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Summary Bulletin

Fire Safety – Smoke Alarms

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Abstract

Smoke alarms provide early warning of a fire in the home, potentially saving residents' lives. It can take just minutes for a fire to reach flashpoint in a modern home. Residents that take longer or require assistance to respond in a fire, including older people, children, and people with disabilities, are at greatest risk. It is essential to have smoke alarms rapidly detect smoke from a fire, and awaken and alert residents, so they can escape safely.

Smoke alarm regulations have led to increased uptake of smoke alarms in Australian homes, but fire authorities and researchers recommend that more be done. Residents in new dwellings are safeguarded by regulations for hard-wired and interconnected smoke alarms. However, the majority of residents living in older dwellings have less regulatory protection; most states and territories require a minimum of just one battery-powered smoke alarm, and some have no requirement for smoke alarms. Even when smoke alarms are installed in dwellings, many are not operational due to lack of maintenance and disconnection to avoid nuisance alarms.

This second edition of *Summary Bulletin: Fire Safety – Smoke Alarms* responds to recent Australian regulatory changes for smoke alarms in dwellings, advances in smoke alarm devices, and current smoke alarm recommendations of fire authorities and researchers. It examines the function and use of contemporary smoke alarm devices and details the applicable national and state/territory regulations for different dwelling types. Recommendations are made for smoke alarm selection, placement and maintenance, to detect fire smoke whilst avoiding nuisance alarms; alert residents of all ages and abilities when fire smoke is detected; and ensure reliable smoke alarm functioning in a fire.

Keywords

fire safety; smoke alarm; housing; home modification; assistive technology; design; disability

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Contribution of Authors

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Joanne Quinn undertook the writing and research for the second edition. The changes to regulations, Standards, and products in the market, since the first edition in 2006 have resulted in all new content for this edition.

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Dr Janice Herbert	National Seniors Australia	Consumer Panel
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A/Superintendent Michael Ollerenshaw & Senior Fire Fighter Melanie Rebane	Fire & Rescue NSW	Guest Expert Panel

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Glossary

ABCB	Australian Building Codes Board
AFAC	Australasian Fire Authorities Council Australasian Fire and Emergency Service Authorities Council
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
BCA	Building Code of Australia
CO	Carbon Monoxide
Class 1a Building*	A free-standing (detached) or attached single dwelling that does not have another dwelling above or below. Dwelling types can include houses, semi-detached houses, duplexes (side-by-side), townhouses, terrace houses and villas.
Class 1b Building*	A free-standing (detached) or attached dwelling, not exceeding 300m2 floor area or having more than 12 residents, that does not have another dwelling above or below. Dwelling types can include small boarding houses and hostels.
Class 2 Building*	A residential building of two or more storeys, containing two or more dwellings. Dwelling types can include apartments, units, flats, and duplexes.
Class 3 Building*	A residential building (not Class 1 or 2) for numerous unrelated people to live in the short-term or long term. Dwelling types can include boarding houses and hostels, residential dwellings in hotels, motels, healthcare buildings and schools, and specialised accommodation the aged, children, and people with disability.
Class 4 Building*	A sole dwelling in a building used for professional, commercial, retail, industrial, services, or other type of public purpose. Dwellings can include shop-top units and caretaker units.
DFES	Department of Fire & Emergency Services – Western Australia
DSQ	Deaf Services Queensland
Dwelling	A Sole-Occupancy Unit (SOU).
FPAA	Fire Protection Association of Australia
ILC	Independent Living Centres Australia
MFB	Metropolitan Fire Brigades - Victoria

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NCC	National Construction Code
QFES	Queensland Fire and Emergency Service
QFRS	Queensland Fire and Rescue Service – incorporated into QFES since 2013
SAMFS	South Australian Metropolitan Fire Service
Sole-Occupancy Unit (SOU)	In a residential building, this is the part for the exclusive use of the occupant or owner. The occupant can be a single person or a household. Most SOUs are self-contained, including one or more bedrooms, bathroom(s), kitchen facilities and living area(s). However, smaller SOUs, such as those in boarding houses and specialised housing, can be just a bedroom with or without a bathroom.
Smoke Alarm	A device that can detect smoke, and activate an audible alarm signal when smoke is detected.
Smoke Detector	A device that can detect smoke and activate a separate alarm or other device in a smoke alarm system, when smoke is detected.
Supplementary Audible Alarm	A separate audible alarm device used by people who are less likely to hear or be awakened by the high-pitched tone of a smoke alarm. It is placed near the person and will sound a low-frequency signal (which may include words) when activated by the smoke alarms, in order to awaken them.
Vibrating Pad	A supplementary device to a smoke alarm used by people who are less likely to hear or be awakened by a smoke alarm. It is placed under the pillow of the person and will shake when activated by the smoke alarm, in order to awaken them.
Visual Alarm	A supplementary device to a smoke alarm used by people who are less likely to hear or be awakened by a smoke alarm. It is placed near the person and will produce a visual signal such as a flashing light when activated by a smoke alarm, in order to awaken them.

***** Building Class definitions are contained in the Australian Building Code's Classification of Buildings and Structures in the National Construction Code (*NCC 2015*, Vol 1, A3.2)

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Background

Fire and rescue authorities emphasise the importance of smoke alarms in all homes to help save lives in a fire. Smoke alarms provide early warning of a fire, particularly overnight when residents are sleeping and residential fires most frequently lead to serious injury or fatality. (Australasian Fire Authorities Council [AFAC], 2009, p50)

In modern homes, flames can reach flashpoint and engulf a room in as little as 2-4 minutes (South Australian Metropolitan Fire Service [SAMFS],Catalyst, 2014; n.d.). It is critical that sleeping residents are rapidly awakened by a smoke alarm and that they respond. At greatest risk, are older people, children, and people with disabilities, as well as people impaired by drugs and alcohol, who might take longer, and need assistance, to evacuate.

> ***Smoke alarms are an integral part of a fire escape plan in the home*** (SAMFS, 2009)

In the last 20 years there has been an increased uptake of smoke alarms in Australian homes. The inclusion of smoke alarms in housing has been heavily influenced by regulation; by 1997 all states and territories had adopted the requirement for hard-wired smoke alarms in all new dwellings, in the Building Code of Australia [BCA]. In 2014, this requirement was increased to having all smoke alarms in new dwellings interconnected, a feature that could potentially save many more lives (Australian Building Codes Board [ABCB], 2012a).

However, new-built housing accounts for fewer than 2% of buildings (ABCB, 2012a). For the majority of existing housing, regulations for smoke alarms have lagged a decade or more behind. Currently, most states and territories (New South Wales, Queensland, Northern Territory, Western Australia, South Australia and Victoria) require a minimum of one battery-powered smoke alarm in all homes. Yet, Tasmania and the Australian Capital Territory have no smoke alarm requirements beyond the Australian Building Code, for new and substantially renovated homes. (ABCB, 2012a, p15)

Fire authorities and researchers recommend that more needs to be done than just installing smoke alarms in all homes. Smoke alarms need to be used more effectively to further save lives and property. (ABCB, 2012a)

Although smoke alarms have been installed in many Australian homes, they are not necessarily operational. Studies of Australian residential fires have revealed that where smoke alarms had been installed, they were not operational in one third of fatal fires, and in one quarter of residential fires resulting in injury. The primary reason for non-operational smoke alarms was the smoke alarm or its battery had been disconnected. (AFAC, 2009, p49-50)

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Australian research has shown that additional smoke alarms, beyond the regulated minimum, are needed so they are located sufficiently close to sleeping residents to awaken them. Also, some residents are less likely to be aroused from deep sleep when a standard smoke alarm is activated. Those most at risk from sleeping through a smoke alarm, are people with hearing impairment, children, and people affected by sleep deprivation or alcohol (Thomas & Bruck, 2008). Many of these residents are further endangered by their reduced ability to respond, once aroused by the smoke alarm.

Making modifications to the home to ensure that *all* dwellings meet the minimum smoke alarm requirements in the BCA and incorporate further smoke alarm recommendations by fire services and researchers, could ensure that smoke alarms provide the effective early warning that is needed for safer evacuation. This would protect all residents, especially those at greatest risk in residential fires.

Smoke Alarm Systems

Smoke alarms incorporate a detector for smoke and an audible alarm signal that activates when smoke is detected (AS 3786-1993, 2004). The current regulatory requirements for smoke alarms in Australian residential homes are contained in Australian Standard:

AS 3786-1993 Smoke Alarms

A new edition of this Standard:

AS 3786:2014 Smoke Alarms using scattered light, transmitted light or ionization

was published in February 2015. However, until it is adopted into the BCA and state and territory legislation, the requirements of AS 3786-1993 still apply.

Many of the requirements in the new edition of the Standard are consistent with the previous edition. The additional requirements in the new edition address recent smoke alarm technologies, features, and practices. Table 1 summarises the main inclusions of AS 3786-1993, applicable for current regulations. Relevant changes in AS 3786-2014 are also noted.

One of the most important changes for smoke alarms in the new Standard is the required activation of a *visual* alarm signal – a red light – when smoke is detected, in addition to the audible alarm signal. There are also various options for the audible alarm signal specified, including a low-frequency signal, a signal that is lower in volume when activated and then increases to maximum volume, and a signal that alternates between the regular alarm sound and a voice message.

Other new specifications for visual signals on smoke alarms in the new Standard, include a green continuous light to indicate external power being supplied to the smoke alarm, and a yellow or amber light to indicate a fault, if an optional fault indicator is included in the smoke alarm.

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Table 1 AS 3786 - Smoke alarm requirements: AS 3786-1993 and AS 3786:2014

Smoke alarm requirements: AS 3786:1993 and AS 3786-2014		
Smoke detection	**1993**	**2014**
- can use photoelectric or ionisation smoke detection methods	✓	✓
Power		
- can be powered internally by batteries (minimum battery life of one year before 'low battery' is indicated)	✓	✓
- can be powered externally (mains or other external power) with an internal or external stand-by power source in case of power failure	✓	✓
- shall have a visual power indicator to show when it is being externally powered	✓	✓
‣ consisting of a continually lit green light	-	✓
Alarm signal when smoke is detected		
- shall have an **audible** alarm signal		
‣ with a pattern meeting ISO 8201 or ISO 7731	✓	✓
‣ for one minute at minimum 85 dBA at a distance of 3m, and at minimum 82 dBA for 4 minutes of continuous alarm	✓	-
‣ at minimum 85 dBA and maximum 105 dBA at a distance of 3m	-	✓
‣ (optional) commencing softly (<45 dBA) and rising to the maximum of 85-105 dBA within 3-12 seconds.	-	✓
‣ (optional) with a square wave pattern at a frequency of 520 Hz	-	✓
‣ (optional) with a voice message that alternates with the audible alarm signal	-	✓
- shall have a **visual** alarm signal that lights up red (continuous or flashing)	-	✓
Alarm silencing		
- (optional) have a control that can be operated to temporarily silence the alarm		
‣ and either show a visible indicator of the 'silenced' mode, an audible trouble signal, or end the 'silenced' mode within 15 minutes	✓	-
‣ for at least 5 minutes and no more than 15 minutes, located on the smoke alarm or separately.	-	✓

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Smoke alarm requirements: AS 3786:1993 and AS 3786-2014		
Interconnection		
- can be single smoke alarms or able to be interconnected with other smoke alarms	✓	✓
Testing		
- shall have a method of testing the alarm	✓	✓
‣ (optional) with a visual fault indicator that lights up yellow or amber (continuous or flashing) when the fault is detected	-	✓
Service Life		
- shall have a minimum 10 year service life	✓	✓
- shall be clearly and permanently marked with the date of manufacture, which can be coded in the batch number or serial number	✓	✓
- shall be clearly and permanently marked with the recommended date for replacement	-	✓

Source: AS 3786-1993 and AS 3786:2014

Smoke alarms that have been tested by an approved testing authority and comply with AS 3786 are registered by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The register lists compliant smoke alarms by state and building type, and includes details of smoke detection method (photoelectric or ionisation) and power type (mains-powered or battery-powered). The register can be viewed at www.activfire.gov.au.

