DET-TRONICS

Fire and Gas Safety Systems in Industry 4.0

How digitalization tools help increase safety and reduce operating costs for high-hazard facilities

Fire and gas (F&G) safety systems detect and mitigate risk in high-hazard environments and industrial processes—offshore oil platforms, onshore refineries and fuel storage sites, pipeline compressor stations and liquefied natural gas (LNG) terminals, turbine enclosures and more. These critical industrial facilities require compliant systems that detect flames or combustible and toxic gases, identify faults in the equipment and activate notification and fire suppression equipment in accordance with standards and codes. As a facility's needs change or expand, operators may require higher and more dependable levels of risk mitigation.

Industry 4.0 gives operators the tools to meet those requirements. Industry 4.0 is the fourth phase of the Industrial Revolution, and it expands digital

industrial technology to a whole new level, through interconnectivity of systems and digitization within manufacturing. Smart devices connected with each other on a data-driven network and communicating within real time can provide plant operators better communication between the F&G safety system and process control systems. This interlinked approach also supports a higher rate of plant survivability in case of an event, and improves predictive maintenance and remote diagnostics. Industry 4.0 gives plant operators the information they need when they need it.

Industry 4.0 tools

The first industrial revolution brought us water- and steam-powered mechanization (Forbes magazine, 9/2/18). The second and third brought us electricity and then computers. The fourth combines computers and automation with smart and autonomous systems. *Ultimately, it's the network of these machines that are digitally connected with one another and create and share information that results in the true power of Industry 4.0.**

In general terms, the transformation that is Industry 4.0 means integrating all areas of a facility, such as digitizing information and communicating via data-driven smart devices. The result for operations is faster time to market, efficient operational productivity, better management of the system, and reduced risk overall.

Evolution of Operations
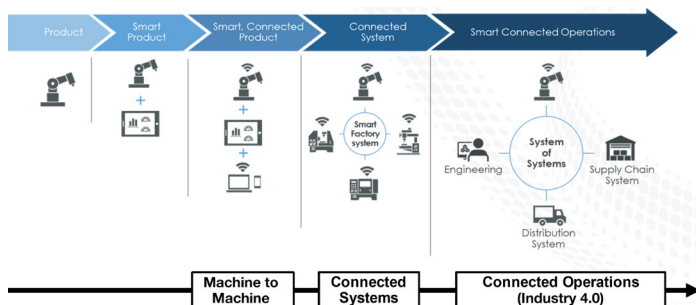
Figure 1: Industrial operations have evolved from "machine to machine" (individual products, smart products and smart connected products) to connected systems to Industry 4.0 smart connected systems. Image courtesy of Rockwell Automation.

Industry 4.0 for fire and gas safety

In the "machine-to-machine" era (Figure 1), F&G safety systems were limited to being hardwired together using analog or contact closures in a conventional (i.e., point-to-point) design. Although still acceptable, this design provides limited diagnostics, is inherently not fault-tolerant and is less flexible to configure. This configuration provides alarm and fault information, but specific details of a hazardous event are not available to the controller because of the simple, binary nature of the communication path.

As the industry has moved to the "connected systems" era, the elements in the F&G safety system have become more interconnected via multiple communication protocols. (Figure 2) In a "connected" high-hazard environment, the heart of this life safety system is a certified fire and gas safety controller. In an Industry 4.0 "smart connected operation," the real-time system data is used to more quickly anticipate possible critical events, such as potential disasters and the need to take corrective action with the safety equipment. Smart connected operations combine the traditional practices of protection, automation, manufacturing and industrial

management with the latest in intelligent and self-diagnosing technology. This provides greater control and the opportunity to diagnose problems without human intervention.

