PINNACLE™

Laser Technology Smoke Detector

SYSTEM SENSOR®

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Contents

Foreword

The purpose of this guide is to provide information concerning the proper application of smoke detectors used in conjunction with fire alarm systems. It outlines basic principles that should be considered in the application of early warning fire and smoke detection devices. Operating characteristics of detectors and environmental factors, which may aid, delay or prevent their operation, are presented.

Fire protection engineers, mechanical and electrical engineers, fire service personnel, fire alarm designers and installers should find the contents both educational and informative.

Though this information is based upon industry expertise and many years of experience, it is intended to be used only as a technical guide. The requirements of applicable codes and standards, as well as directives of the Authorities Having Jurisdiction (AHJ's) should be followed. In particular, NFPA 72 for installation and testing of systems is a key element in the effectiveness of smoke detection systems.

Section 1
Introduction

The Pinnacle™ Laser Smoke Detector senses the earliest particles of combustion. And that provides early warning of fire. Its high sensitivity is balanced with high stability to minimize false alarms. Like an ionization detector, Pinnacle quickly senses a fast-flaming fire. Like a photoelectric detector, it quickly senses a slow-smoldering fire. But unlike these detectors, Pinnacle can quickly identify both types of fire.

Laser technology gives you fast response detection in high sensitivity applications such as clean rooms, telecommunications centers or computer rooms — areas where any damage is too much.

Its early warning performance is comparable to aspiration technology. In fact, independent tests have shown that Pinnacle responds as good as or better than traditional aspirating systems, without the cost of pipe installation. Unlike an aspirating system, Pinnacle can pinpoint the location of the fire. Faster response and pinpoint accuracy can make the difference between a minor emergency and a major catastrophe.

A laser diode and precision optics make this detector super-sensitive to smoke — as much as 100 times more sensitive than a standard photoelectric sensor — with minimal potential for false alarms.

One might expect such a sensitive smoke detector to be subject to false alarms. Not so with Pinnacle. It uses patented on-board algorithms to check for the presence of smoke before alarming. The results: super-sensitivity with solid stability.

Pinnacle works on the same principle as a photoelectric detector. When a particle of combustion crosses the light beam, it causes the light to scatter — which signals the alarm. But the difference between an LED (light emitting diode) beam and a laser beam is like the difference between a butter knife and a razor. The 100x sensitivity of this product means heads up to the first particle of combustion. This in itself is not enough to convince Pinnacle to signal an alarm.

That's where the patented algorithms come into play, distinguishing between transient signals caused by airborne dust…and the first puff of smoke. Before these special algorithms were developed, laser detectors were useful only in extremely clean environments. No longer. By selecting the sensitivity of the detector in the control panel, Pinnacle can protect many environments where rapid response and pinpoint accuracy are critical.

Full adjustability means Pinnacle can be finely tuned to suit each local environment within a global system.

• Day/night sensitivity
• Dust/smoke discrimination
• Automatic test
• Maintenance alert
Rapid • Reliable • Reasonable cost

Section 2
Benefits

Sensitivity.
Extremely high sensitivity with superior early warning performance.

Stability.
Algorithms for proven resistance to false alarms.

Versatility.
One detector can be used for detection of fast-flaming and slow-smoldering fires.

Pinpoint accuracy.
Identifies the precise location of the fire, reducing time to extinguish it.

Lower overall cost.
Reduced cost in installation and maintenance.

Section 3
Applications

The rapid growth in telecommunications and computer technology and manufacturing has fueled a need for extremely early warning fire detection. Today a major fire is not required to create a major catastrophe.

Telecommunications facilities, data processing and computer rooms, clean rooms, traffic control centers — all can be easily shut down even in the presence of small amounts of smoke. And, in some of these environments, even a little downtime can mean a big disaster.

The sooner the fire can be detected, the lower the potential loss. That makes archives and museums where irreplaceable documents and artifacts are housed ideal candidates for early warning systems.

