D296/D297 Series
Projected Beam
Smoke Detectors

Application Guide

Fire Systems

BOSCH

Contents

1.0 Scope

This application guide is intended to assist in determining the best locations and applications of the D296 Series Long Range Beam Smoke Detectors.

This application guide contains information from the National Fire Protection Association standard NFPA-72, the National Fire Alarm Code, on automatic fire detectors and discusses the general application rules for the D296 Series.

Your Local Authority Having Jurisdiction (AHJ) should always be consulted before beginning the installation of any fire alarm system.

2.0 Glossary of Terms

Beam Smoke Detector (Projected Beam Smoke Detector)

A device which senses smoke or smoke and heat by projecting a light beam from a transmitter across the protected area to a receiver that monitors the light signal. Smoke and/or heat entering the beam path will decrease the light signal causing an alarm.

Detector Coverage

The area in which a smoke detector or heat detector is considered to effectively sense smoke and/or heat. This area is limited by applicable listings and codes.

Listed

The inclusion of a device in a list published by a recognized testing organization, indicating that the device has been successfully tested to meet the accepted standards.

Obscuration

The reduction of the ability of light to travel from one point to another due to the presence of solids, liquids, gases, or aerosols.

Receiver

The device, in a projected beam smoke detector system, which monitors the signal level of the light which is sent by the transmitter.

Sensitivity

The ability of a smoke detector to respond to a given level of smoke.

Smoke

The solid and gaseous airborne products of combustion.

Spot-Type Detector

A device which senses smoke and/or heat at its location only. Spot-type detectors have a defined area of coverage.

Stratification

The effect which occurs when smoke, which is hotter than the surrounding air, rises until equal to the temperature of the surrounding air, causing the smoke to stop rising.

Transmitter

The device in a projected beam smoke detector which projects the light across the protected area to its associated receiver.

Trouble Condition

The status of a device or system which impairs its proper operation, i.e., open circuit on an initiation loop. The notification of a trouble condition indicated on a control panel or annunciator is a “TROUBLE” SIGNAL.

3.0 Introduction

Why should I use Beam Smoke Detectors and where should I use them?

- Where there are **high ceilings** such as in atriums and aircraft hangers. Because the detectors mount on the walls easier access is achieved.
- Where there is a **dusty environment** such as in warehouses, factories and barns. The detectors have built-in compensation to prevent alarms due to dust.
- Where there are **expansive ceilings**. One set of beam smoke detectors can replace up to 24 spot type smoke detectors. This saves on service and installation costs especially is such areas as large offices or department stores.
- On **ornamental ceilings** where spot detectors would be a distraction.
- Where there is **limited access** to the ceiling such as in factories and warehouses.

The D296 Series are Long Range Projected Beam smoke detectors which consist of separate transmitters and receivers. The projected beam smoke detectors consist of a transmitter that projects an infrared beam across the protected area to a receiver containing a photosensitive cell, which monitors the signal strength of the light beam. The detector works on the principle of light obscuration. The photosensitive element of the beam smoke detector 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. This sensitivity level is determined by the length of the beam (the distance between the transmitter and receiver) and the desired response time. Eight sensitivity settings are available for selection by the installer based on the length of the beam used in a given application.

The transmitter may be powered independently from the receiver, which can greatly reduce wiring runs and, therefore, installation cost. Since battery back up is required for fire alarm systems, battery back up would be required for the transmitter whether it is powered from the panel or independently.

Unlike spot type photoelectronic smoke detectors, beam smoke detectors are generally less response sensitive to the color of smoke. Therefore, a beam smoke detector may be well suited to applications unsuitable for spot-type photoelectronic detectors, such as applications where the anticipated fire would produce black smoke. Beam smoke detectors do require visible smoke and therefore may not be as sensitive as ion detectors in some applications.

Beam smoke detectors are sensitive to the cumulative obscuration presented by a smoke field. This cumulative obscuration is created by a combination of smoke density and the linear distance of the smoke field across the projected light beam. Cumulative obscuration, then, 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 will see this as a trouble condition, not an alarm. This threshold is at a sensitivity level which 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, being inadvertently placed in the beam path.

Very small, slow changes in the quality of the light source also are not typical of a smoke signature. These changes may occur because of environmental conditions such as dust and dirt accumulation on the transmitter and/or receiver's optical assemblies. These changes are typically compensated for by the automatic environmental compensation circuit. When the detector is first turned on and put through its setup program, it assumes the light signal level at that time as a reference point for a normal condition. As the quality of the light signal degrades over time, perhaps due to dust, the environmental compensation circuit will compensate for this change. The rate of compensation is limited to insure that the detector will still be sensitive to slow or smoldering fires. When the automatic environmental compensation circuit can no longer compensate for the loss of signal (as with an excessive accumulation of dirt) the detector will signal a trouble condition.

The receiver indicates a trouble condition if the the beam strength is increased by more than 20%. This can be caused by incorrect alignment of the transmitter and receiver or a partially blocked beam when the transmitter and receiver are installed.

