DELUGE SYSTEMS
FALSE OPERATIONS
Deluge Water/Foam Systems: False operations result in significant water/Foam damages and might also cause destruction by fire!
Deluge Foam Systems:
In case of Fire, the Main Valve might be close (Management Decision wary about false operations).

I witnessed several cases, when following an annunciation, the employees fearing false deluge, rushed to close the main valve before making sure it was not a fire!!
Deluge Foam Systems:
Obviously, False Operation might defeat the Whole Fire Protection notion, yet there is very little in the Standards to cope with this problem
MAIN CAUSES OF DELUGE SYSTEM FALSE ACTIVATION

• Deluge Valve Related Causes
• False Detection Initiation
• Manual Activation
Surge Pressure in the Supply Line.

While the normal max. pressure in a system is 12 bars, the actual surge pressure may exceed 25 bars, causing opening of the valve.
The Source of a Surge Pressure:

In case of several deluge system fed from the same Mains and Pump room, a surge pressure might be created by the initiation of one of these system.
DELUGE VALVE RELATED CAUSES, Cont.d.,

The Source of a Surge Pressure, Cont.d.,:

4x8” Deluge Valves open simultaneously
Causing pressure drop to ZERO.

Then 6000 GPM Pumps Start…

Imaging Pumps falling down from a Cliff
It is not only causing **FALSE** activation of the second system, but it might deplete the water supply necessary for the first activated system resulting in **FAILED EXTINGUISHMENT** of this system!!
Disintegration of 2x10”, 8” and 4” Pipes due to 8” deluge valve opening. About 300m long piping collapsed.
DELUGE VALVE RELATED CAUSES

Most of the False Deluge initiations are caused by “Unwanted Alarm”.

Investing heavily in the Water Based System creates a tendency to compromise on the detection system.
NFPA 11- False operations

There are several reports from the USA about false activation of foam systems.
NFPA 11 - False operations
A case we investigated: HiEX system caused $2.5 Million loss in a Storage Hall.
Ten (10) other false operations resulted each in several $100K loss.
Water Deluge System

Water Deluge system protects 60MW Transformer.

There was a False Operation, the Transformer was tripped. The consequential losses: Several Millions US $
We Shall see later several cases of False operation
FALSE OPERATION AND DETECTION RELATED REFERENCE IN STANDARDS
REFERENCE STANDARDS

NFPA 11: Foam Systems - No reference.

NFPA 12: CO₂ Gas extinguishing. Some remarks about FACP causes of false operation in the Appendix.

NFPA 15: Instructions regarding Smoke Detection and some reference for false alarm.
REFERENCE STANDARDS

NFPA 409: Some Remarks about detection system. Almost nothing about false operation.


NFPA 11- Deluge Foam Systems: None, except for reference to environment.

NFPA 15 is much better! See next slide
4.9.2 Automatically Actuated Systems.

4.9.2.1 An automatic system shall be activated by automatic detection equipment.

4.9.2.2 Operation shall be controlled by listed or approved mechanical, electrical, hydraulic, or pneumatic means.
4.9.2.5* Automatic Detection Equipment.

A.4.9.2.5 See applicable sections of NFPA 72.

4.9.2.5.1 Automatic detection equipment — whether pneumatic, hydraulic, or electric — shall be provided with supervision arranged so that failure of equipment or loss of supervising air pressure or loss of electric energy results in positive notification of the abnormal condition.

4.9.2.5.2 Where approved by the AHJ, small systems for localized hazards shall be permitted to be unsupervised.
6.7 Operation and Control of Systems

6.7.1* Detection of Fires.

6.7.1.1 Automatic detection shall be used for fixed systems.

6.7.1.1.1* Removal of automatic detection shall be permitted when approved by the AHJ.

6.7.1.2* Automatic detection shall be by listed or approved methods or devices capable of detection and indicating heat, smoke, or flame. Automatic detection devices shall be installed in accordance with *NFPA 72.*
NFPA 12-CO₂ Extinguishing

A.4.5.2 Modern solid-state circuits, including microprocessors, are capable of responding to extremely short electrical impulses.

While response to such transient signals is a desirable characteristic for some types of devices, it is an extremely undesirable characteristic for control units used to discharge carbon dioxide.

