Examination Standard
for
Heat Detectors for Automatic Fire Alarm Signaling

Class Number 3210

October 2021

Foreword

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

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

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1 INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification requirements for heat detectors for automatic fire alarm signaling.

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

1.2 Scope

1.2.1 This standard applies to heat detectors intended for use in fire alarm signaling or extinguishing system applications that operate via the transfer of convected heat energy. This standard employs test protocol dependent on the transfer of heat via convection and not that of radiated energy. The types of heat detectors normally covered by this standard include but are not limited to spot or location specific devices.

1.2.2 Other types of commercially available heat detectors may or may not be applicable to the test protocol described in this document.

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 heat detectors for the purpose of obtaining certification. Heat detectors having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

1.4 Basis for Certification

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

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

- the suitability of the product;
- the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
- the durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5 Basis for Continued Certification

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

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agency's product surveillance program.

1.6 Effective Date

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

The effective date of this Standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this Standard.

1.8 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.

- ANSI/IEEE/ASTM SI 10 - American National Standard for Metric Practice
- ANSI/NFPA 72, National Fire Alarm & Signaling Code®
- ANSI/NEMA 250 – Enclosures for Electrical Equipment (1,000 Volts Maximum)

1.9 Term and Definitions

For purposes of this standard, the following terms apply:

Orientation, Best Case – The orientation of a detector relative to the air stream which results in the fastest operating time, or the lowest Response Time Index (RTI).

Orientation, Worst Case – For use in this standard, the worst case orientation of a detector relative to the air stream which results in the slowest operating time, or the highest Response Time Index (RTI). Testing shall verify that no more than a 50% variation is allowed when compared to the Best Case RTI when the detector orientation to the air stream is rotated through four 90 degree quadrants.

Response Time Index – A measure of heat detectors sensitivity expressed as $RTI = \tau (u)^{½}$ where τ is the time constant of the heat responsive element in units of seconds, and u is the gas velocity expressed in feet per second (or meters per second). The quantity relates the properties of the heat responsive element and the heated gas flow. RTI can be used to predict the response of a heat detector in fire environments defined in terms of gas temperature and velocity versus time. RTI is expressed in units of $(ft.s)^{½}$ or $(m.s)^{½}$.

Heat Detectors for Automatic Fire Alarm Signaling – An automatic, heat actuated, electrical switching device used to detect accidental fires via an abnormally high temperature. A heat detector in service is usually ceiling mounted and operates with other equipment as part of a fire alarm signaling or extinguishing system.

Heat Detector, Spot Type – A heat detector with a sensing element that is concentrated in a particular location, or spot. These devices usually fall into three categories;

Fixed Temperature Heat Detector – A heat detector that responds when the operating element of the detector reaches a specified temperature. The actual air temperature surrounding the sensing element is often much greater than the rated temperature due to thermal lag

Rate-Compensated Heat Detector – A heat detector that responds to a specified fixed temperature, regardless of the rate-of temperature rise.

Rate-of-Rise Heat Detector – A heat detector that responds when the rate-of temperature rise exceeds a specified design threshold.

Heat Detector, Line Type – A heat detector in which the "detection" capability is continuous along the entire length (or line) of the device.

Heat Detector, Heat Sensitive Cable – A Line Type of Detector that has a heat sensitive element whose characteristic (often electrical resistance) changes depending on the air temperature surrounding the cable.

Cr – Rate of Rise Temperature Activation Point – The calculated Rate-of-Temperature Rise that causes actuation in a Rate-of-Rise heat detector element when tested in accordance with the plunge tunnel guidelines described in section 4.6.1.2 of this standard.

K – Change Rate – The rate of temperature rise that the plunge tunnel is set to when measuring or defining the activation point Cr above.

Trv – Virtual Temperature Rating – The measured actuation temperature of a Rate Compensated heat detector when tested in accordance with the plunge tunnel guidelines described in section 4.6.1.3 of this standard.

2 GENERAL INFORMATION

2.1 Product Information

Heat detectors fall into three (3) general categories: fixed temperature, rate-of-rise and rate compensated. They are intended to detect (respond to) changes in the temperature of the ambient air. They are installed through heat convection or the transfer of heated air to the sensing element of the detector. Other designs meeting the criteria of this standard may also be considered for certification.

2.2 Certification Application Requirements

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

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, etc.; 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 documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

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

- For functional testing described below, the manufacturer must provide a minimum quantity of 12 of each detector type which are deemed to be representative of the manufacturer’s normal production regarding construction and calibration.

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

2.3.3 The manufacturer shall submit samples representative of production.

2.3.4 Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.3.5 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the product(s).

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 ease and practicality of installation and use. The certification investigation shall define the limits of the final certification.

3.2 Physical or Structural Features

3.2.1 Required Features

3.2.1.1 Means shall be provided to mount the detector securely and independently of the wiring.

3.2.1.2 The detector shall be capable of withstanding normal handling and installation.

3.2.1.3 Means shall be provided to identify that a detector is in alarm. If the detector is equipped with an integral alarm indicator LED, it shall be red in color.

"Exception: Resettable mechanical contact only type detectors"

3.2.1.4 Heat detectors intended for use in hazardous (classified) locations shall comply with certification requirements for hazardous (classified) location electrical equipment in addition to this standard.

3.2.1.5 The detector and enclosure shall be suitable for the intended environmental exposures as determined by testing in accordance with acceptable national, regional, or international electrical codes.

3.2.1.6 The detector shall accommodate secure wiring methods in accordance with NFPA 72.

3.2.1.7 The detector shall be compatible with a certified fire alarm control unit that will produce an alarm and a distinctive trouble signal.

3.2.1.8 Spot Type Heat Detectors shall have a Response Time Index as defined below

a) Fixed Temperature and Rate Compensated Devices – Less than 125 $(ft\cdot s)^{1/2}$ (68 $[m\cdot s]^{1/2}$)

b) Rate of Rise Devices – Less than 1,400 $(ft\cdot s)^{1/2}$ (770 $[m\cdot s]^{1/2}$)

c) Rate Compensated – Less than 138 $(ft\cdot s)^{1/2}$ (76 $[m\cdot s]^{1/2}$)

3.2.1.9 Other forms of Heat Detection that cannot conform to the RTI testing parameters of this document shall have specific spacing guidelines in accordance with this standard.

