

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, and also associated audible and visual alarm systems and Executive Actions. Its scope 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 shall be installed as per applicable "code" (see definition in 1.3).

The requirements of this DEP apply 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 2011; 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 should 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 voting logic "1 out of N" (1ooN) 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 voting logic "2 out of N" (2ooN) 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 and 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.

Term	Definition
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.
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 co-ordinated
Executive Action	In this DEP, Executive Action is a final action function to provide protection or mitigation of an event, such as: a) Tripping of process equipment (pumps, compressors, valves etc); b) Tripping or isolation of electrical equipment; c) Opening process valves, e.g. blowdown or depressuring valves; d) Tripping of ventilation systems (fans and dampers); e) Firing fire extinguishants, e.g. deluge or gaseous systems.
Fire and Gas System	The Fire and Gas System including 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 (i.e. hydrocarbons, hydrogen, etc).
HSSD	High Sensitivity Smoke Detection; typically aspirated with detection points based on modelling.
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).

Term	Definition
Occupied building	For the purposes of this document normally occupied buildings are buildings where personnel are present for periods of time to carry out normal operations; such as but not limited to office buildings, maintenance shops, control rooms and living accommodation buildings.
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.
Toxic Gas	For the purposes of this document, "Toxic gas" refers to those toxic gases that are hazardous to personnel (e.g. Hydrogen Sulphide).
Transportable Monitor	BS EN 50073 (BSI 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, and may be process buildings, analyzer shelters, metering buildings.

1.3.3 Abbreviations

AC	Alternating current
ALD	Acoustic Leak Detector
ASU	Alarm Summary Unit
ATEX	Atmospheres explosibles
BPCS	Basic Process Control System
CCTV	Closed Circuit television
°C	Celsius
CO	Carbon monoxide
CO ₂	Carbon dioxide
CSA	Canadian Standards Association
dB	Decibel
DC	Direct current

DCS	Distributed Control System
ESD	Emergency Shutdown
EDP	Emergency Depressurisation
EMC	Electro Magnetic Compatibility
EMI	Electromagnetic interference
FAR	Field Auxiliary Room
FAT	Factory acceptance test
FFSIS	Foundation Fieldbus™ Safety Instrument System
FGS	Fire and Gas System
FIREPRAN	Fire Protection Analysis
F&G	Fire and Gas
GOR	Gas to Oil Ratio
GTL	Gas to Liquid
HART	Highway Addressable Remote Transducer
HEMP	Hazards and Effect Management Process
HF	Hydrogen fluoride
HLG	High Level Gas Alarm
HMI	Human Machine Interface
HSE	Health Safety and Environment
HSSE	Health Security Safety and Environment
HVAC	Heating, Ventilation and Air Conditioning
H ₂ S	Hydrogen sulphide
Hz	Hertz
IPF	Instrumented Protective Function
IMS	Ion mobility
IP	Internet Protocol
IR	Infra-red
I/O	Input / output
Kg	Kilograms
kW	Kilowatt
LAV	Local Activation Valve.
LCC	Local Control Centre, Installation Control Centre or any control room
LED	Light emitting diode
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

LPG	Liquefied Petroleum Gas
mA	Milliamperes
NEMA	National Electrical Manufacturers Association
MTBF	Mean time between failures
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratories
PA	Public Address System
PES	Programmable Electronic System
PFD	Probability of Failure on Demand
PPE	Personal Protective Equipment
ppm	Parts per million
PTFE	Polytetrafluoroethylene
QRA	Quantified Risk Assessment
RFI	Radio Frequency Interference
RH	Relative humidity
S	Seconds
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
TSC	Toxic stream concentration
TSR	Temporary Safe Refuge (or Safe Refuge)
TWA	Time weighted average
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
UV	Ultra Violet
Vol	Volume
VDU	Visual Display Unit
2-D	2 dimensional
3-D	3 dimensional

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section 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 revision of the DEP of the same number dated February 2011. The following are the main, non-editorial changes.

