

## GENERAL SPECIFICATION

### Safety

#### GS EP SAF 312

#### Fire and Gas detection

| Rev. | Date    | Purpose of the revision                                                                                      |
|------|---------|--------------------------------------------------------------------------------------------------------------|
| 04   | 08/2016 | General revision                                                                                             |
| 03   | 01/2011 | General revision                                                                                             |
| 02   | 02/2005 | Addition of EP root to document identification and modified/corrected tables 4 and 5 in sections 6.2 and 6.3 |
| 01   | 10/2003 | Change of Group name and logo                                                                                |
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## 1. Scope

### 1.1 Purpose

This General Specification sets out the requirements governing the design, selection, installation, location and logic of (automatic) fire and gas detection equipment and systems.

The intent is to detect a potentially flammable, explosive or toxic gas concentration resulting from a leak or to detect a fire as quickly as possible, to locate it and to initiate:

- Visible and audible alarms
- Automatic fire-fighting actions if planned by design
- Automatic safety process actions (shutdown / blowdown) if relevant to limit escalation of the hazardous event

### 1.2 Application

This specification is applicable to onshore and offshore oil and gas production and processing facilities, including technical and residential buildings which are part of the facility.

For particular requirements dedicated to LNG plants or F(P)SO installations, refer to [GS EP SAF 521](#) or [GS EP SAF 380](#) respectively.

For particular requirements dedicated to rotating machinery enclosures or engines/process units in shelter or enclosed areas, refer to [GS EP SAF 050](#) or [GS EP SAF 222](#).

This specification does not cover the technical characteristics details of each technology which are available in [GS EP INS 143](#) neither the design and functional requirements of the associated automated Fire&Gas safety system(s), which are covered by [GS EP SAF 261](#), [GS EP INS 134](#) and [GS EP INS 198](#).

For materials of construction, refer to [GS EP INS 101](#).

## 2. Reference documents

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

### External Documents

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

| Reference                   | Title                                                                                                                                |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">API RP 14C</a>  | Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms |
| <a href="#">ASTM E 1002</a> | Standard Practice for Leaks Using Ultrasonics                                                                                        |

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| BS EN 61779-4        | Electrical apparatus for the detection and measurement of flammable gases. Part 4: Performance requirements for group II apparatus indicating a volume fraction up to 100% lower explosive limit                                            |
| BS EN 54-20          | Fire detection and fire alarm systems. Part 20: Aspirating smoke detectors                                                                                                                                                                  |
| Directive 94/9/EC    | European Directive 94/9/EC (23/03/94) of the European Parliament and of the Council on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres |
| Directive 2014/34/EU | European Directive 2014/34/EU (26/02/2014) on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmosphere (recast)                                 |
| IEC 60079-0          | Explosive atmospheres – Part 0: Equipment - General                                                                                                                                                                                         |
| IEC 61511            | Functional safety – Safety instrumented systems for the process industry sector                                                                                                                                                             |
| ISO 7240-1           | Fire detection and alarm systems - Part 1: General and definitions                                                                                                                                                                          |
| ISO 7240-11          | Fire detection and alarm systems - Part 11: Manual call points                                                                                                                                                                              |
| ISO 7240-12          | Fire detection and alarm systems - Part 12: Line type smoke detectors using a transmitted optical beam                                                                                                                                      |
| ISO 10418            | Petroleum and natural gas industries - Offshore production installations - Analysis, design, installation and testing of basic surface process safety systems                                                                               |
| ISO 13702            | Petroleum and natural gas industries - Control and mitigation of fires and explosions on offshore production installations – Requirements and guidelines                                                                                    |
| NFPA 72              | National Fire Alarm and Signaling Code                                                                                                                                                                                                      |

**Total General Specifications**

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

| Reference     | Title                                                          |
|---------------|----------------------------------------------------------------|
| GS EP ELE 079 | Electrical Apparatus for potentially explosive gas atmospheres |
| GS EP INS 101 | Instrumentation Design                                         |
| GS EP INS 134 | Design and supply of integrated, control and safety systems    |

