Approval Standard for Fire Protection Monitor Assemblies

Class Number 1421

May 2018

Foreword

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

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

For examining equipment, materials and services, Approval Standards:

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

b) must be readily identifiable.

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

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

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1. INTRODUCTION

1.1 Purpose

1.1.1 This standard states Approval criteria for monitor assemblies that deliver and distribute water for fire protection purposes. These assemblies must operate reliably for many years at rated capacities and pressures during emergency fire incidents, despite being idle for extended periods.

1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

1.2.1 This standard sets performance requirements for the following product categories and associated class numbers:

Class Number	Product Category
1421	Monitor Assemblies

1.2.2 This standard is applicable to monitor assemblies designed to discharge and direct water spray and/or foam onto a fire. Monitors are most commonly operated by manual means but may also have the capability to operate remotely or automatically. In cases where metric sized monitor assemblies are to be examined for Approval, test criteria comparable to the United States equivalent size shall be used.

1.2.3 Master stream nozzles are typically used in conjuction with monitors as a discharge device. Performance requirements for master stream nozzles are established in FM Approval Standard Class 5511.

1.2.4 Requirements for the installation, use, inspection, service testing, and replacement for such monitor assemblies are detailed in the following National Fire Protection Association standards:

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*

NFPA 1965, *Standard for Fire Hose Appliances*

1.2.5 Approval standards are intended to verify that the product described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation.

1.3 Basis for Requirements

1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of monitor assemblies for the purpose of obtaining Approval. These requirements are intended primarily as guides, and strict conformity is not always mandatory. Monitor assemblies having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met.

Alternatively, monitor assemblies that meet all of the requirements identified in this standard may not be FM Approved if other conditions that adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

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

1.4.1 Examination and tests on production samples shall be performed to evaluate

- The suitability of the product;
- The performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
- The durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures shall be made to evaluate the manufacturer's ability to produce the product which was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals product follow-up program.

1.5 Basis for Continued Approval

1.5.1 Continued Approval is based upon:

- Production or availability of the product as currently FM Approved;
- The continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the Master Agreement;
- Satisfactory re-examination of production samples for continued conformity to requirements; and
- Satisfactory Surveillance Audits conducted as part of FM Approvals product follow-up program.

1.5.2 Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

1.6 Effective Date

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

The effective date of this standard is ***May 1, 2019*** for full compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American

Society for Testing Materials (ASTM) SI10-2010*, ''American National Standard for Metric Practice*. Two units of measurement (liter and bar), outside of, but recognized by SI, are commonly used in international fire protection and are used in this standard.

1.8 Normative References

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. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*
ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*
ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension*
ASTM D 573, *Standard Test Method for Rubber - Deterioration in an Air Oven*
FM Approvals' Approval Standard 1112, *Indicating Valves (Butterfly or Ball Type)*
FM Approvals' Approval Standard 3010, *Fire Alarm Signaling Systems*
FM Approvals' Approval Standard 3232, *Video Image Fire Detectors for Automatic Fire Alarm Signaling*
FM Approvals' American National Standard ANSI/FM 3260, *Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling*
FM Approvals' Approval Standard 3600, *Electrical Equipment for Use in Hazardous (Classified) Locations – General Requirements*
FM Approvals' Approval Standard 3611, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*
FM Approvals' Approval Standard 3615, *Explosionproof Electrical Equipment General Requirements*
FM Approvals' Approval Standard 3810, *Electrical and Electronic Test, Measuring and Process Control Equipment*
FM Approvals' Approval Standard 5130, *Foam Extinguishing Systems*
FM Global Property Loss Prevention Data Sheets
IEEE/ASTM SI 10, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*
National Fire Protection Association (NFPA) 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*
NFPA 1965, *Standard for Fire Hose Appliances*

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

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

Area of Coverage

The maximum area which can be protected by a foam discharge device, based upon the minimum effective application rate for the hazard, the maximum application rate which will not cause substantial differences in foam quality from that producing successful extinguishment in tests, and the maximum distance from the application device to the burning surface which will also not significantly effect foam quality.

Automatic Oscillating Monitors

Monitor assemblies affixed with an automatic oscillator, a mechanical or electrical device that automatically oscillates the monitor across the full range of horizontal rotation. See *Electrically Operated Monitors* and *Oscillating Flange* definitions for more information.

Automatic Water Control Valves

A valve used to automatically control (on/off) the flow through a monitor assembly. Automatic operation is achieved through loss of system or supervisory pressure, or signal from a detection device. For the purposes of this standard, examples of automatic water control valves include deluge or pre-action type valves.

Automatically Operated Self-Targeting Monitor Systems

Monitor assemblies designed to operate automatically without the need for any human intervention. Automatic systems typically consist of a flame detector, a monitor equipped with electric motors & a fire scanner, and a central control unit. When a fire event occurs within the protected space, the flame detector sends a signal to the control unit which then mobilizes the monitor assembly to locate the fire. The fire scanner is typically an image-based flame detector equipped with a pair of cameras (either visual or infrared). Once the fire scanner locates the flame, the monitor will be adjusted to its final position and water spray will be delivered upon activation of the control valve.

Cannon Scanning Time

In an automatically operated self-targeting monitor system, the cannon scanning time is defined as the time period from the triggering of the detection alarm to the moment when the water flow control valve is opened.

Class A Fires

Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

Class B Fires

Fires in ignitable liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

Corrosion Resistant

Having resistance to corrosion equal to or exceeding that of bronze alloy having a minimum copper content of 80 percent, or constructed of Series 300 Stainless Steel.

Electrically Operated Monitor Assembly

A monitor assembly equipped with electrical motors to operate the horizontal and vertical rotation of the assembly. This allows for stream positioning from remote locations or automatic operation. Manual stream positioning at the monitor device is not required. An additional electric motor is typically mounted on the nozzle to operate the spray pattern adjustment.

FM Approvals Certification Mark

The FM Approvals Certification Marks are mandatory on all units of FM Approved monitor assemblies. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

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

FM Global Standard Class II Commodity

A commodity product consisting of a 42 in. (1.1 m) cube, double tri-wall corrugated carton with a steel liner. The double carton has a combined nominal 1 in. (25.4 mm) thickness; the open-bottom liner measures 38 in. x 38 in. x 36 in. high (1m x 1m x 0.9m). Each pallet load consists of one double tri-wall carton placed upon a 42 in. x 42 in. x 5 in. (107 cm x 107 cm x 13 cm) two-way, slatted deck hardwood pallet. The vendor requirements for the carton are as follows:

1. "AAA" flute configuration;
2. PPP-B640d (as amended) Class II Government Grade;
3. 1100TW test;
4. RSC Style, triple wall;
5. Conforms with all the requirements of:
    a. Rail Classification Rule 41, Section 3;
    b. National Motor Freight Classification Rule 222;
    c. IATA & ATA shipment by air, both domestic and overseas;
6. Plain printed except certification; and,
7. Dimensions:
    a. One each, 40-7/8 in. x 40-7/8 in. x 40 in. high (1.04 m x 1.04 m x 1.02 m high); and,
    b. One each, 39-5/8 in. x 39-5/8 in. x 37-3/4 in. high (1.01 m x 1.01 m x 0.96 m high).

