



# **Approval Standard for Smoke Actuated Detectors for Automatic Alarm Signaling**

**Class Number 3230**

**January 2010**

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# Foreword

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

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

For examining equipment, materials and services, Approval Standards:

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

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

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

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# 1 INTRODUCTION

## 1.1 Purpose

- 1.1.1 This standard states Approval requirements for Smoke Actuated Detectors for Automatic Alarm Signaling.
- 1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

## 1.2 Scope

- 1.2.1 This standard applies to any spot type smoke and beam type detector intended to be employed in indoor locations in accordance with the National Fire Alarm Code, NFPA 72, and ANSI/UL 268.
- 1.2.2 This standard applies to any duct type smoke detector intended to be employed in indoor locations in accordance with the National Fire Alarm Code, NFPA 72, and ANSI/UL 268A.
- 1.2.3 This standard applies to any aspirating type smoke detector intended to be employed in indoor locations in accordance with the National Fire Alarm Code, NFPA 72.
- 1.2.4 This standard specifically does not apply to video based smoke detector systems.

## 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 Smoke Actuated Detectors for Automatic Alarm Signaling for the purpose of obtaining Approval. Smoke Actuated Detectors for Automatic Alarm Signaling having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the standard is met. Alternatively, Smoke Actuated Detectors for Automatic Alarm Signaling which meet all of the requirements identified in this Standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

## 1.4 Basis for Approval

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

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
  - the suitability of the product;
  - the performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
  - the durability and reliability of the product.
- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures 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. These examinations may be repeated as part of FM Approvals' product follow-up program.

### 1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently FM Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval report;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' product follow-up program.

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

### 1.6 Effective Date

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

The effective date of this Standard is January 1, 2013 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. 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."

### 1.8 Applicable Documents

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

NFPA72, National Fire Alarm and Signaling Code, 2010 edition.

ANSI/UL 268, Standard for Safety Smoke Detectors for Fire Alarm Signaling Systems, 1996, revised October 2003.

ANSI/UL 268A, Standard for Safety Smoke Detectors for Duct Application, December 2008.

### 1.9 Definitions

For purposes of this standard, the following terms apply:

*Aspirating Type detector* – A type of smoke detector wherein air from the protected space is sampled with a tubing network and transported to the detection chamber with a fan.

*Open area/Spot-Type Detector* - A device in which the detecting element is concentrated at a particular location for detecting smoke in a space intended to be occupied.

*Projected Beam-Type Detector* - A type of photoelectric light obscuration smoke detector wherein the beam spans the protected area. Can be tested as a spot type or a duct detector depending on application.

*Smoke Detector* - A device that detects visible or invisible particles of combustion.

*Test medium.*- Smoke from a cotton wick or vaporized paraffin oil.

*Transport time* - a function of the characteristics of the tubing network from the source to the detector. Variations that affect transport time include but are not limited to: aspirating port size and number, tubing size and branches, fan capacity and exhaust port characteristics.

## 1.10 References

1. FM Global Data sheet 8-29 Refrigerated Storage
2. ISO 7420 -20 Fire Detection and fire alarm systems - Part 20: Aspirating Smoke Detectors

## 2 GENERAL INFORMATION

### 2.1 Product Information

Smoke detectors are supplied to connect to a fire alarm system through dry contact relays, or initiating device circuits or signaling line circuits as defined in the National Fire Alarm and Signaling Code, NFPA 72. They may be fabricated as a removable detector and a base that is wired to a permanently mounted electrical box. The smoke detectors are usually manufactured from polymeric materials. The detectors may be supplied as spot type, duct type, beam type, or aspirating type. Other designs meeting the criteria of this standard may also be considered for Approval. Components peculiar to a particular type of detector must have significant details described in the installation instructions as to how they are to be applied/installed/etc.

### 2.2 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to

Electrical Director  
FM Approvals  
1151 Boston-Providence Turnpike  
PO Box 9102  
Norwood, MA 02062  
U.S.A.