Smoke alarm types for use within residential homes can be broadly categorised by their power type and their method of smoke detection. The selection of smoke alarm type is dependent on the applicable regulations, installation location, access for electrical wiring, and the ability of residents or others to maintain the smoke alarms.

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Smoke alarm power types

The two power types of smoke alarm used within dwellings are:

- Battery-powered smoke alarms – permanent battery or replaceable battery
- Mains-powered (hard-wired) smoke alarms

The selection of the appropriate power type is dependent on regulatory requirements, feasibility of wiring, and budget.

Battery-Powered Smoke Alarms

Battery-powered smoke alarms operate using either permanent or replaceable batteries. They generally operate as a single smoke alarm, but some can be wirelessly interconnected so that when one alarm is activated, all alarms in the dwelling will also be activated.

Smoke alarms with permanent lithium batteries are designed as a sealed unit. The batteries have the same ten-year service as the smoke alarm.

Smoke alarms with replaceable batteries require:

- batteries be supplied with the smoke alarm;
- batteries be capable of powering the smoke alarm for at least a year;
- a battery fault signal that will operate for seven days prior to the battery power dropping beyond what is required to operate the smoke alarm;
- a method to indicate when the battery has been removed, such as a warning flag labelled with 'Warning – Battery Removed' that is exposed on the closed unit, or a hinged cover that cannot be readily closed unless a battery is in place. (AS 3786-1993, 2004)

Hard-Wired Smoke Alarms

Hard-wired smoke alarms are connected to the dwelling's main power supply, and need to be installed by a licensed electrician. They can be individually wired to operate as a single smoke alarm, or wired to be interconnected so that when one alarm is activated, all alarms in the dwelling will be activated. Some hard-wired smoke alarms can also be wirelessly interconnected, for situations where it is unfeasible for hard-wired interconnection.

Hard-wired smoke alarms must have a stand-by battery to ensure that the smoke alarm will operate in a power-failure. The stand-by batteries must also have a seven day battery fault signal and method to indicate the battery has been removed, as required for a battery-powered smoke alarm. (AS 3786-1993, Cl2.2.2).

Hard-wired smoke alarms have a 'power on' indicator. This is a small light that is on when the smoke alarm is receiving mains power. The light might be steady, or flash at least every 60 seconds. (AS 3786-1993, Cl2.2.1)

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Table 2 Advantages and disadvantages of different power-types of smoke alarms

Power Type	Advantages and disadvantages
Battery-Powered (replaceable battery) Smoke Alarm	- Supplied with 1-year battery, which requires annual replacement ✓ Some alarms have the capacity to be wirelessly interconnected by radiofrequency - allowing for simultaneous sounding when activated ✓ DIY installation – no wiring changes ✓ Low-cost purchase ✘ Cost and inconvenience of annual battery replacement ✘ Inactive batteries prevents smoke alarm operation
Battery-Powered (sealed battery) Smoke Alarm	- Supplied with 10-year lithium battery sealed inside the smoke alarm ✓ Some alarms have the capacity to be wirelessly interconnected by radiofrequency - allowing for simultaneous sounding when activated ✓ DIY installation – no wiring changes ✓ No battery replacement with associated cost and inconvenience ✘ Higher initial cost than a smoke alarm with replaceable batteries
Mains-Powered (Hard-Wired) Smoke Alarm	- Connected to mains-power with stand-by battery in case of power failure ✓ Alarms have the capacity to be interconnected - allowing for simultaneous sounding when activated ✓ Some alarms have the capacity to be wirelessly interconnected by radiofrequency – allowing for simultaneous sounding without extra wiring ✓ Alarms can be connected to a back-to-base monitoring system/home security system. ✘ Higher cost of installation – requiring a licensed electrician ✘ Power outages will impact the alarm systems – stand-by batteries must be regularly recharged/replaced to prevent alarm failure

Note: Table key for advantages and disadvantages ✓ Advantages ✘ Disadvantages

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Smoke and other fire detection methods

Fire detectors can detect four characteristics of a fire: smoke, heat, carbon monoxide [CO] or flame. Selection of a suitable fire detection method depends on the application. In residential dwellings, it is important that residents are alerted to a fire if they are sleeping. Smoke detection is a suitable detection method for this. (*AS 1670.1-2004*, A1-A2)

However, in kitchens, laundries and bathrooms, steam can potentially falsely activate smoke alarms, resulting in nuisance alarms. In these locations, other methods of fire detection should be considered (*AS 1670.1-2004*, A2). Heat alarms are available for use in residential dwellings to provide early warning of fire. However, they are supplementary devices only. Due to their different method of detecting a fire, they cannot be substituted for the smoke alarms regulated in Australian dwellings. CO alarms are available for home use, but are for detecting CO build-up from gas appliances rather than fire detection. Heat alarms and CO alarms are often combined with smoke alarms in a single unit.

Smoke alarms have two alternative methods for detecting smoke from fires:

- Photoelectric smoke detection
- Ionisation smoke detection

Photoelectric smoke detection alarms

Photoelectric smoke alarms are activated by smoke particles absorbing or scattering a light beam inside the smoke alarm device. Slow-burning, smouldering fires produce dense smoke but little heat, so photoelectric smoke alarms are effective at detecting this type of fire. (*AS 1670.1-2004*, A4)

Ionisation smoke detection alarms

Ionisation smoke alarms are activated by small smoke particles from hot, clean fires changing the current flowing through an ionisation chamber in the smoke alarm device (*AS 1670.1-2004*, A4). The ionisation chamber uses a small amount of radioactive material, generally Americium-241 (AS 3786-1993). Ionisation smoke alarms can be recognised by a label on the inside of the smoke alarm featuring the radiation warning symbol and words “Warning: Radioactive Material” (Figure 1).

Figure 1 Labelling on ionisation smoke alarms

Source: Australian Radiation Protection and Nuclear Safety Agency [ARPNSA], (nd)

Although ionisation smoke alarms contain a small amount of radioactive material, they are not a health hazard. The Australian Radiation Protection and Nuclear Safety Agency [ARPANSA] advises that ionisation smoke alarms can be disposed of with domestic rubbish (if fewer than ten), without creating any environmental or public health hazard.(ARPANSA, nd).

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Heat detection alarms

Heat alarms have a heat detector that is either activated by reaching a preselected temperature, or by having an abnormally rapid change in temperature. Detectors that are activated by a rapid change in temperature respond faster to fire conditions and are generally preferred. (AS 1670.1-2004, A3)

As heat detection is most effective for detecting fast, hot fires with little smoke, it can be considered for bathrooms, laundries and kitchens (AS 1670.1-2004, A2). Heat alarms are less likely to be falsely activated by steam in these areas. Heat detection is also indicated for detecting fires in roof spaces and garages (AS 1670.1-2004, A2).

Heat alarms are not effective in buildings with very high ceilings. Hot air from a fire could be too low to be detected before substantial fire damage occurs. (AS 1670.1-2004, A3)

CO detection alarms

CO alarms are activated by the detection device responding to a change in CO concentration in the air. CO detectors can be used for fire detection, particularly in areas with dust, steam, and cooking vapours that could cause 'false alarms' from a smoke alarm (AS 1670.1-2004, A2,A7).

However, the electrochemical CO alarms that are commonly available for home use are not intended to detect CO due to fire. They detect raised CO concentrations over a time period, and are used to warn of dangerous levels of CO in the air from gas appliances. (Energy Safe Victoria, 2011; Fire & Rescue NSW, n.d.-a)

CO alarms are commonly combined with smoke alarms in a single unit. A disadvantage of CO alarms is their cost; they are more expensive than photoelectric smoke alarms. Also, their life span is significantly less, at approximately five years. (Fire & Rescue NSW, n.d.-a)

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Table 3 Advantages and disadvantages of smoke and other fire detection methods

Smoke Detection system/alarm system	Advantages and disadvantages
Photoelectric Detector	- Detects visible particles of smoke ✓ Quicker to detect smoke from smouldering fires ✓ Contains no radioactive material ✘ Slower to detect hot fires that have little smoke ✘ Prone to nuisance alarms from dust and cooking vapours
Ionisation Detector	- Detects invisible particles of smoke ✓ Quicker to detect smoke from clean, fast fires ✘ Slower to detect smouldering fires that produce dense smoke ✘ Contains radioactive material ✘ Prone to nuisance alarms from steam and cooking vapours
Carbon Monoxide Alarm	- Detects increased carbon monoxide [CO] concentration in air - Can be in a combined unit with a smoke alarm ✓ Less prone to nuisance alarms from dust, steam and cooking vapours ✓ Can detect CO from leaking, or unsafely operated gas appliances ✘ Not a smoke alarm and not used for fire detection in homes - should not be used as the sole alarm system. ✘ Reduced service life of 5 years and sensors can become less sensitive with age
Heat Alarm	- Detects high or abnormally rapid increase in temperature ✓ Less prone to nuisance alarms from dust, steam and cooking vapours ✘ Not suited to very high ceilings ✘ Not a smoke alarm – should not be used as the sole alarm system

Note: Table key for advantages and disadvantages ✓ Advantages ✘ Disadvantages

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Supplementary alarm devices for people with hearing impairment

Residents who are profoundly deaf are unable to hear the alarm signal from a regular audible smoke alarm and require specialised supplementary smoke alarm devices. These supplementary smoke alarm devices are also suited to people with mild to severe hearing impairment, who might hear the smoke alarm signal, but would not be awakened by it.

The requirements for supplementary smoke alarm devices for people with hearing impairments in Australian residential homes are contained in Australian Standard:

AS 1603.17-2011 Automatic fire detection and alarm systems
Part 17: Warning equipment for people with hearing impairment

Three types of supplementary smoke alarm device for people with hearing impairment are:

- Visual alarms
- Vibrating pads
- Supplementary audible alarms

Often, a combined smoke alarm system, with standard audible alarm, a visual alarm, and a vibrating pad, is used. These smoke alarm systems are costly, at around $400 each; however, subsidies are available for eligible residents in some states (Deaf Services Queensland, 2014).

Visual alarms, vibrating pads and supplementary audible alarms can be activated by the registered audible smoke alarm, through a hard-wired connection, or wirelessly through a radio-frequency link. Some supplementary devices can be activated by the audible alarm signal from the smoke alarm, making them portable and compatible with any existing smoke alarm using the standard high-frequency signal.

