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Guidance on Practice for Fire and Gas Detection

GP 30-85

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 30-85. This Guidance on Practice (GP) is based on parts of heritage documents from the merged BP companies as follows:

Amoco

A PS-F&GD-00-E	Process Safety—F&G Detection and Alarm Equipment—Engineering Specification, May 1997.
A PS-F&GD-00-G	Process Safety—F&G Detection and Alarm Equipment—Guide, May 1997.
A PS-F&GD-FDA-P	Process Safety—F&G Detection and Alarm Equipment—Fire Detection and Alarms—Supply Specification, May 1997.
A PS-F&GD-GD&A-P	Process Safety—F&G Detection and Alarm Equipment—Gas Detection and Alarms—Supply Specification, May 1997.

BP (pre 1999)

RP 30-7	Design Philosophy for Fire and Gas Detection and Control Systems, February 1994.
GS 130-10	Guidance for Specification 130-10, Specification for the Supply of Fire & Gas Systems, January 1994.

BP Exploration

SPR/G/97/005	Guidance on F&G Detection, SPR Operational Integrity Team, General Requirements, Part 1, April 1997.
SPR/G/97/005	Guidance on F&G Detection, SPR Operational Integrity Team, Setting Performance Requirements, Part 2, April 1997.
SPR/G/97/005	Guidance on F&G Detection, SPR Operational Integrity Team, Detector Specification, Part 3, July 1997.
SPR/G/97/005	Guidance on F&G Detection, SPR Operational Integrity Team, Audit & Inspection, Part 6, April 1997.

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1. Scope

- a. This GP provides guidance on practice for fire and gas (F&G) detection for BP facilities including:

- 1. Required performance.

There are no recognised national or international codes or standards that cover the performance specification of F&G detection systems.

- 2. Selection.
- 3. Design.
- 4. Installation.
- 5. Operation.
- 6. Maintenance.
- 7. Audit of system designs and installations.

- b. This GP does not cover detection by analysers. Refer to ETPs in ETP document category 31 for information on analysers.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GP 12-60	Guidance on Practice for Hazardous Area Electrical Installations.
GP 30-45	Guidance on Practice for Human Machine Interface for Process Control.
GP 30-75	Guidance on Practice for Safety Instrumented Systems (SIS) – Management of the Safety Lifecycle.
GP 30-76	Guidance on Practice for Safety Instrumented Systems (SIS) – Development of the Process Requirements Specification.
GP 30-80	Guidance on Practice for Safety Instrumented Systems (SIS) – Implementation of the Process Requirements Specification.
GP 30-81	Guidance on Practice for Safety Instrumented Systems (SIS) – Operations and Maintenance.
GIS 30-851	Guidance on Industry Standard for Fire and Gas Detection.

British Standards Institute (BSI)

BSI BS 5839 Part 1	Fire detection and alarm systems for buildings.
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International Electrotechnical Commission (IEC)

IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems – Parts 1 to 4.
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National Fire Protection Association (NFPA)

NFPA 72

National Fire Alarm Code.

3. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:

100N

One out of (100) the number (N) of detectors or circuits in the voting group in a specific area is in alarm.

1002d

One out of (100) the number (N, in this case $N = 2$) of detectors or circuits in the voting group is in alarm, and a different detector or circuit in the same voting group is in fault condition.

200N

Two out of (200) the number (N) of detectors or circuits in the voting group are in alarm.

Blockage ratio

Proportion of unobstructed area on all the boundary faces of a volume. For example, an enclosed box has a blockage ratio of 1.0.

4. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

BS	British standard.
ESD	Emergency shutdown.
FPSO	Floating production, storage and offloading (vessel).
LEL	Lower explosive limit.
LFL	Lower flammable limit.
OD	Outside diameter.
RHO	Radiant heat output.
SIL	Safety integrity level.
STEL	Short-term exposure limit.
TWA	Time weighted average.
UEL	Upper explosive limit.
UFL	Upper flammable limit.
VESDA	Very early smoke detection apparatus. (VESDA is a registered trademark of Vision Systems. Mention of the VESDA name in this GP should not be inferred as a preference for this product over other similar products).



