American National Standard for Spark Detection and Extinguishing Systems

ANSI /FM Approvals 3265
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Foreword

NOTE: This foreword is introductory only and is not part of American National Standard/FM Approvals 3265.

This standard sets performance requirements for Spark Detection and Extinguishing Systems.

This American National Standard has been developed by the canvass method of standards development of the American National Standards Institute (ANSI). FM Approvals is an ANSI-accredited standards developing organization (SDO).

Approval of an American National Standard requires verification by ANSI that the principles of openness and due process have been followed and that a consensus of those directly and materially affected by the standard has been achieved. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached.

The American National Standards Institute does not develop standards nor will it in any circumstances give an interpretation of any American National Standard. Requests for interpretations of this test standard should be addressed to FM Approvals.

ANSI regulations require that this American National Standard shall be revised, reaffirmed or withdrawn within five years of the date of publication.

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1 INTRODUCTION

1.1 Scope

1.1.1 This standard applies to systems for protection of ducting, conveyors or chutes used in pneumatic materials handling systems and most often used in the woodworking and textile industries. Other installation types may also be applicable. Spark radiation detectors are mounted to view in the duct to sense ignition sources. These detectors send signals to a control device, which in turn actuates a valve for a predetermined extinguishing cycle. The valve supplies one or more water-spray nozzles mounted downstream of the detectors; the water discharge is timed to ensure suppression of the ignition source and the material shortly before and after the particle. Because such a system is intended only for protection from a specific hazard, it should not be considered a substitute for general fire protection, including appropriate sprinkler protection.

1.1.2 Spark-extinguishing systems are very effective in reducing the frequency of combustible dust deflagrations. However, they do not reduce the severity of a deflagration, and are not an alternative to deflagration protection in downstream equipment.

1.1.3 These are complicated systems which require careful installation. Many factors, including particle velocity, the radiation characteristics of heated particles, and the ignition energy requirements of the material in dust form affect the ability of this system to protect the property. The manufacturer's instructions should be followed carefully. Access for service must be provided near the detectors and near the water spray nozzles and a regular program of maintenance and testing should be established.

1.1.4 Spark extinguishing systems are typically considered as a special hazards protection or process protections and would not in itself cause a building evacuation. They may connect to the existing protected premises fire alarm system for additional evacuation capability although this is not common.

1.1.5 This standard provides the operating basis for the complete spark extinguishing system, including the alarm initiating (spark detectors), alarm signaling processing (control unit) as well as the water-spray or extinguishing sets for use in ordinary dry locations. It does not by itself cover the use in damp, wet or hazardous (classified) locations (other standards apply). This equipment covered by this standard, may be combined with additional standards for use in other areas.

1.1.6 This standard considers applications involving the detection and extinguishing of small wood, fiber and metal combustibles with spark sensing detectors during the transport of particulate solid materials through pneumatic conveyor ducts within a 8 in. to 118 in. (0.2 to 3.0m) diameter or mechanical conveyors with velocities ranging from 200 to 10,000fpm (1-50mps).

1.2.6 Operation outside of theses parameters is possible with additional testing and would be indicated in the product listing for the particular system.

1.2 Basis for Requirements

The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations.

1.3 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 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-97, "Standard for Use of the International System of Units (SI): The Modern Metric System."
State any exception here, such as the following, which is used in many Hydraulics standards: Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this standard.

1.4 Applicable Documents

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

1. NFPA 15, 2017, *Standard for Water Spray Fixed Systems for Fire Protection*
2. NFPA 72, 2016, *The National Fire Alarm and Signaling Code*
3. NFPA 70, 2017, *The National Electrical Code*
4. NEMA 250, 2003, *Enclosures for Electrical Equipment*
5. IEC 529 1989-11, *Degrees of protection provided by enclosure (IP Codes)*

1.5 Definitions

For purposes of this standard, the following terms apply:

Acknowledge **-** To confirm that a message or signal has been received, such as by the pressing of a button or the selection of a software command.

Authority Having Jurisdiction (AHJ) – an organization, or individual responsible for enforcing the requirements of a code or standard, or for approving the equipment, materials, an installation, or a procedure.

Annunciator **-** A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.

Compatibility **-** A process where the equipment (controls & peripherals) are verified as suitably rated to operate or communicate properly as a system and as intended**.** Equipment can specifically be tested for compatibility and often applies to initiating devices, two-wire and digital communication type to designate operation with certain control equipment. The compatibility of spark detectors are often determined through electrical rating comparisons and testing.

Fire Alarm Signal **–** A signal following multiple (or continuous) spark or ignition signals requiring that a general alarm signal be sent to the local protective signaling system at the protected property, if so equipped.

Fire Alarm System (Local) **-** A life safety system arranged to monitor and annunciate the status of fire alarm or supervisorysignal-initiating devices and to initiate the appropriate response (evacuation or otherwise) to those signals.

Half Power Field of View – The half power field of view (HPFV) is defined as the off-axis angle where the detector responds to a spark source at no less than ½ the distance it is capable of detecting to on-axis.

Spark – A moving particle of solid material that emits energy due to either its temperature or the process of combustion on its surface.

Spark/Ember Detector – A low-energy sensing fire detector that is designed to detect the energy created by sparks, embers, or both. These devices are normally intended to operate in dark environments and in the infrared part of the spectrum.

Spark Detector Circuit – A circuit strictly limited to the connection of specific spark detectors and not other conventional devices such as; manual stations or smoke detectors.

