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1. OBJECTIVE

This document establishes mandatory requirements for water and foam fire-fighting system specification, which shall be installed in the Offshore Units.

2. ABBREVIATIONS AND DEFINITIONS

2.1 ABBREVIATIONS

- ADV: Automatic Deluge Valve;
- AFFF: Aqueous Film-Forming Foam;
- AR-AFFF: Alcohol-Resistant Aqueous Film-Forming Foam;
- DPC: Diretoria de Portos e Costas;
- ESD: Emergency Shutdown;
- FWP: Fire Water Pump;
- LGE: Liquid Foam Generator;
- PFP: Passive Fire Protection.


2.2 DEFINITIONS

- Coamings: Partitioning the main deck floor to contain possible liquid spills from equipment, pipes, fittings etc;
- Fire Water Main: Fire-fighting water main distribution pipe until ADV, usually in ring-shaped;
- FWP Set: Sets of pumps and their sources of power, electrical and control cables, fuel tank, piping and control valves.

3. APLICABLE REGULATIONS, CODES AND STANDARDS

Regulations to be followed in the design, installation and testing of the water and foam fire-fighting are stated below:

- IMO - SOLAS: Convention for the Safety of Life at Sea – 1974 and Amendments in Force;
- IMO-MODU CODE: Code for the Construction and Equipment of Mobile Offshore Drilling Units;

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- FSS CODE: International Code for Fire Safety Systems;
- ISO 13.702: Petroleum and Natural Gas Industries – Control and Mitigation of Fires and Explosions on Offshore Production Installations;
- API RP 14G: Recommended Practice for Fire and Prevention and Control on Open Type Offshore Production Platforms;
- NFPA 11: Standard for Low-, Medium-, and High-Expansion Foam;
- NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection;
- NFPA 16: Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems;
- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection;
- NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems;
- CAP 437 - Offshore Helicopter Landing Areas – Guidance on Standards;
- Applicable Rules of the Brazilian Maritime Administration (DPC) - NORMAM; NORMAM-27 – Normas da Autoridade Marítima para Homologação de Helipontos Instalados em Embarcações e em Plataformas Marítimas;
- Applicable Rules of the Labor Ministry Regulation (MTE) - Regulating Standard – NR-17 – Ergonomia; NR-30 - Segurança e Saúde no Trabalho Aquaviário;
- Rules of the Classification Society of the Unit;
- DR-ENGP-M-I-1.3: Safety Philosophy;
- Piping Standard and Material for Oil Production and Process Facilities applicable to the current project.

4. TECHNICAL REQUIREMENTS

In addition to the provisions of DR-ENGP-M-I-1.3, the design of the fire-fighting system of the Unit shall consider the requirements contained in this Guideline and the Classification Society of the Unit.

All components of water and/or foam fire-fighting systems shall be located in such a way that are not be affected by fire coming from the area protected by them, or to impede its functionality. Therefore, shall be considered the results of the FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS.



In general, rates of application of fire-fighting water to be considered for sizing the deluge system shall attend the requirements of ISO 13.702. For careless and not reported cases in this Guideline, neither by the Classification Society, the NFPA 15 rates shall be applied.

The fire-fighting system shall be composed basically by:

- Fixed system (water and/or foam deluge system);
- Manual systems (hydrants and fixed and portable monitors for water and/or foam).

4.1 FIRE WATER SUPPLY SYSTEM

The fire-fighting water supply by FWP shall be sized to the higher demand as defined in DR-ENGP-M-I-1.3.

At least two main BCIs and one BCI reserve, capable of replacing any of the main BCIs, must be provided.

The FWP set shall be autonomous and dedicated for fire-fighting function.

The components of fire-fighting system shall be installed considering that in any foreseen accident scenario there is no impairment of 100% of the maximum design flow.

4.2 FIRE WATER DISTRIBUTION

The fire ring main shall be routed away from areas subject to mechanical damage and shall be positioned so that the structure of the Unit protects it from those damages, and still be located as close as possible to the edges of the deck, mainly in the FPSO Units.


The fire water main shall be exclusive to the fire-fighting system consumers.

