Chapter 8

EMERGENCY SYSTEMS

Engineering Practices

ENPRA101A

Topic 8-4

EMERGENCY LIGHTING

ENPRA101A – Engineering Practice

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INTRODUCTION

- Evacuation systems must be installed in all buildings that are not single domestic residences.
- Regulatory requirements are from:
  - The Building Code of Australia,
  - AS2293 parts 1 & 2 (Emergency Evacuation lighting in Buildings)
- Requirements state that evacuation systems must be installed in all buildings that are not single domestic residences.

INTRODUCTION

- The evacuation system is required to supply adequate illumination to allow egress (exit) from the building in times of power failure.
- The method used to provide electrical power to egress lighting during times of mains power failure is divided into two broad categories:
  - A central battery system
  - A self contained system

CENTRAL BATTERY SYSTEM

- In this system supply to the evacuation lighting system is by a centralised battery bank.
- Fire rated cabling is run from the battery bank to supply light points throughout the building.
- Advantages of a centralised battery over self contained batteries are:
  - Reduced maintenance time
  - In some installations, can be less expensive to install
  - Lights can be simple LED or compact fluorescent lamps;
  - Batteries can be non specialised lead acid .

CENTRAL BATTERY SYSTEM

- Disadvantages of a centralised battery over self contained batteries are:
  - All cabling between the battery and the luminaires must be fire rated. (MIMS, PVC in steel conduit, Radox, etc);
  - Failure of the battery means total failure of the whole system;
  - Sensing of circuit failure in isolated areas is very complex;
  - A dedicated battery room is required which must be ventilated etc

SELF CONTAINED SYSTEM

- This is the most commonly used system.
- Individual luminaires are equipped with self contained batteries and chargers.
- Each luminaire is independent of all other parts of the evacuation system.
- Advantages of a self contained system are:
  - very flexible system (easy to modify during building alterations);
  - Simple monitoring of individual areas;

SELF CONTAINED SYSTEM

- Advantages of a self contained system (Cont'd)
  - The egress luminaires are simply connected to the local lighting circuit;
  - No specialised wiring required - fittings are connected to the local lighting circuit with whatever cabling is used in the rest of the installation;
  - Multiple batteries provide assurance against total failure of the system.

SELF CONTAINED SYSTEM

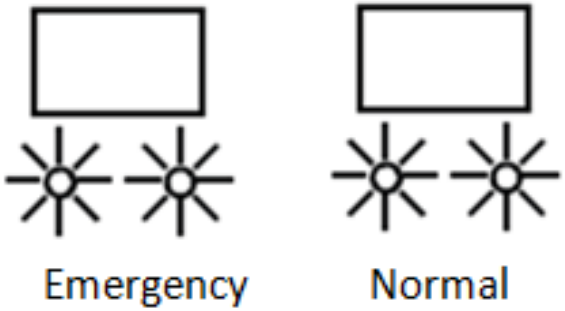
- Disadvantages of a self contained system are:
- Initial high cost of luminaires;
- Multiple batteries to check and maintain;
- Higher replacement cost for batteries.

EVACUATION LUMINAIRES

- Evacuation luminaires are divided into 3 types:
  - Maintained
  - Non-Maintained
  - Sustained

Maintained Luminaires

- Lamp is operated normally by the supply, and continues to operate on battery supply should mains failure occur (see diagram below).



EVACUATION LUMINAIRES

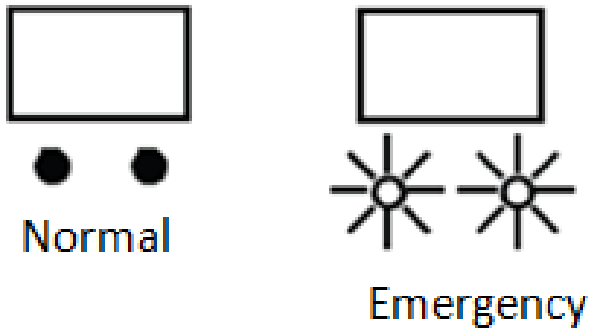
Maintained Luminaires (Cont'd)

- Until relatively recently maintained emergency luminaires usually consisted of 36, 18 or 9 Watt fluorescent lamps.
- Trend now is for compact fluorescent, LED and other energy saving lamps
- During emergency the same lamp(s) are powered from rechargeable battery via an inverter, both the battery and inverter being contained within the luminaire.
- Wiring modifications include the provision of an un-switched active to maintain battery charging.

EVACUATION LUMINAIRES

Non-Maintained Luminaires

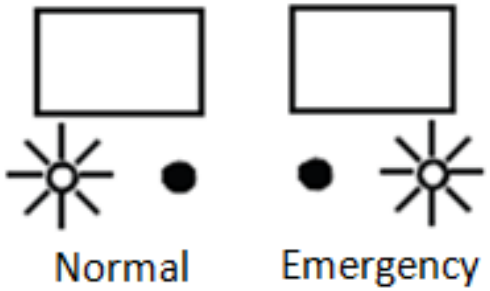
- Luminaire is off during normal supply periods, actuating when supply fails (see diagram below)
- Runs from either self contained battery or central battery.
- Lamps can be any of the energy efficient types



EVACUATION LUMINAIRES

Sustained Luminaires

- Two separate lamps are used, one for normal supply, and the other a separate unit for emergency supply. (See diagram below)



REQUIREMENTS OF THE BCA

- Some of the requirements of BCA and relevant Australian Standards for egress lighting include:
  - **Colour code for exit signs:**
    - white letters on green background;
  - **Position of exit signs:**
    - must be positioned within 2m of every change of direction
    - must be in positions where they can be seen from any point.

REQUIREMENTS OF THE BCA

- egress lighting requirements (Cont'd)
  - **Position of luminaires:**
    - to provide adequate illumination sources.
    - "Edge Lite" type exit signs are not to be used as illumination sources
    - The more common style of exit sign can be used as an illuminance source for the area immediately adjacent to the sign.
    - Minimum level required for evacuation lighting is 0.2 lux.

MAINTENANCE OF EMERGENCY EVACUATION ILLUMINATION SYSTEMS

- Batteries used in emergency lighting systems are either:
  - NiCad
  - Lead Acid
  - NiMH - (have now replaced NiCad in many applications)

NiCad (Nickel Cadmium) Batteries:

- Are more expensive (than Lead Acid)
- Have better discharge characteristic
- Have greater life expectancy - between 3 years and 6 years.

MAINTENANCE OF EMERGENCY EVACUATION ILLUMINATION SYSTEMS

NiCad (Nickel Cadmium) Batteries (Cont'd)

- Must be deep cycled for max. life
- Subjected to regular partial discharging suffer from 'memory' resulting in reduced capacity.
- Should be stored (for long periods) discharged

Lead Acid (or 'gel' sealed type) Batteries

- Are cheaper than NiCad
- Have greater capacity for the same physical size (although heavier).
- Have a life expectancy - between 2 years and 5 years.

