D296/D297

EN

Application Guide

Projected Beam Smoke Detectors

BOSCH

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Notice

Before installing any fire alarm system, consult your local authority having jurisdiction (AHJ).

1.0 Introduction

Use this document to determine the best locations and applications of the D296/D297 Series Projected Beam Smoke Detectors.

Use the D296/D297 Series:

- Where there are high ceilings such as in atriums and aircraft hangers. Mount the detectors on walls for easy access.
- In dusty environments such as warehouses, factories, and barns. These detectors have built-in compensation to prevent alarms caused by dust.
- Where there are expansive ceilings. One set of D296/D297 Series can replace up to 24 spot type smoke detectors. This saves on service and installation costs, especially in areas such as large offices or department stores.
- On ornamental ceilings where spot detectors are a distraction.
- Where there is limited access to the ceiling such as in factories and warehouses.

The detectors have separate transmitters and receivers. The transmitter projects an infrared (IR) beam across the protected area to a receiver containing a photosensitive cell that monitors the signal strength of the light beam.

The D296/D297 Series Projected Beam Smoke Detectors work on the principle of obscuring light. Its photosensitive element sees light produced by the receiver in a normal condition. The receiver is calibrated to a preset sensitivity level based on a percentage of total obscuration. Beam length and the desired response time determine this sensitivity level. The installer can choose from eight sensitivity settings based on the length of the beam used in a particular application.

The transmitter can be independently powered from the receiver, greatly reducing wiring runs and installation cost. Since battery backup is required for fire alarm systems, battery backup is required for the transmitter whether it is powered from the control panel or is independently powered.

Unlike spot type photoelectronic smoke detectors, beam smoke detectors are generally less sensitive to the color of smoke. A beam smoke detector might be suited to applications inappropriate for spot-type photoelectronic detectors, such as applications where the anticipated fire would produce black smoke. Beam smoke detectors require visible smoke and might not be as sensitive as ion detectors in some applications.

Beam smoke detectors are sensitive to the cumulative obscuration presented by a smoke field. A combination of smoke density and the linear distance of the smoke field create this obscuration across the projected light beam. Cumulative obscuration is a measure of the percentage of light blockage.

Since the sudden and total obscuration of the light beam is not a typical smoke signature, the detector sees this as a trouble condition, not an alarm. This threshold is at a sensitivity level that exceeds 90% to 95% total obscuration. This minimizes the possibility of an unwanted alarm due to the blockage of the beam by a solid object such as a sign or ladder inadvertently placed in the beam path.

Very small, slow changes in the quality of the light source are not typical of a smoke signature. These changes can occur because of environmental conditions such as dust and dirt accumulation on the transmitter, the receiver's optical assemblies, or both. Generally, the automatic environmental compensation circuit compensates for these changes. When you initially turn on the detector and run the setup program, it assumes the light signal level at that time as a reference point for a normal condition. Over time, the quality of the light signal degrades (perhaps due to dust), and the environmental compensation circuit compensates for this change. The compensation rate is limited, ensuring the detector remains sensitive to slow or smoldering fires. When the automatic environmental compensation circuit no longer compensates for signal loss (as with an excessive accumulation of dirt), the detector signals a trouble condition.

The receiver indicates a trouble condition if the beam strength increases more than 20%. An incorrectly aligned transmitter and receiver or a partially blocked beam can cause a trouble when the transmitter and receiver are installed.

2.0 Applications

2.1 Coverage

Generally, the D296/D297 Series provides smoke detection in large areas with open or high ceilings.

