Colt International Ltd

General Principles of Smoke Control

CPD Technical Seminar 2020

CPD Accreditation

Colt International Limited

CIBSE CPD

Certification

of CPD course provision

This is to certify that

Colt International Ltd

has been registered as a CPD Course Provider by
The Chartered Institution of Building Services Engineers (CIBSE)

Accredited from 1 June 2019 to 31 May 2021

Andrew Rowe
CPD Panel Chair
CIBSE

Olga Mendes
Membership Development Manager
CIBSE

The Chartered Institution of
Building Services Engineers
222 Balham High Road
London SW12 9BS
T: 020 8675 5211
E: info@cibse.org
www.cibse.org

CIBSE CPD

Colt have a number of CPD accredited topics including:

- Car park ventilation
- The general principles of smoke control
- Pressurisation
- Smoke shafts
- Overheating common corridors
- Smoke and fire curtains
- Louvre
- Evaporative cooling

A brief history of Colt

Colt International Limited

Founded in

1931

2017 UK turnover

£35 million

2017 Group turnover

£180 million

Manufacturing facilities in

UK, Holland & Germany

Accreditations and Memberships

Colt International Limited

Accreditations

- CHAS
- Construction Line
- Safe Contractor
- Worksafe Contractor
- RoSPA

PPQ still required by clients

Chas Accredited

Constructionline
Part of Capita plc

IFC certification
CERTIFICATED INSTALLER OF ACTIVE FIRE PROTECTION

smas worksafe contractor
www.smasltd.com
as recognised by SSIP SAFETY SCHEMES IN PROCUREMENT

health in CONSTRUCTION leadership group

QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001

ENVIRONMENTAL SYSTEM CERTIFICATION DNV·GL ISO 14001

SAFETY SYSTEM CERTIFICATION DNV·GL ISO 45001

Memberships

BSRIA

CIBSE PATRONS

ASFP

CIBSE CPD

FETA

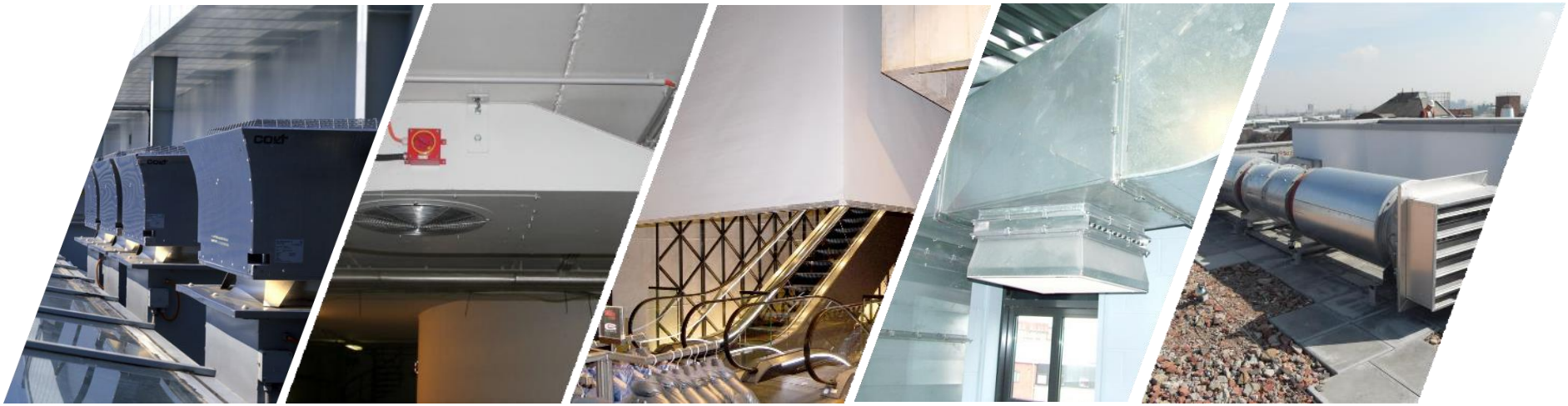
Smoke Control

Climate Control

Louvre & Shading

Service

Smoke Control



SHEVS
Smoke and Heat
Exhaust Systems

Car Park
Ventilation

Smoke
Containment

Pressurisation
Systems

Smoke Shaft
Systems

Climate control

Natural Ventilation

Mechanical Ventilation / HVAC

Evaporative Cooling

Industrial Heating

Louvre

Screening | Ventilation & Rain Defence | Shading | Acoustic

Service

24 hour call out

Nationwide Coverage

Spare Parts

Surveys

Smoke Control

General Principles of Smoke Control 2020

- **History & Development**
- Case Studies
- Why Provide Smoke Control?
  - Smoke clearance Vs smoke control
  - Design Fires
  - Sprinklers
  - Wind Effects
  - Natural or Mechanical?
  - Smoke Reservoirs
- Buildings Types

1953 - General Motors Factory, Michigan

- 6 dead
- 140,000m^2 plant destroyed
- Loss of production of automatic gearboxes for 5 major car manufacturers

Theatre Fires

1881 – Ring Theatre, Vienna – 800 dead

1887 – Theatre Royal, Exeter – 187 dead

1887 – Paris Opera – 200 dead

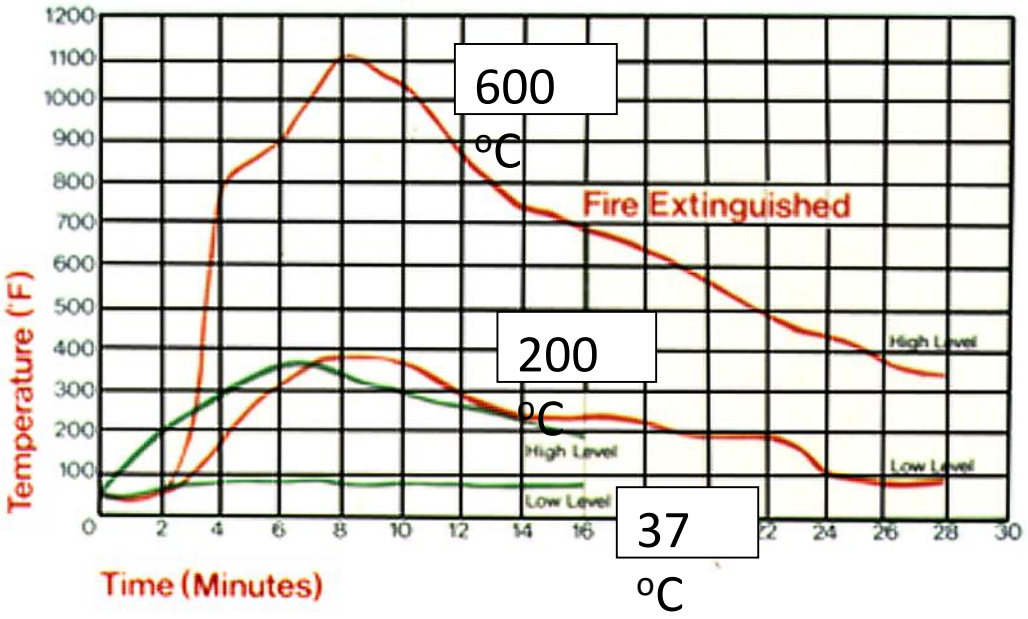
1903 – Iroquois Theatre, Chicago – 602 dead

Portsmouth Fire Test

Temperature recorded on North column thermocouple

Red – Unvented

Green - Vented



Current Documents:

The Building Regulations 2010: Approved Document B (2019)

Codes of Practice:	BS 9999, BS 9991
Specifications:	EN 12101-1, 2, 3, 7, 8 & 10
Design Guidance:	BR 368 – Design Methodologies for Smoke and Heat Exhaust Ventilation BS 7346-4, 5 & 7, CEN TR 12101-5 BS 7974

Smoke Control

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Some recent large fires:

- King's Cross
- B&Q - Leicester
- Dusseldorf Airport
- Heathrow Airport
- Bradford City Football stadium
- York Minster
- Sainsbury's - Chichester
- Windsor Castle
- Warehouse, Atherstone
- Grenfell

Arsonist set fire to this unsprinklered and unvented store, shortly before Christmas. £14.5 million worth of damage including loss of building, loss of all stock and loss of business for many months to follow.

17 people killed including a child, several women and a police officer. Over 60 injured due to smoke logging from a relatively small fire spreading throughout the Terminal.

