American National Standard for Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling

ANSI/FM Approvals 3260

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Foreword

NOTE: This foreword is introductory only and is not part of American National Standard/FM Approvals 3260.

This standard sets performance requirements for radiant energy-sensing fire detectors used for automatic fire alarm signaling for the protection of occupants, building space, structure, area, or object.

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).

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ANSI regulations require that this American National Standard shall be revised, reaffirmed or withdrawn within five years of the date of publication.

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I. INTRODUCTION

1.1 Scope

This standard sets performance requirements for radiant energy-sensing fire detectors used for automatic fire alarm signaling for the protection of occupants, building space, structure, area, or object.

1.2 Basis for Requirements

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

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. The Appendix 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."*

1.4 Applicable Documents

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

ANSI/UL 50 – Enclosures for Electrical Equipment

FM Approval Standard 3600 – *Electrical Equipment For Use In Hazardous (Classified) Locations General Requirements*

IEC 60529 – Degree of Protection Provided by Enclosures (IP Code)

National Fire Protection Association (NFPA) 70 – National Electrical Code.

National Fire Protection Association (NFPA) 72 – National Fire Alarm Code

FM Approval Standard 3615 – *Explosionproof Electrical Equipment*

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 Radiant energy sensing detectors fall into two (2) general categories: flame detectors and spark/ember detectors, depending upon the source of radiant energy they are intended to detect and the ambient in which they are to be used. Flame detectors are intended to respond to the radiant emissions from a flame and are expected to operate in normally illuminated environments. Spark/ember detectors are intended to respond to embers in a fuel stream flowing past them within a sheet metal pneumatic conveyance duct, chute, conveyor, or other location of limited illumination.

2.1.2 All radiant energy sensing detectors have a limited field of view and rely on a line-of-sight transmission of radiant energy from the source to the detector. Radiant energy sensing detectors employ infrared, visible, and/or ultraviolet sensors or combinations of sensors, selected to match the radiant emissions expected from the source to be detected. Since each fuel emits unique spectra, not all detectors are capable of detecting all fuels.

2.2 Requirements for Samples for Examination

For functional tests outlined below, the manufacturer shall provide at least four detectors which are deemed to be representative of the manufacturer's normal production with regard to construction and calibration. All four detectors shall be subjected to the baseline, flame response sensitivity, and false alarm tests; the remainder of the tests shall be spread over the four samples as outlined in Table 1.

Table 1: Test Assignments

Test	*Paragraph*	*Sample 1*	*Sample 2*	*Sample 3*	*Sample 4*
Baseline Sensitivity	4.1.2	x	x	x	x
Flame Response	4.2.2	x	x	x	x
False stimuli	4.3.2	x	x	x	x
Field of view	4.4.2	x			
Switching	4.5.2	x			
Humidity cycling & conditioning	4.6.2		x		
Voltage variation	4.7.2			x	
Temperature extremes	4.8.2		x		
Vibration	4.9.2			x	
Dielectric strength	4.10.2		x		
Bonding	4.11.2		x		
Durability	4.12.2				x
Stability	4.13.2				x
Extraneous transients	4.14.2				x
Surge transient tests	4.15.2				x
Spark/Ember Detector	4.16.2	x	x	x	x

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

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

3.2 Required Features

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

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

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

3.2.4 Radiant energy-sensing fire detectors intended for use in hazardous locations shall comply with applicable national and/or international requirements for hazardous location electrical equipment in addition to this standard.

3.2.5 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.

3.2.6 The unit shall accommodate secure wiring methods in accordance with NFPA 72.

3.2.7 The detector shall be compatible with a fire alarm control unit that will produce an alarm response when the detector is in alarm and that produces a distinctive trouble signal when a power failure disables the detector.

3.2.8 Response may be in milliseconds; however, alarm initiation shall be no greater than 30 seconds from the initial flame exposure.

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

3.2.10 Duplicate terminals or leads, or their equivalent, shall be provided on each radiant energy-sensing fire 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 Markings

3.3.1 The radiant energy-sensing fire detector shall be permanently and legibly marked with the manufacturer's name, city, and state; the model designation; serial number or equivalent means to identify the date of manufacture; operating voltage and electrical load ratings.