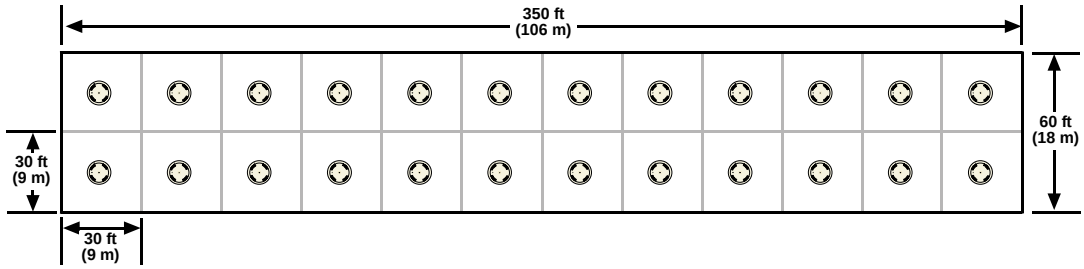
Figure 1 shows the D296/D297 Series coverage range of up to 350 ft (106 m). On a smooth flat ceiling, you can place the beams up to 60 ft (18 m) apart, allowing one D296/D297 Series to replace up to 24 spot smoke detectors with 30 ft (9 m) spacing.

You can install beam detectors vertically or at any angle needed to allow protection of the hazard involved, such as vertical beams through the open shaft area of a stairwell where there is a clear vertical space inside the handrails).

Before installing beam smoke detectors, consider the following:

- Is there a clear line of sight between the transmitter and receiver at all times?
- Might objects such as signs or boxes be placed in the beam's path in the future?
- Will moving objects such as traveling cranes or forklift trucks enter the beam path?
- What type of fire might occur? Would air movement or obstacles prohibit smoke from reaching the detectors?

Figure 1: Coverage Range



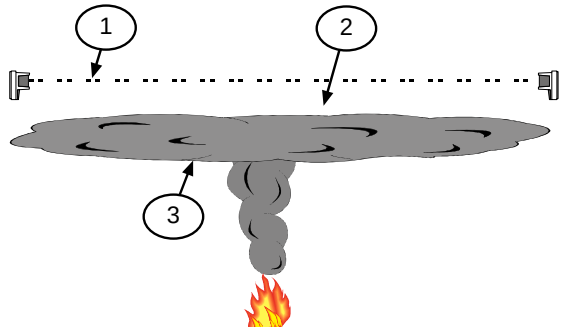
2.2 Stratification

Section B.4.6.1 of NFPA 72, National Fire Alarm Code (2002 Edition) states: "The potential for the stratification of smoke is another concern in designing and analyzing the response of detectors. This is of particular concern with the detection of low-energy fires and fires in compartments with high ceilings."

The smoke's upward movement in the plume depends on the smoke's buoyancy relative to the surrounding air. Stratification occurs when the smoke or hot gases flowing from the fire fail to ascend to the smoke detectors mounted at a particular level (usually the ceiling) above the fire due to lost buoyancy.

This phenomenon occurs because of the continuous entrapment of cooler air into the fire plume as it rises, cooling the smoke and fire plume gases (*Figure 2*). The cooling of the plume reduces buoyancy. Eventually the plume cools to a point where its temperature equals that of the surrounding air and its buoyancy is reduced to zero. Once this point of equilibrium is reached, the smoke stops flowing upward and forms a layer. It maintains its height above the fire, regardless of the ceiling height, unless and until the fire provides sufficient additional thermal energy to raise the layer resulting from its increased buoyancy. The maximum height the smoke ascends, especially early in the development of a fire, depends on the fire's convective heat release rate and the compartment's ambient temperature.

Figure 2: Stratification



1 - Projected beam
2 - Hot fresh air
3 - Stratification

2.3 Environmental Considerations

2.3.1 Outdoor

Do not use the D296/D297 Series for outdoor applications. Environmental conditions such as temperature extremes, bright sunlight, rain, freezing rain, snow, sleet, fog and dew can interfere with the proper operation of the detector. Outdoor conditions also make smoke behavior impossible to predict.

2.3.2 Indoor

Avoid sources of heat and air movement.

- Do not mount the D296/D297 Series where hot or cold air can blow directly into the beam path.
- Heating, ventilating, and air conditioning (HVAC) systems and ceiling fans can cause smoke to blow away from the projected beam. Smoke must accumulate in the projected beam to be detected.
- Heaters mounted close to the projected beam path can cause the beam to be distorted.

Avoid sources of bright light.

