

GENERAL SPECIFICATION

SAFETY

GS EP SAF 334

Foam fire extinguishing systems

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1. Scope

1.1 Purpose of the specification

The purpose of this general specification is to define the requirements for the design of foam fire extinguishing systems for oil and gas production, processing and storage installations.

Foam extinguishes fire in four ways:

- Smothering fire and preventing air from mixing with flammable vapours
- Control and reduction of flammable vapours release
- Separating flames from fuel surface
- Providing some cooling effect for fuel and adjacent metal surfaces.

Foam is **not** suitable for:

- Three-dimensional flowing liquid-fuel fires or for gas fires
- Chemicals releasing sufficient oxygen to sustain combustion
- Energised un-enclosed electrical equipment
- Water-reactive metals
- Water-reactive materials.

1.2 Applicability

This specification is not retroactive. It shall apply to new installations and to major modifications of existing installations. This specification applies to onshore and offshore installations.

This specification does not cover:

- Selection of equipment to be protected by foam application (refer to [GS EP SAF 311](#))
- Chemical foams systems (which are considered as obsolete)
- Mobile foam-generating systems.

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2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
NFPA 11	Low-Expansion Foam
NFPA 11A	Medium and High-Expansion Foam Systems
NFPA 16	Installation of Deluge Foam - Water Sprinkler and Foam - Water Spray Systems
NFPA 18	Standard on wetting agents
NFPA 30	Flammable and Combustible Liquids Code
NFPA 59A	Standard for the Production, Storage, and Handling of Liquefied Natural Gas

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP SAF 311	Rules for the selection of fire-fighting systems
GS EP SAF 321	Fire pump stations and fire water mains

3. Terminology and definitions

Concentration	Percentage of foam concentrate contained in a liquid foam solution (typically ranging from 3 % to 6 %) before it is expanded into foam
Expansion	Ratio of final foam volume to original foam solution volume
Eductor	Device using the Venturi principle to introduce a proportionate quantity of foam concentrate into a water stream. The wording "inductor" is frequently misused
Fluid category	As per French regulation, hydrocarbons fluids are sorted as follows: • Fluid category A: liquefied hydrocarbons with True Vapour Pressure (TVP) > 1 bara at 15°C - A1: Liquefied at t < 0°C

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- A2: Liquefied in other conditions
- **Fluid category B:** Liquid hydrocarbons with flash point $< 55^{\circ}\text{C}$
- **Fluid category C:** Liquid hydrocarbons with: $55^{\circ}\text{C} \leq \text{flash point} < 100^{\circ}\text{C}$
 - C1: With flash point $\leq$ storage temperature
 - C2: With storage temperature $<$ flash point
- **Fluid category D:** liquid hydrocarbons with: $100^{\circ}\text{C} \leq \text{flash point}$:
 - D1: With flash point $\leq$ storage temperature
 - D2: With storage temperature $<$ flash point

As per **British** regulation, hydrocarbons fluids are classified as follows:

- **Fluid class 0:** Liquefied Petroleum Gases (LPG)
- **Fluid class I:** Liquid hydrocarbon with a flash point below 21°C
- **Fluid class II:** Liquid hydrocarbon with a flash point above 21°C but below 55°C
 - II(1): Stored below flash point
 - II(2): With storage temperature above flash point
- **Fluid class III:** liquid hydrocarbon with a flash point above 55°C
 - III(1): Flash point above 55°C but below 100°C and stored below flash point
 - III(2): Same as III(1) but stored above flash point
- **Unclassified:** Liquid hydrocarbon with a flash point above 100°C . Unclassified petroleum liquids should be considered as class III(2) when handled at, or above, their flash point temperature

As per **American** regulation (NFPA), hydrocarbons fluids are classified as follows:

- **Fluid class I**
 - IA: Liquid having a flash point below 22.8°C and a boiling point below 37.8°C
 - IB: Liquid having a flash point below 22.8°C and a boiling point above 37.8°C
 - IC: Liquid having a flash point at or above 22.8°C and below 37.8°C
- **Fluid class II:** Liquid having a flash point at or above 37.8°C and below 60°C
- **Fluid class III**
 - IIIA: Liquid having a flash point at or above 60°C and below 93°C
 - IIIB: Liquid having a flash point at or above 93°C .

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Foam	A mixture of air, water and foam concentrate forming a stable aggregation of small bubbles of low density that exhibits a tenacity for covering horizontal surfaces.
Foam, concentrate	A concentrated liquid foaming agent as received from the Manufacturer. In this document, "foam concentrate" and "concentrate" are used interchangeably.
Foam, solution	A homogeneous mixture of water and foam concentrate. In this document, "foam solution" and "solution" are used interchangeably.
Submergence	Completion of the filling of an enclosure with a high-expansion foam.
Surfactant	Chemical agent decreasing the surface tension and increasing the wetting capability, and additionally the penetration into porous solid materials.

4. Foam extinguishing agents

4.1 Expansion

4.1.1 General

Foams are sorted out into three expansions levels:

- Low-expansion: expansion < 20 (vol./vol.)
- Medium-expansion: 20 < expansion < 200
- High-expansion: 200 < expansion.

Their adequate use is summarised here-after.

