

DEP SPECIFICATION

FIRE, GAS AND SMOKE DETECTION SYSTEMS

DEP 32.30.20.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for fire, gas and smoke detection systems, and includes sensor technology selection, specification, installation, calibration, associated audible and visual alarm systems and executive actions. The scope of this DEP includes detection of fire, flammable gas, oil-mist, narcotic and toxic gases in and around all Shell facilities.

The occupational health or environmental measurements of toxic substances or physical agents, which do not pose an immediate threat to employees, the public or the environment are outside the scope of this DEP. Further, measurements or equipment associated with the control of fire water pumps and deluge systems are also out of scope.

Fire and smoke detection systems inside normally occupied buildings (e.g., office buildings, accommodation buildings and control rooms) are outside the scope of this DEP. Exceptions to this are the gas (flammable and/or toxic) and smoke or CO detection at building entries (e.g., HVAC) which are covered by this DEP. Fire and smoke detection systems for inside normally occupied buildings will follow the applicable code (see definition in (1.3.2)).

This DEP applies to new installations and replacement or upgrades of existing installations. For replacement or upgrades, the Principal may consider retaining a consistent design or operating philosophy for the whole site where ALARP can be demonstrated.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 - Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2014; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
1ooN	The detector 1 out of N (1ooN) voting logic requires a single detector to trigger, (i.e., this is a non-voted configuration). N represents the number of detectors within the zone.
2ooN	The detector 2 out of N (2ooN) voting logic requires two detectors in the same zone to trigger where N represents the number of detectors within the zone.
ALARP	As Low As Reasonably Practicable
AND	Logical operator, where all are required before satisfied.
Bump Test	This is a test where the transportable, portable monitor or personal monitor is subjected to test gases of known concentration, so that the monitor's measurement performance and alarm points can be proven functional.
Code	Local and national regulations, or industry-wide standards and codes of practice for Fire & Gas systems (e.g., NFPA).
Confirmed Gas	Typically two or more detectors within a zone reporting gas, or single detector plus confirmation by Operations.
Confirmed Fire	Typically two or more detectors within a zone reporting fire, or single detector plus confirmation by Operations.
Congestion / Congested Area	An area containing objects such as equipment, pipes, structural supports. The density of objects (blockage) affecting gas dispersion and explosion overpressure. Note that a congested area can be unconfined (no side walls) or confined (enclosed by walls, e.g., module or room).
Containment zone	Refers to any enclosed module which by design includes the use of physical barriers with the primary function to restrict or slow the spread of gas clouds (e.g., toxic) from un-ignited releases, or smoke, to other adjoining or connected enclosed spaces and to outside areas. Containment manages the "overlap" of the hazard (e.g., toxic) from one area to another and also affords segregation between hazardous (e.g., toxic) and non-hazardous (e.g., non-toxic) areas.
Conventional Gas Detection	Sensor technologies that directly detect the presence of a gas and are well established in the industry. This includes infrared (for flammable gas), catalytic, electrochemical, and semiconductor, but does not include acoustic detection.
Detection Coverage	For fire or gas events in each zone, detection coverage is defined as the proportion of modelled idealised events within a zone that would be detected, expressed as a percentage. This definition does not take account of frequency or likelihood of any event – all instances of gas accumulation or fire within a zone are given equal weight when assessing the coverage.