- Sunlight: Avoid pointing the receiver directly at the rising or setting sun. If you are installing the unit where sunlight cannot be avoided, mount the receiver slightly higher than the transmitter and aim it down towards the transmitter. This reduces the problem by causing the receiver to look below the horizon.
- Bright lights: Generally, bright lights are not a problem. Do not place exposed bulbs of high-pressure sodium, mercury vapor, and metal halide close to the receiver. Bare fluorescent lights might pose a problem in long hallways where a series of lights run perpendicular to the beam.

2.3.3 Mounting

Section 5.7.3.4.8 of NFPA 72, National Fire Alarm Code (2002 Edition) states: “The light path of projected beam-type detectors shall be kept clear of opaque obstacles at all times.”

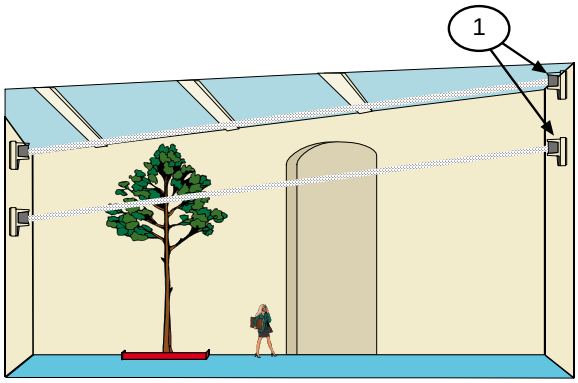
Section A.5.7.3.4.8 of NFPA 72, National Fire Alarm Code (2002 Edition) states: “Where the light path of a projected beam-type detector is abruptly interrupted or obscured, the unit should not initiate an alarm. It should give a trouble signal after verification of blockage.”

Because the D296/D297 Series is a line-of-sight device that goes into trouble on a sudden and total loss of signal, ensure all obstacles are clear of the beam path at all times.

This requirement might cause the detectors to be impractical in factory applications where overhead cranes and hoists are present and in warehouses where high forklifts might block the beam. Also, consider this factor in occupied areas where there are normal ceiling heights.

The D296/D297 Series depends on the measurement of the projected beam to sense smoke. Shifts in the beam alignment from transmitter or receiver movement can cause trouble or alarm conditions. Refer to *Figure 3*.

Figure 3: Multiple Level Mounting



1 - Multiple level mounting locations

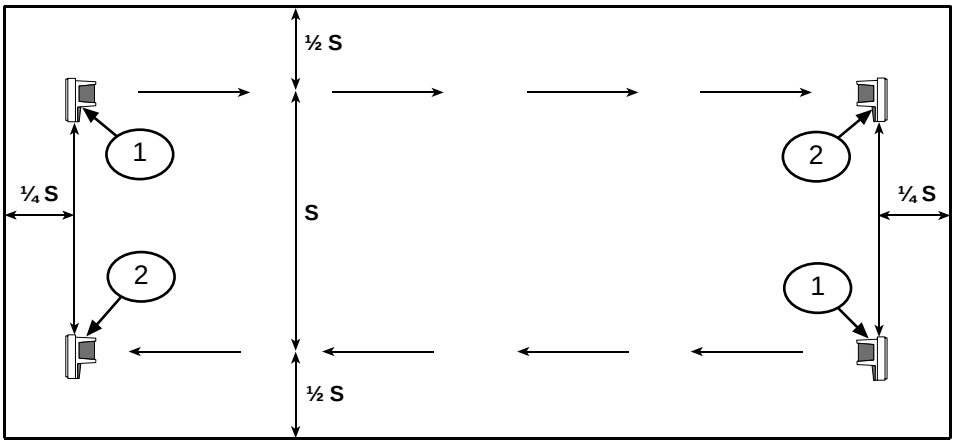
- Always select a stable mounting surface. The walls and attached girders of steel-sided buildings (especially walls facing the sun) might be very unstable throughout the day. In this circumstance, a roof support girder might provide better support.
- Never mount the units on a suspended support such as a pipe or length of wood supported at only one end.
- Never use mirrors to extend the beam around corners.
- Never mount the units behind clear glass or plastic covers other than those supplied by Bosch Security Systems, Inc. with the detectors.
- When mounting in high ceiling areas such as atriums, consider several mounting levels to account for stratification due to ceiling height or low energy fires.

