Examination Standard
for
Deluge and Preaction Sprinkler Systems

Class Numbers 1011/1012/1013

December 2020

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Foreword

This standard is intended to verify that the products and services described will meet the stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standards is to present the criteria for examination of various types of products and services

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistently uniform and reliable product.

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1. INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification requirements for Deluge and Preaction Sprinkler Systems.

1.1.2 Testing and certification criteria may include, but are not limited to: performance requirements, sprinkler system requirements, sprinkler system design, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance audit 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 certification, test criteria comparable to the United States equivalent size shall be used.

Deluge and Preaction Sprinkler Systems are certified 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:

Class Number	***Sprinkler System Category***
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.

1.3 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 certification. Deluge and Preaction Sprinkler Systems having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met.

1.4 Basis for Certification

Certification 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 for certification; and, as far as practical,

- The durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures shall be made to evaluate the manufacturer's ability to consistently produce the product that was examined and tested.

1.5 Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- Production or availability of the product as currently certified;
- The continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the certification;
- Satisfactory surveillance audits conducted as part of certification agency's product surveillance program.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after that date shall satisfy the requirements of this standard.

The effective date of this Standard is eighteen (18) months after the publication date of the standard 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. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

One unit of measurement (Liter), outside of, but recognized by SI, is commonly used in international fire protection and is used in this standard.

1.8 Normative Reverences

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI/FM 3260 - February 2004, *Radiant Energy -Sensing Fire Detectors for Automatic Fire Alarm Signaling*
ANSI/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 1020 - April 2007, *Automatic Water Control Valves*
FM 1031 - May 1977, *Quick Opening Devices (Accelerators and Exhausters) for Dry Pipe Valves*
FM 3210 - April 2007, *Heat Detectors for Automatic Fire Alarm Signaling*
FM 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*
ISO/(IEC 17025 - 2005, *General Requirements for the Competence of Testing and Calibration Laboratories*
NEMA Standards Publication 250-2003, *Enclosures for Electrical Equipment (1000 Volts Maximum)*
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

Installations acceptable to the authority having jurisdiction and enforcing the applicable installation rules. Acceptance is not a characteristic of a product. A product accepted for one installation may not be acceptable elsewhere.

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.

Preaction 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 Preaction 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 certified 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 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- a complete list of all models, types, sizes, and options for the products or services being submitted for certification 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.

Foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency.

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.3.4 It is the manufacturer's responsibility to provide any special test fixtures such as those which may be required to evaluate the automatic water control valves. Testing may be performed at the certification agency, 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, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define the limits of the final certification.

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 the certification agency's 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 certification 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 the material listed herein.
(2) Drawings in a language other than English may require partial translation for use in a certification 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 certification 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 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 the certification agency. These drawings will be identified by the certification agency at the conclusion of the certification program. The manufacturer shall notify the certification agency of changes to these documents.

3.2 Deluge Sprinkler Systems - Approval Standard Class 1011

The Approval Guide, an on-line resource of the certification agency, 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

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. the certification agency 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 - Examination 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 - Examination Standard Class 1012

The Approval Guide, an on-line resource of the certification agency, 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. The certification agency 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, ºF (ºC)/ Minute Temperature Rise
3.2.1.5	Hydraulic Rate-of-Rise	Thermostatic Release, ºF (ºC)/ 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 - Examination Standard Class 1013

The Approval Guide, an on-line resource of the certification agency, 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.

The certification agency 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 certified 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

The certification agency 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 ensures 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 ensures 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 certification 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 certified panel

Certified control panels are listed under the classification “Automatic Releases for Preaction and Deluge Sprinkler Systems” in the Approval Guide, an on-line resource of the certification agency. Those panels were submitted by the control panel manufacturer and examined by the certification agency. These same panels have been selected by current electric deluge and/or preaction valve manufacturers for use in their systems. The certification agency evaluates and tests them as a complete system. The certified 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 certified systems. Specifically, the solenoid substitution may be certified 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 certified solenoid. The decision to accept the different solenoid valve for use with the releasing panel is at the discretion of the certification agency.

It is important to point out that the solenoid release valves listed in Automatic Water Control Valves are not themselves certified. They are certified as part of the manufacturer’s certified 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 the certification agency.

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 the certification agency 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 certification agency listing , 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 certified 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 Preaction 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 certified.

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 certified 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 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 the certification agency. 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 Examination 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 Examination 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 Examination 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 certification agency's mark of conformity.

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

3.8.2 A metal nameplate, attached to the body or hand hole cover with drive screws, shall be attached to the trimmed valve with the following system information:

- The manufacturer's name or trademark;
- Model designation;
- Nominal valve size (inches or millimeters);
- The words "Deluge Valve" or "Preaction Valve";

- The words “Mount Vertical” or “Mount Horizontal”, if limited to a particular orientation; and,
- The certification agency’s mark of conformity.

3.8.3 Markings shall be cast or forged in raised characters or die stamped on the valve body. All letters and symbols shall be large enough to be read by a person with normal (20/20) vision standing 3 ft (0.9 m) away.

3.8.3.1 A corrosion resistant metal nameplate bearing the same information as stated above shall be considered acceptable if permanently fastened to the valve body or cover.

3.8.3.2 Other methods of applying permanent markings will be evaluated on a case-by-case basis.

3.8.4 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product as certified. The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.8.5 The certification agency’s mark shall be displayed visibly and permanently on the product. The manufacturer shall not use these marks on any other product unless such product is covered by separate agreement with the certification agency.

3.9 Valve Sizes

Common sizes for automatic water control valves are: 1-1/2, 2, 2-1/2, 3, 4, 6, and 8 inch NPS.

3.10 Rated Working Pressure

All deluge and preaction sprinkler system components which come in contact with system water pressure shall have a minimum rated working pressure of 175 psig (1205 kPa), or the rating working pressure of the automatic water control valve, whichever is greater.

3.11 Installation, Maintenance, Operation and Testing Manual

This manual must be written for the specific system, for example, Double-Interlocked Electric/Pneumatic Release Preaction Valve. The manual shall be shipped in the container with the automatic water control valve or system trim with instructions to attach the manual to the valve for future reference.

At a minimum, the manual shall contain the following information:

- A description of the system operation, how it works, with a comprehensive description of the interaction of the following major components in the system “set”, “trouble”, and “fire” conditions: detectors, pneumatic actuators, pressure switches, interlocks, control panel alarms, mechanical alarms, manual emergency release, and anti-resetting devices. This description shall be augmented by a drawing of the complete system, typically an isometric drawing. This shall illustrate the automatic water control valve with all trim, trim components (including optional components), and control panel.

- A drawing or photograph of the electrical control panel display board which shows the readouts, such as (but not limited to): AC Power, System Alarm, Solenoid Activated, Supervisory, Detection in Zone 1, System Trouble, System Water Flow, Circuit Trouble, Low Pressure, and Main Valve.

- A wiring diagram of the electrical control panel. This shall include, as a minimum:

  a. The Panel Inputs, such as the manual pull station, detection, supervisory switch, control panel protective smoke detector and water flow switch circuits.

  b. The Panel Outputs, such as the solenoid release circuit, and the notification circuit and any remote annunciator circuit.

  c. Terminal Jacks for monitoring circuit conditions such as the primary and secondary power supplies voltage and current.

- The methods for conducting alarm and trip tests, including written precautions about establishing fire patrols and notifying the Authorities Having Jurisdiction.

- A step-by-step description of returning the system to service. This shall include, as a minimum, draining the system, opening and closing control valves, resetting the control panel, resetting the main valve anti-resetting devices, and re-establishing system water and supervisory pressure.

- A trouble-shooting guide that lists the trouble symptoms and directions for corrective action.

- The Manufacturer's Installation, Maintenance, Operation and Testing Manual shall address the "Common Problems with Deluge and Preaction Sprinkler Systems" discussed in Appendix A.

3.12 Electrical Initiating System Requirements

3.12.1 All fire alarm releasing control panels when used for certified preaction or deluge sprinkler system releasing shall include the following:

a. A statement that the certification agency requires secondary power to provide a minimum of 90 hours of standby operation followed by a minimum of 10 minutes of releasing and alarm operation.

b. Instructions, tables, worksheets or similar method, which permits calculation of the appropriate size of standby battery for the 90 hour requirement based on the panel configuration and connected load(s).

c. Statements, instructions and/or wiring diagrams indicating use of Class A (Style D or E) initiating device circuit(s) or Class A (Style 2, 5, 6 or 7) signaling line circuits (Reference NFPA 72 *National Fire Alarm Code*).

d. Statements, instructions and/or wiring diagrams indicating use of specific circuit arrangements, modules or other devices as required in the system certification.

e. A statement or list showing the certification, compatible solenoid release valve(s) (for certified water control valves) with which the system has been certified, or reference to the Approval Guide listing of AUTOMATIC WATER CONTROL VALVES for this information.

f. Statements, instructions and/or wiring diagrams indicating the maximum wiring length, size or resistance for the releasing circuit such that the voltage across the solenoid release valve remains within the certified range (typically 20.4 to 26.4 VDC, but is dependent upon the specific solenoid release valve).

g. Abort switches shall not be used on systems intended to perform preaction or deluge water functions.

3.12.2 Electrical Malfunction Tests

In order to determine compliance with NFPA72, faults including breaks, shorts and grounds are introduced in power supply circuits, detection circuits, solenoid valve release circuits, and notification appliance circuits. All specified alarms and trouble indicators shall operate satisfactorily.

3.13 Materials

Corrosion resistant materials shall be utilized in mechanisms which are made up of a stationary and a moving part. For example, in clapper type valves, the clapper shaft and latch shaft are commonly stainless steel and mounted in copper alloy bushings. Polymer bushings and dynamic seals may be utilized. The clapper and seat are commonly made of copper alloy material. Components may also be coated to prevent adhesion and corrosion. The piston rod is commonly made of stainless steel with a stainless or copper alloy piston. The rubber material of static seals, such as O-rings, shall be selected for the intended service, evaluated for wear, water absorption, swelling, hardness, aging, and adhesion. Diaphragms are typically reinforced with fabric which is completely encapsulated in rubber. All rubber system components shall be of the same or very similar compound. Solenoid valves shall be completely comprised of non-ferrous materials.

Component detail drawings shall identify the part material including a reference to a nationally or internationally recognized specification (e.g., ASTM or ISO).

3.14 Environment

The complete deluge and preaction sprinkler systems shall be designed to operate in an environment temperature between 32ºF to 125ºF (0ºC to 52ºC). The manufacturer's Installation, Maintenance, and Operation Instructions shall include wording to the effect: "Deluge and preaction sprinkler systems described in this manual must be located in an indoor environment above 40ºF (4ºC), which is not subject to weather, freezing temperatures, or physical damage".

3.15 Calibration

All equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required, indicating that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an accredited ISO 17025 calibration laboratory. The test equipment must be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available .

3.16 Tolerances

Tolerances on units of measure shall be as described in Appendix G, unless otherwise specified.

4. PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 The deluge and preaction sprinkler systems shall conform to the manufacturer's drawings and specifications and to the certification agency's requirements.

4.1.2 A sample shall be examined and compared to drawings and specifications. It shall be verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements.

4.2 Deluge Sprinkler Systems Operational Tests

4.2.1 Wet Pilot Line Operational Tests

4.2.1.1 Each deluge sprinkler system with wet pilot trim shall be trip tested at various system pressures from 20 psi (140 kPa) to the system maximum working pressure, in 20 psi (140 kPa) increments, by reducing the water supply pressure in the diaphragm or piston charge line. The water pressure at the trip point of the automatic water control valve shall be recorded. The trip point pressures and the wet pilot line height limitations, which include a factor of safety of 1.5, shall be tabulated and included in the certification report.

4.2.1.2 Every size of automatic water control valve for the system submitted for certification shall be tested. The automatic water control valve with wet pilot trim shall be installed in the intended orientation. The water supply pressures at the deluge valve inlet shall be varied in 20 psi (140 kPa) increments from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater, by reducing the water supply pressure in the diaphragm or piston charge line. This shall be accomplished by slowly opening a ball valve and observing the pressure gage at the connection. This permits the water pressure in the piston or diaphragm chamber to be reduced to the trip point of the automatic water control valve, and this pressure at trip is recorded. The results and wet pilot line height limitations, which include a factor of safety of 1.5, shall be tabulated and included in the certification report.

4.2.2 Dry Pilot Line Operational Tests

4.2.2.1 An operational test shall be conducted on the automatic water control valve, with dry pilot trim installed in the system. The automatic water control valve shall be trip tested at various system pressures from 20 psi (140 kPa) to the system maximum working pressure, in 20 psi (140 kPa) increments. The system pressure shall be recorded when the automatic water control valve trips, and the pressure at the trip point shall be within the pressure range requirement of 5.0 to 30.0 psi (35 to 205 kPa) over the water supply pressure range of 20 psi (140 kPa) to the system maximum working pressure.