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

- a complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration;
- general assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, and
- the number and location of manufacturing facilities.
- all documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

### 2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing based on the following:
- Sample requirements to be determined by FM Approvals following review of the preliminary information based on the applicable standard for the smoke detector type, see paragraphs 4.2, 4.3, and 4.4.
- 2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of FM Approvals.
- 2.3.4 It is the manufacturer's responsibility to provide any test fixtures necessary to test their specific design, such as those which may be required to evaluate the strength of a properly glued joint of an aspirating detector piping network.

## 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 Approval investigation shall define the limits of the Approval.

### 3.2 Physical or Structural Features

#### 3.2.1 General

The smoke detector ratings shall be appropriate for the service conditions.

As applicable, based on the type of detector and the intended use, the detector will fall into one or more of the following categories and be evaluated to the referenced standards.

#### 3.2.2 Open area/Spot type smoke detector

Spot type smoke detectors, of either the photocell or ionization type, typically characterized by a detachable head of 'clamshell' design that mounts to a base with two or four wire connections and intended installation location of indoor ceilings, shall meet the construction requirements of ANSI/UL 268.

#### 3.2.3 Duct type smoke detector

Duct type smoke detectors, of either the photocell or ionization type, typically characterized by their construction that allows them to be mounted on the outside of a duct and sample the air in the duct, two or four wire connections, and intended installation location, shall meet the construction requirements of ANSI/UL 268A.

### 3.2.4 Aspirating type detector

Depending on the application, aspirating detectors shall comply with the requirements of either 3.2.2 or 3.2.3 in addition to 3.2.4.

3.2.4.1 Aspirating type smoke detectors, usually based on the photocell principle, typically characterized by their construction requiring the use of a tubing network and a fan to move air sampled from the protected space to the sensing chamber, Class A or Class B detection circuit connection, separate power supply connection and intended installation location.

3.2.4.2 Tubing used for aspirating detectors shall be sturdy and resistant to temperature variation as demonstrated by the ability to resist, as a minimum, 28 pounds (125 N) of compression force and 0.37 foot-pound (0.5 J) impact, over the temperature range of 5 to 140°F (-15 to 60°C).

## 3.3 Markings

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, size, rating, capacity, etc., as appropriate.

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 as FM Approved. The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.3.3 The Approval Mark (see Appendix B) 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

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.

## 3.5 Calibration

All examinations and tests performed in evaluation to this standard shall use calibrated measuring instruments traceable and certified to acceptable national standards, specifically ISO 17025.

## 4 PERFORMANCE REQUIREMENTS

### 4.1 Normal ambient conditions

Unless otherwise noted, tests will be conducted under normal atmospheric conditions, temperature 59-95 °F (15 to 35 °C), humidity; 25-70 %RH, air pressure 860-1060 mbar (86-106 kPa)

### 4.2 Open Area Detector

Open area detectors shall conform to the requirements of ANSI/UL 268 for assembly, safety and performance.

### 4.3 Duct Detector

Duct type detectors shall conform to the requirements of ANSI/UL 268A for assembly, safety and performance.

### 4.4 Aspirating Detector

Depending on the application, aspirating detectors shall comply with the requirements of either 4.2 or 4.3 in addition to 4.4.

#### 4.4.1 Airflow- The detector shall indicate a 20% change in airflow as a trouble condition

A reduction in airflow shall be indicated as an obstruction.

An increase in airflow shall be indicated as a break.

-200 seconds is allowed to indicate a change in airflow.

#### 4.4.2 Transport time- The detector shall be capable of detecting test medium introduced in the aspirating port with the longest transport time in the tubing network in 120 seconds or less.

#### 4.4.3 Sensitivity- The detector shall be capable of having a single aspirating port function as a spot type smoke detector. When test medium (cotton wick or vaporized paraffin oil) is applied to the single aspirating port, the detector shall alarm at an applied smoke level of at least 0.5%/ft to no more than 4%/ft (1.6 to 12.5 %/m).

4.4.3.1 The sensitivity of one detector shall be measured six times. The ratio of largest value to smallest value shall be less than 1.6

4.4.3.2 The sensitivity shall be confirmed for eight samples. The average of the eight results shall be reported as the sensitivity of the detector.