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Visual Alarms

A visual alarm is a supplementary device to a smoke alarm, which provides a visual signal when the smoke alarm is activated. A visual alarm is intended as a general alarm warning, not a lone means to awaken sleeping residents (*AS 1603.17-2011*, 2.7). Many people are not awakened by visual alarms (Bruck & Thomas, 2009). There are various methods for producing a visual alarm, but the most common for residential use is a flashing or strobe light.

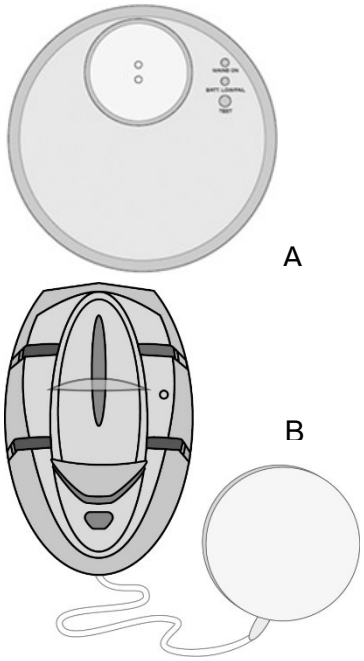

Figure 2
Examples: visual alarms

Visual flashing light and strobe light alarms are available in a device that can be mounted on the wall or ceiling, or as a freestanding device to be placed at the bedside of the person with hearing impairment. The device is activated to flash by the smoke alarm; the flashing intended to awaken the person unable to hear the audible alarm. Visual alarms can be a stand-alone device (Figure 2-A), but are more commonly part of a set, combined with a vibrating pad. (Figure 2-B).

The flash rate for strobe lights must be between 1Hz and 3Hz (AS 1603.11-2010). This is below the flash rate that generally affects people with photosensitive epilepsy (Epilepsy Action Australia, n.d.). Some strobe lights have a synchronisation option so that if multiple strobe light units are in view, their flashing is synchronised (AS 1603.11-2010). This ensures a safe flash rate is maintained.

Vibrating Pads

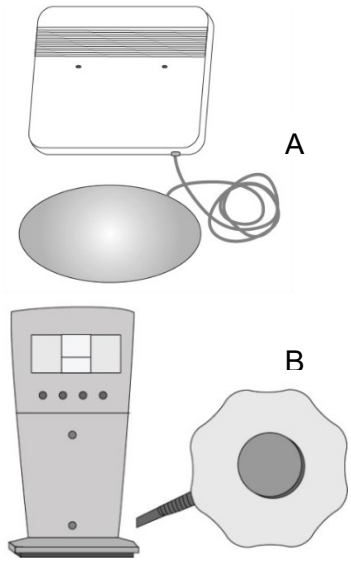

Figure 3
Examples: vibrating pads

A vibrating pad is a device that is placed under the pillow of the person with hearing impairment and is activated to vibrate by a smoke alarm. The vibrations can awaken the person if they are unable to hear the audible alarm.

Vibrating pads are generally combined with, or can be connected to, a visual alarm to provide a dual smoke alarm alert (Figure 3). Some vibrating pads are provided as part of a broader alert system (Figure 3-B). Other devices in these alert systems can include an alarm clock, doorbell, baby monitor and telephone. (ILC, n.d.)

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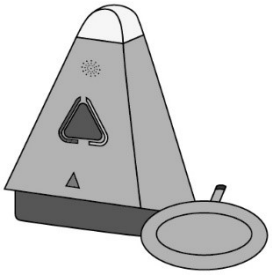
Supplementary audible alarms

A supplementary audible alarm is a device with an alarm signal that is "more effective in both alerting and arousing sleeping occupants with hearing impairment than the sound of traditional smoke alarms" (AS 1603.17-2011, cl 2.11.1). The tone of the alarm signal is a 520Hz square wave (AS 1603.17-2011, cl 2.11.3.2).

To alert occupants, some supplementary audible alarms use only the low-frequency alarm signal. However, most include additional alert methods, such a vibrating pad and strobe light (Figure 4).

A

B



C

Figure 4
Examples:
supplementary audible alarms

Supplementary audible alarms are produced in a stand-alone device that is only activated for fires. However, they are not currently available in Australia. There are also supplementary alarms that are integrated in an alarm system. Other components in the system can include a security alarm, alarm clock, telephone, doorbell, or baby monitor (Figure 4-A). This type of alarm system is available in Australia.

AS 1603.17-2011 specifies the same minimum sound level requirements for the supplementary audible signal as the mandatory audible alarm: 85 dBA at 3m, but also has a maximum sound level of 105 dBA. Similarly, the signal pattern requirements are the same as for the mandatory audible alarm; however, the signal pattern can have a 4-12 second interruption every 12 seconds, which can include a voice message. There are no supplementary audible alarms with a voice signal available in Australia at this time.

A much larger range of supplementary audible alarms is available overseas, and these can be easily purchased online. However, only 240V alarms with Australian power plugs should be used.

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Table 4 Advantages and disadvantages of supplementary alarm devices for hearing impairment

Supplementary alarm device	Advantages and disadvantages
Visual Alarm	- Strobe or other flashing light activated by a smoke alarm - Supplementary device to a smoke alarm, not the sole means of alerting a person with hearing impairment ✓ Can assist people with hearing impairment to arouse from sleep when a smoke alarm is activated ✓ Available as wall-mounted, ceiling-mounted, or free-standing device ✘ Is not effective for all people
Vibrating Pad	- Vibrating pad under the pillow activated by a smoke alarm - Supplementary device to a smoke alarm, not the sole means of alerting a person with hearing impairment ✓ Can assist people with hearing impairment to arouse from sleep when a smoke alarm is activated ✘ Specialised product, which is unlikely to be utilised by people with milder hearing impairment who are unaware they will not be awakened by a smoke alarm
Supplementary audible alarm	- Audible alarm signal is a low frequency 520Hz square wave - Voice messages can also be used with the low-frequency square-wave signal - Supplementary device to a smoke alarm, not available in a smoke alarm device ✓ More effective at awakening people with hearing impairment than the standard high-frequency signal in smoke alarms ✘ No separate, low-frequency supplementary audible alarm devices currently available in the Australian market

Note: Table key for advantages and disadvantages ✓ Advantages ✘ Disadvantages

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Regulatory Requirements for Smoke Alarms in the Home

The regulatory requirements for installation of smoke alarms in the home are dependent on whether the home is a new or substantially-renovated building, or an existing building. New and substantially renovated buildings must comply with the Fire Safety requirements in the BCA, part of the National Construction Code [NCC]. The requirements for smoke alarms in existing homes vary according to state and territory legislation.

Requirements for smoke alarms in new homes in the NCC

In the 2015 edition of the NCC, the requirements for the location of smoke alarms within a dwelling are standardised across residential building types: houses, townhouses, duplexes, villas (Class 1a Buildings), units and apartments in residential buildings (Class 2 Buildings), dwelling units in large boarding houses and hostels (Class 3 buildings), and sole-dwellings within commercial, retail, service, and other types of public buildings (Class 4 buildings). Dwelling units in small boarding houses and hostels (Class 1b Buildings) have additional requirements.

These BCA requirements are applicable to new-built homes, and substantially renovated homes. The acceptable construction practices for smoke alarms in dwellings are shown in Table 5.

Table 5 Acceptable construction practice for smoke alarms within a dwelling (single-occupancy unit) in NCC 2015, for common dwelling types

Smoke alarm requirements within new and substantially renovated dwellings in NCC 2015	
Houses, Townhouses, Duplexes (side-by-side), Villas	
Class 1a Building:	*A free-standing (detached) or attached single dwelling that does not have another dwelling above or below*
	Mains-powered, interconnected (if more than one) smoke alarms, complying with AS 3786, installed on or near the ceiling: - between each area containing bedrooms and the rest of the dwelling - in hallways that lead directly to any bedrooms - in every other storey that does not have bedrooms

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Smoke alarm requirements within new and substantially renovated dwellings in NCC 2015

Small Boarding Houses and Hostels

Class 1b Building:	*A free-standing (detached) or attached single shared dwelling that does not have another dwelling above or below*
	Mains-powered, interconnected (if more than one) smoke alarms, complying with AS 3786, installed on or near the ceiling: - in every bedroom - between each area containing bedrooms and the rest of the dwelling - in hallways that lead directly to any bedrooms - in every other storey that does not have bedrooms A light in the hallway or areas adjacent to bedrooms to assist evacuation, activated by the smoke alarm, either as a separate device or combined with the smoke alarm device.

Apartments, Units, Flats

Class 2 Building:	*Dwelling in a residential building, of two or more storeys, containing two or more dwellings.*
Class 3 Building:	*Dwelling in a residential building (not Class 1 or 2) for numerous unrelated people to live in the short-term or long term.*
Class 4 Building:	*A sole-dwelling in a building used for professional, commercial, retail, industrial, healthcare, services, or other type of public purpose*
	Mains-powered smoke alarms (or smoke detectors if the building has a smoke detector system), complying with AS 3786, installed on or near the ceiling in each dwelling unit: - between each area containing bedrooms and the rest of the dwelling unit - in hallways that lead directly to any bedrooms - "on the egress paths" in every other storey that does not have bedrooms In locations where there are likely to be false alarms from activities (such as kitchens), other types of fire alarms, complying with AS 1670.1, can be used to *supplement* mandatory smoke alarms. Alternatively, if sprinklers installed in these areas, these alarms need not be installed.

Source: Adapted from Building Classifications and Smoke Alarms in NCC 2015 (*NCC 2015*, Vol 1, A3.2 & E2.2a 3; Vol 2, 3.7.2)

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Requirements for smoke alarms in existing homes - state and territory legislation

The BCA requirement for hard-wired smoke alarms in all new and substantially renovated attached and detached houses (Class 1 buildings) and dwellings in Class 2, 3, and 4 buildings, had been adopted in all state and territory legislation by 1997 (BCA 1996). Therefore, all housing of this type built from 1997 should have smoke alarms in the required locations.

The regulatory requirements for smoke alarms in houses built before this date is specified in individual, and varying, state and territory legislation. Since 1997, most states and territories progressively regulated smoke alarms in all dwellings, and though smoke alarms are now mandatory across most of Australia, the requirements differ. The current requirements are shown in Table 6.