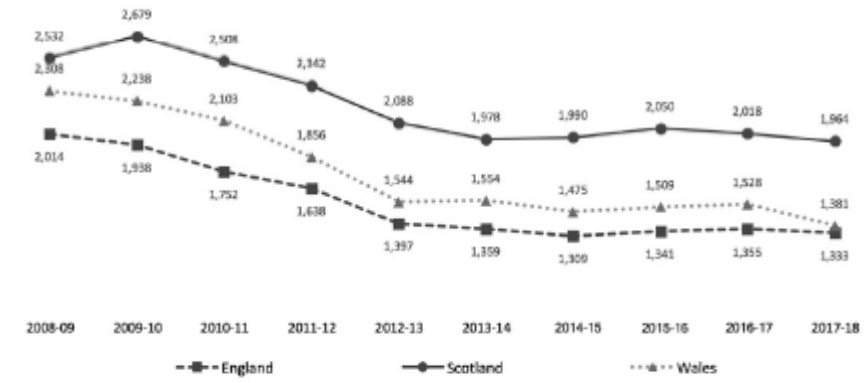
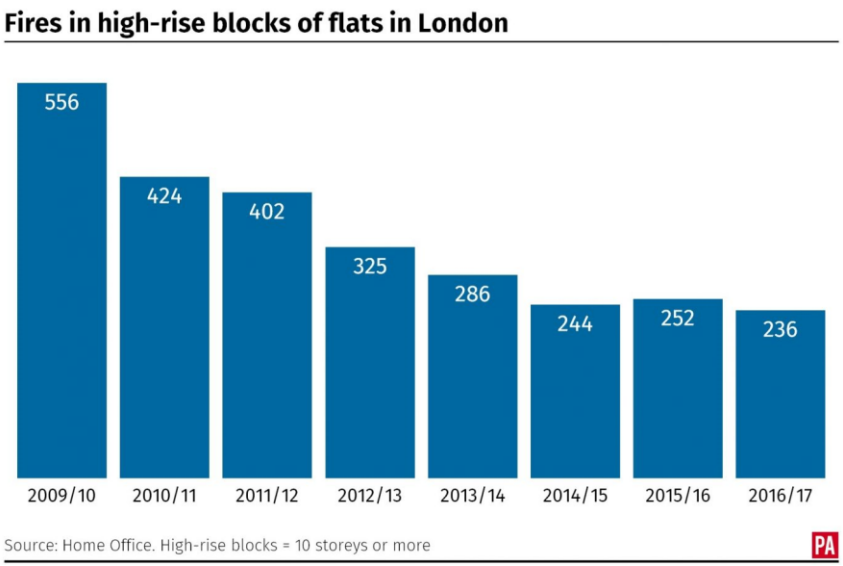


Figure 7: Primary fires per million population, Great Britain, 2008-09 onwards



Fire Statistics - 2017/2018

167k fire attended by Fire and Rescue Services in England – 43% lower than 10 years ago
26k in Scotland

334 fire related deaths – 44% fewer than 36 years ago
44 in Scotland

3,306 non fatal casualties (13% fewer than 5 years ago)
1113 in Scotland

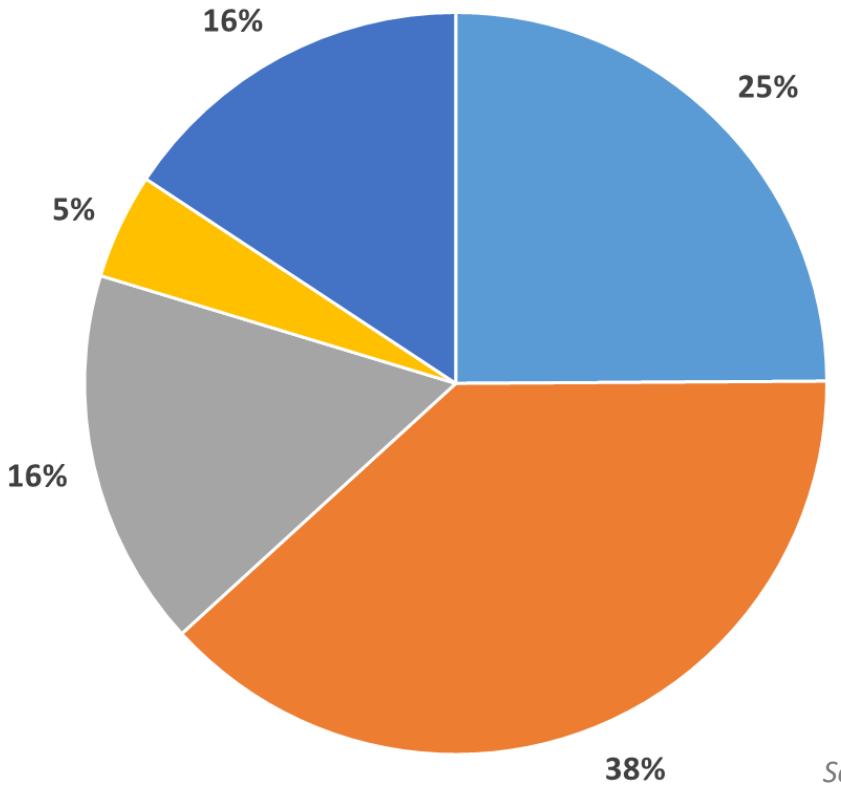
801 Fires in purpose built high rise flats in England

Source: Home Office: Fire & Rescue Statistics: England, year ending March 2018/Fire & Rescue Incident Statistics (Scotland) 2017/2018

November 2017 to January 2018

4 major apartment fires – Manchester, Leeds, Kent & Scotland
2 railway station fires
2 major fires in car parks

Fatalaties from Fires by Cause of Death (England)



Source: Fire Statistics, United Kingdom, 2017 - DCLG

Smoke is by far the biggest killer

Smoke Control

General Principles of Smoke Control 2020

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- Buildings Types

Why Provide smoke control?

General Principles of Smoke Control 2020

- Protect escape routes
- Assist fire fighting
- Protect valuable stock or machinery
- Reduce the risk of explosion and/or roof collapse

Smoke Clearance Ventilation

Uses a notional amount of ventilation to assist fire fighting operations, allowing fire fighters to clear smoke from the relevant building or part of building often after the fire has been extinguished.

Natural:	Natural openings providing a percentage of the plan area of the space
Mechanical:	Extract fans providing a number of air changes of the volume of the space per hour

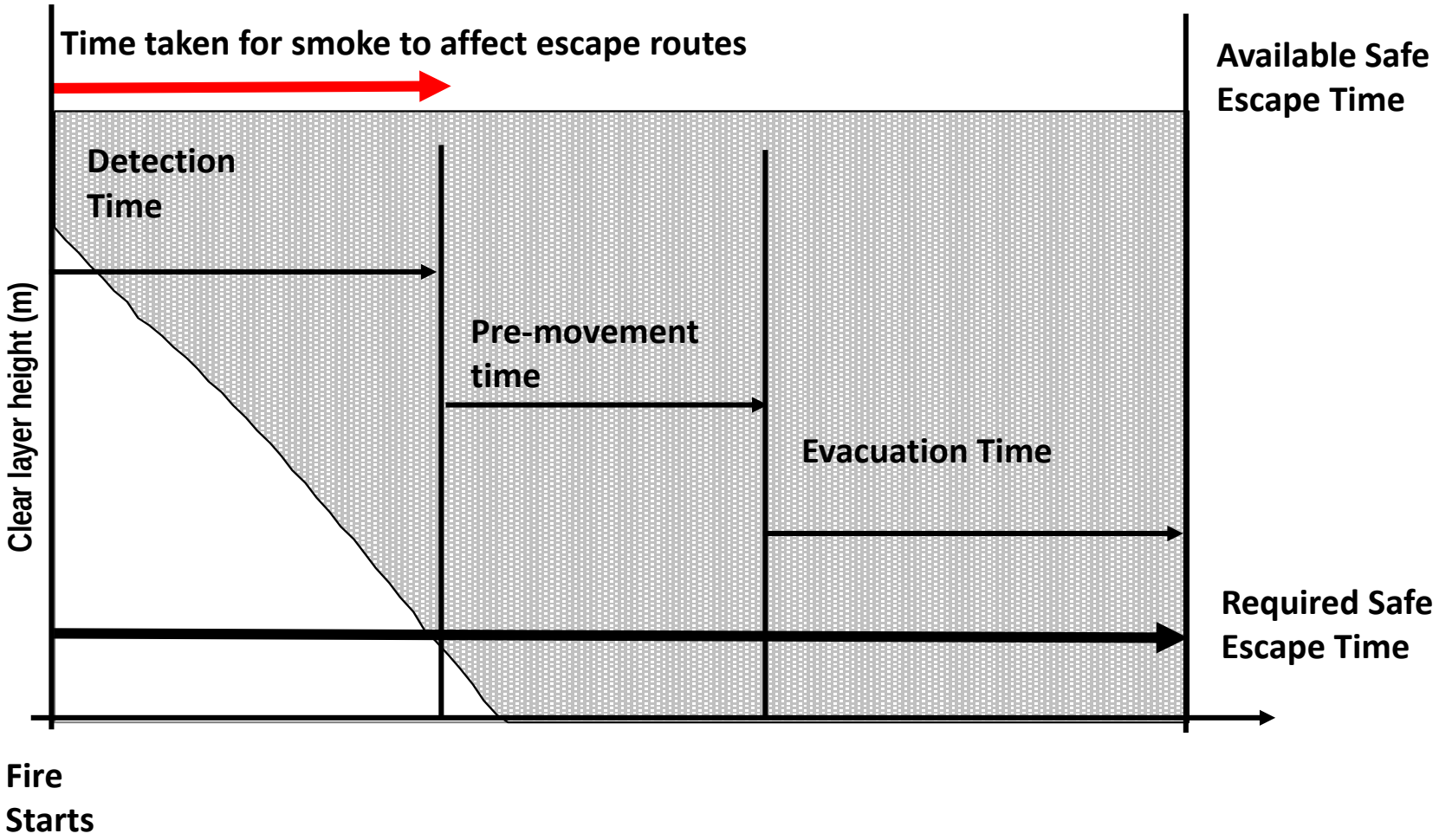
By definition, smoke clearance offers limited benefit during evacuation and has a much simplified design basis.