Term	Definition
Detector Mapping	A layout optimisation technique that uses 2D or 3D computer modelling to assess the coverage of detection systems against the identified hazardous scenarios. It provides an auditable assessment trail of the detection system's ability to meet the detection performance requirements.
Emergency Control Point	Safe area on site or installation from where emergency response is coordinated.
Executive Action	In this DEP, executive action is a final action function to provide protection or mitigation of an event.
Fire & Gas System	The Fire & Gas System including the following components: a) Detectors (fire, smoke, flammable and toxic gas, acoustic leak); b) A logic solver; c) Panel(s); d) Human Machine Interface in a manned control centre, and where appropriate a second HMI at mustering point (where mustering point is in different location) or Emergency Response Centre if separate from control centre; e) Direct outputs, such as fire suppressants, audible and visible alarms; f) Interfaces to other systems, e.g., SIS, DCS; g) FGS Engineering Station.
Flammable Gas	For the purposes of this document, flammable gas refers to those flammable gases or vapours that can be ignited (e.g., hydrocarbons, hydrogen).
HSSD	High Sensitivity Smoke Detection; typically aspirated with detection points based on modelling.
Intelligible message	An intelligible message is defined as one, which alerts inattentive listeners that the message may concern them, and which is then substantially understood when repeated once, even though some individual syllables or words may not be understood.
Narcotic effect	The impaired judgement or loss of ability to respond to commands caused by exposure to sufficiently high concentrations of narcotic products (e.g., hydrocarbon vapour).
Occupied building	A building containing at least one employee or contractor assigned workstation, or used for a recurring function (e.g., meetings, training). Observation shelters provided for weather protection for the marine, road, or rail loading operator may, in consultation with the Principal's relevant Technical Authority, be excluded from the definition of an occupied building. By nature, such buildings are small and require a large amount of window area to satisfy operational safety requirements with the loading operations.
OR	Logical operator, a single requirement satisfies.
Personal Monitor	These are small compact devices that are attached to, and worn by the user whilst carrying out work activities. These personal gas alert devices do not give team or area protection.
Portable Monitor	Portable gas monitors are hand-held monitors used for leak seeking; verification of combustible or toxic gas-free areas; monitoring temporary work areas and safety checks. These are not personal gas alert devices as they can be located several meters away from where personnel are located.

Term	Definition
Subject matter expert (SME)	Person recognised by the Principal as having expertise in the specific subject.
Toxic Gas	For the purposes of this document, Toxic gas refers to gases which, per Part III of DEP 01.00.01.30-Gen., are classified as either "very toxic-acute", "very toxic-chronic", or "very toxic-environment"
Transportable Monitor	BS EN 50073 (1999) defines transportable apparatus as "apparatus which are not intended to be portable but which can be readily moved from one place to another. When required, they are positioned at a predetermined location to provide protection against hazardous events in that area. Transportable monitors should normally be used for monitoring temporary work areas ('hot-work') and in areas where fixed gas detectors are out of service."
Unoccupied building	For the purpose of this document normally unoccupied buildings are buildings where personnel visit infrequently and do not carry out regular lengthy routine activities during normal operation. This includes but is not limited to process buildings, analyser shelters and metering buildings.

1.3.3 Abbreviations

Term	Definition
ASU	Alarm Summary Unit
BPCS	Basic Process Control System
CCTV	Closed Circuit television
DCS	Distributed Control System
EMC	Electro Magnetic Compatibility
EMI	Electromagnetic interference
ESD	Emergency Shutdown
FAR	Field Auxiliary Room
FAT	Factory Acceptance Test
FFSIS	Foundation Fieldbus™ Safety Instrument System
FPSO	Floating Production Storage and Offloading facility
F&G	Fire & Gas
GOR	Gas to Oil Ratio
HART	Highway Addressable Remote Transducer
HEMP	Hazards and Effect Management Process
HF	Hydrogen fluoride
HFA	Hydrofluoric acid
HLG	High Level Gas Alarm
HMI	Human Machine Interface
HSSE	Health, Security, Safety and Environment
HVAC	Heating, Ventilation and Air Conditioning
IPF	Instrumented Protective Function
IMS	Ion mobility

Term	Definition
IR	Infrared
I/O	Input / output
LAV	Local Activation Valve
LCC	Local Control Centre, Installation Control Centre or any control room
LFL (or LEL)	Lower Flammable Limit. For the purposes of this document, the terms lower flammable limit and lower explosive limit (LEL) are deemed to be synonymous.
LLG	Low Level Gas Alarm
LNG	Liquefied Natural Gas
LOS	Line of Sight
MODU	Mobile Offshore Drilling Unit
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
PA	Public Address System
PES	Programmable Electronic System
PPE	Personal Protective Equipment
ppm	Parts per million
QRA	Quantified Risk Assessment
RFI	Radio Frequency Interference
RH	Relative humidity
RTD	Resistance Temperature Detector
SAT	Site Acceptance Test
SER	Sequence of Events Recorder
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SME	Subject Matter Expert
SSSV	Sub Surface Safety Valve
STEL	Short Term Exposure Limit
TSR	Temporary Safe Refuge (or Safe Refuge)
TWA	Time Weighted Average
UPS	Uninterruptible Power Supply
UV	Ultra Violet
Vol	Volume
VDU	Visual Display Unit
2D	2 dimensional
3D	3 dimensional

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (11).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2014. The following are the main, non-editorial changes.