Control units for releasing carbon dioxide systems must be designed to prevent unwanted discharges due to transient electrical impulses and to actuate pre-discharge alarms and time delays before discharging carbon dioxide.
A.4.5.2 Modern solid-state circuits, Cont.d,

Undesired transient impulses can be introduced into the control panel from sources external to the panel, or unwanted transients can be generated within the control panel itself.

For example, a microprocessor could produce undesired transient impulses for various reasons. Designs must incorporate technology to prevent discharge of carbon dioxide in the event that a microprocessor in the control unit emits spurious signals. If circuits that initiate carbon dioxide discharge are not designed to ignore such transients, an unwanted discharge could result.
NFPA 15- Std. for Fixed Spray System: Addresses the detection system in some details for the purpose of operation with some reference for false alarm.

See Chapter 6 Installation Requirements
6.5.2.1 The selection, location, and spacing of automatic fire detectors for the actuation of fixed water spray systems shall meet or exceed the applicable requirements of NFPA 72, National Fire Alarm and Signaling Code, and be consistent with the following:

(1) Data obtained from field experience
(2) Tests
(3) Engineering surveys
(4) Manufacturer’s recommendations
(5) Detectors’ listing criteria
(6) Nature of the hazard being protected
(7) Both normal and abnormal air velocities
(8) Range of anticipated temperatures
(9) Maximum expected rates of temperature change under non-fire conditions
(10) Number and height of structural levels
(11) Effects of precipitation (rain and snow)
(12) Presence and magnitude of electromagnetic interference
(13) Presence of obstructions that might retard or mitigate timely detection
(14) Other conditions that might affect the efficacy of the fire detection employed
6.5.2.2 Detectors shall be located so as to promptly respond to a fire, flammable gas release, or other design condition.

6.5.2.2.1 The detection system shall be capable of detecting a fire up to the elevation of the highest level of protected equipment surface.

6.5.2.2.2 Detectors shall be located so that no portion of the hazard being protected extends beyond the perimeter line detectors.
7.7 Automatic Detection Equipment. 
7.7.1* General. Detection systems providing an actuation signal to fixed water spray systems shall be designed in accordance with NFPA 72, National Fire Alarm and Signaling Code. 
7.7.2 The spacing, location, and position of detectors shall be in accordance with 6.5.2.
7.7.3* The following shall be evaluated when selecting and adjusting detection equipment:
(1) Normally changing conditions
(2) Non-fire temperature changes

7.7.4* Response Time.
7.7.4.1 The detection system shall be designed to cause actuation of the system actuation valve to operate without delay.
7.7.4.2 Where ambient conditions exist that cause false system operations, detection systems shall be permitted to include delays that would override these conditions.

See NFPA 15, Chapter 7- Design Objectives
12.3.14 Detection.

12.3.14.1 General. The detection systems shall be in accordance with NFPA 72, National Fire Alarm Code.
12.3.14.2 Sensing devices shall be as follows:

(1) Response characteristics:
   (a) Radiant energy-sensing devices capable of sensing the expected wavelength emissions of the materials in combustion.
   (b) Other types of sensing devices having equivalent response characteristics to radiant energy-sensing devices shall be permitted to be used.

(2) Protected from physical damage
(3) Suitable for the electrical area classification where they are installed
(4) Accessible for testing, cleaning, and maintenance
(5) Aimed and adjusted to minimize false actuation
12.3.15 Control Panel.

12.3.15.1 The control panel shall conform to the requirements of NFPA 72, National Fire Alarm and Signaling Code.

12.3.15.2 The control panel shall be located in an area protected from physical injury and from electromagnetic energy emitted from other electrical devices that could induce false actuation.

12.3.15.3 Control panel enclosures shall be rated for the ambient environment where they are located.
6.2.8 Detection and Actuation System Design.
6.2.8.1 General.
6.2.8.1.1 Actuation systems shall be provided with complete circuit supervision and shall be arranged in accordance with Section 6.4.
6.2.8.1.2 These detectors shall be installed in accordance with NFPA 72.
6.2.8.1.3 Detection systems shall be provided with supervision as required by NFPA 72.
7.7 Detection and Actuation Systems.

7.7.1 Detectors for actuating pre-action sprinkler systems shall be Rate-of-rise, Fixed-temperature, or Rate-compensation type.

Note: These type have very slow response!!
7.7.2 Detectors for actuating high- or low-expansion foam systems shall be rate-of-rise, fixed-temperature, or rate compensation type or water flow of a wet pipe sprinkler system.