4.0 Specifications

Power:	**D296**	18 to 32 VDC Receiver: 45 mA @ 24 VDC, Transmitter: 20 mA @ 24 VDC
	D297	10.2 to 18 VDC Receiver: 50 mA @ 12 VDC, Transmitter: 20 mA @ 12 VDC
Alarm Output:		One Normally Open (NO) Contact rated 1 A, 60 VDC maximum for resistive loads. One Auxiliary Form "C" (NO/C/NC) contact rated 1 A, 60 VDC maximum for resistive loads.
Tamper/Trouble Output:		One Normally Closed (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 due to dust or dirt buildup on lens and signals a trouble condition upon signal loss of 50%.
Operation:		The transmitter emits an invisible pulsed infrared beam to the receiver. If the beam is obscured beyond the selected threshold by smoke, the receiver signals an alarm. If the beam is completely blocked, the receiver signals a trouble.
Alarm Response Selectivity:		Eight (8) sensitivity settings are available. Selectable response time of 5 or 30 sec.
Storage & Operating Temperature:		-22°F to +130°F (-30° C to +55°C). For UL Certificated Installations +32°F to 120°F (0°C to 50°C).
Test Features:		Externally visible LEDs on transmitter and receiver give indication of signal, alarm, and supervision conditions. Signal voltage output on receiver assists in alignment and troubleshooting. D306 Indicator Plate (included) provides LED indication of the detector's status/condition, and provides a point to read/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 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 to 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 setup on critical frequencies in the range from 26 to 950 Megahertz at 50 v/m.
Listings:		UL Listing UL268 & UL268A, ULC Listing, MSFM Permit #1943, NY City MEA Acceptance #MEA274-93-E, CSFM #7260-1062:106, FM Job #0X2A9.AY, and CE.

5.0 Accessories

Standard:

D306 Remote Indicator Plate. This standard accessory provides a status monitor of the condition of the beam smoke detector and allow for a calibration voltage measurement to determine if the detector is within the calibration range. The D306 may be mounted to a standard single gang box.

Optional:

D307 Remote Test/Indicator Plate. This optional accessory provides a status monitor of the condition of the beam smoke detector and allow for a calibration voltage measurement to determine if the detector is within the calibration range. Remote test and detector reset can also be performed from the plate using a keylock switch. The D307 may be mounted to a standard double Wiremold box.

D309 Alignment Strobe. This optional accessory provides a visual indication to assist on the alignment of the D296 transmitter and receiver.

D1005 Test Cord. This optional accessory provides an electrical connection to the D296 receiver to assist in the alignment of the receiver and transmitter.

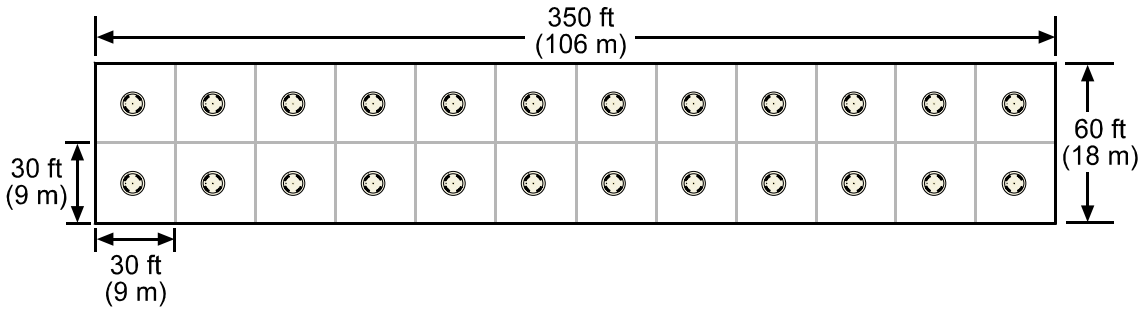
D308 Field Test Kit. This optional accessory allows testing the calibration of the D296 Series Beam Smoke Detectors by providing a calibrated amount of obscuration between the transmitter and receiver.

6.0 Applications

6.1 Coverage

The D296 Series Projected Beam Smoke Detectors are primarily used to provide for smoke detection in large areas with open or high ceilings.

The D296 Series Detectors have a coverage range of up to 350 ft (106 m). On a smooth flat ceiling, the beams may be placed up to 60 ft (18 m) apart. That means that one D296 can replace up to 24 spot smoke detectors with a 30 ft (9.1 m) spacing.



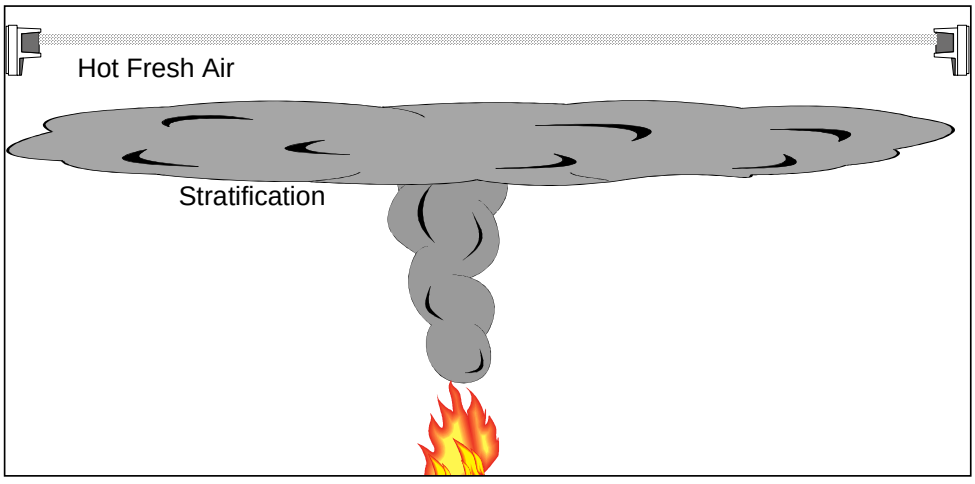
Beams are permitted to be installed vertically or at any angle needed to afford protection of the hazard involved (for example, vertical beams through the open shaft area of a stairwell where there is a clear vertical space inside the handrails).

