LEAK DETECTION AND COOL-DOWN MONITORING AT LNG FACILITIES

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ABSTRACT
Operators of LNG liquefaction and gasification terminals have a responsibility (and are required by local regulators) to prevent major accidents and to limit the consequences of any accident to people and the environment. Regulatory requirements typically cover the loading/unloading equipment at the jetty, the site itself and the pipeline link to the national gas transmission system. Typical Emergency Shut-Down (ESD) systems are required to shut down within 1 minute of the occurrence of a leak in any plant area, unloading equipment at jetty or pipeline. Traditional leak detection technologies have historically not been well-suited to this requirement. Measuring the temperature distribution around the plant is a powerful tool for leak detection, monitoring tank base heating and the cool-down process. This paper will describe the application of distributed temperature sensing (DTS) employing a fiber optic cable, generally deployed alongside or within LNG tanks, tank bases or pipelines to provide continuous temperature monitoring along its length. A single system can hence provide leak detection functionality for pipes and tanks, monitor the initial cooldown process, and also monitor tank base heating on an ongoing basis. Benefits of this approach include enhanced plant safety, minimized downtime and improved plant performance. The system also helps operators to conduct detailed intelligent monitoring operations that reduce the likelihood of undetected leaks and plant damage while optimizing efficiency. The paper will also describe SIL2 (Safety Integrity Level 2) configurations and will include recent case studies of installations of this type including the recently installed SLNG.

INTRODUCTION
Operators of LNG liquefaction and gasification terminals have a responsibility (and are required by local regulators) to prevent major accidents and to limit the consequences of any accident to people and the environment. Regulatory requirements typically cover the loading/unloading equipment at the jetty, the site itself and the pipeline link to the national gas transmission system.

Typical Emergency Shut-Down (ESD) systems are required to shut down within 1 minute of the occurrence of a leak in any plant area, unloading equipment at jetty or pipeline. Traditional leak detection technologies have historically not been well-suited to this requirement.

Leaks from an LNG plant result in cold spots caused by either the release of cryogenic LNG or the cooling effect of escaping high-pressure gas. Measuring the temperature distribution around the plant is a powerful tool for leak detection, monitoring tank base heating and the cool-down process.

A fiber-optic cable, generally deployed alongside or within the LNG tanks, tank bases or pipelines, can be used as a distributed temperature sensor (DTS) to provide continuous temperature monitoring along its length. This technology delivers detailed monitoring of LNG assets to operators’ desktops.

APPLICATION
Traditional leak detection technologies have historically not been well-suited to this requirement. Leaks from LNG plants result in significant cold spots caused by either the release of cryogenic LNG (in the fluid phase) or the cooling effect of escaping high-pressure gas.

High thermal stresses may not cause an immediate problem but can significantly reduce the expected lifetime of the plant or give rise to mechanical failure later in the operating life of the plant. Measuring the
temperature distribution around the plant is a powerful tool for leak detection, monitoring tank base heating and the cool-down process. This is particularly true for cool-down when actual computed thermal stresses are compared to modeled values in order to improve the predictive capabilities of those models.

This paper describes the application of a DTS system employing a fiber optic cable, generally deployed alongside or within LNG tanks, tank bases or pipelines to provide continuous temperature monitoring along its length.

A single system can hence provide leak detection functionality for:

- LNG pipelines
- LNG tanks
- Concrete tank base heating
- Initial cooldown process

Benefits of this approach include enhanced plant safety, minimized downtime and improved plant performance. The system also helps operators to conduct detailed intelligent monitoring operations that reduce the likelihood of undetected leaks and plant damage while optimizing efficiency. System have been installed which have achieved SIL2 (Safety Integrity Level 2) approval.

INSTALLATION

Schlumberger has established an enviable reputation by successfully delivering fiber-optic temperature sensing solutions in the LNG industry for over 15 years.

Schlumberger has an installed base which includes many major projects around the globe where we have provided temperature and leak detection monitoring for LNG storage facilities and pipelines, concrete pad heating management and cool-down monitoring solutions.

