CONTINUOUS FLARE STACK MONITORING

Enhancing Safety and Ensuring Compliance for Industrial Facilities

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How Continuous Flare Stack Monitoring Enhances Safety and Ensures Compliance for Industrial Facilities

Flaring is an essential safeguard that protects people, equipment, and the environment. To ensure both safety and compliance, industrial facilities are required to monitor flare integrity. Most jurisdictions mandate performance standards for combustion efficiency, visible emissions, flame presence, and other key parameters.

Effective flare stack monitoring programs involve a variety of instruments, sensors, and visual observation techniques. Unfortunately, many of the existing approaches are limited in their ability to provide accurate, objective, and real-time data. This lack of visibility increases the likelihood of breaches going undetected and unresolved, resulting in fines or the suspension of operating permits.

As regulations become more stringent, industrial facilities require a better approach. Continuous Flare Stack Monitoring solutions leverage thermal and visual cameras and advanced visualization software to provide 24/7 coverage of multiple flares from a remote location.

This white paper will show why industrial facilities can no longer rely on traditional approaches to flare stack monitoring. It will highlight the limitations of existing tools before demonstrating how companies can deploy and use Continuous Flare Stack Monitoring solutions across a range of applications.

Adapting to a Changing Landscape

The industrial sector is inherently volatile, and a company's performance can be affected by factors outside of its direct control. This changing landscape has led firms to seek out and adopt technologies that reduce costs and improve operations. Below are some of the trends that are shaping the way industrial facilities invest in new solutions.

Decarbonization and Environmental Responsibilities

Around 140 bcm of natural gas is flared each year.[1] A malfunctioning flare can lead to the uncontrolled release of natural gas, methane, or other pollutants that can harm local communities, disrupt surrounding ecosystems, and cause wider environmental damage.

> ***"Around 140 bcm of natural gas is flared each year."***

As governments, investors, and the public demand lower emissions, companies are under increasing pressure to reduce greenhouse gas emissions and demonstrate a commitment to continuous improvement at every stage of the production process.

Shifting Regulatory Requirements

Local, national, and international laws govern how industrial facilities operate. Regulations change frequently, and many governments have specifically targeted regulations on flaring and methane leakage as part of broader efforts to reduce emissions.

Keeping up with changing regulations across jurisdictions is challenging. It creates uncertainty and places an additional burden on companies to accurately measure and report on key metrics. Continuous Flare Stack Monitoring reduces compliance risk by providing Operators with transparent, verifiable data in case of audits or other regulatory investigations.

Workplace Safety

Safety must always be a top priority. After a period of decline from 2006 to 2019, workplace incidents in the US oil & gas and industrial sectors have started to increase again in recent years.[2]

Exposure to hazardous fumes, confined spaces, and combustion incidents are among the most common causes of injuries and fatalities. Implementing workplace safety policies is not always enough, as workers may depart from these standards to complete their tasks. Instead, industrial facilities should look to technology to reduce the time workers spend accessing and operating in hazardous environments.

[1] https://www.iea.org/energy-system/fossil-fuels/gas-flaring
[2] https://int-enviroguard.com/blog/oil-gas-worker-fatalities-on-the-rise/

> ***"Exposure to hazardous fumes, confined spaces, and combustion incidents are among the most common causes of injuries and fatalities."***

Skill Shortages

A recent survey found that 76 percent of energy and utility companies are struggling to find skilled workers.[3]

Experienced workers are retiring or leaving the industry, and recent graduates are looking to other sectors to start their careers. As a result, companies are losing important domain expertise in process operations, flare system behaviour, troubleshooting, and compliance that is increasingly difficult to replace.

New Technologies and Automation

In response to these trends, companies are actively seeking out and investing in new technology. Advances in automation, artificial intelligence, machine learning, smart sensors, and cloud-based platforms have all helped industrial facilities to reduce emissions, remove workers from hazardous environments, and overcome the loss of skilled personnel across the organization.

[3] https://go.manpowergroup.com/talent-shortage

The Need for Better Data

Flare stack monitoring involves the observation, measurement, and analysis of flare systems. It ensures that gases routed to the flare are being completely combusted, minimizing the release of unburned gas into the atmosphere.

Flare stack monitoring is increasingly driven by strict environmental and regulatory standards. But monitoring should not only be viewed as a regulatory obligation. Done well, flare stack monitoring performs an important safety and operational function as well.

> ***"Monitoring should not only be viewed as a regulatory obligation. Done well, flare stack monitoring performs an important safety and operational function as well."***

The Limitations of Existing Technologies

An effective flare stack monitoring system will always include a range of sensors, instrumentation, cameras, and software. Each serves a specific purpose and can provide useful insights into a particular component or function.