2.4 Location and Spacing

Section 5.7.3.4.1 NFPA 72, National Fire Alarm Code (2002 Edition) states: "Projected beam-type smoke detectors shall be located in accordance with the manufacturer's documented instructions."

The D296/D297 Series allows a range of 30 ft to 350 ft (9 m to 106 m) and spacing up to 60 ft (18.3 m). Space the detectors no more than 60 ft (18.3 m) between projected beams and no more than half the spacing between a projected beam and a sidewall. You can determine other spacing based on ceiling height, airflow characteristics, and response requirements. In some cases, mount the transmitter on one end wall and mount the receiver on the opposite wall. You can also mount the transmitter and receiver up to one-quarter of the spacing distance from the end walls. Refer to *Figure 4*.

Figure 4: Location and Spacing



1 - Transmitters (2) *2 - Receivers (2)*

S = Selected detector spacing

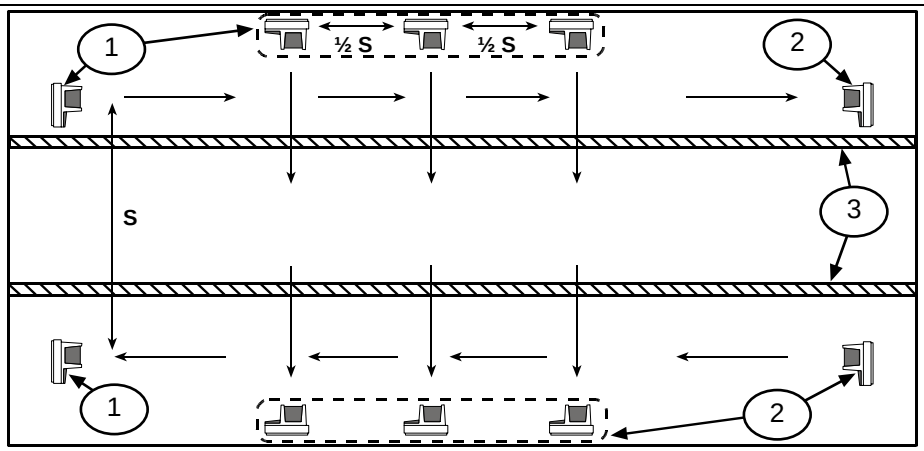
2.5 Ceilings

2.5.1 Flat Ceilings

Projected beam applications have a flat, smooth ceiling with a height of 12 ft (3.6 m) or lower and beam or solid joist depths of 1 ft (0.3 m) or less. Open trusses less than 10% material and 90% open air do not affect the flow of smoke. Smooth flat ceiling guidelines apply where the trusses are used.

Use normal spacing when the projected beams are running in the direction parallel to the run of the beams or solid joists. Use half spacing when the projected beams are running at right angles to the run of the beams or solid joists. A joist is a support that is 4 in. (100 mm) or more in depth and 3 ft (0.9 m) or less in spacing. A beam is a support that is 4 in. (100 mm) or more in depth and 3 ft (0.9 m) or more in spacing. Refer to *Figure 5*.