The following should be considered before installing beam smoke detectors:

- Will there be a clear line of sight between the transmitter and receiver at all times?
- Is it likely that objects such as signs or boxes might be placed in the beam path in the future, or will moving objects such as traveling cranes or forklift trucks enter the beam path?
- In anticipating the type of fire that might occur, would air movement or obstacles prohibit the smoke from reaching the detectors?

6.2 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 upward movement of smoke in the plume depends on the smoke being buoyant 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 the loss of buoyancy. This phenomenon occurs due to the continuous entrapment of cooler air into the fire plume as it rises, resulting in cooling of the smoke and fire plume gases. The cooling of the plume results in a reduction of buoyancy. Eventually the plume cools to a point where its temperature equals that of the surrounding air and its buoyancy diminished to zero. Once this point of equilibrium is reached, the smoke will cease its upward flow and form a layer, maintaining its height above the fire, regardless of the ceiling height, unless and until sufficient additional thermal energy is provided from the fire to raise the layer due to its increased buoyancy. The maximum height to which the smoke will ascend, especially early in the development of a fire, depends on the convective heat release rate of the fire and the ambient temperature in the compartment.

6.3 Environmental Considerations

6.3.1 Outdoor

Beam smoke detectors are inappropriate 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.

6.3.2 Indoor

Avoid sources of heat and air movement:

- Don't mount the detectors where hot or cold air can blow directly into the beam path.
- Heating, ventilating, air conditioning systems and ceiling fans can cause smoke to be blown 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 can't be avoided, mount the receiver slightly higher than the transmitter and aimed down towards the transmitter. This should reduce the problem by causing the receiver to look below the horizon.
- **Bright Lights.** Although bright lights are generally not a problem, exposed bulbs of high pressure sodium, mercury vapor and metal halide should not be placed in close proximity to the receiver. Bare fluorescent lights may pose a problem in long hallways where a series of lights run perpendicular to the beam.

6.4 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."

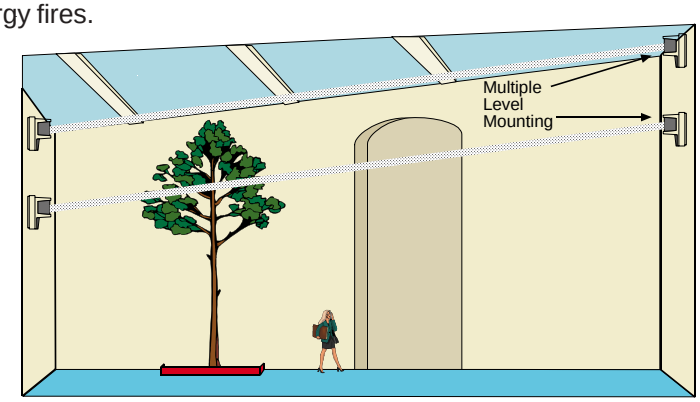
Section A.5.7.3.4.8 of *NFPA 72®, National Fire Alarm Code® (2002 Edition)* states: "Where the light path of a projected beam-type detector is abruptly interrupted or obscured, the unit should not intiiate an alarm. It should give a trouble signal after verification of blockage."

Because beam smoke detectors are line-of-sight devices which go into trouble on sudden and total loss of signal, care must be taken that all obstacles be kept clear of the beam path at all times.

This requirement could make the use of beam smoke detectors impractical in factory applications where overhead cranes and hoists are present and in warehouses where high fork lifts may block the beam. This factor should also be considered in occupied areas where normal ceiling heights exist.

Beam smoke detectors depend on the measurement of the projected beam to sense smoke. Therefore, shifts in the alignment of the beam due to movement of the transmitter or receiver can cause trouble or alarm conditions.

- Always select a stable mounting surface. The walls and attached girders of steel-sided buildings (especially those walls facing the sun) may be very unstable throughout the day. A roof support girder may provide better support in this case.
- Never mount the units to 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 behind clear glass or plastic covers other than those supplied by Bosch with the detectors.
- When mounting in high ceiling areas such as atriums, several mounting levels should be considered to account for stratification due to ceiling height or low energy fires.