However, it has become clear that existing tools are no longer suited to today's requirements. As regulations become more stringent, the limitations of these tools mean facilities are missing out on key information.

Thermocouples

Thermocouples are widely used to detect and verify the presence or absence of the pilot flame. They are simple and low-cost sensors that are typically installed within or near the pilot burner. By tracking temperature, thermocouples alert the Operator if the pilot flame is extinguished.

Thermocouples are generally limited to the pilot flame and do not measure the combustion of the main flame. They offer no visual confirmation of flame quality, shape, or stability, and can be affected by wind and weather. Because they are exposed to the flame, they tend to be prone to failure and require frequent inspection and maintenance. This not only increases costs but also puts workers in hazardous environments at the top of the flare stack.

Pyrometers

Pyrometers are used to assess the combustion zone temperature to determine flame health and combustion efficiency. They are increasingly important in facilities subject to strict emissions regulations or that are pursuing real-time combustion optimization.

Pyrometers are generally intended for targeted applications. Compared to thermal cameras, they have a narrow field of view and only measure a single point temperature. They provide limited data on the entirety of the flare system, meaning they cannot be used for broader analysis of the flame and emissions.

Flow Meters

Flow meters are essential for measuring the volume and rate of gas sent to the flare, both of which are needed to calculate emissions, validate combustion efficiency, and assess flare system loading.

On the other hand, flow meters are expensive to procure, install, and maintain, especially in corrosive environments. They are highly sensitive, requiring frequent calibration, cleaning, and signal validation to provide accurate data. While necessary to measure flow rates, they do not measure flame temperature, composition, or presence.

Visual Observation

In the US, EPA Method 22 is used to measure visible smoke and particulate matter emitted from flares. Similar procedures relying on visual observation are used to determine opacity and other key parameters.

Despite being required by regulations, visual observation techniques are inherently limited. First, they are time and location-dependent. Visible emissions that occur outside of the observation window are not detected or resolved. Moreover, the reliance on human judgment makes visual observation subjective and potentially inaccurate. Finally, it is a time-consuming and inefficient process that requires trained personnel to travel to remote locations to conduct the observation.

Continuous Flare Stack Monitoring

Continuous Flare Stack Monitoring solutions leverage advanced thermal and visual cameras to provide 24/7 coverage of the entire flare system.

Compared to traditional tools, Continuous Flare Stack Monitoring makes it possible to track flame presence, flare integrity, combustion efficiency, and emissions data. Optional pan-tilt-zoom capabilities allow Operators to monitor multiple flares from a single, remote location.

> ***"Continuous Flare Stack Monitoring makes it possible to track flame presence, flare integrity, combustion efficiency, and emissions data from multiple flares from a single, remote location."***

The explosion-proof, HazLoc-certified cameras are designed and built for industrial environments. Once mounted at a safe distance from the flare in weather-resistant enclosures, the cameras differentiate between the heat signature of the flare stack and its surroundings. Thermal sensors offer high detection accuracy during day or night and can see through smoke, fog, or steam.

Advanced visualization software automatically detects black smoke and determines the opacity of the smoke using the Ringelmann Opacity Score. Automated alerts notify Operators of smoke or abnormal flare conditions via email, SMS, or the facility's control system. Alerts include information on the duration, severity, and opacity of smoke as well as flare characteristics and other diagnostic data.

Instant alarms are triggered for loss of flame or other severe events, and the solution integrates directly into the existing plant control system to initiate emergency shutdown or corrective actions without the need for manual intervention.

The system also integrates seamlessly with leading video management systems (VMS) such as Avigilon, Milestone, Exacqvision, and Orchid Fusion using real-time streaming protocol (RTSP). This allows it to bring together data from other sensors and provide a complete picture in a unified dashboard.

Verifiable thermal and visual data is then recorded for future analysis and compliance documentation, simplifying compliance, troubleshooting, and process improvement.

Deploying Continuous Flare Stack Monitoring Solutions

Continuous Flare Stack Monitoring solutions are reliable, non-intrusive, and easy to use. The turnkey solution is pre-programmed to work out of the box. Operators can simply mount the sensors to existing infrastructure and begin using the data to improve flare performance.

To evaluate the sensors, start by identifying facilities with aging equipment or known issues and conducting an initial pilot program. This allows Operators to test the solution in the most difficult conditions while also seeing the greatest results in the shortest amount of time.

From there, expand the deployment to additional sites that would benefit from improved visibility into the flare systems. Over time, organizations gain greater coverage of flare systems across locations with minimal disruption to existing operations.

When mounting the sensors, ensure the cameras have a clear line of sight of the entire flare system. Ideally, the sensors should be mounted on the south side of the flare stack to reduce glare and reflection from the sun.

The cameras can be powered using Power over Ethernet (PoE), solar, line power, or other power sources available at the facility. They can connect using commercial cellular networks or the organization's existing network. Edge processing minimizes cybersecurity risk by keeping sensitive data outside of the organization's firewall.

