Fire Protection Association

RISCAuthority

ACTIVE FIRE PROTECTION GUIDE

Water and Water/Foam Deluge (Sprayer) Systems

This document has been produced by the RISCAuthority Active Suppression & Detection working group to provide information and outline guidance on the application of Deluge Systems.

Summary

Refer to AFPG-01 *Active Fire Protection Guide – All Technologies*, and AFPG-30 *Fire Detection and Alarm Systems Series Overview*.

Deluge systems are principally used for:

- the suppression of fire in high-hazard applications where a rapid heavyweight response is required to address an unfolding fire scenario which might otherwise propagate at a rate faster than a normal type sprinkler system could respond to, and;
- the protection of critical equipment at-risk (i.e., LPG tanks), places (i.e., escape routes), or structural elements (i.e., beams and columns) for involvement in fire from another source (they may also be used for blast mitigation).

Deluge systems are characterised by:

- open delivery nozzles/heads to issue fire suppressing/cooling agent to the whole protected zone, volume, or item (many heads in simultaneous operation)
- open (no-bulb) medium velocity and high velocity solid cone spray heads designed to penetrate the opposing forces of fire and obstruction by complex structure, and wet surfaces effectively
- activation made by pneumatic, hydraulic, electrical, and manual means
- detection of fire made by 'wet pilot', 'dry pilot' or electrical detection system
- an ability to deliver water, water and foam, and other fire suppressing media, including dry-powder and gaseous agents
- prevalence in the oil and gas, chemical manufacturing, and heavy electrical (transformers) sectors.

This guide considers deluge systems delivering water and water/foam mixtures. The terms 'deluge system', 'water spray system', and 'drencher system', are often used interchangeably. When used to protect equipment and infrastructure, a deluge system's prime objective is to keep the target's temperature below 100°C. Any surface above 100°C will become difficult to cool as water will boil off and not 'wet', resulting in hot spots that may endanger a vessel's contents and also cause asymmetric stress leading to structural failure and rupture.

Types of deluge system

The key types of deluge system are typically defined by the means of the detection system used and activation method.

Wet Pilot Deluge System: uses a non-electrical detection/release mechanism comprising a small diameter water-filled pilot line having standard closed sprinkler heads installed over the protected space. On activation of any of these heads, the drop in water pressure in the pilot line causes the deluge valve to open, thereby delivering water to all heads in the open, dry pipe protection network. Water flow detection devices are used to raise a fire alarm. Wet Pilot Systems are only suitable where temperatures are above 4°C so that the potential of

freezing does not impair the detection system. The length and height of wet pilot lines may be limited by the available water system pressure.

Dry Pilot Deluge System: operates on the same basis as Wet Pilot Systems but the pilot line is filled with air or nitrogen making them suitable in applications that may be at risk from freezing. They may also be used to overcome height/distance restrictions placed on the use of wet pilot lines. Pneumatic pressure in the dry pilot line can be maintained by compressors, plant air systems, nitrogen generators, or nitrogen cylinders. Water flow sensing is used to raise a fire alarm. Low pilot line pressure is constantly monitored to prevent accidental activation from system leaks or device failure.

Electric Detection Deluge System: uses standard fire detection systems individually, or in combination to inform of the need to operate. These can include, but are not limited to, smoke, heat, and linear detection. Activation of the valve is made via a solenoid controlled by a 'releasing control panel' that unlatches the clack of the deluge valve. Water flow sensors activate the fire alarm.

Manual Deluge System: large systems will normally additionally allow for manual release via a quick opening valve on the deluge valve trim. The valve is required to operate hydraulically, pneumatically, or mechanically independent of the detection devices.

Deluge system design objectives are defined in NFPA 15 as any one or a combination of:

- extinguishment of fire
- control of burning
- exposure protection
- prevention of fire.

Components of a deluge system

The components of a deluge system include:

Water supply: sized for the required duration of protection.

Fire pump set: which may include both electric and diesel options sized to deliver water at the appropriate rate from all spray heads in the network.

Pressurising air source (Dry Pilot Deluge Systems only): to pressurise the dry pilot line.

Deluge valve: to hold back the water from the open dry pipe network by means of water pressure (hydraulic), air pressure (pneumatic), or mechanical (electronic).

Pilot line (Dry and Wet Pilot Deluge Systems Only): a small-bore pressurised sensing line filled with water or gas fitted with closed head sprinklers or alternative devices, that on rupture from heat drop the line's pressure to release the deluge valve clack.

Distribution pipe network: an open dry pipe network whose layout positions sprinkler/sprayer heads to optimise protection effectiveness.

Sprayer heads: open nozzles specifically designed to delivery water optimally and forcefully over the protected space or item.

Ancillary equipment: including pressure and flow switches, alarms, fire detectors (electronic systems), gauges, and firefighting foam proportioning.

Key applications

Deluge systems are used in special hazard installations requiring a large quantity of water to control a fast-developing fire or protect equipment and people from it. They are commonly found in applications where liquid fuels may be burning in large quantities, or where fuels and structures are at risk from involvement in fire require protection. Typical applications include:

- flammable liquid handling systems
- flammable liquid storage, and chemical storage areas
- hydrocarbon processing plants
- refineries/fuel processing plants
- oil extraction plants
- separation, distillation plants
- large aircraft hangars
- transformers
- crude oil tanks and vessels
- power plants
- paint shops
- theatres.

Challenges and considerations

Speed of response: in many applications where these systems are deployed, the speed of response is as important as the weight of response provided. In combination, the detection and delivery (pressurisation) systems must act to meet the protection requirement. Where very high-speed operation is required, such as in the protection of munitions, pre-pressurised and explosives-pressurised water sources are often used.

Nozzle alignment: the ability of the system to direct water accurately onto its target is recognised as a key parameter in deluge effectiveness.

Blocked nozzles: impairment of spray can result in hot-spots and continued fire growth especially where blockages occur in clusters rather than randomly.

Testing basis: application rates determined from the amount of water leaving the nozzle divided by the target objects surface area is a poor measure of protection because much water may miss the target. Systems are generally designed with an over-provision of water of around 30%.

Fluorine free foams: augmentation of the system with firefighting foam for managing flammable liquid and plastic fires is common practice. However, with the removal of AFFF additives on environmental grounds, there is a need to replace them with fluorine free alternatives. These foams are unlikely at the current time to be 'drop-in' replacements. See AFPG-12 *Migration of foam-enhanced fixed sprinkler and drencher systems to use fluorine-free alternatives* for further guidance.

Application rate: depending upon the protection requirement, application rates vary between 10 and 60 litres per minute per metre squared (mm/min/m^2).

Applicable standards

NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection.

API RP 2030: Application of Fixed Water Spray Systems for Fire Protection in the Petroleum and Petrochemical Industries.

IP MODEL CODE P19, By Energy Institute – Fire Precautions at Petroleum Refineries and Bulk Storage Installations.

HSE Guidance Offshore Information Sheet No. 1/2010 'Water deluge systems: Testing and performance measurement'.

ISO 13702 'Petroleum and natural gas industries – Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines'.

Schemes

LPS 1048 Requirements for the approval of sprinkler system contractors in the UK and Ireland.

Warrington Certification Ltd FIRAS Industrial Sprinkler Certification Scheme.

IFC Certification Commercial Sprinkler Systems.

Approvals

Underwriters Laboratory Solutions, Underwriters Laboratory Canada, FM Global, Loss Prevention Certification Board, VDS Schadenverhutung.

Best practice

All deluge systems should be certificated to a recognised quality scheme.

Fire Services should be consulted on their requirements and necessary provisions for supporting deluge systems.