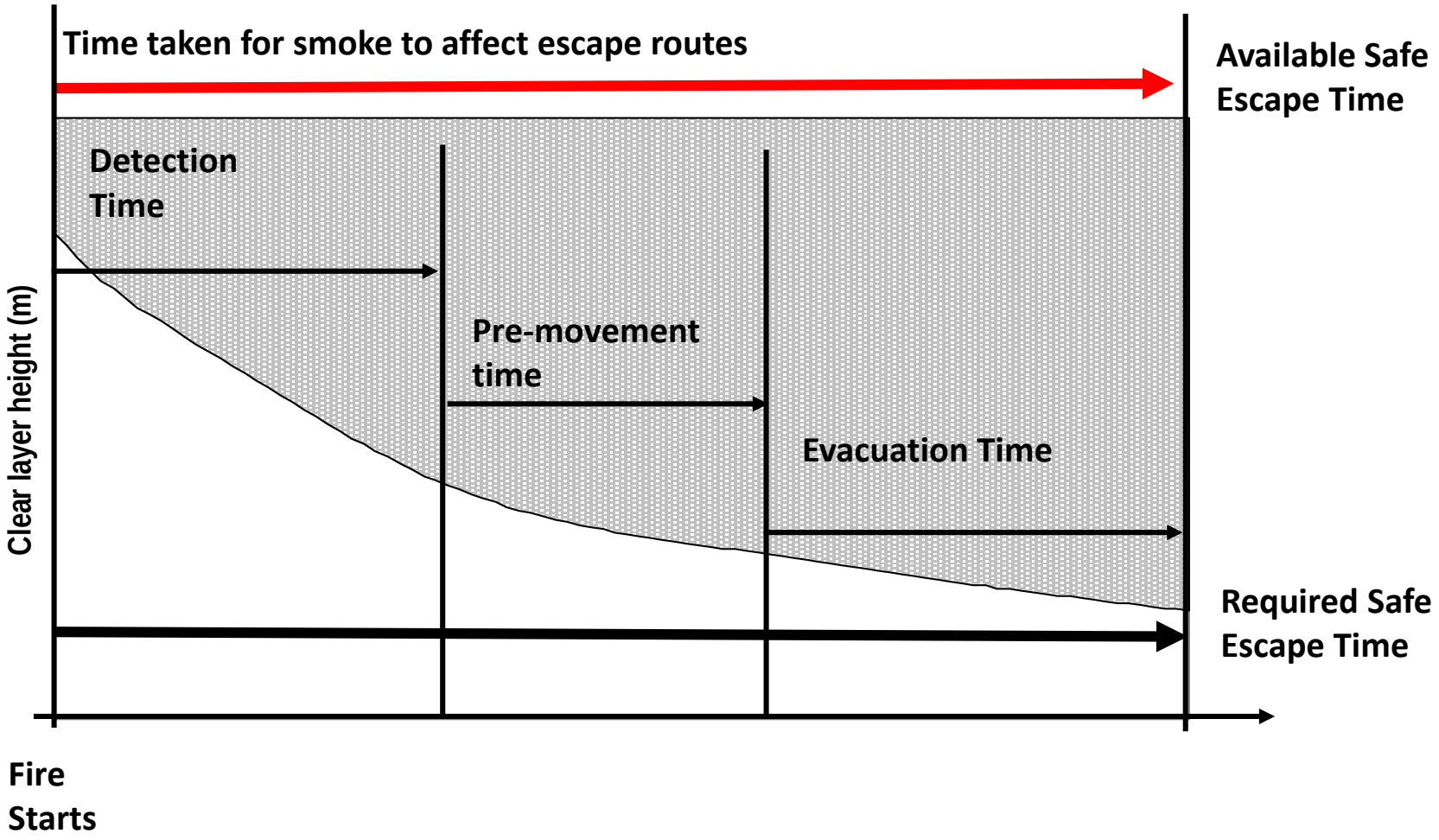
Smoke Control Ventilation

Smoke Control Systems are designed to control or restrict the movement of smoke within the building.

In order to do this it is usually necessary to estimate the amount of smoke produced by a fire and the heat energy present. Then measures such as ventilation can be used to remove smoke to provide vertical control and barriers can be used to control horizontal smoke movement.

Again, these can be natural or mechanical systems, but the design is much more complex and requires an estimate of the fire size.


Time taken for smoke to affect escape routes
Available Safe Escape Time
Detection Time
Pre-movement time
Evacuation Time
Clear layer height (m)
Required Safe Escape Time
Fire Starts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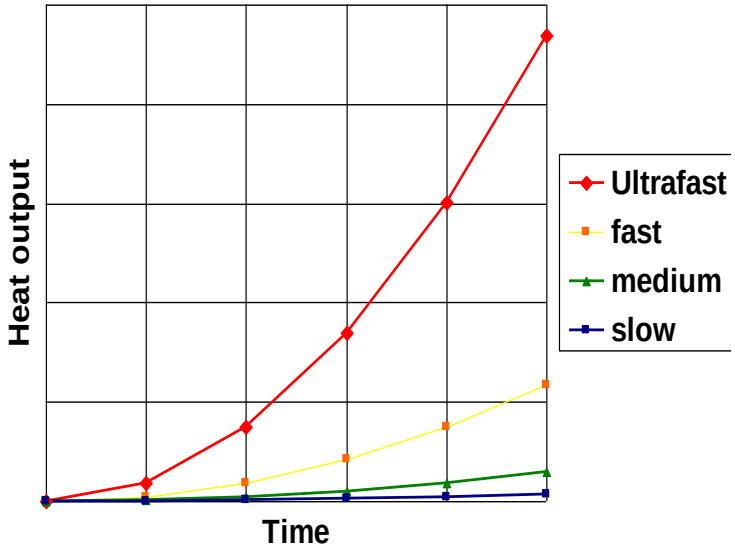
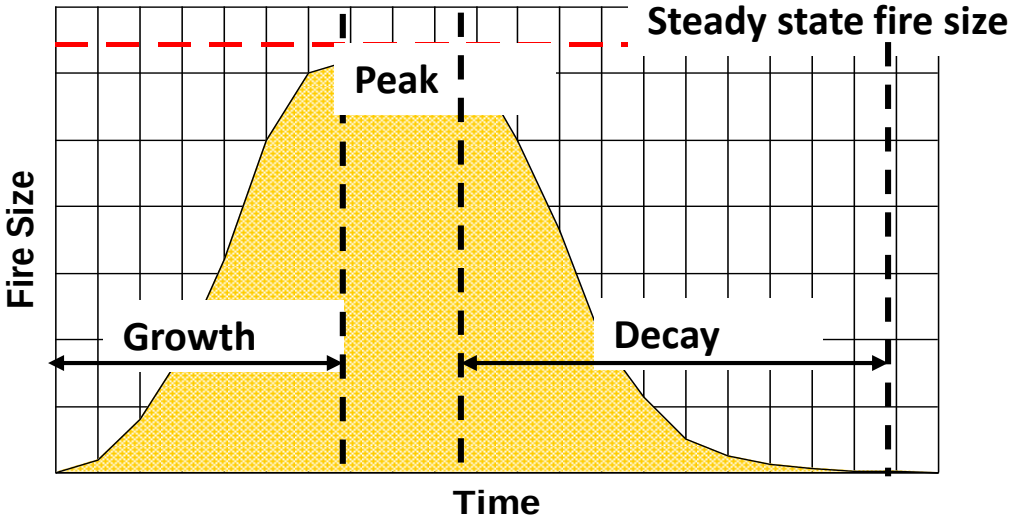
Time dependent Fires



