A.11.5.1.1 Occupancies where smoke alarms are typically required include residential, residential board and care, or day-care home. The term *residential occupancy* is defined in 3.3.164 and includes one- and two-family dwellings; lodging or rooming houses; hotels, motels, and dormitories; and apartment buildings. The term *residential board and care occupancy* is defined in 3.3.164 and includes both small and large facilities. NFPA *101, Life Safety Code,* specifies a small facility to be one with sleeping accommodations for not more than 16 residents. The term *day-care home,* defined in 3.3.40, is a specific category of day-care occupancy. It should be noted that applicable laws, codes, or standards might include conditions that could impact the applicability of these requirements. The local authority should be consulted for specific details.

A.11.5.1.1(1) The term *sleeping room* applies to several occupancies including: one- and two-family dwellings; lodging or rooming houses; hotels, motels, and dormitories; apartment buildings; residential board and care facilities; and day-care homes. The term *guest room,* defined in 3.3.82, is an accommodation that includes sleeping facilities. It applies in the context of hotel and dormitory occupancies.

A.11.5.1.1(2) The term *dwelling unit* is defined in 3.3.54 and applies to one- and two-family dwellings and dwelling units of apartment buildings (including condominiums).

A.11.5.1.1(5) The term *guest suite* is defined in 3.3.83, and the term *living area* is defined in 3.3.95.

A.11.5.1.3.1 The requirements do not preclude the installation of smoke alarms on walls in accordance with 11.8.3.4. Some building configurations, such as division of rooms and open foyers or great rooms, may dictate that alarms be located so that they do not cover distinctly separate 46.5 m^2 (500 ft^2) areas but rather provide overlapping coverage relative to this spacing requirement.

A.11.5.2.1.1 Fire-warning performance is improved when all alarms are interconnected so that alarm notification is achieved throughout the occupiable areas. In some cases for existing construction, interconnection of alarms is specifically exempted by jurisdictional requirements. This allowance takes into consideration the cost of hard-wired interconnection.

A.11.5.2.2 One of the common problems associated with smoke alarms and detectors is the nuisance alarms that are usually triggered by products of combustion from cooking, smoking, or other household particulates. While an alarm for such a condition is anticipated and tolerated by the occupant of a dwelling unit through routine living experience, the alarm is not permitted where it also sounds alarms in other dwelling units or in common use spaces. Nuisance alarms caused by cooking are a very common occurrence, and inspection authorities should be aware of the possible ramifications where the coverage is extended beyond the limits of the dwelling unit.

A.11.7.2 The UL listing for smoke alarms addresses two categories of these devices: one for applications where sensitivity testing is not required [UTGT], and one for applications where sensitivity testing is required [UTHA]. Refer to the testing requirements for these devices in Chapter 10.

A.11.7.3 The linear space rating is the maximum allowable distance between heat detectors. The linear space rating is also a measure of detector response time to a standard test fire when tested at the same distance. A higher rating corresponds to a faster response time. This Code recognizes only those heat detectors with ratings of 15 m (50 ft) or more.

A.11.7.3.2 A heat detector with a temperature rating somewhat in excess of the highest normally expected ambient temperature is specified in order to avoid the possibility of premature response of the heat detector to non-fire conditions.

Some areas or rooms of the dwelling unit can experience ambient temperatures considerably higher than those in the normally occupied living spaces. Examples are unfinished attics, the space near hot air registers, and some furnace rooms. This fact should be considered in the selection of the appropriate temperature rating for fixed-temperature heat detectors to be installed in these areas or rooms.

A.11.7.8.2 Where 11.7.8.2, which provides for screening alarm signals to minimize response to false alarms, is to be implemented, the following should be considered:

(1) Was the verification call answered at the protected premises?
(2) Did the respondent provide proper identification?
(3) Is it necessary for the respondent to identify the cause of the alarm signal?
(4) Should the public service fire communications center be notified and advised that an alarm signal was received, including the response to the verification call, when an authorized respondent states that fire service response is not desired?
(5) Should the public service fire communications center be notified and advised that an alarm signal was received, including the response to the verification call, for all other situations, including both a hostile fire and no answer to the verification call?
(6) What other actions should be required by a standard operating procedure?

A.11.8.2.2 Once these limits have been exceeded, a fire alarm system should be installed.

