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Reduce fugitive emissions with a HIPPS solution

Oil and natural gas producers are under continual scrutiny to lower fugitive emissions by the Environmental Production Agency (EPA) in the United States, TA-Luft in the European Union (EU), and similar regulatory bodies in other producing countries. As an industry, they have responded positively with tighter pollution control standards and reduced greenhouse gas emissions.

By CarstenThoegersen, Emerson Process Management, Valve Automation

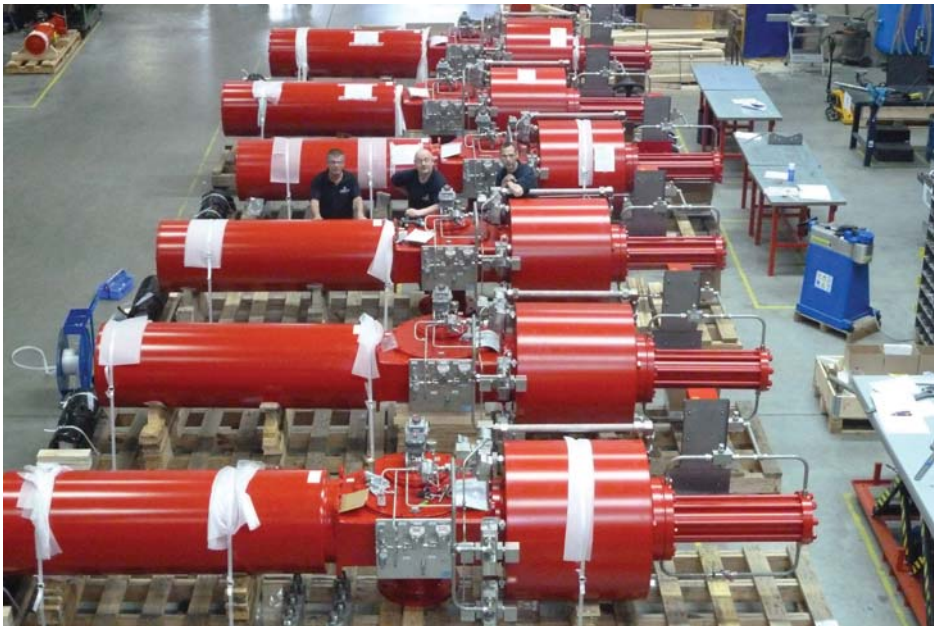
Despite these clean air initiatives, the latest EPA statistics show that oil and natural gas production and processing operations remain as the leading source of methane (CH_4) emissions, sending approximately 145 million metric tons into the atmosphere during 2011 in the U.S. alone. The statistic is even more daunting since those emissions are 20 times more potent than CO_2. While operators are under increased pressure to record and report leaks in their onshore or offshore production facilities, valve and controls manufacturers are charged with improving designs for reducing emissions as well as increasing the reliability of pressure protection systems.

Fugitive emissions within oil & gas

For many years an image associated with the upstream sector of the oil and gas industry and offshore in particular was a platform showing a large flare, burning off the excessive gas located in the reservoir. This practice has been a large contributor to fugitive emissions. In today's environment, however, many operators are either processing the gas or using it for reinjection into the reservoir.

Looking at the installed base of onshore facilities and offshore platforms, the flare is still widely used to provide a vent system to avoid pressure build up in the process. Protection against pressure build up is mainly provided by conventional pressure relief and blow down valves that will discharge gases and liquids to the flare when process design pressures are exceeded. More than 140 billion cubic metres of natural gas is still flared annually,

Worldwide natural gas flaring annually produces 400 million tons of greenhouse gas emissions.
The World Bank GGFR Partnership

