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Engineered Valve Systems for Control and Safety Applications

HIPPS Definition

Associazione Italiana Strumentisti Italy Section

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Agenda

- Foreword
- Definition
- Safety Requirement Specification
- Reliability Criteria
- Reliability Data



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Foreword

High integrity protection systems (HIPS) and especially high integrity pressure protection systems (HIPPS) are an increasingly common feature of oil and gas facilities worldwide.

They can provide an alternative to conventional mechanical protective devices (e.g. relief valves) or reduce the load upon them.

In some cases, they present the only practical option to facilitate field development and/or expansion.

Mokveld has started HIPPS B.U. in 1972

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Definition- HIPS High Integrity Protection System

Within the oil and gas industry, there are various company-specific definitions as to what constitutes a HIPS.

According to the ISO/TR 12489 definition, a nonconventional, autonomous, <u>safety instrumented</u> <u>system</u> with sufficiently high safety integrity to protect equipment against exceeding the design parameters is considered a HIPS



Definition- HIPS High Integrity Protection System

Examples:

- Deviations from industry standards describing mechanical protection systems (e.g. ISO 23251 = API Standard 521, ISO 10418, API RP 14C) are treated as HIPS

- An <u>ultimate protection</u> relying principally, but not necessary solely, on <u>Safety Instrumented Systems</u> (SIS) is qualified as HIPS, irrespective of its required Safety Integrity Level (SIL).

Definition- HIPS High Integrity Protection System

Examples:

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- a <u>final protection layer</u> comprising a combination of partial mechanical and instrumented protective function

- an instrumented protection layer having an integrity requirement of SIL 3 or more

- an instrumented protection layer where the consequence of non-operation is major to catastrophic or disastrous

Definition- HIPPS High Integrity Pressure Protection System

ISO/TR 12489 also defines HIPPS or OPPS as, "a HIPS exclusively devoted to protection against overpressure".



Definition- HIPPS - summary

Safety Instrumented System (SIS -IEC61508-61511) Autonomous Final, instrumented protection layer Dedicated to protect equipment from overpressure by isolating the pressure source



Definition- HIPPS – <u>SYSTEM</u>

Instrumented protection systems rely on instruments to provide a safety function for a given process. Such a function is performed by a <u>Safety Loop</u> consisting of one or more initiators (eg. Switches or transmitters), a logic solver (eg. a Safety Rated PLC) and final elements (eg. relays or valves).





Definition- HIPPS – RISK PROTECTION





Definition- HIPPS – WHY?

Reduction of the plant risk profile (insurance) **Reduction of Flare System and Piping Size** (or increase process system capacity without modifying flare system) **Regulations** issues **Elimination of Separate Platform Reduction in Weight Environmental factors for IOCS** no flaring - reduced emissions

- perception of public

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Production Separator with PSV

API Recommended Practice 14C



slide 15

•The Unit SDV does not close,

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•The SRV is sized for full flow of the well



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slide 16

- •The outlet of the separator blocks,
- •The choke does not close,

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- •The SRV is sized for thermal relief / leakage only,
- •The HIPPS SHALL close is 2 seconds to avoid overpressure in the separator.

Design and Hardware considerations

Shorter stroking times allow tighter design pressures Dynamic simulation is strongly recommended System operation (valve closing) may not be fast enough so the solution may be inadequate (check SRS!)



Safety Requirements Specification

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HIPPS functions should be defined independently of other safety systems in a specific HIPPS <u>Safety</u> <u>Requirements</u> <u>Specification</u> (SRS), normally produced by the end user.

This should consider the <u>complete system</u> comprising sensing element(s), logic solver and final element(s). The HIPPS should be developed and implemented in a similarly complete system manner.

IEC 61511 part 1: performance requirements relating to:

- Functionality
- Availability
- Survivability
- Interdependencies



Additional common requirements:

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- HIPPS should execute all safety functions in automatic mode.
- HIPPS should be autonomous, with dedicated sensors, logic and final elements.
- HIPPS should be a physically segregated system, interfaced with the facility automation system for monitoring only. Any communications with HIPPS should not be able to impede or override the safety function(s).