4.4.3.2.1 The ratio of the maximum value to the sensitivity shall be equal to or less than 1.33.

4.4.3.2.2 The ratio of the sensitivity to the minimum value shall be equal to or less than 1.5.

- 4.4.4 Voltage variation- One sample of each detector shall be operated over the manufacturer's specified voltage range.
- 4.4.4.1 The detector's sensitivity will be measured three times each at maximum, minimum and nominal voltage.
- 4.4.4.2 The ratio of the highest smoke level detected to the lowest smoke level, for all nine readings, detected shall be less than or equal to 1.6.
- 4.4.5 Humidity testing- The sample detector shall be subjected to an ambient humidity of 93% RH at an ambient temperature of 104°F (40°C) for twenty-four hours with no change in performance as determined by the results of the following tests.
- 4.4.5.1 The detector's sensitivity shall be confirmed with three measurements in the last hour of the exposure.
- 4.4.5.2 The detectors airflow shall be confirmed in the last hour of the exposure.
- 4.4.5.3 The detector's sensitivity shall be confirmed with three measurements one hour after the exposure. The ratio of largest value to smallest value shall be less than 1.6
- 4.4.5.4 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.5.5 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.6 Stability at cold temperature- The sample detector shall be subjected to a 32 °F (0°C) environment for twenty-four hours with no change in performance as determined by the results of the following tests.
- 4.4.6.1 The detector's sensitivity shall be confirmed with three measurements in the last hour of the exposure.
- 4.4.6.2 The detectors airflow shall be confirmed in the last hour of the exposure.
- 4.4.6.3 The detector's sensitivity shall be confirmed with three measurements one hour after the exposure. The ratio of largest value to smallest value shall be less than 1.6.
- 4.4.6.4 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.6.5 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.7 Stability at high temperature- The sample detector shall be subjected to a 120°F (49°C), environment for twenty-four hours with no change in performance as determined by the results of the following tests.
- 4.4.7.1 The detector's sensitivity shall be confirmed with three measurements in the last hour of the exposure.
- 4.4.7.2 The detectors airflow shall be confirmed in the last hour of the exposure.
- 4.4.7.3 The detector's sensitivity shall be confirmed with three measurements one hour after the exposure. The ratio of largest value to smallest value shall be less than 1.6.
- 4.4.7.4 The detectors airflow shall be confirmed one hour after the exposure.

- 4.4.7.5 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.8 Vibration - A sample detector, mounted in the intended orientation and manner prescribed by the manufacturer shall be subjected to the vibration test. The test shall include a single axis vibration, in the axis of normal mounting. The duration of the test shall be four-hours. The vibration shall be a sinusoid on sinusoid with a total displacement of 0.02 in (0.5mm) and a sweep frequency of 10-30-10 at two cycles per minute.
- 4.4.8.1 The detector's sensitivity shall be confirmed with three measurements after the exposure. The ratio of largest value to smallest value shall be less than 1.6.
- 4.4.8.2 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.8.3 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.9 Radio frequency transient protection- One sample of each detector shall be tested by exposure to radio frequency transmissions with radiation power levels equivalent to 5 Watts at 12 in. (0.3 m) in the 27 MHz, 150-174 MHz, 450-467 MHz, 850-870MHz, and 900-920 MHz bands. The detectors shall produce no false alarms or trouble signals in the presence of these extraneous transients.
- 4.4.9.1 The detector's sensitivity shall be confirmed with three measurements after the exposure. The ratio of largest value to smallest value shall be less than 1.6.
- 4.4.9.2 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.9.3 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.10 Surge transient tests - One sample of each detector shall be tested by connecting the, field wiring terminals to a source of five transient waveforms having peak levels of 100; 500; 1,000; 1,500; and 2,400 V, as delivered into a 200 ohm load. The detectors shall produce no false alarms or trouble signals in the presence of these transients.
- 4.4.10.1 The detector's sensitivity shall be confirmed with three measurements after the exposure. The ratio of largest value to smallest value shall be less than 1.6.
- 4.4.10.2 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.10.3 There shall be no troubles or alarms in the absence of the test medium.
- 4.4.11 Durability test- Detectors shall demonstrate durability appropriate for the life expectancy of the detector. If the detector is equipped with switching elements such as output relays the detector shall be cycled through 6,000 on-alarm-reset operations to life test the switching elements. During the test the switching elements shall operate under maximum load.
- 4.4.11.1 The detector's sensitivity shall be confirmed with three measurements after the exposure. The ratio of largest value to smallest value shall be less than 1.6
- 4.4.11.2 The detectors airflow shall be confirmed one hour after the exposure.
- 4.4.11.3 There shall be no troubles or alarms in the absence of the test medium

