Workshop 2F:

Smoke control systems in tall buildings

Speakers: Conor Logan & Tom Archer
(Colt International Ltd)
Chaired by: Andrew Burke (NHMF)
Room: Surrey Room

Smoke Control in Tall Buildings

Conor Logan CEng FIMechE FCIBSE

A brief history of Colt

- A private company founded in 1931
- I J O'Hea OBE (1897 - 1984)
- 2016 Group turnover £160 million
- 2016 UK turnover £ 35 million
- Manufacture in the UK, Holland, Germany and China

I J O'Hea
Colt Founder

Colt UK Business Markets

Project Versatility

Scope: Design
Manufacture
Supply
Install & wire
Commission
Maintain

Project Value

Small works: £0 - £30k

Contracting: £30k - £6m

Accreditations

- Achilles
- Altius Gateway
- CHAS
- Construction Line
- Safe Contractor
- Worksafe Contractor

- BSi
- LABC
- CIBSE Patron
- FETA
- Smoke Control Assoc
- ASFP

ISO 9001: 2015

ISO 14001: 2015

History of modern fire legislation in the UK

Year	Incident	Result
1666	Great Fire of London	Rebuilding Acts 1667 and 1670
1947	Post War Fire Studies	Fire Services Act 1947
1951	First 10 storey residential tower	
1968	Ronan Point Gas Explosion 18th floor flat – 4 dead	Changes to building regulations and structural design codes
1969	Rose & Crown Hotel Fire 11 dead	Fire Precautions Act 1971
1973 1974	Summerland Fire 50 Dead Flixborough Disaster	Health and Safety at Work Act 1974
1979	Manchester Woolworths Fire	The Building Act 1984
1985	Bradford City Stadium Fire	The Fire Safety and Safety of Places of Sport Act 1987
1987	Kings Cross Fire	The Fire Precautions (Sub-surface Railway Stations) Regulations 1989
2006		Regulatory Reform (Fire Safety) Order 2005
2007		Construction (Design and Management) Regulations 2007
2009	Lakanal House Fire	
2013		Construction Products Regulation 2013
2017	Grenfell House Fire	Building Regulations Review – Dame Judith Hackitt - Interim Report

Building Regulations Part B (Fire Safety):

B1 Means of Warning and Escape

Requirement

Means of warning and escape

B1. The building shall be designed and constructed so that there are appropriate provisions for the early warning of fire, and appropriate means of escape in case of fire from the building to a place of safety outside the building capable of being safely and effectively used at all material times.

New Construction - Routes to Compliance:

Route 1

Approved Document B
Government Guidance

- Minimum Standard Guidance written by DCLG
- Reviewed by Stakeholders

Route 2

British Standards
Public Guidance

– BS 9991 and BS 9999, BS 99xx

- Guidance written by BSi Committees
- Reviewed by public comment

Route 3

Fire Engineered Solution
Specialist Guidance
– use available guidance and research, e.g.

- PD 7974
- CIBSE Guide E
- Equivalence demonstrated by analysis:
  - Comparative
  - Deterministic
  - Probabilistic

Existing Buildings and Refurbishments:

Fire Precautions Act – repealed in 2005 along with Local Acts and London Act.

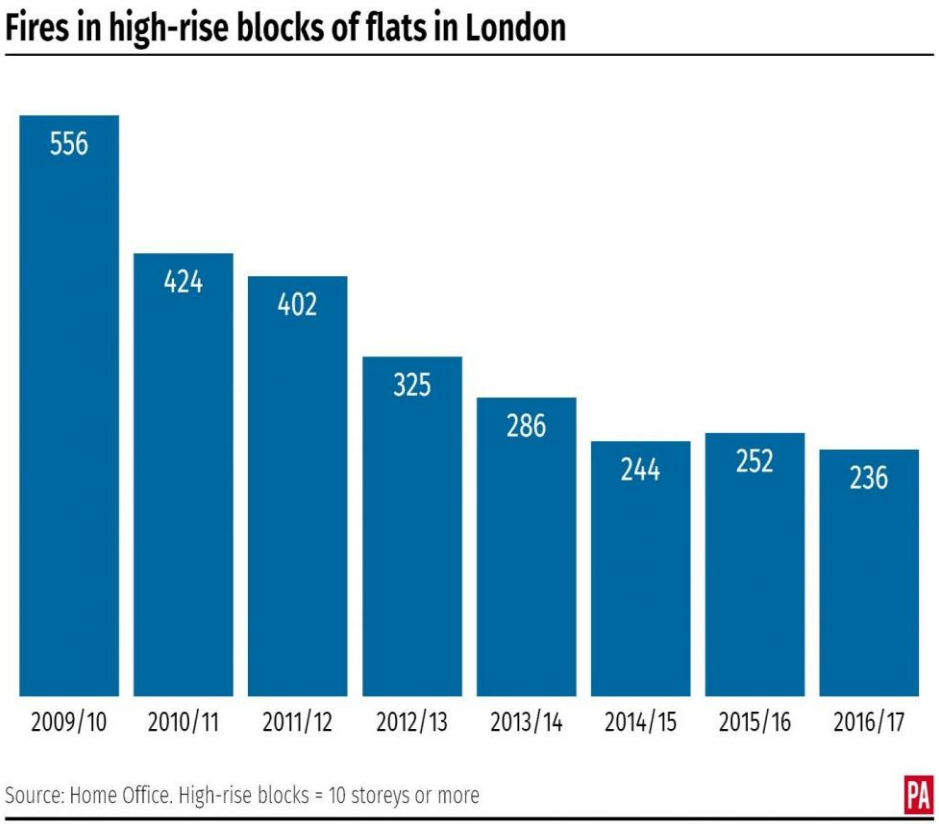
Replaced with Regulatory Reform (Fire Safety) Order

Fire Certificates and inspections by the Fire and Rescue Services replaced with Fire Risk Assessments and owner responsibility.

- Emphasis on self regulation/risk assessment and audits
- Fire Service now have torturous route for correction through audit - alteration, enforcement and prohibition notices through legal process

Maintenance is mandatory – frequency is defined in BS 9999, but often overlooked as owners responsibilities are widely misunderstood

Smoke Control in Tall Buildings



Fire Statistics – April 2016 – March 2017

559k fire attended by Fire and Rescue Services
75k involved fatalities/injuries
714 in high rise apartments – 190 fatalities