Laser technology makes good sense in any environment where there is a substantial cost of downtime or a significant investment in installed equipment. To cut response time even further, this technology is best used where human interface is available.

Application Note: Pinnacle is listed as an open area smoke detector. Unless specific codes or standards exist to the contrary, standard guidelines for spacing and placement should be followed.

Ideal Applications	Applications to avoid
Telecommunications switching stations	*Cigar/cigarette smoke*
Computer rooms	*Cooking fumes*
Clean rooms	*Condensed water vapor, steam or fog*
Hospitals	*High levels of airborne dust*
Museums, archives and historic buildings	*Motor vehicle exhaust*
	Welding or other processes that cause combustion particles

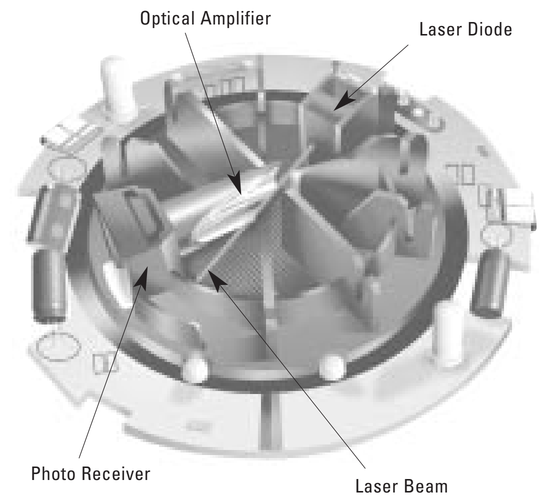
Section 4

How It Works

The principles of laser detection are similar to those of photoelectric technology. In a photoelectric smoke detector, an LED emits light into a sensing chamber that is designed to keep out ambient light while allowing smoke to enter. Any particles of smoke (or dust) entering the chamber will scatter the light and trigger the photodiode sensor.

Pinnacle works on the same light-scattering principle, but with 100x greater sensitivity. This ultra-sensitivity is due to the nature of the laser itself, which is literally amplified light (the word “laser” is an acronym for “Light Amplification by Stimulated Emission of Radiation”). Using an extremely bright, controlled laser diode, the laser beam is transmitted through the chamber to a light trap which eliminates any reflection. If a particle of smoke (or dust) enters the chamber, light from the laser is scattered and the detector, using its patented algorithms, checks the nature of the scattered light to determine whether the source is dust or smoke. If a determination of smoke is made, the alarm is signaled. Smoke particles, especially those by-products of an early fire, are extremely small, hence the need for the high sensitivity of the laser.

Dust particles, on the other hand, are a different story. In some smoke detectors, dust can settle in the darkened chamber. Over time this dust creates a light-colored floor that gradually increases the amount of reflected light in the chamber — making the detector more prone to false alarms. Since Pinnacle uses a focused beam of laser light, reflections are minimized in the chamber. This means that gradual dust accumulation is not as much of a problem.



Section 5

Performance

Currently there are two smoke sensing technologies in wide use: ionization and photoelectric. Both technologies have different strengths. Ionization detectors detect fast-flaming fires well — but are not so quick with slow-smoldering fires. On the other hand, photoelectric detectors detect slow-smoldering fires well — but are not so quick with fast-flaming fires. Pinnacle is highly sensitive to both types of fire.

In order to improve the ability of photoelectric detectors to detect fast-flaming fires, engineers focused on two goals: boosting the signal and reducing noise, i.e., increasing the signal-to-noise ratio. More signal allows earlier warning and increases the ability to detect the extremely small smoke particles of an incipient fire, particles so small they cannot be easily detected by conventional photoelectric detectors. Meanwhile, reducing noise helps reduce the probability of a false alarm.