Spark Extinguishing System - A system that monitors the transport of particulate solid materials through pneumatic conveyor ducts or mechanical conveyors and annunciates the status of spark/ember detector, supervisory devices that support the system and activation of the appropriate response to those signals. This is most commonly a timed release of water into the duct but can also include the diversion or dumping of product for a timed period also and process shutdown if desired.

Spark/Ember Detector Sensitivity – The quantity of energy or power (expressed in Watts) from a point source radiator, applied as a unit step signal at the wavelength of maximum detector sensitivity necessary to produce an alarm signal from the spark/ember detector.

Spray Establishment Time – The sum of several different factors including; a) detector response time, b) system response time and c) extinguishing response time necessary to establish total flooding of the duct being protected. The SET can then be used with the rated duct velocity up to but not exceeding 10,000 fpm (50 mps) times to determine the minimum distance in feet (m) between spark detection zone and spray extinguishing zone.

Supervisory Signal – A signal that results from the detection of a supervisory condition that impairs the proper operation of the Spark Extinguishing System, such as closed water supply valve.

Trouble Signal – A signal that results from the detection of a trouble condition within the Spark Extinguishing System or its supervised components, such as faulty wiring or other equipment problems.

Initiating Device - A system component that originates transmission of a change-of-state condition, such as in a spark/ember detector, manual fire alarm box, or supervisory switch.

Notification Appliance - A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs, or any combination thereof.

Pre-Alarm Signal – A signal where the operation of an input device (spark detector) actuating only a pre-determined selective or partial extinguishing operation or notification of key personnel who then have the option of manually initiating a general alarm.

Response Time - The time interval from the occurrence of an input status change, (alarm, trouble or supervisory) to the activation of a system output.

Reset - A control function that attempts to return a system or device to its normal, non-alarm state.

Supplementary - Equipment, circuits, features or options that are not required by NFPA 72, *The National Fire Alarm Code* or this standard. The use of, or faults from, supplemental equipment shall not interfere with the normal operation of the equipment.

Zone - A defined area within the protected premises from which a signal can be received, an area to which a signal can be sent, or an area in which a form of control can be executed.

1.6 References

1. FM 3011, 1999, *Central Station Service for Fire Alarm Systems & Protective Equipment Supervision*
2. FM 3150, 2003, *Audible Notification for Automatic Fire Alarm Signaling*
3. FM 3210, 2007, *Heat Detectors for Automatic Fire Alarm Signaling*
4. FM 3230 & 3250, 2010, *Smoke Actuated Detectors for Automatic Fire Alarm Signaling*
5. FM 3232, 2011, *Video Image Smoke Detection for Automatic Fire Alarm Signaling*
6. ANSI/FM 3260- 2004 (R2014), *Radiant Energy Sensing Fire Detectors for Automatic Fire Alarm Signaling*

2 GENERAL INFORMATION

2.1 Product Information

Spark extinguishing equipment is comprised of electronic components that when combined in accordance with the manufacturer's instructions make up a spark extinguishing system. They may be fabricated and shipped as complete assemblies or sub-assemblies.

2.2 Requirements for Samples for Examination

2.2.1 The manufacturer shall submit samples for examination and testing based on the following:

2.2.2 Sample requirements to be determined following review of the preliminary information and defined in the test proposal or quotation provided. A typical program will require a minimum of 4 spark detector samples of each model, 2 extinguishing sets of each model and a minimum of one operational control panel.

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

2.2.4 The manufacturer shall submit samples representative of production.

2.2.5 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the maximum rated load capabilities, maximum system configurations and the devices necessary for the determination of peripheral compatibility with the fire alarm signaling equipment.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the practicality of installation and use. The design, installation, operation and maintenance manual must define the limits of the spark extinguishing equipment (e.g. max duct diameter as well as the minimum and maximum duct velocities).

3.2 Physical or Structural Features

3.2.1 Required Features

3.2.1.1 Means shall be provided to mount the spark extinguishing equipment securely and independently of the wiring.

3.2.1.2 The spark extinguishing equipment shall be capable of withstanding normal handling and installation.

3.2.1.3 Spark extinguishing equipment intended for use in hazardous (classified) locations shall comply with suitable for hazardous (classified) location electrical equipment in addition to this standard.

3.2.1.4 The spark extinguishing equipment and enclosure shall be suitable for the intended environmental exposures as determined by testing in accordance with acceptable national, regional, or international codes and standards.

3.2.1.5 The spark extinguishing equipment shall accommodate secure wiring methods in accordance with NFPA 70, *National Electrical Code* and NFPA 72, *National Fire Alarm Code*.

3.2.1.6 The spark extinguishing system output circuits shall be compatible with an Approved or Listed fire alarm control unit that will produce distinctive alarm, supervisory and trouble signals.

3.2.1.7 The spark extinguishing equipment shall have response times in accordance with NFPA 72 *The National Fire Alarm Code* and within those defined in the manufacturer's specifications and installation and operational manual. The maximum response values as found in NFPA 72 are as follows:

- Alarm - 10 seconds (6.8.1.1) (*applies when connected to a local alarm system)*
- Supervisory – 90 seconds (4.4.3.2.3)
- Trouble – 200 seconds (4.4.3.5.1)

Note: Typical spark detection occurs in milliseconds and creates what is in effect a Pre-Signal at the Spark Extinguishing System. Alarm response to the local protected property Fire Alarm Signaling Systems occurs following multiple ignition events. While the exact number of spark events is not defined, when the Spark Detection System is interfaced with a Fire Alarm Signaling System, the Alarm Response cannot exceed 10 seconds of continuous spark event or recognition as specified in the Manufactures documentation.