Work with the vendor to determine the best positioning and connectivity of the cameras based on the specifications, capabilities, and features required for the application.

"Continuous Flare Stack Monitoring means you always have eyes on your flare systems. Instead of sending someone out to a remote site to observe it, you can walk in and immediately check the flame characteristic, pilot flame, smoke - whatever you need - right there on the screen in the control room. Or you can just wait for an alert. The solution simplifies compliance, safety, and process optimization, and the data is there for you to use however you see fit."

Shane Womack
Regional Sales Manager,
Viper Imaging

Questions?
Click here to contact us.

Using Continuous Flare Stack Monitoring Solutions

Continuous Flare Stack Monitoring solutions provide comprehensive coverage of the entire flare system and can be used for a variety of applications.

Pilot Flame Monitoring

The pilot flame must be reliably lit at all times when regulated material is routed to the flare.

Continuous Flare Stack Monitoring solutions provide a better and more reliable alternative to thermocouples. Thermal and visual cameras provide remote, non-contact verification that the pilot flame is present and lit. The system automatically detects if the pilot flame disappears or drops below a specified temperature threshold. It can then trigger alarms, initiate re-ignition, and log thermal and visual data from the event for future compliance documentation.

> ***"Continuous Flare Stack Monitoring solutions automatically detect if the pilot flame disappears or drops below a specified temperature threshold."***

Because the cameras are mounted at a safe distance from the flare, they require minimal ongoing maintenance and do not require personnel to access hazardous environments to inspect or repair the sensors.

Continuous Flare Monitoring

An absent or unstable flame poses a serious safety, environmental, and compliance risk. Facilities traditionally use a range of sensors to verify flame presence and detect abnormal conditions.

Continuous Flare Stack Monitoring provides Operators with greater visibility into flare integrity and combustion efficiency. The system automatically detects anomalies that could indicate incomplete combustion, such as an unstable flame that flickers, partially extinguishes, or lifts off the flare tip. The sensors also provide data on key parameters such as flame size, temperature, color, smoke, and opacity in real-time.

Automated Incident Response

Flare systems incorporate several components that can be optimized to adjust the burn and improve combustion efficiency.

Continuous Flare Stack Monitoring solutions integrate directly with the facility's control systems to automatically adjust steam, air, or fuel gas injection rates without requiring manual intervention. The system maintains a stable flame to maximize destruction and removal efficiency, minimize visible smoke, and improve responsiveness to abnormal conditions.

Future Method 22 Compliance

Method 22 currently requires on-site visual observation by a trained technician. However, the EPA has recently been testing Continuous Flare Stack Monitoring solutions using thermal and visual cameras for Method 22 compliance.

Initial testing has demonstrated that the accuracy and precision of the solution exceed that of traditional visual observation techniques.

Once approved, Continuous Flare Stack Monitoring will remove the need for on-site observation. Instead, remote monitoring will provide a more accurate and complete picture of multiple flare systems in real-time. Instead of relying on periodic data, companies will be able to better understand flare performance, make immediate improvements, and verify the results of corrective action.

"Viper Imaging is not just a camera manufacturer. They know industrial applications. It's rare to find someone who can do both well. They understand how thermal and visual sensors fit into a company's existing monitoring platform, and they ensure that everything integrates together so that your team has access to all the data they need to run their facility."

Kaylor Greenstreet
President,
VisionAery

The Benefits of Continuous Flare Stack Monitoring

Continuous Flare Stack Monitoring solutions deliver substantial benefits across three critical areas of industrial operations: safety, compliance, and process optimization.

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Enhanced Safety

Continuous monitoring enhances safety in a number of ways. First, it ensures that the flare and pilot flame are always lit and functioning properly during gas releases. Automated alerts enable an immediate response to unsafe conditions that could lead to over-pressurization, uncontrolled venting, fire, or explosions. In the case of severe incidents, the system can automatically trigger safety shutdowns or emergency actions before a catastrophic failure occurs.

Second, the remote sensors are deployed at a safe distance to provide continuous monitoring without physical proximity to the flame. This eliminates the need for workers to access the flare stack for routine inspections or verification. Personnel are kept out of high-risk zones where they could be exposed to heat, toxic gases, ignition sources, and other hazards.

Finally, Continuous Flare Stack Monitoring reduces driving risk by removing the need for routine site visits, especially at remote and unmanned facilities. Although often overlooked, vehicle-related crashes are among the most fatal workplace events.[4] Less time spent on the road directly reduces the risk to technicians.

Reduced Compliance Risk

Compliance risks in flare operations primarily stem from failure to meet regulatory requirements for combustion efficiency, continuous operation, and proper documentation. Traditional approaches to flare stack monitoring are limited by gaps in coverage, subjectivity, and inaccurate data.

