FM Approvals℠

Member of the FM Global Group

Not to be distributed outside of FM Approvals and its affiliates except by Customer

APPROVAL REPORT

SigniFire IP video image fire detection system

Prepared for:
axonX LLC
47 Loveton Circle, Suite F
Sparks, MD 21152

Project ID: 3030866
Class: 3230, 3260
Date of Approval: January 4, 2008
Authorized by:

George A. Smith, Director/ Assistant Vice President

SigniFire IP video image detection system

from

axonX LLC

I INTRODUCTION

1.1 axonX requested an examination of the equipment listed in Section 1.4 for compliance with the following standards.

This report may be freely reproduced only in its entirety and without modification.

1.2 The following standards were used for the examination and evaluation of the equipment as described in this report. These are FM Approval Standards of the identified Class No. unless otherwise indicated:

Title	Class Number	Date
Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling	ANSI / FM Approvals Class Standard 3260	February 2004
Smoke Actuated Detectors for Automatic Fire Alarm Signaling	FM Approvals Class Standard 3230, 3250	February 1976
National Fire Alarm Code	ANSI / NFPA Standard 72	2002

Listing: The listing for the SigniFire IP video image detection system will appear in the *Approval Guide*, A Publication of FM Approvals, in the Fire Protection Volume, Chapter 14 under the category titled Fire Detection Smoke Actuated, and Flame Actuated as follows:

axonX LLC, 47 Loveton Circle Suite F, Sparks, MD 21152

The SigniFire IP video image detection system consists of a CCTV camera with 2.8mm, 6.0mm or 8.0mm lenses, input power over Ethernet [POE, 48VDC] or 12 VDC from NRTL Approved power supply with 24 hour battery back up [not provided], software revision 1.824 supporting the SigniFire IP camera, SpyderGuard User Interface software revision 1.1.4.21, and FSM IP software revision 1.0.0.13 with Signifire [watchdog] revision 1.0.0.4. The SigniFire model number designations are: SigniFire IP 2.8, SigniFire IP 6.0, and SigniFire IP 8.0. The SigniFire IP configurations are: 1.) Listed FACP supplied 12VDC power with FACP receipt of alarm and trouble signals through dry contact relays; 2.) Listed 12VDC power supply with 24 hour battery back up supplying power to the SigniFire IP camera, a Listed FACP receiving alarm and trouble signals through dry contact relays; 3.) SigniFire IP camera is connected by Ethernet POE cable [not provided] to Ethernet POE switch [not provided] that is connected to the Approved FSM 8 computer with the FSM IP software. Or optionally, the SigniFire IP camera is connected by CAT 5 coax cable and Listed 12VDC power supply with 24 hour battery back up to the Approved FSM 8 computer with FSM IP software. The SigniFire IP camera continuously monitors the image feeds for smoke and fire

and can detect visible fire/smoke conditions using a minimum detection zone of 49 pixels on a screen size of 307,200 pixels. The SigniFire IP will respond to visible smoke as well as flaming fires in line of sight. For NFPA applications, SigniFire IP and the Approved FSM 8 are required to be powered locally via an uninterruptible power supply (UPS), such as APC Smart- UPS XL 2200VA RM. The area protected by the SigniFire IP camera should be properly illuminated to allow for a suitable camera image. Performance based detection scenarios protected by the SigniFire IP unit will require full scale smoke and/or fire testing in order to verify that the desired level of protection has been met at the time of commissioning. The intended primarily use for the SigniFire IP video detection system is automated early warning and not as a primary protection method except where no other detection method is suitable. Extreme care and knowledge of the fire risk and smoke/fire detection principles, as well as keen knowledge of video camera application methods are required to use this device effectively. This new detection technique is not a replacement to required existing conventional detection principles.

1.3 This smoke and flame video detection product represents new technology not directly applicable to an existing test standard or protocol used by FM Approvals. For the purpose of this Approval program, applicable portions of existing industry standards have been combined where appropriate in order to define the smoke and/or fire response of the SigniFire IP, verifying the SigniFire IP's response to standard fire sources provides data from which performance based detection system can be designed. This capability is similar to what has been successfully used with radiant energy flame detection technology. The smoke and/or fire test protocol is intended to demonstrate the video product effectiveness in detecting smoke and/or fire so that judgment can be made as to its actual usefulness in a given application.

1.4 For definition purposes, visual or video smoke and/or fire detection is the identification of a smoke and/or fire signature from digitized video images using proprietary algorithms and hardware. Detection decisions are made based on the movement, the shape, and the contrast of the video image.

1.5 Visual detection capability is not dependent on transport time, i.e. smoke does not have to reach the detector as with conventional smoke detection devices.

1.6 Visual detection is dependent on clear unobstructed views of the protected area. This product operates as a line-of-sight device, similar to a flame radiant detector.

1.7 Although designed to detect a wide variety of smoke and/or fire conditions, the intended use of the video detection system is primarily as an automated early warning system and not as a primary protection method except where no other detection method is suitable. Extreme care and knowledge of the fire risk and smoke/fire detection principles, as well as keen knowledge of video camera application methods are required to use this device effectively.

1.8 This new detection technique provides smoke and/or fire detection capability for applications where use of spot-type detection devices are not applicable, such as large open areas and high ceiling applications, etc. It is not currently seen as a replacement to existing conventional detection principles.

1.9 Although implicit in the name, Visual Smoke/Fire Detection, it can not be emphasized enough that if smoke and/or fire is not visible, it can not be detected! This limitation prohibits the SigniFire IP's use in applications that do not provide good quality lighting at all times for the monitored area.

1.10 Except as described in this report, any additional components, applications or environmental suitability described in the manual or literature are not covered by this Approval. A listed 5U 120V + (3) UXBP48 Battery unit, with 24 hour stand-by capacity and power fail and trouble contacts [monitored by the existing local fire alarm control]. The SigniFire IP is suitable for 32 °F to 120 °F (0 °C to 49 °C). This device is intended for use as a supplemental early warning device and not that of primary protection method except where no other detection method is suitable. The camera's field of view (FOV) is to be free of obstructions that would prevent detection

II DESCRIPTION

2.1 The following sections contain: a brief description of the equipment covered by this report. Additional information can be found in the "SigniFire IP Smoke and Fire Detection Camera Installation Manual" issue date 11/07.

2.2 The Signifire video image detection system model SigniFire IP consists of: CCTV camera with power over Ethernet [POE, 48VDC] or coax CAT 5 connection with NRTL Approved 12 VDC power supply and 24 hour battery back up power.

2.3 The software supporting the SigniFire IP product is SigniFire IP revision 1.824, SpyderGuard User Interface revision 1.1.4.21, and FSMIP revision 1.0.0.13 with Signifire [watchdog] revision 1.0.0.4.

2.4 The SigniFire IP camera lenses are 2.8mm, 6.0mm or 8.0mm.

2.5 The SigniFire IP can be optionally powered by an NRTL Approved 12 VDC power supply [not provided]

2.6 The SigniFire IP model numbers are: SigniFire IP 2.8, SigniFire IP 6.0, SigniFire IP 8.0, and EX SigniFire IP 6.0.

2.7 The SigniFire IP may have the following optional configurations:

2.7.1 Listed FACP supplies 12VDC power and receives alarm and trouble signals through dry contact relays [trouble and alarm],

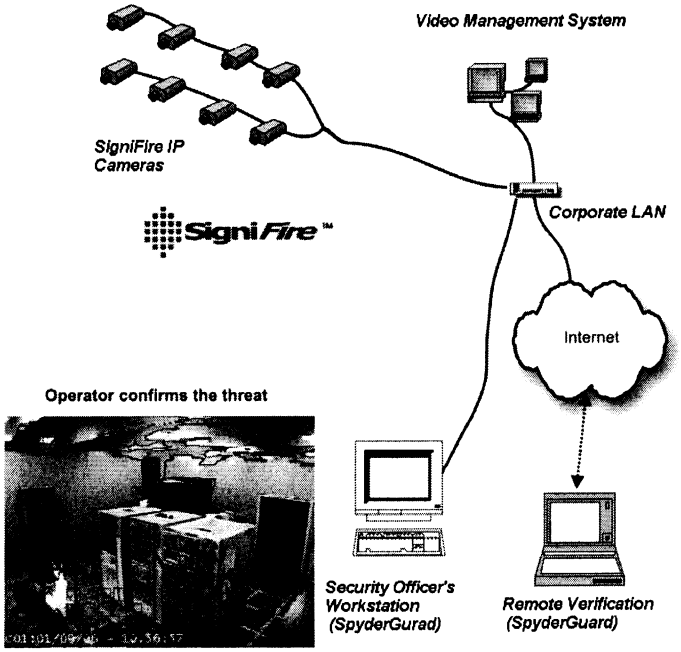
2.7.2 Listed 12VDC power supply with 24 hour battery back up supplies power to the SigniFire IP camera, the Listed FACP receives alarm and trouble signals through dry contact relays [trouble and alarm],

2.7.3 SigniFire IP camera is connected by Ethernet POE (power over internert) cable to POE Ethernet switch which is connected to the Approved FSM8 computer. Or the SigniFire IP camera is connected by CAT 5 coax cable and listed 12VDC power supply with 24 hour battery back up to the Approved FSM 8 computer.

2.8 The outdoor fire tests and smoke room testing were conducted at the Aberdeen Proving Grounds in Aberdeen, Maryland and at the customer facility. All other testing was performed at FM Approvals.

2.9 The SigniFire IP product is a machine vision technology that uses video images and software algorithms to continuously monitor camera feeds. The SigniFire IP system through the camera feeds continuously monitors for smoke and fire and can detect a fire and/or smoke condition that is 7 x 7 pixels in size on a 640 by 480 NTSC signal resulting in a Detection zone (49 pixels) to screen size (307,200 pixels). SigniFire IP is capable of early detection and notification to flaming and smoldering events. SigniFire IP can detect a flaming fire when the flame is within the camera's line of sight. The SigniFire IP technology can also detect smoke patterns within the FOV and reflected fire light off of walls or objects that are related with the fire profile. SigniFire IP observes and identifies the fire condition within the entire observed space of the CCTV camera. In the event of a fire or smoke, SigniFire IP "sees" the event and issues an alarm signal providing a visual picture of the situation to responding personnel and/or by dry contact relay to the Approved FACP.

2.10 An overview of the SigniFire IP system components and system architecture is provided in the diagram below and contained in the installation manual.



2.11 The SigniFire IP software is factory installed [tested version 1.824] and is viewable on the cameras web interface supplied by the camera with the SigniFire IP system.

2.12 The SigniFire IP system is shipped with default sensitivity settings of medium [fire] medium [smoke], and medium [offsite]. The Signifire IP software version 1.824 was tested with medium sensitivity. The three different sensitivity monitor settings can be supplemented with zoning and scheduling as defined in the "SigniFire IP Smoke and Fire Detection Camera Installation Manual" revision November 2007. These settings will be established during the commissioning period.

Flame detection – low, medium, high
Smoke detection – low, medium, high, Ultra
Offsite detection – low, medium, high

2.13 The SigniFire IP system sensitivity is a function of sensitivity, zone, and schedule settings.

2.14 Similar to flame radiation detectors, the line-of-sight, the field-of-view, the distance, and the type of fuel as well as the resulting smoke production must be considered in determining the SigniFire IP sensitivity

2.15 The system settings will be established during SigniFire IP commissioning period. The defined commission settings will be the "default" settings. The "default" settings must be maintained. No setting changes are allowed unless authorized and verified by the AHJ.

System Settings

Camera Name/number	Flame Sensitivity	Smoke Sensitivity	Offsite sensitivity	Motion sensitivity	Zones	Schedules	Buffer duration

2.16 The SigniFire IP provides trouble, supervisory and alarm dry contact relay outputs.

2.17 As a performance based detection system, each installation is subject to actual smoke and/or fire tests in order to verify the desired level of performance can be met. Video recording the tests at commissioning allows detection capability verification at a later date without having to run actual smoke and/or fire testing.