Table 6 Regulatory requirements for smoke alarms within a dwelling (single-occupancy unit) in existing dwellings in Australia

Smoke alarm requirements in existing dwellings - state and territory legislation								
REQUIREMENTS **Dwelling Types**[i]	**ACT**	**NSW**	**QLD**	**NT**	**WA**	**SA**	**VIC**	**TAS**
- Smoke alarm regulations for homes built *prior to* 1997 (BCA) or other mandatory year in state/territory legislation, apply to dwellings in Building Classes:	-	1 2 3 4	1a 2 - -	1 2 3 4	1 2 - 4	1 2 - -	1 2 3 4	1 2 3 4 (iv)
Manufactured homes and caravans - as for Class 1a buildings	-	✓	-	✓	-	-	-	-
Permanent residential-use tent with floor - as for Class 1a buildings	-	-	-	✓	-	-	-	-
Smoke Alarm Type								
- Smoke alarms - ionised	-	✓	✓	(vi)	✓	✓	✓	✓
- Smoke alarms - photoelectric	-	✓	✓	✓	✓	✓	✓	✓
Maintenance								
- People must not remove a smoke alarm or a battery in a smoke alarm, or reduce the effectiveness of the warning provided by the smoke alarm	-	-	✓	✓	-	-	-	-
- People must not remove or interfere with the operation of a smoke alarm or heat alarm that has been installed in a building in which people sleep.	-	✓	-	-	-	-	-	-
- Owners using their residential premises or moveable dwelling must test and clean each smoke alarm, at least every 12 months, and immediately replace a smoke alarm or stand-by battery if not functioning.	-	-	-	✓	-	-	-	-

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Smoke alarm requirements in existing dwellings - state and territory legislation

REQUIREMENTS **Power**	ACT	NSW	QLD	NT	WA	SA	VIC	TAS
- Hard-wired in homes built or having major renovations *since* 1997 (BCA) or other mandatory year in state/territory legislation:	✓ 1997	✓ 1997	✓ 1997	✓ 1997	✓ 1997	✓ 1995	✓ 1997	✓ 1997
- Interconnected in homes built since 2014 (BCA)	✓	✓	✓	✓	✓	✓	✓	✓
- Smoke alarms that are hard-wired or battery-powered, in homes built *prior to* 1997 (BCA) or other mandatory year in state/territory legislation:	-	✓ 1997	✓ 1997	-	-	✓ 1995	✓ 1997	(v) 1997
- Smoke alarms that are hard-wired or sealed unit powered with 10-year lithium battery, in homes built *prior to* 1997 (BCA) or other mandatory year in state/territory legislation	-	-	-	✓ 1997	-	✓ 1998 (ii)	-	(v) 1997
- Smoke alarms that are hard wired, in homes built *prior to* 1997 (BCA) or other mandatory year in state/territory legislation	-	-	-	-	(iii) 1997	-	-	-
- Smoke alarms that are hard-wired or sealed unit powered with 10-year lithium battery in class 1a and class 3 buildings	-	✓	-	-	-	-	-	-
- Smoke alarms that are hard-wired in class 1a and class 3 buildings	-	-	-	-	-	-	✓	-

ADDITIONAL REQUIREMENTS **When Selling**	ACT	NSW	QLD	NT	WA	SA	VIC	TAS
Smoke alarms that are mains-powered must be installed in all residential properties that are subject to sale, by the vendor.	-	-	-	-	✓	-	-	-
Vendors must replace any ionisation smoke alarms with photoelectric alarms one day prior to settlement of a property sale	-	-	-	✓	-	-	-	-
New owners must install mains-powered alarms or sealed smoke alarms unit powered with 10-year lithium battery with six months of title transfer	-	-	-	-	-	✓	-	-

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Smoke alarm requirements in existing dwellings - state and territory legislation

ADDITIONAL REQUIREMENTS For Renting	ACT	NSW	QLD	NT	WA	SA	VIC	TAS
Smoke alarms that are mains-powered or have a 10-year non-removable battery, must be installed in all residential rental properties	-	-	-	✓	✗	-	-	✓ (v)
Smoke alarms that are mains-powered must be installed in all residential properties that are subject to lease	-	-	-	-	✓	-	-	-
Lessors must replace ionisation smoke alarms with photoelectric alarms prior to new or renewed lease	-	-	-	✓	-	-	-	-
Lessors must maintain smoke alarms in working order	-	-	-	-	✓	-	-	
Lessors must replace alarms before the end of their service life	-	-	✓	✓	-	-	-	✓
Lessors must test and clean smoke alarms and replace batteries if required, prior to new or renewed lease	-	-	✓	✓	-	-	-	✓
Tenants must replace smoke alarm batteries when required, during tenancy	-	✓	✓	✓	-	-	-	✓
Tenants must test and clean smoke alarms during tenancy, at least every 12 months	-	-	✓	✓	-	-	-	✓
Tenants must notify the lessor if there is a failure or malfunction in the smoke alarms	-	-	-	✓	-	-	-	✓

(i) Does not include healthcare buildings.
(ii) Required to be installed by new owner within 6 months from change of title.
(iii) Only dwellings being sold, leased, or purchased - must have mains-powered smoke alarms unless approved for 10-year battery powered smoke alarms
(iv) For rental properties only.
(v) For rental properties only, hard-wired or battery smoke alarms to be installed from 2013. From 2016, replaceable battery alarms will no longer be permitted.
(vi) Ionisation smoke alarms must be replaced with photoelectric alarms: at the end of their life, or the day before the property is sold, leased or hired.

Sources:

NSW: *Environmental Planning and Assessment Amendment (Smoke Alarms) Regulation 2006* (NSW) (Austl)
QLD: Smoke Alarm Legislation (Queensland Fire and Rescue Service [QFRS], 2013)
Fire and Emergency Services Act 1990 (QLD) div. 5A (Austl)
NT: Factsheet 2 Smoke Alarm Legislation (Northern Territory Fire and Rescue Service, n.d.-a)
Factsheet 3 Requirement to Install (Northern Territory Fire and Rescue Service, n.d.-b)
Fire and Emergency Regulations (NT) reg. 13-13H (Austl)
WA: Smoke Alarm Legislation Frequently Asked Questions (DFES, n.d.-b)
Renting, hiring or selling your property? (DFES, n.d.-a);
Building Regulations 2012 (WA) div. 3 (Austl)
SA: *Development Regulations 2008* (SA) reg. 76B (Austl)
Domestic Smoke Alarms South Australian Legislation (SAMFS, 2005)
TAS: Residential Tenancy (Smoke Alarms) Act 2012 and Residential Tenancy (Smoke Alarms) Regulations 2012 (Department of Justice Tasmania, 2013)
VIC: Only Working Smoke Alarms Save Lives (Metropolitan Fire Brigades [MFB], 2010)
Building Regulations 2006 (VIC) r707,709 (Austl)

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Smoke alarm locations

The BCA and all Australian state and territory legislation require a smoke alarm between each area containing bedrooms and the rest of the dwelling. This could result in one or more smoke alarms, depending on grouping of the bedrooms.

Grouped Bedrooms

When bedrooms are grouped together, only one smoke alarm is needed. Figure 5 indicates the required location of the alarm.

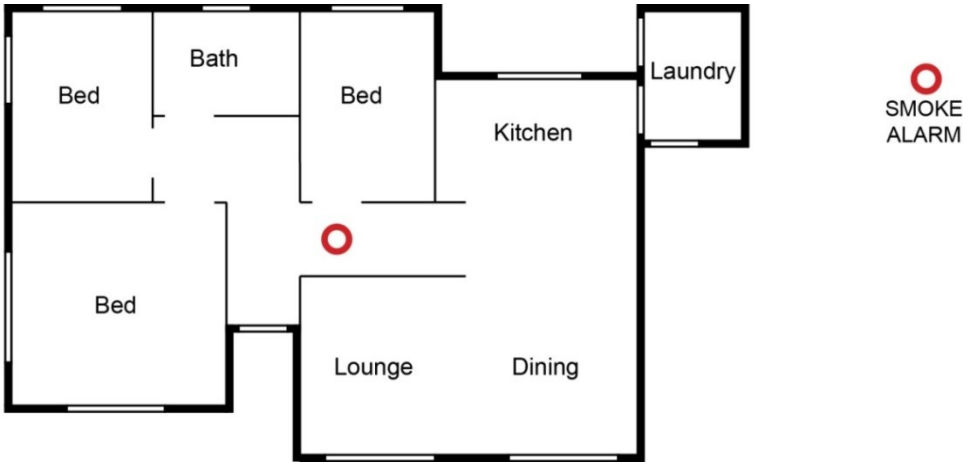

Figure 5 Smoke alarm placement in Class 1a, 2, 3 and 4 dwellings – grouped bedrooms

Source: Adapted from Smoke Alarm Location Requirements in NCC 2015 Information sourced from the Australian Building Codes Board (ABCB) www.abcb.gov.au

Ungrouped Bedrooms

Where bedrooms are not grouped together, more than one smoke alarm will be needed. Figure 6 indicates the required locations of the alarms.

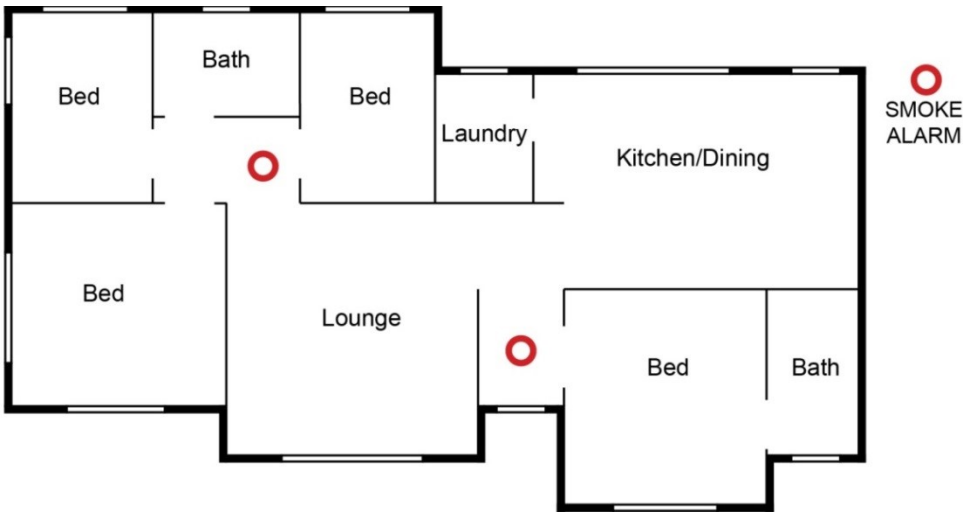

Figure 6 Smoke alarm placement in Class 1a, 2, 3 and 4 dwellings - ungrouped bedrooms

Source: Adapted from Smoke Alarm Location Requirements in NCC 2015 Information sourced from the Australian Building Codes Board (ABCB) www.abcb.gov.au

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Bedrooms in Small Boarding Houses and Hostels (Class 1b Dwellings)

Small boarding houses that are Class 1b buildings, require smoke alarms in the same areas as Class 1a buildings, but also have the additional requirements of a smoke alarm in every bedroom and lighting to assist evacuation when the smoke alarm is activated. This lighting can either be incorporated within the smoke alarm, or can be separate lighting located in the hallway or area leading to the bedroom (Figure 7).

