Fire & Smoke Detection

in Residential Buildings
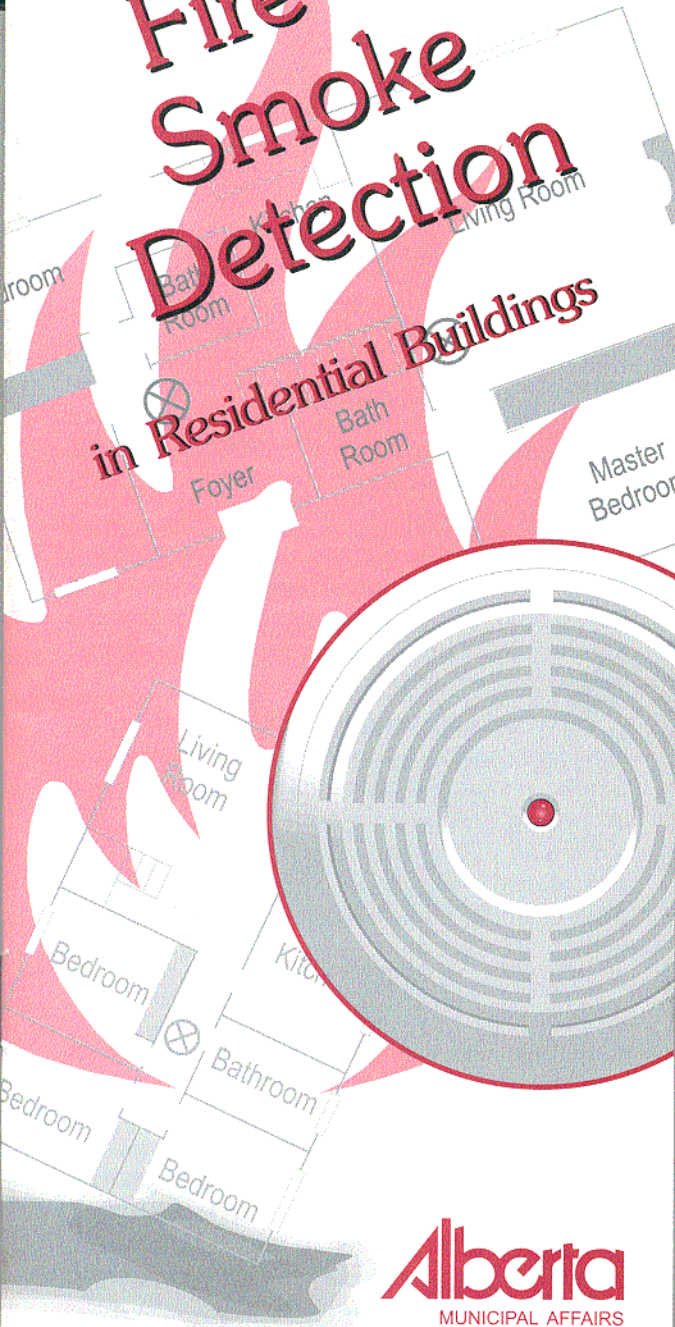
The Alberta Fire Code requires that smoke alarms:

- be installed in <u>all</u> dwellings, between each sleeping area and the remainder of the dwelling unit.
- be installed and maintained according to manufacturer's instructions.

Smoke alarms may be battery operated, unless otherwise required by the Alberta Building Code.

Smoke Kills

Nearly 300 people die in household fires in Canada each year. It has been conservatively estimated that 150 of these lives could be saved by the installation of smoke alarms. Though these devices are no substitute for carefully pre-planned fire prevention measures, they are invaluable in providing early warning when fire strikes.

Alberta's statistics are close to the national average. About 25 people die annually in residential fires in this province. Ninety per cent of residential fires occur in one- and two-family dwellings, apartments or mobile homes.

Smoke causes the majority of fire-related deaths. Hot flames are low on the list of killers during a fire. Smoke contains deadly gases such as carbon monoxide and when smoke is produced, life sustaining oxygen is consumed. In many fires extinguished in early stages, people have been found dead of smoke inhalation without having suffered burns.

A smouldering fire may go undetected for hours, especially when people are asleep. Such a fire will continue developing, giving off smoke and gases which may not be visible – but which consume oxygen and replace it with toxic gases. Normally, air is about 21 per cent oxygen. When it falls below the 17 per cent level, thinking and co-ordination may become difficult. Below 16 per cent, a person's efforts to escape may be irrational. Breathing becomes impossible when oxygen levels fall below six per cent.

