GENERAL SPECIFICATION

SAFETY

GS EP SAF 322

Fixed fire water systems

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<tr>
<th>Rev.</th>
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1. Scope

1.1 Purpose
The purpose of this general specification is to define the minimum requirements for the design and installation of fire water cooling and extinguishing systems to be installed on onshore and offshore petroleum facilities.

The main fixed systems dealt with in this specification are as follows:
- Deluges
- Water curtains
- Sprinklers systems
- Monitors
- Hydrants
- Hose reels (in French: robinet d'incendie armé).

The choice of adequate fire fighting systems shall be made in accordance with GS EP SAF 311.

1.2 Applicability
This specification applies to all hydrocarbon processing or production facilities, onshore or offshore, excluding onshore aboveground hydrocarbon storage tanks for which protection systems are described in GS EP SAF 341.

Requirements for the protection of LNG installations are defined in other specifications.

The safety rules for the protection of buildings, diesel engines, turbines and process units located in enclosed areas are defined in GS EP SAF 221 and GS EP SAF 222.

2. Reference documents
The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

**Standards**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>IEC 60331</td>
<td>Tests for electric cables under fire conditions – Circuit integrity – Fire-Resisting Characteristics of Electrical Cables</td>
</tr>
<tr>
<td>IEC 60332-3-10</td>
<td>Tests on electric cables under fire conditions – Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus</td>
</tr>
<tr>
<td>ISO 13702</td>
<td>Petroleum and natural gas industries. Control and Mitigation of Fires and Explosion on Offshore Installations – Requirements and guidelines</td>
</tr>
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### Professional Documents

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>NFPA 13</td>
<td>Standard for the Installation of Sprinkler Systems</td>
</tr>
<tr>
<td>NFPA 15</td>
<td>Standard for Water Spray Fixed Systems for Fire Protection</td>
</tr>
<tr>
<td>NFPA 16</td>
<td>Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems</td>
</tr>
<tr>
<td>NFPA 25</td>
<td>Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems</td>
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### Regulations

<table>
<thead>
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### Codes

<table>
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<tbody>
<tr>
<td>Not applicable</td>
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### Other documents

<table>
<thead>
<tr>
<th>Reference</th>
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<tr>
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### Total General Specifications

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>GS EP PVV 112</td>
<td>Piping material classes</td>
</tr>
<tr>
<td>GS EP SAF 221</td>
<td>Safety rules for buildings</td>
</tr>
<tr>
<td>GS EP SAF 222</td>
<td>Safety rules for turbines, diesel engines, gas engines and process units in sheltered or enclosed areas</td>
</tr>
<tr>
<td>GS EP SAF 311</td>
<td>Rules for the selection of fire-fighting systems</td>
</tr>
<tr>
<td>GS EP SAF 334</td>
<td>Foam fire extinguishing systems</td>
</tr>
<tr>
<td>GS EP SAF 341</td>
<td>Location and protection of onshore hydrocarbon storage</td>
</tr>
</tbody>
</table>
Order of Precedence

In case of conflict or ambiguities between documents, the following order of precedence shall prevail:

- Local laws
- The Safety Concept
- This General Specification
- Professional documents

It shall be noted that international codes and standards should be considered as design guidelines and shall not prevail upon Company documents and HSE policy.

3. Terms and Definitions

Shall:
Indicates a mandatory requirement. Any deviation from a “shall” statement requires Company approval through a derogation

Should:
Means that it is strongly recommended to comply with the requirement of the specification. Alternatives shall provide an equivalent level of protection and this shall be documented

May:
Is used where alternatives are equally acceptable

Application rate:
The discharge density of fire water supplied to the area or equipment to be protected, usually expressed in liters/minute/m²

Deluge valve:
A stand alone or skid assembled valve, normally closed, opened by the operation of a detection system or by remote/local manual actuation, supplying fire water to the deluge system

Deluge system:
An arrangement of open type spray nozzles connected by a dry pipe-work, specifically designed to provide exposure protection, control of burning or extinguishment of fire over a dedicated area or equipment.

Foam concentrate:
A concentrated liquid foaming agent that mixes with water and air to form a stable aggregation of small bubbles (foam solution). It can be of low, medium of high expansion type depending on the type of hazard.