The pair of terms LEL and LFL and the pair of terms UEL and UFL are practically interchangeable. They are all units of measurement for gas flammability. The terms LFL and UFL are more common in the Americas, and LEL and UEL are more common in Europe.

5. General

5.1. Legislative regulations, local codes, and standards

- a. If F&G legislative requirements for an area conflict with guidance given in this GP, legislative requirements shall take precedence.

In practice, this is not usually an issue. Legislation generally only mandates that a detection system be provided and does not dictate the quality or sensitivity of the detection system.

- b. F&G detection equipment shall comply with local codes and standards.

No national or international standards that cover the requirement for F&G detection at BP facilities are available at the time of creating this GP. For offshore installations, ISO 13702 provides guidance in the broader subject of control and mitigation of fires and explosions and ISO 10418 (2003 version) provides guidance on emergency support systems including fire and gas detection systems.

- c. Specification of performance requirements should include expectations and assumptions of:
 1. Facility management.
 2. Risk assessors.
 3. Safety teams.
 4. Maintenance crews.
 5. Auditors.
 6. System designer.

5.2. Safety management

Processes for competency of people, planning activities, documentation and verification should be in accordance with GP 30-75. GP 30-75 shall be followed if any of the F&G detection functions require SIL 1 or higher integrity.

5.3. Specifier role

- a. Specifiers of F&G system performance requirements should have the following capabilities:
 1. Be experienced in design of F&G detection systems.
 2. Have a familiarity with other engineering disciplines (in particular, process, electrical, and instrumentation) and how they interact with one another.
 3. Have an understanding of site operations.
- b. Specifiers shall ensure that F&G detection systems comply with:
 1. Local codes and standards.
 2. Safety requirements for the site.



Compliance with local codes and standards is important. However, the specifier's role is to ensure that the performance of the F&G detection system complies with the safety requirements for the site and not just the minimum to comply with code.

- c. Specifier's role shall include coordination and communication.
- d. Required level of performance for all parts of the F&G detection system shall be recorded on sheets, such as those provided in Annex A.

5.4. Performance

- a. The following shall be reviewed and recorded to determine F&G performance requirements:
 - 1. Legislative requirements for F&G detection.
 - 2. Operator expectations for the system. This review should include a discussion of hazards in terms of damage they can cause, such as:
 - a) Size of fires.
 - b) Time to escalation.
 - c) Tolerable levels of damage.
 - 3. Integrity levels determined in accordance with GP 30-76, claims of safety studies, and any other claims for F&G detection system performance.

These claims are often discussed in terms of outcomes and probabilities for successful risk reduction.

- b. Default performance levels to be used for assigning performance requirements for each part of the site shall be specified, including any interactions with other mitigation measures (for example, ESD and blowdown).
- c. The following shall be assigned for each part of the site that requires gas detection:
 - 1. Gas detection risk volume category. Refer to Table 2 for this categorisation.
 - 2. Fire detection grade. Refer to Table 3 for fire detection grade definitions.
 - a) If default values are not appropriate in the judgement of the specifier, special requirements for F&G detection shall be specified.
 - b) Special requirements shall take site-specific risks into account (for example, risks to safety, environment, production, or reputation).

"Good practice" requirements are a straightforward issue. However, "special" requirements can be difficult because they are more subjective.

Special requirements are defined by what consequences BP wants to prevent and how BP expects fire or gas detection to provide confidence that these consequences can be prevented.

5.5. Hazards

5.5.1. General

F&G hazard shall be defined as one of the following:

- a. Flaming fire.
- b. Flammable gas.
- c. Toxic gas.



5.5.2. Flaming fire

Radiant heat output (RHO) should be used to specify fire detection targets for flaming fires. Table 1 compares RHO with flame area for some typical hydrocarbon fires. The measurement is the apparent area of the flame to a bystander, not the flame's base area.

Table 1 - Comparison of RHO and apparent flame area

	10 kW	50 kW	100 kW	250 kW
Gas jet	0,3 m ² (3 ft ²)	1,5 m ² (16 ft ²)	3 m ² (32 ft ²)	7,5 m ² (80 ft ²)
Oil jet	0,25 m ² (2.5 ft ²)	1,3 m ² (14 ft ²)	2,5 m ² (27 ft ²)	6,5 m ² (70 ft ²)
Oil pool	0,5 m ² (5 ft ²)	1,9 m ² (20 ft ²)	4 m ² (43 ft ²)	8,5 m ² (91 ft ²)

The base area of a fire is not a good measure of the damage a fire can do. A small premixed propane torch flame, for example, can be much more aggressive than a larger diffusion flame. For this reason, BP defines a fire hazard by its RHO. RHO is a good indication of the potential damage and the probability that a fire will escalate or cause loss.