Section/Clause	Change
9.7	Public Address and General Alarm (PAGA) added
Appendices	Removed

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. THE FIRE, GAS & SMOKE DETECTION SYSTEM

2.1 GENERAL

A typical Fire, Gas & Smoke detection system consists of the following components:

- a. *Detectors (fire, smoke, flammable and toxic gas, acoustic leak);*
- b. *A logic solver which initiates the following actions;*
 - i. *Tripping of process equipment (e.g., pumps, compressors, valves);*
 - ii. *Tripping or isolation of electrical equipment;*
 - iii. *Opening process valves, e.g., blowdown or depressuring valves;*
 - iv. *Tripping of ventilation systems (fans and dampers);*
 - v. *Activating fire protection systems, e.g., deluge or gaseous systems.*
- c. *Panel(s);*
- d. *Human Machine Interface (HMI) located in a manned control centre and where appropriate a second HMI at mustering point (where mustering point is in different location) or Emergency Response Centre if separate from control centre;*
- e. *Direct outputs, such as fire suppressants, audible and visible alarms;*
- f. *Interfaces to other systems, e.g., SIS, DCS;*
- g. *Fire & Gas system Engineering Station.*

Fire, Gas & Smoke detection systems are one of the (risk reducing) recovery controls used where there is potential for fire or loss of containment (release and / or gas accumulation) that would pose a risk to employees, the public, the environment or the business.

1. The Fire, Gas & Smoke system shall enable mitigation of hazardous conditions such as fire or loss of containment by performing three basic functions:
 - a. Detect the Hazard;
 - b. Alert People;
 - c. Initiate Action.

The three basic functions are described in the sections below.

2.2 DETECT THE HAZARD

1. Fixed fire, gas and smoke detection equipment shall be selected to meet the requirements of this DEP and to provide, within practical limits, the earliest detection of emerging or significant hazards, specifically:
 - a. The presence of a fire;
 - b. The presence of smoke from smouldering or incipient fires;
 - c. The presence of a hazardous release or accumulation of flammable gases due to loss of containment;
 - d. The presence of a hazardous release or accumulations of a toxic or asphyxiating gas (including those with a narcotic effect) due to loss of containment.

2.3 ALERT PEOPLE

1. The Fire, Gas & Smoke detection system SHALL [PS]:

- a. Alert the operator at a continuously manned control centre to any detected hazards, their approximate location and type of event;
- b. Alert personnel in the vicinity of the hazard to the detected hazard so that they are able to take appropriate and timely action and evacuate to a safe location;
- c. Provide data about the Fire, Gas & Smoke event at the emergency control points to facilitate management of the incident.

There may be the additional requirement to provide notification of emergency situations to local community services, e.g., fire brigades.

2.4 INITIATE ACTION

1. The initiated action shall be automatic, except where human action has been assessed for the facility and hazard type, and it is demonstrated that human action is an effective part of the mitigation process.

The following are examples of actions to be implemented within a Fire, Gas & Smoke system:

- *To alert or warn off approaching personnel or manned transport (e.g., helicopters, boats) using audible and visual means;*
- *Isolate and minimise the inventory of hazardous materials (which may contribute to escalation) in the affected area;*
- *Minimise potential ignition sources by electrical isolation of non-essential equipment or equipment not suitable for use in the present hazard;*
- *Initiate active fire protection systems, where applicable, within the response time required;*
- *Minimise the ingress and spread of smoke within buildings or closed modules, where smoke may impair escape, refuge and evacuation;*
- *Provide HVAC operation that is required for the detected hazard, where applicable, e.g., maintain module air flow when gas is present in the module.*
- *Initiate restrictions of access, e.g., road blocks or warning strobes and horns on and offsite.*

For unmanned facilities, see (9.10).

3. DESIGN PROCESS

The following steps detail the design of a Fire, Gas and Smoke detection system.

3.1 IDENTIFY HAZARDS RELATED TO FIRE, GAS AND SMOKE EVENTS

1. There shall be a structured method of analysing fire & gas hazards which forms the basis of the Fire, Gas & Smoke system design objectives, and as a minimum contains the following:
 - a. Zone definitions (Containment, Fire, Hazard)
 - b. Detection requirements per zone
 - c. Fire, Gas & Smoke system hardware robustness requirements
 - d. Fire, Gas & Smoke system cause & effects matrix

3.2 DEFINE SITE HAZARDOUS ZONES, FIRE ZONES

1. Identification of zone boundaries shall consider features of the geography of firewalls, bundwall, decks and module levels, roadways, buildings, HVAC items, fire protection systems, and facility extremities.

