



OCCUPATIONAL SAFETY



Figure 8: Wearable Location Tags automatically detect a person's whereabouts and send signals to fixed Location Anchors for relevant-time updates.

Location software (Figure 9) supports safety functions:

- Geofencing indicates if individuals have moved into areas where they should not be due to presence of a hazard or lack of training.
- Safety mustering lets first responders know which people have moved to the correct safe areas during a drill or incident.
- Safety alerting allows a worker who is injured, in an unsafe situation, or a witness to an incident to press the user-assistance button on the Location Tag to indicate an emergency in progress and the location.



Figure 9: The Plantweb™ Insight Location application provides visualization for raw location data.

SAFETY SHOWER AND EYEWASH STATIONS

Mishaps in a plant may result in a worker being splashed or sprayed by hazardous chemicals. To minimize potential injury, plants have safety shower and eyewash stations, but they are not always monitored. A worker needing attention may have to call for help on the plant radio or hope to be spotted by a colleague. With a simple WirelessHART valve monitoring device (Figure 10), any activation immediately reports the situation and location to the control room, and to first responders in the plant.



Figure 10: Adding a Rosemount 702 Wireless Discrete Transmitter can tell the control room which safety shower or eyewash station has been activated.

Wireless instrumentation and accompanying apps simplify the installation, configuration, and maintenance of equipment monitoring systems. These systems can be brought online at a fraction of the cost of traditional wired transmitters and complex enterprise-wide analysis software.



3 | PROCESS SAFETY





PROCESS SAFETY

Process safety is the most complex given the number of possible hazards and potential for damage from incidents. Dozens and even hundreds of individual SIFs must be coordinated to provide the necessary layers of protection, calling for comprehensive systems.

Yet, in many respects, the most critical systems in a plant or process unit are an effective distributed control systems (DCS) combined with reliable SISs. If the process has sound control strategy built using modern hardware and software (Figure 11), and if it is supported by adequate instrumentation, it will be able to keep the process stable, even in the face of potential upsets and feedstock inconsistencies. In the event the DCS cannot control the process, the SIS will take the process to a safe state. Tight integration between DCS and SIS provides multiple benefits through the lifecycle of the systems. Proper integration between DCS and SIS does not compromise the independence of the two layers of protection.

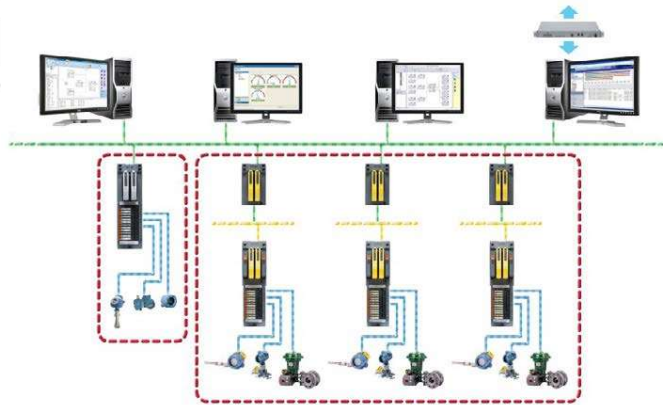


Figure 11: An effective Integrated Control and Safety System, such as the DeltaV Control System, combined with traditional and WirelessHART instrumentation and field devices, will provide dependable and stable production.

When well-trained operators have deep visibility into process conditions, and are assisted by carefully managed alarms, they can deal with abnormal situations before they escalate into incidents. Under these conditions, an effective SIS remains critically important, but it will have little to do.

On the other hand, a poorly controlled process will be unstable and generate too many demands for the SIS.

Cybersecurity is a critical aspect of automation systems since a malicious attacker can exploit a vulnerability to find a way to either disrupt the process or create a hazardous condition. Today's automation system architectures, such as DeltaV 14, DeltaV SIS, and WirelessHART, have many built-in protections, but companies still must be aware of potential threats, and tighten up work practices to minimize vulnerabilities.

