is over temperature, loses communication or power failure

## Example Projects

### POX Reactor Monitoring South Korea (2011)

- Green field project with Linde Engineering
- 11 fixed cameras suitable for mounting in Zone 2 environments to monitor the surface temperature of a partial oxidation mixed feed gasification reactor (GE License).



### POX Reactor Monitoring China (2013)

- Revamping project directly with the plant outside Beijing
- 8 fixed cameras suitable for mounting in hazardous area environment to monitor the surface temperature of oil gasification reactors
- Chinese language pack





CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE

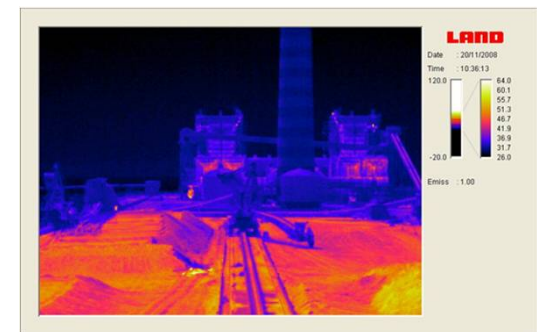
# Flammable Material Storage

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

[WWW.LANDINST.COM](http://WWW.LANDINST.COM)

## Why monitor material storage locations?

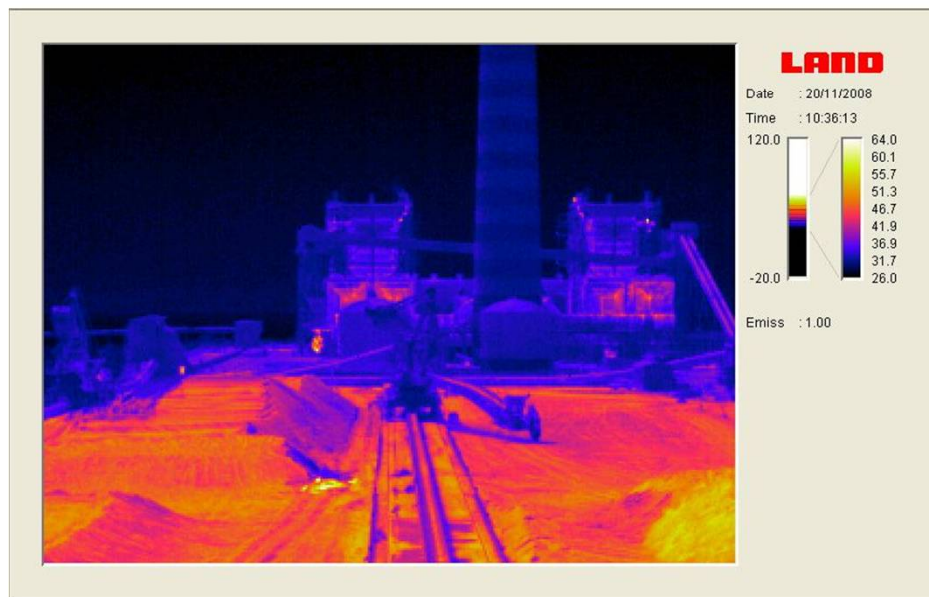
- The storage of any flammable material in large piles has the inherent risk of spontaneous combustion
- The current drive to maximize each barrel of oil means that previously waste material is now being stored and reused within the plant
- An early warning system is the most reliable solution for fire prevention
- Improves operator safety
  - Monitoring the coal surface for hot spots and alerting the operator to take action before the situation becomes critical
- Reduces risk of damage to plant
  - Early hotspot detection alerts the operator to a problem before it becomes a hazard. Simple alarms initiate preventative action before the fire takes hold





## The Solution

High resolution thermal imaging camera mounted on scanning mechanism can view complete coal Pile. Alarm outputs can be configured to indicate detection of “hot spot”





## The Benefits

- Early hotspot detection using a thermal imager in all environments
- Fully-automated continuous monitoring of remote storage areas
- Simple alarm to initiate preventative action
- Variable levels for warnings and alarm
- Alert operators to critical conditions
- Clear display and alarm outputs when hot spots are detected
- Used to trigger preventative action by plant personnel
- Success of user intervention can be immediately assessed
- Designed specifically for industrial environments
- delivering the ultimate in reliability and measurement availability
- Data Exchange
  - All processed data can be requested by a process control system for easy integration

