High Integrity Pressure Protection Systems (HIPPS)
For oil & gas installations
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>01</td>
</tr>
<tr>
<td>Benefits of HIPPS</td>
<td>02</td>
</tr>
<tr>
<td>HIPPS vs Emergency Shut Down</td>
<td>02</td>
</tr>
<tr>
<td>Delivery Wheel</td>
<td>03</td>
</tr>
<tr>
<td>Why the Severn Glocon Group?</td>
<td>03</td>
</tr>
<tr>
<td>How does HIPPS work</td>
<td>04</td>
</tr>
<tr>
<td>HIPPS</td>
<td>06</td>
</tr>
<tr>
<td>Electronic HIPPS for Topside</td>
<td>06</td>
</tr>
<tr>
<td>Mechanical HIPPS for Subsea</td>
<td>07</td>
</tr>
<tr>
<td>Safety Systems &amp; HAZOP Study</td>
<td>08–09</td>
</tr>
<tr>
<td>Integrated HIPPS Benefits</td>
<td>08–09</td>
</tr>
</tbody>
</table>
The Severn Glocon Group is able to offer integrated High Integrity Pressure Protection Systems (HIPPS) for oil and gas installations. Rated SIL 1–4, they are designed and built in accordance with IEC 61508 and IEC 61511 safety instrumented systems (SIS) standards and provide a dual electronic and mechanical redundancy solution.
Benefits of HIPPS

Severn Glocon Group integrated HIPPS are designed to set a new standard in safety, performance, assembly and test of high integrity pressure protection systems, enabling oil and gas operators to:

- Reduce the environmental impact of pressure release burn off valves
- Reduce the potential economic impact arising from a lack of containment and subsequent loss of production and increased maintenance costs
- Reduce the catastrophic effect of a lack of containment to both people and the environment
- Significantly reduce process risk enabling development of higher pressure / flow rate fields – flowline and riser pipe rated to the flowing pressure
- Economically tie-back high pressure marginal fields to existing pipeline infrastructure and topsides

HIPPS vs Emergency Shut Down

HIPPS is an application-specific safety system to prevent over-pressurisation of a pipeline, and resultant damage to plant and equipment. It is the last line of defence in the event of an over pressurisation incident and should not be confused with an Emergency Shut Down (ESD) system.

An ESD system provides a safe and orderly shutdown of a process. HIPPS is an emergency response to a pressure build-up rapidly closing the pipeline, the time of closure will be dependent on the protected volume.

Once activated, the HIPPS will automatically shut off and isolate the source of the high pressure, before the design pressure of the system is exceeded, thus preventing an uncontrolled loss of containment. In effect HIPPS creates a barrier between a high-pressure and a low-pressure section of pipe.
Delivery Wheel

The Severn Glocon Group fully satisfy HIPPS requirements by ensuring that the level of safety, quality and service is delivered at all levels.

Why the Severn Glocon Group?

The Severn Glocon Group is able to offer a full ‘Functional Safety Management’ service.

- It has a dedicated HIPPS design, assembly and test facility.
- All HIPPS projects are performed using a standard design methodology, ensuring consistency of interpretation of IEC 61508 and IEC 61511, and HAZOP Study; under the responsibility of Certified Functional Safety Professionals.
- The Severn Glocon Group HIPPS facility enables Integrated Factory Acceptance Test (IFAT) bringing together the HIPPS components and customer and Classification Society in a single space for validation and testing of the HIPPS.
How does HIPPS work

HIPPS is an application-specific safety system to prevent over pressurisation of a pipeline by rapidly closing the final elements to shut off the pipeline.
01 Pressure Transmitters
Pressure transmitters monitor the pipeline pressure against a pre-defined limit. The number and types of transmitters and their voting systems is a function of the SIL rating. In a HIPPS pressure transmitters are configured for 2oo3 voting to achieve SIL 3.

02 Logic Solver
The HIPPS logic solver captures signals from the pressure transmitters, and performs a 2oo3 voting logic, before activating the solenoids and closing the pipeline. Two types of TÜV certified logic solvers are available: PLC and hardwired, both provide scalable redundancy.

03 Comms Link
Separate Failsafe communications links for each of the three pressure transmitters (inputs) and each of the four solenoids (outputs), together with communications to the Control Module.

04 Solenoids
Two different types of valve solenoids, configured 2oo2, are used to close the final elements. They are optimised to provide fast reliable stroking / partial stroke testing over an extended service life.

