

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>				Nº <b>I-ET-3000.00-5400-947-P4X-003</b>																																																																
	CLIENT:							SHEET <b>1 of 14</b>																																																													
	JOB:																																																																				
	AREA:																																																																				
<b>SRGE</b>	TITLE: <b>FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG</b>							<b>INTERNAL</b>																																																													
								<b>ESUP</b>																																																													
MICROSOFT WORD / V. 2016 / I-ET-3000.00-5400-947-P4X-003_C.DOCX																																																																					
<b>INDEX OF REVIEWS</b>																																																																					
<b>REV</b>	<b>DESCRIPTION AND / OR SHEETS ACHIEVED</b>																																																																				
0	ORIGINAL VERSION																																																																				
A	REVISED TO ALIGN WITH PBREF REQUIREMENTS																																																																				
B	REVISED WHERE INDICATED																																																																				
C	REVISED WHERE INDICATED																																																																				
<table border="1"> <tr> <td></td> <td>REV. 0</td> <td>REV. A</td> <td>REV. B</td> <td>REV. C</td> <td>REV. D</td> <td>REV. E</td> <td>REV. F</td> <td>REV. G</td> <td>REV. H</td> </tr> <tr> <td>DATE</td> <td>APR/28/2020</td> <td>JUL/23/2020</td> <td>MAR/15/21</td> <td>JUN/24/06</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>PROJECT</td> <td>ESUP</td> <td>EPS</td> <td>EPS</td> <td>EPS</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>EXECUTION</td> <td>PAULOJUNIOR</td> <td>UTQ2</td> <td>YMYC</td> <td>U436</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CHECK</td> <td>DANIELA</td> <td>B79G</td> <td>CWEQ</td> <td>B79G</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>ACCEPTANCE</td> <td>PAOLO</td> <td>CXK4</td> <td>UP6E</td> <td>EK9U</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>											REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H	DATE	APR/28/2020	JUL/23/2020	MAR/15/21	JUN/24/06						PROJECT	ESUP	EPS	EPS	EPS						EXECUTION	PAULOJUNIOR	UTQ2	YMYC	U436						CHECK	DANIELA	B79G	CWEQ	B79G						ACCEPTANCE	PAOLO	CXK4	UP6E	EK9U					
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H																																																												
DATE	APR/28/2020	JUL/23/2020	MAR/15/21	JUN/24/06																																																																	
PROJECT	ESUP	EPS	EPS	EPS																																																																	
EXECUTION	PAULOJUNIOR	UTQ2	YMYC	U436																																																																	
CHECK	DANIELA	B79G	CWEQ	B79G																																																																	
ACCEPTANCE	PAOLO	CXK4	UP6E	EK9U																																																																	
INFORMATION IN THIS DOCUMENT IS PROPERTY OF PETROBRAS, BEING PROHIBITED OUTSIDE OF THEIR PURPOSE																																																																					
STANDARD FORM BY PETROBRAS N-381-REV.L.																																																																					

	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5400-947-P4X-003	REV. C
	JOB	SHEET: 2 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG	INTERNAL ESUP	
<h2 style="text-align: center;">Summary</h2>			
1.	ABBREVIATIONS AND DEFINITIONS.....	3	
2.	INTRODUCTION.....	4	
3.	OBJECTIVES .....	4	
4.	SCOPE .....	5	
5.	REFERENCE DOCUMENTS .....	5	
6.	GENERAL REQUIREMENTS .....	6	
7.	DETECTORS REQUIREMENTS.....	7	
7.1.	Flame Detectors.....	7	
7.2.	Fusible Plugs .....	7	
8.	DESIGN REQUIREMENTS.....	8	
8.1.	Detection Strategy.....	8	
8.2.	Flare Influence Area .....	9	
8.3.	Flame and Fusible Plugs Detectors Allocation Analysis .....	9	
8.4.	Report Requirements .....	10	
9.	ASSEMBLY AND FIELD ADJUSTMENTS DURING COMMISSIONING PHASE .....	14	