Super-heated air and gases rise quickly and produce what is known as a "hot" fire. Temperatures above 149^{0}C (300^{0}F) are common and unconsciousness and death in this environment can occur within a few minutes. Bedrooms located in the upper floors of residences are frequently subjected to these conditions in the later stages of a fire.

In addition to deadly carbon monoxide, smoke carries poisons such as hydrogen cyanide plus irritants such as formaldehyde and acetic acid. Added to this lethal environment are the toxic substances that come from burning synthetic materials commonly found in the home, especially plastics. Oxides of nitrogen, sulphur dioxide and ammonia are just a few examples.

These agents can have an effect before a sleeper is disturbed. An early warning system – a smoke alarm – is considered one of the most effective defences against this situation.
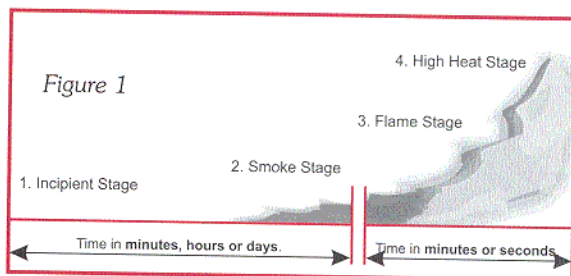
How Fire Progresses

Understanding the sequence of events in a residential fire makes it easier to appreciate how smoke alarms can provide a time margin that can **save** your **life.** Most fires progress through four distinct stages: the incipient stage; the smoke stage; the flame stage; and finally, the high heat stage. *See Figure 1.*

Incipient stage – there are no obvious fire signs. Smoke, flame and heat are not apparent. Thermal decomposition releases tiny combustion particles which are invisible to the human eye.

Smoke stage – combustion increases the size and output of particles which now become visible smoke. This usually happens with no appreciable increase in heat.

Smoke alarms can alert the occupants in these early stages of a fire while conditions are such that a safe evacuation is still possible.

Figure 1

4. High Heat Stage

3. Flame Stage

2. Smoke Stage

1. Incipient Stage

Time in **minutes, hours or days.**   Time in **minutes or seconds**

Flame stage – when enough heat is available, gases ignite. The outburst of flame produces heat. Great quantities of combustible gases are generated from the thermal decomposition of furniture and the building materials.

High heat stage – super-heated air rapidly carries the flame-front through the building making escape virtually impossible. Flames are at their peak, dense smoke is present, oxygen is rapidly consumed and air is heated to a killing intensity.

Fire Detection

There are three general types of detectors available. They are smoke alarms, heat or thermal detectors, and flame detectors.

Smoke alarms give the earliest warning of fire and are used where life, safety and protection are the primary concerns. They are ideal for residential use.

Heat or thermal detectors are generally used where the heat buildup can be expected to be rapid, as in small enclosed areas such as closets and storage rooms.

Flame detectors are generally used where any fire may first be expected to appear in the form of an open flame such as around flammable liquids and similar substances. They are not suitable for early warning during the incipient and smoke stages common in residential fires.

Smoke alarms are the best fire detection system for residential use.

How Smoke Alarms Operate

Smoke alarms are activated by the earliest signals of combustion. The two basic types are **photo-electric** and **ionization**.

The detector is that portion of a smoke alarm which actually senses the presence of combustion products. Here the term "smoke alarm" is used to describe a unit incorporating a detector, a power source and a device, usually a horn, which alerts the occupants of a building.

The **ionization alarm** contains a radioactive source in a smoke chamber that emits radiation, resulting in a weak flow of electric current. When particles such as ones produced by fire enter the smoke chamber, they reduce the current and trigger the alarm. *Figure 2* illustrates this type of alarm.

Ionization Smoke Alarm
Figure 2
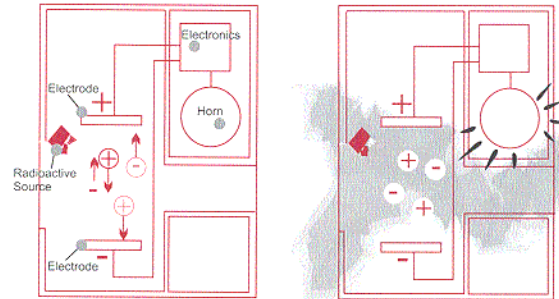
The **photo-electric alarm** contains a chamber with either overlapping or porous covers which prevent the entrance of outside sources of light but which allow the entry of smoke. The unit contains a light source and a special photosensitive cell in the darkened chamber. The cell and light are positioned within the alarm in one of the two manners indicated in *Figure 3* so that either the light beam is interrupted by the smoke as in the obscuration type or the beam is deflected into the cell as in the light-scattering type.