Old section	New section	Change
All		Dual units have been added throughout the DEP; see also (1.7).
6.4.1	6.4.1	Additional instruction on voting requirements for multiple detectors. Added exceptions to the requirement for a minimum of 3 detectors.
6.4.2	6.4.2	Changed requirement for voted executive action.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of “DEPs on the Web”, available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

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.

2. THE FIRE & GAS DETECTION SYSTEM

Fire and gas 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.

The Fire & Gas System shall enable mitigation of hazardous conditions such as fire or loss of containment by performing three basic functions:

- Detect the Hazard;
- Alert People;
- Initiate Action.

These are described in more detail in the sections below.

2.1 DETECT THE HAZARD

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:

- The presence of a fire;
- The presence of smoke from smouldering or incipient fires;
- The presence of a hazardous release or accumulation of flammable gases due to loss of containment;
- 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.

2.2 ALERT PEOPLE

The fire and gas system SHALL [PS]:

- Alert the operator at a continuously manned control centre to any detected hazards, their approximate location and type of event;
- 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;
- Provide data about the fire and gas event at the emergency control points to facilitate management of the incident.

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

2.3 INITIATE ACTION

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 actions shall to be implemented within a fire and gas system:

- To alert or warn off approaching 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 on and offsite.

3 DESIGN PROCESS

The typical sequence of design activities relevant to a Fire, Gas and Smoke Detection System is:

- Identify hazards related to fire, gas and smoke events;
- Define site hazardous zones, fire zones;
- Classify the level of criticality of the identified hazards;
- Generate fire & gas design requirements and philosophy;
- Detailed Design of FGS, including configuration and layout;
- Construct and commission;
- Operate and maintain.

It may be necessary to reiterate some steps to achieve the optimum result. The above steps also apply to modifications to Fire, Gas and Smoke Detection systems.

3.1 IDENTIFY HAZARDS RELATED TO FIRE, GAS AND SMOKE EVENTS

The Shell "HEMP" Hazards & Effect Management Process shall be applied.

The results of the FGS hazard analysis shall form the FGS system design objectives comprising:

- Zone definitions (Containment, Fire, Hazard)
- Detection requirements per zone
- FGS hardware robustness requirements
- FGS system cause & effects matrix

3.2 DEFINE SITE HAZARDOUS ZONES, FIRE ZONES

3.2.1 Zone Boundaries

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

The FGS are safety critical systems and shall be subjected to functional safety management as per DEP 32.80.10.10-Gen.

This DEP shall be read in conjunction with the IPF DEPs and except as noted in this DEP the design, sensor selection, logic solver, horns/beacons, installation and maintenance of the FGS shall be in compliance with the requirements of the Instrument Protective Function DEPS whether or not all aspects are addressed explicitly in this DEP.

The IPF SIL assessment process shall be carried out for F&G protective functions on air intakes to occupied buildings (control rooms), (Field) Auxiliary Rooms, Substations, or a "containment zone" that is within dispersion hazardous boundaries, and always for offshore platforms. All other F&G detection with Executive Action do not need SIL assessment.

Where a F&G detection function has not been SIL assessed a PFD better than 2% shall be achieved for:

- A single detector up to and including the detection input to the logic solver, and including the annunciated alarm when an operator action is required.

3.4 GENERATE FIRE AND GAS DESIGN REQUIREMENTS AND PHILOSOPHY

The Fire and Gas Design Requirements (and/or F&G Philosophy) document shall be written and maintained. The document includes:

- Statement of the concepts, assumptions, regulatory requirements and references to be used in developing the safety design and functional specification of the Fire and Gas detection systems. This includes the requirements from the HEMP process.
- Summary of the overall Fire and Gas detection system (e.g. system architecture), including diagnostic capabilities associated with F&G sensors.
- Description of the application of the philosophy to each unit, area or zone of the facility (e.g. perimeter, area coverage)
- Human-machine interface philosophy (including policy for integration with other alarm systems, alarm levels and expected operator response, alarm locations, etc)
- Maintained system performance
- Detection requirements for fire, flammable gas and toxic gas, by zone
- Detection technologies and suppliers to be used
- Deployment approach (e.g. coverage mapping, selective placement)
- Voting schemes, including how to respond to diagnosed faults
- Detection layout assessment and performance criteria e.g. "Detection Performance" for fire and gas detection mapping.
- Operator competence, knowledge and training requirements.
- Facility to capture sequence of events.