	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5400-947-P4X-003	REV. C
	JOB	SHEET: 3 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG	INTERNAL	ESUP

## 1. ABBREVIATIONS AND DEFINITIONS

For the purposes of this Technical Specification, the following abbreviations and definitions shall be appreciated:

### Acronyms and Abbreviations:

ADV – *Automatic Deluge Valve*  
 PHA - Preliminary Hazard Analysis  
 TS – Technical Specification  
 FOV – *Field of Vision*  
 FVR – *Field of View Restrictor*  
 RHO – *Radiant Heat Output*

### Definitions

Detection range - It is the distance that the detector can "see" the flame. It depends on the burning substance, the size of the flame and the detector sensitivity.

Detection time - Time from the start of the fire to its detection by automatic means or manual system.

Field of view - It is the monitoring cone in front of the flame detector where the electromagnetic waves emitted by the flame are detected.

Fire - Physical and chemical phenomenon of unwanted and uncontrolled chain reaction, generated by the involvement of combustible substance, oxidizer, heat source and chemical reaction.


Fire Detection System - It is the Unit's fixed detection and monitoring system composed of flame, smoke and temperature detectors, control systems, alarms and actuators that initiate or carry out safety actions in cases of confirmed fire.

Fire zone - A subdivision of a fire area not necessarily surrounded by sets of structures with gradations of fire classes. It can also refer to a subdivision of a fire detection or suppression system, which will give alarm indications on the central alarm panel. This concept aims to "map" the Unit in related areas, for the dimensioning of FGS detection and firefighting systems.

Fixed temperature detector - Detector that is activated in a previously determined temperature.

FVR – *Field of View Restrictor* – Device used to reduce the detector's coverage angle.

IP degree - Ingress Protection degree. It is an international standard defined by the International Electrotechnical Commission (IEC), standard IEC 60529, to classify and evaluate the degree of protection of electronic products supplied against the entry of dust and water. Optical flame detector - Type of detector that works receiving electromagnetic waves emitted by the flame.

	TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5400-947-P4X-003	REV.	C	
	JOB				SHEET:	4 of 14
	TITLE:	FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG			INTERNAL	
					ESUP	

Reflection - Electromagnetic flame waves incident on equipment, structures or objects that are reflected by their surfaces.

Response Time - Time elapsed after internal processing by the detector, sending and receiving the signal by the actuation logic controller.

Temperature detector - Fusible plug type - Fire detection device, fixed temperature type, which melts when reaching 70°C, temperature defined by the Safety Engineering Guideline.

Triple IR detector (IR3) – Detectors are designed to compare 3 wavelength bands within an Infrared spectral region and their ratio to one another. Undue or undesired detection - Detector actuation by sensitizing a source of electromagnetic wave emission or heat that is not a fire. Ex: flare flame.

Voting - Logical configuration of the fire detection system. The voting of fusible plugs in a fire zone / monitored area resulting from the detection shall initiate safety actions, such as activating alarms, closing dampers, emergency shutdowns, etc.

## 2. INTRODUCTION

The process safety of Floating Production Unit (FPU) or Fixed Units, hereinafter referred to as Unit, has in the instrumented fire detection system one of its main pillars to prevent or mitigate accidental fire scenarios.

The fire detection system acts in the detection and confirmation of fire in the various monitored areas of the installation, with activation of alarms and safety interlocking of instrumented systems, activation of a fire water pump and opening of deluge valves - ADVs. At the Units, the fire detection system is composed of smoke detectors, fixed temperature / thermovelocimetric, flame and temperature detectors.


This TS only contemplates flame type (IR3) or temperature detectors (fusible plugs) installed in open areas of the Unit, in accordance with the requirements of the Petrobras Safety Engineering Guideline.

The Safety Engineering Guideline establishes the types of detectors to be used in each area of the Unit, the detection and interlocking safety criteria, alarms, voting criteria for detectors, criteria for override and fault handling of detectors, besides some installation and maintenance access requirements.