3.3 CLASSIFY THE LEVEL OF CRITICALITY OF IDENTIFIED HAZARDS

1. The Fire, Gas & Smoke systems are safety critical systems and shall be subjected to functional safety management as per DEP 32.80.10.10-Gen.
2. The design, sensor selection, logic solver, horns/beacons, installation and maintenance of the Fire, Gas & Smoke system shall be in compliance with the requirements of DEP 32.80.10.10-Gen. apart from the exceptions identified within this DEP.
3. The IPF SIL assessment or HEMP barrier assessment process shall be carried out for Gas and Smoke detection protective functions on HVAC air intakes for process buildings e.g., (Field) Auxiliary Rooms, Substations, Temporary Refuges, Control rooms.
4. The requirement for IPF SIL assessment within process buildings shall be assessed in consultation with relevant process safety department.
5. All other F&G detection with executive action, including detection in outdoor process areas, do not need SIL assessment. Consult the Fire, Gas & Smoke system preventative maintenance library documents, for maintenance and test interval recommendation.

3.4 GENERATE FIRE, GAS & SMOKE SYSTEM DESIGN REQUIREMENTS AND PHILOSOPHY

1. The Fire, Gas & Smoke system design requirements (and/or Fire, Gas & Smoke system Philosophy) document shall be written and maintained. The document includes:
 - a. Statement of the concepts, assumptions, regulatory requirements and references to be used in developing the safety design and functional specification of the Fire, Gas & Smoke detection systems;
 - b. Summary of the overall Fire, Gas & Smoke detection system (e.g., system architecture), including diagnostic capabilities associated with F&G sensors;
 - c. Description of the application of the philosophy to each unit, area or zone of the facility (e.g., perimeter, area coverage);
 - d. Human-machine interface philosophy (including policy for integration with other alarm systems, alarm levels and expected operator response, alarm locations, refer (9.5);
 - e. Maintained system performance;
 - f. Detection requirements for fire, flammable gas and toxic gas, by zone;
 - g. Detection technologies and Suppliers to be used;
 - h. Deployment approach (e.g., coverage mapping, selective placement);
 - i. Voting schemes, including how to respond to diagnosed faults;
 - j. Detection layout assessment and performance criteria, e.g., detection performance for Fire, Gas & Smoke detection mapping;
 - k. Operator competence, knowledge and training requirements;
 - l. Facility to capture sequence of events.

3.5 DETAILED DESIGN OF FIRE, GAS & SMOKE SYSTEM, INCLUDING CONFIGURATION AND LAYOUT

Detection designs are for early detection of hazardous loss of containment events.

1. The type, number and location of fire, gas and smoke detectors and their associated equipment (e.g., horns, beacons) shall be determined during detailed engineering using a documented assessment, including consideration of the following:
 - a. Regulatory requirements;
 - b. Hazardous area zoning, HEMP, QRA (where available) results;
 - c. Limits of equipment congestion;
 - d. Potential leak sources and areas where accumulation of gas may be likely or particularly hazardous;
 - e. Type of detection approach to be provided – perimeter, area, or equipment specific;
 - f. Detector voting logic to be deployed;
 - g. Properties of process fluids (composition, volatility, phase, temperature, pressure, toxicity);
 - h. Characteristics of potential releases (jet or flashing liquid, plume, buoyancy);
 - i. Forced or natural draft ventilation patterns, wind speed and wind direction.
2. The detector layout design shall use detection mapping to assure that the detection meets the identified detection performance criteria (e.g., fire sizes, gas cloud sizes). See (6).
 - a. The same study may assess the placement of horns/beacons to verify that the appropriate operator and staff awareness is achieved.
3. When applying selective placement of detectors for specific leak events, (e.g., gas detection within “bunded” areas or boundary / perimeter detection) the detection shall be placed such that so far as reasonably practicable the detection will provide early detection.
 - a. To ensure early detection, selective placement shall consider release size, momentum and air movement (e.g., prevailing wind, HVAC).

