MANUAL

FIRE, GAS AND SMOKE DETECTION SYSTEMS

DEP 32.30.20.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the type selection, specification and installation of fire, gas and smoke detection systems (FGSs). This is a revision of the DEP of the same number dated August 1987.

FGSs shall detect at an early stage:

- the presence of flammable and toxic gases
- incipient fires
- the presence of a fire.

In order quickly to assess the overall situation in the event of an alarm in highly hazardous and low-manned areas with limited direct visibility, remote plant surveillance by means of Closed Circuit Television (CCTV) may also be considered as a supplementary item, but **not** as a replacement. For further information on CCTV, refer to DEP 32.71.00.10-Gen.

Procedures for toxic gas detectors which are in compliance with Category 2 as defined in (2.3) are outside the scope of this DEP. For Category 2 type toxic gas measurements, the procedures described in DEP 32.31.50.12-Gen. shall apply.

For situations which are not covered in this DEP the codes of the USA National Fire Protection Association (NFPA) should be consulted.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of or managed by the Royal Dutch/Shell Group, and to Contractors nominated by them (i.e. the distribution code is "C" as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable, in supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may 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 as regards 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 with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which 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 which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. 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 word **should** indicates a recommendation.

1.3.2 Abbreviations

DCS	-	Distributed Control System
FGS	-	Fire, Gas and Smoke detection system
HSE	-	Health, Safety and Environment
IPF	-	Instrumented Protective Function
IPS	-	Instrumented Protective System
LED	-	Light Emitting Diode
LFL	-	Lower Flammable Limit
STEL	-	Short Term Exposure Limits
TLV	-	Threshold Limit Value

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 (6).

2. FIRE, GAS AND SMOKE DETECTOR SELECTION

2.1 GENERAL

FGSs and their related detection systems shall comply with the requirements of instrument protective functions as specified by DEP 32.80.10.10-Gen.

The estimated quantity, general type selection and probable location of detectors is determined by assessing the fire safety as described in DEP 80.47.10.30-Gen. The number and location of the detectors shall be indicated on the master plan of fire safety systems.

The exact number and location of fire, gas and smoke detectors and their associated equipment (horns, beacons, etc.) shall be determined by the Contractor, in consultation with the Principal, during detailed engineering.

The make and specific type of fire, gas and smoke detectors required shall be stipulated in the project specification. The hardwired interface between the detector or control unit and the FGS IPS shall be either 4-20 mA or potential-free contact.

The construction of the detector should allow calibration and verification by a single person.

Gas detectors are used for detection of leakages from potential sources of leakage, taking into account their proximity to accumulation areas, possible sources of ignition, work areas and public places.

For general information on heat detectors, refer to Appendix I of this DEP.

Spot-type (individual) monitoring should be applied for detectors, unless zone monitoring is approved or specified by the Principal.

NOTE:

1) Spot-type (Individual) monitoring

   Each detector is considered on an individual basis in order to provide a one-to-one alarm / message presentation to the operator, i.e. each alarm / message represents one detector only.
   This can be achieved by applying :
   - a serial pulse-code type data transmission (bus) between the detector and the rest of the system, in which case a number of detectors are interconnected in series and terminated to one system input. Serial pulsed coded detectors are not allowed for IPF class III and higher unless TÜV Bayern or Rheinland approved according to the requirement class (AK class) that is related to the IPF class.
   - an analogue data transmission between the detector and the rest of the system, in which case each detector is connected to an individual system input (star configuration).

2) Zone monitoring
   A number of detectors are connected to one system input only, to provide an 'n' to one alarm / message presentation to the operator, i.e. one common zone alarm / message represents any one of these detectors.

2.2. FLAMMABLE GAS DETECTOR SELECTION

2.2.1 General

In open process plants, the hydrocarbon-containing equipment is so designed that, should leakages of flammable material occur, they are not very likely to escalate into fires or explosions within the confines of the plant. This is achieved by optimising the lay-out during the design stage such that the probability of coincidence of a flammable vapour-air mixture and known electrical or other sources of ignition is reduced to an acceptable level

Nevertheless, hydrocarbon releases with a high potential for escalation shall be detected promptly. Instrumented detection is indispensable if detection by personnel or by other means is likely to be too late to prevent escalation of the incident.

2.2.2 Selection of point detectors

Flammable gas detectors shall be selected from following types:

- Infrared absorption type
- Catalytic combustion-type.

When catalytic combustion type detectors are selected, these shall be poison resistant. Use of non-poison resistant sensors require the approval of the Principal, who shall be made aware of the restricted lifetime of non-poison resistant sensors.

Infrared type gas detectors have distinct advantages with respect to:

- fast response times;
- poison resistance;
- maintenance load;
- a high degree of fail-safety; and
- self-diagnostic features.

Infrared type gas detectors are only responsive to a limited group of hydrocarbons and may therefore not cover all situations. Beyond that, infrared absorption is the preferred technology.

2.2.3 Area/perimeter monitoring

2.2.3.1 Optical type detectors

"Open path gas monitors" can be used to monitor a complete area or to monitor the perimeter of a process unit. These optical-type instruments monitor a given area or perimeter for the presence of flammable gas.

Open path gas monitors for other than flammable gas shall be used only with the approval of the Principal, because there is as yet little experience with this type of instrument.

For area monitoring, at least two open path instruments shall be applied. For monitoring a jetty or the border between e.g. an existing operating process unit and a unit under construction or shut-down, one (1) monitor is normally sufficient.

NOTE: Open path gas monitors:

1) Typically have a random drift of 0.25 LFLM (25% LFL extended for one metre) and a minimum alarm level setting of 0.5 LFLM (50% LFL extended for one metre). That is, it can be set to give an alarm if there is a flammable gas cloud of 5% LFL over a distance of 10 metres or 0.5% LFL over a distance of 100 metres.

2) Are available covering distances from 10 to 300 metres. However, an optimum distance is 50 metres. When an open path gas monitor is used over a distance of 100 metres or more it may give nuisance alarms (these are true alarms but are a nuisance because clouds of a very low concentration of flammable gas may not constitute hazardous situations). In that case it is better to raise the alarm level setting. On the other hand, small gas clouds with a high flammable gas concentration may not be detected and may thus create a hazardous situation.

2.2.3.2 Acoustic type detectors

Acoustic type detectors may be used only with the approval of the Principal.

Because of the spatial coverage, this type requires a limited number of acoustic detectors to be installed as compared to single point detectors (2.2.2). Detectors may be sensitive to high-pitch noise, although they should be immunised for the most common frequencies outside the bandwidth that is characteristic for leaking gases.

2.3 TOXIC GAS DETECTOR SELECTION

2.3.1 General

Release of toxic gases into the atmosphere will generally create a health hazard rather than an explosive hazard, although ultimately the latter situation may develop, for example, with carbon monoxide or hydrogen sulphide. Generally the concentrations at

which toxic gases need to be detected are at a far lower level than is applicable for flammable gas detection. Flammable gas detectors shall therefore not be used for the detection of toxic gas, even if the latter coexists with a flammable gas of a different compound, e.g. H_2S in combination with a hydrocarbon mixture.

Detectors for toxic gases may be considered in two major categories as follows:

Category 1:

Detectors for gases which create an immediate health hazard (danger to life), e.g. hydrogen sulphide, carbon monoxide, hydrogen fluoride, hydrogen chloride, chlorine gas. These gases usually have a STEL which is slightly higher than the TLV.

The following applies for the selection of detectors in category 1:

- Detection shall be fast and reliable and preference shall be given to speed of response over precision;
- All aspects of HSE shall be included in the design study.