Past 6 months

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

Smoke Control in Tall Buildings

Longer vertical escape time

Sleeping Risk

Psychological impact of smoke

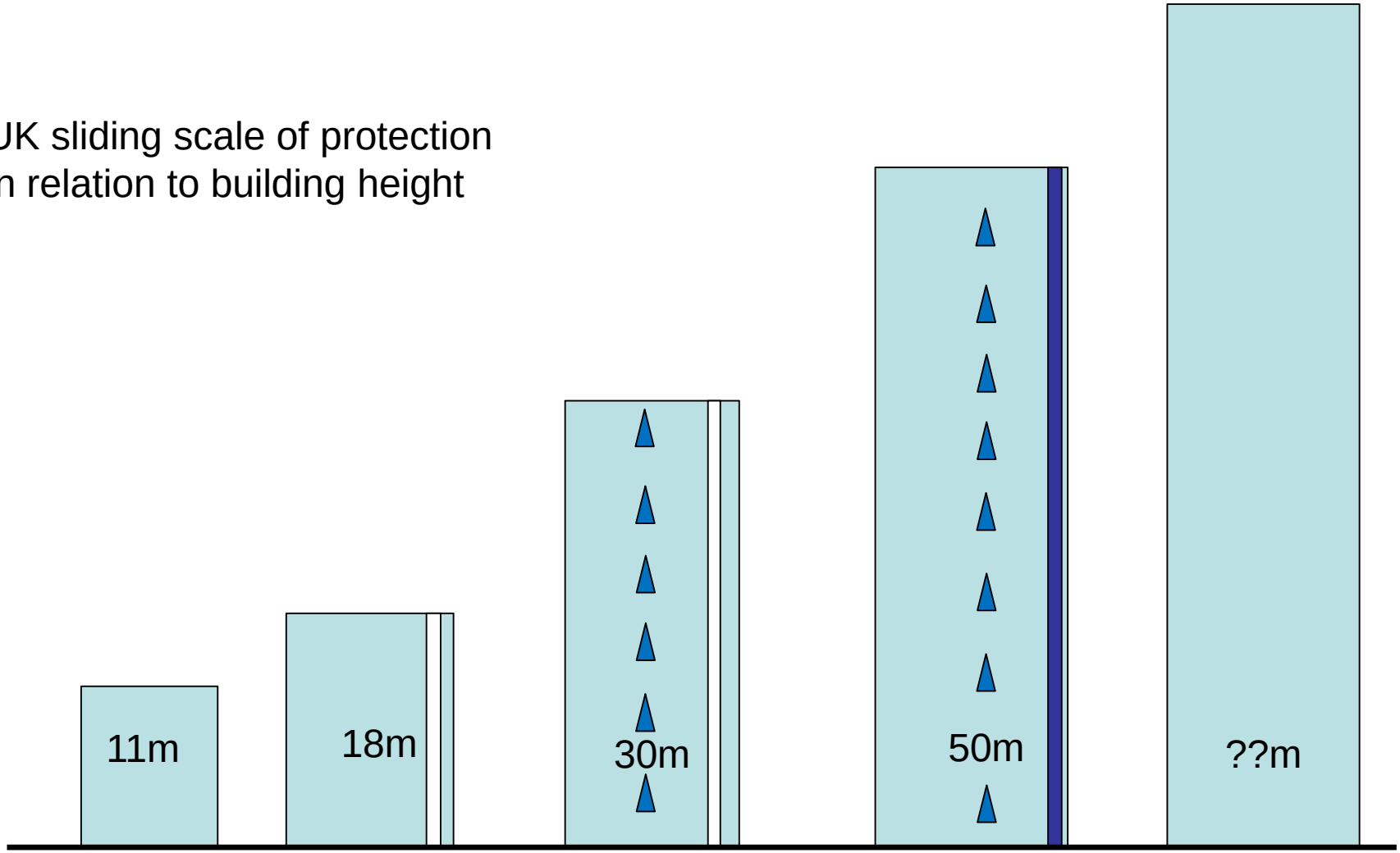
Defend in Place/Stay put

Fire Service Intervention

Single stair buildings

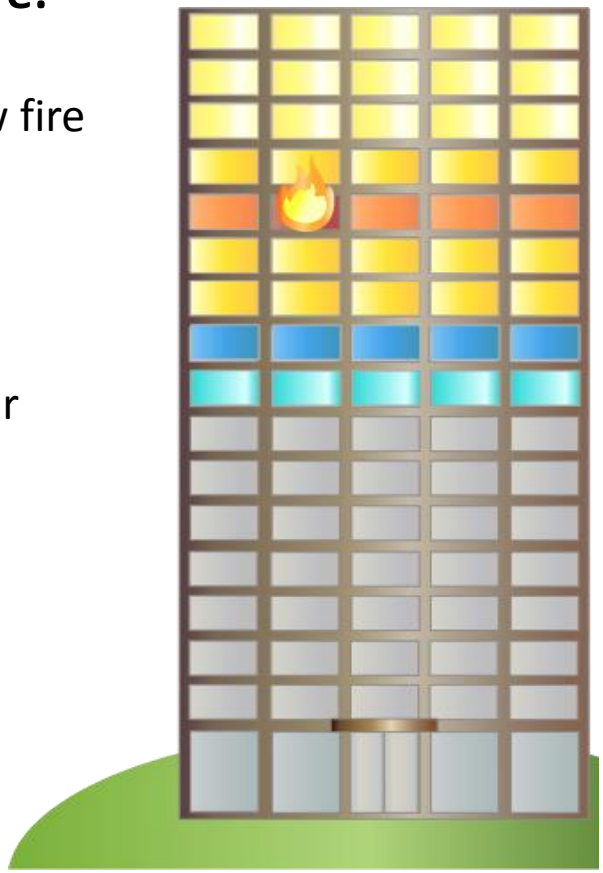
Smoke Control in Tall Buildings

UK sliding scale of protection
in relation to building height



Typical Operating Procedure:

- Take lift to two floors below fire floor
- Connect to risers
- Progress to fire floor by stair
- Establish bridgehead
- Dynamic situation



Floor of Incidence

Bridgehead
Staging Sector

Lobby - Command

Current options for Smoke Control:

- Naturally – using AOVs – up to 30m
- Naturally using shafts/chimneys – 1.5/3.0 m^2 plan area.
- Mechanically, using shafts.
- Mechanically, using pressurization, in accordance with BS EN 12101-6: 2005.

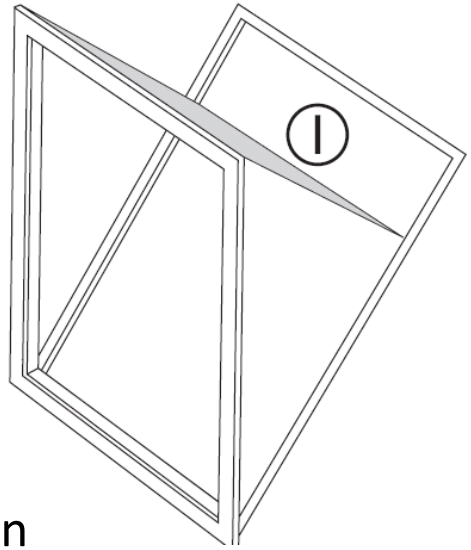
Natural AOVs – Automatic Opening Vents

Lobbies / corridors should be ventilated by an AOV with a free area of at least 1.5m²

AS PER CURRENT VERSION OF ADB:

1.5m² can only be achieved via open area at 90° to direction of airflow, ie area ①.

