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Part B – 2024

BS 9999, BS 7974 and performance-based Fire Design Approaches to new and existing buildings.

Michael P. Lyons, Chartered Engineer

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September 25, 2024

Fire Safety Part B :

TGD-B 2024 and Alternative Approaches

– Michael P. Lyons CEng MIEI

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Part B – TGD-B
1991 - 1997 – 2006(20) - 2024

- Provide For The Health, Safety And Welfare Of People In And Around Buildings
- Performance based regulations - prescriptive technical guidance

Technical Guidance Documents A To M

- Give Guidance On How To Comply With The Regulations
  - 1991 Regulations – Part B - 1 June, 1992
  - 1997 Regulations – Part B - 1 July, 1998.
  - 2006 Regulations – Part B – 1 May, 2006
  - 2024 Regulations – Part B – 01 May, 2025

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Compliance with Part B of the Building Regulations, 1997-2024

- Regulation B1 – Means of Escape
- Regulation B2 – Internal fire Spread (Linings)
- Regulation B3 – Internal Fire Spread (Structure)
- Regulation B4 – External Fire Spread
- Regulation B5 – Access and Facilities for the Fire Service
- Regulation B12 – information of fire safety systems

  - TGD-B - 2024 : Implementing European Standards
    - Section 0 – Use of the guidance
    - Section 1 – 9
      - Preamble
      - Guidance details
    - Appendices

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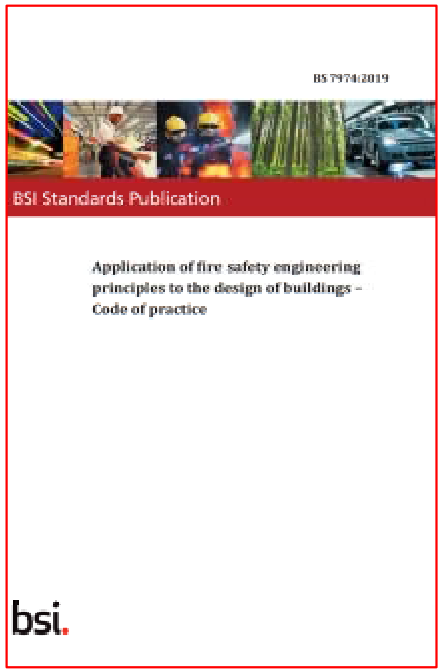
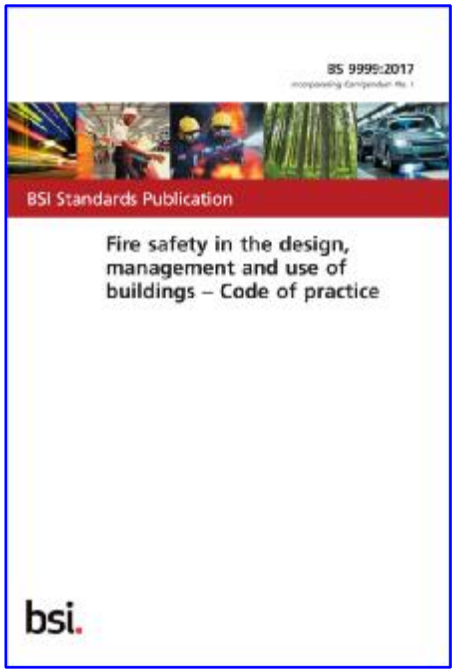
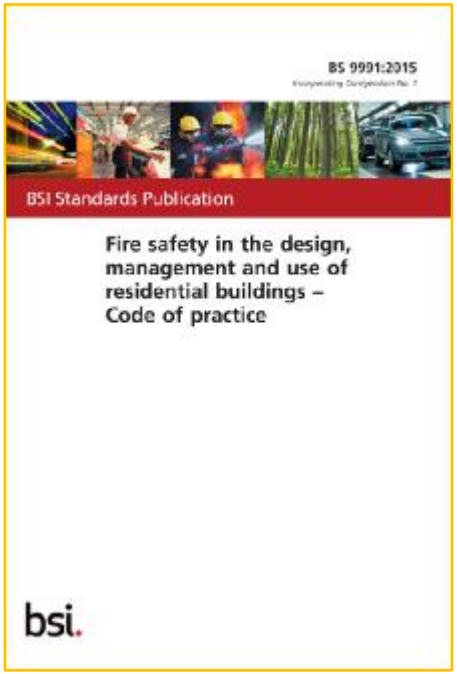
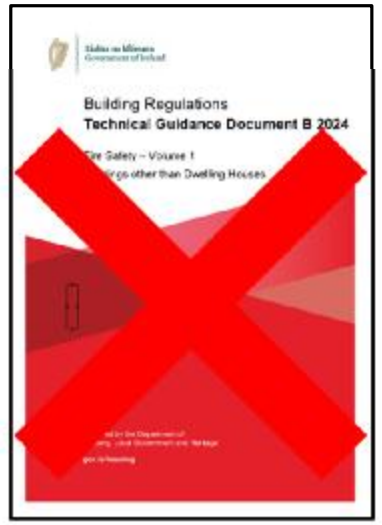
Alternative Approaches