Figure 5: Flat Ceiling – Example A



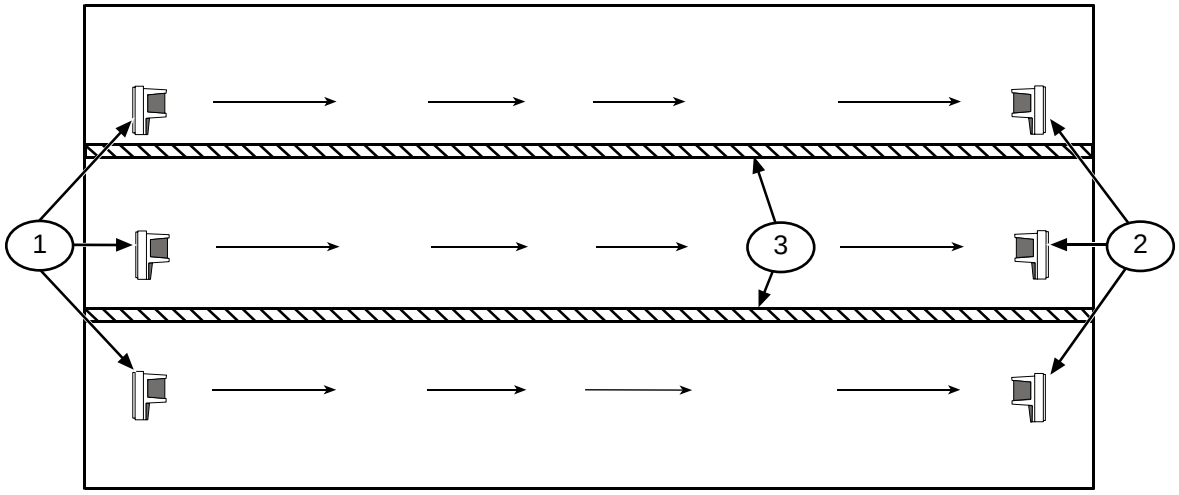
1 - Transmitters (5) *2 - Receivers (5)* *3 - Ceiling beams (joists [2])*

S = Selected detector spacing

Place the detectors in every ceiling beam pocket when the ceiling beams (joists) exceed 1 ft (.03 m), the spacing between the beams exceeds 8 ft (2.4 m), or the ceiling height exceeds 12 ft (3.6 m).

If you expect the fire size to exceed 1 MW (1000 kW), the ceiling height can be up to 28 ft before each beam pocket must be treated separately. Review *Section B-2 Performance-Based Approach to Designing and Analyzing Fire Detection Systems* in *NFPA 72, National Fire Alarm Code (2002 Edition)* to determine the potential fire size at the location. Refer to *Figure 6*.

Figure 6: Flat Ceiling – Example B



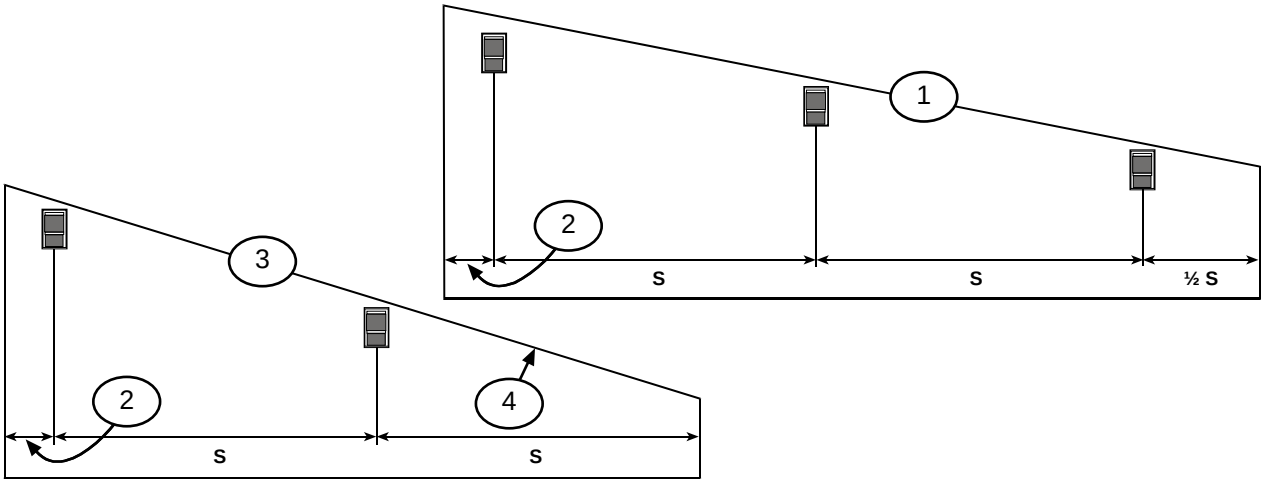
1 - Transmitters (5)
2 - Receivers (5)
3 - Ceiling beams (joists [2])

2.5.2 Sloped Ceilings

Use the spacing for flat beamed ceilings in installations with beams running parallel to (up) the slope. The ceiling height is the average height over the slope. For slopes greater than 10°, detectors at half the spacing from the low end are not required. Spacing is measured along a horizontal projection of the ceiling.

