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GP 30-85

Fire and Gas Detection

Group Practice

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This revision of Engineering Technical Practice (ETP) Group Practice (GP) GP 30-85 includes the following significant changes since the 2008 issue (requirements have been simplified and made more explicit, which should result in greater consistency in implementation of fire and gas [F&G] detection):

- a. Reference to radiant heat output (RHO) of fires as the basis for specifying flame detector performance has been changed to specifying as multiples of detection sensitivity in accordance with the FM 3260 standard 1 ft² (0,1 m²) n-heptane pool fire, closely approximating the previous RHO based detection sensitivity of 10 kW minimum fire size to be detected in Grade B areas on offshore and onshore enclosed facilities. This change was made because of feedback that the translation from RHO requirements to detector specification and layout was difficult to make.
- b. The basis for fire grading has been simplified and made more explicit. The previous Grades A and B have been combined into the new Grade B. Grade definitions for Grades B and C have been specified more clearly than in previous issues. It was previously a rather subjective process.
- c. Flame detector effective distance has been added to explicitly take account of reduced sensitivity due to automatic response to false alarm stimuli, dirty optics, and reduced detection distance away from the centreline of the field of view.
- d. Smoke detection for sleeping areas depends on the predominant fire risk in those areas.
- e. The detection target for gas releases has been changed from gas cloud sizes to what will be achieved by specified spacing of point detectors set to alarm at 20% lower explosive limit (LEL) or open path gas detectors set to alarm at 1 LEL.m. This change was made because most gas releases form plumes and not spherical gas clouds, and the relationship between plume shaped clouds and detection effectiveness is probabilistic, rather than deterministic, dependent on size and direction of release.
- f. Duplication has been reduced by removing some performance related content from 5 and incorporating in 6, 7, or 8.
- g. Some “should” requirements have been upgraded to “shall” statements.
- h. Examples and background information are provided in annexes.

Because of the extent of changes, revisions are not identified by a bar in the margin as is normal practice.

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1. Scope

- a. This GP provides requirements for performance, selection, design, installation, operation, maintenance, testing, and review of system designs and installations for F&G detection for BP facilities.

There are no recognised national or international codes or standards that cover the performance specification of F&G detection systems in terms of sizes and types of fires and gas releases.

- b. A detailed fire and explosion analysis that has been performed for the facility may be used for defining fire and gas detection performance requirements in place of respective parts of 6 and 7.
- c. Detection by process analysers and portable gas detectors is not covered in this GP. Refer to category 31 ETPs for requirements on analysers.
- d. Fire protection systems, such as deluge and explosion suppression systems, are also not covered in this GP. Refer to category 24 ETPs.
- e. The purpose of fire and gas systems is to reduce the risk to people, the environment, and the business, due to:
 1. Fires and smoke.
 2. Release of flammable fluids.
 3. Release of toxic fluids.
 4. Accumulation of asphyxiants.
- f. A fire and gas detection system performs three functions:
 1. Detect - monitor for fires and potentially hazardous releases or accumulations.
 2. Alarm - initiate alarms to alert personnel to take appropriate response.
 3. Protect - initiate signals that drive effective actions, manual or automatic, which reduce escalation and/or minimise loss.
- g. These systems do not prevent releases, fires, or explosions, but they are typically one of a series of protection systems in place to manage risk.

2. Normative references

The following referenced documents may, to the extent specified in subsequent clauses and normative annexes, be required for full compliance with this GP:

- For dated references, only the edition cited applies.
- For undated references, the latest edition (including any amendments) applies.

BP

GIS 30-851	Fire and Gas Detection.
GP 10-30	Hydrogen Sulphide and Hazardous Materials in Well Operations.
GP 24-20	Fire and Explosion Hazard Management of Offshore Facilities.
GP 24-21	Fire Hazard Analysis.
GP 24-22	Gas Explosion Hazard Analysis.
GP 24-40	Fire Protection of Atmospheric Storage Tanks.
GP 30-45	Human Machine Interface for Process Control.



GP 30-47	Alarm System Design and Management (scheduled for 2010 release).
GP 30-60	Automation Systems Digital Security and Integrity.
GP 30-75	Safety Instrumented Systems (SIS) - Management of the Safety Lifecycle.
GP 30-80	Safety Instrumented Systems (SIS) - Specification and Implementation.
GP 30-81	Safety Instrumented Systems (SIS) - Operations and Maintenance.
GP 59-82	Public Address and General Alarm.

FM Approvals LLC (FM)

FM 3260	Flame Radiation Detectors for Automatic Fire Alarm Signaling.
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International Electrotechnical Commission (IEC)

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

NFPA 72	National Fire Alarm Code.
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3. Terms and definitions

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

1ooN

One out of (1oo) the number (N) of detectors or circuits in the voting group in a specific area that is in alarm.

1oo2D

One out of two (1oo2) with diagnostics (D). If both detectors are healthy, this arrangement operates as 2oo2. If a fault is diagnosed on one detector, the arrangement reverts to 1oo1D, with time restrictions on operating in this degraded mode. A diagnosed fault is thus treated as an alarm condition.

2ooN

Two out of (2oo) the number (N) of detectors or circuits in the voting group that are in alarm.

Authority having jurisdiction

Organisation, office, or individual responsible for enforcing the requirements of a code or standard or for approving equipment, materials, an installation, or a procedure (National Fire Protection Association [NFPA] definition).

Blockage ratio

Proportion of obstructed area on all six boundary faces of a volume. For example, an enclosed box has a blockage ratio of 1,0.

An open space with a solid floor has a blockage ratio of 0,17, as one boundary face is completely blocked.

