PETROLVALVES GROUP
enabling your energy flow

HIPPS VALVES

what is hipps

HIGH INTEGRITY PRESSURE PROTECTION SYSTEMS

HIPPS is applied to **prevent over-pressurization of a plant or pipeline** by isolating and containing the source of the high pressure and protect the low-pressure line.
It is a better alternative commercially and technically compared to a full fledge flare and pressure relief system.

HIPPS is also known as;

- HIPS = High Integrity Protection System
- IPS = Instrumented Protection System
- SSD = Safety Shutdown System
- SIS = Safety Instrumented System
- OPPS= Overpressure Protection System

Pressure vessels and piping systems are designed **to contain certain pressure**, which is called design pressure. We can design the whole system to withstand the maximum wellhead pressure (MWP) however that will be a very expensive design especially when the fields are of high pressure.

The effective design will be to step down **the pressure as early as possible by using a pressure control valve**. The remaining system downstream of the control valve will be **in lower pressure to improve capacity and cost.**

During an upset condition such as **fire, blocked outlet, pressure control valve failure** and others can lead to excessively high pressure build up in the downstream system. When the pressure due to such an incident exceeds the design pressure of the downstream system, it can cause the rupture of the vessel or piping which in turn can cause severe hazard for human life, plant assets or the environment. Therefore, **it is essential to protect the system from the effects of over-pressure.**

There are two ways of protecting the downstream system from over pressurization.

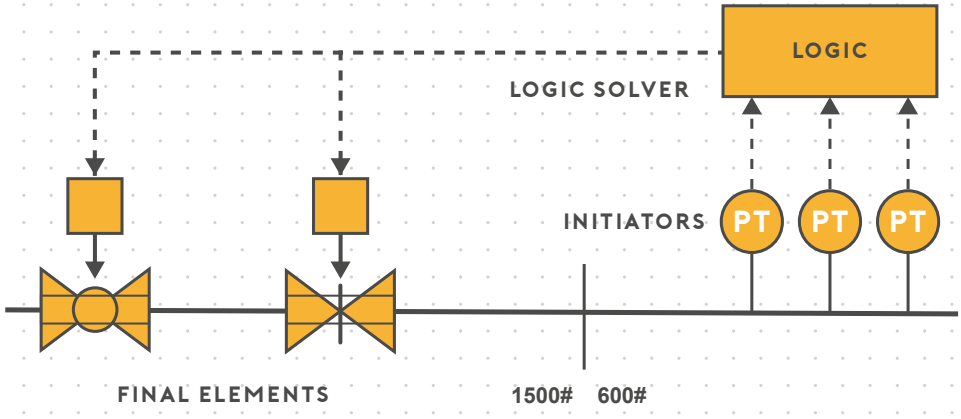
One, by using mechanical devices such as a pressure safety valve (PSV). The other, by using a safety instrumented system such as high integrity pressure protection system (HIPPS). A HIPPS protects the downstream pressure vessel and piping systems by isolating the source of overpressure in the upstream. The time it takes to make this isolation is called Safety Instrumented System (SIS) response time or simply HIPPS shutdown time. **This is usually half of time taken for the downstream system to reach its maximum operating pressure.**

Therefore, the final element used in a SIS must be **"proven in use" to ensure reliability of the SIS**. The final element should close on demand, close within the response time and maintain the leakage rate specified (usually ISO 5208 rate A).

hipps SUMMARY

A HIPPS is designed and built according to the International Electrotechnical Commission (IEC) standard 61511 (Functional Safety - Safety Instrumented Systems for the Process Industry Sector), part 1, part 2 and part 3 and IEC 61508.

It consist of Initiators (sensors), Controllers (logic solvers), and Final Elements (safety shutdowns valves, actuators and controls). For overpressure protection system, the final elements remain open as long as controller via the initiators sense a value less than the predetermined value (that corresponds to less than or equal to design pressure of the system). As soon as the controller senses a value exceeding the predetermined value via the initiator, it signals the final element to close on demand. Initiators and final elements are **generally provided with redundancy to meet the required level of performance of the HIPPS.**



Level of performance of a HIPPS is expressed in terms of Safety Integrity Level (SIL) which is described in the following table. Higher SIL means higher level of performance. Higher risk reduction.

Representation of risk reduction

SAFETY INTEGRITY LEVELS	PFD	REDUCTION OF RISK, COMPARED TO NO SIL
SIL - 1	10^{-1} - 10^{-2}	10 - 100
SIL - 2	10^{-2} - 10^{-3}	100 - 1000
SIL - 3	10^{-3} - 10^{-4}	1000 - 10000
SIL - 4	10^{-4} - 10^{-5}	10000 - 100000

The layer of protection model show what types of protective measures typically exist.

The risk is reduced in completely different approaches. These approaches are also called **layers of protection**. These different layers of protection are structured hierarchically and are to be viewed independently of each other. If one layer fails, the next higher layer steps in to limit or avoid damage. The layer of protection model above shows what types of protective measures typically exist.

