



Elevating Safety - Challenges with High-rise Residential Fire Lift Evacuation



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Lift Evacuation Historical Context



1914 - NFPA meeting - Discussion regarding the use of lifts for evacuation and committee:

- Enclosing lift shafts, improving the fire resisting powers of lift doors, ensuring the integrity of the electric current applied to lifts.
- Training lift operators in emergency procedures, including that persons in the upper stories shall first be taken to the ground.

1935 - NBS (National Bureau of Standards) report discussed potential use of lifts for evacuation:

- Not suitable to consider lifts for egress capacity.
- Uncertainties were such that no direct credit be given for lifts but to recognize their availability in high buildings.

Enclosing in fire resistant construction

"... elevator shafts properly enclosed and with openings adequately protected have decided value from an escape standpoint, and are absolutely necessary in high buildings."

Proposed not considered for contributing to egress capacity

"...capacity and rate of speed is not great." And
"... they are not subject to a single will as in the case of an elevator operator, but to demands from many tenants."

Lift Evacuation Historical Context



1970s

- Lift evacuation simulations conducted at University of Berkley (Bazjanac, 1977)

2000s

- World Trade Center 911 Attacks – Many people used lifts to evacuate
- Collaborative task group (ASME, NIST, ICC, NFPA, US Access Board, and the IAFF) developed technical requirements for occupant and firefighter use of lifts for emergencies.
- NFPA 101/5000 & IBC – Occupant Evacuation Elevators
- Human Behaviour in Fire Conference 2009 – Dedicated sessions discussing lift evacuation
- A number of evacuation models introduced lifts e.g. Pathfinder, STEPS, buildingEXODUS, etc.

“...In the 30+ years of work, the effectiveness of using elevators for reducing overall building evacuation time has been immediately recognized at every workshop; the focus has been on ensuring that the procedures and technology are robust enough to maintain or improve the safety record of using stairs during a fire emergency.”

1. Proulx, G., Johnson, P., Heyes, E., Hedman, G., Averill, J., Pauls, J., McColl, D., (2009), 'The use of elevators for egress: Discussion Panel', Proceedings of Human Behaviour in Fire Conference, pp97-110.

Lift Human Behaviour – WTC 911

Overriding training due to perceived **urgency**...

"Shouldn't we be taking the stairs in an emergency like this?" which was replied by her colleague with, "No! Just get in the elevator! C'mon!" (Experience 1172)

Overriding training due to perceived **travel time**...

"We got to the 78th floor and Judy said, "Let's see if the elevators are working. I'm thinking I shouldn't be taking an elevator, but I guess the thought of walking down 78th floors in my high heels was not exactly something I wanted to do." (Experience 3314)

Reluctance to wait with **crowds**...

"But he looked into the marble-lined lobby, more than half a city block long, and saw people were standing shoulder to shoulder, waiting for elevators. This is pointless, he thought." (Experience 2182)

Reluctance to wait with **crowds**...

"Let me add too that, at the 44th floor there was what they call an inter-zone lift bank, we were led off the stairwell at the 44th floor and shown to that lift where there are hundreds of people milling and I looked at that and I turned around to my team and I said „no, I am not waiting for a elevator in a building on fire. Let's go" and I walked back to the stairwell and they did too and then we proceeded down" " (Experience 2182)



1. HEED: High-Rise Evacuation Evaluation Database, Fire Safety Engineering Group, University of Greenwich
2. Kinsey. M.J "Vertical Transport Evacuation Modelling", PhD Thesis, University of Greenwich, 2011

Lift Human Behaviour – Grenfell Tower

Overriding expectation due to perceived **urgency**...