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A Fire Safety Certificate application must demonstrate / prove

Building Control Regulation 13.(2)

13.(2) subject to paragraph (3), an application for a fire safety certificate shall be accompanied by—

(a) such plans (including a site or layout plan and drawings of floor plans, elevations and sections) (in duplicate), calculations, specifications and such other particulars as are necessary to —

(i) identify and describe the works or building to which the application relates, and

(ii) enable the building control authority to assess, whether the said works or building would, if constructed in accordance with the said plans, calculations, specifications and other particulars, comply with requirements of Part B of the Second Schedule to the Building Regulations,

(b) particulars of the nature and extent of the proposed use and, where appropriate, of the existing use, of the building concerned, and

(c) such fee (if any) as may from time to time be prescribed for that purpose in Part V.

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Terminology

- **Prescriptive**
  - 'The period of fire resistance shall be 30 minutes**.'**
- **Performance**
  - The structure shall remain in place for as long as people are evacuating so that all people can escape:
    - Fixed: within ***30 minutes.'***
    - Variable: within t minutes, where: t = formula

- **Part B - Functional requirement**
  - The building shall have ***appropriate provisions for the early warning of fire,*** and appropriate means of escape in case of fire from the building.'

PBD – Performance Based Design : Design target

'Maintain tenable conditions on stable escape routes until the occupants have all evacuated.'

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Fire Safety Strategy

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• Prevention

- Fire safety management
- *Control of ignition sources*
- ***Control of combustibles***
- *Maintenance of electrical equipment*
- *Smoking policy…etc*

• Containment

- **Compartmentation**
- Structure
- Separation
- Smoke management
- Fire safety management…etc

• Escape

- – Fire alarm systems
- – Fire detection systems
- – **Escape routes**
- – Fire safety management…etc

• Suppression

- First aid fire-fighting
- **Automatic suppression**
- Fire & Rescue Service facilities
- Fire safety management…etc

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Prescriptive Code Limitations

- Large Retail Shops > 4000m^2 or Large Warehousing / Industrial buildings
  - Compartmentation ?
  - Travel Distances, Exits, Smoke Control, Voice assisted evacuation /A, high ceilings
- Basement car parks
  - No sprinklers (TGD B)
  - Fire spread (Liverpool, Cork), EV vehicles
- Recreational environments – open planning
  - Small Bar, Restaurant
  - Open stairs
- Airports / Underground Transport Stations / Large
- Heritage Buildings
  - Single stairway – lobbies
  - Pressurisation, smoke control, sprinklers

- Fire Safety B5 Strategies
  - Grenfell: Stay In Place

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Alternative design frameworks

BS7974

- Performance Based Design

BS9999 – Other buildings

- Risk profile based
- Semi-prescriptive/performance but flexible

BS9991 - flats

- TGD-B 2024 incorporates adequate guidance

Tools like **CFD**

Computational **F**luid **D**ynamics

International Building Code

USA -

NFPA - USA

- NFPA 1
- NFPA 101

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Fire Safety Engineering approach

Diagonal Grid - DiaGrid

30 St Mary Axe,

also known as the "**Gherkin**" and the **Swiss Re** *(Schweizerische Rückversicherungs-Gesellschaft AG)* **Building**, is a skyscraper in London's main financial district

[completed December 2003

opened in May 2004]

Capital Gate, Abu Dhabi
designed with a striking lean.
At 160 m and 35 storeys

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Part B – factors/characteristics must all still

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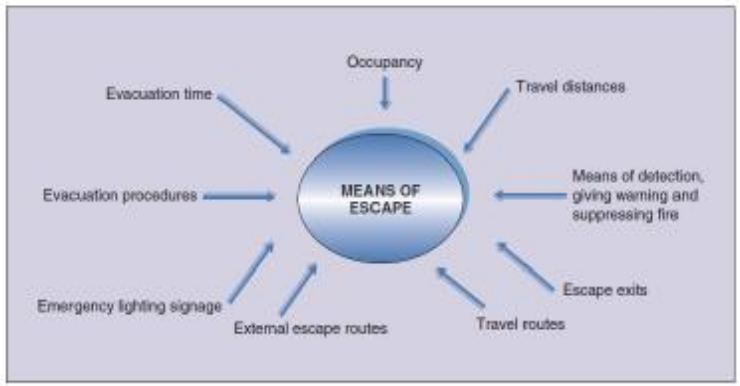
- Single exit/stairs vs. multiple means of escape
- Purpose groups – fire loading
- Widths of escape – adequacy criteria ?
- Inner rooms – measures to provide adequate means of escape
- Floor space factors
- Travel distance limits {vs. direct distance…}
- Direction of opening
- Automatic doors as exit doors
- Fastenings vs. security
- Seated audiences / overcrowding / management
- Protected lobbies / corridors
- External escape stairway(s)
- Fire door sets – period/accessories/closers/smoke
- Fire detection systems / Warning systems
- Emergency lighting / Primary lighting arrangements
- Persons with disabilities
- Smoke control and Discharge arrangements
- Fire Suppression systems
- Degree of compartmentation



Factors affecting means of escape

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BS 7974:2019 : Application of fire safety engineering principles to the design of buildings – Code of Practice

BS7974

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Objectives of BS 7974

(a) Provide a structured framework for assessing the interaction between buildings, people and fire,

(b) Enable an objective assessment of the fire safety measures required to achieve defined objectives, and

(c) Assist in developing alternatives to prescriptive codes and enable the effect of these to be evaluated.