Smart connected operation: Real-time system diagnostics

A distributed F&G safety system in the Industry 4.0 "smart connected operation" can be defined as a network of detector and annunciation devices that monitors, supervises, initiates and controls flame, gas, smoke and heat detection devices in a certified configuration. A certified system is approved by a Nationally Recognized or Accredited Test Laboratory (NRTL) to be compliant to the National Fire Protection Association NFPA 72®: National Fire Alarm and Signaling Code® for meeting life safety code requirements. The F&G system is able to:

- Detect specialized hazardous events (gases or vapors, fires, etc.)
- Minimize responses to false events
- Provide automatic and/or manual mitigation of detected hazardous events
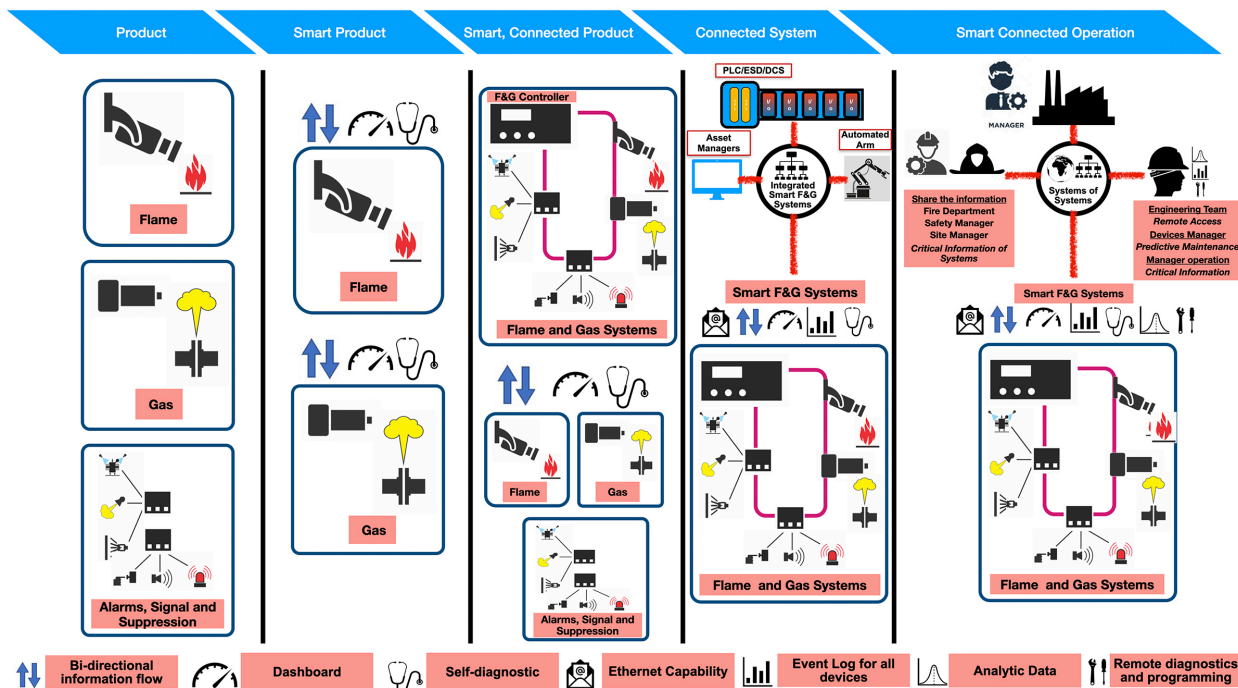
Figure 2: Elements of a fire and gas safety system have evolved from individual products (flame and gas detection and annunciation) to smart products with bi-directional information flow, dashboards and self-diagnostics, to smart products connected by a controller. Connected systems have Ethernet capability and smart logs. Smart, connected operations expand to include analytical data and remote diagnostics and programming. Image: Det-Tronics.

- Annunciate events to personnel
- Provide information on system readiness/health
- Provide historical information, including calibration, alarm and fault logs
- Communicate with third-party systems such as the process control system (PCS) and emergency shutdown (ESD) system

It integrates all the components and provides real-time diagnostics and networking. An ideal F&G safety system has a bi-directional communication capability, where "smart" fire, gas, flame and smoke detectors are configured on a fault-tolerant redundant topology. This fault-tolerant design has built-in isolation for each device. The F&G safety system controller continually analyzes the data via a bi-directional, fault-tolerant information loop on a Local Operating Network (LON).