A.11.8.3 One of the most critical factors of any fire alarm system is the location of the fire detecting devices. This annex is not a technical study. It is an attempt to provide some fundamentals on alarm or detector location. For simplicity, only those types of alarms or detectors recognized by Chapter 11 (e.g., smoke and heat alarms or detectors) are discussed. In addition, special problems requiring engineering judgment, such as locations in attics and in rooms with high ceilings, are not covered.

Smoke Alarm or Smoke Detector Mounting — Dead Air Space. The smoke from a fire generally rises to the ceiling, spreads out across the ceiling surface, and begins to bank down from the ceiling. The corner where the ceiling and wall meet is an air space into which the smoke could have difficulty penetrating. In most fires, this dead air space measures about 0.1 m (4 in.) along the ceiling from the corner and about 0.1 m (4 in.) down the wall, as shown in Figure A.11.8.3. Detectors should not be placed in this dead air space.

Smoke and heat detectors should be installed in those locations recommended by the manufacturer's published instructions, except in those cases where the space above the ceiling is open to the outside and little or no insulation is present over the ceiling. Such cases result in the ceiling being excessively cold in the winter or excessively hot in the summer. Where the ceiling is significantly different in temperature from the air space below, smoke and heat have difficulty reaching the ceiling and a detector that is located on that ceiling. In this situation, placement of the detector on a sidewall, with the top 0.1 m to 0.3 m (4 in. to 12 in.) from the ceiling, is recommended.

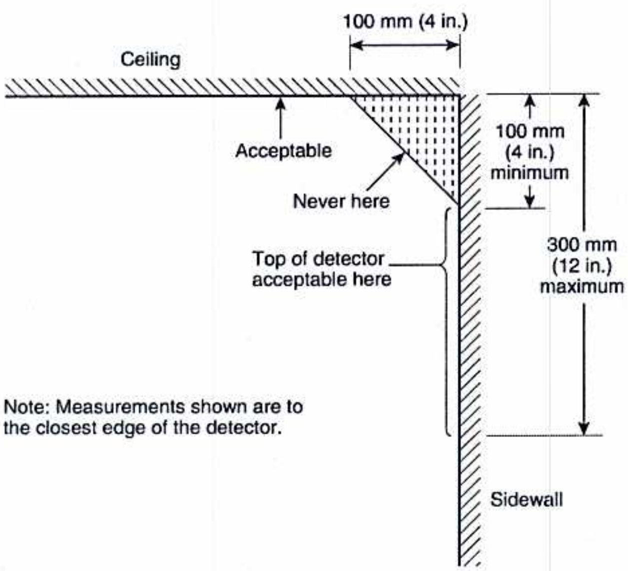

FIGURE A.11.8.3 Example of Proper Mounting for Detectors.

The situation described previously for uninsulated or poorly insulated ceilings can also exist, to a lesser extent, in the case of outside walls. The recommendation is to place the smoke alarm or smoke detector on a sidewall. However, where the sidewall is an exterior wall with little or no insulation, an interior wall should be selected. It should be recognized that the condition of inadequately insulated ceilings and walls can exist in multifamily housing (apartments), single-family housing, and mobile homes.

In those dwelling units employing radiant heating in the ceiling, the wall location is the recommended location. Radiant heating in the ceiling can create a hot-air, boundary layer along the ceiling surface, which can seriously restrict the movement of smoke and heat to a ceiling-mounted detector.

A.11.8.3.2 See Figure A.11.8.3.2 for further information on a smoke alarm or smoke detector mounting layout for a peaked ceiling.

A.11.8.3.3 See Figure A.11.8.3.3 for further information on a smoke alarm or smoke detector mounting layout for a sloped ceiling.

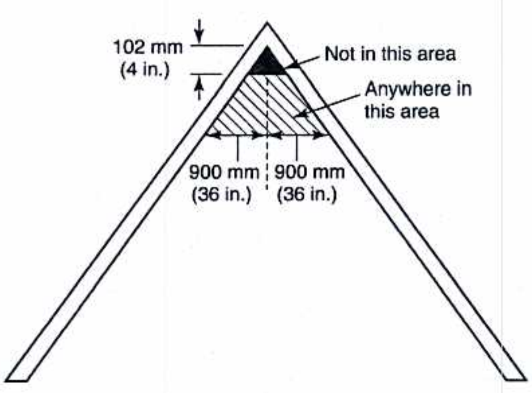

FIGURE A.11.8.3.2 Example of Proper Mounting for Alarms and Detectors with Peaked Ceilings.

