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APPLICATION & EFFECTIVENESS OF FIRE & GAS MAPPING ASSESSMENT IN HYDROCARBON INDUSTRY

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ABSTRACT: *The Abstract is intended for the application of Fire & Gas detectors and the effectiveness of placing the detectors with the help of three dimensional Fire & Gas Mapping Software. The following are the significant steps that will help improving the detector coverage.*

The Fire and Gas mapping study to be carried out based on geographic coverage assessment type for both fire detection and gas detection. Detector coverage review to be first performed on the existing F&G detector location (Here existing F&G location means the detectors that were placed without performing mapping exercise). The coverage maps from the Fire and Gas mapping of the existing F&G detector location to be compared against the performance target criteria for an assessment of adequacy. Wherever the detector coverage targets are not achieved, the location to be modified until the specified performance target are achieved. Design changes typically include relocating or adding detectors and changing detector technology.

For the existing F&G detectors which were already installed in the field, varying the elevation and orientation of the existing detectors to be given preference over all other modifications. Detector placement shall also be to be governed by constructability and maintainability point of view. This means taking into account the location of structural steel and other obstructions for mounting detectors, as well as ensuring that detectors are not placed in front of potential interferences, e.g. heat exchanger tube bundles, flare stacks, or other equipment items that may confuse the detectors.

KEYWORDS: *Fire and gas detection, Mapping, Constructability, Performance Target, Coverage etc.*

1. INTRODUCTION

Fire & Gas hazard is major threat to people, environment and asset. The early detection of a developing fire or gas leak and an early warning to operational and fire-fighting personnel form an important aspect in the basic concept of fire protection.

The fire and gas detection system provides early warning to plant personnel of potentially dangerous situations in terms of flammable or toxic atmospheres or fires of in all plant areas. This enables the initiation of remedial actions to avoid or minimize escalation of events and risk reduction measures to be taken. The early warning signal will enable personnel and/or system to take remedial actions to reduce escalation effects of the dangerous situation and, certainly at least as important; personnel are made aware of a dangerous situation. In most instances, confirmed detection of fire and gas the system will automatically alert personnel via the plant General Alarm system. This will result in all personnel stopping work and evacuating the area, thus reducing potential loss of life.

Apart from the life & system safety objective, the objectives of the insurance and hydrocarbon handling companies regarding Fire & Gas leak is to minimize financial loss.

Worldwide most oil & gas companies standards are based on the BP GP 30-85, Shell DEP 32.30.20.11, ISA standard & NFPA codes

2. SCOPE & OBJECTIVE

Scope taken here involves the installation of two new filters in a natural gas metering station which is to prevent carryover of black powder particles through the pipeline and preventing damage to the downstream equipment, valves & inline instruments.

The objective of this study is to define the Performance Target requirements of Fire & Gas detection system and to perform Fire & Gas Mapping Study using 3D software tool to recommend suitable locations and adequate number of detector for the hazard.

The Fire & Gas performance target and mapping study has been performed of by using BP GP 30-85 guideline; Fire & Gas Mapping software tool ‘Kenexis Effigy’ has been used to assess the location and coverage of the Fire & Gas detection system against the performance targets.

Though the name “F&G” generally abbreviated both fire and gas, the analysis taken is specific to flame detectors.

3. METHODOLOGY

The following study methodology has been adopted:

a) Layout development

Project's 3D model is required for performing 3D mapping study. A representative 3D model of the facility is developed for carrying out the mapping study.

b) Identification of hazard scenarios and grading of areas

The process is analyzed to determine the fire and gas hazards present. This includes identifying the typical process material(s), normal operating conditions, and whether the materials processed contain hydrocarbon fire hazards, flammable gas hazards, or toxic gas hazards.

Grading is classification of part of an area with a defined hazard and defined specification of detection. Based on the procedure specified in BP GP 30-85, grading is done for the facility under study.

c) Define the performance target requirement for the Fire and Gas detection system