## Example Projects

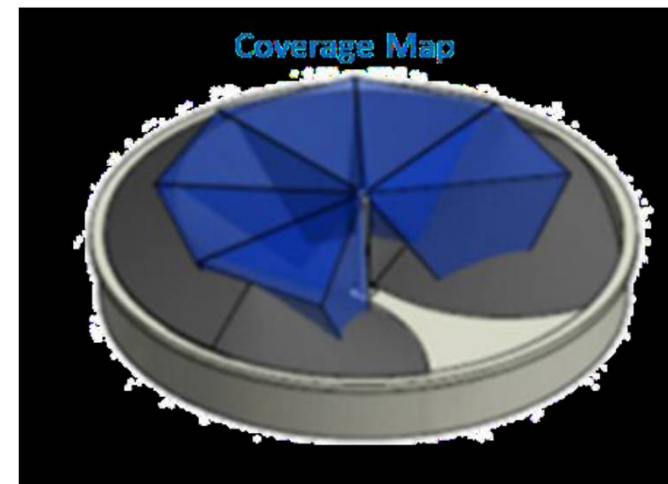
### Coke & Sulphur Storage Saudi Arabia (2014)

- Green field project with Gulf Consolidated Contractors
- 44 fixed cameras suitable for mounting in IEC-Ex dust certified housings to monitor refinery storage locations



### Pet Coke Storage India (2017)

- Expansion project directly with the end user
- 2 x 6 fixed cameras for monitoring pet coke storage domes





CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE

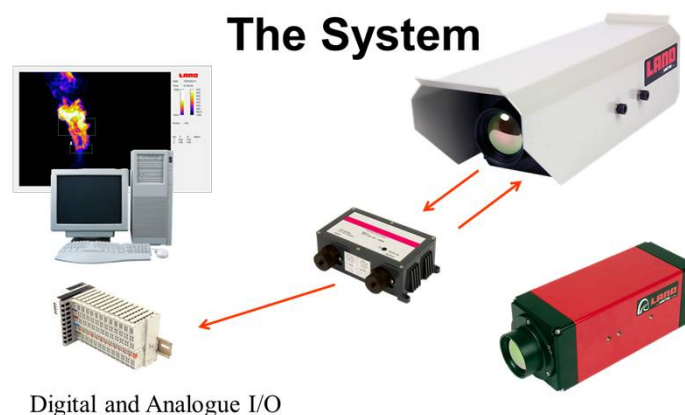
# Flare Stack Monitoring

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

[WWW.LANDINST.COM](http://WWW.LANDINST.COM)

## FLARE STACK MONITORING

- Plants need continuous monitoring of the flare and pilot light to avoid unignited flaring.
- Stack mounted sensors are often unreliable.
- Flare is often invisible to the naked eye.
- Thermal imaging can overcome this challenge and give a reliable status signal for the flare and pilot light.
- AMETEK LAND offer a hazardous area approved system with simple status signal for PLC / DCS integration.



CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE



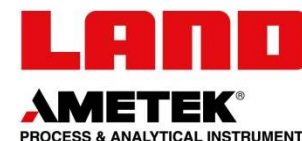
# Tube Wall Temperatures Reformers & Crackers

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

[WWW.LANDINST.COM](http://WWW.LANDINST.COM)



# Heater TWT



Managing TWT is extremely important and producers understand this, up until recently everyone relies on operators taking TWT reading with handheld pyrometers manually and on a limited schedule. These measurements are only spot readings and the operator might not always find the hottest area of the tube which can lead to overheating. Many producers also have outlet temperatures that they monitor, the issue here is once the outlet temperature gives an alarm of rising temperatures the TWT are normally above the max temperature set by the plant. To operate within an integrity operating window there is a need for continuous TWT monitoring.



# Heater TWT

The cost of not properly managing TWT can be extremely high. As a rule of thumb operating at 20C above design temperature will cut the tube life from a designed 10 years to 5 years of life – Fig1. A typical rebuild of a 400 tube reformer can easily exceed €7M just for material, when you add in labour and lost production this cost can double.

