Integrated Fire and Gas Solution - Improves Plant Safety and Business Performance
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Introduction

In today’s competitive marketplace, maintaining a high level of process and plant safety is a critical concern. Manufacturers can reduce costs by minimizing damage to equipment and eliminating incidents that impact people and the environment. At the same time, they can maintain a positive image as a company that is aware of its corporate responsibility and acts accordingly.

Fire and gas (F&G) detection and mitigation systems are key to maintaining the overall safety and operation of industrial facilities. F&G systems include offshore petroleum exploration and production, onshore oil and gas facilities, refineries and chemical plants, marine operations, tank farms and terminals, pipelines, power plants, mining and paper mills.

A F&G safety system continuously monitors for abnormal situations such as a fire, or combustible or toxic gas release within the plant; and provides early warning and mitigation actions to prevent escalation of the incident and protect the process or environment.

By implementing an integrated fire and gas strategy based on the latest automation technology, plants can meet their plant safety and critical infrastructure protection requirements while ensuring operational and business readiness at project start-up.

Background and Trends

Throughout the process industries, plant operators are faced with risks. For example, a chemical facility normally has potential hazards ranging from raw material and intermediate toxicity and reactivity, to energy release from chemical reactions, high temperatures, high pressures, etc.

According to international standards, safety implementation is organized under a series of protection layers, which include, at the base levels, plant design, process control systems, work procedures, alarm systems and mechanical protection systems.

The safety shutdown system is a prevention safety layer, which takes automatic and independent action to prevent a hazardous incident from occurring, and to protect personnel and plant equipment against potentially serious harm. Conversely, the fire and gas system is a mitigation safety layer tasked with taking action to reduce the consequences of a hazardous event after it has occurred.
The F&G system is used for automating emergency actions with a high-integrity safety and control solution to mitigate further escalation. It is also important for recovering from abnormal situations quickly to resume full production.

A typical F&G safety system comprises detection, logic control and alarm and mitigation functions. Logic solver is the central control unit of the overall F&G detection and control system. The controller receives alarm and status or analog signals from field monitoring devices required for fire and gas detection. The controller handles the required actions to initiate alarms and mitigate the hazard (See Fig 2).

Fire and gas detection devices have developed greatly over recent years. Using new techniques and adding intelligence to these instruments to reduce the number of spurious alarms has greatly improved detection rates. Correct and proven connection of fire and gas detectors to plant safety systems is an important factor in reliable performance of the F&G system and for establishing the desired safety integrity level (SIL).

In the past, proprietary F&G systems were standalone equipment or a hardwired mimic overview panel via relays. Mitigation of the risk would take place via manual activation of fire control measures. These methods are not considered best practice. Today, F&G detection systems are generally programmable electronic systems (PES) type with high safety availability and mitigation effectiveness. As modern F&G systems are tightly integrated with the overall process safety strategy, mitigation either takes place via the emergency shutdown (ESD) system or directly from the F&G system itself.
Challenges Facing Industrial Manufacturers

Now, more than ever, industrial companies are concerned with fire and gas in their production operations.

Manufacturing plants must cope with business challenges ranging from increased accident, incident and insurance costs, to compliance with strict standards and codes such as NFPA, API and OSHA in the U.S. and BS EN and SEVESO II in Europe. Also, issues related to corporate image and environmental stewardship have growing implications in the global market.

Industrial plants need effective solutions for improving a wide range of process-safeguarding practices. This requires a control system architecture allowing engineers to design and build standalone safety applications, as well as distributed plant-wide safety topologies.

Plants must find ways to improve F&G system effectiveness through optimization of fire and gas detector coverage, system safety availability and mitigation effectiveness, and at the same time, reduce the cost of ownership for safety equipment. Many facilities are also dealing with the cost of upgrading and refurbishing existing, non-integrated F&G systems.