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| Reference     | Title                                                                                                          |
|---------------|----------------------------------------------------------------------------------------------------------------|
| GS EP INS 143 | Fire and Gas detectors and associated detection systems                                                        |
| GS EP INS 198 | Safety and Fire & Gas Standard Functions                                                                       |
| GS EP PLR 104 | Onshore pipeline systems                                                                                       |
| GS EP SAF 050 | Fire and Gas System and Fire Extinguishing System for Packaged Rotating Machinery Enclosures                   |
| GS EP SAF 216 | Area Classification                                                                                            |
| GS EP SAF 221 | Safety rules for buildings                                                                                     |
| GS EP SAF 222 | Safety requirements for turbines, diesel engines, gas engines and process units in sheltered or enclosed areas |
| GS EP SAF 253 | Impacted areas, restricted areas and fire zones                                                                |
| GS EP SAF 261 | Emergency Shutdown and Emergency Depressurisation (ESD & EDP)                                                  |
| GS EP SAF 361 | SIL assignment                                                                                                 |
| GS EP SAF 380 | Safety engineering requirements for an F(P)SO                                                                  |
| GS EP SAF 521 | Safety specific requirements for LNG onshore liquefaction plants and export                                    |

### 3. Terms and definitions

There are three types of statements in this General Specification: “shall”, “should” and “may”. They shall be understood as follows:

**Shall** Is to be understood as mandatory. Any deviation from a “shall” statement requires a derogation approved by the Company.

**Should** Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide a similar level of protection and this shall be documented.

**May** Is used where alternatives are equally acceptable.

For the purpose of this document only, the following terms and definitions apply.

**Addressable detectors** An addressable system gives each detector an individual number, or address. These systems allow the exact location of an alarm to be plotted on the control panel.

**ALD** Acoustic Leak Detector

**Company** Total Exploration & Production or Total E&P affiliates

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|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ESD</b>                             | Emergency Shut-Down                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Failure of equipment</b>            | Malfunctioning of equipment, hardware or software related to an external factor (power cut, mechanical damage, cable rupture, etc.). (Company)                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Fault of equipment</b>              | Malfunctioning of equipment, hardware or software related to an internal factor (device breakdown, error, drifting, virus, etc.) (Company).                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Fire&amp;Gas System (FGS)</b>       | <p>A centralised electronic programmable safety instrumented system comprising I/O cards, relays, CPU, logic, voting, human machine interface, etc. in accordance with <b>GS EP SAF 261</b>, and <b>GS EP INS 134</b>. Objectives are to:</p> <ul style="list-style-type: none"> <li>• Provide continuous automatic monitoring functions to alert personnel of the presence of a hazardous fire or gas condition.</li> <li>• Allow executive actions to be initiated manually or automatically in order to minimize the likelihood of escalation. (Company from <b>ISO 13702</b>)</li> </ul> |
| <b>Fire loop</b>                       | Pneumatic control line containing temperature-sensing elements which, when activated, will initiate control actions in response to a hazardous situation. Examples of temperature-sensing elements are: fusible plugs, synthetic tubing, etc. ( <b>ISO 10418</b> )                                                                                                                                                                                                                                                                                                                           |
| <b>HPU</b>                             | Hydraulic Power Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>ICSS</b>                            | Instrumented Control and Safety System which includes the ESD system, PSS, FGS and PCS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>IMO</b>                             | International Maritime Organisation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>LFL (Lower Flammable Limit)</b>     | Lower concentration of gas (by volume and expressed in percentage) in a gas-air mixture that will form an ignitable mixture. (API, NFPA)                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Manual (Alarm) Call point (MAC)</b> | Device for the manual initiation of an alarm. ( <b>ISO 7240-1</b> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>PB</b>                              | Push-Button                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>PCS</b>                             | Process Control System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>PFD</b>                             | Probability of Failure on Demand. (Company)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>PSS</b>                             | Process Safety System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Safe State of equipment</b>         | No hazardous condition, i.e. the detection equipment is working correctly, no fire is detected, or gas concentration is below trip threshold value (Company).                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Safety Action</b>                   | Executive actions by the Fire&Gas System as per Cause & Effect matrix (Company).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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| <b>SIF</b>                            | Safety Instrumented Function ( <a href="#">IEC 61511</a> )                                                                                                                                                                                                                                         |
| <b>Threshold Limit Value (TLV)</b>    | Short Time Exposure Limit (STEL): used to quantify short term exposure of personnel to toxic gas (minimum of 4 exposures per day of less than 15 min each).<br><br>Time Weighted Average (TWA): used to quantify continuous exposure of personnel to toxic gas (8 hours a day or 40 hours a week). |
| <b>Trip State</b>                     | Hazardous condition, i.e. fire is detected, or gas concentration is at/above trip threshold value, causing an automatic executive action (Company).                                                                                                                                                |
| <b>T<sub>50</sub>, T<sub>90</sub></b> | Time interval between the moment when it is subject to a gaseous atmosphere and the moment when the indication reaches 50 % or 90 % of the final indication.                                                                                                                                       |
| <b>WHSP</b>                           | Well-Head Shut-in Pressure                                                                                                                                                                                                                                                                         |

## 4. Installation and design requirements

The Fire&Gas system is designed, located or protected to be available in all emergencies.