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BS7974 - BENEFITS

- Facilitates the practice of fire safety engineering
- Provides designer with a **disciplined approach** to fire safety
- Allows safety levels for alternative designs to be compared
  - Provides a basis for selection of appropriate fire protection systems
- Provides opportunities for innovative design
  - Provides information on building's management of fire safety
- Framework that is **flexible but formalised**
- Approach to Fire Safety Design can be readily assessed by authority
  - Fire is an extremely complex phenomenon and gaps still exist in available knowledge.

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Fire Safety Engineering approach – BS 7974:2019

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- PD 7974-1, *Initiation and development of fire within the enclosure of origin*;
- PD 7974-2, *Spread of smoke and toxic gases within and beyond the enclosure of origin*;
- PD 7974-3, *Structural response and fire spread beyond the enclosure of origin*;
- PD 7974-4, *Detection of fire and activation of fire protection systems*;
- PD 7974-5, *Fire service intervention*;
- PD 7974-6, *Evacuation*;
- PD 7974-7, *Probabilistic fire risk assessment*.

a **framework** for the application of fire safety engineering (FSE) principles to the design of buildings, giving recommendations and guidance for the protection of people, property and the environment from fire

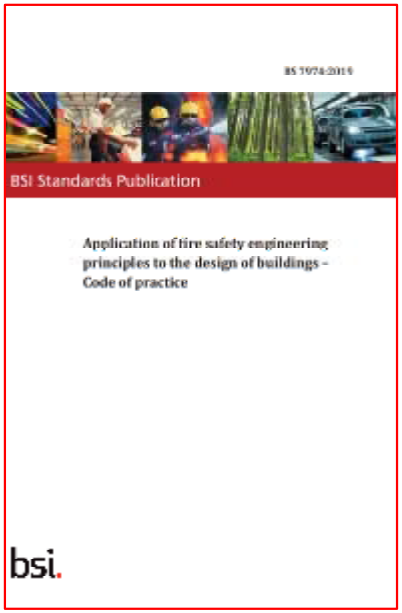
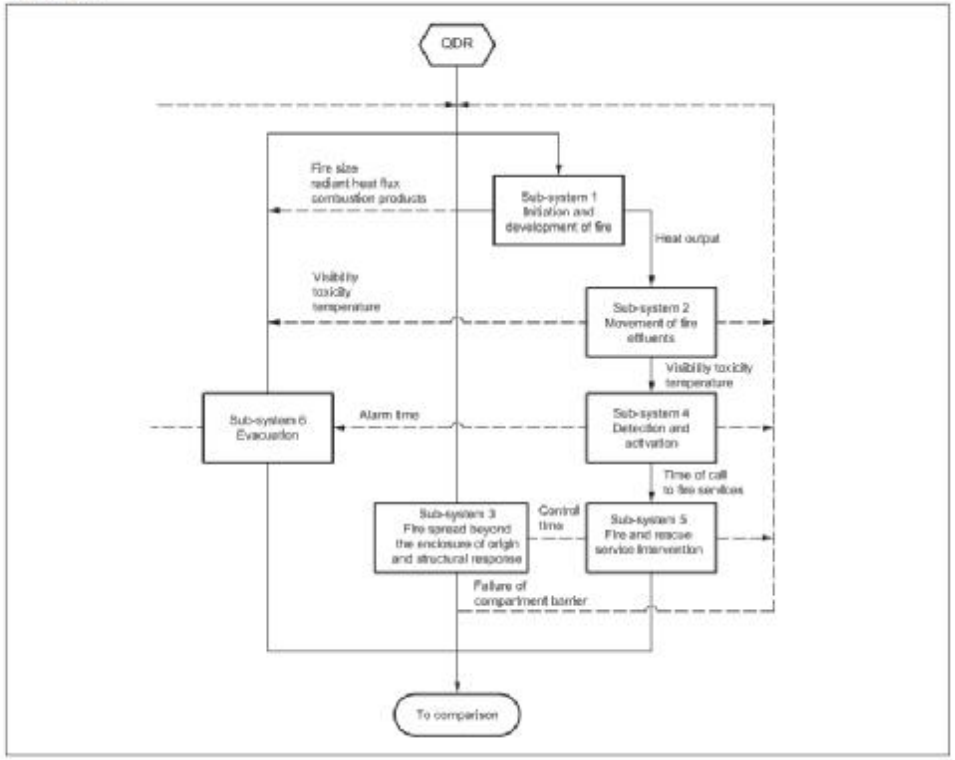


Figure 2 — *Example of the complexity of the linkages between the sub-systems that can arise if the analysis is not simplified*



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BS7974 - SUPPORTING SUB-SYSTEMS

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- Sub-systems described within 8 Published Documents that support BS 7974.
- PDs contain guidance / information on how to undertake detailed analysis of specific aspects of fire safety engineering in buildings.