3.5 DETAILED DESIGN OF FGS, INCLUDING CONFIGURATION AND LAYOUT

Detection designs are for early detection of hazardous loss of containments. This may be from product accumulation or from leaks.

The detector layout design for accumulation events shall use modelling to assure that the detection meets the identified detection performance criteria (e.g. fire sizes, gas cloud sizes). The same study may assess the placement of horns/beacons to verify that the appropriate operator and staff awareness is achieved.

When selective placement of detectors for specific leak events, (e.g. detection or boundary / perimeter detection) the detection shall be placed such that so far as reasonably practicable the detection will provide early detection. To ensure early detection, selective placement shall consider release size, momentum and air movement (e.g. prevailing wind, HVAC).

3.6 CONSTRUCT AND COMMISSION

Factory and site acceptance tests and site commissioning processes shall be carried out as per DEP 62.10.08.11-Gen.

The commissioning procedures shall ensure that devices (e.g. detectors, horns/beacons, etc) have been installed in the correct locations and orientations (with clear field of view of intended coverage area for optical devices), mounts are robust, interfaces and alarms are functioning.

4 DETECTOR TYPE SELECTION, DEPLOYMENT AND LOCATION

4.1 GENERAL REQUIREMENTS FOR ALL DETECTORS

Detectors selection SHALL [PS] take the following aspects into account to ensure detection of the hazards as they occur:

- Contaminants (e.g., dust, dirt, sand, silicones, oil, or sea water spray);
- Potential interferences (e.g., EMI / RFI, other gas constituents for gas detectors, welding arcs for fire detectors, sunshine for optical detectors);
- Output signal compatibility with interfaces;
- Local environmental conditions during normal and emergency situations (e.g. ambient temperature, vibration, background noise, effects of rain, snow, fog and wind).
- Site installed supplier/model equipment base (applicable to Brownfield upgrades);
- Technology robustness and proven reliability;
- Maintenance Philosophy,
- Manned / unmanned, accessibility, occupancy, etc
- Fire class as per table below

American	European/Australian	Fuel/Heat source
Class A	Class A	Ordinary combustibles
Class B	Class B	Flammable liquids
	Class C	Flammable gases
Class C	Unclassified / Class E	Electrical equipment
Class D	Class D	Combustible metals
Class K	Class F	Cooking oil or fat

Note: Electrical equipment fire class is Unclassified for Europe and Class E for Australia

The exact number and location of fire, gas and smoke detectors and their associated equipment (horns, beacons, etc.) shall be determined during detailed engineering. For guidance, a general overview of the typical FGS application is shown in (4.1.1). The number, type and location of detectors SHALL [PS] be determined by an assessment of selection criteria, including:

- Regulatory requirements;
- Hazardous area zoning, HEMP, QRA (Quantified Risk Assessment) results;
- Limits of equipment congestion;
- Potential leak sources and areas where accumulation of gas may be likely or particularly hazardous;
- Type of detection approach to be provided – perimeter, area, or equipment specific;
- Detector voting logic to be deployed;
- Properties of process fluids (composition, volatility, phase, temperature, pressure, toxicity);
- Characteristics of potential releases (jet or flashing liquid, plume, buoyancy);
- Forced or natural draft ventilation patterns, wind speed and wind direction.

Device installation and design specification (e.g. mounting) shall be in accordance with Manufacturer's installation instructions. Correct installation and orientation of detection equipment is critical to reliable performance.