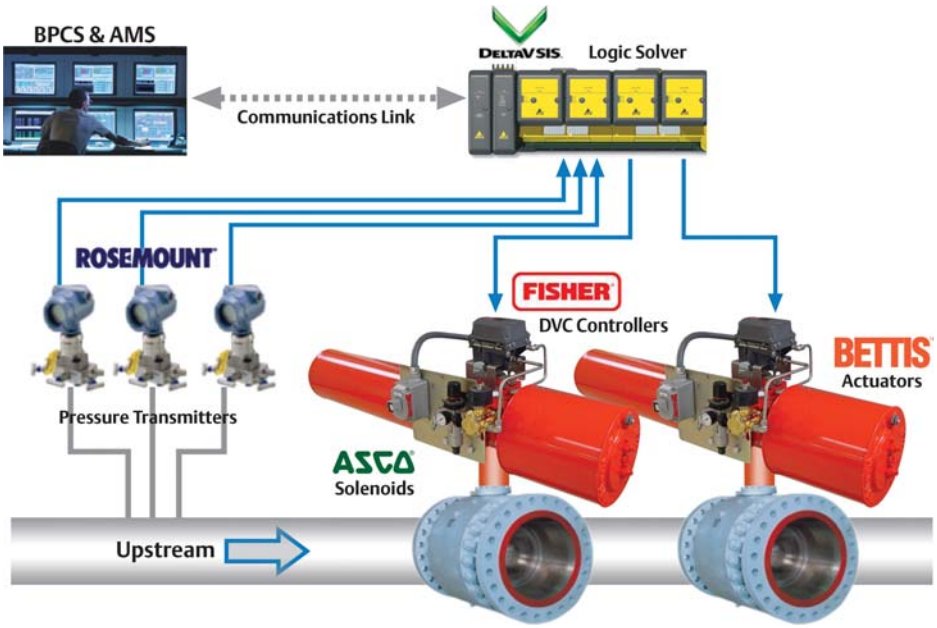


Some of the 16 actuators for HIPPS service are readied for shipment to, and installation on, a Western Australian offshore natural gas facility.

one-quarter of which is from offshore platforms.
In addition to pressure protection, leak points at valves, piping connections, mechanical seals and other related equipment will also add to fugitive emissions. This article, however, will be focused on how the High Pressure Protective System (HIPPS) can help end users/operators reduce fugitive emissions resulting from pressure protection.

What is HIPPS?

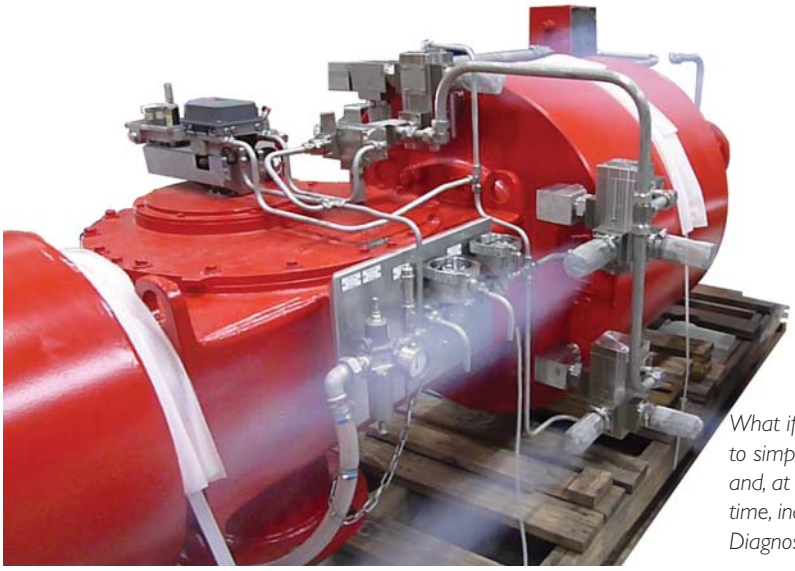
HIPPS is a part of the Safety Instrumented System (SIS) and is designed to prevent overpressure by shutting off the source and capturing the pressure in the upstream side of the system, thus providing a barrier between the High Pressure and Low Pressure sides of the process plant. The tight shutoff will prevent loss of the containment and eliminate fugitive emissions. HIPPS is seen as the "last line of defense".
With new installations taking advantage of HIPPS, Emerson are seeing an increased demand, not just for greenfield projects but also for brownfields sites around the world. A key driver reducing or supplementing the number of existing pressure relief systems with HIPPS, has been the added operating expense (OPEX) of testing relief valves once a year.
A typical HIPPS will include 2 or 3 final elements in series, isolating the upstream pressure source from the downstream side, to avoid any pressure build up. The system is often required to shutdown within 2-3 seconds for gas and 6-8 seconds for liquids, depending on the pipeline pressure, flow rate and the diameter and class of the pipeline.
The initiator of the shutdown sequence (peak pressure surge) will be detected by a pressure sensing system. In this case 3 sensors are shown, being connected to the logic solver, which is configured to vote with a 2oo3logic (2 out of 3). If the predefined parameters for pressure are exceeded, the Logic Solver will shut down the final elements and the process.
The 2oo3 configuration is usually preferred for HIPPS, as it provides availability as well as reliability for the system.