Category 2:

Detectors for gases which create a health hazard on long-term exposure, e.g. carcinogenic gases such as vinyl chloride, benzene, toluene, etc.

For detectors in this category the following applies:

- Detection shall be reliable and precise;
- TLV (threshold limit values for an 8 hour working day) shall be monitored;
- HSE aspects shall be included in the design study;
- A logic control system with capabilities such as statistical analysis and a data base to enable collection of long-term exposure data is very important and should be considered.

2.3.2 H_2S gas detectors

H_2S gas detectors shall be selected from the following types:

1. The electrochemical cell-type.

This is the preferred type.

NOTE:
1) This type is based on an electrochemical cell which reacts exclusively to H_2S.
As a result of the chemical reaction of the cell organic electrolyte with H_2S, an electric current is generated which is proportional to the H_2S concentration in the sample gas.

2) Electrochemical cells have a restricted lifetime of typically one year from the date of installation, but life is not adversely affected by ambient conditions

2. The semi-conductor type.

NOTE:
1) The semi-conductor type is based on the adsorption of H_2S molecules on the surface of a solid state semi-conductor crystal, which causes a change in resistance of the electrical circuit of which the semi-conductor forms part. The change in resistance is proportional to the H_2S concentration in the sample gas.

2) Semiconductor type sensors theoretically have an infinite lifetime. However life is adversely affected when exposed to poisonous contaminants (e.g. paint solvents) or when exposed to humid atmospheres (even for periods of less than 24 hours) or when not regularly exposed to small H_2S concentrations (causing a loss of speed of response, which effect is usually reversible).

2.3.3 Other toxic gas detectors

For the detection of most other toxic gases of category 1 (2.3.1) electro-chemical sensors are most commonly used.

NOTE: CO is sometimes measured with infrared type instruments, but these are then usually applied in the aspirating mode, requiring aspirating compressors, a sampling system, etc.

2.4 FIRE AND SMOKE DETECTOR SELECTION

2.4.1 Detector type selection

2.4.1.1 General

Detectors shall be selected from the following list, depending on their specific properties and their specific field of application.

In the first instance, the following types of detectors shall be considered:

- Detection by persons (with manual call points)
- fire detection tubing
- infrared (IR) fire detectors
- Smoke detectors, e.g.
  - scattered-light type detectors
  - ionisation-type detectors.

Other types of detectors may be considered for specific applications, such as:

- Heat detectors, e.g.
  - quartzoid bulbs
  - fusible alloy links or plugs
  - heat sensitive cable
  - compensated rate-of-rise heat detectors
  - combination of fixed temperature and compensated rate-of-rise heat detectors
- Fire detectors, e.g.
  - ultraviolet (UV) fire detectors.

2.4.1.2 Detection by persons

Manual call points shall be of the break-glass, auto-release type.

The complete housing of manual call points installed outdoors shall be constructed in accordance with requirements for the classified hazardous areas, be corrosion-resistant and fully weather-proofed. For identification, they shall be coloured red to DIN Standard RAL 3000 or equivalent.

2.4.1.3 Optical type fire detectors

Optical detectors shall have automatic self-checking facilities.

1) Infrared type fire detectors

These shall be solar blind should be applied only where fast detection of a hydrocarbon fire, or of other flammable products with a high hydrocarbon content, is of prime importance. The design of the detectors is based on the flame-flicker principle, i.e. the detector responds to the flickering of most hydrocarbon fires. They are not suitable for the detection of smouldering fires.

NOTE: IR type fire detectors have an upper ambient temperature limit of 70 °C.

2) UV type fire detectors

Ultraviolet light type detectors are also extremely fast in detecting fire but they should not be applied in dusty environments or in an environment with airborne oil droplets or where fires are expected to produce heavy smoke which may foul the lens. The detectors shall have an automatic self checking facility.

UV detectors are normally applied, for example, for fire detection under the hood of gas turbines.

NOTE: 1) UV detectors are subject to interference from welding activities, X-rays used in non-destructive testing, direct sunlight and lightning.

2) These detectors have an upper ambient temperature limit of 150 °C.

2.4.1.4 Smoke detectors

Scattered light type of detectors should be used.

This type is particularly sensitive to incipient and smouldering fires which develop relative large smoke particles.

Ionisation-type detectors may be considered when scattered light type of detectors are not suitable for the application. If ionisation-type detectors are selected they shall be selected from the models employing an Am^{241} ionising radiation source with an activity of less than 0.1 micro curie. Ionisation-type of detectors are sensitive to fully developed fires which release fine aerosols. Ionisation-type detectors should be applied only in combination with heat detectors for the detection of smouldering fires in buildings.

NOTE: The application of this type of detector may be restricted due to the fact that the detection principle employs a small radioactive source.

Infrared open path smoke/oil mist detectors may be used only with the approval of the Principal.

2.4.1.5 Ultra-sensitivity smoke detectors

These are used for the rapid detection of incipient fires in control buildings, system cabinets, computer rooms and similar. They are usually configured around an aspirated system. The Principal shall be consulted for the selection of this type of equipment.

2.4.1.6 Heat detectors

Heat detectors should be applied for the detection of fires which are expected to build up quickly and generate much heat. They generally have a low spurious alarm rate, but are slow in detecting fires. They may also be applied as a back-up for fire detectors in, for example, gas turbine enclosures (Appendix I).

3. SYSTEM ENGINEERING, SPECIFICATION AND INSTALLATION PRACTICES

3.1 GENERAL

FGSs are typically used to initiate the following functions automatically or manually:

- Audible and visual alarms/messages in the control centre and/or in the plant. Additional alarm/message presentation and/or control shall be provided when specified, e.g. in the gate-house, storage area and jetty, etc.
- Messages of emergency situations to local community services, e.g. fire brigades, etc.
- Starting of fire fighting equipment, e.g. fire water pumps, water spray and fog systems, etc.
- Activation of safeguarding and depressuring (blowdown systems).
- Automatic closure of air ventilation inlets.
- Personnel evacuation systems (barriers, howlers, etc.)

For each project a cause and effect matrix shall be prepared. For a typical cause and effect matrix refer to Appendix II. The final cause and effect matrix shall be submitted for approval by the Principal.

The design of an FGS shall be in compliance with DEP 32.80.10.10-Gen. Additionally:

- Initiators of FGSs shall be normally closed contacts unless otherwise specified by the Principal.
- When gas/fire detection is provided for specific plant equipment, such as a turbine which is equipped with its own dedicated control/safeguarding system, the output of the gas/fire detection system shall be used as a (shut-down) initiator for the control/safeguarding system of that piece of equipment as appropriate. This may also be the case for batch processes, where the output of the FGS shall be fed as a (shut-down) initiator to the logic controller of the batch process.

  NOTE: In particular, packaged units, e.g. gas turbines, may be fully self-contained and separate from the general signal processing control module.

Due to the requirement that the FGS has an availability in case of power failure different from the control and IPSs, and because the operator may, for Fire and Gas IPFs up to class IV, be one link in the IPF chain, the operator interface shall be via the following routes:

- DCS VDUs

and

- hardwired mimic panel if the IPF class is III or higher.

At locations where colour coding of visual alarms and arrangements for audible alarms already exist and are different from those described below, the Principal shall decide which coding system will be applied for any extensions or new FGSs.

