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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) GP 30-85 includes BP and industry operational experience and technology development since the first issue in 2003.

This issue includes the following significant changes:

1. Linkage to category 24 ETPs on fire protection.
2. Deletion of fire risk categorisation.
3. Relaxation of requirements for onshore open facilities.
4. Relaxation of recommendation on single frequency IR fire detectors.
5. New section on notification appliances.
6. More specific guidance on detector calibration and testing.
7. Fewer "shall" statements.

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1. Scope

- a. This GP provides requirements for performance, selection, design, installation, operation, maintenance, and audit of system designs and installations for fire and gas (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. Detection by analysers and portable gas detectors, and extinguishant systems are not covered in this document. Refer to category 31 ETPs for requirements on analysers.

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 24-20	Fire and Explosion Hazard Management of Offshore Facilities.
GP 24-21	Fire Hazard Analysis.
GP 24-22	Gas Explosion Hazard Analysis.
GP 30-45	Human Machine Interface for Process Control.
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 59-40	Wireless Interfacility Selection.

British Standards Institute (BSI)

BS 5839-1	Fire detection and fire alarm systems for buildings - Code of practice for system design, installation, commissioning and maintenance.
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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 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 are in alarm.

Area

Enclosed spaces that extend to the walls and open spaces that extend to within 2m (6,6 ft) radius of Grade A and Grade B areas.

Blockage ratio

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

Escalation

Escalation is an occurrence whereby a fire from an original source causes hazardous conditions at adjacent equipment that has fire potential (e.g., tanks, vessels, piping, or structures), which then contributes to the original fire, thereby enlarging the fire envelope and putting even more adjacent equipment at risk of fire and explosion.

Heat release rate

Total amount of energy per unit time (kW) that is released by a fire.

Muster location

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

Temporary refuge

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.
ESD	Emergency shutdown.
F&G	Fire and gas.
FHA	Fire hazard analysis.
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 the Americas, and LEL and UEL are more common in Europe.

LOPA	Layer of protection analysis.
OD	Outside diameter.
PFD	Probability of failure on demand
PHA	Process hazard analysis.
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 the system or components to 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, and ISO 7240 parts 1-22.*
 - *IEC 60079-29-2 addresses 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.*
- c. Specification of performance requirements should include expectations and assumptions of the following:
1. Facility management.
 2. Risk assessors.
 3. Safety and emergency response teams.
 4. Maintenance crews.
 5. Auditors.
 6. System designer.

5.2. Safety management

- a. Processes for competency of people, planning activities, documentation, and verification should comply with GP 30-75.
- GN 30-751 provides a template for a safety lifecycle plan.*
- GN 30-752 provides a template for competence requirements and assessment for safety instrumented systems that can be adapted to suit F&G detection.*
- b. F&G detection functions that require SIL 1 or higher integrity shall be subject to compliance with GP 30-75.

5.3. Specifier role

- a. Specifiers of F&G system performance requirements shall hold current permits or licence for design of F&G systems if required by the local authority having jurisdiction.
- This is a requirement in some U.S states.*
- b. Specifiers of F&G system performance requirements should have the following capabilities:
1. Experience in design of F&G detection systems.
 2. Familiarity with other engineering disciplines (in particular, process safety, electrical, and instrumentation) and how they interact with one another.
 3. Understanding of facility operations.
 4. Familiarity with available detection devices and associated control logic and notification appliances and their capabilities and limitations.
- It is useful for them to be familiar 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. Safety requirements for the facility.



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 the safety requirements for the facility and not just the minimum required to comply with code.

- d. Specifier role shall include coordination with other disciplines.
- e. Required performance for all parts of the F&G detection system shall be recorded.

Example record forms are provided in Annex A.

5.4. Performance

- a. The following shall be reviewed and recorded to determine F&G system performance requirements:
 - 1. Regulatory requirements for F&G detection.
 - 2. Functional requirements determined by fire hazard analysis. This review should include a discussion of hazards in terms of damage they can cause, such as:
 - a) Size of flammable gas cloud to be detected.
 - b) Size of fires.
 - c) Time to escalation.
 - d) Tolerable levels of damage.
 - e) Actions to be taken either manually in response to alarms or automatically.
 - 3. Reliability requirements that may be expressed as integrity levels determined in accordance with LOPA studies or from claims in other safety studies for F&G detection system performance.
 - 4. Any requirements for F&G detection systems to be able to survive a major incident.

GP 24-20, GP 24-21 and GP 24-22 address fire hazard analysis.

These requirements are often specified in terms of outcomes and probabilities for successful risk reduction.

This GP sets the severity of F&G events that are annunciated sufficiently low such that they are below thresholds for escalation while also minimising unwanted alarms and automatic control actions.

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

Fire detection grading is addressed in 1.1.1 and 6.4.1.