This TS aims to detail the technical aspects of the fire detection system in order to meet the requirements of the National Agency of Petroleum, Natural Gas and Biofuels - ANP, Secretary of Labor of Ministry of Economy, requirements of Classification Societies, applicable standards and the Petrobras' Safety Engineering Guideline.

## 3. OBJECTIVES

This technical specification has the following objectives:

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>	Nº	<b>I-ET-3000.00-5400-947-P4X-003</b>	REV.	<b>C</b>
	JOB				SHEET: <b>5 of 14</b>
	TITLE:	<b>FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG</b>			<b>INTERNAL</b>
					<b>ESUP</b>
<ul style="list-style-type: none"><li>- Define scope, methodology and criteria to ensure the effectiveness of the performance of flame and temperature detectors to be installed in open areas of the Unit (process areas, main deck, riser balcony, utilities, etc.). It involves the basic design, detailing design, commissioning and operation phases of the Unit;</li><li>- Define scope, methodology and criteria to avoid undue (unwanted) activation of flame and temperature detectors;</li><li>- Guide the dynamics for the planning, development and monitoring of the project, acquisition, installation, verification and approval of the flame and temperature detection system;</li><li>- This TS does not comprise the requirements for smoke detectors, fixed temperature and thermovelocimetric and fire detection in closed areas of the installation.</li></ul>					

#### 4. SCOPE


The content of this TS includes and provides consistent information for:

- Technical support for the design of flame detection systems, including the selection, positioning and quantification of detectors in order to enable alarms and the Unit's safety actions in case of a fire;
- Define the methodology for carrying out the allocation project of flame detectors, including vertical and horizontal directions, shadow zones, reflections, aspects of facilities for maintenance and tests;
- Define the technical requirements for the instrumented system of interface of the flame detector;
- Define the minimum technical requirements that fusible plugs shall contain;
- Define corrective actions for cases in which, after following all the definitions of this TS, there is an undue detection of flame by the detector.

#### 5. REFERENCE DOCUMENTS

The following documents shall be used as a reference source:

- a) DR-ENGP-M-I-1.3 – Safety Engineering Guideline;
- b) ISO 13.702 - Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines;
- c) API RP 14 C - Analysis, Design, Installation, and Testing of Safety Systems for Offshore Production Facilities;
- d) NFPA 72 (2019) – National Fire Alarm and Signaling Code;

	TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5400-947-P4X-003	REV.	C	
	JOB				SHEET:	6 of 14
	TITLE:	FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG			INTERNAL	ESUP

e) ANSI FM 3260 – 2004 (rev. 2014) – American National Standard for Radiant Energy-Sensing Fusible plugs for Automatic Fire Alarm Signaling;

f) ISA-TR84.00.07-2018 - Guidance on the Evaluation of Fire, Combustible Gas, and Toxic Gas System Effectiveness;

g) ISO/TR 13.387-7 - Fire safety engineering — Part 7: Detection, activation and suppression;

h) NEMA SB 23-2016 - Guide for Application of Flame Detection;

i) BS EN 54-10:2002 - Fire detection and fire alarm systems - Part 10: Flame detectors - Point detectors;

j) ISO 7.240-2 (2017) - Fire detection and alarm systems - Part 2: Fire detection control and indicating equipment;

k) DI-1PBR-00196 – HSE Management / Guideline 6 - Management of Change;

l) PP-2E&P-00074 - Guidelines for Inhibition of Control and Safety Systems Logic.


## 6. GENERAL REQUIREMENTS

Flame detectors, when installed under the modules’ decks, shall preferably be positioned at most 1 meter of distance under coverings (preferably 0.5 m) to facilitate maintenance and a maximum height of 4.5 m from the floor.

It is important to consider the accessibility to the detector to become easier the maintenance and repairs. Assembly in structures subject to strong vibration shall be avoided. Design shall consider detectors’ orientation so that rain incidence and dirt build-up on the lenses are avoided and excessive heating of the detectors’ electronics is prevented; proper protection devices shall be supplied should the positioning and orientation not be enough to prevent these effects.

The following characteristics shall be considered for flame detectors:

- Immunity to false alarms;
- Detection range;
- Response time;
- Field of view;
- Self-diagnosis.