The fire ring main and the branch lines shall be fitted with block valves to isolate its sections, in order to guarantee the water supply to other areas and, in at least 50% of the hydrants in each area. Additionally, the location and amount of block valves shall be such that allow their maintenance without damage to the system.

All block valves of the fire water main shall be easily accessed and preferably operable from the same level of the Unit. Additionally, it shall be properly identified to permit easy visibility.

The branch pipes of fire-fighting water, when located at high points, shall be provided with means to avoid water hammer.

Valves and piping accessories shall comply with Petrobras' piping specification.

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4.2.1 REQUIREMENTS FOR PIPING AND VALVES OF THE SYSTEM

All piping, valves and fittings shall be in agreement with the Petrobras' piping specification. All fire-fighting equipment shall be suitable for operation in marine environment. Equipment, piping and accessories used for fire-fighting shall be suitable to stay with seawater. Connections between them shall be of mutually compatible materials from the galvanic corrosion point of view, or shall be properly isolated from each other.

All system components shall be suitable to the maximum operating pressure in the hydrants in any area. The maximum pressure shall be lower than 1373 kPa (14.0 kgf/cm²) in any part of the fire water main.

The location of the valves, fire-fighting equipment and operating devices shall follow ergonomic factors, in order to ensure an efficient and safe operation as required by the Brazilian Standard NR-17.

4.2.2 REQUIREMENTS FOR FIRE WATER MAIN

The fire water main shall be optimized so as to reduce the piping diameters.

Hydraulic balancing of water main water shall be performed.

Due to the periodic use of fire water main and aiming to reduce diameters, may be admitted maximum flow velocity of 6.0 m/s.

The system must be pressurized by jockey pumps connected directly to the fire water main.


4.3 FOAM FIRE-FIGHTING SYSTEM

4.3.1 General

The main consumers of the foam system are:

- Monitors and system deluge of coamings in the main deck of FPSO Units;
- Hydrants and monitors in process area, as defined in the Unit Design;
- Monitors for helideck protection;
- The helicopter refueling system (when applicable).

For the fixed systems shall be provided two foam concentrate pump sets, each one capable of supplying 100% of the AR-AFFF demand.

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The foam protection system for process plants shall be by means of portable systems, as specified in NFPA 11, with autonomy for at least 30 minutes. Therefore, shall be considered the use of hydrants and AFFF drums.

The film forming foam to be used in the formation of the foam must be of the type for polar solvents and hydrocarbons, (Alcohol Resistant Aqueous Film Forming Foam 3% - AR-AFFF 3%) suitable for fire fighting in volatile fluids with a flash point below 60 ° C.

The helideck protection system design shall attend the provisions of NORMAN-27 and CAP 437, and additionally consider:

- Three foam monitors, each capable of providing 6 l/min per m² of 3% AR-AFFF solution during 10 minutes, over an area of 0.75 x B², where "B" is the maximum length of the helicopter, at a pressure of at least 687 kPa (7kgf/cm²) at the foam eductor inlet.

4.3.2 Foam System in FPSO Units

A foam ring main of 3% AR-AFFF, plus the branch pipes to consumers, shall be foreseen to supply the foam to deluge system and foam monitors.

A foam deluge system shall be provided for coamings protecting. This system shall be designed according to requirements of NFPA 16. The definition of mixture supply (water and LGE) for a single eductor or specific for coamings shall be determined considering a cost analysis and be approved by Petrobras.

The minimum pressure at the nozzle further away from the foam deluge main shall be 140 kPa (1.43 kgf/cm²), to be confirmed in the Detail Design.

Foam ADV shall be supplied in individual skids, including by-pass valves. The skids shall be easily identified and installed in safe and easily accessible areas, so that a fire in the area covered by them shall not prevent their operation. The ADV location shall be verified according to the results of FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS.