5.5.3. Flammable gas**5.5.3.1. General area coverage**

- In areas sufficiently confined or congested, flammable gas hazards should be defined by their size based on the gas type and geometry of the area in terms of the confinement and congestion.
- Stoichiometric concentration should always be assumed, and the gas cloud specified in terms of a sphere.

The consequence of an explosion can either be direct loss and damage through blast, or escalation through further releases caused by pressure pulses that can move pipes or even large vessels and wind effects that can hurl missiles. These events are unlikely to occur if the flame speed is below about 100 m/s (330 ft/s).

In the same way that an athlete performing long jumps needs a runup to reach takeoff speed, the flame front of an explosion needs a space in which to accelerate. For many types of gases (typically alkanes) that BP handles at upstream facilities and the geometry of BP plants, the minimum acceleration distance is about 5 m to 6 m (16 ft to 19 ft), even if assuming perfect combustion.

5.5.3.2. Nonhazardous spaces

In areas containing electrical apparatus that have not been assessed as hazardous (as defined by relevant national or international standards) and are supplied by mechanical ventilation for overpressurisation, the hazard is from gas ingress via the ventilation system.

5.5.3.3. Perimeter monitoring

Gas hazards that may result from ignition of gas that has migrated from large unconfined and uncongested areas containing hydrocarbon handling equipment shall require detection of significant gas volumes leaving the handling area.

Examples of such application would be onshore gas terminals or refineries. The base area of most offshore installations would generally be too small for perimeter detection to be effective.

5.5.4. Toxic gas

Toxic gas hazard performance requirements shall be specified in terms of concentration and response time.



Toxic gas effects are directly linked to concentration, and for some gases, exposure time.

6. Fire detection performance

6.1. General

The method described below is based on many years experience gained at many facilities. The method tailors detection requirements to the type of hazard and levels of risk on a site, and is strongly linked to workforce expectations and major risk reduction requirements. The process is summarised in Figure 1.

- a. Fire detection requirements shall be determined using the process defined in Figure 1.
- b. Legislative requirements for automatic fire detection shall be established.
- c. Site shall be divided into areas for the purpose of determining level of fire detection.
- d. Required fire sensitivity levels shall be defined for the site.
- e. Areas shall be assigned grades according to defined criteria.
- f. Areas shall be assessed to determine where fire detection could reduce risk of personnel exposure to fire.

Area assessment is normally performed through formal safety studies.

- g. Potential losses from fire damage shall be assessed in terms of plant replacement or lost production costs. Determination of how automatic fire detection could reduce such losses shall be made.
- h. Risks shown in Table 2 should be used to determine the need for and quality of fire detection.
- i. Fire detection grading should be performed as follows:
 1. A risk classification shall be assigned to each area.
 2. A protection grade shall be assigned to each area.

Fire detection requirements for an area are determined by the risk in that area, and defined by the grade of protection required.

6.1.2. Grading basis

Areas within a site shall be assigned a grade based on the following factors:

- a. Legislative requirements for automatic fire detection that apply to the site.
- b. Safety studies.
- c. Required fire sensitivity level.
- d. Fire risk category.
- e. Type of area, including:
 1. Hydrocarbon handling area.
 2. Nonhydrocarbon-handling area.
 3. Special risk area.
- f. Purpose and use of the area, including:
 1. Human occupation.
 2. Turbines and other engines.



3. Special equipment.
4. Ventilation air intake.

6.1.3. Legislative requirements

Legislative requirements that apply to the site shall be recorded and applied to the grading process.

6.1.4. Safety studies

Previous site safety studies shall be examined and applicable results incorporated into the grading process.

6.2. Fire sensitivity levels fire risk analysis

- a. A fire risk analysis for the site should be performed to determine fire sensitivity levels of Low, Medium, and High.
- b. Sensitivity levels should be set relative to the type of site.