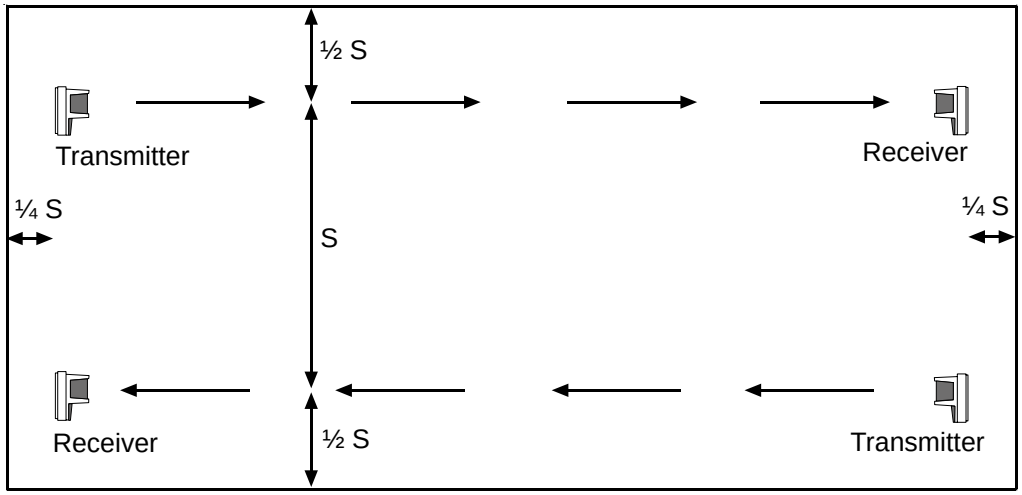


6.5 Location and Spacing

NFPA 72-2002®, 5.7.3.4.1 states: “Projected beam-type smoke detectors shall be located in accordance with the manufacturer’s documented instructions.” The D296 Series Projected Beam Detectors allow for a Range (distance between the Transmitter and Receiver) of 30 to 350 feet (9.1 to 106 meters) and a Spacing (the distance between systems) of up to 60 feet (18 meters).

On smooth ceilings, a spacing of not more than 60 ft (18.3 m) between projected beams and not more than one-half that spacing between a projected beam and a sidewall (a wall parallel to the beam travel) should be used. Other spacing may be determined based on ceiling height, airflow characteristics and response requirements.

In some cases, the transmitter is mounted on one end wall and the receiver is mounted on the opposite wall. It is also permitted to mount the transmitter and receiver up to one-quarter of the spacing distance away from the end walls.



S = Selected detector spacing

6.6 Ceilings

6.6.1 Flat Ceilings

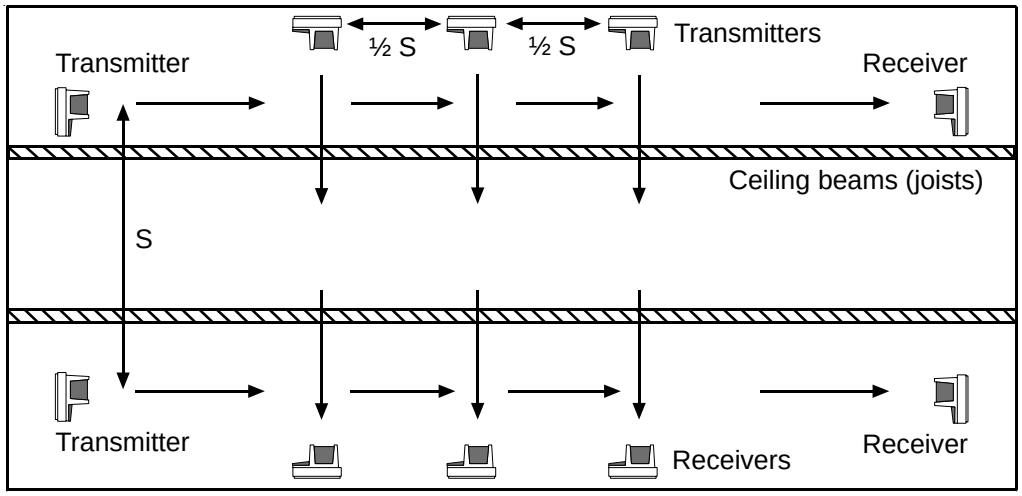
For projected beam applications, a flat, smooth ceiling is considered to have a height of 12 ft (3.6 m) or lower, and beam or solid joist depths of 1 ft (0.3 m) or less. Open trusses that are less than 10% material and 90% open air are not considered to affect the flow of smoke. Smooth flat ceiling guidelines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

Normal spacing may be used if the projected beams are running in the direction parallel to the run of the beams or solid joists.

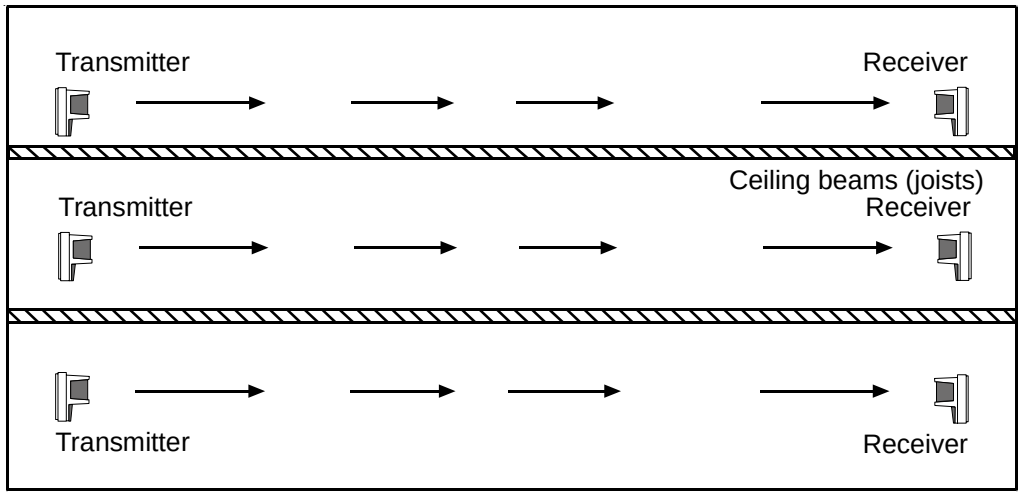
One-half spacing must be used if the projected beams are running at right angles to the run of the beams or solid joists.