4.2.2.2 Every size of automatic water control valve submitted for certification for this system shall be tested. The automatic water control valve with dry pilot trim shall be installed in a vertical riser. The pilot line pressure shall be set to the manufacturer's recommendations as contained in their Installation and Instruction Manual. The water supply pressures at the automatic water control valve inlet shall be varied in 20 psi (140 kPa) increments from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater. The pilot line pressure shall be reduced by opening a nominal 1/2 inch orifice sprinkler head. The pilot line pressure when the valve trips shall be recorded. The pressure at the trip point shall be within the pressure range requirement of 5.0 psi to 30.0 psi (35 kPa to 205 kPa) over the water supply pressure range of 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater.

4.2.3 Electric Release Deluge Valve Operational Tests

4.2.3.1 An operational test shall be conducted on the automatic water control valve with the electric trim installed in the system. The automatic water control valve shall be trip tested at various system pressures from 20 psi (140 kPa) to the system maximum working pressure, in 20 psi (140 kPa) increments.

4.2.3.2 Operational tests shall be conducted on the automatic water control valve(s) submitted for certification. The automatic water control valve with electric trim is installed in the intended orientation. Water supply pressures at the automatic water control valve inlet shall be varied from 20 psi (138 kPa) to the system maximum working pressure. The solenoid valve is energized open at each system pressure. Confirmation of automatic water control valve trip shall be verified.

4.3 Single-Interlock Preaction Operational Tests

4.3.1 Electric

4.3.1.1 No false trips shall occur throughout the range of water supply pressures from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater, with the operation of an initiating device.

4.3.1.2 Every size single-interlock preaction system shall be tested. Water supply pressures shall be varied from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system's maximum working pressure, whichever is greater. At each pressure, the solenoid valve shall be energized open, to simulate the operation of an initiating device. This permits the water pressure in the chamber to be reduced to the trip point of the valve. Confirmation of automatic water control valve trip shall be verified.

4.4 Double-Interlock Preaction Operational Tests

4.4.1 Pneumatic-Pneumatic Double Interlock Preaction System Operational Tests

4.4.1.1 When configured as part of a pneumatic-pneumatic double interlock preaction system no automatic water control valve trip shall occur, with the water supply pressure from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater, when the pilot line supervisory pressure is reduced by the equivalent of an open nominal 1/2 inch orifice sprinkler head. The system supervisory pressure shall then be reduced by the equivalent of an open nominal 1/2 inch orifice sprinkler head. The system supervisory pressure when the valve trips shall be within the pressure range requirement of 5.0 to 30.0 psi (35 to 205 kPa) over the water supply pressure range of 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure. The sequence of pilot/system activation shall be alternated at every 20 psi (140 kPa) increment of water supply pressure. The automatic water control valve trip shall require both activations throughout the range of water supply pressures. No false trips are allowed.

4.4.1.2 Operational tests shall be conducted on all sizes of Preaction Sprinkler Systems submitted for certification. This valve is double-interlocked with two pneumatic actuators: one actuator shall be connected to the dry pilot line and one actuator shall be connected to the supervisory system. The automatic water control valve shall be installed in the intended orientation. The system supervisory supply pressure and pilot line pressure shall be set to the manufacturer's recommendations as contained in their Installation and Instruction Manual. Water supply pressures at the automatic water control valve inlet shall be varied from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater. At each water supply pressure, the pilot line pressure shall be reduced by opening a valve equivalent to a nominal 1/2 inch orifice sprinkler head. No automatic water control valve trip shall occur. Next, the system supervisory pressure shall be reduced by opening a nominal 1/2 inch orifice sprinkler head, or equivalent. This dual reduction of pilot line and supervisory pressure shall result in both pneumatic actuators opening and shall vent the water supply pressure behind the diaphragm or piston to drain and the automatic water control valve shall trip. The sequence of pilot/system activation shall be alternated for every 20 psi (140 kPa) increment of water supply pressure. The system supervisory pressure when the valve trips shall be recorded and this supervisory pressure at the trip point shall be within the pressure range requirement of 5.0 to 30.0 psi (35 to 205 kPa) over the water supply pressure range of 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater.

4.4.2 Pneumatic-Electric Double Interlock Preaction Valve Operational Tests

4.4.2.1 When configured as part of a pneumatic-electric double interlock system no automatic water control valve trip shall occur with the water supply pressures at the preaction valve inlet varied from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater, when the system supervisory pressure is reduced by the equivalent of an open nominal 1/2 inch orifice sprinkler head. Following the reduction in system supervisory pressure the automatic water control valve shall trip with the operation of an initiating device. The sequence of pneumatic actuator/solenoid valve activation shall be alternated at every 20 psi (140 kPa) increment of water supply pressure. When pneumatic activation is second, the system supervisory pressure when the valve trips is recorded and this pressure at the trip point shall be within the pressure range requirement of 5 psi (35 kPa) to 30 psi (205 kPa). The automatic water control valve trip shall require both activations throughout the range of water supply pressures. No false trips are allowed.

4.4.2.2 Operational tests shall be conducted on all sizes of Preaction Sprinkler Systems submitted for certification. This valve is double-interlocked with a pneumatic actuator operated by a reduction of the system supervisory pressure and a detector activated normally closed solenoid valve connected to the diaphragm or piston charge line. The automatic water control valve shall be installed in a vertical riser. The system supervisory supply pressure shall be set to the manufacturer's recommendations as contained in their Installation and Instruction Manual. Testing shall be conducted for various water supply pressures from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater. No automatic water control valve trip shall occur when the system supervisory pressure is reduced by opening a nominal 1/2 inch orifice sprinkler head, or equivalent. Following the release of the system supervisory pressure the automatic water control valve shall trip when the solenoid valve is energized open, to simulate the operation of an initiating device. The sequence of system supervisory supply/detection system operation shall be alternated for every 20 psi (140 kPa) increment of water supply pressure. When pneumatic activation is second, the system supervisory pressure when the valve trips is recorded and this supervisory pressure at the trip point shall be within the pressure range requirement of 5.0 psi (35 kPa) to 30.0 psi (205 kPa).

4.4.3 Pneumatic-Electric/Electric Double Interlock Preaction System Operational Tests

4.4.3.1 When configured as a Pneumatic-Electric/Electric Double Interlock Preaction System no automatic water control valve trip shall occur when the system supervisory pressure is reduced by opening a nominal 1/2 inch orifice sprinkler head prior to the operation of an initiating device. The automatic water control valve must trip with the operation of an initiating device if the system supervisory pressure has dropped. The sequence of pressure drop/initiating device activation shall be alternated at every 20psi (140 kPa) increment of water supply pressure. When pneumatic activation is second, the system supervisory pressure when the valve trips is recorded and this supervisory pressure at the trip point shall be within the pressure range requirement of 5.0 psi (35 kPa) to 30.0 psi (205 kPa). Automatic water control valve trip shall require both detection and low system supervisory pressure throughout the range of water supply pressure. No false trips are allowed.

4.4.3.2 Operational tests shall be conducted on all sizes of automatic water control valve submitted for certification. This valve is double-interlocked with a normally closed solenoid valve which is wired to the output circuit of a cross-zoned electrical control panel. A system supervisory pressure supervisory switch is also wired to the same panel output circuit. The automatic water control valve shall be installed in the intended orientation. The system supervisory supply pressure shall be set to the manufacturer's recommendations as contained in their Installation and Instruction Manual. For various water supply pressures from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, the system supervisory pressure shall be reduced by opening a nominal 1/2 inch orifice sprinkler head, or equivalent. No automatic water control valve trip shall occur. Following the drop of system supervisory pressure the solenoid valve shall be then energized open, simulating the operation of an initiating device. The automatic water control valve must trip. The sequence of pressure switch/solenoid activation shall be alternated for every 20 psi (140 kPa) increment of water supply pressure. When pneumatic activation is second, the system supervisory pressure when the valve trips is recorded and this supervisory pressure at the trip point shall be within the pressure range requirement of 5.0 psi (35 kPa) to 30.0 psi (205 kPa).

4.4.4 Horizontal Deluge and Preaction Valve Orientation

The aforementioned operational tests discussed the common vertical valve installations. If the manufacturer also seeks certification of valves in a different orientation, representative sizes, shall undergo operational testing selected at the sole discretion of the certification agency.

4.5 Accelerators

Accelerators shall meet the requirements of Examination Standard Class 1031, *Accelerators and Exhausters*. Accelerators are often offered by preaction sprinkler system manufacturers as optional equipment and are examined with their preaction sprinkler systems. In addition to the requirements of Class 1031, accelerator operational tests shall be conducted on preaction systems submitted for certification.

4.5.1 Operational Tests

4.5.1.1 The water supply pressures shall be varied from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure, whichever is greater. The pressure in the system shall be reduced by opening a sprinkler, or equivalent, which provides a pressure decay of from 20 psi (140 kPa) to 10 psi (70 kPa) over a period of one minute. The time required to trip the preaction valve after sprinkler activation shall be less than 30 seconds.

4.5.1.2 Tests shall be conducted on representative sizes of automatic water control valves submitted for certification. Water supply pressures are varied from 20 psi (140 kPa) to 175 psi (1205 kPa) or the system maximum working pressure. The system is typically an air tank with a volume of 750 gallons (2.85 cubic meters). The air pressure in the system shall be reduced by opening a sprinkler, or equivalent, which provides a pressure decay of from 20 psi (140 kPa) to 10 psi (70 kPa) over a period of one minute. The time required to trip the preaction valve shall be measured from the opening of the sprinkler head.

4.6 Hydrostatic Tests – Trim Piping and Components (Excluding Solenoid Valves)

4.6.1 Diaphragm Strength/Seat Leakage

4.6.1.1 All components with diaphragms or rubber seats shall withstand a hydrostatic pressure of 350 psi (2415 kPa) or two times the rated working pressure, whichever is greater, across the diaphragm or against the clapper for 5 minutes. No leakage or functional impairment shall result from this test. Following this test the component shall be fully operational.

4.6.1.2 A differential pressure of 350 psi (2415 kPa) or two times the rated working pressure, whichever is greater, shall be applied to the outlet side of the valve with the inlet of the device open to atmosphere. The test pressure shall be held for five minutes. During and at the conclusion of the test, no leakage, fracture, permanent distortion or functional impairment shall occur.

4.6.2 Hydrostatic Strength

4.6.2.1 All system components that come in contact with the system water pressure shall withstand a hydrostatic pressure of 700 psi (4825 kPa) or four times the rated working pressure, whichever is greater, without functional impairment, rupture, cracking or permanent distortion.

4.6.2.2 With the clapper or disc in the partially open position, or the diaphragm removed, component bodies of each size and end connection style shall be subjected to a hydrostatic test pressure of 700 psi (4825 kPa) or four times the rated working pressure, whichever is greater, for a duration of five minutes. There shall be no functional impairment, rupture, cracking, or permanent distortion to the component body as a result of this test.

4.7 Solenoid Valve Testing

4.7.1 Voltage Variation

4.7.1.1 The valve shall open and close satisfactorily at 85 and 110 percent of nominal (24 VDC) or rated voltage range, whichever is greater, with the inlet pressure equal to 175 psi (1205 kPa) or the system rated working pressure, whichever is greater.

4.7.1.2 The solenoid valve shall be connected to a power supply. The solenoid valve shall then be subjected to a voltage variation between 85 and 110 percent of the nominal (24 VDC) or rated voltage range, whichever is greater. The valve shall be opened and closed with the inlet pressure equal to 175 psi (1205 kPa) or the system rated working pressure, whichever is greater.

4.7.2 Cycle Test

4.7.2.1 Solenoid valves shall be capable of 20,000 cycles of normal operation without leakage, excessive wear, damage or failure of any valve component.

4.7.2.2 A sample valve of each size shall be cycled 20,000 times, at a rate not exceeding 6 cycles per minute, through its full range of travel with the inlet pressure equal to 175 psi (1205 kPa) or the system rated working pressure, whichever is greater. The valves nominal rated voltage shall be used. After the completion of the cycling test, the valve shall be tested for leakage at 175 psi (1205 kPa) or the valves rated working pressure, whichever is greater. No leakage shall be allowed. After testing, the valve shall be disassembled. Parts shall be visibly examined for signs of excessive wear, damage or failure.

4.7.3 Vibration Test

4.7.3.1 Solenoid valves shall exhibit normal operation and shall not leak at 175 psi (1205 kPa) or the system rated working pressure, following a 24 hour vibration test of 0.020 inch double amplitude displacement, with a frequency varying in the range of 10 to 30 cycles per second.

4.7.3.2 One solenoid valve of each size shall be subjected to a 24 hour vibration test of 0.020 in. (0.508 mm) total displacement, with a frequency varying in the range of 10 to 30 cycles per second at a sweep rate of 30 seconds (2 cycles per minute). The solenoid valves shall then be tested for normal operation and leakage with the inlet pressure equal to 175 psi (1205 kPa) or the system rated working pressure, whichever is greater. No leakage shall be allowed. No loosening of the solenoid valve components shall be allowed, nor failure of the solenoid valve to operate satisfactorily at the valves minimum rated voltage (85% of nominal).