3.2.1.8 Equipment rated at or above 30 V ac and 60 V dc requires a proper (protective) ground terminal to be provided.

3.2.1.9 For products intended for use in unsecured (public) areas, the controls for signal acknowledgement, reset, optional program initiation, manual override of any control sequence, or altering of system parameters, shall be of restricted access requiring software security code or other equivalent protection.

Note: If the manual controls are accessed via the opening of the key-locked enclosure, the equipment shall be arranged so that access does not result in the exposure of live electrical parts.

3.2.1.10 As a minimum all control equipment and their displays shall use the following basic indicators:

- GREEN (Normal). This green indicator shall illuminate when all power is applied to the system and no off-normal situations exist.
- ANY COLOR EXCEPT RED or GREEN (Pre-Alarm). This indicator shall illuminate when a spark or ignition source is detected and extinguishing/suppression is active and automatically extinguish once complete.
- RED (Fire Alarm). This red indicator shall illuminate when a fire condition exists from a manual station, smoke or heat alarm, or via the multiple or continuous spark counter from a spark detector, flashing until acknowledged, steady state following acknowledgement.
- YELLOW (Supervisory Alarm). This yellow indicator shall illuminate when any supervisory condition exists, flashing until acknowledged, steady state following acknowledgement.
- YELLOW, (Trouble Alarm). This yellow indicator shall illuminate when any trouble condition exists, flashing until acknowledged, steady state following acknowledgement.

3.2.1.11 The facility (protected property) must ensure that the spark extinguishing system has sufficient water supply to meet the minimum flow requirements in accordance with the manufacturer's instructions.

3.3 Markings

3.3.1 Marking on the product or, if not possible due to size, must exist on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- date of manufacture or code traceable to date of manufacture or lot identification;
- model number, size, rating, capacity, etc., as appropriate.
- Inter-equipment wiring diagrams
- When hazard warnings are needed, the markings should be universally recognizable.

3.3.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product.

3.3.3 All markings shall be legible and durable.

3.4 Manufacturer's Design, Installation Operational and Maintenance Instructions

3.4.1 The product design, installations, operating, and maintenance instructions shall provided for each spark extinguishing system and model of spark detector and extinguishing set. The instructions shall be complete and appropriate for the equipment. The instructions shall be marked with the document name, number, revision and or date. The following information is required for each sub-assembly (aka controls, detectors and extinguishing set):

- Operating environment (temperature and humidity)
- Voltage range
- Enclosure ratings
- Specific sensitivity of the detector rated in watts or size and temperature of the spark and detection range of the detector, on-axis and at the specified HPFV
- False alarm sources (often ambient light)
- Instructions for determining the detector sensitivity
- Minimum and maximum requirements for water supply and adequate extinguishing operation.

- Spark detector response time and the spray establishment times must be specified and verified as it is required for the proper location of the extinguishing sets at different air-flows within the duct
- Incorporate a functional test capability to activate the extinguishing set (with the inclusion of a test valve if necessary)
- Identify piping component specifications to be used in accordance with NFPA 15, 2017 ed, Ch. 5 requirements
- Identify test and inspection frequencies in accordance with Section 12.5 requirements of NFPA 15, 2017 ed.

3.4.2 The installation, operating and maintenance instructions shall be included with each system.

3.4.3 All wiring terminal designations and adjustment controls shall be clearly marked or labeled. Instructions for connection and setting shall be included in the instruction and operation manual. All field adjustments will be in accordance with this document.

3.5 Calibration

All examinations and tests performed in evaluation to this standard shall use measuring instrument calibrated in a ISO/IEC 17025 compliant process, traceable and certified to acceptable national standards.

3.6 Installation and Maintenance

3.6.1 Detectors are adversely affected by the accumulations of dust or other coating on the lens or other sensitive element of the detector. The product literature shall include cleaning and maintenance instructions, and stress the need for regular response testing.

3.6.2 A "thru-the-lens monitoring capability" if provided will indicate when a detector is no longer capable of detection due to lens contamination. This feature or capability would reduce the interval and amount of manual testing required at the installation and its operation will be verified as a part of the test process.

The literature shall specify a device or readily reproducible technique for checking the response of an installed detector. The device or technique shall be evaluated during the examination of the detector for reliability, accuracy of calibration, and, if applicable, suitability for hazardous location use. The response test shall be equivalent or proportional to the radiation emitted by the test sources used to establish the sensitivity of the detector during the examination. The test source shall not employ a radiator of unknown emittance or at an uncontrolled distance.

3.6.3 An installation acceptance test shall be conducted and documented by the installer in accordance with Chapter 10 of NFPA 15.

3.7 Specifications

3.7.1 All manufacturer-specified sensitivities, i.e. ignition source, distance and response time shall be verified during the examination. The sensitivity shall be expressed as the maximum distance from the spark (or ember) from which the detector will give consistent alarm responses in a specified time, not to exceed the manufacturer's specification. The manufacturer of a park/ember detector shall specify the minimum size and velocity of the spark or ember of the given fuel that the detection system is intended to detect.