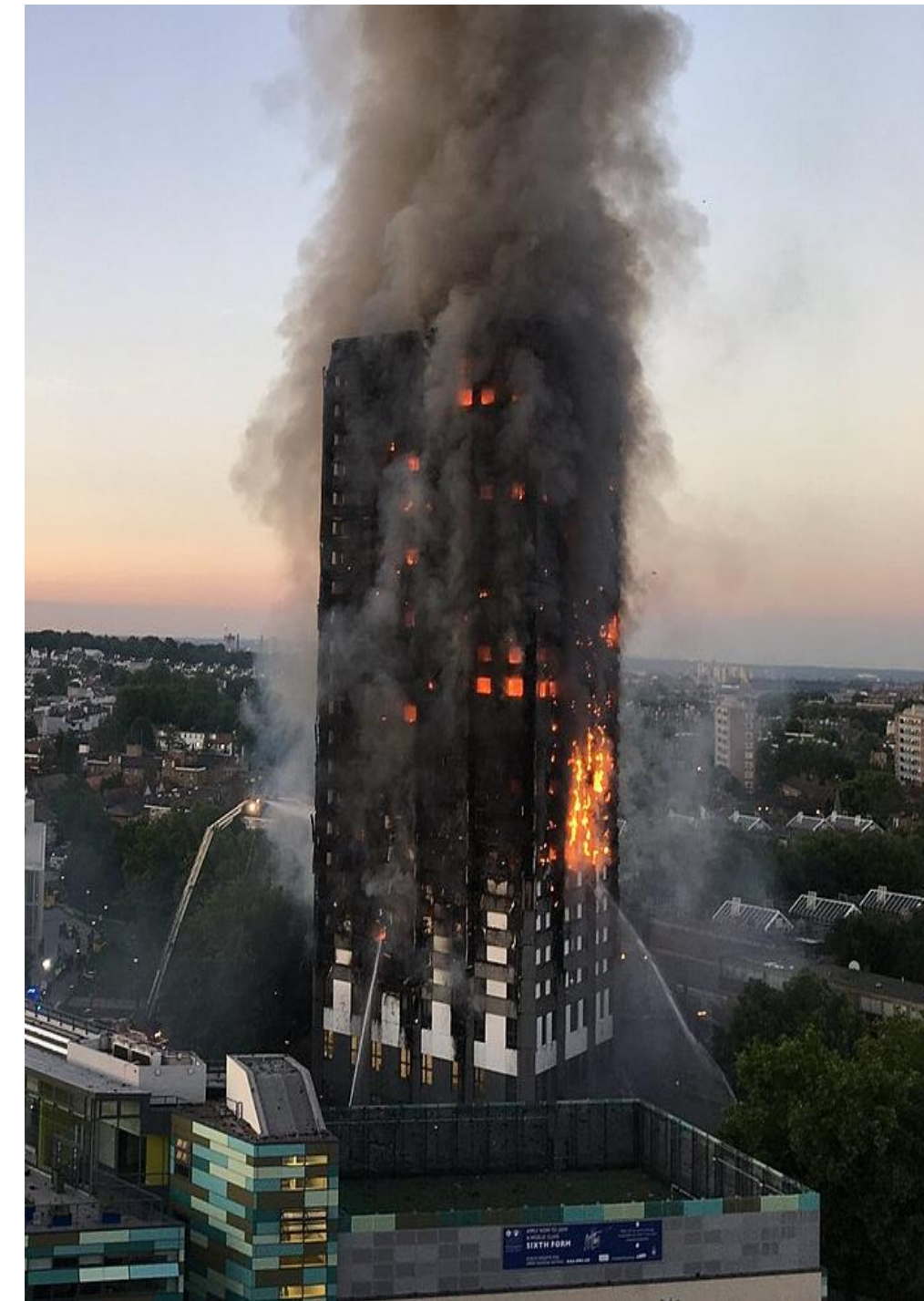
“But inside the building, many residents were fleeing the tower on their own initiative. The instinct of most of these residents was to get out of the building. **With the lift still in service a group of five residents entered it. As they descended, the lift stopped unexpectedly on the tenth floor, the doors opened and thick black smoke poured in. ‘It was terrifying, and the smoke was horrible. There was a strong and bitter chemical smell.’**”

Perception of **poorly maintained lifts**...

“Living in Grenfell Tower was difficult for those with disabilities. If the lifts were out of service (and they often were – particularly during the refurbishment when one was given over to workmen), they were trapped in the building....no plans had been made for how people with disabilities could leave the tower in an emergency.”

Perception of **poorly maintained lifts**...

“But life in the tower was made difficult by the poor maintenance and the often broken down lifts. ‘There was no care. We understood that something was going to happen and maybe we were going to lose the estate,’”



Part B of the Building Regulation 2010

"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."

The London Plan

"[buildings should] **be designed to incorporate safe and dignified emergency evacuation for all building users. In all developments** where lifts are installed, as a minimum **at least one lift per core (or more subject to capacity assessments)** **should be a suitably sized fire evacuation lift** suitable to be used to evacuate people who require level access from the building."

