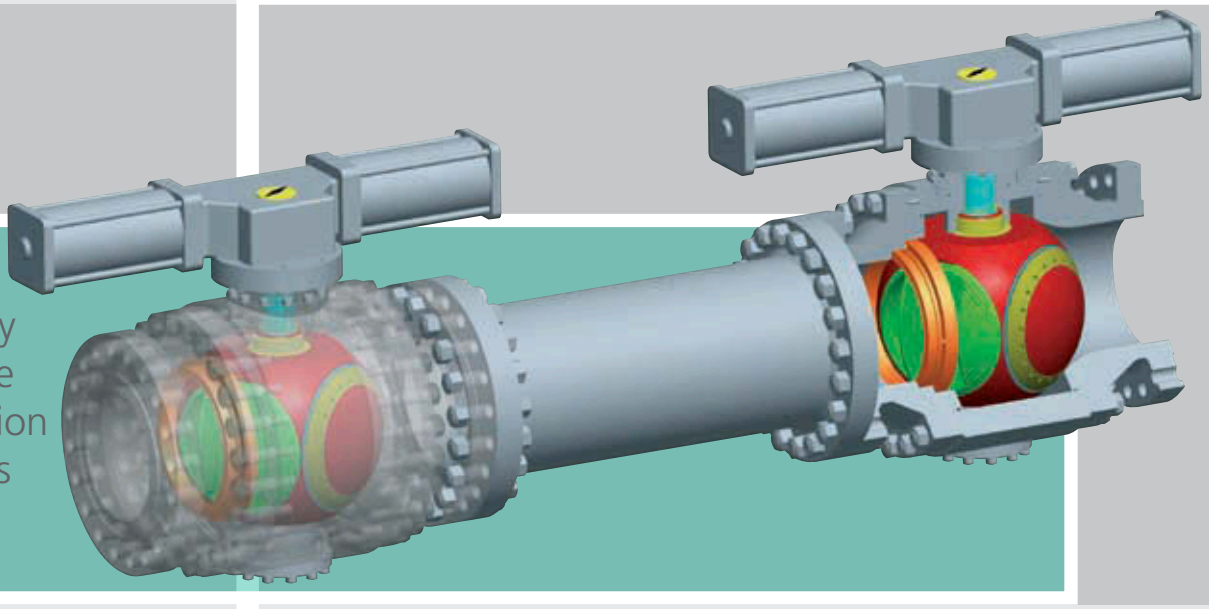
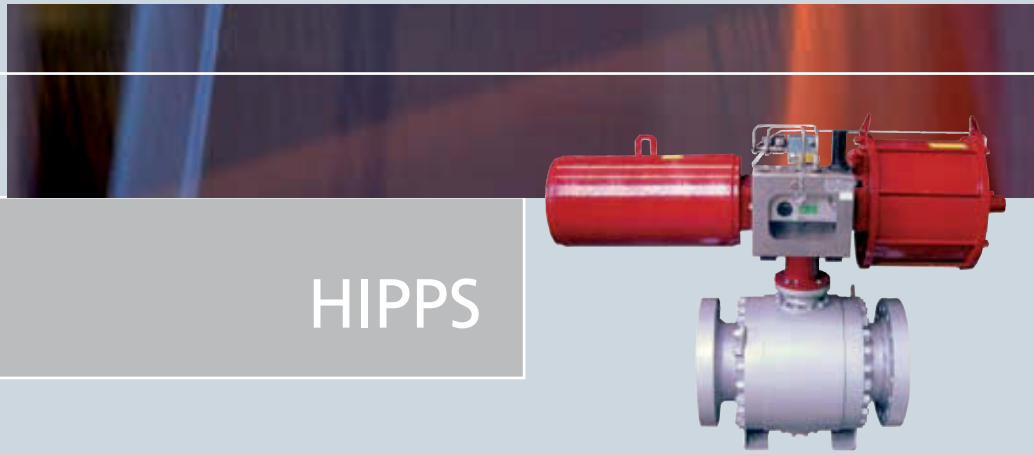
HIPPS

High
Integrity
Pressure
Protection
Systems



Pietro Fiorentini®



HIPPS

> High Integrity Pressure Protection Systems

WHAT IS A HIPPS

The High Integrity Pressure Protection Systems (HIPPS) is a mechanical and electrical system designed in order to reduce the chance that the system pressure will exceed the tolerable allowable pressure. The protection against over-pressure is obtained by quickly isolating the source causing the overpressure.