Continuous Flare Stack Monitoring significantly reduces compliance risk. It allows Operators to immediately detect anomalies and respond the moment flare performance deteriorates. By taking corrective action to restore compliant operation before a breach occurs, facilities significantly reduce the duration and severity of any release. This minimizes reportable emissions, avoids permit violations, and prevents costly enforcement actions.

Additionally, continuous monitoring solutions automatically log visual and thermal data to create transparent, verifiable records of flare operations. This data supports internal compliance tracking, simplifies reporting requirements, and strengthens the facility's position during audits or enforcement actions.

Ongoing Process Optimization

Continuous Flare Stack Monitoring solutions provide real-time insights into flare performance, which can then be used to optimize upstream operations. For example, persistent fluctuations in flame stability or temperature can indicate upstream process imbalances such as uneven gas flow or inefficient gas routing.

By integrating thermal and visual data with process control systems and data from other sensors, Operators can optimize relief valve settings, adjust fuel gas flows, or modify processes to maintain optimal combustion conditions.

[4] https://www.bls.gov/news.release/pdf/cfoi.pdf

Greater Visibility Into the Entire Flare Systems

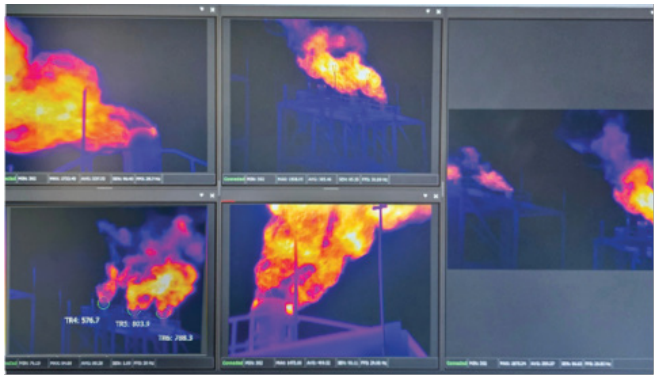
Flares are essential, and they are also a regulatory necessity. Facilities that operate flares must comply with numerous regulations that are often changing across local, national, and international jurisdictions.

Existing monitoring solutions, such as thermocouples, pyrometers, and flow meters, are effective at measuring specific parameters but are not designed for broader analysis of the flare system. Moreover, traditional visual observation techniques, though still required by regulatory agencies, no longer meet the needs of industrial applications.

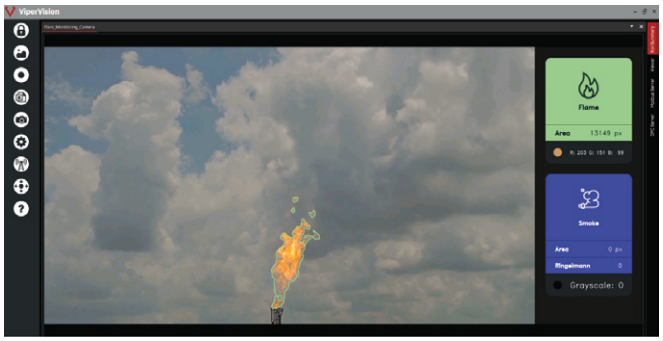
Continuous Flare Stack Monitoring solutions leverage thermal and visual cameras to provide 24/7 coverage of multiple flares from a single remote location.

With greater visibility and real-time data on flare characteristics, including shape, color, temperature, and smoke, Operators can detect abnormal conditions, immediately adjust inputs, or take emergency action to prevent failure.

Instead of being a passive safety device, the sensors serve an active role in improving overall performance. When implemented as part of a comprehensive system, Continuous Flare Stack Monitoring solutions reduce compliance risk, enhance workplace safety, and enable ongoing optimization of upstream processes.



This is a screenshot of ViperVision showing several flares in the monitoring system.



This is a screenshot of ViperVision, powered by VisionAery, showing Flare stats and Ringelmann Opacity Score.

About Viper Imaging

Monitoring industrial processes often seems like a complicated endeavor, but it doesn't have to be. Using top-of-the-line devices creates a seamless thermal monitoring system that's designed to prevent disasters, reduce costs associated with catastrophes and allow your industrial complex to continue operating at optimal performance levels.

At Viper Imaging, we understand the needs of our industrial customers. As a top supplier and integrator of thermal imaging-based systems and industrial process monitoring equipment, we have a track record of success in various industrial settings, such as metals, energy production and distribution, oil and gas, wood products, and industrial automation. Our systems are specially designed to scale from a small-scale plant or mill to the largest industrial complex, and our experienced team of application specialists and engineers are here to help build a solution that works for you.

Questions?
Click here to contact us.