MAINTENANCE OF EMERGENCY EVACUATION ILLUMINATION SYSTEMS

Lead Acid (or 'gel' sealed type) Batteries (Cont'd)

- Are not particularly suitable for deep cycling. By fully discharging a lead acid battery, life expectancy is shortened and capacity is reduced.

TESTING

- All emergency systems are required to be tested on a regular basis (every six months).
- This testing involves removal of power supply from the area and running the egress system on battery for the prescribed time (normally 90 minutes).
- Units that fail to operate for the minimum time must be replaced.

SPECIAL REQUIREMENTS

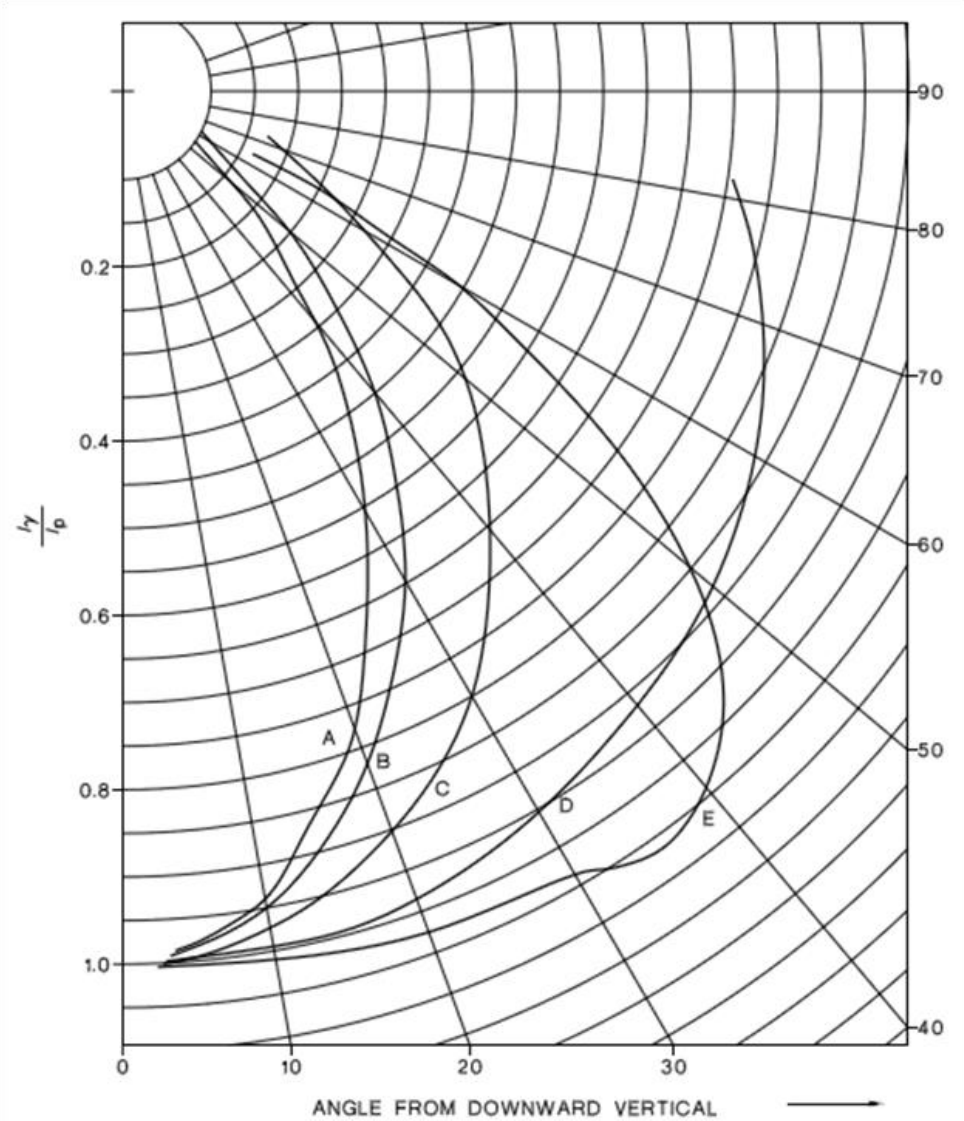
- Sites such as theatres require special lighting controls.
- All theatres, shows, etc, are required to have a master switch in the main entry area to turn all lights on in an emergency.
- This system allows emergency services (fire ambulance police etc) to turn all lights on, regardless of other controls.

LUMINAIRE CLASSIFICATION

- Emergency luminaires are available in several different types to suit various applications.
- Emergency luminaire have a photometric classification that is used with a photometric chart to determine spacings for given mounting heights.
- The resultant spacings provide the required standard minimum of 0.2 Lux of emergency lighting in the determine area.

LUMINAIRE CLASSIFICATION

- The method used for classifying emergency luminaires is given in **AS 2293** and uses an alpha-numeric method.
- The alphabetic component of the classification, is in the form of the letters A, B, C, D or E and is an indicator of the 'beam spread'.
- The photometric curves corresponding to these letters are given in **AS 2293,** Part 3, Fig. C2 and is reproduced below as **Fig PF-8-4-1** .



NOTE: It is not necessary for the intensity distribution curve for an emergency escape luminaire to precisely match the indicative curves illustrated above, only that the luminous intensities at particular measurement angles be not less than the minimum values determined in accordance with Paragraph C3.2.2.

Fig **PF-8-4-1** (reproduced from Fig C2 of **AS 2293 Part 3**,

LUMINAIRE CLASSIFICATION

- The numerical component of the classification is the actual luminous intensity of the particular luminaire.
- The permissible numbers are 1, 1.25, 1.6, 2, 2.5, 3.2, 4, 5, 6.3, 8, 10, 12.5, 16, 20, 25, 32, 40, 50.....etc.
- The classification of the luminaire is done by the manufacturer who will supply a table giving correct spacing for each class of luminaire for a particular mounting height to give the statutory level of illumination (0.2 Lux). A partial table is shown in **Fig PF-8-4-2**.