- 4.4.12 Fire tests- A single sample, considered to be representative of the product line, shall be used for the purposes of these tests. To be satisfactory, the test results must comply with the requirements of the referenced standard.
- 4.4.12.1 For aspirating detectors for open area detection the standard piping network installed in the smoke room shall be connected to the detector (See Appendix C). The smoke sources and test protocols for these tests are described in ANSI/UL 268 section 39.
- 4.4.12.2 For aspirating detectors for duct detection the manufacturer's specified piping network installed in the duct tester shall be connected to the detector (See Appendix D). The smoke sources and test protocols for these tests are described in ANSI/UL 268A section 36.
- 4.4.13 Dielectric Voltage Withstand Test – Detector shall comply with the requirements of ANSI/UL 268 section 60 or ANSI/UL 268 A section 47 depending on application.

#### **4.5 Smoke Detectors for Freezer Applications**

- 4.5.1 Smoke detectors for freezer applications shall conform to the requirements of 3.2, 4.2, 4.3 and 4.4 as applicable to the type of detector for assembly, safety and performance.
- 4.5.2 Additional requirements for freezer applications, see Appendices E, F, and H for descriptions of the smoke generation methods.
- 4.5.2.1 Detector shall respond to smoke generated by smoldering red oak block before smoke obscuration exceeds 0.6% per foot.
- 4.5.2.2 Detector shall respond to smoke generated by smoldering polyurethane foam before smoke obscuration exceeds 4.7% per foot.
- 4.5.2.3 Detector must be capable of supporting class A wiring to the panel.
- 4.5.2.4 Detector must be capable of proper operation in accordance with section 4.4.4 Voltage Variation, at minimum rated temperature

#### **4.6 Additional Tests**

- Additional tests may be required, at the discretion of FM Approvals, depending on design features and results of any foregoing tests.
- Any test, including re-tests, following a failure shall be acceptable only at the discretion of FM Approvals and with a technical justification of the conditions or reasons for failure.

## 5 OPERATIONS REQUIREMENTS

### 5.1 General

A quality assurance program is required to assure that subsequent smoke detector(s) produced by the manufacturer shall present the same quality and reliability as the specific smoke detector(s) 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 Approval Report.
- Continued conformance to this Standard is verified by the Facilities and Procedures Audit (F&PA).
- Quality of performance is determined by field performance and by periodic re-examination and testing.

### 5.2 Demonstrated Quality Control Program

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

- Existence of corporate quality assurance guidelines;
- Incoming quality assurance, including testing;
- In process quality assurance, including testing;
- Final inspection and tests;
- Equipment calibration;
- Drawing and change control;
- Packaging and shipping; and
- Handling and disposition of non-conforming materials.

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

5.2.3 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.

5.2.4 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production.
- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to FM Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals' Form 797, FM Approved Product/Specification-Tested Revision Report or Address/Main Contact Change Report.
- Records of all revisions to all FM Approved products shall be maintained.

### 5.3 Facilities and Procedures Audit (F&PA)

- 5.3.1 An audit of the manufacturing facility is part of the Approval 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 insure a uniform product consistent with that which was tested and FM Approved.
- 5.3.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives.
- 5.3.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

### 5.4 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 FM Approvals.

### 5.5 Manufacturer's Responsibilities

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

### 5.6 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.

**APPENDIX A: UNITS OF MEASUREMENT**

LENGTH:	in. - "inches"; (mm - "millimeters") mm = in. x 25.4
AREA:	ft - "feet"; (m - "meters") m = ft x 0.3048 in <sup>2</sup> - "square inches"; (mm <sup>2</sup> - "square millimeters") mm <sup>2</sup> = in <sup>2</sup> x 6.4516 x 10 <sup>2</sup>
MASS:	ft <sup>2</sup> - "square feet"; (m <sup>2</sup> - "square meters") m <sup>2</sup> = ft <sup>2</sup> x 0.0929 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 x 1.0551 x 10 <sup>3</sup>
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 <sup>3</sup> - "cubic decimeters") L = dm <sup>3</sup>
FLOW RATE:	gal/min - "gallon per minute"; (L/min - "liters per minute") L/min = gal/min x 3.785