An open space with a grated deck floor above another open space could have a blockage ratio of 0,07.

An offshore module with solid floor and roof and essentially open at the four walls has a blockage ratio of 0,33, if the space is a cube. If the area of the open walls is less than the sum of the areas of the floor and roof, the blockage ratio will be greater than 0,33.



An offshore module with solid floor and roof, two solid walls, and essentially open in the other two directions has a blockage ratio of 0,67, if the space is a cube.

Escalation

Escalation is the condition whereby the effects of the initiating fire or explosion extend to and involve adjacent targets containing sufficient energy to contribute to the original event. This escalation enlarges the area of the incident, thus exposing even more of the facility to the effects of fire and/or explosion. Examples of escalation targets include tanks, vessels, and piping having flammable or combustible contents. Failure of structural steelwork can damage other equipment, thereby causing escalation. In some cases, building or module construction can also be considered an escalation target.

Grade

Classification of part of an area with a defined fire risk and defined specification of fire detection. Designated by letters B, C, D, E, F, S, T, and V.

Heat release rate

Total amount of energy per unit time (kW) that is released by a fire. This energy is made up of the radiant heat output and the convective heat component.

Muster location

Designated place where personnel can muster and survive the effect of a major hazard accident while awaiting evacuation.

Radiant heat output

The total amount of energy per unit time (kW) released by a fire in the form of electromagnetic radiation.

Temporary refuge (TR)

A location (typically in an enclosure or building) that will enable occupants to survive defined major accidents, including fire or blast events.

4. Symbols and abbreviations

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

AWG	American wire gage.
CCTV	Closed circuit television.
CO	Carbon monoxide.
CO ₂	Carbon dioxide.
D	Diagnostics (in a voting group option).
D	Flame detector effective viewing distance.
D _{av}	Detection distance (average).
ESD	Emergency shutdown.
F&G	Fire and gas.
FHA	Fire hazard analysis.



H ₂ S	Hydrogen sulphide.
HCl	Hydrochloric acid.
HCN	Hydrogen cyanide.
HF	Hydrogen fluoride.
HP	High pressure.
HVAC	Heating, ventilation, and air conditioning.
IR	Infrared.
LEL	Lower explosive limit.
LFL	Lower flammable limit.

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 North America, and LEL and UEL are more common in Europe.

LNG	Liquefied natural gas.
LOPA	Layer of protection analysis.
LP	Low pressure.
LPG	Liquefied petroleum gas.
PFD	Probability of failure on demand.
PVC	Polyvinyl chloride.
RHO	Radiant heat output.
SIL	Safety integrity level.
SIS	Safety instrumented system.
STEL	Short term exposure limit.
TLV	Threshold limit value.
TR	Temporary refuge.
TWA	Time weighted average.
UEL	Upper explosive limit.
UFL	Upper flammable limit.
	<i>See comment under LFL.</i>
UV	Ultraviolet.
VESDA	Very early smoke detection apparatus.



5. General

5.1. Legislative regulations, local codes, and standards

- a. If F&G related regulatory requirements conflict with requirements in this GP, the more stringent requirements shall take precedence.

Legislation generally only mandates that a detection system be provided and does not dictate the quality or sensitivity of the detection system. However, in some jurisdictions, regulations require that the system or components be tested and approved or certified by a recognised third party.

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

- *Standards applicable to detector performance include FM 3260, FM 6310, FM 6320, IEC 60079-29-1, IEC 60079-29-4, and ISO 7240-1 through ISO 7240-22.*
- *IEC 60079-29-2 and API RP 14C address gas detector selection, installation, use, and maintenance.*
- *For offshore installations, ISO 13702 provides information in the broader subject of control and mitigation of fires and explosions. ISO 10418 (2003 version) and API RP 14C address emergency support systems, including F&G detection systems.*

5.2. Safety management

F&G detection functions that require SIL 1 or higher integrity shall comply with GP 30-75. There will normally not be any such SIL rated functions except as required by local regulatory expectations.

Normally, F&G systems are not relied on as protection layers in LOPA studies, because they cannot prevent the undesired events being analysed. Also, for escalated events, they are typically not credited with greater than a factor of 10 risk reduction and, so, are below SIL 1. GP 30-80 discourages attempting to determine integrity requirements for F&G systems using LOPA. SIL requirements may be specified by local regulations or authority having jurisdiction.

GP 30-75 provides a framework for competency of people, planning activities, documentation, and verification that may also be used for managing F&G functions that do not have any SIL rating. Detector selection and location can make a greater contribution to detection reliability than hardware reliability that is addressed in SIL rating.

GN 30-751 provides a template for a safety lifecycle plan that could be adapted to F&G systems.

GN 30-752 provides a template for competence requirements and assessment for safety instrumented systems that can be adapted to suit F&G detection.

Appropriate people will need to be trained and be competent in the selection and characteristics of specific detectors and F&G panel equipment to be used.

5.3. Specifier role

- a. Specifiers of F&G system performance requirements shall hold current permits or licences for design of F&G systems, if required by the local authority having jurisdiction.

This is a requirement in some parts of the U.S.



- b. Specifiers of F&G system performance requirements should have the following capabilities or be able to deliver these capabilities through collaboration with other discipline engineers:
 - 1. Understanding of applicable regulatory requirements related to the specification, design, and installation of F&G detection systems.
 - 2. Experience in design of F&G detection systems.
 - 3. Familiarity with other engineering disciplines (in particular, process safety, electrical, and instrumentation) and how they interact with one another.
 - 4. Understanding of facility operations.
 - 5. Familiarity with available detection devices and associated control logic and notification appliances and their capabilities and limitations.
 - 6. Familiarity with fire hazard analysis in accordance with GP 24-21.
- c. Specifiers shall ensure that F&G detection systems comply with:
 - 1. Local codes and standards.
 - 2. BP's approach to managing safety through the Local Operating Management System for the facility including:
 - a) Inherently safer design practices.
 - b) The relationship between F&G requirements and hazard management.