This configuration is more reliable, as the controller is in constant communication with each device on the loop for alarm and diagnostic information—improving the probability that the diagnostic information will be received by the F&G safety system controller.

The architecture of the fire and gas detection system can be integrated with process automation using a variety of communication protocols, including EtherNet/IP™ Device Level Ring (DLR). The DLR is an EtherNet protocol that is deployed in the ring topology and allows for detecting, managing and recovering from single faults in the ring-based network.

A F&G safety system integrates multiple smart sub-systems on the information loop. These sub-systems link devices certified to meet a variety of safety requirements for flame and gas applications. This is unlike traditional fire panels, which are not approved for process monitoring. F&G safety system certifications vary depending on application and location. They may include but are not limited to:

- Comply with IEC-61508 and IEC 61511 - Certified SIL 2 capable
- Approved as flame & gas safety instrumented function (SIF)
- FM Approved for suppression system control
- Compliance with FM 6130/6320, CSA 22.2 #152

- Approved to FM 3010 in accordance with NFPA 72®: National Fire Alarm and Signaling Code®, 2013 Edition
- Marine-certified for Safety of Life at Sea (SOLAS), DNV-GL, USCG, ABS
- Approved for Class I, Division2/Zone 2 (components), enclosures rated up to Class I/Division 1/Zone 1

The result of systems meeting such certifications is a fail-safe life safety system that provides real-time system diagnostics and high survivability. Operators receive the information they need when they need it to enable them to use the data to make the timely, effective decisions for an efficient and safe operation.

The key benefits of a smart fault-tolerant Industry 4.0 F&G system are:

- Ability to integrate the fire and gas safety system with the process control system
- Higher survivability
- Remote diagnostic capability
- Predictive maintenance

Process control system: Independent but integrated

Many marine regulations require that the F&G safety system must be independent from the process control system.

In the United States, NFPA 72® National Fire Alarm and Signaling Code® (2016) dictates that the F&G safety system cannot be dependent upon the PCS, but rather a F&G system must be able to take immediate action to mitigate a detected risk and then report the action to the PCS regarding any process actions required.

Although required to operate independently of the PCS, integrating the F&G safety system allows communication about an event that could be threatening to personnel or process operations. However, since the F&G safety system and the PCS remain independent, a failure on the PCS will not affect the operation of the F&G safety system.

While standards, codes and recommended practices state that the two systems — F&G safety and process control —must not interfere with each other, the guidance does not specifically prescribe methods for integrating the two systems. The result is several possible approaches for F&G safety system integration and process control system communications.

Higher survivability

F&G safety systems with bi-directional communication capability can have higher survivability compared to point-to-point designs due to a variety of factors.

- Redundant communication pathways—Bidirectional, redundant controllers provide duplex communication, constantly monitoring devices and reporting service diagnostics. If one controller fails, the other takes over and ensures the system continues to operate. The operator is alerted in real time that one controller has an issue and knows immediately that the duplicate controller has taken over.

- Fault-tolerance—Safety-system components are integrated on a fault-tolerant digital communication LON network. (Figure 3) Built-in isolators on each device protect from an open or short, on both the single circuit and power-supply circuit. In the event of an open or short, the affected section will be isolated, and communication will be uninterrupted. For example, if water shorts on the power wires, the isolation relay will isolate that one loop of communication to the next device and communication will continue from the opposite direction.

- Class X SLC designated wiring—Class X signaling line circuit (SLC loop) on redundant paths isolate shorts and opens and identifies the affected areas in real time. Pathways maintain alarm capability in the event of a single ground fault and during the combination of a single open and a single ground fault. Operation continues past a single open or short circuit. Operators receive messaging remotely or onsite about the condition and that operation continues past the single open or short circuit.

- Local Operating Network/Signaling Line Circuit (LON/SLC)—This fast, fault-tolerant digital network expands to meet future needs. Reliable communication, arranged as a loop, starts and ends at the controller. The network manages, maintains and monitors the loop devices. Multiple protocols support communication with ancillary systems, including emergency shutdown (ESD) and process control (PCS).