THE LONDON PLAN



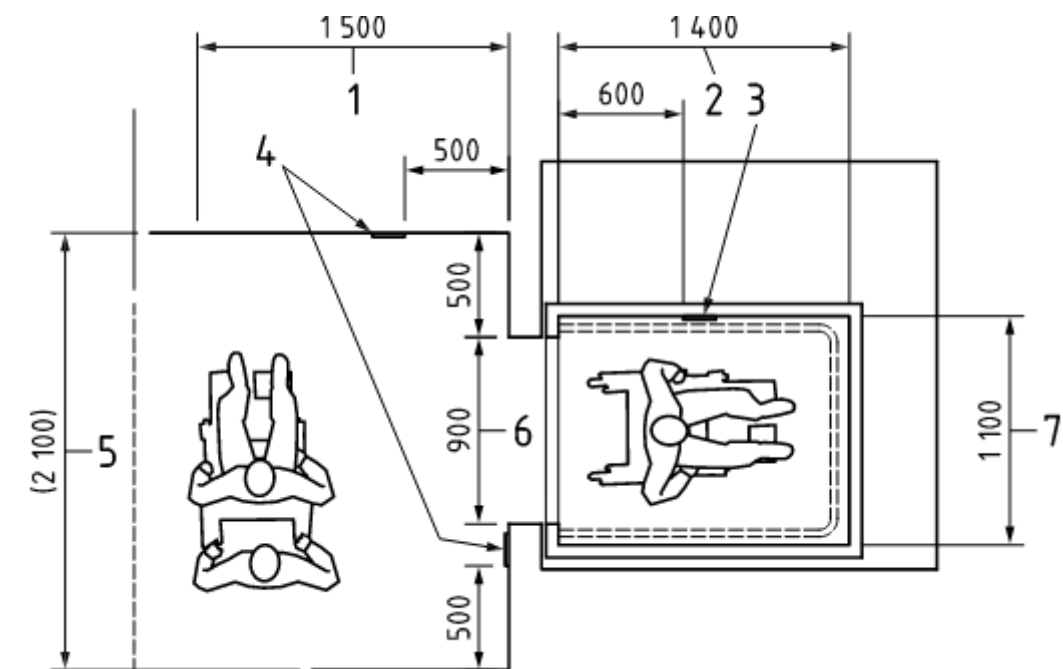
THE SPATIAL DEVELOPMENT
STRATEGY FOR GREATER LONDON
MARCH 2021

UK Regulations & Fire Design Guidance



BS 9991 (2024) Section 7.4.1

- **All buildings with lifts need evacuation lifts (no minimum height)** - Buildings that are provided with passenger lift access to an upper or lower level should also be provided with a means of using lifts for escape.
- **All evacuation lifts need to be designed/programmed accordingly (cannot use normal lifts for evacuation)** - Any lift provided for means of escape should be designed and programmed as an evacuation lift.
- **At least one evacuation lift should be provided for each escape stairway, or more if required by capacity assessment.**
- **All lifts need to be dual purpose firefighting/evacuation lifts (buildings > 50m)** - For buildings with a storey at 50 m or more above ground level and designed with a stay put strategy, every lift should be designed as a firefighters lift programmed to function as an evacuation lift, until the lift is recalled using the firefighters lift switch.
- **Lift operations should be in accordance with BS EN 81-76 (Draft)**



Draft Evacuation Lift Automatic Operational Guidance BS EN 81-76 (Draft)

Phase 1: Evacuation Recall:

1. Initially an evacuation recall activates e.g. BMS or evacuation lift switch (what BMS/management?)
2. Lifts go to main evacuation floor

Phase 2: Evacuation Operation (after Phase 1):

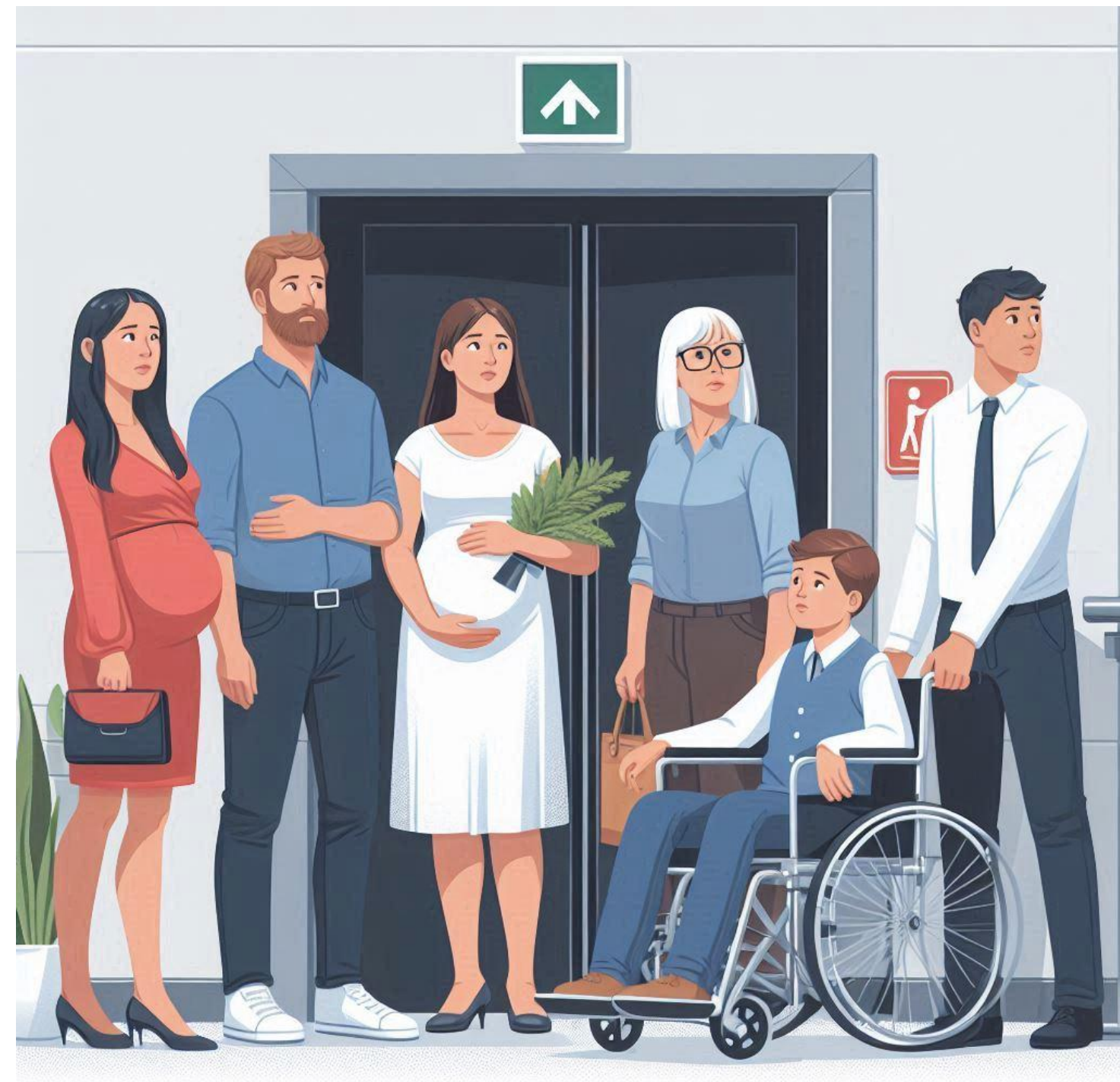
Automatic Evacuation Operation

1. Lifts serve registered landing calls
2. The priority of the landing calls shall be based on the evacuation strategy. Where no other strategy is defined, priority shall be based on the distance from the main evacuation floor with the furthest landing call getting highest priority (e.g. top-down evacuation, **not fire floor prioritised**).