Compliance with local codes and standards is important. However, the specifier role is to ensure that the performance of the F&G detection system complies with BP requirements for the facility and not just the minimum required to comply with code.
- d. Specifier role shall include coordination with other disciplines and, for operational facilities, consideration of operating expertise and any concerns of operating personnel.
- e. Required performance for all parts of the F&G detection system shall be recorded.

Example record forms are provided in Annex A. Example completed record forms are provided in Annex B.

5.4. Performance

- a. This GP provides a default process for establishing F&G system performance, but the following shall take precedence:
 - 1. Regulatory requirements for F&G detection.
 - 2. Functional requirements determined by fire and explosion hazard analysis, including the following:
 - a) Flammable gas detector spacing.
 - b) Size of fires to be detected.
 - c) Actions to be taken manually or automatically in response to alarms.

GP 24-10, GP 24-20, and GP 24-21 address fire hazard analysis. GP 24-22 addresses vapour cloud explosion hazard analysis.

Fire and explosion hazard analyses take account of specific equipment, hazards, and environment of a facility that can mean reduced or increased numbers of F&G detectors compared to the default method in this GP.



This GP sets the severity of annunciated F&G events such that manual and/or automatic response can be taken to prevent escalation, while also minimising unwanted alarms and automatic control actions.

3. Functional requirements for detection of toxic and asphyxiant gases determined from health assessments.
4. Reliability requirements that have been determined from other safety studies.

The reliance placed on F&G systems, particularly for managing risks to people and the environment, is usually low, such that there may not be any SIL rated F&G functions or that they may be limited to a few specific applications, including gas ingress to ventilation systems for accommodation areas. This is because F&G systems cannot prevent the initial event, and people not affected by the initial event can usually get away from the area before escalation leads to more severe consequences. There is not an industry agreed method or approach for determining required reliability of F&G functions.

5. Requirements for F&G detection systems to be able to survive a major incident.

An example of a survivability performance standard: the proper location and protection of the F&G control and logic panel will ensure that it can continue to function for the duration of credible major incidents.

- b. F&G detection performance requirements for each part of the facility should include interactions with other mitigation measures (e.g., ESD and blowdown) that are developed as part of the hazard management programme.

6. Fire detection performance

6.1. General

Fire hazards include heat, smoke, and other products of combustion from smouldering or flaming fires.

In the context of this GP, fire detection means by fire detection devices without reliance on or taking credit for manual detection of fires by people.

6.1.1. Objective

- a. The main objective of fire detection is to detect fires as early as practical to minimise immediate consequences and prevent escalation. Detection enables action to be taken manually or automatically to:
 1. Isolate the fuel source, if safe to do so, to minimise fire size and risk to personnel, the environment, and damage to the facility.
 2. Evacuate personnel to safety.
- b. The secondary objective is to achieve this detection:
 1. With minimum unwanted alarms.
 2. At minimum installed cost and operating cost.
- c. This GP addresses detection of fires in the following areas and assigns appropriate grades that have associated performance requirements:
 1. Hydrocarbon processing areas.
 2. Nonhydrocarbon processing areas.
 3. Machinery enclosures.
 4. Ventilation air intakes.