2.18 The SigniFire IP system contains a "buffer" that can store quantity of events on a 400GB HDD. The ability to recall an event is useful and unique tool to video smoke detection.

2.19 A complete set of hardware, software and installation instructions are provided for each SigniFire IP commissioning.

III EXAMINATIONS AND TESTS

3.1 Samples as detailed in Section II above were submitted for examination and testing. The samples were considered to be representative of production and were examined, tested, and compared to the manufacture's drawings. All documentation is on file at FM Approvals along with other documents and correspondence applicable to this program.

3.2 **Baseline Sensitivity Test** – Tests were performed in a 22 ft wide x 36 ft long with 10 ft high drop ceiling, enclosed test room, see Figures below. The test area was not climate controlled. The walls were painted white. The floor was concrete. The lighting was a total of 16, 2ft by 4ft fluorescent, Philips Universal T8 TL741 32 Watt Cool bulb fixtures. Exhaust ports were located at one end of the room opposite the entrance door and fire source.
The test room lighting had three calculated lighting conditions: 111.8 Fc +/- 27.6 Fc, 32.4 Fc +/- 18.6 Fc, and zero illumination.

The SigniFire IP system was tested using small-scale fires generated by a propane torch. The baseline flame response distance was 18ft. 4in. Other fuels used were: [shredded news] paper and wood crib. Determination of the system response to the specific fuels was made. This established baseline sensitivity was determined (and was proportional to the full-scale testing done at a different time). The propane torch test was repeated after vibration, temperature exposure, etc.) Although the SigniFire IP system is not intended to be operated in this type of application, it serves as a baseline to compare SigniFire IP's response to other more conventional detectors and known test criteria. Note baseline test fire described is for Flame not smoke detector.

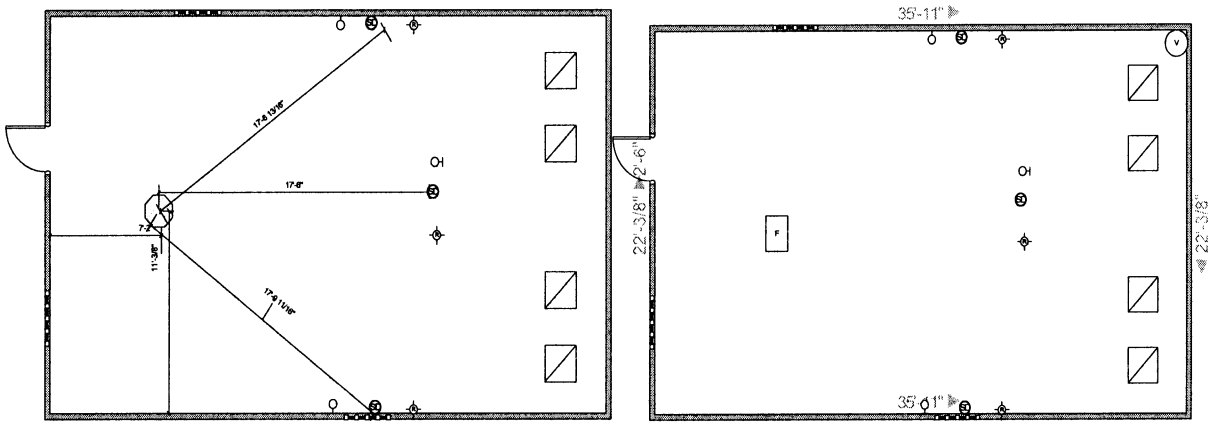


Figure Key

	Fire source location
SD	Smoke Detector
	Exhaust Vent

3.2.1 **Paper Test** [smoke generation] – For this test, shredded newspaper was burned in the test room as described in 3.2 and in the Appendix. Fuel loads were varied from one half to one and a half ounces of paper to match the smoke build up curves required by standard smoke detector test protocols. For this type of fire, the SigniFire IP consistently indicated an ALARM condition well in advance of the conventional smoke detectors. SigniFire IP response was observed less than 130 seconds after ignition and before any smoke readings were obtained

from the instrumentation in the room. This is acceptable with SigniFire IP providing good response to the smoke created from this type of fire.

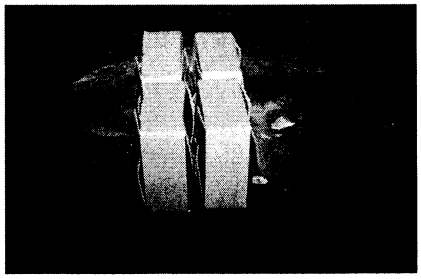
3.2.2 **Wood Crib Test** [smoke generation] – In this test, kiln dried fir strips, 154 x 19 X 19mm (6 by ¾ by ¾ inch) were burned in the test room as described in 3.2 and in the Appendix. Fuel loads are varied from 18 to 14 individual pieces to match the smoke build-up curves required. For this type of fire, the SigniFire IP indicated an ALARM condition in advance of standard smoke detection principles. SigniFire IP response was observed to be not greater than 3 min. after ignition. This is acceptable with the SigniFire IP providing good response to a very noticeable smoke pattern.

3.2.3 **Toluene/Heptane Mixture Test** [fire generation] - In this test, a mixture of 25% toluene and 75% heptane were burned in the test room as described in 3.2 and in the Appendix. Fuel loads are varied from 100 to 50 ml (3.4 to 1.7oz.) to match the smoke build-up curves required. For this type of fire, the SigniFire IP indicated an ALARM condition in advance of standard smoke detection principles. SigniFire IP response was at less than 30 seconds after ignition. This is acceptable with the SigiFire providing good response to a dark smoke pattern.

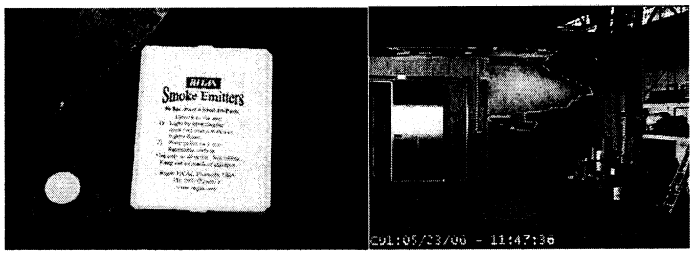
3.2.4 **Smoldering Test** [smoke generation] - In this test, ponderosa pine sticks 7.62cm by 2.54cm by 1.9cm (3 by 1 by ¾ inch) were burned in the test room as described in 3.2 and in the Appendix. Fuel loads are varied from 10 to 7 individual pieces to match the smoke build-up curves required. - As the SigniFire IP responded to the smoke before a smoke obscuration level of 4%/ft was reached as demonstrated by alarming before an Approved X%/ft detector alarmed, this response was considered acceptable. This long term smoldering test produces no easily discernable smoke pattern with a general loss of visibility with the camera only seeing a room going grey. There is no defined edge or movement visible to the smoke pattern. While average response from the SigniFire IP to the smoldering test, is understandable given the video image detection algorithm capabilities at this point. The test provides application knowledge that is important towards understanding the system capabilities and limitations.

3.3 **Smoke/Flame Response Sensitivity Test** - Using an indoor test area that minimizes the effects of outside stimuli such as reflection of flame, wind conditions, and artificial lighting, the SigniFire IP system was subjected to large scale smoke and/or fire tests. For these tests, the performance based detection principles of FM Approval Standard 3260 were utilized to assist in quantifying the SigniFire IP's response. The SigniFire IP flame response sensitivity performance was tested with 25% toluene/75%heptane mixture as well as a wide range of fuel types, smoke generators [smoke response], and cardboard box/paper fuels [smoke responseas described below. The alarms were monitored on the display monitor and relay outputs.

3.3.1 **Cardboard Box Fire** - Four 10 x 10 x 4.5 in. boxes (ULINE part number S-4346) were arranged in two parallel rows, with the 10 x 10 in. sides facing the opposite row. The boxes were loosely filled with a 30 inch by 36 inch piece of crumpled packing paper (ULINE part number S-2210). A 1.0 in. flue space was arranged between the rows. A butane lighter was used to light the flap of one corner of a box half way up the flue space so that flames propagated up the flue space and involved both rows. The distance from the SigniFire IP cameras to the fuel source was 100ft. The system alarmed in less than 120 seconds for the 6.0 and 8.0 mm FOV and under 300 seconds for the wider 2.8 mm FOV.



3.3.2 **Smoke emitter** – Regin HVAC Product 4 minute smoke emitters (part number S103) were place on a non-combustible surface. The open face of the emitter was ignited with a butane lighter. The distance from the SigniFire IP cameras to the fuel source was 75ft. The system alarmed in an average of 39s.



3.3.3 **1 ft Pan Fire** – A 1 ft by 1 ft steel pan filled with 100 mL of fuel was ignited using a match. The distance from the SigniFire IP cameras to the fuel source was 100ft. The system alarmed in less than 15 seconds irregardless of location within the FOV vertically of horizontally and fuel type. Fuels included heptane, JP-8, ethyl alcohol, isopropyl alcohol and unleaded gasoline.

3.3.4 **False Stimuli Response Test** – The SigniFire IP video detection system was subjected to the following false alarm sources: Direct Sunlight, Indirect Sunlight, Arcwelder, Resistive Electric Heater[FM1], Flourescent light, Halogen light, Incandescent light. The SigniFire IP video imaging detection system will produce nuisance alarms to changing light conditions or direct light that saturates the imaging element. The video imaging detection SigniFire IP system will alarm to modulated light sources.

3.3.5 **Flame Response Sensitivity** –Four samples of the FDS301 Visual Flame Detector were exposed to a series of test fires as described below along the centerline (0° viewing angle) of the sensor.

Fuel	Distance	Fire size	Avg. time
n-heptane	100 ft (44m)	1 ft x 1ft (32.5 cm) pan	10.1 sec
JP8	100 ft (305m)	1 ft x 1ft (32.5 cm) pan	10.2 sec.

The alarm response of the detectors was below the 30 second response time specified by the manufacturer and required by Class Standard 3260 and are considered satisfactory.

3.3.6 **Field of View** – The SigniFire IP camera viewing angle was varied from the center line up, down, left and right. The camera was exposed to each of the test fires described in section 3.3.5 at a distance described in the table below. The response time was within the manufacturer's specifications and within the requirements of the standard. This is considered satisfactory.

Fuel n-heptane	Min. Distance	Avg. Time [sec.]	Comments
0%-45% H	100 ft (30.5m)	<20s	H=horizontal
0%-15%V	100 ft (30.5m)	<15s	V=vertical

3.3.7 **Switching** – It was verified that the maximum response time to any flame source was less than 30 seconds during all testing. This is considered satisfactory.

3.4 **Normal Operation –** The SigniFire IP video detection system was tested to verify operation under normal conditions. The system performed as described in the "SigniFire IP Smoke and Fire Detection Camera Installation Manual".

3.4.1 **Trouble and Alarm Signals** – The appropriate signals were indicated at the SigniFire IP display monitor and the appropriate alarm/supervision contacts activating.

3.4.2 **Circuit Supervision** – The routine supervision tables of ANSI/NFPA 72 for IDC, NAC and SLC wiring do not match the wiring methods employed for this video detection system; however, the supervision principles found in ANSI/NFPA 72 can be applied to the SigniFire IP based on equivalency.

3.4.3 **Communication Connection** – Ethernet cable connects the camera to the Approved FSM-8 unit. When the video signal cable was interrupted [opened] or shorted, the camera screen went blank and a trouble signal was observed on the display and signaled via the transfer of the trouble contacts.

