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High Integrity Pressure Protection Systems (HIPPS)

Index

1. Introduction to HIPPS Technology 3

2. Typical Applications of HIPPS 5

3. HIPPS Architecture and Functional Elements

3.1 Initiators (Pressure Transmitters) 6
3.2 Logic Solver (High Integrity Control System) 8
3.3 Final Elements (Valves and Actuation Systems) 9

4. In-House Assembly and Testing 10

SAMSON STARLINE High Integrity Pressure Protection Systems (HIPPS)

Advanced pressure safety solutions for critical Oil & Gas applications

1. Introduction to HIPPS Technology

High Integrity Pressure Protection Systems (**HIPPS**) represent an advanced, safety-critical technology designed to provide a **final layer of protection against overpressure scenarios in the process systems**.
As a Safety Instrumented System (SIS), HIPPS are specifically engineered to detect abnormal pressure increases and to isolate the high-pressure source before the process containment is compromised.

Core Objective
To deliver a rapid and highly reliable shutdown mechanism, preventing downstream overpressure damage and ensuring compliance with functional safety standards.

Engineering Philosophy

Upon decades of excellence in valve design and integration of automated actuation systems, Samson Starline HIPPS solutions meet the most demanding process safety challenges - ensuring asset protection, regulatory compliance and environmental responsibility in every application.
Samson Starline provides comprehensive project execution capabilities covering the entire HIPPS lifecycle, from the initial concept through manufacturing, testing and technical/operational support.
Each system is engineered in strict compliance with the international safety standards and the process industry's best practices, including:

- **IEC 61508** - Functional Safety of Electrical/Electronic/Programmable electronic safety-related systems
- **IEC 61511** - Functional safety - Safety Instrumented Systems for the Process Industry Sector
- **UNI EN 17955** - Industrial valves, Functional safety of safety-related automated valves
- **ANSI/ISA S84.01** – Application of Safety Instrumented Systems for the Process Industries
- **API 6A** - Specification for Wellhead and Tree Equipment
- **API 6D** - Specification for Valves

The final products are designed and validated to meet the required Safety Integrity Level (SIL) through detailed hazard and risk assessments, safety lifecycle analysis and comprehensive functional testing.

Understanding Safety Integrity Level (SIL) as a key element in the context of HIPPS

Safety Integrity Level (SIL) is a key metric used to define the required reliability and performance of a Safety Instrumented Function (SIF) to maintain a system in a safe state and reduce risk to an acceptable level.
Safety Integrity is categorized into four levels, from SIL 1 to SIL 4; with higher levels indicating a lower probability of dangerous failure and therefore greater system reliability.
The SIL target for a Safety Instrumented System (SIS) is determined through risk analysis of the process. This ensures that tolerable risk levels are not exceeded and that the required degree of protection is provided for the application.
Two important quantitative measures that define the performance targets of a safety system are:

- **PFDavg (Average Probability of Failure on Demand)**

Applies to "Low demand" mode: safety demand interval typically equal to or longer than one year.
It represents the probability that the safety function will fail when required.
A lower PFDavg indicates a more reliable safety function.

- **PFH (Probability of Failure per Hour)**

Applies to "High demand" or "Continuous" mode: safety demand interval shorter than one year.
It quantifies the average frequency per hour at which the system may fail to perform its safety function during operation. A lower PFH value reflects a lower likelihood of dangerous failures.

Here's an overview of the PFDavg and PFH ranges for each SIL:

SIL Level	PFDavg Range	PFH Range
SIL 1	$\geq 10^{-2}$ to $< 10^{-1}$	$\geq 10^{-6}$ to $< 10^{-5}$
SIL 2	$\geq 10^{-3}$ to $< 10^{-2}$	$\geq 10^{-7}$ to $< 10^{-6}$
SIL 3	$\geq 10^{-4}$ to $< 10^{-3}$	$\geq 10^{-8}$ to $< 10^{-7}$
SIL 4	$\geq 10^{-5}$ to $< 10^{-4}$	$\geq 10^{-9}$ to $< 10^{-8}$

Note: The ranges are defined by international standards such as IEC 61508 and IEC 61511.

Achieving the required SIL involves also:

- **Careful selection of components** based on reliability data.
- **Appropriate system architecture**, including redundancies.
- **Implementation of online diagnostics** to ensure rapid and safe response.

SIL and HIPPS Systems

In the specific context of **High Integrity Pressure Protection Systems (HIPPS)**, the SIL provides a quantifiable means to ensure that the system performs its function of keeping the process in a safe status by shutting off the overpressure source before it exceeds critical limits, becoming dangerous for the downstream equipment, personnel and environment.
Due to the potentially severe consequences of a failure, HIPPS must typically meet a high Safety Integrity Level, usually SIL 3 or even SIL 4.