Shadow area:
The area not being impinged by fire water due to obstructions of obstacles

Stand-off distance:
The effective distance between the nozzle discharge point and the protected surface
Water wastage:
The quantity of fire water that does not impinge on the area or equipment being protected

4. Deluge systems
The expressions "deluge system" and "water spray system" are equivalent. "Deluge" or "Deluge system" shall be used in the present specification.

Fixed water deluge are installed to provide cooling or fire intensity control. As a general rule, they are not intended to extinguish fires, except when they provide a mean to apply foam to extinguish hydrocarbon pool fires. See GS EP SAF 334. A deluge system consists of a number of spray nozzles, always open, fitted onto a length of pipe (generally a ring) kept dry and in which the water flow is controlled by a (or a set of) deluge valve(s).

4.1 Deluged equipment
Unless specific considerations prevail, deluge shall be installed to protect the following equipments:

<table>
<thead>
<tr>
<th>Concerned equipment</th>
<th>Remarks</th>
<th>Offshore</th>
<th>Onshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wellhead</td>
<td></td>
<td>Yes (1)</td>
<td>No</td>
</tr>
<tr>
<td>Process equipment</td>
<td>Vessels, pumps, shell and tube heat exchangers, LACT, column</td>
<td>Yes</td>
<td>Yes (2)</td>
</tr>
<tr>
<td>Slug catchers</td>
<td>Finger type only</td>
<td>NA</td>
<td>Yes (3)</td>
</tr>
<tr>
<td>Air coolers</td>
<td></td>
<td>Yes (7)</td>
<td>No</td>
</tr>
<tr>
<td>Engines</td>
<td>Open air and sheltered area</td>
<td>Yes</td>
<td>Yes (2)</td>
</tr>
<tr>
<td>Piping and pig traps</td>
<td>Inside battery limit</td>
<td>Yes</td>
<td>Yes (2)</td>
</tr>
<tr>
<td>Compressors</td>
<td></td>
<td>Yes</td>
<td>Yes (4)</td>
</tr>
<tr>
<td>Structures</td>
<td></td>
<td>Yes (5)</td>
<td>No</td>
</tr>
<tr>
<td>Pipe racks</td>
<td></td>
<td>Yes (9)</td>
<td>Yes (9)</td>
</tr>
<tr>
<td>Storage tanks (crude oil + LPG)</td>
<td></td>
<td>NA</td>
<td>Yes (6)</td>
</tr>
<tr>
<td>Loading terminal</td>
<td>Road or rail</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>Heaters and reboilers</td>
<td>Excluding furnaces</td>
<td>Yes (8)</td>
<td>No</td>
</tr>
<tr>
<td>TEG regeneration skid</td>
<td>Triphasic flash drum only</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Transformers</td>
<td>Oil filled transformers</td>
<td>Yes (10)</td>
<td>No (10)</td>
</tr>
</tbody>
</table>

Note 1: If wellhead platform is connected to Central Complex where fire water is available.

Note 2: Deluge shall be installed if HC liquid inventory > 5 m³. Deluge shall also be installed, regardless of liquid inventory, if (i) mobile fire-fighting means are not quickly available and/or of sufficient capacity or if (ii) unit layout does not allow for efficient use of fire monitors.
Note 3: Deluge shall be installed on large units (pressure x volume > 3000 bar.m³); monitors are adequate for smaller units. Deluge shall be limited to equipment extremities and 5 m beyond.

Note 4: Deluge not necessary if compressor can be located at sufficient distance from other process units and if layout is compatible with fire monitor efficient operation. Particular care shall be given to include lube oil and seal oil systems within the deluge coverage.

Note 5: Restricted only to structures not protected by passive fire protection and whose integrity is a pre-requisite for safe evacuation of personnel.

Note 6: Deluge for tanks larger than 1000 m³. For smaller tanks, decision to install deluge shall be governed (i) by availability and capacity of other fixed or mobile fire-fighting systems, (ii) tank geographical location (close vs. remote, time to intervene) and (iii) environmental impact in case of hazard.

Note 7: Deluge only on the three exposed faces of distribution header(s).

Note 8: Fixed deluge system for low expansion foam solution (rate 3 l/min/m²) on heater shell only, to be avoided onto fire box and flange.

Note 9: Inside unit battery limits and only if surrounding equipment are deluged. Cable trays shall not be deluged. Cables shall be at least flame retardant as per IEC 60332-3-10 and cables related to safety systems shall be fire resistant as per IEC 60331.