3.4.4 **Connection to Power Sources** – Disconnecting or shorting the POE or 12 VDC supply to the video camera resulted in loss of signal, the screen went blank and a trouble signal via dry trouble contact [transfer of state] was generated.

3.4.5 The SigniFire IP video detection system **wiring technique** differ from conventional fire alarm techniques and operation with a single ground was deemed not applicable as alarms are not triggered by the action of shorting wires in the field.

3.4.6 **Power Supply Supervision** – The SigniFire IP video camera input power are supplied with power fail indications, display going blank, and trouble relay contacts. It is necessary that these contacts be monitored by the associated local fire alarm control equipment at the protected property.

3.4.7 **Additional Supervision Features** – Operation of the SigniFire IP systems built-in trouble conditions or warnings were demonstrated for the following conditions: loss of video signal, loss of communication, and video camera that is either too dark, too light or insufficient contrast.

3.5 **Humidity Cycling and Conditioning** – The SigniFire IP video detection system including a IP camera housed in a Pelco EX listed enclosure remained functional with no trouble signals or change in operating characteristics after subjecting the product to the requirements of: relative humidity of 93%±2%, and temperature of 90°F±3°F (32°C±2°C) for 24 hours.

3.6 **Temperature Extremes** – The SigniFire IP video detection system including the IP camera housed in a Pelco EX listed enclosure was tested for operational response with acceptable results after each extreme [32°F and 120°F, (0C-49°C)] exposure for 24 hours using the fuel source from the baseline test.

3.7 **Voltage Range** - The SigniFire IP video detection system was tested for operational response with acceptable results at minimum, nominal and maximum voltages. The fuel source from the baseline test was used for the variable voltage test.

3.8 **Electrical Safety Tests** – It was determined by examination and electrical measurements that the voltage does not exceed 30VAC or 60VDC.

3.8.1 **Dielectric Strength** – The SigniFire IP video detection system successfully withstood the dielectric strength tests as required by the standard.

3.8.2 **Protective Grounding** – It was verified that the conductive parts of the listedFSM-8 equipment that are likely to become energized in the event of a fault are properly grounded, when the connection to the mains is via a standard detachable moulded cord set with proper ground connections.

3.8.3 **Field Wiring Terminal Spaces** – The creepage and clearance spacings between field wiring terminals and between field wiring terminal parts and the enclosure including the IP camera housed in the Pelco EX listed enclosure were found to be acceptable by measurement and by inspection.

3.8.4 **Electrical Shock** – It was determined by examination and electrical measurements that the voltage does not exceed 30VAC or 60VDC.

3.8.5 **Vibration** - The system cameras including the IP camera housed in a Pelco EX listed enclosure were tested for operational response with acceptable results during and after the 4 hour vibration test. The fuel source from the baseline test was used for the vibration test

3.8.6 **Name Plate Rating** – With the maximum loading on the power supply, the input load drawn must not exceed the marked load rating of 5W. The measured input load required as configured for the SigniFire application was 0.05A [5W].

3.8.7 **Protection from Fire** –It was determined by examination and electrical measurements that the voltage does not exceed 30VAC or 60VDC. The SigniFire IP enclosure is metal.

3.8.8 **Extraneous Transients including RFI Protection** – The SigniFire IP video detection system did not produce false alarms or trouble signals in the presence of the extraneous transients and the system responded satisfactorily to a test fire source in the presence of the extraneous transients.

3.8.9 **Surge Transients** – It was determined by examination and electrical measurements that the input voltage does not exceed 30VAC or 60VDC. Line transient testing was not applicable.

3.9 **Durability** – The SigniFire IP system demonstrated the limited durability test appropriate for the life expectancy of the product. The product operated with no trouble or alarm conditions when cycled through 500 on-alarm-reset operations.

3.10 **Stability** – The SigniFire IP exhibited operational stability over a 30 day time period.

IV MARKING

4.1 The following information appears on the apparatus identified in Section 1.5 and meets Standard requirements:

- Manufacturer's name and manufacturing location.
- Type number and date code
- Maximum input and output ratings
- Maximum ambient temperature
- Control Drawing Reference
- Approval Mark
-

4.2 The SigniFire IP video detection system software is controlled via the revision level. The SigniFire IP system as tested operated using SigniFire IP 1.824. This information is displayed in the report tab of the SigniFire IP camera web interface (see manual).

V REMARKS

5.1 Installation, use, and maintenance of this equipment shall comply with the relevant requirements of the latest edition of the National Electrical Code (ANSI/NFPA 70) and National Fire Code (ANSI/NFPA 72).

5.2 An engineering study of the hazard, detector location and detector characteristic response is necessary for any application of the SigniFire IP video detection system. Any installation of the SigniFire IP requires that a commissioning smoke and flame testing as well as time exposure to the environment must be conducted to confirm that the desired level of performance has been met.

5.3 As is characteristic of all optical detectors, dust dirt, condensation, and other foreign material on the lens may impair the detector's response to fire. This must be considered in the application of these units.

5.4 Tampering or replacement with non-factory components may adversely affect the proper operation of this detector.

5.5 Installations shall comply with the latest edition of the manufacturer's instruction manual.

VI FACILITIES AND PROCEDURES AUDIT

The manufacturing site in Sparks, MD is subject to follow-up audit inspections. The facilities and quality control procedures in place have been found to be satisfactory to manufacture product identical to that examined and tested as described in this report.

VII MANUFACTURERS RESPONSIBILITIES

7.1 Documentation considered critical to this Approval is on file at FM Approvals and listed in the Documentation File, Section VIII of this report. No changes of any nature shall be implemented unless notice of the proposed change has been given and written authorization obtained from FM Approvals. The FM Approved Product Revision Report, Form 797, shall be forwarded to FM Approvals as notice of proposed changes.

7.2 The manufacturer shall make available to users of the subject equipment "SigniFire IP Smoke and Fire Detection Camera Installation Manual". The manufacturer shall make additional copies available upon request.

7.3 The manufacturer shall subject each SigniFire IP unit to a full 100% Quality Control and Audit procedure. The SigniFire IP units will demonstrate the ability to detect events, and send out event messages to an Approved FACP via dry contacts and/or to the Approved FSM-8. In addition, SigniFire IP unit setting will be checked to ensure that fire is set to "medium", smoke is set to "medium", and offsite is set to "medium" (offsite was not evaluated by FM)

7.4 100 percent of lenses will be verified for make and model/part number.

VIII DOCUMENTATION

The following drawings describe the SigniFire System and are filed under Project 3026784.

Drawing No.	**Issue**	**Description**
Signi*Fire* IP Camera Operations Manual	November 2007	Signi*Fire* IP Smoke & Fire Detection Camera Operations and Installation Manual
16-00001-020	1	Top Assembly BOM
27-00001-040	1	DSP Assembly BOM
27-00009-010	1	Sensor Assembly BOM
27-00012-020	1	IO Assembly BOM
25-00001-040	D	AIT-100 DSP Board schematic
25-00009-010	A	SOC 1.3-3M schematic
25-00012-020	B	AIT-100 AC/DC input-relay IO board schematic
36-00001-003	8/12/2007	Front lens plate
36-00002-003	8/12/2007	Connector plate
36-00003-002	8/12/2007	Filter plate

IX CONCLUSION

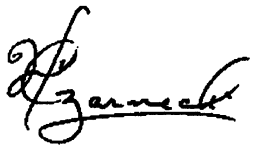
The axonX SigniFire IP video image detection system described in 1.4 meets FM Approvals requirements. Since a duly signed Master Agreement is on file for this manufacturer, Approval is effective the date of this report.

EXAMINATION AND TESTING BY: Sparks, MD and FM Approvals, Norwood, MA - **Henry Czarnecki**
Aberdeen Proving Grounds (APG) in Aberdeen, MD – **Henry Czarnecki**

PROJECT DATA RECORD: Henry Czarnecki

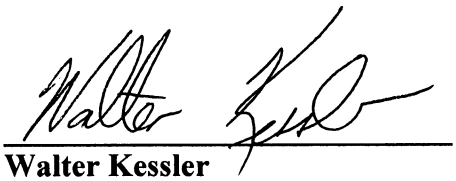
ATTACHMENTS: FM label, SigniFire IP System Description and configuration, Flame/Smoke Response Sensitivity, specifications, Test Set Up,.

REPORT BY:



Henry Czarnecki
Senior Engineer
Electrical Systems

REPORT REVIEWED BY:



Walter Kessler
Senior Engineer
Electrical Systems

ATTACHMENTS

axonX FM Label (Bottom of Camera)

SigniFire IP™

Sparks, MD
www.axonx.com
Part No: SigniFire IP™-01
Serial No: IP00001
Software version:
Power 12VDC, POE
Electrical Load Rating 5W

FM APPROVED

SIGNIFIRE IP SYSTEM

Scalable System Architecture

A SigniFire™ system is comprised of at least one IP camera, a video management system, and the monitoring solution. You can connect any number of IP cameras and network recorders via standard LAN / Ethernet network to expand the system to meet end user needs (limit of 32 cameras per Network recorder). SigniFire IP cameras can be powered by a fire alarm control panel (FACP), an approved security and fire camera power supply with battery backup, or a POE switch with battery backup. With SpyderGuard™, any PC workstation can be used as a monitoring system so long as it is connected through a standard IP network connection. Figure 2 is an example of the scalable enterprise architecture.

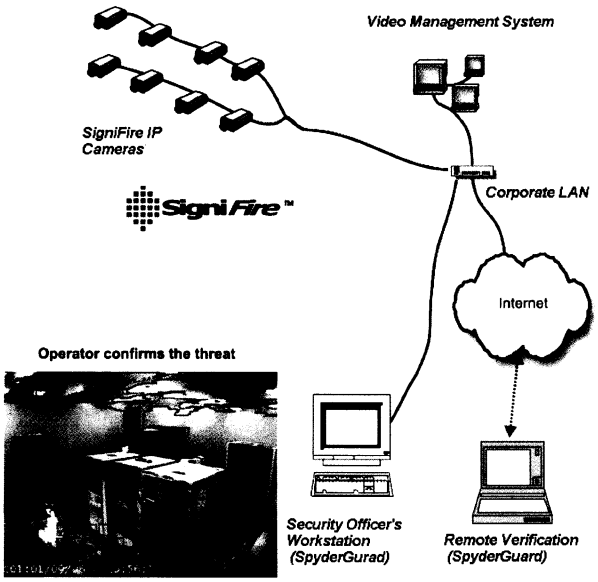


Fig 2 – Typical installation of a SigniFire™ system with 8 FM approved IP cameras, a FM approved video management system (FSM-8 or equivalent), and a LAN network connected to Security workstation and remote monitoring of the site.

Signi*Fire* IP™ comes with a video management system called FSM-IP™. This Microsoft Windows® application allows an FSM-8 or equivalent computer to act as a Network Video Recorder (NVR), providing storage of video alarms from the Signi*Fire* IP™ Cameras and acts as an information conduit between the Spyder*Guard*™ monitoring station and the cameras themselves.

The number of Signi*Fire* IP™ cameras that can be supported in any Signi*Fire*™ installation is dependent on the speed and robustness of the network to which the cameras are attached and the speed of the PC and its harddrive that is running the FSM-IP™ NVR application. Multiple PC's running FSM-IP™ may be monitored by one or more Spyder*Guard*™ stations. In lieu of using the FSM-IP™ application, a Software Development Kit (SDK) exists to allow third party video management products to interface to Signi*Fire* IP™ cameras and perform the same functions (not FM approved).

Field of View (FOV)

The most significant factor affecting system performance is the camera positioning and the resulting FOV. It is important to position cameras to maximize the FOV as well as the area covered by the cameras. A performance based design should be used to determine the number of cameras needed to properly cover the space from the determined fire threat. Table 1 shows the response times to various fire sources. Cameras should be placed high in the space so as to over look the hazard area and avoid objects within 2 meters of the camera.