	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5400-947-P4X-003	REV. C
	JOB	SHEET: 7 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG	INTERNAL	ESUP

## 7. DETECTORS REQUIREMENTS

The requirements for flame detectors and temperature detectors are presented below.

### 7.1. Flame Detectors

The flame detectors to be purchased shall comply with all the performance requirements settled in the ANSI FM 3260 and NFPA72 standards and be certified according to the requirements of ANSI FM 3260.

The output signal of the instruments shall be 0-20 mA, the range 4-20 mA being used for detection and the range 0-4 mA for diagnosing the instrument. In addition, digital communication shall be added using the HART protocol, approved by HART FOUNDATION.

As defined by the relevant standards, diagnostics for continuous monitoring of the optical path shall always be foreseen for the flame detectors.

The self-check procedure is designed to ensure that the optical path is clear, the detectors are working and the electronic circuit is operational. Self-checking routines shall be programmed in the flame detectors control circuits to be activated periodically and systematically. If the same fault occurs twice in the cycle, then there shall be a warning indication via the 0-20 mA output **and** digital communication protocol compliant with Unit's Asset Management System.

According to Safety Engineering Guideline, in item 7.2 FIRE AND GAS DETECTION SYSTEM:

*"The fire and gas detectors, installed in open areas of the Unit or in closed areas containing flammable and / or combustible fluids, shall be suitable to operate in classified areas as, at least, "Group IIA, T3".*


Detectors shall be provided with supports that allow corrections to the viewing angles and that can be rigidly fixed in this position. In addition, graduated scales are required on the two rotation axes (horizontal and vertical) indicating how many degrees the detector is displaced related to the center point of the support.

According to the Safety Engineering Guideline, flame detectors shall be IR3 type technology. The purpose of this technology is to detect flame by burning hydrocarbons, which minimizes the sensitivity to radiation from other infrared sources, such as welding arcs and the sun.

### 7.2. Fusible Plugs

When installing fusible plugs, the API RP 14 C standard, annex G, table G.1, shall be followed. According to the analysis of design and geometry of the equipment to be protected, detectors can be added to guarantee the most effective fire detection.

According to defined in the Safety Engineering Guideline, in item 7.2.1.2, the distance between the temperature detectors and the equipment surface shall be as follows:

	TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5400-947-P4X-003	REV.	C	
	JOB				SHEET:	8 of 14
	TITLE:	FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG			INTERNAL	
					ESUP	

“Fusible-type detectors shall be installed at a maximum of 1 m and a minimum of 50 cm from the protected equipment, and the routing of the tubing shall minimize damage from impacts.”

During the installation and eventual maintenance of the compressed air tubing, care shall be taken so that there is no possibility of causing damage by impacts to them. The routing of tubing shall avoid places where people and objects can pass.

In places where fire detection is carried out exclusively by fusible plugs, redundancy of the sensor and pressure transmitter (PIT) shall be provided to avoid interlocking actions in the event of spurious failure of one of the PITs.

The tubing shall be made of a metal alloy that prevents pitting corrosion.

The alloys used in the manufacture of the fusible elements shall be resistant to the formation of oxides on the surface, which alter the defined melting temperature.

## 8. DESIGN REQUIREMENTS

### 8.1. Detection Strategy

To comply with Prevention, Control and Mitigation of Fire and Explosion Strategy (FES), according to the requirements of the ISO 13.702 standard, fire detection shall be dimensioned to quickly identify the scenarios, at the beginning.


When fire is confirmed by detectors, automatic actions to control the accidental scenario shall be started, such as triggering the deluge system and depressurization in the respective zone, isolating inventories, de-energizing non-essential charges through ESD-3P and general alarm in the unit.


As established in ISO 13.702, item B.6, the quantity and the location of fusible plugs shall be suitable to guarantee the prompt detection of fires, considering the potential fire escalation in the affected area.

