Electrical Tech Note — 252
Biosystems &Agricultural Engineering Department
Michigan State University

Smoke Alarm Requirements for Dwellings[1]

Smoke alarms that are properly installed and maintained are an essential part of a home safety program. The major threat from fire in a dwelling is when everyone is asleep and the primary threat to persons in sleeping areas comes from fires in the remainder of the house. While the *National Electrical Code®* does not require the installation of smoke alarms, the *Michigan Residential Code®* requires their installation. The *MRC®* requires that smoke alarms be installed in accordance with *NFPA 72®*, which is known as the *Fire Alarm Code®*. Anyone installing smoke alarms in dwelling units should be aware of the requirements in the *Fire Alarm Code®*.

Placement of Smoke Detectors

The *Fire Alarm Code®* requires that smoke alarms be installed in each bedroom of a dwelling. Additional smoke alarms are required in the bedroom area. The bedroom area is defined as the part of the dwelling that is between the bedroom and the remainder of the living unit. See Figure 1. The *Fire Alarm Code®* does not require a maximum or minimum distance the smoke alarm be placed from a bedroom. The most common practice acceptable to the authority having jurisdiction (inspector) is in the hallway leading to the bedroom. Note that in Figure 1, there are two separated bedroom areas. Consequently a smoke detector is required outside the bedrooms in each area.

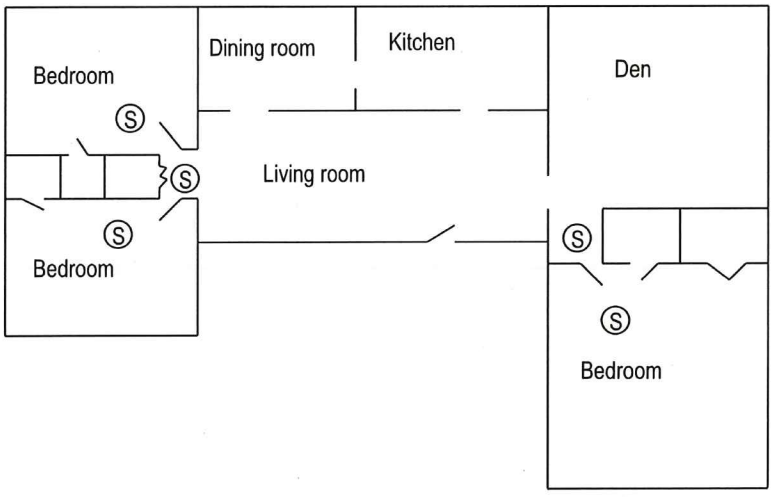

Figure 1. Smoke alarms must be placed in each bedroom as well as in the area outside the bedroom area.

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In addition to the smoke detectors outside the sleeping areas, the *Fire Alarm Code*® requires the installation of a smoke detector on each additional story of a dwelling unit, including the basement. These installations are shown in Figure 2. The living area smoke detector should be installed in the living room or near the stairway to the upper level, or in both locations. The basement smoke detector should be installed in close proximity to the bottom of the stairway leading to the floor above. The basement smoke detector should be positioned relative to the stairway, so as to intercept smoke coming from a fire in the basement, before the smoke enters the stairway. When the basement is an open-joist ceiling, the detector should be placed at the bottom of the joist where the alarm is free from obstructions.

While *NFPA 72*® does not prohibit the installation of smoke detectors in any particular rooms, they do suggest that you avoid certain areas. Kitchens, attics, and garages are not normally recommended, as these locations occasionally experience conditions that can result in improper operation.