- **PD0 -** Guide to the design framework and fire safety engineering procedures.
- **PD1 -** Initiation and development of fire within the enclosure of origin [SS 1]

- **PD2 -** Spread of smoke/toxic gases within/beyond enclosure of origin [SS 2]
- **PD3 -** Structural response & fire spread beyond enclosure of origin [SS 3]

- **PD4 -** Detection of fire and activation of fire protection systems [SS 4]
- **PD5 -** Fire service intervention [SS 5]

- **PD6 -** Evacuation [SS 6]
- **PD7 -** Probabilistic fire risk assessment [SS 7]

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Fire Safety Engineering approach – BS 7974:2019

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- BS 7974 divides the fire safety engineering design process into three main stages:

1. Qualitative design review (QDR),
2. Quantitative analysis (QA), and
3. Assessment against criteria (AAC)

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Fire Safety Engineering approach – BS 7974:2019

Quantitative analysis

- Initiation and development of fire
- Smoke movement beyond the room of origin
- Response of structure to fire
- Activation of detection and fire suppression systems
- Fire Brigade Intervention
- Human response and evacuation
- Probabilistic risk assessment

Probabilistic

- § Statistical likelihood of scenarios, success, failure
- § Reliability of fire safety measures
- § Event probabilities

o Fire begins, Doors closed/open, Detection, fire safety system failure, human response

- § Probability of fire starts multiplied by fire safety system failure probabilities

o Failure probability

- Code, societal values
- Useful for sleeping risk buildings

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Fire Safety Engineering approach – BS 7974:2019

Qualitative Design Review (QDR)

Tasks carried out in the QDR include:

1. Layout and structural design of building - *Review of the architectural design*
2. determine building, environment and occupant characteristics
3. Establish Fire safety / Protection objectives
4. Decide / agree acceptance criteria
5. Identify Fire hazards & potential consequences
6. Propose Trial fire safety designs
7. Propose an Evacuation Strategy
8. Make reasonable assumptions to simplify the problem
9. Acceptance criteria & method of analysis
10. Specify scenarios for analysis
11. Report Results of QDR
    - § Non-numerical examination
    - § Experience, knowledge and engineering judgement
    - § *Assess and compare with code-compliant design using logical judgement*
    - § Simpler proposals

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Fire Safety Engineering approach – BS 7974:2019

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Assessment of FSE Design

- follow the BS7974 procedures
  - Fire Models are limited by degree of extrapolation that can be made
- Compare results of a quantified analysis with Original QDR design criteria

Factors, inter alia, that should be taken into account include:

- the anticipated probability of a fire occurring;
- the anticipated fire severity;
- the ability of a structure to resist the spread of fire and smoke; and
- the consequential danger to people in and around the building.

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Fire Safety Engineering approach – BS 7974:2019