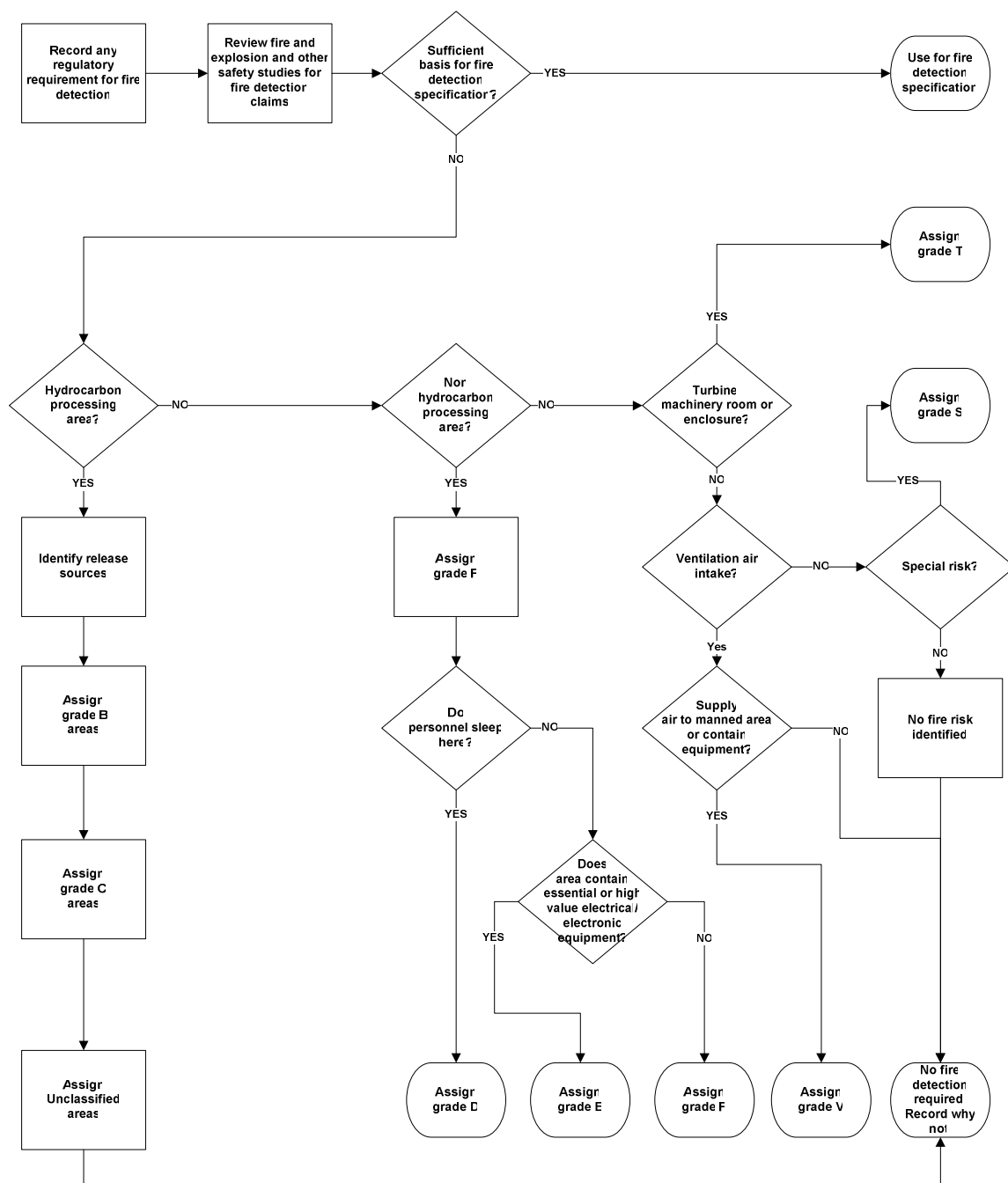


5. Special areas.

6.1.2. Requirement determination

- a. Fire detection requirements shall be determined using the process defined in 6 and summarised in Figure 1, unless they can be established by fire hazard analysis as in 5.4.
- b. Areas within a facility shall be assigned grades based on the factors listed in 6.2.

Figure 1 - Method for setting fire detection requirements



Note: The figure shows a summary and does not necessarily address all cases. The main text is definitive.



6.2. Grade definitions**6.2.1. Grades and areas**

Fire detection grades shall be assigned to areas in accordance with definitions in Table 1.

Table 1 - Fire detection grade definitions

Grade	Area definition
B	Hydrocarbon processing, with normal to high sensitivity.
C	Hydrocarbon processing, with low sensitivity.
D	No hydrocarbons, with protection of human life.
E	No hydrocarbons, with protection of special equipment.
F	No hydrocarbons, with general coverage.
S	Special risk, for which no other grade is appropriate.
T	Special risk, with gas turbine and other engine enclosures.
V	Special risk, with ventilation air intakes.

Because Grade S areas are a special case, each Grade S area has its own definition.

6.2.2. Hydrocarbon processing areas - Grade B and Grade C

- a. An area shall be classified as a hydrocarbon processing area if it contains any item in the facility intended to process, convey, or store hydrocarbon fluids (e.g., oil, gas, condensate, or significant quantities of diesel fuel or methanol) but excluding:
 1. Pipework (but not vessels) outside the boundary of production, process, drilling, utility, or personnel accommodation areas.
Such pipework may be on pipe racks and may include flanges and a few tappings for instruments in freely ventilated areas.
 2. Gas turbine enclosures and other similar machinery enclosures that are graded separately.
GP 24-21 includes requirements for scenarios to be addressed in fire hazard analysis.
- b. Grade B shall be assigned to spaces around equipment within hydrocarbon processing areas where fires could cause significant consequences. Initial and escalated fires may be due to any of or a combination of the following:
 1. Fuel (e.g., high pressure gas from a compressor or large volumes of flammable fluids in spill containment areas).
 2. Recognised fire risk (e.g., small bore pipework or single seals on pumps and compressors).
 3. Potential for escalation to more severe consequences.
- c. Grade C shall be assigned to spaces within hydrocarbon processing areas where all of the following apply:
 1. Fuel has flashpoint above 60°C (140°F).
 2. Release pressure is less than 1 barg (14,7 psig).
 3. Liquid fuel pools will have a surface area of less than 50 m² (540 ft²).
- d. Grade C shall also be assigned to spaces, including spaces around equipment, within hydrocarbon processing areas that are less sensitive to fires than Grade B, where some fire protection capability is desired.



- e. Remaining spaces within hydrocarbon processing areas shall be unclassified, provided that both of the following apply:
 - 1. Grade B or Grade C does not apply.
 - 2. They do not contain any significant fuel source.

6.2.3. Nonhydrocarbon processing areas - Grade D, Grade E, and Grade F

- a. An area that is not designated as hydrocarbon processing and is any of the following shall be classified as a nonhydrocarbon processing area:
 - 1. Normally occupied for over 10% of time.
 - 2. Containing machinery or electrical and electronic equipment.
 - 3. Containing significant inventory of nonhydrocarbon flammable materials.

Hydrogen is not a hydrocarbon but is flammable. Compressed oxygen significantly aids the combustion process, and its presence may cause everyday fuels to burn extremely violently.
 - 4. A designated escape route that could be affected by 1. through 3. (even if the area contains no fire hazard of its own).
- b. Grade D shall be assigned to rooms that contain a bed (including medical areas), as well as enclosed escape routes. This performance level protects a sleeping person from a fire in the same cabin or in an adjacent space. If the ventilation system can transfer smoke (either directly or by induction) into escape routes or sleeping areas, these areas should also be Grade D.
- c. Grade E shall be assigned to rooms that contain electrical or mechanical safety equipment or other high value equipment (e.g., ESD and process control system cabinets, emergency power supplies, communication systems, and incident control centres).
- d. Grade F shall be assigned to all other nonhydrocarbon areas for which fire detection is appropriate. This should include public areas (common rooms, offices, etc.), utility spaces (voids, etc.), and areas that contain less valuable equipment (storage rooms for or that contain flammable materials, etc.).