4.7.4 Watertight Test

4.7.4.1 All solenoid valves that utilize totally encapsulated molded coils, where the actuator coil and electrical leads are potted in a one-piece epoxy construction shall be watertight.

4.7.4.2 (a) The energized encapsulated molded coils shall be immersed in water without shorting.
(b) If shorting does occur, the solenoid valve shall be tested in accordance with NEMA Standards Publication 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum). The valve shall be determined to be NEMA 4 watertight.

4.7.5 Dielectric Test

4.7.5.1 The solenoid valve shall provide the required degree of protection from electrical shock.

4.7.5.2 A minimum of two solenoid valve coils shall successfully withstand for one minute a 60 Hz dielectric strength test of 1000 VAC plus twice the maximum rated voltage. Solenoid valve coils whose voltage ratings are less than 30 VAC or 60 VDC shall successfully withstand 500 VAC or 710 VDC for one minute. The dielectric strength test shall be conducted between all applicable combinations of the following: power supply conductors, ground connection, other output conductors, and the valve body. Any current leakage shall be less than 5 milliamps and there shall be no evidence of arcing or thermal breakdown of wire or component insulation.

4.7.6 Environmental Test

4.7.6.1 Solenoid valves shall withstand an environment of 100ºF (38ºC) at 90 percent relative humidity for 24 hours. The samples shall operate satisfactorily at the conclusion of the test with no increase in current draw.

4.7.6.2 A sample solenoid valve shall be subjected to an environment of 100ºF (38ºC) at 90 percent relative humidity for 24 hours. The sample shall then be tested for proper operation, with no increase in current draw when compared to the pre-conditioned current draw allowed.

4.7.7 Temperature Exposure

4.7.7.1 Solenoid valves shall operate satisfactory following exposure to ambient temperatures of 32ºF (0ºC) and 185ºF (85ºC).

4.7.7.2 A sample solenoid valve shall be subjected to ambient temperature of 32ºF (0ºC) for 4 hours. It shall then be subjected to an ambient temperature of 185ºF (85ºC) for 4 hours. The valve shall then be tested for proper operation at minimum, nominal and maximum rated voltage input for the device.

4.7.8 Valve Body Shell Hydrostatic

4.7.8.1 Requirements

Solenoid valve bodies shall withstand a hydrostatic pressure of four times the rated working pressure without rupture, cracking or permanent distortion.

4.7.8.2 Valve bodies of each valve size and end connection style shall be subjected to a hydrostatic test pressure of 700 psi (4825 kPa) or four times the rated working pressure, whichever is greater, for a duration of five minutes. The normally closed (NC) valve shall be energized open, resulting in pressurization of the entire valve body and bonnet. There shall be no visible rupture, cracking, or permanent distortion to the valve body as a result of this test.

4.7.9 Seat Leakage

4.7.9.1 Solenoid valves shall be subjected to a hydrostatic pressure of 350 psi (2415 kPa) or two times the system rated working pressure, whichever is greater. There shall be no seat leakage or damage as a result of this test.

4.7.9.2 A solenoid valve of each size submitted for certification shall be subjected to a hydrostatic pressure of 350 psi (2415 kPa) or two times the system rated working pressure at the valve inlet for five minutes. The normally closed (NC) valve shall be de-energized closed for this test. There shall be no seat leakage or damage as a result of this test.

4.8 Optional Testing

When the manufacturer applies for an certification examination, they shall submit valve, pneumatic actuator, and anti-resetting device assembly, and any other proprietary devices necessary for meeting the performance requirements of this standard, along with detail drawings which are sufficiently detailed for the certification agency's engineer to evaluate the expected performance. The following optional tests may be added to the examination following the evaluation.

4.8.1 500 Cycle Test

4.8.1.1 Automatic water control valves shall be tripped for 500 cycles, seated to fully open to seated, for a complete cycle. At the conclusion of 500 cycles, the valve shall be reset with the inlet pressure set for 175 psi (1205 kPa) or the maximum system working pressure, whichever is greater. The valve shall then be cycled for 10 complete operations. The valve cover plate shall be removed, and the valve internals inspected. There shall be no signs of leakage, excessive component wear, or impending failure.

4.8.1.2 One representative size electrically operated automatic water control valve shall be installed in a vertical riser with an inlet water supply pressure of 120 psi (825 kPa) and atmospheric pressure on the system side. The valve shall be tripped for 500 cycles, seated to fully open to seated for a complete cycle. The valve shall be reset to the manufacturer's Installation, Maintenance, and Operation Instructions at the end of each cycle. Full flow through the valve shall be observed. At the conclusion of 500 cycles, the valve shall be reset, and the inlet pressure set for 175 psi (1205 kPa) or the maximum system working pressure, whichever is greater. The valve shall then be cycled for 10 complete cycles of operation. During the test the alarm test port shall be observed for leakage which may indicate valve seat leakage. Following the 10 cycles, the valve cover plate shall be removed, and the valve internals inspected. Signs of excessive component wear or incipient failure shall be evaluated. In a clapper type valve, the fit between the clapper latch and clapper shall be examined. The latch wear surface on the clapper may be superficial but shall not exhibit a deep groove indicative of latching failure. The latch, latch shafts, clapper and bushings shall show no significant damage. The piston shaft and rod seal (if so equipped) shall be undamaged. The piston diaphragm shall be examined for signs of distortion, tears, and degradation. The clapper facing and valve seat shall be examined for severe damage. In a diaphragm type valve, the diaphragm and seat shall be examined for damage and signs of incipient failure.

4.8.2 Ammonia Exposure of Rubber or Rubber Coated Pneumatic Actuator Diaphragms.

The diaphragms contained in pneumatic actuators in the closed position for long periods of time customarily are exposed to system supervisory pressure on one surface and system water on the opposite surface. In this position, the diaphragms are subject to stresses which may result in a "set" condition which is exacerbated by harmful environments. Although it is beyond the scope of this standard to evaluate all harmful environments to which these systems are exposed, ammonia exposure is a common one.

4.8.2.1 A sample pneumatic actuator with the diaphragm closed shall be subjected to exposure in an atmosphere of 35 percent ammonia, 5 percent water vapor, and 60 percent air at a constant temperature of 93°F ± 4°F (34°C ± 2°C) for 10 days, 24 hours per day. Following the test, the ammoniated diaphragm shall be compared with a new diaphragm for spring rate and resiliency. If significant differences are observed, the ammoniated diaphragm shall be subject to the operational tests described in Section 4.2, Deluge Sprinkler Systems Operational Tests.

4.8.2.2 A. Section 4.8 stated that the necessity for this optional test would be determined by an evaluation by the certification agency's engineer. In this case, the stress in the diaphragm in the closed position is evaluated. A flat diaphragm of uniform thickness which is highly deflected can be determined to be highly stressed. A diaphragm with molded convolutions and short stroke would have less residual stress. The manufacturer shall submit production pneumatic actuators and diaphragms for this evaluation.

B. A sample pneumatic actuator with the diaphragm closed shall be subjected to a moist ammonia environment for a period of 10 days.

The inlet end of each sample shall be filled with deionized water and sealed with a non-reactive material (e.g., plastic cap) so as to prevent the introduction of the ammonia atmosphere into the waterway of the pneumatic operator. The sample to be tested shall be free from any non-permanent protective coating and, if necessary, shall be degreased. If a permanent coating is an inherent part of the design, such coating shall be subjected to tests as deemed necessary by the certification agency to evaluate its protective integrity. When feasible, the sample shall be tested in its intended orientation.

There shall be provisions in the test chamber to prevent droplets of condensation from falling from the top of the enclosure directly onto the pneumatic actuators. Such shield or other means shall be constructed of glass or other non-reactive materials.

The sample shall be exposed to the moist ammonia-air mixture maintained in a glass chamber with a volume of 0.73 ± 0.43 ft^3 (0.02 ± 0.01 m^3).

Aqueous ammonia having a density of 58.7 ± 0.6 lb/ft^3 (0.94 ± 0.01 g/cm^3) shall be maintained in the bottom of the chamber, approximately 1.5 in. (40 mm) below the bottom of the sample. A volume of aqueous ammonia equal to 0.075 gal/ft^3 ± 0.006 gal/ft^3 (10 L/m^3 ± 0.86 L/m^3) of the test chamber volume shall result in approximately the following atmospheric concentrations: 35 percent ammonia, 5 percent water vapor, and 60 percent air. Prior to beginning the exposure, the test chamber shall be conditioned to a temperature of 93°F ± 4°F (34°C ± 2°C) for a period of not less than one hour, and shall be maintained as such throughout the exposure period. The moist ammonia-air mixture shall be maintained at essentially atmospheric pressure. Provision shall be made for venting the chamber, such as by the use of a capillary tube, to avoid buildup of pressure.

Upon removal, the pneumatic actuator with diaphragm shall be rinsed in potable water and air dried. Following a 48 to 96 hour drying period, visual examination of the samples shall be made.

Following the test, the ammoniated diaphragm shall be compared with a new diaphragm for spring rate and resiliency. If significant differences are observed or if the comparison is inconclusive, the ammoniated diaphragm shall be used in an operational test described in Section 4.2, Deluge Sprinkler Systems Operational Tests with satisfactory results.

4.8.3 Cabinet Enclosures for Deluge and Preaction Sprinkler Systems

Many Deluge and Preaction System manufacturers offer their certified systems assembled in a cabinet and shipped from their facility.

The cabinet contains the automatic water control valve, with the assembled trim and trim components, pressure gages, switches, actuators, shut off valves, check valves, and inlet water supply manifold, all plumbed and wired together. The front door(s) of the cabinet contain(s) the electrical release control panel components (in electrically activated systems). The AC input and DC outlet terminal strips, 90 hour stand-by backup batteries, and remote relay panels are pre-wired together and to the electrical components (for example, solenoid valves). The control panel display board which shows the system readouts is clearly externally visible. The system pressure gages are mounted in the door and are externally visible.

In summary, this configuration comprises an integrated fire protection system package which is assembled and tested at the factory, and requires only the connection to the water supply inlet, water outlet (to system), main drain, the alarm and detection connections, and the electrical power supply. Options are offered, including an automatic air compressor, air tank, and pressure maintenance device, for maintaining system air pressure in supervised air piping systems, all items mounted inside the enclosure.

4.8.3.1 Even if the valve system is certified, the cabinet integrated system must undergo a certification examination. A review of the drawings and documentation shall be required. Testing shall be determined based on the drawing and documentation review. In cases where the assembly of the cabinet is subcontracted by the valve manufacturer, the vendor facility shall have a Facilities and Procedure Audit (see Section 5.2).

4.8.3.2 The responsible certification agency engineer shall review the drawings and documentation for the cabinet system. Any testing deemed necessary shall depend on design features, results of any tests, material application, or to verify the integrity and reliability of the cabinet systems. Any testing is at the sole discretion of the certification agency.

4.9 Electrical Initiating System Tests

4.9.1 Battery Charge/Discharge Test

4.9.1.1 System charging capability shall be examined using the largest capacity battery specified and maximum standby and alarm loads. Discharge tests to be performed for a 90 hour standby (for preaction/deluge) followed by a 5 minute alarm load for local protective, or 10 minute alarm load for Emergency Voice/Alarm Communications (EVAC). The batteries shall return to a fully charged condition within a 48 hour recharge period.

4.9.1.2 The manufacture shall provide instructions, tables, worksheets or similar method, which permits calculation of the appropriate size of standby battery for the 90 hour requirement based on the panel configuration and connected load(s). The test results are considered satisfactory if the charging current is less than 3 mA per Ah rated for the battery bank at the conclusion of the test period.

4.9.2 Device Supervision

4.9.2.1 The device circuit used to initiate the solenoid shall be supervised Class A (formerly Style D or E) initiating device circuit(s) or Class A (Style 6 or 7, formerly Style 2, 5, 6 or 7) signaling line circuits (Reference NFPA 72 National Fire Alarm Code).

4.9.2.2 The specified failure modes, short, open and ground are introduced into the signal line. Proper alarm annunciation shall occur.

4.9.3 Releasing Capability Test

4.9.3.1 The releasing voltage at the solenoid shall be sufficient to initiate release.

4.9.3.2 The specified releasing solenoid shall be evaluated with the maximum wiring length, size or resistance for the releasing circuit. The voltage across the solenoid is measured with the lowest specified input voltage to the fire alarm control. The voltage across the solenoid release valve shall remain within the certified range (typically 20.4 to 26.4 VDC for a 24 VDC system) but is dependent upon the specific solenoid release valve.

4.10 Additional Tests

Additional tests may be required at the sole discretion of the certification agency, depending on design features and results of any foregoing tests.