In recent years there has been increasing interest in the use of Process thermal imaging cameras for continuous and more complete measurement of the equipment/process. Some hydrogen producers are reporting a 2% increase in production all while still operating at a safe condition within their integrity operating window

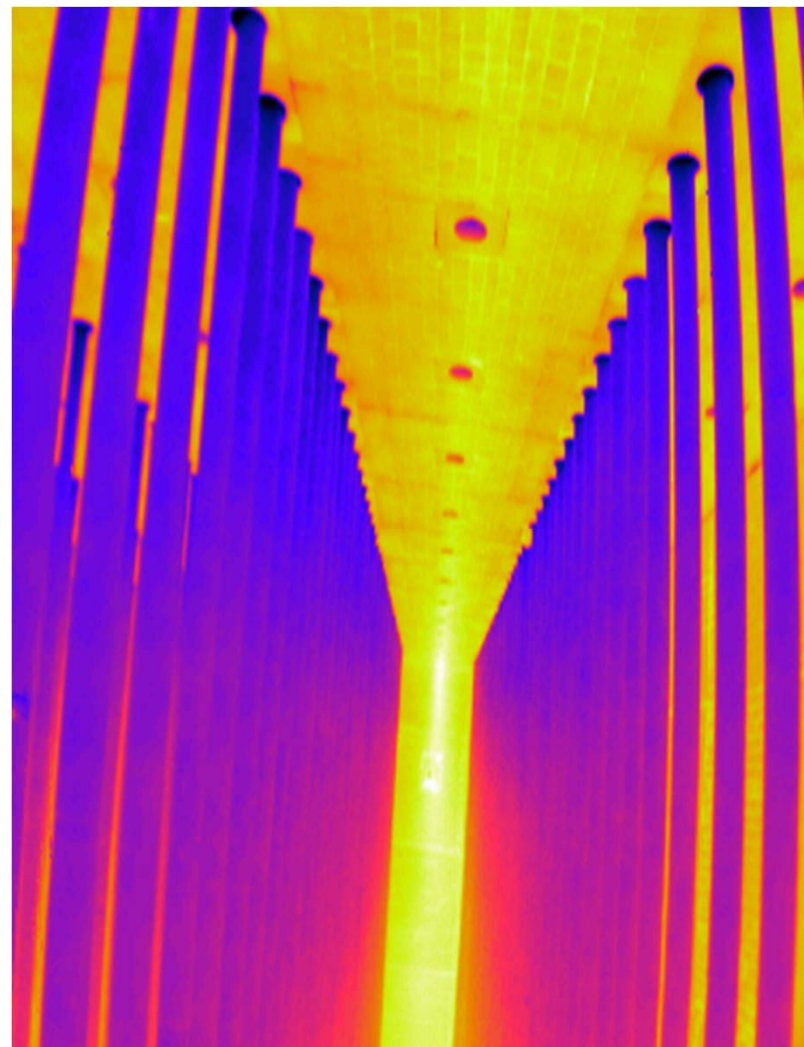
Deg C	Mean Tube Life
860	10 Years
880	5 Years
900	2.5 Years
925	11 Months
950	4.5 months
975	2 months
1000	4 weeks
1050	5.5 days
1100	1 day

Fig1.



# Heater TWT

- Extend tube and catalyst life
- Monitor TWT 24/7 early warning of increasing temperature
- Safely increase temperature to increase production
- Remote support in real time
- Balance Reformer
- Build spreadsheets for weekly/monthly TWT average/min/max temps
- Monitor during startups and shutdowns
- Enhance operator safety due to the fact they are not required to be on the reformer as often
- Cost savings on personnel/operators taking TWT measurements €80,000 - €100,000 per annum.