Samson Starline Expertise

The consolidated experience in SIL applications and assessments allows Samson Starline to provide **fully engineered, manufactured and tested HIPPS systems**, qualified up to SIL3 - SIL 4 and compliant with the specific safety and reliability requirements such as partial stroke testing and other diagnostic coverage of the elements.
Samson Starline can also develop **skid-mounted HIPPS solutions**, where all components are **assembled, interconnected, and factory-tested** as a "plug-and-play" installation solution into the plant environment.
Safety integrity reports and SIL certification of Samson Starline HIPPS solutions are always carried out and validated by recognized third-party authorities such as TÜV Rheinland, TÜV Thüringen, Bureau Veritas, CSA Group, EXida, DNV and Others.

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2. Typical Applications of HIPPS

Samson Starline HIPPS solutions are deployed across a wide spectrum of upstream, midstream, and downstream operations, particularly in environments where conventional relief systems (e.g., pressure relief valves or rupture discs) are insufficient, impractical, or environmentally unapplicable.

Application Scenarios

- **Wellhead & Manifold Protection**

Prevention of catastrophic failure due to well overpressure; protects separators and downstream processing equipment.

- **Gas Processing & Compression Stations**

Controls surges and protects high-value compressors and process lines in midstream operations.

- **LNG Facilities**

Ensures overpressure protection during liquefaction, cryogenic storage, and regasification phases.

- **Pipeline Infrastructure**

Protects long-distance pipelines from transient pressure spikes and enhances pipeline integrity.

- **FPSOs and Offshore Installations**

Compact, corrosion-resistant systems for high-risk offshore environments; essential for weight and space-constrained applications.

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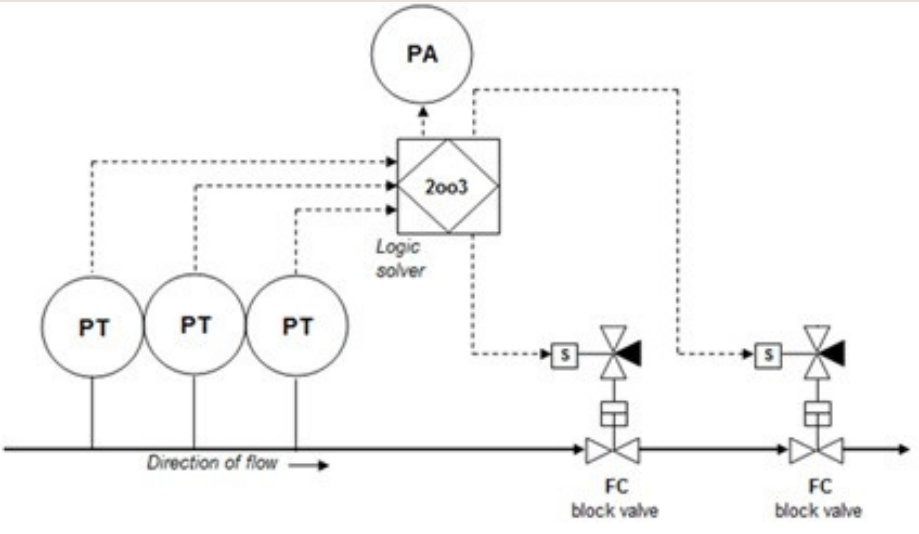
3. HIPPS Architecture and Functional Elements

HIPPS are composed of three core subsystems designed to detect, decide, and act in a fail-safe, time-critical sequence:



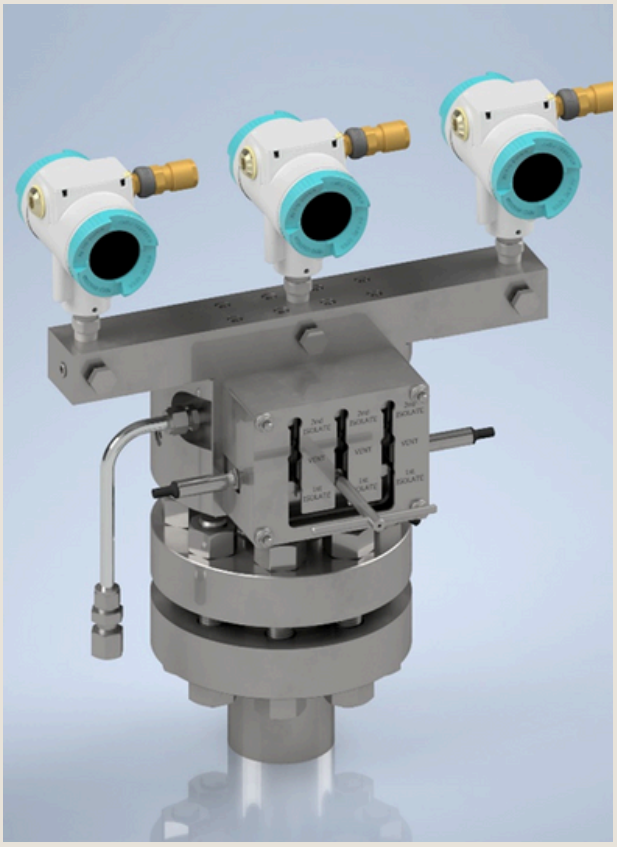
3.1 Initiators (Pressure Transmitters)

