

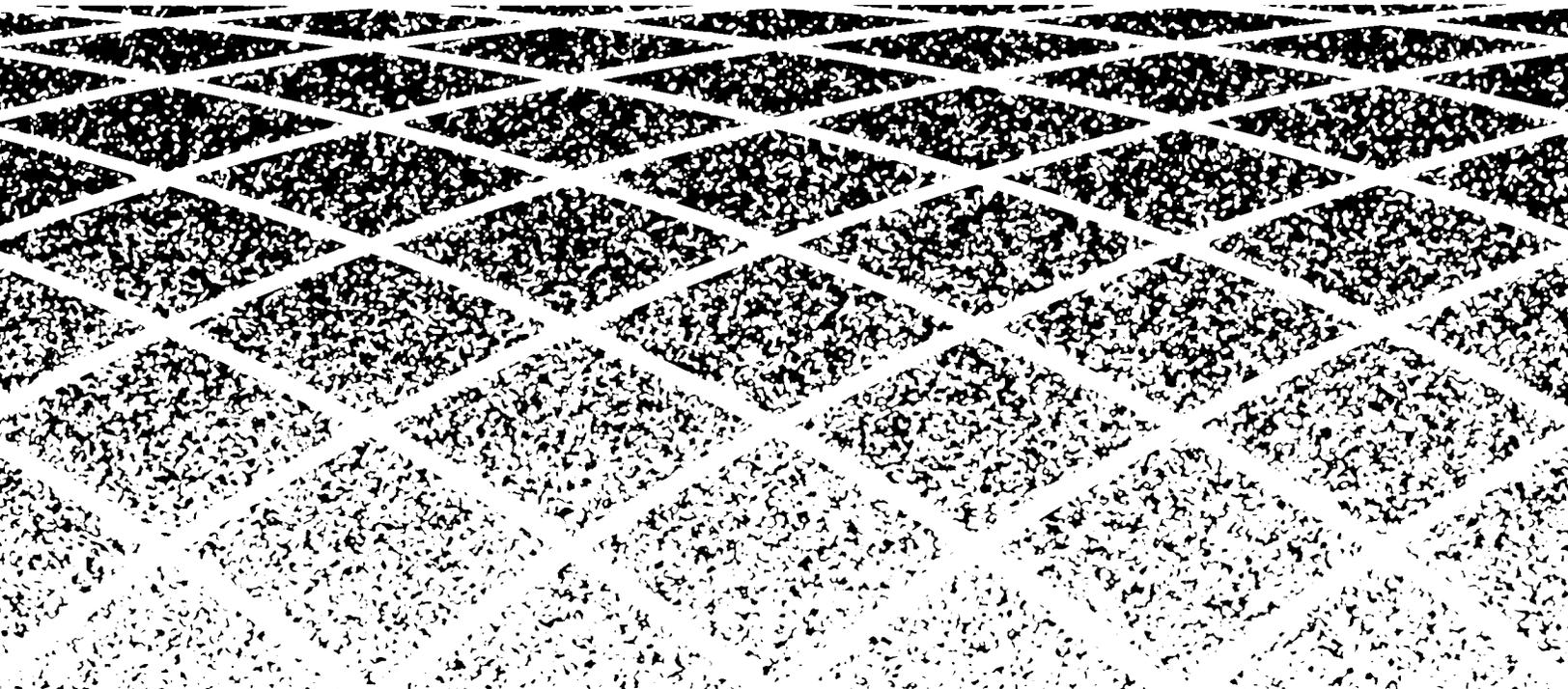


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Smoke Detection



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Smoke Detection

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1. Overview

1.01 Appropriately selected and properly installed early-warning smoke detection devices can have a major effect on reducing loss of life and property due to fire. This practice describes smoke detection equipment used in Company facilities and provides information concerning proper selection and installation of this equipment. The following topics are covered:

- Types of smoke detectors and mode of operation
- Areas for application and limitations of use
- Maintenance, installation, and testing.