FM Global Standard Igniter

A standard igniter is the ignition source used for all FM Approvals full scale fire tests. A standard igniter consists of either 2 or 4 half-igniters, depending on the ignition location. **For the purposes of this standard, 2 half igniters are used in the Class A fire tests for automatic self-targeting monitor systems.** Each half-igniter consists of a 3 in. diameter by 3 in. long (76 mm x 76 mm) cylinder of rolled cellucotton, soaked with 4 fluid ounces (118 ml) of gasoline, then sealed in a polyethylene plastic bag. Igniters are prepared no more than 15 minutes prior to testing. They are positioned at the base of the bottom tier pallet loads, lit with a propane torch to signal the start of the test, and the fires are allowed to develop naturally.

FM Global Standard Plastic Commodity

A commodity product of cartoned Group A unexpanded plastic, consisting of rigid crystalline polystyrene jars (empty, 16 oz. size) packaged in compartmented, single wall, corrugated cartons measuring 21 in. x 21 in. x 20 in. (53 cm x 53 cm x 51 cm). Jars are arranged in five layers, 25 per layer for a total of 125. Each pallet load consists of eight cartons, arranged in a 2x2x2 array upon a 42 in. x 42 in. x 5 in. (107 cm x 107 cm x 13 cm) two-way, slatted deck hardwood pallet.

Master Stream Nozzle

A nozzle designed to be directly attached to the outlet of a monitor assembly.

Maximum Operating Pressure

See *Rated Working Pressure*.

Monitor

A water discharge device upon which a fire fighting nozzle may be mounted, that has a base which may be secured to absorb reaction forces, and which is adjustable to direct discharge through a range of vertical and horizontal angles. FM Approved monitors are specially designed with large clear waterways to give a powerful, far-reaching stream for the protection of pulpwood piles, lumber yards, or other locations where a large amount of water must be instantly available without the delay of laying hose lines.

Oscillating Flange

A mechanical device installed between the monitor and the flange connection which automatically oscillates the monitor assembly throughout the full range of horizontal rotation. Oscillating flanges are typically powered by the flow of extinguishing system water through the pipework and require no external power sources (self-oscillating flanges).

Rated Working Pressure

The maximum pressure at which a monitor assembly is designed to operate.

Shutoff Valve

A valve, typically manually operated, that is mounted directly underneath a monitor assembly used to control the flow of water (on/off) to the monitor assembly. Examples of types of shutoff valves include Outside Stem & Yoke (OS&Y) gate valves, Non Rising Stem (NRS) gate valves, ball, or butterfly valves.

Underwriters Playpipe

A large bore, straight stream fire hose nozzle. Before the introduction of spray nozzles, playpipes were the only nozzles used with 2-1/2 in. (65 mm) fire hose for industrial fire fighting. Playpipes are now primarily used as water measuring devices during water testing. One type has a 30 in. (760 mm) barrel and is known as the standard Underwriters playpipe with a 1-3/4 in. (45 mm) nozzle tip and an alternate attachable 1-1/8 in. (30 mm) nozzle tip. The other type has a 15 in. (380 mm) barrel and is known as the short playpipe. The detachable tip for the barrel has a 1-1/8 in. (30 mm) orifice. Swivel handles provide a good handgrip for two persons. The short playpipe, when used for fire fighting, usually has a detachable 1 in. (25 mm) shutoff tip.

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 Monitor assemblies covered by this standard include those designed for 100 gal/min through 5000 gal/min (380 L/min through 18 925 L/min) or larger capacities. Monitor assemblies designed for rated capacities greater than 5000 gal/min (18 925 L/min) shall be evaluated on a case-by-case basis.

2.1.2 In order to meet the intent of this standard, monitor assemblies 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 in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample monitor assemblies, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to information@fmapprovals.com.

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

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration;
- General assembly drawings, one complete set of manufacturing drawings, materials list(s) and material specifications (such as ASTM A48 CL 40 - Cast Iron), anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures; and,
- The number and location of manufacturing facilities.

All documents 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.

2.3 Requirements for Samples for Examination

Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements are to be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer’s responsibility to submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals. The manufacturer shall provide all equipment to perform the tests.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.

3.2 Physical or Structural Features

3.2.1 General Design Requirements

3.2.1.1 Monitor assemblies shall be designed for a maximum rated operating pressure of at least 200 psi (13.8). Monitor assemblies with higher rated operating pressures will be evaluated on a case-by-case basis.

3.2.1.2 Typical inlet and outlet end connections shall be male threaded, female threaded, flanged, grooved, or fire hose thread or Storz type end connections, and shall conform to a nationally or internationally recognized standard as listed in Paragraph 1.8, or equivalent. Other types of end connections shall be evaluated on a case-by-case basis. End connections with threaded end connections shall be provided with a section to serve as a wrench grip. If a special wrench is required, it shall be supplied with the monitor.

3.2.1.3 Monitor assemblies shall be free of sharp edges, burrs, or other imperfections which might injure the installer or interfere with proper assembly of the unit, or with full water flow.

3.2.1.4 Monitor assemblies shall be equipped with a means for rotational movement in the horizontal and vertical planes to allow for stream positioning. Monitors shall be capable of traveling throughout their rated range of motion freely and without any binding. The rated range of motion shall be published in the manufacturer's literature. This also applies to oscillating flanges and their range of horizontal rotation.

3.2.1.5 For monitors equipped with shutoff valves, valves shall be clearly marked to indicate valve position. Operating a shutoff valve shall require a force of no more than 80 lb_f (360 N) to open or close when subjected to their rated pressure and flow. Reference FM1112, Section 4.6.2.1. Additional testing included in other FM Approval Standarrds appropriate for the type of valve may be deemed necessary.

3.2.2 Monitors and Monitor Assemblies

3.2.2.1 FM Approval of a monitor is applicable only when used as an assembly complete with a FM Approved master stream nozzle. The monitor assembly unit (monitor and nozzle) is considered the discharge device of an extinguishing system.

3.2.2.2 Wherever it is not explicitly stated that a master stream nozzle is included, the term "monitor assembly", as it is used in this Standard, only applies to the monitor device itself; not the nozzle.

3.2.3 Applications for Automatic Self-Targeting Monitor Systems

3.2.3.1 FM Approval of automatic self-targeting monitor systems shall be limited to non-storage, high clearance height applications (i.e. plastic seats in indoor stadiums, trash piles in tipping halls, etc). The spray path from the monitor to all possible ignition sources shall

be free and clear of any obstacles.