DIAGNOSTICS DETECT PROBLEMS

Advanced instruments used for SIFs can recognize a variety of equipment and process problems. For example, the Rosemount 3051S with Advanced Diagnostics (Figure 12) can detect unusual conditions early and send messages to operators of an abnormal condition developing. This can happen without interfering with the basic safety function. If the diagnostics are fully enabled to take advantage of their capabilities, reliability and maintenance technicians can fix these undetected failures before they escalate to the point of creating a false trip.



Figure 12: Safety-certified transmitters have the same Advanced Diagnostics as their conventional counterparts.

A safety-certified Rosemount 3051S with Advanced Diagnostics can recognize and report:

- Changes in the process noise signature that could be indicative of an issue, such as furnace flame instability or pump cavitation
- Plugged impulse lines or other process connection issues
- Water in the transmitter housing
- Wiring damage or corroded terminals
- Poor power quality or improper grounding.

Rosemount Magnetic Flow Meters and Micro Motion™ ELITE™ Coriolis Flow Meters (Figure 13) are available with Smart Meter Verification, a specialized set of diagnostics that monitor the entire flow meter's performance and integrity





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continuously while the process is running. This meter diagnostic software provides information in real-time to ensure flow measurement accuracy and when it is time to schedule calibration. When combined with a digital control network, this diagnostic tool can eliminate the need for scheduled visits to the field, and it can extend testing intervals.



Figure 13: Smart Meter Verification is a specialized set of diagnostics that monitor the entire flow meter's performance and integrity continuously.

All these diagnostic capabilities can indicate something might be wrong with the process or the specific SIF. Some, if left unaddressed, could result in a false system trip. This shows how advanced diagnostics provide a double benefit, improving availability by reducing the potential for a false trip while simultaneously providing insight into equipment condition and even process changes. Taking advantage of the advanced diagnostics is only possible if the SIS can process the diagnostic information. A legacy SIS may only process the 4-20 mA signal, while DeltaV SIS can utilize the advanced diagnostics. For example, DeltaV SIS can recognize a malfunctioning device and remove it from the voting architecture.

MINIMIZING HAZARDS

As mentioned earlier, effective automation minimizes manual processes, such as operator rounds to gather data or perform inspections. This serves two important functions, overlapping with occupational safety:

- Operators spend less time in the plant where there is opportunity for exposure to hazards
- Automated data gathering is more effective because it can be continuous and avoids human errors.

A prime example of this concept is continuous monitoring of pressure relief valves (PRVs) and steam traps using an acoustic monitor (Figure 14).



Figure 14: Rosemount 708 Wireless Acoustic Transmitters mount on piping adjacent to PRVs and steam traps to detect if they are functioning correctly or might be leaking. They are self-powered and send data via WirelessHART, so there is no need for any wiring.

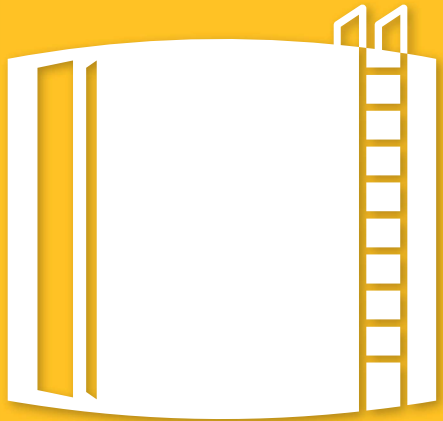
PRVs are critical safety equipment, but create operational problems due to a tendency to remain partially unsealed after a release event. This permits simmering, a slow leakage of process fluid into the collection system. Leakage can also interfere with their ability to open correctly during an incident, while wasting energy, and increasing emissions. Such problems are often difficult to diagnose due to PRV inaccessibility, calling for scaffolding and putting workers into potentially unsafe situations to evaluate their condition manually.

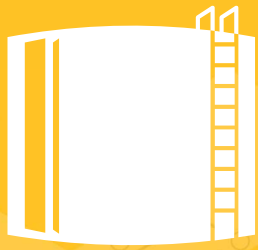
Steam traps are subject to frequent malfunctions in many environments, wasting product and energy. There is also potential for safety-related incidents caused by condensate backing into the steam lines, resulting in piping ruptures and other equipment damage due to water hammer effects.

