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PRELIMINARY

1 SCOPE

This document establishes the minimum technical requirements for the design of Passive Fire Protection (PFP) systems for offshore units.

The CONTRACTOR shall incorporate the total set of the additional requirements for ensuring the supply and assembly of reliable, safe and functional systems.

Detailing Design shall be developed in accordance with the requirements herein established. Any modifications have to be submitted to PETROBRAS for approval prior to implementation.

2 ABBREVIATIONS AND DEFINITIONS


2.1 Abbreviations

The following abbreviations and definitions are applicable:

- FPSO: Floating Production Storage and Offloading;
- PFP: Passive Fire Protection;
- SDV: Shut Down Valves;
- BDV: Blowdown Valves;
- DPC: Diretoria de Portos e Costas;
- HVAC: Heating, Ventilation and Air Conditioning;
- MCT: Multi Cable Transit.

2.2 Definitions

"A" class division: Division of steel that went through standard fire test for the "A" class (cellulosic material), capable of preventing the passage of fire, gas and smoke for one hour, and when complemented by fireproofing (non-combustible material) ensures that the temperature on the unexposed face does not exceed the predetermined temperatures for a period of time determined (15, 30 e 60 minutes), according to IMO-SOLAS.

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“B” class division: Division of non-combustible material, capable of preventing the passage of fire, gas and smoke for one hour, keeping the unexposed face within a temperature limit, and when thermally isolated ensures that the average temperature of the unexposed surface, does not exceed the predetermined temperatures for a period of time determined (15 e 30 minutes), according to IMO-SOLAS.

“H” class division: Attend the same criteria of the bulkhead type A (IMO-SOLAS), except for the standard fire tests, which are done using the heat curves for hydrocarbons (Class H). In this case, fireproofing shall provide a consistent protection of fire radiation in hydrocarbons puddle and explosion.

“J” class division: Attend the same criteria of the bulkhead type H, except for fireproofing, which shall confer a consistent protection with jet fire about the same.

Passive Fire Protection (PFP): Ensemble measures and design criteria (classified divisions installation with or without fireproofing, as well as, fireproofing application in structural members), which aims to avoid, isolate or retard the fire action or excessive heat, independently of any external action.

Fireproofing: Coverage placed on a steel surface, which gives a thermal protection, to limit the rate at which heat is transmitted to the area to be protected, or maintain structural resistance characteristics.


3 APPLICABLE REGULATIONS, CODES AND STANDARDS

The design criteria herein established are guidance for the application of the Standards and Recommendations included in this chapter and/or as additional requirements.

In case of items in conflict with this document, PETROBRAS shall be consulted.

3.1 IMO – SOLAS – INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA – 1974, AND AMENDMENTS IN FORCE.

3.2 IMO-MODU CODE – CODE FOR THE CONSTRUCTION AND EQUIPMENT OF MOBILE OFFSHORE DRILLING UNITS – 1989, AND AMENDMENTS IN FORCE.

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3.3 UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL – 1989.

3.4 ISO 13702 – PETROLEUM AND NATURAL GAS INDUSTRIES – CONTROL AND MITIGATION OF FIRES AND EXPLOSIONS ON OFFSHORE PRODUCTION INSTALLATIONS – REQUIREMENTS AND GUIDELINES.

3.5 CLASSIFICATION SOCIETY APPLICABLE STANDARDS.

3.6 DR-ENGP-M-I-1.3 – Diretriz de Engenharia de Segurança.

3.7 ISO 834 – Fire resistance tests – Elements of building construction.

3.8 Labor Ministry Regulation (MTE) – Regulating Standard – NR-30 - Segurança e Saúde no Trabalho Aquaviário.

3.9 ASTM E119 – Standard Test Methods for Fire Test of Building Construction and Materials.

4 TECHNICAL REQUIREMENTS

4.1 General

4.1.1 Mandatory safety items as established in the DR-ENGP-M-I-1.3 – Diretriz de Engenharia de Segurança, listed in chapter 3, shall be considered complementary requirements to this technical specification. In case of items in conflict with this document, PETROBRAS shall be consulted.