3.2.3.2 Where applicable, automatic self-targeting monitor systems may be considered as a supplemental protection measure only. The system shall not be considered as a replacement of any primary protection system (i.e. sprinkler system).

3.3 Materials

All materials used in these monitor assemblies shall be suitable for the intended application. At a minimum, all parts exposed to water shall be constructed of corrosion resistant materials. When unusual materials are used, special tests may be necessary to verify their suitability.

3.4 Markings

3.4.1 Each monitor assembly shall be permanently marked on its external surface with the following information:

- Manufacturer's name or trademark;
- Nominal size;
- Rated working pressure;
- Model designation; and
- FM Approvals Certification Mark.

3.4.2 Monitor assemblies that are produced at more than one location shall be identified as the product of a particular location.

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

3.4.4 The FM Approvals Certification Mark shall be displayed visibly and permanently on the product. The manufacturer shall not use this Mark on any other product unless such product is covered by separate report or agreement with FM Approvals.

3.4.5 All markings shall be legible and durable.

3.5 Manufacturer's Installation, Operation, and Maintenance Instructions

Installation, operation, and maintenance instructions, including any special dimension requirements, shall be furnished by the manufacturer. Instructions shall be provided with each monitor assembly.

3.6 Calibration

All equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage of the equipment. A copy of the calibration certificate for each piece of test equipment is required for FM Approvals records, indicating that the calibration was performed against working standards whose calibration is certified as traceable to the National Institute of Standards and Technology (NIST) or to other acceptable reference standards and certified by a 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 accreditation certificate as an ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories", calibration laboratory is required for FM Approvals records.

The calibration of recently purchased new equipment is also required. Documentation indicating either the date of purchase or date of shipment, equipment description, model and serial number is required for identification. The period from the time the equipment was put into service to the date of testing must be within an interval that does not require the equipment to be calibrated as determined on the basis of the parameters mentioned above.

3.7 Tolerances

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

4. PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirements

The monitor assembly shall conform to all the manufacturer's specifications and to FM Approvals requirements.

4.1.2 Test/Verification

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

4.2 Hydrostatic Proof-Pressure

4.2.1 Requirement

Monitor assemblies shall not leak at twice the rated pressure and shall not rupture, crack, or exhibit permanent distortion at four times the rated pressure.

4.2.2 Test/Verification

The monitor assembly shall be hydrostatically pressurized to 400 psi (27.6 bar), or twice its rated pressure, whichever is greater, and held at that pressure for a period of one minute. No visible leakage shall occur.

The monitor assembly shall be hydrostatically pressurized to 800 psi (55.2 bar), or four times its rated pressure, whichever is higher, and held at that pressure for a period of five minutes. No ruptures, noticeable distortions, or other failure that would impair function shall occur.

4.3 Operation and Freedom of Movement

4.3.1 Requirement

The monitor assembly shall operate freely, with no binding, in both the horizontal and vertical planes while hydrostatically pressurized to 200 psi (13.8 bar), or the manufacturer's maximum specified rated pressure, whichever is greater. The monitor assembly shall operate freely with no binding, in both the horizontal and vertical planes while under flowing conditions of 100 psi (6.9 bar) inlet pressure. The mechanism shall maintain the monitor in its set position.

4.3.2 Test/Verification

The assembly's nozzle connection shall be suitably plugged. The monitor assembly shall then be hydrostatically pressurized to 200 psi (13.8 bar), or the manufacturer's specified maximum pressure, whichever is greater. While at this pressure, the monitor assembly shall be operated over both its full range of horizontal and vertical movements.

The monitor assembly shall then be operated, over both its full range of horizontal and vertical movement while under flowing conditions of 100 psi (6.9 bar) pressure at the inlet.

Full range of movement with no binding shall be available under both test conditions.

4.4 Pressure Versus Flow Rate

4.4.1 Requirements

The pressure differential between the inlet and the outlet of the monitor shall be measured and recorded at various flow rates. The manufacturer's published values shall be within +/- 1 psi (.07 bar) of the measured values.

4.4.2 Tests/Verification

The pressure differential between the inlet and the outlet of the monitor shall be measured for flow rates from 100 to 5000 gal/min (380 to 18,925 L/min)) or as appropriate for the minimum and maximum flow capacity range of the monitor assembly. Appropriately sized nozzles (or Underwriters playpipe), as required to achieve the specified range of flows, shall be attached to the monitor. The nozzles may be changed to achieve the specified flow rates, as needed. Monitor inlet and outlet pressures and flow rates, as well as nozzle selections for each flow rate shall be recorded and compared to manufacturer's published values.

4.5 Weatherability

4.5.1 Requirements

The monitor assembly shall operate freely, with no binding, in both the horizontal and vertical planes and shall show no significant deformation, blistering, or fracture, following exposure to a simulated rain and freezing conditions with a low temperature of -40ºF (-40ºC) for a period of 24 hours. After completion of the weatherability exposure test, if deemed necessary after visual inspection, deterioration of the performance characteristics shall be evaluated, including the use of any or all of the tests detailed in Section 4.2 (Hydrostatic Proof-Pressure), Section 4.3 (Operation and Freedom of Movement), and Section 4.4 (Pressure Verses Flow Rate). Failure to exhibit normal operation as a result of freezing shall be deemed a failure.

4.5.2 Tests/Verification

A monitor assembly shall be subjected to a water spray at an approximate rate of 0.6 in./min (15 mm/min), or full immersion bath, for an elapsed time of 5 minutes to observe the collection of water, if any, within the assembly. This is to simulate exposure to a heavy rainstorm. The inlet and nozzle connections shall be suitably plugged to prevent water from entering the flow path of the assembly. The monitor assembly shall then be conditioned in a freezer set at -40ºF (-40ºC) for a minimum period of 24 hours. Upon removal from the conditioning chamber, the unpressurized monitor assembly shall be allowed to return to room temperature and then shall be tested for proper function of the adjustments and controls. The monitor assembly shall then be visually examined and, if deemed necessary, the monitor assembly shall be subjected to the post-tests as detailed in Section 4.5.1.

4.6 High Temperature Exposure

4.6.1 Requirements

A dry monitor assembly shall operate freely, with no binding, in both the horizontal and vertical planes and shall show no significant deformation, blistering, or fracture following exposure to a high temperature of 135ºF (57ºC) for a period of 24 hours. After completion of the high temperature exposure test, if deemed necessary after visual inspection, deterioration of the performance characteristics shall be evaluated, including the use of any or all of the tests detailed in Section 4.2 (Hydrostatic Proof-Pressure), Section 4.3 (Operation and Freedom of Movement), and Section 4.4

(Pressure Verses Flow Rate).

4.6.2 Tests/Verification

The monitor assembly shall be conditioned in an oven or furnace set at 135ºF (57ºC) for a period of 24 hours. Immediately upon removal from the conditioning chamber, the unpressurized monitor assembly shall be tested for proper function of the adjustments and controls. Then the monitor assembly shall be visually examined and, if deemed necessary, the monitor assembly shall be subjected to the post-tests as detailed in Section 4.6.1.