### 4.1 Environmental and climatic conditions

A dedicated specification for each project shall define the indoor and outdoor environmental characteristics of the site, equipment and installations to be monitored.

Range of operability of Fire&Gas detectors shall be in line with the environmental and climatic conditions (temperature, humidity...). To face any gaps, protective measures can be installed (shadows on sensors in case of excess of temperature or solar radiation, tracing in case of arctic conditions, tight weather protection for rain and deluge...).

### 4.2 Area classification and electrical certification (Company concept)

All electronic Fire&Gas sensors and final elements installed in a hazardous area, defined as per [GS EP SAF 216](#), shall be certified ATEX or IECEx as per [GS EP ELE 079](#) requirements for use in:

- Zone 1, Gas Group IIA, Temperature Class T3, by default, or more stringent Gas Groups or zone if required by hazardous area classification
- Zone 1, Gas Group IIC, T3, in case of hydrogen (e.g. battery rooms).

Refer to [GS EP INS 101](#) for more details on permitted Ex types and ATEX / IECEx categories.

For reasons of standardization, indoor Fire&Gas detection equipment may be identical brand and model as the Ex-certified Fire&Gas detection equipment installed outdoors, with the exception of that smoke and fire detectors installed in living quarters and being part of an addressable fire detection system may be non-Ex-certified.

### 4.3 SIL Certification

The value by default of the required SIL for Fire&Gas loops shall be minimum 2.

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SIL assignment for Fire&Gas loop may be carried-out during Basic Engineering to validate or not this value by default (refer to **GS EP SAF 361** for the methodology). Then, if assigned SIL value is higher than the value by default, the SIL shall be adjusted accordingly; if not, the value may be lowered or kept equal to the value by default.

Refer to **GS EP SAF 261** for more details on reliability requirements on logic solver and SIFs.

All suppliers's reliability certificates shall be certified by a Company approved third party (e.g. TÜV, EXIDA, SIRA...).

#### 4.4 Application limit of addressable type detection systems

Only non-addressable type detectors/systems shall be used for (automatic) executive actions by the main Fire&Gas/ESD systems. Therefore fire detected by an addressable type system shall be interfaced with the main Fire&Gas/ESD systems, which further controls (automatic) executive actions (via hardwired links exclusively), refer to **GS EP INS 134**.

As per **GS EP INS 134**, addressable type detectors/systems comprises of a network of addressable smoke, heat and MAC loops reporting back to a central control unit and shall only be used for fire detection in residential buildings (e.g. living quarters or technical building inside residential buildings), in which case the addressable system shall be SIL-2 certified.

In case of floating production facilities for which the IMO classification rules stipulate the installation of an addressable fire detection system in any room part of the living quarters or hull, then an additional certification by the applicable IMO classification body shall be provided.

Addressable type systems shall have their own dedicated operator panel, but shall also be connected to the PCS (Process Control System) system for alarm announcement on the CCR (Central Control Room) operator work stations and for event recording (via redundant serial communication link). It shall not compromise reliability (see section 4.4) and availability.

Refer to **GS EP SAF 050**, for addressability requirements dedicated to packaged rotating machinery enclosures.

### 5. Selection and implementation of detectors

#### 5.1 General

The type of Fire&Gas detectors shall be selected upon the characteristic phenomena of combustion, its kinetics, the type of gas to be detected (heavier or lighter than air), toxicity and/or flammability issues and of the predictable initial leak in the monitored zone.

The flammable gas detection function shall be totally separated from the toxic gas detection function (if the fluid is a mixture of toxic and flammable compounds, then two types of detectors shall be installed. No deduction shall be done on the basis of one activated type of detection concerning the potential concentration released of the other). Detection of toxic gases is intended to protect personnel, the main concern for E&P facilities is H<sub>2</sub>S.

Appendix 1 lists the classification and type of detectors.

#### 5.2 Location

Fire&Gas system shall be provided in accordance with the requirements of the Fire&Gas philosophy. This document describes the expectations to which the Fire&Gas system shall

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respond, based on the strategy being selected, site/lay-out constraints, operability and environmental conditions.