A **Joist** is considered to be 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 considered to be a support that is 4 in. (100 mm) or more in depth and 3 ft (0.9 m) or more in spacing.



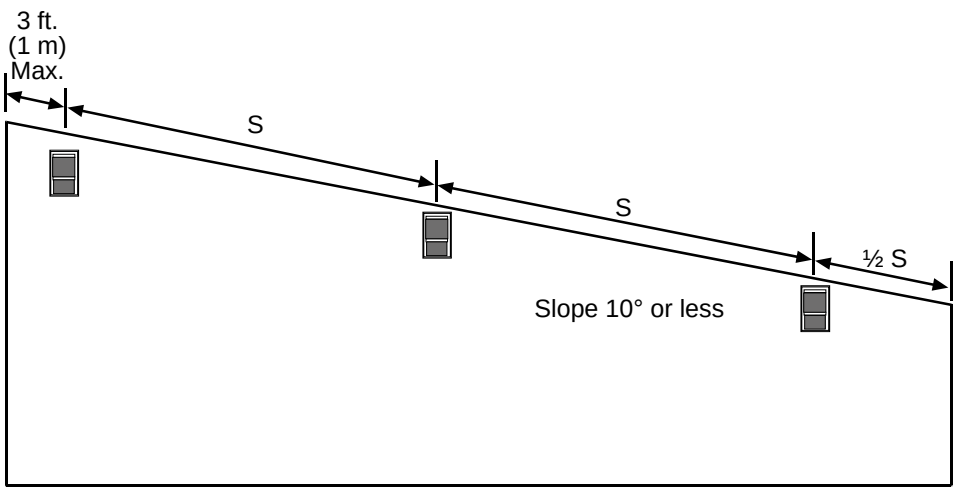
If the ceiling beams (joists) exceed 1 ft (.03 m), the spacing between the beams exceeds 8 ft (2.4 m) or the ceiling height exceeds 12 ft, the detectors must be located in every ceiling beam pocket.

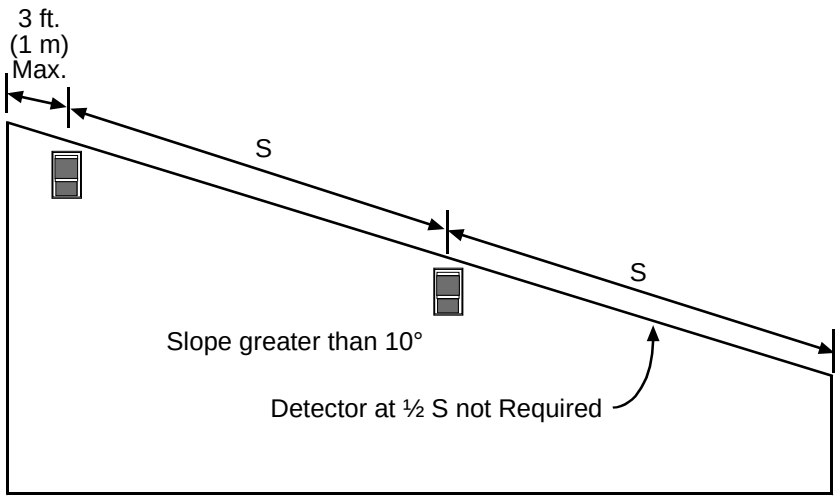


If the fire size is expected to exceed 1-MW (1000 KW), the ceiling height may be up to 28 ft before each beam pocket must be treated separately. It is recommended that you review *Section B-2 Performance-Based Approach to Designing and Analyzing Fire Detection Systems* in *NFPA 72®, National Fire Alarm Code® (2002 Edition)* to determine the potential fire size at the locaton.