4.7 Durability

4.7.1 Requirements

A dry monitor assembly shall operate freely, with no binding, in both the horizontal and vertical planes and shall show no significant damage after 500 cycles of operation throughout its full range of motion. After completion of the 500 cycles of operation, if deemed necessary after visual inspection, deterioration of the performance characteristics shall be evaluated, including the use of any or all of the tests detailed in Section 4.2 (Hydrostatic Proof-Pressure), Section 4.3 (Operation and Freedom of Movement), and Section 4.4 (Pressure Verses Flow Rate).

4.7.2 Tests/Verification

The monitor assembly shall be mounted in its normal operating position and cycled through its full range of motion in both the vertical and horizontal planes while unpressurized. A cycle is considered to be movement across the full range of motion in one direction, then back. Cycling shall be at the normal operating speed of the adjustments and operated either manually or powered. If the monitor is designed to be operated using an electric motor, the motor must be used to perform this test. The cycling shall be conducted in an environment maintained at 68, +/- 18ºF (20, +/-10ºC). Upon conclusion of 500 cycles in both the horizontal and vertical planes, the unpressurized monitor assembly shall be tested for proper function of the adjustments and controls. The monitor assembly shall then be visually examined and, if deemed necessary, the monitor assembly shall be subjected to the post-tests as detailed in Section 4.7.1.

4.8 Corrosion - Salt Spray

4.8.1 Requirements

In order to evaluate the resistance to corrosion of the assembly, such as might be experienced by dissimilar materials in contact over long periods of time; the monitor assembly shall withstand a timed exposure to a salt spray atmosphere.

When tested as detailed in Section 4.8.2, visual evidence of severe deterioration or impending failure of any component shall constitute failure. Following exposure, the sample shall operate freely, with no binding, in both the horizontal and vertical planes and shall be subjected to the Hydrostatic Proof-Pressure evaluation of Section 4.2, with no failure.

4.8.2 Tests/Verification

The monitor assembly, with provision for sealing the inlet and outlet connections, shall be exposed to salt spray (fog) as specified by the latest version of the Standard for Salt Spray (Fog) Testing, ASTM B117. The salt solution shall consist of 20 percent by weight of common salt (sodium chloride) dissolved in demineralized water.

The samples shall be exposed to a salt spray (fog) for a continuous period of 10 days. Each monitor assembly shall be mounted in its intended installation position.

Following the exposure to the salt fog, the samples shall be removed from the test chamber and permitted to air dry for a two to four day drying period. Following this test, the sample shall be operated across it's full range of motion in the horizontal and vertical planes. The sample shall also be subjected to the tests detailed in Section 4.2, Hydrostatic Proof-Pressure.

4.9 Elastomeric Parts - Tensile Strength, Ultimate Elongation, Air-Oven Aging

4.9.1 Requirements

Elastomeric parts used in construction, such as gaskets or o-rings, shall have a tensile strength of not less than 500 psi (34.5 bar) and an ultimate elongation of not less than 100 percent.

The tensile strength and ultimate elongation values of specimens subjected to the air-oven aging test shall not be less than 80 percent of the tensile strength and 50 percent of the ultimate elongation of the unconditioned specimens.

4.9.2 Tests/Verification

For standard elastomers, the material manufacturer's certificates of compliance verifying the conformance to the performance requirements listed in Section 4.9.1 shall be considered acceptable. The test certificates shall demonstrate that the tests were conducted by an ISO 9000 certified facility, and that the test equipment was calibrated by an ISO 17025 (*General Requirements for the Competence of Testing and Calibration Laboratories*) certified agency. Where such certifications are not available, tests of the elastomer shall be conducted.

Tensile strength and elongation shall be determined in accordance with the test methods specified in ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.* Material sheets shall be obtained for each type of elastomer used in the coupling gaskets. Three dumbbell specimens shall be cut with a Type A or C die transversely from the sample. Samples shall be buffed prior to cutting with the die. If the nature or thickness of the material is such that buffing cannot be accomplished without damaging the lining, unbuffed specimens may be used for the tensile strength and elongation tests.

Three measurements for thickness shall be made in the constricted portion of each specimen. The minimum value obtained shall be used as the thickness of the specimen in calculating the tensile strength. Two benchmarks 1 in. (25 mm) apart shall be stamped centrally on the constricted portion of each specimen. A tensile test machine shall be used to pull the dumbbell specimens to the point of rupture. The average tensile strength and elongation of the three specimens shall be considered the tensile strength and ultimate elongation of the rubber lining or cover. If a dumbbell test specimen breaks outside the benchmarks, or if the result of either tensile strength or elongation based on the average of three specimens is not acceptable, another set of three specimens shall be tested, and the results from this set shall be considered final. Results of tests of specimens that break in the curved portion just outside the benchmarks may be accepted if within the minimum requirements.

Three additional dumbbell specimens shall be prepared as described above. The specimens shall be conditioned in an oven for 96 hours at 158°F±3.6°F (70°C±2°C) following the procedures described in ASTM D 573, *Standard Test Method for Rubber - Deterioration in an Air Oven*. The specimens shall then be tested for tensile strength and ultimate elongation as described above, and the values shall be compared to those obtained on the unconditioned specimens.

4.10 Foam Monitors

Monitors to be FM Approved for use with fire-fighting foam shall meet all requirements of this standard and shall also be evaluated per the applicable sections of FM Approval Standard Class 5130, *Foam Extinguishing Systems*. FM Approvals offers Approval of foam systems only – not components. Components are considered Approved only when they are used in a system that they have been specifically evaluated/tested with. At minimum, a foam system must include a concentrate, a proportioner, and a discharge device. A monitor assembly complete with a specified master stream nozzle is considered the discharge device. As such, the monitor assembly manufacturer shall determine a suitable concentrate and proportioner to be evaluated/tested for use with their device. If the concentrate is not FM Approved, topside fire performance testing will be required per FM 5130, Section 4.1. Per FM 5130, Section 4.3, the monitor assembly must demonstrate the capability to generate foam of sufficiently similar quality as compared to that which was fire tested, throughout its operating range.

4.11 Automatic Oscillating and Electrically Operated Monitors

4.11.1 Oscillating Flanges

Automatic oscillation of a monitor assembly may be achieved through the use of an oscillating flange, provided as a bolt on addition or an integrated part of the assembly. Oscillating flanges are specialty type flanges installed between the monitor and the flange connection designed to automatically oscillate the monitor assembly throughout the full range of horizontal rotation. Oscillating flanges are typically powered by the flow of extinguishing system water through the pipework and require no external power sources (known as self-oscillating flanges).

4.11.1.1 Oscillating flanges may also be Approved to FM1421 for use only with FM Approved monitor assemblies. The applicable portions of the tests outlined in this Standard will apply to the oscillating flange component.

