

Approval Standard

Deluge and Preaction Sprinkler Systems

Class Number 1011, 1012, 1013
September 2009



Member of the FM Global Group

Approval Standard for Deluge and Preaction Sprinkler Systems

Class Numbers 1011/1012/1013

September 2009

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for Deluge and Preaction Sprinkler Systems.
- 1.1.2 Approval criteria may include, but are not limited to: performance requirements, sprinkler system requirements, sprinkler system design, marking requirements, examination of manufacturing facilities, audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for 1-1/2, 2, 2-1/2, 3, 4, 6 and 8 inch nominal pipe size (NPS) Deluge and Preaction Sprinkler Systems for use in automatic sprinkler systems. Other sizes may be evaluated on a case-by-case basis. In cases where metric sized Deluge and Preaction Sprinkler Systems are to be examined for Approval, test criteria comparable to the United States equivalent size shall be used.

Deluge and Preaction Sprinkler Systems are approved as complete systems, engineered by the manufacturer to be installed at the protected site with all necessary components. The sprinkler system piping is either open to atmosphere as in deluge systems, or contains supervisory pressure as in preaction systems. Water flow to the sprinklers is controlled by an automatic water control valve, the requirements of which are described in Approval Standard Class 1020. The automatic water control valve opens and allows water to flow to the sprinklers in response to the action of various releasing devices in the valve trim and sprinkler piping.

- 1.2.2 This standard sets performance requirements for Deluge and Preaction Sprinkler Systems in the following product categories and class numbers:

<i>Class Number</i>	<i>Sprinkler System Category</i>
1011	Deluge Sprinkler Systems
1012	Preaction Sprinkler Systems
1013	Double Interlock Preaction Sprinkler Systems (Refrigerated Area Sprinkler Systems)

- 1.2.3 It is beyond the scope of this Standard to provide details of the various heat, smoke and other fire detection devices. See Section 1.8, Applicable Documents, for additional guidance.
- 1.2.4 Approval Standards are intended to verify that the product described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The requirements of this standard are intended to describe current and common industry designs of deluge and preaction sprinkler systems, and their Approval requirements.
- 1.2.5 Approval Standards are intended to verify that the product described will meet stated conditions of performance, safety and quality useful to the ends of property conservation.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine the design of Deluge and Preaction Sprinkler Systems for the purpose of obtaining Approval. Deluge and Preaction Sprinkler Systems having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, Deluge and Preaction Sprinkler Systems which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate:
- The suitability of the product;
 - The performance of the product as specified by the manufacturer and required by FM Approvals; and, as far as practical,
 - The durability and reliability of the product.
- 1.4.2 For manufacturing facilities not currently included in the FM Approvals audit program, an initial facilities and procedures audit shall be conducted to evaluate the manufacturer's ability to consistently produce the product that was examined and tested as part of the Approval project. The audit shall review the facility and in-place quality control procedures used in the manufacturing of the product. Typically, areas of review are incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures, and document and drawing control. These examinations are repeated periodically as part of the FM Approvals product follow-up program. (Refer to Section 5.2, Facility and Procedures Audit.)

1.5 Basis for Continued Approval

- 1.5.1 Continued Approval is based upon:
- Production or availability of the product as currently Approved;
 - The continued use of acceptable quality assurance procedures;
 - Satisfactory field experience;
 - Compliance with the terms stipulated in the Master Agreement;
 - Satisfactory re-examination of production samples for continued conformity to requirements; and
 - Satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' Product Follow-up Program.
- 1.5.2 Also, as a condition of retaining Approval, manufacturers may not change an Approved product or service without prior written authorization by FM Approvals. (Refer to Section 5.1.3 for further details regarding changes.)

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after that date shall satisfy the requirements of the standard. Products Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this Standard is **August 31, 2011** for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix F lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-2002, *"American National Standard for Use of the International System of Units (SI): The Modern Metric System."* One unit of measurement (Liter), outside of, but recognized by SI, is commonly used in international fire protection and is used in this standard. The units of measurement for pressure discussed in this standard are gage pressures unless otherwise noted in the text.

1.8 Applicable Documents

The following standards, test methods, and practices are referenced in this standard or are beneficial in understanding this standard:

American National Standard Institute (ANSI) /FM Approvals 3260 - February 2004, *Radiant Energy -Sensing Fire Detectors for Automatic Fire Alarm Signaling*
 ANSI/Underwriters Laboratories (UL) 268 - 2006, *Smoke Detectors for Fire Alarm Signaling Systems*
 ANSI/UL 864 - 2003, *Standard for Control Units and Accessories for Fire Alarm Systems*
 ASME B16.5, November 2003, *Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard*
 ASTM D 471 - 2006^{e1}, *Standard Test Method for Rubber Property - Effect of Liquids*
 ASTM D 572 - 2004, *Standard Test Method for Rubber - Deterioration by Heat and Oxygen*
 FM Approvals Approval Standard 1020 - April 2007, *Automatic Water Control Valves*
 FM Approvals Approval Standard 1031 - May 1977, *Quick Opening Devices (Accelerators and Exhausters) for Dry Pipe Valves*
 FM Approvals Approval Standard 3210 - April 2007, *Heat Detectors for Automatic Fire Alarm Signaling*
 FM Approvals Approval Standard 3230-3250 - February 1976, *Smoke Actuated Detectors for Automatic Fire Alarm Signaling*
 FM Global Property Loss Prevention Data Sheets - Latest Edition
 IEEE/ASTM SI 10, 2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*
 International Standards Organization (ISO)/International Electrotechnical Commission (IEC) 17025 - 2005, *General Requirements for the Competence of Testing and Calibration Laboratories*
 National Electrical Manufacturers Association (NEMA) Standards Publication 250-2003, *Enclosures for Electrical Equipment (1000 Volts Maximum)*
 National Fire Protection Association (NFPA) 13 - 2007, *Standard for the Installation of Sprinkler Systems*
 NFPA 70 - 2008, *National Electric Code*
 NFPA 72 - 2007, *National Fire Alarm Code*

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. When this authority is FM Global, such locations are termed “FM Global Accepted.” Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Pressure Maintenance Device

A pneumatic pressure maintenance device used to automatically maintain the correct pneumatic pressure in dry pipe systems, preaction systems, or in dry pilot lines. When installed in these systems, this device eliminates the need for manual filling to overcome small leaks or temperature changes. Pressure maintenance devices do not interfere with the prompt operation of dry pipe valves and deluge valves including when used with quick opening devices.

Deluge System

A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through an automatic water control valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

Deluge sprinkler systems have open sprinklers or open spray nozzles and are used where it is desirable to discharge water through all of the system's sprinklers or nozzles simultaneously. Prior to discharge there is no water in the sprinkler piping. The water supply is held back by an automatic water control valve which is operated manually or automatically by the actuation of a fire detection system. The fire detection system is required to be one of the following types: wet pilot sprinkler line, dry pilot sprinkler line, hydraulic rate-of-rise, pneumatic rate-of-rise or electric.

An Electrical detection system may consist of an electrical Releasing Fire Alarm Control Panel, using a heat detector, smoke detector or radiant energy detector as an initiating device or signal line circuit device.

FM Approvals Certification Mark

The FM Approvals Certification Marks are detailed in Appendix B. Their use is mandatory on all units of FM Approved Deluge and Praction Valves and Control Panels. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific systems and components.

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an online resource of FM Approvals. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. These forms obligate the manufacturer to allow re-examination of the product and audit of facilities and procedures at FM Approval's discretion. It further requires the manufacturer not to deviate from the as-FM Approved configuration of the product without review by and agreement of FM Approvals.

Praction System, Single-Interlock

A sprinkler system employing automatic sprinklers attached to a piping system containing supervisory pressure with a supplemental detection system installed in the same areas as the sprinklers. Actuation of the detection system signals a fire alarm control system which opens the automatic water control valve which permits water to flow into the sprinkler piping system and to be discharged from any sprinklers that are open.

Single-Interlock Praction systems are used where it is important to prevent the accidental discharge of water. These systems may also be used where an alarm is desired in advance of sprinkler operation or where it is desired to minimize the water delivery delay inherent in a standard dry-pipe system.

Preaction System, Double-Interlock (Also referred to as a Refrigerated Area System)

A sprinkler system employing automatic sprinklers in the system piping which contains supervisory pressure. Installed in the area of the system sprinklers are detectors/releasing devices, which are either electric heat (or smoke) detectors or pneumatic release detectors such as a fixed temperature sprinkler head in a dry pilot line. This arrangement requires two independent detector/releasing activations in order to trip the automatic water control valve and flow water into the sprinkler piping. This system provides an additional safeguard against accidental water discharge than that of Single-Interlock Preaction Systems.

The system is also referred to as a **Refrigerated Area System** because they are predominately installed in refrigerated areas where the accidental charging of the distribution lines with water could have detrimental effects on the installation.

In contrast, the Single-Interlock Preaction System would fill the system piping with water upon one detector activation only. This would result in frozen sprinkler heads and piping without an activated sprinkler. The sprinkler system would have to be dismantled, resulting in a prolonged time without fire protection.

However, these double-interlock systems are also employed in sensitive non-freezer applications where the accidental water discharge would cause damage and production downtime of expensive equipment, such as found in semi-conductor manufacturing.

Rated Working Pressure

The maximum sustained pressure at or below which the systems shall operate trouble free. This also sets the basis for the testing described in Section 4, Performance Requirements.

Refrigerated Area System

See Preaction System, Double-Interlock

On-Off Multicycle Sprinkler Systems

Multicycle Sprinkler Systems are designed to stop the flow of water out of the sprinkler system after the heat of the fire subsides. This automatic water shutoff reduces the water damage ordinarily present with an unattended sprinkler system. This system will subsequently re-initiate sprinkler flow if the fire is rekindled, and this cycle is capable of being repeated numerous times. The key feature is a detector which acts as a switch, opening and closing in response to the detector. This switch typically energizes a solenoid valve open through a special electrical control/releasing panel and this opens the automatic water control valve and sends water flowing out of the sprinklers. When this detector switches to de-energize, the solenoid valve (as a result of a lower sensed temperature, for example) will close, which will in turn close the automatic water control valve and stop sprinkler water flow to the system.