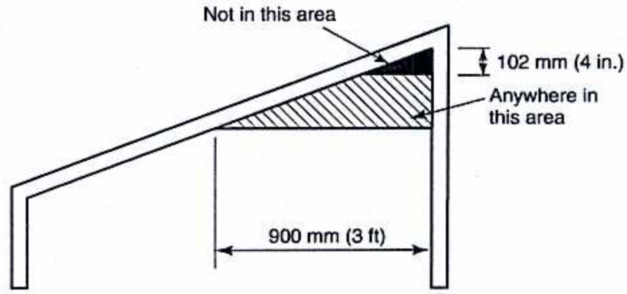

FIGURE A.11.8.3.3 Example of Proper Mounting for Alarms and Detectors with Sloped Ceilings.

A.11.8.3.4 See Figure A.11.8.3 for an example of proper mounting for smoke alarms.

A.11.8.3.5(10) Figure A.11.8.3.5(10) illustrates acceptable locations for tray-shaped ceilings.

A.11.8.4 While Chapter 11 does not require heat detectors as part of the basic protection scheme, it is recommended that the householder consider the use of additional heat detectors for the same reasons presented under A.11.8.3. The additional areas lending themselves to protection with heat detectors are the kitchen, dining room, attic (finished or unfinished), furnace room, utility room, basement, and integral or attached garage. For bedrooms, the installation of a smoke alarm or smoke detector is recommended over the installation of a heat detector for protection of the occupants from fires in their bedrooms.

Heat Detector Mounting — Dead Air Space. Heat from a fire rises to the ceiling, spreads out across the ceiling surface, and begins to bank down from the ceiling. The corner where the ceiling and the wall meet is an air space into which heat has difficulty penetrating. In most fires, this dead air space measures about 100 mm (4 in.) along the ceiling from the corner and 100 mm (4 in.) down the wall as shown in Figure A.11.8.3. Heat detectors should not be placed in this dead air space.

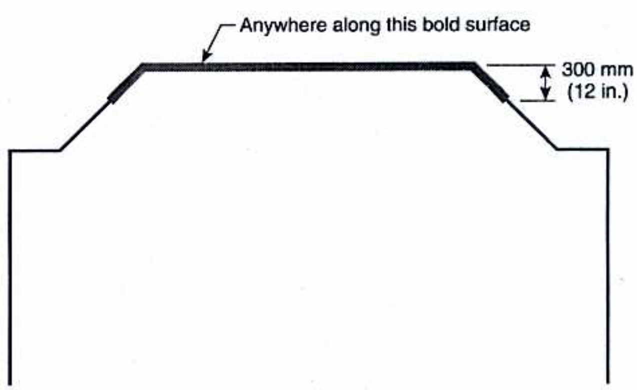

FIGURE A.11.8.3.5(10) Locations Permitted for Smoke Alarms on Tray-Shaped Ceiling.

The placement of the detector is critical where maximum speed of fire detection is desired. Thus, a logical location for a detector is the center of the ceiling. At this location, the detector is closest to all areas of the room.

The next logical location for mounting detectors is on the sidewall. Any detector mounted on the sidewall should be located as near as possible to the ceiling. A detector mounted on the sidewall should have the top of the detector between 100 mm and 300 mm (4 in. and 12 in.) from the ceiling.

The Spacing of Detectors. Where a room is too large for protection by a single detector, several detectors should be used. It is important that they be properly located so all parts of the room are covered. *(For further information on the spacing of detectors, see Chapter 5.)*

Where the Distance Between Detectors Should Be Further Reduced. The distance between detectors is based on data obtained from the spread of heat across a smooth ceiling. Where the ceiling is not smooth, the placement of the detector should be tailored to the situation.

For instance, with open wood joists, heat travels freely down the joist channels so that the maximum distance between detectors [15 m (50 ft)] can be used. However, heat has trouble spreading across the joists, so the distance in this direction should be one-half the distance allowed between detectors, as shown in Figure A.11.8.4, and the distance to the wall is reduced to 3.8 m (12.5 ft). Since one-half of 15 m (50 ft) is 7.6 m (25 ft), the distance between detectors across open wood joists should not exceed 7.6 m (25 ft), as shown in Figure A.11.8.4, and the distance to the wall is reduced [one-half of 7.6 m (25 ft)] to 3.8 m (12.5 ft). Paragraph 11.8.4.4 requires that detectors be mounted on the bottom of the joists and not up in joist channels.