4.11.2 Electrically Operated Monitors

Monitor assemblies may be designed to operate remotely or automatically through the use of electric motors. The motors are coupled to the shafts which drive the horizontal and vertical movement of the assembly. This effectively allows for spray positioning without manual intervention at the assembly. There is typically another electric motor that is mounted to the nozzle which controls the spray pattern adjustment.

4.11.2.1 For monitor assemblies offered with an option for electrical operation, the Weatherability (Section 4.5), High Temperature Exposure (Section 4.6), and Durabililty (Section 4.7) tests detailed above shall be conducted on a monitor assembly equipped with the approporiate electrical motors and auxillary components. The monitor shall operate freely as intended. All other tests detailed above may be completed with a manually operated monitor option, if available. Electrical components normally installed indoors in a conditioned space (i.e. control panel) do not apply to the conditioning tests outlined in Section 4.6 and 4.7.

4.11.2.2 The electric motors and their related components (i.e. junction box, wiring, control panel) will be subject to an additional electrical examination. All electrical components will be subject to the appropriate requirements in the following Standards:

*FM Approvals, *Approval Standard for Electrical Equipment for Use in Hazardous (Classified) Locations – General Requirements*, Class 3600.

*FM Approvals, *Approval Standard for Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, Class 3611.

*FM Approvals, *Approval Standard for Explosionproof Electrical Equipment General Requirements*, Class 3615.

FM Approvals, *Approval Standard for Electrical and Electronic Test, Measuring and Process Control Equipment*, Class 3810.

ANSI/NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

*If HAZLOC or explosion proof rating is desired.

4.12 Automatically Operated Self-Targeting Monitor Systems

Monitor assemblies may be designed to operate automatically without the need for any human intervention. Automatic systems typically consist of a flame detector, a monitor equipped with electric motors & a fire scanner, and a central control unit. There may also be cases where a system is designed with multiple detectors or fire scanners. When a fire event occurs within the protected space, the flame detector sends a signal to the control unit which then mobilizes the monitor assembly to locate the fire. The fire scanner is typically an image-based flame detector equipped with a pair of cameras (either visual or infrared). Once the fire scanner locates the flame, the monitor will be adjusted to its final position and water spray (or foam) will be delievered upon activation of the automatic water control valve.

Automatic monitor systems shall be tested and Approved as a system. The monitor, discharge nozzle, electric motors, flame detector, fire scanners, control valves, and all other auxillary components (including the software program) must be specified and tested together as a system.

Such systems are applicable to special test considerations/requirements as detailed in this section. Certain design elements of a system may not be addressed in this protocol and additional testing may be required at the discretion of FM Approvals.

Each system shall be configured for continuous operation with provisions for manual shutdown only. Sections 4.12.2 and 4.12.3 shall be performed indoors in a stable environment with little or no air flow.

4.12.1 Pre-Test Requirements – Aging, Cycling, and Temperature Extreme Tests

4.12.1.1 Requirements

An automatic monitor system shall undergo aging, cycle, and temperature extreme testing prior to the performance testing detailed in Sections 4.12.2, 4.12.3, and 4.12.4. An automatic monitor system that is subjected to the aging, cycling, and temperature extreme tests shall be the same samples as that used for the performance testing.

4.12.1.2 Tests/Verification

The automatic monitor assembly and all system components that would normally be exposed to the protected space shall be conditioned at 158°F (70°C) for a period of 90 days. The control panel, fire scanner, and flame detector (i.e. components with no moving parts) may be exempt from this requirement.

Following the conditioning period, the monitor assembly shall be cycle tested as described in Section 4.7. It shall then be tested for operability at the temperature

extremes, as described in Sections 4.5 and 4.6. Section 4.11.2 shall also be referenced for requirements related to electrically operated monitors.

Subsequently, the monitor shall continue to operate freely and shall undergo the performance testing detailed in the Sections 4.12.2, 4.12.3, and 4.12.4. It is recommended that multiple samples are tested so that a backup is available if needed.

4.12.2 Targeting System Functionality and Accuracy

4.12.2.1 Requirements

An automatic monitor system shall have the capability to detect, locate, and accurately deliver water spray to the intended target location.

In each test scenario, the cannon scanning time shall be less than 1 minute. The cannon scanning time is defined as the time period from the triggering of the detection alarm to the moment when the water flow control valve is opened. In addition, the distance from the calculated center of spray to the target location shall be no greater than one-half of the spray area radius.

4.12.2.2 Tests/Verification

The test setup shall consist of 10.8 ft^2 (1m^2), 12 in. (.3 m) high steel pans arranged in a 10 x 10 array with a 12" (.3 m) gap along the horizontal and vertical center axis. Each pan shall be secured in place to prevent any movement. A heptane pan fire shall be used as the intended ignition target and placed at the center of the array. Refer to Figure 4.12.2.2 below.