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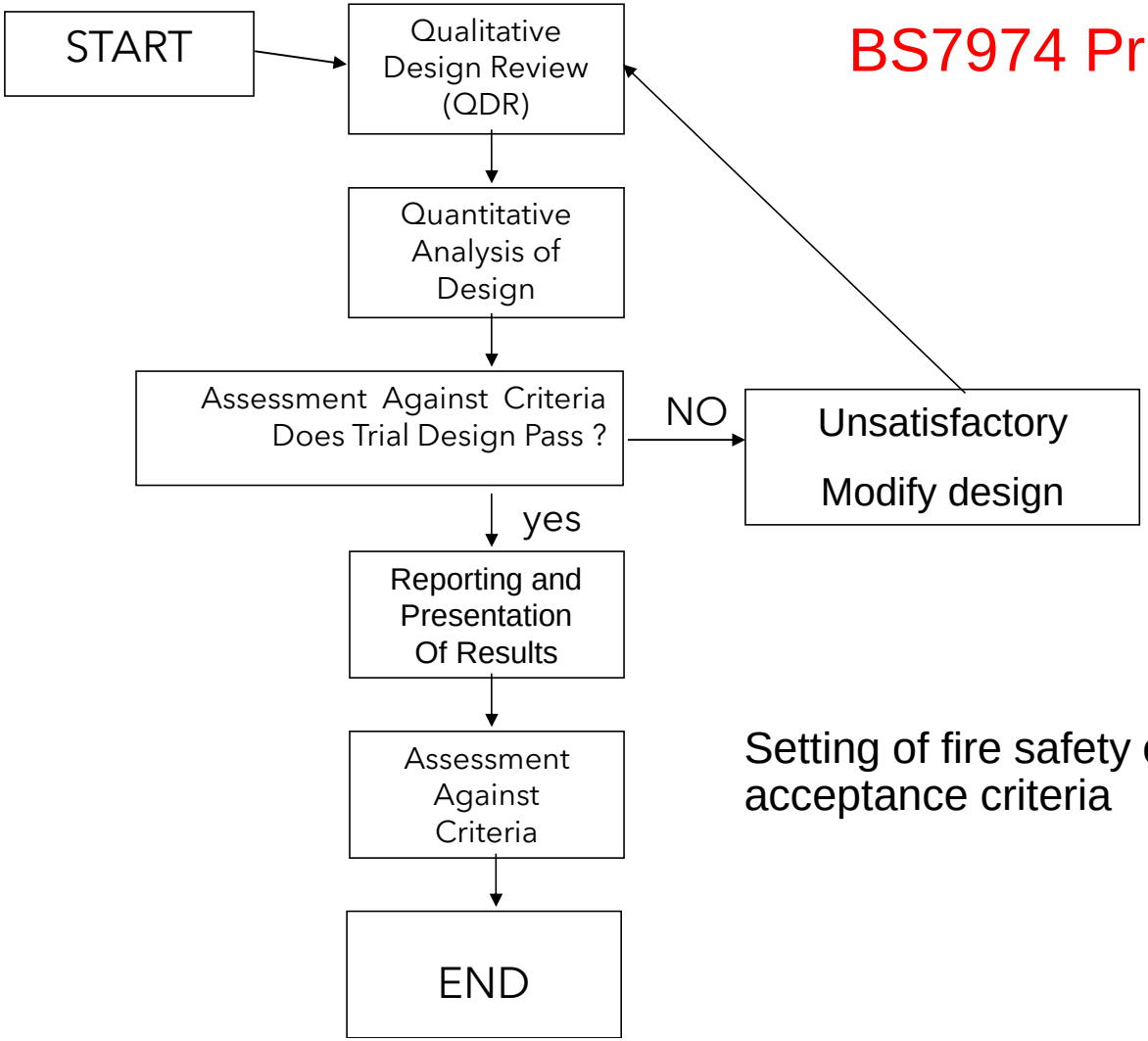

BS7974 Process

Setting of fire safety objectives and acceptance criteria

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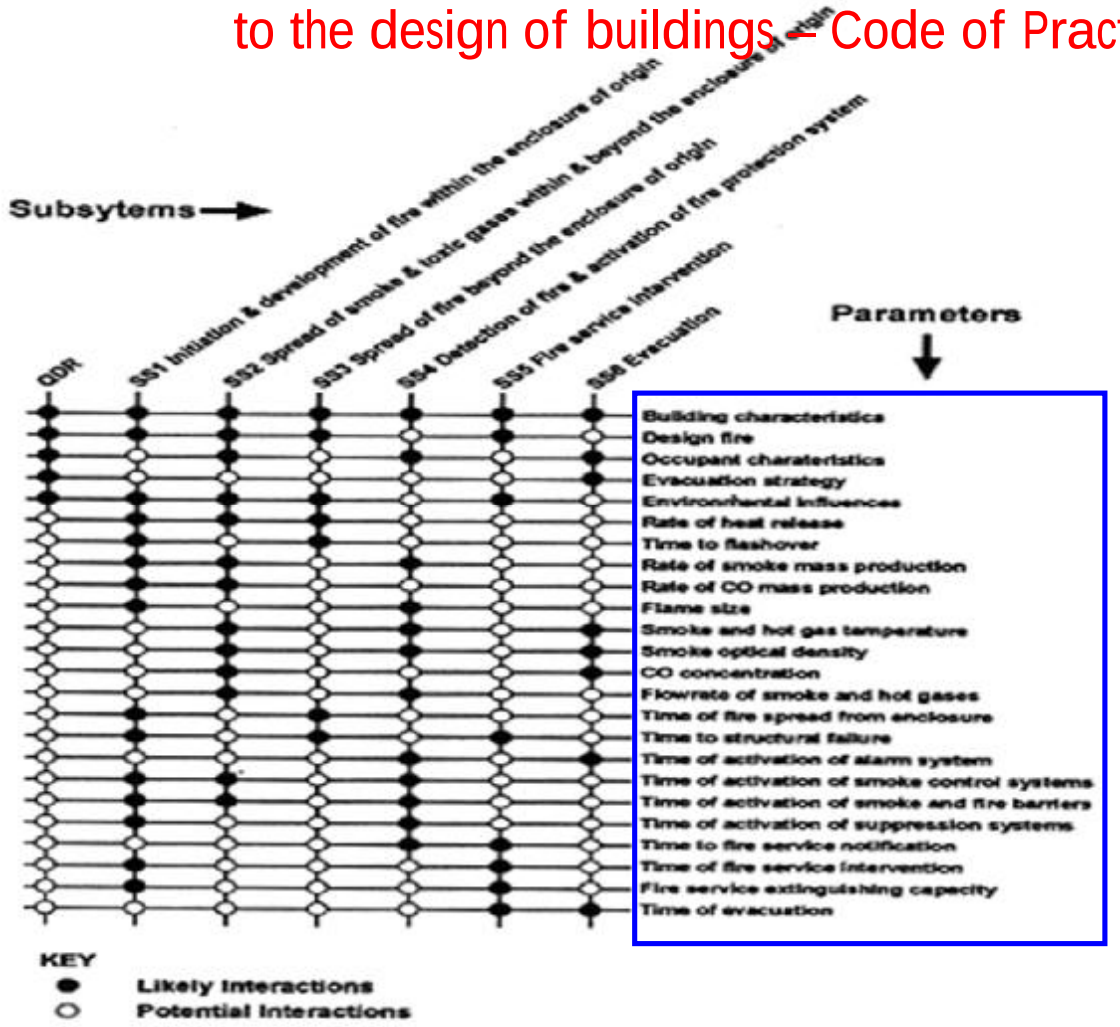
Fire Safety Engineering approach – BS 7974:2019