As more plant owners move toward “smart” plants, appropriate integration with other systems will play an important role in increasing safety as well as efficiency. The Fire & Gas System shall have a communications integration with the DCS in order to have Fire & Gas graphics and alarms for display to the operator, meanwhile, there shall be independent displays such as independent HMIs to draw attention to fire & gas excursions when the DCS HMIs are not available; The plant Fire & Gas system, with fire system for occupied buildings, shall be integrated with Plant Evacuation and System/Site Security Centre for plant evacuation. As part of an overall plant safety strategy, end users need a unified platform for emergency shutdown and fire & gas detection to have a single window for operators and common tool for engineering and maintenance to drive down operational risk and costs.

Understanding Industry Safety Performance Standards

Industrial Standards are playing a large role in developing, implementing and installing fire and gas systems. The IEC 61511 standard (ANSI/ISA S84.01 in the U.S.) is a major step towards protecting industrial plants. The overall safety lifecycle model described in the IEC standard lists all of the necessary project activities, from the concept (definition) phase to the decommissioning phase, necessary to ensure the functional safety of equipment under control (EUC). These activities can be divided over a wide range of categories such as procedures, documentation, testing and validation, planning, hardware and software development, and risk assessment.

More recently, there have been discussions over whether fire and gas detection systems should contribute to risk reduction or be considered as a protection for the installation only. The implementation of the IEC 61511 and S84.01 standards is becoming increasingly prevalent for F&G detection systems. An ISA technical report TR84.00.07 to provide guidance on the evaluation of fire & gas system effectiveness is currently in draft review.

The IEC 61511 standard concerns the determination and development of risk reduction measures (RRMs) required as the outcome of the EUC risk assessment. The basic principle of risk assessment is that all potential risks to the EUC are identified and analyzed. This includes calculating the probability of each potential EUC hazard and determining the risk reduction measures required to achieve an acceptable SIL.

The potential risk of EUC hazards can be considered as the outcome of the probability that the hazard occurs, and the consequences of the hazard:

\[ \text{Risk} = \text{Probability} \times \text{Consequences} \]

The prescribed reduction measures either decrease the risk probability (e.g. ESD systems), or mitigate their consequences (e.g. F&G systems). The risk of EUC hazards can be reduced by a combination of several RRMs, where each measure takes care of a part of the total required risk reduction factor (RRF).
Components of a Good Fire and Gas System

A good F&G system combines innovative fire and gas detectors, conventional and analog addressable fire panels, clean agent and inert gas fire suppression systems, and a SIL 3-certified fire and gas logic solver into a consistently designed and executed solution. An integrated system provides common tools, operating interface and networking, resulting in a common platform with independent systems (See Fig. 3).

Thanks to advancements in F&G detectors, F&G systems can detect early warnings of explosive and health hazards, including combustible and toxic gas releases, thermal radiation from fires and minute traces of smoke in sensitive equipment enclosures. They also provide audible and visual alarm indications helping to ensure operators and personnel are informed of potentially hazardous situations. The F&G system automatically initiates executive actions minimizing escalation of safety incidents and protecting personnel, property and the environment.

Integration at the controller level provides plant-wide safety instrumented system (SIS) point data, diagnostics and system information, as well as alarms and events, operator displays and sequence of event information to any station. This minimizes intervention and shutdowns, reduces hardware costs, and allows plants to recover more easily from process upsets.

The new generation of fire & gas solutions provides alerts of abnormal situations in a fast, accurate and structured way, giving personnel time to decide upon the correct course of action. These solutions include new integration capabilities with process simulation tools, F&G detectors and control communication protocols, enabling safety engineers to design and build large integrated and distributed plant-wide safety strategies.
Overall, SIS technology integrates safety measures dispersed throughout a plant to reduce risk to employees and assets, increase process availability, and improve regulatory compliance. SIS solutions can be integrated with fire & gas detectors for increased protection, and unified with third-party applications and systems to reduce validation and acceptance testing costs.