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Corporate Fire Protection Engineering Organization
131 Morristown Road
Basking Ridge, NJ 07920
908-204-8230 (Telephone)
908-204-8214 (Fax)

1.02 This practice is reissued to incorporate information concerning recent changes to air-sampling smoke detection systems.

1.03 This practice does not contain admonishments.

1.04 AT&T welcomes your comments on this practice. Your comments will aid us in improving the quality and usefulness of AT&T documentation. Please use the Feedback Form provided in this practice.

1.05 Additional copies of this practice may be ordered from the AT&T Customer Information Center as follows:

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- 1.06** This practice does not contain a disclaimer notice.
- 1.07** This practice does not contain an FCC Warning.
- 1.08** This practice does not contain a security statement.
- 1.09** This practice is based on the National Fire Codes of the National Fire Protection Association (NFPA) including NFPA 72E, *Automatic Fire Detectors*; various model building and fire prevention codes; Occupational Safety and Health Act (OSHA) regulations; and on the requirements of our corporate insurance carriers. Consult them for additional information if necessary.
- 1.10** This practice is issued by the AT&T Corporate Environment and Safety Engineering organization under AT&T Action Information Letter AI-93-10-006. Questions concerning its content may be referred to the:

Corporate Fire Protection Engineering Organization
131 Morristown Road
Basking Ridge, NJ 07920
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Glossary

- 2.01** The terms in this document that have a specific meaning are defined as follows:
- **Air sampling-type detector**— a device which analyzes the surrounding atmosphere for products of combustion. An air-sampling system uses pipes or tubes to connect the detector unit to the area(s) to be protected. A pump draws air from the protected area back to the detector through air-sampling ports in the piping or tubing. At the detector, the air is analyzed for products of combustion.
 - **Approved**— refers to acceptance by the Authority Having Jurisdiction at the particular company location.
 - **Line-of-sight type detector**— a device in which detection is continuous along a straight-line path.
 - **Listed**— refers to a requirement which is satisfied if the equipment, component, or device has been tested and certified by an independent testing laboratory. In the United States, either Underwriters Laboratories (UL) or Factory Mutual (FM) are generally accepted. In Europe, laboratories certified by European Electrotechnical Committee for Standardization (CENLEC), such as the British Approvals Service for Electrical Equipment in Flammable Atmospheres (BASEEFA) and Physikalisch-Technische Bundesanstalt (PTB) in Germany, are accepted. Many other testing laboratories are accepted in other areas of the world. Some of the better-known labs include the Canadian Standards Association (CSA), the Standards Association of Australia (SAA), and the Research Institute for Industrial Safety (RIIS) in Japan. Listings or approvals

granted by these or similar recognized agencies will satisfy this requirement.

- **Shall**— indicates a requirement for compliance with this practice.
- **Should**— indicates a strong recommendation which is not required.
- **Spot-type detector**— a device with a detecting element that is concentrated at a particular location.

Fire Signatures

3.01 The signature of a fire is the combination of changes that the fire creates in the surrounding atmosphere. One or more of these changes may potentially be used to detect the presence of a fire. One example of a signature change is the relative size of particles given off during combustion. A slowly developing fire gives off large particles, whereas a rapidly developing (high-energy) fire produces small particles. Because smoke detection systems are designed to respond to specific signatures, their selection is based on the signature type most likely to be encountered.

Types of Detectors

4.01 To protect the wide variety of environments found in AT&T locations, three basic types of smoke detectors are commonly used: ionization, photoelectric, and air-sampling.

Ionization Detectors

4.02 Ionization detectors are spot-type detectors that respond to the many small, highly migratory particles produced by a rapidly developing, flaming fire.