3.2.1.10 Detectors rated at or above 30 V ac and 60 V dc require a proper ground terminal to be provided.

3.2.1.11 Duplicate terminals or leads, or their equivalent, shall be provided on each heat detector for the express purpose of connecting into the fire alarm system to provide supervision of the device and termination in accordance with NFPA 72 requirements.

3.3 Marking

3.3.1 Marking on the product or, if not possible due to size, 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, operating voltage, electrical rating, temperature rating and RTI Classification. When hazard warnings are needed, the markings shall be universally recognizable.

3.3.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity . The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.3.3 The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate. The manufacturer shall not use this mark on any other product unless such product is covered by a separate report.

3.3.4 All markings shall be legible and durable.

3.4 Manufacturer's Installation and Operation Instructions

3.4.1 The manufacturer shall provide the user with:

- 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.

3.4.2 The instructions for two-wire detectors shall either include or provide reference to other identifiable literature and its source that contains the following information:

a) Name of manufacturer, model number(s) of compatible control unit(s), IDC interface and compatibility identification marker.

b) Identification of any part of the control unit, such as specific wiring terminal numbers, or reference to the control unit installation wiring diagram by issue number and date, or any other variables requiring programming which are a factor in determining compatibility.

c) The maximum number of detectors that are intended to be connected to each initiating device circuit of the control unit. This includes detectors that employ an integral component, such as a relay or sounder that consumes power during an alarm condition.

d) Minimum and maximum rated operating voltage, standby current, and alarm current required for intended operation of integral components, such as a relay or sounder.

3.5 Calibration

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

3.5.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

4 PERFORMANCE REQUIREMENTS

4.1 Storage Temperature Pre-Conditioning

4.1.1 The detector shall be capable of withstanding extended storage at temperatures of -40° and 125°F (-40° and 52°C) with no adverse effects.

4.1.2 Detector samples shall be subjected to -40° and 125°F (-40° and 52°C) for a period of 24 hours at each extreme and allowed to attain thermal equilibrium at normal room temperature prior to continuing with any other tests.

4.2 Elevated Ambient Temperature Test – (Oven Test)

4.2.1 The detector shall be able to remain at 10% below its rated fixed operating temperature without false alarm. 10% below is defined as 10% of the operating temperature expressed in °F, relative to 0°F. For example, for a detector rated at 135°F, 10% is 13.5°F.

4.2.2 Two detector samples shall be subjected to a temperature 10% below its rated set-point rating while powered and monitored without false signals occurring for a period of four hours.

4.3 Humidity Tests

4.3.1 The detector shall remain functional and produce no false indication of fire when subjected to the following humidity test as follows:

a) For detectors intended solely for indoor dry environments, a relative humidity of 85%±5% and temperature of 90°F±3°F (32°C±2°C) for a period of 24 hours.

b) For detectors intended for indoor/outdoor damp or wet environments, a relative humidity of 95%±3% and temperature of 140°F±3°F (60°C±2°C) for a period of 24 hours.

4.3.2 After conditioning at 50% relative humidity and 70°F (21°C) for four hours, the test sample shall remain functional and produce no false indication of fire when subjected one of the following conditions.

4.3.3 The test sample will be conditioned in a relative humidity and temperature as noted in paragraph 4.3.1.a or 4.3.1.b (above) for a period of 24 hours. There shall be no trouble signal and no false indication of fire during this exposure.

4.4 Set-Point Accuracy (Oven Tests) – Fixed and Rate Compensated Devices

4.4.1 Detector samples shall operate within 5% of its rated fixed operating temperature.

4.4.2 Three detector samples shall respond within +/-5% of its rated set-point (expressed in °F relative to 0°F) when subjected to an ambient temperature, increasing less than 2.0°F (1.1°C) per minute.

4.5 Set-Point Accuracy (Oven Tests) – Rate-of-Rise Devices

4.5.1 Detector samples shall operate at a temperature rate-of-rise of between 15° and 25°F (8.3° and 13.9°C) per minute.

4.5.2 Three detector samples shall be subjected to an increasing ambient of 15°F (8.3°C) per minute (starting at a room temperature of 68°F [20°C]) and checked for alarm operation. ***If no response is observed, the test shall be repeated, adding 2°F (1.1°C) per minute increments until detector***

operation is determined. Operation must occur prior to the maximum rate of 25°F (13.9°C) per minute.

4.6 Sensitivity Spacing Test – (Plunge Tunnel or Full Scale Fire Test)

The installation spacing limitations of spot type heat detectors is determined through a series of plunge tunnel test to determine the RTI value as described in sections 4.6.1.

Due to size or technology limitations, some heat detectors that can not be subject to a plunge tunnel operation will require full scale fire testing as described in sections 4.6.1(A).

Response Time Index (RTI)

4.6.1 All spot type fixed temperature, rate compensated and rate-of-rise heat detectors, shall have a Response Time Index (RTI) within the limits detailed in Table 4.6.1 (4.6.2 or 4.6.3 as applicable) when the detector is tested in the best case orientation.

Table 4.6.1: Fixed Temperature Detectors

Detector Temperature Rating	*Standard*	*Quick*	*Fast*
135°F (57°C)	< 125 (ft•s)^{½} < 68 (m•s)^{½}	< 45 (ft•s)^{½} < 25 (m•s)^{½}	< 5 (ft•s)^{½} < 3 (m•s)^{½}
160°F (71°C)	< 120 (ft•s)^{½} < 66 (m•s)^{½}	< 40 (ft•s)^{½} < 22 (m•s)^{½}	< 3 (ft•s)^{½} < 2 (m•s)^{½}
190°F (88°C)	< 120 (ft•s)^{½} < 66 (m•s)^{½}	< 40 (ft•s)^{½} < 22 (m•s)^{½}	< 3 (ft•s)^{½} < 2 (m•s)^{½}

4.6.2 All spot type rate-of-rise only heat detectors, shall have a Response Time Index (RTI) within the limits detailed in Table 4.6.2 when the detector is tested in the best case orientation.