5. OPERATIONS REQUIREMENTS

5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent deluge and preaction sprinkler systems produced by the manufacturer shall present the same quality and reliability as the specific systems examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and may be documented in the certification report.
- Conformance to design is verified by control of quality and is covered in the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawings, Operating Manuals, and specific Test Procedure change control;
- packaging and shipping;
- handling and disposition of non-conformance materials;

5.1.3 Documentation/Manual

There should be an authoritative collection of procedures and policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture

5.1.5 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by, the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

5.2 Surveillance Audits

5.2.1 An audit of the manufacturing facility may be part of the certification agency's surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior.

5.3 Installation Inspections

The certification agency's engineers frequently inspect deluge and preaction sprinkler system installations in insured facilities. The inspections are conducted because major malfunctions in these systems often result in loss of automatic fire protection, notification of the Authority Having Jurisdiction, establishment of fire patrols in the affected zone(s), significant production downtime, furloughed employees, product and facility equipment loss, high maintenance costs, and expensive follow-up system modifications. These inspections are conducted to evaluate: (1) the performance of the manufacturer's certified Deluge and Preaction Systems; (2) the installation relative to the manufacturer's Installation, Maintenance, Operation and Testing Manuals; (3) the installation relative to FM Global Property Loss Prevention Data Sheets, NFPA Standards, and this examination standard. The results of these evaluations are disseminated to FM Global field engineers and the certification agency, particularly if the observed installation anomalies are reoccurring and can be anticipated in other similar insured locations. Of course, the system manufacturers are notified if their equipment performance is deficient so that appropriate corrective action can be taken. Additionally, if chronic problems relative to system installation are observed, the manufacturer may be asked to revise their Installation, Maintenance, Operation and Testing Manuals.

5.4 Manufacturer's Responsibilities

The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5.5 Manufacturing and Production Tests

5.5.1 Operational Tests

The manufacturer shall test 100 percent of production Deluge and Preaction Sprinkler Systems for proper operation. The system shall operate as detailed in Section 4 for the type of system being tested.

5.5.2 Seat Leakage Tests

The manufacturer shall test 100 percent of automatic water control valves for seat leakage at the rated working pressure. The pressure shall be held for a minimum of 1 minute with no evidence of leakage past the valve seat.

5.5.3 Hydrostatic Tests

The manufacturer shall test 100 percent of automatic water control valves for body integrity to two times the rated working pressure. The pressure shall be held for a minimum of 1 minute with no evidence of body leakage or distortion.

APPENDIX A: Common Problems with Deluge and Preaction Sprinkler Systems

The purpose of the following is to explain common problems that have been encountered in locations of large industrial properties due to malfunctioning of deluge and preaction sprinkler systems. This is included in this examination standard for various reasons:

- To encourage the deluge and preaction systems manufacturer to include specific and detailed recommendations to address these problems in their "Installation, Maintenance, and Operation Instructions" that are shipped with the valve systems.
- To assist the system designer, end-user and installation contractor in the installation, maintenance, debugging, and resetting of these systems. It must be emphasized that false trips and non-trips often result in system impairments which could result in significant production downtime, product and facility equipment loss, and maintenance costs.

A.1 False Deluge and Preaction Valve Trips – Water and Air Pressure Supply Design

A.1.1 Air Supply Pressure and Capacity

Figures C-9 and C-10 in Appendix C should be referred to in the following discussions.

Figure C-9 illustrates a simplified, but common, air supply design for providing supervisory system air pressure to preaction systems. Supervisory air pressure is a small range of pressure specified by the system manufacturer that must be maintained in the riser and sprinkler piping when the system is in the set position. Figure C-9 illustrates two valves feeding two sprinkler zones, but it is not uncommon that dozens of valves and zones are fed by a common air supply provided by a single large compressor. The compressor shall be sized by the sprinkler system designer to provide adequate air volume and pressure to all zones based upon calculations of total air pressure leakage in the set position.

The valve manufacturer typically specifies the need for an Air Maintenance Device (AMD) for supervisory pressure regulation. The AMDs shown on Figure C-9 and C-10 are the simplest and most common. The fast fill line incorporates a larger bore ball valve for initial pressurizing of the system. This ball valve is closed during system set so that air flow is through the U-leg containing the ball check, pressure adjustment regulator, and restrictor orifice. The check valve is to "lock in" the air pressure in the system set position and to maintain pressure to compensate for system air leaks. In the event of an activated sprinkler, the restrictor orifice, commonly about 0.125 inch diameter, limits the air flow into the riser to a rate less than that released by an open sprinkler so that the sprinkler piping is not re-pressurized. Otherwise, the pneumatic actuator would not open and the automatic water control valve would not trip.

The AMD shown in the air supply header of Figure C-9, directly downstream of the large air compressor, is a single AMD installed to feed all automatic water control valves and sprinkler system zones in an area. *This arrangement is a very common reason for false trips and shall not be utilized.* The reason is that the air flow through the single AMD is severely restricted by the small orifice and the pressure regulator. The regulator has a very small air capacity when compared to the output of the large compressor upstream of the AMD. As a result, the air supply to all systems is not sufficient to maintain the supervisory pressure regulation. In "normal" conditions with no sprinkler activation, one or several systems may trip merely because of the air pressure drop at the pneumatic actuator which results because the air leaks in the total system exceed the available air capacity. If a sprinkler in one zone is activated, the resultant air flow into that zone can cause system air pressure drops in other zones, despite the check valves shown, and false trip other automatic water control valves in other sprinkler zones.

False trips in commercial food freezers are especially problematic because the water in the sprinkler piping becomes frozen. The fire protection system must be shut down, and the sprinkler piping and components dismantled and/or replaced. Even when double-interlocked preaction systems are installed in a freezer warehouse, false trips are a common problem. The reason is that both activations required to flow water into the sprinkler piping, sprinkler and detector activation, occur simultaneously when a forklift truck strikes and damages both sets of components which are installed in the food storage racks.

Figure C-10 of the Appendix illustrates the *preferred arrangement* of one air maintenance device for each automatic water control valve. In this configuration, each sprinkler system zone is provided with independent supervisory pressure regulation which is not affected by other zones. More importantly, the relatively large pipe air supply header from the large compressor delivers full air capacity to the several AMD's and their individual automatic water control valves.

A.1.2 Water Supply Pressure

Figure C-10 in the Appendix should be referred to in the following discussion.

Both valves shown in Figure C-10 have a small (commonly 1/2 inch NPS) pipe assembly between the water supply header and either the piston or diaphragm charge line. This water supply pressure in the piston of diaphragm charge line maintains the automatic water control valves in the closed position. This is sometimes referred to as the system set position. A check valve in this pipe assembly is installed in order to maintain the pressure in the charge line in the event that the supply pressure in the water supply header is shut off. Shut off of the water supply pressure is a common occurrence, such as when a fire pump is undergoing maintenance. This pressure shut off may prevail for an extended period of time, during which small leaks of water out the charge line piping, or back through the check valve, will reduce the pressure holding the piston or diaphragm closed. When this pressure is reduced sufficiently, the automatic water control valves may tend to open. In the clapper type, shown on the right, the piston will retract and the clapper latch will disengage. In the diaphragm type, on the left, the diaphragm may move up off its seat. In both cases, the charge line venting devices will operate. The effect of this scenario is that the automatic water control valves must be reset in conjunction with the re-establishment of water supply pressure in the header. Otherwise, with the inlet shutoff valve open and the water supply pressure restored, water will flow through the valves to the sprinkler piping inadvertently.

The manufacturer's Installation, Maintenance, and Operation Instructions shall clearly identify this possibility and the steps necessary to reset the system in the event of water supply shutoff.

A.2 Priming Water/ Ice Plugs/ Corrosion

Figure C-11 in Appendix C should be referred to in the following discussion.

Many earlier designs of automatic water control valves called for priming water to be utilized in the valve at all times. This pool of water in the valve body above the clapper is maintained to affect the seal between the valve clapper, or disc/diaphragm and the valve seat. Priming cups were included in the trim so that the replenishment of priming water would be part of the valve maintenance. These valves with priming water are still installed in the field, and the manufacturer's maintenance instructions shall be followed.

However, many modern designs of automatic water control valves do not require priming water, and this fact must be identified in the manufacturer's Installation, Maintenance, and Operation Instructions. Additionally, the manufacturer shall provide a low point drain in the valve body, in order to drain all water above the valve seat, and an explanation for use in the operation instructions, in particular in the valve resetting procedure.

The illustration on the left of Figure C-11 shows a pool of priming water above the clapper as a result of trip tests. The system drain valve was opened to drain the riser, but the location of this drain valve often prevents a complete draining of the water pool at the bottom of the valve body. Therefore, if the valve does not require priming water, the valve manufacturer shall provide a tapped plug at the low point, a provision for installation of a small drain valve. The manufacturer's Installation, Maintenance, and Operation Instructions shall include a statement that priming water is not required and that the draining of the water pool shall be conducted whenever the valve trips and the system is reset.

The illustration on the right side of Figure C-11 shows a double-interlocked preaction valve installed in a freezer installation. For purposes of this discussion, this modern valve does not require priming water or the installation of a standard check valve in the riser above it. However, if the lower body is not drained of water, NFPA 13 stipulates the installation of the additional check valve shown with a 1/32 inch diameter hole in the clapper (or a pipe bypass around the check valve with a 1/32 inch diameter orifice). The 1/32 inch diameter hole allows for system pressure to communicate with the sprinkler piping, but precludes the formation of ice plugs where the sprinkler piping penetrates into the freezer. A complete discussion is in Sections 7.9.2 and A.7.9.2 of the 2007 Edition of NFPA 13.

Some current valves include a standard riser check valve in the riser above the automatic water control valve in double-interlock sprinkler systems in order to contain the sprinkler system air pressure. If a water pool is present above this standard check valve, the additional check valve (1/32 in. hole) is required. In this scenario, there would be two check valves in the riser above the preaction valve. In summary, the manufacturer shall identify whether priming water is required in the standard riser check valve, and if not, provide means for its draining and identify this in the reset procedure.

The presence of a pool of stagnant water in the valve body is a source for long term corrosion on the inner surfaces of these iron valves. Unlike the filled inlet pipe below the valve element, this pool of water with a free surface in contact with the sprinkler system air leads to accelerated corrosion. Heavy rust, scale, and tubercles are formed on the valve interior over time. These tubercles are corrosion nodules with hard and soft components which are susceptible to dislodgement during flow through the valve. These dislodged nodules may result in interference and clogging of the numerous valve mechanisms including orifices, strainers, accelerators, actuators and alarm lines, for example. This is another important reason for the manufacturer to identify whether priming water is required in the standard riser check valve, and if not, provide means for its draining and identify in the reset procedure.

A.3 Long Term Adhesion of Rubber Valve Discs and Seats

Examination of all of the Figures in Appendix C demonstrates that common deluge and preaction systems are characterized by numerous valves with rubber discs and non-ferrous seats. These valves include the main valve, piston or diaphragm actuator, pneumatic actuator(s), charge line vent and shutoff devices, supervisory pressure switches, accelerators, dynamic seals, rubber seated check valves, and some detectors.

All these valves are closed for long periods of time in the system set position. Therefore, the disc and seat are susceptible to adhering together and can result in trip delays and even no trips over time. In addition, contaminants entering the air or water supply may accelerate this adhesion. One example is excessive ammonia gas from refrigerant systems entering the air supply of double-interlock preaction systems and affecting the rubber discs.

The rubber discs shall be designed to help preclude adhesion. Commonly, manufacturers are also coating the non-ferrous seats with various non-stick materials and this is encouraged.

An examination for certification may require testing for adhesion over time to evaluate the effects of long-term seating in chemical atmospheres.

It should be noted that a basic requirement in supervisory air pressure sprinkler systems is that the chamber air pressure at valve trip should exceed 5.0 psi (35 kPa). One reason for this, in addition to providing a common baseline for all systems, is that it attempts to ensure that sufficient force is available to actuate the aforementioned disc/seat devices when called for.