3.7.2 A graphical representation of the sensitivity of the detector shall illustrate the relationship of sensitivity in distance and the off axis detection capability of the spark detector. (See Fig 1)

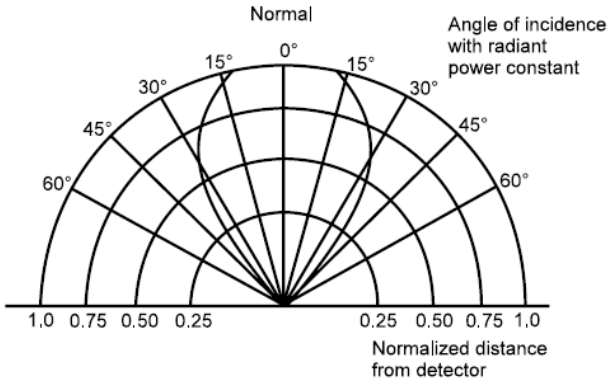

Fig. 1

3.7.3 This graphical representation shall detail the sensitivity of the detector over its effective field of view and identify the HPFV of the spark detector.

3.7.4 The manufacturer must specify the minimum quantity/location of detectors required for adequate detection of the entire duct range of its intended use.

3.7.5 The manufacturers specified Spray Establishment Time (SET) shall not exceed the manufacturer's specifications as outlined in the design, installation, operation and maintenance manuals.

3.7.6 The manufacturer must specify the minimum and maximum water supply necessary and the proper quantity/location of extinguishing nozzles for adequate extinguishment for the entire duct range of its intended use.

3.8 Software Requirements

3.8.1 For spark/ember detectors that are dependent on software/firmware programs for normal operation:

- All software and firmware shall be identified by release level which shall be clearly marked on, or which can be displayed by, the product for ease of identification.
- All changes to the software shall result in a revision to the release level.
- The software/firmware shall not be accessible for and changes or modifications beyond what it has been approved for; and
- Any software failure that renders the detector inoperable shall result in a trouble condition at the detector and be appropriately transmitted to the fire alarm control (e.g. watchdog timer).

4 PERFORMANCE REQUIREMENTS

4.1 Enclosures *(Including Polymeric Housings)*

4.1.1 Requirement

4.1.1.1 The enclosure must meet the ingress protection requirement for a NEMA, Type 1 and or IEC, IP30 enclosure ratings as a minimum for indoor applications. It is not necessary to mark the product for Type 1 enclosures. Additional claims made by the manufacturer will be verified according to specified enclosure classifications.

4.1.1.2 Polymeric Materials used as an enclosure (or the sole support of current carrying parts) shall not warp to an extent that it impairs the intended operation or exposes high voltage components.

4.1.2 Test/Verification

4.1.2.1 The enclosure will be evaluated according to acceptable national, regional or international electrical codes.

4.1.2.2 When constructed of polymeric materials, an enclosure sample shall be mounted as intended and placed in an circulating air-oven shall be aged at 194°F (90°C) for seven days or at 158°F (70°C) for twenty eight days.

Following the aging tests, the samples are to be viewed for:

- No evidence of warping and distortion.
- No exposure to high voltage components.
- The unit shall operate normally following this test.

4.2 Normal Operations

4.2.1 Requirement

4.2.1.1 Representative samples of the equipment (system or modules) will be powered according to the manufacturer's instructions and programmed (if applicable) for proper operation and application. Re-wiring, re-configuring or programming to satisfy different types of applications is often required. Demonstrations or simulations at maximum rated loads of power supplies, spark initiating circuits and extinguishing circuits will be required.

4.2.1.1.1 Basic operation and function of a spark extinguishing system shall include all of the following features:

(1) Automatic alarm signal initiation (via spark/ember detectors)
(2) Monitoring of abnormal conditions in all field wiring connections
(3) Activation of spark detection and extinguishing operation
(4) Activation of additional process protection functions (i.e. process shutdown)
(5) Activation of alarm notification appliances (supplied by others, via local FACP)
(6) A manual means of activating the extinguishing process

5.2.1.2 Optionally, the spark extinguishing system may provide the capability to activate additional process protection functions (a.k.a. process shutdown) as well as activation of local protective signaling equipment when provided with independent alarm, supervisory and trouble signals.

Tests/Verification

Basic operation to NFPA 72 will be verified and documented as specified in the owners or instruction manual.

4.3 Power Supply/Electrical Supervision

4.3.1 Requirement

At least two independent, reliable and supervised power sources are required for any spark extinguishing system. A primary dedicated branch electrical circuit and a dedicated storage battery system are the most common. Other options, if intended to be used, must be specified in the installation manual and would be at the discretion of local on-site verification and AHJ acceptance.

4.3.2 Tests/Verification

Failure of either one of the power supplies shall result in proper annunciation, be seamless and not result in any loss of data, signal transmission or annunciation that differs from normal primary power (except the loss of an AC power indication).

4.3.2.1 Any secondary power supply shall have sufficient capacity to power the system for a minimum of 4 hours of standby operation and 5 minutes at the maximum alarm load specified by the manufacturer.

4.3.2.2 Both primary and secondary source are to be monitored at the point of connection to the fire alarm equipment.

4.3.2.3 The secondary power supply shall automatically provide power to the spark extinguishing system immediately and seamlessly whenever the primary power supply fails to provide the minimum voltage required for proper operation.

4.4 Circuit Supervision

4.4.1 Requirement

Proper monitoring and operation of the spark detector initiating circuits will comply with basic supervision requirements (open/short/ground) and proper identification of each in accordance with the manufacturers data.

4.4.2 Tests/Verification

Each spark detector initiating circuit shall:

- Be supervised for open, short and ground conditions of each conductor.
- Be supervised for the integrity and presence of each spark detector.