05 Final Elements
The final element closes the pipeline. The valves are piggable, and designed for in-line maintenance.
HIPPS

HIPPS is a complete functional loop comprising three main elements: a final element (valve and actuator) to isolate the pipeline, pressure sensors (initiators) to detect a pressure build-up and a logic solver to check the pressure signal is real rather than spurious, thus avoiding ‘no cause’ HIPPS activation. Given the safety critical nature of the HIPPS, the system is normally duplicated with two final elements.

The Severn Glocon Group supplies two types of HIPPS: **Electronic and Mechanical.**

**Electronic HIPPS for Topside applications**

- Electronic initiators to detect an increase in pressure (pressure transducers, PT).
- Hard wired solid state, or PLC based, Logic Solver to process signals from the Initiators and perform “two out of three” (2oo3) voting, diagnostics, and partial stroke testing.
- Final Element to perform the action needed to isolate the high-pressure zone, allowing a safe shutdown. The final elements, valves and actuators, have proven track record in critical safety systems.

**A typical HIPPS safety loop comprising 2oo3 initiators**

**Benefits of electronic HIPPS include**

- Sensor connection to pipeline including remote sensors
- One sensing unit for parallel streams
- Logic Solver unit 2oo3 configuration
- Ability to access status information and diagnostics
- Enables partial stroke testing
Dual redundancy HIPPS for Subsea applications

For Subsea applications, Severn Glocon offers a fully integrated, dual redundancy HIPPS combining independent electronic and mechanical systems.

- In addition to the Electronic HIPPS’s pressure transmitters, the Mechanical HIPPS uses mechanical initiators to detect an increase in pressure (pressure sensors, PS), providing an additional level of protection in the event of over pressurization.

- Two pairs of pressure sensors are linked to two final elements in series. Each final element has mechanical initiators with ‘one out of two’ (1oo2) voting. This standalone system has no external power requirements.

A dual redundancy electrical and mechanical HIPPS

The Subsea HIPPS combines the benefit of both electronic and mechanical activation. The additional pressure protection offered by mechanical HIPPS comprises two pipeline isolation valves, each controlled by two independent hydraulic control sub-systems. The valves are arranged in series within the pipeline, with each valve capable of independently isolating the flow when closed.

Benefits of electrical and mechanical HIPPS include

- Combined electronic and mechanical pressure protection
- Independent operation
- Simple operation of mechanical HIPPS
- Partial and full stroke testing
Safety Systems

Design of the HIPPS safety system is in accordance with International Electrotechnical Commission standard IEC 61508 (Functional safety of electrical / electronic / programmable electronic safety related systems) and IEC 61511 (Safety instrumented systems for the process industry sector) international standards. These provide a total life cycle approach to safety instrumented systems.

Hazop Study

The starting point for designing the HIPPS is a detailed Hazard and Operability (HAZOP) study. This is a structured and systematic examination of a planned or existing process or operation. Its objective is to identify and assess problems that may represent risks to personnel, equipment, and the process.

Risk Graph based on HAZOP defines SIL

Integrated HIPPS Benefits

Severn Glocon Group integrated HIPPS offers a number of safety and operational advantages over other suppliers. These include:

Safety

- Combined electronic and mechanical HIPPS provides an additional level of redundancy, and safety, due to the variance between the pressure detection parts used.
- HIPPS closure time customised to reflect actual rather than theoretical requirements – the industry reference a 2 second closure, however, this may jeopardies other parts of the process (the actual required closure time needs to be qualified). It is imperative that required speed of closure for the final elements is calculated based on the protected volume, correct speed of operation is critical to ensure a surge is not created, compounding the initial problem.

- Integrated design, assembly and test – the Severn Glocon Group fully understands the importance of the architectural constraints of IEC 61508, which is a non-prescriptive performance based standard for functional safety systems but not specific to the Oil and Gas Industry, and IEC 61511 which is more relevant to the Oil and Gas Industry.

Integrated HIPPS Benefits

Severn Glocon Group integrated HIPPS offers a number of safety and operational advantages over other suppliers. These include:

Safety

- Combined electronic and mechanical HIPPS provides an additional level of redundancy, and safety, due to the variance between the pressure detection parts used.
- HIPPS closure time customised to reflect actual rather than theoretical requirements – the industry reference a 2 second closure, however, this may jeopardies other parts of the process (the actual required closure time needs to be qualified). It is imperative that required speed of closure for the final elements is calculated based on the protected volume, correct speed of operation is critical to ensure a surge is not created, compounding the initial problem.

- Integrated design, assembly and test – the Severn Glocon Group fully understands the importance of the architectural constraints of IEC 61508, which is a non-prescriptive performance based standard for functional safety systems but not specific to the Oil and Gas Industry, and IEC 61511 which is more relevant to the Oil and Gas Industry.