The entire HIPPS package consists of:
> Initiators
> Logic solver
> Final Element

The initiators are field sensors and they are the inputs required to detect the hazardous condition. The logic solver accepts these inputs and generates correct outputs that change the state of the final elements in order to mitigate the hazardous condition.

WHY AND WHEN USE A HIPPS

The HIPPS are used in the oil & gas industries in order to provide pressure protection of pipelines, piping, vessels and process packages against over pressure, allowing the use of lower design pressure downstream the HIPPS.

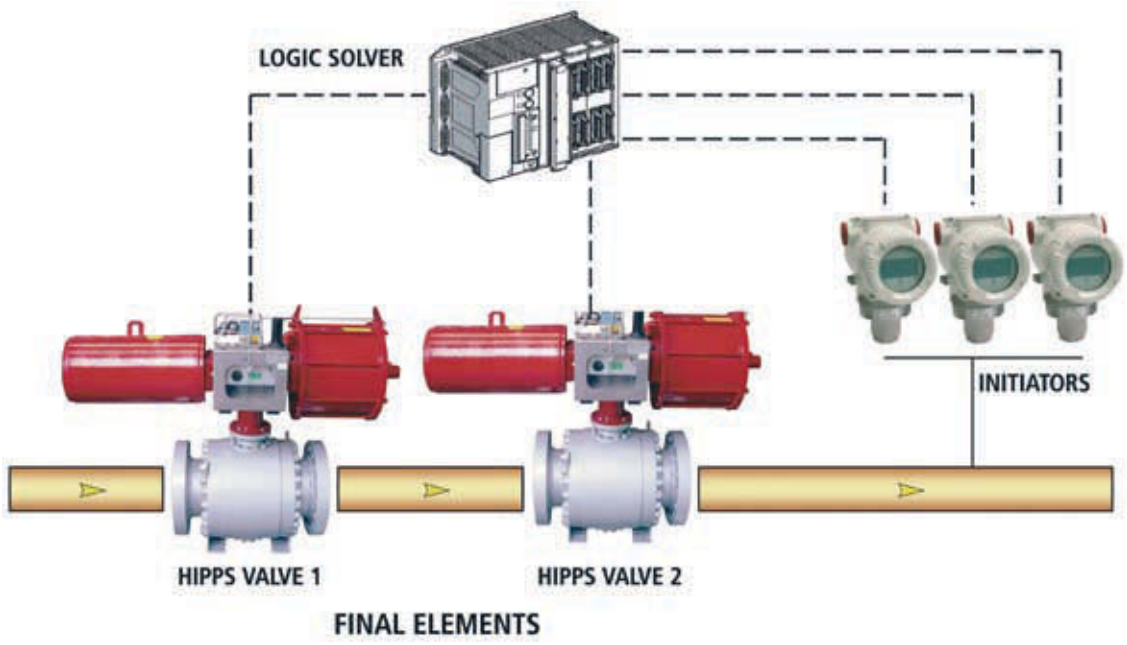
Conventional design standards against overpressure are based on the use and the proper sizing of relief devices, such as relief valves.

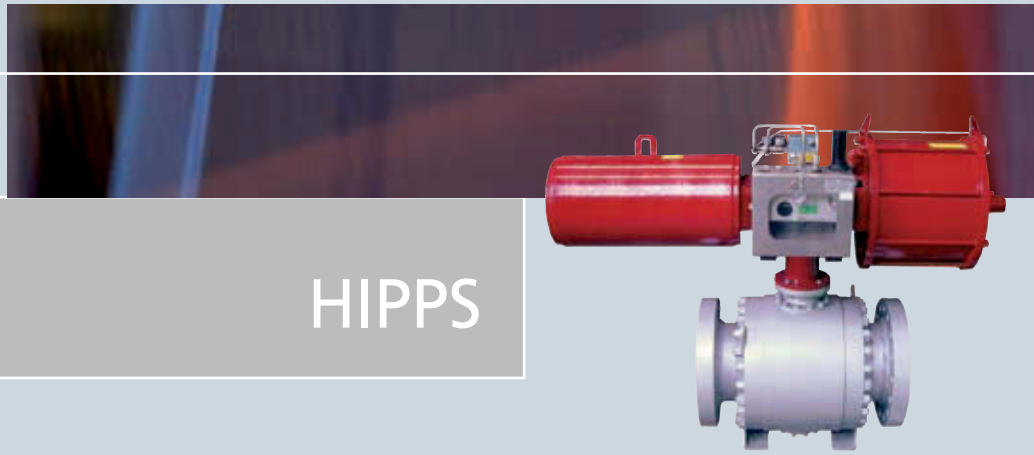
With HIPPS the overpressure protection is achieved by reducing to a tolerable degree the risk that the pressure can exceed certain maximum levels. HIPPS design is governed by:

> IEC 61508: "Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems"
> IEC 61511: "Functional Safety: Safety Instrumented Systems for the Process Sector,"
> ANSI/ISA S84.01-1996, "Application of Safety Instrumented Systems (SIS) for the Process Industry,"

The use of the HIPPS becomes the only feasible and practicable approach from a technical and commercial point of view, especially when:

> environmental restrictions and safety constraints limit the venting
> overpressure risk shall be reduced
> extremely high pressure and/or flow rate are involved
> sizing of relief device is difficult to define or inadequate due to chemical reactions, multiphase fluids or plugging
> on existing systems in order to avoid replacement of flare system when adding new units





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TECHNICAL DESCRIPTION

THE HIPPS System is based on a logic solver with two shutdown valves and three pressure transmitters.

INITIATORS

The pressure sensing initiators are electronic pressure transmitters, two wire 4-20 mA smart devices, mounted on a High Integrity Manifold Block (HIMB) and wired to separate card in the logic solver. The 2oo3 voting logic is implemented in the logic solver. The pressure transmitter contains self diagnostic and is programmed to send its output to a specified failure state.

LOGIC SOLVER

The logic solver is responsible for activation of the relevant signal outputs on the basis of the preconfigured applications and inputs from the initiators.
PLC available on the market, SIL 3 certified, are used as logic solver. The system consist of a Central Processing Unit (CPU) and fail-safe redundant I/O suitable for safety-related applications.
All safety communication between the control unit and the associated I/O cards are redundant.
The logic solver can also be designed based on Solid State Logic (SSL), as alternative.
Control Cabinet can be supplied suitable for hazardous area installation in EEx-d enclosure IP-66 or for safe area installation in standard 19" rack cabinet IP-54.

FINAL ELEMENTS

The final control element contributes approximately 50% to the PFD (Probability of Failure on Demand).
Pietro Fiorentini, since 1940, has a long well proven experience in design and manufacture different type of valves, including DELTAFLUX, the quarter turn control valve used in HIPPS package.
DELTAFLUX is designed to be opened against full differential pressure, so that there is no need for a by-pass arrangement for pressurization and start-up as typically the case with ball valves.
One of the most difficult parts of complying with SIS standards is the testing interval often required for final elements, such as block valves. Most SIS block valves are function tested only at unit turnaround. Consequently, many users are looking for ways to supplement the off-line full stroke test, such as on-line full stroke testing or partial stroke testing.

With DELTAFLUX, it is possible to perform Partial Stroke Testing (PST), a cost effective alternative to on-line Full Stroke Testing (FST). The use of PST often eliminates the need for full flow bypasses, reducing engineering, capital, and installation costs, as well as potentially hazardous operation such as the case of having the by-pass inadvertently left open. SIS standards do not recommend the use of the by-pass on the final element.

The valve is designed to maintain tight shut-off capabilities under all possible operating conditions, and even long periods of inactivity of the valve do not influence the response time of the valve.

The installed actuator is a spring return hydraulic or pneumatic high pressure actuators.

The overall response time of the system can be in the range of 2 or 3 seconds depending on the valve/actuator combination.

Valve can be supplied with different material of construction for all valve components (body, bonnet, seat, ball, steam).