Note 10: Large oil filled transformers located onshore should generally be installed within fire resistant masonry walls housing. Therefore, manual fire fighting means adequately located in the vicinity should provide enough means to control any incident related to the transformers. On offshore installations, preference should be given to the installation of dry (sealed) transformers. Where water spray systems are deemed necessary, they should be designed and installed in accordance with NFPA 15, unless other means of fire protection are foreseen (water mist or dry chemical systems).
4.2 Application rate
Once the decision to install deluge has been made as per criteria exposed in section 4.1 and in accordance with options selected in the SAFETY CONCEPT, water application rate (or discharge density) for burning control or exposure protection shall be calculated according to the following table in accordance with NFPA 15 and ISO 13702 recommendations:

### Table 2: Deluge application rate

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Application rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessels, columns (1), exchangers</td>
<td>10.2 l/min/m² of the developed surface</td>
</tr>
<tr>
<td>Pumps</td>
<td>20.4 l/min/m² of the floor area, including an outskirt of at least 1.5 m around the foundation/skid</td>
</tr>
<tr>
<td>Compressors</td>
<td>20.4 l/min/m² of the floor area, including an outskirt of at least 1.5 m around the foundation. Protection to include the compressor casing, associated piping and valving, the gearbox, the lube-oil console and other auxiliary equipment</td>
</tr>
<tr>
<td>Wellheads (2)</td>
<td>24 m³/h minimum per unit</td>
</tr>
<tr>
<td></td>
<td>30 m³/h minimum per unit for gas wells</td>
</tr>
<tr>
<td>Manifold zone</td>
<td>10 l/min/m² of floor area in the zone</td>
</tr>
<tr>
<td>Pipe rack</td>
<td>- Single level: 10.0 l/min/m² of plane surface</td>
</tr>
<tr>
<td></td>
<td>- Several levels: 8.2 l/min/m² (lower level)</td>
</tr>
<tr>
<td></td>
<td>6.1 l/min/m² (intermediate / upper level)</td>
</tr>
<tr>
<td>Structural steel members (main spars unprotected by passive fire protection)</td>
<td>- Horizontal: 4.1 l/min/m² over the wetted area</td>
</tr>
<tr>
<td></td>
<td>- Vertical: 10.2 l/min/m² over the wetted area</td>
</tr>
<tr>
<td>Transformers (oil filled)</td>
<td>10.2 l/min/m² of all exposed surfaces</td>
</tr>
</tbody>
</table>

**Note 1:** Columns shall be deluged up to a height of 12.2 m above grade, or a level at which a pool fire could form. Fire sources shall be investigated to confirm that equipment/structures above 12.2m are not impacted by the effects of fire. Manual fire fighting means shall be provided in the vicinity to enable fire fighters to cover higher parts of the concerned equipment.

**Note 2:** Deluge for wells shall be made by means of High Velocity (HV) spray nozzles.

4.3 General design
A deluge system consists of a fixed dedicated dry pipe work fed by a deluge valve (or a deluge valve skid assembly) and fitted with open spray nozzles that are arranged to discharge fire water over the area or equipment to be protected.

Fixed deluge systems shall be designed so as to optimize water coverage efficiency and minimize water wastage. The quantity of sprayed water impinging the surface of protected equipment shall not be less than 80%.
The design of the deluge systems shall take into account the required flexibility for potential future evolutions. Drainage of the discharged fire water after system activation shall need to be considered. Due care shall be given to potential surge effects that may occur when opening/closing a deluge valve.

The design of the water spray system shall be in compliance with NFPA 15 recommendations.

4.4 Piping downstream of the deluge valve

4.4.1 Installation

Piping is normally dry. It shall be designed to be robust and shall be adequately secured and supported. The effects of surge shall be considered. Provisions shall be made to drain the piping after operation.

Maximum fire water velocity in deluge networks shall be 5 m/s. This figure shall however be checked against piping Vendor recommendations. Minimum diameter for deluge piping shall not be less than 1 1/2 ".

Care shall be taken in the design and installation of deluge system to limit the number of low points and trapped sections of pipe that require drains. Caps and blinds shall be adequately provided so as to allow flushing as a routine operation.

The design and implementation of piping associated with the deluge system shall not interfere with maintenance activities or process equipment operation. Therefore, adequate dismantling flanges shall be installed in order to enable maintenance activities. In the same way, deluge piping ends shall be provided with blind flanges for flushing purpose.

4.4.2 Material

The acceptable materials for fire water deluge piping (both for soft water and for sea / brackish water) are provided in GS EP PVV 112 as well as in GS EP SAF 321.