Additional common requirements:

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- HIPPS should be designed according to fail-tosafe principles.
- Resetting should not be possible without a clear understanding of the initiating cause and/or fault (eg. Manual reset on SOVs)

Signals between sensors, logic solver and final elements should be hardwired.

Additional common requirements:

- HIPPS design should define and include allowance for test and maintenance activities. Bypass functions should be avoided. When required, bypass functions should be subject to a thorough assessment of the risk and consequences for system integrity.
 - HIPPS packages should be designated as 'high' focus with respect to quality management

Additional common requirements:

- HIPPS design should consider the full safety life cycle.
- As component age the probability of failure increases.
- The component(s) lifetime depends on the test frequency and ability to detect dangerous failure
- Less reliable systems will therefore require higher test frequencies to suit same SIL requirement!

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HIPPS - Reliability Criteria

HIPPS components, including sensors, logic solver and final elements should each be designed as <u>fail-safe</u> (i.e. failure of any component/ sensor/logic solver/power supply/motive fluids moves final elements to the safe state).



HIPPS - Reliability Criteria

IEC 61511



HIPPS components or sub-systems are then selected such that the overall integrity (SIL) target of the HIPPS Safety Instrumented Function (SIF) is achieved.

 $PFD_{sis} = PFD_I + PFD_{LS} + PFD_{SOV} + PFD_{SDV}$



Risk graph based on HAZOP defines SIL





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SIL required defines the design of safety loop

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Safety Integrity Level	Probability of Failure on Demand	Risk Reduction Factor					
SIL	PFD	RRF					
0	No safety requirements (at all)						
а	No special safety requirements (e.g. only a procedure)						
1	≥10 ⁻² to <10 ⁻¹	> 10 to ≤ 100					
2	≥10 ⁻³ to <10 ⁻²	> 100 to ≤ 1.000					
3	≥10 ⁻⁴ to <10 ⁻³	> 1.000 to ≤ 10.000					
4	≥10 ⁻⁵ to <10 ⁻⁴	> 10.000 or better					
b	A single safety system is not suff	icient (even with redundant components)					





HIPPS - Reliability Data

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The HIPPS operator should approve the reliability data utilized to demonstrate the integrity achieved by the HIPPS. Reliability data sources include, in order of preference:

 Field data – but only where the quantity collected is sufficient to be considered statistically significant

See 7.4.10.4 : A proven in use safety justification shall be documented that the element supports the required safety function with the required systematic safety integrity. This shall include: the suitability analysis and testing of the element <u>for the</u> <u>intended application</u> and the demonstration of <u>equivalence</u> <u>between the intended operation and the previous operation</u> <u>experience</u>, including the impact analysis on the differences

Database filled since 70's

Each after-sales related action entered in database

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HIPPS - Reliability Data

- 2. <u>Databases/reference handbooks</u>— The data selection process should consider similar service and environmental conditions, and maintenance regimes (OREDA3, PDS Data Handbook4, SINTEF5)
- 3. Failure Mode and Effect Analysis (FMEA) reports
- 4. Vendor data



PFD / SIL of complete safety loop to be verified

- Architecture to be verified
- Failure rates shall be dependable or "proven in use":
 - Based on field experience in same application
 - For same stroking time (< 2 sec.)
- Integrated FAT & SAT



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Example in Europe



Location Specs

: Gasunie Netherlands BBL Balgzand pipeline : 2 x 1002 Electronic HIPPS protecting ANSI 600 control valves against pressure from ANSI 900 compressor

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Example in Europe



Location Specs

NAM Netherlands mobile production unit
1002 Mechanical HIPPS protecting ANSI 900 pipeline against pressure from ANSI 2500 wellhead

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Example in Europe



Location Specs Dong Denmark Nybro
1002 Electronic HIPPS protecting ANSI 600 onshore installation against pressure from ANSI 900 pipeline

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Example in Europe



Location Specs

 Statoil Germany Zeepipe landfall
 1002 Mechanical HIPPS protecting ANSI 600 onshore installation against pressure from ANSI 900 pipeline

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