

## GENERAL SPECIFICATION

### SAFETY

#### GS EP SAF 260

#### Design of High Integrity Protection Systems (HIPS)

|      |         |                                                             |
|------|---------|-------------------------------------------------------------|
| 05   | 12/2017 | General revision                                            |
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| 03   | 01/2012 | Revision and update following the EP reorganisation, March  |
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| 01   | 02/2004 | Fully revised                                               |
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## 1. Scope

### 1.1 Purpose of the specification

Where the provision of a **High Integrity Protection Systems (HIPS)** has been duly justified and formally approved by Company, this General Specification covers the main design and functional requirements related to HIPS.

The present specification is to be read in conjunction with the **GS EP TEC 260** which covers in details the minimum requirements for the design, procurement, implementation, and life-cycle of all instrumented parts of the HIPS, comprising sensors, logic solver, final elements and interface with other systems.

### 1.2 Applicability

This specification applies to all projects managed by Total E&P and its Affiliates and to Companies of which Total is a shareholder and which have decided to apply the Total E&P General Specifications.

It applies to new installations and to major modifications or extensions of existing installations, both onshore and offshore, and to subsea systems in all project phases as well as during operation phase.

This specification applies to HIPS which can be devoted to protect against specific process parameters deviation or specific hazards such as, typically:

- Exceeding the design pressure (overpressure).
- Exceeding the design flowrate.
- Exceeding the design temperature.
- Liquid carry over.
- Exceeding the radiation criteria.

As per Company practice, HIPS shall not be implemented for the following applications:

- The protection of liquid transfer installations against over-pressure caused by hydraulic surge (e.g. "water hammer" effect).
- The protection of topsides processing equipment (e.g. de-rated production separator) against over-pressure caused by a "blocked outlet" scenario.

## 2. Reference documents

The reference documents listed below form an integral part of this General Specification.

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## External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

| Reference       | Title                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------|
| API RP 14C      | Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms |
| API STD 521     | Pressure-relieving and Depressuring Systems                                                                                            |
| IEC 61508       | Functional safety of electrical/electronic/programmable electronic safety-related systems                                              |
| IEC 61511       | Functional safety - Safety instrumented systems for the process industry sector                                                        |
| IOGP Report 443 | High integrity Protection Systems - Recommended Practice                                                                               |
| ISO 10418       | Petroleum and natural gas industries - Offshore production installations - Basic surface process safety systems                        |
| ISO/TR 12489    | Petroleum, petrochemical and natural gas industries - Reliability modelling and calculation of safety systems                          |

## Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

| Reference     | Title                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------------|
| GS EP ECP 103 | Process sizing criteria                                                                             |
| GS EP EXP 405 | Standard Reliability Data                                                                           |
| GS EP EXP 407 | Implementation scheme for identification and management of Safety and Environment Critical Elements |
| GS EP INS 101 | Instrumentation Design                                                                              |
| GS EP SAF 041 | Technological Risk Assessment Methodology                                                           |
| GS EP SAF 253 | Impacted area, restricted area and fire zones                                                       |
| GS EP SAF 261 | Emergency Shutdown and Emergency Depressurisation (ESD & EDP)                                       |
| GS EP SAF 361 | SIL assignment                                                                                      |
| GS EP TEC 260 | HIPS Design, Implementation and Life cycle                                                          |
| GS EP PVV 154 | Ball Valves                                                                                         |
| GS EP PVV 156 | Axial Valves & Axial Flow Check Valves according to API SPEC 6D or API SPEC 6A                      |

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### 3. Preamble

A HIPS is considered as a **non-conventional** protection based design and constitutes a deviation from **conventional** protection design based on Industry Standards (as described in [API RP 14C](#), [API STD 521](#)).

**The selection of HIPS as an ultimate protection barrier is not an option given preference by Company and it should never be the base case.**

**It is Company practice to consider HIPS solution as last resort based on strong justifications when conventional protection is considered impracticable.**

HIPS can be an alternative solution to impractical designs, but HIPS shall not take precedence over robust and proven-in-use design recognised by Industry Standards.

The implementation of HIPS requires a number of special procedures within the design process to ensure a safe and robust design and requires particular attention during its operational life such as **maintenance, testing and inspection**. The strict observance of the periodic proof tests of the HIPS in operation is fundamental to maintain the HIPS functional safety at its required SIL level.

The decision to implement a HIPS on a given Project should be made with careful consideration and with the involvement of all the relevant technical entities (i.e. **Safety, Process, Operation, Instrumentation, and Reliability**).

The recognition that there is one credible scenario or more that cannot be managed by means of a conventional protection is the foundation of a HIPS design.

A HIPS **may be envisaged** on a case by case basis and the recourse to a HIPS shall be supported by the demonstration that:

- A conventional design cannot be implemented because it implies the use of non-proven technology or technology beyond the present state-of-the-art.
- OR, that conventional design induces insurmountable technical or environmental issues or disproportionate costs <sup>(1)</sup> in relation to the overall development budget.