Modern safety systems, seamlessly integrated with the plant automation system through a secure communication network, transfer alarm signals, fault signals and system diagnostics. Information from all related systems can be transferred, gathered and handled at the same location, and an additional layer can be achieved to monitor the status and operability of the total F&G detection and control system.

Safety system platforms based on Quadruple Modular Redundant™ (QMR) diagnostic technology execute automated safety functions and provide the interfaces and input functions for standard connection of a wide range of fire & gas detection devices. Applications include emergency shutdown, process shutdown, fire and gas systems, burner management, compressor control, pipeline management or any critical safeguarding in the process industry. Thanks to this technology, end users can achieve 2oo4D (2 out of 4 with integrated diagnostic to a > 99.9% coverage)—providing a fully SIL 3 certified solution which allows continuous production.

With innovative simulation solutions, safety engineers can easily test the impact of safety strategies on the overall plant design and operations before implementation. This reduces overall risk and the impact of system modifications and, ultimately, increases profitability by bringing new plants into full production much faster.

In addition, new field device configuration tools allow plant personnel to automatically configure intelligent safety devices and integrate them into the control system database. Facilities subsequently save money by using a single tool to manage all equipment assets.

**Integrated Approach Improves Plant Safety**

Industrial operations benefit from a holistic approach to safety that supports a secure process control network to the perimeter of the plant to protect people, assets and profitability. A layered safety strategy encompasses process and system technology—and the people who interact with that technology—to help plants achieve their safety objectives (See Fig. 4).

A layered safety strategy unifies all plant protection layers (i.e., basic control, prevention and mitigation) required for achieving optimum functional safety. Plus, it provides the required functional safety with a high SIL. This includes superior visualization and logging facilities enabling optimal operator response and accurate evaluations. By integrating basic control, prevention and mitigation components, overall project costs and ongoing maintenance expenses can be vastly reduced.
Integrated Fire and Gas Solution - Improves Plant Safety and Business Performance

A truly integrated safety system delivers:

- Integrated operational interface
- Integrated peer control
- Integrated diagnostics
- Integrated postmortem analysis
- Integrated fire and gas system
- Integrated power supplies
- Integrated modifications
- Integrated simulation and optimization

Operational integration allows plant personnel to have a seamless interface to the process under control, and at the same time, maintain safe separation. From an operational perspective, it makes no difference where the application is running. All required information is available to the operator. This allows applications ranging from rotating equipment and compressor protective systems, to emergency shutdown systems and large plant-wide fire and gas applications to be monitored from any operator console.

Integrated control and safety systems (ICSS) provide multiple benefits to process plants. For instance, they help operators to minimize intervention and shutdowns and recover more easily from process upsets. They also allow facilities to reduce hardware and installation cost, and ensure easier system configuration with preconfigured function block selections.

Plants implementing an ICSS platform for F&G, ESD and DCS systems can significantly lower their operation and maintenance costs, and in many cases, reduce overall wall-to-wall project costs by 25%. Seamless integration with the ESD and DCS via a common network protocol also provides a safe landing in case of emergencies and eliminates the need for additional equipment or engineering. Integration of fire detection & security systems for off-sites and utilities with the plant automation infrastructure further improves operator efficiency through single-window access for alarm visualization, diagnostics, and events/historians.

At the core of a layered safety strategy is process design—the embodiment of the business, safety, and production considerations necessary for effective operations. At the next layer, this approach implements tools and procedures for managing abnormal situations and reducing incidents. When an abnormal situation occurs, alarm management, early event detection, and abnormal situation management (ASM)-designed displays ensure operators have the information available in the context they need it. This enables faster reaction to hazardous situations, thereby avoiding safety incidents.

Next, properly designed emergency shutdown systems and automated procedures can move a plant to a safe state in the event an incident escalates beyond the inner sphere of protection. Should an incident occur, fire and gas detection solutions coupled with rapid location of individuals and a carefully designed emergency response procedure will help contain the impact.