The electrical detection system employed as part of an On-Off Multicycle Sprinkler System shall only be considered FM Approved for this application when listed in this category.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 Nominal sizes of automatic water control valves used in deluge and preaction sprinkler systems for fire protection service addressed in this standard are: 1-1/2, 2, 2-1/2, 3, 4, 6 and 8 inch nominal pipe size (NPS) with a minimum rated working pressure of 175 psig (1205 kPa). Other sizes and pressure ratings may be evaluated on a case-by-case basis.
- 2.1.2 In order to meet the intent of this standard, all system components of deluge and preaction sprinkler systems must be examined on a model-by-model, type-by-type, manufacturer-by manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated using identical materials by different manufacturers, or, even by different plants of the same manufacturer, have sometimes been shown to perform differently in testing. Sample deluge and preaction sprinkler systems selected in conformance to this criterion shall satisfy all of the requirements of this standard.

2.2 Approval Application Requirements

- 2.2.1 To apply for an Approval examination the manufacturer, or an authorized representative, shall submit a request to:

Group Manager - Hydraulics
FM Approvals
Hydraulics Laboratory
743A Reynolds Road
West Glocester, R.I. 02814, USA

- 2.2.2 The manufacturer shall provide the following preliminary information with any request for Approval consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration,
- General assembly drawings, one complete set of manufacturing drawings, materials list(s), anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures, and
- Number and location of manufacturing facilities making the products submitted for Approval.

Foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements are to be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and field performance, if applicable. It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals. The manufacturer shall provide any special test fixtures which may be required to evaluate the automatic water control valves. Testing may be performed at FM Approvals, at the manufacturer's test facility, or at a third-party location, as mutually agreed.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

- 3.1.1 During the initial investigation and prior to physical testing, FM Approvals shall review the manufacturer's specifications, technical data sheets, and design details to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.
- 3.1.2 The manufacturer's dimensional specifications and/or dimensional drawings shall fully describe the product. All critical dimensions shall be indicated with the allowed upper and lower tolerance limits clearly shown.
- 3.1.3 All documents pertaining to the product materials, dimensions, processing, and marking shall be controlled by the manufacturer's Quality Assurance procedures, and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language documents shall be provided with English translation.
- 3.1.4 The documentation for an Automatic Release control panel system for Preaction and Deluge Sprinkler Systems shall include:

For the purposes of (1) assessing compliance of equipment with FM Approvals requirements, (2) determining what test samples will be required for the test and examination program, and (3) providing a means for design modification control, the manufacturer shall submit documents which give a full and correct specification of the critical construction aspects of the equipment. One copy (except as noted) of the following documentation as it pertains to the Approval request shall be assembled in an organized manner. All documents shall identify the following: the manufacturer's name, document number or other form of reference identification, title, and date of document's latest revision and/or the revision reference (i.e., number or letter indicating revision level).

NOTE: (1) Test programs will only be scheduled upon receipt of all of the material listed herein.
 (2) Drawings in a language other than English may require partial translation for use in an approval program.

1. Marketing/Ordering Literature showing general specifications and functions of the equipment. These are generally very useful in determining project costs and may also be used as attachments to the final report for equipment approval projects. Typically, one copy will be sufficient.
2. Model Number Breakdown, i.e., control drawings showing all model variations and options to be examined. Each model variation shall have a unique means of identification.
3. Instruction Manual(s) providing the following information; installation, operation, maintenance instructions.
4. Quality Control Procedures, i.e., document(s) detailing routine testing and final inspection procedures.
5. Production Drawings
 - a. Electrical Schematic(s)
 - b. Final Assembly drawing and parts lists. The Comparative Tracking Index (CTI) shall be stated for electrical insulation materials used in the equipment
 - c. Product label drawing(s) showing all required marking information. The label drawing should show proposed artwork indicating the manufacturer's name, address, model and serial numbers, equipment ratings, warning markings, and the FM Approvals Certification Mark and its location on the final assembled product.
 - d. Protective Grounding Detail drawing(s) showing the method of protective grounding provided, including location, size, and marking.
6. Documentation Control Specification showing proposed method of controlling documents which may be identified as Critical documents by FM Approvals. These drawings will be identified by FM Approvals at the conclusion of the approval program. The manufacturer shall notify FM Approvals of changes to these documents using Form 797, *FM Approved Product/Specification-Tested Revision Request Form*.

3.2 Deluge Sprinkler Systems - Approval Standard Class 1011

The Approval Guide, an on-line resource of FM Approvals, lists these systems as “Deluge Sprinkler Systems”. These systems use open sprinklers and are used where it is desirable to deliver water simultaneously through all sprinklers in the system. These systems are used in such locations as aircraft hangars, petrochemical processing and storage, and similar special hazard occupancies requiring the immediate flow through every sprinkler in the system upon system activation. FM Global Data Sheet 2-8N, “Installation of Sprinkler Systems”, should be referenced with regard to the application and installation of deluge sprinkler systems.