3.2 HUMAN-MACHINE INTERFACE (HMI)

3.2.1 Hardwired mimic panels

The hardwired mimics shall contain simplified geographical lay-outs of the plant area which is to be monitored, showing all traffic access gateways, roads and major plant equipment for each process unit. The lay-out shall be in accordance with the plot plans. The indications on the mimic panel shall be driven via hard-wired signals from the FGS IPS.

The mimic panel shall be ergonomically integrated with the DCS console. The size of the panel requires the approval of the Principal.

The FGS IPS shall group together all types of FGS inputs for a single zone (unit or piece(s) of equipment). If any input is in the alarm state, a zone (unit) fire alarm LED on the mimic panel shall operate. Separate 'zoned' indications shall be provided for fire, flammable gas, toxic gas and system alarms.

Detector types shall be indicated by means of coloured LEDs. The colour code shall be as follows:

- toxic gas : yellow,
- flammable gas : blue,
- fire : red,
- system fault : white,
- fire water pump running lights : green,
- other alarms : red.

Flammable gas visual alarms should distinguish between H and HH values by assigning one LED to H and one LED to HH level.

The mounting of the LEDs shall be such that they protrude at least 3 millimetres above the surface of the panel to enable recognition of an alarm from various angles.

The following plant common alarms shall be grouped in the top left-hand corner to facilitate quick appraisal by operating personnel. Each alarm shall be presented by means of a coloured lamp and the corresponding text as appropriate.

- fire,
- flammable gas,
- toxic gas,
- fire water pump auto-start stand-by indication,
- system fault,
- utility fault,
- UPS fault.

The normal situation shall be indicated by extinguished LEDs and lamps on the mimic. In the event of an alarm the relevant LEDs and lamps shall start flashing. After acknowledgement the flashing shall stop and change into steady light, but be reactivated on the recurrence of any alarm condition. Return to the normal situation, after acknowledgement, shall extinguish the LEDs and lamps.

The audible alarm annunciation in the control room shall be by means of a buzzer mounted at the rear of the mimic having an intermittent tone at 2000 Hz, which shall stop when the operator acknowledges the alarm by means of a button on the mimic. An all-clear signal shall not be provided in the control room.

A wind speed and direction indicator shall be mounted in the top right-hand corner. Plant north shall be indicated on the mimic by an arrow.

For a typical layout of a mimic panel refer Appendix III.

Design and construction of the mimic panel shall provide a scratch-proof, non-reflective plastic surface. A degree of 'mosaic', e.g. multi-tile, lay-out shall be provided to facilitate future modification of the panel. The mimic panel shall be delivered by the FGS IPS

Supplier. The layout and design shall be provided by Contractor.

Additional mimics, possibly with control, shall be provided if specified, e.g. in the gate-house, storage area, jetty and temporary refuge.

The following controls, mounted in the bottom section of the mimic panel, shall be available to the operator:

- Lamp Test: a non-latching push button to test all indication lights on the mimic.
- Acknowledge: a non-latching push button to change all alarm lights (except for the plant beacons) from flashing into steady and to silence the audible alarm in the control room.

  NOTE: Pressing this acknowledge button will not acknowledge the DCS alarm. The operator has to acknowledge the DCS alarm separately.
- Reset: a non-latching push button to reset all visual and audible alarms, provided that all initiators have returned to normal.
- All-Clear: a non-latching push button to initiate an all-clear signal in the buildings and in the plant.
- Fire Alarm: a non-latching push button to manually initiate a fire alarm with effects similar to the activation of a break glass push button.
- Toxic Gas Alarm: a non-latching push button to manually initiate a toxic gas alarm in the relevant unit.
- Flammable Gas Alarm: a non-latching push button to manually initiate a flammable gas alarm in the relevant unit.
- Start Fire Water Pumps: a non-latching push button to manually start the fire water pumps start sequence.

  NOTE: It shall not be possible to stop the fire water pumps from the mimic panel.
- Fire Water Header Pressure Controller: a single loop fire water header pressure controller.
- Close Dampers: latching push buttons to manually close the dampers.
- Water spray valves: three-position switches with the positions and related text: open, auto and close. The positions of the deluge valve switches shall be monitored such that if a switch is not in the auto position an alarm is presented at the DCS.
- Water spray valve reset: non-latching push buttons to reset the water spray valves.

The fire, toxic gas and flammable gas alarm push buttons shall be of the illuminated type to indicate that fire, toxic gas and flammable gas alarms were initiated from that location. The start fire water pumps push button shall also be of the illuminated type, the lamp shall be on when the fire water pumps start sequence has started.

Depending on the application of the FGS, operator controls in addition to those indicated above may be required (e.g. remote release of extinguishing agent), and will be indicated by the Principal on the preliminary cause and effect matrix.

Where the controls mentioned above are non-latching push buttons, the fire and gas detection system shall be able to accept the pulse input from these switches. All manual operator controls with their related effects shall be indicated in the project cause and effect matrix.

3.2.2 Distributed control system

The operator interfaces shall be grouped together to form a dedicated FGS DCS operator console. All individual FGS alarms shall be presented to the operator via a FGS DCS operator console.

The number of operator stations in the console shall be at least two. It shall be possible to use each of the operator stations as a back-up for the other(s), thus providing revealed failure robustness.

The hierarchy of displays shall be as follows:

- Area Overview Display - This shall show the relevant plants as a simplified plot plan. If there is any fire, smoke, flammable gas, toxic gas or system fault alarm present in a plant, the plant box shall fill red (yellow for revealed failure robust initiators with only one of the initiators in alarm), flash until the alarm is accepted and remain steady until all abnormal states are healthy again. A flashing message shall come up indicating whether a fire, smoke, flammable gas, toxic gas or system alarm has been detected. The message shall steady upon acceptance and clear when the initiators return to normal. The boxes and message shall re-flash if a new condition of the same type occurs in that plant using the same basic principles as for the mimic panel. Wind speed and direction shall be shown on this display. It shall be possible to call up the plant displays from each box via touch screen or equivalent method.
- Plant Overview Displays - One plant overview display shall be provided for each plant. This shall show the various units in that plant as a simplified plot plan. If there is any fire, smoke, flammable gas, toxic gas or system fault alarm present in a unit, the unit box shall fill red (yellow for revealed failure robust initiators with only one of the initiators in alarm), flash until the alarm is accepted and remain steady until all abnormal states are healthy again. A flashing message shall come up indicating whether a fire, flammable gas, toxic gas or system alarm has been detected. The message shall steady upon acceptance and clear when the initiators returns to normal. The box and message shall re-flash if a new condition of the same type occurs in that unit using the same basic principles as for the mimic panel. Wind speed and direction shall be shown on each of these displays. It shall be possible to call up the unit displays from each box via touch screen or equivalent method.
- Unit Detailed Displays - One unit detailed display shall be available for each process unit, each building, substation and analyser house and one for the FGS, utility and UPS fault conditions. In the case of process units, the displays shall consist of a simplified unit layout showing the approximate physical locations of individual sensors. For buildings, all fixed fire-protection and fire control systems shall be shown on the geographical lay-out (including fire walls, smoke doors and dampers). When an initiator is in alarm, the symbol shall turn red and flash until it is accepted whereupon it shall steady until it returns to normal. A similar method showing the FGS layout shall be used for presenting FGS, utility and UPS fault alarms.

All FGS alarms shall be presented via the standard DCS alarm displays and be logged and printed via the standard DCS alarm logging facilities. Standard DCS audible warning shall be provided.

For analogue inputs, trending shall be undertaken using the standard DCS trend facilities.

Historical data shall be archived using the standard DCS archiving facilities.