Finally, a layered approach to safety protects the perimeter of the plant using physical security that safeguards access to structures and monitors traffic approaching the facility.
Supplier Support Increases Lifecycle Sustainability

Industrial facilities can leverage the benefits of their fire and gas strategy by employing an integrated main automation contractor (I-MAC) to help them meet critical asset protection needs—and ensure operational and business readiness at project startup. With the I-MAC approach, plant management has a single point of contact throughout the entire system lifecycle. This results in optimized risk reduction and operational performance, better compliance with safety standards, and increased lifecycle sustainability.

End users should select a main automation contractor who brings together all necessary expertise in fire and gas detection for a complete, integrated solution. Certified device connections to the fire and gas safety system improve reliable performance of the overall mitigation function and establish the desired SIL. The chosen supplier should have global capabilities with consistent local support and implementation, as well as consistent engineering tools and processes for each project phase.

An effective project strategy starts with an assessment of future or existing fire and gas performance according to functional safety standards. Based on this assessment, end users have a detailed roadmap for installing new equipment or updating obsolete infrastructure to an optimal level of safety. The main automation contractor can help to identify F&G hazard points and possible risks, and develop basic design packages and related acceptance test criterions to meet safety requirements (See Fig. 5).

By partnering with a knowledgeable, experienced automation contractor, industrial plants can develop an IEC 61511 / ISA S84-compliant fire & gas detection and suppression capability, as well as solutions meeting desired international standards such as NFPA or EN. Supplier assistance can extend to implementing SIS solutions; live hot cutover, implementation and execution of revamps; and installation, commissioning and safety validation.

To sustain the end user’s fire and gas system performance, leading automation contractors also provide lifecycle support services that include periodic proof testing; system maintenance; training programs on safety, code and standard compliance; and spare parts management.
Typical Industry Application

Like other process industry operations, oil & gas terminals present difficult challenges for automation and safety technology. Tank farms, storage areas, and loading/unloading operations all require fire & gas and safety systems to protect personnel, assets and the environment. The consequences of incidents at oil and gas terminals can be enormous (See Fig. 6).

In December 2005, an explosion at the Buncefield fuel terminal in Hertfordshire, U.K. ignited millions of gallons of fuel. Water and land quality were adversely affected across southern England, and the clean-up operation for this accident cost hundreds of millions of pounds.

Incidents such as the Buncefield terminal fire illustrate potential threats to the world's oil and gas supply chain and other vital process industry resources. Clearly, comprehensive solutions addressing both safety and security at these facilities are required.

In oil and gas terminal applications, operators need an integrated fire and life safety system allowing proactive response to alarms and events and a single real-time view to any potential threat. Industrial plants have procedures and safety systems designed to bring operations to a safe state in the event of equipment malfunctions and other operational problems. In the case of a significant security incident, an integrated system can activate these same procedures and systems. An integrated system also leads to less expensive implementation and maintenance because all the pieces work together.

An integrated fire and life safety solution for terminals typically includes high-high tank alarms and loading system interlocks (compliant with IEC 61511) that prevent overflow through shutdown of pumps. Likewise, it incorporates the latest technology gas/vapor detectors, integrated with the overfill shutdown system, to detect incidents before they escalate. The system will mitigate safety incidents by ensuring all personnel are informed of hazardous situations in a clear and unambiguous manner, and providing fast and efficient response to associated risks.

An effective terminal automation and safety/security solution will also integrate security access control, personnel mustering systems and video monitoring to reduce the possibility of unauthorized access or intrusion. Integration of technologies such as security biometrics and wireless mesh networks enhance the operation and the lower cost of implementation of these systems.
Conclusion

For today’s manufacturers, the safety of their facilities, personnel, production processes and the environment is crucial to achieving on-time delivery and minimizing any potential losses. Plants must meet their safety needs while ensuring operational and business readiness at project start-up. Faced with this reality, they are seeking the lowest risk, and highest value protection, from their safety system and fire & gas technology.

For More Information
For more information about Honeywell integrated fire and gas solution, visit our website at www.honeywell.com/ps or contact your Honeywell account manager.

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