## APPENDIX B: FM APPROVALS CERTIFICATION MARKS

FM Approvals certifications marks are to be used only in conjunction with products or services that have been Approved by FM Approvals and in adherence with usage guidelines.



### FM APPROVED mark:

Authorized by FM Approvals as a certification mark for any product that has been FM Approved. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



### Cast-On FM Approvals marks:

Where reproduction of the FM Approved mark described above is impossible because of production restrictions, use these modified versions of the FM Approved mark. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable.



### FM Approved Mark with “C” only:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



### FM Approved mark with “C” and “US”:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with US and Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.

# FM Approvals Certification Marks

## USAGE GUIDELINES

All FM Approvals certification marks are the sole property of FM Approvals LLC (“FM Approvals”) and are registered or the subject of applications for registration in the United States and many other countries. They are for use only according to these guidelines.

FM Approvals certification marks may be used only on FM Approved products and related product packaging, in advertising material, catalogs and news releases.

Use of FM Approvals certification marks on such material is not a substitute for use of the complete FM Approvals certification mark on FM Approved products and/or product packaging.

No FM Approvals certification mark or aspect thereof may be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/ product lines. This includes both design aspects (the FM Approvals “diamond,” etc.) and word aspects (“FM,” “Approved,” etc.). The use of any FM Approvals certification mark as a trademark is strictly prohibited.

The Approval Standard number or class number may not be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. For example, a company may not say “ABC Company’s 4100 Fire Door is FM Approved”; the proper terminology is, “ABC Company’s Fire Door is FM Approved per Approval Standard 4100.”

FM Approvals certification marks, except for the FM Approvals Quality System Registration mark, may not be used on business stationery/cards/signage because this could mischaracterize the relationship with FM Approvals. Additionally, these items should not reference any FM Approvals certification mark.

Products or services may not be marketed under any mark or name similar to “FM Global,” “FM Approvals” or any of the FM Approvals certification marks. Further, products or services may not be marketed to imply a relationship beyond the scope of any Approval made by FM Approvals.

When an FM Approvals certification mark is used in advertising material or on product packaging, all material must reflect the specific circumstances under which the product was FM Approved. The material must clearly differentiate between products that are FM Approved and those that are not, and may not, in any way, imply a more substantial relationship with FM Approvals.

A company may not reference the intent to submit a product for Approval or the expectation that a company will have a certain product FM Approved in the future. For example, a company may not state, “Approval by FM Approvals pending” or “Approval by FM Approvals applied for.”

FM Approvals certification marks should not be preceded or followed by a qualifier that indicates a degree of certification or acceptability. For example, “exceeds,” “first” or “only” may not be used to qualify any FM Approvals certification mark.

Only original artwork issued by FM Approvals should be used. The FM Approvals certification marks should not be altered in any way other than to resize the artwork proportionately. Unacceptable uses of the marks include, but are not limited to, adding/deleting wording or artwork, reducing the artwork to an illegible size, animation or distortion.

The text of the FM Approvals certification marks may not be translated into any language other than English.

FM Approvals certification marks must appear in a size and location that is readily identifiable, but less prominent than the name of the owner of the certification or the manufacturer/seller/distributor of the certified products.