For example, a fire of sufficient heat output to damage 6 mm (0,25 in) OD instrument tubing may have no effect on 0,9 meter (36 in) heavy wall pipe.

- c. Fire risk analysis should be based on one or more of the following:
 1. Qualitative analysis based on experience of fire risk analysis.
 2. Site-specific safety studies.
 3. Project-specific safety studies.

6.3. Fire risk categories

A fire risk category shall be assigned to each area of the site in accordance with Table 2.



Table 2 - Fire risk categorisation

Damage replacement cost level (L)	Cost of lost production	Possibility of operator action to reduce consequences	Risk category
Minor (L1)	Minor (F1)	Possible (P1)	0
		Unlikely (P2)	1
	Major (F2)	Possible (P1)	1
		Unlikely (P2)	2
Moderate (L2)	Minor (F1)	Possible (P1)	1
		Unlikely (P2)	2
	Major (F2)	Possible (P1)	2
		Unlikely (P2)	2
Major (L3)	Minor (F1)	Possible (P1)	2
		Unlikely (P2)	2
	Major (F2)	Possible (P1)	2
		Unlikely (P2)	2

Notes

1. Fire Risk Category 0 requires no automatic fire detection.
2. Examples of Fire Risk Category 1 include onshore gas terminals, oil refineries, and chemical plants.
3. Examples of Fire Risk Category 2 include offshore platforms, FPSOs (Floating Production, Storage, and Offloading units) and onshore enclosed production plants.
4. Facilities may justify changes to these values with risk-based assessments.

6.4. Area types and use

6.4.1. Hydrocarbon handling areas

- An area shall be classified as a hydrocarbon handling area if it contains any item in the facility intended to process, convey, consume, or store hydrocarbon fluids (for example, oil, gas or condensates, and fuel gas).
- Areas containing significant quantities of flammable utility fluids (for example, diesel fuel, and methanol) shall also be included as hydrocarbon handling areas.
- Exceptions to classification as a hydrocarbon handling area are:
 - Pipework (except for vessels) outside the boundary of production, process, drilling, utility, or accommodation areas.
 - Turbine enclosures and other similar machinery enclosures that are described separately.

Note that NFPA 30 (the Flammable and Combustible Liquids Code) uses different and stricter definitions of the words “combustible liquid” and “flammable liquid”.

6.4.2. Nonhydrocarbon handling areas

Nonhydrocarbon handling areas shall be enclosed spaces other than those designated as hydrocarbon handling areas and that have one of the following characteristics:

- Is normally occupied.
- Contains machinery or electrical and electronic equipment.
- Contains significant inventory of flammable materials.



- d. Is a designated escape route that could be affected by one of the above (even if it contains no fire hazard of its own).

6.4.3. Special risk areas

6.4.3.1. General

The following area types shall be classified as special risk:

- a. Enclosures for turbines, other engines, and similar machinery.
- b. Ventilation air intakes.
- c. Areas that require fire detection, but to which no other previously defined area type applies.

6.4.3.2. Turbine engine machinery enclosures

Machinery enclosures require early fire detection if either of the following applies:

- a. Fires in the enclosure would be difficult or dangerous to control.
- b. The type of fire that could occur may quickly lead to unacceptable damage or loss.

Examples of this type of fire are if a fire could be particularly aggressive (high-pressure fuel or lubricating oil fires) or if equipment in the enclosure is easily damaged and critical (fire pumps or analyser houses).

6.4.3.3. Ventilation air intakes

- a. Ventilation air intake areas shall include air intakes that supply one of the following:
 - 1. Personnel.
 - 2. Plant areas that require monitoring.
- b. Air intakes that require incoming air to be monitored for the protection of the facility or personnel within the area shall have smoke detection fitted.
- c. Applications that require toxic gas and fire detection on air intakes shall have fire detection performance requirements specified in terms of:
 - 1. Smoke concentration.
 - 2. Toxic gas concentration.
 - 3. Required response time.

6.4.4. Areas requiring no detection

If fire detection is not required in an area, the reason shall be documented.

Changes in the facility (for example, new storage of flammable materials) may later invalidate that decision.

6.5. Grade definitions

6.5.1. General

Fire detection grades shall be assigned to areas in accordance with Table 3.