4.1.2 All PFP systems shall be approved by a recognized institution and designed according to recognized codes/standards. Certifying requirements for the PFP systems are to be in accordance to the requirements of Classification Society of the unit.

4.1.3 PFP is required to:

- Segregate main areas;
- Protect areas/rooms which are vital in emergency situations;

- Protect surrounding from areas/rooms which represent a high risk of fire;
- Ensure structural integrity during dimensioning accidental events;
- Protect process equipment and piping which would lead to intolerable consequences upon failure;
- Protect supports of critical or very heavy/large equipment and piping;
- Protect Safety Systems/functions.

The FPSO structural elements that may be exposed in a fire and where a collapse will cause total or partial damage to the FPSO shall be protected according to the results stated in the FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS. The identification of these elements shall be reviewed in Detailing Design by means of supplementary study, as required in the DR-ENGP-M-I-1.3.

4.1.4 An adequate PFP system shall be provided to protect critical items such as the pipe/valves/actuators, piping and connections, from riser connection up to the SDV, including it, when routed inside Process Areas, as required in DR-ENGP-M-I-1.3.

4.1.5 The fire integrity of bulkheads, decks and load bearing structures of the FPSO shall comply with PETROBRAS standard, applicable IMO and Classification Society requirements, as listed in the chapter 3.

4.1.6 CONTRACTOR shall remove all materials containing asbestos from the Unit and assure that the materials are disposed of properly. No new materials containing asbestos shall be used.

4.2 Systems components

4.2.1 The PFP shall comprise the following components:

- Classified divisions, as indicated in the reference documents listed in I-DE-General Arrangement and required according to the fire risk category defined in Safety Data Sheets;

- Fireproofing on pipelines critical items, which would be exposed to a jet fire emanating from a leaking flanged or clamped connection on adjacent or nearby gas piping;
- Fireproofing of equipment and piping which would lead to intolerable consequences upon failure, using the risks acceptance criteria established in the Fire Propagation and Smoke Dispersion Analysis.

4.3 Fireproofing

4.3.1 Fireproofing for structural elements shall be applied on the face exposed to fire hazard and shall cover all surfaces of such exposed elements.

4.3.2 The class of the division will depend on the fire type, fire duration and requirement to the systems protected by the firewall.

4.3.3 The PFP shall be designed to withstand the accidental loads for the area such that adjacent equipment, structures and safety systems can be protected to avoid escalation.


4.3.4 Fireproofing shall be designed considering the local ambiental conditions, according defined in Technical Specification of Metocean Data, as: humidity, intemperate weather (sun, rain, minimum/maximum ambient temperature), exposure to seawater (spray and deluge), and also the conditions of maximum and minimum temperature of the fluid in pipe and/or equipment, where relevant.

4.3.5 Recognized test certificates from alternative test procedures may also be accepted, but shall be submitted to PETROBRAS for approval prior to implementation. Certificates and test results for the material shall be provided by the CONTRACTOR.

4.3.6 Fireproofing shall be applied on intersecting firewalls thus preventing escalation of the initial fire. At the intersection between an "H" or "A" class division and another division with lesser degree of protection (e.g., A-60 versus A-0), an

extended fireproofing of the higher degree class material is to be provided to a distance of at least 1.0 meter beyond this point.