Replacing dangerous manual inspection rounds with acoustic monitors provides continuous data while allowing operators to perform higher level tasks.



4 | CONTAINMENT SAFETY





CONTAINMENT SAFETY

Chemical plants generally have tanks on site to hold various liquid products, such as feedstocks, intermediates, and final products. Some may be dangerously toxic or flammable, so it is important to ensure tanks can't be overfilled, or have releases caused by leaks or inadvertent valve openings.

As a case in point, in January 2014, residents in a southeastern U.S. state noticed a strange odor from their drinking water and called local authorities. The odor was caused by 4-methylcyclohexylmethanol leaking from a nearby chemical storage facility. The chemical was running out of a one-inch hole in the bottom of a 40,000-gallon tank. Approximately 7,500 gallons escaped and affected the water supply to 300,000 local residents.

Containment incidents must be prevented by effective safety automation:

- Appropriately selected level instruments and an effective SIS can stop operators from overfilling a tank.
- An effective level instrument and SIS can recognize when the contents in a tank decrease with no corresponding process reason but is instead caused by a leak.
- Automated valves tied to a control program to set up valve lineups during liquid transfers avoid spills caused by incorrect procedures.

While catastrophic events understandably get attention, smaller incidents are common, but these can be prevented. Safety certified level instruments (Figure 15) are very accurate and monitor their respective tanks continuously, watching for unexplained changes. They can support SIFs designed to shut down filling actions before tanks reach their limit and detect minute changes in level resulting from leaks. These protect workers, the surrounding community, and the plant itself from potential disasters.

Leaks can also be recognized by gas detectors that detect escaping hydrocarbon gases or toxic gases such as hydrogen sulfide. Selecting the right gas detectors naturally depends on the types of feedstock and final product manufactured at the site.

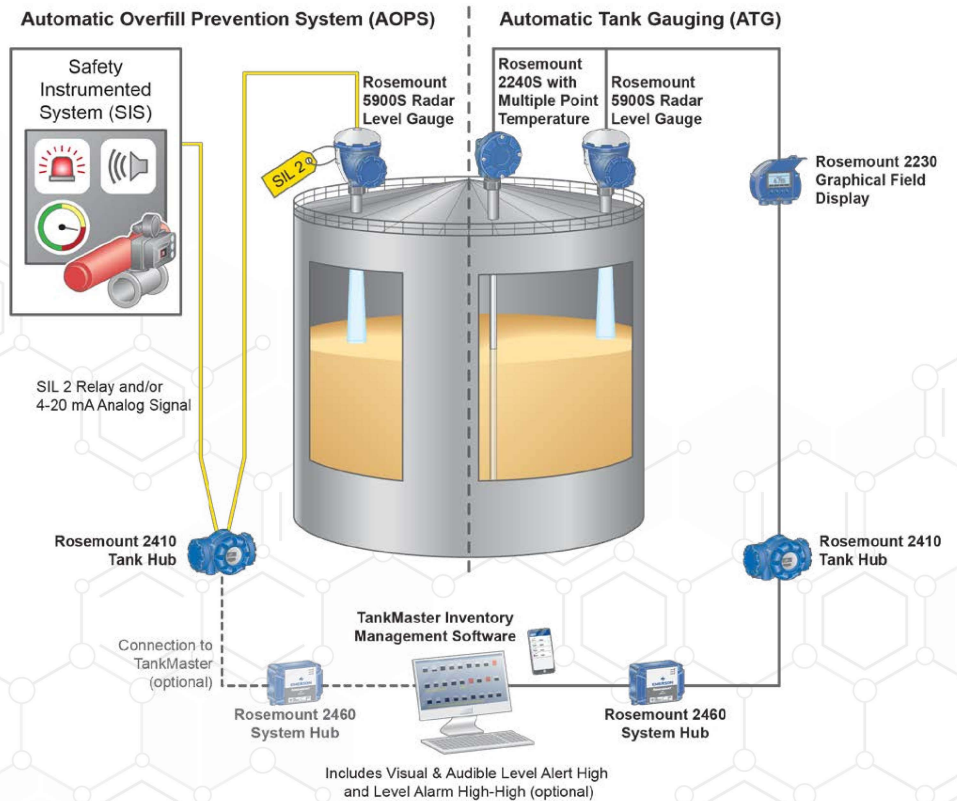
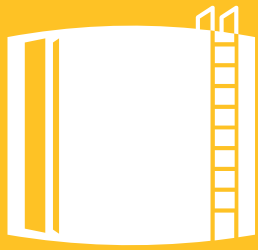