Flammable gas detection requirements are addressed in 7.2.1.

- c. Special requirements should take facility specific risks into account (e.g., risks to safety, environment, production, or reputation).

“Good practice” requirements are straightforward. However, “special” requirements can be difficult because they require detailed analysis by specialists to determine the role of F&G detection in hazard mitigation.

5.5. Hazards

5.5.1. General

F&G hazards are defined as one of the following:

- a. Flaming fire.



- b. Flammable gas.
- c. Toxic gas.
- d. Smoke from smouldering or incipient fires.

5.5.2. Flaming fire

RHO should be used to specify fire detection targets for flaming fires.

The following table compares RHO with flame area for some typical hydrocarbon fires. The gas used is butane and the oil is diesel. The measurement is the apparent area of the flame to a bystander, not the flame base area. Heat release rate may be a more appropriate measure of fire size than RHO in enclosed volumes, because it accounts for the convective heat as well as radiated heat. The convective component is more significant for larger fires in smaller volumes. HRR varies by fuel and combustion efficiency. In small enclosed volumes, HRR is a better measure of damage potential than RHO, but for the detection target fire sizes, RHO is considered a better measure. RHO is assumed to be 30% of heat release rate.

	10 kW		50 kW		100 kW		250 kW	
	m ²	ft ²	m ²	ft ²	m ²	ft ²	m ²	ft ²
Gas jet	0,3	3	1,5	16	3	32	7,5	80
Oil pool	0,1	1	0,5	5	0,7	8	1,2	13

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.

For comparison, the FM 3260 standard test fire (0,1 m² [1 ft²] n-heptane fire) produces approximately 70 kW RHO.

5.5.3. Flammable gas

5.5.3.1. General area coverage

- a. 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 confinement and congestion.

Congestion is addressed in 7.2.

- b. Stoichiometric concentration should always be assumed and the gas cloud specified in terms of a sphere.

The consequence of a deflagration (rapidly expanding fire) or explosion (pressure shock wave following detonation) 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 less than approximately 100 m/s (330 ft/s). These issues are addressed in FHA.

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 approximately 5 m (16 ft) to 6 m (19 ft), even if assuming perfect combustion.

5.5.3.2. Nonhazardous/nonclassified spaces

In areas (rooms or enclosures) containing electrical apparatus that have not been assessed as hazardous/classified (as defined by relevant national or international standards in accordance



with GP 44-60 or GP 44-65) and are supplied by mechanical ventilation for purging and maintaining overpressure, the hazard is from gas ingress through the ventilation system.

It is important to note that the hazard of gas ingress across a boundary may exist due to poor boundary integrity related to relative movement during transportation, introduction of unsealed penetrations, or deterioration of door seals and this will need to be recognised in the area classification process.

5.5.3.3. Perimeter monitoring

- a. Gas hazards that may result from ignition of gas that has migrated from large unconfined and uncongested areas containing hydrocarbon processing equipment should require detection of significant gas volumes leaving the processing 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.

- b. Perimeter monitoring to detect significant gas volumes leaving a congested area that may present a hazard to a nearby area or facility may be required.

5.5.4. Toxic gas

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

Toxic gas effects are directly linked to concentration and, if appropriate for some gases, exposure time. These include narcotic effects of hydrocarbon gases.