Steady State Fires

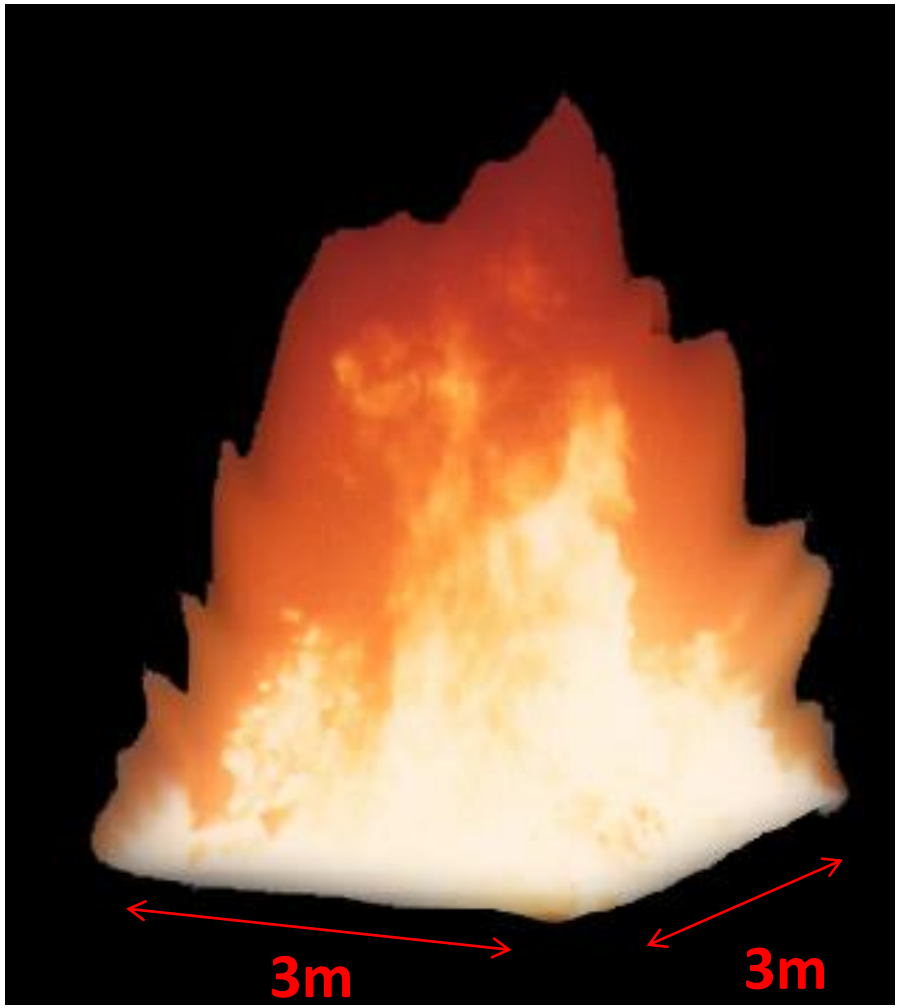


Steady State design ignores growth and decay of fire and takes into account the largest probable fire for a given risk

Steady State Fires

- 3 m x 3 m (minimum)
- 9 m x 9 m (maximum)

Double area for design purposes if not sprinkler controlled



Internal view of a 1MW fire.