**<sup>(1)</sup> The “disproportionate cost” criterion alone is not sufficient to justify a HIPS solution, but it can be a contributing factor to support the demonstration.**

As part of the decision process, the following criteria should also be carefully evaluated:

- Location remoteness and accessibility with respect to HIPS maintainability and testability. Hence, HIPS solution should be avoided in remote location or on not permanently manned installations that are hardly accessible.
- Operational constraints and possible additional operational costs that may be generated by HIPS in operation (e.g. production shortfalls) and the impact associated to HIPS maintenance, inspection, tests and repairs.
- Variation in operating parameters over the field life which may render the HIPS problematic under future normal operating conditions, or even unnecessary.

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### Note on API RP 14C (8<sup>th</sup> Edition):

Annex E of API RP 14C 8<sup>th</sup> Edition covers topsides “HIPPS” (High Integrity **Pressure** Protection Systems) for offshore installations presented as an option to conventional overpressure protection. However, API RP 14C clearly mentions the following reservations with respect to the use of HIPPS:

- “While HIPPS has been presented as an option for overpressure protection of multiple components, an HIPPS is used after thorough consideration of other alternatives. **Caution should be applied when using HIPPS** given the rigorous design, testing, and maintenance requirements for the system”.
- “The use of HIPPS should be applied **only when** a traditional method for relief system design, in accordance with API STD 521, is not practical. **Justifications** for the HIPPS shall be documented and approved by the Owner / Operator. Approvals should be at an Owner / Operator organizational level that is appropriate for the level of risk managed by the HIPPS”.
- “**HIPPS may be considered for specific overpressure scenarios** where installation of a pressure relief valve may not be practical or where a relief device is ineffective or create unacceptable hazards. **However, a practically sized relief system may be required to cover all other design contingencies.**”

### Note specific to subsea HIPS:

It is reminded that a subsea HIPS has the drawbacks inherent to a subsea installation on top of the drawbacks inherent to a HIPS, mainly due to the increased technical and operational constraints specific to subsea environment:

- Regular tests and maintenance whose complexity is increased in subsea conditions.
- Increased complexity of interventions and accessibility for subsea HIPS repair, replacement.
- Availability issues upon untimely subsea HIPS activation.
- Subsea HIPS are more complex to design and to build.
- Subsea logic solvers technology and reliability level are less advanced than topsides logic solvers.

Subsea HIPS applications are relatively recent development in the Oil and Gas Industry, thus requiring a lot of effort during the design phase, when implemented. Since subsea HIPS may involve significant operational constraints (e.g. maintenance, inspection, tests and repairs), it is important to define a clear Operating Philosophy in an early stage of the HIPS design, including logistics and the impact on the overall availability of the installations.

Although not the preferred option, subsea HIPS **may be envisaged** on a case by case basis.

Subsea HIPS follows the same life-cycle management process than the one applied for topsides HIPS.

## 4. HIPS implementation process from conception to operation

### 4.1 Company approval

The implementation of a HIPS (either in new development or as part of a revamping of an existing unit) shall be agreed upon by Company and supported by a preliminary HIPS dossier.

The Responsible Entity submits the preliminary HIPS dossier to the HIPS Committee examination for review and evaluation of the justification and pertinence of the proposed design.

**To formalise the implementation of a HIPS, considered as a non-conventional protection, the Responsible Entity shall submit a formal derogation to Company approval.**

At each following engineering stages (Basic and Detailed Engineering), the Responsible Entity shall submit the HIPS dossier to the HIPS Committee for review and evaluation. The review and evaluation of the HIPS dossier is performed through dedicated HIPS Committee sessions organised at the request of the Responsible Entity, at the end of which the HIPS Committee addresses comments and recommendations to the Responsible Entity.

**HIPS implementation shall be recorded in the project SOR and Safety Concept.**

### 4.2 Conceptual / pre-project stage

The Responsible Entity nominates a **HIPS Champion** to lead and coordinate the elaboration of the preliminary HIPS dossier.

The **preliminary HIPS dossier** consists of the following typical documentation:

- Process scenarios hazard assessment: identification of sources of hazard, relevant process scenarios (e.g. overpressure; overflow; over temperature); protection layers selected for management of the hazard, detailed description of the sequence of the scenario(s) of concern including barriers involved.
- HIPS justification against Industry Standards.
- Preliminary process dynamic simulation studies.
- Preliminary risk assessment: refer to methodology specified in [GS EP SAF 253](#) and [GS EP SAF 041](#)
  - Consequence analysis <sup>(1)</sup>: evaluation of the consequences and damage severity on **People, Environment** and **Asset** <sup>(2)</sup> of the hazard scenarios of concern without any SIS.
  - HIPS demand rate evaluation.