6.2.4. Machinery enclosures - Grade T

Grade T shall be assigned to gas turbine and other machinery enclosures, if either of the following applies:

- a. Fire in the enclosure would be difficult or dangerous to control.
- b. Fire could rapidly lead to unacceptable consequences.

Examples of this are fires that could be particularly aggressive (high pressure fuel or lubricating oil fires) or fires for which equipment in the enclosure is easily damaged and is critical (e.g., fire pumps).

6.2.5. Ventilation air intakes - Grade V

Grade V shall be assigned to spaces with air intakes, if the incoming air needs to be monitored for personnel or equipment protection in the area served by the air supply.

6.2.6. Special areas - Grade S

Grade S shall be assigned to spaces or areas for which none of the default grades in 6.2.2 through 6.2.5 apply, but fire detection is required to manage specific fire hazards.



This could apply, for example, to areas that process flammable nonhydrocarbons in which the risks are different from those in 6.2.2 or from fire pump rooms where no control actions may be required.

6.2.7. Unclassified areas

Unclassified shall be assigned to areas that meet all of the following requirements:

- a. Are not assigned a grade.
- b. Do not contain fuel sources.
- c. Do not require fire detection for any other reason not covered in the grading process.

6.3. Grading process

6.3.1. General

Fire detection grades shall be assigned in accordance with the process in 6.3.2 through 6.3.7.

The process is summarised in Figure 1 but the main text is definitive.

6.3.2. Regulatory requirements

Regulatory requirements that apply to the facility shall be recorded and applied to the grading process.

6.3.3. Safety studies

- a. Previous facility safety studies, such as fire hazard analysis and smoke and gas ingress studies, if available, shall be examined and applicable results incorporated into the grading process.
- b. Studies that have been performed in sufficient detail may form the basis for grading as an alternative to the default process in 6.3.4 through 6.3.7.

GP 24-21 addresses fire hazard analysis and includes assessment methods and tolerability limits for smoke and gas ingress.

6.3.4. Hydrocarbon processing areas Grade B and Grade C

The fire grading process for hydrocarbon processing areas is revised from the less definitive method in the 2008 and 2003 issues of this GP. Grade A and Grade B are merged into Grade B. Further information on the change is included in Annex C.

6.3.4.1. Determination of fire grades

Individual equipment items and specific systems in hydrocarbon processing areas shall be assessed for potential for release of flammable fluids and fire escalation and Grade B, Grade C, and unclassified areas identified in accordance with definitions in 6.2.2.

6.3.4.2. Fire grade area descriptions

- a. Grade B areas should extend at least 2 m (6 ft) from any equipment or associated liquid containment boundary or to a fire zone solid wall boundary, if it is closer.
- b. If this boundary in a. results in a Grade B boundary close to a fire zone boundary, extending Grade B to the fire zone boundary should be considered.

Fire zone boundary is typically a solid wall or a wide open space containing no fire hazards.

- c. Grade B areas should be surrounded by Grade C areas, unless already at a fire zone solid wall boundary.



- d. Grade C areas should extend at least 3 m (10 ft) from any equipment or associated liquid containment boundary or a Grade B area, whichever is the greater, or to a fire zone solid wall boundary, if it is closer.

These area descriptions are illustrated in a fire grading diagram in Annex D.

6.3.5. Nonhydrocarbon processing areas Grade D, Grade E, and Grade F

- a. Initially, Grade F shall be assigned to nonhydrocarbon processing areas (defined in 6.2.3).
- b. Grade F areas shall be reviewed for life protection risks and reassigned as Grade D.
- c. Remaining Grade F areas shall be reviewed for special equipment protection requirements and reassigned as Grade E detection.
- d. Remaining Grade F areas shall be reviewed for places where detection is not required. Reasons that fire detection is not required shall be documented.

Parts of Grade F areas where fire detection may not be required could include larger open spaces in a compound containing machinery.

6.3.6. Special areas Grade S, Grade T, and Grade V

- a. Grade T shall be assigned to gas turbine and similar machinery enclosures where early detection of an internal fire is required because fire would be difficult to control or would have severe consequences.
- b. Grade V shall be assigned to mechanically ventilated spaces with air intakes that require fire detection for protection of personnel or equipment.
- c. Inevitably, there are places in the facility with some fire sensitivity and requiring fire detection that do not fall into one of the other seven grades. Such areas shall be identified and assigned Grade S.

Fire pump rooms could be considered Grade S because, in a fire event, the fire pumps may be required to run until destruction.

6.3.7. Areas without fire risks

Areas with no or insignificant fire risks should not require fire detection, and the reasons for not installing fire detection should be documented.

6.4. Fire detection specification

6.4.1. General

This clause on specification of fire detection applies regardless of the process used for fire grading in 6.3.

6.4.2. Specification of flaming fire hazards

Fire detection targets for flaming fires should be specified in terms of viewing distances obtained from a 1 ft² (0,1 m²) n-heptane pool fire in accordance with FM 3260 and other factors as detailed in 6.4.3.g.