Fire detectors shall follow the definitions of the Safety Engineering Guideline, Item 7.2.1.1:

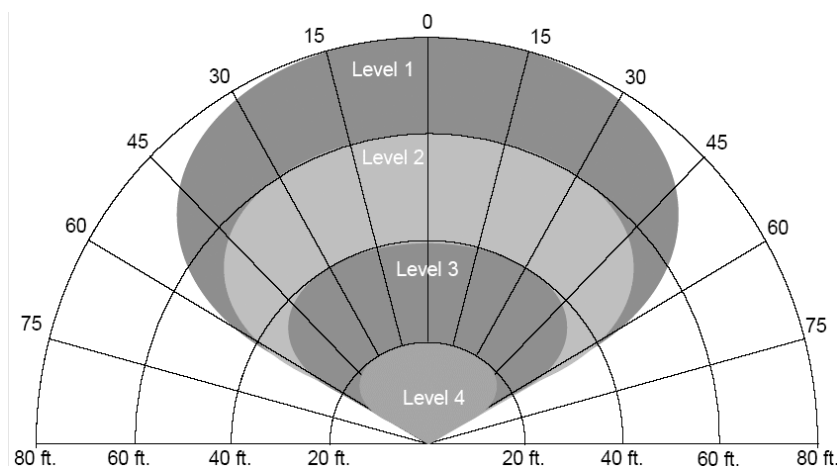
- Flame detector shall not be used in areas where it can be impacted by radiation or flame from the flare.
- Fire detection on the main deck shall be dedicated to each coaming and shall not detect the fire in the regions of the other coamings.
- In areas protected simultaneously by a fusible plug and flame detector, the actions shall comply with the following provisions:
  - a) Detection by fusible plug: General alarm in the Unit and opening of the corresponding ADV.
  - b) Detection by only one (01) flame detector: General alarm in the Unit.



 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>		Nº	<b>I-ET-3000.00-5400-947-P4X-003</b>	REV.	<b>C</b>
	JOB				SHEET: <b>9 of 14</b>	
	TITLE: <b>FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG</b>				<b>INTERNAL</b>	
					<b>ESUP</b>	
<p><i>c) Detection by fusible plug and one (01) flame detector OR by two (02) flame detectors: Activation of the emergency shutdown level ESD-3P or T; opening of ADV in the corresponding area, through CSS and start up firefighting pump.</i></p> <ul style="list-style-type: none"><li><i>In the area under the influence of the flare, where there is only the fusible plug detector, the activation of the fusible plug system characterizes a confirmed fire and shall lead to the opening of the corresponding ADV and activation of the emergency shutdown level ESD-3P.</i></li></ul> <p>The voting logic criteria are those defined by Safety Engineering Guideline. In the absence of a definition for specific criteria, Petrobras shall be consulted.</p> <h3>8.2. Flare Influence Area</h3> <p>Areas under the influence of the flare are defined during the basic design and the fire detector type to be used in these areas is fusible plugs.</p> <p>During the design of the fire detection system, there shall be an interaction between the designer, the system manufacturers and Petrobras, to adapt the available technologies to avoid unwanted alarms caused by direct radiation or by reflection of the flare flame.</p> <p>Last elevations of the processing modules shall also be considered as “influenced by the flare radiation” and, as so, on these elevations if it is foreseen fire detection by the basic design, they shall be performed by fusible plugs. It is prohibited to use flame detectors in these elevations.</p> <h3>8.3. Flame and Fusible Plugs Detectors Allocation Analysis</h3> <p>The allocation of flame detectors shall be performed using suitable software for this, which uses 3D model of the Unit and is capable of automatically evaluate the shadow effects due to obstructions and evaluate every detector’s coverage areas. For this reason, the usage of only 3D model for the performance of this study is unacceptable.</p> <p>The software shall also be able to properly model the cone-like field of view of the flame detectors that will be used on the design, which shall be informed by the designer, and also to cross-check the cones fields of the detectors to verify whether the requisites on item 8.1 of this TS are being complied with. It is prohibited to use cone-like field of view of different detectors than the ones used on the design.</p> <p>This software shall be approved by Petrobras prior to the beginning of the study. The pre-approved software by Petrobras is Detect 3D.</p> <p>Provided that this analysis shall be performed using the 3D model of the Unit, this study shall only be performed using a 3D model completeness of least 60% for HULL and 60% TOPSIDE.</p> <p>At 90% of 3D model completeness, considering HULL and TOPSIDE, in the executive design, the study executioner shall redo this study.</p>						