3.6 CONSTRUCT AND COMMISSION

1. Factory and site acceptance tests and site commissioning processes shall be carried out as per DEP 62.10.08.11-Gen.
2. The commissioning procedures shall ensure that devices (e.g., detectors, horns/beacons.) have been installed in the correct locations and orientations (with clear field of view of the intended coverage area for optical devices), mounts are robust, interfaces and alarms are functioning.

4. DETECTOR TYPE SELECTION, DEPLOYMENT AND LOCATION

4.1 ALL TYPES OF DETECTORS - GENERAL

4.1.1 Detector selection

1. To ensure that a suitable detector type, make and model is chosen for the application, the detector selection shall take the following aspects into account through a documented assessment, as a minimum:
 - a. Environmental aspects applicable to the detector location:
 - i. Contaminants (e.g., dust, dirt, sand, silicones, oil, or sea water spray);

- ii. Local environmental conditions during normal and emergency situations (e.g., ambient temperature, vibration, background noise, effects of rain, snow, fog and wind);
 - iii. Potential interferences (e.g., EMI / RFI, other gas constituents for gas detectors, welding arcs for fire detectors, sunshine for optical detectors, radiation interference for optical detectors in areas where radiography equipment is used for NDE or other activities).
- b. Operational aspects:
 - i. Maintenance philosophy and associated maintenance burden.
- c. Technical performance aspects:
 - i. Technology robustness and proven reliability;
 - ii. Suitable detector type for the hazard to be detected;
 - iii. Suitable certification.
- 2. All field mounted flammable gas, toxic gas and fire detectors (i.e., excluding smoke detectors inside unclassified buildings) SHALL [PS] be certified for use in a hazardous area Zone1 (Class 1, Div 1), even where they are installed in areas that are normally classified as non-hazardous.
 - a. Refer to DEP 32.31.00.32-Gen. section 5.4 for details.
- 3. Detectors shall be listed or approved for their intended function (e.g., gas detection, flame detection, smoke detection).
- 4. All field mounted devices shall be protected against water ingress to IP65 as defined in IEC 60529 or the NEMA equivalent.
- 5. For brownfield upgrades, compatibility with existing interfaces and the site installed equipment base should be considered.

4.1.2 Detector location

- 1. The precise location and elevation of Fire, Gas & Smoke sensors/detectors shall be such that:
 - a. Access for testing and maintenance is considered during the design. Access wherever practical shall be from grade or platform without ladders, scaffolding, or lifting devices, or fall protection;
 - b. Where point gas detectors are mounted at locations inaccessible without scaffolding, then test gas tubing up to the detectors shall be used;
 - c. Potential for damage during normal plant maintenance is minimal;
 - d. Detectors always function within the environmental conditions in which they are installed, i.e., sand, dust, water spray, direct rain, snow or ice build-up, salt spray;
 - e. They allow for normal activities in the region of the detection that would block LOS type gas detectors or optical fire detectors.

This may include regular maintenance activities such as those requiring scaffold.
- 2. The minimum elevation of Fire, Gas & Smoke detectors located outdoors shall be 0.6 m (24 in) above grade or ground level.
 - a. Where snow or other weather conditions may affect the detection capabilities, then the height shall be set taking these conditions into account.

4.1.3 Detector installation

1. Device installation design specification and mounting shall be in accordance with Manufacturer's installation instructions.
Correct installation and orientation of detection equipment is critical to reliable performance.
2. Mounting arrangements shall ensure correct detection operation and be sufficiently rigid to ensure that vibration does not impact on performance.
 - a. Detector mounts should be welded to structural steelwork where practicable.
3. Where optical detectors, including reflector plates, are used, then anti-condensation heating shall be used when the environment can cause condensation likely to impair detector performance.
4. Sun shields or rain hoods shall be installed at detectors identified as being exposed to environmental conditions that might affect their operation.

4.2 FIRE DETECTORS

4.2.1 General

1. Detection equipment SHALL [PS] be capable of detecting fires of the fuel-types that may be present in the coverage area.
2. Fire detection shall be optical flame detection except where it can be demonstrated that these may not be capable of detecting, for example due to high levels of congestion, interference from flaring activities or environmental conditions.
 - a. The alternative detection system may be from other technologies, e.g., pneumatic detection systems.

4.2.2 Optical flame detectors

Multi-wavelength (triple band) infrared fire detection is the selected detection technology for detection of hydrocarbon gas and liquid fires, hydrogen fires and alcohol fires.