4.03 The detection mechanism consists of a radiation source (typically Americium 241 or Radium 226) in a chamber containing positive and negative electrodes. The radiation ionizes the oxygen and nitrogen molecules in the air between the electrodes and permits a small current to flow between the electrodes. Visible or invisible particulates in the chamber reduce the current flow between the electrodes by combining with ions and reducing their mobility. The change in current flow is used to activate an alarm. The alarm threshold level is usually adjustable and is commonly referred to as the sensitivity adjustment (see Figures 1 and 2).

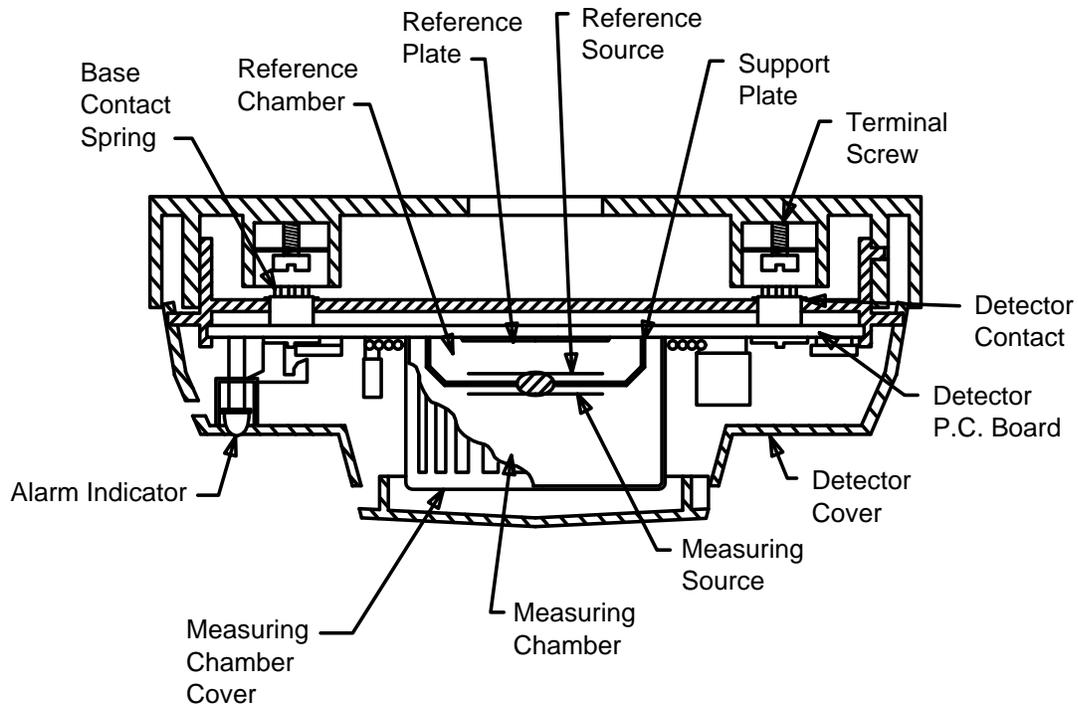


Figure 1. Ionization Detector

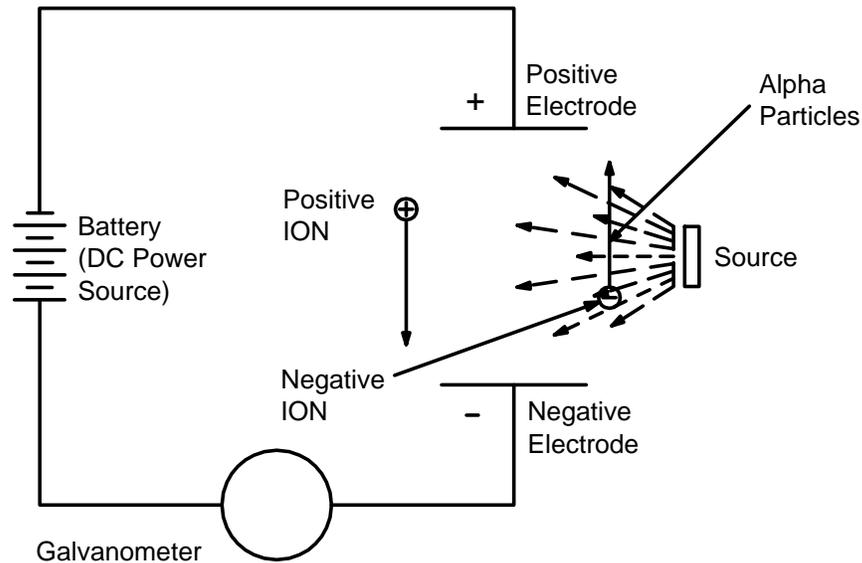


Figure 2. Ionization Chamber Principle

4.04 Ionization smoke detectors should be used in areas where fires of high energy (open flaming) are anticipated. These fires produce large quantities of small smoke particles which are easily sensed by this type of detector. The detectors are usually located in the anticipated path of the products of combustion so that the particles emitted by the fire will enter the detector. Ionization detectors are subject to changes in sensitivity. High air velocities can sweep ions from the chamber. This results in a reduced chamber current with no particles present and a probability of a false alarm. Conversely, insufficient air flow can allow particle ion pairs to reach the electrodes. This can contribute to the chamber current and result in false readings due to reduced sensitivity.