<sup>(1)</sup> Consequences severity is evaluated against the risk of the equipment being exposed to conditions exceeding its applicable design code. The applicable design codes for pipelines, process piping and vessels are defined by the relevant HQ responsible entities (i.e. "Piping Valves and Vessels"; "Pipelines and Risers", "Subsea Production Systems").

<sup>(2)</sup> Consequences associated to "**production loss**" may be evaluated for information purpose although this particular risk criterion is not considered in [GS EP SAF 041](#).

- Preliminary SIL assignment analysis (i.e. evaluation of the HIPS **SIL target**; **RRF** provided by the HIPS). Refer to methodology specified in [GS EP SAF 361](#).

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Company practice is to use the “**LOPA**” methodology (semi-quantitative analysis) rather than the “risk graph” methodology considered too qualitative. The LOPA analysis can be complemented with fault/event-trees for specific complex hazard scenarios having multiple initiating causes for instance. This approach allows a better identification of the effective barriers that intervene in each initiating chain of event leading to the scenario of concern, and a more accurate evaluation of the initiating event frequency and HIPS demand rate.

- Preliminary SIL achievement study (Support from HQ reliability specialists may be required for this purpose).
- The selected hazard scenarios are plotted on the Company risk matrix (**GS EP SAF 041**) with and without SIS in order to visualise the risk reduction achieved by the HIPS protection compared to the risk tolerance criteria defined by Company.
- HIPS Safety logic diagrams.
- HIPS graphical scheme and associated protection layers.
- HIPS preliminary design and Operating Philosophy.
- **Derogation** submitted to Company approval for implementation of a HIPS (see §4.1).

#### 4.3 Project stage (Basic and Detailed Engineering)

The Responsible Entity nominates a **HIPS Champion** to lead and coordinate HIPS studies, to serve as liaison with the HIPS Committee, to organise the elaboration of the HIPS dossier and to ensure the transfer of the HIPS dossier to the next development phase, all the way to operation phase.

Refer to **GS EP TEC 260** for typical detailed list of HIPS Engineering Contractor deliverables.

The **HIPS dossier** consists of a **design section** and an **operation section**.

The **HIPS dossier** **design section** consists of the following typical documentation:

- Update of HIPS justification against Industry Standards.
- Update of the process scenarios hazard assessment.
- Update of process dynamic simulations to demonstrate the HIPS required response time (if applicable).
- Update of the consequence (scenarios damage severity) and frequency analysis (HIPS demand rate).
- Update of the SIL assignment analysis (SIL target).
- Graphical scheme of the HIPS and associated protection layers.
- HIPS design principles and functional specification.
- PFD's, P&ID's, layout; Cause & Effect Charts, ESD Logic Diagram.
- HIPS functional logic diagrams.
- Material selection (e.g. HIPS components data-sheets).
- HIPS detailed specifications for the engineering and construction phases.

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- Reliability and availability calculations, at Detailed Engineering stage when the HIPS components (sensors, logic solvers, final control elements) have been selected, including:
  - **SIL achievement** demonstration.
  - HIPS required **periodic proof test intervals**.
  - Diagnostic coverage of failures, detailed CCF / CMF analysis, effect of spurious trips on the availability of the production installation.
- HIPS maintenance, testing and repair policy (frequency based on availability calculations).
- HIPS Integrator documentation at Detailed Engineering. Refer to **GS EP TEC 260** for further details.
- **Third party verification** documentation. Refer to **GS EP TEC 260** for further details.
- HIPS **Safety Requirements Specification (SRS)**. Refer to **GS EP TEC 260** for further details.

The **HIPS dossier operation section** consists of the following information and documentation:

- Key information from the as-built HIPS design documentation useful and necessary to Field Operations team (e.g. main design characteristics and functionalities; scenarios covered by HIPS and protected equipment; HIPS graphical scheme and associated protection layers; HIPS sensors set points; HIPS required response time; HIPS required periodic proof test intervals etc.).
- HIPS pre-commissioning and commissioning test requirements and test results.
- Comprehensive and complete HIPS operating manual: maintenance, inspection, testing and repair procedures; Re-start, reset and black start procedures.

#### 4.4 Operational phase

**Note:** this chapter applies to Company Field Operations Entity.

The **HIPS dossier** including the **design section** and the **operational section** is handed over to the Field Operations Entity who is accountable for:

- Keeping the HIPS dossier up-to date and available on site (it can be subject to audit review upon request e.g. OPERSAFE).
- Nominating a “**SECE Guardian**” and manage the HIPS in operation as a “**SECE**” in accordance with **GS EP EXP 407**.
- Ensuring that Operators are properly trained and informed about the HIPS operations and challenges.
- Ensuring that the HIPS in operation is maintained, inspected, tested and repaired as required.

**Note: it is essential that HIPS periodic proof testing (as defined in the as-built HIPS dossier) are performed on site during the HIPS operational life in order to maintain the HIPS functional safety at its required SIL level.**

- Submitting to HIPS Committee for examination any HIPS modification or decommissioning proposals.