BS 7974:2019 : Application of fire safety engineering principles to the design of buildings – Code of Practice



Grid Diagram – BS7974

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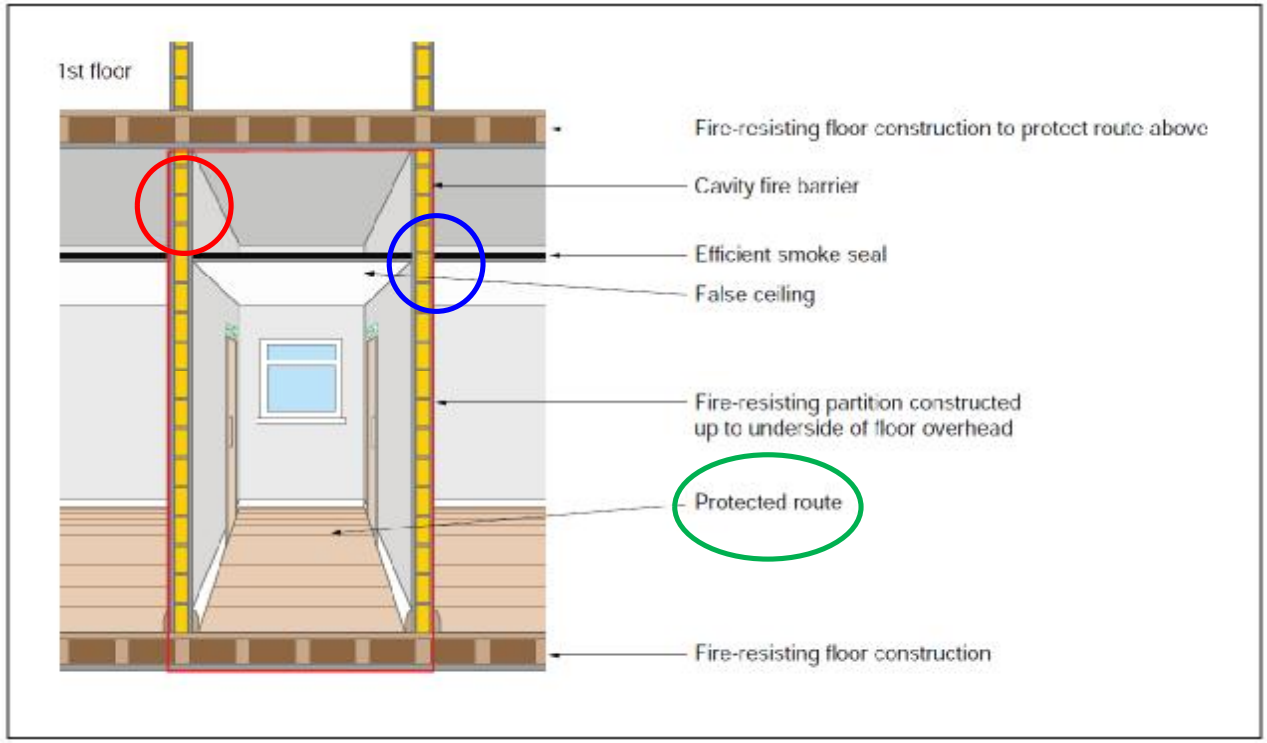
Designer decisions under PBD

– no safety net for the designer



- Example – FR cavity barriers
- TGD_B tells you where and what
- PBD - designer decides - to omit - to include - to enhance – to reduce

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FSEngineering - Deterministic Analysis

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Acceptance criterion:

ASET $> T_{esc}$ (RSET)