3.2.1 Deluge Releasing Systems

As stated in Approval Standard Class 1020, for Automatic Water Control Valves, the common designs of automatic water control valves, the clapper or diaphragm type, open (trip) when the water supply pressure in the piston or diaphragm chamber is reduced. This reduction of chamber pressure is controlled by the releasing mechanisms of the trim assemblies. These releasing mechanisms may be pneumatic, hydraulic, or electrical. FM Approvals presently considers the following five deluge valve releasing systems:

Item	Release System	Detection Devices
1	Wet Pilot Line (Hydraulic)	Fixed Temperature Release
2	Dry Pilot Line (Pneumatic), Pneumatic Actuator	Fixed Temperature Release
3	Electric, Control Panel/Solenoid Valve	Heat, Smoke or Radiant Energy Actuated Detector
4	Pneumatic Rate-of-Rise Pilot Line	Thermostatic Release, °F (°C)/Minute Temperature Rise
5	Hydraulic Rate-of-Rise Pilot Line	Thermostatic Release, °F (°C)/Minute Temperature Rise

An illustration of these various deluge release and detector systems in the system “set” position is shown in Figures C-1 and C-2 of Appendix C, and should be referenced in the following discussions.

3.2.1.1 Wet Pilot Line

When the pilot line sprinkler is activated (see Figures C-1 and C-2), water supply pressure in the piston or diaphragm charge line is released, allowing the piston or diaphragm to retract causing the automatic water control valve to trip. The maximum wet pilot line height for the range of water supply pressures shall be established by recording the water pressure in the piston or diaphragm chamber when the automatic water control valve trips and applying an additional factor of safety. These values will establish the maximum elevation of the closed sprinkler in the wet pilot line for specific water supply pressures to ensure proper operation of the system.

3.2.1.2 Dry Pilot Line

Most dry pilot deluge systems (see Figures C-1 and C-2) include a pneumatic actuator between the dry pilot line and the piston or diaphragm charge line. The pneumatic actuator is commonly a diaphragm valve as shown in Figures C-1 and C-2. Regulated pilot line pressure acts on the diaphragm top surface to hold it closed against the actuator seat, thus maintaining the water pressure in the automatic water control valve chamber. When the pilot sprinkler is activated, pilot line pneumatic pressure is released, allowing the pneumatic actuator diaphragm to open, causing piston or diaphragm chamber pressure to be released in turn causing the automatic water control valve to trip. The minimum system pilot line pressure at trip is 5.0 psi (35 kPa), which shall be maintained throughout the range of water supply pressures.

3.2.1.3 Electric Release Systems

Electric release systems include three additional devices (see Figures C-1 and C-2): initiating devices installed in the sprinkler array, a releasing panel, and a solenoid valve in the water charge line to the automatic water control valve piston or diaphragm chamber. A typical heat detector can be described as a thermostatic electrical switch. A common fixed temperature detector has contacts which open or close when it reaches its design temperature. When a detector activates, the releasing panel energizes the releasing (output) circuit connected to a normally closed (NC) solenoid valve installed in the charge line to the automatic water control valve piston or diaphragm chamber that is maintaining the chamber water pressure which keeps the automatic water control valve closed. When the detector circuit changes state, the solenoid valve releasing (output) circuit is energized.

The energized solenoid coil causes the solenoid valve to open, which releases the automatic water control valve piston or diaphragm chamber pressure and causes the automatic water control valve to trip.

3.2.1.4 Pneumatic Rate-of-Rise

The pneumatic rate-of-rise pilot line release device is a thermostatic detector which commonly consists of a metal tube enclosing a metal rod, and these two elements have different coefficients of thermal expansion. When this assembly is subjected to a temperature rate-of-rise (Δ temperature/minute), the differential thermal expansion between the rod and tube creates a force which opens a valve assembly and thereby releases the pneumatic pressure in the pilot line. This pressure reduction causes the pneumatic actuator diaphragm to open, and the piston or diaphragm chamber pressure is released which causes the automatic water control valve to trip. The minimum pilot line pressure at trip is 5.0 psi (35 kPa), which shall be maintained throughout the range of water supply pressures. (See Figures C-1 and C-2)

It should be noted that this rate-of-rise detector is self resetting, meaning that it will close when the temperature at the detector becomes constant. This will cause the pilot line pressure to increase, close the pneumatic actuator, and close the deluge valve. However, this detector is sometimes fitted with a fixed temperature release, a closed sprinkler, as a safeguard. The closed sprinkler will activate at a fixed temperature regardless of the temperature rate-of-rise device.

3.2.1.5 Hydraulic Rate-of-Rise

This device is typically the same thermostatic detector described above. System water supply pressure is maintained in the pilot line, and a reduction of this pressure causes the release of the automatic water control valve piston or diaphragm chamber pressure which causes the automatic water control valve to trip. This detector is self resetting.