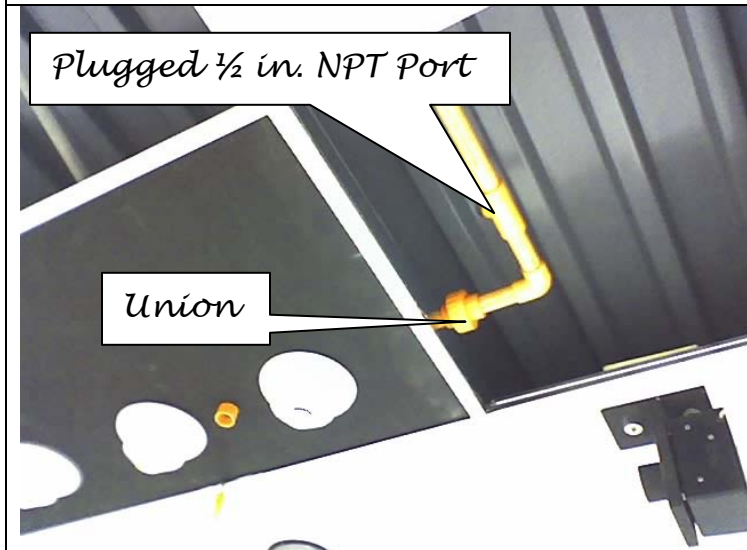
### APPENDIX C: SMOKE ROOM ASPIRATING PIPE INSTALLATION



Two aspirating ports have been installed in-between the 3 standard spot detector locations.

- On the left is a small 1/4 in. (approx. 5mm) continuous flexible tube that goes straight to the control room, no T's, L's or anything to dilute the smoke.

On the right is a 3/4in. (approx.19mm) glued hard line. The cap in the room is not glued to be removable and interchangeable for different sampling port sizes.



Above the tiles, you can see a union that allows removal of the detector mounting tile, if needed. Also a T with a 1/2in NPT thread (plugged) but available for some of the drops available by some aspirating manufacturers.

### APPENDIX C: SMOKE ROOM ASPIRATING PIPE INSTALLATION

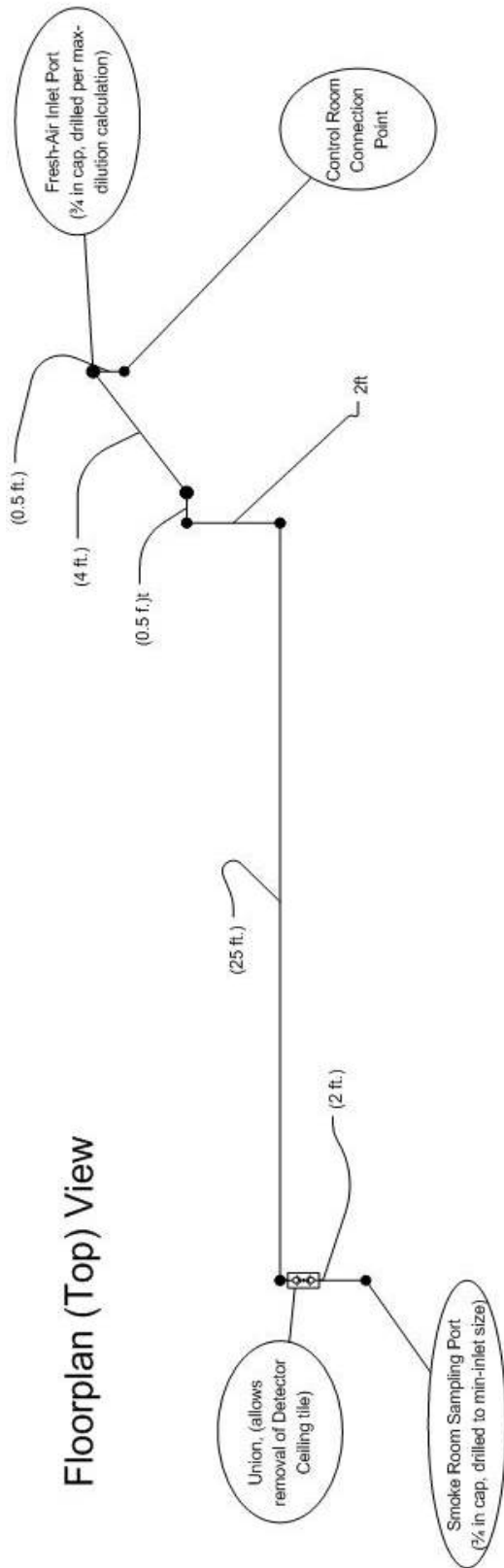


Essentially a straight run back to the control room wall, then out and down the outside of the room.