Pinnacle achieves these dual goals of high sensitivity and high stability by using an extremely bright laser diode — 10,000 times brighter than a standard LED — coupled with an optical amplifier that further concentrates the light into the photo sensor. This combination allows Pinnacle to detect both small and large particles — which allows it to quickly detect both fast-flaming and slow-smoldering fires.

The narrow focus of the laser beam reduces the reflected light in the sensing chamber and results in a high signal-to-noise ratio (with noise defined as reflected light). The reflector captures scattered light up to 180 degrees around the beam, at a very low scattering angle. This low angle enhances the detection of smoke by improving the detection signal. It also allows a reduction in electronics gain in order to obtain better electrical interference performance while rejecting ambient interference.

Chamber Designed to Eliminate Background Noise

In a typical photoelectric detector, which uses a widely dispersed light beam from an LED, noise levels can be high. The laser beam, conversely, is extremely focused, concentrated and small (see Figure 1). When this light is received by a specially-designed light trap, Pinnacle achieves an even lower noise level.

Software Algorithms to Enhance Performance

In order to achieve rock-steady stability, Pinnacle incorporates extensive on-board software processing including multi-alert drift compensation, internal self diagnostics, and superior transient signal rejection algorithms.

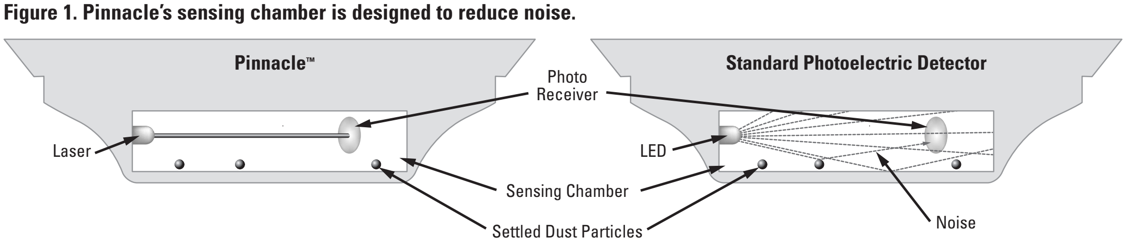
With the use of sophisticated algorithms, the system can reject false alarm signals caused by large airborne particles such as dust, moisture, and small insects — even when set to extremely high sensitivity.

Dust Spike Rejection

If an individual detector registers a large signal spike, the algorithm recalls the values of the two previ-

Regardless of the industry or application, the ideal smoke detection system will provide high sensitivity for the earliest warning of fire, combined with high stability to reduce false alarms.

Figure 1. Pinnacle’s sensing chamber is designed to reduce noise.



ous sensor readings. Using a "lowest of three" analysis system, the algorithm chooses the lowest value of the present and two previous readings. It would therefore ignore one or two transient data spikes.

On-board Drift Compensation

Laser algorithms include drift compensation that adjust for gradual dust accumulation to maintain sensitivity and resistance to false alarm. Eventually, so much compensation may be required that the detector must be cleaned.

Three fault modes accompany the drift compensation algorithm in order to provide advance warning of required maintenance. The first two are "Alert" signals. One "Alert" signal is to be used for high sensitivity setpoints (alarm levels 1-7) and the other is to be used with the lower sensitivity setpoints (alarm levels 7-9). These faults indicate that the sensor has accumulated sufficient amounts of dust and should be cleaned in the near term. Separate signals are provided for high and low sensitivities so that the sensor may be cleaned before the dust that is accumulated in the chamber compromises stability resulting in a false alarm. The third fault, "Urgent", indicates that the sensor has reached the end of its dynamic compensation range. At this point, drift compensation is still operational. However, if the sensor continues to become dirty it will no longer be able to compensate. Its sensitivity thresholds will become more sensitive and it may falsely alarm.