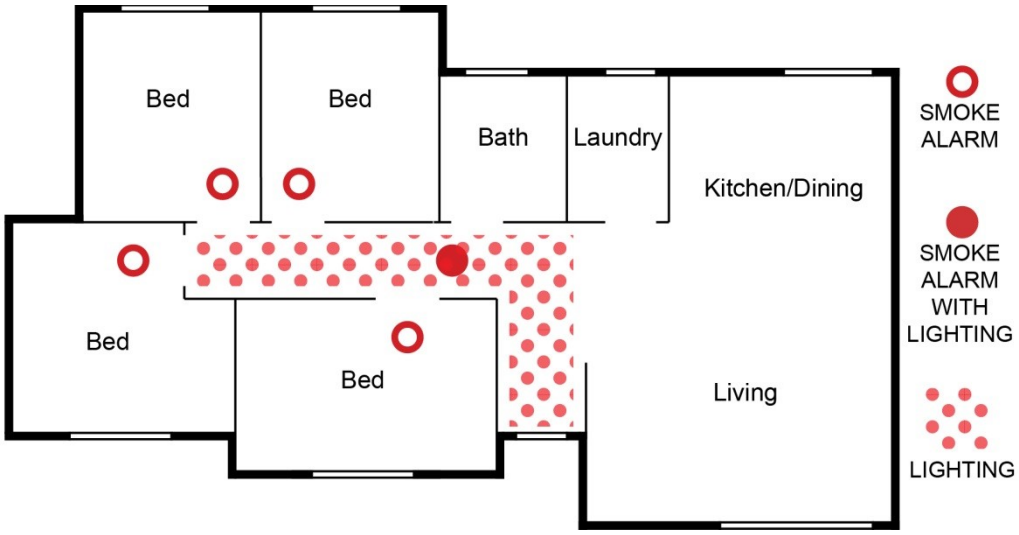

Figure 7 Smoke alarm placement in Class 1b dwellings, with evacuation lighting

Source: Adapted from Smoke Alarm Location Requirements in NCC 2015
Information sourced from the Australian Building Codes Board (ABCB) www.abcb.gov.au

Multi-storey dwellings

In multi-storey dwellings, storeys with no bedrooms must have smoke alarms installed in the most likely path of evacuation, i.e.: above stairwells (Figure 8). Storeys with bedrooms must have smoke alarms installed between the bedrooms and the rest of the home, or the connecting hallway.

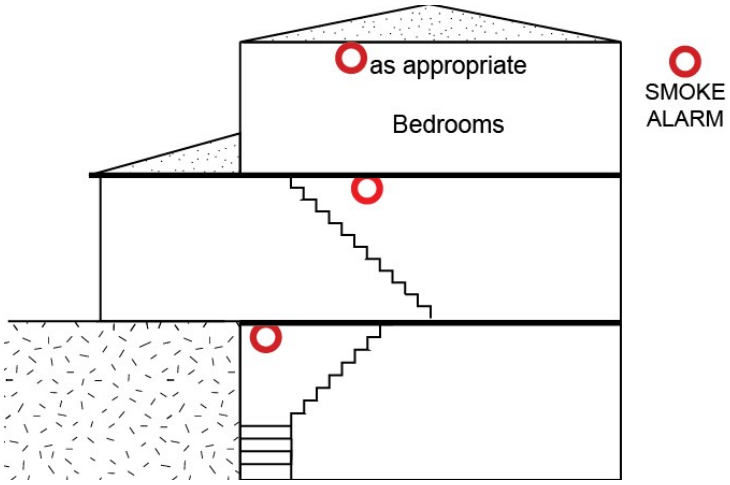

Figure 8 Smoke alarm placement in multi-storey dwellings

Source: Adapted from Location of Smoke Alarms on Different Storeys Requirements in NCC 2015
Information sourced from the Australian Building Codes Board (ABCB) www.abcb.gov.au

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Installation requirements

Smoke alarms should be installed on or near the ceiling (*NCC 2015*, Vol 1, E2.2a 3c; Vol 2, 3.7.2). Smoke alarms need to be located where smoke can reach them. Smoke alarms should not be located in areas of "dead air space" including near the junction of the wall and ceiling, near the peak of a sloped ceiling, or between exposed joists. The recommended locations are shown in Figure 9.

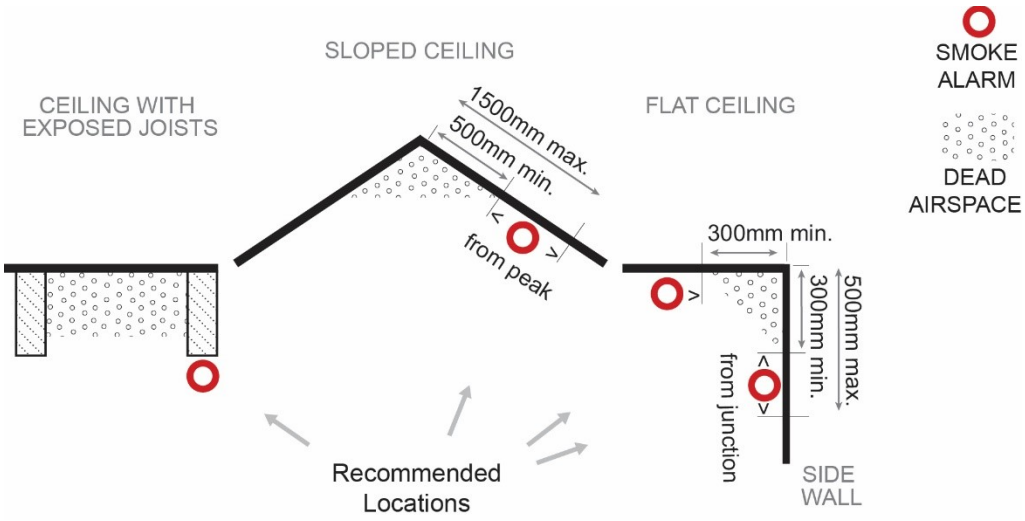

Figure 9 Areas of dead airspace and recommended installation of smoke alarms

Source: Adapted from 'Dead Airspace and Proper Mounting of Smoke Alarms on Side Walls in NCC 2015 (*NCC 2015*, Vol 2, 3.7.2, Explanatory information 2.3 Diagram 1) Information sourced from the Australian Building Codes Board (ABCB) www.abcb.gov.au

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The Need for Further Protection by Smoke Alarms

Smoke alarms are an integral part of a fire escape plan in the home (SAMFS, 2009). Reliable, early detection and warning of a fire is important for the safety of all residents, but even more so for people who can be slower, or need assistance, to respond. This includes people who are very old, are very young, or have disabilities. (Thomas & Bruck, 2008)

Residents living in new and substantially renovated housing that has been built to comply with BCA requirements since 2014, have interconnected hard-wired smoke alarms installed between bedrooms and the rest of the dwelling, and on every storey without bedrooms. Interconnection of smoke alarms greatly improves the early warning of fire when the source of the fire is a considerable distance from where residents are located, particularly when they are sleeping. Hard-wiring of smoke alarms, a BCA requirement for new and substantially renovated housing since at least 1997, increases smoke alarm reliability as they are not solely dependent on batteries.

However, residents living in housing built prior to the BCA's smoke alarm requirements don't have this minimum degree of safety assured through building regulation compliance. Most (but not all) states' and territories' legislation have at least some requirements for smoke alarms, but not to the same requirements of the current BCA.

The costs of retrofitting interconnected, hard-wired smoke alarms can be prohibitive for some home owners, and so, less likely to be undertaken by owner-occupiers, or by landlords of rental properties. However, there are a range of methods for home owners and even renters, to increase their smoke alarm protection through simple home modifications.

In addition to the minimum level of protection provided by the BCA's smoke alarm requirements since 2014, fire authorities and fire researchers have further recommendations for using smoke alarms to increase fire safety in the home. In particular:

- improving the detection of smoke from fires;
- improving the rapid alert of residents when smoke is detected; and
- ensuring reliable functioning of smoke alarms.

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Improving the detection of smoke (without nuisance alarms)

Smoke alarms need to effectively detect smoke, whilst avoiding nuisance alarms. Methods for improving smoke detection recommended by fire authorities and researchers include:

- using photoelectric smoke alarms in all dwellings;
- having a smoke alarm to detect smoke in every room where there is a risk of fire (unless use of the room is likely to trigger nuisance alarms); and
- supplementing smoke alarms with heat alarms in high-risk areas likely to trigger nuisance alarms.

Should nuisance alarms occur, or an alarm continues to sound from lingering smoke despite the source of smoke being eliminated, dwelling occupants might want to silence the alarm. A method for faster and easier silencing of an alarm is the 'hush' function.

Photoelectric smoke alarms

The AFAC recommends photoelectric smoke alarms be installed rather than ionisation alarms. It notes that although ionisation smoke alarms detect flaming fires earlier than photoelectric smoke alarms, photoelectric alarms "detect smouldering fires and fires starting in areas remote from smoke alarms significantly earlier than ionisation smoke alarms"(2006), and many fires in homes begin as smouldering fires. There is concern that ionisation smoke alarms might not activate quickly enough to alert residents and allow them to escape from a smouldering fire. Photoelectric alarms are considered the best all-round smoke detection (AFAC, 2006).

Ionisation alarms are very common in Australian dwellings. They were the most widely available and low-cost smoke alarms when many states introduced smoke alarm legislation. In recent years, photoelectric smoke alarms have lowered in price, and the cost disparity between ionisation and photoelectric alarms is now minimal (Fire Protection Association of Australia [FPAA], 2011).

The AFAC recommends that at the end of the lifecycle of any installed ionisation alarms, they be replaced with photoelectric alarms (2006). This replacement is regulated in the Northern Territory (*Fire and Emergency Regulations* (NT). In the meantime, if installed ionisation alarms are within their ten-year lifespan and residents want to keep them until they require replacement, the AFAC advises that additional photoelectric alarms be installed, in all bedrooms (2006).

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Smoke alarms to detect smoke in rooms where there is fire risk

In the recent assessment of options for the Australian Building Code's residential smoke alarm provisions, a referenced Victoria University study estimated "that smoke alarms in every room in every dwelling in Australia would result in 17% to 30% fewer fatalities" (Thomas & Bruck (2010) cited in ABCB, 2012b). This study revealed that the room of fire origin and the room in which smoke alarms were located were important to the time taken for a smoke alarm to activate, as was whether the doors in the dwelling were open or closed. The study also reported numerous cases in the study, where smoke alarms did not activate, including sometimes when located in the room of fire origin. Non-activation of smoke alarms was prevalent when the room of fire origin was on the upper storey of a two-storey house but the smoke alarms were on the lower storey.

The Victoria University study concluded that "having alarms close to the smoke source (preferably in the same room) is preferable for reliable activation and minimum activation times" (Thomas & Bruck, 2010, p17). Should smoke alarms in every room not be practical or economical, they should be located where most fatal home fires and fatal fire injuries have occurred. This is the bedroom, lounge room and kitchen. Fatalities also occurred due to fires in ceilings, verandas, laundries, and toilet/bathrooms (Thomas & Bruck, 2010, p35), suggesting other areas of the home where smoke alarms should be considered. If these high risk areas are unsuited to smoke alarms due to potential false alarms, other types of fire detectors, such as heat alarms, could be suitable.

The kitchen, lounge room, and bedroom were also the location of most residential fires that resulted in occupant injury. The majority of these fires occurred in the kitchen (40.6%). In more than half (24.9%), the cause of fire ignition was 'properly operating electrical appliances', and the most common ignition factor for fires was leaving equipment unattended. (AFAC, 2009, p48-49)

Despite the increased fire risk in the kitchen, people may avoid placing smoke alarms or disconnect smoke alarms in the kitchen, due to false alarms from cooking activities. Fire authorities advise against having smoke alarms in kitchens (AFAC, 2006). Rather than leaving kitchens (and other high risk areas) unprotected by smoke alarms to avoid nuisance alarms, a smoke alarm should be installed in a more suitable location to detect fires. Alternatively, another type of fire detector, such as a heat alarm, could be used.