APPENDIX B:

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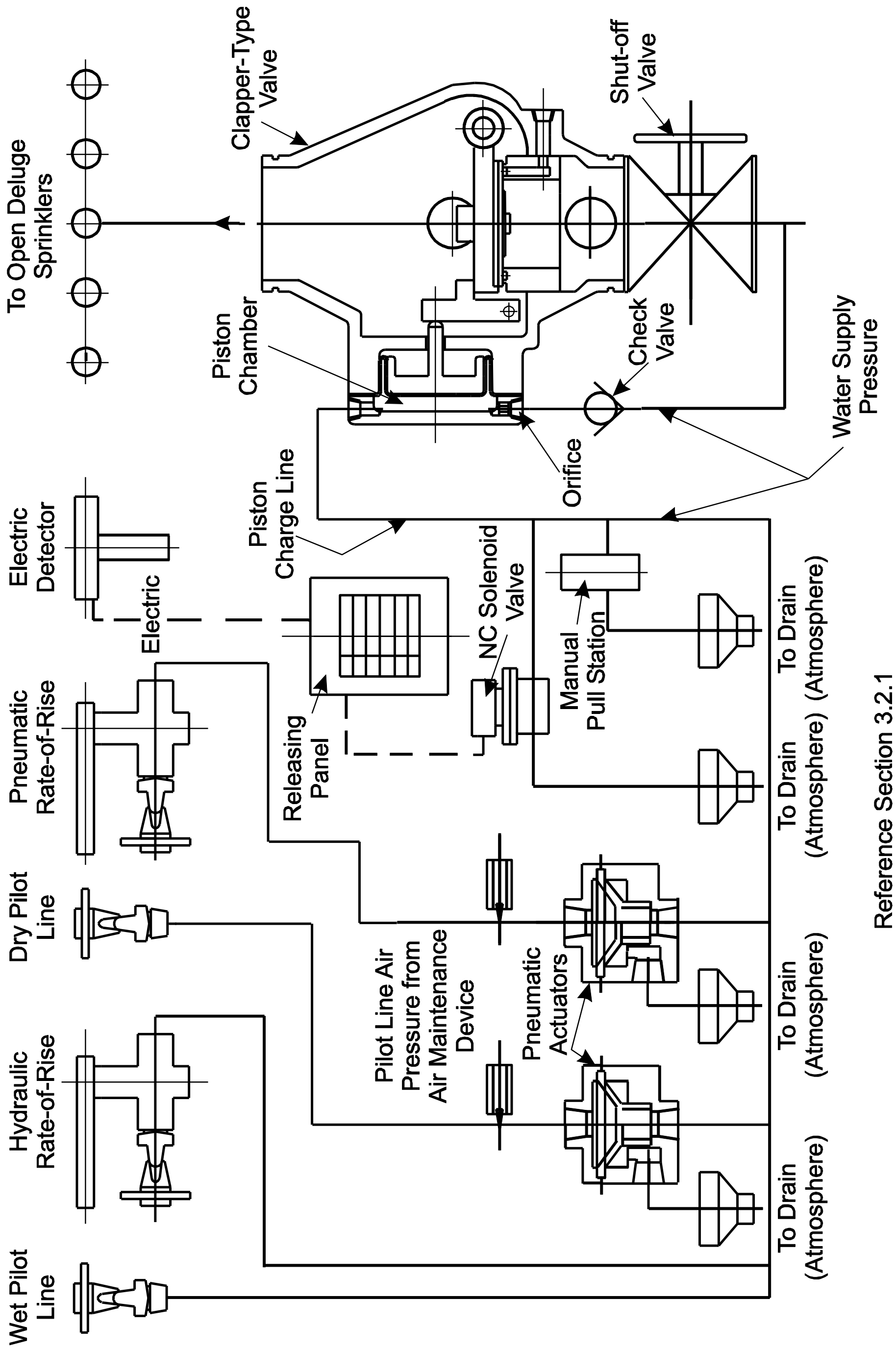
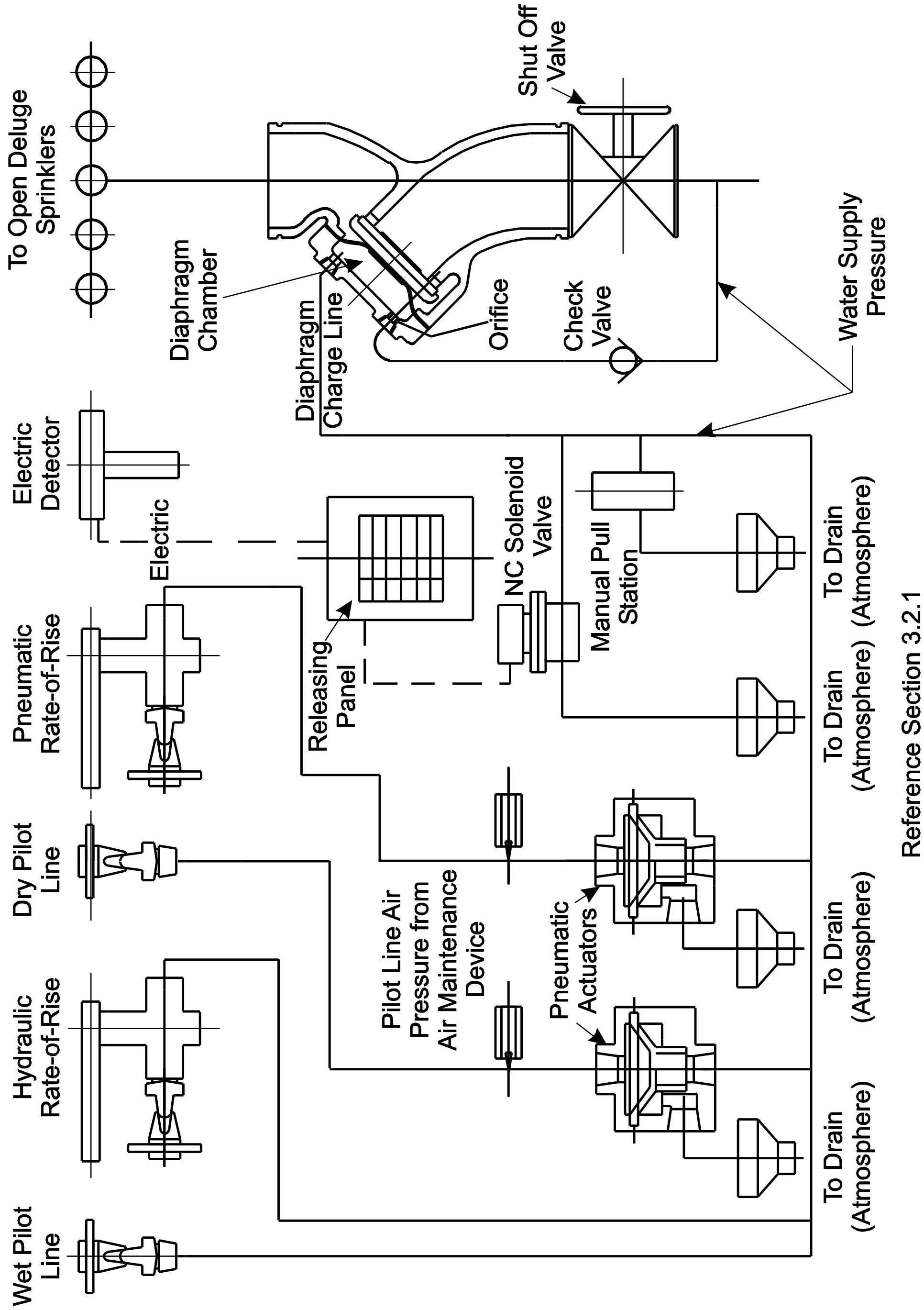
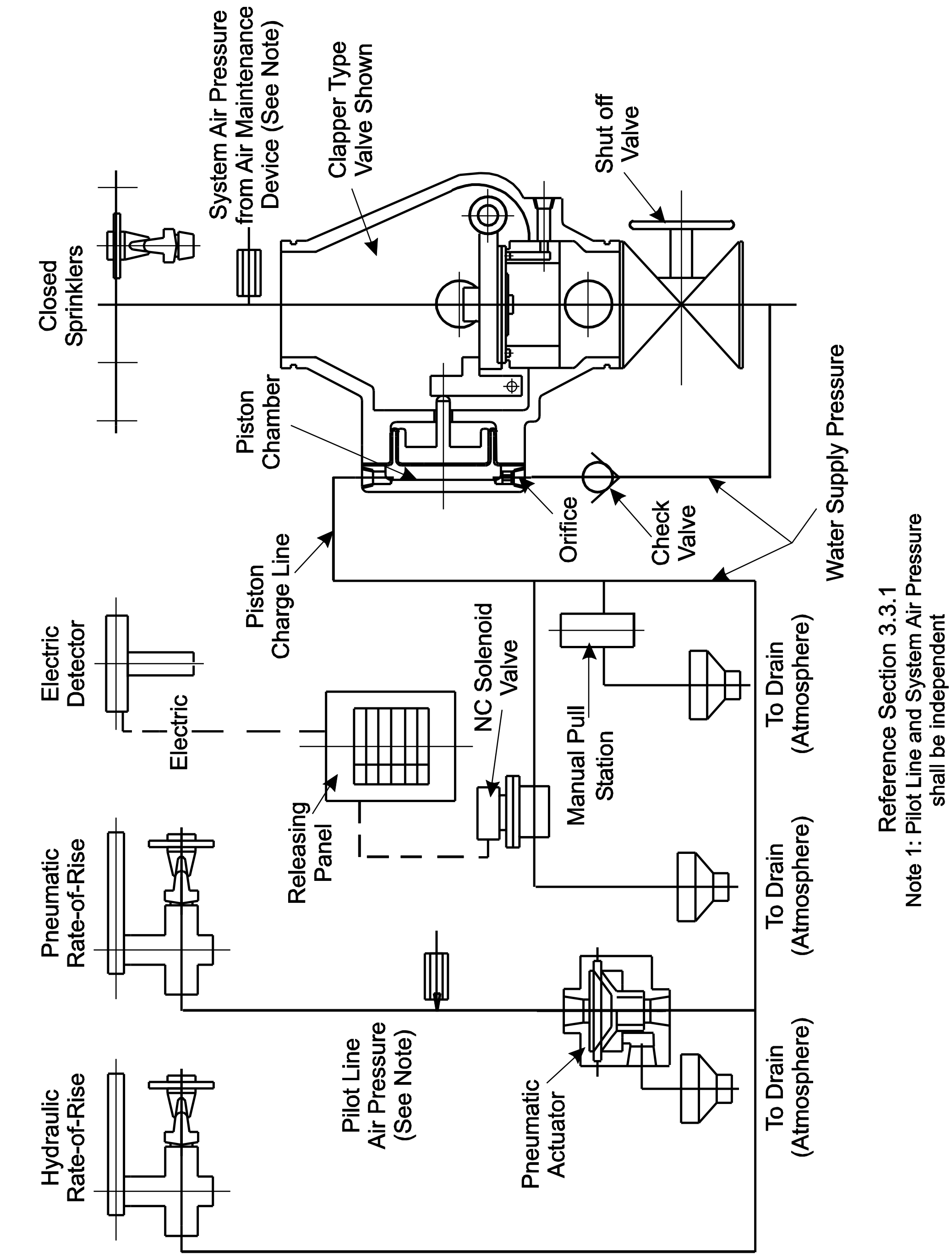
APPENDIX C: Figures



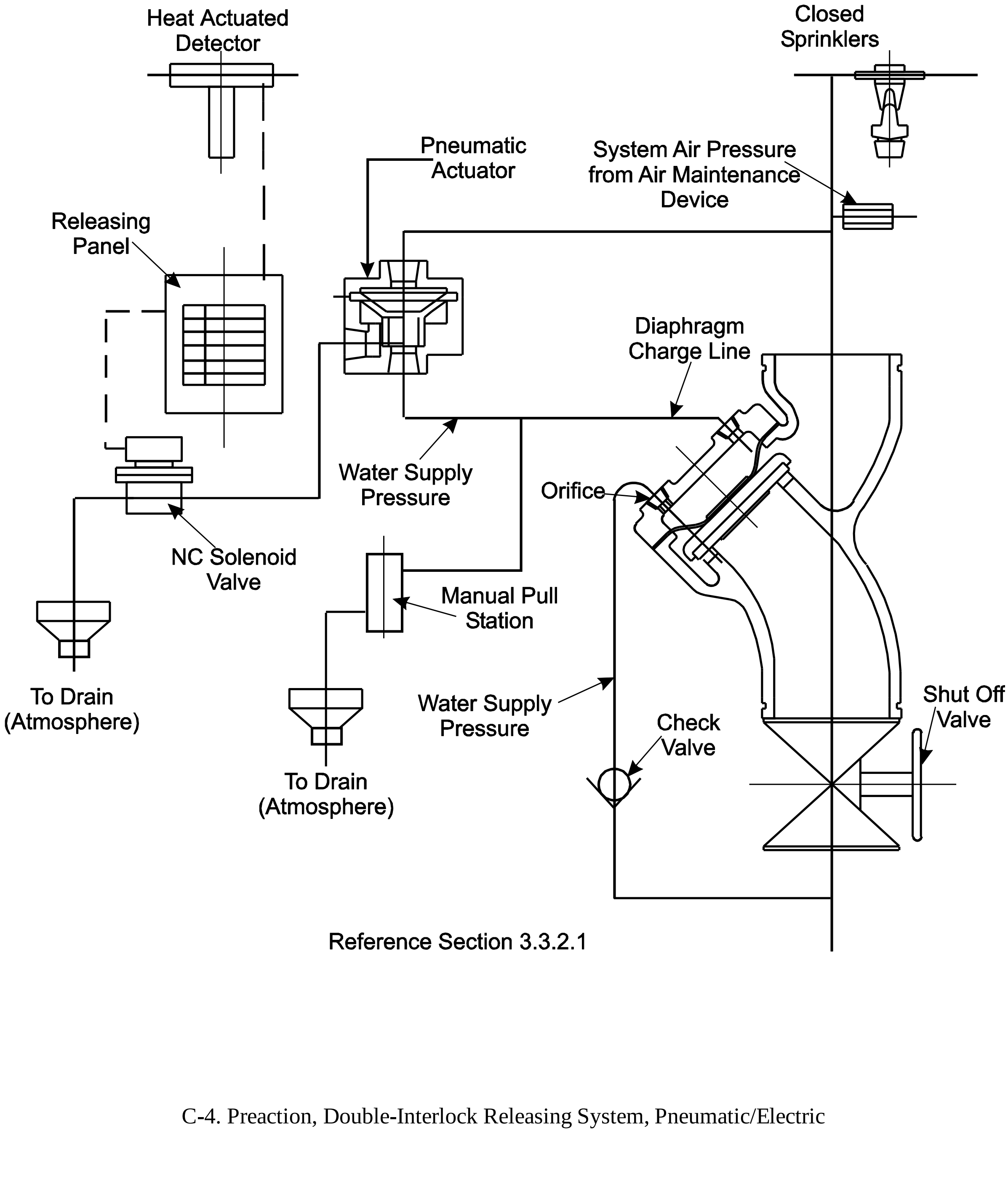
C-1. Deluge Releasing Systems with Clapper Type Valve



