# TENDING THE FLAMES

**David Ducharme, LumaSense Technologies, USA,** explains why safe flare operation and environmental protection require reliable and accurate flare pilot monitoring.

Flaring systems are used to burn gases before they enter the atmosphere and are commonplace across many industries – perhaps none more so than in oil and gas. Safe operation of a flaring system requires the continuous monitoring of pilot flames and flared gases to ensure that vented gases are ignited.

## Pilot monitoring

Original equipment manufacturers (OEMs) use standard thermocouples for pilot detection for flare stacks. Pilot thermocouples are mounted into the pilot burner housing and detect heat transfer from the pilot flame into the pilot burner housing. The increase in temperature of the pilot burner housing is an indication that a pilot is lit. However, this method is slow, owing to the time needed for heat absorption and transfer into the burner housing.

Typical installation of a LumaSense FlareSpection flare imager on an M-4 heavy duty swivel mount.

Thermocouples in flare stack monitoring applications are subject to extreme thermal shock as they are exposed to low temperatures from pilots and extreme temperatures from flaring events. This cycling of temperature causes thermocouple failures that rarely correspond to the facility's planned maintenance outages. An alternative monitoring method using an infrared (IR) detection solution provides a secondary pilot monitoring system in situations with frequent thermocouple failures and/or industrial applications where it is not practical to use thermocouples.

## IR pyrometers

In the industrial market, professionals have traditionally relied on IR detection systems for thermal monitoring of furnaces and process control. IR systems for flare pilot monitoring applications have been on the market for more than 25 years. The early flare monitoring IR pyrometers were 'off the shelf' industrial pyrometers with limited optical resolution options and minimal environmental and hazardous area protection. Today, the industry has a selection of flare application-specific IR products designed exclusively for flare monitoring and designed to meet the application's environmental and hazardous area challenges.

An IR monitoring system can be as simple as an IR pyrometer that provides a basic 'flame' or 'no flame' switched signal to confirm to the operator whether the pilot is on or off. Other systems offer more advanced features and automated controls. Options such as proportional 4 – 20 mA outputs that correlate to a flare's flame size are useful in monitoring gas assist flaring flame size and ensure that a given flaring level is maintained. Another application for a proportional 4 – 20 mA output is as a staged flare's stage indicator for the operator. An mA output level can be confirmed for each of a flare's stages and a setpoint input to the distributed control system (DCS) for each flare stage indication. The staged flare and gas assist flare applications would require a larger field of view to encompass the entire flare tip, so that it includes the whole flaring event.

## IR thermal imaging

Thermal imaging systems utilise lenses with high resolutions, allowing for the detection of a very small pilot flame, and can provide a reliable detection signal. Many systems also include software that allows for a multitude of control regions of interest (ROIs) that can be integrated into the operator's pilot re-ignition control and flare monitoring system alarms.

Thermal imaging systems are helpful for monitoring pilots on multi-flare tip demountable flares where spacing between flare tips is minimal. Demountable flare tips normally have minimal tip spacing of approximately 3 ft on centres, creating a very close operation. This type of close flare tip operation causes a lot of flame interaction between the adjacent flare tips, making accurate flare pilot detection difficult for basic pyrometer solutions that only work when no flaring is happening. With multiple flare tips in close proximity, a basic pyrometer can be fooled when wind blows the flaring flames into the field of view of an adjacent flare tip. Thermal imaging systems can make software calculations that can determine the detection of pilots or if there is flaring interference from an adjacent flaring flare tip. Thermal imaging is the best monitoring solution for multiple flare tips in close proximity.

## Optimising installation location

Installation of an IR monitoring solution as a secondary monitoring system to thermocouples offers a redundancy to the flare control systems. These remote monitoring solutions are designed for installation in a location that is easily accessible for maintenance, at an acceptable distance for weather conditions, which also minimises the possible influence of the sun.

Installation is normally in a location that allows the monitor to view the flare tip. The minimum installation distance is normally specified as a location that is the height of the flare stack away from the base of the stack or 45˚ maximum elevation (e.g. if the flare stack height is 120 ft, the installation would be 120 ft from the base of the flare, providing 45˚ elevation from the horizon). While this is preferable, there are instances where installation closer to the flare stack is required because of the physical limitations of the site.

The recommendation for mounting an IR detection system for best operation in bad weather conditions is as close to the flare stack as possible while maintaining ±45˚ elevation to allow viewing over the flare tip edge. The greater the distance between the installation and the flare stack, the more the weather will attenuate the pilot or flaring IR energy reaching the detector. This would block the IR signal and prevent the IR detector from measuring the presence of pilots or flaring accurately.

Another important location consideration for the sighting angle is to avoid the sun's annual path. Normally, the wavelength of an IR detection system allows for installations with the system's detection spot size to be within a distance of 6˚ of the sun's annual path and not detect the false signal the sun would create. If the sun travels inside the detection spot size of the system detector, a false detection event would occur. The sun's annual path can be avoided entirely by installing the IR system within ±45˚ true south of the flare stack in the northern hemisphere or ±45˚ of true north of the flare stack in the southern hemisphere.