Most flame detectors available globally have been tested and certified in accordance with FM 3260. It specifies a range of tests using different fuels and in the presence of false alarm stimuli. Detection distances and response times should be stated on Vendor datasheets or in manuals or are otherwise available on request from the Vendor. The 1 ft² n-heptane pool fire test is the most frequently quoted benchmark test.

Previous issues of this GP specified fire detection targets for flaming fire in terms of RHO. However, it has been unclear how RHO targets are converted into coverage



requirements by optical flame detectors, and there was inconsistency in application across BP facilities. Background information on the change away from RHO is provided in Annex C. The intent is not to significantly change the resultant number of detectors required at any facility from accepted good practice under previous issues of this GP.

6.4.3. Specification in hydrocarbon processing areas Grade B and Grade C

Fire detection specification of each grade should include:

- a. Flame detection sensitivity. Recommended default maximum viewing distances are stated in Table 2.

See Annex C for background to these values and relationship to RHO.

Table 2 - Default flame detection maximum viewing distances for Grade B and Grade C

	Area grade	Maximum viewing distance relative to D	
		For alarm only	For initiating automatic control action
Onshore open facility	Grade B	1,5 D	Not normally required
	Grade C	4 D	Not normally required
Offshore facility and onshore enclosed facility	Grade B	0,5 D	D
	Grade C	1,5 D	3 D

- b. Coverage factor for Grade B and Grade C areas, with default minimum values as stated in Table 3. This includes loss of view from obstructions and lack of coverage for any other reasons.

Table 3 - Default minimum coverage factors for Grade B and Grade C

Grade	Coverage factor
B	80%
C	70%

- c. Response time from the moment the condition occurs until the correct output signal is given.
- d. Availability, which is a measure of system uptime and accounts for lockout, bypass or override, and downtime for testing and maintenance.
- e. Reliability, which is the probability that fire will be detected and the correct output given. This probability accounts for random equipment failure.
- f. Requirements for manual or automatic control actions that the system should promote (e.g., operator alarms and process shutdowns).
- g. D is the effective viewing distance calculated from parameters X, F1, F2, and F3, as follows:
 1. $D = X \times F1 \times F2 \times F3$.
 2. X = Specified detection distance for a 1 ft² (0,1 m²) n-heptane pool fire under ideal FM 3260 test conditions at the chosen sensitivity setting, if applicable, and to give the required response time. This distance can be obtained from the detector specification, manual, or FM 3260 test report.
 3. F1 = Factor representing reduction in sensitivity to genuine flame in the presence of unwanted alarm stimuli. From the detector manual or, otherwise, from the detector manufacturer, obtain the detection distances at the chosen sensitivity setting for the



FM 3260 tests for a 1 ft² (0,1 m²) n-heptane pool fire in the presence of the following false alarm sources:

- a) Sunlight (direct, modulated, reflected).
- b) Arc welding.
- c) 6 kW heater, modulated at 24,4 m (80 ft) at 3 m (10 ft).
- d) 300 W incandescent lamp, modulated at 0,9 m (3 ft).
- e) 500 W shielded quartz halogen lamp, modulated at 2,4 m (8 ft).
- f) 500 W unshielded quartz halogen lamp, modulated at 2,4 m (8 ft).
- g) 250 W vapour lamp modulated.
- h) Two 34 W fluorescent lamps modulated.

It is planned to publish a Guidance Note, GN 30-851, in 2010 containing F1 factor information for fire detectors commonly used in BP and other specific guidance on makes and models of fire and gas detectors.

4. Take the average detection distance (D_{av}) from these eight tests with a weighting factor of 3 for the sunlight test. This means adding the 8 distances plus twice the sunlight test distance and dividing by 10. If not all of these tests have been performed select a similar number of similar type false alarm source tests, if these specific tests have not been performed. F1 will have the effect of reducing the ideal detection distance X to the midpoint of X and D_{av} . Thus, $F1 = (X + D_{av}) / 2X$.
5. F2 = Factor representing reduction in sensitivity due to dirty optics. Determine from the detector specification or instruction manual the fraction of maximum detection distance at which the dirty optics fault alarm occurs. F2 is the midpoint between this fraction and 1. Thus, if the dirty optics alarm is initiated at 60% of maximum distance, F2 will be 0,8.
6. F3 = Factor representing reduction in sensitivity across the claimed field of view from the maximum at the centreline. A default value of 0,9 should be used, unless a different value is justified from analysis of the detector field of view diagrams for horizontal and vertical planes.

Worked example: The manual for an IR flame detector shows a value of X of 30 m (100 ft) at medium sensitivity.

The average distance during the five unwanted alarm stimuli tests from the manual is 18 m (60 ft), so F1 is 0,8.

F2 is 0,75, as the fault alarm comes in at half the detection range, according to the manual.

F3 is 0,9 as default.

So, $D = 100 \times 0,8 \times 0,75 \times 0,9 \text{ ft} = 16 \text{ m (54 ft)}$.

- h. Coverage factor means the proportion of a Grade B or Grade C volume within the effective field of view of one or more detectors for alarm and the voted number or more detectors for control actions. These are independent of detector viewing distance factors.
- i. If these coverage factors are not achieved, additional detection should be considered.

6.4.4. Specification in nonhydrocarbon processing areas Grade D, Grade E, and Grade F

Fire detection specification should include:

- a. Compliance with an industry standard level of performance, if feasible. Table 4 lists typical detection and performance requirements.