6. Fire detection performance

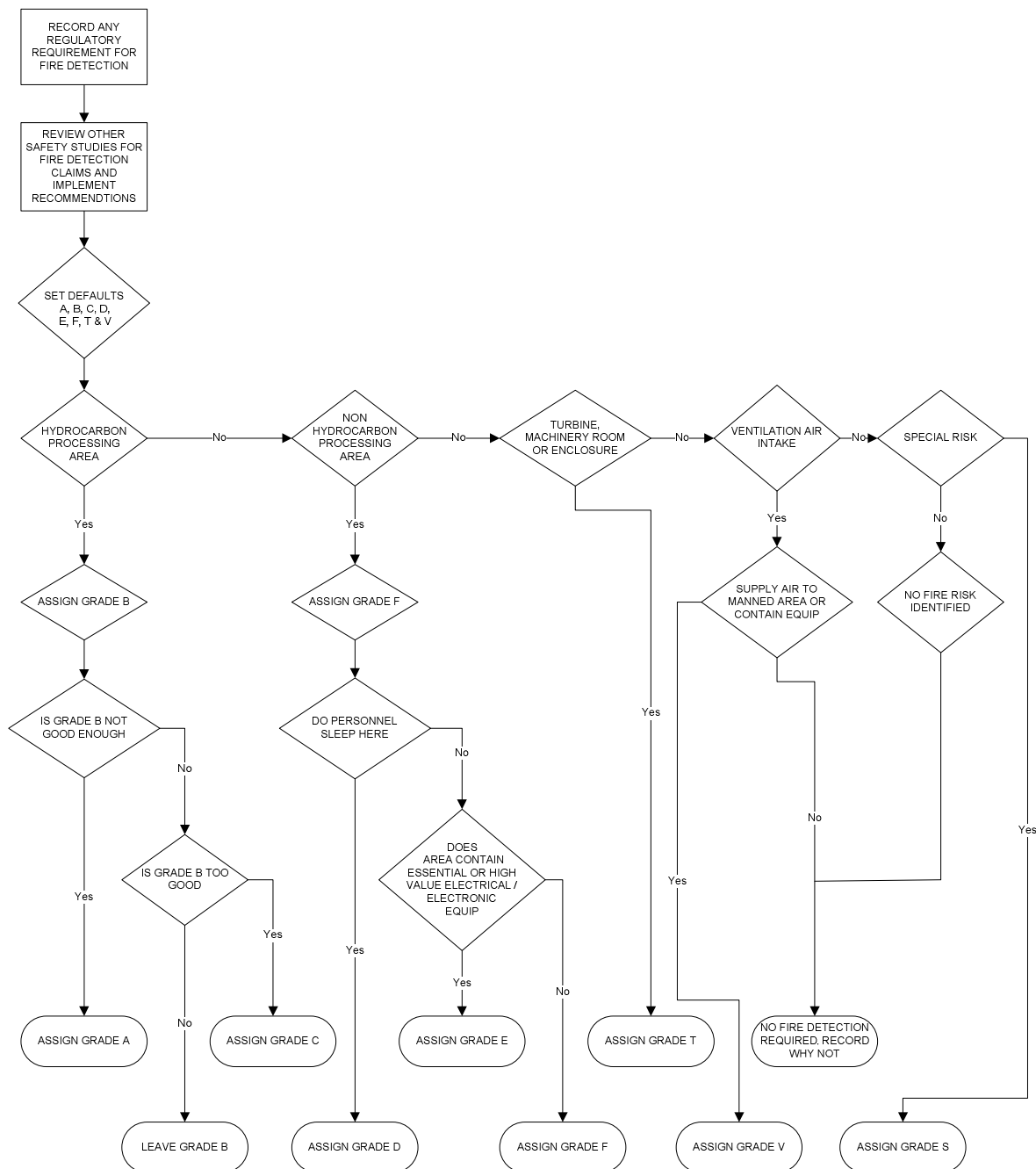
6.1. General

6.1.1. Requirement determination

- a. Fire detection requirements should be determined using the process defined in Figure 1.

The figure refers to grades that are defined in Table 1.

Figure 1 - Method for setting fire detection requirements



- b. Regulatory requirements for automatic fire detection shall be determined.
- c. Required fire sensitivity levels should be defined for the facility.
- d. Areas should be assessed to determine where fire detection could reduce risk of personnel exposure to fire.

Area assessment is normally performed through formal safety studies.

- e. Potential losses from fire damage should be assessed in terms of plant replacement or lost production costs. Determination of how automatic fire detection could reduce such losses should be made.

6.1.2. Grading basis

Areas within a facility should be assigned a grade based on the following factors:

- a. Regulatory requirements for automatic fire detection that apply to the facility.
- b. Safety studies.
- c. Required fire sensitivity level.
- d. Type of area, including:
 1. Hydrocarbon processing area.
 2. Nonhydrocarbon processing area.
 3. Special risk area, including:
 - a) Human occupation.
 - b) Turbines and other engines.
 - c) Special equipment.
 - d) Ventilation air intake.

6.1.3. Regulatory requirements

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

6.1.4. Safety studies

Previous facility safety studies, such as fire hazard analysis and smoke and gas ingress studies, should be examined and applicable results incorporated into the grading process.

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

6.2. Fire sensitivity levels and FHA

- a. FHA for the facility should be performed to determine fire sensitivity levels of low, medium, and high.
- b. Sensitivity levels should be set relative to vulnerability of personnel, equipment, and systems to fire damage at the facility.

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 m (36 in) heavy wall pipe.

- c. FHA should be a project or facility specific safety study in accordance with GP 24-21.

6.3. Area types and use**6.3.1. Hydrocarbon processing areas**

- a. An area should 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, or condensates).
- b. Areas containing significant quantities of flammable utility fluids (for example, diesel fuel and methanol used in gas production) should also be included as hydrocarbon processing areas.
- c. Exceptions to classification as a hydrocarbon handling area are:



1. Pipework (except for vessels) outside the boundary of production, process, drilling, utility, or personnel accommodation areas.
2. Turbine enclosures and other similar machinery enclosures that are graded separately.

6.3.2. Nonhydrocarbon processing areas

A nonhydrocarbon processing area is an area that is not designated as hydrocarbon processing and that is any of the following:

- a. Normally occupied.
- b. Containing machinery or electrical and electronic equipment.
- c. Containing significant inventory of flammable materials.