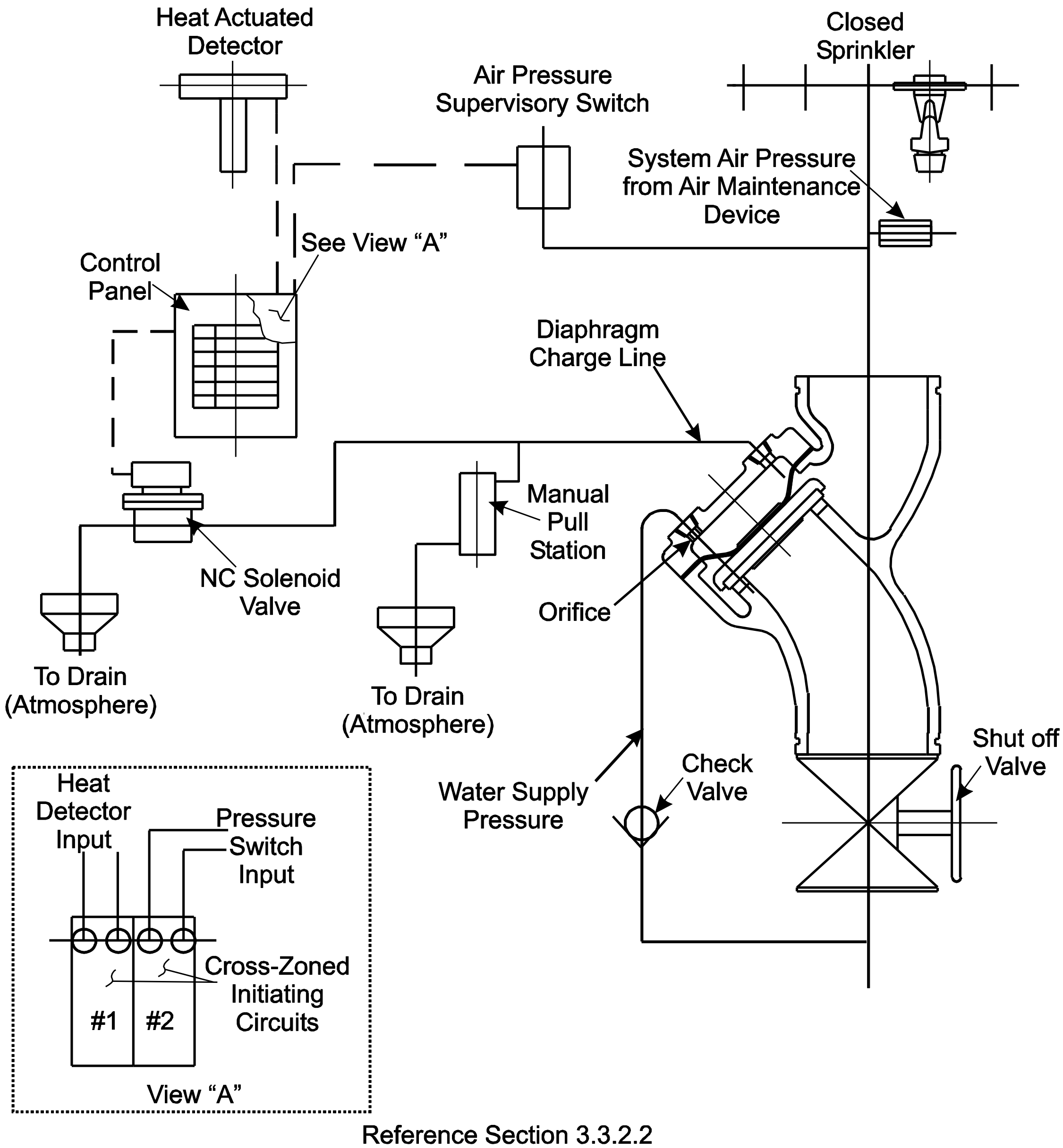
C-2. Deluge Releasing Systems with Diaphragm Type Valve