- b. Availability, which is a measure of system uptime and accounts for lockout, bypass or override, and downtime for testing and maintenance.
- c. Reliability, which is the probability that fire will be detected and the correct output given. This probability accounts for random equipment failure.
- d. The need for manual or automatic control actions that the system should promote (for example, operator alarms and unit or process shutdowns).
- e. Grade D areas (life protection - sleeping areas and enclosed escape routes) should have smoke detectors with sensitivity dependent on whether or not sprinkler systems are installed in the areas.
 - 1. If sprinklers are installed in Grade D areas standard sensitivity smoke detectors (meeting UL 268, EN 54, or equivalent performance) should be used. If the predominant fire risk in the area, as determined by a fire professional, is smouldering fire or electrical fire, point optical smoke detectors should be used. If the predominant fire risk is flaming fire, ionisation detectors should be used.
 - 2. If no sprinklers are installed in Grade D areas high sensitivity smoke detectors should be used, such as point optical, meeting the burnt wire test requirements in Annex F.

If burning dust from electrical heaters in sleeping rooms is present, high sensitivity optical detectors are not suitable, unless they are the type that automatically switch from standard to high sensitivity on a predetermined temperature rise.
- f. An alternative approach to determine smoke detection requirements in Grade D areas is to perform a detailed fire engineering assessment as part of FHA. This assessment should take account of the following, at least:
 - 1. Fuel load.
 - 2. Fire hazard type (i.e., electrical, smouldering, or flaming).
 - 3. Tenability.
 - 4. Room geometry.
 - 5. HVAC effects.

Table 4 - Typical performance requirements for Grade D, Grade E, and Grade F

Grade	Description	Required performance
D	Life protection - sleeping areas, enclosed escape routes.	Refer to 6.4.4.
E	Critical equipment protection.	Smoke detection complying with test requirements in Annex F.
F	General.	Comply with local regulatory expectations and test in accordance with Vendor recommendations.

6.4.5. Specification for Grade T

Fire detection specification should include:

- a. Type of detection suitable for the predominant hazards. Gas turbines with ventilation systems should have rate compensated heat detection in the enclosure and oil mist detection in the ventilation outlet ducting to detect leaks of fuel oil and lubricating oil.
- b. Availability, which is a measure of system uptime and accounts for lockout, bypass or override, and downtime for testing and maintenance.
- c. Reliability, which is the probability that fire (or oil mist or excessive heat) will be detected and the correct output given. This probability accounts for random equipment failure.



- d. The need for manual or automatic control actions that the system should promote (for example, operator alarms and unit or process shutdowns).
- e. Table 5 includes typical requirements for fire detection for Grade T.
- f. Rotating equipment vendors may install additional detection as a condition of warranty.

6.4.6. Specification for Grade V

- a. Air intakes that require incoming air to be monitored for protection of personnel or the facility shall have smoke detection.
- b. 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.

Toxic gas is included as a product of combustion and, hence, an indicator of fire.

- c. Types of smoke or toxic gas to be monitored should be specified.
- d. Supplied air used to pressurise living space volumes and dilute or prevent leaks of higher smoke concentrations from doors, drains, and other penetrations should be categorised as “breathable”.

“Breathable” air is different from “uncontaminated” air. In many cases, the supplied air is normally used to pressurise living space volumes and dilute or prevent leaks of higher smoke or toxic gas concentrations from doors, drains, and other penetrations. If pressurisation is lost at an early stage of a major incident (e.g., in response to very sensitive detection), the resulting leaks can quickly lead to fatality of the occupants.

- e. For areas that require breathable air, detection should detect concentrations of smoke or toxic gas at the upper limit of breathability.
- f. Upper limit of breathability depends on how long personnel are expected to remain in the volume. Advice should be sought from a health professional.
- g. Specification should refer to any smoke and gas ingress analysis that has been performed.

GP 24-21 describes smoke and gas ingress assessment. It covers TR impairment and escape route impairment (e.g., escape to the TR and evacuation routes from the TR). The intended use of the model is for testing the practicality of the escape, evacuation, and rescue strategy for a facility.

- h. Table 5 includes typical requirements for fire detection for Grade V.

6.4.7. Specification for Grade S

Specification of fire detection for Grade S (special case) areas should be based on:

- a. Type of fire and its fuel (the hazard).
- b. Risk to be mitigated.
- c. Planned actions, including response time (the role).
- d. Required sensitivity.
- e. Required system outputs (the function).
- f. Highest acceptable probability of failure on demand for detection elements but only if particularly high reliability is required.



Table 5 - Typical requirements for Grade T and Grade V

Grade	Function	Sensitivity
T	To detect oil mist or vapour from fuel or lubrication system releases in the enclosure or smoke arising from combustion of these fuels.	1 dB/m (1 dB/3,3 ft) (equivalent to 22,3% obscuration/m [6,8% obscuration/ft])
	To detect excessive air temperature in the enclosure and in the ventilation air outlet.	Ambient temperature outside enclosure +40°C (+72°F)
	An alarm from either form of detection should automatically cause alarm at the control point. Alarms from the temperature detection should cause automatic control actions.	
V	To detect a smoke plume from an oil or gas fire at the limit of "breathability" for an exposure time determined by facility specific fire analysis.	Determined by analysis
	To prompt control actions that prevent smoke at the stated limit from reaching any room in the protected space.	

6.5. Fire detection control actions

6.5.1. General

- a. Voting logic should be used for automatic control actions to minimise nuisance trips and unnecessary production losses.

This means using combinations of detector alarm signals from a fire area in, typically, 2ooN voting arrangements, such two detectors are required to register a fire before control action can occur.

- b. When 2ooN voting for control actions is used, this may require overlapping detector coverage to achieve required flame detection viewing distances for control actions specified in Table 2 for Grade B and Grade C areas, and in 6.5.3 to 6.5.7.
- c. Fault alarms from fire detectors that are part of 2ooN voting logic should be treated by the voting logic as fire conditions (e.g., one detector in fault condition in a 2oo3 voting group means the logic requires 1oo2 of the remaining detectors for control action).