Table 1. Pinnacle Sensitivity Settings

Alarm level 1	0.02%/ft. smoke (0.06 %/m)
Alarm level 2	0.03%/ft. smoke (0.10 %/m)
Alarm level 3	0.05%/ft. smoke (0.16 %/m)
Alarm level 4	0.10%/ft. smoke (0.33 %/m)
Alarm level 5	0.20%/ft. smoke (0.66 %/m)
Alarm level 6	0.50%/ft. smoke (1.65 %/m)
Alarm level 7	1.00%/ft. smoke (3.24 %/m)
Alarm level 8	1.50%/ft. smoke (4.85 %/m)
Alarm level 9	2.00%/ft. smoke (6.41 %/m)

Signal Smoothing

Laser algorithms are designed to take note of any sudden jump in the signal. Because local environments in the system will vary, the signals can be "smoothed" to adjust the sensitivity setting and prevent false alarms.

Pre-Alarm and Alarm Decisions

Users can select from nine different sensitivities in the range of 0.02–2% per foot for either pre-alarm or alarm settings. This gives the user enormous flexibility in configuring a system to a range of different conditions. See Table 1.

Local Use

Certain installations require high sensitivity only in a local area. For example, an office building may require high sensitivity detection in computer and document storage areas, but standard protection would suffice in offices or the lobby. Pinnacle integrates well with other types of smoke detection systems, including photoelectric, ionization, multi-criteria, and thermal detectors. All of these detectors use the same type of wiring and mounting bases and are maintained in similar ways.

Since ultra high sensitivity spot type detection is relatively new to the fire protection industry, there are few codes and standards that reference the technology directly. In many cases, NFPA 72, The National Fire Alarm Code, will need to be referenced for appropriate spacing and placement considerations. The following are some excerpts of applicable standards for high sensitivity detection.

Section 6

Codes and Standards

NFPA 318, Standard for the Protection of Clean Rooms

This standard applies to all semiconductor facilities containing a cleanroom or clean zone.

2-3.1 A listed or approved smoke detection system shall be provided in the cleanroom return airstream at a point before dilution from make-up air occurs. The system shall have a minimum sensitivity of 0.03 percent per ft. obscuration.

Smoke detection systems which are non-air-sampling shall be listed for the airflow rate of the return airstream. Where the system is of the light-scattering type, it shall have a minimum sensitivity of 0.03 percent per ft. obscuration.

NFPA 76, Standard for the Protection of Telecommunication Facilities

This standard provides minimum requirements for fire protection of telecommunications facilities, where telephone, data, cellular, internet, and video services are rendered.

Note: As this application guide goes to print NFPA 76 is only a "recommended practice."

The standard defines three levels of protection.

6-5.1 For telecommunications facilities, fire detection systems shall be designed, installed and maintained to provide one of three levels of protection: (1) very early warning fire detection (VEWFD), (2) early warning fire detection (EWFD), (3) standard fire detection (SFD). This section establishes requirements for each level of protection, and provides suggested design and installation requirements for meeting the objectives of this standard.

6-5.2.1 EWFD and VEWFD smoke detection systems shall utilize sensors or ports with spacing which is less than that normally required by NFPA 72, National Fire Alarm Code.

Very Early Warning Fire Detection is defined.

6-5.3.1 Very Early Warning Fire Detection (VEWFD).

6-5.3.1.2 Every type of sensor and port installed in a space shall be limited to a maximum coverage area of 200 sq. ft.

6-5.3.1.3 The sensors or ports need not be located directly in the center of the bay but shall be located so that they are exposed to the movement of smoke. The sensor or port shall not be located within 3 feet of supply duct registers. Locations selected shall be visible from the floor and accessible for maintenance.

6-5.3.1.4 Sensors or ports shall be installed to monitor return air from the space. Spacing of sensors or ports shall be installed such that each covers no greater than 4 sq. ft. of the air grille.

6-5.3.1.5 Minimum sensitivity settings above ambient air-borne particulate levels for the VEWFD systems used shall be as follows:
Alert Condition: 0.2% per ft. obscuration
Alarm Condition: 1.0% per ft. obscuration

Early Warning Fire Detection is defined.

