

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. This DEP is for global application. 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 2018; 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.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
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 Fire	Typically two or more detectors within a zone reporting fire, or single detector plus confirmation by Operations.
Confirmed Gas	Typically two or more detectors within a zone reporting gas, 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 and Gas System	The fire and gas system includes the following components: • Detectors (fire, smoke, flammable and toxic gas, acoustic leak); • A logic solver; • Panel(s); • 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; • Direct outputs, such as fire suppressants, audible and visible alarms; • Interfaces to other systems, e.g., SIS, DCS; • FGS Engineering Station.
Flammable Gas	For the purposes of this document, flammable gas refers to those gases or vapours that can be ignited (e.g., hydrocarbons, hydrogen).
HSSD	High sensitivity smoke detection; typically aspirated with detection points based on modelling. Commonly known as Very Early Smoke Detection Apparatus (VESDA).
Intelligible message	An intelligible message is defined as one, which alerts inattentive listeners that the message can concern them, and which is then substantially understood when repeated once, even though some individual syllables or words might 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).
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.
Occupied building	Building that personnel occupy while doing a major part of their work. For full definition, examples, exceptions, and additional inclusions, refer to DEP 34.17.10.32-Gen., Section 1.3.2.
OR	Logical operator, a single requirement satisfies.

Term	Definition
1ooN	The detector 1 out of N (1ooN) voting logic requires a single detector to trigger, (e.g., this is a non-voted configuration). N represents the number of detectors within the zone.
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.
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
ALARP	As Low as Reasonably Practicable
ASU	Alarm Summary Unit
BPCS	Basic Process Control System
CCTV	Closed Circuit Television
DCS	Distributed Control System. Also referred to as BPCS (Basic Process Control System)
2D	2 dimensional
3D	Three Dimension

Term	Definition
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Emergency Shutdown
F&G	Fire & Gas
FAR	Field Auxiliary Room
FAT	Factory Acceptance Test
FFSIS	Foundation Fieldbus™ Safety Instrument System
FGS	Fire and Gas System
FPSO	Floating Production Storage and Offloading facility
GOR	Gas to Oil Ratio
HART	Highway Addressable Remote Transducer
HEMP	Hazards and Effects Management Process
HF	Hydrogen Fluoride
HFA	Hydrofluoric acid
HLG	High Level Gas Alarm
HMI	Human-Machine Interface
HSSE	Health, Safety, Security and Environment
HVAC	Heating, ventilation and air-conditioning
I/O	Input/Output
IMS	Ion mobility
IR	Infrared
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

Term	Definition
MAC	Manual alarm call
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	Quantitative Risk Assessment
RFI	Radio Frequency Interference
RH	Relative humidity
RTD	Resistance Temperature Detector
SAT	Site Acceptance Test
SER	Sequence of Events Recorder
SIF	Safety Instrumented Function
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
VDU	Visual Display Unit
Vol	Volume

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 is a revision of the DEP of the same number dated February 2018. This is an administrative update only to correct references to DEPs that have been involved in either a merge or a split.

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://www.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 AND SMOKE DETECTION SYSTEM

2.1 GENERAL

Fire, Gas and 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.

The Fire, Gas and Smoke detection system enables mitigation of hazardous conditions such as fire or loss of containment by performing three basic functions:

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

The three basic functions are described in sections (2.2) through (2.4).

2.2 DETECT THE HAZARD

1. Fixed Fire, Gas and Smoke detection equipment shall provide, within practical limits, the earliest detection of emerging or significant hazards, specifically for the following:
 - 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).

2.3 ALERT PEOPLE

1. The Fire, Gas and Smoke detection system SHALL [PS] perform the following:
 - 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 and Smoke event at the emergency control points to facilitate management of the incident.

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

2.4 INITIATE ACTION

1. The Fire, Gas & Smoke detection system shall initiate automatic executive actions, 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.

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 and gas hazards which forms the basis of the Fire, Gas and Smoke system design.
2. The system design process shall include the following steps:

- a. Zone definitions (containment, fire, hazard);
- b. Detection requirements per zone;
- c. Fire, Gas and Smoke system hardware robustness requirements;
- d. Fire, Gas and Smoke system cause and effects matrix.

3.2 DEFINE SITE ZONES (FIRE ZONES)

1. Identification of zone boundaries shall take account of the following geographical features:
 - a. firewalls;
 - b. bundwall;
 - c. decks and module levels;
 - d. roadways;
 - e. buildings;
 - f. HVAC items;
 - g. fire protection systems;
 - h. facility extremities.

3.3 ESTABLISH FIRE GAS AND SMOKE SYSTEM INTEGRITY REQUIREMENT

Fire, Gas and Smoke systems are safety instrumented systems (SIS) and as such DEP 32.80.10.10-Gen. applies.

1. The design, sensor selection, logic solver, horns/beacons, installation and maintenance of the Fire, Gas and Smoke system shall comply with the requirements of DEP 32.80.10.10-Gen. with the following exceptions:
 - a. The fire gas and smoke system logic solver shall be specified, designed, and installed as suitable for use in a SIL 2 (or better) system.

This is a prescriptive integrity (SIL) requirement, and as such DEP 32.80.10.10-Gen. section 4 (Risk Analysis and Allocation of Protection Layers) does not apply.
 - b. Gas and Smoke detection protective functions on HVAC air intakes for process and equipment buildings (e.g. Field Auxiliary Rooms, Substations, Temporary Refuges, Control rooms and turbine enclosures) shall be specified to meet SIL 2 from the detection device(s) to the SIS input card, including any sensor voting arrangements (i.e., the SIF input sub-function).

This means the sub function is required to meet a prescriptive SIL 2 target, thus DEP 32.80.10.10-Gen. section 4 does not apply.
 - c. All other Fire and Gas detection devices (including detection in outdoor process areas), shall be suitable for use in a SIL 1 (or better) function.

This does not mean the Fire and Gas function is required to meet SIL 1, simply that the detection devices have been verified as suitable for use in such service – this is a quality control measure. As such DEP 32.80.10.10-Gen. does not apply to these devices.

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

1. A Fire, Gas and Smoke system design requirements document (and Fire, Gas and Smoke system philosophy) shall be written and maintained that includes the following:

- 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 and Smoke detection systems;
- b. Summary of the overall Fire, Gas and Smoke detection system (e.g., system architecture), including diagnostic capabilities associated with Fire and Gas 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 Manufacturer/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 and Smoke detection mapping;
- k. Operator competence, knowledge and training requirements;
- l. Facility to capture sequence of events.
- m. Statement of resilience of the system against unnecessary trips and alarms, e.g., when defining size of voted zones, trip logic, and alarm level sensitivity.

3.5 DETAILED DESIGN OF FIRE, GAS AND 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, velocity (duct detectors), 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).