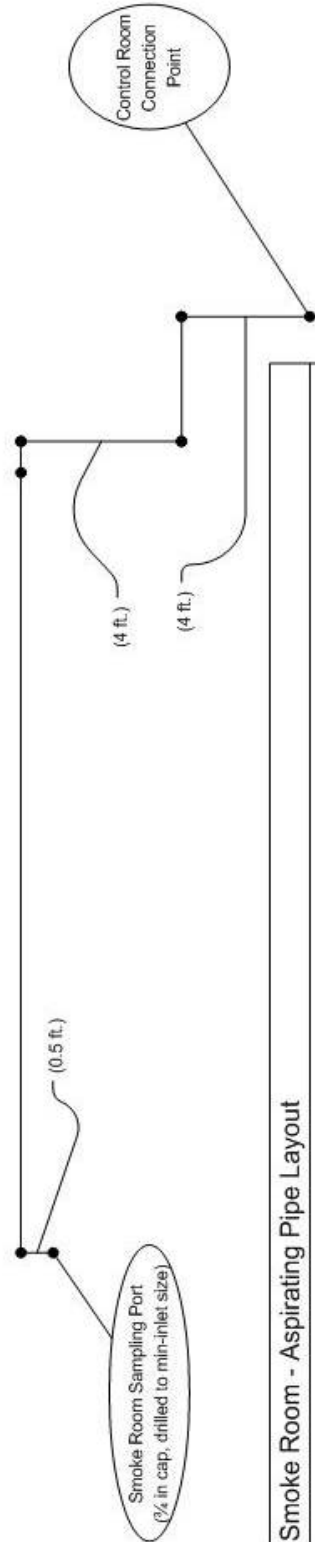
Overall is around 40ft with several L's to get to the control room.

There is a T outside the smoke and control room with a removable cap. Again adjustable for worst case dilution vs the 1 sampling port inside the room.

### Floorplan (Top) View



### Section (Side) View



#### Smoke Room - Aspirating Pipe Layout

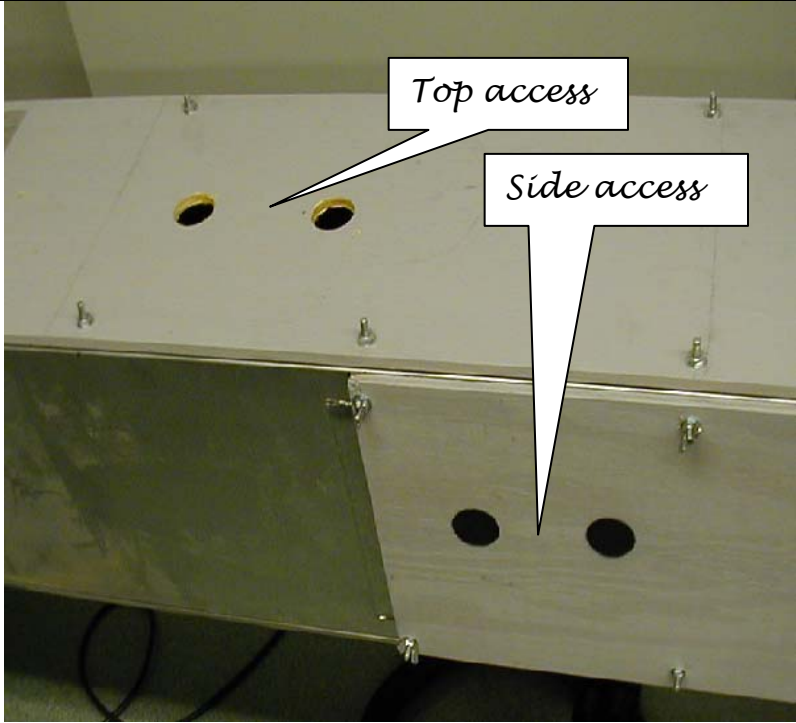
RWE - 8/25/08 - Scale (1ft per division)

Note: (2) Independent lines or system installed. Inlet ports at normal Detector Ceiling Location with pipes brought into the control room.