Classification	Mounting Height in Metres									
	2.1	2.4	2.7	3.0	3.3	3.6	4.0	4.5	5.0	6.0
C2.0	4.1	4.1	4.1	3.9	3.7	3.3	2.6			
C2.5	4.5	4.6	4.6	4.5	4.4	4.2	3.7	2.8		
C3.2	5.0	5.1	5.2	5.2	5.2	5.1	4.8	4.3	3.4	
C4	5.4	5.6	5.7	5.8	5.8	5.8	5.7	5.3	4.8	2.6
C5	5.9	6.1	6.3	6.4	6.5	6.5	6.5	6.3	6.0	4.8
C6.3	6.3	6.6	6.8	7.0	7.3	7.3	7.3	7.3	7.1	6.4
C8	6.8	7.2	7.4	7.7	7.9	8.0	8.2	8.3	8.2	7.8
C10	7.3	7.7	8.0	8.3	8.6	8.8	9.0	9.1	9.2	9.1
C12.5	7.8	8.2	8.6	8.9	9.2	9.5	9.8	10.0	10.2	10.3
C16	8.3	8.8	9.3	9.7	10.0	10.3	10.7	11.0	11.3	11.6
C20	8.9	9.4	9.9	10.3	10.7	11.1	11.5	12.0	12.3	12.8
C25	9.4	10.0	10.5	11.0	11.5	11.9	12.4	12.9	13.4	14.0
C32	10.0	10.7	11.3	11.8	12.3	12.8	13.4	14.0	14.5	15.4
C40	10.6	11.3	12.0	12.6	13.1	13.6	14.3	15.0	15.6	16.6
C50	11.3	12.0	12.7	13.4	14.0	14.5	15.2	16.0	16.7	17.9
D3.2	6.5	6.6	6.6	6.5	6.4	6.2	5.8	5.1	4.1	
D4	7.2	7.3	7.3	7.3	7.3	7.2	6.9	6.5	5.8	3.1
D5	7.8	8.0	8.1	8.2	8.2	8.2	8.0	7.7	7.3	5.7
D6.3	8.6	8.8	9.0	9.1	9.2	9.2	9.2	9.0	8.7	7.7
D8	9.4	9.7	9.9	10.1	10.2	10.3	10.4	10.3	10.2	9.5
D10	10.2	10.6	10.9	11.1	11.3	11.4	11.5	11.6	11.6	11.2
D12.5	11.5	11.5	11.8	12.1	12.4	12.5	12.7	12.9	13.0	12.8
D16	12.1	12.6	13.0	13.3	13.6	13.9	14.1	14.6	14.6	14.6
D20	13.1	13.6	14.1	14.5	14.8	15.1	15.5	15.8	16.1	16.4
D25	14.2	14.7	15.3	15.7	16.1	16.5	16.9	17.3	17.7	18.1
D32	15.4	16.1	16.7	17.2	17.6	18.0	18.5	19.1	19.5	20.2
D40	16.7	17.4	18.0	18.6	19.1	19.6	20.1	20.8	21.3	22.1
D50	18.0	18.7	19.4	20.1	20.7	21.2	21.8	22.5	23.2	24.2
D63	19.4	20.3	21.1	21.8	22.4	23.0	23.7	24.5	25.2	26.4
E10	7.8	8.4	9.0	9.4	9.8	10.2	10.8	11.2	11.4	11.8
E12.5	8.0	8.8	9.4	10.0	10.4	11.0	11.4	12.0	12.4	13.0
E16	8.4	9.2	9.8	10.6	11.0	11.6	12.2	12.8	13.4	14.4
E20	8.8	9.6	10.4	11.0	11.6	12.2	13.0	13.6	14.4	15.4
E25	9.0	10.0	10.8	11.4	12.2	12.8	13.6	14.4	15.2	16.6
E32	9.4	10.2	11.2	12.0	12.8	13.4	14.4	15.4	16.2	17.8

Fig **F-8-4-2**
Table of required luminaire spacing to give 0.2 Lux for a given mounting height

LUMINAIRE CLASSIFICATION

- The numerical component of the classification is the actual luminous intensity of the particular luminaire.
- The permissible numbers are 1, 1.25, 1.6, 2, 2.5, 3.2, 4, 5, 6.3, 8, 10, 12.5, 16, 20, 25, 32, 40, 50.....etc.
- The classification of the luminaire is done by the manufacturer who will supply a table giving correct spacing for each class of luminaire for a particular mounting height to give the statutory level of illumination (0.2 Lux).
- A partial table is shown in **Fig PF-8-4-2**.

SPECIFIC LOCATIONS

- Emergency escape luminaires are required:
  - within 2m of the approach side of each doorway requiring an exit sign:
  - within 2m of the intersection of the centre-lines of intersecting corridors.
  - within 2m of the intersection of centre-lines at each change of direction (other than on a staircase).
  - within 2m of any change of floor level, on the low' side.

SPECIFIC LOCATIONS

Exits

- AS 2293 states that exit signs of compliant design must be installed in the locations determined as necessary in accordance with the BCA.
- A typical exit luminaire is shown at **Fig PF-8-4-3**, the one shown is illuminated by a 10W fluorescent tube and has a maximum viewing distance of 24m

Fig **PF-8-4-3** Typical exit luminaire complying with **AS 2293**

SPECIFIC LOCATIONS

Stairwells.

- Three acceptable methods of determining location and spacing of emergency luminaires in stairwells are given in AS 2293:
  - Direct lighting (spacing rules)
  - Direct lighting (illuminance calculations)
  - Indirect lighting (illuminance calculations).

SPECIFIC LOCATIONS

Corridors

- An emergency escape luminaire should be sited
  - Within 2 m of the intersection of the centre-lines of intersecting corridors.
  - Within 2 m of the intersection of centre-lines at each change of direction

Topic 8-5

FIRE DETECTION SYSTEMS

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INTRODUCTION

- The fire detection system in buildings may sense either heat or smoke or a combination of these.
- Smoke detectors are increasingly being used because of their earlier warning of an emergency situation.
- Smoke detectors may also be used to activate fire doors to isolate zones in the building.
- The Building Code of Australia (BCA) together with individual State legislation provide the requirements for fire safety in buildings.

INTRODUCTION

- BCA classifies buildings into 10 groups with each group having slightly different requirements. For information these groups are shown below
- Part 1 of the BCA deals with requirements of building classes 2 through to 9, while part 2 sets out requirements for building classes 1 and 10.
- In summary buildings class 1 and 10 are houses, sheds, carports etc., and buildings class 2 to 9, are primarily commercial and public buildings.

Building Class	Type of building
Class 1	**Class 1a** - a single dwelling being i. a detached house; ii. one of a group of two or more attached dwellings, each being a building, separated by a *fire-resisting* wall, including a row house, terrace house, town house or villa unit; **Class 1b** - a boarding house, guest house, hostel or the like i. with a total area of all floors not exceeding 300 m^2 measured over the enclosing walls of the Class 1b; and ii. in which not more than 12 persons would ordinarily be resident, which is not located above or below another dwelling or another Class of building other than a private garage.
Class 2	a building containing 2 or more sole-occupancy units each being a separate dwelling.