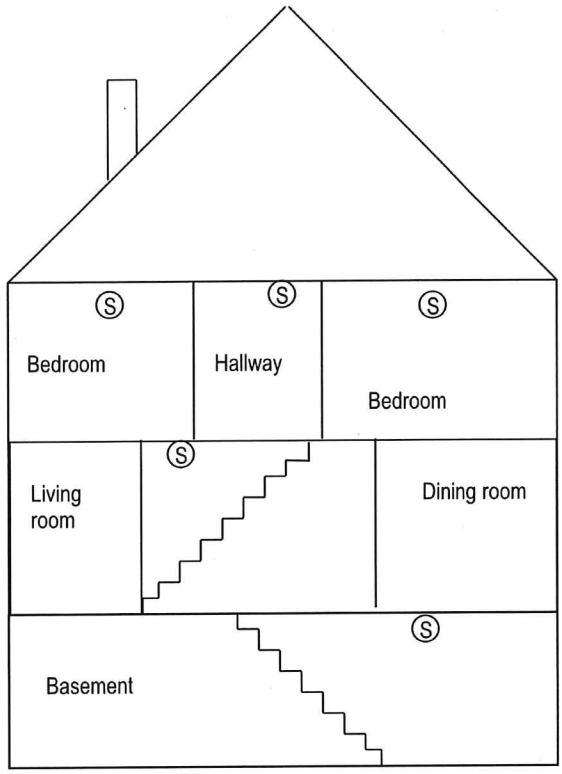

Figure 2. In addition to the smoke alarms installed in each bedroom, they must also be installed on each habitable floor, including the basement.

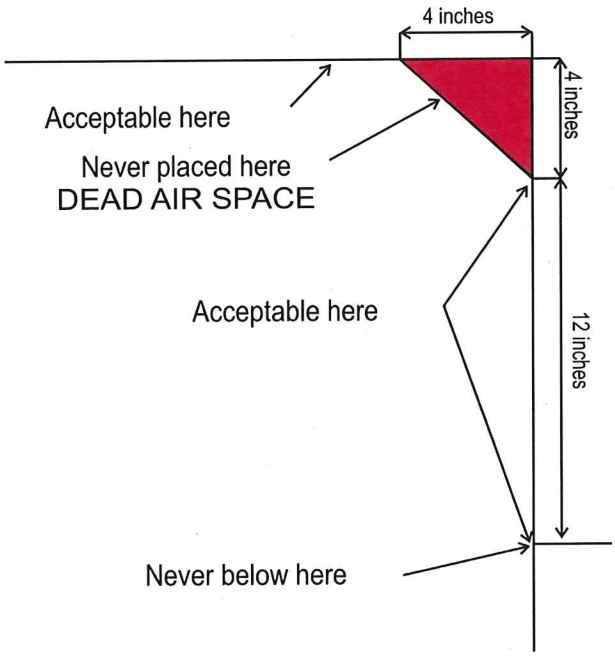

Figure 3. Smoke alarms are not permitted to be installed in the dead air spaces near corners. The dead air space is the area four inches along the ceiling from the corner and about four inches down the wall.

The placement of the smoke detector is critical, if maximum speed of fire detection is desired. Thus, a logical location for a detector is in the center of the ceiling. However, this is not a requirement by the *Fire Alarm Code*®. A more typical location is in an off-centered location on the ceiling. The smoke from a fire generally rises to the ceiling, spreads out across the ceiling surface, and begins to bank down the walls. The corner where the ceiling and the wall meet is an air space into which the smoke could have difficulty penetrating. In most fires, this dead air space measures four inches along the ceiling from the corner and about four inches down the wall, as shown in Figure 3. Smoke detectors are not permitted to be installed in this dead air space. Dead air spaces can also be found on sloped and peaked ceilings. Examine Figure 4, for the permitted placement of smoke detectors for these ceilings.

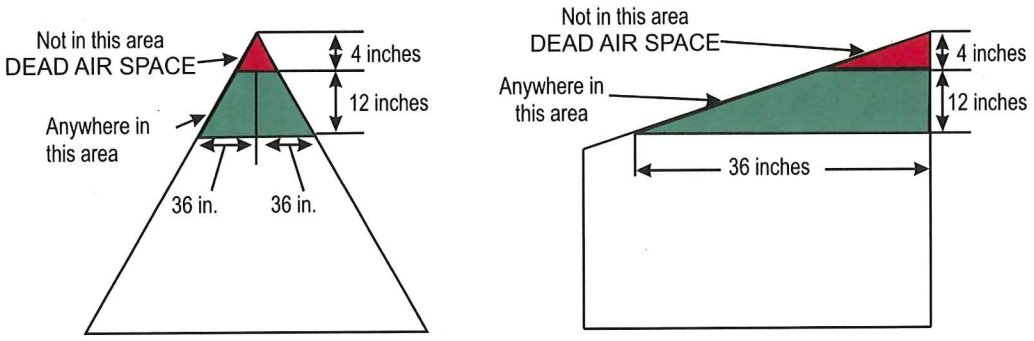

Figure 4. Smoke alarms are not permitted to be installed in the dead air spaces near corners of peaked and sloped roofs.