Table 4.6.2: Rate of Rise Detectors (Cr = 16°F/min (9°C/min)

Detector Temperature Rating	*Quick*	*Fast*	*Very Fast*	*Ultra Fast*
135°F (57°C)	< 600 (ft•s)^{½} < 330 (m•s)^{½}	< 440 (ft•s)^{½} < 135 (m•s)^{½}	< 280 (ft•s)^{½} < 85 (m•s)^{½}	< 120 (ft•s)^{½} < 66 (m•s)^{½}
160°F (71°C)	< 950 (ft•s)^{½} < 520 (m•s)^{½}	< 725 (ft•s)^{½} < 220 (m•s)^{½}	< 475 (ft•s)^{½} < 145 (m•s) ^{½}	< 220 (ft•s)^{½} < 120 (m•s)^{½}
190°F (88°C)	< 1400 (ft•s)^{½} < 770 (m•s)^{½}	< 1050 (ft•s)^{½} < 320 (m•s)^{½}	< 700 (ft•s)^{½} < 213 (m•s)^{½}	< 350 (ft•s)^{½} < 193 (m•s)^{½}

Note * – This is the temperature rating of the sprinkler used in full scale fire tests determining detector spacing.

4.6.3 All spot type rate compensated temperature, heat detectors, shall have a Response Time Index (RTI) within the limits detailed in Table 4.6.3 when the detector is tested in the best case orientation.

Table 4.6.3: Rate Compensated Detectors

Detector Temperature Rating	*Quick*	*Fast*	*Ultra Fast*
135°F (57°C)	< 117 (ft•s)^{½} < 64 (m•s)^{½}	< 52 (ft•s)^{½} < 29 (m•s)^{½}	< 16 (ft•s)^{½} < 9 (m•s)^{½}
160°F (71°C)	< 138 (ft•s)^{½} < 76 (m•s)^{½}	< 68 (ft•s)^{½} < 39 (m•s)^{½}	< 25 (ft•s)^{½} < 14 (m•s)^{½}
190°F (88°C)	< 125 (ft•s)^{½} < 69 (m•s)^{½}	< 54 (ft•s)^{½} < 30 (m•s)^{½}	< 16 (ft•s)^{½} < 9 (m•s)^{½}

4.6.4 A maximum deviation or spread of RTI values obtained from all ten samples shall be within a 10% range.

4.6.5 Compliance with the requirements for RTI shall be determined by operating detector samples in a plunge tunnel, as described below. The plunge tunnel is further described in Appendix A. All tests shall be conducted with the geometric center of the heat responsive element located at least 1.5 in. (38 mm) from the interior horizontal surfaces of the test section, and with the centerline perpendicular to the air flow through the test chamber.

4.6.6 Ten samples shall be tested in the best-case orientation, as described in Section 4.6.1. If, in the judgment of the certification agency, compliance with the requirements for worst-case RTI is in question, a sufficient number of tests may be conducted in various detector orientations relative to air flow, such that the worse-case orientation is determined. Subsequently, five samples shall be tested in the worst case orientation, and five samples shall be tested in the best case orientation.

4.6.7 The plunge tests are conducted using the detector mount detailed in Appendix Figure A-2. The detector alarm contacts shall be monitored for detector operation in accordance with the manufacturers' instructions or recommendations.

4.6.8 A tunnel with gas velocity and temperature conditions as prescribed in the following tables (4.6.8.1, 4.6.8.2 and 4.6.12.2) in this section shall be utilized to conduct the RTI test.

4.6.8.1 Plunge Tunnel Parameters for Fixed Temperature Devices.

Table 4.6.8.1 Plunge Tunnel Parameters for Fixed Temperature Devices.

Fixed Temperature Rating		*Temperature in Test Section*		*Average Gas (Air) Velocity of Test Section*	
°F	*(°C)*	*°F*	*(°C)*	*ft/s*	*(m/s)*
135°F	(57°C)	387	197	5	1.6
160°F	(71°C)				
190°F	(88°C)				

4.6.8.2 Plunge Tunnel Parameters for Rate-of-Rise Temperature Devices.

Table 4.6.8.2 Plunge Tunnel Parameters for Rate-of-Rise Temperature Devices.

Rate-of-Rise Temperature Rating		*Rate of Rise (K) in Test Section*		*Average Gas (Air) Velocity of Test Section*	
°F	*(°C)*	*°F/S*	*(°C/S)*	*ft/s*	*(m/s)*
15°F/min	9.1°C/min	0.36	0.2	4.65	1.5
		0.42	0.231		
		0.5	0.277		

4.6.8.3 Plunge Tunnel Parameters for Rate-Compensated Devices

4.6.8.4 Rate-Compensated Devices shall be verified by testing to both tables 4.6.8.1 and 4.6.8.2.

4.6.9 Each detector and mount shall be allowed to reach ambient temperature for a period of not less than 5 minutes prior to testing.

4.6.10 A timer accurate to +/- 0.01 seconds, with suitable controlling devices shall be used to accurately measure the time to operate.

4.6.11 In all cases, the RTI shall meet the requirements as stated in this section when calculated as follows:

Fixed Temperature Plunge Tunnel

Fixed Temperature Plunge Tunnel

Where RTI

$$= \frac{\sqrt{\mu}\ t_i^f}{1\text{n}\left(\frac{T_g - T_o}{T_g - T_\gamma}\right)}$$

μ = plunge tunnel air velocity

t_i^f = elapsed time to activation

T_g = plunge tunnel air temperature

T_o = ambient Temperature

T_γ = Temperature Rating of Detector (or Trv for Rate Compensated Type)

Rate of Rise Plunge Tunnel

Where $RTI = t\ \sqrt{\mu}$

$$t = \frac{-\,t_i^f}{1\text{n}\left(1 - \frac{Cr}{k}\right)}$$

t_i^f = elapsed time to activation

Cr = detector R-o-R activation point

k = plunge tunnel R-o-R setting

4.6.12 Detector Classification Verification Tests

(For Rate Compensated vs. Rate of Rise Only)

4.6.12.1 Detectors other than simple fixed set point devices (i.e., rate of rise or rate compensated) will be subjected to plunge tunnel tests of varying start temperature of the ambient air inside the tunnel. A Rate-of-Rise device will have an activation point that increases linearly following the initial ambient conditions while the Rate-Compensated device will activate at relatively the same temperature, regardless of the ambient starting point.