Analysis of residential fires resulting in occupant injury revealed that almost twice as many of these fires originated in the bedroom (21.9%), compared to the lounge room (11.5%) (AFAC, 2009, p48). A smoke alarm in the bedroom is particularly important as many bedrooms now contain electronic equipment that could potentially become a source of fire (SAMFS, n.d.).

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Supplementary Heat Alarms

Heat alarms are less likely to produce nuisance alarms in areas of the home that are affected by steam or cooking smoke, such as kitchens, bathrooms and laundries, because they are activated by a high or rapid increase in temperature. This enables them to detect fast fires in these locations, when the residents' attention is elsewhere or they are sleeping. Situations might include a fire on a cooktop when a pot is unattended, a fire in clothes dryer, or a mishap with an electrical heating appliance that has been left on in the bathroom, such as a space heater or hair straightener.

The AFAC and FPAA do not explicitly support the use of heat alarms, nor does the BCA require them. However, the BCA states:

> In kitchens and other areas where the use of the area is likely to result in smoke alarms causing spurious signals—
> (i) any other alarm deemed suitable in accordance with AS 1670.1 may be installed provided that smoke alarms are installed elsewhere in the sole-occupancy unit (*NCC 2015*, Vol 1, E2.2a, 3b).

New South Wales and Queensland Legislation refer specifically to heat alarms being permissible for this purpose (*Environmental Planning and Assessment Amendment (Smoke Alarms) Regulation 2006*, (NSW, Section 186B, Clause 3; *Fire and Emergency Services Act 1990*, (QLD, Section 104RB).

Silencing Nuisance Alarms

Some smoke alarms include an alarm silencing function, which can be useful but is not mandatory in the Australian Standard (AS 3786-1993). Commonly referred to as a 'hush' function, it reduces the sensitivity of the alarm. The smoke alarm will either show that the alarm has been silenced through a visual indicator (such as a light) or audible signal, or automatically reset itself to function within 15 minutes (*AS 3786-1993*, Cl2.14).

The hush function is usually activated by a push button on the alarm itself, which is often also the 'test' button. Some hush buttons are larger in size, enabling them to be easily operated by a broom handle. This avoids the difficulty and risk of having to climb up to the ceiling to operate a hush button by hand. Other smoke alarm models can be silenced with a hush button on a remote control or on a separate control pad installed on the wall at a convenient height.

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Improving rapid alert of residents when smoke is detected

Recent research suggests that a dwelling fire can 'flashover', with flames engulfing a room, in as little as 2-4 minutes in a modern dwelling. This is far quicker than for older dwellings, and makes rapid alert of a fire critical, if residents are to safely escape. (Catalyst, 2014; South Australian Metropolitan Fire Service, n.d.)

For residents to be rapidly alerted to a fire in the dwelling, a smoke alarm needs to detect smoke close to where a fire starts and activate a sounding device close to where residents are located (Thomas & Bruck, 2008). However, if smoke alarms are only installed in the minimum locations required by the BCA and state and territory legislation:

- between each area containing bedrooms and the rest of the dwelling,
- in hallways that lead directly to any bedrooms, and
- in every other storey that does not have bedrooms, located on path of travel used for evacuation,

detection and alert of smoke could be delayed. Also, if the area where the fire starts is a considerable distance from where residents are located (particularly in larger dwellings), then it is likely that residents will not hear the smoke alarm signal from the smoke alarm that detects the fire, and the time it takes for the their nearest smoke alarm to detect the smoke will risk their safe escape from the fire (Thomas & Bruck, 2008).

Methods for providing a more rapid alert of fire include:

- smoke alarms installed in all bedrooms and living areas
- interconnecting smoke alarms
- low-frequency auditory alarm signals
- supplementary alert devices for people unlikely to wake from an auditory signal.

Smoke alarms installed in all bedrooms and living areas

In addition to the required smoke alarm locations in the BCA, the AFAC and Australian fire safety services recommend that smoke alarms be installed within all sleeping areas (AFAC, 2006; FRNSW, n.d.-b; MFB, 2010; QFRS, 2014a; SAMFS, 2009; TFS, 2014). This applies to all new and existing dwellings. A smoke alarm in every bedroom is already a BCA requirement for boarding houses (Class 1b). Indicative smoke alarm placement in bedrooms of Class 1a, 2, 3 and 4 dwellings is shown in Figure 9.

In addition to permanent dwellings, AFAC recommends that battery-powered smoke alarms (when 240 volt power is unavailable or impractical) be installed in all sleeping areas of all temporary accommodation. This includes tents, boats and caravans. (AFAC, 2006, p6)

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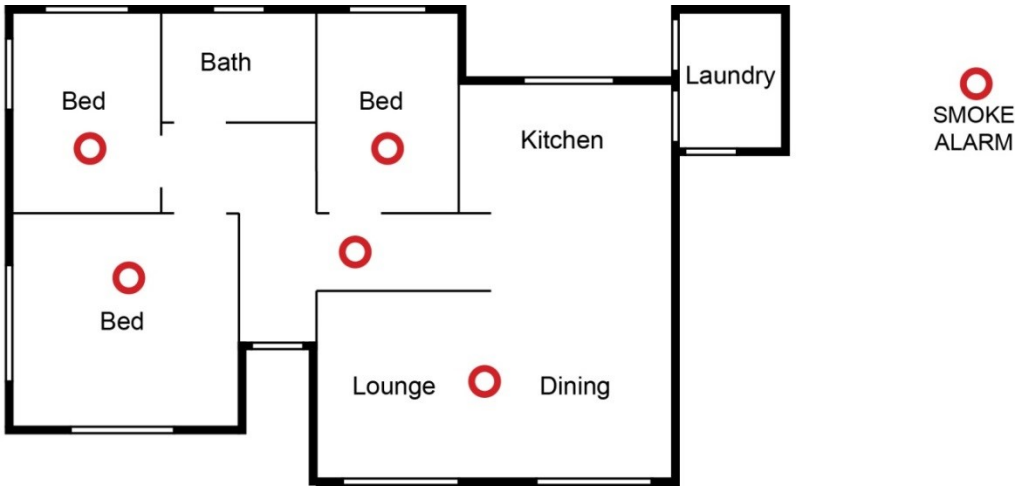

Figure 10 Smoke alarm placement in Class 1a, 2, 3 and 4 dwellings – grouped bedrooms: Regulated locations and recommended additional locations of smoke alarms

The sound level of the smoke alarm signal is required to be 85 dBA at a distance of 3m away, which is intended to wake a sleeping person. Research conducted by Victoria University showed that when the smoke alarm was located in the hallway, the sound level of the alarm signal was considerably lower than 85 dBA in the bedrooms, and even more so when the door was shut. At this lowered sound level, many groups in the population, especially older adults, young adults, children, and people with hearing impairment, would not be awakened by the alarm. It was therefore essential to have a smoke alarm within every bedroom (whether or not residents sleep with the door shut), to ensure that the alarms signal was sufficiently loud to awaken most residents. (Thomas & Bruck, 2010)

Even when residents are awake, the study found that the substantial reduction of sound level from room to room indicated that some residents may not hear a smoke alarm in another room or hallway. When doors were closed, the reduced alarm sound level could be close to ambient sound (Thomas & Bruck, 2010, p5). If entertainment devices are being used or headphones worn, the increased ambient sound level would make the smoke alarm signal more difficult to detect. This suggests that nearby location of the smoke alarm is essential also during times when residents are awake, and they should be located in all living areas and bedrooms, rather than solely in hallways or selected rooms.

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Interconnecting smoke alarms

By interconnecting smoke alarms, all alarms in the dwelling will sound when one of the alarms is activated, giving all occupants earlier warning of fire. This is very important in modern house designs which have the main bedroom situated away from living areas and children's bedrooms (SAMFS, n.d.). It is also essential for residents who are hard of hearing, or have permanent or temporary disabilities, and may need the assistance of others in a fire. For residents who live alone and need evacuation assistance from others, smoke alarms can be interconnected to the neighbouring home of a carer or friend. Alternatively, interconnected smoke alarms can be installed as part of a monitored or unmonitored emergency call system or a security alarm system.

The AFAC and FPAA recommend that smoke alarms in dwellings be interconnected (2006; 2011). This interconnection of smoke alarms is supported by research conducted by Victoria University, and reported in the ABCB's assessment of options for residential smoke alarms in the BCA (2012a, 2012b). Following this assessment, the interconnection of all smoke alarms was adopted in NCC 2014.

The Victoria University study concluded that "early detection **and** notification requires **interconnected** smoke alarms in every room" (Thomas & Bruck, 2010, pvii). Interconnection of smoke alarms in every room in every dwelling in Australia would lead to a 50% reduction in fatalities, saving about 50 lives each year. The greatest benefit could be achieved if these interconnected smoke alarms are located in bedrooms, living rooms and kitchens. (Thomas & Bruck, 2010, pvii)

The interconnection of mains-powered smoke alarms required by the BCA in all new dwellings is the most feasible option for installation, as wiring connections are easily accessible prior to wall and ceiling surfaces being installed. However, a variety of home modifications can provide this interconnection without the need for major construction and electrical works in existing dwellings.

Existing hard-wired smoke alarm devices can be replaced with newer models of smoke alarm that feature a radio-frequency base, providing mains-powered smoke alarms with wireless interconnection. Battery-powered smoke alarms (both permanent and replaceable battery) are also available, capable of radio-frequency interconnection. These wireless smoke alarms can be used to replace existing battery-powered smoke alarms, or supplement existing mains-powered smoke alarms to provide additional protection in bedrooms and living rooms.

When residents are alerted by an alarm signal from their interconnected smoke alarm system, they might need to know which smoke alarm has been activated. Large dwellings could have several smoke alarms, or smoke alarms located on multiple storeys. Various types of 'activated alarm locator' are available for interconnected smoke alarms. They are usually on a conveniently-located control panel with the locator button only, or with buttons for other functions such as 'hush' or 'test'. When the locator button is pressed, all smoke alarms except for the one detecting smoke, will be temporarily silenced. This allows for more rapid investigation to see whether it is necessary to evacuate, and if so, the best evacuation route. This is useful if any residents have a disability or require assistance to evacuate.

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Low-frequency auditory alarm signals

The standard smoke alarm signal has a high-frequency (3,100Hz). This is problematic when high-frequency hearing loss is common as people age (Bruck, Thomas, & Kritikos, 2006, p29-30), especially as hearing loss often goes unrecognised. Thomas and Bruck (2008) have shown that in numerous studies, many older people do not wake, or take an excessively long time to wake, to this high-frequency alarm. Similarly, children and people impaired by alcohol are high-risk groups, less likely to wake to the standard high-frequency smoke alarm signal (Thomas & Bruck, 2008). Recent research indicates that people affected by drugs, particularly hypnotics (sleeping tablets) are likewise less likely to wake (Lykiardopoulos, 2014).