Initiators are the frontline of **pressure detection** in the process line.
Typically configured in **2oo3 redundancy**, they continuously monitor the process pressure and send real-time signals to the logic solver.

Technical Features:

- **SIL certified pressure transmitters**
- **High diagnostic coverage** and signal integrity
- Industry communication standards (HART protocol, 4-20mA loop)
- Configurable alarm thresholds with integrated fault diagnostics
- Installed close to process lines to reduce signal latency and minimize reaction time

Samson Starline Interlocking Manifolds:
Samson Starline designs and manufactures interlocking manifolds specifically engineered for the isolation, testing, and maintenance of the pressure transmitters used in HIPPS applications.



This device can be fully customized according to the project requirements and allows:

- **Safe replacement and maintenance of the transmitters**, without system shutdown or any other process interruption
- **Mechanical interlocking** to enforce correct operational sequencing and eliminate the risk of human error
- **SIL 4-capable design**, ensuring maximum system integrity and safety
- **Compact design and modular** solution for ease of installation
- **Highest level of customization**, with a wide range of construction materials and optional features to meet the most challenging application requirements
- **Integration into special cabinet enclosures** to protect the manifold components from extreme external conditions and other environmental threats

Samson Starline interlocking manifolds support operational efficiency, particularly in offshore and high-risk zones, by enabling maintainability without compromising safety.

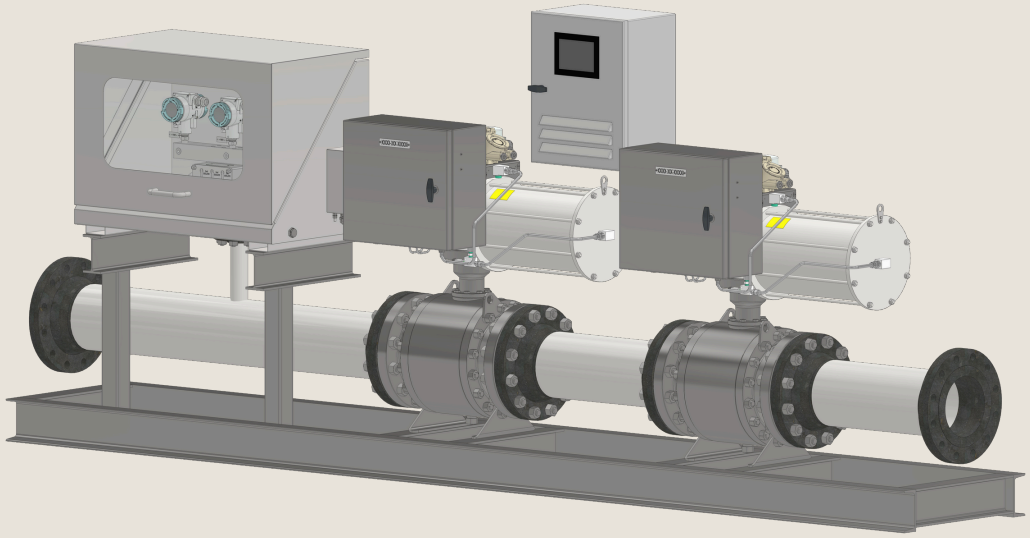
3.2 Logic Solver (High Integrity Control System)

The logic solver acts as the **decision-making unit.**
It collects the data from the initiators and determines whether to trigger the shutdown procedures based on the defined safety function logic and voting application.