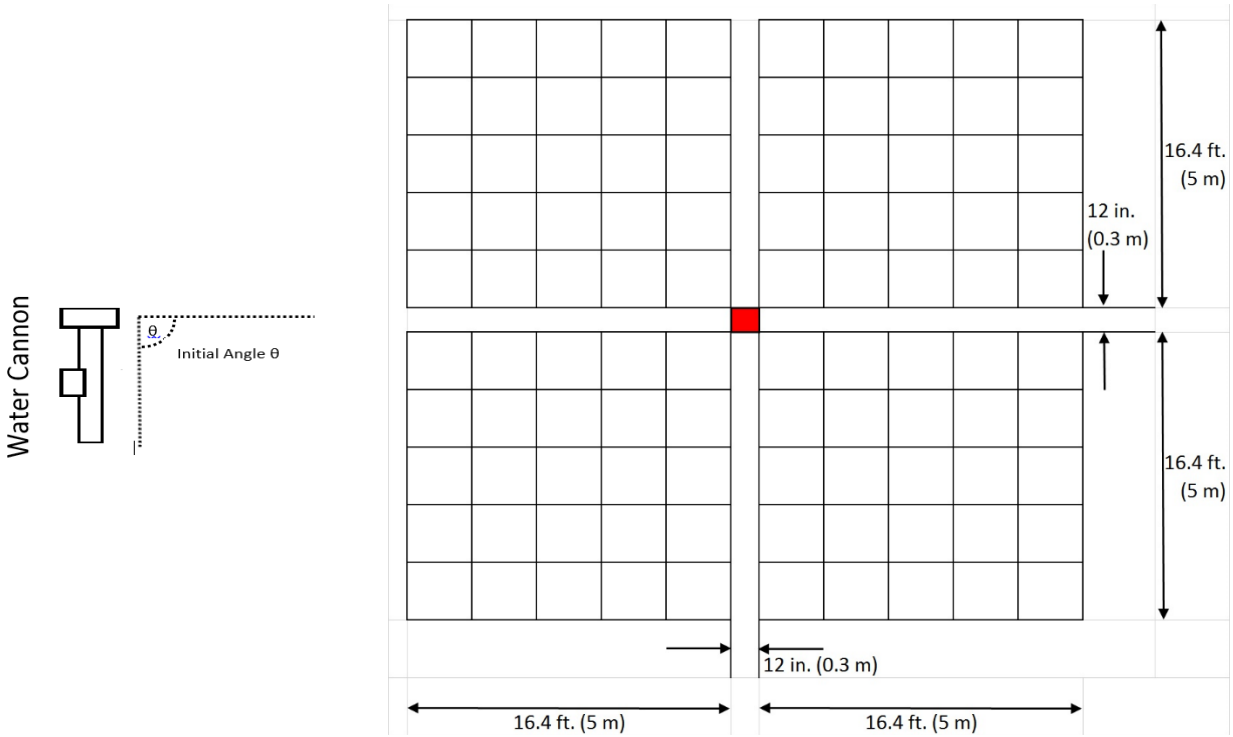

Figure 4.12.2.2 – Targeting System Functionality and Accuracy Test Arrangement

The heptane pan shall be of steel construction and 12" in. (.3 m) high with no lip. It shall be 12 in. (0.3 m) wide and 12 in. (0.3 m) long. A water base of 2.1 in. (5 cm) in height shall be added to the pan. The pan shall then be filled with approximately 7.9 in. (20 cm) of commercial grade heptane fuel. Freeboard should be approximately 2.1 in. (3 cm).

The automatic monitor unit shall be installed along the center axis of the array. The distance from the monitor unit to the center of the fuel array shall be the manufacturer's maximum specified range. The flame detector may be installed at a separate location where the target is within its known field of view. Prior to ignition, the starting position of the discharge nozzle shall be manually adjusted so that it points in a direction away from the intended discharge direction. This position shall be at the manufacturer's maximum specified horizontal coverage angle, or in the case where a unit covers a full 360 degrees, a maximum travel distance of 180 degrees.

Parameters for each test scenario are identified in the table below. The range is measured as the distance from the monitor assembly to the center of the fuel array along a horizontal plane. The supply pressure is to be measured at the base of the monitor assembly. Provisions shall be made for measuring cannon scanning time as well as measuring the mass or volume of water collected in each pan.

Test Scenario:	**1**	**2**	**3**	**4**
Height:	Maximum Rated	Maximum Rated	Minimum Rated	Minimum Rated
Stream Pattern:	Straight Stream/Narrowest Angle	Straight Stream/Narrowest Angle	Straight Stream/Narrowest Angle	Straight Stream/Narrowest Angle
Supply Pressure:	Minimum Rated	Maximum Rated	Minimum Rated	Maximum Rated
Range:	Maximum Rated	Maximum Rated	Maximum Rated	Maximum Rated
Sweep:	None/Minimum	None/Minimum	None/Minimum	None/Minimum

Table 4.12.2.2 – Targeting System Test Scenario Parameters

The target is to be ignited and the system operated. The test is to be terminated after 60 seconds of system discharge. After the test, the mass or volume of water collected in each pan shall be measured.

The center of spray shall be calculated as follows:

$$Center\ of\ Spray\ Coordinates = (X_c, Y_c)$$

$$X_c = \frac{\sum(m * x)}{\sum m}$$

$$Y_c = \frac{\sum(m * y)}{\sum m}$$

Where,

m = mass collected (may also use volume)

x = X coordinate of pan (For pans in first column, x = .5 m. For pans in last column, x = 9.5 m + .3 m)

y = Y coordinate of pan (For pans in first row, y =.5 m. For pans in last row, y= 9.5 m + .3 m)

The spray area radius shall be calculated as follows:

$$Spray\ Area\ Radius = \frac{\frac{x_{max} - x_{min}}{2} + \frac{y_{max} - y_{min}}{2}}{2}$$

Where,

x_{max}, y_{max} = maximum X or Y coordinate of pan with measurable & significant discharge

x_{min}, y_{min} = minimum X or Y coordinate of pan with measurable & significant discharge

4.12.3 Fire Extinguishment Performance Testing

4.12.3.1 Class A Fire Tests

4.12.3.1.1 Requirements

The automatic monitor system shall successfully extinguish (or control) the fire in each test scenario detailed below. The fire is deemed controlled, and test considered successful, if no damage is incurred to the outer edges of the fuel test array.

Additionally, in each fire test scenario, the cannon scanning time shall be less than 1 minute. The cannon scanning time is defined as the time period from the triggering of the detection alarm to the moment when the water flow control valve is opened.

4.12.3.1.2 Tests/Verification

The test array shall consist of an arrangement of palletized fuel loads as shown in Figure 4.12.3.1.2. Each fuel load is 42" long by 42" wide (the height will vary depending on commodity). The fuel loads shall be arranged in a 2 by 6 pattern to form a main central array and a 1 by 6 pattern on each longitudinal side to form two target arrays. There shall be a 6" (15 cm) gap between all edges of the fuel loads. The spacing between the longitudinal sides of the main array and each target array shall be 60" (1.52 m).

The monitor assembly shall be installed at the height specified for each scenario in Table 4.12.3.1.2. It shall be positioned to spray perpendicular to the longitudinal flue of the test array and at the centerline along the point of ignition, as shown in Figure 4.12.3.1.2. The flame detector shall be installed at it's worst case position – at the maximum specified distance and field of view angle from the target. Prior to ignition, the starting position of the discharge nozzle shall be manually adjusted so that it points in a direction away from the intended discharge direction. This position shall be at the manufacturer's maximum specified horizontal coverage angle, or in the case where a unit covers a full 360 degrees, a maximum travel distance of 180 degrees. Ignition shall occur at the center of the main array using the FM Global standard igniter (see Section 1.9).