Total Area = ① only = 1.5m²



To achieve 1.5m², a 1.5m wide vent will need to open over 1m

Site fitting of motors to windows

Natural AOVs – Automatic Opening Vents

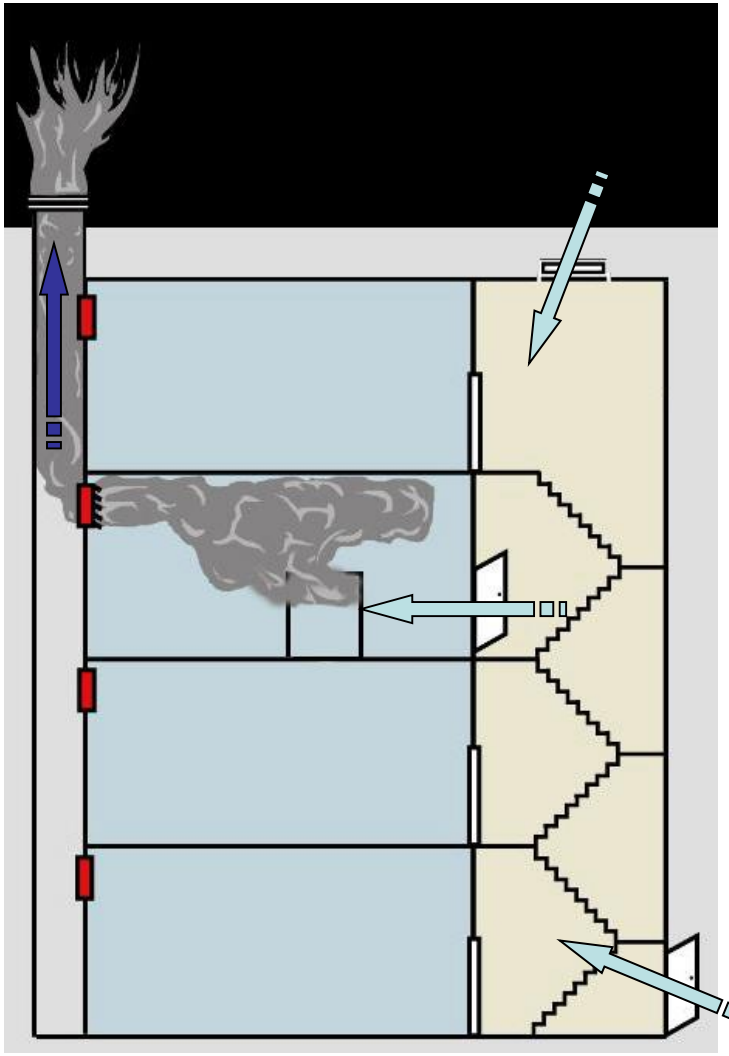
Under the CPR, Smoke ventilators should be CE marked to EN 12101-2, ensuring:

- Compatibility of components
- Reliability
- Robustness
- Resilience to heat
- Opening under wind

Natural Shaft Systems - Residential

Typically:

- 1.5m^2 shaft
- 1.5m^2 damper
- 1.0m^2 stair vent
- Battery back up system
- Fire rated cabling – 24Vdc

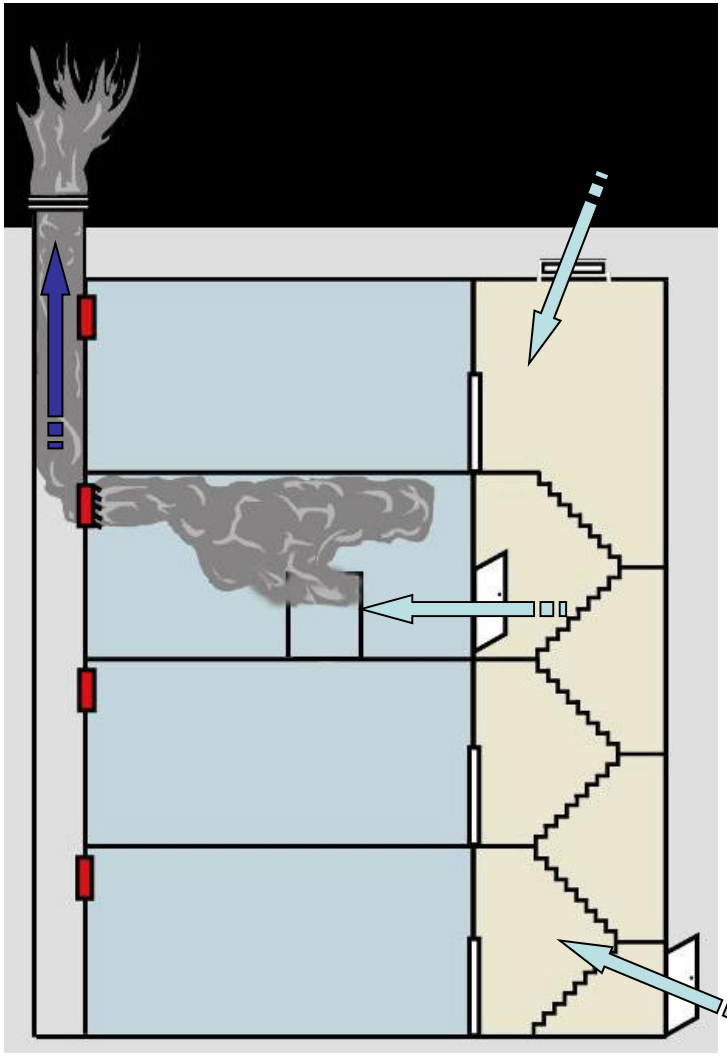


Natural Shaft Systems – Commercial

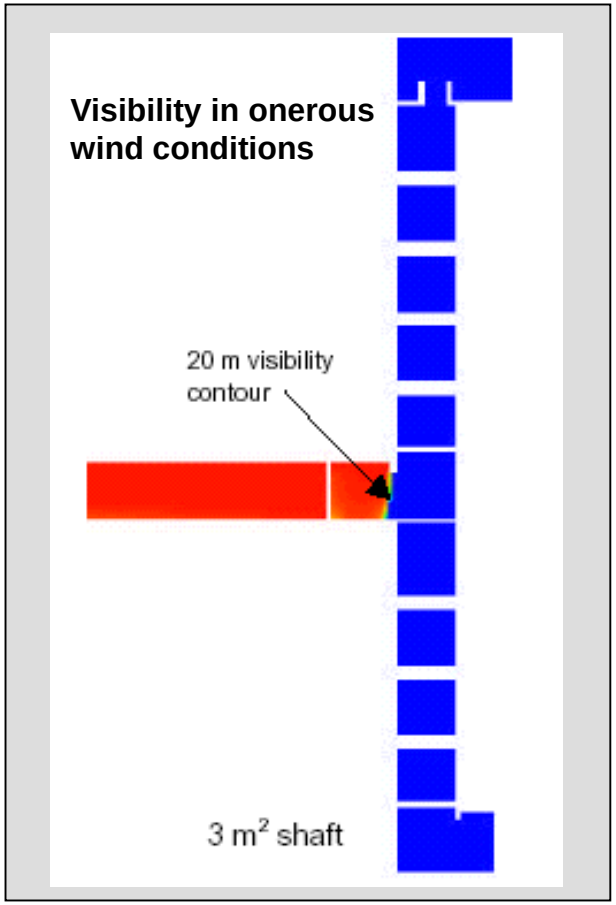
BRE Shaft for fire fighting

Typically:

- 3.0m^2 shaft
- 1.5m^2 damper
- 1.0m^2 stair vent
- Battery back up system
- Fire rated cabling – 24Vdc