4.05 Other environments which may have an impact on detector sensitivity and should be avoided are those where high ambient radioactivity levels are expected or where high concentrations of ozone or ammonia are present (see Tables A and B).

Table A. Detector Response Characteristics

Detection Principle	Response Affected By Smoke Color	Response Affected by Air Velocity > 300'/MIN	Good Response to Flaming Fires	Good Response to Smoldering Fires
Ionization	NO	YES	YES	NO
Photoelectric	YES	NO	NO	YES
Projected Beam	NO	NO	NO	YES
Air Sampling	NO	NO	YES	YES

Table B. Typical Detector Applications

Detection Principle	Computer Rooms	Telephone			Atriums	MFG Areas
		Switching Rooms	Clean Rooms	Anechoic Chambers		
Ionization	2	2	2	3	3	2
Photoelectric	2	2	3	3	3	2
Projected Beam	2	3	2	3	1	3
Air Sampling	1	1	1	1	1	3

1 = Highly Recommended

2 = Recommended

3 = Not Recommended

Photoelectric Detectors

4.06 Photoelectric detectors respond to the large particles produced by a slowly developing, smoldering fire.

4.07 Smoke particles generated during the combustion process affect the propagation of light as it passes through air. Smoke attenuates (decreases the intensity of) a beam of light and also scatters light rays at various angles to the original light beam (see Figures 3 and 4).