4.1.2 Low expansion

Low-expansion foams are the most widely used for pool fires of liquid hydrocarbons. Their main effectiveness in fire prevention, control and fire-fighting is that some of them (AFFF, FFFP) can actually spread and wet the surface of most fuels, and form a thin layer acting as an effective vapour seal arresting the combustion and suppressing the evolution fuel vapours. They can be sprayed at large distances, they stick to equipment and they also provide a cooling coat onto the equipment.

4.1.3 Medium expansion

Medium-expansion foams were developed to meet the need for foams that were more wind resistant than high-expansion foam for outdoor applications. Medium-expansion foams can be used on solid fuel and liquid fuel fires where some degree of in-depth coverage is necessary, for instance engine enclosed or semi-enclosed rooms, transformer rooms, etc.

Medium-expansion foams can also provide quick and effective coverage of flammable liquid spill fires (pool fires) or some toxic liquid spills where rapid vapour reduction is essential.

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4.1.4 High expansion

High-expansion foams are agents for control and extinguishing of Class A (combustible material) and Class B (flammable fluids) fires and are particularly suited as flooding agent in confined spaces. Although application onto a LNG spill will accelerate LNG vaporisation, high expansion foam can be used to provide vapour dispersion control for LNG spills, forcing the vapours upwards once they have been heated up by the foam itself. High expansion foams can also be used on LPG pools for the same purposes but the risks in doing so are increased as compared to LNG because of the higher MW of LNG vapours. If the decision to proceed is taken nevertheless, then the foam application system shall be sized in such a way that a foam blanket at least 1.5 m thick can be laid on top of the LPG pool.

High-expansion foams and, to a lesser extent, medium-expansion foams, have the following effects on fires:

- Where generated in sufficient volume, they can prevent the free movement of air, and if accumulated in depth, they provide an insulating barrier, and prevent fire from spreading.
- Where forced to the heart of the fire, part of the water in the foam is converted to steam, thus reducing the oxygen rate; additionally the conversion of water to steam absorbs heat.
- Due to their low surface tension, the solution that is not converted into steam tends to penetrate combustible materials and plug them off.
- Class A fires are controlled when the foam completely covers the burning material. If the foam is maintained long enough, the fire can be extinguished.
- Class B fires can be extinguished when the surface is cooled below the flash-point, or when a foam blanket of sufficient depth is established over the liquid surface.

As general rule, high-expansion foam shall not be used outdoor because of the effects of wind and the lack of confinement.

4.2 Foam concentrate type

There are different types of foam concentrates that can be sorted out as follows:

- Proteins and Fluoro-proteins
- Synthetic: Aqueous Film Forming Foam (AFFF)
- Film-Forming Fluoro-Proteins (FFFP)
- Alcohol-resistant.

4.2.1 Protein and Fluoro-protein foams

They are based on hydrolysed proteins from natural material. In addition and contain stabilising and inhibiting products to protect from freezing, prevent corrosion, resist bacterial decomposition, control viscosity, and to ensure readiness for use under emergency conditions. They are not expensive and have a good stability and fire resistance. They have a limited storage time capability and are increasingly replaced by AFFF.

Fluoro protein foams are essentially a compromise between protein and chemical foams such as AFFF (see **section 4.2.2**). In addition to proteins, they contain a synthetic fluorinated surfactant additive that decreases the surface tension and enhances the surface coverage

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effectiveness and the penetration into materials. They are cheaper and have a better fire resistance and stability than synthetic foams.

Protein and Fluoro-protein concentrates produce low expansion foam (6 to 12).

4.2.2 Synthetic foams

Synthetic-foam concentrates are based on foaming agents other than hydrolysed proteins and include the following types.

Under normal storage conditions, the life duration of synthetic foam concentrates is significantly higher than protein or fluoro-protein concentrates even when mixed with water. For this reason they are more suitable for such application as twin-agent skid.

4.2.2.1 Aqueous-Film Forming Foams (AFFF)

They are the most commonly used for low-expansion foams. They are based on fluorinated surfactants, plus stabilising and anti-freezing additives. They can be regarded as super detergents which, in solution, have such a low surface tension that they can actually spread and wet the surface of most fuels, and form a thin layer acting as an effective vapour seal arresting the combustion. They should preferably be applied as a spray.

Their main advantage is the very high speed of fire control they provide. They are particularly valuable for first-aid use in dealing with spill fires without any appreciable depth. They can be used with conventional water spray nozzles on fixed installations (deluge systems) and/or water monitor/hose reels.

They produce low expansion foam (6 to 12).

4.2.2.2 Medium- and high-expansion foams

They are usually derived from hydrocarbon surfactants. They require specially designed foam generators, which can be air-aspirating or blower-fan type. They are mainly used to fill enclosures.

They can have expansion up to 1000.

4.2.2.3 Other synthetic foams

Other synthetic foam concentrates are based on hydrocarbon surface active agents, and are listed as wetting agents, foaming agents, or both. In general, their use is limited to portable nozzle foam application for spill fires. For further details, refer to [NFPA 18](#).

4.2.2.4 Film-Forming Fluoro-Proteins (FFFP)

They can be considered as an adequate alternative to AFFF (see **section 4.2.2**). They consist of fluorinated surfactants to produce an aqueous film suitable for suppression of hydrocarbon vapours. They utilise a protein base plus stabilising and inhibiting additives to protect against freezing, corrosion, and bacteria. They can be used with conventional water spray nozzles on fixed installations (deluge systems).