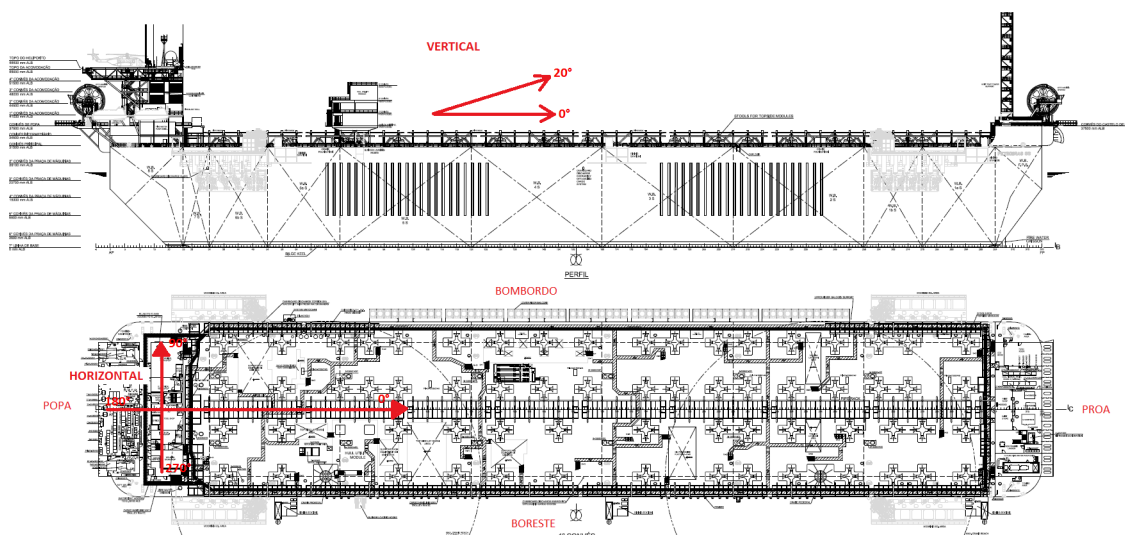
	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5400-947-P4X-003	REV. C
	JOB	SHEET: 10 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG	INTERNAL	ESUP
<p>The following premises shall be considered on the development of the study and as input for software:</p> <ul style="list-style-type: none"> <li>a) It shall be considered a fire pan size that shall be calculated by the Fire Propagation Study of the Unit. The pan size to be used is the one calculated for the smallest pool fire that can occur on the main deck area due to crude oil leakage on the loading headers. This pan size, shall also be considered for the flame detectors allocation on the topside modules;</li> <li>b) The RHO to be used is 100 kW;</li> <li>c) All areas, on main deck, bigger than the area of the pan size calculated on item “a” above shall be detected by at least one flame detector.</li> <li>d) For shutdown actions to be performed on the main deck, all areas bigger than the area of the pan size calculated on item “a” above shall be covered by at least 2 flame detectors.</li> <li>e) For fire detection on the topside, all areas bigger than the area of the pan size calculated on item “a” above shall be detected by at least 1 flame detector;</li> <li>f) For shutdown actions to be performed on the topside, if there are areas being covered by at least 2 detectors bigger than the area of the pan size calculated on item “a” above, it shall be added fusible plugs for coverage according to item <b>Erro! Fonte de referência não encontrada.</b>;</li> <li>g) For the main deck area, the detector sensitivity to be used can be high or medium;</li> <li>h) For the topside modules, with exception of the last elevations, detector sensitivity to be used shall be no higher than medium;</li> <li>i) Last elevations of the topside modules with piping areas and/or PSVs areas and to where is foreseen fire detection on the basic design shall be protected by fusible plugs according to item <b>Erro! Fonte de referência não encontrada.</b>;</li> <li>j) Fusible plugs from one fire zone shall not be used to detect fires on another fire zone.</li> </ul> <p>This analysis shall also consider the temperature detectors that might be present on the fire zones protecting equipment. They shall also be considered on the evaluation of the accomplishment of the established requirements on item 8.1 of this TS.</p> <p>Temperature detectors shall comply with criteria established on item <b>Erro! Fonte de referência não encontrada.</b></p> <p><b>8.4. Report Requirements</b></p> <p>The report shall contain at least the following information:</p> <ul style="list-style-type: none"> <li>a) Executive Summary;</li> </ul>			