Note: These type have very slow response!!
7.7.3 These detectors shall be installed in accordance with *NFPA 72*.

7.7.4 Detection systems shall be provided with supervision as required by *NFPA 72*. 
NFPA 2001 - Gas Extinguishing; Abort Switch is necessary. No guidelines for “prevention”.

Dan Arbel Risk Engineering
NFPA 2010- Aerosol Extinguishing

6.4.6* Unwanted System Operation. Care shall be taken to thoroughly evaluate and correct any factors that could result in unwanted discharges.
NFPA 72- Detection; The term used is: “Unwanted Alarm”. But there is no reference for extinguishing systems except for “Abort Switch” if exist.
3.3.304* Unwanted Alarm. Any alarm that occurs that is not the result of a potentially hazardous condition.

3.3.304.1 Malicious Alarm. An unwanted activation of an alarm initiating device caused by a person acting with malice.
3.3.304.2* Nuisance Alarm. An unwanted activation of a signaling system or an alarm initiating device in response to a stimulus or condition that is not the result of a potentially hazardous condition. 3.3.304.3 Unintentional Alarm. An unwanted activation of an alarm initiating device caused by a person acting without malice.

3.3.304.4 Unknown Alarm. An unwanted activation of an alarm initiating device or system output function where the cause has not been identified.
Unwanted alarms might be intentional, unintentional, or unknown. If they were caused intentionally, they might have been done by someone with the intent to cause disruption and should be classified as malicious.

However, an unintentional alarm might occur when, for example, a child activated a manual fire alarm box not knowing the consequences. Similarly, someone accidentally causing mechanical damage to an initiating device that results in an alarm is causing an unintentional alarm.
A.3.3.304 Unwanted Alarm. Unwanted alarms are any alarms that occur when there is no hazard condition present. These are sometimes also called false alarms. Because the term false has been used by many people to mean many different things, this Code is instead using the terms unwanted, fault, nuisance, unintentional, unknown, and malicious to categorize the different types of alarms.
THE FIRE DETECTION SYSTEM,
What do we get?

The Foam Designer System, being a “Water Engineer” has no Idea.

The Fire Detection Designer being an Electrical / Electronic Engineer, has no idea about the Foam /Deluge system requirements.
Detection Approved System, what is this:

There is UL approval Standard,


Edition 10 is dated Dec 1, 2014 to be effective Dec 1, 2018
UL 864 Standard, Cont.d.,

More Stringent Testing to reduce False Alarm.

In Israel Systems are Approved based on older UL edition.

Probable adoption of Edition 9 in 2017, 10 years after the official adoption in the US
UL 864 Standard, Cont.d.,

For the approval Detection Lab., the “Detection” is of importance.

For the Deluge System’s designer, the mere detection is less important than the releasing role both in terms of operation and reliability.
Detection Reliability

One Addressable Loop to which many detectors are connected, many none water proof connection boxes are unreliable.

After one test the detection system circuity is wet. The system is approved but the damage remains....
Releasing Reliability

To achieve better reliability use a Dedicated Releasing Module or Panel rather than an “Output Module” for the job.
The only “respectable” reference to false operation is by NFPA 15, NFPA 2010 and Some Explanation in NFPA-12.
CAUSES OF FALSE OPERATION:

• Unwanted Activation of the FACP:
• Detectors responding to none-fire elements such as Dust, Steam, Water Fog, Exposure to moisture, corrosion....
• Human Error
• Intentional Activation.
CAUSES OF FALSE OPERATION: Detectors

In the case of Linear Beam Detectors:

Any Obscuration, Misalignment, Partial Obstruction, Lighting Fixtures as well as wrong positioning.
CAUSES OF FALSE OPERATION: Detectors

The New “OSID” Detectors are supposed to respond only to smoke particles via UV and IR radiation. WE had 3 unexplainable initiations in one system. The detectors also responded to FOAM!
CAUSES OF FALSE OPERATION: FACPs

FACP may activate operation due to voltage disturbances, lightning, effect of nearby power system (See also NFPA 12 reference) It may also activate system due to initiation of unrelated detector.
CAUSES OF FALSE OPERATION: FACP

We had recently a case of a point type detector that responded to dust. The FACP activated a foam deluge system although this detector was not configured by the software to activated the foam system!
CAUSES OF FALSE OPERATION: DELUGE VALVES

The Diaphragm was damaged by previous pressure surges.