4.5 Valves

4.5.1 Block valve

Isolation of any automatic deluge system shall be made possible by means of manual operated block valve (See Appendix 1 and section 4.5.4). The block valves immediately upstream (shutoff valve) and downstream the deluge valve shall be provided with a system to lock them in open position in normal service.

4.5.2 Deluge valves

Deluge valves shall be of the Pressure controlled reinforced sleeve type (see figure 1), and shall be maintained closed using the fire water pressure upstream the deluge valve. No external services shall be used to keep the valve closed.

The pressure control trim shall be calibrated to the required downstream pressure of the deluge system, enabling the valve to maintain a constant downstream pressure regardless of the fire water ring main pressure variations.

The maximum diameter for deluge valves shall be 10”. The nominal flow through deluge valve shall be limited to 600 m³/h and the pressure drop across the valve shall not exceed 0.7 barg at nominal flow.
Quick opening (“clack” type) automatic valves (see figure 2) can be accepted provided that the deluge network is proven to handle potential surge effects related to the valve opening/closing rapidity. This shall be demonstrated by carrying out a transient hydraulic analysis of the system.

Opening of the deluge valves shall be made by:

- the fire and gas detection system, upon confirmed fire or gas detection (unless otherwise specified by the Safety Concept)
- Remote manual activation, from Control Room
- Local manual activation (mechanical) on the valve itself

Where and when deemed necessary, a “local remote” manual activation can be foreseen, by means of an electrical release pull handle located near escape ways.
Actuation of deluge valves shall be made by a solenoid valve, triggered either electrically or pneumatically. The solenoid valve signal shall be of the “energize to open” type, with permanent line monitoring. Opening and closing time of the deluge valves shall be adjustable so as to avoid water hammer effects.

Deluge valve reset shall always be accomplished locally and manually. Means shall be provided to enable testing of the deluge valve without discharging fire water through the deluge piping and nozzles.

4.5.3 Location

Attention shall be paid to minimize the risk of damage or destruction of the deluge valves, following a fire or an explosion.

The valves (deluge valves and shut-off valves) shall be outside the protected area and in a location where manual intervention on the valves could be possible in case of fire. The deluge valve shall be either located a minimum of 15 m off the protected area (e.g. onshore) or, if it is not possible, behind a firewall. The firewall shall be blast rated for large process/utility platforms.

Where necessary, deluge valves or deluge valves skids (especially instrumentation) shall be protected from solar radiation.

4.5.4 Installation

Each deluge system shall always be supplied by two points, as far apart as technically feasible and fed by separate headers. A by-pass may be installed around the deluge valve(s) but this is not compulsory. The deluge system shall be supplied by one or two automatic deluge valve(s), depending upon the facility specific requirements.

Deluge valve(s) and associated piping shall be sized so that water velocity does not exceed 5 m/s in any part of the deluge branch. When two deluge valves are installed hydraulic calculations shall be carried out to ensure that the deluge system shall be fed with an adequate water supply (both flow and pressure) even if one of the deluge valve remains closed.

4.5.4.1 Typical arrangements

One automatic deluge valve and one manual shut-off valve

This configuration can be installed onshore or offshore on low/medium risk facilities and/or if manual shut-off valve remains always operable, even in case of fire. Applicable for example to an unmanned offshore wellhead platform, an onshore metering/pigging station, etc.

Figure 3: Typical arrangement with one automatic deluge valve
Two automatic deluge valves

This arrangement shall be installed onshore or offshore on medium/high risk and/or unmanned facilities. Applicable for example to an offshore production platform or an onshore gas/oil separation plant or gas compression facility.

![Diagram of typical arrangement with two automatic deluge valves]

Legend:

- Automatic Deluge Valve
- Deluge nozzles
- FW ring main
- NO: Normally Open
- NC: Normally Closed

**Note 1:** By-pass valve can be deleted if deluge valve manual opening device is operable in all circumstances, including worst fire scenario considered by SAFETY CONCEPT.

**Note 2:** Test valve and block valve downstream of deluge valve can be deleted if soft fire water is used and if it is deemed acceptable by Company to deluge facility for test purposes.

4.5.5 Safe position for automatic deluge valve

In case the use of quick opening (clack type) deluge valves is selected, the fail position of deluge valves shall be fail open on low water pressure, but the signal from the ESD/F&G system shall be of the "energize to open" type.