Table 1 – Detection times in seconds of IP camera models to various sources.

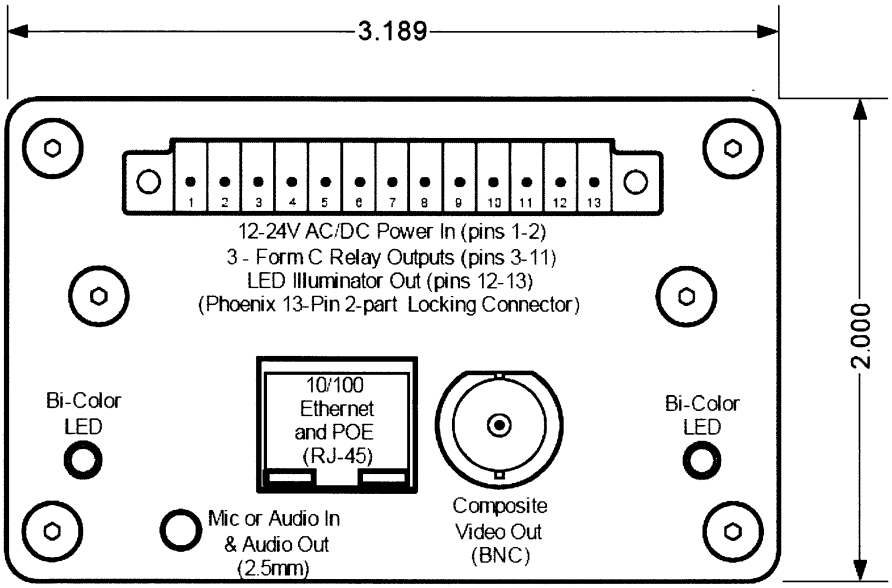
Fuel Source	Distance to detector	2.8 mm FOV	6 mm FOV	8 mm FOV	EX 8 mm FOV
1 ft pan of Heptane	100 ft	18	9	9	9
1 ft pan of JP-8	100 ft	18	10	10	10
1 ft pan of Ethyl Alcohol	100 ft	21	10	11	11
1 ft pan of Isopropyl Alcohol	100 ft	16	9	9	10
1 ft pan of Unleaded Gasoline	100 ft	8	8	8	9
4 min Smoke Emitter	100 ft	301	94	52	63
4 min Smoke emitter	75 ft	43	24	22	48
6 in pan of Heptane	100 ft	100	10	9	10
Cardboard boxes and paper 4 ea. 10 x 10 x 4-in. boxes	100 ft	278	83	101	97
6 in diameter pan of Heptane/toluene 75/25	28 ft	19	19	20	18
Shredded newspaper	28 ft	127	150	102	151
Smoldering wood	28 ft	3062	3279	3027	2927
Wood Crib 6 x 6 x 2.5-in.	28 ft	142	192	145	194

IP Camera Setup
Once the camera locations have been selected, the entire procedure will consist of the following steps:

- Unpack and inspect IP Cameras
- Power up and connect to the IP camera
- Configure camera
- Install camera and set focus.
- Commission cameras

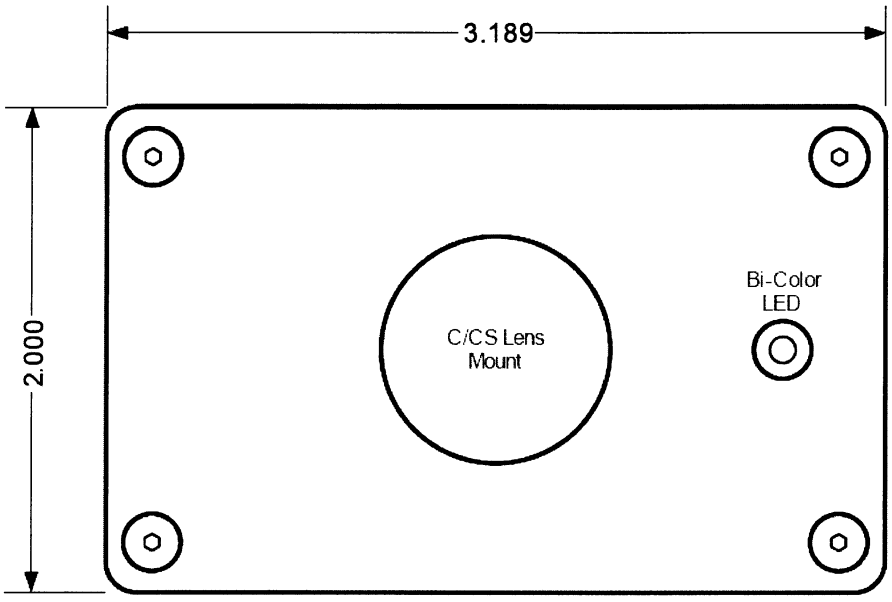
Unpack the camera and provided lens. Inspect both camera and lens for defects or damage. Affix the provided lens to the camera. Familiarize yourself with the camera layout and all of it connections, Figures 5 and 6. The Signi*Fire* IP™ Camera offer standard power and coax video connectors as well as an RJ45-10 connector that accepts

POE, three configurable dry contact closers, and a power out connection for approved accessories.



Back View

Fig 5 – Back plane of the IP camera showing the layout of the LED's, and dry contact, Ethernet, BNC, power in, power out, and audio connections.



Front View

Fig 6 – Front Plane of the IP camera showing location of the C/CS Lens mount and Front panel LED.

To obtain a video output connect a video coaxial cable terminated with a 75Ω BNC connector to the BNC socket on the rear of the camera. Another way to transfer video is over CAT-5 wiring through the RJ45-10 connector.

There are three LED's located on the IP camera; front, right rear and left rear. The color of the pulse and the resulting state are listed in Table 4. The Front LED provides the alarm condition of the camera. The right rear LED indicates the condition of the network connection for trouble shooting purposes. The left rear LED indicates the state of the image collection and internal processing of the images by the analytics.

Front LED	
Color	State
Green Pulse (1 sec interval)	Normal
Green Pulse rapid	Motion
Yellow Pulse	Trouble
Red Pulse	Alarm
Right Rear LED (ref from rear)	
Green Pulse	Network normal
Red Pulse	Network Failure
Yellow Pulse	http server Failure
Left Rear LED (ref from rear)	
Green Pulse	Every 15th frame (Image task)
Yellow Pulse	Camera Control Task Failure
Red Pulse	Image Task Failure

Table 4: Color and State of the three LED's located on the IP camera.

To run the IP camera interface and configure the camera a computer with either FireFox or Internet Explorer is required. If Internet Explorer is used, Java must be properly installed and up to date in order to see the video feed. FireFox can be easily downloaded and will run both Java and multipart stream video feed options.

In addition to the web browser a network connection with a fixed IP configuration must be established. The IP camera comes pre-configured with a Fixed IP address of 192.168.0.100. This requires the computer used to configure the camera be set to a fixed IP to initially communicate with the camera. Once the initial communication is acquired

the camera can be configured to function on a DHCP or a Fixed IP Network and its IP address can be changed to specifically identify the camera.

Administration Features

The administrator (a trained and certified authority having sole control of the settings) of the system has a number of features he/she should be familiar with and will have to configure to fit the architecture and design of the system. This includes the network configuration, sensitivity settings, relay closures, schedules, zones, and passwords. The first feature on the administrator menu is the configuration tab that contains a number of sub menu items, Figure 14.

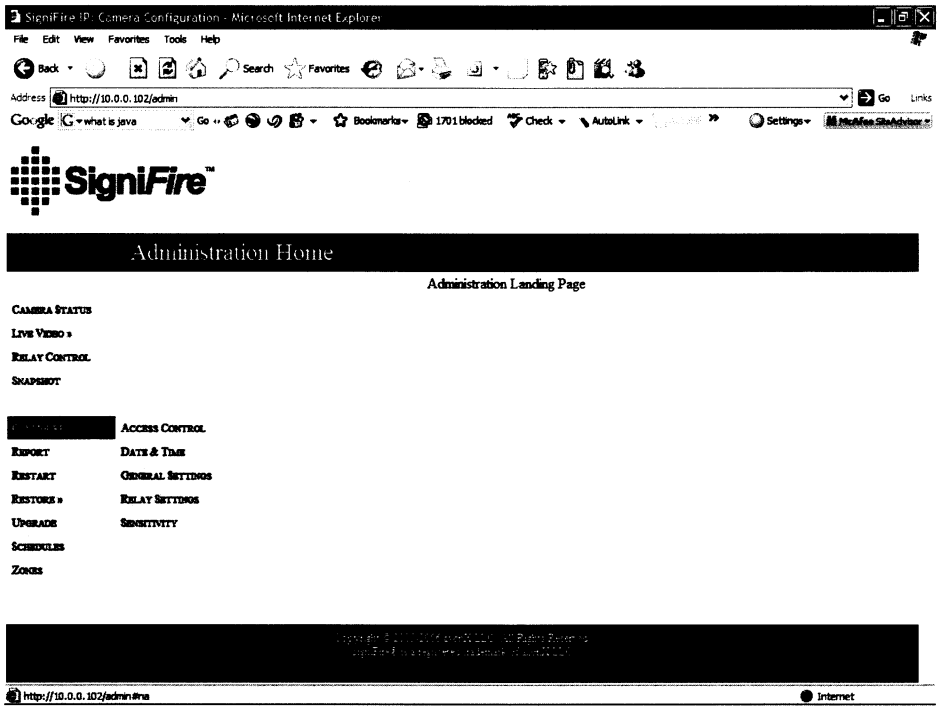


Fig 14 – Configure option under the administrator section has a number of sub menu features.

SENSITIVITY

The final sub menu feature is the cameras **sensitivity settings,** Figure 19. All three fire algorithms are by default set to medium and the dynamic function is set to off. The system is FM approved for a sensitivity setting of medium for both fire and smoke. The Offsite algorithm is not an FM approved detection method. The fire, smoke and offsite (reflected fire light) algorithms can be set to low medium or high. The smoke also has an ultra sensitivity setting used for very clean and stable environments. The dynamic setting is used in applications that have light fluctuations do to windows, large doors, or

processes that make the background image unstable and may cause nuisance alarms. The system is for indoor applications only.

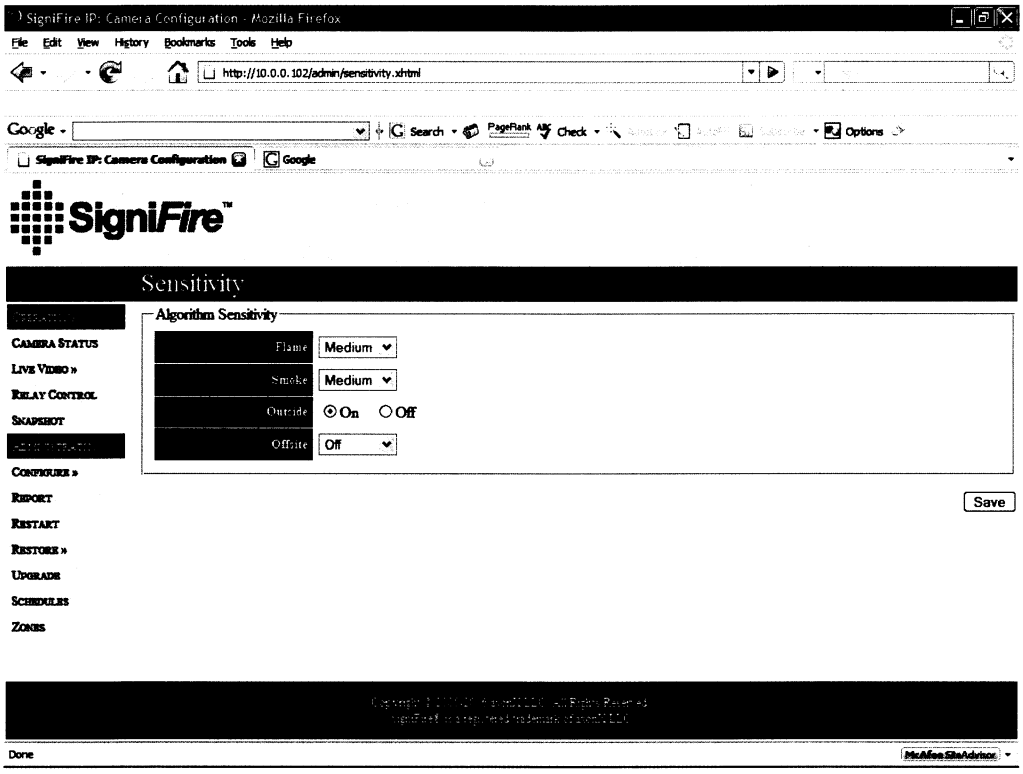


Fig 19 – Sensitivity settings

Commissioning

It takes approximately 30 days to properly install, commission, and fill out commissioning paperwork. It is important to contact the local Authority Having Jurisdiction (AHJ) or the facility manager in charge of monitoring the fire protection system prior to application to ensure all required paper work has been completed.