C-3. Preaction, Single-Interlock Releasing Systems

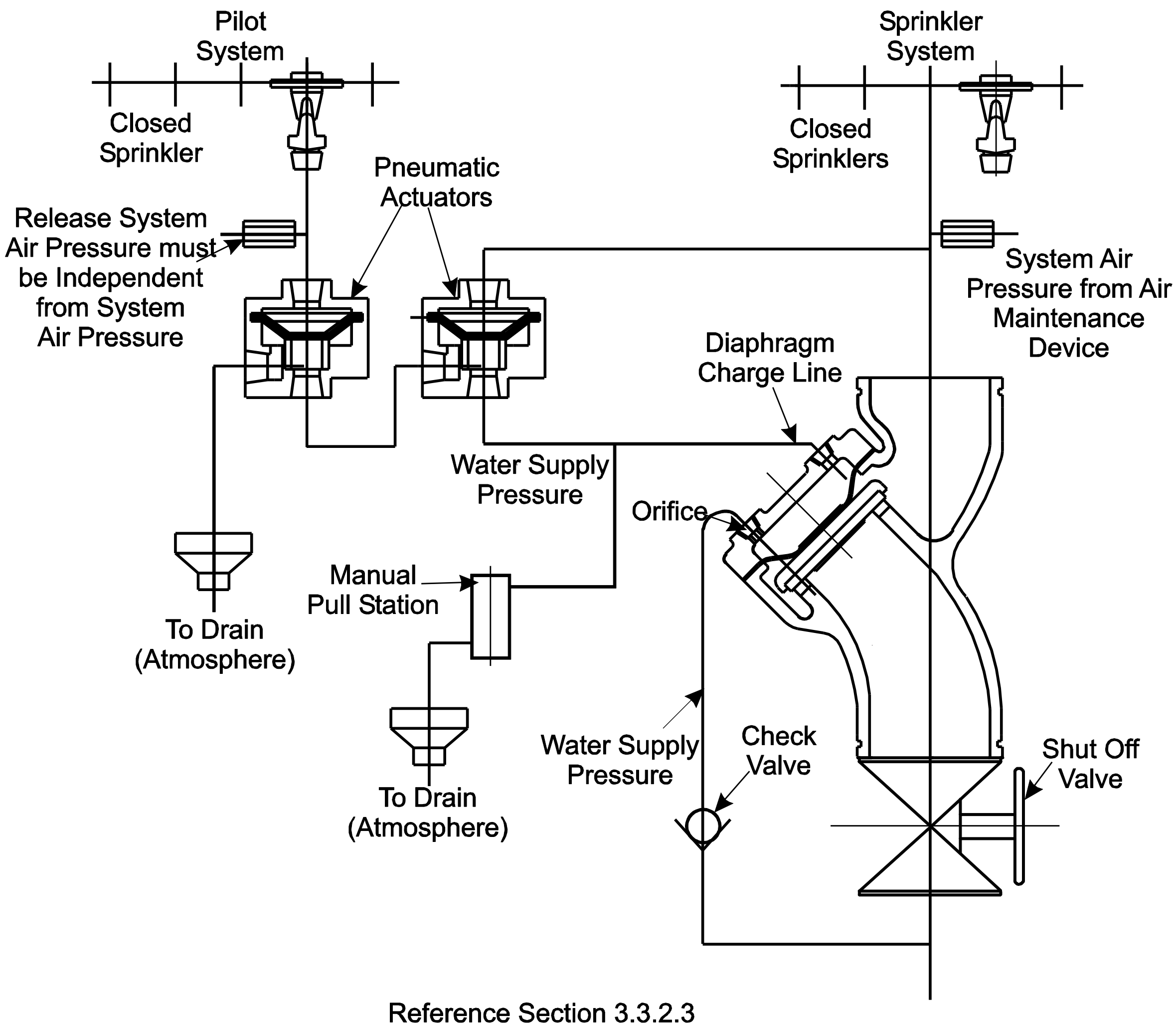


C-4. Preaction, Double-Interlock Releasing System, Pneumatic/Electric

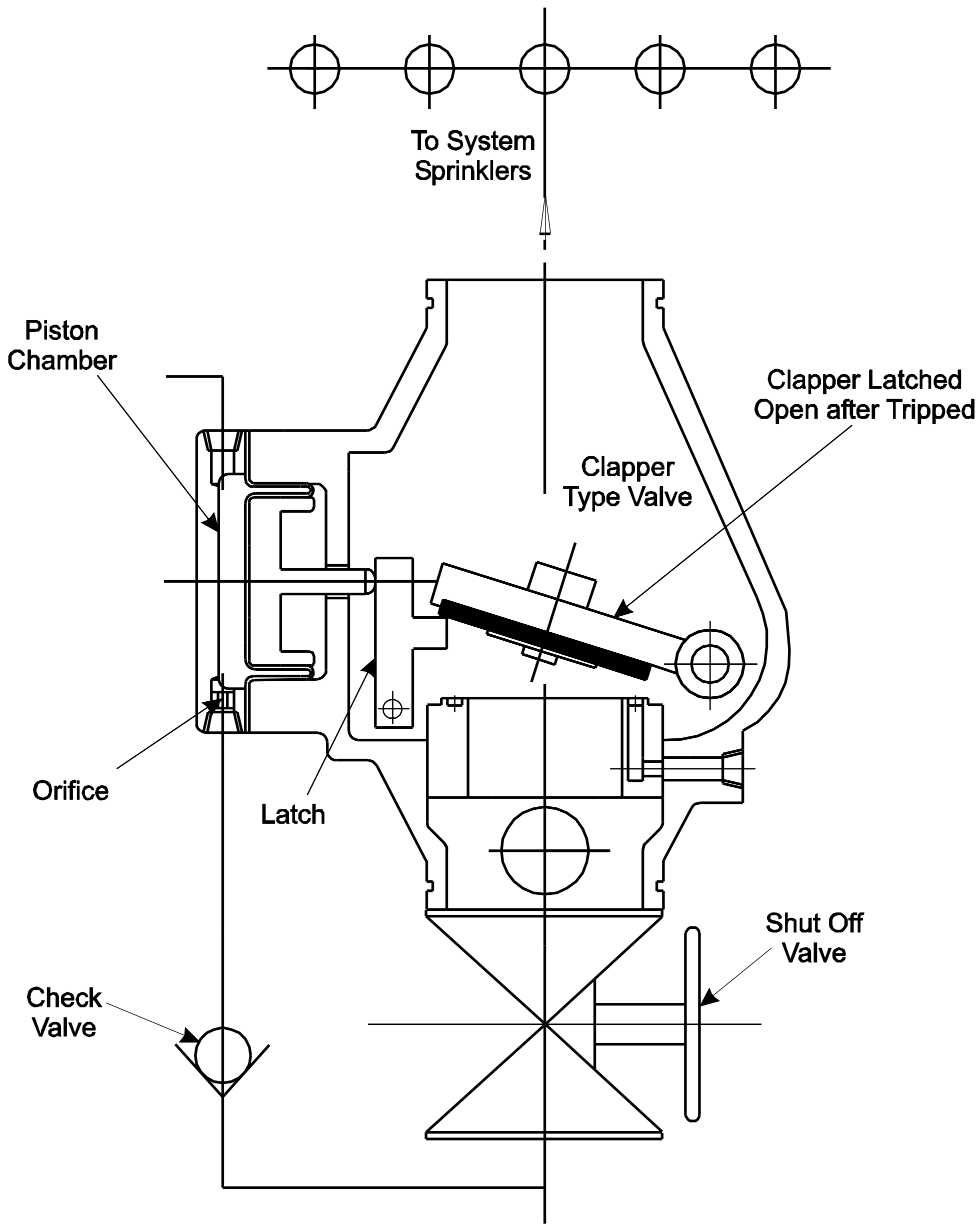


Reference Section 3.3.2.2

C-5. Preaction, Double-Interlock Releasing System, Electric/Pneumatic-Electric

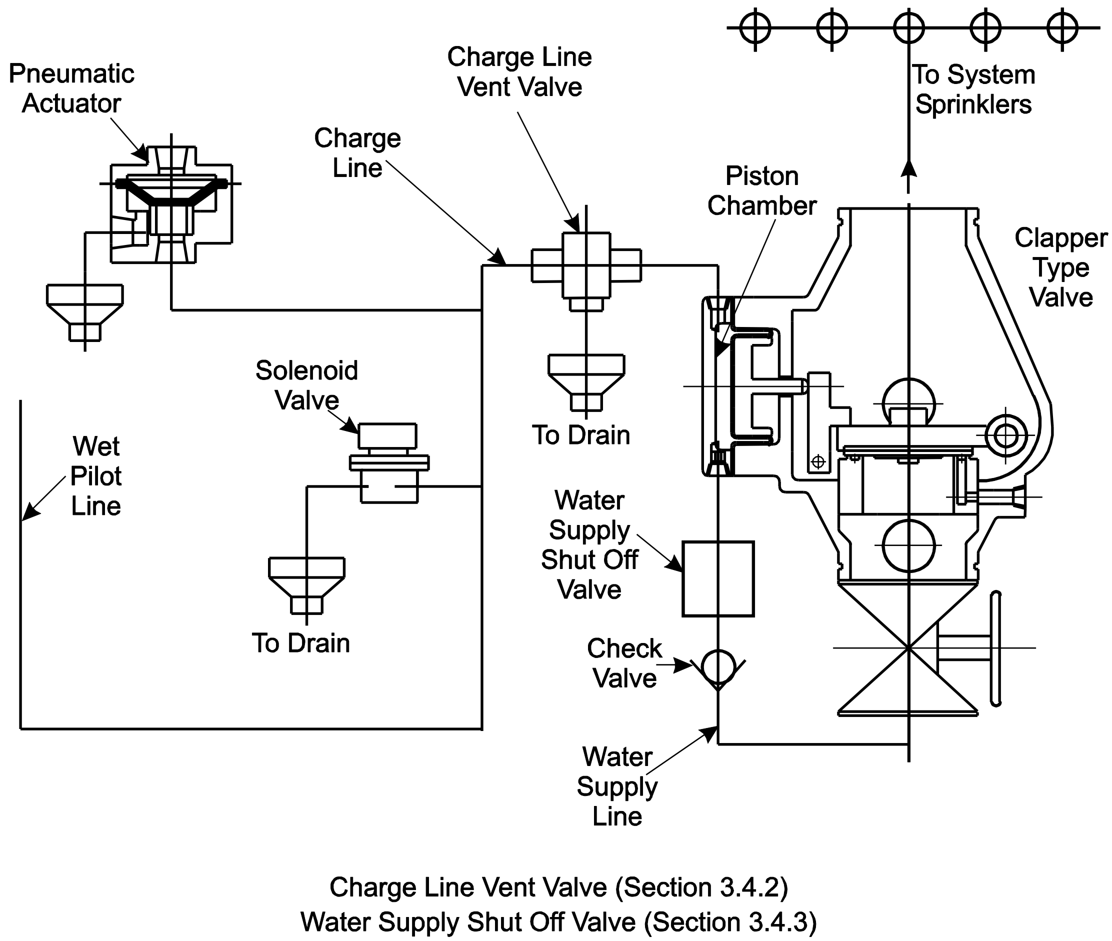


C-6. Preaction, Double-Interlock Releasing System, Pneumatic/Pneumatic

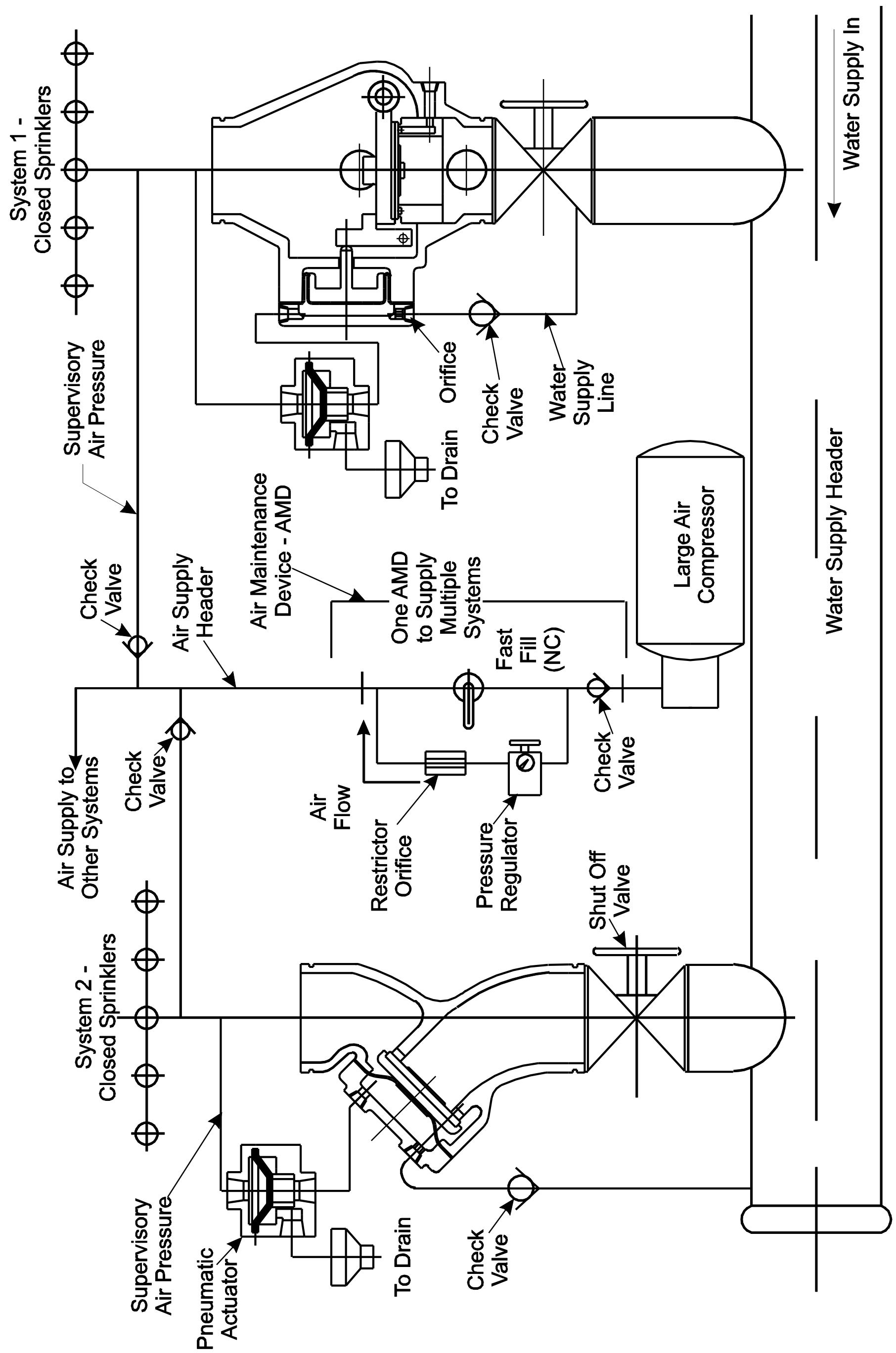


Mechanical Clapper Latch (Section 3.4.1)

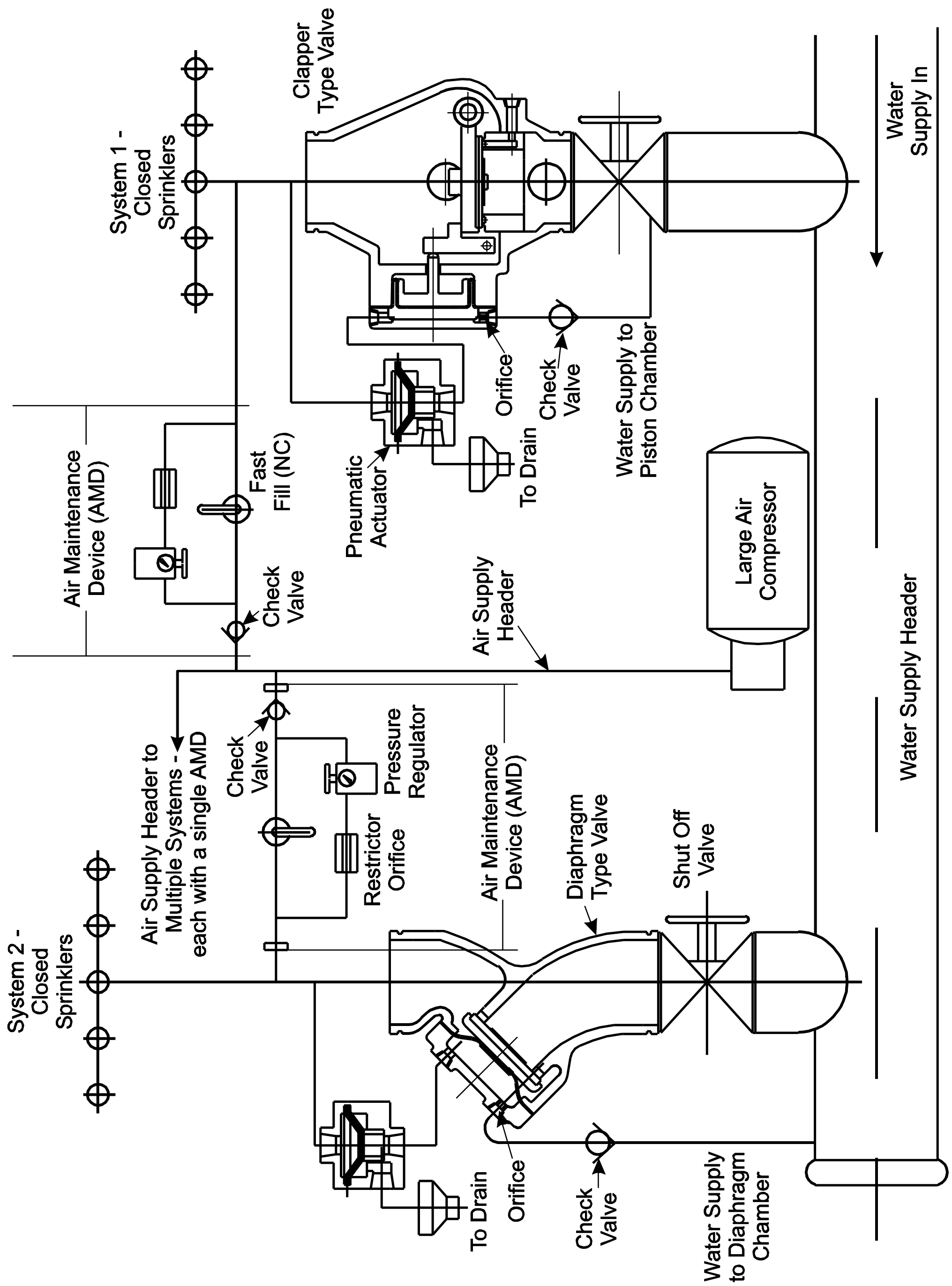
C-7. Deluge and Preaction Valve Anti-Resetting Devices - Mechanical Clapper Latch