4.6.12.2 Detectors will be tested using the parameters described in the table below. A linear increase in temperature activation point indicates a true Rate-of-Rise device while a consistent (or slightly decreasing) activation point indicates a Rate Compensated device.

Table 4.6.12.2

Initial Temperature		*Rate of Rise (K) in Test Section*		*Average Gas (Air) Velocity of Test Section*	
°F	*(°C)*	*°F/S*	*(°C/S)*	*ft/s*	*(m/s)*
68°F	20°C	0.36	0.2	4.65	1.5
86°F	30°C				
104°F	40°C				

4.7 Alternate Full-Scale Spacing Test for Non-Spot Types of Heat Detection

4.7.1 A heat detector shall operate at least as quickly as a comparably rated, standard response, automatic sprinkler on a 10 ft by 10 ft (3.05 m by 3.05 m) spacing when exposed to the same heat conditions.

4.7.2 The maximum spacing of non-spot type heat detectors shall be determined through full scale fire tests that simulate a ceiling mounted detector exposed to a floor level fire.

4.7.3 The test compares the response of the comparably rated sprinkler on a 10 ft (3 .05 m) spacing and heat detectors under test installed at 15 ft (4.57 m), 20 ft (6.1 m), 25 ft 7.6 m) and 30 ft (9.1 m). The test fire is sized such that sprinkler operation occurs two minutes after ignition. Refer to Appendix A-4 for more information.

4.7.4 Line type and heat sensitive thermal cable is tested with a 20ft (6.1m) section installed on the ceiling forming a 90 degree angle with each leg measuring 10 ft (3.05 m). This 20 ft section and 90 degree angle is repeated for each representative spacing distance (15, 20, 25 or 30 ft). Refer to figure A-3 for more information.

4.8 Voltage Range

4.8.1 The device shall be operated between 85% and 110% of nominal rated input voltage. Over that range, it shall produce no trouble signal or false indication of fire and shall meet the applicable requirements of either 4.4 or 4.5 with the exception that Fixed and Rate Compensated Devices shall operate within 10% of rated set-point. If an absolute voltage range, beyond the 85% and 110% of nominal, is specified by the manufacturer, the unit will be tested at the extremes of the range.

4.8.2 The device, with nominal rated voltage applied, shall be exposed to the Set-Point test described in 4.4 and 4.5 and actuation points recorded. The input voltage shall then be varied from 85 to 110% of nominal, or the manufacturer's range (whichever is greater). The unit shall produce less than 10% shift in rated set-point, no trouble signal, and no false indication of fire during these tests.

4.9 Vibration

4.9.1 The detector assembly, including base and mounting hardware, shall withstand the effects of vibration.

4.9.2 With rated input voltage applied and mounted in its intended orientation the detector shall be subjected to a 4-hour vertical vibration test of 0.02 in. (0.5 mm) total displacement at a linear frequency sweep of 10 to 30 Hz, at sweep rate of approximately two cycles per minute. The unit shall produce no false indication of alarm or non-resettable trouble signal, and shall meet the applicable requirements of either 4.4 or 4.5 with the exception that Fixed and Rate Compensated Devices shall operate within 10% of rated set-point at the conclusion of this test. There shall be no loosening of parts or permanent deformation as a result of this test.

4.10 Jarring

4.10.1 The detector assembly, including base and mounting hardware, shall withstand the jarring resulting from an impact as might be expected during normal installation.

4.10.2 With rated input voltage applied and mounted in its intended orientation to a ¾ in. (19.1 mm) thick plywood board measuring 6 by 4 ft (1.8 by 1.2 m) secured in place at four corners. The detector shall be subjected to a 3 foot-pound (4.08 joule) impact applied to the reverse side of this board via a 1.18 pound (0.54 kg), 2 inch (50.8 mm) diameter steel sphere swung through an arc (or dropped) from a height of 2.54 ft (775 mm), depending on the mounting for the equipment (see Appendix A-4). The unit shall produce no false indication of alarm signal or non-resettable trouble signal, and shall meet the applicable requirements of either 4.4 or 4.5 with the exception that Fixed and Rate

Compensated Devices shall operate within 10% of rated set-point at the conclusion of this test. There shall be no loosening of parts or permanent deformation as a result of this test.

4.11 Dielectric Strength

4.11.1 The device shall provide the required degree of protection from electrical shock.

4.11.2 A sample detector shall successfully withstand for one minute a 60 Hz dielectric strength test of 1000 V ac plus twice the maximum rated voltage.

4.11.3 Detectors whose voltage ratings are less than 30 V ac or 60 V dc shall successfully withstand 500 V ac or 707 V dc for one minute.

4.11.4 The dielectric strength test potential shall be applied between the protective ground terminal and all applicable combinations of the following: power supply line conductors, signaling circuit conductors, and other input or output conductors.

4.12 Bonding

4.12.1 Any accessible conductive surface which is likely to become energized in the event of a fault shall be bonded to the protective ground terminal with a circuit resistance of less than or equal to 0.1 ohm. This requirement applies to heat detectors in which the maximum voltage is greater than 30 V rms or 60 V dc. The bonding conductor(s) shall be green or green with one or more yellow stripes. The size of the bonding conductor(s) shall be at least equivalent in size to the primary circuit conductors.

4.12.2 The detector sample shall be evaluated according to Section 4.11. Measurements of bonding resistance shall be made with a calibrated multimeter.

4.13 Durability

4.13.1 A re-settable detector susceptible to the wearing of parts (i.e., a mechanical relay) shall be cycled through 500 operate-reset functions under maximum rated load.

4.13.2 A detector head/base combination that is attached or secured via a snap or twist type action shall withstand 50 cycles of removal and replacement and comply with the jarring test, section 4.10.

4.13.3 One or more sample detectors shall be cycled through 500 power on/off cycles. The device is required to perform its switching function satisfactorily at the conclusion of the test, and it must not exhibit any instability such as alarm signals and non-self-restoring trouble signals during testing.

4.13.4 A detector installed as intended, shall be removed and replaced or open and closed following the manufacturer’s instructions prior to performing the jarring test described in section 4.10.

4.14 Reverse Polarity

4.14.1 A heat detector shall operate as intended following a reverse polarity connection for a minimum of 24 hours or until a trouble or alarm signal is obtained. A trouble or alarm signal is permitted under a reversed polarity condition.