Key Capabilities:

- Integration with all the industry-standard **hardwired safety controllers** and **PLC platforms** (HIMA, Siemens, Yokogawa, Schneider, etc)
- Dedicated **voting logic configuration** (e.g., 2oo3) for the initiators fault tolerance
- **Event logging, diagnostics**, and time-stamped trip reports
- Support for **HART, Modbus, Profibus, Ethernet/IP** and other std. communication protocols
- **SIL-certified solid state or programmable logic**, with tamper-proof access controls
- **Redundant architecture** and failover options for critical applications
- Installation inside IP-rated dedicated cabinets
- **Human-Machine interface (HMI)** or other custom-made local control panels are available and configurable on request

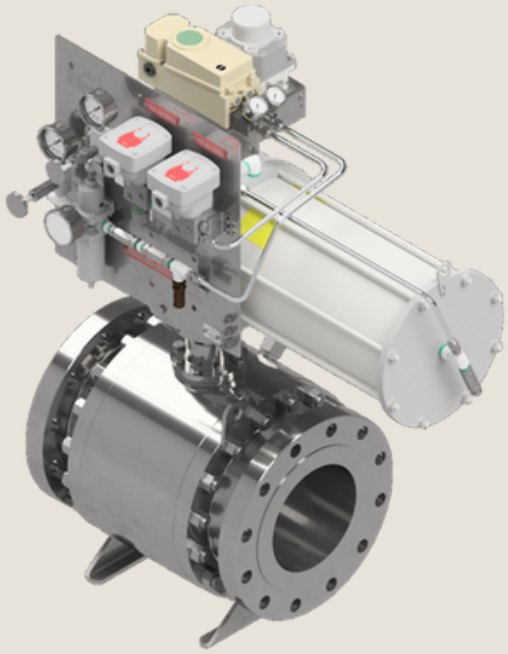
Each logic solver system is delivered with full functional safety documentation, including the **Safety Requirements Specification (SRS)** and validation test reports, as per IEC 61511.



3.3 Final Elements (Valves and Actuation Systems)

The final elements are responsible for executing the physical shutdown and isolation of the process.
Typically, these consist of two shutdown valves with associated actuators installed in series, providing redundancy for enhanced safety.
Samson Starline offers a broad range of **ball valves** and automated control panels compatible with the complete range of actuation technologies, including pneumatic, hydraulic, and electro-hydraulic systems.
All selected components are highly reliable, fast-acting, and fully compliant with the most stringent safety and performance standards and have a proven record of supplies in SIL 3 certified systems.

Available in all materials and pressure classes (150Lbs to 2500 Lbs and API 6A up to 15000), in sizes from ½" up to 36", valves can be supplied with soft seats or metal seats with guarantee of TSO sealing in all conditions.



Samson Starline Actuation Systems:
Samson Starline designs and manufactures integrated systems for the automation of its ball valves.
All the systems undergo rigorous development and validation processes, ensuring compliance with the specific safety requirements of HIPPS applications.
Fail-safe operation: via spring return actuators and high-performance emergency solenoid valves
Fast Response Time: Control panels are engineered for high-speed signal processing and actuator response, crucial for HIPPS where timing is critical.
Online diagnostic capability: Partial Stroke Testing (PST), Solenoid Valve Testing
Remote Monitoring & Control: Optional integration with plant DCS/SIS via HART or Foundation Fieldbus.
Modular Design: Allows easy maintenance or reconfiguration without full system replacement.
Heavy duty components: Selection of corrosion-resistant alloys and special features such as recirculation systems for harsh environments.

4. In-House Assembly and Testing

Each HIPPS unit undergoes complete in-house assembly, configuration and functional testing at Samson Starline dedicated facilities, to ensure full compliance with design specifications, safety requirements, and operational performance.
All valves and complete units are tested in a dedicated protected area, with high pressure gas, to verify the correct performance of the products.
The synergies between the team following the mechanical part and the one dedicated to instrumentation and digital part ensure effective collaboration and system performance.

Our integrated testing process includes:

Leak and Performance Testing

All valves and components are subjected to rigorous pressure and leak tests to verify tight shut-off capability, actuation speed, and mechanical integrity under simulated process conditions.

Fail-Safe and Emergency Shutdown (ESD) Verification

The control system is tested against all safety scenarios to confirm correct response time to failure events. This includes full verification of the fail-safe operation at the critical pressure, in accordance with the defined Safety Instrumented Function (SIF).

Partial Stroke Testing (PST)

PST functionality is tested to verify valve operability without full closure, allowing for predictive maintenance and improved availability while reducing the need for full shutdowns.

All components - Initiators, Logic Solvers and Final Elements (Valves, Actuators, Control panel) are tested as a fully integrated, SIL-capable system during the Factory Acceptance Testing (FAT) phase. This approach simulates real operating conditions, ensuring that the entire system performs seamlessly as designed.

FAT documentation includes:

- Test protocols and procedures
- Verification of SIL-related parameters
- Functional test results and certificates
- Compliance with customer specifications and international standards
- IFAT (integrated Factory Acceptance Test) to be done at Starline facility with all components - Initiators, Logic Solver and Final Elements (Valves, Actuators, Control Panel)

By conducting the complete assembly and testing in-house, Samson Starline guarantees full quality control, traceability, and consistent performance, providing customers with reliable, field-ready HIPPS solutions.

KNOW
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VALVES:

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