Integrated HIPPS Benefits

Severn Glocon Group integrated HIPPS offers a number of safety and operational advantages over other suppliers. These include:

Safety

- Combined electronic and mechanical HIPPS provides an additional level of redundancy, and safety, due to the variance between the pressure detection parts used.
- HIPPS closure time customised to reflect actual rather than theoretical requirements – the industry reference a 2 second closure, however, this may jeopardies other parts of the process (the actual required closure time needs to be qualified). It is imperative that required speed of closure for the final elements is calculated based on the protected volume, correct speed of operation is critical to ensure a surge is not created, compounding the initial problem.

- Integrated design, assembly and test – the Severn Glocon Group fully understands the importance of the architectural constraints of IEC 61508, which is a non-prescriptive performance based standard for functional safety systems but not specific to the Oil and Gas Industry, and IEC 61511 which is more relevant to the Oil and Gas Industry.
The Risk Reduction Factor (RRF) or Probability of Failure on Demand (PFD) of the system must be better than that required by the application specific SIL level.

One of the outcomes for the HAZOP is a risk graph that is used to define the safety integrity level (SIL) for the project. SIL is defined as a relative level of risk-reduction provided by a safety function, or to specify a target level of risk reduction.

**SIL required defines the design of the safety loop**

<table>
<thead>
<tr>
<th>SAFETY INTEGRITY LEVEL</th>
<th>PROBABILITY OF FAILURE ON DEMAND</th>
<th>RISK REDUCTION FACTOR</th>
<th>ARCHITECTURE FOR FINAL ELEMENTS &amp; SENSORS</th>
<th>ARCHITECTURE WHEN “PROVEN IN USE”</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No safety requirements (at all)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>No safety requirements (e.g. only a procedure)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>$10^{-2}$ to $10^{-1}$</td>
<td>$&gt; 10$ to $\leq 100$</td>
<td>0</td>
<td>1oo1</td>
</tr>
<tr>
<td>2</td>
<td>$10^{-3}$ to $10^{-2}$</td>
<td>$&gt; 100$ to $\leq 1000$</td>
<td>1</td>
<td>1oo2</td>
</tr>
<tr>
<td>3</td>
<td>$10^{-4}$ to $10^{-3}$</td>
<td>$&gt; 1000$ to $\leq 10000$</td>
<td>2</td>
<td>1oo3</td>
</tr>
<tr>
<td>4</td>
<td>$10^{-5}$ to $10^{-4}$</td>
<td>$&gt; 10000$ or better</td>
<td>Special requirements to IEC 61508</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>A single safety system is not sufficient (even with redundant components)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The IEC 61508 standard defines four levels of SILs: SIL 1 being the lowest and SIL 4 the highest. A SIL is determined based on a number of quantitative factors, in combination with qualitative factors such as development process and safety life cycle management. In effect, defining the degree of redundancy required.

**Operational**

- Isolation valves maintained in-line, avoiding the cost and disruption of removing the valve during process maintenance. In addition, the valve design permits the pipeline to be pig inspected.
- Periodic testing and automated diagnostics together with full and partial stroke testing to run diagnostics on the critical control components in the shutdown circuit, to ensure the integrity of the safety loop.
Severn Glocon Group plc
Gloucester, England, UK

Mars Valve UK
Gloucester, England, UK

L.B. Bentley
Stroud, England, UK

Ionex SG
Nailsworth, England, UK

Severn Unival
Brighouse, England, UK

Severn Subsea Technologies
Redruth, England, UK

Severn Unival
Widnes, England, UK

Severn Ball Valves
Aberdeen, Scotland, UK

Severn Norway
Bergen, Norway

Severn Glocon Atlantic Canada
Newfoundland, Canada

Severn Glocon
Calgary, Canada

Severn Glocon
Houston, Texas, USA

Severn Glocon
Rio, Brazil

Severn Valve Solutions
Basra, Iraq

Severn Glocon
Saudi Arabia

Severn Glocon
Doha, Qatar

OTRCO SG
Dubai

Severn Glocon FZE
Dubai

Severn Glocon India
Chennai, India

Severn Glocon
Kuala Lumpur, Malaysia

Severn Glocon Australia
Perth, Australia

Severn Glocon
Beijing, China

Severn Glocon
Seoul, Korea

Severn Glocon
Tokyo, Japan

The Severn Glocon Group policy is one of continuous improvement and we reserve the right to modify these specification details without notice.

Brochure design by verycreativepeople.co.uk