The layers of protection must be independent in their function. Thus, devices for open-loop and closed-loop control technology from the lowest level should generally not be used simultaneously for safety applications of a higher level. Overall risk reduction results from the measures of the individual layers of protection and must result in an acceptable residual risk.

Safety integrity of a HIPPS is the probability that the HIPPS performs its required **safety instrumented function satisfactorily under all the stated conditions and within a specified period of time**. Safety Integrity requirement of a HIPPS is specified in terms of a discrete level called SIL. SIL or availability value of the HIPPS is measured by the probability of failure of the HIPPS to **perform its design function** on demand or simply probability of failure on demand (PFD). Higher SIL means lower PFD and higher probability of HIPPS performing its required function.

There are four safety integrity levels according to IEC 61511-1 i.e SIL-1, SIL-2, SIL-3 and SIL 4. SIL-4 means highest safety integrity or availability and SIL-1 lowest (see above).

A HIPPS can be used **to provide better risk reduction than PSV** or, in combination with PSV, to provide additional risk reduction. The actual required SIL of a HIPPS in a given situation is determined in a SIL assignment study **based on the required risk reduction** and following the guidelines of IEC 61511.

following are the advantages
OF HIPPS OVER PSV:

- PSV protects against over-pressurization by releasing the excess medium from the system, a HIPPS protects the system by isolating the over-pressurized medium. Thus, a PSV will require **additional installation of facilities for disposal of the medium contained in the system e.g. a flare system**, whereas no such facility is required in case of a HIPPS. Thus, the use of HIPPS can reduce the cost of flare system and foot print substantially.

- A revamp of an existing plant may require capacity expansion of existing flare system if PSV is installed. This may involve substantial cost addition. The use of HIPPS instead of PSV may lead to substantial cost saving by eliminating the need for increase in **capacity of existing flare system as it does not involve any fluid release**. Moreover, capacity expansion of existing flare system may be impractical due to plot size limitation. In such a situation, HIPPS may be the only option available as a means of over-pressure protection.

- While PSV's operation may cause harmful impact on environment by releasing greenhouse gases in atmosphere, HIPPS **protects environment by not releasing any emission in the atmosphere.** Thus, application of HIPPS may get preference over PSV where stricter environmental laws are in force.

- HIPPS can provide better risk reduction than PSV by increasing its performance level. Performance level or SIL of a HIPPS can **be increased by increasing the redundancy level of sensor,** and final control element and/or using high availability components (safety instrumented function), typically "proven in use".

- When installed in combination with PSV, HIPPS can **reduce the risk to extremely low levels.**

- HIPPS may be used for all commonly known over-pressure scenarios while PSV is reduced and used to eliminate thermal expansion scenarios. Thus, **PSV and HIPPS compliments each other to provide a complete safe environment**.

- While both PSV and HIPPS serve the purpose of providing protection against overpressure, they function entirely different. A PSV is a mechanical device whereas HIPPS is an instrumented system. The advantages and disadvantages of one over the other are underpinned by the fact that the PSV provides overpressure protection by releasing containments from the system into atmosphere (often after flaring) whereas HIPPS does the same **by shutting the source of the overpressure**. A decision as to which one to be applied in a given situation has to consider cost and benefits of the two as discussed in above.

PETROLVALVES expertise as manufacturer
AND HIPPS INTEGRATORS

- **1956 - PETROLVALVES** is established
- **1964 -** range of production includes Wedge Gate Valves and Swing Check up to 42", Ball valves up to 36", Slab Gate Valves up to 36"
- **1968 -** First Top Entry Ball Valve is patented by the Company
- **1970 -** Company enters the International Gas Market and shortly becomes a leader in Subsea Market developing dedicated products.
- **1980/90 -** The first metal - to - metal sealing ball valve is developed and the After Sales Department is created. Company reinforces its commercial network by opening branch offices worldwide today **PETROLVALVES** is a leading valves manufacturing company with more than 500 employees and a strong presence worldwide.
- **Since 2000**, we started to document activities around manufacturing and installation of our safety shutdown valves and eventually attained proven in use SIL certificates for our safety shutdown valves.
- **In 2019,** We have attained the Functional Safety Management certification for TUV Italy and certified to supply, as single point of source, the complete HIPPS (High Integrity Pressure Protection Systems). With more than 80 engineers and functional safety engineers inhouse we are self-sufficient and independent in manufacturing and integrating a proven in use HIPPS.

We have installed a significant number of HIPPS system worldwide; please contact us to get a reference list.

licenses
AND CERTIFICATIONS

- API 6A
- API 17D
- API 600
- API 6D
- API 6DSS
- ISO 9001:2008
- ISO 14001:2004
- OSHAS 18001:2007
- TR CU n.n. 010, 012, 032
- For Russia/Kazakhstan/Belarus
- CE ATEX
- PED (Pressure Equipment Directive) 97/23/EC
- Certification of the complete HIPPS PACKAGE as SAFETY ELEMENT according to the Pressure Equipment Directive PED 97/23/EC - CATEGORY IV
- SIL Certification and SAR (Safety Analysis Report) - IEC 61508 and IEC 61511
- SIL Certificates for Safety Shutdown Valves
- Functional Safety Management certification from TUV Italy

final element
PV VALVES

PETROLVALVES can offer the below Final Elements in accordance to end-user requirement.