Class 3	Backpacker accommodation, residential parts of hotels or motels, residential parts of schools, accommodation for the aged, disabled or children a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including - a. a boarding-house, guest house, hostel, lodging-house or backpackers accommodation; or b. a residential part of a hotel or motel; or c. a residential part of a school; or d. accommodation for the aged, children or people with disabilities; or e. a residential part of a health-care building which accommodates members of staff; or f. a residential part of a detention centre.

Class 4	a dwelling in a building that is Class 5, 6, 7, 8 or 9 if it is the only dwelling in the building.
Class 5	an office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9.
Class 6	a shop or other building for the sale of goods by retail or the supply of services direct to the public, including: a. an eating room, cafe, restaurant, milk or soft-drink bar; or b. a dining room, bar, shop or kiosk part of a hotel or motel; or c. a hairdresser or barber shop, public laundry, or undertaker establishment; or d. market or sale room, showroom, or service station.
Class 7	**a. Class 7a** - a carpark; or **b. Class 7b** - for storage, or display of goods or produce for sale by wholesale.

Class 8	a laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain.
Class 9	**a.** **Class 9a** - a health-care building, including those parts of the building set aside as a laboratory; or **b.** **Class 9b** - an assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class; or **c.** **Class 9c** - an aged care building.
Class 10	**a.** **Class 10a** - a non-habitable building being a private garage, carport, shed, or the like; or **b.** **Class 10b** - a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.

DESIGN OF DETECTORS

Ionisation Smoke Detector

- Has an ionisation chamber containing a minute amount of radioactive material (Americium).
- Under normal conditions the air in the ionisation chamber is ionised and conductive
- This allows a small current to flow from the battery through the chamber, through the detection circuit and back to the battery.

DESIGN OF DETECTORS

Ionisation Smoke Detector (Cont'd)

- When smoke enters the chamber it disrupts the current flow and activates an alarm. See **Fig PF-8-5-1** for principle of operation.
- Ionization smoke detection is generally more responsive to flaming fires.

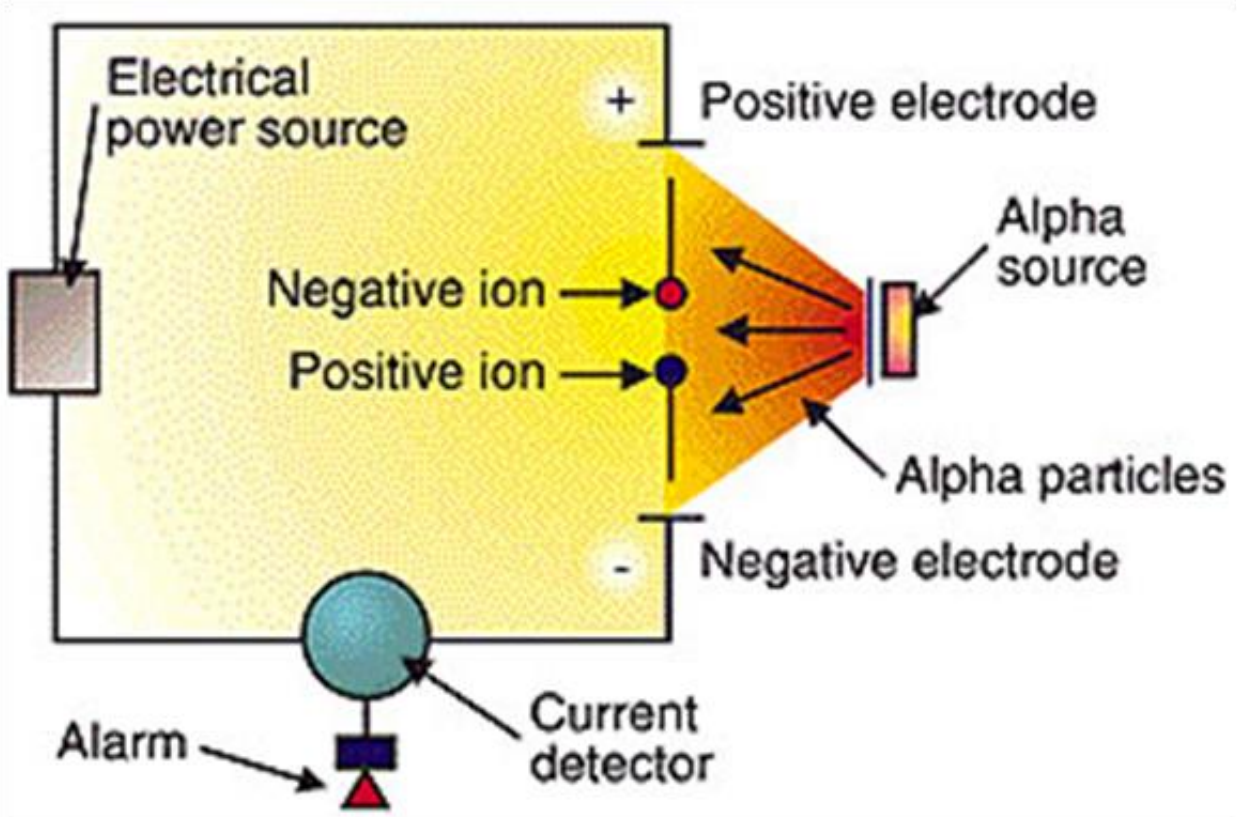

Fig PF-8-5-1 Principle of Operation of an ionisation type detector

DESIGN OF DETECTORS

Photoelectric Smoke Detector

- Photoelectric smoke detectors use the principle of scattered or reflected light to indicate the presence of **visual smoke**.
- In the absence of smoke, the chamber is dark and light shines across the chamber and is received in a light trap on the far side.

DESIGN OF DETECTORS

Photoelectric Smoke Detector (Cont'd)

- When smoke is present in the chamber, a photocell located at right angles to the light source senses the light scattered off the smoke particles and, at a certain level of illumination, triggers the alarm.
- See **Fig PF-8-5-2** for principle of operation and **Fig PF-8-5-3** for physical appearance .
- Photoelectric smoke detection is generally more responsive to fires that begin with a long period of smouldering.