Walls, partitions, doorways, ceiling beams, and open joists interrupt the normal flow of heat, thus creating new areas to be protected.

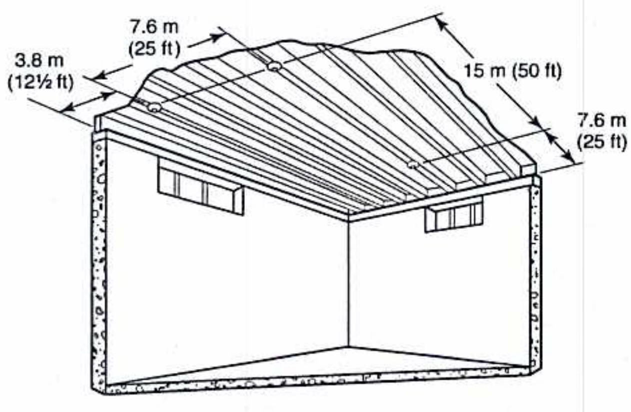

FIGURE A.11.8.4 Open Joists, Attics, and Extra-High Ceilings are Some of the Areas that Require Special Knowledge for Installation.

In addition to the special requirements for heat detectors installed on ceilings with exposed joists, reduced spacing also might be required due to other structural characteristics of the protected area, possible drafts, or other conditions that could affect detector operation.

A.11.8.4.5 Refer to Figure A.11.8.4, where the distance between detectors should be further reduced.

Annex B Engineering Guide for Automatic Fire Detector Spacing

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

Users of Annex B should refer back to the text of NFPA 72 to familiarize themselves with the limitations of the design methods summarized herein.

Section B.2, and particularly B.2.2 and B.2.3, are largely based on the work of Custer and Meacham as found in "Performance-Based Fire Safety Engineering: An Introduction of Basic Concepts" (Meacham and Custer 1995) and Introduction to Performance-Based Fire Safety (Custer and Meacham 1997).

The National Fire Protection Association and the Technical Committee on Initiating Devices for Fire Alarm Systems gratefully acknowledge the technical contributions of the Society of Fire Protection Engineers, Richard Custer, and Brian Meacham to performance-based design and this annex.

B.1 Introduction.

B.1.1 Scope. Annex B provides information intended to supplement Chapter 5. It includes a procedure for determining detector spacing based on the objectives set for the system, size, and rate of growth of fire to be detected, various ceiling heights, ambient temperatures, and response characteristics of the detectors. In addition to providing an engineering method for the design of detection systems using plume-dependent detectors, heat detectors, and smoke detectors, this annex also provides guidance on the use of radiant energy–sensing detectors.

B.1.2 General.

B.1.2.1 In the 1999 edition Annex B was revised in its entirety from previous editions. The correlations originally used to develop the tables and graphs for heat and smoke detector spacings in the earlier editions have been updated to be consistent with current research. These revisions correct the errors in the original correlations. In earlier editions, the tables and graphs were based on an assumed heat of combustion of 20,900 kJ/kg (8986 Btu/lb). The effective heat of combustion for common cellulosic materials is usually taken to be approximately 12,500 kJ/kg (5374 Btu/lb). The equations in this annex were produced using test data and data correlations for cellulosic (wood) fuels that have a total heat of combustion of about 12,500 kJ/kg (5374 Btu/lb).

B.1.2.2 For the purposes of this annex, the heat produced by a fire is manifested either as convective heat or radiant heat. It is assumed that conductive heat transfer is of little consequence during the early stages of the development of a fire, where this annex is relevant. A convective heat release rate fraction equal to 75 percent of the total heat release rate has been used in this annex. Users should refer to references 12 and 13 in G.2.3 for fuels or burning conditions that are substantially different from these conditions.

B.1.2.3 The design methods for plume-dependent fire detectors provided in this annex are based on full-scale fire tests funded by the Fire Detection Institute in which all fires were geometrically growing flaming fires. *(See Environments of Fire Detectors — Phase 1: Effect of Fire Size, Ceiling Height and Material; Measurements Vol. I and Analysis Vol. II [10].)*