3.3 Preaction Sprinkler Systems - Approval Standard Class 1012/1013

Preaction Sprinkler Systems have many of the same components used in deluge systems. Two important differences are that normally closed sprinklers are used, and that supervisory pressure is maintained in the preaction system sprinkler piping. These systems are used when it is important to prevent the accidental discharge of water. For example, if an automatic sprinkler is inadvertently broken in a wet pipe or dry pipe system, water will flow out of this open sprinkler. In preaction systems, a broken sprinkler will not result in water discharge, but will result in a signal that would initiate the sounding of a trouble alarm. The action of an additional single releasing device (single-interlock) or two releasing devices (double-interlock) is necessary to trip the automatic water control valve and send water flowing out the sprinklers.

3.3.1 Single-Interlock Preaction Releasing Systems - Approval Standard Class 1012

The Approval Guide, an on-line resource of FM Approvals, lists these as “Preaction Sprinkler Systems” (Refer to Appendix C, Figure C-3). The automatic water control valve trips when the water pressure in the piston or diaphragm chamber is reduced. This reduction of chamber pressure is controlled by the releasing mechanisms of the trim assemblies. These releasing mechanisms may be pneumatic, hydraulic, or electrical. FM Approvals considers the following three to be single-interlock preaction valve releasing systems:

Section	Release System	Detection Devices
3.2.1.3	Electric, Control Panel/Solenoid Valve	Heat, Smoke or Radiant Energy Actuated Detector
3.2.1.4	Pneumatic Rate-of-Rise	Thermostatic Release, °F (°C)/ Minute Temperature Rise
3.2.1.5	Hydraulic Rate-of-Rise	Thermostatic Release, °F (°C)/ Minute Temperature Rise

Complete release system descriptions are contained in the deluge releasing system Section 3.2.1. For example, the single-interlock preaction, electric release description in is Section 3.2.1.3.

In single-interlock preaction systems, the automatic water control valve trips when one of the above detection devices activates and reduces the water pressure in the piston or diaphragm chamber. Water flows into the sprinkler piping and will flow out of any open system sprinklers.

An illustration of these various single-interlock preaction release systems is shown in Figure C-3 of the Appendix C.

3.3.2 Double-Interlock Preaction Releasing Systems - Approval Standard Class 1013

The Approval Guide, an on-line resource of FM Approvals, lists these as “Refrigerated Area Sprinkler Systems”. Double-interlock preaction systems utilize the same automatic water control valves as discussed in the previous sections for deluge and single-interlock systems. The valves trip when the water pressure in the piston or diaphragm chamber is reduced. This reduction of chamber pressure is controlled by the releasing mechanisms of the double-interlock trim assemblies. These releasing mechanisms may be pneumatic, hydraulic, electrical, and, most commonly, a combination of two of these releasing mechanisms.

The main difference between single-interlock and double-interlock systems is that, in the latter, two independent detection devices must activate in order to trip the automatic water control valve. Double-interlock systems are often installed to protect freezer areas and are also referred to, and listed in the Approval Guide, as “Refrigerated Area Systems”.

A typical refrigerated storage area has the automatic water control valve system installed in a room heated to 40°F (4°C) or above. The valve riser, downstream of the automatic water control valve, typically extends through the wall of the heated room into the freezer area. If a single- interlocked preaction system were installed, a damaged or malfunctioning detector may trip the preaction valve and send water to the sprinkler piping. This would result in the water freezing in the sprinkler piping, resulting in an inoperable sprinkler system and major downtime, maintenance, and cost to remove the ice.

With a double-interlocked preaction system, two independent events must occur, and this redundancy adds an additional safeguard to the inadvertent discharge of water.

Double-interlocked preaction systems are frequently used in locations other than freezers where the inadvertent water damage to highly sensitive areas could be catastrophic. Examples are computer centers, semiconductor manufacturing, telecommunication switching centers, museums, and libraries.

FM Approvals considers the following current industry designs of double-interlocked preaction valve releasing systems:

Item	Release System	Detection Devices
1	Pneumatic/Electric, Pneumatic Actuator/Control Panel and Solenoid Valve	Activated System Sprinkler/Thermostatic Release and Heat, Smoke or Radiant Energy Actuated Detector
2	Electric/Pneumatic-Electric, Cross-Zoned Control Panel Initiating Circuits/Solenoid Valve/Low System Pressure Switch	Activated System Sprinkler and Heat, Smoke or Radiant Energy Actuated Detector
3	Pneumatic/Pneumatic, Two Pneumatic Actuators	Activated System Sprinkler and Pneumatic Pilot Line with Fixed Temperature or Thermostatic Release

Schematics of these various double-interlock preaction release systems are shown in Figures C-4, C-5, and C-6 in Appendix C.

3.3.2.1 Pneumatic/Electric

In this system, closed sprinkler heads are utilized and sprinkler system supervisory pressure is maintained in the sprinkler system (see Figure C-4). This system supervisory pressure acting on the top of the diaphragm of the pneumatic actuator holds the diaphragm closed against water supply pressure in the diaphragm or piston charge line. Water supply pressure in the piston diaphragm charge line is also maintained by the normally closed solenoid valve. The activation of a heat or smoke detector activates the initiating circuit in the electrical releasing panel which opens the solenoid valve, but the automatic water control valve does not trip. When a sprinkler is activated and system pressure is reduced, the pneumatic actuator opens and releases the diaphragm charge line pressure to drain and thus trips the automatic water control valve. Both detector activation and reduction of system pressure are required to trip the valve, hence the term double-interlock.