Limited published guidance regarding the operation of evacuation lifts in residential buildings that does not rely on building management operating the lift cars in person.

No onsite staff with the majority of residential buildings will not be provided with permanent onsite staff, making managed lift evacuation unfeasible and impractical to implement.



Design Persuasion



Design Persuasion: Persuading clients/design teams to include evacuation lifts where there are limited explicit guidance/regulatory requirements.

"We didn't need to do this on my last project..."

"Another fire engineer said we don't need a lift ..."

"I've already got a refuge area ...[but no management]"

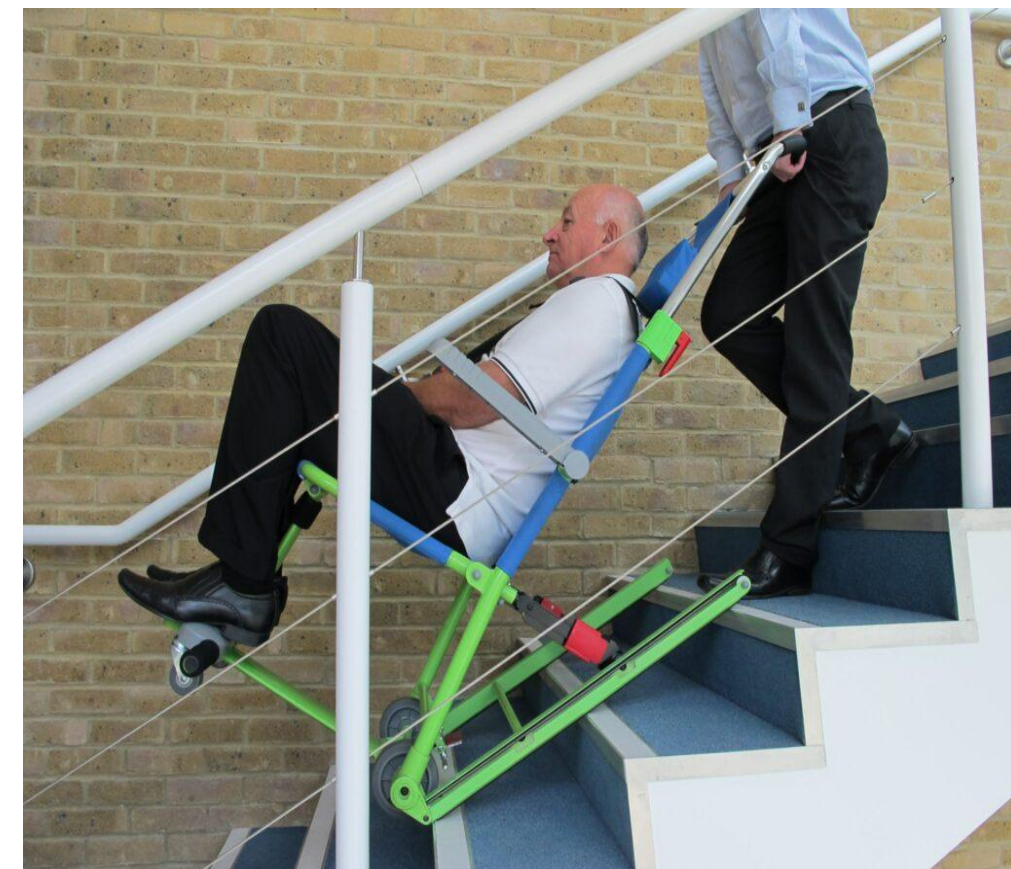
"This is only a small 2-4 storey building, surely stairs are enough..."

"Approved Document B/~~BS 9991~~ doesn't require evacuation lifts..."



Myth of Carry Down/Up

Myth of Carry Down/up: Where management is provided, assuming carry-down procedures are a realistic option for very long distances, more disabled people, future ageing population/increases in obesity, small numbers of staff etc.



Training

Training: Resident training and human behaviour - Informing/persuading...

- a) People who cannot use the stairs they can use a lift during an evacuation;
- b) People who can use the stairs to **not use the lifts** (so others can do so).



Operation: Operational procedures for lift floor dispatch strategies for defend-in-place *and* full-building lift evacuation.

A. Defend-In-Place Lift Evacuation

1. How long people might wait if others are using a lift for normal usage?
2. Should the fire floor landing calls be prioritised?
3. Should dynamic signage be used to direct others to not use the lift?

B. Full-Building Lift Evacuation

1. *Which floors should evacuate first e.g. priority fire floor, top floor, etc?*
2. *How many lifts are required considering the total occupancy?*
3. *What is an acceptable total evacuation time?*
4. *Will weight sensors not activate due to wheelchair users so lifts will stop at all floors?*
5. *Should lifts be available for all people?*
6. ...