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

3.3.3 Two-wire detectors shall be marked with the word ''WARNING'' and the following or equivalent text. ''Connect Detector Only to Control Unit Initiating Device Circuit as Specified in the Installation Manual or System May Not Operate.''

3.4 Manufacturer's Installation and Operation Instructions

3.4.1 The product installation, operating, and maintenance instructions shall be reviewed for each type and model of detector examined; the instructions shall be complete and appropriate for the detector. The installation instructions or manual shall be marked with a document name, number, revision, and date. The following items are required:

- Operating temperature
- Humidity
- Voltage
- Enclosure ratings
- Fuel, size of fire, distance from detector
- False alarm sources as enumerated in paragraph 4.3
- Instructions for determining detector sensitivity, including value for Zeta (1.0, the radiant energy absorption factor for air), e.g. calibrated test method, calibrated sensitivity test instrument.

3.4.2 The installation, operating, and maintenance instructions shall be included with each detector or installation as required.

3.4.3 All wiring terminal designations and adjustment controls shall be clearly labeled. Instructions for connection and settings shall be included in the Installation and Operation Manual. All field adjustments shall be in accordance with this document.

3.4.4 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 contact required for intended operation of integral components, such as a relay or sounder.

3.5 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to national standards.

3.6 Installation and Maintenance

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

3.6.2 The product literature shall specify a device or a 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.

3.6.3 The response test shall be equivalent or proportional to the radiant emissions from the test sources (flames or embers) used to establish the sensitivity of the detector during the course of the examination. The response test shall not employ a radiator of either unknown emittance or uncontrolled distance.

3.7 Specifications

3.7.1 All manufacturer-specified sensitivities, i. e. fuel, size, distance, and response time shall be tested during the examination. The sensitivity shall be expressed as the maximum distance from the fire center at which the flame detector gives consistent alarm responses in a specified time not to exceed thirty seconds. The manufacturer shall identify the sensitivity of a flame detector to one or more of the fires defined below.

a) 12 x 12 in. (0.3 x 0.3 m) N-heptane pan fire;

b) 12 x 12 in. (0.3 x 0.3 m) alcohol (type specific) pan fire;

c) 12 x 12 in. (0.3 x 0.3 m) JP4 jet fuel fire;

d) 5 in. (127 mm) propane flame from a 0.021 inch (0.53 mm) orifice;

e) 4 in. (102 mm) and/or 8 in. (203 mm) diameter pan of polypropylene pellets for wet bench applications.

3.7.2 For a spark/ember detector, the manufacturer shall specify the minimum size and velocity of the spark or ember of the given fuel that the detection system is to detect.

3.7.3 An algebraic, graphical or statistical description of the sensitivity of the detector shall illustrate the relationship between the distance from the fire center and response time. (See Figure 3.7.3)

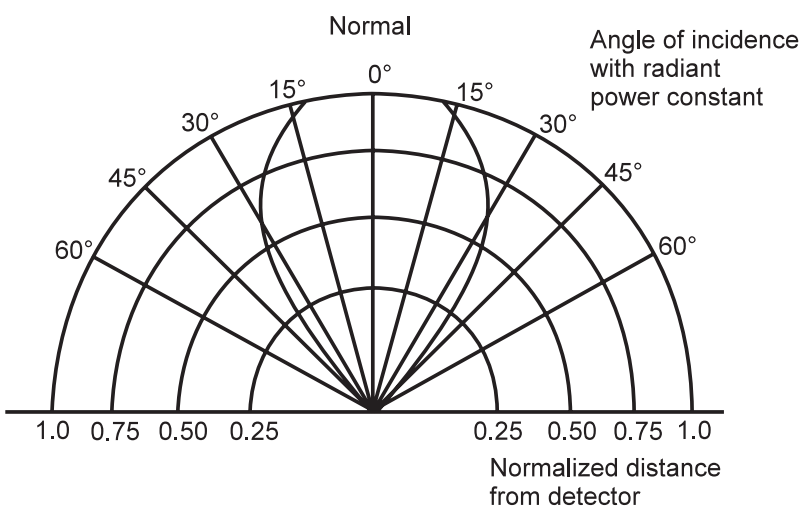

Figure 3.7.3. Field of vision vs. distance.