Smoke detectors are permitted to be installed on walls. Because of convection currents of air along cool surfaces, place smoke detectors on the interior walls of a dwelling rather than on the exterior wall. Placing smoke detectors on the interior walls will result in a detector having a quicker response time. When placing smoke detectors on walls, they are not permitted to be placed lower than 12 inches below the dead air space. See Figure 3 and Figure 4.

Wiring of Smoke Detectors

For dwelling units, *NFPA 72®* requires a certain type of detector be installed. Smoke detectors must have two sources of power. Typically the two power sources are 120 volt ac, and a battery back-up. The battery back-up provides protection in the event of a power outage. In addition to the two power sources, the detectors must be interconnected. When one of the smoke detectors sets off its alarm, all of the other detectors in the dwelling must also sound an alarm. To achieve this, smoke alarms have an interconnect lead to set off all of the other alarms. See Figure 5.

Smoke alarms are placed on 15- or 20-ampere rated circuits. For a 15-ampere circuit, nonmetallic-sheath cable, type NM-B 14-2 with ground, is run to the first smoke detector, with type NM-B 14-3 with ground run between the alarms. If the circuit is 20-ampere rated, the circuit wire must be at least a 12 AWG conductor. The alarms can be supplied by a dedicated circuit or they may be connected to any general purpose circuit. The *National Electrical Code®*, requires that any 15- or 20-ampere, 125 volt outlet installed in a bedroom of a dwelling unit be protected by an arc-fault protective device (AFCI). Smoke alarms according are exempted from this rule according to *NFPA 72*. Therefore, an arc-fault protective device is not required for the smoke detector circuit in a dwelling.

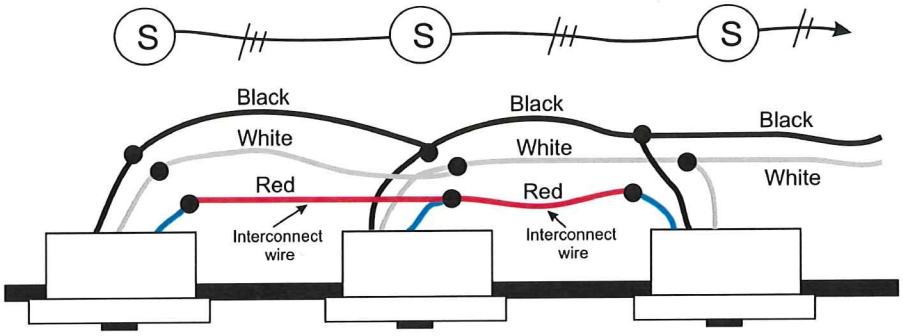

Figure 5. Smoke alarms are required to have a battery back-up and be interconnected, resulting in all of the smoke alarms in the dwelling going off at once.

Types of Smoke Detectors

There are two types of smoke alarms available today, photoelectric and ionization. ***Ionization detectors*** are the most common and often least expensive detectors available. This detectors' smoke chamber contains a radioactive source that emits radiation, resulting in a weak flow of electric current. When particles such as those produced by fire enter the smoke chamber, they reduce the current and trigger the alarm. This type of detector is generally most effective in detecting the "products of combustion" produced during the beginning stage of a fire. Although early detection is always desirable, there are several inherent flaws with this technology. For example, some ionization detectors are not as effective in detecting the smoke produced during the smoldering stage. Another downfall is their general susceptibility to false alarms that have a tendency to become more than a minor nuisance, once the fire department is dispatched.

Photoelectric detectors, although not effective in detecting the invisible gases created during the beginning stage of a fire, they are generally more stable and reliable when it comes to false alarms. Photoelectric detectors are far superior at detecting visible smoke that may not contain the invisible gases required to set off an ionization detector. There are two types of detection methods within the photoelectric realm, ***obstruction*** and ***light scattering***. Obstruction involves the interruption of a beam of light, while light scattering utilizes the light diffusing properties of smoke to redirect a beam of light to a light sensor. Both are effective, however, the obstruction type detector requires more smoke to activate than the light scattering type.