The methodology specified in BP GP 30-85 is used for the preparation of performance targets which defines flame detector viewing distance

d) Fire & Gas Mapping for Coverage Verification

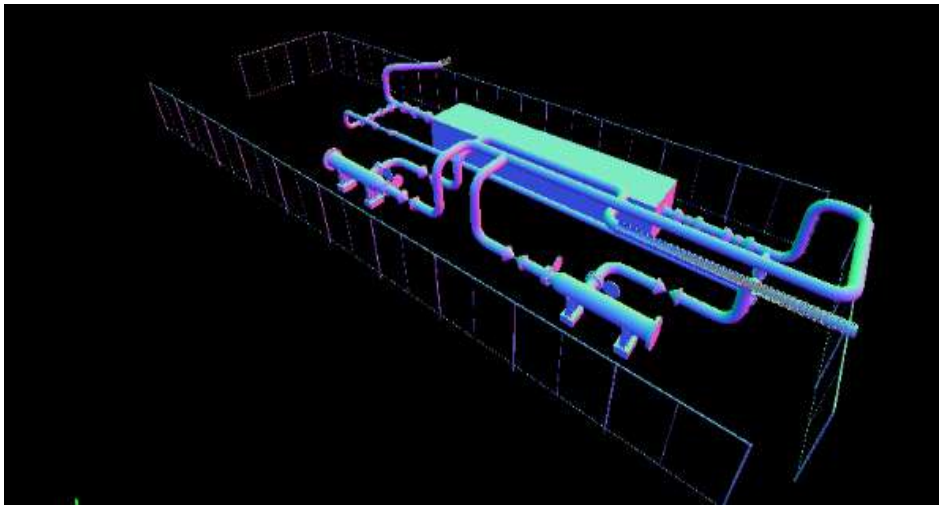
Fire & Gas detector coverage is first plotted by placing detectors based on experience & near to potential leak sources, and various combinations of F&G detectors and their location and quantity are reviewed until the established performance targets are achieved.

The flame detectors' location is reviewed based on the coverage of graded area. Gas detectors location is assessed based on the detector coverage of the graded area with respect to the location of leak source.

e) Fire and Gas detectors Layout

Based on the outcome of study, F&G detector layout will be developed to meet the above performance requirements of F&G detection system.

4. MAPPING EXERCISE



4.1 3D Model Development

A representative 3D model of the project facility is developed using PDMS software and is presented in figure below. The 3D model reflects all major equipment in the project facility.

Description	Scenario	
	HC Gas Dispersion	HC Fire
Flanges & valves in Filter Skid	✓	✓

4.2 Hazard Identification & Grading

Hazard Identification

The composition present in the project facility assumed here is methane rich gas. The identified scenarios which can lead to loss of containment of Hydrocarbon Gas are presented in below table.

Grading

Grading is classification of part of an area with a defined hazard and defined specification of detection. The grading of an area defines the:

- Size of the physical "target area"
- The requirements of detection system to detect fire / gas within the target area.
- The coverage requirements of the graded area

Grading Area Allocation as per BP GP 30-85:

Grade	Area Definition
B	Hydrocarbon Processing, with normal to high sensitivity.
C	Hydrocarbon Processing, with low sensitivity.
D	No Hydrocarbon, with protection of human life.
E	No Hydrocarbon, with protection of special equipment.
F	No Hydrocarbon, with general coverage.
S	Special risk, for which no other grade is appropriate.
T	Special risk, with gas turbines and other engine enclosures.
V	Special risk, with ventilation air intakes.