BRE Shaft – scale model and CFD Validation



Natural Shaft Systems - Limitations

Space

Geometry

Thermal

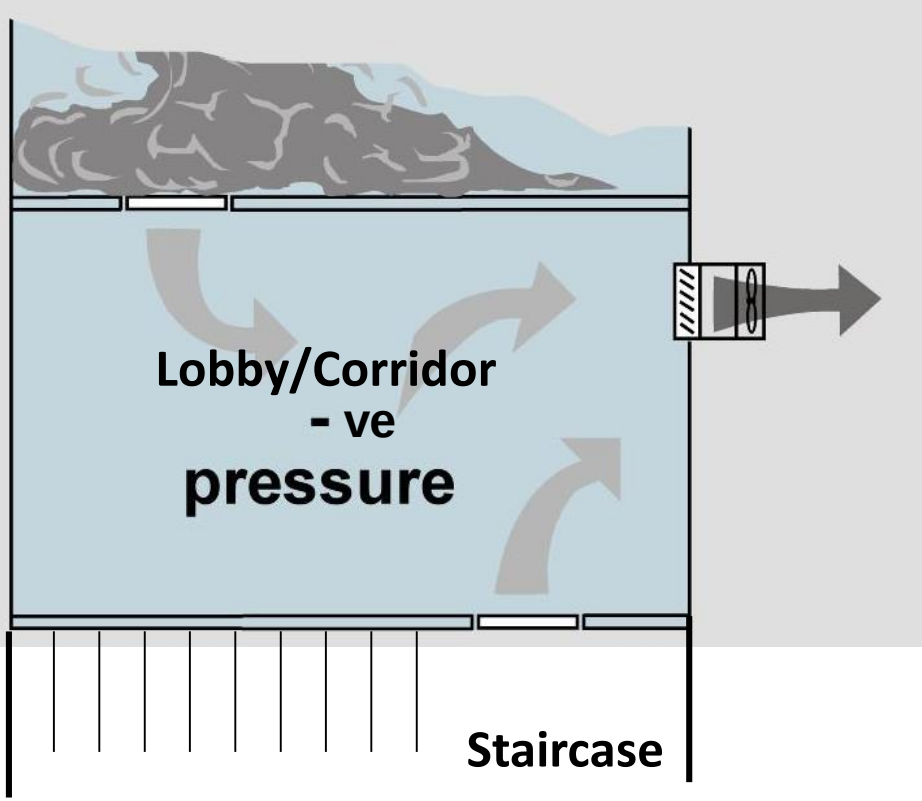
Mechanical Shaft Systems

- Designed to provide equivalent performance to the BRE Natural Shaft
- Requires run and standby motors, standby power and fire rated wiring to provide a resilient system
- Shaft sizes are much smaller, often by as much as 80%.
- Guaranteed rate and direction of ventilation, regardless of relative temperatures and wind direction.
- Can have horizontal sections, bends, fans can be located at top or bottom of shaft.

But, mechanical extract requires a means of preventing over-depressurising the fire fighting lobby

Mechanical Shaft Systems

The major challenge is to avoid excessive depressurisation of the lobby to prevent smoke being drawn in and avoid problems opening doors



This can be avoided by:

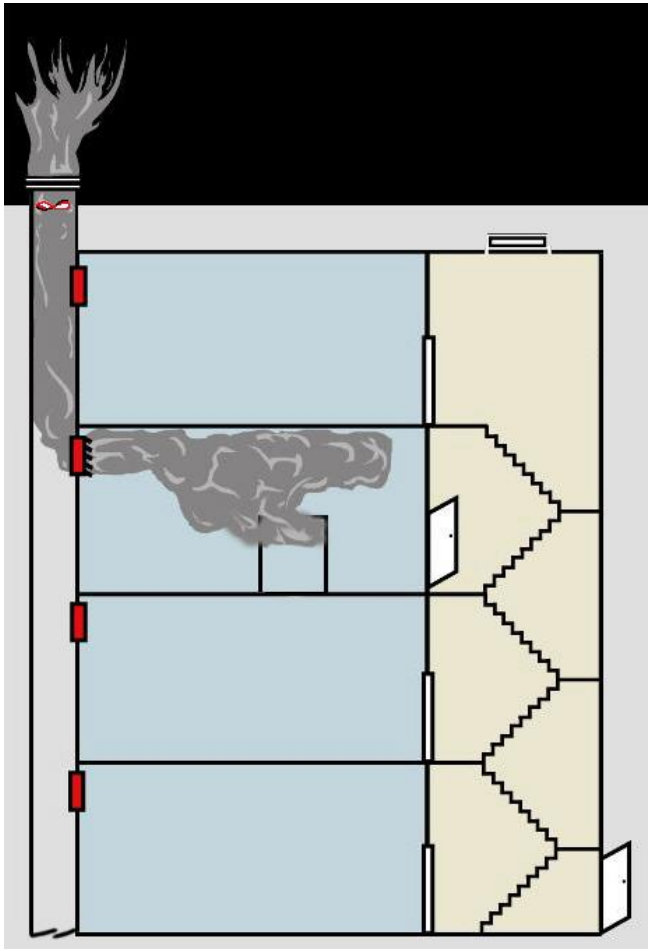
- Low level inlet
- An inlet shaft
- Door to open into lobby
- Grilles in doors
- Variable speed fans

Mechanical Shaft Systems

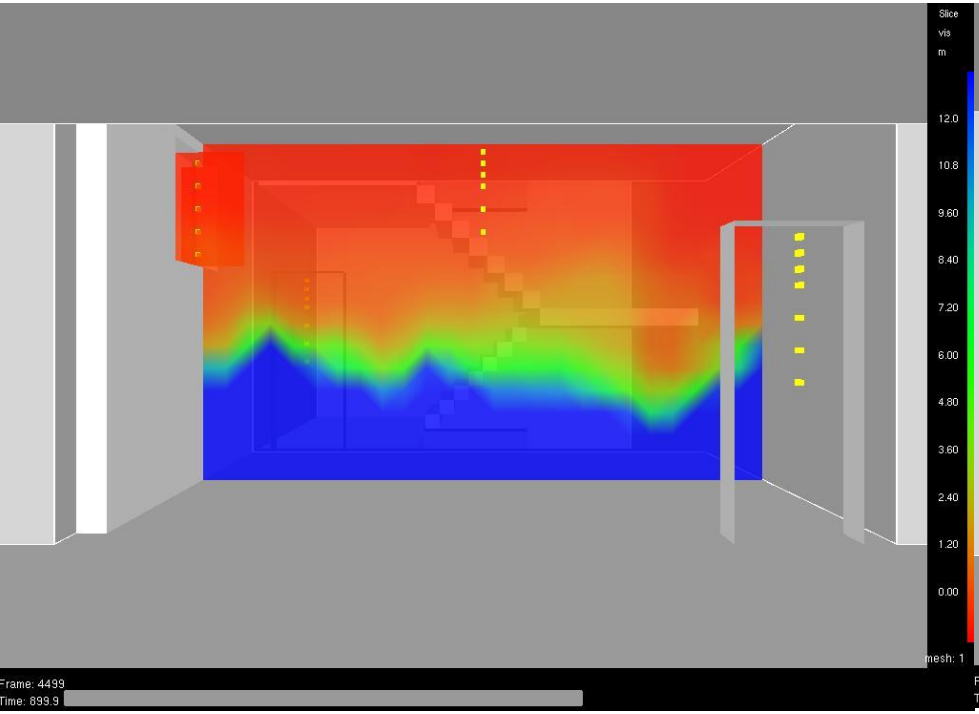
Designed to be at least as good as the BRE smoke shaft and better in adverse wind conditions