3.7.4 The product literature shall specify the field of view of the radiant energy detector within which sensitivity is at least 50% of the on-axis sensitivity.

3.8 Software Requirements

3.8.1 For radiant energy detectors dependent on software/firmware programs for normal operation:

- All software and firmware shall be identified by release level which is clearly marked on, or capable of being displayed by, the product for ease of identification;
- All changes to software/firmware shall result in a revision to the release level;
- The operating software/firmware shall not be accessible for any changes or modifications beyond those for which it has been examined; 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 Baseline Sensitivity Test

4.1.1 Requirement

Detector samples shall be subjected to a baseline sensitivity test to establish sensitivity by which the results of other tests in the program shall be measured.

4.1.2 Test/Verification

Each detector sample shall be subjected to a small-scale sensitivity test, specified by the manufacturer, with specified fuel, size, and distance. The results of the small-scale sensitivity test will establish base-line sensitivity equivalent to the full-scale testing in the Flame Response Sensitivity testing. The results of the flame response sensitivity test shall be documented and used to evaluate any deviation following those tests outlined below. A shift in measured sensitivity in response to the test conditions shall not exceed 10%. This shift is defined as a reduction in the distance to the fire center with respect to that used in the baseline sensitivity test. The sample detector must respond at a distance equal to 90% of that used for the baseline sensitivity test.

4.2 Flame Response Sensitivity Test

4.2.1 Requirement

The flame detector shall respond to all of the manufacturer specified fires as described in Section 3.7.1.

4.2.2 Test/Verification

The test shall be set up in an area which will minimize the effects of outside stimuli such as reflection of flame, wind conditions, and artificial lighting. At least three tests of each fuel at each specified distance shall be conducted in order to get a consistent response. Distance from the detector shall be measured to the center of the pan when a pan fire is involved. Response times to each type of fire shall be documented, along with the size of fire and distance from the detector to the fire.

4.3 False Stimuli Response Test

4.3.1 The flame detector shall respond to radiation of the intended wavelength (infrared, visible and/or ultra-violet) without false alarm due to modulated (an interruption of the exposure to the false alarm source) and non-modulated direct and reflected sunlight, or to various modulated and non-modulated sources of artificial light when installed in accordance with the manufacturer's instructions. The chop rate shall be defined in the test procedure.

4.3.2 Test/Verification

The flame detector shall be tested in the presence of modulated and non-modulated direct and reflected sunlight, arc welding, heated bodies such as electrical heaters (one-Ni-Chrome ribbon type 120V/1500W heater), and various sources of artificial light such as incandescent (one-100W shop or drop type), fluorescent (two-40W tube type), and halogen (one-500W quartz element shop light). The arc welding shall use a ⅛ in. (0.3 cm) or 3/16 in. (0.5 cm) type 7014, 7013 or 6012 rod, ¼ in. (0.6 cm) to ½ in. (1.3 cm) steel plate, and a 180-200 Ampere setting. Distances from these sources shall be permitted to vary according to manufacturer's claims or the type of detector. The detector shall produce no trouble or false alarm signal in the presence of these false stimuli, and it shall continue to respond satisfactorily to a test fire in the presence of these sources.

4.4 Field of View

4.4.1 Requirement

For all fuels claimed in the specifications, the flame detector shall be tested to confirm the manufacturer's claims for field of view.

4.4.2 Test/Verification

Tests shall be conducted using at least one of the fires described in Section 3.7.1. Within the specified field of view, the detector response shall be at least 50% of the on-axis sensitivity (measured in units of distance) in at least four directions (left, right, up, and down).

4.5 Switching

4.5.1 Requirement

The detector's alarm signal to the control shall occur within the manufacturer's specified response time not to exceed 30 seconds.

4.5.2 Test/Verification

A test sample shall be exposed to flame radiation, and its response shall be monitored to ensure actuation according to the manufacturer's specifications (the manufacturer's specified source may be used for the radiation source).