6.6.2 Sloped Ceilings

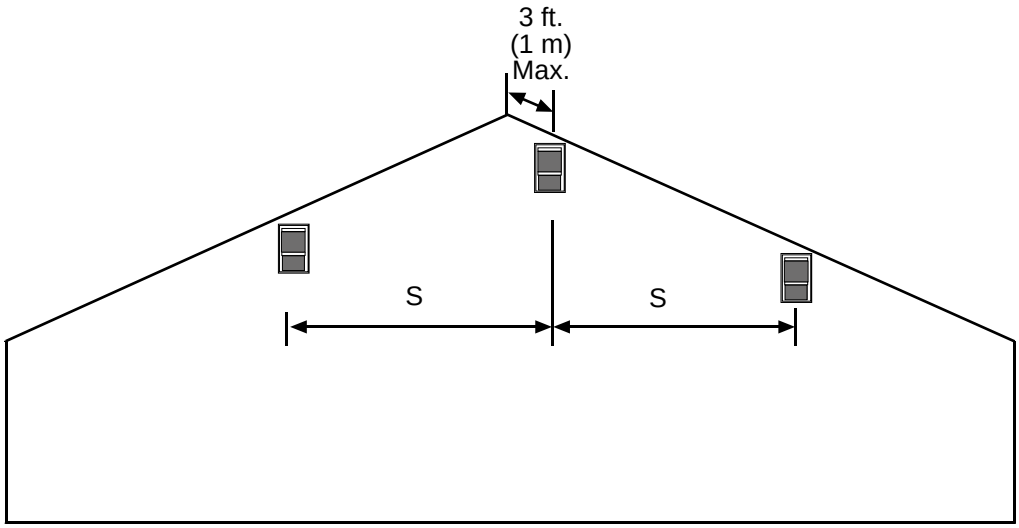
Beamed ceilings with beams running parallel to (up) the slope, the spacing for flat beamed ceilings should be used. The ceiling height is considered the average height over the slope. For slopes greater than 10 degrees, the detectors located at one-half the spacing from the low end are not required. Spacing will be measured along a horizontal projection of the ceiling. For beamed ceilings with the beams running perpendicular to (across) the slope, the spacing for flat beamed ceilings should be used. One set of beams must be within 3 ft (1 m), measured horizontally, of the high point of the ceiling.





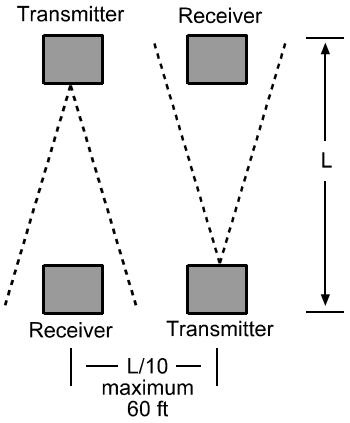
6.6.3 Peaked Ceilings

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. Additional detectors are spaced down from the detector near the peak.