To minimise unwanted fire detection control actions this means that:

- *Fire detector faults should be fixed quickly to reduce the likelihood of unwanted control actions.*
- *Protection should be provided against rain and snow to minimise fault alarms.*
- *Detectors should be selected, positioned, and orientated to minimise potential for unwanted alarm stimuli including reflections from flares.*

- d. Operator override/bypass of fire detectors should be treated by the voting logic as being in the healthy condition.

Measures should be put in place under a risk assessment process to manage such override/bypass situations.

6.5.2. Control actions from fire detection

- a. Automatic control actions from fire detection should be targeted for the hazard that they are protecting against on an area by area basis and determined in consultation with a process safety professional.

It is important that automatic control actions from fire detection are targeted, rather than taking a blanket approach across the facility. For example, in a facility that contains both office and process areas, it is not sensible to shut down the process on detection of an office fire. This increases the probability of hazard in the process



facility. Also, in some cases, shutting down part of a facility may be more hazardous than keeping in operation but taking a more limited response.

- b. The philosophy for blowdown of a facility following confirmed fire shall be determined based on the balance of risk. Possible decisions include:

1. Immediate automatic shutdown and blowdown following confirmed fire.

Offshore manned facilities normally shutdown and blowdown automatically without time delay on confirmed fire.

2. Delayed automatic shutdown and blowdown following confirmed fire.

3. Delayed automatic shutdown with ability to manually delay further and manually abort the automatic action.

4. Manual response to fire alarms.

Onshore facilities normally either blowdown manually or automatically after a time delay (that can be manually aborted). This allows time to assess the most suitable response to fire.

GP 44-80 addresses relief disposal and depressurisation systems and emergency depressurisation in event of fire.

6.5.3. Grade B and Grade C

- a. For Grade B and Grade C areas, where automatic control actions cause process or plant shutdown and/or activation of fire protection systems, 2ooN voting logic (two of the detectors or circuits in the voting group in alarm) should be used for all electrical and electronic detection systems.

Currently, no optical flame detection systems have sufficient history to justify their use in a nonvoting mode for automatic control actions in the majority of BP applications. If deciding on the requirement for voting detectors, consideration should be given to the cost of adding the necessary number of detectors to achieve the performance targets versus the cost of unwanted production shutdowns.

- b. Pneumatic fire detection systems may be used in Grade B and Grade C areas without duplication of pneumatic loops but with voting of pressure loss detection devices.

Pneumatic fire detection systems with continuous air supply through a small diameter restriction will compensate for minor air losses without causing unnecessary production impact.

- c. Hybrid voting arrangements involving pneumatic fire detection and voted optical detection may be used to prevent unwanted production losses from false activation of the pneumatic system or individual electronic detectors.
- d. If the hybrid voting arrangement in c. is used, the optical detection voting should not be degraded by the less sensitive pneumatic system. Both objectives could be achieved by 2oo3 voting of two optical detectors and one pneumatic detection device or system.

6.5.4. Grade D, Grade E, and Grade F

For Grade D, Grade E, and Grade F areas, detectors should not normally be voted, unless unwanted automatic control actions would cause significant losses.

6.5.5. Grade S

For Grade S areas, detector voting requirements should be assessed on a case by case basis.



6.5.6. Grade T

For Grade T areas, detectors that are used to automatically shut down the machine and initiate the fire protection system should be voted in a 2ooN configuration.

6.5.7. Grade V

For Grade V areas, detector voting requirements should be assessed on a case by case basis.

6.6. Manual fire alarm stations

Manual fire alarm stations (also known as manual alarm call points and manual pull stations) are for personnel to raise alarms.

- a. Manual fire alarm station devices shall be located where required by applicable regulations, as a minimum.
- b. Manual fire alarm station devices should be located at exits on designated escape routes.
- c. Maximum personnel travel
 1. Maximum personnel travel on designated escape routes from exited area to nearest station shall be determined by national standards but shall not exceed 60 m (200 ft).

Practice in the Gulf of Mexico that meets US Coastguard and Minerals Management Service guidance is for travel distance not to exceed 23 m (75 ft).

2. If the travel distance between exits exceeds the maximum limit, additional manual fire alarm stations shall be positioned throughout the designated escape routes.
- d. The role of manual fire alarms should be clearly defined and personnel properly trained in their use.
- e. If manual stations are to be used to raise alarms for events other than fire and gas release, uniquely identified stations should be provided for these extra functions including ESD.

7. Flammable gas detection performance**7.1. General****7.1.1. Objective**

- a. The main objective of flammable gas detection is to detect accumulations and, in special cases, leaks of flammable gas as early as practical, such that action can be taken manually or automatically to:
 1. Isolate the source, if safe to do so, to minimise release size and likelihood of ignition, which results in risk to personnel, the environment, and damage to the facility.
 2. Evacuate personnel to safety.
- b. The secondary objective is to achieve this detection:
 1. With minimum unwanted alarms.
 2. At minimum installed cost and operating cost.
- c. This GP addresses the following categories of flammable gas detection:
 1. Accumulation at deck/floor/grade level for heavier than air gases.
 2. High elevation (above deck/floor/grade) accumulation detection at 5 m (16 ft) horizontal spacing for lighter than air gases in higher risk areas.
 3. High elevation (above deck/floor/grade) accumulation detection at 10 m (33 ft) horizontal spacing for lighter than air gases in lower/medium risk areas.