Figure 15: The ATG and AOPS exist side-by-side but separately so they can function independently. Rosemount 5900S Radar Level Gauge is available in conventional and SIL-rated versions for these types of applications.





CONTAINMENT SAFETY

Gas detectors take two forms (Figure 16), fixed point detectors and open path. Fixed point detectors can monitor critical areas such as valve clusters, while open path gas detection is typically used to monitor perimeters around tanks.



Figure 16: Fixed point combustibles and toxic gas detectors use multiple sensor technologies, such as infrared, catalytic bead and electrochemical. The Net Safety Millennium II series (left) can detect all flammable gases and common toxic gases. Rosemount 935/936 Open Path Combustible and Toxic Gas Detectors (right) use infrared and ultraviolet technology to detect hydrocarbon and toxic gases, including methane, propane, ethylene, hydrogen sulfide and ammonia.

Many sites also deploy flame detectors (Figure 17) to cover areas where a process leak may find a source of ignition. Flame detectors generally activate alarms but may also trigger fire suppression equipment to douse strategic areas in foam.



Figure 17: Rosemount 975 Multi-Spectrum Ultraviolet & Infrared Flame Detectors respond to the specific wavelengths of light produced by a variety of burning fuels.

DETECTING LOSS OF CONTAINMENT BEFORE IT OCCURS

While some incidents are caused by human error, corrosion is also a root cause for safety and maintenance issues. Industrial accidents are often related to uncontrolled or unexpected corrosion. By monitoring corrosion, the elevated

risk and damage are detected long before loss of containment, which improves operational safety for the plant, personnel, and the environment. Since corrosion attacks from the inside, it is difficult to spot by visual inspection, but it can be detected in two ways.

First, conditions capable of causing corrosion can be detected via an electrical resistance (ER) probe inserted into a pipe or vessel wall (Figure 18). This can warn operators when it is necessary to change some process variable, or add an inhibitor, to slow corrosion. Historized data can also be analyzed to calculate how much damage may have been done over a critical period.



Figure 18: The Roxar™ Retrievable ER Probe monitors internal corrosion in common environments such as chemicals, oil, gas, and water. It provides sensitive and fast responses to corrosion change.

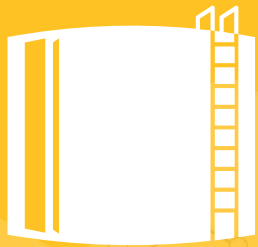
Second, it is possible to monitor pipe and vessel wall thickness using ultrasonic sensors (Figure 19). These clamp on at strategic points, such as a pipe elbow, and send data via WirelessHART to a central collection and analysis platform. They measure the wall thickness continuously and can detect changes as small as 2.5 microns. Over time, it is possible to recognize periods when metal loss was particularly aggressive.



Figure 19: Rosemount Wireless Permasense Corrosion and Erosion Monitoring Systems measure wall thickness continuously so maintenance can determine when pipe must be replaced.

A data-driven corrosion and integrity management program will ensure that asset conditions are known. As a result, the timing and scope of maintenance and repair strategies can be optimized to avoid unplanned outages or safety issues.