A dedicated DCS printer shall be available to print out all fire and gas alarms, system faults and other events in order of occurrence. The alarm message shall contain time, tag number, description, process data and the type of alarm.

3.2.3 Sequence of events recorder (SER)

A dedicated FGS SER should be provided.

3.2.4 Means of communication

Telecommunication facilities such as telephone, plant radio, public address system etc. shall be provided on the FGS console.

3.2.5 Buildings

Annunciation in the buildings for fire, gas and smoke alarm in the building itself, including auxiliary rooms and offices, shall be by means of a bell with an intermittent ring having a mark-space ratio of 1:1 and a cycle time of 2 seconds. Duration of the annunciation after initiation shall be fully adjustable over a range of 1-10 minutes and not be affected by the reset on the mimic.

The all-clear signal in the control centre shall be a continuous ring of the bell. The duration of the all-clear shall be adjustable between 10 and 120 seconds. The same arrangements should also be applied for satellite buildings, gate house and fire station.

The number and location of the bells shall be specified in the requisition of the FGS of the building, which is usually supplied by the Civil Contractor.

3.2.6 Field

If specified by the Principal the detection of a fire shall be announced by audible means in the field.

Detection of toxic and flammable gas shall be indicated by stroboscopic beacons and shall be announced by audible means in the field.

All detectors, manual call points, horns, beacons and loudspeaker positions shall be clearly indicated on the plot plan of the FGS lay-out drawing(s).

The beacons shall have the same colour coding as the related LEDs on the mimic, to ensure that the correct action is taken in the event of an emergency.

The beacons shall be located so that they will be visible in the area for which they are to provide a warning and are accessible for maintenance. Suggested locations are pipe racks, top corner of analyser houses, the main passages inside auxiliary buildings and on field-mounted panels. Attention shall also be given to the rigidity of supports and the routing and clamping of cables. Tag numbering shall be assigned and be clearly visible from accessible locations.

The audible annunciation in the plant for toxic and flammable gas shall be generated by means of two separate audio-amplifiers. Line and distribution audio-amplifiers shall be suitable to provide the required output levels as specified and should have a balanced line impedance of 600 ohm.

The loudspeaker annunciation for toxic gas shall be by means of an interrupted tone, having a mark-space ratio of 1:1, a cycle time of 2 seconds and a frequency of 1000 Hz. The all-clear signal shall be a continuous tone of 1000 Hz.

The loudspeaker annunciation for flammable gas shall employ two different frequencies, having a mark-space ratio of 1:1, a cycle time of 1 second and frequencies of 1000 and 2000 Hz. The all-clear signal shall be a continuous tone of 2000 Hz.

If the Principal specifies that there shall be audible fire alarms in the field, then motor driven sirens shall be provided. The motor-driven siren annunciation for fire shall be by means of an on-off modulated tone with a frequency of 520 Hz, the on-time adjustable between 3 and 10 seconds and the off-time adjustable between 1 and 5 seconds.

Duration of the annunciation after initiation shall be fully adjustable over a range of 1-10 minutes and not be affected by the reset on the mimic. The duration of the all-clear shall be adjustable between 10 and 120 seconds.

The sound level of loudspeakers and sirens shall be at least 6 dB(A) above the area noise in all areas, but not more than 120 dB(A) at 1 metre distance on the main axis. The number of loudspeakers and sirens shall be selected accordingly. During the engineering stage, it may be possible to utilise a computer noise simulation to optimise the number and the location of horns and loudspeakers. Sirens and loudspeakers shall be installed in accordance with DEP 31.10.00.31-Gen.

If a piping model is available, the detectors, horns, beacons and loudspeaker positions should also be finalised on the model after the model review. Instrument and safety engineers shall contribute to this Choice.

Manual call points with the facility of an electronic location code should be wired into loops so that the resulting alarm indication will direct fire appliances and personnel to the specific spot, road or building from where the call was initiated.

Local fire water pump start and stop buttons shall be provided near to the fire water pumps. These buttons shall be wired directly to the electrical switch gear and not via the

IPS.

Electrical apparatus for use in gas hazardous areas shall be selected in accordance with the guidance given in the DEP 32.31.00.32-Gen.

Functional checks shall be carried out before plant commissioning, noise levels shall be checked and the number of horns and loudspeakers increased or reduced as found necessary.

3.2.7 Communication interfaces with other systems

With DCS:

the individual contacts which are communicated from the FGS IPS to the DCS shall remain latched open until the initiator returned to normal and is reset from the mimic.

With other systems:

no sub-systems communications shall be applied. Interfaces between IPS and other systems shall be hard-wired. Fire detection systems for buildings shall provide per zone a potential free output as an initiator to the FGS.

With local community services:

automatic or manual relay of warnings of emergency situations to local community services, e.g. fire brigades, etc. shall be provided.

3.2.8 Overrides

Inputs to the FGS from initiators having executive actions other than alarming in the control room, shall be provided with maintenance override facilities to allow testing of such inputs.

Operational overrides shall not be used for FGSs.

3.3 DETECTOR STANDARDS

3.3.1 Standards of construction and performance

Construction and performance of fire, gas and smoke detectors shall meet the standards of the country where they will be used. In the absence of national standards, the following European standards shall be followed, unless otherwise permitted by the Principal.

- Heat detectors	EN 54
- Flame and ionisation-type detectors	EN 54
- Combustible (flammable) gas detectors	EN 50054, EN 50055, EN 50056, EN 50057, EN 50058

The housing of detectors for use in process areas shall be stainless steel AISI-316. Use of carbon steel or anodised aluminium material requires the approval of the Principal.

3.3.2 Standards of certification

Electrical certification of fire, gas and smoke detectors shall be in compliance with local regulations. In lieu of such regulations IEC 79 shall be followed. In addition to that:

- non-certified (general purpose) detectors may be used only for fire, toxic gas and smoke detection in non-hazardous areas;
- fire, smoke and gas detectors for use in process areas shall be certified for use in zone 1 areas as a minimum;
- flammable gas detectors for use in all areas shall be certified for use in zone 1 areas as a minimum.

3.4 CONTROL MODULES

Transmitter types of sensors do not usually require a control module. This section applies to control modules for other types of gas detector.

The failure of a circuit in a multiple detector input/output module should not affect other circuits. If so, the circuit concerned shall be revealed failure robust.

Control modules should be suitable for single man calibration (refer also to Section 2).

The control module shall contain as a minimum the following self-diagnostic features:

- open loop detection (input and output)
- short circuit (input and output)
- earth fault(s)
- power supply failure, e.g. low battery voltage (of UPS)
- control unit failure
- system fault
- end of sensor life (if applicable).

Any of the above failures shall interrupt the associated hard-wired output signals from the control module to the FGS IPS, thereby forcing a failure alarm for each affected function.

Alarm level(s) settings shall be protected against changes by unauthorised persons, e.g. by means of a key lock.

3.5. ALARM LEVEL SETTINGS

Alarm levels for gas detectors for personnel protection should not be set at levels higher than the STEL levels. For the current recommendations on STEL levels refer to the HSE executive assigned to the project.

For Flammable gas detectors the alarm level setting shall be:

- 10% LFL as minimum for point detectors;
- 1 LFLM typically for open path detectors (see 2.2.3.1).

NOTE: The typical long term random drift of flammable gas detectors is in the order of 5% LFL. Setting the alarm level at 10% LFL minimum prevents false alarms.

For H_2S gas detectors the alarm level setting shall be minimum 10 ml/m^3 H_2S.

NOTE: The typical long term random drift of H_2S gas detectors is in the order of 5 ml/m^3 H_2S. Setting the alarm level at 10 ml/m^3 minimum prevents false alarms.