- 4.3.7** Rigid type fireproofing applied by means of spray system shall not be used on closed-in areas.
- 4.3.8** Where external surfaces are fitted with rigid type fireproofing, corner beads shall be used or the insulation shall be extended right up to the face of a structural member, to provide mechanical protection and to avoid infiltration of water into the fireproofing material, as indicated in the APPENDIX I. At protruding vertical corners, corner beads are to be installed up to a height of 2.0 meters above the floor level to protect the PFP against impacts.
- 4.3.9** Fireproofing for main load bearing structural elements shall be designed so as to withstand a fire condition as given in the UL 1709 test requirements, and considering the maximum steel design temperature or the heat input as derived from the in the Fire Propagation Study. The resulting insulation thickness required for ensuring such protection shall also comply with the Classification Society requirements and are to be submitted to PETROBRAS for approval.
- 4.3.10** For structural profiles other than the tested sample, the same thickness of fireproofing may be adopted, whenever the ratio "Hp/A" (element perimeter divided by its cross sectional area) is less than or equal to that one of the test sample. Special considerations shall be adopted to structural bulkheads and decks.
- 4.3.11** The profile shapes used as structural elements which are to be insulated shall be selected in such a manner as to help the fireproofing application.
- 4.3.12** Welding type and procedures for fixing devices of fireproofing to FPSO structural elements shall be submitted to PETROBRAS approval, according to the Topsides Structural Requirements.
- 4.3.13** Since epoxy-based fireproofing may not be defined as a non-combustible material, its application is allowable in external locations only, where personnel

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are not normally present. Anyway, the application is to be approved by the Administration Flag and the Classification Society during the Detailing Design.

4.3.14 When the adoption of fireproofing epoxy based, shall be required to have the same properties to avoid corrosion of the element to be protected and be resistant to crack, vibration, bending and impact loads, normally present during the phases of construction and operation. The maintenance required, as well as the lifetime of the fireproofing, shall be such that minimize gaps and damage of possible interventions.

4.3.15 The PFP system to be provided shall have acceptable corrosion protection properties.

4.4 Classified doors and windows

4.4.1 The number of doors and windows set into classified bulkheads shall be reduced to the minimum and comply with the functional and safety requirements of the FPSO.

4.4.2 The doors and windows installed in classified class bulkheads shall have at least the same classification of the partition.


4.4.3 Doors and windows, besides meeting the fireproofing requirements, shall also comply with those of watertighting, weatherproofing and mechanical operation, depending on the kind of use involved.

4.4.4 Fireproof doors and windows shall be of the self-closing type.

4.4.5 The installation of doors and windows shall be avoided in bulkheads H60/A60 classes.

4.5 Fire stops

4.5.1 The number and area of penetrations passing through classified divisions are to be kept to a minimum, by means of the optimization of the pipe, duct and cable routes.

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4.5.2 Penetrations for classified divisions are to have fire stops (fire stops seals or MCT) in order to provide at least the same fire resistance of the partition.

4.5.3 Fire stops components are to be installed in accordance with the requirements of the certification documents.

4.5.4 Divisions penetrations by set of pipes, where the proximity of the individual members makes it hard to use individual sealing devices, shall to be done with special fire stops devices, tested and certified by the classification society of the unit.

4.5.5 MCT used for divisions penetrations by electrical cables shall be of easy installation and that allows the removal, replacement or inclusion of cables, without the need of its complete removal and/or device replacement.

4.5.6 The penetrations of structural elements through "H" and "A" class divisions are to be provided with sealing welds. The fireproofing shall be specified in order to protect the structural element. The extension of fireproofing shall be determined in order to ensure temperature limitation requirements on the unexposed face of division, as well as the structure integrity.


4.5.7 The extension of fireproofing shall comply with the Classification Society requirements and are to be submitted to PETROBRAS approval.

4.5.8 Penetrations for HVAC ducts through classified divisions shall be provided with fireproofing, when applicable, extended beyond the dampers. The fireproofing extension shall comply with Classification Society requirements of the Unit.

4.6 Design documentation

Detailing Design shall issue documents that include, at least, the following information:

- Architectural plan with classified divisions and structural elements provided with PFP;
- Detailed specifications of classified divisions indicating the type of fireproofing, as well as, doors, windows, square and penetrations and their respective devices;

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- Details of construction and installation of classified divisions, their fireproofing, classified doors and fire stops;
- Specifications of the structural elements, with details of supporting and structural stiffeners required for installations in classified divisions and respective fireproofing;
- Details of the interfaces between classified divisions, their fireproofing, fire stops doors, including fireproofing finishing, in order to ensure the extension of the properties all over the insulated area;
- Drawings of each classified division, giving the respective dimensions, size and type of fireproofing to be applied, and location plans of all fire stops doors (penetration drawings) installed, indicating applicable construction and installation details;
- List of materials needed for the installation of all the "J", "H", "A" and "B" class divisions, their fireproofing, classified doors and fire stops;
- A Description Data Book, listing and justifying methods, procedures and solutions adopted, indicating the respective design documents.