- b) Unit Process Description;
- c) Unit Modules/Ares Description;
- d) Objective;
- e) Description of Methodology;
- f) Established Premisses;
- g) Description of Flame Detectors Models used on the Design. The Data Sheet of all detectors shall be attached on the report;
- h) Figures presenting the field of vision detection cones used for every flame detector on the analysis. These fields of vision shall also consider used sensitivities;



**Figure 1 – Illustration of a typical flame detector vision cone with several levels of sensitivity adjustments and distances related to a target fire.**

- i) The detector's coordinates shall be informed in reference to the global coordinates of the Unit and they shall be illustrated on the report. The document that can be used to consult the global coordinates of the platform is the General Arrangement.



	TECHNICAL SPECIFICATION		Nº	I-ET-3000.00-5400-947-P4X-003	REV.	C
	JOB				SHEET: 12 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG				INTERNAL	
					ESUP	

**Figure 2 – Illustration of the global coordinates and vertical angles.**

j) Indication of maximum allowed deviation on exis x, y and z for flame detectors and fusbile plugs;

k) The results of flame detectors allocation shall present tables per anylzed fire zones indicating at least:

- i. Tag of the detectors;
- ii. Coordinates of detectors;
- iii. Vertical and horizontal adjustment angles of the detectors;
- iv. It shall be clearly indicated whether the design of the detectors' location considered the use of a vision reducing cone in each of the detectors;
- v. Considered sensitivity for every detector;
- vi. TAG of the monitored equipment in the fire zone;
- vii. Equipment not monitored by the detectors;
- viii. Total quantity of fusible plugs on the fire zone;
- ix. The indication of which detectors shall use vision reducing cone.

l) The results of fusible plugs allocation analysis shall present tables per anylzed fire zones indicating at least:

- i. Equipment tag. In cases of use of fusible plugs on “area protection” (e.g. PSVs areas, piping areas, etc.), it shall be thouroughly described and having indication of them on arrangement 2D drawings for properly identification;
- ii. Quantity of noozles installed on the equipment/area;
- iii. Fusible plugs tags and fire zones at which they contribute to the voting logic.

m) Table indicating which equipment/area is covered by fusible plug;

n) Conclusions;

o) Recommendations;

p) References;

q) On attachment, sectional and plan views of all fire zones showing the coverage areas for detection and emergency actions, with indication of all fusible plugs tags. These views shall also indicate the measurement of the areas indicated on letters “c” and “d” of item 8.3;



Figure 3 – 2D illustration of flame detectors coverage for detection (blue zones) and emergency actions (red, green and yellow zones) on a fire zone.

- r) Attached 3D model plots showing the nozzles arrangements of fusible plugs, with indication of the fire zone and measurement lines indicating the space between the elements being protected (i.e. equipment, piping, etc.) and the nozzles.