The type and location of detectors shall be based on:

- Relevant accidental scenarios identified in the safety studies as well as on their potential consequences (Dispersion, fire envelopes...)
- Heat and material balances
- Development kinetics of these scenarios and detectors response times
- Lay-out of the installation via 2-D drawings
- Structural arrangements via the 3-D model (Walls, partitions, obstructions, obstacles, topography etc.) which could allow gas or liquid to accumulate
- Environmental conditions (Prevailing wind speed and direction, local atmospheric conditions: sand/dust/rain ingress or accumulation)
- ATEX zones and ignition sources identification
- Indications given throughout this General Specification and Appendices 1 and 3
- Accessibility issues
- Manufacturer's recommendations (Adequate supports to cope with potential vibrations, linear gas detection to be protected against heavy rains, potential pollution protections...)
- Good engineering practices (Typical applications refer to tables 1 and 5) and common sense
- Locations to be validated with mapping studies during detailed engineering phases (Refer to section 6)

### 5.3 Fire&Gas function response time

Automatic actions shall be compatible with the development kinetics of the studied incident. Then, response times of detectors', logic solver's and final elements' need to be assessed carefully. To satisfy this principle, detection located as closed as possible from the leak sources is the preferred means of detection so that, afterwards, manual or automatic actions remain feasible and efficient.

The response times of combustible gas detectors, whether catalytic or IR, are set out in standard [BS EN 61779-4](#). They concern the minimum performance expected from the apparatus to be certified. For this standard,  $T_{50}$  is 10 s and  $T_{90}$  is 30 s.

Typical response time, i.e. the time interval between the start of the phenomena (fire-smoke-gas) and the time when the response reaches a stated indication, are:

- For heat detectors  $\leq 5$  minutes
- For smoke detectors  $\leq 2$  minutes
- For flame detectors  $\leq 10$  seconds
- For electro-chemical  $H_2S$  detectors  $< 30$  seconds
- For semi-conducteur  $H_2S$  detectors  $< 1$  minute

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Typical response time, i.e. the time interval between the contact of the gas with the detector and the time when the response reaches a stated indication, are:

- For gas detectors in HVAC < 60 seconds
- For flammable gas detectors <10 seconds

#### 5.4 Fire detectors selection

Fire detectors shall be selected and located as per Table 1.

Any deviation to the below list shall be done via a formal derogation to Company.

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**Table 1: Selection and implementation of fire detectors**

| Type of detector           | Technology                                                                                  | Typical application                                                                                                                                                                                                                                                                                                                                                                | Comments                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Point heat detectors       | Thermostatic detector (RDH) <sup>(1), (4)</sup>                                             | Workshops, HVAC rooms, HPU, gas turbines enclosures / unit rooms <sup>(2, 3)</sup> , gas or diesel engines enclosures / unit room <sup>(2, 3)</sup> or above transformers<br><br>Normally not used in battery rooms, electrical rooms and instrumentation rooms.                                                                                                                   | Threshold set normally between 50°C and 80°C. Only used for SD-3 fire alone.<br><br>Strong ventilation (>12 vol air change/hour) may interfere on the detectors performances.                                                                                                                                                                                                   |
|                            | Thermovelocimetric (rate-of-rise) bimetallic blade type detector (RDHR) <sup>(1), (4)</sup> | Workshops, HVAC rooms, HPU, gas turbines enclosures / unit rooms <sup>(2, 3)</sup> , gas or diesel engines enclosures / unit room <sup>(2, 3)</sup> , kitchens, and, in areas with high ambient temperatures and where temperature variation is not expected in normal operating conditions<br><br>Normally not used in battery rooms, electrical rooms and instrumentation rooms. | Normally more than 5°C/min.<br><br>Strong ventilation (>12 vol air change/hour) may interfere on the detectors performances.                                                                                                                                                                                                                                                    |
| Linear type heat detectors | Fusible plugs <sup>(5)</sup>                                                                | Around production equipment (horizontal or vertical vessels, heat exchangers...) as well as wellheads areas...<br><br>For more details, refer to list in Appendix 2.                                                                                                                                                                                                               | <b>Pressure detection installed in a 2oo3 voting configuration is required for ESD-1 level executive actions.</b> Pressures sensors for fusible plug loops shall be analogue pressure transmitters.<br><br>Refer to Appendix 2 for more details.<br><br>The use of fuel gas or hydraulic oil for fusible loop instead of air on remote installations requires Company approval. |