6-5.3.2 Early Warning Fire Detection (EWFD)

6-5.3.2.1.2 The area of coverage for a single sensor or port shall be limited to 400 sq. ft.; spacing at 20 ft. by 20 ft.

6-5.3.2.1.3 The sensors or ports need not be located directly in the center of the bay but shall be located so that they are exposed to the movement of smoke. The sensor or port shall not be located within 3 feet of supply duct registers. Locations selected shall be visible from the floor and accessible for maintenance.

6-5.3.2.1.4 The minimum alarm sensitivity setting at the sensor or port used for EWFD in telecommunications equipment spaces shall be 1.5% per ft.

The fire detection requirements vary depending upon the size of the telecommunications facility.

Chapter 4 Large Telecommunication Facilities

4-1 General. A large telecommunications facility includes operations such as switching, transmission, and routing of voice, data and/or video signals within an enclosed area greater than 2500 sq. ft.

4-5.6.1 General. Telecommunications equipment spaces shall be provided with very early warning smoke detection system in accordance with Chapter 6 requirements for detection and alarm processing.

4-6.6.1 General. Cable entrance facilities shall be provided with early warning fire detection systems in accordance Chapter 6 requirements for detection and alarm processing.

4-7.6.1 General. Power areas shall be provided with an early warning smoke detection system in accordance with Chapter 6 requirements for detection and alarm processing.

4-8.6.1 General. Main distribution frame spaces shall be provided with an early warning smoke detection system in accordance with Chapter 6 requirements for detection and alarm processing.

Chapter 5 Small Telecommunication Facilities

5-1 General. A small telecommunications facility includes operations such as switching, transmission, and routing of voice, data or video signals within an enclosed area of 500-2500 sq ft. Where the performance-based approach of Chapter 3 is not used, the prescriptive requirements of this chapter shall apply.

5-5.6 Fire Detection. Small facilities shall be provided with an early warning fire detection systems, in accordance with Chapter 6, requirements for detection and alarm processing. Installation and maintenance shall be in accordance with NFPA 72, National Fire Alarm Code.

NFPA 76 allows for the use of performance based approaches in the design of fire detection systems. When these performance based designs are used, system performance shall be verified by testing. Separate tests are defined for the Very Early Warning Fire Detection and Early Warning Fire Detection systems.

Very Early Warning Fire Detection

The purpose of this test procedure is to prove the performance of very early warning smoke detection systems in a smoldering fire scenario of much less than 1 kW. The test is intended to simulate a small amount of smoke, barely visible, that would be created in the early stages of an electrical overload in electronic equipment or cables. The test is intended to provide quantitative information useful for a performance-based specification. Prescriptive requirements, such as detector chamber sensitivity and detector/port spacing, do not reliably equate to detection response time and do not assure the ability to detect fires during early stages. This test is also intended to meet the following general objectives:

- It is intended to be repeatable, so that multiple tests can be used to accurately measure the effect of changes in the test environment or changes in the detection system design.
- It is intended to use low cost test equipment that can be quickly set up in actual telecommunications facilities if desired.
- It is intended to prevent or minimize the potential of smoke damage to the equipment in the room under test. It should create little or no corrosive products of combustion and no flames.
- It is intended to avoid the creation of large amounts of smoke and gas that could pose a health threat to personnel in the test area.

The described test using an electrically overloaded PVC-coated wire is intended to simulate the early stages of a fire. Although a PVC wire is used, hydrogen chloride vapor is unlikely to be produced due to the relatively low temperatures reached. The off-gases produced by this test are not sufficient to drive off the chlorine in the PVC formulations. If the current is applied for a longer time, or if the wire sample is shorter than stated, small quantities of HCl may be generated. In either event, a clearly perceptible odor that should dissipate in short time is produced by the test. The test is essentially identical to the test specified in section A.3 of British Standard BS 6266: 1992, Fire Protection for Electronic Data Processing Installations.