At a minimum, commissioning includes:

- Testing and stability period – where the system is subjected to fire and nuisance sources to demonstrate stability and performance.
- Documentation - Documentation of the organizational structure, camera settings, sensitivity settings, zones, schedules and events archive. (see Appendix D)
- Preliminary Maintenance and service check - The system should be checked according to the service and maintenance requirements to establish the systems condition upon installation.

Once the system is in place and settings adjusted as necessary to ensure optimum performance, the system can be handed over to the end user (on-site security or a remote monitoring facility). The system owner should record any changes up to one year after commissioning of the system.

NOTE: During the commissioning period the cache file and memory storage on the video management system should be regularly checked to ensure that adequate memory is available to store events for 30 days.

SigniFire™

SPECIFICATION SHEET

IP Camera
Early Warning/Early Response

The SigniFire IP camera is the newest edition to the SigniFire™ Early Warning fire detection line of products

- Detection algorithms embedded on network camera
- Intelligent Edge Device
- Benefits of IP network camera security system
- Increased system reliability
- Remote monitoring over the Internet
- Addresses security needs of organization

The SigniFire IP camera is capable of detecting and alarming on a variety of events. Once an alarm occurs it can be signaled through contact closures or by digital streamed transmissions over IP.

Video Processing Algorithms Include:

Flaming Fires
Looks for a specific fire pattern consisting of a bright core of the flame and a flickering corona.

Reflected Fire Light
Detects the presence of the flickering component of fire light reflected off of surfaces facing the fire.

Smoke Plumes
Identifies the anomalies that are caused by smoke and analyze the progression over a period of time to identify a growing smoke plume.

Ambient smoke
Monitors the light diffusion from light sources and bright objects in the video images to detect the pattern consistent with the slow accumulation of smoke.

Intrusion detection
Can monitor multiple areas of the video image for the presence of moving objects at different times. This can be used to detect and record wanted or unwanted persons.

axonX
47 Loveton circle, suite E F
Sparks MD. 21152
Voice: +1 (410) 472 6590
Fax: +1 (410) 472 6595
e-mail: emailus@axonx.com

Processor Memory and Clock	Texas Instruments TMS320DM642 Digital Media Processor 128 MB RAM Battery backed up real time clock
Imager	Micron CMOS MT9M11
Video Format	Color NTSC
Video Resolution	640x480 (NTSC)
Video Compression	MJPEG
Minimum Illumination	5.0 Foot-candles (50 Lux)
Events notification medium	http network based communications, Alarm, Trouble and Auxiliary Dry Contacts
Detector Performance	Flame: 1 ft pan fire at 100 ft Smoke: Indoor detection verified at 100 ft Motion: Configurable motion detection based on zones and schedules
Detection zones	User defined, including detect/non-detect logic Each zone may be linked to multiple detection Schedules (daily, weekly, monthly, yearly, Single occurrence)
Dimensions and Weight	4.25" x 3.18" x 2" 1.5 lbs
Environmental limits	Temperature range 32—122°F (0—49°C) Humidity up to 5-95% non condensed
Power	Power over Ethernet (POE) 12 VDC. Consumption +/- 5 Watts
Video Management Software	SpyderGuard, FSM-IP API available for video management integration
Connectors	RJ-45 Ethernet Jack Terminal block for three relay outputs and DC power connections BNC For coaxial analog out
Lenses available	2.8 mm, 6 mm, and 8 mm Field of Views

© axonX LLC

Objective

The objective of this test series is to document the flame and smoke detection performance of the axonX SigniFire IP Video Image Detection system for FM approval. The system will be exposed to a range of fire sources within a closed ANSI 268 room. The testing will vary the source type, illumination level, and camera model . Testing these variables will determine the ability of the SigniFire IP system to detect a given fire source.

Approach

The test objectives will be completed by conducting tests at the axonX fire lab in Sparks, Maryland. Four fire sources will be tested. The sources will be initiated and allowed to progress and fill the test facility with smoke until alarm conditions occur for all camera views, the source has been consumed, or the source is terminated by the test director.

Experimental Setup

Test Facility

Tests will be conducted at the axonX fire lab in Sparks, Maryland. The test facility is a 22 ft wide x 36 ft long and 10 ft high enclosure, Fig 1. The space is not conditioned. The walls are constructed of steel studs and drywall. The walls are painted white, however, much of the wall space transitions to black due to soot deposits from past tests. The deposits are more prevalent higher up the wall. The floor is poured concrete. The lighting is supplied by artificial means with all windows covered to prevent extraneous light from entering the room. The lighting is supplied by 2ft by 4ft fluorescent fixtures with four Philips Universal T8 TL741 Cool bulbs. Each bulb is uses 32 Watts and outputs 2,850 lumens. A total of 16 fixtures are spread around the room, Fig 2. The ceiling is a 10 ft high drop ceiling with the light fixtures replacing many of the ceiling panels creating a smooth ceiling surface. Exhaust ports to clear the room are located at one end of the room opposite the entrance door and fire source.

The light fixture described above and shown in Fig. 2 were installed to provide a range of lighting conditions. The lights were divided into three groups (1, 2, 3), Fig 2. When all three light groups are on approximately 111.8 Fc +/- 27.6 Fc illuminate the space, Fig 3. The lowest illumination is provided by group 3, 32.4 Fc +/- 18.6 Fc, Fig 4. In addition if all light groups are powered off the room will have zero illumination. A photometric survey was conducted to document the uniformity and level of illumination at 0.76 m (30 in) above the floor in the facility. A height of 0.76 m was used to comply with DOD-HDBK-289 section 4.1.3. The photometric survey used a light meter [Extech model number 401025]. The meter is capable of measuring up to 5000 foot-candles (Fc)

with a measuring resolution of 0.1 for the 0-200 Fc range. The procedure for mapping the illumination level was to mount the photometer on a tripod to ensure a height of 0.76 m and mapping the space via 2 ft squares. A photo survey will also be taken after the test series is complete.

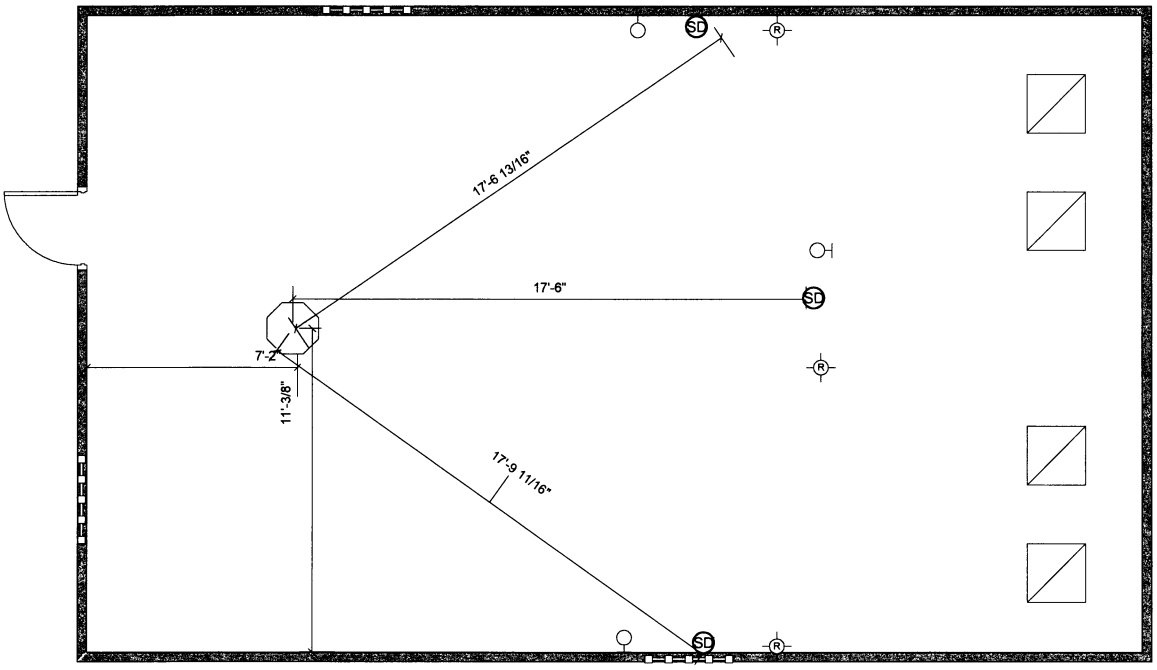


Figure Key

⬡	Fire source location
SD	Smoke Detector
⧄	Exhaust Vent

Fig. 1 – Layout of ANSI 268 Facility with dimensions.

	1		2		2		1	
				1		3		
	2		3		3		2	
		3		1				
	1		2		2		1	

Fig 2 – ANSI 268 lighting configuration.