4.14.2 A detector sample is to be powered with the power leads reversed for a period of 24 hours or until a trouble or alarm signal is obtained.

4.14.3 Following this exposure and re-connected in accordance with the manufacturer’s instructions, the detector will have its set-point accuracy, re-verified. The device shall meet the applicable requirements of either 4.4 or 4.5 with the exception that Fixed and Rate Compensated Devices shall operate within 10% of rated set-point.

4.15 Dust Test

4.15.1 The sensitivity of a heat detector shall not be reduced by the accumulation of dust.

4.15.2 Two detector samples are placed un-energized in the air tight dust chamber. Approximately 2 ounces (0.06kg) of cement dust, maintained in an ambient room temperature of approximately 73.4 +/- 3.6ºF (23 +/- 2ºC) at 20-50% relative humidity and capable of passing through a 200 mesh screen, are to be circulated for 15 minutes by means of compressed air or blower to completely envelop the sample in the chamber. The air flow is maintained at an air velocity of at least 50fpm (0.25m/s).

4.15.3 Following exposure to dust, the detector is to be removed carefully and its set-point accuracy, re-verified. The device shall meet the applicable requirements of either 4.4 or 4.5 with the exception that Fixed and Rate Compensated Devices shall operate within 10% of rated set-point.

4.16 Static Discharge Test

4.16.1 The intended performance of the detector shall not be impaired or a false alarm obtained, when the detector is subjected to static electric discharges.

4.16.2 Two detector samples are mounted on the underside of a ¾ inch (19.1mm) thick plywood panel in its intended mounting position and connected to a nominal power source in accordance with the manufacturer’s instructions. If an electrical junction box is normally employed, it shall be properly connected to earth ground for the purpose of this test.

4.16.3 A 250 Picofarad low leakage capacitor, is charged through a 1,500 ohm resistor for a minimum of 2 seconds to a 10,000 Vdc power source. Once charged, it is then discharged through an insulated 3 ft long probe with ½ in. (12.7 mm) spherical ends by attaching one probe to the detector and the other to earth ground. A commercial static discharge tester meeting the voltage and impedance requirements may also be employed.

4.16.4 Discharges shall be applied at 5 minute intervals to different positions on the surface of the detector as well as locations accessible during cleaning or field adjustments.

4.16.5 A total of 10 discharges are made with the probe, with an additional 10 discharges to the accessible internal locations unless the detector is marked that no field servicing is possible.

4.17 Extraneous Transients

4.17.1 No false signal will be generated when the heat detector is subjected to extraneous transients from sources which are described below.

4.17.2 One powered sample of the detector will be subjected to extraneous transients described below.

a) radio frequency transmissions with radiation power levels equivalent to 5 Watts at 24 inches (0.6 m) in the 27 MHz, 150-174 MHZ, 450-467 MHZ, 850-870 MHz, and 900-920 MHz bands.

b) 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 hertz primary; 10,000 volts, 60 hertz, 23 mA secondary. The two wires are to be formed in a taper, starting with a ⅛ in. (3.2 mm) separation at the bottom (adjacent to terminals) and extending to 1.25 in. (32 mm) at the top.

c) operation of an electric drill rated 120 V, 60 Hz, 2.5 A.

d) operation of a soldering gun rated 120 V, 60 Hz, 2.5 A.

e) operation of a 6 in. (150 mm) diameter solenoid-type vibrating bell with no arc suppression and rated 24 V dc.

The detector will produce no false alarm or trouble signal in the presence of these extraneous transients.

4.18 Surge Transient Tests

4.18.1 Protection against line surge transients will be a requirement for each submitted heat detector.

4.18.2 One powered sample of the detector will be subjected to transient waveforms having peak levels of 100, 500, 1000, 1500, and 2400 V dc, as delivered into a 200 ohm load. This test applies to all field wiring terminals that have a possibility of being subjected to line-induced voltage (i.e., initiating device circuits, power circuits, and remote/auxiliary connections). The device is required to perform satisfactorily at the conclusion of the test, and it must not exhibit any instability such as alarm signals and non-self-restoring trouble signals during testing.

EXCEPTION:

Circuits specified to be 20 ft (6 m) or less in length and in conduit.

4.19 Enclosure Requirements (Including Polymeric Housings)

4.19.1 The detector enclosure must meet the ingress protection requirement only for ANSI/NEMA 250 Type 1 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 appropriate enclosure classifications.

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

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

4.19.4 Polymeric Materials, three complete detector samples (if possible) 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 distortion, removed and allowed to cool. Examination shall verify that the detectors normal operation is not affected and that there is no exposure to high voltage components.

5 OPERATIONS REQUIREMENTS

5.1 Demonstrated Quality Control Program

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

- Design quality is determined during the examination and tests, and is documented in the certification report
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