Where $T_{esc} = T_{det} + T_{alarm} + T_{pre} + T_{travel}$

ASET Available safe escape time RSET Required safe escape time

T_{esc}	time from ignition to evacuation complete
T_{det}	time from ignition to detection or cue received
T_{alarm}	time from detection to general alarm
T_{pre}	pre-movement time
T_{travel}	travel time

- ASET criteria : Maintain visibility and limit hot layer temperature

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Evacuation Modelling

- Manual methods very laborious and takes too long
- Simple layouts only, iterative process
- Fire Spread Modelling :
  - Two types of fire model, namely the zone model and field (CFD) model
- Egress modelling :
  - Simple software Egress Models
    - Actions = function of F(densities, exit capacities)
    - Coarse network
  - Complex software Egress Models
    - Account for behaviour, response times, exit preferences
    - Range of evacuation times
    - Fine network
    - Individual perspective
    - Rule based or implicit behaviour

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BS 7974 : Application of fire safety engineering principles to the design of buildings – Code of Practice

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- Guidance and recommendations
- promotes effective and competent Engineering Judgement
- about likely interactions and potential interactions of appropriate data input into relevant sub-systems,
  - as indicated in the BS7974 grid diagram

- E.G. **the time to flashover**
  - arising from ignition of a particular material
  - is likely to have a significant interaction with
    - the development of fire, and
    - the spread of fire beyond the enclosure of origin

- Note that 'time to flashover' is the underlying principle of the 7 Euroclasses for "reaction to fire", A1 to F

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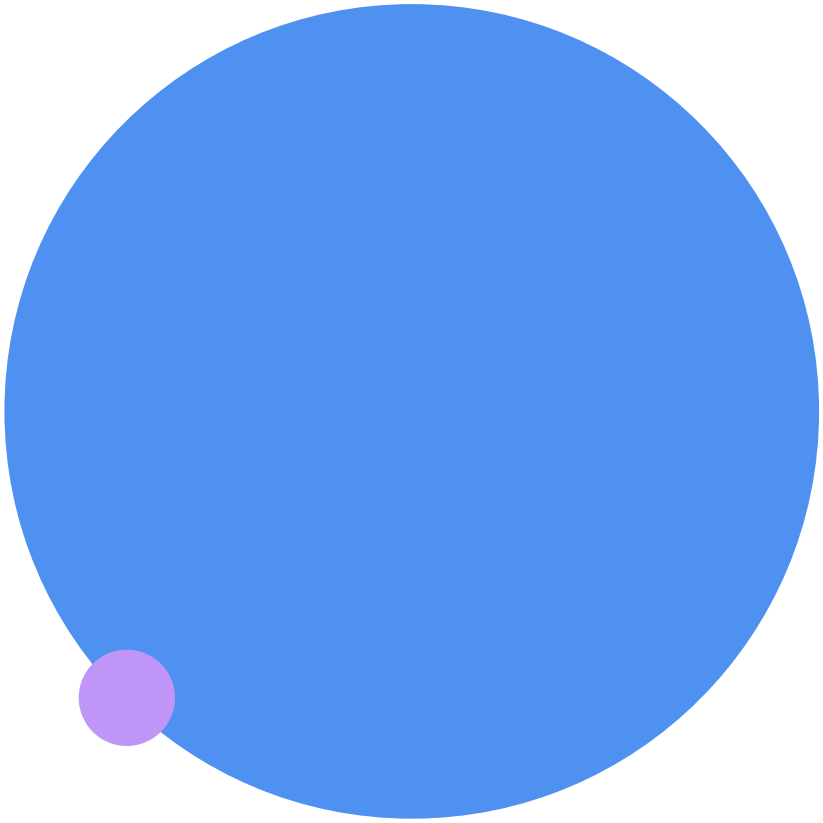

BS9999

Hybrid

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BS9999:2017

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Fire Safety Strategy

- Risk Assessment of activities
  - a) the anticipated likelihood of a fire occurring;
  - b) the anticipated severity and potential spread of any fire;
  - c) the ability of the structure to resist the spread of fire and smoke;
  - d) the consequential danger to people in and around the building; and
  - e) the need to address property and contents protection, business interests and the environment.
- Risk profiles
  - Wakefulness, familiarity
- Factors
  - Fire safety measures
- Fire Safety Management System

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Lifts for evacuation – 46.9 BS9999

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For the evacuation of disabled people :

- should be an **evacuation lift** or a **fire-fighting lift**
- should be operated under the direction and control of the fire safety manager
    - § *or a delegated representative*

- Evacuation lifts should be provided, constructed and operated in accordance with Annex G of BS9999

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BS9991

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Fire Strategies – Means of escape – Apartment Blocks

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Basic Fire Safe Designs

- Room
- Room door
  - Corridor
  - Entrance hall
  - Stairway
- Flat entrance door
- Common lobby
- Door
- Stairs
  - Exit door
  - Services
- Exterior
- Common areas vs. the dwelling