In the fire-fighting foam manual system design, shall be considered the following topics:

- Protection for fixed foam monitors to stern and bow offloading areas, as well as facilities for the use of hydrants and drums as additional protection;
- The capacity of any fixed monitor protecting the main deck area shall be at least 3 l/min of foam solution per m² of deck area protected by that monitor. Such area shall



be entirely forward of the monitor. The capacity shall be not less than 1250 l/min, according to FSS Code;

- Fixed foam monitors for protection of cargo tanks as defined in IMO SOLAS, and additionally, facilities for the use of hydrants installed in areas with coupling to the AFFF drums.
- In the foam system design the amount of fixed monitors needed shall be defined through a study considering also the following items:
 - Coverage area of fixed foam monitors (shadow analysis, including supplying the maps of the analysis);
 - The foam monitors shall be installed outside the plant projection line, in a manner that the fire from the areas protected by them does not compromise their use;
- Portable monitor shall be foreseen on main deck, which each flow shall not be less than 400 l/min and the reach, in any climatic conditions, shall not be less than 15 m, as required in the FSS Code.


4.4 REQUIREMENTS FOR AUTOMATIC WATER SPRAY DELUGE SYSTEMS

The water spray deluge systems basically consist of block valves, ADV, piping and nozzles, and shall be in accordance with NFPA 15.

The Unit shall be divided into several fire zones. Each consumer fire water system shall be determined according to the areas that protects. The selection of areas that shall compose each consumer system shall be defined considering the following criteria of the deluge system:

- Affected area by fire;
- Adjacent areas to the affected area, according to result of FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS requested in DR-ENGP-M-I-1.3;
- Simultaneous interventions consumer fire water systems shall be set in alignment with the results of FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS.

Note: Fire-fighting areas may be limited by means of "A" or "H" class type fire bulkheads and decks.

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Deluge system activation in adjacent areas mentioned above shall rely on fire confirmation at the respective areas. For this, there shall be monitoring for fire sensors (fusible-plug and/or flame detectors), for each process area provided with water deluge.

The follow itens shall be protected with water deluge:

- Pressurized vessels and tanks containing flammable fluids;
- Pumps and compressors (except those enclosed) handling flammable liquids;
- Manifolds, receivers and launchers (including shutdown valves);
- Riser connection areas of oil and gas (including shutdown valves);
- Oil metering stations.

The need for protection in other equipment and/or areas such as: pipe containing flammable and combustible fluids, including pipe-rack, diesel engine (except those enclosed), and diesel tanks (except those enclosed), shall be determined by the FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS or when required by the Classification Society.

The ADV shall be supplied with markings to indicate "open" and "closed" positions, in individual skids, including by-pass valves. The skids shall be easily identified and installed in safe and easily accessible areas, so that a fire in the area covered by them shall not prevent their operation. The ADV location shall be verified according to the results of FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS.


Note: The FIRE PROPAGATION AND SMOKE DISPERSION ANALYSIS shall determine the need of PFP for ADV skids.

The minimum pressure at the most remote nozzle in each deluge water main shall be 140 kPa (1.43Kgf/cm²).

The fixed fire-fighting systems, including ADV and fire water distribution pipe shall be designed so that fire water protection is effective within 20 seconds of the demand. This requirement does not comprise the time needed for the start of diesel FWP.

4.5 FIRE-FIGHTING WATER AND FOAM MANUAL SYSTEMS

It shall be possible to reach any point of the unit by at least two water jets – derived from different hydrants. One of them shall derive from a 15 m hose line and the other, may be from two extensions of 15 m hose lines (total of 30 meters). Hydrant nozzles shall provide the combination of fog and straight stream.

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Indoor hydrants (1 x 1 ½ inch) for "A" class fire, only in accommodation areas, shall operate at a pressure of at least 350 kPa (3.6 kgf/cm²) at the nozzle inlet.

Outdoor hydrants (2 x 2 ½ inch) shall be capable of delivering at least 20 m³/h per jet, at a pressure of at least 490 kPa (5.0 kgf/cm²) at the nozzle inlet.

Process areas shall also be protected by manual foam eductors, according to NFPA 11 requirements. The eductors shall be capable of delivering at least 200 l/min of AFFF solution, at a pressure of at least 350 kPa (3.6 kgf/cm²) at the nozzle inlet. Two fire hoses 1 ½ inch diameter and 15 meters long, series-coupled, shall be provided downstream of the eductor.

5. MINIMUM DOCUMENTS REQUERIDED

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