Use the spacing for flat beamed ceilings in installations with the beams running perpendicular to (across) the slope. One set of beams must be within 3 ft (1 m) measured horizontally of the high point of the ceiling (*Figure 7*).

Figure 7: Sloped Ceilings

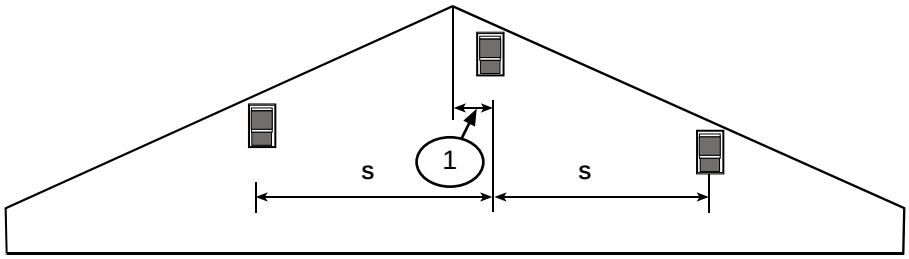


1 - Slope 10° or less
2 - 3 ft (1 m) maximum
3 - Slope greater than 10°
4 - Detector at ½ S not required
S = Selected detector spacing

2.5.3 Peaked Ceilings

Peaked structures follow the same guidelines as sloped ceilings with one exception. When calculating the location of the detectors, the first detector is within 3 ft (1 m) of the peak (measured horizontally). Space additional detectors down from the detector nearest the peak. Refer to *Figure 8*.

Figure 8: Peaked Ceilings



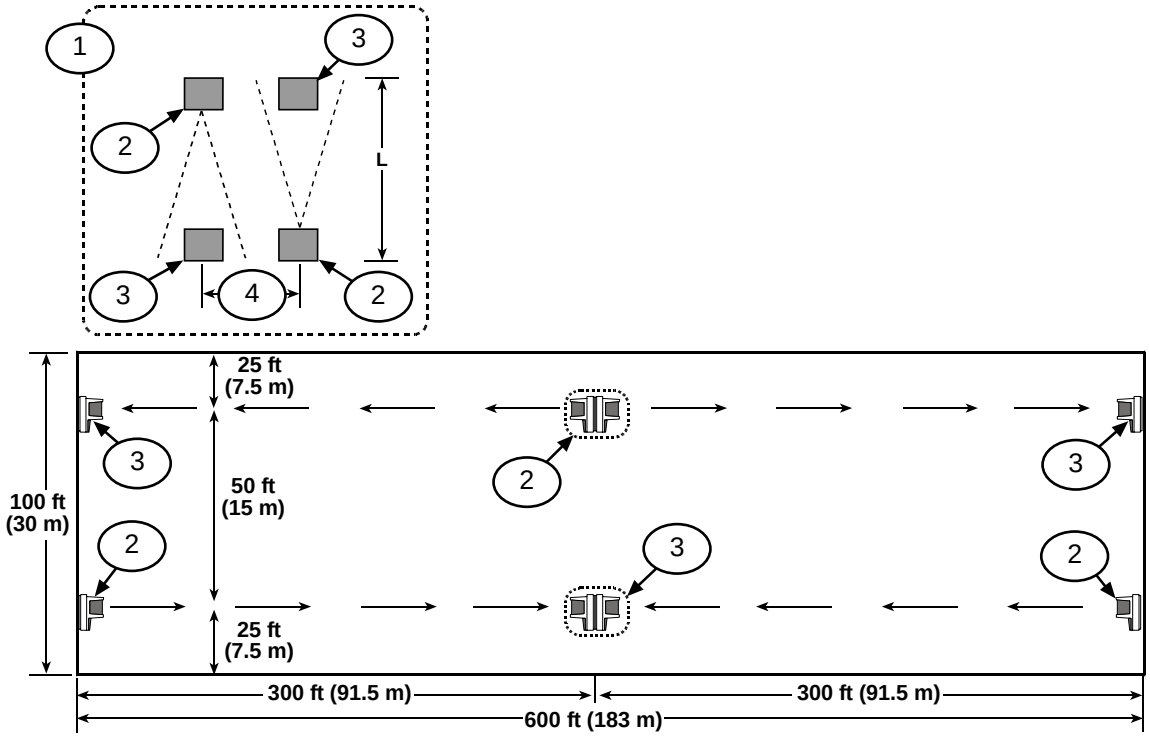
1 - 3 ft (1 m) maximum
S = Selected detector spacing