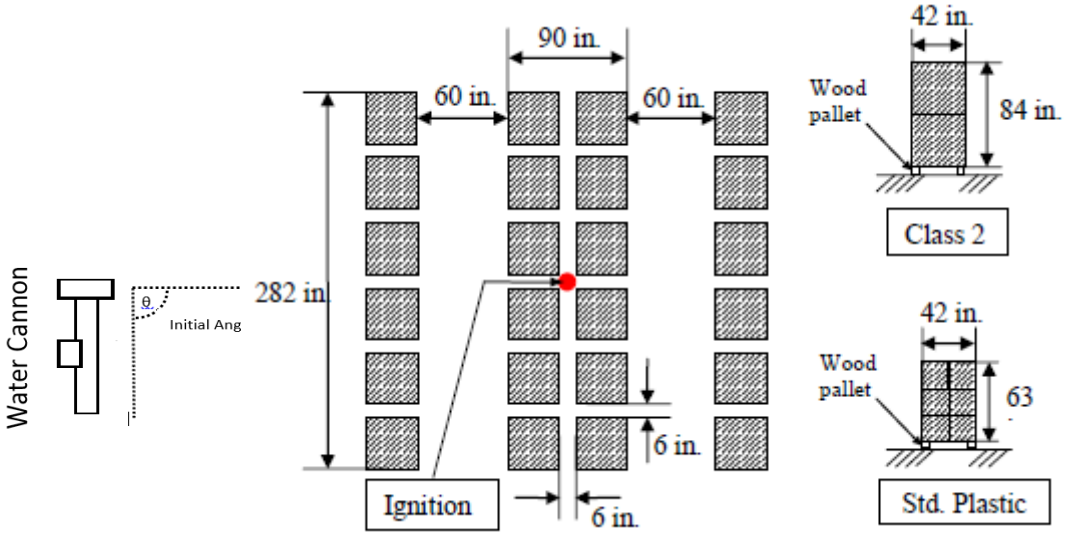

Figure 4.12.3.1.2 – Class A Fire Test Fuel Array Arrangement

Parameters for each fire test scenario are identified in the table below. The range is measured as the distance from the monitor assembly to the center of the fuel array along a horizontal plane. The supply pressure is to be measured at the base of the monitor assembly. Provisions shall be made for measuring cannon scanning time and extinguishment/control time. Extinguishment/control time shall be measured from the point of ignition.

Fire Test Scenario:	**1**	**2**	**3**	**4**	**5**
Commodity:	Class II	Class II	Std. Plastic	Class II	Std. Plastic
Height:	Maximum	Minimum	*	Maximum	Maximum
Stream Pattern:	Straight Stream/Narrowest Angle	Straight Stream/Narrowest Angle	*	Widest Angle Spray	Widest Angle Spray
Supply Pressure:	Minimum Rated	Maximum Rated	*	Minimum Rated	Minimum Rated
Range:	Maximum Rated	Minimum Rated	*	Maximum Rated	Maximum Rated
Sweep:	None/Minimum	None/Minimum	*	Max, slowest	Max, slowest

*Test scenario 3 shall be a repeat of the worst performing test scenario 1or 2 (based on extinguishment/control time), using standard plastic commodity.

Table 4.12.3.1.2 – Class A Fire Test Scenario Parameters

Note: Additional fire test scenarios may be required at the discretion of FM Approvals to evaluate the limits of certain design parameters that have not been accounted for in the fire test scenarios described above.

Each fire test is to be terminated after successful extinguishment or after control has been obtained (no fire growth for >10 min). If control is clearly not established and the fire continues to grow, the test may be terminated immediately.

4.12.3.2 Class B - Minimum Application Rate and Area of Coverage

Automatic monitor systems designed and Approved for use with foam and for the protection of Class B hazards are applicable to the requirements detailed in Section 4.10. The automatic monitor system shall be tested to FM5130, Section 4.19.1 and shall achieve 1.6 times the minimum application rate, as established by the topside fire tests in FM5130, throughout the rated area of coverage. 1.6 is designated as the safety factor.

4.12.4 Fire Scanners – False Stimuli

4.12.4.1 Requirements

Upon activation, fire scanners shall locate and target the correct fire source within 1 minute when in the presence of both modulated and non-modulated sources of possible false stimuli.

4.12.4.2 Tests/Verification

The false stimluli test shall be conducted using a heptane pan fire. The pan shall be of steel construction, 0.068 in. (1.73 mm) thickness and 3.9 in. (10 cm) high with no lip. It shall be 12 in. (0.3 m) wide and 12 in. (0.3 m) long. A water base of 2.1 in. (5 cm) in height shall be added to the pan. The pan shall then be filled with approximately 0.8 in. (2 cm) of commercial grade heptane fuel. Freeboard should be approximately 1.2 in. (3 cm).

An automatic monitor system equipped with fire scanners shall be installed at the maximum distance from the fire test pan, as specified by the manufacturer. Prior to ignition, the starting position of the discharge nozzle shall be manually adjusted so that it points in a direction away from the intended discharge direction. This position shall be at the manufacturer's maximum specified horizontal coverage angle, or in the case where a unit covers a full 360 degrees, a maximum travel distance of 180 degrees. The flame detector may be installed at a separate location where the target is within its known field of view.

A test shall be conducted in the presense of the following possible sources of false stimuli.

- Direct and reflected sunlight
- Arc welding (1/8 in. (0.3 cm) or 3/16 in. (0.5 cm) type 7014, 7013, or 6012 rod, and a 180-200 Ampere setting)
- Heated bodies (1,500w electrical heater)
- Artificial light (100w incandescent)
- Artificial light (40w fluorescent)
- Artifcial light (500w halogen)

The false stimuli shall be placed within the field of view at a distance of at least 10 ft. (3.0 m) from the fire test pan so as to discern proper targeting. These tests may be run dry if it can be confirmed that the targeting system is operating correctly without water spray.

4.12.5 Fire Scanners – Dielectric Strength

4.13.5.1 Requirements

A fire scanner shall provide the required degree of protection from electrical shock

4.13.5.2 Tests/Verification

A sample fire scanner shall successfully withstand for one minute a 60 Hz dielectric test strength of 1000 VAC plus twice the maximum rated voltage. Scanners whose voltage ratings are less than 30 VAC or 60 VDC shall successfully withstand 500 VAC or 710 VDC for one minute. The test shall be conducted between all applicable combinations of the following: power supply, conductors, signaling circuit conductors, ground connection, other output conductiors, and the scanner body.

4.12.6 Flame Detectors

Flame detectors used in an automatic monitor assembly must be specifically identified and evaluated/tested for use with the system. All flame detectors must be FM Approved and meet the requirements of the appropriate standard listed below.

FM Approvals, *Approval Standard for Video Image Fire Smoke Detectors for Automatic Fire Alarm Signaling*, Class 3232.

FM Approvals, *American National Standard for Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling*, ANSI/FM Class 3260.

4.12.7 Control Unit

The control unit used in an automatic monitor assembly must be specifically identified and evaluated/tested for use with the system. All control units must be FM Approved and meet the requirements of the standards listed below.

FM Approvals, *Approval Standard for Fire Alarm Signaling Systems*, Class 3010.

FM Approvals, *Approval Standard for Electrical and Electronic Test, Measuring, and Process Control Equipment*, Class 3810.

4.12.8 Automatic Water Control Valve

If a water control valve is provided with the automatic monitor system, it shall be tested to the requirements of the standard(s) listed below, as applicable.

FM Approvals, *Approval Standard for Automatic Water Control Valves*, Class 1020.

FM Approvals, *Approval Standard for Fire Service Water Control Valves (OS&Y and NRS Type Gate Valves*, Class 1120,1130.

4.12.9 Programmable Software

All programmable software versions and adjustable limits shall be identified and evaluated with the system. A unique revision level shall be assigned and clearly indicated on the display. The

manufacturer is not permitted to change/update any part of the software that was tested with the system without prior acceptance by FM Approvals.

4.12.10 Availability/Reliability Study

FM Global may require an availability/reliability study to supplement FM Approval for installation of the product in FM Global insured locations.