4.6 Nozzles

4.6.1 Nozzle type

The nozzles shall be listed UL (Underwriters Laboratories Inc.), FM (Factory Mutual) or approved by a recognized international certification authority. Contractor / Vendor shall require Company acceptance with regard to the selected certification authority.
Nozzles shall be either "Type D" (Medium velocity) or "Projector Type" (High velocity) or else piggy tail. See sketches below:

![Type D hemispherical spray nozzle](image1)
![Projector Type Spray nozzle](image2)
![Piggy tail spray nozzle](image3)

Unless otherwise specified, spray nozzles shall be of the medium velocity type (i.e. water being ejected at about 20 m/s) in order to provide the proper degree of water pulverization. The normal working pressure of the nozzles shall be around 3.5 barg and shall never be less than 2.5 barg.

Spraying nozzles shall be designed to minimize plugging with only an orifice, a splitter and a deflector. Nozzles with internal vanes or strainers are not recommended. The nozzle orifice shall be at least 5 mm in diameter and the nozzle internal configuration shall allow easy cleaning.

Spray nozzles shall be made of brass (marine type), stainless steel, gun metal or cupro-nickel depending upon the service. Special care shall be given to compatibility between the piping and nozzle metallurgy. Unless specifically required, spray nozzles shall not be painted.

### 4.6.2 Configuration

The nozzle configuration shall provide a uniform film of water over all parts of the equipment so that the water absorbs the heat from the fire and keep the equipment cool. Dry areas resulting from incomplete nozzle coverage and thus developing hot spot that can cause a vessel to rupture or a structure to collapse, shall be avoided.

The nozzles shall deliver enough flow to comply with water requirements as per table enclosed in section 4.2 (Application rate). Refer to Appendices 2, 3 and 4 for nozzle arrangements. The number of nozzles, their spacing as well as their location shall be determined by combining the total water flow requirement for the equipment to be protected augmented by 20 % to account for irregular distribution pattern, wind effect, etc.; the flow delivered under service conditions by each spraying nozzle and the nozzle jet pattern (hemispherical or conical, 60°, 90°, etc.) making sure that all the surface to be protected is adequately covered.

In general, the tappings for spray nozzles shall preferably not be positioned below the generatrix of the supply pipe. However, where deluge piping is not susceptible to corrosion (e.g. cupro-nickel, stainless steel, titanium), the nozzles can be supplied directly from the underside of the deluge headers. The headers feeding the spray nozzles shall be fitted with adequate drainage facilities.
The arrangements illustrated here under are recommended.

![Figure 5: Direct Mounting](image1)

![Figure 6: Shifted Mounting](image2)

The number of nozzle types shall be minimized in order to render maintenance activities easier.

4.6.3 Evacuation of water

The operation of deluge places large quantities of water on the ground floor. Drains shall be provided to evacuate this water and to prevent hydrocarbon release spilling over the water and possibly spreading the fire.

4.7 Remote alarm and control

For each deluge system, remote signals and control available in the main control room and in the main fire station (if any) are the following:

4.7.1 Signals

- Operation of deluge valve (Refer to Appendix 1)
- Electrical power supply failure
- Lack of instrument air (if any, system using fusible plugs for detection/deluge).

4.7.2 Control

- Remote automatic opening for automatic deluge valve
- Remote manual opening for automatic deluge valve (from Control Room)
- Local manual opening (mechanical) on the valve/skid itself
- When necessary, local remote opening (electric release pull handle)

Electrical lines pertaining to "energize to actuate" systems (e.g. deluge valve opening signal) shall be permanently monitored to allow any fault to be quickly and accurately identified. Electrical cables necessary to control the deluge valve shall be "fire resistant" type or shall be placed in "one hour fire resistant" sheaths.

If the facility is remote controlled or controlled by a detection system, the total time for actuation shall never exceed one minute after initiation of the system.
5. Water curtains

The purposes of water curtains are mainly to limit thermal effect (radiation) coming from a fire area and, additionally, to achieve dilution of a gas layer between a potential source in case of leakage and a potential ignition point (heaters, furnaces, etc.). These two different applications require specific installation schemes.

5.1 Exposure protection water curtains

It is recommended to install large downwards facing flat jet nozzles because this type of nozzles has a large spray angle and is simple to install and maintain. Vertical spacing between nozzle rows shall be less than 5 m, unless otherwise justified. Nozzles shall be of the "flat jet" type, spaying an elliptic shaped pattern in order to improve efficiency (see schematic below). Screen spraying nozzles with horizontal axis are not recommended.