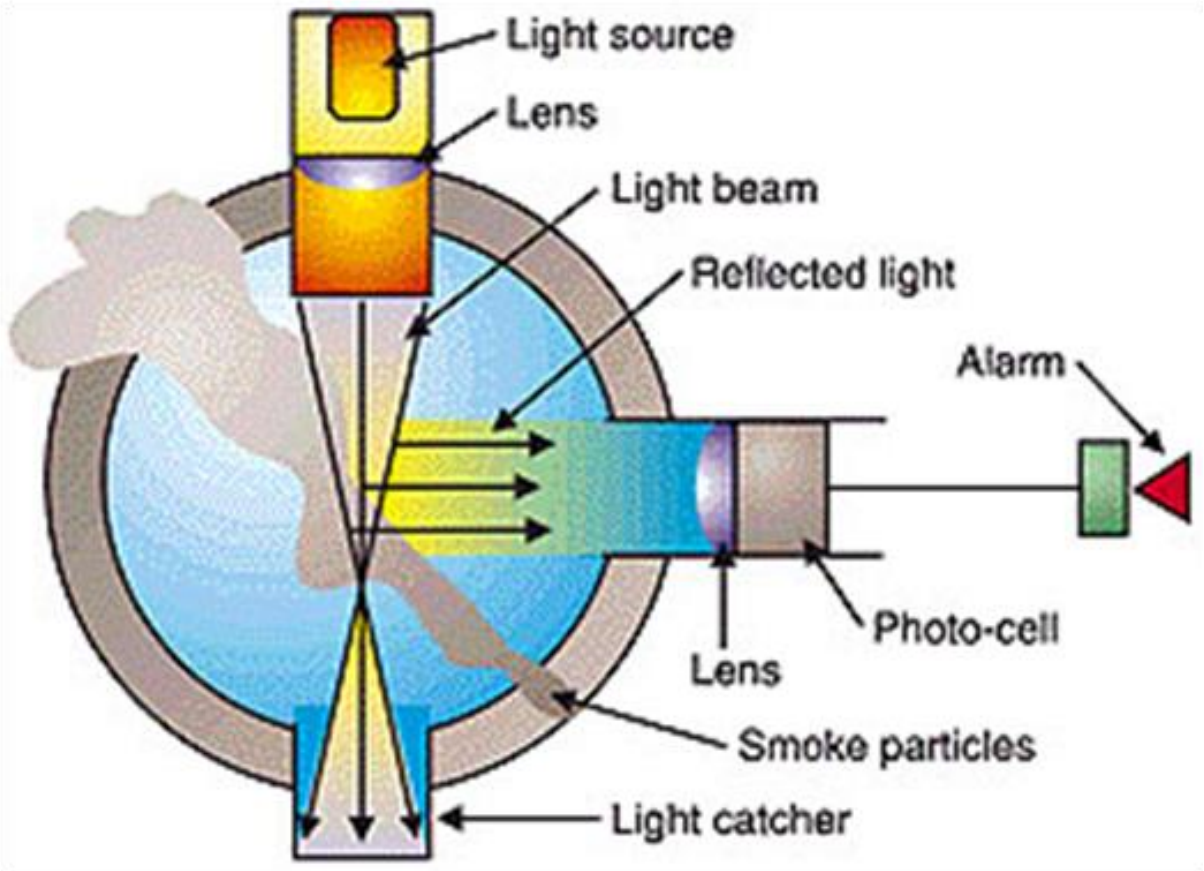

Fig PF-8-5-2 Principle of Operation of a Photoelectric type detector

Fig PF-8-5-3 Typical optical type smoke detector

DESIGN OF DETECTORS

Heat Detector

- Two types are available:
  - **Fixed Temperature Detector**

    A fixed temperature detector measures the air temperature surrounding it

    It is the most common type of heat detector.

    For electrically connected heat detectors, the most common fixed temperature is around 58°C.

    Newer detectors trigger at temperatures as low as 47°C

DESIGN OF DETECTORS

Heat Detector types (Cont'd)

- **Rate-of-Rise Detector**

  A rate-of-rise detector monitors changes in temperature, for example an explosion.

  This type of heat detector is able to operate at a lower temperature than a fixed temperature detector.

BCA REQUIREMENTS

- BCA outlines the statutory requirements for Fire and Smoke detection and Alarm Systems.
- The full reference for the relevant section is:

  BCA Volume 1, Section E, Specification E2.2a Smoke Detection and Alarm Systems

- It is strongly advised BCA is consulted before any design activity involving smoke detection and alarm systems is undertaken.

BCA REQUIREMENTS

- Specification ***E2.2a*** sets out the requirements as follows:
  i. **Scope**
  ii. **Type of system**
  iii. **Smoke Alarm System**
  iv. **Smoke Detection System**
  v. **Smoke Detection For Smoke Control Systems**
  vi. **Building Occupant Warning System**
  vii. **System Monitoring**

GENERAL COMPLIANCE WITH STANDARDS

- Basic requirement of a smoke alarm is as follows;
  1. It is to be hard wired to mains supply IAW AS 3000
  2. Must have battery back up
  3. Must have low battery warning
  4. Must have a battery removed warning facility built into circuit
- Smoke alarms must comply with AS 3786.
- Smoke alarms installed prior to 1 May 2006 that do not comply with AS3786 will be deemed to comply (if they are working and in the correct location).

INSTALLING SMOKE ALARMS

- Aim of a smoke alarm is to awaken sleeping occupants.
- Therefore the focus should be on sleeping areas.
- For complete protection smoke alarms should be installed in all rooms (accept those where combustion particles normally present - kitchen, etc).
- Smoke alarms are most effective when located on the ceiling, preferably away from walls and fittings.
- The best locations are in hallways leading from bedrooms and in sleeping areas.

INSTALLING SMOKE ALARMS

- Smoke alarms must be installed on or near the ceiling.
- Special care is required to avoid ‘dead air spaces’.
- A dead air space is an area in which trapped air will prevent smoke from reaching the alarm (See Fig **Fig PF-8-5-4**).