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

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

5.1.3 Documentation/Manual

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

5.1.4 Records

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

5.1.5 Drawing and Change Control

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

5.2 Surveillance Audit

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

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

5.3 Installation Inspections

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

5.4 Manufacturer's Responsibilities

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

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APPENDIX A: Figures

A-1: Response Time Index/R-O-R Plunge Tunnel

A-2: Plunge Tunnel Test Plate

A-3: Alternate Spacing Test Layout

A-4: Jarring Test

Figure A-1: Response Time Index/Rate of Rise Plunge Test Tunnel

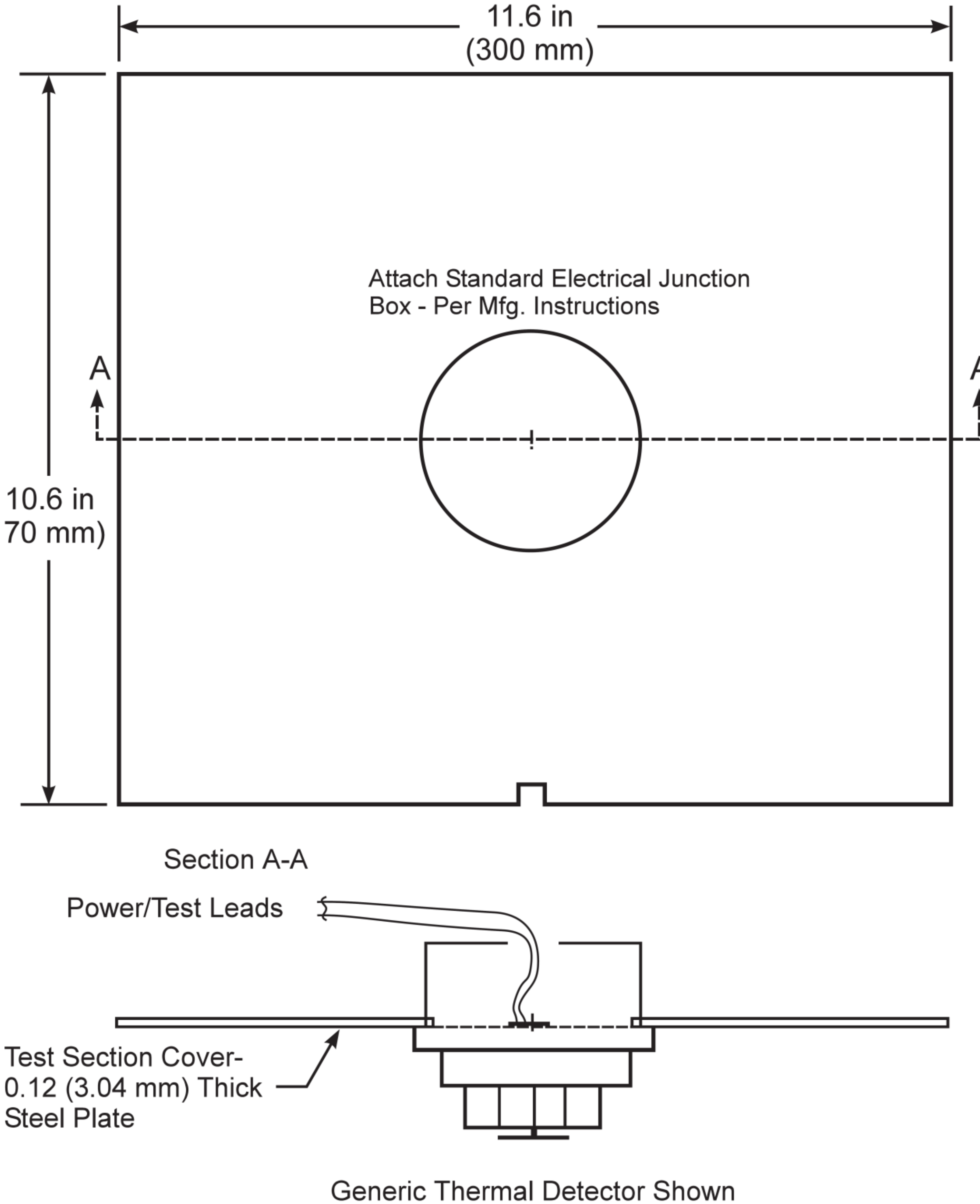

Figure A-2: Plunge Tunnel Test Plate (for Sensitivity – RTI Test)