2.5.4 Long Ceilings

Long ceilings over 350 ft (107 m) require more than one set of detectors to cover the entire length. Determine the number of detector sets by:

1. Dividing the ceiling length by 350 ft (107 m) and rounding up to the nearest number.
2. Placing the detector sets to cover an equal amount of area.
3. Setting the transmitters and receivers to the right and below to avoid possible cross talk (*Figure 9*).
4. Setting the minimum spacing between adjacent detectors to L/10 the distance between the transmitter and the receiver. For example, the minimum spacing for a beam length of 300 ft (91.5 m) is 30 ft (9 m).

Figure 9: Long Ceilings



1 - Alternate transmitter and receiver locations in multiple unit installations
2 - Transmitters (2)
3 - Receivers (2)
4 - L/10 minimum; 60 ft (18 m) maximum

3.0 Worksheets

Sketch the layout of the area to be protected.

_____ = ☐
Scale in ft (m)

Ensure you include site features such as:

- Support beams (include direction)
- Support posts
- Peaks
- Lights
- Air handling units such as HVAC
- Shelving
- Anything suspended from the ceiling that might interfere with the beam
- Directions (north, south, and so on)

Sketch the layout of the area to be protected.

_____ = ☐
Scale in ft (m)

Ensure you include site features such as support beams, ceiling height, and peaks.

Sketch the layout of the area to be protected.

_____ = ☐
Scale in ft (m)

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4.0 Glossary

Table 1: Glossary

Term	Definition
beam smoke detector	A device such as the D296/D297 Series Projected Beam Smoke Detectors that senses smoke or smoke and visible heat waves by projecting a light beam from a transmitter across the protected area to a receiver that monitors the light signal. Smoke, visible heat waves, or both entering the beam path decrease the light signal causing an alarm.
detector coverage	An area in which a projected beam smoke detector effectively senses smoke. This area is limited by applicable listings and codes.
obscuration	The reduction of light's ability to travel from one point to another due to the presence of solids, liquids, gases, or aerosols.
range	The distance between the transmitter and receiver. Also known as beam length.
receiver	A device, in a projected beam smoke detector system, that monitors the signal level of the infrared light sent by the transmitter.
sensitivity	The ability of a projected beam smoke detector to respond to a given level of smoke.
sidewall	A wall parallel to the beam's path of travel.
spacing	The distance between projected beam smoke detector receiver and transmitter pairs.
spot-type detector	A device that senses smoke, heat, or both **only** at the detector's location. These detectors have a defined area of coverage.
stratification	An effect that occurs when air containing smoke particles or gaseous combustion products is heated by smoldering or burning material. The air becomes less dense than the surrounding cooler air and rises until it reaches a level at which there is no longer a difference in temperature between it and the surrounding air. Stratification can also be caused by forced ventilation.
transmitter	A device in a projected beam smoke detector that projects the infrared light across the protected area to its associated receiver.
trouble	A service condition that needs to be corrected, such as a broken wire, dirty detector, misaligned detector, and so on.