Any failure to properly operate as the result of any of the single fault conditions described above shall result in a trouble condition indicated at the control. Any failure effecting one circuit shall not have an adverse effect with the proper operation of any other circuit.
Exception: A*ny circuit specified to remain in the same room or 20 ft (6 m) or less in length and in conduit and limited to the connection of a single device (detector or solenoid).*

4.5 Spark/Ember Detector Compatibility

4.5.1 Requirement

Spark/Ember detector compatibility shall be verified with respective control equipment and /or spark detector interface circuits and defined in the installation instructions or on a label affixed to the control panel itself.

4.5.2 Tests/Verification

Detectors shall demonstrate compatibility as specified in the manufacturers installation instructions and be supervised for presence. Letters of agreement from both detection and control panel manufacturers must be provided stating agreement to and the proper operation the combined compatibility of the equipment with no changes in warranty or otherwise.

4.6 Voltage Variations

4.6.1 Requirement

It shall be verified that the spark extinguishing system maintains the normal operational capability and functionality throughout typical voltage extremes of both the primary and secondary power supplies they are powered from.

4.6.2 Tests/Verification

As a minimum, the operation of the equipment in normal supervisory and alarm conditions shall be verified at 85% to 110% of the rated primary (AC) and secondary (DC) power sources. If the manufacturer specifies a voltage range beyond these extremes, the equipment will be tested using those values specified by the manufacturer.

4.6.2.1 Typical Voltage Ranges are defined as shown in the table below:

Nominal	**+10%**	**-15%**
120 Vac	132Vac	102Vac
240 Vac	264Vac	204Vac
12 Vdc	13.2 Vdc	10.2 Vdc
24 Vdc	26.4 Vdc	20.4 Vdc

4.7 Environmental Conditioning

4.7.1 Requirement

It shall be verified that the spark extinguishing system is designed so that it is capable of performing its intended normal operational capability and functionality throughout temperature extremes and high humidity conditions that are typical of equipment intended for indoor applications. If the manufacturer specifies a temperature range beyond those typical for indoor/dry locations, the equipment will be tested using the values specified by the manufacturer.

4.7.2 Tests/Verification

As a minimum, all equipment shall be subjected to the following environmental extremes. If rated for extremes beyond these values, the equipment will be tested using those values specified by the manufacturer.

- For a period of 4 hours at 32°F (0°C) and 120°F (49°C).

> *Special Note; It is understood that water based extinguishing sets should not be used below 40°F (4.4°C) and must state this in the Installation Manual, but will be verified as operational and combined with the rest of the spark extinguishing equipment of similar ratings for the purpose of this test in dry conditions (i.e., not actually connected to a source of water).*

- For a period of 24 hours at a relative humidity of 90% and ambient temperature of 100°F (37.8°C).

The equipment shall:

- Operate as intended and show no signs of instability or false alarms during these exposures.

4.8 Battery Charge/Discharge

4.8.1 Requirement

It shall be verified that the equipment is capable of recharging the secondary batteries fully within 24 hours following a single discharge cycle as specified in 4.3.2 of this document.

4.8.2 Tests/Verification

The equipment is allowed to be powered in a normal condition for a minimum of 72 hours to ensure that the batteries are fully charged and the charge voltage and current levels recorded. With the equipment configured to simulate the worst case standby load or condition and the primary power is disconnected (turned OFF) and the equipment is powered solely from the secondary power source for a period of 4 hrs.

Following this standby (discharge) time, the equipment is then placed into an alarm condition (with outputs at the maximum rated load) for a period of 5 minutes and the secondary battery voltage and current reading recorded.

Following the alarm (discharge) time, the primary power is restored (turned ON), the equipment is returned to a normal standby condition and allowed to charge the secondary batteries for a period of 24 hours. At the end of the 24 hour recharge, the voltage and current readings are made at the battery and compared to those obtained at the start of the test. The readings are required to be similar to the initial readings indicating a fully charged battery for the results to be acceptable. The battery trickle or charge current should not exceed 5ma/AH rating of the battery under test.

4.9 Vibration

4.9.1 Requirement

The line connected power supply equipment (enclosure and assemblies), detector assemblies as well as the extinguishing set shall be tested to verify its mechanical strength and ability to withstand the vibration as defined in this section. As a result of this testing, there shall be no loosening of parts or visible signs of permanent deformation.

4.9.2 Tests/Verification

With the equipment powered and installed in accordance with the manufacturer's instructions, the equipment shall be subjected to a vertical movement as described below.

Duration	4 hours
Displacement	0.022 in. (0.55 mm)
Sweep Frequency Range	10 Hz-30 Hz-10 Hz
Sweep Rate	2 cycles/min.

Following the 4 hour vibration exposure, the equipment shall:

- not have loose parts;
- not have visible signs of permanent deformation that would compromise the electrical safety of the equipment;
- operate as intended.

4.10 Dielectric

4.10.1 Requirement

The equipment shall withstand for 1 minute the application of approximately 60 Hz AC voltage, or a DC voltage applied between live parts and the enclosure and dead metal parts that may come in contact with, and live parts of circuits operating at different voltages. The test voltages are described below.

Circuit Ratings	**Dielectric Test Voltage**
≤ 30 Vac (60 Vdc)	500 Vac (707 Vdc)
≥ 30 Vac (60 Vdc)	1,000 Vac +2x rated (1414 Vdc)

4.10.2 Tests/Verification

There shall be:

- no indication of a dielectric breakdown or leakage current greater than 0.5mA during the 1 minute test exposure.

4.11 Equipment Load Rating

4.11.1 Requirement

The standby or alarm current necessary to power the equipment shall not exceed 110% of the rated value over the entire voltage range that the equipment is rated or intended for.