Early Warning Fire Detection

EWFD systems should be designed, installed, and maintained to detect the products of combustion from the lactose/chlorate test described in the following sections. The lactose/chlorate test used here is one of the test methods specified in BS 6266, with modifications. This method produces a controlled fire that produces both flame and smoke.

British Standard BS 6266: 1992, Fire Protection for Electronic Data Processing Installations

This British Standard makes recommendations for the protection from fire of electronic data processing (EDP) installations. The standard does not outline specific requirements for particular types of sensing technologies or sensitivities, but does detail the considerations involved in the design of automatic fire detection systems in these types of facilities. The appendix of the standard outlines several system performance test methods. High sensitivity point type detectors, such as Pinnacle, are not addressed.

A.1 System performance test method using lactose/chlorate mixture

A.1.1 **General**
This method is suitable for the testing of standard sensitivity fire detection systems. A controlled fire producing both flame and smoke is initiated by ignition of a mixture of lactose and potassium chlorate.

A.1.4 **Requirement**
The fire detection system should respond within 120 seconds of ignition.

A.2 System performance test method using polyurethane mat(s)

A.2.1 **General**
This method is suitable for the testing of standard sensitivity fire detection systems. A controlled fire is produced by ignition of flexible polyurethane foam mat(s).

A.2.4 **Requirement**
The fire detection system should respond within 180 seconds of ignition.

A.3 System performance test method using electrically overloaded PVC-coated wire (2m)

A.3.1 **General**
This method is suitable for the testing of high sensitivity fire detection systems. To simulate the early stages of a fire, a length of wire is electrically overloaded so that smoke or vapours are driven off. Unlike the test described in A.4, hydrogen chloride vapour is unlikely to be produced due to the relatively low temperatures reached. This test may be undertaken in underfloor spaces or ceiling voids.
NOTE: The wire is subject to cooling if positioned in direct contact with air flows and may need to be shielded.

A.3.4 **Requirement**
The fire detection system should respond within 120 seconds of the cessation of energization.

A.4 System performance test method using electrically overloaded PVC-coated wire (1m)

A.4.1 **General**
This method is suitable for the testing of high sensitivity fire detection systems.
To simulate the early stages of a fire, a length of wire is electrically overloaded so that smoke or vapors are driven off.
Warning: This test produces sufficiently high temperatures to generate small quantities of hydrogen chloride but may be undertaken in underfloor spaces or ceiling voids where rapid air flow may render the test described in A.3 unsuitable.

Section 7

Testing of Pinnacle

Laser tests have been conducted at several telephone switching stations in the United States and Europe to determine performance levels under a variety of conditions.

When first introduced, the laser-based photoelectric smoke detector was revolutionary. No one else had successfully developed a spot-type smoke detector using laser technology. Since the product was so new, extra steps were taken to assure that it met its design objectives — ultra-high sensitivity with false alarm immunity.

The product met all of the necessary regulatory agency requirements worldwide, but the question remained: how would it work in a real world fire scenario? So the product was tested in clean rooms and telecommunications facilities. The tests were performed and observed by independent fire industry professionals. Some of the tests were conducted as head-to-head comparisons with the prevailing technologies of the day for those types of facilities. To date, dozens of tests have been conducted, on different days, in different facilities all around the world.

The conclusion is always the same. Spot type laser detection performs as good or better than competing technologies in these types of facilities, but it provides significant additional benefits to the end user.

Beyond responding quickly to real fires, a detector also needs to be problem free. That means that it must be false alarm free. Simply creating a highly sensitive smoke detector is not enough, if that means it will create unwanted alarms. We have addressed this concern through the development of sophisticated algorithms and on-going, long term stability tests.