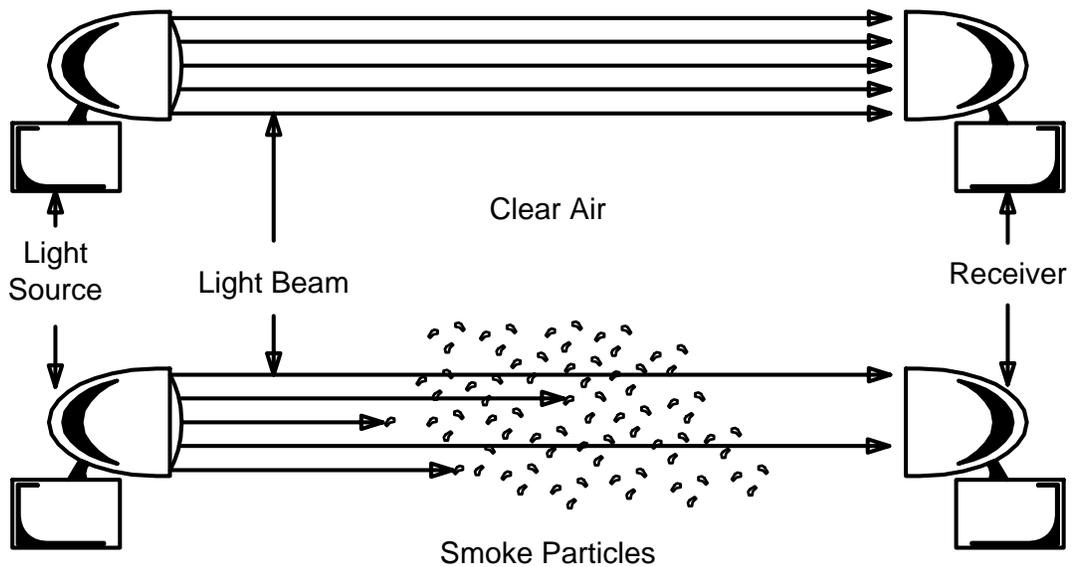


Figure 3. Smoke Attenuation Principle

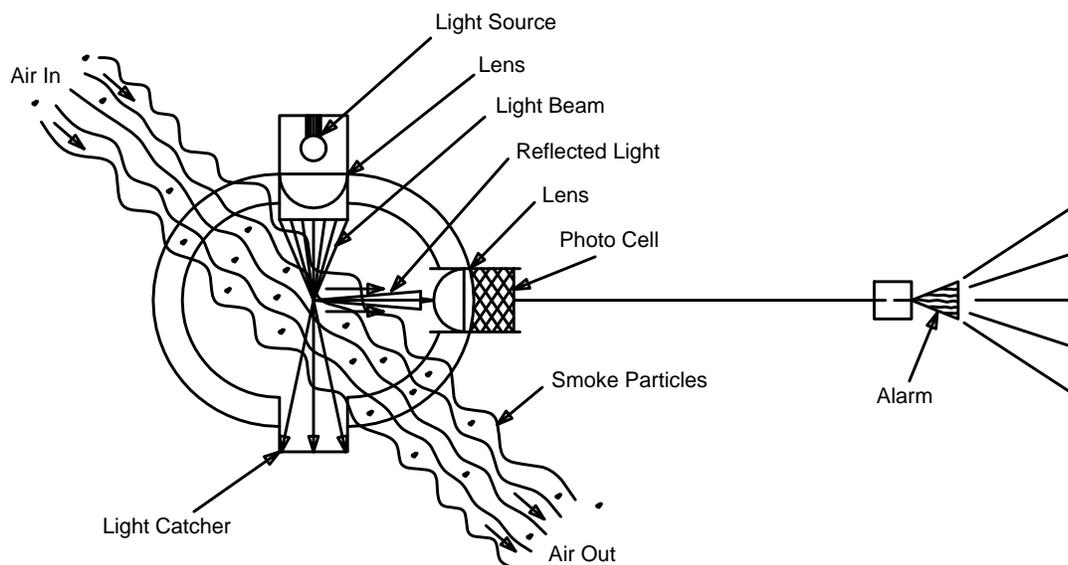


Figure 4. Scattered Light Principle

4.08 Smoke detectors based on attenuation consist of a suitable light source, a light beam collimating system which directs the light into a beam, and a photosensitive receiver cell. The light beam strikes the cell and produces an electrical signal which is characteristic of the specific cell being used. If smoke is present in the light beam, it will attenuate the light before it strikes the cell. Variations in the intensity of the light beam striking the cell will cause a change in the electrical output of the cell which is used to signal an alarm.

4.09 Spot-type detectors employing this principle incorporate a light path with a sealed reference chamber and an open sampling chamber. Each chamber contains a photocell. Smoke in the sampling chamber results in a voltage reduction that can be compared to the reference chamber voltage to produce a signal. In these systems, the beam path is completely contained within the detector.