The location and elevation of fire and gas sensors/detectors shall be such that:

- Access for testing and maintenance shall be considered during the design. Access wherever practical shall be from grade or platform without ladders, scaffolding, or lifting devices, or fall protection;
- Where point gas detectors are mounted at heights or inaccessible locations then test gas tubing up to the detectors may be used;
- Potential for damage during normal plant maintenance is minimal;
- Mounting arrangements shall ensure correct detection operation and shall be sufficiently rigid to ensure that vibration does not impact on performance. Structural steelwork used where practicable;
- Installed detectors always function within the environmental conditions, i.e. sand, dust, water spray, direct rain, snow or ice build up, salt spray;
- They allow for normal activities e.g. maintenance, scaffolding, lifts etc. which would block LOS type gas detectors or optical fire detectors.

FGS detectors located outdoors shall not be installed lower than 0.6 m (24 in) above grade or ground level. Where snow or other weather conditions may affect the detection capabilities, then the height shall be set taking these conditions into account.

When optical detectors, including reflector plates, are used, then anti-condensation heating shall be used when the environment can cause condensation.

Selection of certified electrical equipment for Fire and Gas systems SHALL [PS] follow:

- Zone1 (Class 1 Div 1) for all field mounted flammable gas and fire detectors irrespective of the actual electrical hazardous area classification.
- Zone1 (Class 1 Div 1) for flammable gas, toxic gas and/or smoke (if any) detectors at the inlet of unclassified buildings that are to be protected for gas/smoke ingress.
- Smoke, heat, emergency lighting, PA systems, control systems panels in unclassified building(s), that buildings are protected by gas detection at the inlets, may remain electrically energized if the equipment is certified for Zone 2 (Class 1 Div 2) or greater.

4.1.1 Overview Of Detector Requirements by Application

Table 4-1 and 4-2 provides common FGS detection options that may come from the hazard analysis. These are for guidance and may only be used if detailed review and hazard identification has not been carried out.

Table 4-1 Fire, Smoke and Gas Detection Process Area Application Guide

Facility Type	Flammable Gas		Toxic	Fire (Optical)	Fire (Smoke)	Heat	
	LOS	Point				Linear	Spot (a)
Offshore Platform (Process Areas)	Yes	Yes (5)	(1)	Yes	(2)	(3)	
Onshore Well Site	Yes (4)	Yes (4, 5)	(1)	No	No	Yes (4)	
Pump House	Yes (4)	Yes (4)	(1)	Yes	No	Yes (4)	Yes
Compressor / Turbine Station	Yes (4)	Yes (4, 5)	(1)	Yes	No	Yes (4)	No
Onshore Gas, LNG, GTL Plant	Yes	Yes (5)	(1)	Yes	(2)	(3, 4)	ER
Onshore Refinery / Chemical Plant	Yes	Yes (5)	(1)	Yes	(2)	(3, 4)	ER
Road/Rail Gantry	(4)	(4)	Yes (1)	Yes (4)	No	(3)	ER
Analyser Shelter/House		Yes (4)	(1)	No	Yes (4)	No	
LNG/LPG/Storage/ Handling Areas (b)	Yes	Yes (5)	No	Yes (ER)	No	Yes (ER)	Yes (6)
Refrigerated LPG/LNG Tank	Yes	Yes (5)				Yes (4)	
Other hydrocarbons Storage/Handling Areas	ER	ER	(1)	ER	No	ER	
Slug Catchers	Yes	Yes (5)	(1)	ER		ER	ER
Floating roof tank rim seal area						Yes (4)	
(1) If toxic gas is present and a hazard (2) In non process buildings such as control rooms, electrical rooms (3) May be used as main detection or as secondary detection system (4) May be required depending upon control, hazard assessment (5) Point detection may include Acoustic Gas Leak Detector (6) Low temperature heat detector ER Subject to Engineering Review (a) Use either pneumatic or electric linear heat detection or frangible quartzoid bulb detector. (b) LPG/LNG service requires early detection that is located close to potential leak sources.							