Even small fires can produce large quantities of toxic smoke

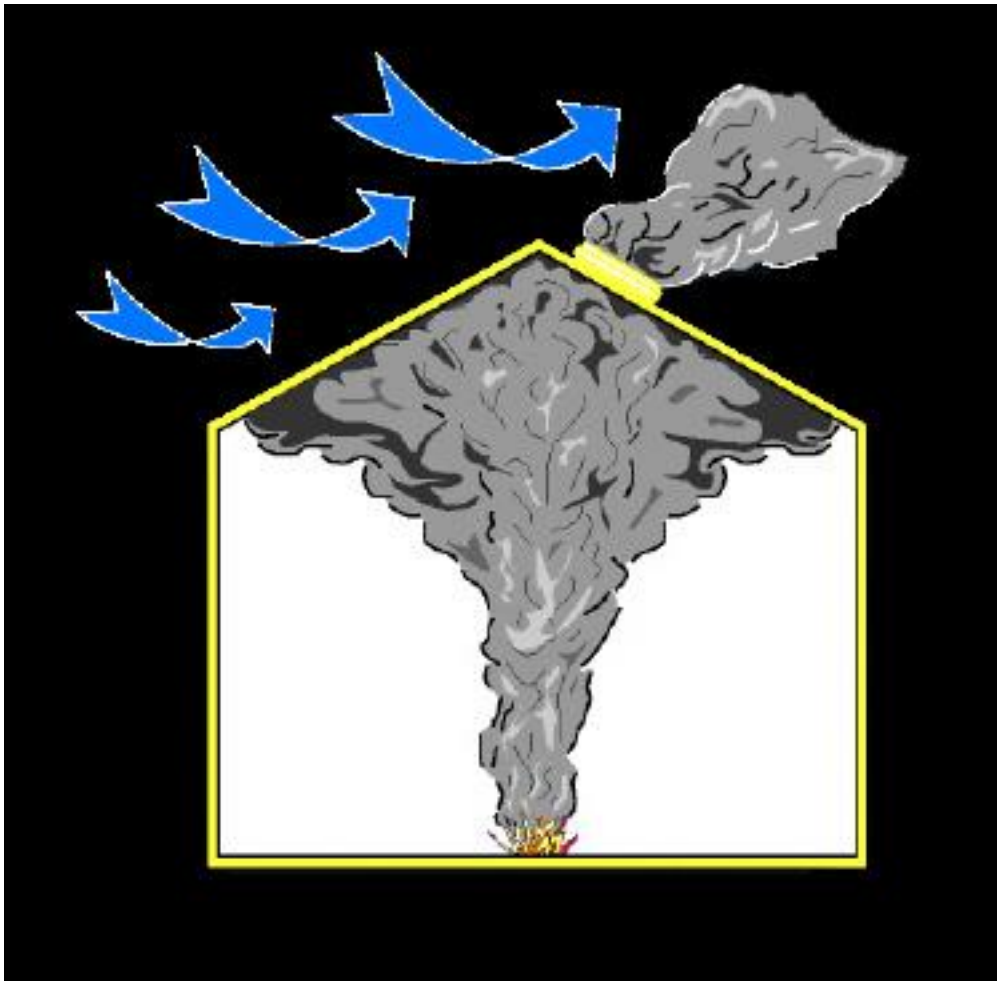
Sprinklers

- Will limit fire spread and control growth
- Will not reduce smoke damage

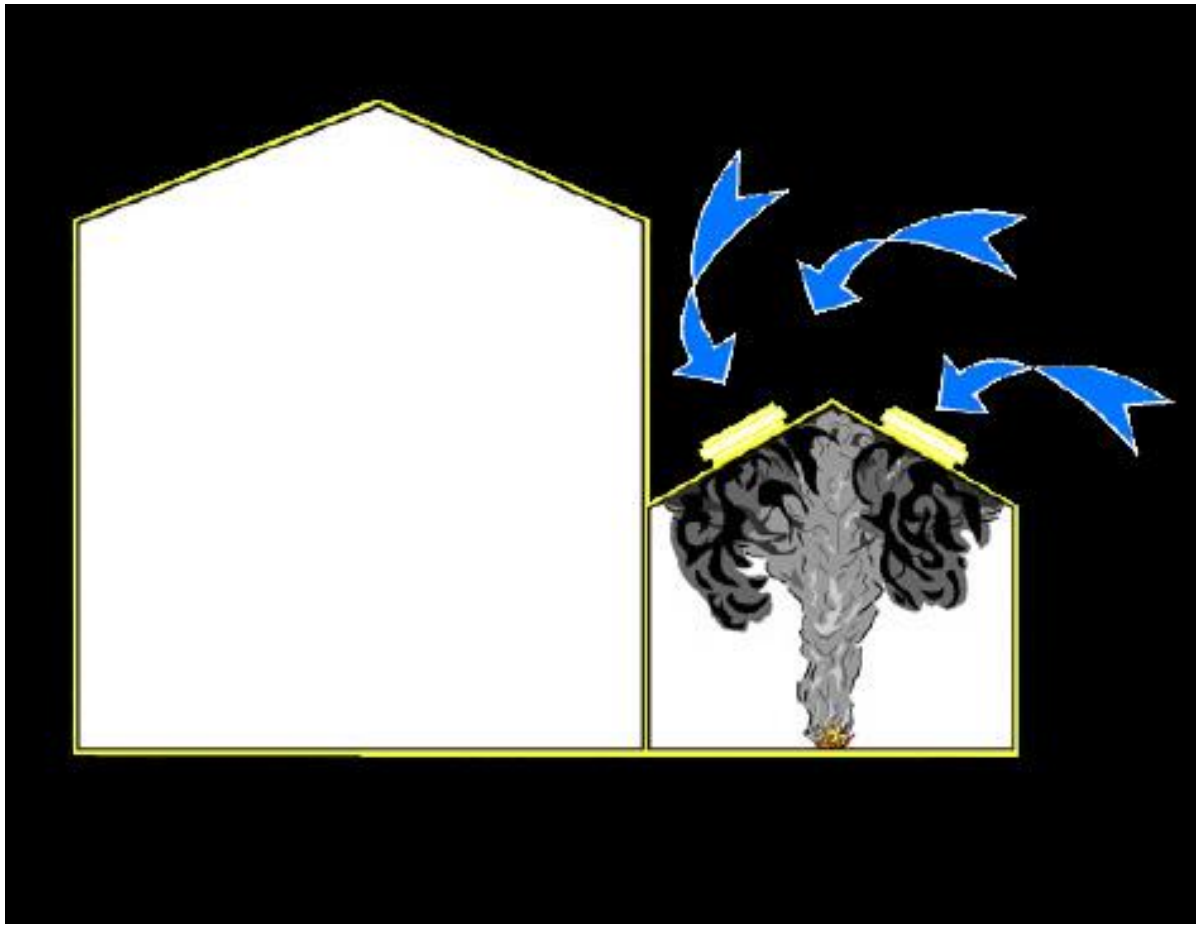
Ventilation

- Will prevent smoke logging
- Assist escape
- Aid fire fighting

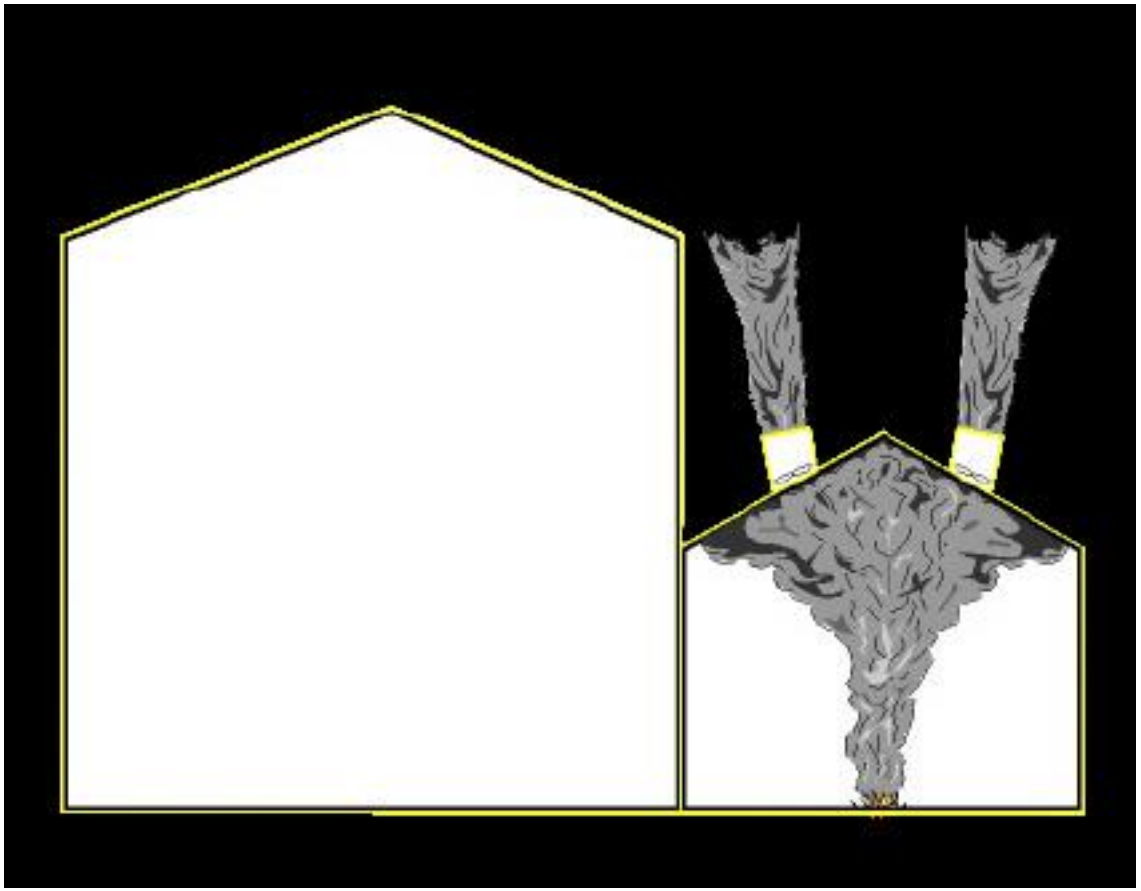
Sprinklers are designed to reduce damage, but offer limited benefit to occupants. Smoke ventilation alone will not save the building but is primarily designed to assist escape.



Positive wind pressures may be experienced on
roof pitches steeper than 30 degrees….



… and from higher adjacent structures



Mechanical Ventilation may be the only alternative

Natural

- Fail safe operation
- Self compensating
- Silent operation
- No time or temperature limits
- Lightweight
- Sensitive to wind effects

Mechanical

- Not wind pressure sensitive
- Suitable for ducting
- Fixed extract volume
- Noise and Weight
- Maintained electrical supply
- Dedicated air inlet
- Standby unit in case of fan failure

Ventilator types

General Principles of Smoke Control 2020

Louvred Roof Vents

Casement Roof Vents

Glazed Wall Louvres

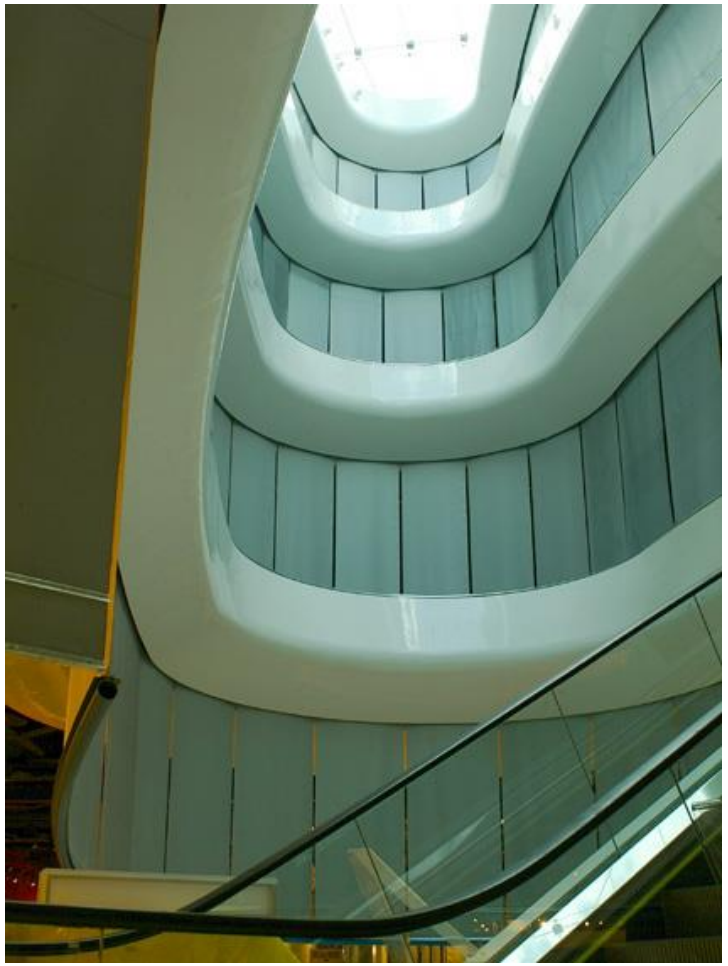
Double Flap Roof Vents


BULLRING

Inlet or ‘replacement’ air

- Required to limit the spread of smoke
- Formed using fixed or automatic drop smoke barriers
- Arranged to limit the size of the smoke reservoir at high level to a maximum of :
  - 2000/2600 m^2 plan area, and
  - 60 m long in any direction