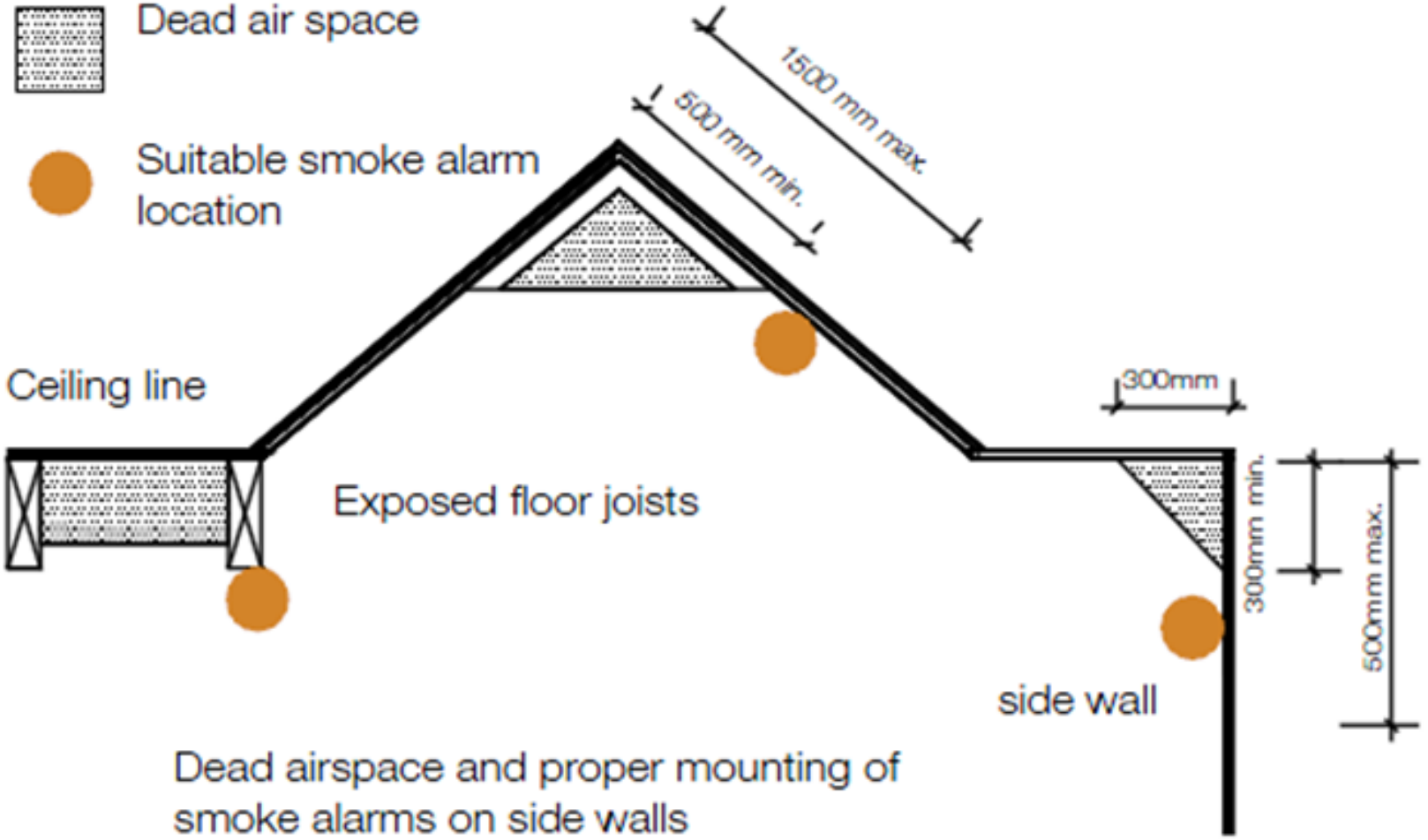

Fig PF-8-5-4 Location of Smoke Detectors

HOUSES, VILLAS ETC. AND RE-LOCATABLE HOMES (BCA CLASS 1A)

- In Class 1a buildings and re-locatable homes, smoke alarms must be installed on every storey.

Storeys with bedrooms

- In storeys containing bedrooms smoke alarms are to be located on or near the ceiling:
  - in every corridor or hallway associated with a bedroom, or
  - if there is no corridor or hallway, between the part of the building containing the bedroom and the remainder of the building or home.

HOUSES, VILLAS ETC. AND RE-LOCATABLE HOMES (BCA CLASS 1A)

Storeys with bedrooms (Cont'd)

- **Fig PF-8-5-5** shows preferred location of smoke alarm in a dwelling where bedrooms are grouped together and connected to the living areas by a corridor or hallway.
- In those dwellings where the bedrooms are not grouped together or no connecting hallway exists, then smoke alarms should be located as shown in **Fig PF-8-5-6**.