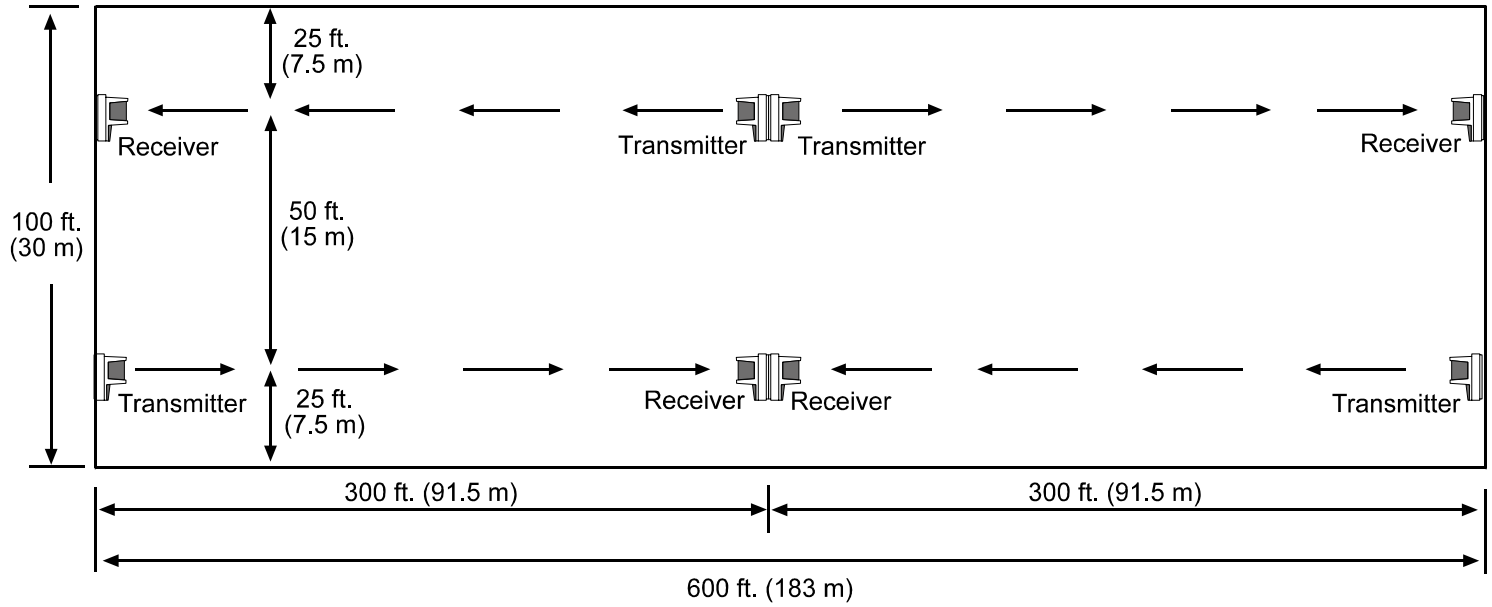


6.6.3 Long Ceilings

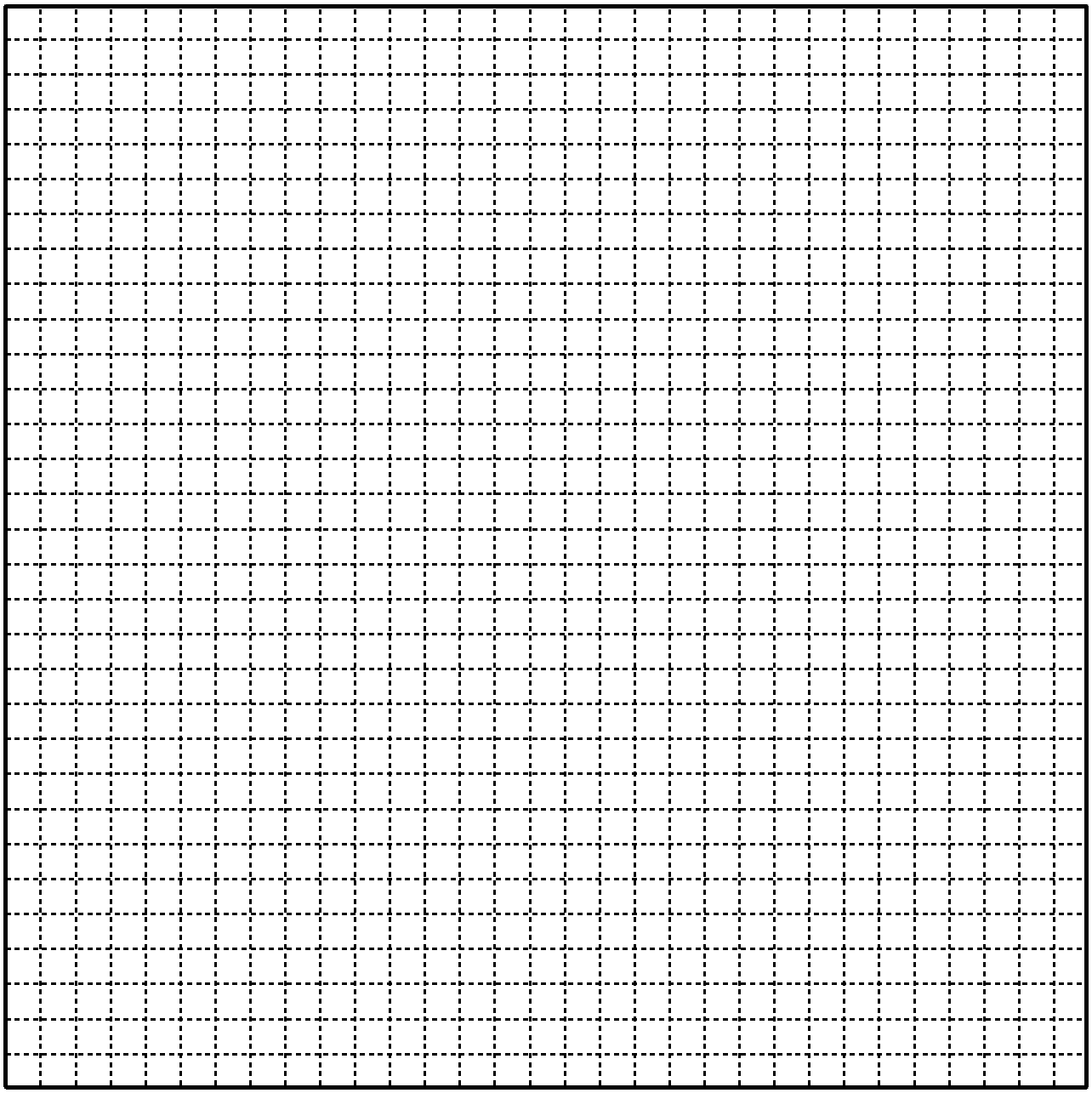
Long ceilings over 350 ft (107 m) require more than one set of detectors to cover the entire length. To determine the number of detector sets required, divide the length of the ceiling by 350 (107 if using metric standards) and round up to the nearest number. Locate the detector sets so that they cover an equal amount of area. Set the transmitters and receivers as shown to the right and below to avoid possible "cross-talk." The minimum spacing between adjacent detectors is 1/10th of the distance between the transmitter and the receiver. For example, for a beam length of 300 ft (91.5 m), the minimum spacing is 30 ft (9.1 m).



Alternate transmitter and receiver locations in multiple unit installations.