Table 4-2 Fire, Smoke and Gas Detection Non-Process Area Application Guide

Facility Type	Flammable Gas		Toxic	Fire (Optical)	Fire (Smoke) (b)	Heat	
	LOS	Point				Linear	Spot (a)
Workshop – General					Yes (3)		Yes
Workshop – process analyzers		Yes (4)	(1)				Yes
Warehouse – general	Yes (4)	Yes (4)	(1)		Yes (8)		Yes
Dangerous Goods Store	Yes (4)	Yes (4)	(1)		Yes (8)		Yes (6)
Instrument auxiliary room, cabinets, floor cavity, cable routes					Yes (8)		Yes (6)
Electrical Switch Room/Substation					Yes (8)		Yes
Flammable gas storage yard	Yes	Yes		Yes (2)			
Administration buildings					Yes (9)		
Canteen					Yes (9)		Yes
Kitchen				Yes (2)	Yes (9)		Yes
Training centre					Yes (9)		Yes
Fire station				Yes (2)	Yes (9)		
Garage				Yes (2)	Yes (9)		
Control Rooms		Yes (5)	Yes (5)		Yes (9)		
Laboratories (main/Plant)		Yes (4)			Yes (9)		Yes
Battery Rooms		Yes (7)					
Computer rooms					Yes (8, 9)		Yes
(1) If it is possible for toxic gas to be present and in hazardous concentrations (2) In non process buildings such as control rooms, electrical rooms (3) May be used as main detection or as secondary detection system (4) May be required depending on control, hazard assessment (5) Located at the air intake (6) Rate of rise heat detector (7) If Hydrogen gas is possible during charging (8) High Sensitivity Smoke Detection (HSSD) (9) To the relevant country building code (a) Use either pneumatic or electric linear heat detection or frangible quartzoid bulb detector (b) Unless otherwise indicated, spot smoke detectors should be the integral heat detector type.							

4.2 FIRE DETECTORS

Detection equipment SHALL [PS] be capable of detecting fires of the fuel-types that may be present in the coverage area.

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. The alternative detection system may be from other technologies e.g. pneumatic detection systems.

4.2.1 Optical Flame Detectors

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

For special fuel applications, such as sulphur, consult the Principal for the selection of the detection technology for the application.

Single or dual wavelength IR (infra-red) detectors shall not be used.

UV (ultraviolet) detectors shall not be used in open modules. With the approval of the Principal they may be used in enclosed supplier packages.

The Principal's approval shall be required before UV/IR flame detectors are used as a detection method.

Optical type fire detectors are "field of view" devices. The following points shall be considered when positioning detectors:

- The detector's field of view covers the potential fire locations which are required to be monitored;
- The maximum distance from detector to the item or area requiring coverage shall be set after considering the fire size and fuel types, any desensitising effects from local conditions (e.g., steam plumes) and the detector's response to that fuel type of fire at that distance.

Flame detectors shall be oriented at an angle of pitch between 5 and 40 degrees below horizontal, so as to promote natural drainage of any condensed water or rain and to reduce accumulation of dust, ice, snow or debris.

4.2.2 Closed Circuit Television (CCTV) Based Flame Detectors

The Principal's approval shall be required before CCTV optical flame detectors are used as a detection method.

If CCTV systems are used, then the lenses shall either be self-cleaning, or be easily accessed for cleaning.

4.2.3 Heat Detectors

4.2.3.1 General

Heat detection is divided into two technology categories; point detection or linear detection.

Heat detection may be used as a second detection technology in conjunction with optical detection. When used as a second detection technology the heat detection systems shall comply with the requirements in section (4.2.3).

Heat detection may be used under any of the following conditions:

- 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));
- The other forms of fire detection would have unacceptable false alarm rates;
- To supplement the primary flame detection;

- Local regulations require it.