Hydrogen is not a hydrocarbon but is flammable. Compressed oxygen is highly flammable in contact with any fuel.

- d. A designated escape route that could be affected by a. through c. (even if area contains no fire hazard of its own).

6.3.3. Special risk areas

6.3.3.1. General

The following area types should be classified as special risk:

- a. Enclosures or rooms 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.

This could apply, for example, to areas that process hydrocarbons but where a different control action philosophy will be applied than in 6.3.1.

6.3.3.2. Machinery enclosures

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

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

Examples of this type of fire 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 critical (fire pumps or analyser houses).

6.3.3.3. Ventilation air intakes

- a. Ventilation air intake areas include air intakes that supply air to 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.
- c. Applications that require toxic gas and fire detection on air intakes shall have fire detection performance requirements that are 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 indicator of fire.

6.3.4. Areas requiring no detection

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

6.4. Grade definitions

6.4.1. General

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

Table 1 - Fire detection grade definitions

Grade	Area definition
A	Hydrocarbon processing, with high sensitivity.
B	Hydrocarbon processing, with normal 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 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.

6.4.2. Definition of grades in hydrocarbon processing areas

- For each hydrocarbon processing area requiring fire detection, an appropriate grade (A, B, or C) should be set.
- Hydrogen, though not a hydrocarbon, may be included.
- Specification of each grade should include:
 - Fire detection sensitivity (refer to recommended defaults in Table 2).
 - Response time from the moment the condition occurs until the correct output signal is given.
 - Availability, which is the probability that the fire will be detected and the correct output given. This probability accounts for random equipment failure, design limitations (such as incomplete coverage), and operational failures (such as lockout or maintenance).
 - Requirements for manual or automatic control actions that the system should promote (for example, operator alarms and process shutdowns).

6.4.3. Definition of grades in nonhydrocarbon processing areas

For each nonhydrocarbon processing area requiring fire detection, an appropriate grade (D, E, F) should be set. The specification should include:

- Compliance with an industry standard level of performance, if feasible. Table 3 lists typical performance requirements.
- Availability, which is the probability that the fire will be detected and the correct output given. This accounts for random equipment failure, design limitations, such as incomplete coverage, and operational failures, such as lockout or maintenance.
- The need for manual or automatic control actions that the system should promote (for example, operator alarms and process shutdowns).



Table 2 - Fire detection sensitivity recommended defaults for Grades A, B, and C

	Area grade	Sensitivity required - RHO in kW	
		For alarm only	For initiating automatic control action
Onshore open facility	Grade A	50	Not required
	Grade B	100	Not required
	Grade C	500	Not required
	Grade A	10	10
	Grade B	10	50
	Grade C	100	250

For comparison, the FM 3260 standard test fire (0,1 m² [1 ft²] n-heptane fire) produces approximately 70 kW RHO.

Table 3 - Typical performance requirements for Grades D, E, and F

Grade	Required performance
D (Life protection)	Designed to comply with test requirements defined in Annex B.
E (Equipment protection)	Designed to comply with test requirements defined in Annex B.
F (General)	Designed to comply with requirements of the local fire detection standards (for example, NFPA 72 or BS 5839-1 for Class P2 systems). If no national standards are available, the latest version of NFPA 72 should be used.

6.5. Assigning grades to hydrocarbon processing areas

6.5.1. Grade usage

- Grade A should be used for places in hydrocarbon processing areas where fires that may start as small fires could cause significant damage in a short period of time. Such fires might be due to the fuel source (for example, high pressure gas from a compressor) or from the area inherent sensitivity to fire (for example, small bore pipework and pump seals). Such risks normally have well defined risk reduction measures (control actions), some of which may be active and may need to be triggered by automatic fire detection.

For example, the areas surrounding condensate pumps, high pressure compressors, and pig launchers and receivers could be classified as Grade A.

- Grade B is the “normal” level of fire detection in hydrocarbon risk areas. It should be used if another grade is not more appropriate.

For example, the areas surrounding many process vessels could be classified as Grade B.

- Grade C should be used if the Grade B level of detection is excessive, and a reduced performance grade is appropriate.

For example, the areas surrounding pipework racks could be classified as Grade C.

6.5.2. Method

The steps in assigning fire detection grades to hydrocarbon processing areas are as follows:

- Initially, assign all hydrocarbon processing areas as Grade B. Grade B zones should extend either a minimum of 2 m (6 ft) from any facility that is protected by the zone or to the area boundaries, if any are within 4 m (13 ft) of the facility.
- Identify any portions of Grade B areas where better detection is required and assign them as Grade A. Grade A zones should extend a minimum of 1 m (3 ft) from the applicable area and should be segregated from Grade C areas by a further 2 m (6 ft) of Grade B areas.