1. For special fire detection requirements, such as sulphur fire (in sulphur storage area), consult the Principal for the selection of the detection technology for the application.
2. Single or dual wavelength IR (infra-red) detectors shall not be used.
3. UV (ultraviolet) detectors shall not be used in open modules. With the approval of the Principal, they may be used in enclosed Supplier packages.
4. Approval of the Principal shall be required before UV/IR flame detectors are used as a detection method.
5. Optical type fire detectors are field of view devices. The following requirements apply:
 - a. The detector's field of view shall cover the potential fire locations which are required to be monitored.
 - b. The maximum distance from detector to the item or area requiring coverage shall be set after considering the following:
 - i. assessed fire hazard scenario for that location (fire size and fuel types);
 - ii. the detector's response distance characteristics for a fire of that fuel type;
 - iii. any desensitising effects from local conditions (e.g., steam plumes).
6. Flame detectors shall be oriented at an angle of pitch between 5 and 40 degrees below horizontal, to promote natural drainage of any condensed water or rain and to reduce accumulation of dust, ice, snow or debris.

4.2.3 Closed Circuit Television (CCTV) based flame detectors

1. Approval of the Principal shall be required before CCTV optical flame detectors are used as a detection method.
2. If CCTV systems are used, then the lenses shall either be self-cleaning, or be easily accessed for cleaning.

4.2.4 Heat detectors

4.2.4.1 General

Heat detection is divided into the following two technology categories:

- a. *point detection, e.g., frangible (quartzoid) bulbs, fusible plug systems, or*
 - b. *linear detection, e.g., pneumatic tube, hydraulic fluid, electrical or optical fibre systems.*
1. Heat detection may be used as a second detection technology in conjunction with optical detection.
 2. Heat detection may be used under any of the following conditions:
 - a. The other forms of fire detection are not suited to detection of the hazards (e.g., highly congested area where optical detection cannot provide coverage due to equipment blocking the field of view (e.g., high equipment density));
 - b. The other forms of fire detection would have unacceptable false alarm rates;
 - c. To supplement the primary flame detection;
 - d. Local regulations require it.
 3. Heat detection when considered as an alternative technology may be located in (but not limited to) the following type of areas:
 - a. Flammable liquid handling and storage area.
 - b. Storage tanks rims
 - c. Risers and wellheads
 - d. Congested modules / areas
 - e. Around pumps
 - f. Compressor drive end and non drive end bearing housings
 - g. Inside machine hoods (compressors, generators)
 - h. Non-hydrocarbon storage areas
 - i. Under false floors in Control Rooms, Computer and Auxiliary rooms
 - j. Selective placement of detection such as at pumps seals.
 4. When used as an alternative, the heat detection system shall detect the fires identified in the HSSE documentation within sufficient time to initiate appropriate actions, and if relevant, activate the deluge firewater valve either through Fire, Gas & Smoke System or independent of Fire, Gas & Smoke System.
 - a. In case these actions are executed directly and independently from the Fire, Gas & Smoke system, the heat detection system shall also be connected to the Fire, Gas & Smoke system and activate any alarms and other cause and effect identified actions upon initiation.
 5. In open, naturally ventilated areas, point heat detectors may be sited with a density in the order of one detector per 10 m² (1,050 ft²) and at a maximum spacing of 5 m (16 ft) apart. The maximum distance from a bulkhead should be no further than 2.5 m (8 ft).
 6. Response times of heat detectors depend on the amount of heat transferred from the fire to the detector. The actual quantity and placement of detectors should be

determined by following the requirements of the detector Manufacturer and applicable codes and standards, taking into account factors such as:

- a. Height of ceiling and depth to which the detector projects below the ceiling
 - b. Proximity to the source of fire or equipment to be protected (without blocking access for operation and maintenance)
 - c. Ventilation flow patterns in the building
 - d. Size of area to be protected
 - e. Objects possibly blocking the heat flow to the detector, e.g., system cabinets, cable trays.
7. In enclosed, mechanically ventilated modules point heat detectors should be installed at a density of at least one per 25 m² (6,700 ft²), and at a maximum spacing of 7 m (23 ft) apart.
- a. The maximum distance from a bulkhead should be no further than 3.5 m (12 ft).
8. Heat detectors shall not be applied in areas where ceiling heights are above 8 m (26 ft).
9. Smoke modelling software may be used to assist in siting point heat detectors.
10. The sensing element shall be located between 25 mm (1 in) and 150 mm (6 in) below the ceiling level, and mounted away from effects that could cause false alarms.