4.6 Humidity Cycling and Conditioning

4.6.1 Requirement

a) The detector shall remain functional and produce no false indication of fire when subjected to a change from 50% relative humidity at 70°F (21°C), to 90% relative humidity at 100°F (38°C) in 15 minutes.

b) The detector shall remain functional, with no trouble signal or change in operating characteristics, shall have less than 10% shift in measured sensitivity, and shall produce no false indication of fire when subjected to a humidity test as follows:

1) For detectors intended solely for indoor dry environments, a relative humidity of 93%±2% and temperature of 90°F±3°F (32°C±2°C) for a period of 24 hours.

2) 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.

4.6.2 Test/Verification

a) After conditioning at 50% relative humidity and 70°F (21°C), the test sample shall remain functional and produce no false indication of fire when subjected to a change in environmental conditions to a relative humidity of 90% and temperature of 100°F (38°C) within 15 minutes.

b) The test sample shall be conditioned in a relative humidity and temperature as noted in paragraph 4.6.1b (above) for a period of 24 hours. There shall be no trouble signal and no false indication of fire during this exposure. At the end of the conditioning period, while still exposed to the test conditions, the sample shall be exposed to the baseline sensitivity radiation source and shall produce less than 10% shift in measured sensitivity.

4.7 Voltage Range

4.7.1 Requirement

The device shall produce no trouble signal or false indication of fire and less than 10% shift in measured sensitivity when operated between 85% and 110% of rated input voltage. If an absolute voltage range, beyond the 85% and 110% of nominal, is specified by the manufacturer, the unit shall be tested at the extremes of the range.

4.7.2 Test/Verification

The unit, with nominal rated voltage applied, shall be exposed to a flame radiation source. The input voltage shall then be varied from 85 to 110% of nominal, or the manufacturer's range (whichever is wider), and the unit again exposed to the radiation source at both of these voltage extremes. The unit shall produce less than 10% shift in measured sensitivity, no trouble signal, and no false indication of fire during these tests.

4.8 Temperature Extremes

4.8.1 Requirement

The device shall produce less than 10% shift in measured sensitivity, no trouble signal, and no false indication of fire following exposure to temperature extremes described below.

4.8.2 Test/Verification

For indoor applications, the device shall be exposed to minimum limits of 32° and 120°F (0° and 49°C) for a period of at least 24 hours at each limit. For outdoor applications, the device shall be exposed to minimum limits of -40° to 140°F (-40° to 60°C) for at least 24 hours at each limit. The device shall then be exposed to a flame radiation source at the end of each conditioning period while still exposed to the test conditions. The unit shall produce less than 10% shift in measured sensitivity based upon flame radiation distance and shall produce no trouble signal or false indication of fire during and at the conclusion of these tests.

Note: DETECTORS INTENDED FOR USE AT HIGHER OR LOWER TEMPERATURES THAN THOSE SHOWN ABOVE SHALL BE TESTED AT THE SPECIFIED TEMPERATURE EXTREMES AND SPECIALLY MARKED FOR USE AT THE SPECIFIED TEMPERATURES.

4.9 Vibration

4.9.1 Requirement

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

4.9.2 Test/Verification

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 a sweep rate of approximately two cycles per minute. The unit shall produce no false indication of fire, no trouble signal, and less than 10% shift in measured sensitivity at the conclusion of this test. There shall be no loosening of parts or permanent deformation as a result of this test.

4.10 Dielectric Strength

4.10.1 Requirement

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

4.10.2 Test/Verification

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. Detectors whose voltage ratings are less than 30 V ac or 60 V dc shall successfully withstand 500 V ac or 710 V dc for one minute. The dielectric strength test shall be conducted between all applicable combinations of the following: power supply conductors, signaling circuit conductors, ground connection, other output conductors, and detector body.

4.11 Bonding

4.11.1 Requirement

Any accessible conductive surface which is likely to become energized in the event of a fault shall be bonded to a ground terminal with a circuit resistance of less than or equal to 1.0 ohm. This requirement applies to those radiant energy-sensing fire 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.

4.11.2 Test/Verification

The detector sample shall be evaluated according to Section 4.11.1 requirements. Measurements of bonding resistance shall be made with a calibrated multimeter.