4.11.2 Tests/Verification

With the equipment configured for its maximum rated current draw (outputs at full rated load). The input voltage is varied over the extremes as determined in 4.6 of this document. At no time shall the current value measured exceed 110% of that rated on the nameplate or the manufacturers installation instructions.

4.12 Battery Circuit Reverse Polarization

4.12.1 Requirement

Battery charging circuits shall be tested with the battery installed in a reverse polarity condition if such installation is possible without mechanically altering, modifying or damaging the equipment or battery.

4.12.2 Tests/Verification

The battery leads are reversed while the primary power is OFF, and if possible, the primary power is turned ON. Normal operation is not required following this test, but the equipment shall fail in a safe mode (no indication of continued heating, visible fire or molten material) and indicate a trouble condition if no longer operational.

4.13 Protective Grounding/Bonding

4.13.1 Requirement

Any equipment that contains or connects to a high voltage circuit shall provide a positive grounding system for all exposed dead metal parts to reduce the risk of electrical shock.

4.13.2 Tests/Verification

The grounding system shall consist of a dedicated (green head) screw or terminal and clearly marked (G, GR, GND, Ground, International Ground Symbol or the like), or dedicated, flexible green (or green and yellow) bonding conductors.

- The bonding resistance shall be measured at ≤ 0.1 ohm.
- All bonding conductors shall be 14 AWG minimum.

Exception: Metal-foil markings, screws, handles, etc., which are located on the outside of the enclosure and isolated from electrical components or wiring by grounded metal parts so that they are not liable to become energized or those which are positively separated from wiring and un-insulated live parts.

4.14 Power Supply Failure

4.14.1 Requirement

The equipment shall provide the required degree of protection from fault as demonstrated by the simulation of a worst case condition failure, shorting the secondary's of line voltage connected equipment.

4.14.2 Tests/Verification

With the equipment connected to an appropriately rated, time delayed, fused branch circuit in accordance with the manufacturer's instructions. All field serviceable fuses on the equipment under test are replaced with those of maximum current ratings.

The unit shall be powered and produce or result in:

- operation of the branch circuit fuse;
- operation of any of the field serviceable fuses (when replaced with those of the maximum rated value);
- operation of any non-replaceable protection components or;
- temperature stabilization where there is no further change due to the fault.
- And there shall be no emission of flame, escape of molten metal, or infringement of the protection against electrical shock.

4.15 Internal Transients

4.15.1 Requirement

No false signal will be generated when the equipment (controls, detection and extinguishing set) is subjected to extraneous transients from source described below.

4.15.2 Test/Verification

One powered sample of the spark extinguishing system will be subjected to 500 on/off cycles by the interruption of the primary AC mains, the transfer to the secondary power supply and the return to AC mains.

The unit shall produce:

- No Non-Resettable false signals (alarm or trouble) and
- No evidence of instability during or at the end of this test.
- The unit shall operate normally following this test.

4.16 Extraneous Transients (RFI Immunity)

4.16.1 Requirement

No false signal will be generated when the equipment (controls, detection and extinguishing set) is subjected to extraneous transients from sources which are described below.

4.16.2 Test/Verification

One powered sample of the spark extinguishing equipment will be subjected to extraneous transients described below at distances as close as 24 inches (0.6 m) to the DUT.

- Radio frequency transmissions with radiation power levels equivalent to 5 Watts in the 27 MHz, 150-174 MHz, 450-467 MHz, 850-870 MHz, and 900-920 MHz bands.
- A sequential arc (Jacob's ladder) generated between two 15 in. (0.4 m) long, No. 14 AWG (2.1 mm) solid copper conductors attached rigidly in a vertical position to the output terminals of an oil burner ignition transformer or gas tube transformer rated 120 volts, 60 Hz primary; 10,000 volts, 60 Hz, 23 mA secondary. The two wires are to be formed in a taper, starting with a 1⁄8 in. (3.2 mm) separation at the bottom (adjacent to terminals) and extending to 1.25 in (32 mm) at the top.
- operation of an electric drill rated 120 V, 60 Hz, 2.5 A.
- operation of a soldering gun rated 120 V, 60 Hz, 2.5 A.
- Operation of a 6 in (150 mm) diameter solenoid-type vibrating bell with no arc suppression and rated 24 V dc.

The unit shall produce:

- No Non-Resettable false signals (alarm or trouble) and
- No evidence of instability during or at the end of this test.
- The unit shall operate normally following this test.

4.17 Surge Line Transient (low voltage circuits)

4.17.1 Requirement

Protection against line surge transients will be a requirement for any low voltage circuit (power, input and outputs).

4.17.2 Test/Verification

This test applies to all field wiring terminals that have a possibility of being subjected to line-induced voltage (i.e., spark initiating device circuits, release circuits, power circuits and auxiliary connections). One powered sample of the control equipment shall be subjected to transient waveforms having peak levels of:

- 100 V dc
- 500 V dc
- 1,000 V dc
- 2,400 V dc

The unit shall produce:

- No latched or constant alarm (intermittent or spurious alarms are possible) or non-restoring trouble signals and
- No evidence of instability during or at the end of this test and
- The unit shall operate normally following this test.

Exception: A*ny circuit specified to remain in the same room or 20 ft (6 m) or less in length and in conduit.*

4.18 Surge Line Transients

4.18.1 Requirement

The Spark Extinguishing Systems AC voltage supplied circuits shall be protected against AC line surge transients.