Photo-electric Smoke Alarm
Figure 3

Obscuring Type

Light Scattering Type
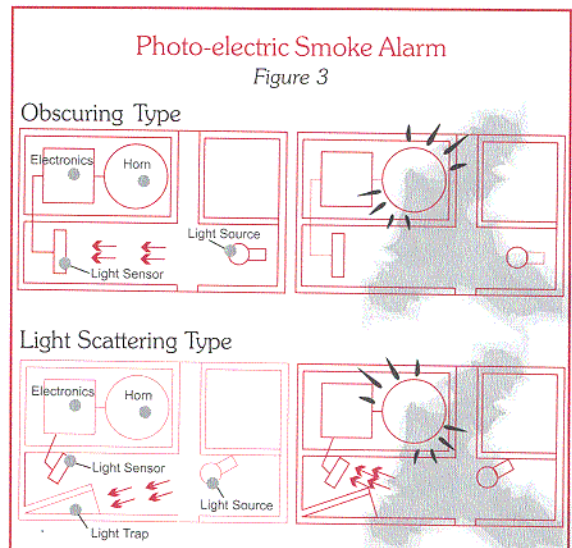
Locating Smoke Alarms in a Dwelling Unit

Every home, apartment suite, mobile home, or any other type of dwelling unit should have a **minimum** of one smoke alarm.

The major threat from fire is at night when everyone is asleep. Fires usually occur in some part of a dwelling outside of the bedrooms. The smoke alarm is therefore best located between each bedroom area and the rest of the dwelling unit.

The alarm serves to alert the occupants of the sleeping area to the presence of smoke before the escape route becomes blocked.

For those residences having sleeping areas located on more than one floor, or sleeping areas separated by common usage rooms such as kitchens or living rooms, a smoke alarm is required in the vicinity of each sleeping area.

The location of the smoke alarm in the vicinity of sleeping areas does not provide protection for the occupants from a fire starting in their bedroom with the door closed. It may be desirable, particularly if you smoke, to have additional alarms within each bedroom itself, and in other areas such as basements, family rooms, etc. Research indicates that substantial increases in warning time can be obtained with each properly installed additional alarm.

A closed door can delay the movement of smoke preventing it from reaching a smoke alarm. Fire confined in a large room often develops great intensity before it breaks out of the room. The basement is one area that can be large, remote from the alarm, and isolated by some type of closure at the top of the stairs such as a door. Basements also account for a significant number of fires. For these reasons, it is recommended that the smoke alarm be placed at the head of the stairs from the basement.

A smoke alarm is also recommended at the head of each stairway leading to an occupied area. This location may also serve the purpose of protecting a sleeping area in a two storey house if the room layout is suitable.

Figures 4 to 10 illustrate some of the locations discussed in dwelling units. Smoke alarms should be located on or near the ceiling.

The kitchen, bathroom, furnace room and garage are poor locations for a smoke alarm because of the proximity to products of combustion or steam which can trigger false alarms.

Locating Smoke Alarms in a Room, Hall or Stairway

Basic Rules
- Since the products of combustion rise toward the ceiling, for best performance, an alarm should be mounted on the ceiling in or near the centre of the room, hall or stairway.
- Should wall mounting be necessary, the optimum location is at least 15 cm (six in.) down from the ceiling but not more than 30 cm (12 in.).
- Avoid locations where the temperature is less than $5^{0}C$ ($41^{0}F$) or exceeds $48^{0}C$ ($119^{0}F$).
- Read the manufacturer's instructions carefully.

Avoid Air Currents
(Turbulent air may prevent combustion particles from reaching the alarm)
- Keep alarms away from doors and windows.
- Don't locate an alarm near fans or vents.
- Don't locate an alarm in front of an air register.

Avoid Nuisance Alarms
- Don't locate a smoke alarm in a kitchen. Burned toast and foods, plus the combustion effects caused by baking and broiling may trip the alarm.
- Don't locate an alarm in or near areas where high humidity is present, such as bathrooms.
- Don't locate a smoke alarm in the garage as your car engine produces particles which will trigger an alarm.

