Fire and Gas Protection in Natural Gas Compressor Stations: Safety Logic with the SLA

Customer:
Natural Gas Pipeline Operator

Application:
Natural Gas Compressor Station Fire and Gas Protection

Product Used:
Moore Industries SLA Multifunctional Safety Logic Solver and Alarm

Overview

Natural gas compressor stations are critical for maintaining pressure and flow in long-distance transmission pipelines. These facilities often contain multiple high-power compressors housed in ventilated enclosures, where leaks or fires present significant operational and safety risks.

To safeguard personnel, equipment, and continuous operations, a major Australian pipeline operator sought a highly reliable and SIL 2 capable logic solver solution to manage Fire and Gas (F&G) protection at a new compressor station. Each compressor enclosure needed local detection, alarming, and emergency shutdown (ESD) capabilities, as well as seamless integration with the site's PLC and centralized SCADA system.

The Challenge

The operator required a high-integrity, SIL 2 compliant logic solver capable of continuously monitoring multiple fire and gas detectors, executing complex trip logic, and ensuring both local and site-wide protection. The solution had to reliably detect dangerous conditions, initiate alarms and emergency shutdowns, and integrate seamlessly with the plant's control systems to maintain safe, uninterrupted operations. Key requirements of the Safety Instrumented System are:

- Monitor multiple fire and gas detectors across two independent compressor enclosures.
- Provide local hardwired trip and shutdown logic with complex voting schemes (1oo2, 2oo2, and 4oo4).
- Trigger site-wide ESD and evacuation alerts when dangerous gas or fire conditions are confirmed.
- Integrate with the site PLC via MODBUS/TCP, enabling centralized monitoring and diagnostics from a remote gas operations SCADA center.
- Meet specified safety requirements with fail-safe performance and high reliability.

The Moore Industries Solution

The SLA Multifunctional Safety Logic Solver and Alarm was selected as the logic solver for each compressor enclosure due to its IEC 61508 Functional Safety Certification and SIL capability, compact design, flexible logic programming, and proven reliability in safety-critical applications.

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Compressor Station - Natural Gas Pipeline - Fire & Gas Detection

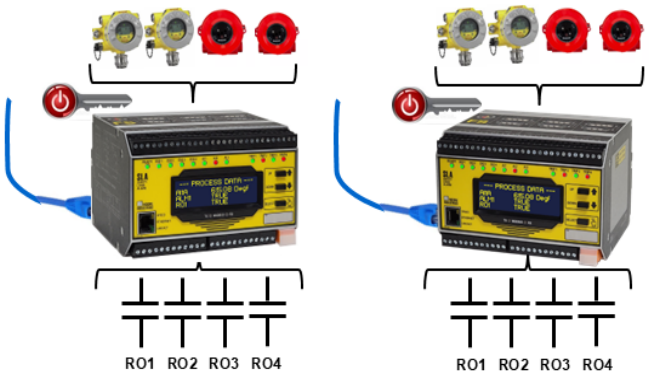
SLA I/O	Alarm / Trip Description	Initiators
RO1	GD1 or GD 2 HH Trip (1oo2)	GD1 or GD2 LEL>40%
RO2	GD1 & GD2 Fault Trip (2oo2) **or** GD1 HH & GD2 Fault (2oo2) **or** GD2 HH & GD1 Fault (2oo2)	GD1 & GD2 < 3.5mA
RO3	FD1 & FD 2 HH Trip (2oo2) **or** FD1 Fire & FD2 Fault (2oo2) **or** FD2 Fire & FD1 Fault (2oo2)	FD1 & FD2 >19mA
RO4	ESD String Shutdown Trip	All 4 HH trips (Above)
DIO1	FD1 & FD 2 Fault Trip (2oo2)	FD1 & FD2 >3.5mA
DIO2	Bypass Key Switch Input	Closed contact on key switch
DIO3	F&G in Bypass / Inhibit	Closed contact on key switch

Fire and Gas Detection (8 x 4-20mA Inputs) for Two Gas Compressors with Bypass Key Switch.

Transmission of 16 Soft Alarms via MODBUS/TCP Communication to Site PLC.

Hardwired Alarms with voting for Fire and/or Gas Detection Trip or Fault

Initiate an Emergency Shutdown (ESD) and site wide Sirens & Beacons when all four HH trip conditions (Fire Detectors and Gas Detectors) are met.



Application diagram of the SLA Safety Logic Solver monitoring Fire and Gas detectors with trip logic, relay outputs, and MODBUS/TCP communication.

Key features of the SLA that addressed the challenge:

- **Compact Logic Solution:** Delivered full Fire and Gas protection in a space-saving DIN-mounted package, eliminating the need for a large-scale safety PLC.
- **Programming Ease:** Advanced logic functions and complex alarm voting architectures for the ESD procedure, such as 1oo2, 2oo2, and 4oo4 strategies, were easily implemented and documented.
- **High Reliability:** Fail-safe relay logic continuously monitored system health to meet strict operational safety standards.
- **Seamless Integration:** Broadcast alarms and status via MODBUS/TCP to both the site PLC and centralized SCADA network, improving situational awareness.
- **Safety and Operational Confidence:** Personnel and assets are protected, and the operator can maintain continuous pipeline operations with reduced risk.

When all high-high gas and fire trip conditions were met, the SLA initiated an Emergency Shutdown of the compressor string and activated the site-wide siren and beacon system, giving personnel time to evacuate.

Results

- Each SLA **processed four 4-20mA signals** from connected fire and gas detectors, with the flexibility to accommodate up to six inputs as needed.
- Supported **complex logic conditions** such as high-high gas trip (LEL>40%) and confirmed fire (19mA), with voting combinations (1oo2, 2oo2).
- Generated **four hardwired relay outputs (RO1–RO4)** for Gas Trip, Detector Faults, Fire Trip, and Emergency Shutdown.
- Transmitted **16 soft alarms via MODBUS/TCP** to the site PLC, including detector diagnostics (dirty window, power fault, general fault).
- Delivered a highly reliable **SIL 2 capable logic solver** solution for fire and gas protection.

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Conclusion

Fire and gas hazards are among the most serious risks in natural gas compressor stations. By deploying the SLA Multifunctional Safety Logic Solver and Alarm, the pipeline operator achieved a compact, reliable, and SIL 2 capable logic solver solution that integrates both local shutdown protection and remote supervisory visibility.

With the SLA, the operator ensures continuous pipeline operation, protects critical assets, and safeguards personnel from potentially catastrophic fire and gas events.

Resources

SLA Multifunctional Safety Logic Solver and Alarm
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