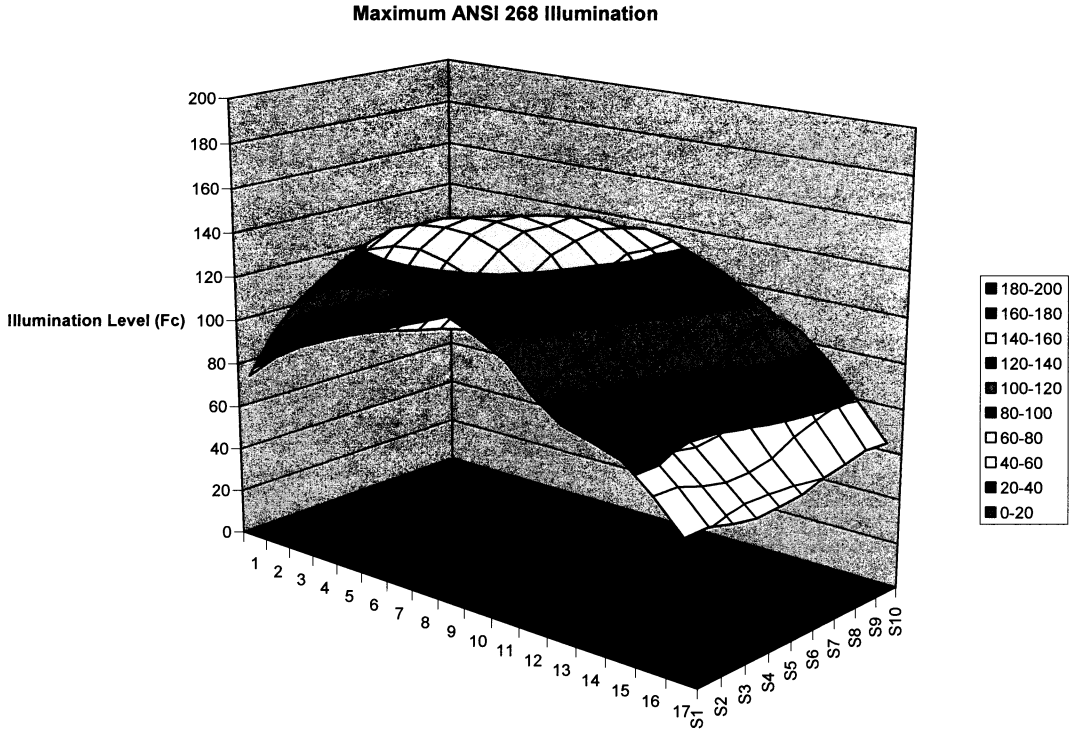


Fig 3 – Map of illumination topography. Illumination level average is 111.8 Fc with a standard deviation of 27.6 Fc

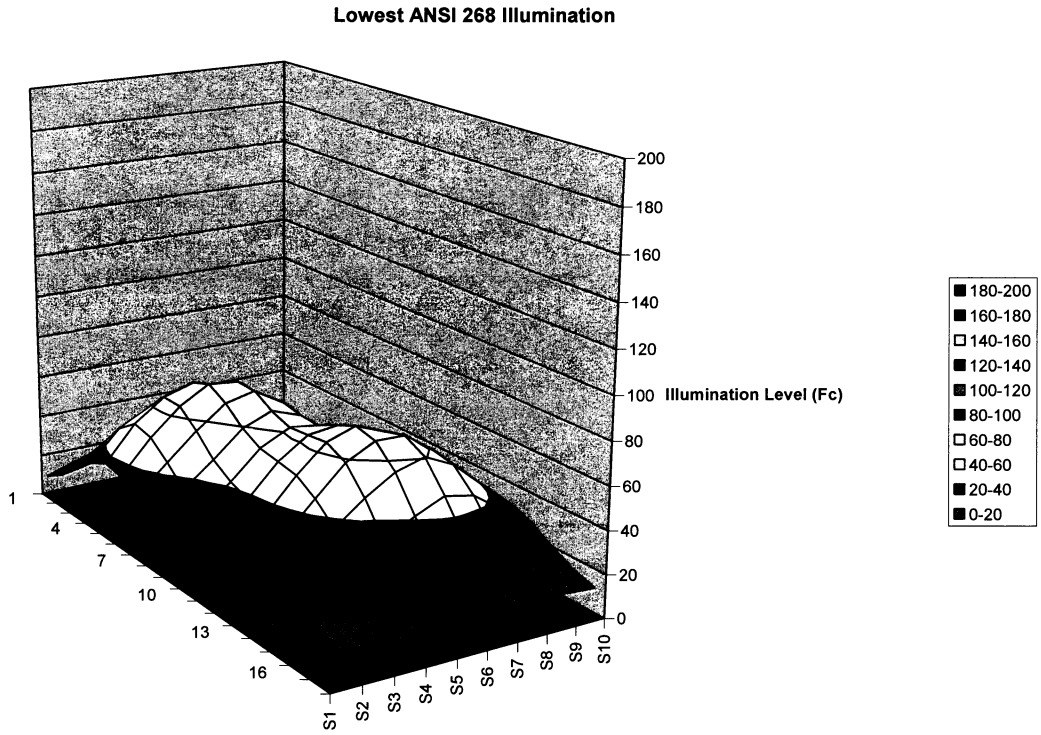


Fig 4 – Map of illumination topography. Illumination level average is 32.4 Fc with a standard deviation of 18.6 Fc

Optical density meters and spot type detectors are installed within the room and data is collected from the devices using a data acquisition system (DAQ). An ion spot type detector, a photoelectric spot type detector, and an optical density meter are co-located at three locations in the room. One set of detectors is located on the ceiling 17.7 feet from the fire source location. The two remaining sets are located 17.7 feet from the fire source on opposite walls, Fig 5. The fire source is 7 feet from the front wall and centered in the room (11 feet) between the two side walls.

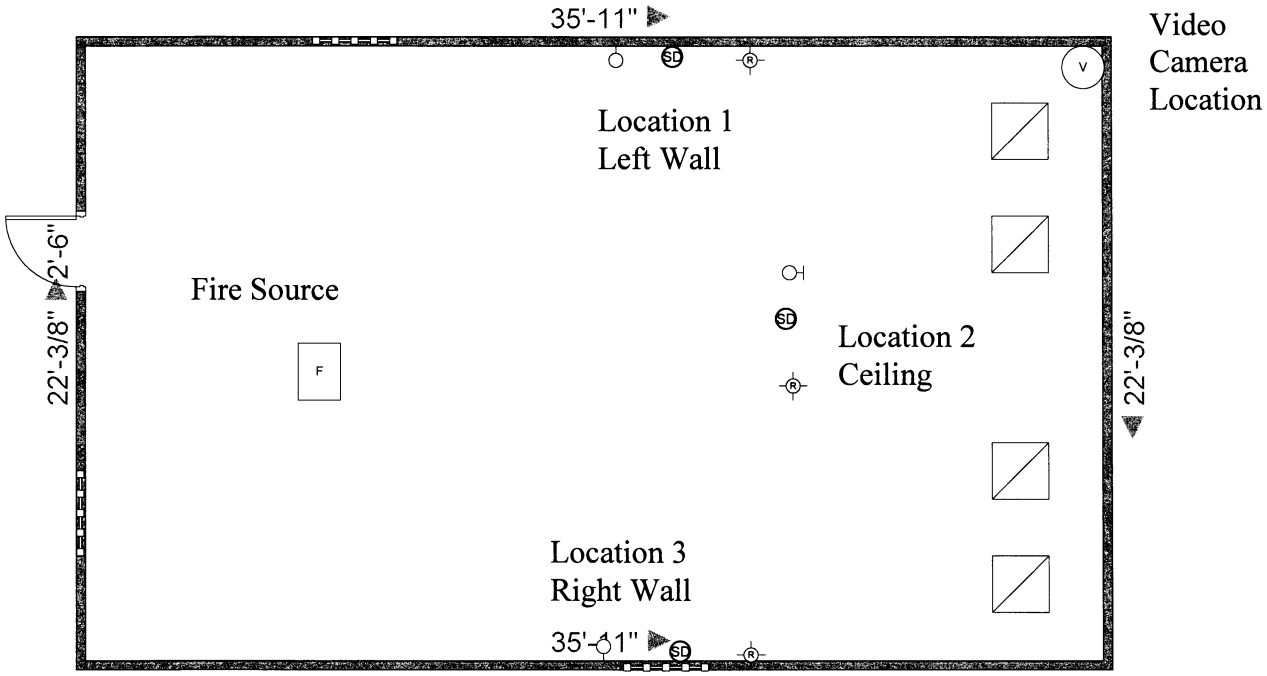


Fig 5 – Fire source and instrumentation in the ANSI 268 room.

VID System

The axonX system will be running SigniFire IP camera firmware version 1.824. The settings defined by the user are listed in Table 1. This system consists of two flame algorithms and one smoke alarm algorithm. The flame algorithms consist of one for fires that are directly in the field of view of the camera, and a second "Offsite" algorithm to detect fires outside the field of view. Optimal camera settings will be determined based on visual observation of the video image as well as by image metrics provided by the VID system. The cameras will be optimized per the VID manufacture's recommendations and reviewed by the manufacturer as testing begins. At the beginning of the test series the system will be adjusted to establish an optimized image background.

Table 1 – User defined settings of the SigniFire system

Setting	2.8 mm	6.0 mm	8.0 mm	EX 6.0 mm
Flame	Medium	Medium	Medium	Medium
Smoke	Medium	Medium	Medium	Medium
Offsite	Medium	Medium	Medium	Medium

The VID system will maintain an electronic history file of all alarms, including a digital movie showing the video image that caused the alarm condition for each entry. The SigniFire system will provide for each historical movie, the time and date of the event, the alarm type, camera identification and file name. This will allow for a review of each alarm to ensure that the event was due to fire or smoke and not from an unintended source.

The cameras will be mounted to a rack indicated in Fig. 5 by the V within a circle. The fire location is indicated by the F within a square on Fig. 5. The cameras will be mounted at an elevation of approximately 6 ft during testing.

Instrumentation and Documentation

In addition to the IP cameras to be tested, instrumentation will consist of a FSM-8 DVR with the FSM-IP software to record the video signals. Three ODMs, three ionization spot-type smoke detectors, and three photoelectric spot-type smoke detectors. A digital camera will be used to take photographs. A tape measure and compass will be taken to record position and provide bearings.

Fuel Sources

Four fuel sources will be tested;

1. Paper Fire
2. Wood Fire
3. Flammable liquid fire
4. Smoldering Smoke Test

Igniter assembly

The igniter assembly is to consist of the following or equivalent components:

a) Igniter Probes – The metal probes, ¼ inch (6.4 mm) diameter and tapered at the ends to form a point and maintained ½ inch (12.7 mm) apart, are connected to the high-voltage insulated output leads of an oil burner ignition transformer: see (c). Adjustments and support for the probes is to be provided by metal clamps affixed to a vertical steel bar integral with the igniter assembly.

b) Support – A ring clamp, 5 inches (127 mm) in diameter, is clamped to a ring stand to support the container holding the combustible.

c) Ignition Source – Consists of a 120 colt, 60 hertz primary, 10,000 volt, 23 milliamperes, secondary oil burner ignition transformer, the output of which is to be connected to the igniter probes. The arc used for ignition is to be obtained by the closure of a remote, low-voltage, momentary contact switch which energizes a relay whose contacts control the transformer primary.

Paper fire – Test A

The following materials and procedures are to be used for the paper fire 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 – Shredded newsprint (black printing only) is to be cut in strips ¼ to 3/8 inch (6 to 10 mm) wide, 1 to 4 inches (25.4 to 102 mm) long, total weight 1-1/2 oz (42.6g). The paper is to be poured into the receptacle, see (b), with the bottom covered temporarily by a flat plate. The receptacle is to tampered periodically during pouring operation until the paper contents are even with the

top of the receptacle. The paper is then to be further tamped by hand or by a rod 1 inch in diameter until the paper level is 4 inches below the top edge of the receptacle. A hole 1 inch in diameter is to be formed through the center from top to bottom of the paper. The temporary bottom plate is then removed and the assembly mounted three feet (0.9m) above the floor on a 5 inch (127mm) diameter ring support.

b) Receptacle – To be formed of 1/32 inch (0.8 mm) thick sheet metal, 4 inches (102 mm) diameter and 12 inches (0.3 m) high and seamed together, with no air gap at the seam, with a 6 inch (152 mm) square support flange at the bottom.
c) Point of Ignition – The probe tips of the igniter are to be placed at the bottom center of the receptacle and arcing sustained for up to 5 seconds.
d) Smoke Profile – For this test the following conditions apply:
    1. Flame break though is to occur at between 1 and 3 minutes.
    2. The first principle peak is to occur at between 1 and 3 minutes
    3. Smoke is to peak at between 27 and 37 percent per foot obscuration [0.137 and 0.2 OD/foot (0.45 and 0.66 OD/m)] at the ceiling detector location, and between 21.5 and 37 percent per foot [0.0105 and 0.2 OD/foot (0.345 and 0.66 OD/m)] at each sidewall location.
    4. There is between 20 and 40 seconds of 4 percent per foot, [0.018 OD/foot (0.058 OD/m)] or higher obscuration at the ceiling detector location, and between 10 and 30 seconds 0f 10 percent per foot [0.045 OD/foot (0.15 OD/m)] or higher obscuration at the sidewall detector locations
    5. The secondary peak is not to exceed 13 percent per foot obscuration [0.061 OD/foot (0.198 OD/m)] at any detector locations.
    6. Length of test is to be 4 minutes.