Stones or Debris caught between the diaphragm and the seat.

Pressure Surges overcoming the diaphragm.
CAUSES OF FALSE OPERATION: DELUGE VALVES, Cont.d.,

The Pressure Surge is prevalent on Pump Starts when the pressure in the Main was low, mainly due to line maintenance.
CAUSES OF FALSE OPERATION, THE DELUGE VALVES

In particular when the pressure on the diaphragm drops whilst the main pressure is minimal or zero.
DEPENDANCE ON THE RELIABILITY FIRE DETECTION SYSTEMS.
The Deluge system requires a detection system.

NFPA 11 that addresses Foam Systems send us to NFPA 72 which is Detection System Code.

The Time Response of the Foam system which is a function of the performance of the detection system is critical to its success. Yet, no guidelines are provided (Unlike NFPA 15).

NFPA 72 addresses Detection but has no guidelines about the applications initiated by detection system except for the notification arrangements.

Water Based Engineers using NFPA 11 have no communication with the Electronic Engineers dealing with the detection system.
CASE #1

False Alarm operating a Low Expansion Foam system in a storage space.

The system was configured to discharge foam upon initiation of any of four (4) Flame Detectors.

The detection system consisted of a FACP with 4 flame detectors. An additional point type smoke detector was added to “protect” the FACP. This detector was configured to operate only a notifying device.

The FACP and the detector where positioned about 30 m from the protected space.
CASE #1, Cont.d.,

The point type detector was installed just next to the FACP, a poor position.

While drilling a concrete floor for installation of a new rack, about 4 m from the FACP, the dust cloud generated initiated the detector installed 1.5 m above the floor.

The detector initiated through the FACP the foam system.

The detector initiated through the FACP the foam system.
CASE #2
False Discharge of Hi-Ex Foam. Linear Beam Detectors responded to windy dust activated the system.
Header feeding 4x8” deluge Valves.
False Discharge of Hi-Ex Foam due to False operation of two linear beam detectors
CASE #3 & 4
Two Foam Deluge Valves, for two storage halls.

Two False Foam Discharge:
#1: False Initiation of two Linear Beam Detectors.
#2: Shutoff of Main Line for several hours, Pump Restart when the pressure on the Diaphragm was low.
CASE #4, Pressure loss over the diaphragm during Mains shutoff for repairs.
CASE #4, Cont.d.,

One of two deluge valves. The Easy Lock internal balls playing the roll of Non-Return Valve.
We disconnected the Supply System.

CASE #4, Cont.d.,
Within 4 hours the pressure on the diaphragm drops from 140 to 56 PSI.

When a pump starts the deluge valve opens.
There is no filter in the system, thus stones propelled by the rushing water might cause the damage seen on the photo below.
CASE #4, Cont.d.,

After two false operations and a couple of testing the diaphragm of the valve failed due to “Surge Pressures” (Water Hammer).
Due to maintenance, the fire pumps were tripped.

After a day the Pumps were restarted. The pressure in the mains overcome the diaphragm.
CASE #7

Storage Hall,, no detector initiation. Seems to be FACP false initiation.
Recommendations:

1. Make sure there is a suitable filter upstream to prevent debris ingress.
2. Prevent pressure drop from the Diaphragm.
3. If the Mains is shut off, instructs closing the system Valve.
Recommendations, Cont.d.,

4. Install a pressostat warning against Low Pressure over the Diaphragm.

5. Regarding the Manual operation, don’t make it trivial for a curious person to play with it.

6. It is very important to provide maintenance instructions with the valve.
Recommendations, Cont.d,

7. For close air pressurized system, make sure the air compressor is provided with a dryer.

8. Detection System plays a major part in the successful operation of the whole system as well as i.r.o. False Operation: See Item 10 below
9. The Detection System Designer should study the importance of prompt operation of the whole system. NFPA-15 has reasonable guidelines.

10. Make sure that the FACP together with the releasing station are approved by UL Edition 9 or EN54 and EN 12094.
11. Use dedicated Releasing Module or Panel

12. False operations might have severe consequences. It is up the designer to take it under consideration
11. False operations might have severe consequences. It is up the designer to take it under consideration.