The system comprises:

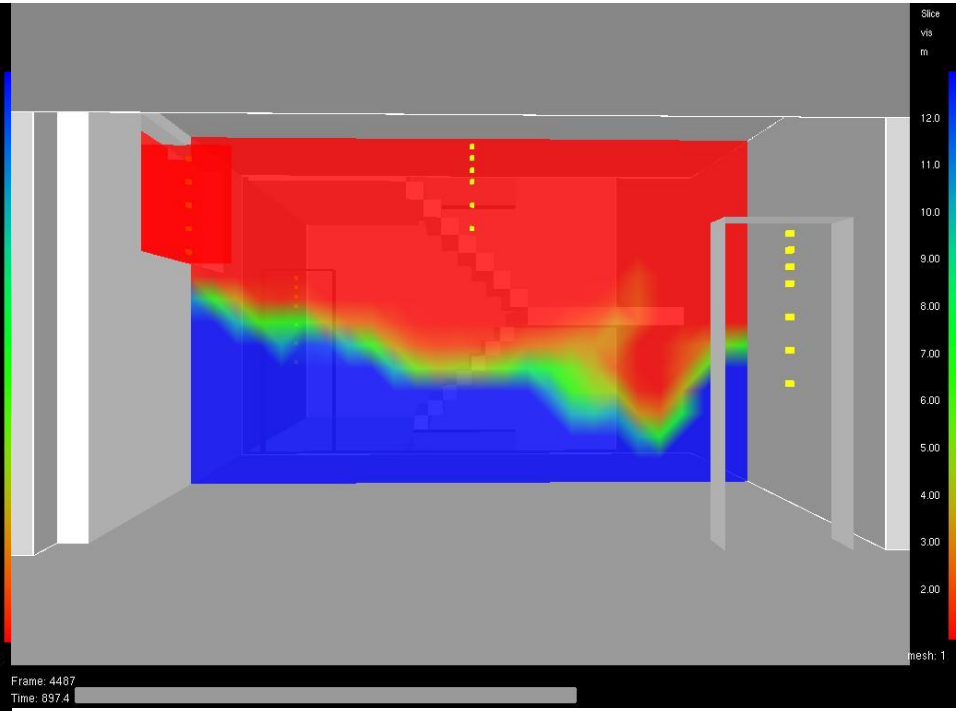
- a small vertical shaft 0.6m^2 instead of 3.0m^2
- a variable speed extract fan set (run and standby)
- a pressure sensor in each lobby
- a small motorised damper to each lobby
- a 1m^2 stairwell ventilator



Mechanical Shaft vs Natural Shaft – Visibility (doors open)