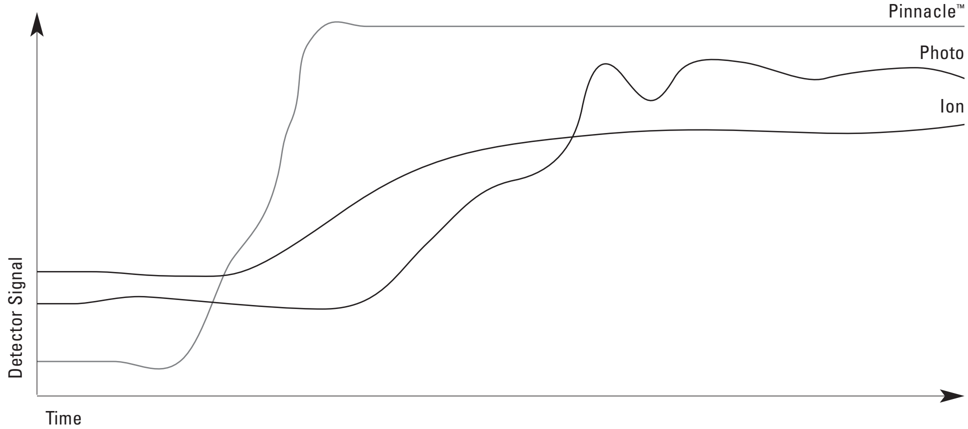
The Pinnacle laser smoke detector has been and will continue to be tested for fire test response and false and nuisance alarm avoidance. Ongoing quality assurance testing is the key to the success of this and all smoke detection products.

Laser has been rigorously tested for:
Radio frequency interference
Lightning simulation
Corrosion
Mechanical integrity
Detection performance
Dust immunity
Humidity extremes and variations
Temperature extremes and variations
Static discharge
Radiated radio frequency emissions

Sample responses of different detection technologies

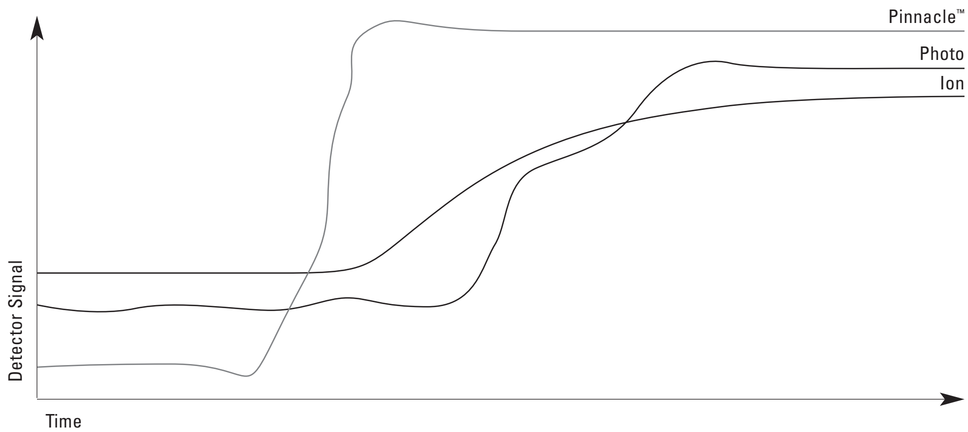
This graph shows the performance of Pinnacle compared to a standard photoelectric and ionization smoke detector in a UL gasoline fire. Pinnacle reaches its full alarm level well before the other types of detection.

UL Gasoline Fire Test



This graph shows the performance of Pinnacle compared to a standard photoelectric and ionization smoke detector in a UL Heptane fire, an example of a flaming fire. Pinnacle reaches its full alarm level well before the other types of detection.

UL Heptane Fire Test



Section 8

Pinnacle vs. Aspirating

In the past, aspirating systems were accepted as the standard for high sensitivity and early warning. These tubular networks draw air from fire protection areas to a central sensor, which is typically a single enclosure containing high-sensitivity optics. Filters remove large particles and thus reduce false alarms. The system must be continuously aspirating in order to sample air. For many years, these systems were the only detection solution available.