3.6. REQUIREMENTS FOR CIRCUIT INTEGRITY.

FGSs shall be robust against spurious activation.

When normally de-energised actuating circuits are applied, pneumatic systems, e.g. for the activation of valves, shall be connected to a secured instrument air system of which the components shall be fire resistant, e.g. ASI 316 tubing instead of copper tubing. Refer to DEP 31.37.00.11-Gen.

Critical instrument and electric cabling shall be installed in such a way that they are protected against direct heat radiation and flame impingement. If this is not possible special fire-resistant cables shall be used, which have a minimal 30 minute fire rating.

Exposed field cables shall be of a fire resistant type, with a minimal 30 minute fire rating, if they are required to function when exposed to fire.

Electric circuitry shall be enhanced with line monitoring facilities. Line monitoring shall be able to discriminate between safe condition, alarm condition, open loop and short circuit.

Digital inputs from the initiators shall comply with the following.

- Field initiators should be individually wired to the control module or to the FGS IPS. Normally closed contacts shall be applied. Line monitoring shall be achieved by serial and parallel resistors at the initiators. The resistors shall be placed as close as practicable to the initiator and should form an integral part of it.
- Zoning of initiators may be applied for buildings. Zoned circuitry shall be achieved by parallel (normally open contacts) configuration of the initiators. The line monitoring shall be achieved by a resistor in series with the initiator which should form part of that initiator and by terminating the circuit by an end of line (EOL) resistor which shall be located furthest away from the control module and which should form an integral part of the last initiator in the chain.

3.7. EXTINGUISHING SYSTEMS

Normally de-energised actuating circuits may be applied if a spurious release of extinguishing agent will result in unnecessary damage to the plant or unacceptable hindrance to the operation of the plant. The risks of such a spurious release shall be assessed.

If carbon dioxide is used as extinguishing agent, 20 seconds notice shall be given before the actual release of extinguishing agent in an enclosed room or cubicle. Annunciation shall be by the same means specified in (3.2.5).

3.8. PURCHASING REQUIREMENTS

3.8.1 Detector specification

For detectors used with pumps which are equipped with 'noise hoods', high temperature resistant detectors shall be specified and the cable between the detector and junction boxes shall be of the fire resistant-type.

3.8.2 Calibration and testing facilities

Where special test equipment is specified for calibration, testing and checking the instrument such test equipment shall be made part of the order.

Calibration gas cylinders with the appropriate calibration gases and all necessary equipment such as pressure regulators, sensor head connections, fittings, etc. shall be part of the order.

A certificate shall be supplied with every cylinder, stating the composition of the gas contained, the date of filling and the expiry date.

3.8.3 System requirements

3.8.3.1 Self-diagnostics and error messages

For detector and control module self-diagnostics, see (3.4).

3.8.3.2 Electro Magnetic Compatibility (EMC)

The design of the FGS shall be such that it is not adversely affected by electromagnetic interference as defined in IEC 801.

3.8.3.3 Electricity supply

Electricity supply for FGSs shall meet the requirements of DEP 33.64.10.10-Gen.

3.8.3.4 Tagging of sensors

A unique number shall be assigned to each detector, manual call point, horns, beacons, etc., in accordance with DEP 32.10.03.10-Gen.

3.9. INSTALLATION PRACTICES FOR DETECTORS AND ASSOCIATED EQUIPMENT

3.9.1 General

Sensor heads shall have safe access for maintenance, e.g. from grade or from a platform. Access shall be possible without the need for scaffolding.

Sensors shall not be located lower than 1 metre above grade or ground level.

Power supply and electronic measuring circuits shall be located in a non-hazardous area, e.g. the auxiliary room of the control centre or field auxiliary room.

3.9.2 Location of gas detectors

3.9.2.1 General

Detector location should be based on typical leakage calculations (kg/hour), taking into account plant and equipment lay-out, prevailing wind speed and direction, atmospheric conditions, etc.

Sensor heads shall be installed such that they are not adversely affected by strong winds or high velocity flows, e.g. in ducting. Therefore, they should not be installed inside ducting. Instead, they may be installed at the inlet or outlet openings, but with sufficient protection, e.g. by wind protection hoods or equivalent.

Gas detectors shall be mounted such that they are protected from influences adversely affecting their functioning, such as sand / dust, spray water, direct rain, salt spray, etc., which can block the flame arrester, or strong winds which can cause excessive drift or reduced output signals.

NOTE: Detectors may be positioned at approximately the same elevation as the potential source of leakage, but should not be less than 1 m above grade level to avoid damage by ingress of splash water.

Gas detectors which are not easily accessible for calibration shall be equipped with a permanent calibration/test connection which is accessible from grade or from an existing platform.

3.9.2.2 Location of flammable gas detectors

The location of flammable gas detectors shall be defined on the basis of an auditable study for each individual application in consultation with the Principal. General guidelines and requirements are given below.

Variables such as prevailing wind direction, wind speed, etc., shall be taken into account when selecting a location.

Typical locations for detectors with shutdown action are where air shall be normally free from flammable gas, such as:

- air inlets for HVAC (heating, ventilation and air conditioning)
- air outlets of enclosed hazardous areas/modules, etc.
- air inlet to analyser houses
- the suction of instrument air compressors
- inlets to furnaces in gas plants
- inlets to air compressors in gas plants
- inlets to breathing air systems.

For flammable gas detection in ducting the sensors shall be installed at the inlet air opening. This ensures the fastest possible response time and obviates the need for sampling systems.

In process units, flammable gas detectors may also be installed near the seals of centrifugal process gas compressors and pumps and in LPG bottling facilities.

The elevation at which the flammable gas detectors are mounted shall reflect the presence of heavier or lighter-than-air gases. The flammable gas detectors shall be mounted below

or above the possible sources accordingly. Collecting cones may be considered, where appropriate.

NOTE: For flammable gas detectors applied to detect leakage from pump glands, a maximum distance of 1 m from the potential leak source is applicable.

3.9.3 Location of H2S gas detectors

3.9.3.1 H2S gas detectors - point detection

Detectors shall be located close to potential sources of leakage, such as at pump and compressor seals, and also at 2 to 4 metres distance to detect further dispersion of gas. Assuming that high H_2S containing equipment has been grouped in the smallest area, a fixed number of detectors around and/or within this area should give an effective cover.

The Hydrotreating/Hydro-desulphurization Process Guide - MFD 136/86 Chapter 8, and the Shell Safety Committee Publication, 'Hydrogen Sulphide' (MF 87-0179) shall be consulted for additional information on H_2S gas detectors.

3.9.3.2 H_2S gas detectors - area monitoring

The location of H_2S gas detectors shall be based on a careful study of the particular plant/project in which all the relevant factors such as process equipment type, potential sources of leakage, concentration of H_2S in the process streams and plant lay-out, etc., have been considered.

As H_2S-containing vapours are often heavier than air and tend to disperse downwards, detectors should be located at levels lower than the expected leak source (but not lower than 1 m above grade). However, if the vapour is lighter than air (possibly due to a higher temperature) detectors should be located at levels above the expected leak source.

Detectors shall be placed along logical entrance routes to an H_2S-containing process area.

Prevailing wind directions shall be taken into account in selecting locations for H_2S gas detectors.

3.9.4 Location and positioning of smoke and fire detectors

3.9.4.1 Smoke detectors

1) General

Ionisation-type and scattered light type of smoke detectors shall be used for enclosed spaces and buildings such as offices, archives, store rooms, medical centres, computer rooms, and instrument auxiliary rooms, etc. (2.4.1.3).