Resilience: Operational resilience in case of lift system failures e.g. Plan A, B, C, etc.

- What happens when a lift is out of service e.g. breaks down, for maintenance, etc?
- A well-maintained lift will still break down 1-2 times a year
- Doors and operators often account for some 80% of breakdowns on lift systems
- People may be using lifts for transporting furniture as they move in and out in high-rise residential – which may increase failure rates as they bump into doors

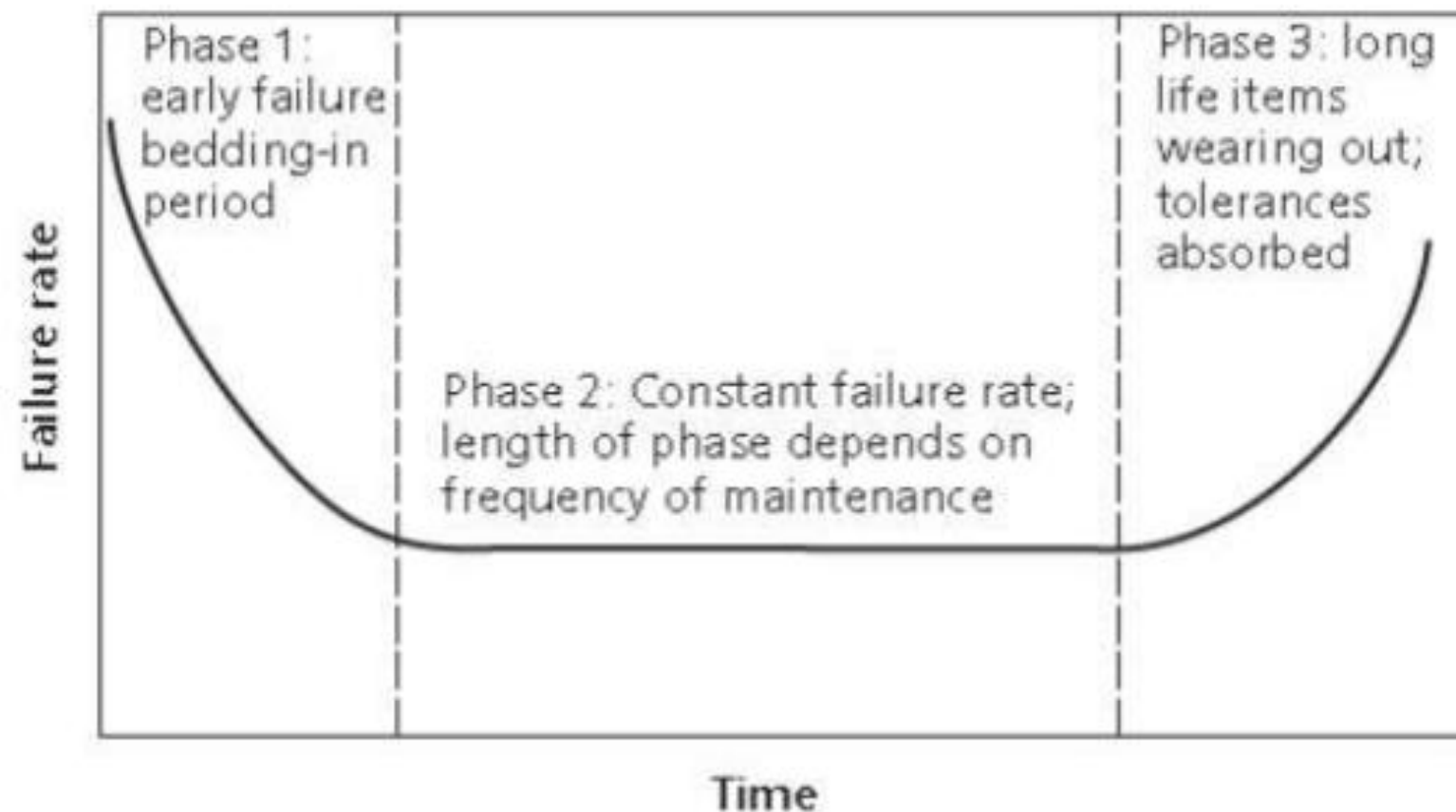


Figure 2 Phases of equipment life

Grounding

Grounding: Operations if smoke/fire is detected in the lift lobbies.