Water curtains require a flow rate of more than 25 l/min/linear meter (for each row). Water shall be supplied at a minimum pressure of 5 barg. The number of nozzles shall be determined in function of the nozzle flow characteristics, their spraying patterns and the water flow requirement by row and by unit of length.

Where a fire water curtain is intended to provide separation of two fire zones or deluge zones, the minimal flow rate shall be 50 l/min/linear meter.

5.2 Dilution water curtains

Dilution water curtains are not considered as reliable means to achieve the purpose for which they are allegedly designed and shall not be installed, as a general rule, on Company designed/operated facilities.

5.3 Installation

The requirements for installation and control (valves, piping, remote alarm and control, etc.) are similar to deluge systems. Refer to section 4.4 (Piping), section 4.5 (Valves) and section 4.7 (Remote alarms and control).

6. Sprinkler systems

Automatic sprinkler systems are basically fire detection system and are typically used where fires are expected to involve cellulosic material. The sprinkler head is both a thermal detector and a water spray nozzle. Automatic sprinkler systems shall be connected to a pressurized...
water supply so that the system is capable of immediate operation and no action by personnel is necessary.

Sprinkler systems were used to protect Living Quarters but are not recommended anymore and smoke detection coupled with manual fire-fighting means (hose reels, fire extinguishers, etc.) shall be preferred instead.

Sprinkler installation as well as the general design of the water spray system shall be in compliance with NFPA 13.

7. Monitors

Fire monitors are used to provide water spray or foam for fire-fighting or cooling. They also supplement fixed deluge systems. Monitors can be ground level or elevated (for congested area or where obstructions prevent the effective use of ground level monitor), locally or remote controlled, fixed or oscillating type.

7.1 Water supply requirement

The standard and therefore recommended water capacity is 120 m³/h at a working pressure of 7 barg immediately upstream of the monitor. However, larger (or smaller) capacity monitors could be required for particular services.

7.2 Characteristics

Each monitor shall have sufficient movement in the horizontal and vertical planes to permit the monitor to reach any point of the part protected by that monitor. There shall be means for locking the monitor in position. The minimum movement capabilities shall be:

- Rotation angle: 360° stop to stop
- Elevation angles: 80° upwards, 45° downwards.

Each monitor should be capable of discharging under jet and spray conditions. The distance reached shall be 40 to 45 m horizontal at straight water stream or 30 m for the centre of water spray pattern for a 120 m³/h monitor.

When a monitor is used for foam application, a specific type of foam monitor shall be used (water-only monitors are not suitable for foam application). When foam/water monitor are necessary, a double-gun type (one for water and one for foam) should be provided if it is intended to make a water screen. Conversely the foam tube can be used alone for water spray and in that case the distance reached shall be only 30 m.

7.3 Location

The location and discharge characteristics of the monitors shall be selected to suit the role and exposure protection required from the monitors and the local environmental conditions. Generally, two monitors shall be installed for each protected equipment, to allow at least the use of one in any fire scenario and wind configuration. The wind conditions on the site shall be evaluated to locate the monitors. Additional monitors shall be provided in areas where shifting wind pattern may reduce the effectiveness of the protection.

Monitors shall be located in the periphery of protected areas. Onshore, special precautions shall be taken to ensure that monitors are adequately protected from possible road traffic accidents. Monitors arranged for local operation shall be provided with an access route, easily accessible.
in fire conditions, and so sited (as far as possible) as to protect the operator from the effects of radiant heat. Heat shielding shall be provided if necessary. A minimum distance from protected equipment of 15 m and a maximum of 30 m shall prevail.

Monitors may be operated either remotely or locally, but they shall be always operated from a safe location: for remote controlled monitors, the operating panel shall be located upwind of the prevailing wind direction and at least 50 m from the potential fire.

7.4 Installation and control

7.4.1 General
Monitors shall be of such design that the hydraulic forces, including pressure surge when opening the monitor valve, are balanced. Each monitor shall have a block valve. This block valve shall be locked open in normal service.

Drainage system and specific protection (control valve and upstream piping protected against freezing) shall be provided where atmospheric conditions could disturb the operation of the monitors.