4.10 “Projected Beam” detection systems use detectors based on the attenuation principle. The light source is installed at one end of the area to be protected, and the receiver is installed at the other end. The path of the light beam can be up to 330 feet (100 meters) long. Smoke entering the beam anywhere along its length will attenuate the beam and cause an alarm. These systems are useful in protecting large areas such as warehouses, auditoriums, and atriums because of the long beam paths required. Care must be taken to ensure that the beam path is free from obstructions at all times. Continuous exposure to light can damage or accelerate the aging of photocells, resulting in increased maintenance and possible system failure.

4.11 Projected beam detectors are essentially line-of-sight detectors. Smoke must be present in the path of the beam in order to be detected. Where long beam paths are used, considerable smoke must be present in any segment of the beam in order for sufficient attenuation to be achieved. However, sensitivity can be increased by using reflecting mirrors to redirect the beam through the smoke more than once.

4.12 Smoke detectors using the light-scattering principle measure the light that is scattered when smoke enters a chamber. The units are spot-type and may be used as single-station devices with self-contained power supply and alarm, or as part of an integrated system with remote power supply, alarm, and zone-indicating hardware.

4.13 Light-scattering detectors do not respond well to dark smoke because the dark materials absorb light and reduce scattering. False alarms can be caused by the entrance of insects or dust accumulation on the optically-black internal surfaces of the chambers (see Tables A and B).

Air-Sampling Detectors

4.14 Air-sampling detectors are extremely sensitive smoke detection systems which provide a continuous analog reading of ambient air in a protected area. The system uses the light-scattering principle to detect the airborne particulates generated during the pre-combustion stages of an incipient fire. This often occurs prior to the first signs of visible smoke or flames.

4.15 Air to be sampled is continuously drawn from a protected area through a network of piping (typically at ceiling level) with sampling ports (holes) at specified intervals. The air is passed through a filter and a detection cell, and is continuously monitored by a sensitive optical detector utilizing a xenon light source and solid-state receptors. Light reflected by airborne particles is measured by a solid-state receiver. The resultant signal is amplified and processed to provide an analog smoke intensity reading which appears on the control unit's bar-graph display (see Figure 5).

⇒ NOTE:

Another available model uses a laser light source and does **not** have a filter.

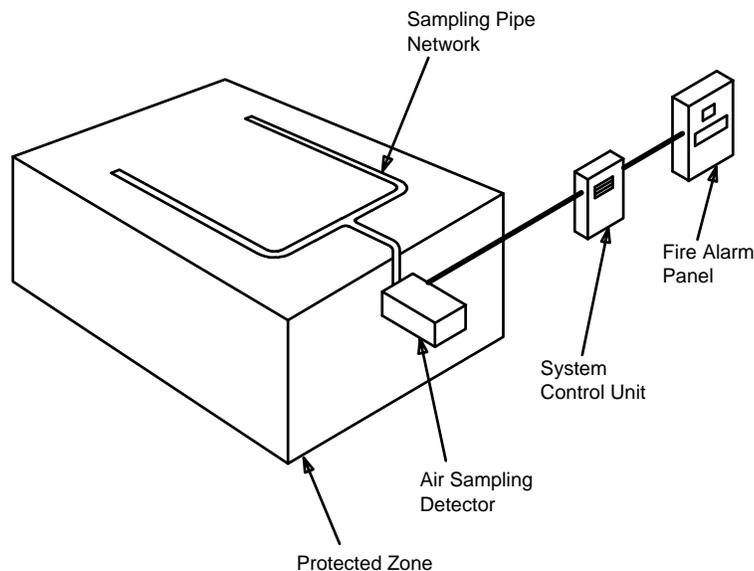


Figure 5. Air Sampling

4.16 The combination of continuous air sampling, an ultra-stable light source, and a high signal-to-noise ratio results in a system which is 10 to 100 times more sensitive than conventional light-scattering devices or other similar detectors.

4.17 Detectors are available in three sensitivity levels. Selection is based on the normal level of background contaminants and the spectrum of potential contaminants that may be encountered at the facility. As smoke contamination increases, each 10 percent gradation within the range is indicated by a separate bar graph Light Emitting Diode (LED) to allow monitoring of contamination development.