4.18.2 Test/Verification

One powered sample shall be subjected to 6 kV oscillatory (100 kHz) transient pulses. Each transient pulse shall have a rise time of less than 0.5 microseconds and a total duration of 20 microseconds. The pulse decay shall result in each peak being no more than 60% of the amplitude of the preceding pulse. Each pulse shall be applied at the peak of the AC waveform.

500 transitory pulses are to be applied at a rate of 6 transients per minute. [250 positive pulses with reference to earth ground and 250 negative pulses with reference to earth ground. Each set of pulses is to consist of 225 pulses in supervisory condition and 25 pulses in the alarm condition]

The system shall produce:

- No latching false signals
- No evidence of instability during or at the end of this test including memory [ex. retention event history], and
- The system shall operate normally following this test.

4.19 Marking Requirements

4.19.1 Requirement

The equipment shall be plainly and permanently marked so it is visible after installation and identifiable. Any information not directly affixed to the equipment must be referenced on a label affixed to the equipment. This includes references to Wiring Diagrams and Installation Instructions if not affixed to the installed system.

4.19.2 Tests/Verification

The product, as well as the installation, operating, and maintenance instructions shall be reviewed for each type and model examined; the instructions shall be complete and appropriate for the control equipment. The installation instructions or manual shall be marked with a document name, number, revision, and date. The following information is required with each system:

- Name (or Trademark) and Model designation
- Environmental suitability (Operating temperature, humidity)
- All switches and indicators must be clearly marked as to the function of each
- Electrical ratings
- Enclosure ratings beyond normal suitability
- Intended use, Spark Extinguishing System or other as necessary
- Applicable NFPA references.

- Instructions for the installation, maintenance, and operation of the product;
- Facilities for repair of the product and supply replacement parts; and
- Services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance
- All terminals and field serviceable components shall be identified

4.20 Spark Detector Sensitivity Tests

4.20.1 Requirement

The detectors shall be tested to determine a baseline/minimum response to a level of energy as delivered from a simulated spark traveling in ductwork. (See Figure 2)

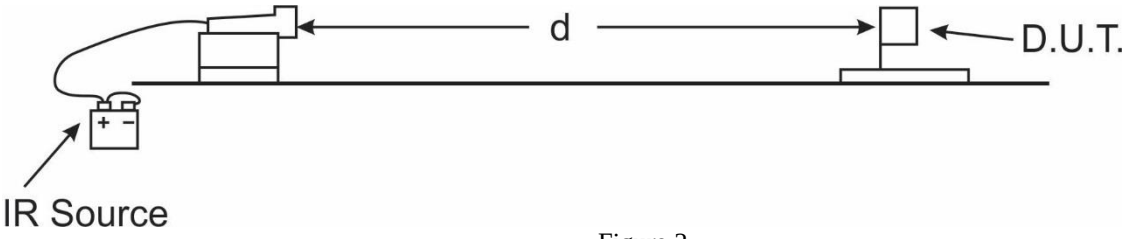

Figure 2

IR Source - Spark Simulator: GaAs Infrared Emitter with a peak wavelength of 900nm and set to an energy output of 400-500nw/sr at given distances. The spark simulator is pulsed for short durations to simulate the time would be visible within the HPFV of the detector. The times shown below assume a spark traveling 24 inches from the face of the detector, or at the midpoint of a 48 inch (1.2 m) duct. *Note: Measuring the sensitivity at ½ the duct diameter assumes a dual or redundant detector arrangement. D.U.T = Device Under Test.*

HPFV	Spark Duration in Seconds Min V = 200fpm (1mps)	Spark Duration in Seconds Max. V = 10kfpm (50mps)
30^0 or total of 60 degrees	0.66	0.012
45^0 or total of 90 degrees	1.21	0.024
60^0 or total of 120 degrees	2.4	0.048
75^0 or total of 150 degrees	4.8	0.96

4.20.2 Test Verification

Within a dark environment, the detector is positioned on-axis facing the IR Source Spark Simulator and the distance varied to find the minimum reliable detection distance from the spark to the detector for each value corresponding to its HPFV. This on-axis distance is recorded minimum energy distance (D min.) and defines the maximum duct diameter that the detector shall be listed for use. In no case shall the minimum distance be less than 6 in (0.15 m).

Note: Alternate spark simulator equivalent sources may be provided by the manufacturer if they can be determined as equivalent.

4.21 Field of View

4.21.1 Requirement

The spark detector's Half Power Field of View will be verified to the manufacturer's claims and instructions.

4.21.2 Test Verification

Tests are conducted on the spark simulator fixture that allow for off-axis measurement of the DUT to determine the Half Power Field of View (HPFV).

a) The HPFV distance is = to ½ the D min. as determined in the on-axis testing of 4.19.
b) The minimum angle for the HPFV will be verified in four quadrants (up/down/left/right) from on-axis to the spark simulator source. The minimum HPFV must match the manufacturer's specification and ensure that the entire duct is protected within the HPFV when installed in accordance with the manufacturer's instructions.

4.22 Release Circuits

4.22.1 Requirement

The proper monitoring, supervision and operation of release circuits shall be verified in accordance with the manufacturer's instructions. Compatible solenoid/valve combinations shall be identified in the manufacturer's instructions with specifications (limitations) on its proper use.

4.22.2 Tests/Verification

Release circuit shall be:

- Supervised for open and ground conditions
- Supervise the integrity and presence of the releasing device
- Each circuit must remain within 20.4 to 26.4 Vdc under all conditions
- Each solenoid/valve combination must remain operational at maximum specified distance and/or load.

4.23 Hydrostatic tests

4.23.1 Requirement

All system components that come in contact with the system water pressure shall withstand the 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.