3.3.2.2 Electric/Pneumatic-Electric

In this system, closed sprinkler heads are utilized and supervisory pressure is maintained in the sprinkler system (see Figure C-5). Water supply pressure in the piston or diaphragm charge line is maintained by the normally closed solenoid valve which is wired to the output circuit of the electrical releasing panel. A system pressure supervisory switch and a detector control the output circuit in the panel for the solenoid valve. The supervisory switch is preset to energize the panel output circuit when system supervisory pressure is reduced to a predetermined pressure, usually 6 - 10 psi (40 - 70 kPa), and the detector is activated. This configuration is termed cross-zoned, meaning that excitation of both the detector and pressure switch is required to open the solenoid valve and trip the automatic water control valve. Often the releasing panel is programmable to provide the cross-zoned circuitry. Sometimes another circuit board must be added to a releasing panel. The term should not be confused with cross-zoned sprinkler systems where one preaction system serves two or more protected areas.

3.3.2.3 Pneumatic-Pneumatic

In this system, closed system sprinkler heads and closed pilot line sprinkler heads are utilized and sprinkler system and pilot line pressure is maintained independently (see Figure C-6). The system pressure acting on the upper diaphragm of the system pneumatic actuator holds the diaphragm closed against water supply pressure in the piston or diaphragm charge line. Pilot line pressure acting on the diaphragm pilot line pneumatic actuator also holds the diaphragm closed against water supply pressure in the piston or diaphragm charge line. When a pilot line sprinkler is activated, the automatic water control valve does not trip. Only when a system sprinkler is activated and system supervisory pressure is reduced does the system pneumatic actuator open and release the diaphragm charge line pressure to drain, thus tripping the automatic water control valve. Both reduction in pilot line pressure and reduction of system pressure are required to trip the automatic water control valve, hence the term double-interlock.

3.4 Solenoid Valves used in Electric Release Systems

- 3.4.1 Normally closed (NC) solenoid valves are always used as the release in electric deluge and preaction systems. They are closed in the system set position in the de-energized mode. A solenoid coil activation circuit is closed by the heat detector, and voltage is applied across the solenoid coil to open it and allow the automatic water control valve to trip. Therefore, the solenoid coil is de-energized, with no power to it, most of the time. If power were supplied most of the time, heat generated by the coil in the solenoid enclosure may reduce the life of the solenoid. This is especially true in NEMA 4 watertight enclosures, hazardous location enclosures, and explosion proof enclosures. These enclosures provide electrical insulation, as well as thermal insulation, which holds in the heat responsible for coil degradation. When the coil fails, the solenoid valve reverts to its fail-safe condition. Therefore, if power failed with a NC solenoid, it would remain closed in the set position, the automatic water control valve could not trip and send water flow to the sprinklers. This is one of the reasons to have the 90 hour battery backup and control panel alarms: to alert the facility of a malfunction within this period of time.

If the solenoid failed during sprinkler water flow in a fire situation, it would close but the deluge or automatic water control valve would remain open because of the anti-reset devices discussed in 3.5: the mechanical latch, the charge line vent valve, or the water supply shut off valve.

- 3.4.2 There have been instances where an end-user has substituted a normally open (NO) solenoid valve in a system Approved with an NC solenoid valve. End-users have also requested deluge and preaction system manufacturers to provide the NO solenoid valves instead of the NC solenoid valves.

The NO solenoid valves is viewed as fail-safe in the system because it will fail open, and the automatic water control valve will open, or remain open, if the coil or power fails at any time.

Problems associated with this NO substitution are:

1. The coil will burn out faster because it is always energized,
 2. In a double interlock system, the failure of the solenoid open will convert the system to a single interlock system. In a freezer, water would flow into the sprinkler system upon solenoid and/or power failure.
 3. In an electric deluge system, water or foam would be discharged out the open deluge sprinklers if the NO solenoid failed or AC power and 90 hour backup failed.
- 3.4.3 There currently are fail-safe preaction systems designed to operate properly if solenoid failure occurs. They utilize both NC and NO solenoid valves, none of which are energized continuously. If the main NC solenoid valve fails closed, the NO solenoids automatically open and the system is converted to a dry pipe system, which is not dependent on electrical power. If a fire occurs and activates sprinklers, the preaction valve will trip because of the decrease in system pressure

FM Approvals will not accept an examination for the NO solenoid substitution, unless other design features address the aforementioned pitfalls.

3.5 Devices to Prevent Deluge and Preaction Systems from Resetting Automatically after Initial Trip

There are circumstances in which automatic water control valve releases may reset themselves during sprinkler flow in a fire. For example, the rate-of-rise detectors reset when steady state ambient temperatures are restored. Damaged heat detectors may reset, or loss of electrical power to the releasing panel may close the release solenoid, and result in premature, and inadvertent, closure of the automatic water control valve. There are other circumstances such as shutting of the water supply pressure to the automatic water control valve during a fire and then re-pressurizing the system. This resetting of the automatic water control valve is caused by the piston or diaphragm charge line being pressurized after the initial trip, and results in the clapper latch re-engaging the clapper or the pressure in the diaphragm valve closing the diaphragm.