7.4.2 Remote controlled monitor
Remote controlled monitors shall be installed in the following situations:

- Where escape way could be rapidly destroyed
- Where sea-fire could be a great danger (bridge)
- Where thermal radiation in case of fire is greater than 6.5 kW/m² (2000 Btu/h.ft²)
- For LNG terminals, especially for the protection of jetties and loading arms
- And more globally, where monitor access can present a danger for personnel in case of fire, remote controlled monitors shall be installed:

The monitors shall be provided with a hydraulic system driven by an electric motor. The monitors and the operating panel shall be powered by the essential network and shall be suitably rated (as a minimum) to operate in a zone 2 hazardous area. Electrical and instrumentation cables shall preferably be installed underground. If not possible, fire resistant cables or cables enclosed in fire resistant ducting shall be installed.

The operating panel shall be weather proofed with at least the following facilities:

- Joy stick for integrated rotation and elevation
- Monitor position indicators
- Pushbuttons for jet/fog or deflector control
- Switch for opening water supply valve
- Switch for opening the foam solution inlet valve (if any)
- Switch for opening pre-mix supply valve (if case of double-gun)
- Valves position indicators
- Motor failure and electric supply fault.
The following signals shall be provided in the main control room and in the main fire station (if any):

- Valve position indicator with alarm (valve closed)
- Flow indicator system with low flow alarm
- Motor failure and electric supply fault.

### 7.4.3 Foam production

The installation shall be in compliance with NFPA 16 and GS EP SAF 334.

### 8. Hydrants

Fire water mains shall be equipped with hydrants to which hoses can be connected.

#### 8.1 Onshore facilities

##### 8.1.1 Fire hydrant type

The fire hydrant shall be 6" (150 mm) type with a single hydrant valve. One 4" (100 mm) and two 2"1/2 (65 mm) outlets with chained caps are required.

Wherever imposed by weather conditions, hydrants shall be provided with an automatic draining system, activated by the closure of the hydrant valve itself, and draining the water contained in the aboveground part of the hydrant.

For extension of existing installations, couplings shall be of the same type as already supplied for the existing facilities. Preferably coupling shall be symmetric type. Couplings shall also be compatible with the type used by the local Fire Brigades.

##### 8.1.2 Location

Hydrant number and position shall be sufficient to permit effective fire-fighting by the Emergency Response Team or Fire Brigade (if any). Hydrants shall be arranged to provide coverage of the target area from two different directions. Hydrant spacing shall not exceed 60 m for process facilities and 80 m for storage facilities.

Hydrants shall be located along access ways and roadways, around process and storage facilities, at least 15 m away from the equipment to be protected. Possible damage by road traffic shall be minimized and, if necessary, hydrants should be protected by guard systems.

#### 8.2 Offshore facilities

##### 8.2.1 Fire hydrant type

On offshore facilities, fire hydrants shall consist of a 3" (80 mm) branch connection with two 1"1/2 (40 mm) outlets, each outlet being provided with a quarter turn valve.

Couplings shall be of the symmetrical type, either “Guillemin” or “DSP”.

Pressure control devices shall be provided where standing pressure can create risk for personnel handling the hose. The outlet pressure shall be limited to 6 barg.
8.2.2 Location
Accessibility from other decks, proximity of a stairway, possibility of damage from a fire, and interference from other platform activities shall be carefully considered prior to determining hydrant location. Hydrants shall be arranged to provide coverage of the target area from two different directions.

8.3 General requirements
The hydrants shall be connected to the fire water mains and provided with an isolation valve. Hose boxes shall be provided in the vicinity of hydrants, containing all required equipment (usually defined for each project).

8.4 Hose Reels
Hose reels are first intervention devices provided to allow non-specifically trained personnel to commence fire-fighting immediately and efficiently while a more powerful response is either being organized or under way. Hose reels shall be implemented in living quarters, workshops, warehouses and, more generally, in places where hydrocarbon inventory is not the primary hazard. Hose reels are fitted onto the permanently pressurized part of the fire water network.
Hose reels comprise the four following components:

1. A globe valve size 1” or 1”1/2
2. A reel with axial water supply connected to the globe valve
3. A semi rigid hose 20 or 30 m long, Ø 1” or 1”1/2
4. An adjustable jet with orifice Ø 8 or 12 mm.