Aspirating	**Pinnacle**
Tubular networks can have a lag time for the delivery of smoke to the detection enclosure, dilution of smoke, and removal of smoke in the tubes.	Smoke-assessing optics reside at each sampling location — drastically reducing lag times, dilution, and smoke removal.
The system cannot identify which sampling port delivered smoke to the detector.	Addressable system identifies exact location of fire.
Limited supervision means system cannot always detect leaks in piping or blockage of a port.	Continuously supervises each detector and wire run in the system.
Tubing requires unconventional installations and does not allow other types of detectors within its system.	Because it is a plug-in spot type detector, Pinnacle can easily be mixed with standard photoelectric or ionization detectors on the same loop or system.
In the case of a small localized fire, most sampling ports draw in clean air, diluting smoke levels in measuring chamber.	Measurement points away from the fire do not degrade response time, regardless of fire size.

Section 9
Myth vs. Reality

Myth
An aspirating system must be used in areas where regular maintenance cannot be done.
Reality
The National Fire Protection Association (NFPA 72, Chapter 7) requires regular maintenance of both the ports in an aspirating system and the detectors in the laser system.
Myth
The pinpoint location of the fire is not necessary.
Reality
Pinnacle detects smoke at extremely low levels, sometimes before the smoke is visible to the human eye. By knowing which detector is in alarm, you can easily locate the source of the smoke. Thus, the fire can be extinguished quickly to avoid major damage.
Myth
An extremely sensitive spot type detector such as Pinnacle will be prone to false alarms.
Reality
Pinnacle continually runs sophisticated stability and immunity routines to virtually eliminate false alarms.
Myth
Pinnacle is more expensive to install than an aspirating system.
Reality
The total installed cost of a laser system can be less than an aspirating system. The cost to install a laser system is comparable to the cost to install any spot type detection system. An aspirating system, however, requires the installation of pipe and fittings by a qualified installer.
Myth
A spot type detection system, such as Pinnacle, could never be as sensitive as an aspirating system.
Reality
Since an aspirating system senses smoke at one central unit, the smoke becomes diluted by the time it reaches the detector. Pinnacle is actually more sensitive than an aspirating system. A recent draft of proposed changes to NFPA 76 explicitly recognizes this dilution effect by requiring the sensitivity at the central unit in an aspirating system be multiplied by the number of ports. For example, 0.002%/ft. sensitivity at the central unit with 20 ports is really 0.04%/ft. sensitivity.

Section 10
Specifications

Pinnacle Low-Profile Plug-in Intelligent Laser Smoke Detector

Voltage Range	15 – 32 volts DC peak
Standby Current (max. avg.)	230μA @ 24 VDC (without communication) 330μA (one communication every 5 seconds with LED enabled)
LED Current (max.)	6.5mA @ 24 VDC (on)
Height	1.66″ (4.2 cm)
Diameter	4.0″ (10.2 cm)
Shipping Weight	5.6 oz. (159 g)
Operating Temperature Range	North America: 32° to 100°F (0° to 38°C) Europe: –10°C to 55°C
Velocity Range	0 – 4000 fpm (0 to 20.3 m/s)
Relative Humidity	10% – 93% noncondensing
Self Diagnostics	Initiated by control panel; activated by test magnet
Smoke Sensitivity	9 levels: 0.02, 0.03, 0.05, 0.20, 0.20, 0.50, 1.00, 1.50, 2;00%/ft. obscuration (0.06, 0.10, 0.16, 0.33, 0.66, 1.65, 3.24, 4.85, 6.41%/m obscuration)
Drift Compensation	High sensitivity maintenance alert signal Low sensitivity maintenance alert signal Maintenance urgent signal

Pinnacle with Flanged Mounting Base

Pinnacle with Flangeless Mounting Base

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A05-1028-001