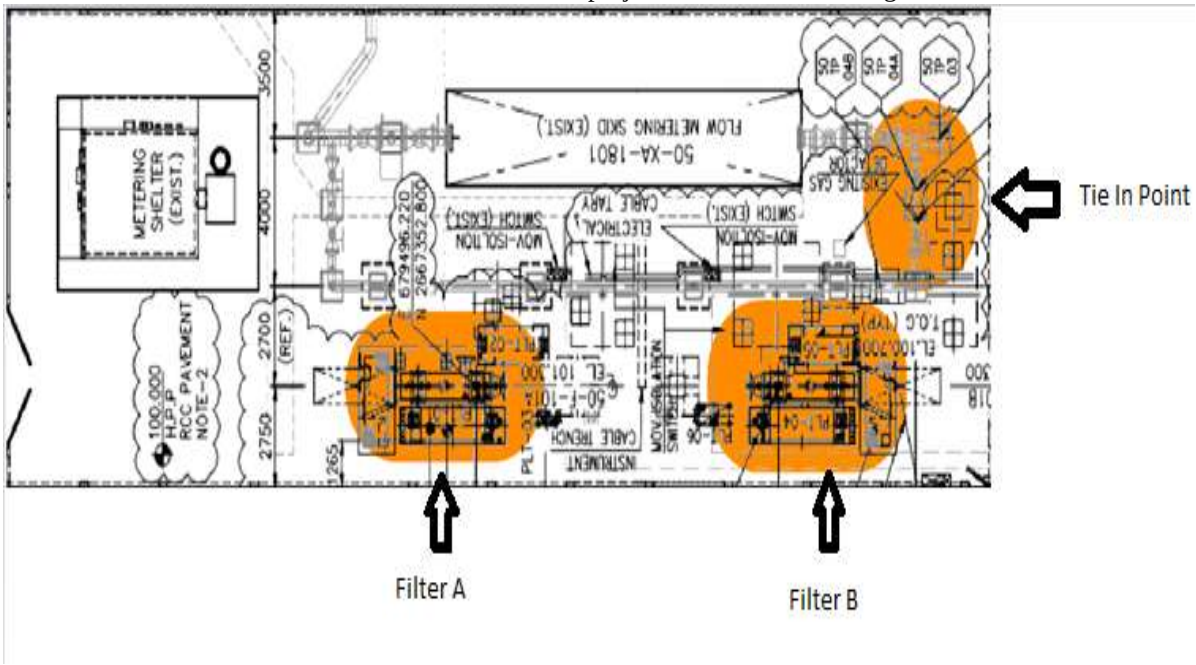
As per BP GP, Grade B shall be assigned to spaces around equipment within hydrocarbon processing areas where fires could cause significant consequences. Initial and escalated fires may be due to any of or a combination of the following:

- Fuel (e.g., high pressure gas from a compressor or large volumes of flammable fluids in spill containment areas).
- Recognized fire risk (e.g., small bore pipework or single seals on pumps and compressors).
- Potential for escalation to more severe consequences.

4.3 Performance Target

Performance Target means the target criteria given to proportion of a Grade B area within the effective field of view of one or more detectors. As per BP standards, the required coverage by a flame detector on Grade B area is 80%(meaning the target here is 80%).Grade B is considered to be applicable within a distance of 2m from the potential release source of the filter.

Grade B area Identified for the project is shown in below figure.



Flame Detector Specification

Triple IR flame detectors are used for analysis in the project. Triple IR detectors may produce false alarms when on the highest sensitivity setting. To avoid this it is common for manufacturers to recommend that the highest sensitivity setting on these types of detectors is not selected. It is recommended that these detectors are implemented on the medium setting. The study has been conducted using the assumption that the medium sensitivity setting will be used.

a) Voting Logic

The voting philosophy applied to the flame detection in this assessment is 1ooN. As there are no executive actions such as "Shutdown" assumed in this project, 1ooN coverage of detectors for the graded areas is sufficient, in line with BP GP 30-85. 1ooN detection from flame detectors shall initiate only an alarm without any executive actions.

b) Location and Orientation

To cover the potential hazards, Flame detectors shall be located within the detectors' Field of View (FOV) which requires 1ooN voting philosophy. This takes into consideration the physical blockages in the field of view and the effective range of the detector.

c) Viewing Angle

The viewing angle (sometimes called pitch) of the flame detectors has been assessed as 30º - 45º below horizontal. This is in line with most detector installation/operations manuals which recommend similar viewing angles. This encourages natural drainage of water and contaminants on the face plate to avoid 'dirty optics' faults. Detector should not be orientated viewing above horizontal for this purpose.

d)Typical Elevation

Flame detectors shall be fixed at an elevation of 2m-3m above target hazard level to cover the potential fire hazard.

e)Flame Detector Effective Viewing Distance

All flame detectors are subject to inhibitors, false alarm stimuli or desensitizing effects which must be considered during F&G mapping. Ideal viewing distances of flame detectors can be obtained from manufacturer's data sheets or manuals. The Effective viewing distance of flame detectors taken for this project is 20m.