# Heater TWT

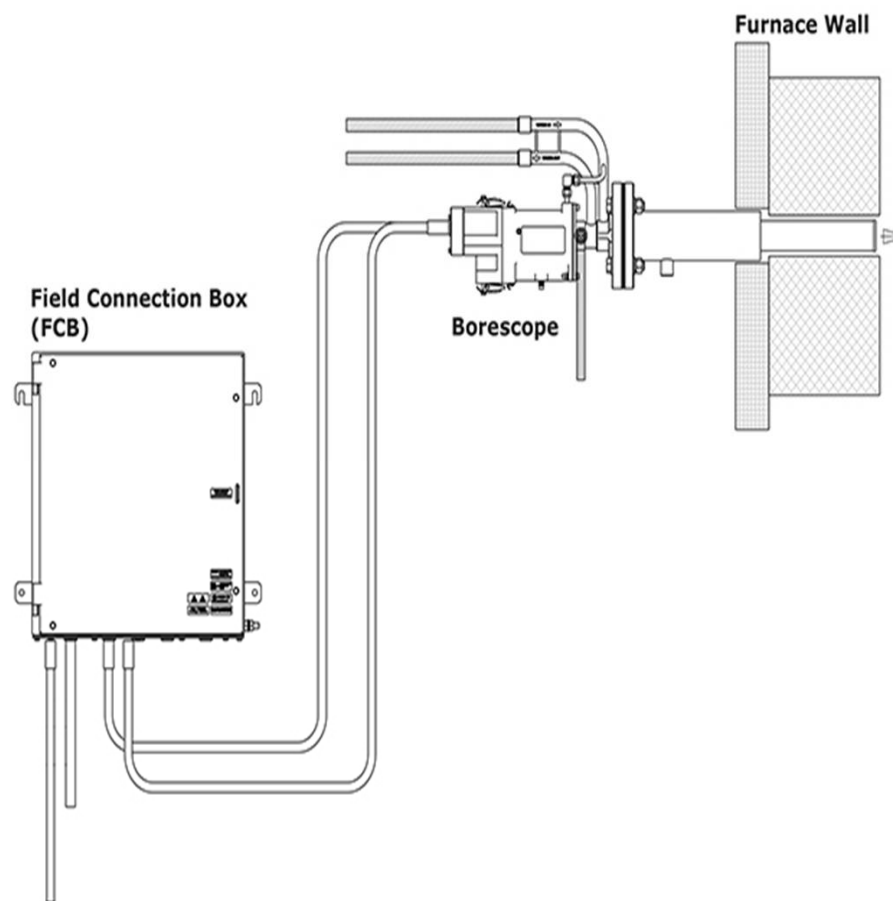


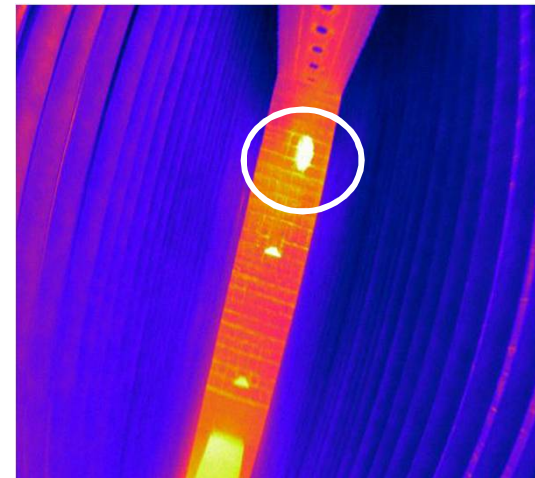
Figure above shows a diagram of where the thermal imager would sit in relation to the refractory.