Heat detection when considered as an alternative technology may be located in (but not limited to) the following type of areas:

- Flammable liquid handling and storage area.
- Storage tanks rims
- Risers and wellheads
- Congested modules / areas
- Around pumps
- Compressor Drive End and Non Drive End bearing housings
- Inside machine hoods (compressors, generators)
- Non-hydrocarbon storage areas
- Under false floors in Control Rooms, Computer and Auxiliary rooms
- Areas where gas remains under pressure, e.g. fuel gas system.
- Selective placement of detection such as at pumps seals.

When used as an alternative the heat detection system shall detect the fires identified in the HSE documentation within sufficient time to initiate appropriate actions, and if relevant, activate the deluge firewater valve directly and independently from the FGS system. The heat detection system shall also be connected to the FGS and activate any alarms and other cause and effect identified actions upon initiation.

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 to be no further than 2.5 m (8 ft).

Response times of heat detectors however depend on the amount of heat transferred from the fire to the detector. The actual quantity and placement of detectors will be determined by following the requirements of the detector manufacturers and applicable codes and standards taking into account factors such as:

- Height of ceiling and depth to which the detector projects below the ceiling
- Proximity to the source of fire or equipment to be protected (without blocking access for operation and maintenance)
- Ventilation flow patterns in the building
- Size of area to be protected
- Objects possibly blocking the heat flow to the detector, e.g. system cabinets, cable trays etc.

In enclosed, mechanically ventilated modules point heat detectors are 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. The maximum distance from a bulkhead to be no further than 3.5 m (12 ft).

Heat detectors shall not be applied in areas where ceiling heights are above 8 m (26 ft).

The use of smoke modelling software may be employed to assist in siting point heat detectors.

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.

4.2.3.2 Pneumatic (Linear and point)

Pneumatic 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 FGS and provide alarm and other cause and effect identified actions when activated.

When pneumatic detection technology is required for fire detection, pneumatic tubing shall be used. At approval of the Principal, frangible bulb or fusible plugs may be used.

In case of Well head areas, facilities SHALL [PS] be provided to allow collective closure of all wells sub surface safety valve (SSSV) automatically upon confirmed fire in the wellhead area as detected by pneumatic fusible plugs or frangible bulbs. For offshore installations, this fire detection system shall also initiate a full platform shutdown.

Where pneumatic systems are used in hydrocarbon areas then the detection shall be installed locally to the expected fire sources, and at the required spacing for detection of the identified fire sizes.

When used as a heat detection system it shall detect the fires within sufficient time to initiate appropriate actions, and if relevant, activate the deluge firewater valve directly and independently from the FGS system.

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.

These 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. They shall also have a means to lock the air in the fire detection loop on loss of air supply to the individual detection loop.

Polytube shall be protected from accidental damage in such a manner so as to not affect its detection capability.

Stainless steel tubing shall be used between the detector station and the Polytube at the fire hazard area.

All joints in the system shall be taped or coated with insulating varnish.

A vent valve (for system testing and manual actuation) 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.

At approval of the Principal a fire loop may use nitrogen as the medium, and a typical installation example is in Appendix G.

4.2.3.3 Electrical or Optical Fibre (Linear)

Linear wire shall only be used at the approval of the Principal.

Linear heat detection may be used to supplement other forms of fire detection in difficult areas (for example, Tank rims, heavily congested plant areas or where flare radiation may cause false alarms using optical detectors).

Appendix H provides details of linear heat detection for a floating roof.

4.2.4 Smoke Detectors

4.2.4.1 General

Smoke detectors in general shall only be used in areas with potential for non-hydrocarbon fires.

In hydrocarbon processing plants, smoke detectors may be used in normally unoccupied buildings. The use in such applications is determined by the principal from hazard assessment.

The application of smoke detectors in normally occupied buildings is covered by "code".

When required in process areas, the smoke detection technology shall be optical. Ionisation detectors may be used at the discretion of the Principal (due to possible false alarms caused by dust or steam).