4.23.2 Test/verification

With the solenoid or disc in the partially open position, or the diaphragm removed, component bodies of each size and in connection style shall be subjected to hydrostatic test pressure of 700 psi (4825 kPa) or four times the rated working pressure, which ever 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.

4.24 Solenoid Valve Tests

4.24.1 Requirement

The valve shall open and close satisfactorily at 85 and 110% of the nominal (24 V DC) 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.

4.24.2 Test/verification

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% of the nominal (24 V DC) 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

4.25 Diaphragm Strength/Differential Pressure Test

4.25.1 Requirement

All components with diaphragms or rubber seats shall withstand the 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 five minutes. No leakage or functional impairment shall result from this test. Following this test the component shall be fully operational.

4.25.2 Tests/Verification

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.

4.26 Endurance/Cycle Test

4.26.1 Requirement

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

4.26.2 Tests/Verification

A sample valve of each size shall be cycled 20,000 times, at a rate not exceeding six 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 valve's 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 valve's

rated working pressure, whichever is greater. No leakage shall be allowed. After testing, the valve shall be disassembled. Parts shall be visibly examined for the signs of excessive wear, damage or failure.

4.27 Flow Test (K-Factor) Hydraulics Discharge Coefficient

4.27.1 Requirement

Discharge coefficient tests shall be conducted on assemblies of each submitted orifice size to determine conformance within the Approval requirements for the equivalent automatic sprinklers as stated in Table 3.2.6 in FM Approval Standard 1625. The mean value of the K-Factor shall be consistent with Table 4.3.1 of FM Standard 1625 when tested as detailed below. Additionally, no individual values may fall outside of the stated range.

4.27.2 Tests/Verification

Prepare the assembly for testing by connecting a water supply line to one end of the assembly, with the ball of the test and drain valve in the partially open position. The only outlet for the water is through the test and drain valve. Slowly fill the entire assembly with water making sure to release any trapped air. Once full, the sample is ready to test.

Readings over the manufacturers operating pressures ranges shall match those obtained during testing.

4.28 Spray Pattern Demonstration

4.28.1 Requirement

The spray pattern of each nozzle shall be verified to match that specified by the manufacturer as to the a) Spray Establishment Time and b) the spray pattern as to its capability of filling the entire duct up to the maximum diameter. The Spray Establishment Time shall be maintained throughout the entire range of air velocities specified by the manufacturer.

4.28.2 Test Verification

Static demonstrations of the spray pattern can often determine the nozzle's response time and spray pattern but practical/live demonstrations of the discharge in full scale in-duct applications are generally required.

a) The *Spray Establishment Time* shall be verified to be $\leq$ those specified by the manufacturer
b) The spray pattern shall be verified so that complete in-duct coverage can be expected within the SET specified by the manufacture.

Note: This in-duct demonstration must be supplied or provided by the manufacturer.

4.29 Software Requirements

4.29.1 Requirement

Equipment dependent on software program(s) to achieve proper operation shall meet all of the requirements described below.

4.29.2 Tests/Verification

- Any changes to the software /firmware shall result in a revision to the release level. (refer 6.2.2)
- The operating software and firmware shall not be accessible for any changes or modification beyond what it has been Approved (listed) for. (refer 8.2.6.1.3)
- All software and firmware shall be protected from unauthorized changes. (6.2.2.2)
- Any software failure that renders the system inoperable shall result in a trouble condition at the fire alarm control (e.g. watchdog timer).

4.30 Additional (Optional) Tests

Additional tests may be required depending on design features and results of any foregoing tests.

4.31 Test Failure Disposition

Any test following a failure shall be acceptable with a technical justification of the conditions or reasons for failure.

4.32 Manufacturing and Production Tests

4.32.1 Dielectric Voltage-Withstand Test

Equipment rated at 30V rms or 60 V dc and above shall be dielectric tested on 100% of production. The power leads and/or relay terminal leads and associated circuitry shall withstand for one minute with no insulation breakdown, the application of 1,000 V ac, 60 Hz, or 1,400 V dc with respect to protective ground lead. Alternatively, test potential 20% higher may be applied for at least one second.

WARNING

The dielectric test required may present a hazard of injury to personnel and/or property and should be performed only by persons knowledgeable of the potential hazards of such testing to minimize the likelihood of shock and/or fire.

4.32.2 Ground Continuity Test

The manufacturer shall verify the electrical continuity of any high-voltage cord-connected equipment to the grounding blade of the attached plug.

APPENDIX A: UNITS OF MEASUREMENT

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") $m^2 = ft^2 \times 0.0929$
MASS:	lb - "pounds"; (kg - "kilograms") kg = lb x 0.454
PRESSURE:	psi - "pounds per square inch"; (bar - "bar") kPa = psi x 6.895
	bar - "bar"; (kPa - "kilopascals") bar = kPa x 0.01 bar = psi x 0.06895
HEAT:	Btu - "British thermal units"; (J - "joules") $J = Btu \times 1.0551 \times 10^3$
HEAT RELEASE RATE:	Btu/min -"British thermal units per minute"; (kW - "kilowatts") kW = Btu/min x 0.0176
TEMPERATURE:	°F - "degrees Fahrenheit"; (°C - "degrees Celsius") °C = (°F - 32) x 0.556
LIQUID:	gal - "gallons"; (L - "liter") L = gal x 3.785
	L - "liter"; (dm^3 - "cubic decimeters") $L = dm^3$
FLOW RATE:	gal/min - "gallon per minute"; (L/min - "liters per minute") L/min = gal/min x 3.785