7.0 Worksheet



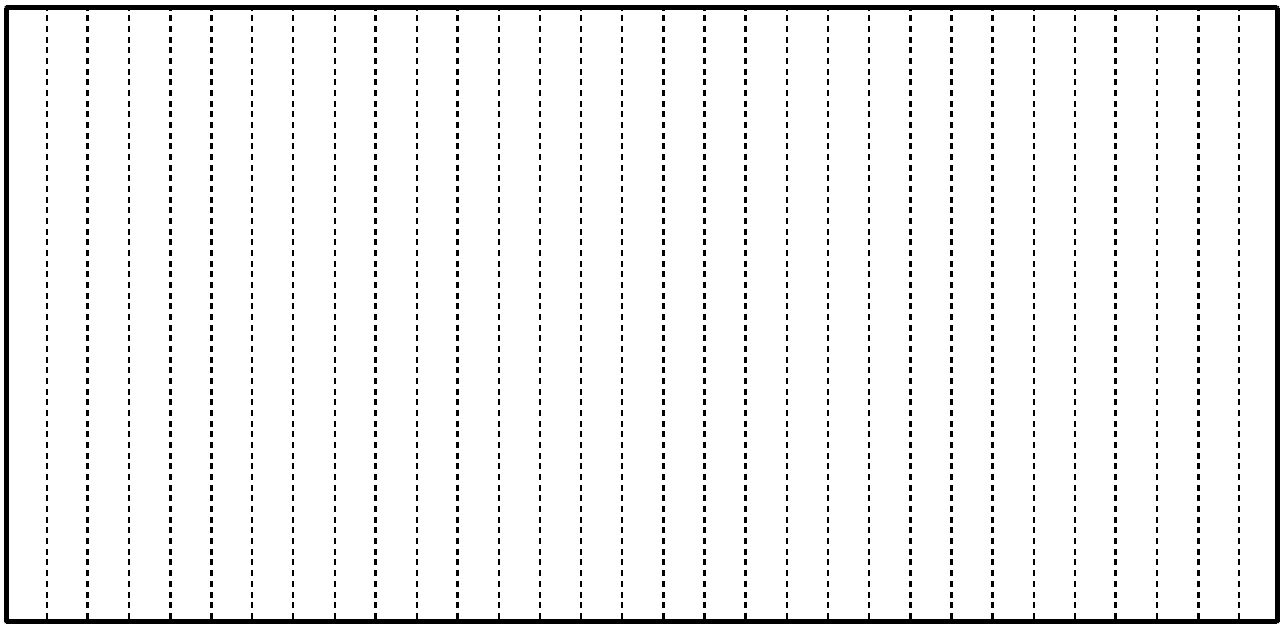
Sketch the layout of the area to be protected.

_____ = ☐

Scale in ft (m)

Be sure to include site features such as:

- Support Beams (include direction)
- Support posts
- Peaks
- Lights
- Air handling units (HVAC)
- Shelving
- Anything suspended from the ceiling that might interfere with the beam
- Directions (North, South, etc.)



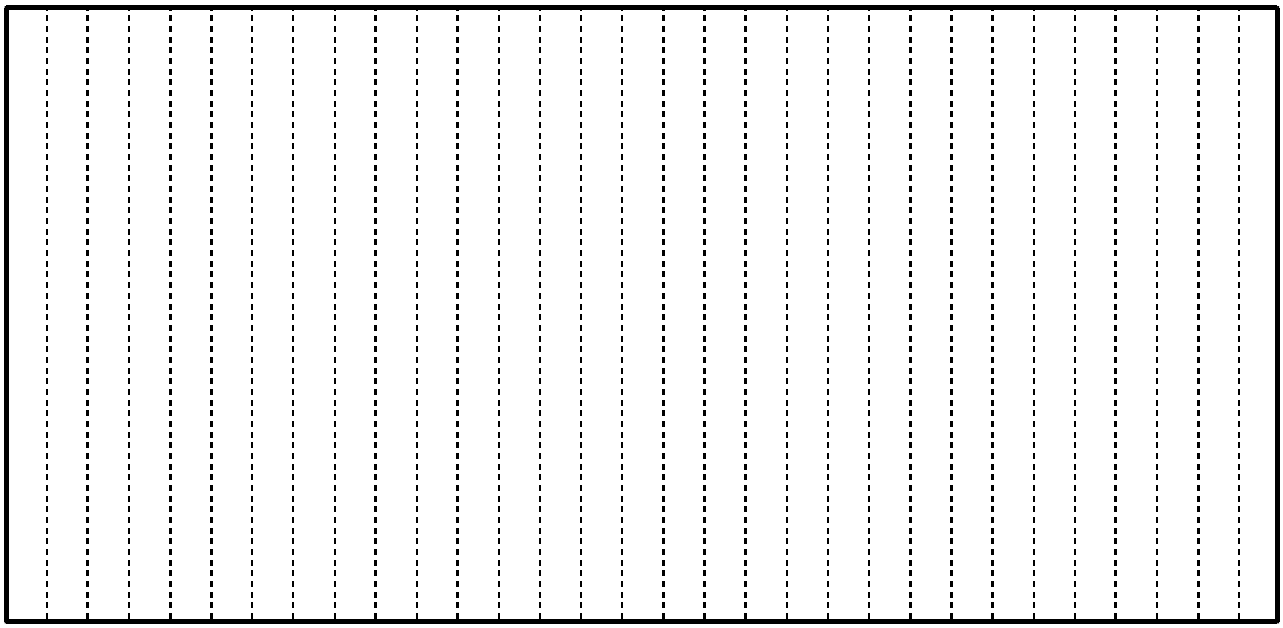
Sketch the layout of the area to be protected.

_____ = ☐

Scale in ft (m)

Be sure to include site features such as:

- Support beams
- Ceiling height
- Peaks



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Scale in ft (m)

Be sure to include site features such as:

- Support beams
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