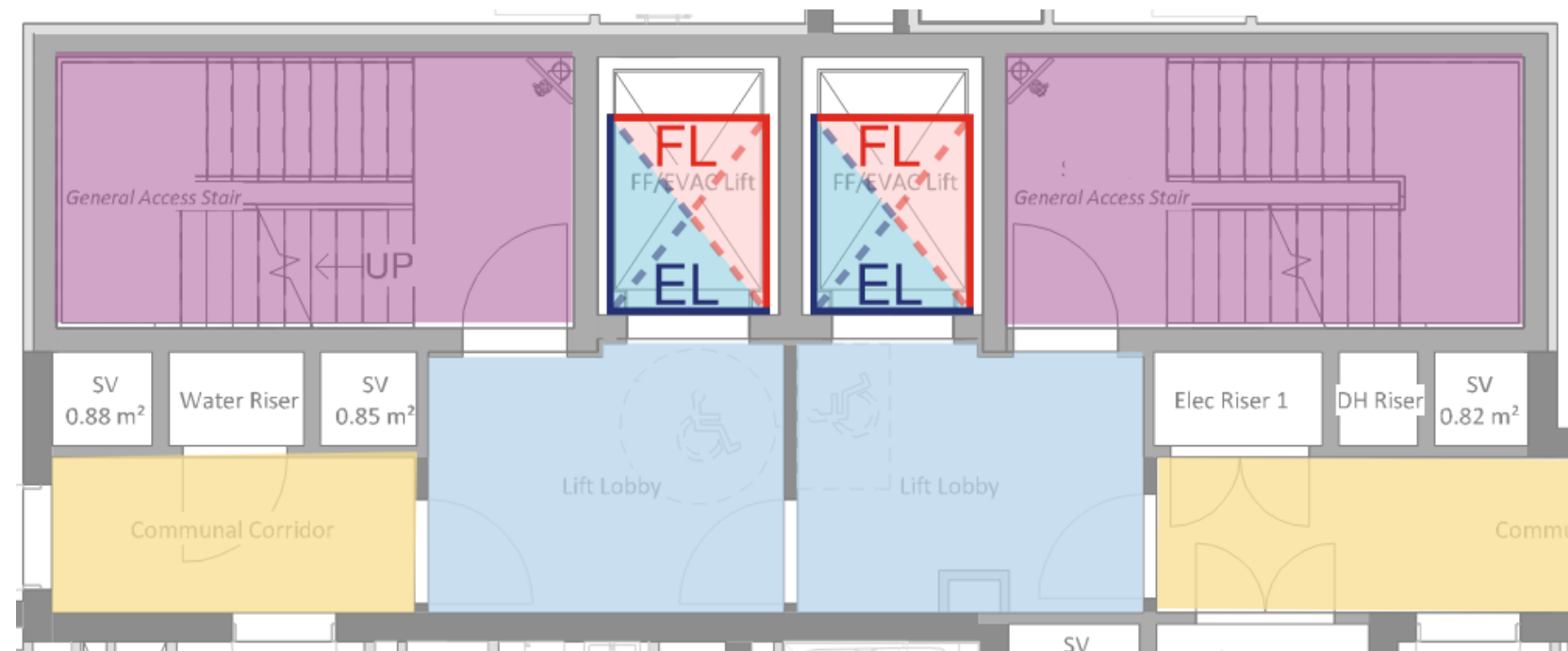
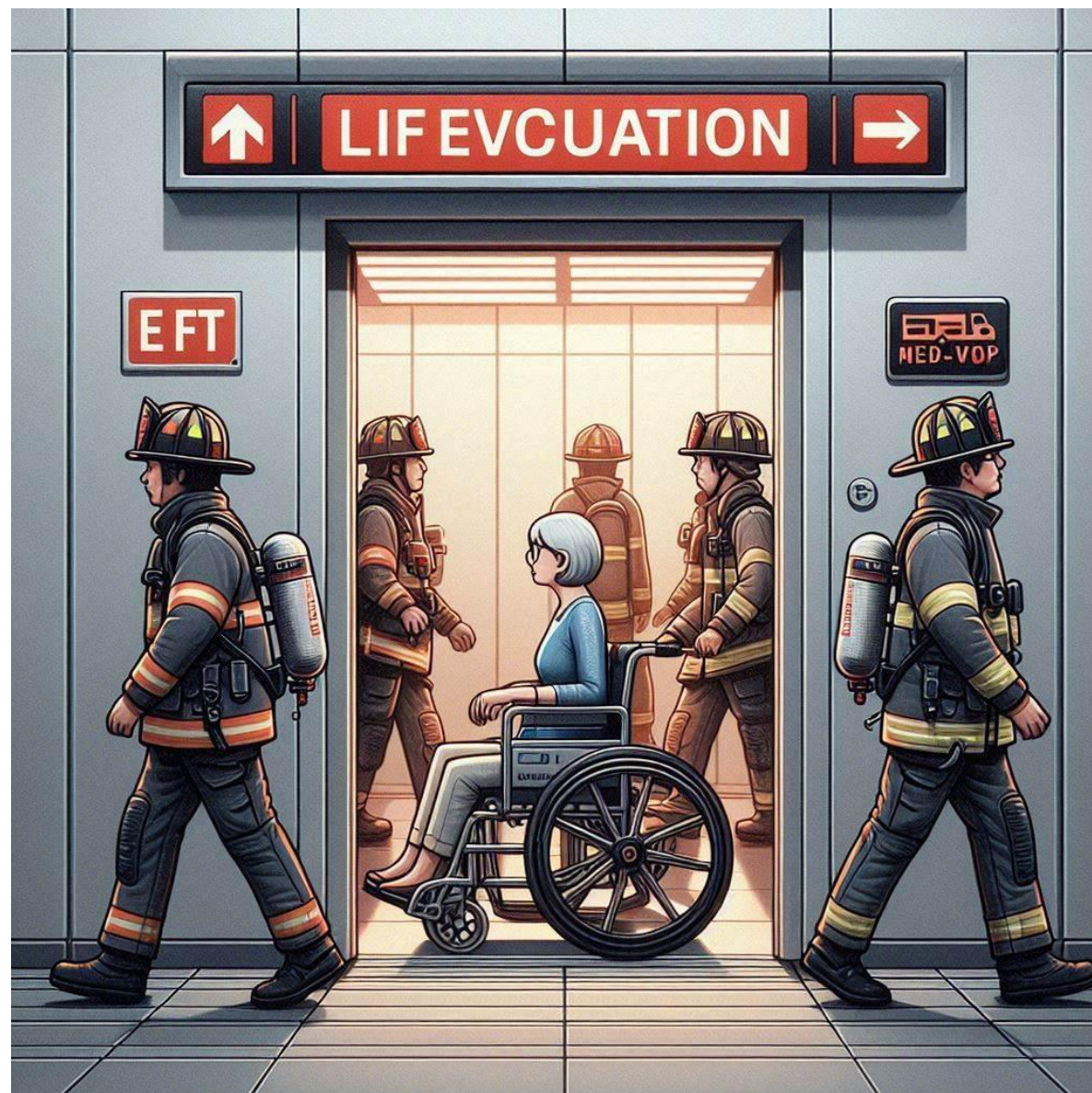
- Should lifts be grounded if smoke is detected in lift lobbies?
- Should heat detectors be located in lift lobbies instead of smoke detectors?