The hose reel may or may not be placed in a cabinet, either metallic or GRP.
The pressure requirements at the hydraulically most remote reel is 2.5 barg minimum and the pressure shall never exceed 12 barg for 1” and 7 barg for 1”1/2 systems. If necessary, a pressure control valve can be installed. At 2.5 barg water pressure the flow rates requirements are: 55 l/min for a 1” hose fitted with an 8 mm jet, 120 l/min for a 1”1/2 hose with a 12 mm jet. The distance reached shall be between 15 and 20 m for both equipments under these pressure conditions.
Hose reels shall be located so that any single spot where a fire may exist shall be reachable by at least two hose reels, the jet range not being considered in this calculation. Hose reels shall be located away from the potential sources of hazard, preferably close to accesses e.g. stair landings, doors, etc.

9. Technical documents and tests

9.1 Tests

The tests shall be in compliance with NFPA 13, NFPA 15, NFPA 16 and NFPA 25 recommendations (wherever applicable) and Company piping specification GS EP PVV 112.

9.1.1 Deluge and water curtain tests

The tests shall be in compliance with NFPA 15 (flushing of piping, hydrostatic pressure tests, water discharge tests, operating tests, etc.).

9.1.1.1 Shop tests

The automatic deluge valves, especially the actuation system, shall be fully tested at the factory.

9.1.1.2 Preliminary acceptance tests

A second test shall be carried out, in operating conditions, with the pumps connected to the network and the whole fire water system operated at its design flow rate. This test can be conducted wherever it proves convenient: on the site itself, at the integration site or on construction yard. The purpose of this test is to ensure that:

- No line and no nozzle is plugged
- The distribution of water on the protected equipment is correct
- The required design flow rate is achieved at the deluge valves and in the branch where restriction orifices are installed (measure by flow-meter)
- The pressure required at the remote nozzle of the deluge system and at one or two representative nozzles for each protected equipment is achieved.

If the installation is controlled by a detection system, automatic operation of all accessories such as valves, alarms, flow indicators, shall be thoroughly tested. A check shall be made to ensure that all signals are correctly transmitted to the control room and that the total time for installation actuation is within specification. See section 4.7 (Remote alarm and control).

9.1.2 Sprinkler systems

The tests shall be in compliance with NFPA 13.

9.1.3 Monitors

For foam monitors, the tests shall be in compliance with NFPA 16.

9.1.3.1 Shop tests

The monitors shall be fully tested at the factory.
9.1.3.2 Preliminary acceptance tests

A second test shall be carried out in operating condition, with the pumps connected to the network and the whole fire water system operated at its design flow rate. The inlet pressure, the flow rate (measured by flow-meter) and the distance reached shall be checked. The foam injection system shall also be fully tested. This test can be conducted wherever it proves convenient: on the site itself, at the integration site or on construction yard. In case of doubts the flow rate can be measured with non intrusive Doppler radar.

9.2 Documents to be supplied

9.2.1 Documents to be supplied by Engineering

Documents to be supplied by Engineering at basic design and detailed engineering stages shall include, as a minimum:

Table 3: Engineering documents

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9.2.2 Documents to be provided by Supplier

9.2.2.1 Documents to be supplied after the purchase order

- Preliminary drawings
- Preliminary dimension and weight for the equipment (deluge skid, monitor, control station, etc.)
- Preliminary calculation notes
- Preliminary list of spare parts.

9.2.2.2 Documents to be supplied for shop acceptance

- Final drawings approved by ENGINEERING
- Calculation notes
- Material certificates
- Technical documents for equipment
- Final list of spare parts.
If fire-fighting systems have to be certified, application files shall be submitted to the competent certifying authorities for agreement.

9.2.2.3 Documents to be supplied upon provisional acceptance

- Contractor's Material and Test Certificate (examples in NFPA 13 Chapter 8, System acceptance)
- Pressure and flow rate report
- Other relevant detailed test reports.
Appendix 1  Deluge valve typical schematic
Appendix 2  Typical nozzle arrangement - Horizontal vessels

In countries where severe weather conditions prevail (wind) nozzle spacing shall be specifically calculated.
Appendix 3  Typical nozzle arrangement - Vertical vessels

In countries where severe weather conditions prevail (wind) nozzle spacing shall be specifically calculated.
Appendix 4  Typical nozzle arrangement for pumps

Recommended distance: 1.5 m

Max. dist.: 2.5 - 3 m
Bibliography

American Petroleum Institute  API RP 14G- Recommended Practice for Fire Prevention and Control on Open Type Offshore Production Platforms


Dr Sam Mannan / Frank P. Lees  Lee’s Loss Prevention in the Process Industries – Third edition