4.4 Fire & Gas Mapping - Coverage Verification

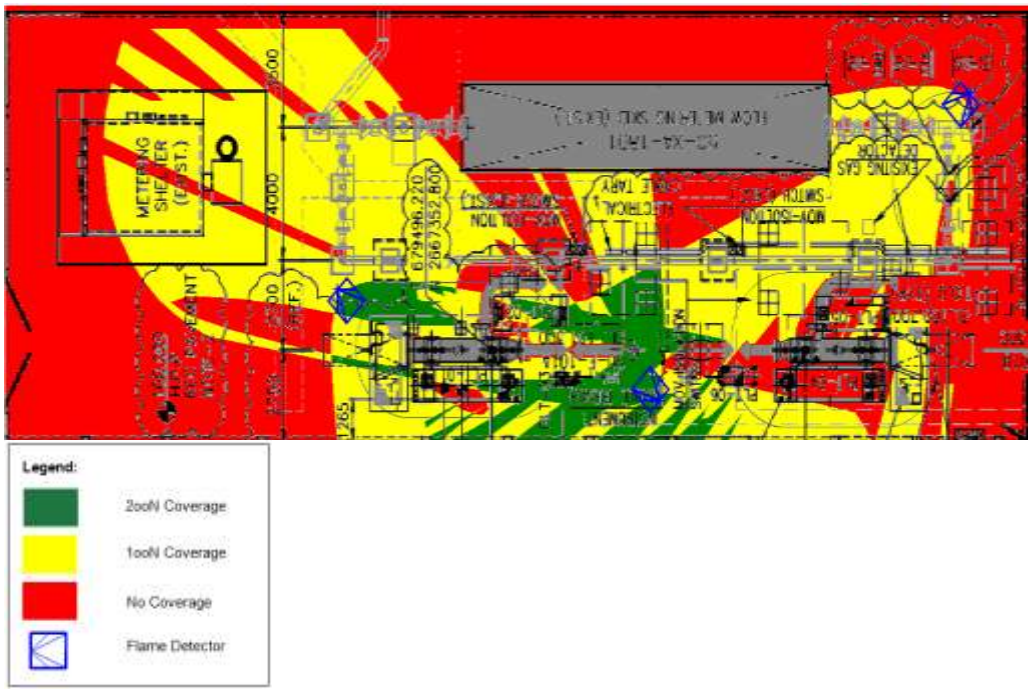
4.4.1 Base Case Flame Detector Coverage

The flame detector coverage review has been performed with preliminary placed locations i.e. Flame Detectors were randomly placed based on coverage area of detector.

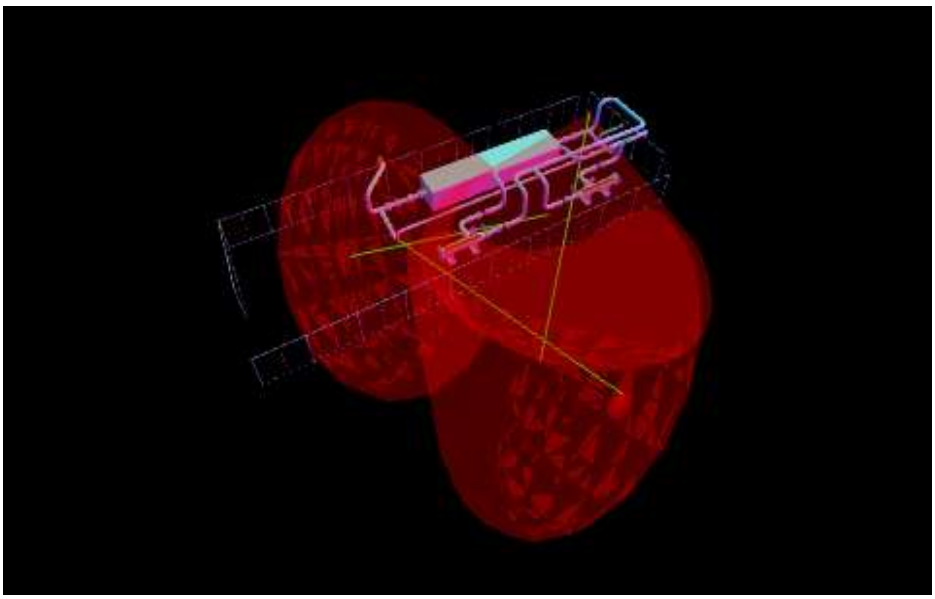
Base Case Detector Mounting details:

Area	Tag	Flame Detector Coordinates		
		Height (m)	Field of View	Declination Angle
Filter	FD-01	3	90°	-30°
	FD-02	3	90°	-30°
	FD-03	3	90°	-30°

The flame detector coverage map for base case is presented in below figure.



The 3D dimensional view of Flame detector coverage for the base case is presented in below figure.



Area	Grade	Flame Detector Coverage	
		1ooN	No Coverage
Filter	Grade B	65.6%	34.4%

It is evident that the flame detectors placed initially just based on detector coverage in a random way are not meeting the 1ooN coverage of 80% target. Hence revised case has been performed.