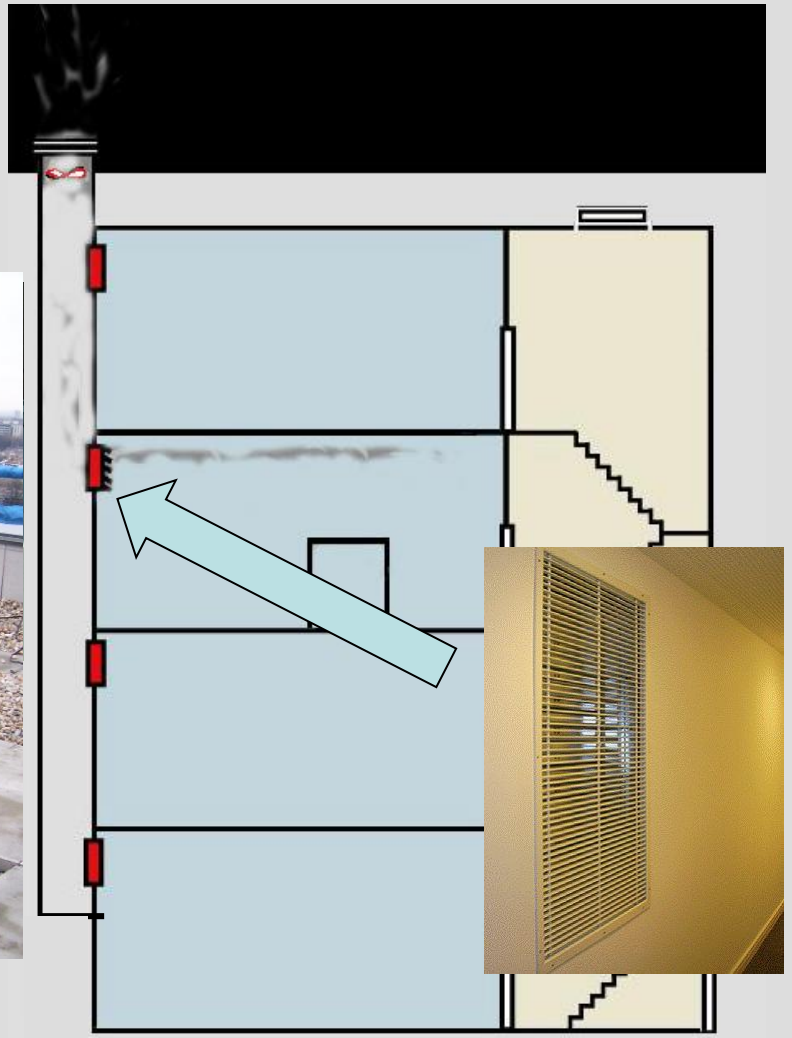


Mechanical shaft



BRE shaft

Smoke Control in Tall Buildings



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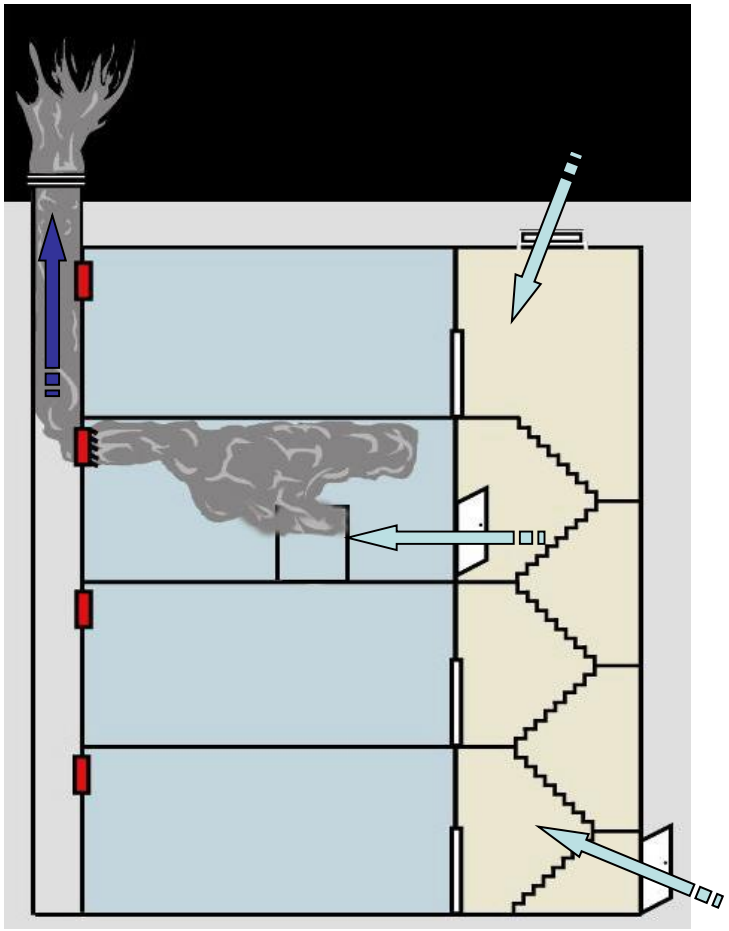
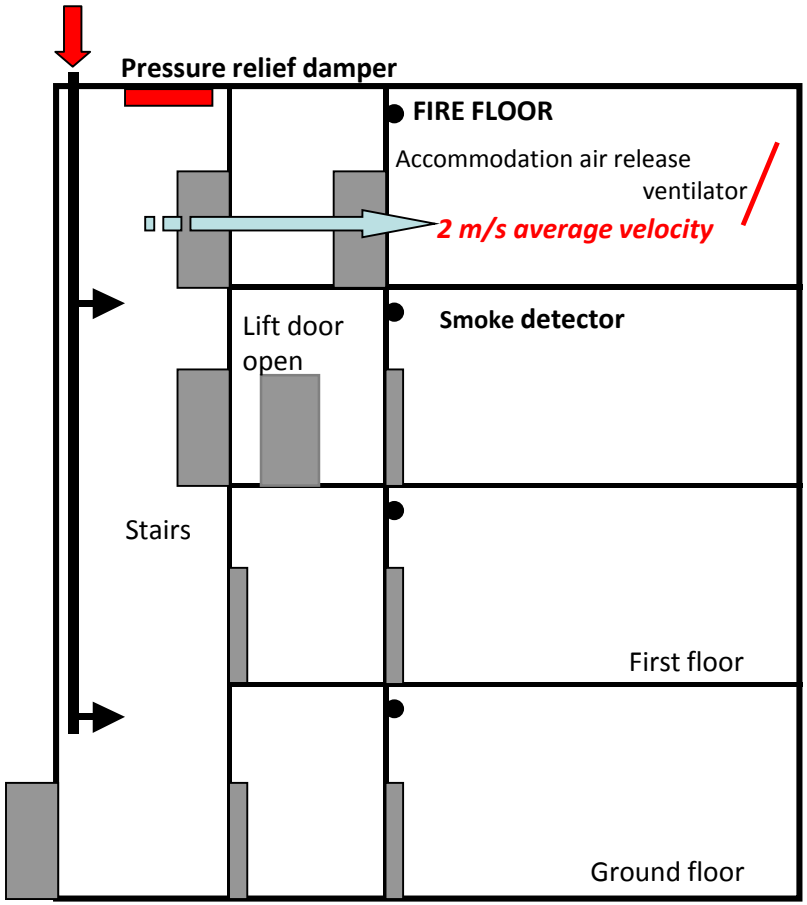


Shaft System



Pressurisation

Challenges for Smoke Control Design in Tall Buildings:

- Greater occupant numbers
- Architectural Constraints
- Environmental Effects – Stack/Wind
- Greater resistance paths
- More leakage paths – unavoidable/avoidable
- Inlet sources
- Social Issues
- Construction/Fit out

Increasing Occupancy Numbers

- People remain in the building longer
- Doors are open for greater periods
- Stairs are occupied for longer, with more people
- Waiting time in lobbies increase

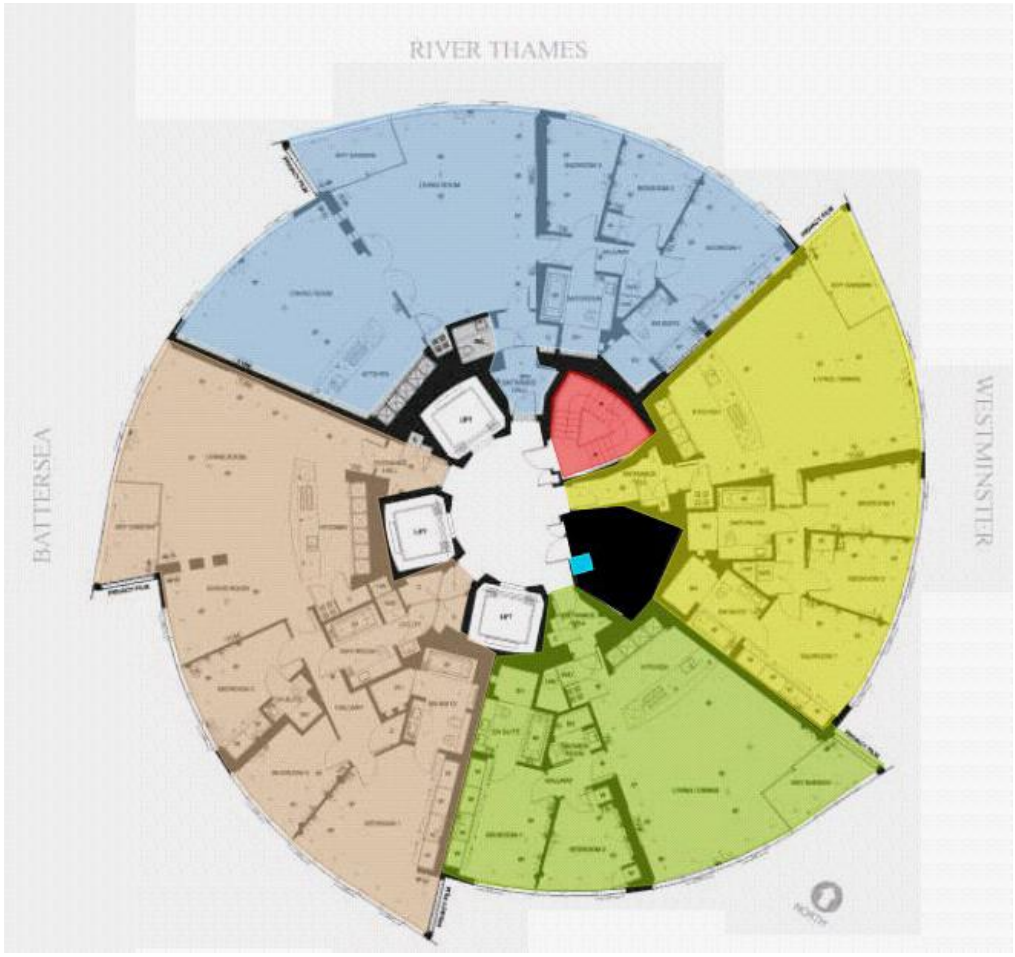
Architectural Constraints:

- Full height doors
- Poorly sized shafts, in wrong locations
- Aesthetic pressure to conceal extract from view – grilles/damper types

St George's Tower, London

- 52 levels – single stair Residential
- Sprinklered
- Mechanical extract from lobbies
- Full hieight doors
- Undersized extract shaft