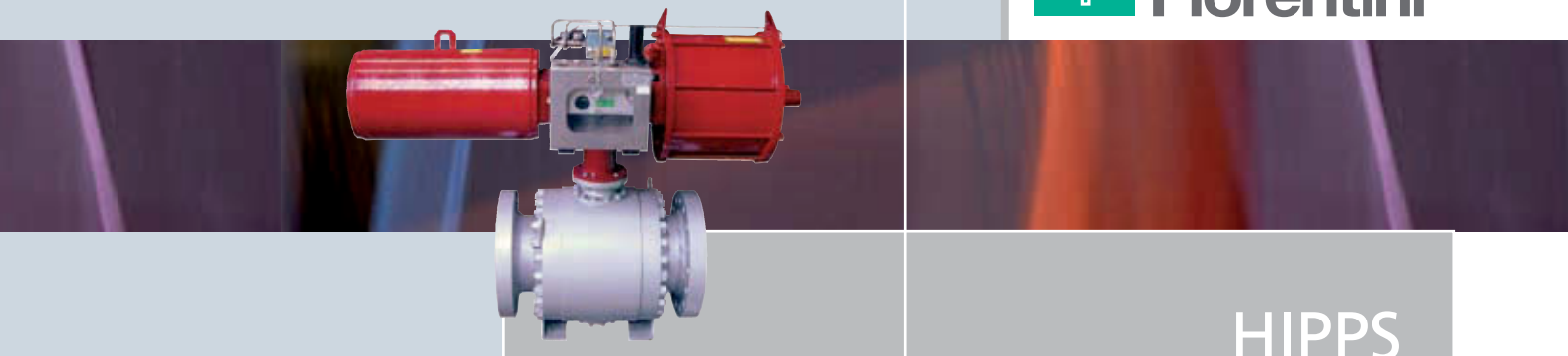
Valve size ranges from 2" to 40" rating up to Rating ANSI1500.THE HIPPS System is based on a logic

STANDARDS

IEC 61508 is a performance based standard which provides a detailed framework and life-cycle approach for the design and implementation of safety systems with different level of risk definition. This standard is mainly focused on Electrical/Electronic/Programmable Electronic Safety related equipment, but it also provides a framework for safety related equipments, including mechanical components.
The "performance" of the safety instrumented system (SIS) is based on a target safety integrity level (SIL) that is defined during the safety requirements specification development.
According to the standards the ability of the SIS to achieve a specific SIL must be validated at each stage of design and prior to any change made to the design after commissioning. The entire operation, testing, and maintenance procedures and practices are also judged for agreement with the target SIL.
Four different SIL are defined, depending on the consequence severity, the possibility of avoiding the hazardous event and the likelihood frequencies of the event. The SIL must be assigned by the user based on the risk reduction necessary to achieve the user's risk tolerance.It is the user's responsibility to ensure consistent and appropriate SIL assignments by establishing a risk management philosophy and risk tolerance.
The risk reduction provided by the HIPPS is equivalent to the probability of failure on demand attributable (PFD) to all of the HIPPS devices from the sensor through the logic solver and final elements. The relationship between the SIL and PFD for low Demand Mode of Operation is shown in following Table.

Safety Integrity Level (SIL)	Low Demand Mode of Operation Average Probability of Failure on Demand (PFD)	Risk Reduction Factor (RRF)
4	≥ 10-5 to < 10-4	10,000 to 100,000
3	≥ 10-4 to < 10-3	1,000 to 10,000
2	≥ 10-3 to < 10-2	100 to 1,000
1	≥ 10-2 to < 10-1	10 to 100

According to IEC 61508 in order to meet the SIL 3 requirements, the system must comply with both probabilistic requirements and with architectural constraints.



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ABBREVIATIONS, SYMBOLS & DEFINITIONS

The most commonly used abbreviation and concept for the HIPPS are the following:

> **CCF**	Common Cause Failure
> **Fph**	Failure per hour
> **FPPD**	Failure Probability per Demand
> **FST**	Full Stroke Testing
> **HFT**	Hardware Fault
> **HIMB**	High Integrity Manifold Block
> **HIPPS**	High Integrity Pressure Protection Systems
> **IEC**	International Electromechanical Commission
> **MTBF**	Mean Time Between Failure
> **MTTR**	Mean Time to Repair
> **PFD**	Probability of Failure on Demand
> **PLC**	Programmable Logic Controller
> **PST**	Partial Stroke Testing
> **RRF**	Risk Reduction Factor
> **SFF**	Safe Failure Fraction
> **SIL**	Safety Integrity Level
> **SIS**	Safety Instrumented System
> **SSL**	Solid State Logic

Pietro Fiorentini HIPPS package is SIL 3 certified by TUV


CERTIFICATE

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