Remote diagnostic capability

Accessing this critical information from each flame and gas detection device increases productivity and helps mitigate risk.

- Advance communications can mitigate the downsides of remote monitoring by providing access to real-time status and historical data logs. After receiving a fire alarm from its component detectors, a remote detection system should be capable of notifying the appropriate personnel wherever they
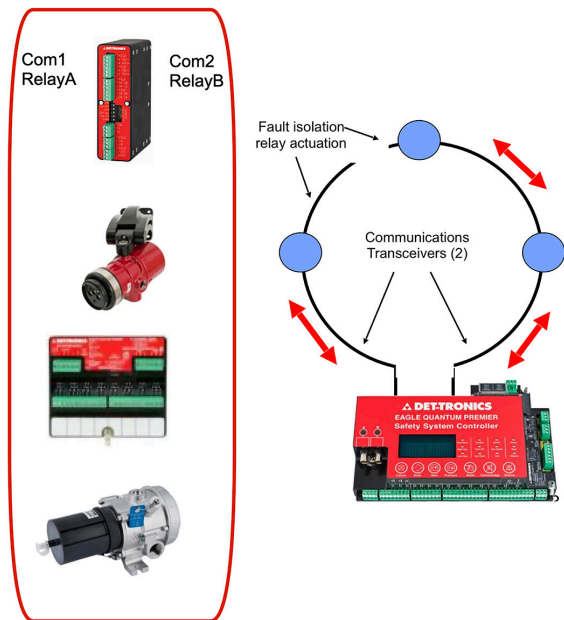
Figure 3: Fault-tolerant safety-system components are integrated on a fault-tolerant Local Operating Network (LON) network. In the event of an open or short, the affected section will be isolated, and communication will be uninterrupted. Image: Det-Tronics.

are located via an Internet connection. In addition, connected devices should have automatic self-test features that pull diagnostic information from the devices and make it available to remote personnel accessing the system from wherever they are in the world.

Predictive maintenance

Operators can monitor the system either on-site or remotely from a safer location and receive diagnostics in real-time. This reduces maintenance and operating costs.

- Smart sensors— Smart sensors test for many parameters and validate that the detector will be functional when needed. They detect reductions in light levels, for example, due to storm-caused limited visibility or dirt, oil or other contamination, and provide service diagnostics. Before an on-site trip, operators know what is wrong and how it needs to be fixed.

Summary

Industry 4.0 gives owners and operators of high-hazard facilities the ability to improve operating efficiency and respond faster to events. Compliant fire and gas safety systems that detect flames and gases, activate notification and suppression devices, and monitor equipment for maintenance issues can relay information in real time, without fail, to wherever the operator is located. Industry 4.0 technologies can provide the tools to help meet those requirements. The architecture of an Industry 4.0 fire and gas safety system comprises "smart" fire, gas, flame and smoke detectors configured on a fault-tolerant, redundant and bi-directional topology. These inter-connected technologies give facility officials the ability to integrate with the process control system and ensure greater probability of survivability in case of an event. Smart sensors provide real-time information anytime, anywhere. Remote diagnostics identify an issue without requiring on-site inspection. These state-of-the-art fire and gas safety systems can apply the power of Industry 4.0 to risk mitigation and protection.

About Det-Tronics

Det-Tronics is a global leader in fire and gas safety systems, providing premium flame and gas detection and hazard mitigation systems for high-risk processes and industrial operations. The company designs, builds, tests and commissions SIL 2 Capable flame and gas safety products ranging from conventional panels to fault-tolerant, addressable systems that are globally certified. Det-Tronics is a part of Carrier Global Corporation, a leading global provider of innovative HVAC, refrigeration, fire, security and building automation technologies. For more information, visit Det-Tronics.com.

Resources

* https://www.forbes.com/sites/bernardmarr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/#1c79b8789788

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DET-TRONICS

Corporate Office
6901 West 110th Street
Minneapolis, MN 55438 USA
det-tronics.com

Phone: +1 952.941.5665
Toll-free: +1 800.765.3473
Fax: +1 952.829.8750
det-tronics@carrier.com