An alarm signal with a low-frequency (520Hz) square-wave sound has been shown to be far more effective at waking high-risk groups, including older people, deep sleeping young adults, people with hearing impairment, children, and people affected by alcohol, than the standard 3,100Hz alarm signal in a mandatory smoke alarm (Thomas & Bruck, 2008). Children were twelve times more likely to wake to this low frequency alarm signal, and these other at-risk populations were 4-7 times more likely to wake (Bruck & Thomas, 2008). The relative effectiveness of a low-frequency signal was noted in the recent assessment of options for smoke alarms in dwellings in the BCA (ABCB, 2012a; ABCB, 2012b).

Currently there are no smoke alarms on the ActiveFire register that list a low-frequency 520 Hz square-wave alarm signal (CSIRO, 2015), nor are there any evident in the Australian market. However, the currently regulated Australian Standard for smoke alarms, AS 3786-1993, which requires the alarm signal comply with ISO 8201 or ISO 7731, does not prevent this type of low-frequency signal being used in a mandatory smoke alarm (Bruck & Thomas, 2008; *ISO 7731:2003(E)*; *ISO 8201 : 1987*). The new edition of this Standard, AS 3786:2014, includes a 520Hz square-wave alarm signal as an optional function (4.2.1.3).

There are also no stand-alone supplementary signal devices for smoke alarms that have a low-frequency 520 Hz square-wave signal, available in Australia. These supplementary devices are available overseas and could potentially be purchased online. If they are purchased from overseas, they should be 240V, fitted with an Australian power plug, and meet Australian Standards (*AS 1603.17-2011*), to ensure safe use in Australia.

Development and registration of an Australian smoke alarm with integrated low-frequency 520 Hz square-wave signal, would have a number of advantages over relying on a specialised supplementary alarm device for people with hearing impairment. It would:

- consider the rapidly increasing ageing population, who are likely to develop hearing impairment;
- address the needs of an 'at risk' population that is much larger than people with severe hearing impairment, such as children, people with moderate hearing impairment and those who are affected by alcohol or sleeping tablets; and
- allow for the changing occupants of dwellings, and their varying needs (Bruck & Thomas, 2008).

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Supplementary alert devices for people unlikely to wake from an auditory signal

Residents with a severe hearing impairment will be unable to hear an auditory signal from a smoke alarm. In this case visual (strobe light) and tactile (pillow-shaker) alarm signals are needed.

Visual alert devices, such as strobe lights, can be effective at alerting people with hearing impairment when they are awake. However, research has shown that a pillow-shaker alarm signal is far more reliable than a sole strobe-light alarm signal, at waking people with a hearing impairment from a range of sleep-stages (Bruck & Thomas, 2007). Many people are not awakened by visual alarms (Bruck & Thomas, 2009). AS 1603.17 advises that a visual alarm signal "is not intended alone to arouse sleeping occupants" (*AS 1603.17-2011*, Cl 2.7).

There is some evidence of tactile 'under mattress' vibrating pad alert devices also being effective at arousing people with hearing impairment (Bruck & Thomas, 2007). These 'mattress shakers' require a stronger vibration than 'pillow shakers' though (Bruck & Thomas, 2007), and are not included in the accepted warning devices in AS 1603.17.

Pillow shakers can also be effective at arousing people with only moderate hearing impairment and others who are less likely to be awakened by the current high-frequency smoke alarm signal, such as people affected by alcohol (Bruck & Thomas, 2007; Bruck, Thomas, & Ball, 2007). Their use though, is limited by being a specialised device that is marketed as being for people who are deaf, and their cost. The effectiveness of pillow shakers is also affected by their dependence on the shaker unit always being located under the pillow when the resident goes to sleep.

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Ensuring reliable functioning of smoke alarms

There is no protection provided by smoke alarms that are not functional. Several studies have shown that the number of working smoke alarms in residential dwellings is considerably less that the number of smoke alarms installed (Barnett, 2008, p189-193). There is also evidence that when residents undertake maintenance of smoke alarms, the smoke alarms in their dwelling are more likely to be functional (Barnett, 2008, p190).

Smoke alarms will have their required maintenance process specified in the manufacturer's written instructions. This process should be followed.

The general maintenance schedule for smoke alarms outlined by AFAC is:

> "— testing once per month to ensure the battery and the alarm sounder are operating;
>
> — cleaning with a vacuum cleaner annually to remove particles that will affect smoke alarm performance; and
>
> — replacing removable batteries annually, including removable batteries in smoke alarms powered primarily by 240 volts." (AFAC, 2006, p5)

Also, as Australian Standards AS 3786-1993 and AS 3786:2014 specify a 10-year service life for smoke alarms, it is essential that they are replaced before this service life expires.

Testing smoke alarms – battery and sounder

AS 3786-1993 and AS 3786:2014 require smoke alarms to have written instructions on how they are to be tested. Most smoke alarms have a 'test' button that needs to be pressed until the alarm signal sounds; a broom handle can be used to press the test button if it is large enough. There are also smoke alarms available that can be tested with a remote control. For further ease of testing, some smoke alarms can be installed with a separate wall-mounted panel, which transfers the test button to a convenient location. Both stand-alone test-button control panels, and control panels that incorporate other functions like a hush button or alarm locator button, are available.

The required frequency for testing will be specified in the smoke alarm instructions. The AFAC specifies testing smoke alarms every month "to ensure the battery and the alarm sounder are operating" (AFAC, 2006, p5). Only the Northern Territory has legislated smoke alarm testing (Northern Territory Fire and Rescue Service, n.d.-c). However, their minimum testing period of every 12 months is far less than the recommendation of fire services.

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Cleaning smoke alarms

The AFAC specifies cleaning smoke alarms with a vacuum cleaner, annually (AFAC, 2006, p5). However, Queensland Fire & Emergency Services' guidelines for seniors recommends a more frequent cleaning schedule – monthly, when the smoke alarms are tested (QFES, 2014b, p10). Barnett's study of smoke alarm maintenance showed that fewer than a quarter of dwelling occupants cleaned their smoke alarms, mainly because they were unaware it was required (2008, p218).

Particles in and around the smoke alarms can result in reduced detection of smoke, and increased nuisance alarms. A more frequent cleaning schedule could be needed if there is a greater likelihood of dirt and other particles interfering with the smoke alarms; for example, in dirty or dusty environments, if ceiling and wall surfaces are deteriorating, or if building works are being undertaken.

Replacing batteries in smoke alarms

Smoke alarms powered by removable batteries require the batteries to be replaced annually (AFAC, 2006, p5). Some fire services advocate changing the batteries on the day that daylight saving ends, with the campaign: "Change your clock; change your smoke alarm battery" (MFB, 2010; SAMFS, 2009).

It is not just battery powered smoke alarms that require annual replacement of removable batteries. All mains-powered smoke alarms must have a backup battery in case of power failure, and if this backup battery is removable, it also needs to be replaced annually. A study of smoke alarm maintenance practices revealed that more than half (53.1%) of hard-wired smoke alarms did not have batteries replaced annually, and the reason why most dwelling occupants did not change the battery was that they did not realise they needed to (Barnett, 2008, p217).

It is essential that the replacement batteries are the correct type for the smoke alarm. The battery type will be specified by the smoke alarm manufacturer, both in the instructions for the smoke alarm, and marked on or near the battery compartment on the smoke alarm (*AS 3786-1993*, 4.1-4.2). It is not safe to use a different type of battery. AS 3786-1993 (4.1) requires a warning be marked on the smoke alarm:

> CAUTION: USE ONLY SPECIFIED BATTERIES. THE USE OF DIFFERENT BATTERIES MAY HAVE A DETRIMENTAL EFFECT ON OPERATION OR MAY CAUSE THE BATTERY TO EXPLODE RESULTING IN INJURY OR FIRE.

Replacing batteries in a smoke alarm usually requires climbing a ladder to reach the ceiling. If residents could have difficulty or be at risk in this task, and they do not have assistance from others, smoke alarms with permanent batteries should be used. Smoke alarms with permanent lithium batteries do not need to have the batteries changed; the batteries last the full 10-year service life of the smoke alarm. Battery-powered smoke alarms with permanent batteries, and mains-powered smoke alarms with permanent back-up batteries are available.

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Replacing smoke alarms at the end of their 10-year service life

Australian Standards require smoke alarms to have a service life of at least 10 years under normal conditions of use (*AS 3786-1993*; *AS 3786:2014*). After this time they might not function properly due to "accumulated dust, insects, airborne contaminants and corrosion of the electrical circuitry" (QFRS, 2014b). When replacing smoke alarms it is important that current applicable state or territory regulations are checked to ensure the planned location and type of replacement smoke alarms will comply. It is also an opportunity to incorporate fire services' and researchers' recommendations for more effective use of smoke alarms. This could include additional smoke alarms if they were not previously located in the recommended locations, especially in bedrooms; interconnecting the replacement smoke alarms; adding features that make testing and silencing smoke alarms more convenient; and adding supplementary alert devices for residents who might not be awakened by the audible alarm signal in the regular smoke alarm.

AS 3786:2014 requires smoke alarms to have the recommended date for replacement permanently marked on the housing (*AS 3786:2014*, 4.22.1). However, many currently installed smoke alarms will pre-date this requirement. Smoke alarms complying with AS 3786-1993 will have the year of manufacture marked, possibly coded into the serial or batch number (*AS 3786-1993*, 2004, 4.1), so this can be used to calculate the replacement date, 10 years after.

Table 7 Recommendations for improved smoke alarm protection

Improved Smoke Alarm Protection		
DETECTION	Photoelectric alarms	- New-installed smoke alarms to be photoelectric - Replace ionisation alarms at end of their 10-year lifecycle with photoelectric alarms - Install supplementary photoelectric alarms in bedrooms if ionisation alarms are not ready for replacement ✓ This is the smoke alarm type that has proven to have best overall detection of smoke, especially for smouldering fires
	Smoke alarms in every room at risk of fire, as well as regulated locations	- Minimum: living areas and bedrooms ✓ More rapid detection of smoke in areas of the dwelling most likely to have fires that result in occupant fatality or injury
	Supplementary heat alarms	- Heat alarms in high risk areas, including kitchens, where nuisance alarms are more likely ✓ Less likely than smoke alarms to result in nuisance alarms ✓ Provide additional protection of fire detection in areas at risk of fire, where smoke alarms are unlikely to be used

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Improved Smoke Alarm Protection		
ALERT	Smoke alarms in all rooms	- Minimum: living areas and bedrooms ✓ Maximises the sound level of the alarm to achieve the required (85dB) for rapid alert and waking
	Interconnection of smoke alarms	- Interconnection of all alarms either hard-wired or through radiofrequency ✓ Essential for rapid detection and alert of smoke from fire ✓ Dramatically reduces risk of fire fatality + If there are several smoke alarms or a multiple storey dwelling, an 'activated alarm locator' will temporarily silence all smoke alarms not detecting smoke. This helps identify if or where there is a fire, to better guide evacuation; particularly useful for residents with a disability or requiring assistance. + If living alone, smoke alarms could be interconnected to a neighbouring home or installed as part of an alarm or emergency call system, if assistance is required.
	Lower frequency signal	- Low-frequency 520 Hz square-wave alarm signal ✓ Far more effective than standard alarm signal for waking older people, people with hearing impairment, children, and people affected by alcohol
	Supplementary non-acoustic alarm signal for people with hearing impairment	- Pillow shaker with optional flashing light signal ✓ Can awaken people with no hearing or hearing impairment who are unlikely to be awakened by a standard smoke alarm
RELIABILITY	Testing smoke alarms – signal and battery	- Test according to instructions, at least every month ✓ Ensures smoke alarm is operational + If accessing a test button is difficult, some alarms are available with remote control testing, or a test button on convenient control panel
	Cleaning smoke alarms	- Clean according to instructions, annually as minimum, monthly recommended, or more frequently in a dusty environment ✓ Maximises smoke alarm performance ✓ Avoids nuisance alarms from dust and dirt in the smoke alarm
	Replacing batteries in smoke alarms	- Replace removable batteries, annually as minimum + If battery replacement difficult, sealed smoke alarms with 10-year batteries are available, eliminating need to change the battery.
	Replace smoke alarms every 10 years	- Check manufacturing date marked on smoke alarm and replace within 10 years of this date ✓ Ensures smoke alarm is within its service life

Note: Table key ✓ Advantages + For extra assistance

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Assistance with Smoke Alarms

Australian states have a range of different programs to advise and assist residents with their smoke alarms.