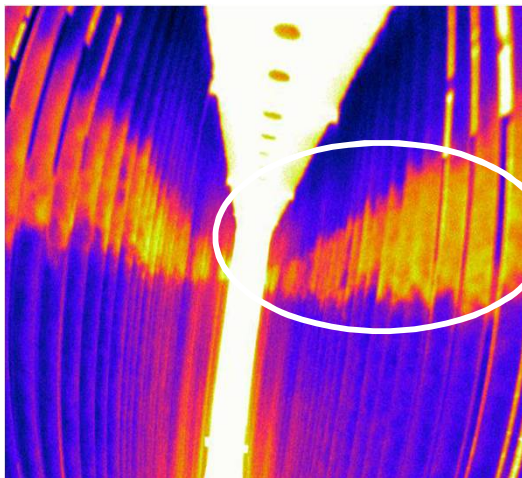
# Heater TWT



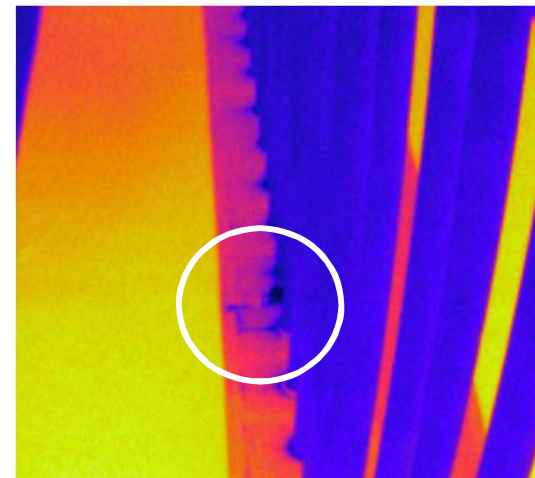
Hot spots



Flame impingement



Hot bands



Refractory damage



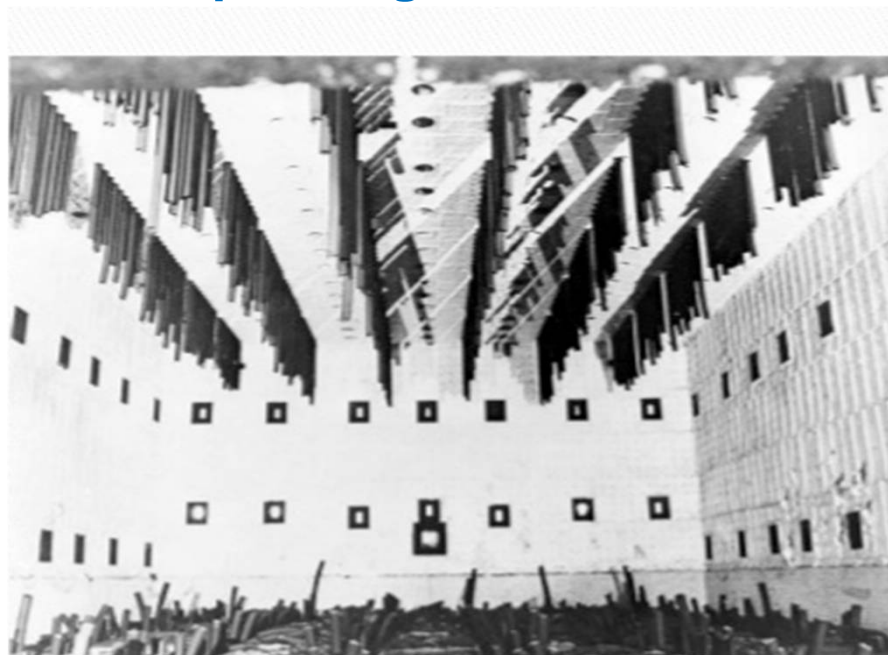
# Heater TWT



Continuous monitoring of the reformer TWT and process provides many advantages. It allows the plant to operate within an integrity operating window by doing this production can be increased in a safe manner.

Equipment and personnel safety can be increased as 24/7 monitoring will give operators immediate notice thru preset alarms of any changing conditions of temperatures and process within the reformer.

**There's no way to alleviate all issues with the reformer but by giving your operators better tools they will be able to make more informed and confident decisions when operating the reformer.**



CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE



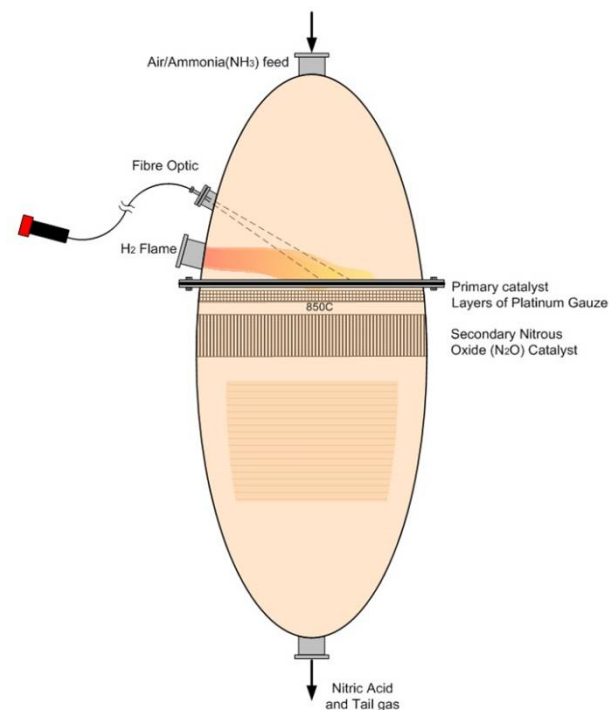
# Ammonia Burners Nitric Acid Plants

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

[WWW.LANDINST.COM](http://WWW.LANDINST.COM)