Avoid Dead Air Space
(Smoke tends to bypass corners, closets and dead ends)
- Keep alarms at least 60 cm (two feet) from any corner of a room.
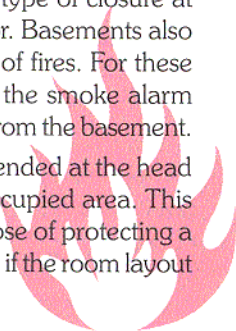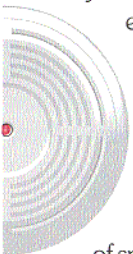
- Maintain a 15 - 30 cm (6 - 12 in.) clearance from a side wall when mounting an alarm on the ceiling.
- Don't recess an alarm.
- Smoke alarms in rooms with ceiling slopes greater than 30 cm (one foot) rise per 240 cm (eight feet) horizontally should be located at the high side of the room.
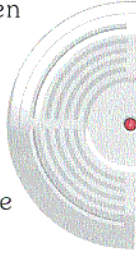
– But –

Avoid locating an alarm in the peak of an "A" frame type ceiling.

Other Important Details

When having an alarm connected into the electrical wiring system in a house:

(a) use a qualified electrical contractor;

(b) don't install a circuit disconnecting means except at the main panel;

(c) check the alarm's operation when the installation has been completed.

- Never paint a smoke alarm.
- Keep alarms 60 to 90 cm (two to three feet) away from light fixtures.

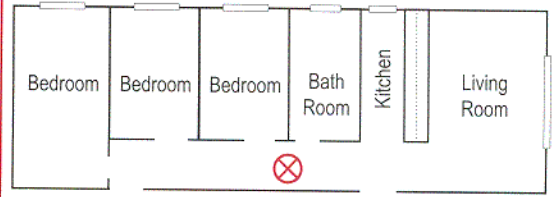⊗ Location of Smoke Alarms on Ceilings

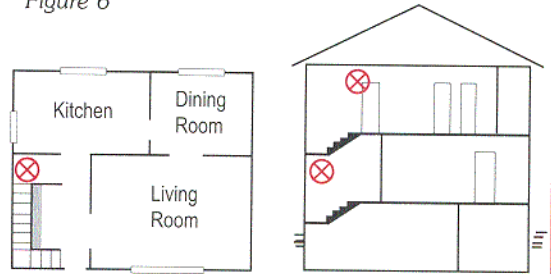**Single storey house with basement**
Figure 4
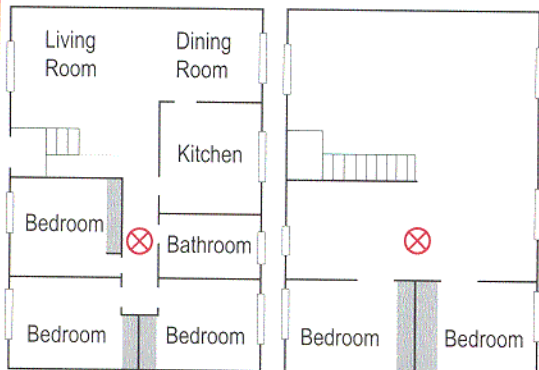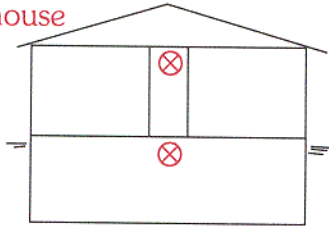
First Floor Plan

Basement Plan

Typical mobile home
Figure 5

Two storey house with basement
Figure 6
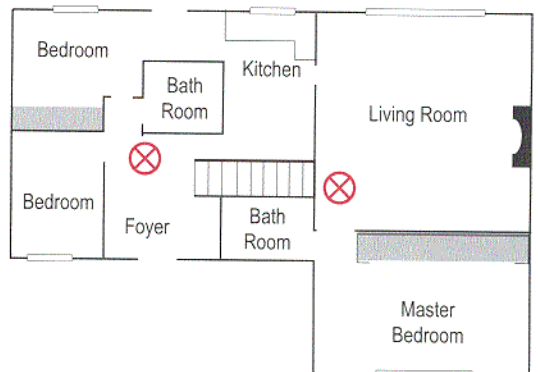
First Floor Plan

Second Floor Plan   Basement Plan

House with separate sleeping areas
Figure 7

Locating Smoke Alarms in Hotels, Motels, and Apartment Buildings

Every hotel, motel or dormitory-type **bedroom** is required to have a smoke alarm which should be mounted in or near the centre of the room, on the ceiling or, if on the wall, near the ceiling in the centre of the area to be covered. *Figure 11* illustrates a typical situation.

Where a residential-type building has a fire alarm system, **the corridor** is required to have smoke detector protection tied into the fire alarm system. *Figure 12* illustrates a typical situation.