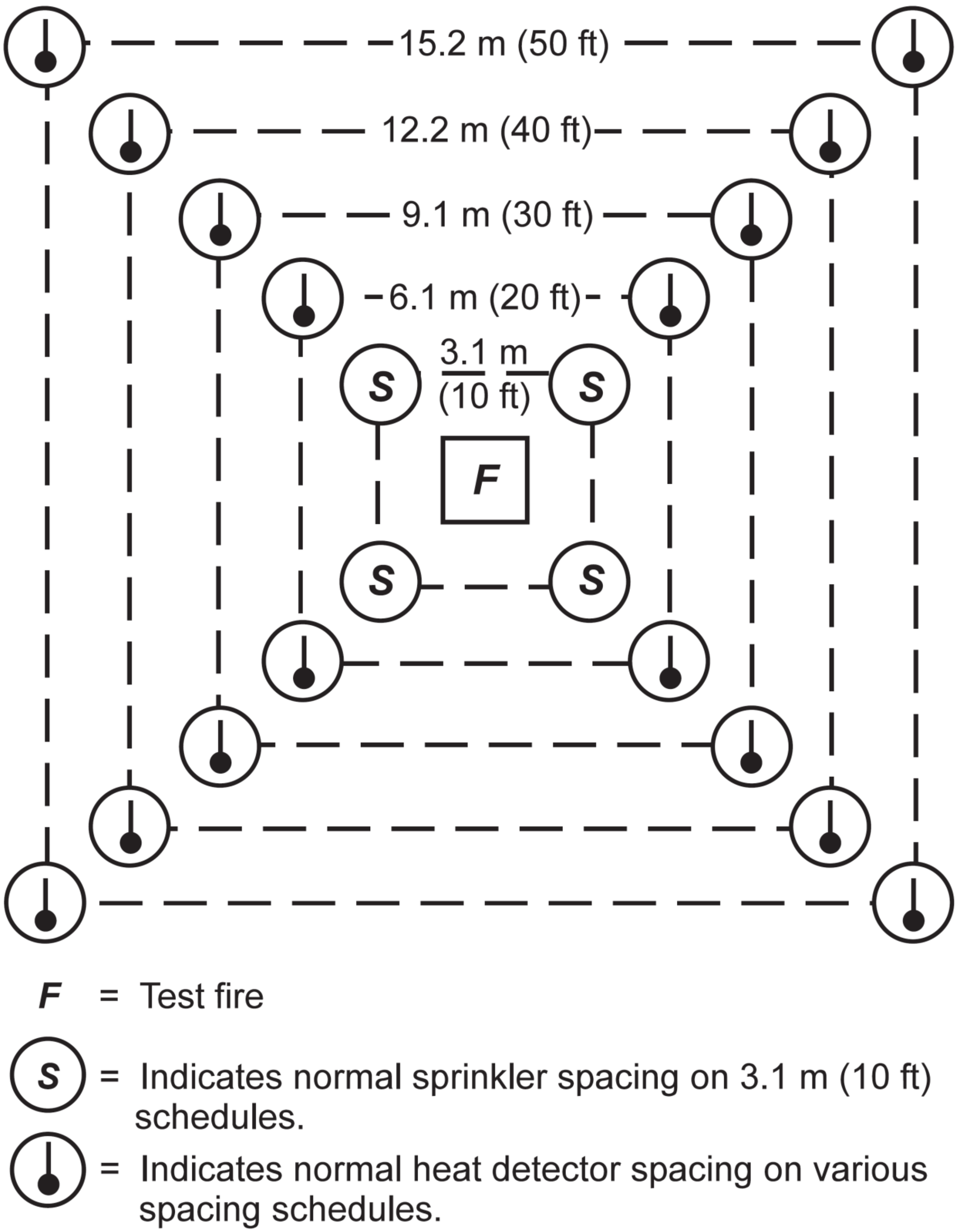

Figure A-3: Alternate Spacing Test Layout

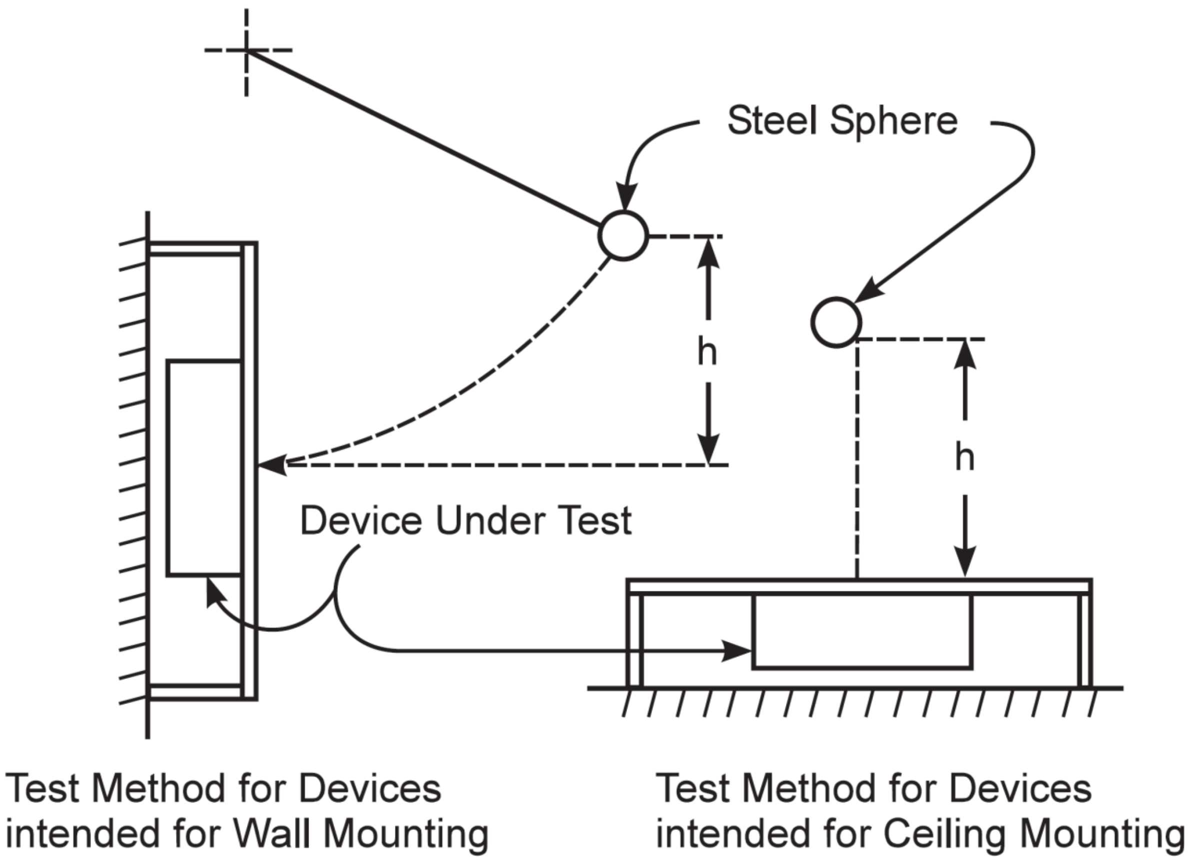

Figure A-4: Jarring Test

APPENDIX B: Examples of RTI used for Maximum Detector Spacing

The maximum spacing of heat detectors has long been determined through a series of actual fire tests. A sprinkler with a temperature rating close to that of the detector under consideration was installed at the center of a 10 ft by 10 ft spacing as the reference detecting device. Detectors were then installed at various common spacing distances and a fire source was located at the most remote place from the installed detectors and the sprinkler. The fire size was adjusted so that sprinkler actuation occurred within 2 minutes (+/- 30 seconds) of ignition. Detectors that successfully activated prior to the reference sprinkler actuation determined the maximum spacing of the given detector model.

In practice, however, some difficulties were realized when the standard tests were executed. First, it is not always possible to find a reference sprinkler the temperature rating of which matches exactly with that of the detector under consideration. Second, choosing a standard fire source that would actuate the reference sprinkler within 2 min plus minus 30 seconds depends on the ambient temperature and the test site dimension to a large extent. The size of the source fire can make large differences in determining spacing of heat detectors. Thus, it is desirable if the RTI of the detectors can be indexed to detector spacing so that no more real fire tests may be required to assign detector spacing.

It is, however, necessary to recognize that the indexing of RTI to the maximum detector spacing should depend on the site and the intended objective of the detector at each specific location. The following text depicts one example and will introduce several virtual fire sources that meet the requirements mentioned above. The computation can be carried out as follows:

1. A virtual reference sprinkler which has the same temperature rating as that of the detector was assumed to be installed on a 15-ft high flat ceiling 7.07-ft radial distance away from a fire source. The RTI of the sprinkler was assumed as 260 (ft.s)½. The fire source was assumed to be located on the floor. The heat release rate (HRR) of the fire source was arranged to have the sprinkler be activated around 120 s. Here the virtual fire source was invented based on the HRR of a fire from three wood cribs. Each crib meets the specification of the International Maritime Organization (IMO). The specified IMO crib consists of six, trade size 2 in. by 2 in. by 18 in. long, kiln dried spruce or fir lumber having a moisture content of 9 ~ 13 percent. The members should be placed in four alternate layers at right angles to one another. The approximate heat release rate of each crib is 300 kW.