Firefighting Coordination

Firefighting Coordination: Managing firefighting access and those evacuating using dual-purpose firefighting/evacuation lifts.

- Should at least two firefighting/evacuation lifts be required?
- How do firefighters decide which lift to use for firefighting and notify people to use the other lift?



Existing Buildings

Existing buildings: Retrofitting existing buildings with evacuation lifts present a number of challenges and require design features in addition to the lift system itself.

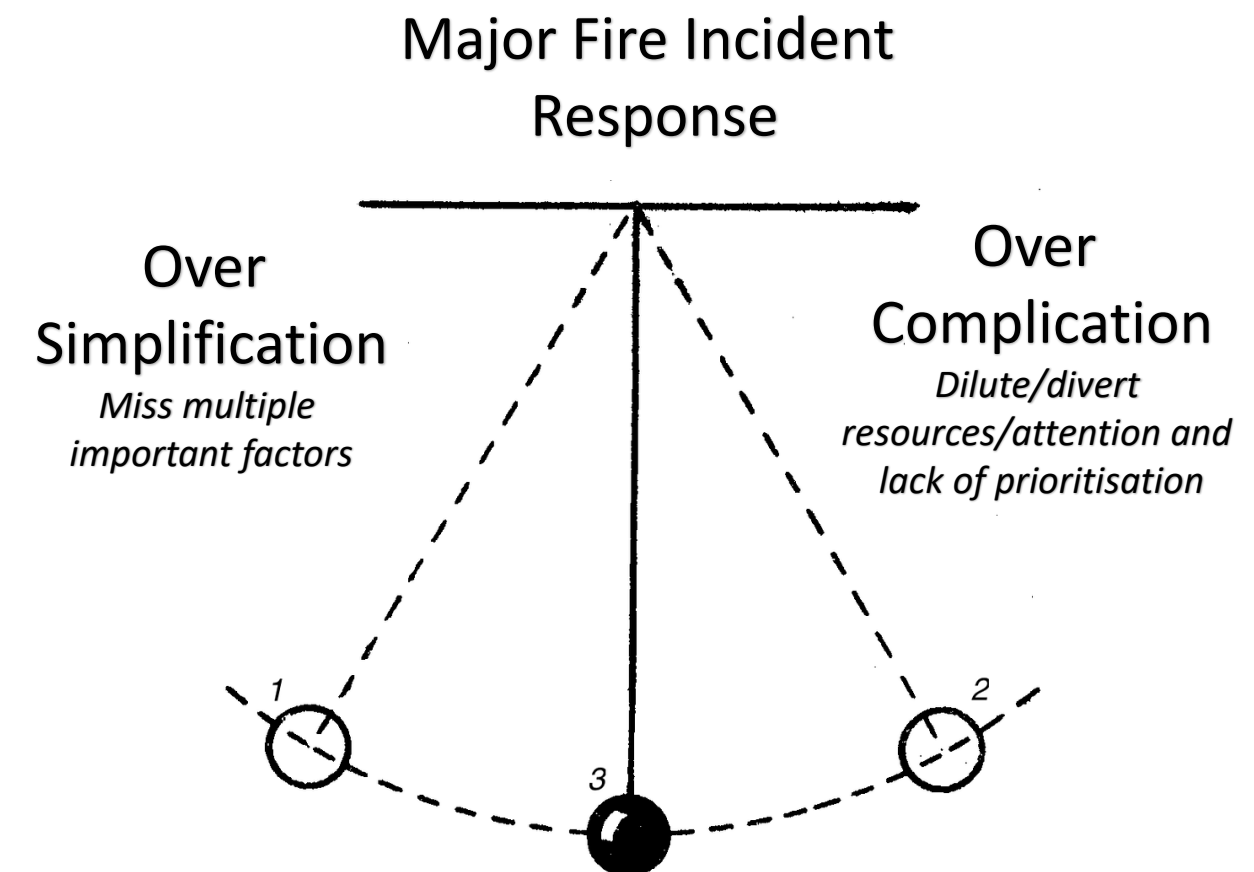
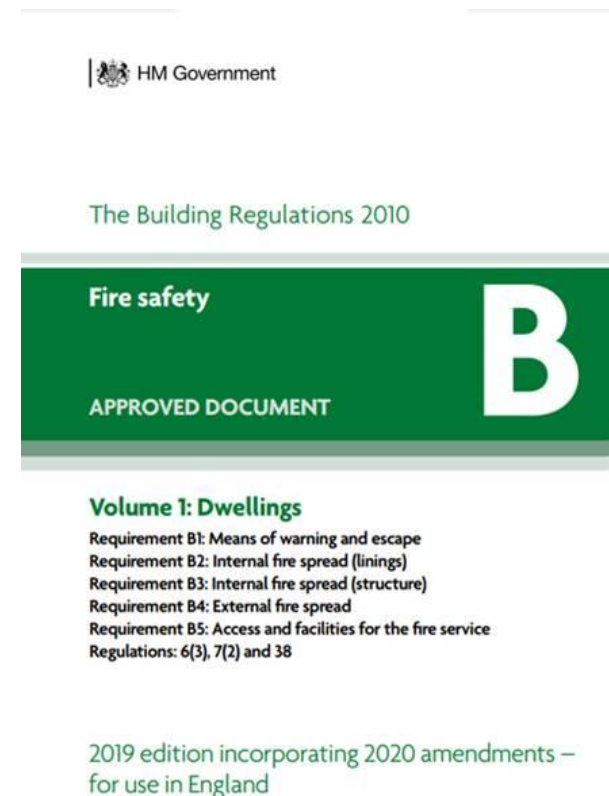
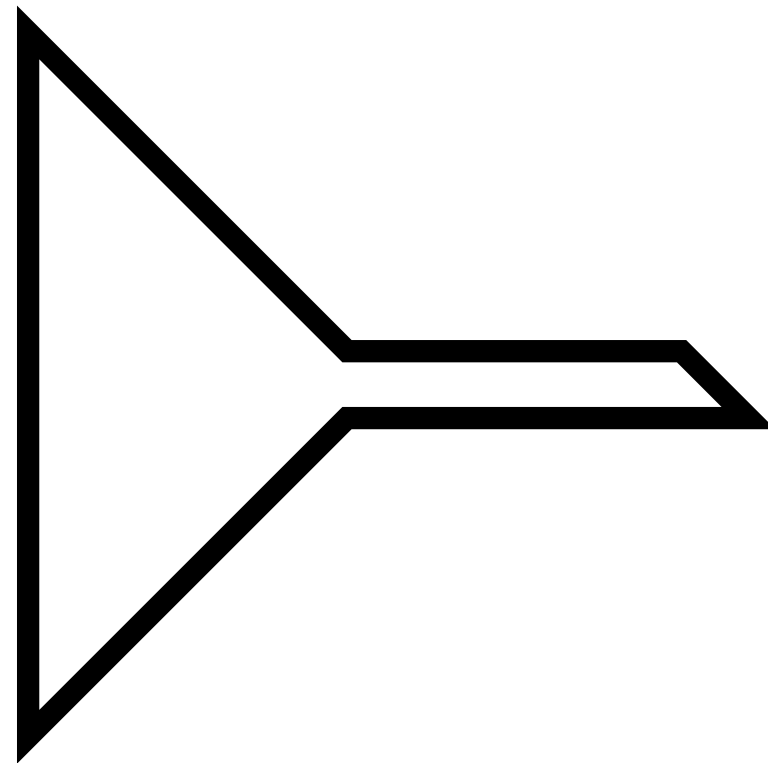
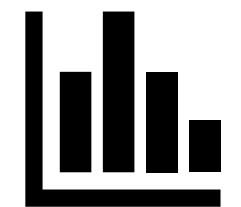
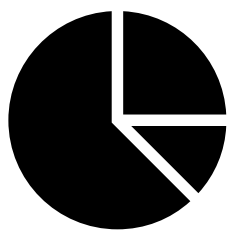
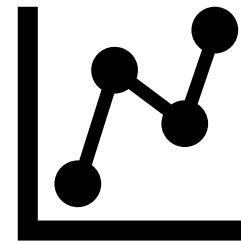
- Are there areas to wait which a protected from the effects of fire smoke?
- Will existing smoke control provisions be acceptable e.g. extracting from the lobby?
- Is it acceptable to allow the use non-evacuation lifts if fire/smoke are not in the local vicinity?



Guidance Development Process

Guidance Development - Empiricism over Plausibility: Developing traceable empirically-based fire design guidance based on research and data rather than committees using “plausibility” and “magic numbers”.

- Is getting groups of smart confident people to come up with “plausibly acceptable” lift guidance “good enough”?
- How do we better prepare to learn from the next major fire about lift usage to ensure we don’t *over-simplify* or *over-complicate* identified issues?



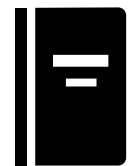
Summary



Lift Evacuation is Not New – Lift evacuation and associated benefits have been discussed for over 100 years.



Human Behaviour – People have used lifts during evacuations even when they were trained not to (but it is sensitive to different factors).



Lack of Adoption & Guidance - Widespread adoption and associated guidance is lacking – it's often only following major incidents their use has been reviewed.



Residential Lift Evacuation Challenges - Residential lift evacuation presents a number of challenges, many of which are different to that of commercial premises, which need to be considered beyond the lifts themselves.