5 MINIMUM DOCUMENTS REQUIRED

Classification Society Certificates of Approval issued by Ministério da Marinha – DPC.

6 FIREPROOFING ON STRUCTURAL ELEMENTS

6.1 Preliminary study findings

6.1.1 General:

- The application of PFP identified in Fire Propagation and Smoke Dispersion Analysis is based upon the loads found in the preliminary studies. This identification shall be reviewed in Detailing Design by means of the supplementary study, as required in the DR-ENGP-M-I-1.3 – Diretriz de Engenharia de Segurança.

6.1.2 Structural Elements:

- Fireproofing for the main load bearing of structural elements shall be designed to provide protection for a duration and type of fire necessary to prevent a structural collapse scenario.

6.1.3 Critical Equipment Supports:

- Fireproofing for the main load bearing of critical equipment supports shall be designed to provide protection for a duration and type of fire necessary to avoid escalation of the fire scenario.

7 FIREPROOFING ON PIPELINE CRITICAL ITEMS

7.1 General

7.1.1 The largest ignitable hydrocarbon inventory is from the seabed isolation valve to the SDV at riser hang-off.

7.1.2 The main purpose of the PFP systems, with respect to hydrocarbon hazards, is to prevent significant escalation of a scenario such that the integrity of the FPSO and the safety systems should not be threatened within the time required for safe evacuation. The fireproofing shall ensure protection under the specified service conditions.

7.1.3 A PFP system shall be provided to protect pipeline critical items, such as valves/actuators, piping and connections. In case of the use of enclosures, the system shall be easily removable to allow inspection. The guidelines provided by “typical PFP applications”, as required by ISO 13702 - Annex C.4, shall also be considered.

7.1.4 The fireproofing shall be applied on the production and injection lines, import and export gas piping at the riser balcony area. The “J60” PFP division class shall be applied onto the SDV’s, comprising the valve and actuator, on the risers hang-off at the balcony area which would be exposed to a jet fire emanating from a leaking flanged or clamped connection on adjacent or nearby

gas piping; this application do not depend on the impediment frequency, that is, the requirement is compulsory and deterministic.

7.1.5 The SDVs in the process area do not require PFP, considering the safe position for these items in case of fire confirmation.

7.1.6 The PFP shall be designed to withstand the accidental loads estimated for the area such that the risers adjacent to the point of the initial accident scenario can be protected to avoid escalation.

7.1.7 The fireproofing shall be applied on BDVs with delay time, comprising the valve and actuator. The PFP shall be certified to ensure that the valve surface temperature does not reach 200 °C in 15 minutes.

7.1.8 New materials, homologated and certified by the classification society, but not used commercially for offshore industry, shall be submitted to PETROBRAS for approval prior to be applied.

7.2 Service conditions

7.2.1 The PFP shall be designed for service in a marine environment, suitable for the design life of 25 years.

7.2.2 The PFP is required to be suitable for use in an exposed location within the risers' area and shall be suitable for continuous service in the following conditions:

- Temperature:
 - Minimum/maximum ambient temperature, according to Metocean data;
 - Maximum fluid temperature in pipework;
 - Flare induced temperature rise.
- Humidity: Up to 100% in highly saliferous conditions.



7.2.3 The PFP shall be designed to prevent the entrapment of moisture, rainwater or seawater from the deluge system, and to ensure that a build-up of flammable gas cannot occur within the enclosures.

7.2.4 The PFP shall be capable of withstanding, at least, the following hazard scenario, unless otherwise required by specific study:

- A hydrocarbon jet fire with properties as derived from the required study. The PFP shall reduce the heat input to the material providing a maximum material core temperature in accordance to the supplier's temperature tolerance data.

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APPENDIX I - RIGID TYPE FIREPROOFING FINISHING DETAILS