2. After the source fire was determined with each temperature rating of the reference sprinkler, activation times of given detectors were computed with various RTI values using the same source fire. Among the detectors that responded earlier than the sprinkler actuation time, the location of the farthest one from the fire source was determined as the maximum spacing of the detector.

3. On the other hand, if the spacing classifications are already determined (one example: 20 × 20 ft, 25 × 25 ft, and 30 × 30 ft), a range of RTI values that correspond to each spacing category per temperature rating can be easily assigned too. The examples contained below in Appendix B are the outcome of the processes described above.

Fixed Temperature Detectors		
Detector Temperature Rating	Spacing and Associated RTI	
	(20 × 20) ft (6 × 6) m	(25 × 25) ft (8 × 8) m
135°F (57°C)	< 45 $(ft \cdot s)^{1/2}$ < 25 $(m \cdot s)^{1/2}$	< 5 $(ft \cdot s)^{1/2}$ < 3 $(m \cdot s)^{1/2}$
160°F (71°C)	< 40 $(ft \cdot s)^{1/2}$ < 22 $(m \cdot s)^{1/2}$	< 3 $(ft \cdot s)^{1/2}$ < 2 $(m \cdot s)^{1/2}$
190°F (88°C)	< 40 $(ft \cdot s)^{1/2}$ < 22 $(m \cdot s)^{1/2}$	< 3 $(ft \cdot s)^{1/2}$ < 2 $(m \cdot s)^{1/2}$

Rate of Rise Detectors (Cr = 16°F/min (9°C/min)				
Temperature Rating of Sprinkler in Spacing Test (see note *)	Spacing and Associated RTI			
	(20 × 20) ft (6 × 6) m	(25 × 25) ft (8 × 8) m	(30 × 30) ft (9 × 9) m	(50 × 50) ft (15 × 15) m
135°F (57°C)	< 600 $(ft \cdot s)^{1/2}$ < 330 $(m \cdot s)^{1/2}$	< 420 $(ft \cdot s)^{1/2}$ < 230 $(m \cdot s)^{1/2}$	< 320 $(ft \cdot s)^{1/2}$ < 176 $(m \cdot s)^{1/2}$	< 120 $(ft \cdot s)^{1/2}$ < 66 $(m \cdot s)^{1/2}$
160°F (71°C)	< 950 $(ft \cdot s)^{1/2}$ < 520 $(m \cdot s)^{1/2}$	< 650 $(ft \cdot s)^{1/2}$ < 360 $(m \cdot s)^{1/2}$	< 500 $(ft \cdot s)^{1/2}$ < 275 $(m \cdot s)^{1/2}$	< 220 $(ft \cdot s)^{1/2}$ < 120 $(m \cdot s)^{1/2}$
190°F (88°C)	< 1400 $(ft \cdot s)^{1/2}$ < 770 $(m \cdot s)^{1/2}$	< 1000 $(ft \cdot s)^{1/2}$ < 550 $(m \cdot s)^{1/2}$	< 750 $(ft \cdot s)^{1/2}$ < 412 $(m \cdot s)^{1/2}$	< 350 $(ft \cdot s)^{1/2}$ < 193 $(m \cdot s)^{1/2}$

Rate Compensated Detectors			
Detector Temperature Rating $T_r : T_{rv}$	Spacing and Associated RTI		
	(20 × 20) ft (6 × 6) m	(25 × 25) ft (8 × 8) m	(30 × 30) ft (9 × 9) m
135°F (57°C) : 120°F (49°C)	< 117 $(ft \cdot s)^{1/2}$ < 64 $(m \cdot s)^{1/2}$	< 52 $(ft \cdot s)^{1/2}$ < 29 $(m \cdot s)^{1/2}$	< 16 $(ft \cdot s)^{1/2}$ < 9 $(m \cdot s)^{1/2}$
160°F (71°C) : 136°F (58°C)	< 138 $(ft \cdot s)^{1/2}$ < 76 $(m \cdot s)^{1/2}$	< 68 $(ft \cdot s)^{1/2}$ < 39 $(m \cdot s)^{1/2}$	< 25 $(ft \cdot s)^{1/2}$ < 14 $(m \cdot s)^{1/2}$
190°F (88°C) : 161°F (72°C)	< 125 $(ft \cdot s)^{1/2}$ < 69 $(m \cdot s)^{1/2}$	< 54 $(ft \cdot s)^{1/2}$ < 30 $(m \cdot s)^{1/2}$	< 16 $(ft \cdot s)^{1/2}$ < 9 $(m \cdot s)^{1/2}$

Examination Standard Addendum Number: 1 August 2011

Class Number: 3210
Title: Heat Detectors for Automatic Fire Alarm Signaling
Date: April 2007

The information contained in this addendum addresses a new category of line type heat detectors for extremely corrosive environments. This is a line type heat detector with an exterior coating which enables its use in extremely corrosive environments such as flue gas desulphurization systems, metal acid pickling ducts and chemical industry exhaust systems. The corrosive environments encountered are typically; sulfuric, hydrochloric, nitric or hydrofluoric acids.

Manufacturers of all certified line type heat detection devices must comply with all relevant sections of FM3210 in addition to the requirements listed below to be Listed in this category.

The effective date is the release date shown at the top right of this Addendum. This information will be included in the next revision of the standard.

1. Linear Heat Detectors for Extremely Corrosive Environments

1.1. Linear heat detectors intended for use in extremely corrosive environments must be constructed with an outer coating of at least 99.0% of Halar (CAS # 25101-45-5, ECTFE fluoropolymer) coating.

Note: Other materials may be considered on a case-by-case basis but would require extensive laboratory and field-based testing. Additional testing for material evaluation may be required at the sole discretion of the certification agency.

1.2. All materials must be controlled by means of the manufacturer's drawings. For the external coating, a material certificate must be supplied to the certification agency from the manufacturer's vender for each material.

Note: If a material certificate cannot be supplied, additional testing for the material evaluation may be required at the sole discretion of the certification agency.

2. Coating Thickness

2.1. The Halar coating shall provide even and continuous coverage over all exposed surfaces of the line type heat detector. The coating thickness shall be no less than 0.017” (0.4318 mm).

2.2. The coating of four previously untested 1” samples shall be measured. Additional samples and measurements may be required at the sole discretion of the certification agency .