2) Diffusion-type detectors

The following shall be taken into account when selecting the actual location:

- Room ventilation patterns, i.e. draught due to air conditioning.
- The diluting effects of air conditioning and ventilation systems.

Detector spacing shall be in accordance with national/local fire protection standards and the manufacturer's recommendations. Closer spacing shall be applied wherever the characteristics of the protected hazard would impair the effectiveness of detection.

3) Smoke aspirating type detectors

These are generally used for aspirating smoke from the following locations:

- under elevated floors in computer rooms, auxiliary rooms, and inside electrical and auxiliary rooms.
- on cable trays in buildings.

The typical construction of an aspirating type smoke detector employs a detector cabinet

containing up to 5 detectors connected to sample points via sample lines. The detectors share a common aspirating fan, drawing the sample through the lines to the detectors.

3.9.4.2 Fire detectors

Fires can be detected by e.g. the following type of detectors.

1) Heat detectors

Maximum spacing of detectors shall be according to national fire protection standards, taking into account the Manufacturer's recommendations and requirements. Closer spacing shall be applied where the characteristics of the protected hazard would otherwise impair the effectiveness of detection.

Heat detectors shall respond in a timely manner to the development of a fire. Response times depend on the amount of heat transferred from the fire to the detector. Therefore, the following factors shall be taken into account for the positioning of detectors:

- Height of ceiling and depth to which the detector projects below the ceiling.
- Ventilation patterns in the building/room.
- Objects possibly blocking the heat flow to the detector, e.g. system cabinets.

2) Fire detection tubing

Fire detection tubing shall be positioned near to the potential fire source of the equipment to be protected. Fire detection tubing shall be black (i.e. resistant to ultraviolet light), flame retardant polyethylene. The grade shall be "Polyflo 44-PF" (supplied by Imperial Eastman) or "Decoron Tubing FR 1219-4404" (supplied by Samuel Moore) or an equivalent approved by the Principal.

The instrument air in the tubing shall be maintained at a pressure of 2 bar (ga) and shall be connected to pressure transmitters with alarm set at 1.5 bar (ga).

NOTE: The instrument air lines for inter-connections and for connecting the tubing to the instrument air header shall be of plastic-sheathed copper tubing.

For a typical application of fire detection tubing, refer to Standard Drawings S 88.020 and S 88.021.

Systems based on fire detection tubing are vulnerable and prone to failures induced by exposure to chemicals or by mechanical damage. A sturdy alternative is a point detection system with frangible bulb detectors in AISI 316 tee fittings interconnected by AISI 316 tubing and mounted at two metre intervals. An alternative to frangible bulbs is the use of fusible plugs.

3) Optical type fire detectors

Optical type fire detectors are line-of-sight devices and shall therefore be positioned such that they can see the entire section to be protected. They shall be mounted so that they are free from the effects of vibration and shock, spaced in accordance with the manufacturer's recommendations.

Infrared (IR) lenses shall be protected against the effects of water and the possibility of freezing.

NOTE: Certain hydrocarbons and other gases (e.g. carbon dioxide) may interfere with the signal to the IR detector.

Ultraviolet (UV) detectors shall be protected from possible fouling of their windows / lenses while taking care not to degrade their function.

3.9.5 Positioning of beacons

Beacons shall be positioned such that they will be visible in the area for which they are to provide a warning, but they should be accessible for maintenance. Suggested locations are pipe racks, top corner of buildings, and the principal passages inside auxiliary buildings.

3.9.6 Positioning of manual call points

Manual call points shall be positioned such that they stand out against the background, i.e.

they shall be clearly recognisable from a distance. If necessary they shall be provided with signs to enhance their visibility from access roads.

Manual call points shall be positioned as follows:

- Along roads in the plant area at intervals not exceeding 100 m, preferably at or near to lamp posts.
- Along roads in storage / tank areas not exceeding intervals of 200 m.
- Near or at locations having a higher risk such as remote pump floors, oil catchers, manifolds, motor control centres, jetty heads.
- Inside buildings, office entrance, canteens, warehouses, medical centres, gate and guardhouses, etc.
- Inside the plant and positioned:
  - outside power station(s)
  - outside analyser house(s)
  - outside control room(s)
  - outside utility buildings
  - outside hazardous enclosed areas
  - along logical escape routes.

4. INSPECTION AND TESTING

4.1 FACTORY INSPECTION AND TESTING

4.1.1 General

Inspection and testing at the Manufacturer's works shall be carried out in accordance with the requirements of DEP 62.10.09.11-Gen., and the Manufacturer's own procedures.

If specified by the Principal, the Principal shall be invited to witness the Factory Acceptance Test (FAT).

4.1.2 Acceptance test

The detectors and their associated hardware shall be tested prior to shipment at the Manufacturer's works to demonstrate that the system performs as specified.

Testing shall comprise a full check on the operational requirements and on proper functioning of all hardware and, where applicable, software in the system.

Serial communications, if any, shall be demonstrated.

4.2 SITE INSPECTION AND TESTING

4.2.1 General

Inspection and testing shall be carried out on site in accordance with the requirements of DEP 62.10.08.11-Gen. and the Manufacturer's own procedures.

Prior to the site inspection and test, the detectors shall have been calibrated (see Section 5).

4.2.2 Acceptance test

A full site acceptance test shall be performed to demonstrate that the FGS functions correctly. A test manual shall be supplied by the system Manufacturer/Supplier for this purpose. If assistance by the system Manufacturer is required, this shall be specified in the requisition.

The complete FGS and control system shall be commissioned on the basis of realistic tests prior to start-up. The tests shall, as far as is practical, simulate fire, smoke and gas detection which can arise in the protected area under normal operating conditions, e.g. smoke detectors shall be commissioned with the heating, ventilating and air conditioning system in operation with a smoke source at ground level. This should ensure that the response time of the system is measured reliably.

5. MAINTENANCE

5.1 GENERAL

Maintenance, calibration and testing of fire, smoke and gas detectors can be carried out by the site service organisation or by an outsider under a service contract.

5.2 PRECAUTIONS DURING CONSTRUCTION, SHUTDOWNS AND COMMISSIONING

Gas detectors other than the optical types are in general sensitive to environmental conditions. The Manufacturer's recommendations on how to store new sensors shall be followed. In general, installation of the sensors in the field as part of new projects should be delayed to the latest possible moment, and the sensors should not be left without power supply once installed. Proper protection as recommended by the Manufacturer shall be applied to the sensors if powering-down is unavoidable, e.g. during shutdowns. It may be considered to remove the sensors from their housing and storing them at an appropriate location if such conditions are severe.

Pellistor-type flammable gas detectors are sensitive to a variety of poisoning agents like silicon compounds, volatile vapours from drying paint, welding fumes, lead compounds as found in leaded gasolines, etc. The sensitivity depends on the type and make.

Semi-conductor type H_2S sensors are sensitive to ingress of moisture which will eventually lead to permanent damage. They should therefore not be left exposed to atmospheric air, unless under powered conditions. If it is unavoidable to switch off the power from the sensors, they should be capped off using the caps with which they were supplied from the factory. If it is expected that power-off conditions may be of a long duration, the sensors should be disconnected and stored in a clean atmosphere with caps on.

Semi-conductor-type H_2S sensors are easily poisoned by welding fumes and other poisoning contaminants like paint solvents.