4.13 Additional Tests

Additional tests may be required, depending on design features, results of any tests, material application, or to verify the integrity and reliability of the monitor assembly, at the discretion of FM Approvals.

Unexplained failures shall not be permitted. A re-test shall only be acceptable at the discretion of FM Approvals and with adequate technical justification of the conditions and reasons for failure.

5. OPERATIONS REQUIREMENTS

A quality assurance program is required to ensure that subsequent monitor assemblies produced by the manufacturer at an authorized location present the same quality and reliability as the specific monitor assemblies that were examined. Design quality, conformance to design, and performance are the areas of primary concern. Design quality is determined during the Approval examination and tests, and is covered in the Approval Report. Conformance to design is verified by control of quality and is covered in the Surveillance Audits. Quality of performance is determined by field performances and by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 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;
- Drawing and change control;
- Packaging and shipping; and,
- Handling and disposition of non-conformance materials.

5.1.2 Documentation/Manual

There shall be an authoritative collection of quality procedures and policies. Such documentation shall provide an accurate description of the quality management system and serve 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.

5.1.3 Records

In order to ensure adequate traceability of materials and products, the manufacturer shall maintain records of all quality control tests performed, and shall maintain these records for a minimum period of two years from the date of manufacture.

5.1.4 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 Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production.

- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to FM Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals' Revision Request, FM Approved Product/Specification-Tested Revision Report or Address/Main Contact Change Report.

- Records of all revisions to all FM Approved products shall be maintained.

5.1.4.1 The table below has been included as a guide to manufacturers of what is considered to be a significant change to FM Approvals. To facilitate the Approval of significant changes, modifications that fit this category shall be documented by means of a letter stating the change, and requesting a quotation for an Approval examination.

Modification	*Description/ Example*
Change in pressure:	• The product was originally FM Approved at 200 psi (13.8 bar) and now is to be evaluated at 250 psi (17.2 bar)
Addition or relocation of the manufacturing location:	• The product was originally FM Approved when made in location A, and now it is desired to make the same product in locations A and B, or in Location B only.
Changes to Critical Dimensions:	• Modifications that would have an effect on the ability of the product to maintain the same performance as the originally FM Approved product.

5.1.4.2 The table below has been included as a guide to manufacturers of modifications which may be submitted on the FM Approvals Revision Request.

Modification	*Description/Example*
Change in Company Contact Information:	• Contact Name, Title, Phone Number, FAX Number, Office Address, Company Name
Updating of Drawings:	• Minor dimensional changes, or note changes, Re-creation of old drawing on CAD
Change in material or marking:	• Where new material is superior, or to show proposed new marking

5.1.4.3 For the instances where the modification is difficult to categorize, manufacturers are encouraged to contact FM Approvals and to discuss the nature of the proposed change, and how to send the information to FM Approvals. The examples shown in Sections 5.1.3.1 and 5.1.3.2 are based on common examples of modifications as they relate to the manufacture of ductile iron pipe and fittings, flexible fittings and couplings.

5.1.4.4 FM Approvals, at its sole discretion, shall determine when additional testing is necessary to validate proposed changes.

5.2 Surveillance Audits

5.2.1 An initial surveillance audit of the manufacturing facility(ies) is part of the Approval investigation to verify implementation of the quality control program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are implemented and maintained to insure a consistently uniform and reliable product consistent with that tested and FM Approved. Initial inspections of facilities already producing similar FM products may be waived at the discretion of FM Approvals.

5.2.2 Each facility shall then remain part of the FM Approvals Surveillance Audit program as a condition of ongoing Approval. Surveillance audits shall be conducted at least annually by FM Approvals, or its representative, to determine continued compliance. More frequent audits may be required by FM Approvals or jurisdictional requirements.

5.2.3 The client shall manufacture the product or service only at the location(s) audited by FM Approvals

and as specified in the Approval Report. Manufacture of products bearing the FM Approvals Certification Mark is not permitted at any other locations without prior written authorization by FM Approvals.

5.3 Manufacturer's Responsibilities

The manufacturer shall notify FM Approvals of changes in product construction, design, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation of such changes.

5.4 Manufacturing and Production Tests

5.4.1 Test Requirement No. 1 - *Hydrostatic Test*

The manufacturer shall test 100 percent of production monitor assemblies for body leakage to 400 psi (27.6 bar), or twice its rated pressure, whichever is greater. The pressure shall be held for a minimum of one minute with no ruptures, leakage or noticeable distortions.

5.4.2 Test Requirement No. 2 - *Operational and Freedom of Movement Test*

The manufacturer shall test 100 percent of production monitor assemblies for operational and freedom of movement as detailed in Section 4.3.2. The monitor assembly shall operate freely, with no binding, in both the horizontal and vertical planes while hydrostatically pressurized to 200 psi (13.8 bar).

5.4.3 Test Requirement No. 3 – *Automatic Self-Targeting Monitor Assemblies: Fire Scanner Dielectric Strength*

The manufacturer shall test 100 percent of fire scanner devices used in automatic self-targeting monitor assemblies for dielectric strength, as detailed in Section 4.13.5. The fire scanner shall withstand the required voltage for the required duration between all applicable combinations of the following: power supply, conductors, signaling circuit conductors, ground connection, other output conductiors, and the scanner body.

APPENDIX A: Units of Measurement

FLOW: gal/min – ”gallons per minute”; (L/min – ”liters per minute”)
L/min = gal/min x 3.785

LENGTH: in. – ”inches“; (mm - ”millimeters”)
mm = in. x 25.4
ft – ”feet“; (m - ”meters”)
m = ft x 0.3048

AREA: in^2 - ‘‘square inches’’ (mm^2 -‘‘square millimeters’’)
$mm^2 = in^2 \times 6.4516 \times 10^2$
ft^2 - ‘‘square feet’’ (m^2 - ‘‘square meters’’)
$m^2 = ft^2 \times 0.0929$

PRESSURE: psi – ”pounds per square inch“; (kPa – ”kilopascals”)
kPa = psi x 6.895
inHg – ”inches of mercury”
psi = inHg x 0.491

bar – ”bar“; (kPa - ”kilopascals”)
bar = kPa x 0.01
bar = psi x 0.06895

FORCE: lb – “pounds”, (N – Newtons)
N = lb x 4.448

TEMPERATURE: °F – ”degrees Fahrenheit“; (°C – ”degrees Celsius”)
°C = (°F -32) x 0.556

WATER DEPOSITATION: in/min – “inches per minute” (mm/min – “millimeters per minute”)
mm/min = 25.4 x in/min

APPENDIX B: Tolerances

Unless otherwise stated, the following tolerances shall apply:

Angle:	± 2°
Length:	± 2 percent of value
Volume:	± 5 percent of value
Volume Per Unit Area:	± 5 percent of value
Pressure:	± 5 percent of value
Temperature:	± 4°F (2°C)
Time:	+ 5/–0 seconds +0.1/–0 minutes

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