Wood fire – Test B

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

a) Combustible – A wood brand formed of three layers of kiln dried fur strips, each strip ¾ inch (19.1 mm) square in cross section, 6 inches (152 mm) long with six strips in each layer, is to be used. Wood strips are to be nailed or stapled together with adjacent layers at right angles to each other. Overall dimensions of the wood brand to be 6 by 6 by 2-1/2 inches (152 by 152 by 64 mm). the brand is to be supported on a 5-inch (127 mm) diameter ring support 3 feet (0.9 mm) above the test room floor.
b) Promoter – The wood brand is to be ignited by burning 4 milliliters of denatured alcohol consisting of 190 proof (95 percent) ethanol to which 5 percent methanol is added as a denaturant. The alcohol is to be placed in a 1-1/2 inch (38 mm) diameter, 1 inch (25.4 mm) deep metal container, the bottom of which is to be 3 ½ inches (89 mm) below the bottom of the wood brand and centered so that the

flame does not break through the top of the wood brand. The container is to be supported by a ¼ inch (6.4 mm) hardware cloth. The alcohol is to be placed in the container no earlier than 30 seconds prior to ignition.

c) Point of ignition – Ignition is to be by probes in alcohol. Probe tips of the igniter are to be placed as near the container lip as possible without arcing to the sides.
d) Smoke profile – For this test the following conditions apply:
    1. Smoke buildup is to begin at between 80 and 120 seconds at the ceiling detector location, and between 60 and 120 seconds at each sidewall detector location.
    2. There is to be at least 60 seconds of 4 percent per foot [0.018 OD/foot (0.058 OD/m)] or higher obscuration at all detector locations.
    3. Maximum obscuration is not to exceed 17 percent per foot [0.081 OD/foot (0.265 OD/m)] at the ceiling detector location, and 27.5 percent per foot [0.14 OD/foot (0.46 OD/m)] at either sidewall detector location.
    4. Flame breakthough is to occur at between 150 and 190 seconds.
    5. Length of test is to be 4 minutes.

Flammable liquid fire – Test C

The following materials and procedures are to be used for the gasoline fire 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 – Consists of a mixture of 25 percent toluene and 75 percent heptane (of sufficient quantity to generate curves within the limits specified by figure 39.1) which is to be burned in a metal receptacle.
b) Receptacle – To be formed of 0.025 inch (0.635 mm) stainless steel, 6-1/4 inches (158 mm) in diameter and 1-1/4 inch (32 mm) deep, rounded bottom formed by ½ inch (12.7 mm) radius. Located 3 feet (0.9 m) above the test room floor and centered with a ring support. The liquid is to be poured into the receptacle 30 seconds prior to ignition.
c) Point of Ignition – The probe tips of the igniter are to be placed so that they are above the lip of the pan and not extending into the pan. This results in ignition of the vapors above the liquid.
d) Smoke Profile – For this test the following conditions apply:
    1. Maximum obscuration is not to exceed 13 percent per foot [0.061 OD/foot (0.199 OD/m)] at the ceiling detector location, or 21.5 percent per foot [0.105 OD/foot (0.345 OD/m)] at either sidewall detector location.
    2. Length of test is to be 4 minutes.

Smoldering Smoke Tests

The combustible for this test is to be ten Ponderosa pine sticks (nonresinous, free from knots or pitches) placed in a spoke pattern on the hot plate so that sticks are 36 degrees (0.63 rad) apart. The end of each stick is to be flush with the edge of the hotplate. Each stick is to be 3 by 1 by ¾ inches (76.2 by 25.4 by 19.1 mm) with the ¾ by 3 inch (19.1 by 76.2 mm) face in contact with the hotplate. All surfaces of each stick are to be relatively smooth and free from burrs or holes. The grain of the wood is to be parallel to the stick length. Each stick is to be conditioned for not less than 48 hours at 52 degrees C (125 degrees F) in air-circulating oven. The stick weight is to be 16 +/- 2 grams (0.546 +/- 0.07 oz) following the oven conditioning.
The heat source is to be a 240 volt, 1550 watt hotplate having a steel plate 8-1/2 inches (216 mm) in diameter and ¼ inch (6.4 mm) thick, the top most portion of which is to be 8 inches (200 mm) above the floor. The temperature of the hotplate is to be monitored by an iron-constantan No. 30 AWG (0.05 mm2) (type J) thermocouple attached to the edge of the steel plate by placing its junction in a hole 0.015 inch (0.38 mm) in diameter and ¼ inch deep and peening over the opening to secure it. The thermocouple is to be connected to a proportioning temperature controller that is able to be precisely set for the specified hotplate temperature. The controller sensitivity is to be adjusted so that all conditions for this test are met. Once set for a specific temperature, the hotplate is to be maintained at that temperature, (and monitored by a temperature measuring meter). Prior to the start of the test, the hotplate temperature is to be 23 +- 2 Degrees C (73 +-4 degrees F). The initial proportioning controller temperature setting is to be 205 degrees C (401 degrees F). The hotplate and controller are then to be energized and the test time started (T=0). The proportioning controller setting is to be increased to obtain the temperature sequence specified in Table 40.1 and Figure 40.1 (the hotplate temperature normally lags the controller setting by 2 minutes during the incremental increases). A hotplate intended for this purpose is Emerson Electric Co., Series PH-400 Chromalox.

Time (minutes)	Hotplate Temperature
0	23 +-2 C (73 +-4F)
0-3	Increased 60.7 C (109F) per minute to 205 C (401 F)
More than 3	Increased 3.2C (5.8 F) per minute for remainder of test

All detectors shall respond to the test trial before the obscuration level exceeds 10.0 percent per foot (26.26 percent per meter [0.0458 OD/foot (0.15 OD/m)] at the detector location as measured by the photocell-lamp assembly described in 31.4.1 41.3.3 (f) and (m). Flaming of the wood shall not occur before the obscuration level is reached.

For this test, the visible smoke buildup rate is to be maintained within the limits illustrated in Fig. 7. At no time during the test trial is the buildup to exceed 5 percent obscuration per minute as measured over the length of the 5-foot (1.5m) light beam.

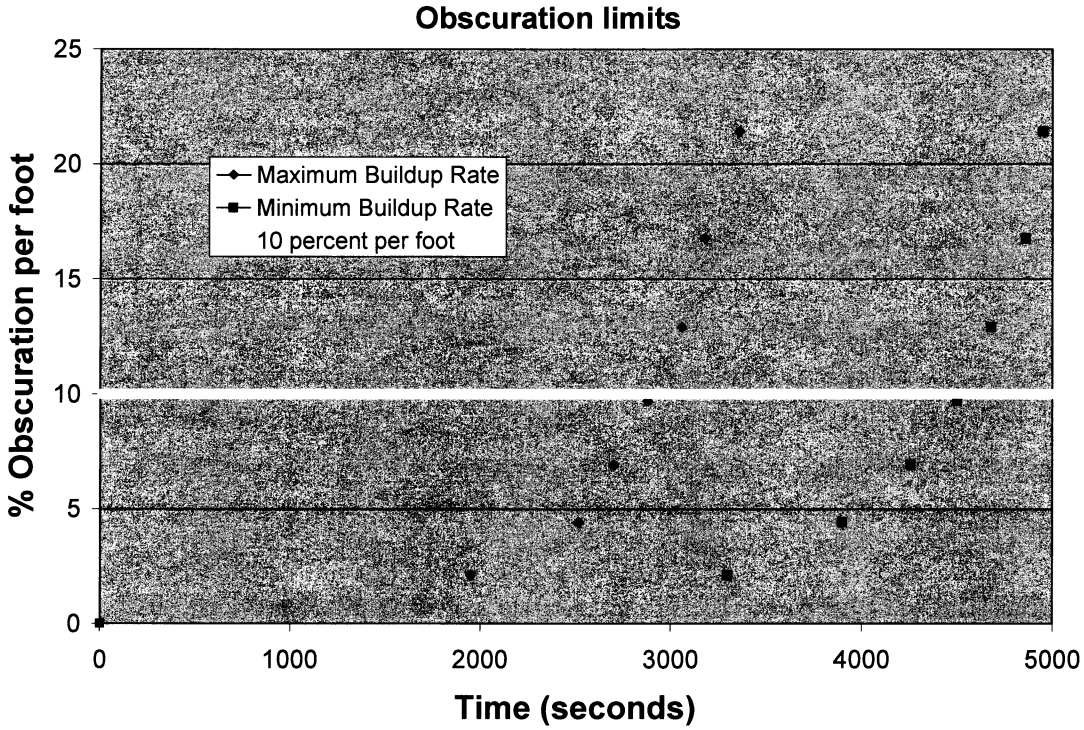


Figure 7: Obscuration limits for smoldering source.

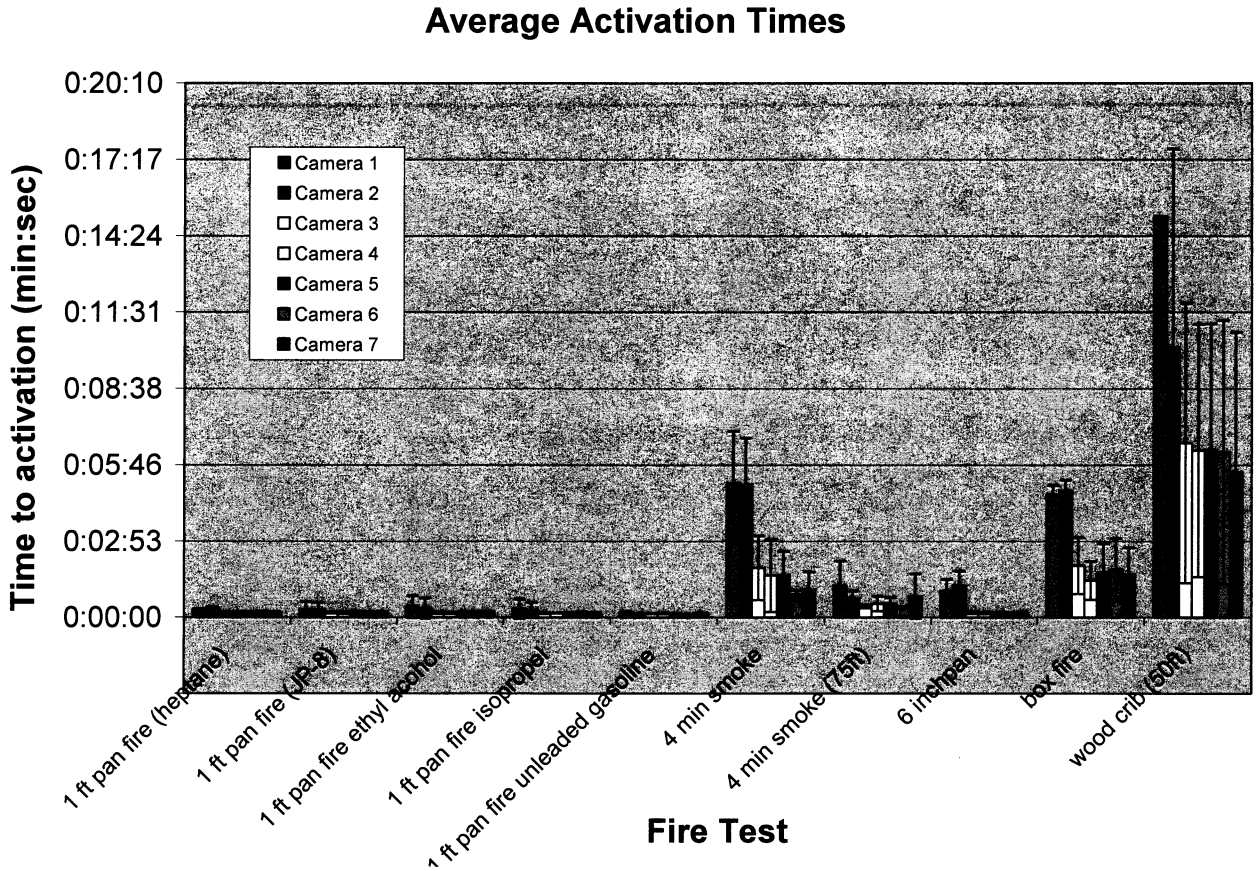
Test Procedure

The general test procedure will be to assure that all equipment is operational and that all system clocks are synchronized. The test will then be conducted. Once the testing is complete, the compartment will be ventilated and the next test begun. The procedure will include an overall system check and establishment of a clean baseline between tests. For each test, the VID system will be started and allowed to collect background data for a minimum of 120 seconds. After the background data is collected, the source will be initiated and allowed to continue until fully consumed, all cameras are in alarm, or the VID system shows no change in detection due to quasi-steady state conditions. Times for source initiation, VID system start, VID system stop, and source termination will be recorded for each test. A test checklist has been created to document each test, Appendix A.