# Ammonia Burners

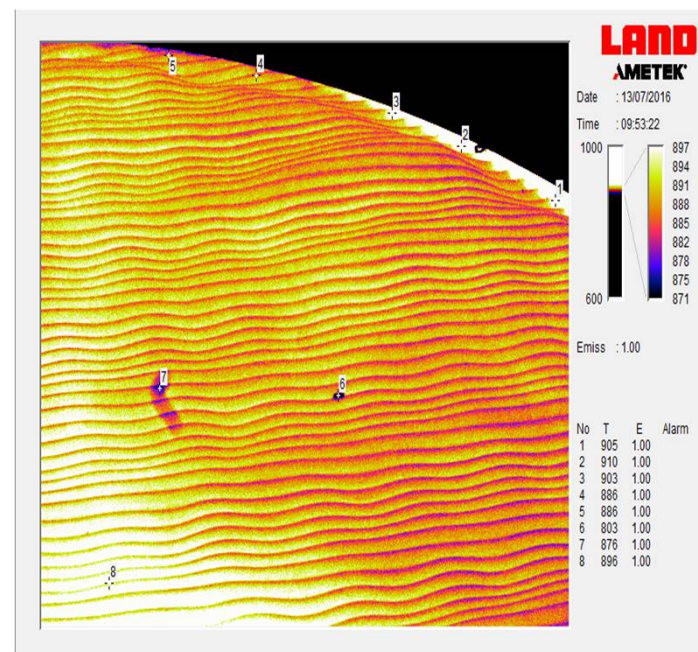
The requirement to monitor catalytic gauze temperatures during operation in Ammonia burners in Nitric Acid plants is important. Currently thermocouples are used on the lower gauze to monitor the operating temps but these only provide spot measurements and don't provide enough information when trying to detect hotspots.



# Ammonia Burners

Hot spots along the edges

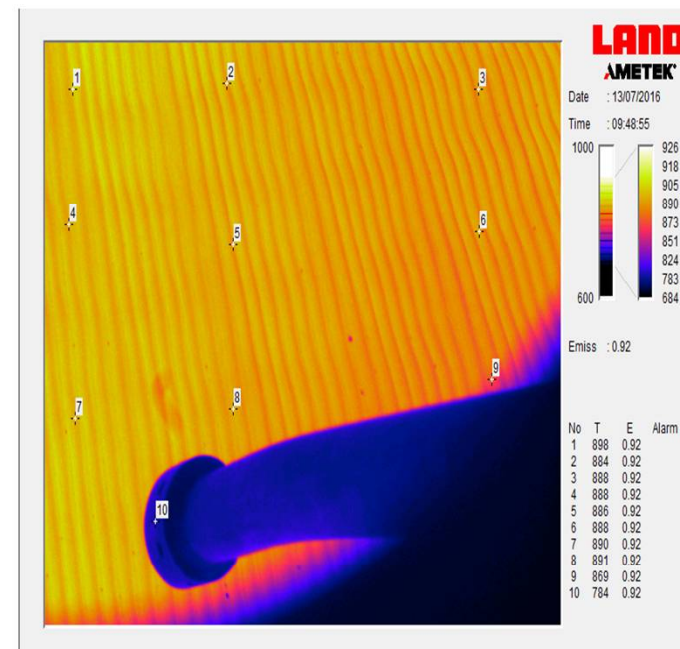
The aggressive way the temperatures are brought online is a concern for operators and there is a need for continuous monitoring during the startup. This can be achieved by using the LAND NIR imager to monitor continuously during operation and start-ups and shutdowns. In the image you can see the edges are a little hotter than the rest of the gauze.



# Ammonia Burners

View from opposite port

We are able to monitor the temperatures thru the current viewing ports so no additional changes are required. There would be a possibility to install this during operation if the customer needed this option. If the area is classified there is also the option to use fiber optics to move the imager outside of the classified area.





# Ammonia Burners

When you have an area of this size trying to measure the temperature with 3-4 thermal couples is not sufficient. When using the NIR Imager you will be able to monitor 80%+ of the surface the only limitation will be the viewing angle thru the sight glass.





CLEAR VISION   SOUND STRATEGIES   SOLID PERFORMANCE

For more information

**FOR THE MOST CURRENT  
INFORMATION PLEASE VISIT:  
AMETEK LAND'S WEBSITE**

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

**[WWW.LANDINST.COM](http://WWW.LANDINST.COM)**