4.2.4.2 Pneumatic/Hydraulic (linear and point)

1. Pneumatic/hydraulic tube, frangible (quartzoid) bulb, and fusible plug systems may be used when direct control of firewater deluge valves is required. These systems shall be connected to the Fire, Gas & Smoke system and provide alarm and other cause and effect identified actions when activated.
2. When pneumatic detection technology is required for fire detection, pneumatic tubing shall be used. With approval of the Principal, frangible bulb or fusible plugs may be used.
3. The hydraulic fluid used in hydraulic-based detection systems shall be “not very toxic” (refer to Part III of DEP 01.00.01.30-Gen.).
 - a. The safety and environmental risks due to release of the hydraulic fluid during a fire shall be assessed and approved by the Principal prior to use.
4. Where pneumatic systems are used in areas containing flammable substances, the detection shall be installed locally to the expected fire sources, and at the required spacing for detection of the identified fire sizes.
5. The pneumatic or hydraulic heat detection system shall detect those fire scenarios in the design intent within sufficient time to initiate appropriate actions, and if relevant, activate the deluge firewater valve directly and independently from the Fire, Gas & Smoke system.
6. The polyethylene tubing (polytube) fire detection system shall be installed with a minimum number of connections by continuously looping it around the fire hazard area, in accordance with Standard Drawings S 88.020 and S 88.021.
7. Pneumatic systems shall be configured so that instrument air is supplied through a filter regulator and a restriction orifice (e.g., 1 mm (0.04 in)), such that on fire detection the tube ruptures and the pressure falls rapidly causing the pressure alarm to be raised.
 - a. They shall have a means to lock the air in the fire detection loop on loss of air supply to the individual detection loops to prevent false alarms and/or deluge activation.

8. Polytube shall be protected from accidental damage so as to not affect its detection capability.
9. Stainless steel tubing shall be used between the detector station and the polytube at the fire hazard area.
10. All joints in the system shall be taped or coated with insulating varnish.
11. A vent valve (for system testing) shall be installed at the end of the polytube system remote from the detector station and located in a clearly marked box at grade level within 15 m (50 ft) from the protected equipment.
 - a. The vent valve shall be provided with an activated heat detector (plug, bulb, sprinkler), or air flow restriction orifice (tube) that will simulate the flow (leakage) of air from a single detector activated.
12. Subject to the approval of the Principal, a pneumatic linear fire loop may use nitrogen as the medium.

4.2.4.3 Electrical or optical fibre (linear)

1. Linear wire shall only be used with the approval of the Principal.
2. Linear heat detection may be used to supplement other forms of fire detection in difficult areas.

Examples include, tank rims, heavily congested plant areas or where flare radiation may cause false alarms using optical detectors.

4.2.5 Smoke detectors

4.2.5.1 General

1. Smoke detection shall not be used for general detection of hydrocarbon fires in open process areas.
2. In process plants, smoke detectors may be used in normally unoccupied buildings as determined by the Principal from hazard assessment.
3. When smoke detection is required in process plants (e.g., within unoccupied buildings, at building air intakes), the detection technology shall be optical.
 - a. Ionisation detectors may be used at the discretion of the Principal (due to possible false alarms caused by dust or steam).
4. Optical detector technology shall be photoelectric, open path infrared beam, or laser-based aspirating.
5. Combined devices (e.g., combined smoke and heat) shall be used unless the hazard is a low-heat-output smouldering fire.
6. Heat and smoke stratification shall be considered when siting detectors that are to be used in areas where the fire has potentially low heat output (e.g., electrical equipment rooms).
 - a. Aspirated detection systems may be used, with the approval of the Principal, in areas where 8 or more point smoke detectors would be required.
7. In open or forced ventilated areas, smoke detectors shall be sited considering the effects of stratification and how local air currents may influence smoke movement.
8. For open or forced ventilated areas, smoke generator tests or computer-based smoke release modelling shall be used to check that the detection is capable of detection during the ventilation air movements.
9. Single station smoke detectors of the following types shall not be used:
 - a. completely powered by a self-contained battery;
 - b. powered directly by the building electrical system;