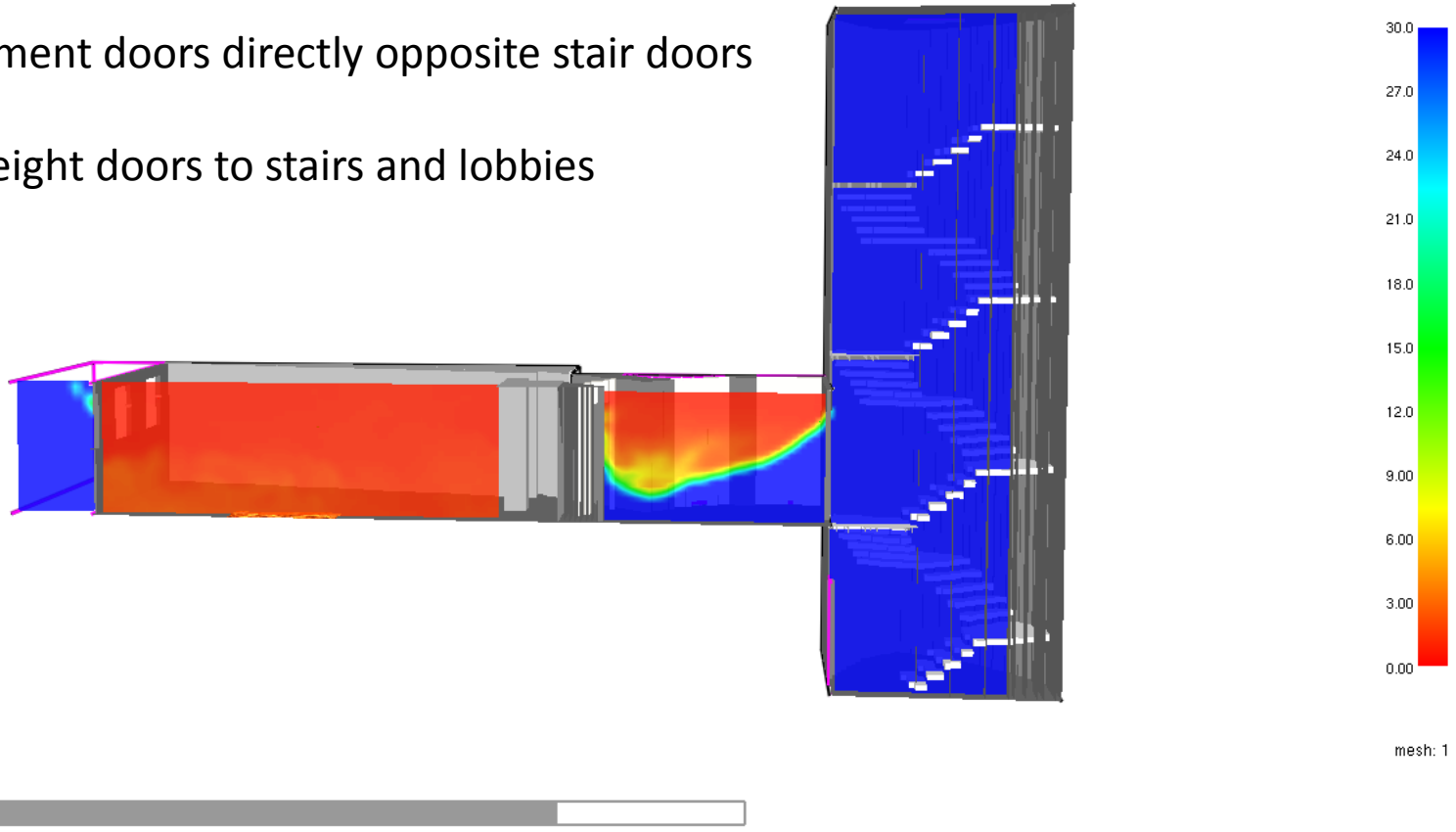
Smoke Control in Tall Buildings



Special considerations:

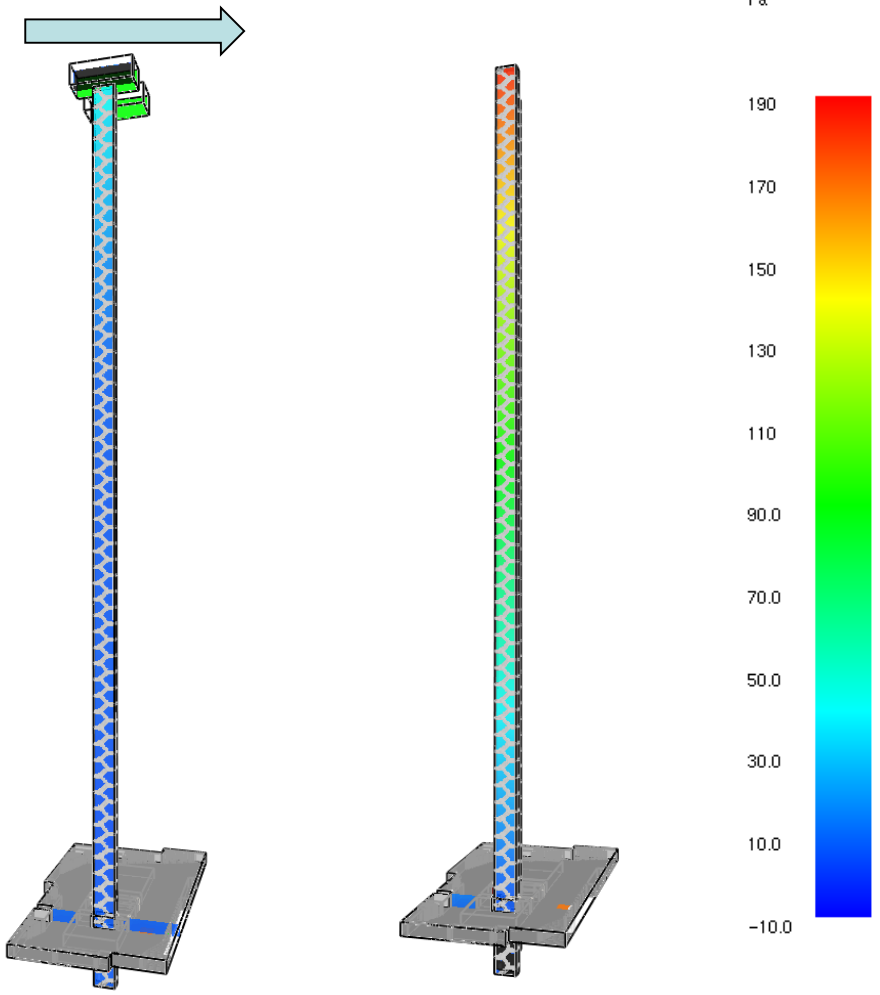
Avoid:

- Apartment doors directly opposite stair doors
- Full height doors to stairs and lobbies



Stack Effect

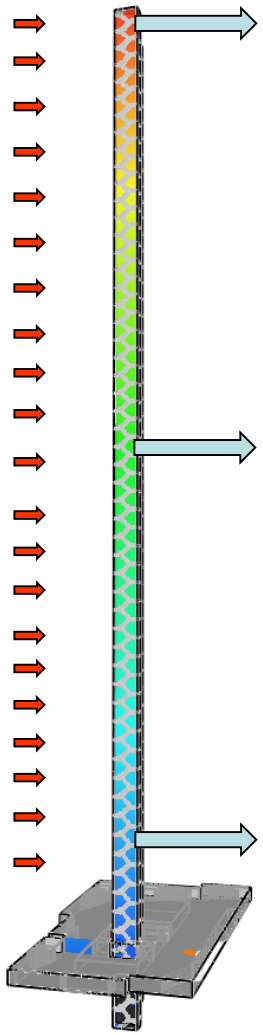
Wind effect



Resistance Paths/Leakage

- Flexibility in the extract plant location will drastically reduce resistance paths