Semi-conductor-type H_2S sensors tend to lose their speed of response when not exposed to H_2S for a prolonged period of time. Once powered up the sensors should therefore be exposed to H_2S concentrations not exceeding 200 ml/m^3 H_2S at intervals not exceeding one month.

NOTE: The speed of response can often be restored by carrying out calibrations (at low and high span levels) daily until they have recovered. A recovery period may last approximately one week.

Electro-chemical-type sensors have a limited shelf-life, necessitating a well-thought-out stocking policy. Also, since these sensors are easily damaged they should only be installed shortly before commissioning.

Some ionisation-type smoke sensors are sensitive to airborne dust. The aspirated, ultra-sensitivity types are most susceptible to this condition. Commissioning should therefore be done at the latest possible moment in order to allow the atmosphere in newly constructed buildings to settle down.

5.3 INITIAL CALIBRATION

Initial calibration shall be in accordance with the Manufacturer's recommendations.

Initial readings (output values and response times) shall be recorded in the relevant part of the site "Instrument Maintenance Management System".

Initial calibration of semi-conductor-type of H_2S detectors shall start only after the sensor has been powered on for a period of 24 hours as a minimum. At the start of that period, the sensor shall have been exposed to an H_2S concentration not exceeding 200 ml/m^3 in air.

5.4 CALIBRATION/TESTING OF FLAMMABLE GAS DETECTORS

Flammable gas detectors should be calibrated to local standards with a certified, suitable

test gas mixture of the prevailing gas in air. Test gas mixtures with a LFL concentration exceeding 60% LFL shall not be used.

NOTE: Air/methane mixtures are normally used for Natural Gas applications, while propane is more common for refinery applications. Concentrations ranging from 20 to 50% LFL equivalent are normally used.

When the detector is tested for its performance, adjustments should be carried out only if the difference of the output signal from the value of the test gas exceeds 5% LFL. On these occasions, the speed of response should also be tested. A sensor is suspect when it fails to read higher than the value of the test gas minus 5% LFL once the accepted response time has lapsed.

NOTE: Gas detectors need to be replaced when the mV or mA output signal per % LFL exceeds a certain level as advised by Manufacturer.

Open path detectors should be verified with test wands.

5.5 CALIBRATION/TESTING OF H_2S GAS DETECTORS

5.5.1 General

When the detector is tested for its performance, adjustments should be carried out only if the difference of the output signal from the value of the test gas mixture exceeds 5 ml/m^3 H_2S. On these occasions, the speed of response should also be tested. A sensor is suspect when it fails to read higher than the value of the test gas minus 5 ml/m^3 H_2S once the accepted response time has lapsed.

NOTE: Gas detectors need to be replaced when the mV or mA output signal per ml/m^3 H_2S exceeds a certain level as advised by Manufacturer.

H_2S gas detectors can be calibrated using either:

calibration chambers and calibration ampoules,
or a cylinder with H_2S-in-nitrogen.

NOTE:
1) Response times during calibration/validation/testing are faster when using calibration chambers than when using gas under flowing conditions.
2) H_2S-in-air mixtures are not stable.

5.5.2 Electrochemical type H_2S gas detectors

This type of detector can be calibrated with bottled air for zero adjustment, and with a test gas mixture containing 15 ml/m^3 H_2S in nitrogen for sensor response.

5.5.3 Semi-conductor type H_2S gas detectors

Calibration shall be carried out with at least 2 different mixtures as recommended in the manual of the sensor. Normally, the following procedure is applicable:

- A glass ampoule containing a known concentration of H_2S is inserted in a slip-on calibration chamber of a known volume. This chamber is slipped over the sensor head, after which the ampoule is broken by turning a screw on the side of the chamber. The sensor head is thus exposed to a known concentration of H_2S and the detector can be calibrated. Glass ampoules with concentrations of 4, 10, 20, 50, 100 ml/m^3 are available from Manufacturers of H_2S gas detectors.

5.6 CALIBRATION/TESTING OF FIRE AND SMOKE DETECTORS

5.6.1 General

The preferred method for testing a detector is to expose it to a source of heat, smoke or fire as the area classification allows. Otherwise test conditions should simulate the actual

hazard as closely as possible.

Testing of fire and smoke detection systems may also depend on the application. Reference is made to DEP 80.47.10.31-Gen. or, in the absence of recommendations therein, to the Manufacturer's proposed procedures.

5.6.2 Testing of ultra sensitivity smoke detectors

If the response time of a smoke detector is not sufficiently fast, the air ventilation conditions should be improved.

NOTE: Some standards on testing the performance of smoke detectors specify unrealistically fast response times. It should be realised that response times can not be faster than the ambient air velocity and also depend on the air flow pattern in the atmosphere. Response times should be calculated from data on air flow velocities in ambient atmosphere, air flow velocities in aspirating tubes or diffusion velocities of smoke detectors and detector response times as quoted by Manufacturer.

5.7 TESTING FREQUENCIES

The testing frequencies shall comply with the IPF requirements (also see DEP 32.80.10.10-Gen.) and should take into account the Manufacturer's recommendations.

NOTE:
1) Gas detectors may be considered to have an acceptable performance when the Mean Time Between Adjustments is equal to or greater than one month. The period advised by the Manufacturer is normally better than 2 months. This period can sometimes not be met due to adverse ambient atmospheres at site.
2) For record purposes, a specific calibration record should be completed after each calibration, and a test sheet after each test. These sheets should include the date, the name of the technician, and the type of calibration or test.

6. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Noise control	DEP 31.10.00.31-Gen.
Instrument air supply	DEP 31.37.00.11-Gen.
Symbols and identification system - Instrumentation - Part 1 - Process (engineering) flow schemes	DEP 32.10.03.10-Gen.
Instruments for measurement and control	DEP 32.31.00.32-Gen.
On-line process stream analysis - Analysers	DEP 32.31.50.12-Gen.
Plant telecommunication	DEP 32.71.00.10-Gen.
Classification and implementation of instrumented protective functions	DEP 32.80.10.10-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Field inspection and testing of instruments and instrument systems	DEP 62.10.08.11-Gen.
Factory inspection and testing of instruments and instrument systems	DEP 62.10.09.11-Gen.
Assessment of the fire safety of onshore installations	DEP 80.47.10.30-Gen.
Active fire protection systems and equipment for onshore facilities	DEP 80.47.10.31-Gen.
Hydrogen sulphide (Shell HSE committee publication)	MF Report MF 87-0179

STANDARD DRAWINGS

Arrangement of polyethylene tubing for fire detection of pumps below pipe racks	S 88.020
Arrangement of polyethylene tubing for fire detection of pumps outside pipe racks	S 88.021

AMERICAN STANDARDS

Test method for rate of burning and/or extent and time of burning of self-supporting plastics in a horizontal position	ASTM D 635
Specification for polyethylene plastics molding and extrusion materials	ASTM D 1248

EUROPEAN STANDARDS

Components of automatic fire detection systems	EN 54
Electrical apparatus for the detection and measurement of combustible gases; general requirements and test methods	EN 50054
Electrical apparatus for the detection and measurement of combustible gases; performance requirements for group I apparatus indicating up to 5% (v/v) methane in air	EN 50055
Electrical apparatus for the detection and measurement of combustible gases; performance requirements for group I apparatus indicating up to 100% (v/v) methane	EN 50056
Electrical apparatus for the detection and measurement of combustible gases; performance requirements for group II apparatus indicating up to 100% lower explosive limit	EN 50057
Electrical apparatus for the detection and measurement of combustible gases; performance requirements for group II apparatus indicating up to 100% (v/v) gas	EN 50058

Issued by:
CENELEC
European Committee for Electrotechnical Standardization
2 Rue Brederode
B-1000 Brussels
Belgium

Copies can be obtained through the national standards organizations.