Fiber optic monitoring can deliver thousands of temperature measurements along a sensor cable, thereby providing much more comprehensive coverage of the LNG asset than can be practically achieved with traditional thermocouple or infrared sensors.

The fiber-optic system provides a precise location and detailed information about any temperature event and relays this information to a monitoring facility. The temperature data can be analyzed and used to deliver the thermal footprint of the asset.

Visualization of the asset is delivered to the control room using proprietary Data2View user interface which can be used alongside the engineering solution to provide a graphical layout of the asset with temperature information. The information can be viewed on site or in a control room environment to provide personnel with instant access to critical data. Multiple units can be networked to monitor larger and more complex installations. Users can analyze historical data of the monitored area.

Based on fiber-optic technology, the Schlumberger solution delivers real-time, continuous temperature monitoring. The many thousands of sampling points provided by this technology enable detailed information about the location of any temperature event to be relayed to a remote monitoring facility.

The technology uses a fiber-optic cable that is not affected by electromagnetic interference and has no electrical in-field components. The low-power cables ensure that the monitoring system complies with explosive atmosphere standards.
Double-ended processing technology, which interrogates the fiber optic sensor from both ends simultaneously, provides high accuracy and speed of response. With appropriate planning and design of the cable deployment, changes of less than 1degC can be detected at any point in real time. The double-ended system also provides a fiber break-recovery feature that helps to ensure continuous measurement, even in the event of a complete cable break. In addition the system will automatically recover its full monitoring function following a power failure. This combination delivers reliable and accurate monitoring.

If facilities are expanded, the flexibility of system design enables an installed monitoring system to be extended to include additional tanks or pipelines.

COOL DOWN MONITORING

The initial cool-down process during which the plant is brought down to cryogenic temperatures is a critical phase in the start-up process, requiring close control to minimize thermal stress.

This technology allows cool-down monitoring functionality in storage tanks and pipes, replacing the manual measurements during the cool-down process.

A single system is used to monitor the cool down process as that is used for the ongoing leak detection of the plant and pipelines. Additional as coils are set up in 5-metres and 10-metre sections along the outer shell of inner pipe to enable the cool down process to be monitored in real time and from within the control room. Differential stress (real-time temp to stress conversion) is also measured.

This process has been proven at the Isle of Grain, UK where systems were installed on all three phases of the LNG plant build.

BENEFITS

The benefits of DTS monitoring include rapid detection and location of leaks, a reduction in tank base heating costs and no need to pre-determine sensor locations. The technology requires only simple field installation, no electronics outside the control room, giving an intrinsically safe (ATEX) solution immune to EMI or fiber cable redundancy taking place in the event of a break.

Benefits experienced by system users include a quick response capability to identify locations; plant and energy efficiency and low maintenance costs - while still attaining health and safety standards and safe and continuous plant operation.

Key benefits of Schlumberger Distributed Temperature sensing include:

- System profiles along the entire length of fiber allowing interpolation of measurable events.
- Leak detection, cool-down, pipeline integrity and frost heave are all possible using fiber temperature detection technology
- 2D & 3D interface screens show easily and effectively the status of terminal infrastructure
- Schlumberger DTS solution can conform to SIL2 compliant, a growing need in a high-integrity application
- Optical low-power detection hardware means non-incentive system leading to ATEX compliance
- The system can be extended with ease to include additional tanks or pipelines when increased capacity is required.
CONCLUSION

Liquefaction, transportation and regasification are crucial elements of the LNG value chain and their associated plant and pipelines represent very significant capital investments. Effective monitoring of these assets can reduce the environmental, safety and financial impacts of leaks and improve operational efficiency. In addition, local regulators often require high levels of plant integrity monitoring to ensure safety.

Schlumberger fiber optic temperature sensing technologies can monitor the entire surface of any plant, including LNG pipes and tanks. They deliver accurate and continuous real-time measurements of temperature at all points along fiber-optic sensors. From these measurements, the location and severity of impending insulation failure or leaks, hot spots and trace – heat failure can be detected.