SIGNIFIRE VISIBLE SMOKE/FIRE DETECTION RESULTS

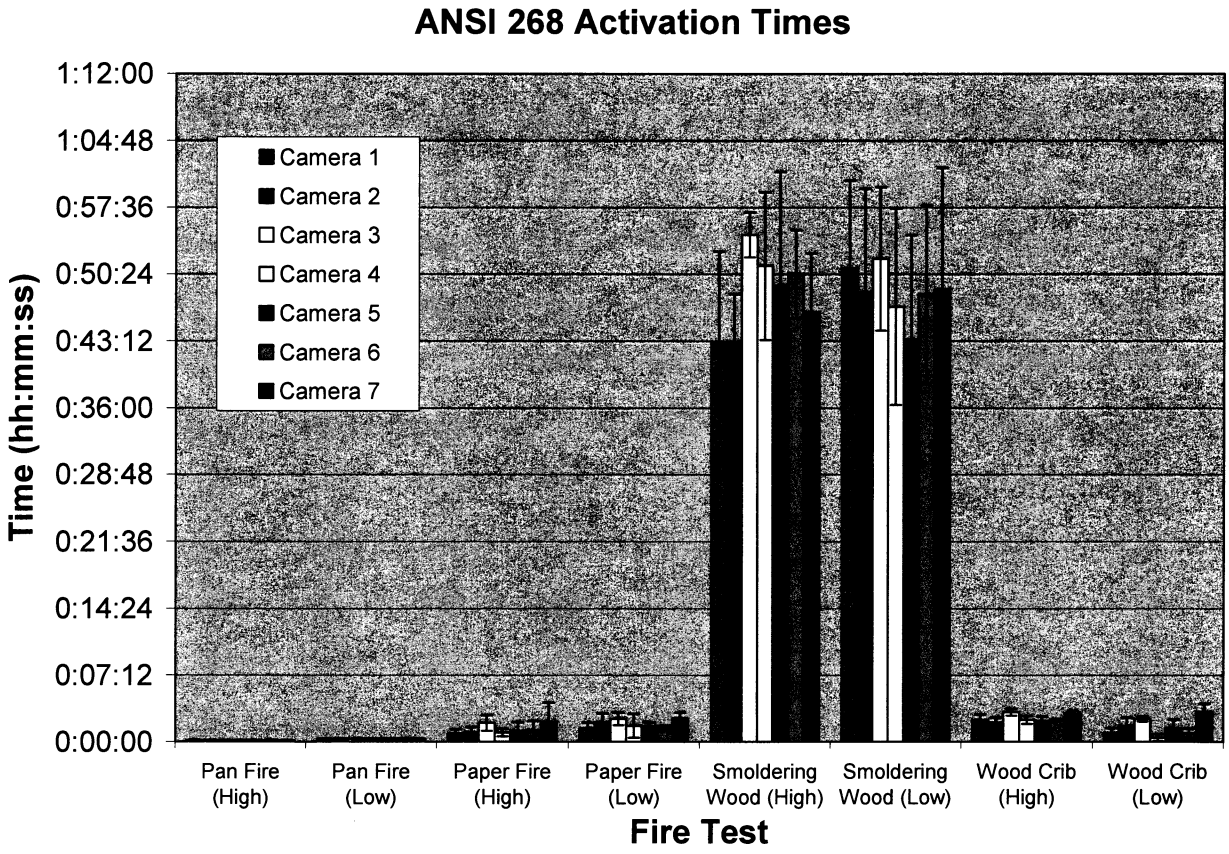
Average alarm times (hh:mm:ss) for the 7 cameras tested to various fire sources. Camera models include 2.8 mm FOV (cameras 1 and 2), 6.0 mm FOV(cameras 3 and 4), 8.0 mm FOV(cameras 5 and 6) and a 6.0 mm FOV within a explosion proof case (camera 7). All fire sources were 100ft from the cameras unless specified. Below is a graphical representation of the test data with standard deviations.

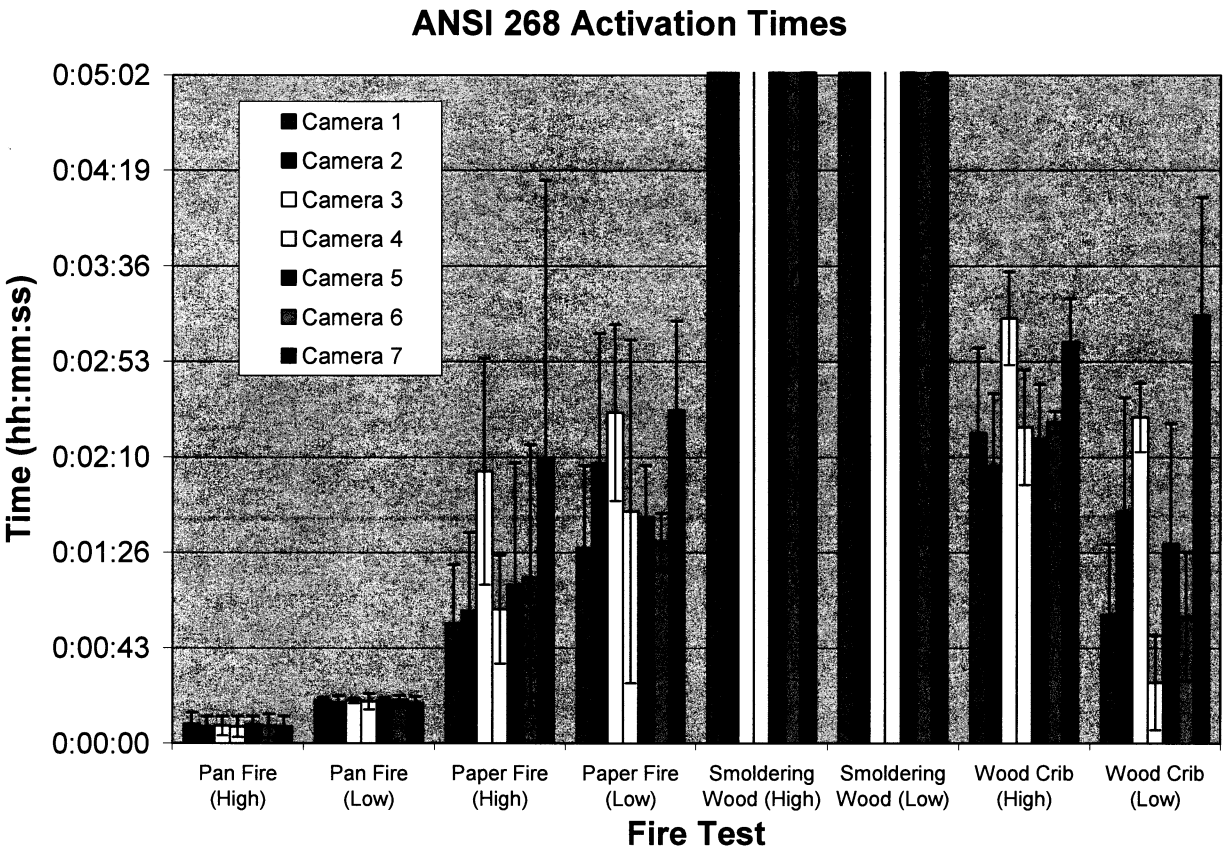
Source	Camera 1	Camera 2	Camera 3	Camera 4	Camera 5	Camera 6	Camera 7
1 ft pan fire (heptane)	0:00:18	0:00:21	0:00:09	0:00:09	0:00:09	0:00:10	0:00:09
1 ft pan fire (JP-8)	0:00:18	0:00:18	0:00:10	0:00:10	0:00:10	0:00:10	0:00:10
1 ft pan fire ethyl acohol	0:00:24	0:00:21	0:00:10	0:00:10	0:00:11	0:00:11	0:00:11
1 ft pan fire isopropel	0:00:19	0:00:16	0:00:09	0:00:09	0:00:09	0:00:10	0:00:10
1 ft pan fire unleaded gasoline	0:00:10	0:00:08	0:00:08	0:00:09	0:00:08	0:00:08	0:00:09
4 min smoke	0:05:04	0:05:01	0:01:52	0:01:34	0:01:35	0:00:52	0:01:03
4 min smoke (75ft)	0:01:12	0:00:43	0:00:24	0:00:31	0:00:30	0:00:22	0:00:48
6 inchpan	0:01:00	0:01:12	0:00:10	0:00:10	0:00:10	0:00:09	0:00:10
box fire	0:04:38	0:04:47	0:01:56	0:01:23	0:01:41	0:01:48	0:01:37



Average alarm times (hh:mm:ss) for the 7 cameras tested to various fire sources. All fire sources were initiated in the ANSI 268 room. All fire sources were tested at a low (4.8 Fc) and High (115 Fc) illumination level. Below is two graphical representations of the test data with standard deviations, one is corrected for better viewing of the faster alarm times..

Sources	Camera 1	Camera 2	Camera 3	Camera 4	Camera 5	Camera 6	Camera 7
Pan Fire (High)	0:00:09	0:00:08	0:00:08	0:00:08	0:00:08	0:00:08	0:00:08
Pan Fire (Low)	0:00:19	0:00:19	0:00:19	0:00:19	0:00:19	0:00:20	0:00:18
Paper Fire (High)	0:00:54	0:01:00	0:02:03	0:01:01	0:01:12	0:01:15	0:02:09
Paper Fire (Low)	0:01:28	0:02:07	0:02:30	0:01:45	0:01:42	0:01:31	0:02:31
Smoldering Wood (High)	0:43:01	0:42:52	0:54:39	0:51:18	0:49:08	0:50:27	0:46:18
Smoldering Wood (Low)	0:51:02	0:48:26	0:52:05	0:46:54	0:43:24	0:48:17	0:48:47
Wood Crib (High)	0:02:20	0:02:06	0:03:12	0:02:23	0:02:18	0:02:25	0:03:02
Wood Crib (Low)	0:00:58	0:01:45	0:02:27	0:00:27	0:01:30	0:00:57	0:03:14




ANSI 268 Activation Times
0:05:02
0:04:19
0:03:36
0:02:53
0:02:10
0:01:26
0:00:43
0:00:00
Time (hh:mm:ss)
Camera 1
Camera 2
Camera 3
Camera 4
Camera 5
Camera 6
Camera 7
Pan Fire (High)
Pan Fire (Low)
Paper Fire (High)
Paper Fire (Low)
Smoldering Wood (High)
Smoldering Wood (Low)
Wood Crib (High)
Wood Crib (Low)
Fire Test