<u>Note</u>: In shopping centres the reservoir is assumed to be 50% in the shop and 50% in the mall



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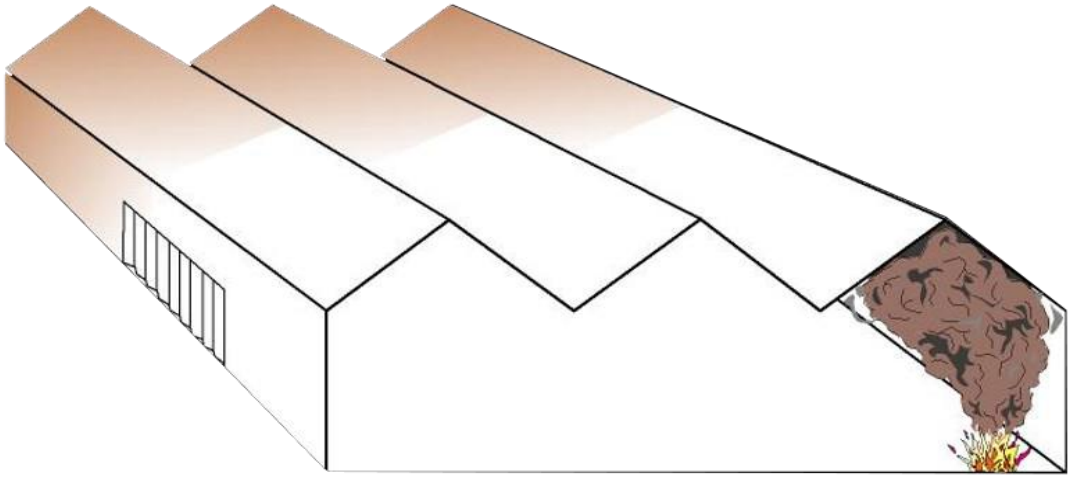
Approved Document B only limits travel distances for means of escape.

Escape distances may be extended, usually with a trade-off for compensatory features, e.g. a ‘fire-engineered’ collection of measures, which may or may not included smoke control.

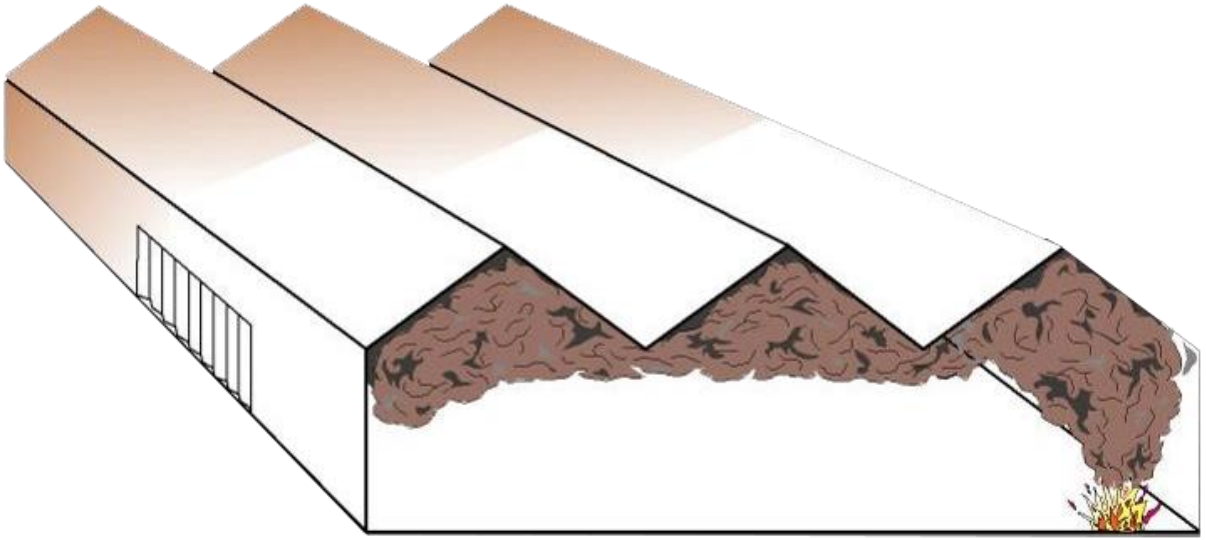
Design Guidance: BS 7346-4 & 5 & SVA Guide Issue 3

Large single storey buildings

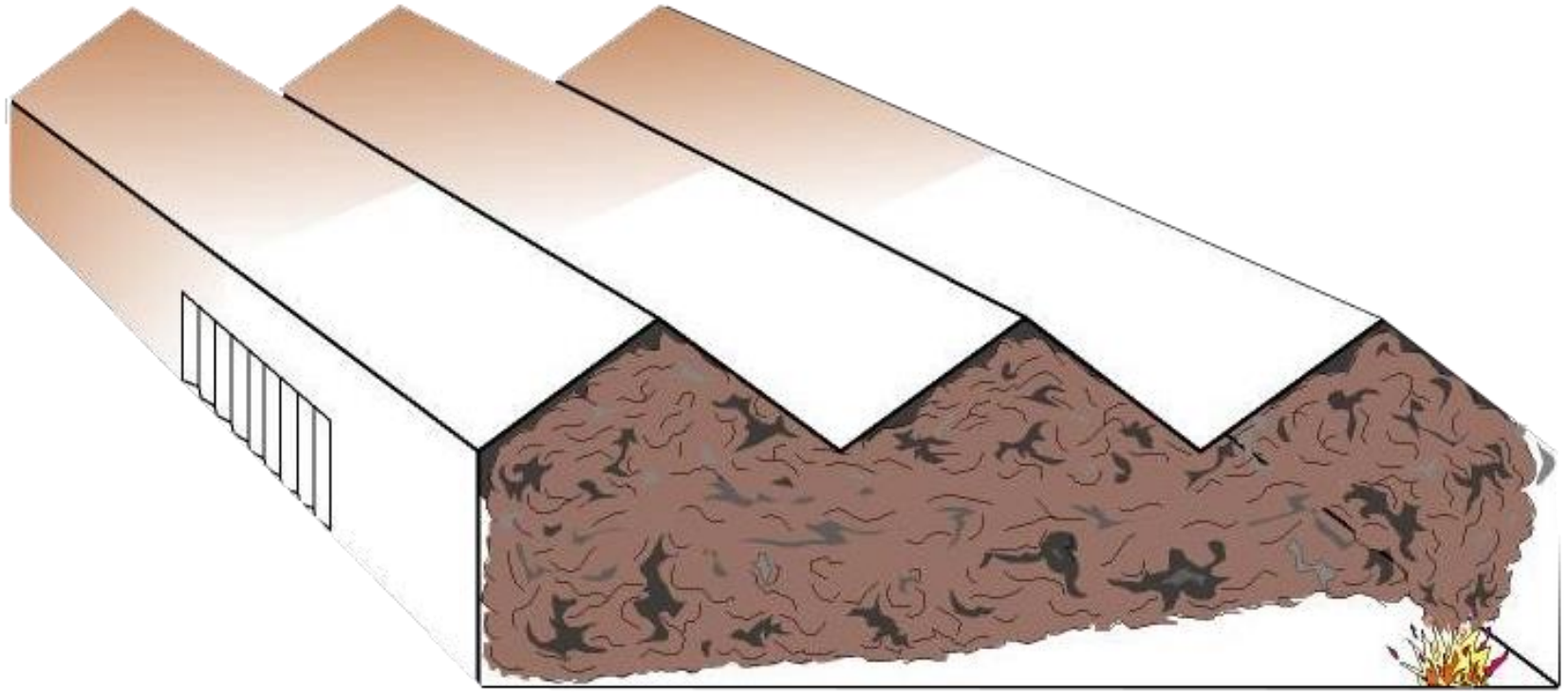
General Principles of Smoke Control 2020