Figures C-7 and C-8 in Appendix C demonstrates the three most current methods designed to prevent the inadvertent resetting of the automatic water control valve after the initial trip, and should be referred to in the following discussions.

3.5.1 Mechanical Clapper Latching

In this design, when the automatic water control valve is tripped, a spring loaded latch mechanically engages the underside of the open clapper and prevents it from reseating even if piston or diaphragm chamber pressure is restored (See Figure C-7). The mechanical latching results in the valve flowing water to the sprinkler system until the fire is determined to be fully contained. Then, the system is reset by closing the water supply valve to the automatic water control valve inlet, and fully opening the drain valves above and below the clapper. The valve must be manually reset (latched) by removing the cover plate. Some designs use manual external reset knobs on the valve body which obviates removing the cover.

3.5.2 Venting of Piston or Diaphragm Chamber Charge Line

In this design, when the automatic water control valve is tripped, a charge line vent valve opens and vents the piston or diaphragm charge line continuously, precluding any reestablishment of water pressure in the piston or diaphragm chamber and possible valve resetting (See Figure C-8). This insures that the automatic water control valve remains open and flows water to the sprinkler system until the fire is determined to be fully contained. Then, the system is reset by closing the water supply valve to the automatic water control valve inlet, and fully opening the drain valves above and below the clapper. The charge line vent valve must be manually reset when resetting the automatic water control valve. Some charge line vent valves will automatically reset when depressurized, and the manufacturer's instructions should be followed.

3.5.3 Shutting Off Pressure to Piston or Diaphragm Chamber Charge Line

In this design, when the automatic water control valve is tripped, a water supply shutoff valve closes and prevents any reestablishment of water pressure in the piston or diaphragm chamber and possible valve resetting (See Figure C-8). This insures that the automatic water control valve remains open and flows water to the sprinkler system until the fire is determined to be fully contained. Then, the system is reset by closing the water supply valve to the automatic water control valve inlet, and fully opening the drain valves above and below the clapper. The water supply shutoff valve must be reset to the open position when resetting the automatic water control valve.

3.6 Release Control Panels for Preaction and Deluge Sprinkler Systems

In the previous descriptions of these sprinkler systems, the term control panel was used to describe the electrical panel which operated the release solenoid valve upon detector activation. In fact, it is an Alarm/Release Control Panel which also causes visual and audio alarms at the panel itself and within the protected premises with the potential capability of remote signaling.

Among the typical alarm, trouble, and supervisory LED's on the releasing panel's display board are low (pressure) supervisory, low (pressure) alarm, AC power, Release Solenoid Circuit, Detector Circuit, System Trouble, and Alarm/Water Flow.

The Alarm/Release Panel is powered by 120 VAC or 230 VAC and converts that to 24 VDC compatible with the solenoid valve, detectors, pressure switches, alarm switches, and LED readouts. It also contains storage batteries arranged in series, with an integral continuous battery charger, which is required by this Standard to provide a minimum of 90 hours of battery backup to the system in the event of AC power failure. At the end of this period, the back-up supply shall be able to operate the system at the maximum rated pressure and provide a satisfactory alarm for at least 10 minutes. The system designer must calculate the maximum electrical load for each installation, including optional accessories, to ensure that the battery pack storage capacity in amp-hours is sufficient for the 90 hour backup. Available battery capacity and maximum combined load from the panel to all external devices must be contained in the panel supplier's Installation, Maintenance, and Operation Instructions. The pertinent information shall also be included in the valve manufacturer's Installation, Maintenance, and Operation Instruction manual, often with reference to the specific panel supplier's manual.

A valve manufacturer seeking Approval of their electric deluge and/or preaction systems shall specify and provide a panel for testing as part of the examination.

The manufacturer has two options in this regard:

A. Select a currently FM Approved panel

FM Approved control panels are listed under the classification “Automatic Releases for Praction and Deluge Sprinkler Systems” in the Approval Guide, an on-line resource of FM Approvals. Those panels were submitted by the control panel manufacturer and examined by FM Approvals. These same panels have been selected by current electric deluge and/or preaction valve manufacturers for use in their systems. FM Approvals evaluates and tests them as a complete system. The Approved valve manufacturers typically include the exact panel specification in their system technical data sheets. The manufacturers therefore market the complete system, including the panel. This panel is referred to as the “baseline” panel in the following discussion.

In practice, the system designer who designs the sprinkler system and procures the components for a given installation frequently selects an Alarm/Release Control Panel which is different from the “baseline” panel. The designer must select a compatible panel based upon the ability to provide the power to drive the solenoid valve, provide 90 hours of battery backup, and sound the alarms. The Approval Guide provides guidance in this selection of a panel, other than baseline, in the Fire Protection Division section “Automatic Sprinkler Systems, Valves, System Valves, Automatic Water Control Valves”.