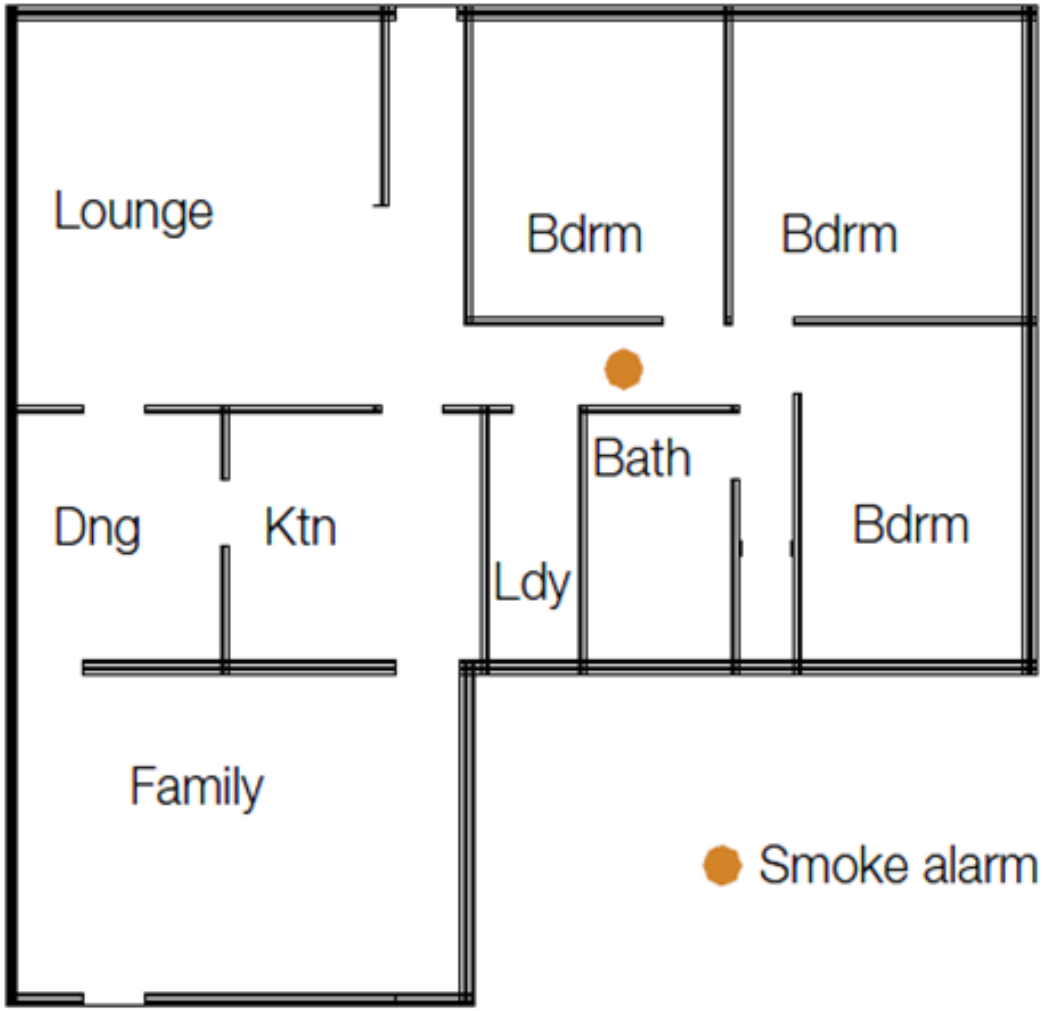

Fig PF-8-5-5 Dwellings with bedrooms grouped together

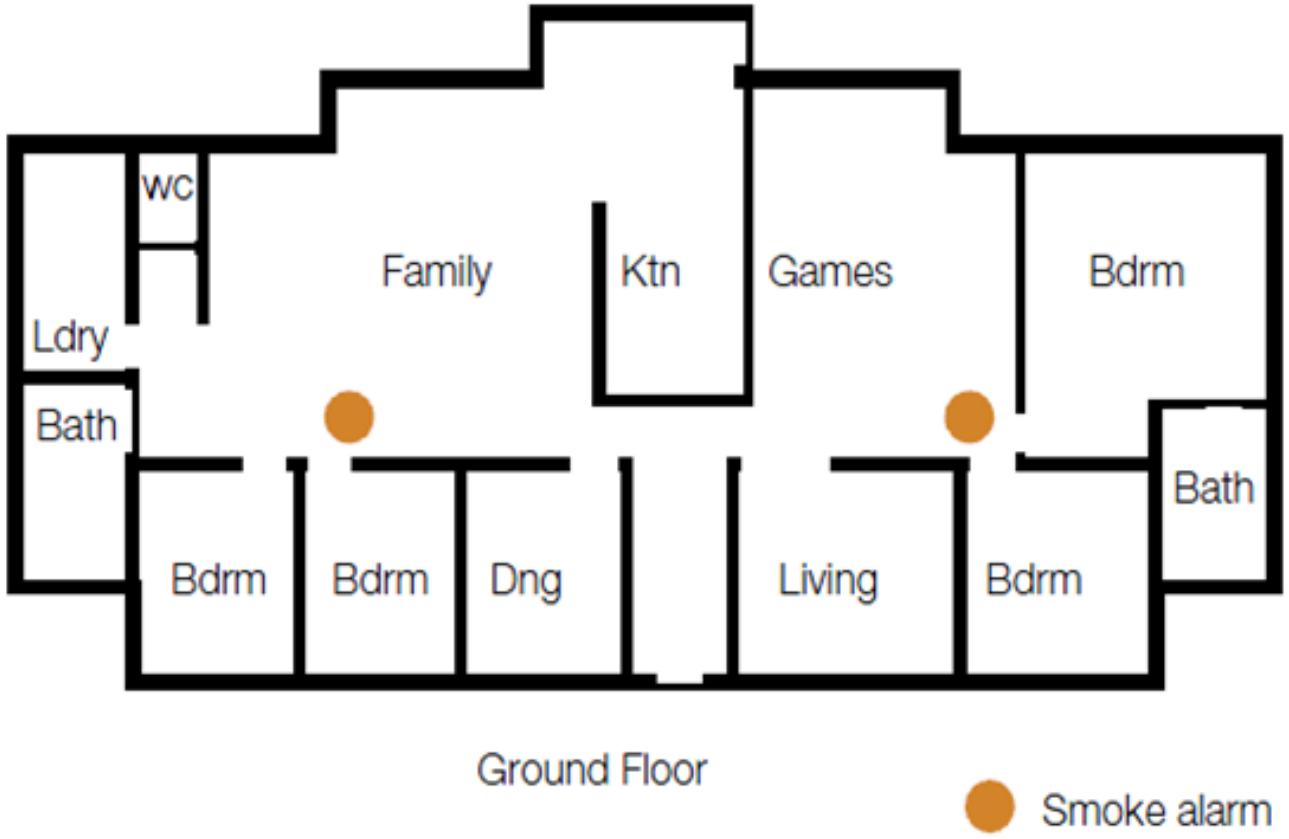

Fig PF-8-5-6 Dwellings with separated sleeping areas

HOUSES, VILLAS ETC. AND RE-LOCATABLE HOMES (BCA CLASS 1A)

Storeys with no bedrooms

- A smoke alarm must be installed in storeys not containing bedrooms.
- In these storeys a smoke alarm should be located in the path of travel people will most likely take to evacuate the building.
- This will ensure an alarm is sounded before smoke makes the escape route impassable.

HOUSES, VILLAS ETC. AND RE-LOCATABLE HOMES (BCA CLASS 1A)

Storeys with no bedrooms (Cont'd)

- If the bedrooms are on the first floor, then an alarm should be positioned near the area of the interconnecting stair, as shown in **Figs PF-8-5-7** and P**F-8-5-8** .
- Alarms should be mounted at or near centre of ceiling and mounted outside entrance to each bedroom where no common hallway (distance of 900mm recommended).

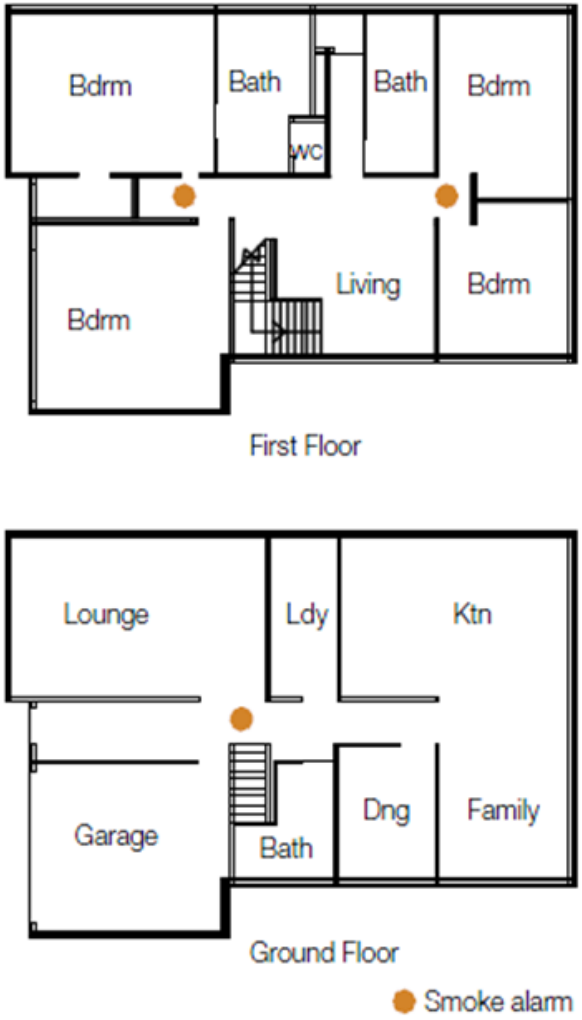

Fig PF-8-5-7 Two storey dwelling showing smoke alarms in the storey containing bedrooms (first floor) and the storey not containing bedrooms (ground floor)