- System should accommodate leakage from multiple levels and locations
  - 10% allowance is not enough



Build Quality – avoidable leakage

Social Issues

- Cramming
- Hoarding
- Garden Cities

Social Issues

- Social Housing
- Physical Capability/Ability
- Wilful damage/neglect

Minimum Requirements

Shaft:

- Fire rated
- Non combustible
- Well sealed – 3.8$m^3/hr/m^2$ at 50 Pa
- Free from services and obstructions
- Cabling – BS 8519 Control Systems Cat 3

Fans:

- Temperature Rated
- F300 minimum (CE Marked EN12101-3)
- Sized to meet required duty + leakage
- VSD/DOL

Smoke Ventilators

- CE Marked - EN 12101-2
- Open and stay open if required
- Known ventilation performance
- Life cycle tested

Construction/Fit out Issues

- Incomplete installations of fire protection measures – active and passive
- Storage of construction materials
  - fire load
  - changing evacuation routes
- Ignition risk from construction process
- In a tall building one or more floors will be undergoing fit out throughout the building life

Commissioning Process:

1. Complete installation

2. Check for conformity to design

3. Electrical installation checks
   - Continuity/Impedance
   - Insulation
   - Resistance
   - Network

4. Electrical Performance Tests (fans):
   - Test incoming voltage to MCC Panel from Primary and secondary supplies
   - Record resistance and current across phases
   - Rotational check – speed and direction where required

6. Cause and Effect Testing
   - Primary / secondary fan switchover
   - Primary / secondary supply switchover – Black Building

7. Test and prove compliance with design

8. Smoke Test - where specifically required

Testing and maintenance

- Smoke control is a life safety system, covered by the Regulatory Reform Order. Testing and maintenance is covered by BS 9999 Annex I
- Regular testing – weekly
- Three monthly full test
- Annual inspection and maintenance by a competent person

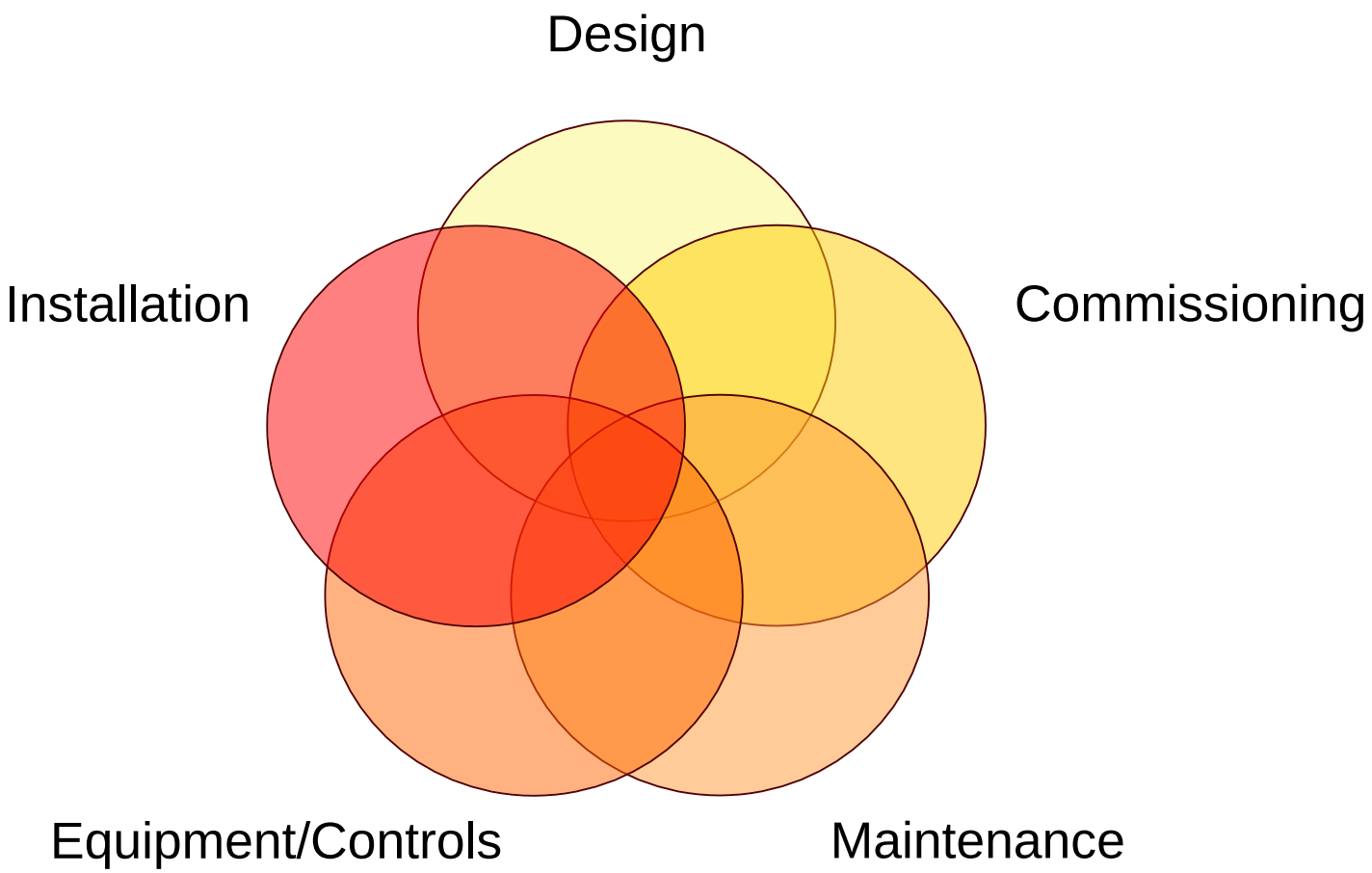
BS 9991
BS 9999 → SCA Guide → BS 7346-8 → **Documentation**

Changes to UK Building Regulations - Action Required

- Defined levels of competency – designers, installers, commissioning, maintenance
- Clearly defined system objectives
- Life safety over aesthetics
- Design on the basis a fire will occur over building life
- Resilience and robustness over state of the art
- Comprehensive maintenance regime - recalibration
- Training and re-training for FM teams

Frequent maintenance issues

- Lack of testing/maintenance
- Poor records
- Poor initial installation of equipment
- System disconnected or not reset after fault or activation
- Inappropriate equipment, e.g. Non fire rated cables.
- Improper use of equipment, e.g. Smoke extract used for day to day ventilation.
- Repair quotes not always taken up by customers.
- Recommendations of battery changes and basic maintenance not taken up.
- Misuse of smoke equipment by tenants, e.g. Fire alarm disconnected, smoke detectors removed, smoke ventilators forced open.
- Incorrect advice from unqualified contractors and subsequent poor service & maintenance provided.


Design
Installation
Commissioning
Equipment/Controls
Maintenance

Thank You