The IR detection of pilots requires the physical site path to the targeted pilot flames be clear. Windshields create a physical obstruction to the pilot view path and are not compatible with an IR detection system. However, there has been some success with creating a

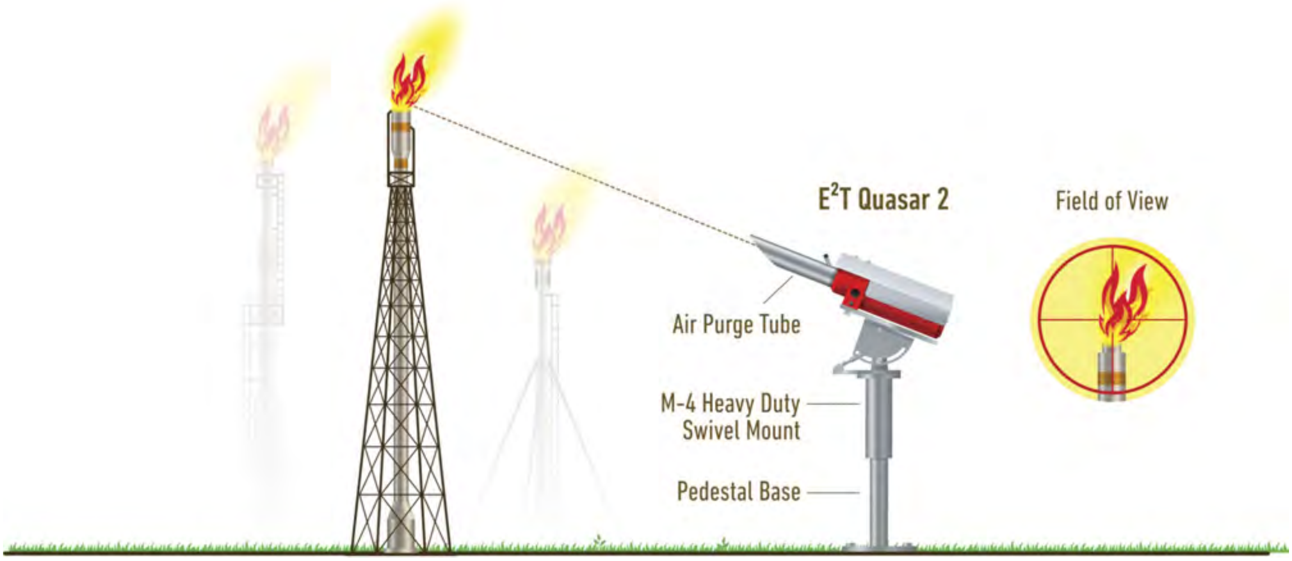


**Figure 1.** Flare monitoring systems are located at a distance about equal to the height of the flare stack to get a proper field of view.

pilot viewing window in the windshields to allow the IR monitors a view path to the pilot flames.

## Optical resolution and spot size

An IR detection system must have a field of view that is optimised for the application it is designed to detect and the physical type of flare stack being monitored. For example, for pilot detection on a 120 ft guy wire flare stack, the optical field of view resolution should account for the flare tip diameter and the sway of the flare stack, which can be as much as 18 in. depending on the wind impacting the flare. The standard pyrometer installation would be specified as 1.5 – 2 times the flare tip diameter. This would give a detection spot that, when targeted on the flare tip, would be bigger than it, allowing for the flare to move up to 18 in. in windy conditions but still keep within the pyrometer's detection spot.

Flaring measurements require larger fields of view that will ensure that a good percentage of the flaring flame is always within the spot size detection area of the monitor. This is an issue when the wind is blowing the flame in different directions.

## Environmental enclosure considerations

An environmental enclosure for an IR detection system should have a rating that will allow for operation in extreme weather conditions. The enclosure should be rated for IP67 to ensure an environmental seal to protect the system's electronics. For offshore platforms, corrosion resistance is required and a 316L stainless steel enclosure is normally specified for marine grade protection.

The ambient operating temperature range of a system should be between -40˚C and +55˚C, and additional accessories are available to accommodate for ambient temperatures outside this range. Additional options are normally offered for higher ambient limits such as sun shields and thermal jackets for lower ambient temperatures.

Installations are normally outside in remote locations, in facilities that do not have area classifications, but installations can often be within hazardous zones. An IP or National Electric Manufacturers Association (NEMA) rating ensures that the system's enclosure has a rated sealing that can be purged to meet a hazardous area classification. However, purging systems are costly and require regular maintenance, and facilities normally request EExd* or intrinsically safe certifications as their first choice of hazardous protection methods.

## Conclusion

Both the pyrometer and thermal imaging IR detection systems are beneficial for flare monitoring, depending on the needs of the site. While basic detection and monitoring are done by a basic pyrometer system, advanced systems can vary in features to meet almost any flaring application. Currently, pyrometers are normally used in single flare tip applications while thermal imagers are used in applications where pyrometers cannot meet the detection requirements or where there are multiple flare tips in close proximity. The software capability of an imaging system can also integrate both the pyrometer and thermal imaging technology into a customised flaring monitoring and control solution. An all-pyrometer detection system costs less but has fewer capabilities, while an all-thermal imaging solution comes with more capabilities but higher costs. A middle solution can integrate a pyrometer and thermal imaging system using software that can reduce a monitoring and control system's overall costs. HE

## Note

*E = European certificate in accordance with harmonised standards; Ex = explosion-proof electrical equipment; d = flameproof enclosure.