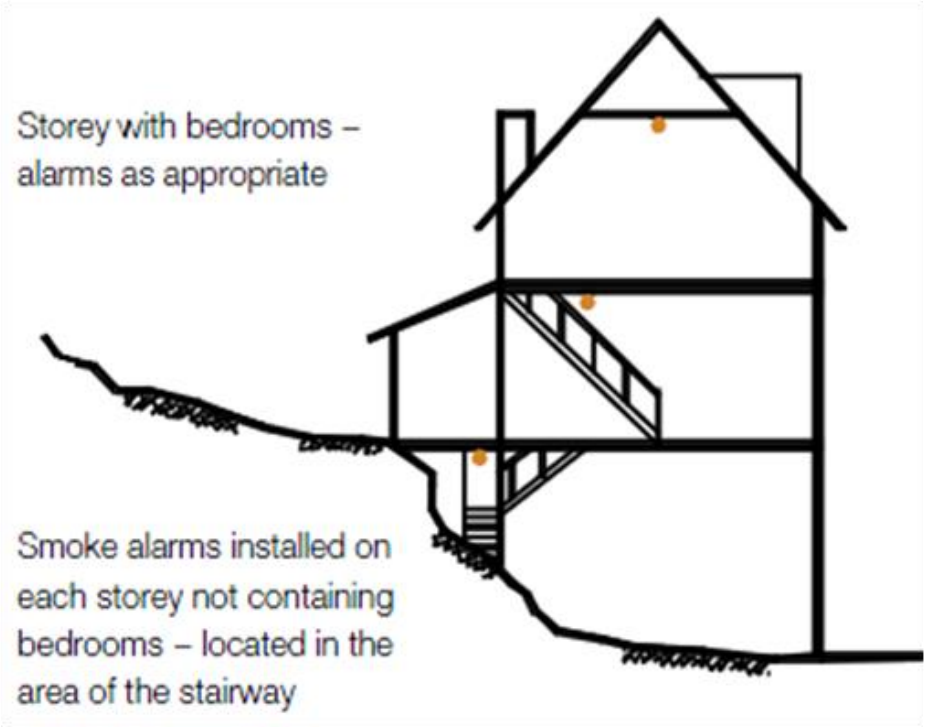

Fig PF-8-5-8 : Section through a dwelling showing smoke alarms in the storey containing bedrooms (top floor) and the storeys not containing bedrooms. Smoke alarms located within area of stairway

SMALL BOARDING HOUSES, GUEST HOUSES, HOSTELS, B&BS ETC (BCA CLASS 1B)

- In Class 1b buildings, smoke alarms must be installed on every storey, See **Fig. PF-8-5-9**.

Storeys with Bedrooms

- In storeys containing bedrooms, smoke alarms must be installed on or near the ceiling in every:
  - bedroom
  - corridor or hallway associated with a bedroom, or, if there is no such corridor or hallway, between each part of the building containing a bedroom and the remainder of the building.

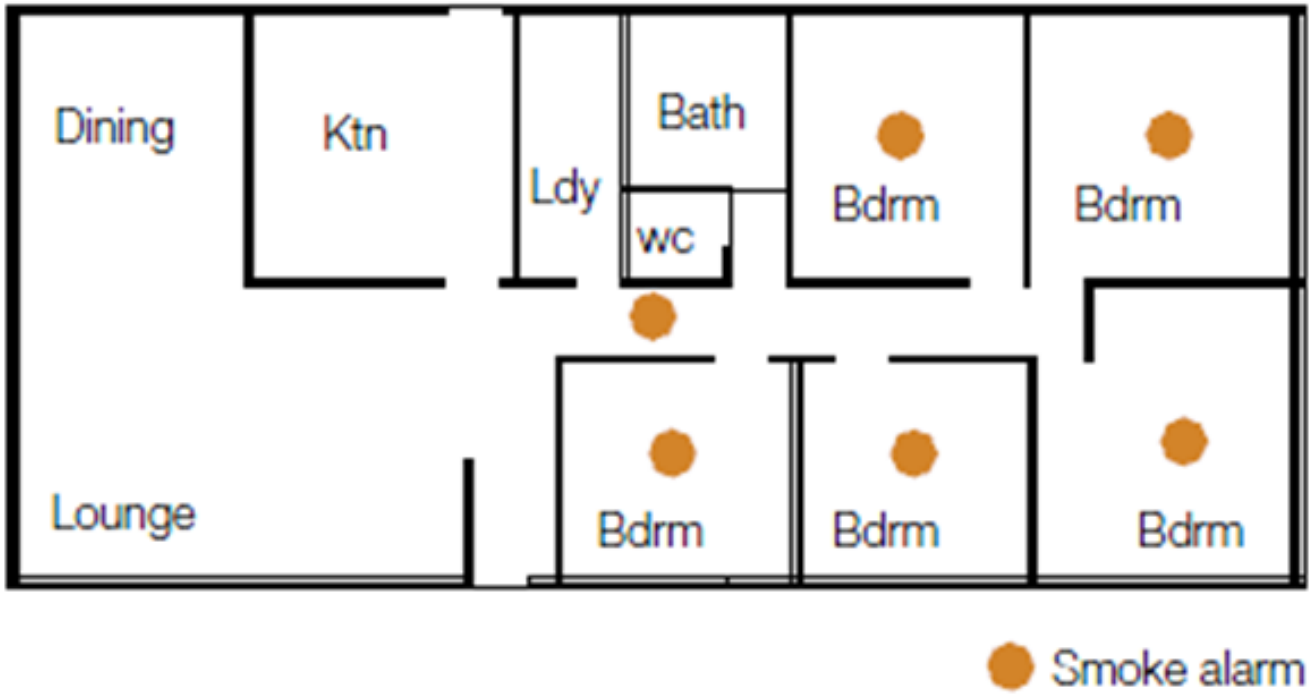

Fig PF-8-5-9 Example for small boarding houses, guest houses, hostels, B&Bs etc

SMALL BOARDING HOUSES, GUEST HOUSES, HOSTELS, B&BS ETC (BCA CLASS 1B)

Storeys with no Bedrooms

- A smoke alarm must be installed in storeys not containing bedrooms.
- In these storeys smoke alarms should be located in the path of travel people will most likely take to evacuate the building, similar to that for Class la buildings.

APARTMENTS, UNITS AND FLATS (BCA CLASS 2)

- Smoke alarms must be installed within each home unit or apartment in a Class 2 building.
- The requirements for the location of smoke alarms for dwellings in Class 2 buildings are the same as those for Class 1a buildings.


END