In the early stages of fire, smoke quickly rises into roof space



Smoke travels laterally beneath the roof and spreads throughout the building



Even large buildings can become totally smoke logged in minutes

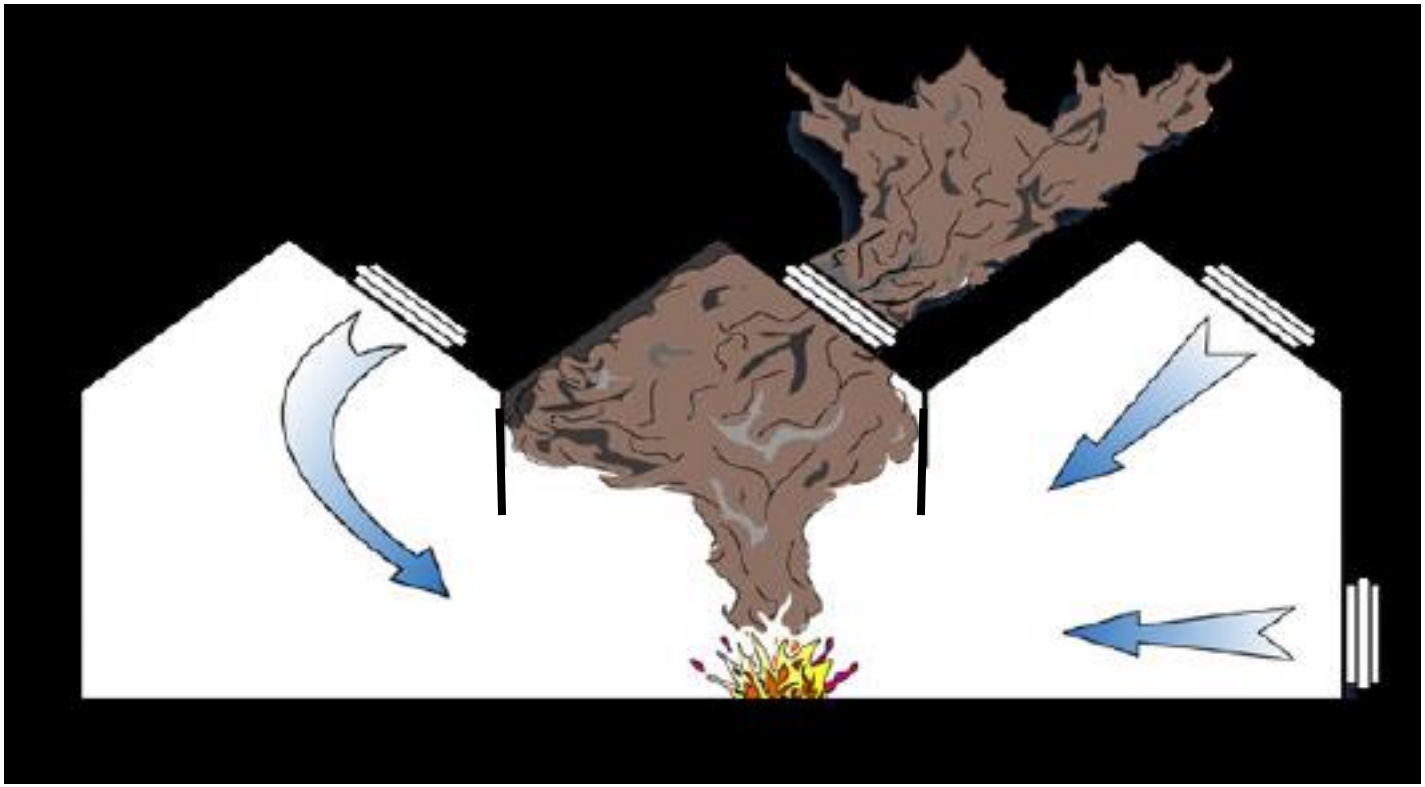
In a smoke logged building, way finding can be very difficult and temperatures will rise rapidly – leading to loss of structural stability and building collapse.

Evacuation is safer and fire fighting more effective when the routes are clear

Objectives of Smoke Control:

- Assist escape by extending available safe evacuation time
- Assist fire fighting by improving conditions in the building during the fire and clearing smoke from the building after.
- Protect valuable stock or machinery
- Reduce the risk of explosion and/or roof collapse

Components of a Smoke Control System

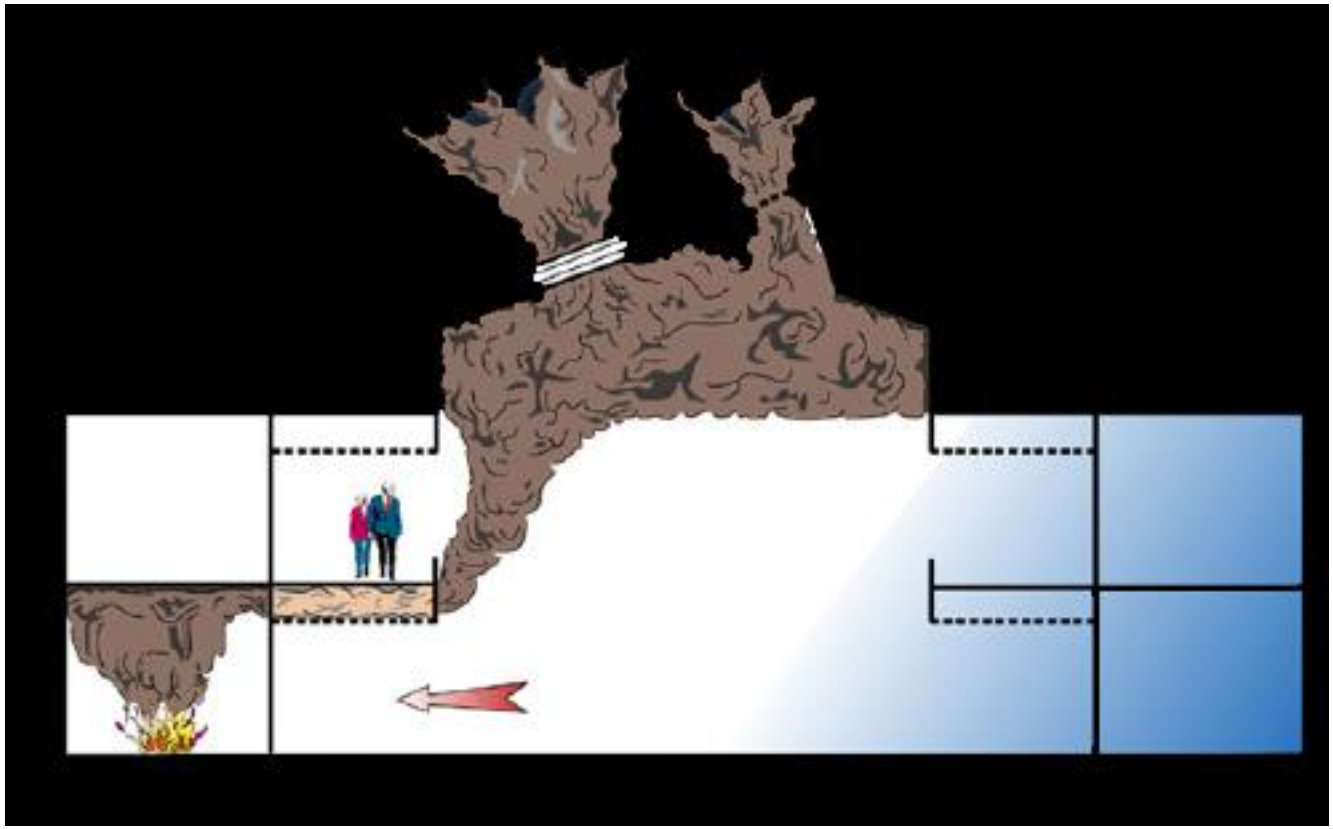


Mezzanine Floors

- Large uncompartmented buildings
- Full of people who are unfamiliar with the building layout.
- Varied cross-section community, e.g. elderly and disabled.
- Evacuation time can be considerable.