Some of the parameters that should be considered are ceiling shape and surfaces, ceiling height, width and ventilation. On smooth ceilings with no forced air flow, a spacing of 9 metres (30 feet) on centre may be used as a guide. **This implies a limit of 4.5 metres (15 feet) to a wall.** In all cases, the manufacturer's recommendations should be followed.
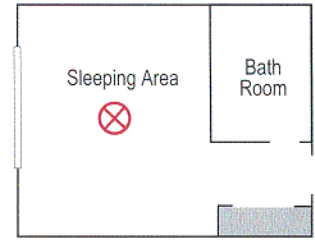
⊗ Location of Smoke Alarm on Ceiling

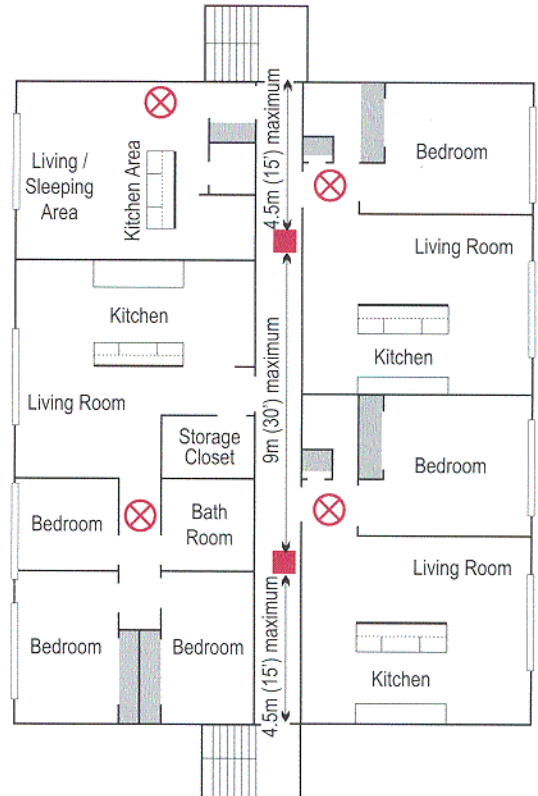🟥 Location of Smoke Detector on Ceiling
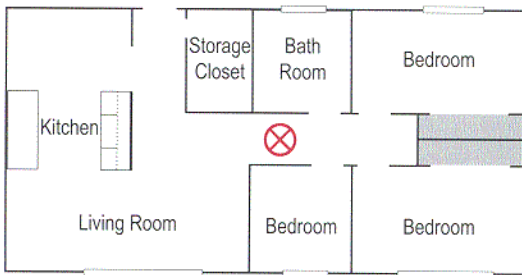
Typical motel unit
Figure 11

Sleeping Area ⊗

Bath Room

Typical room & corridor layout in apartment, hotel or motel
Figure 12

Living / Sleeping Area — Kitchen Area ⊗

4.5m (15') maximum

Bedroom

Living Room

9m (30') maximum

Kitchen

Kitchen

Living Room

Storage Closet

Bedroom

Bedroom ⊗ Bath Room

⊗ Living Room

Bedroom Bedroom

4.5m (15') maximum

Kitchen

Suite with more than one Bedroom
Figure 8

Kitchen

Storage Closet | Bath Room | Bedroom

⊗

Living Room | Bedroom | Bedroom

Suite with one bedroom
Figure 9

Kitchen

⊗ Bath Room

Living Room | Bedroom
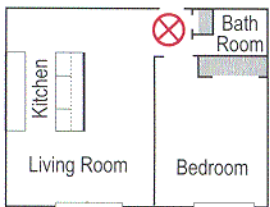
Bachelor Suite
Figure 10

Living/Sleeping Area

Kitchen Area ⊗

Bath Room | Storage Closet

Maintenance

Smoke alarms should be cleaned periodically (usually once every six months) as recommended by the manufacturers. This can be done by opening the cover and gently vacuuming out the interior of the alarm. The cover can usually be wiped clean with a damp cloth.

The operation of the smoke alarm should be checked monthly by activating the alarm with smoke to ensure that the alarm is functioning.

If the smoke alarm is battery operated, replace the battery when it's low – don't just remove it. With no battery, a smoke alarm is powerless to save your life.

Smoke alarms save lives by providing early warning of smoke and fire danger, but only if they are working properly.

For further information contact:

Fire Commissioner's Office
(780) 427-8392

Building and Fire Safety

(780) 427-8265

Call toll free from anywhere in Alberta by dialling 310-0000.

Visit the Alberta Municipal Affairs web site at:
www.gov.ab.ca/ma