1<sup>st</sup> - 3/4 in. (19mm) CPCV as shown, concealed above ceiling tiles in smoke room and then outside of control room prior to entrance. (41 ft. O/A 8 - L's)

2<sup>nd</sup> - 1/4 in. (5mm) flexible line follows the 3/4 in layout and has no breaks, L's, T's or otherwise, 1 continuous line, approx 32ft plus.

### APPENDIX D: DUCT ASPIRATING PIPE INSTALL

 <p>The photograph shows a white duct assembly with two callout boxes. The 'Top access' callout points to two circular openings on the top surface of the duct. The 'Side access' callout points to two circular openings on the side panel of the duct. The duct is secured with several screws.</p>	<p>Two locations for the introduction of the aspirating tubing will be tested in conjunction with ANSI/UL 268A.</p> <p>Sampling tubing will be introduced from the side and the top of the duct as shown at left.</p>
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## APPENDIX E: POLYURETHANE FOAM SMOKE GENERATION

The following materials and procedures are to be used for the polyurethane smoke test. Dimensions and locations of test apparatus are intended for reference only. These are variable as long as the correct build up rates are achieved.

- a. Combustible- soft polyurethane foam (density 0.025 +/-0.002 g/cc) ½”x ½” x 6 1/2” (12.7 mm x 12.7 mm x 165.1 mm)
- b. Point of ignition- gas grill type butane lighter, flame to be held to the ½” x ½” end of the polyurethane block until it ignites in a self sustaining flame.
- c. Smoke profile- smoke concentration is regulated by the apparatus for aspirating detector sensitivity measurements described in Appendix F



## APPENDIX F: RED OAK SMOKE GENERATION

The following materials and procedures are to be used for the red oak smoke test. Dimensions and locations of test apparatus are intended for reference only. These are variable as long as the correct build up rates are achieved.

- a. Combustible- a single block of kiln dried red oak (water content 5-17%) 1" x 1" x 1" (25.4 mm x 25.4 mm x 25.4 mm) with a single face in contact with the hotplate, placed on the outer diameter of the plate. Each stick is to be conditioned for not less than 48 hours at 52°C (125°F) in an air-circulating oven. The block weight is to be  $7.6 \pm 1$  grams ( $0.268 \pm 0.035$  oz) following the oven conditioning. The block dimensions are variable as long as the correct smoke build up rates are achieved.
- b. The hot plate is to be a 240 volt, 1550 watt hotplate having a steel plate 8-1/2 inches (216 mm) in diameter and 1/4 inch (6.4 mm) thick. The temperature of the hotplate is to be monitored by an iron-constantan No. 30 AWG (0.05mm<sup>2</sup>) (Type J) thermocouple attached to the edge of the steel plate as described in ANSI-UL 268).
- c. Smoke profile- smoke concentration is regulated by the apparatus for aspirating detector sensitivity measurements described in Appendix F.



Photo of inside of smoke generation chamber

## APPENDIX G: COTTON WICK SMOKE GENERATION (PARAFIN OIL SMOKE MAY BE SUBSTITUTED)

The following materials and procedures are to be used for the polyurethane smoke test. Dimensions and locations of test apparatus are intended for reference only. These are variable as long as the correct build up rates are achieved.

- a. Combustible- UL wick Item # 1115S conditioned in environmental chamber/oven set to 113°F(45°C) for 72 hours, cut to 6" (152.4 mm)
- b. Point of ignition- gas grill type butane lighter, flame to be held to the ½" x ½" end of the polyurethane block until it ignites in a self sustaining flame.
- c. Smoke profile- smoke concentration is regulated by the ANSI/UL 268 smoke box with a sampling tube in place of the spot detector as shown below:



## APPENDIX H: APPARATUS FOR ASPIRATING DETECTOR SENSITIVITY MEASUREMENTS

The apparatus described below allows a wide range of adjustment of the aerosol concentration and direct measurement of the concentration entering a single aspirating port of the specimen. The dilution factor is controlled by the tubing network provided by the client. In this fashion, it can generate and measure the low aerosol concentrations. This apparatus is similar to the apparatus described in ISO/DIS 7240-20 Annex A.