Smoke Control is therefore a requirement to assist in keeping escape routes safe for an extended time period.

Design guidance is given in BS 5588 Part 10: 1991, BS 9999, BS 7346-4 and BR 368.



Multiple levels further complicate the situation

Extract direct from shop

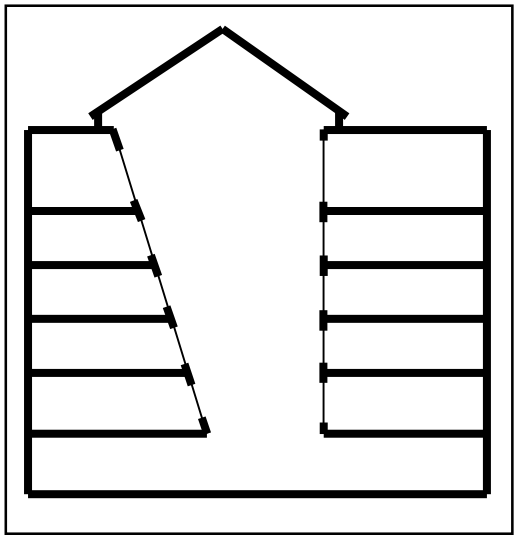
- Extract from under balcony
- Extract from mall roof space

- Smoke flow only through one void
- Limit perimeter of spill edge
- Limit smoke reservoir length in mall
- Limit plume height for practicality / cost effectiveness
- Natural ventilators to be as high as possible
- Inlet availability

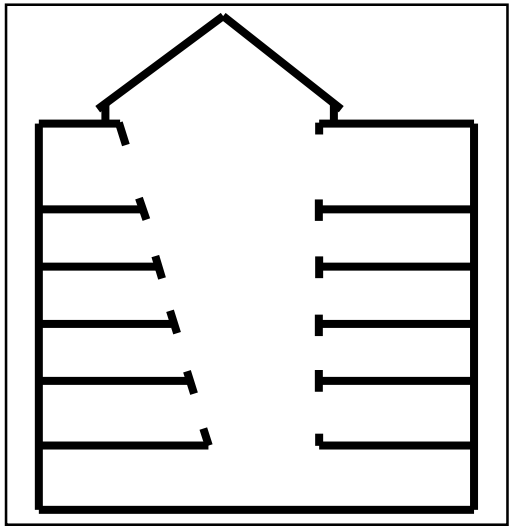
If the vertical compartmentation specified in ADB cannot be met, i.e. the building has an Atrium, then it should be designed in accordance with BS5588 Part 7:1997 or BS 9999, which, depending on the application, may require smoke clearance or smoke control.

Important factors are whether people are unfamiliar with the building (e.g. public buildings) and possibly asleep (e.g. hospitals or hotels).

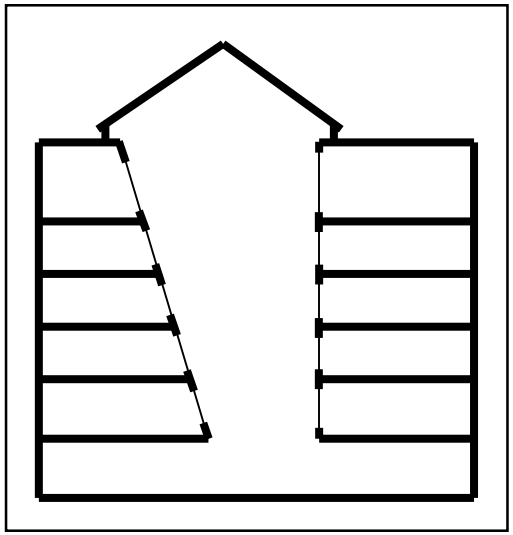
Sterile Tube



Open Atrium



Closed Atrium



Possible Solutions

Depends on use of building, fire risk, occupancy type, type of atria, etc….

But usually one of the following:

- Smoke clearance
- Extract from room of origin
- Extract from floor of origin
- Through flow
- Depressurisation

As natural ventilation is buoyancy driven, exhaust ventilators should be located at the highest point possible.

Approved Document B requires fire fighting access in all buildings. If there is a floor level 18 m or more above fire service access level or a basement more than 10 m below, then a fire fighting shaft is required.

A fire fighting shaft contains a protected stair, lobby and usually a lift. The stair and lobby require smoke ventilation to allow fire fighters safe access to every level. This is defined in BS 5588 Part 5: 2004 and BS 9999.

The ventilation system is intended to keep the stair free of smoke and improve conditions in the lobby.

Stairwell ventilation

- A 1.5 m^2 openable vent at the head of the stairwell; or
- A 1 m^2 openable window at each storey (OV)

Lobby ventilation

- A 1 m^2 vent (OV) in the fire fighting lobby; or
- A 3 m^2 BRE shaft with 1.5 m^2 dampers on each level; or
- A mechanical shaft; or
- A pressurisation system

ADB requires the common corridors of apartment buildings to be ventilated to protect common escape staircases from smoke ingress and to allow smoke to be cleared from corridors.

The basic requirement in England and Wales is that each escape stair and every adjacent corridor or lobby should be ventilated.

The requirements are given in ADB, BS 5588-1 and BS 9991.

Common Corridors/lobbies can be ventilated by:

- A vent with a minimum free area of 1.5 m^2; or
- A 1.5 m^2 smoke shaft, with 1m^2 dampers at each level; or
- A mechanical smoke shaft; or
- A pressurisation system

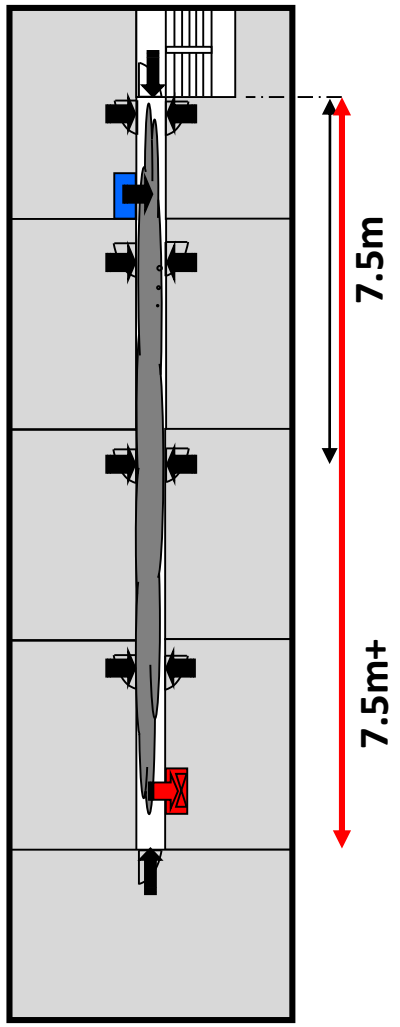
The stairs require a 1 m^2 vent at the top floor

Extended Travel Distances in Residential Common Corridors

ADB 2006 states: *"There may be some instances where some increase on these maximum figures [travel distances] will be reasonable."*

In these cases mechanical systems can be designed to enhance safety, allowing travel distances to be extended from 7.5 m to in excess of 20 m in one direction.

These are fire engineered systems, usually designed to achieve specified conditions.



Ventilation in car parks is provided for two purposes

- To prevent the build up of fume during the daily use of the car park in accordance with Approved Document F
- To provide smoke **clearance** ventilation in the event of a fire to assist the Fire Service in accordance with Approved Document B.

A single dual purpose system is normally provided to meet both requirements

Ventilation systems may be:

- Natural with openings equal to a % of the floor area
- Ducted mechanical with air flow based on an air change rate
- Impulse ventilation with air flow based on an air change rate

Systems are not expected to maintain a smoke layer at high level.

CO control is often used in fume control mode for energy efficiency.

Smoke Control Systems

Specifically designed to achieve the CONTROL of smoke movement. Usually requires additional extract over and above the basic clearance requirement.

Can be designed to:

- Aid escape and therefore extend safe escape distances
- Assist fire fighting as an alternative to sprinklers
- Control smoke as a alternative to compartmentation

In the UK, sprinklers are generally not required in car parks, except in certain applications, such as shopping centres or larger projects in London and Scotland.

The application of smoke clearance and smoke control are varied and with specialist knowledge can be used to compensate for other standard features in many ways.

As with many fire safety systems, the concept is usually quite straightforward but life safety systems must be robust and comprehensive, not only in their design, but also in the application and maintenance of the equipment that makes up the system.

Q&A Session…