The aforementioned sections also provide a guide for the electric deluge and/or preaction system manufacturer to substitute a different solenoid valve in their currently Approved systems. Specifically, the solenoid substitution may be FM Approved merely based upon the valve having equal or lower power consumption, equal or larger orifice size, and equal or greater rated working pressure than the originally approved solenoid. The decision to accept the different solenoid valve for use with the releasing panel is at the discretion of FM Approvals.

It is important to point out that the solenoid release valves listed in Automatic Water Control Valves are not themselves FM Approved. They are FM Approved as part of the manufacturer’s FM Approved electric deluge and/or preaction system because they were included in the operational testing. Also, the solenoid valve was tested in accordance with the requirements of Section 4.7 for the valve manufacturer, and the data for that solenoid testing is kept on file for that specific manufacturer at FM Approvals.

B. Provide a different panel for examination

When a manufacturer submits a system with a new Alarm/Release Control Panel for Approval, it shall be evaluated by FM Approvals under Class 3010, “Fire Alarm Signaling Systems”. The Electrical Test Outline is contained in Class 3010’s Appendix 2.

At the successful conclusion of testing, the listing in the Approval Guide, an on-line resource of FM Approvals, would include these components: the automatic control valve, all trim components, the solenoid valve, the control panel, and the detectors in some specialized systems. The electric deluge and/or preaction valve manufacturer publishes this information in their Technical Data Sheets and Installation, Maintenance, and Operation Instructions. An end-user would be able to purchase the described complete system with the appropriate size preaction or deluge valve and install it to protect one sprinkler zone of their facility. One sprinkler zone is defined as one deluge or preaction system that serves one distinct protected area.

It is beyond the scope of this Standard to identify all the functions available in modern Alarm/Release Control Panels. It is important to point out that many available panel functions and valve/detector circuits are not approved for installation in FM insured locations. Specific applicability is contained in FM Global Property Loss Prevention Data Sheets, in particular, 2-8N, “Installation of Sprinkler Systems”, and 8-29, “Refrigerated Storage”. For example, in 8-29, 2.3.3.4, “Fire Alarm Control Panels”, it is stated that: “for reliability, one control panel should be used for each sprinkler system. Do not use one control panel to activate multiple systems”. In 2-8N, 3-3.1.6, “Detection Devices and Systems” (for Deluge and Praction Systems), Section 4 states that “Separate detection systems, control panels, and release device

circuitry should be provided for each sprinkler system.” This mandate for single-zone circuitry makes it imperative that the deluge and preaction system manufacturer include the information in their Installation, Maintenance, and Operation Instructions that cross-zoned detection systems are not FM Approved.

3.7 Fire Detection Devices

The component of a deluge or preaction sprinkler system that actually detects and signals the presence of a fire is the fire detection device. Fire detection devices are distributed throughout the same area as the sprinklers. Those which are FM Approved can be spaced so as to at least be as sensitive as an automatic sprinkler. It is outside the scope of this Standard to provide details of the various fire detection devices, nor is it necessary for Approval examinations of most deluge and preaction sprinkler systems. These devices are listed in the Fire Protection Division, in the “Electrical Signaling” section, under the Alarm Signal Initiating Devices section in the Approval Guide, an on-line resource of FM Approvals. However a brief explanation with applicable references is provided below.

3.7.1 For electrical fire detection, use one of the following classes of devices to detect a fire based on predefined fire event characteristics, and use electrical means to signal the extinguishing system to release.

3.7.1.1 Heat responsive devices may have either a fixed temperature release mode or a rate-of-rise mode or rate compensated (incorporating fixed and rate-of-rise elements) which actuates the release mechanism, in accordance with FM Approvals’ Approval Standard 3210, *Heat Detectors for Automatic Fire Alarm Signaling*.

3.7.1.2 Smoke responsive devices respond to smoke levels corresponding to the reduction in visibility and light penetration described as %/ft obscuration in accordance with FM Approvals’ Approval standard 3230-3250, *Smoke Actuated Detectors for Automatic Fire Alarm Signaling*.

3.7.1.3 Radiant Energy responsive devices respond to energy emitted from either a flame or a spark in the infrared or ultraviolet wavelengths of light in accordance with FM Approvals’ Approval Standard 3260, *Radiant Energy – Sensing Fire Detectors for Automatic Fire Alarm Signaling*.

3.7.2 Pneumatic Fire Detection

Heat responsive devices may have either a fixed temperature release mode or a rate-of-rise mode which actuates the release mechanism.

3.7.3 Hydraulic Fire Detection

Heat responsive devices may have either a fixed temperature release mode or a rate-of-rise mode which actuates the release mechanism.

3.8 Markings

3.8.1 The following information shall be permanently marked on each automatic preaction or deluge water control valve:

- The manufacturer’s name or trademark;
- Nominal valve size (inches or millimeters);
- Directional flow arrow;
- The foundry and casting date code;
- Rated working pressure, psi or bar;
- Model designation; and,
- The FM Approvals Certification Mark (see Appendix B).

External adhesive labels are not permitted for use as valve markings.