AXIAL FLOW VALVE

+

LINEAR ACTUATOR

SLAB GATE VALVE

+

LINEAR ACTUATOR

TOP ENTRY BALL VALVE

SIDE ENTRY BALL VALVE

+

QUARTER TURN ACTUATOR

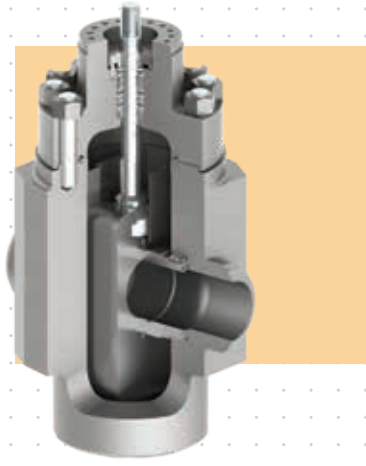
As mentioned above, the final element used in a SIS must be "proven in use" to ensure reliability of the SIS. The final element should close on demand, close within the response time and maintain the leakage rate specified (usually ISO 5208 rate A).

Following will be our highlight of our valves in HIPPS application.

- Our failure rates are based on hardware safety integrity Route 2_H (proven in use).
- How we achieve quick closing

GATE VALVES

The Through Conduit Slab Gate Valve is designed and manufactured with the rising stem to accommodate the floating movement of the gate. During the valve operation, the line fluid fills the bore cavity. The fluid pressure in the bore cavity generates a vertical force on the stem that pushes the trim from bottom to top. In case of emergency this force is used to assist the actuator spring to bring the valve gate to the required failure mode position. To achieve quick closing, a reverse acting design is in practice so the valve is closed with the gate/stem upwards, and is common for fail close configuration, because the "stem ejection force" assists the actuator spring to close the valve.



AXIAL VALVES

The quick acting is achieved by the sliding tooth racks with matching teeth located on both piston rod and stem. The thrust is transferred 90° from the stem to piston rod

BALL VALVES

The Ball Valve is able to be operate in relatively quick time as it is a quarter turn valve with stroke equal to 90°. Moreover, due to the relatively low energy to operate the valve, it is required reduced sized and reduced swept volume of actuator.

- How do we achieve the leakage rate

GATE VALVES

PETROLVALVES slab gate valve construction includes spring energized floating seats, which provide positive seating on both sides, regardless of upstream or downstream pressure conditions. The seat seals are spring energized to ensure sealing under low pressure conditions. When the line pressure increases, the seat-to-gate contact pressure increases accordingly to provide positive shutoff. The valve exhibits identical performance, regardless of direction of flow, and /or orientation of differential pressure. Different solutions are available for seat-to-body gaskets, depending on service fluid type, pressure, and temperature conditions.

ELASTOMERIC GASKET

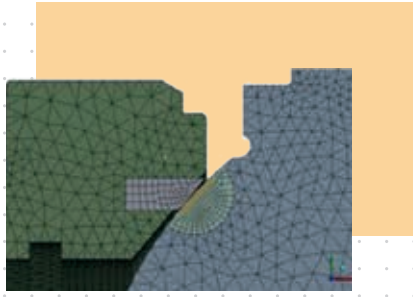
POLYMERIC GASKET

AXIAL VALVES

Available with different type of sealing (metal seated or with thermoplastic insert), axial valve has the advantage that no contact between seat and plug occurs during opening / closing stroke. Furthermore the sealing area is not directly exposed to throttling; this guarantees long-life tight seal.

BALL VALVES

With thermoplastic insert fitted, the seat is pressure energized. Our design provides tight shutoff seat-to-ball sealing, ISO 5208 rate A (no visible leakage) , in any condition. Multiple choices for the insert material are available to suit the service condition.



logic solver

PROGRAMMABLE AND/OR NON – PROGRAMABLE.

The Logic Solver processes the signals from the initiators (sensors) and closes the final element by de-energising the solenoids. The logic solver is probably the most complex device in the loop, especially the programmable ones.

Where the potential risk is extremely high, one will require a safety controller that always runs error-free and that is resistant to cyberattacks. With the solid state logic solver, one benefit from a hardwired controller that is extremely robust and resilient. These controllers are approved for implementation up to SIL 4 in accordance with IEC 61508 Edition 2 (2010).

PV have experience in working with all well known logic solver supplier, programmable and/or non-programmable (solid state) and hence can work with any supplier according to end-user preference,

initiators

The pressure sensing initiators are electronic pressure transmitters, two wire 4-20 mA smart devices, "mounted on an Interlock Manifold" either individual 3 nos. 1oo1 manifolds or 1nos. 2oo3 manifold. Both are available with mechanical interlock. The pressure sensors are wired to separate card in the logic solver. The 2oo3 voting logic is implemented in the logic solver. The pressure sensor contains self-diagnostic and is programmed to send its output to a specified failure state.

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