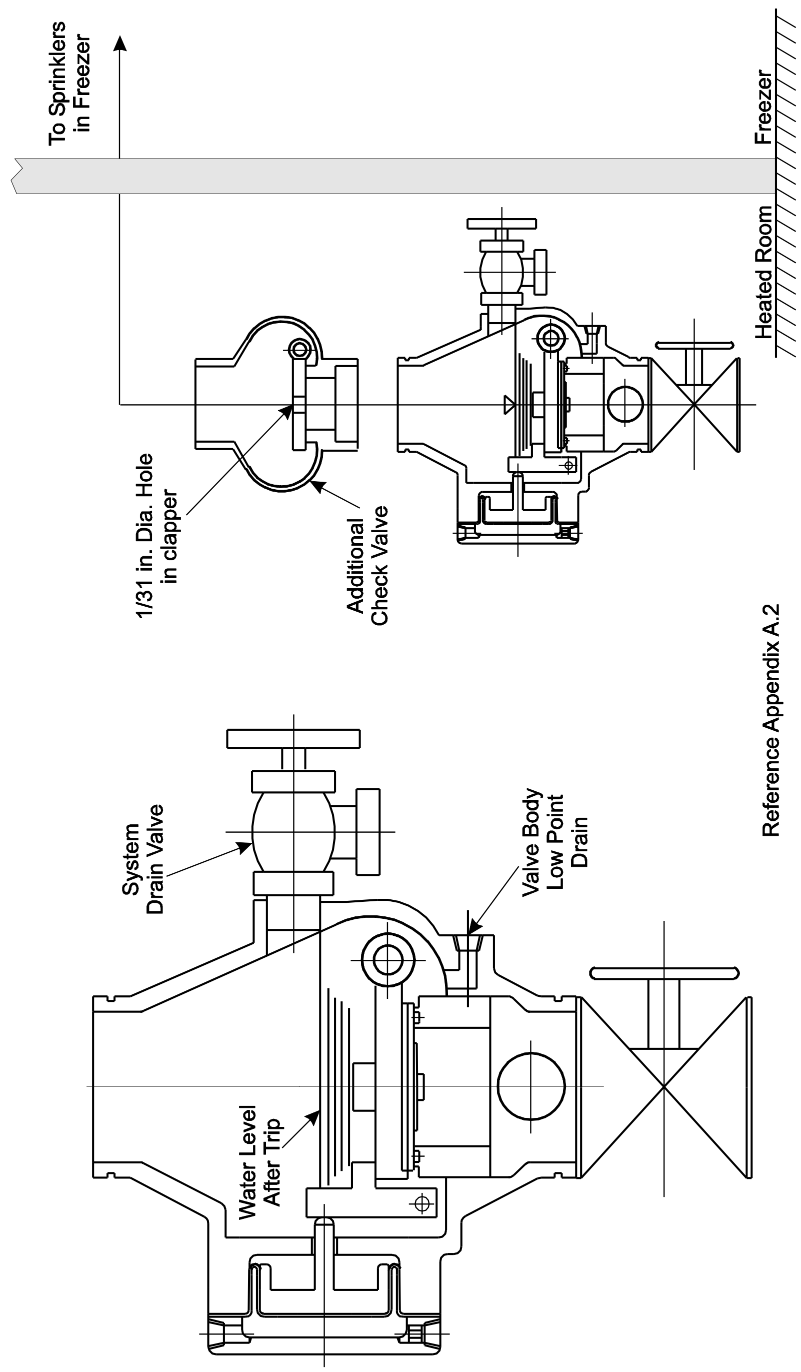
C-8. Deluge and Preaction Valve Anti-Resetting Devices - Charge Line Vent or Water Supply Shut off Valve



C-9. Deluge and Preaction Systems and Air Supply with one AMD
NOT AN ACCEPTABLE INSTALLATION (See Appendix A1.1)



C-10. Deluge and Preaction Systems and Air Supply with Multiple AMD's
ACCEPTABLE INSTALLATION (See Appendix A1.1)



C-11. Priming Water, Ice Plugs, and Corrosion (see Appendix A.2)

APPENDIX D: Fire Alarm Signaling Systems - Test Outline

FM Approvals Electrical Section Class 3010

The following test outline is largely based on NFPA 72 "The National Fire Alarm Code" 2007 Edition and other applicable examination standards. References to the appropriate NFPA standard and Section describing the specific requirement pertaining to a Fire Alarm Signaling System may be included.

This outline provides information regarding the typical tests that are required by the certification agency. The certification agency reserves the right to modify this outline as required to suit the specific tests needs of a given piece of equipment.

BASIC REQUIREMENTS

	Test Description
1	Enclosures
2	Normal Operation
3	Power Supply/Electrical Supervision
4	Circuit Supervision (IDC)
5	Smoke Detector Compatibility
6	Circuit Supervision (NAC)
7	Circuit Supervision (SLC)
8	SLC Device Compatibility
9	Voltage Variations
10	Environmental Conditioning
11	Battery Charge/Discharge
12	Vibration
13	Dielectric/Shock
14	Equipment Load Rating
15	Battery Circuit Reverse Polarization
16	Protective Grounding
17	Protection from Fire
18	RFI Immunity
19	Surge Line Transient Tests
20	Marking Requirements

SPECIAL SYSTEM FEATURES/APPLICATIONS (OPTIONAL)

	Test Description
21	Release Circuits: A) *Automatic Extinguishing Release Applications* B) *Pre-Action and Deluge Release Applications*
22	Cross Zoning
23	Confirmation/Verification
24	Presignal
25	Positive Alarm Sequence
26	Drift Compensation
27	Guards Tour
28	Emergency Voice/Alarm Communications Service
29	Sound Pressure Level Tests
30	Auxiliary Service
31	Central Supervising Station Systems
32	Remote Supervisory Station Systems
33	Proprietary Supervisory Station Systems

BASIC SYSTEM TEST REQUIREMENTS

1. ***Enclosures***

   Claimed NEMA (__) or IP (__) ratings will be verified in accordance with current issues of each standard (ref. NEMA 250-1991 or IEC 529 1989-11 as appropriate).

2. ***Normal Operation***

   A sample of each system or module must be provided. The sample is required to be pre-programmed and made operational to the NFPA 72 criteria specified in the installation manual. Demonstrations or simulations at maximum rated loads of power supplies, IDC, SLC and NAC will be required. Alarm, trouble and supervisory functions will be demonstrated & verified. *Note: Refer to project proposal letter for a complete list of equipment required for testing.*

3. ***Power Supply/Electrical Supervision***

   Proper operation and supervision of primary and secondary power sources shall be verified.

4. ***Circuit Supervision (IDC)***

   Proper supervision and operation of all IDC circuit(s) shall be verified in accordance with NFPA classifications (NFPA ref. Table 3-5)

5. ***Smoke Detector Compatibility***

   All two wire detectors shall be verified for operational compatibility with the control interfaces (NFPA ref. 1-5.3). Compatibility shall be limited to certified devices only. *Note: UL compatibility data forms may be used in lieu of FM testing.*

6. ***Circuit Supervision (NAC)***

   Proper supervision and operation of all NAC circuit(s) shall be verified in accordance with NFPA classifications (NFPA ref. table 3-7). Operational compatibility shall be limited to certified devices with compatible V and I ratings.

7. ***Circuit Supervision (SLC)***

   Proper supervision and operation of all SLC circuit(s) in accordance with NFPA classifications (NFPA ref. table 3-6) shall be verified. In addition, any supplemental circuit will be verified under fault conditions with normal panel operation required.

8. ***SLC Device Compatibility***

   All SLC devices (detectors input/output modules) shall be verified for operational compatibility with the control interfaces (NFPA ref. 1-5.3). All compatible devices must be certified.

9. ***Voltage Variations***

   Normal operation of the system at 85 to 110 percent of rated primary and secondary power supplies at minimum and maximum loads shall be verified (NFPA ref. 1-5.5).

10. ***Environmental Conditioning***

    Consists of 4 hours at 32°F and 120°F (0°C and 49°C) and 24 hours at 100°F (38°C) and 90 percent relative humidity while powered at nominal AC voltages with DC outputs circuits loaded to the maximum standby current. *Note: Original UL test data may be used in lieu of FM testing if equivalent temperature and humidity extremes used.*

11. ***Battery Charge/Discharge***

System charging capability shall be examined using the largest capacity battery specified and maximum standby and alarm loads. Discharge tests shall be performed for a 24 hour standby period (for local protective signaling), 60 hour standby period (for auxiliary and remote station), or 90 hour standby (for preaction/deluge), followed by a 5 minute alarm load for local protective, or 10 minute alarm load for EVAC. A 48 hour recharge period is allowed to return the batteries to a fully charged condition, as determined by comparing V & I readings with those obtained originally.

12. ***Vibration***

Consists of a 4 hour vibration test with a total displacement of 0.02 in. (0.5mm) and sweep frequency of 10-30-10 at 2-cycles/minute on system components. This test will be limited to a small enclosure (minimum system) and not a maximum system configuration.

13. ***Dielectric***

Performed at 1000 plus 2 times the rated voltage for one minute on circuits rated above 30 VAC or 60 VDC.

14. ***Equipment Load Rating***

While powered at nominal rated voltages (VAC), the measured loads (I AC) shall not exceed the maximum specified on the equipment name plate and/or installation instructions.

15. ***Battery Circuit Reverse Polarization***

The battery connections are reversed to demonstrate the ability of the equipment to fail in a safe mode. *Note: This test may be waived if polarized connectors or other mechanical means eliminate the possibility of a misconnection during installation & tests.*

16. ***Protective Grounding***

Positive ground terminal provisions shall be provided.

17. ***Transformer Failure***

The secondaries of line voltage connected transformers shall be short circuited to demonstrate the ability of the equipment to fail in a safe mode.

18. ***RFI Immunity***

Radio frequency interference tests at 155, 450, and 850 MHZ (5w) at distances as close as 2 ft. (0.6 m) shall be performed on the system.

19. ***Surge Line Transient Tests***

- Tests shall be performed tested at 100, 500, 1,000, 1,500 and 2,400 volts on each input and output circuit.
- The power supply shall able to withstand surge line transients of 6 kV superimposed on the main line input.
- Protection against internally induced transients shall be verified. The power to the control shall be cycled five hundred times while monitoring the releasing circuits for instability. The equipment shall not false alarm, and shall operate as intended, and retain its required stored memory. *Note: Original UL test data may be used in lieu of FM testing.*

20. ***Marking Requirements***

Control drawings must be provided that indicates the Name and Model information for the equipment, the operating specifics, and use and location of the certification mark.

SPECIAL SYSTEM FEATURES/APPLICATIONS

Proper demonstration of the following requirements may not be required. Refer to the manufacturer's documentation regarding specific capabilities.

21. ***Release Circuits***

    Proper supervision and operation of all release circuits shall be verified. Proper operation (actuation) verified as well as no false tripping/dumping for the period of 500 power on/off cycles.

    A. *Automatic Extinguishing Release Applications*
       Release circuit voltages shall remain between 20.4-26.4 under all load conditions.

    B. *Pre-Action and Deluge Release Applications*
       Each circuit must be compatibility tested with certified devices (reference: Automatic Water Control Valves, groups A-H). Wiring instructions that clearly detail the certification agency's requirements: i.e., Class A initiating circuits; 90 hr standby; solenoid connection, list compatible devices and specify maximum wiring losses in order to maintain 20.4V at the valve.

22. ***Cross Zoning***

    Proper operation of any cross-zone application shall be successfully demonstrated (includes counting zones, virtual zones and the like).

23. ***Confirmation/Verification***

    Proper operation of any detector confirmation application shall be successfully demonstrated.

24. ***Pre-signal***

    Proper operation of pre-signal capability shall be successfully demonstrated.

25. ***Positive Alarm Sequence***

    Proper operation of positive alarm sequence shall be successfully demonstrated.

26. ***Drift Compensation***

    Proper operation of detector drift compensation shall be successfully demonstrated.

27. ***Guards Tour***

    Proper operation of Guards Tour Supervisory Service shall be successfully demonstrated.

28. ***Emergency Voice/Alarm Communications Service (EVAC)***

    Proper operation of EVAC Service shall be successfully demonstrated.

29. ***Sound Pressure Level Tests***

    Proper operation of any amplifiers output capability shall be successfully demonstrated over the complete operating range with compatible certified speakers.

30. ***Auxiliary Service***

    Proper operation of a controls ability to properly supervise and trip a local energy master box (Gamewell p/n 21757-10) shall be successfully demonstrated.

31. ***Central Supervising Station Systems (FMRC 3011)***

Proper operation of a control's ability to properly supervise and communicate with transmitting/receiving equipment described in accordance with NFPA 72 shall be demonstrated. *Note: The compatibility of equipment if limited to the use of certified equipment only.*

32. ***Remote Supervisory Station Systems***

Proper operation of a controls ability to properly supervise and communicate with transmitting/receiving equipment described in accordance with NFPA 72 shall be demonstrated. *Note: The compatibility of equipment if further limited to the use of certified equipment only.*

33. ***Proprietary Supervisory Station Systems (FMRC 3012)***

Proper operation of a controls ability to properly supervise and communicate with transmitting/receiving equipment described in accordance with NFPA 72 shall be demonstrated.

APPENDIX E:

Appendix E is intentionally blank

APPENDIX F:

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APPENDIX G: Tolerance

Unless otherwise stated, the following tolerances shall apply:

Flow	± 2 percent of value
Force	± 3 lbs of valve
Frequency (Hz)	± 5 percent of value
Length	± 2 percent of value
Ohm	± 0.25 percent of value
Pressure	within + 5/- 0 psi of value
Temperature	± 5 percent of value
Time	+ 5/-0 seconds + 0.1/-0 minutes + 0.1/-0 hours + 0.25/-0 days
Volts	± 5 volts of value
Volume	± 5 percent of value

Unless stated otherwise, all tests shall be carried out at a room (ambient) temperature of 68°F ± 9°F (20°C ± 5°C).