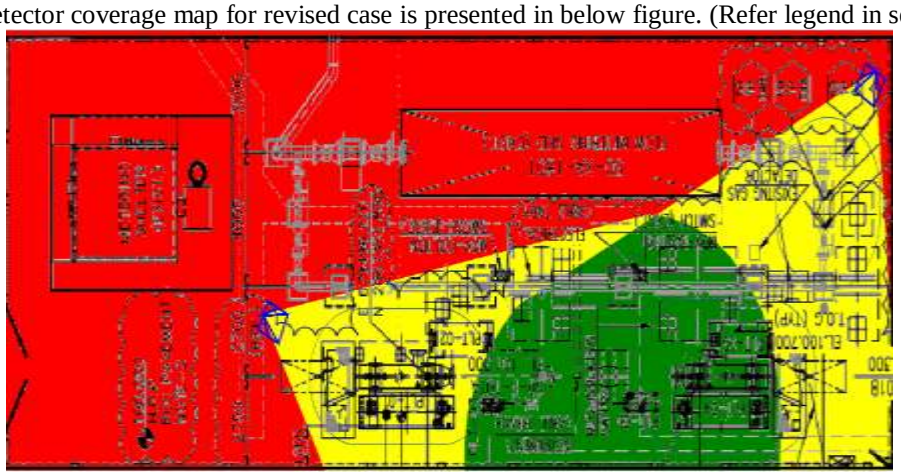
4.4.2 Revised Case Flame Detector Coverage

An analysis has been performed for various arrangements of Flame detectors using 3D F&G mapping software to achieve the required performance target levels. Based on the analysis, the following results were obtained.
The adequate coverage of flame detectors with respect to potential fire was achieved by reducing the number of flame detectors from 3 no's to 2 no's as well as by relocating 2 no's of flame detectors.

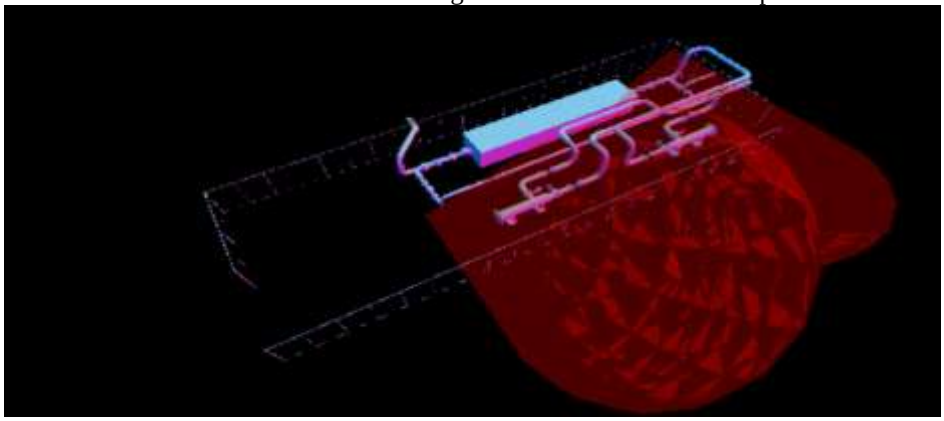
Revised Case Detector Mounting details:

Area	Tag	Flame Detector Coordinates		
		Height (m)	Field of View	Declination Angle
Filter	FD-01	3.75	90°	-30°
	FD-02	3.75	90°	-30°
	FD-03	Removed		

The flame detector coverage map for revised case is presented in below figure. (Refer legend in section 4.4.1)



The 3D dimensional view of Flame detector coverage for the revised location is presented in below figure.



The summary of coverage targets achieved for the revised case is presented in below table.

Area	Grade	Flame Detector Coverage	
		1ooN	No Coverage
Filter	Grade B	96%	4%

5. CONCLUSION

Through Fire & Gas mapping, the appropriate types and quantities of flame and gas detectors that provide the desired detection coverage can be objectively determined. Fire & Gas mapping also equips the engineer with the means to measure detection improvements when small incremental design changes are made. Mapping can therefore help minimize overall system costs.

Improve design accuracy and engineering efficiency - With Fire & Gas mapping, deciding detector layouts becomes a lot easier because Fire & Gas mapping provides a methodical and systematic approach for determining the areas with the highest likelihood of flame and gas risks. Understanding the locations and likelihood of risks will help remove guesswork and inefficiencies from engineering.

6. REFERENCES

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