CONTAINMENT SAFETY

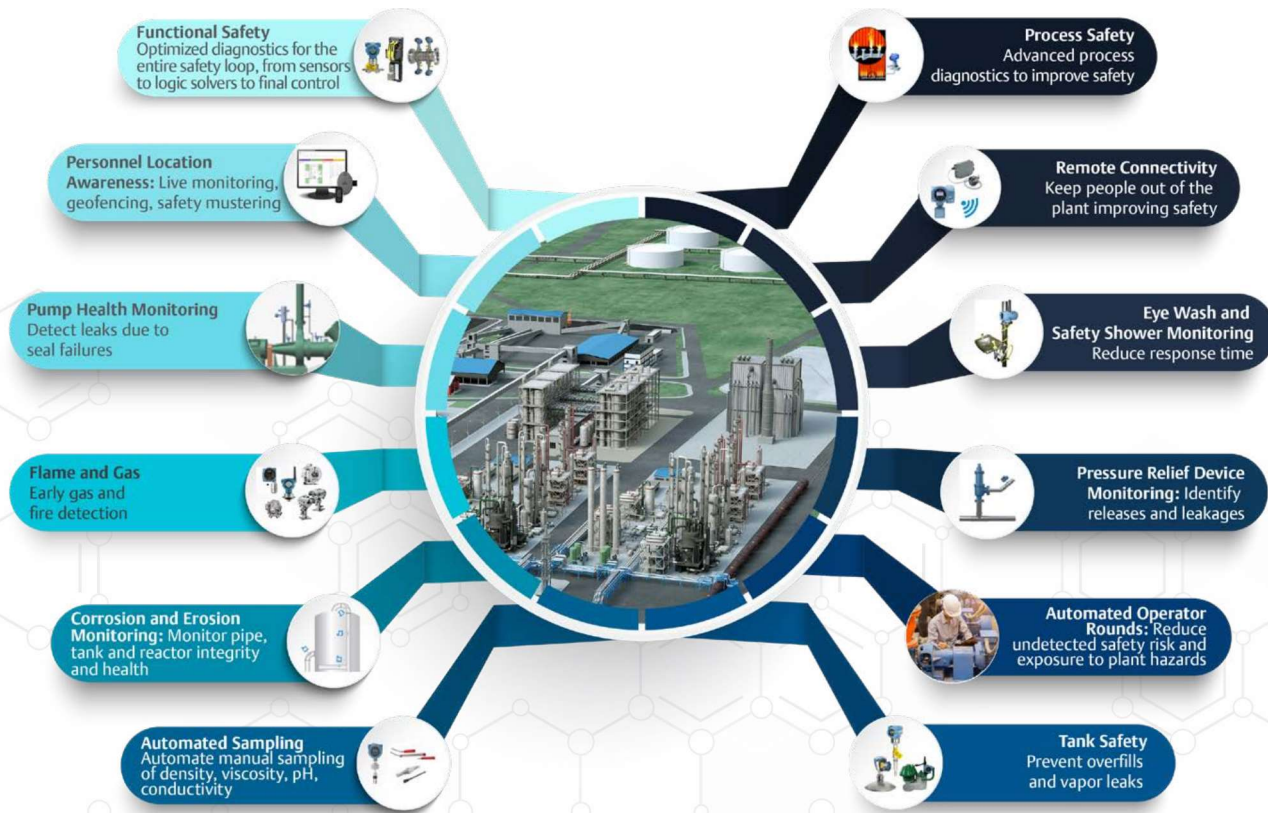


Figure 20: Emerson has a comprehensive set of technologies and services to provide early detection and avoidance of potential safety incidents and to mitigate the consequences.

- Prevent fires, explosions, and other process incidents with our modern SIS
- Meet SIL requirements with our portfolio of safety certified devices
- Avoid leaks, spills, and releases with tank management solutions and corrosion monitoring
- Improve personnel safety and reduce emergency response time throughout the facility.

ELEMENTS FILLING A LARGER STRATEGY

All the individual topics discussed so far must come together to create a coordinated strategy to link all the protective layers in all the areas. Safety takes many forms (Figure 20), and Emerson has the widest range of products in the industry.

The selection of various functional safety devices and how they are integrated to provide occupational, process, and containment safety through larger safety systems must be analyzed, planned, and maintained carefully by experts. Preserving a facility's ability to operate while avoiding safety and environmental incidents calls for the right strategy, equipment, proof-testing, and personnel training. Emerson can provide assistance in all these areas, starting with walkdowns and recommendations, and continuing with a complete array of required products.



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