Assistance with placement, installation, and maintenance of smoke alarms

Only two states have programs to assist with placement, installation, or maintenance of smoke alarms. New South Wales has a service for older people and people with disabilities, to assist with smoke alarm installation and changing of batteries. Queensland has a program for smoke alarm and general fire safety advice, available to all residents.

In addition to these two programs facilitated by state fire services, private professional smoke alarm service organisations can provide assistance with locations, installation, and maintenance of smoke alarms.

- **New South Wales - SABRE**

  In New South Wales, the Smoke Alarm and Battery Replacement [SABRE] program assists older people and people with a disability to install and maintain their smoke alarms. This ensures that vulnerable residents living on their own who do not have family, friends or neighbours to assist with smoke alarm installation and maintenance, have working smoke alarms.

  Eligible residents can contact their local fire station by phone on 1800 151 614, or through the fire station search on the Fire & Rescue NSW website at www.fire.nsw.gov.au. They can arrange a time for firefighters to install their battery-powered smoke alarm or change batteries in their existing smoke alarms. Residents need to purchase their own smoke alarms and batteries, but there is no charge for installation. (Fire & Rescue NSW, 2012)

- **Queensland - SafeHome**

  The Queensland SafeHome program provides all Queensland residents with advice on fire and home safety. Residents (including tenants) can book a visit from local firefighters, to assist them to recognise and plan to eliminate fire hazards in their homes. This includes advice on correct placement of smoke alarms. Residents living in areas serviced only by volunteer firefighters are sent a SafeHome kit and Bushfire Preparedness package, in lieu of a visit. SafeHome is a free service provided by Queensland Fire and Emergency Services. (QFES, 2014a)

  Residents can contact SafeHome to book a firefighter visit, online at safehome-booking on the Queensland Fire and Emergency Services website at fire.qld.gov.au or by phone on 13 QGOV (13 74 68).

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Subsidies for supplementary smoke alarm devices for people with hearing impairment

Subsidy schemes are available in most states (New South Wales, Queensland, South Australia, Tasmania and Victoria) to assist with the cost of specialised smoke alarms for residents with hearing impairments (National Relay Service, 2014). Eligibility, cost, and specialised smoke alarms provided, differ between the schemes.

New South Wales

New South Wales has a Smoke Alarm Subsidy Scheme [SASS] available to residents who are profoundly deaf or severely deaf in the better ear. This scheme is funded by the NSW Department of Family and Community Services: Ageing, Disability and Home Care, and operated through the Deaf Society of NSW and Fire & Rescue NSW. Residents eligible for a smoke alarm under the subsidy can choose one from a selection of mains-powered, or lithium battery-powered smoke alarms, with strobe light device and vibrating pad (pillow shaker) device. If the resident does not have family or friends to assist with installation, this can be included in the subsidy. The cost to eligible residents is $20; however, this fee can be waived if the resident is experiencing financial hardship. (Deaf Society of NSW, 2014, 2015)

Applications can be made through the Deaf Society of NSW, phone (02) 8833 3600, TTY (02) 8833 3691, or their website at deafsocietynsw.org.au.

Queensland

Queensland residents who are deaf or hearing impaired and require a specialised smoke alarms could be eligible for the Smoke Alarm Subsidy Scheme. This scheme, funded by the Department of Community Safety and managed by Deaf Services Queensland [DSQ] provides a wireless lithium battery smoke alarm, with a flashing light and vibrating pad, to eligible residents. The cost is $50 or $20 for eligible residents with a concession card. (DSQ, 2014; QFES, 2014c)

Information and applications are available from Deaf Services Queensland on phone (07) 3892 8500, TTY: (07) 3892 8501, or from their website at www.deafservicesqld.org.au/sass.

South Australia

The South Australian Government scheme supplies and installs a specialised smoke alarm with strobe light and vibrating pad for eligible residents who are deaf or have profound hearing loss. There is no cost to residents. Information and application packs are available form Guide Dogs SA.NT on phone (08)8203 8390, or from their website at www.guidedogs.org.au/smoke-alarm-scheme. (Guide Dogs SA/NT, n.d.)

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Tasmania

The Tasmanian Visual Smoke Alarm Subsidy Program provides a free home fire safety check by the Tasmania Fire Service, with subsidised installation of a visual and vibrating smoke alarm package, and installation of free audio smoke alarms if needed, to eligible residents who are deaf or hard of hearing. More than one smoke alarm package can be provided if eligible residents sleep in separate bedrooms; the resident contributing $50 for the cost of each. (Tasdeaf, 2014; Tasmania Fire Service, 2010)

Information and applications are available through Hearing Link on phone 1800 982 212 (freecall) or email info@hearinglink.com.au, or an application form can be downloaded from the Tasdeaf website at tasdeaf.org.au.

Victoria

Victorian residents who are profoundly deaf also have a smoke alarm subsidy available. Victorian Government funding subsidises the cost of a visual and vibrating smoke alarm for eligible residents (or more than one alarm per household if people who are deaf sleep in different bedrooms). The cost to the resident is a $50 co-payment, though the resident can apply to have this waived if they have difficulty meeting the cost. (Vicdeaf, 2014)

Information and applications are available from Vicdeaf on phone (03) 9473 1111, TTY: (03) 9473 1199, or from the Vicdeaf website at www.vicdeaf.com.au.

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Checklist

The following smoke alarm checklist is intended to assist occupational therapists and other home safety specialists, in assessing the effectiveness of smoke alarms in the home. This checklist can be included as part of a home fire escape plan.

Smoke alarms that meet regulatory requirements

- ☐ Does the dwelling have hard-wired smoke alarms in the minimum required locations, if built after 1997 (or applicable year in state/territory legislation)?
- ☐ Does the dwelling have interconnected hard-wired smoke alarms in the required locations, if built after 2014?
- ☐ Does the dwelling have hard-wired or battery-powered smoke alarms in the minimum required locations to meet state/territory legislation, if built prior to 1997 (or applicable year in state/territory legislation)?
- ☐ Are installed alarms listed on the www.activfire.gov.au register?

Smoke alarm functioning and maintenance

- ☐ Are currently-installed alarms within their 10 year service life?
- ☐ Are all currently-installed smoke alarms operating when tested - not disconnected, battery is charged?
- ☐ Are residents aware of the maintenance requirements for their installed smoke alarms – following manufacturer's instructions, or if not available, annual replacement of replaceable batteries, monthly cleaning and testing?
- ☐ Are residents capable of maintaining their installed smoke alarms – annual replacement of replaceable batteries, monthly cleaning and testing?

  If residents are unable to maintain their installed smoke alarms,

  - ☐ are there arrangements in place with friends and family to change batteries, and clean and test smoke alarms?
  - ☐ are other assistance programs in place to change batteries, and clean and test smoke alarms?
  - ☐ can any smoke alarms with removable batteries be replaced by sealed smoke alarms with 10-year batteries?

Detecting smoke without nuisance alarms

- ☐ Are currently-installed smoke alarms photoelectric?
- ☐ Do any currently installed smoke alarms need to be replaced with an alternative type of smoke alarm or another fire detection device to avoid nuisance alarms, e.g. heat alarm rather than smoke alarm near cooking appliances?
- ☐ Are residents capable of easily silencing nuisance alarms, or are separate 'hush' switches required?

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Rapid smoke detection and alert

- ☐ Are there smoke alarms installed in sleeping areas within 3m of sleeping residents, to better ensure alarm volume will awaken them?
- ☐ Are there smoke alarms installed in living rooms, where there is a higher risk of both fire and not hearing smoke alarms in other rooms due to background noise?
- ☐ Are additional smoke alarms or other means of fire detection needed in other areas of particular risk, such as the kitchen, and in rooms with a lot of electrical equipment or where heating appliances are regularly used?
- ☐ Are the smoke alarms installed in sleeping areas interconnected with smoke alarms in all areas of the dwelling building where a fire could start?
- ☐ Is an 'activated alarm locator' needed due to having many interconnected alarms, or a multiple-storey dwelling?

Awakening to smoke alarms

- ☐ Do any residents or regular visitors have a hearing impairment and require supplementary alarm devices to ensure they are awakened by the smoke alarm?
- ☐ Are there methods in place, such as interconnected smoke alarms or supplementary alarms, for any residents or regular visitors who are less likely to be awakened by a standard smoke alarm, e.g. children, young adults, people affected by alcohol or drugs

Evacuation

- ☐ Do any residents or regular visitors require assistance from other residents to awaken and evacuate from the dwelling if an alarm is activated, making interconnected smoke alarms essential?
- ☐ Does a lone-resident require assistance to awaken and evacuate, making interconnection of smoke alarms with a neighbouring friend or carer, or remote monitoring of smoke alarms through an emergency call or alarm system essential?
- ☐ If smoke alarms are activated at night, is there sufficient light for all residents to evacuate or is lighting required to be linked to the smoke alarms?

Assistance with smoke alarms

- ☐ Are residents who require supplementary alarms due to hearing impairment, eligible for state-based subsidy programs?
- ☐ Have vulnerable elderly residents or residents with disabilities sought advice on smoke alarm location and evacuation, from their local fire brigade?

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Appendix 1: Standards Relevant to Home Smoke Alarms

AS 3786:2014
Smoke alarms using scattered light, transmitted light or ionization

AS 3786-1993
(Incorporating Amendment Nos 1, 2, 3 and 4) Smoke Alarms

AS 1670.1-2004
(Incorporating Amendment No. 1) Fire detection, warning, control and intercom systems-System design, installation and commissioning. Part 1: Fire

AS 1603.11-2010
Automatic fire detection and alarm systems Part 11: Visual warning devices

AS 1603.14-2001
Automatic fire detection and alarm systems. Part 14: Point type carbon monoxide (CO) fire detectors

AS 1603.17-2011
Automatic fire detection and alarm systems Part 17: Warning equipment for people with hearing impairment

AS 1851-2012
Routine service of fire protection systems and equipment

ISO 8201 : 1987 (E)
Acoustics - Audible emergency evacuation signal

ISO 7731:2003(E)
Ergonomics — Danger signals for public and work areas — Auditory danger signals

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