4.12 Durability

4.12.1 Requirement

The unit shall be tested for durability.

4.12.2 Test/Verification

One or more sample detectors shall be cycled through 500 power on/off cycles. Any detector susceptible to the wearing of parts (i. e. a mechanical relay) shall be cycled through 500 operate-reset functions under maximum rated load. The detector shall continue to operate and there shall be less than 10% shift in measured sensitivity based upon flame radiation distance at the conclusion of this test.

4.13 Stability

4.13.1 Requirement

The detector shall be able to withstand an extended period in standby operation.

4.13.2 Test/Verification

One or more detector samples, adjusted to maximum sensitivity, shall be energized for normal standby operation in a clean-air (working-office type) atmosphere for a period of at least 30 days. There shall be no false signal nor any evidence of instability.

4.14 Extraneous Transients

4.14.1 Requirement

No false signal shall be generated when the radiant energy detector is subjected to extraneous transients from sources that are described below.

4.14.2 Test/Verification

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

a) radio frequency transmissions with radiation power levels equivalent to 20V/m field strength in the 27 MHz, 150-174 MHZ, 450-467 MHZ, 850-870 MHz, and 900-920 MHz bands; one 30 second exposure at each frequency is required;

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; and

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

The detector shall produce no false alarm or trouble signal in the presence of these extraneous transients, and it shall respond satisfactorily to a test fire source in the presence of the extraneous transients.

4.15 Surge Transient Tests

4.15.1 Requirement

Protection against line surge transients shall be a requirement for each submitted radiant energy detector.

4.15.2 Test/Verification

One powered sample of the detector shall be subjected to transient waveforms having peak levels of 100, 500, 1000, 1500, and 2400 V dc, as delivered into a 200 ohm load. Each circuit is subjected to a total of 60 pulses: (2 at each voltage, plus and minus) referenced to ground (40 pulses) and 2 at each voltage between each circuit lead (20 pulses). 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). *Exception*: Circuits specified to be 20 ft (6 m) or less in length and in conduit. The device shall be required to perform satisfactorily at the conclusion of the test, and it shall not exhibit any instability such as alarm signals and non-self-restoring trouble signals during testing.

4.16 Spark/Ember Detectors

4.16.1 Requirement

The spark/ember detector must meet the minimum sensitivity requirements specified by the manufacturer using a source specified by the manufacturer.

4.16.2 Test/Verification

The test shall be performed in accordance with the manufacturer's instructions in a suitable environment. Testing shall include response to the minimum size and velocity of the spark or ember as specified by the manufacturer. Using the manufacturer's recommended source, the maximum on-axis distance at which the spark detector under test can reliably respond to the test source shall be determined. Tests shall be conducted to confirm the manufacturer's field of view claim. Within this field of view, the detector response shall be at least 50% of the on-axis sensitivity (measured in units of distance) in at least four directions (left, right, up, and down).

4.17 Enclosure Requirements (including Plastic housings)

4.17.1 Requirement

The detector enclosure shall meet 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 shall be verified according to appropriate enclosure classifications.

4.17.2 Test/Verification

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

5. MANUFACTURING AND PRODUCTION TESTS

Detectors rated at 30 V 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 1000 V ac, 60 Hz, or 1400 V dc with respect to the protective ground lead. Alternatively, test potentials 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 under controlled conditions, and by persons knowledgeable of the potential hazards of such testing to minimize the likelihood of shock and/or fire.

APPENDIX

UNITS OF MEASUREMENT

LENGTH:	in. – ‘‘inches’’; (mm – ‘‘millimeters’’) mm = in. × 25.4 ft – ‘‘feet’’; (m – ‘‘meters’’) m = ft × 0.3048
AREA:	ft^2 – ‘‘square feet’’ (m^2 - ‘‘square meters’’) $m^2 = ft^2 \times 0.0929$
TEMPERATURE:	°F – ‘‘degrees Fahrenheit’’ (°C – ‘‘degrees Celsius’’) °C = (°F-32) × 0.556
FREQUENCY:	Hz – ‘‘hertz’’ (Also the SI unit)
WAVELENGTH:	‘‘micron’’ = 10^6 m Å angstrom = m 1×10^{-10}

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