4.18 A typical system consists of three components: a detector, an air-sampling network, and a control unit. The detector can be used effectively in areas having a wide range of combustion products. Response to gray and dark combustion products is virtually identical.

⇒ NOTE:

Other versions of this detection system are available which incorporate the basic features into one self-contained unit and may be used for smaller protected areas.

4.19 The air-sampling network uses a fan within the detector enclosure to create and maintain air movement through the detection chamber. Metallic or nonmetallic piping can be installed in a variety of configurations to allow point-detection in numerous patterns. Area coverages can extend up to 20,000 square feet (1858 square meters).

- 4.20** The control unit contains all alarm, supervisory, indicating, test, and output functions required for up to four zones. Strip-chart recorder outputs are available for monitoring, testing, and recording.
- 4.21** Applications for this system include clean rooms, anechoic chambers, computer facilities, telephone equipment/switching rooms and other areas where very early detection of a fire is critical. Air sampling is not affected by high air velocities or frequent air exchanges, other than to dilute the amount of particles available for sensing. If air flow to the detection chamber deviates from normal, an "airflow warning" indication occurs.
- 4.22** The inherent sensitivity of the system may preclude successful application in areas with normally high ambient airborne particle levels, unless the sensitivity level is selected based on background monitoring data. In any event, this system enhances smoke detectability where high air turnover dilutes particle concentration to below the usual detection thresholds.
- 4.23** The dynamics of the sampling system are dependent on being able to draw a representative sample from the protected area. If pressure differences exist between two rooms or compartments, a separate detection system will be required for each room or compartment. (See Tables A and B.)

Detector Maintenance

- 5.01** Poor maintenance of detectors can adversely affect their reliability. All detectors should be kept free of contaminants by periodic cleaning. The frequency of cleaning will depend upon the type of detector and the ambient conditions in the protected space. Consult the manufacturers' instructions for specific cleaning and maintenance requirements.

Detector Installation and Testing

- 6.01** New installation of smoke detection systems and alteration of existing systems shall conform to the provisions of the current issues of the NFPA Standard 72E, UL Listing Standards, recognized international standards organizations, and manufacturers' specifications. The Corporate Fire Protection Engineering Organization is available for consultation for any alterations or new system installations.
- 6.02** As a general rule, installation of smoke detection systems should allow for:
- Protection of detectors and wiring from mechanical damage
 - Independent support of detectors and circuit conductors
 - Mounting detectors only in a manner in which they are approved or listed
 - Anticipated air movement by natural convection and air-handling equipment.

- 6.03** A semi-annual visual inspection of all smoke detection devices shall be conducted. Obstructed detectors shall be relocated or the obstruction shall be removed. Damaged detectors shall be immediately replaced.
- 6.04** Functional testing of smoke detection devices shall be performed according to the following schedule:
- Spot type detectors - Functional testing shall be conducted so that a minimum of 10 percent of all detectors for each system are tested annually.
 - Projected beam and air-sampling detectors - Functional testing shall be conducted annually.
- 6.05** All detection devices should be tested after restoration from an alarm condition. If a detector is exposed to a fire, it shall be tested to ensure that it meets the requirements necessary for correct operation of the system.
- 6.06** Detector sensitivity shall be checked within 1 year after installation and every alternate year thereafter. Detectors with abnormal sensitivity shall be cleaned and recalibrated or replaced. A sensitivity test shall also be performed following any disassembly or cleaning of the detector. Detectors found to have a sensitivity outside the approved range shall be replaced.
- 6.07** Specifics for cleaning and testing the various detectors should be obtained from the individual equipment manufacturers.
- 6.08** Records for testing and maintenance performed on detection systems should be maintained on file for review by corporate and insurance personnel and the Authority Having Jurisdiction.

FEEDBACK FORM

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