5.0 Accessories

Table 2: Accessories

Product	Description	
Standard		
D306 Remote Indicator Plate	Monitors the status condition of the detector and allows the user to measure a calibration voltage to determine if the detector is within the calibration range. Can be mounted on a standard single-gang box.	
Optional		
D307 Remote Test/Indicator Plate	Monitors the condition of the beam smoke detector and allows the user to measure a calibration voltage to determine if the detector is within the calibration range. Use a Keylock switch to perform a remote test and detector reset. Can be mounted on a standard double-gang box.	
D309 Alignment Strobe	Provides a visual indication to help align the D296/D297 Series transmitter and receiver.	

Table 2: Continued

Product	Description	
Optional (cont)		
D1005 Test Cord	Provides an electrical connection to the D296/D297 Series receiver to help align the receiver and transmitter.	
D308 Field Test Kit	Tests the calibration of the D296/D297 Series by providing a calibrated amount of obscuration between the transmitter and receiver.	

6.0 Specifications

Table 3: Specifications

Power	**Voltage**	**Standby Current**	**Alarm Current (Receiver)**
D296	18 VDC to 32 VDC	45 mA @ 24 VDC, Transmitter: Receiver: 20 mA @ 24 VDC	60 mA @ 24.0 VDC
D297	10.2 VDC to 15 VDC	50 mA @ 12 VDC, Transmitter: Receiver: 20 mA @ 12 VDC	75 mA @ 12.0 VDC
Alarm Output	One auxiliary Form C (NO/C/NC [normally-open/common/normally-closed]) contact rated 1 A, 60 VDC maximum for resistive loads. One NO contact rated 1 A, 60 VDC maximum for resistive loads.		
Tamper/Trouble Output	One NC contact rated 1 A, 60 VDC maximum for resistive loads. Opens when the cover is removed, power is lost, or the beam is blocked.		
Signal Processing	Automatic signal synchronization eliminates the need for a synchronization wire. Self-compensating circuitry compensates for signal loss from dust or dirt buildup on lens and signals a trouble condition at a signal loss of 50% or a signal increase of 20%.		
Operation	Transmitter emits an invisible pulsed infrared (IR) beam to the receiver. If smoke obscures the beam beyond the selected threshold, the receiver signals an alarm. If the beam is 90% blocked, the receiver signals a trouble.		
Alarm Response Selectivity	Eight sensitivity settings available. Selectable response time of 5 sec or 30 sec.		
Storage and Operating Temperature	-22°F to +130°F (-30° C to +54°C). For Underwriters Laboratories, Inc. (UL) Certificated installations +32°F to +120°F (0°C to +48°C).		
Test Features	Externally visible LEDs on the transmitter and receiver indicate an alarm signal and trouble conditions. An output voltage on the receiver assists in alignment and troubleshooting. The D306 Indicator Plate (included) uses LEDs to indicate detector status and condition, and provides a point to read and test the signal voltage.		
Dimensions (H x W x D)	7 in. x 5.5 in. x 5.5 in. (17.8 cm x 13.9 cm x 13.9 cm)		
Coverage	30 ft to 350 ft (9 m to 107 m) range. Up to 60 ft (18 m) spacing on smooth, flat ceilings.		
Mounting	Surface or ceiling mount on standard 4 in. (10.2 cm) square or octagonal electrical boxes		
Pattern Pointability	Internally pointable ±90° horizontal, ±10° vertical.		
Radio Frequency Interference (RFI) Immunity	No alarm or jamming on critical frequencies in the range from 26 MHz to 950 MHz at 50 V/m.		
Listings	UL Listing (UL268 and UL268A) Underwriters Laboratories of Canada (ULC) Listing Maryland State Fire Marshal (MSFM) Permit #1943 New York City – Material Engineering Association (NYC-MEA) Acceptance #MEA274-93-E California State Fire Marshal (CSFM) #7260-1062:106 Factory Mutual Research (FM) Job #0X2A9.AY European EMC Conformity (CE)		

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