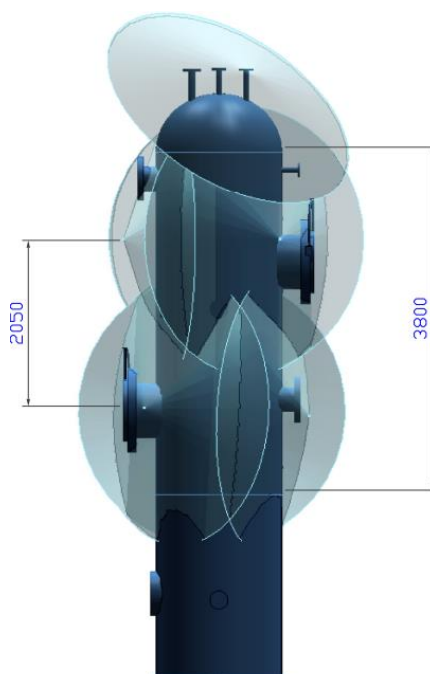



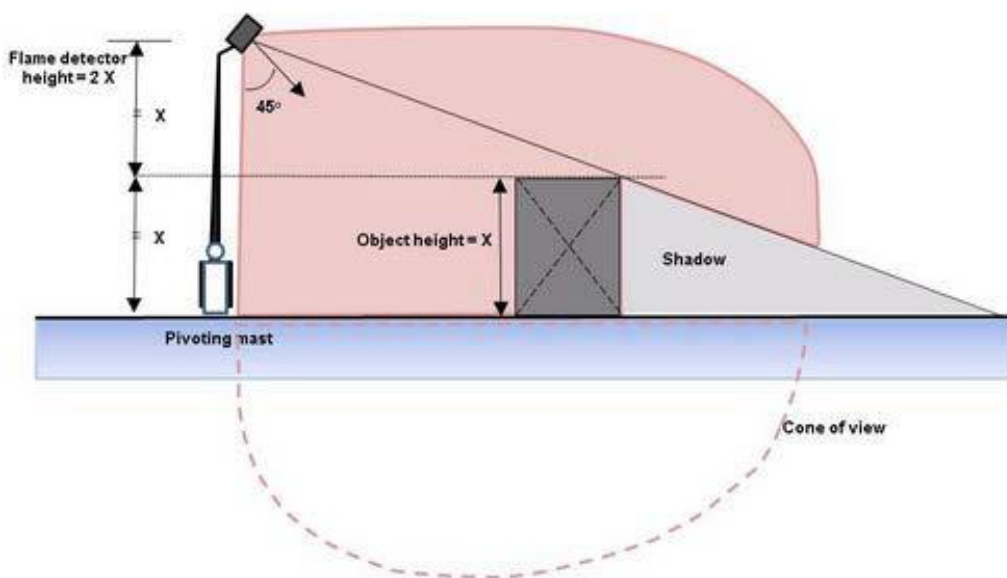
Figure 4 – 3D illustration of the nozzles arrangement of fusible plugs on an equipment.

	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5400-947-P4X-003	REV. C
	JOB	SHEET: 14 of 14	
	TITLE: FIRE DETECTORS IN OPEN AREAS OF OFFSHORE PRODUCTION UNITS – FLAME AND FUSIBLE PLUG	INTERNAL ESUP	

## 9. ASSEMBLY AND FIELD ADJUSTMENTS DURING COMMISSIONING PHASE

If it is necessary to evaluate the design of the flame detectors during the commissioning phase or beginning of operation of the Unit, considering any flame detector in the design, the following points shall be evaluated and the measures taken according to the required:

- Check the position and height (x, y, z coordinates) and the orientation (vertical angle - pitch - and horizontal angle - roll) in which the detector was installed, according to the design and manufacturer's guidelines;
- In case of improper detection, evaluate the reduction of the sensitivity of the flame detector, as long as its coverage area is guaranteed;
- Check if there is reflection that sensitizes the detector. If so, evaluate the possibility of applying coating in the region of the equipment / structures for which the detector is aimed, with anti-reflective paint (use paint in accordance with N-2680 and in the color Munsell Black N-1);
- Install field of view restrictor (FVR), ensuring that monitored equipment remains covered by the detector's field of view;
- Assess the possibility of adjusting the detector assembly height (z) to twice the height of the largest monitored object in the field of view;



**Figure 5 – Illustration for detector installation considering the field of view.**

- Evaluate the cost / benefit ratio of adjusting the coordinates (x, y, z) compared to replacing the detector model.
- Update detector allocation reports and design documentation according to adjustments implemented.