HIPPS flow schematic.

HIPPS and the challenges faced

Working closely with end users/operators and contractors, there are many challenges in engineering, building, and testing the HIPPS, to ensure that the system will provide the required safety throughout the lifetime of the installation.
One of the first challenges with which contractors are faced is the lack of standards outlining the design parameters of a HIPPS. Whereas conventional pressure reliefs are designed using prescriptive standards like ASME and BS, HIPPS is designed as another Safety Instrumented Function (SIF) tied into the SIS. Designing the HIPPS, engineering contractors will have to use performance based standards like IEC 61508 and IEC 61511, which will require a high level of interaction with the end user/operator, who will be specifying the required Safety Integrity Level (SIL).
Looking at the equipment available on the market today, it is not difficult to source the different components needed to build the HIPPS. The more difficult challenge is in the validation and verification of the system to ensure it fully meets the required SIL level and can be maintained throughout the safety lifetime of the installation. A starting point is always a clear Safety Requirement Specifications (SRS) to ensure the end



What if you were able to simplify the control and, at the same time, increase your Diagnostic Coverage?

During a test, a Bettis G10 actuator exhausts air while closing a 20-inch, 1500# ball valve within two seconds.

user/contractor requirements are fully understood and met.

Design of HIPPS is often more complex in that they require the successful functioning of multiple devices to achieve the same performance as a single pressure relief. That is the calculated reliability of the multiple devices needs to meet or exceed the reliability of a conventional pressure relief valve. In addition, the design needs to be verified through Site Integration Test (SIT) and also needs to be validated through compliance to EIC 61511 and the SRS given by the end user.

There is a huge difference between the issues the multi-national operator experiences and the problems smaller national and independent end users/ operators are faced with. Multi-national operators often have their own guidelines for how HIPPS needs to be built, implemented and tested. However, more than once, major projects have been put on hold just before first oil as the validation failed as a result of poor communication between the end user and the contractor.

The smaller national and independent end users do not have their own guidelines and rely on the engineering contractor to design and build the HIPPS. The contract for HIPPS is normally focused on the design, supply and implementation of the HIPPS and does not address the entire safety lifecycle, which ultimately is the responsibility of the end user/operator.

A solution addressing all phases

Emerson has a one-stop-shop solution for HIPPS, which not just addresses most of the issues faced in designing, building and installing the HIPPS. It also provides the operator with a proof test and inspection plan that will consider the safety lifecycle and ensure the required SIL is maintained throughout the lifetime of the installation.

On the component level, Emerson manufactures control equipment with adequate certified failure data to meet SIL3 requirement for HIPPS. The well regarded and field-proven components include Bettis actuators, Fisher DVC controllers, ASCO solenoids, DeltaV SIS logic solvers and Rosemount pressure transmitters.

This solution is different in that it includes safety consultancy to make sure there is a holistic view of the process from front end engineering over SRS to the validation of the system. This ensures the requirements are aligned and avoids the project being put on hold at the last stage just before first oil.

Speed of operation and closing is critical for HIPPS, which is why operators fear spurious valve trips and unplanned closing when Partial Stroke Testing (PST) is carried out. This can often results in the design of overly complex systems where the majority of the control components are duplicated, allowing the operator to "isolate" critical components for test.

To increase the reliability of the pneumatic/mechanical control of the final element, a simplified control system is needed allowing the operator to run diagnostics on all the critical control components in the shutdown circuit. The increased diagnostic coverage (DC) is integrated as an automated part of the Partial Stroke Test and is proven through an extensive laboratory test. The results of the test are clear and used in the test procedure to reduce the spurious trip rate of these large and complex shutdown systems.

Governmental air quality regulatory bodies are continuing to issue regulations to reduce harmful greenhouse gases from entering the atmosphere. The oil and gas industry, too, is doing its part in controlling emissions while protecting operating personnel and assets by containing and shutting off high pressure sources. HIPPS has many advantages compared with conventional pressure relief. Although it will not be able to fully replace existing systems for pressure relief using flares in the near future, it is a sound and safe way to help operators and end users reduce fugitive emissions.

About the author

Mr. Carsten Thoegersen has more than 20 years of experience with Oil & Gas/Subsea. At Emerson Process Management Valve Automation he has held multiple positions, as Branch Manager, Subsea Sales Director and is currently focused on business development as an Industry Specialist for Oil & Gas/Subsea. He has a degree in International Sales and Marketing, an Engineering degree and is also a Certified Functional Safety Professional (CFSP).