Fire Safety Measures

- Linings on walls & ceilings
- Interior Enclosure walls
- Fire stopping gaps
- Detection & alarm systems
- Emergency Lighting system(s)
- Sprinkler System(s)
- Smoke Discharge/Control/Ventilation/Clearance
- First Aid Firefighting equipment
- Floor constructions
  - Stacked services from storey to storey
  - Fire stopping
- Compartment Enclosure walls
- Common areas
- Ancillary fire safety features
- Party walls
- External walls common cavities
  - Insulation
  - Rain cladding
  - Fire stopping

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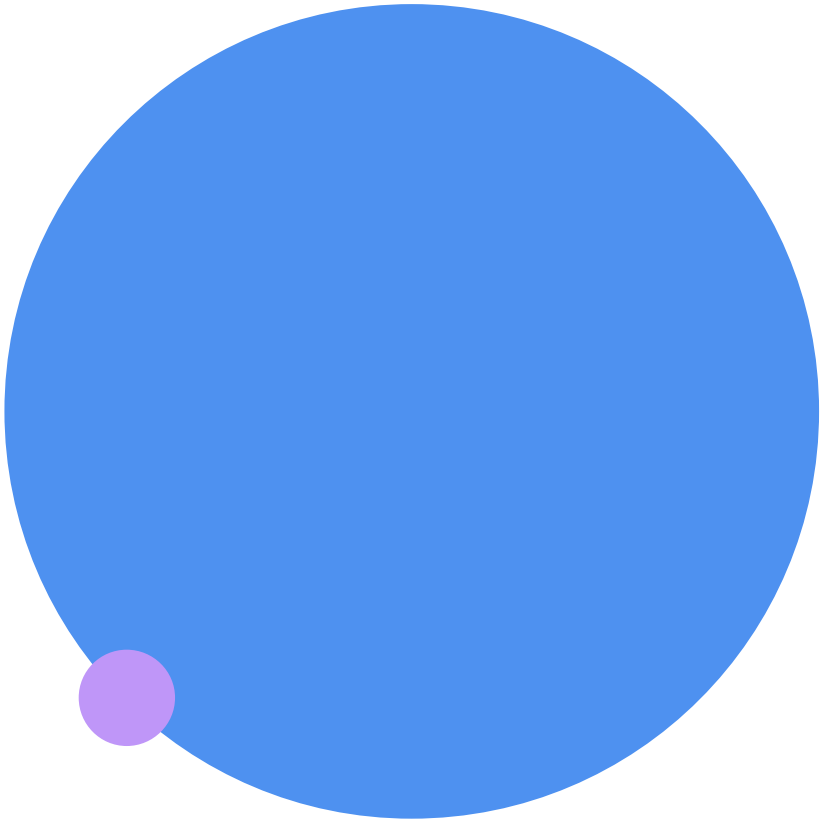

Existing Buildings

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Welcome - “existing”

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- **0.3 Existing Buildings 8**
- New Full **Section 7.0**
- In The Case Of Material Alterations Or Changes Of Use Of Existing Buildings, The **Adoption Without Modification Of The Guidance** In This Document May Not, In All Circumstances, Be Appropriate.
- In Particular, The Adherence To Guidance — Including Codes, Standards Or Technical Specifications — Intended For Application To New Work May Be Unduly Restrictive Or Impracticable.
- Buildings Of **Architectural Or Historical Interest** Are Especially Likely To Give Rise To Such Circumstances.
- In These Situations, Alternative **Approaches Based On The Principles Contained** In The Document May Be More Relevant And Should Be Considered.

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B1 to B5, B12 requirements

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Reg	Feature	Prove	Standard of proof	Circumstances	
		Design and Construction			
B1	Means of warning	early warning of fire	appropriate provisions	in case of fire	
	Means of escape	from the building to a place of safety outside the building	Adequate capable of being safely and effectively used		
B2	internal linings	Have a rate of heat release, or have a rate of fire growth	reasonable in the circumstances	inhibiting the spread of fire within a building	
		have a resistance to ignition	reasonable in the circumstances	inhibiting the spread of fire within a building	
		have a resistance to the spread of flame over their surfaces	shall offer adequate resistance		
B3	stability		Shall be maintained for a reasonable period	in the event of fire	
	wall common to two or more buildings	offers resistance to the spread of fire	adequate resistance	between those buildings	
	building shall be sub-divided	with fire resisting construction	to inhibit the spread of fire within the building	where this is necessary	
	unseen spread of fire and smoke	within concealed spaces in its structure or fabric	is inhibited where necessary	unseen spread	
B4	external walls	over the face of the building	afford adequate resistance to the spread of fire	to and from neighbouring buildings	
	external roof	over the face of the building	afford adequate resistance to the spread of fire	to and from neighbouring buildings	
B5	access for fire appliances	to assist the fire service in the protection of life	as may be reasonably required		
	such other facilities	to assist the fire service in the protection of life	as may be reasonably required		
B12	Sufficient information	the active fire safety systems installed for the purpose of fire safety in the building	so that the building can be operated in order to protect the health and safety of the building occupants	be provided to the building owner	

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Questions