GERMAN STANDARDS

RAL - colour cards

Issued by:
RAL
Bornheimerstraße 180
D-5300 Bonn 1
Germany.

INTERNATIONAL STANDARDS

Electromagnetic compatibility for industrial process measurement and control equipment	IEC 801

Issued by:
International Electrotechnical Commission
3 Rue de Varembé
CH 1211 Geneva 20
Switzerland.

Copies can be obtained through the national standards organizations.

APPENDIX I HEAT DETECTOR CLASSIFICATION

Heat detectors are classified as follows:

1) Fixed temperature detectors

   These detectors are either of the linear type, such as fire detection tubing and heat sensitive cable, or spot type, such as quartzoid bulb and fusible alloy links and plugs.

   - Fire detection tubing is often applied in process areas or around equipment which is to be protected such as pumps, vessels, loading platforms, etc., handling flammable products, and other potential fire hazards such as flanges and drains.

     Fire detection tubing shall be black (UV light resistant), fire retarding polyethylene, in accordance with Standard Drawings S 88.020 and S 88.021.

   - Heat sensitive cable consists of two conductors held apart by heat sensitive insulation covered with an outer protective wrapping. The insulation melts at a predetermined temperature allowing the conductors to contact and initiate events.
     Later developments of this type use an insulation whose electrical resistance changes with temperature. If corrective action is taken quickly the cable will not be damaged and will not need replacing.

   - Quartzoid bulbs can be applied in spray heads to combine detection with executive action, i.e. upon detection of a fire the bulb bursts and an extinguishing agent is released from the spray heads.

   - Fusible alloy detectors use alloys of bismuth, lead, tin and zinc to solder links together or to form plugs which melt rapidly at a predetermined temperature. The links and plugs form the operating elements of the heat detector. These detectors can also be applied to combine detection and executive action.

2) Rate-of-rise heat detectors

   These detectors are designed to function when the temperature of their operating element rises at a rate exceeding a predetermined amount, regardless of the temperature level.

   They are typically used in those applications where, under normal circumstances, appreciable variations in ambient temperature may be expected, for example during the start up and normal operation of gas turbines.

3) Combination-type detectors

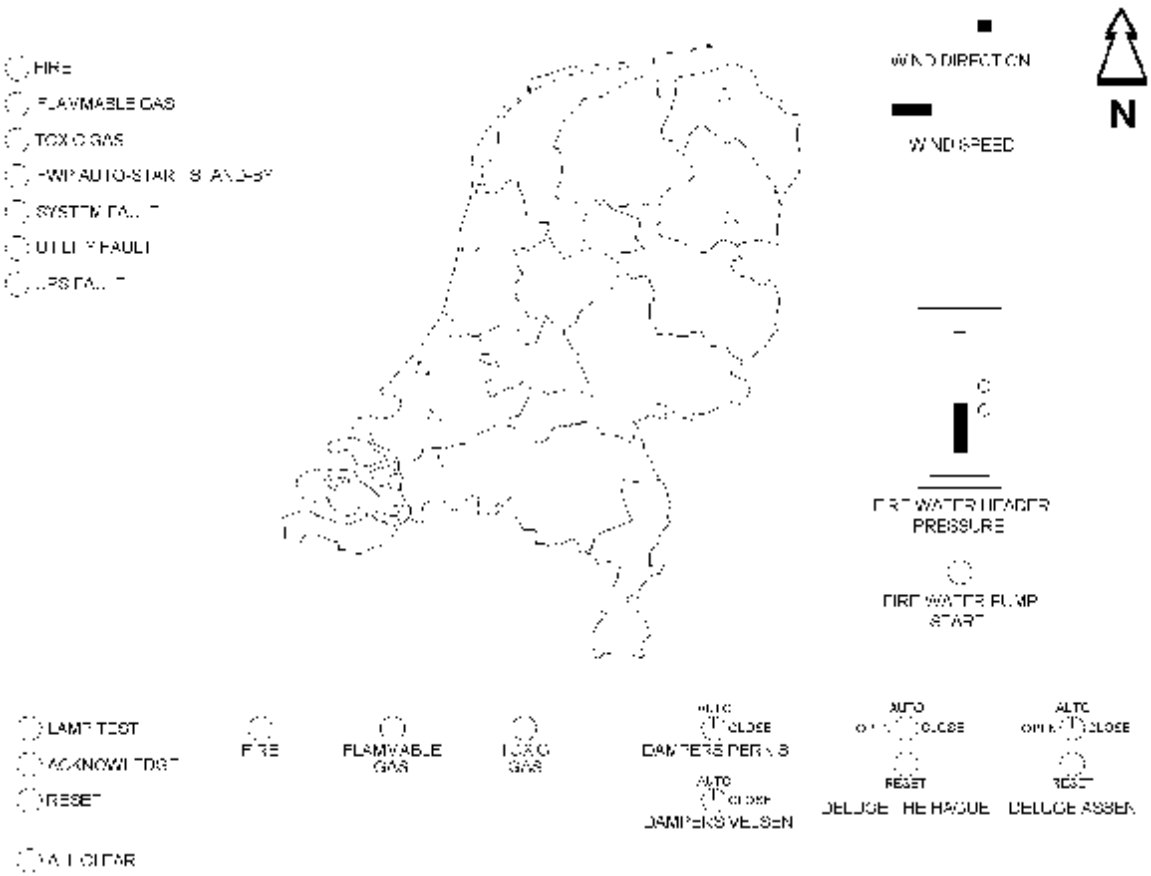
   Combination-type detectors may employ more than one operating principle. A typical example is a combination of fixed temperature and compensated rate-of-rise detector, which is capable of responding accurately to both slow and fast temperature rises. They should therefore be applied where a combination of the circumstances described under fixed and compensated rate-of-rise detectors are expected.

APPENDIX II TYPICAL CAUSE AND EFFECT MATRIX

	EFFECT											
CAUSE	Audible alarm in CR	Visual and audible alarm on DCS	Visual alarm on mimic panel	Audible alarm in building	Visual alarm in building	Audible alarm in plant 1)	Visual alarm in plant 1)	Close fresh air intake 1)	Close fire tight dampers 1)	Start fire-water pump 1)	Open waterspray valves 1)	Activate gaseous extinguishing system 1)
GENERAL ALERT												
Manual call point (in building)	X	X	X	X	X			X				
Manual call point (in open plant)	X	X	X			X	X			X		
HEAT												
Space	X	X	X	X	X							
Rate of rise	X	X	X	X	X			X				X
Polyethylene tube	X	X	X							X	X	
Frangible quartzoid bulb	X	X	X							X	X	
FIRE / FLAME												
Infra red	X	X	X	X	X			X	X			X
Ultra violet	X	X	X	X	X				X			
Building air intake high temperature	X	X	X	X				X				
SMOKE												
Ionisation	X	X	X	X	X			X	X			
Scattered light	X	X	X	X	X			X	X			
Ultra sensitive	X	X	X	X	X			X	X			X
GAS												
Toxic gas	X	X	X	X	X	X	X	X				
Flammable gas high	X	X	X					X				
Flammable gas high high	X	X	X	X	X	X	X	X				X

NOTE: 1) Where revealed failure robust initiators are implemented, action shall only be performed when 2 out of 'n' initiators are in alarm.

APPENDIX III TYPICAL HARDWIRED MIMIC PANEL LAYOUT



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