Theoretical Evaluation of Evacuation Lift Capacity Assessments

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Abstract. Evacuation lift capacity assessments are a requirement of the London Plan Guidance which states buildings should "be designed to incorporate safe and dignified emergency evacuation for all building users".

Where designated in the approved Fire Strategy, lifts can be used for evacuation purposes and "a minimum of one lift per core, or more subject to capacity assessments" should be provided.

This paper proposes a theoretical methodology to assess the evacuation lift capacity for a 34-story typical office development in London, with the assessment required by the building's Fire Strategy in line with the London Plan Guidance.

A phased evacuation strategy has been specified by the Fire Engineer and theoretical lift traffic analysis has been undertaken to estimate the total time to complete Phase 1 of the evacuation, for a series of fire floors throughout the building.

This report will highlight the agreed assumptions for the development and total evacuation times, and provide information regarding the minimum required space-take for passengers who require lifts for evacuation within the refuge space provided in the protected lobby.

This study serves as a benchmark for building design and evacuation planning, emphasising the importance of incorporating theoretical traffic analysis in the early stages of development to ensure safety and compliance with fire safety regulations.

1 INTRODUCTION

Evacuation lifts are nothing new in the Buildings industry. They have been provided in varying capacities, to varying codes and standards, around the world for many years. Evacuation lifts are now coming to prominence in London, and other parts of the UK, to ensure dignified emergency evacuation is provided for all building users.

The purpose of this paper is to provide a summary of the methodology used to assess the evacuation lift capacity for an office development in London, in line with the building's approved Fire Strategy and London Plan guidance.

Theoretical lift traffic analysis using Elevate™ has been undertaken to determine the estimated total time to complete Phase 1 of the evacuation for an arbitrary series of fire floors at levels 6, 8, 20 and 33 in a 34-storey building. The series of floors have been chosen in alignment with the building's Approved Fire Strategy to indicate how evacuation may take place throughout the height of the building and is not representative of multiple fires happening in the building.

1.1 The London Plan

The draft London Plan was introduced in 2018 which set out a comprehensive set of criteria to "consider the impacts on equality, the environment, health, community safety and natural habitats" [1] in London.

In 2021 the London Plan was formally introduced. Policy D5 of the London Plan sets out the requirements for "*the highest standards of inclusive design*" stating that developments should "*be designed to incorporate the safe and dignified emergency evacuation for all building users*". Policy D5 further states that "*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*" [2].

Despite being issued in 2021, there is a lack of clarity on how to perform a lift capacity assessment and what an acceptable outcome/time to evacuate a building may be. As a VT consultant, it is understood that others, such as the Fire Engineer, London Fire Brigade and Building Control, will use the Evacuation Lift Capacity Assessment (where undertaken) to determine whether the theoretical Evacuation lift capacity is acceptable in line with the relevant policy documents.

"The London plan is a legally part of each of London's Local Planning Authorities Development Plan and must be taken into account when planning decisions are taken in any part of Greater London" [3] [4]. Depending on the Guidance provided by the Fire Engineer during the design stages, an Evacuation Lift Capacity Assessment will need to be considered and/or undertaken.

1.2 Building Safety Act

Following on from the Grenfell Tower tragedy in 2017, a renewed spotlight has been put on life safety in buildings in the UK. This tragedy has acted as a catalyst to ensure that life safety is at the core of building design and provided the requirement for an adequate evacuation strategy using lifts [5].

1.3 BS 9999, BS9991 and prEN 81-76 (draft)

The following documents are often used by Fire Engineers to define the Fire Strategy for the relevant development:

- BS 9991:2015 – Fire Safety in the design Management and use of Residential buildings – Code of Practice.
- BS 9999:2017 – Fire Safety in the Design, Management and use of Buildings – Code of Practice

At the time of writing this report (June 2024), BS 9999 is the only formal document which defines an Evacuation Lift and its usage. As such, where evacuation lifts are required as part of the Fire Strategy (notably to satisfy the London Plan), the Evacuation Lift will need to be designed and installed in line with the requirements as set out in BS 9999 [6]. Where evacuation lifts are required in a residential building, BS 9991 refers to the requirements as set out in BS 9999 [7].

These documents also currently define the only acceptable means of evacuation. This ensures that an operator will be available and use the lifts to evacuate the relevant population of the building. Section 1.4 will further define this operation. An operator is defined as a person who is trained to use the lifts in the event of an evacuation and their duties should include "taking control of the lift and operating the evacuation lift switch", "determining the part of the building as being the location of the fire, and determining the storeys in which people are awaiting assistance and proceed to move people requiring assistance to the final exit level" [6]. For the purposes of this report, it is assumed that an operator will always be available at this building and that this is included in the building management plan.

At the time of writing this report (June 2024) prEN 81-76:2023 (E) – Evacuation of Persons with Disabilities Using Lifts [8], has not been formally released by the British Standards Institute [9]. The following information may therefore not be applicable subject to the final release of this standard.

This standard defines usage cases for evacuation lifts, as well as requirements for the construction and installation of evacuation lifts. prBS EN81-76 proposes three types of operational modes for evacuation, these are “operator assisted evacuation”, “automatic evacuation operation” and “remote assisted evacuation” [8].

1.4 Behavior of Evacuation Lifts in a Fire / Evacuation Event (BS 9999)

All the proposed evacuation lifts in this development are combined Passenger / Evacuation lifts in line with the building's Fire Strategy. The lifts will operate as standard passenger lifts where an emergency evacuation is not occurring. It should be noted that these lifts in this development specifically do not have firefighters functionality.

Once an emergency signal is received, the evacuation lifts shall be recalled to the designated evacuation exit landing as specified in the Fire Strategy and in compliance with BS 9999.

Once the lifts have been recalled to the designated landing, the lift doors will open to allow any passengers within the lifts to exit and stay parked at the designated landing with the doors open.

The lifts will then be changed into evacuation mode by the operator via the evacuation panels at the designated landing. This will allow the lifts to be controlled from the lift car via the car operating panel. Upon changeover, this will also ensure that the evacuation communication systems between the main evacuation floor and refuge spaces will become active.

At the time of writing, the evacuation lifts are assumed to be BS 9999 compliant and installed as appropriate for operator-assisted evacuation. It should be noted that the publishing of EN 81-76 may place additional requirements on the operation of the evacuation lifts which may change the results of the analysis presented in this report.

2 BUILDING OVERVIEW

The development will comprise levels sub-basement (B2), Basement (B1), Ground (G), Levels 1-34 (L1-34) and roof plant areas. It is proposed that End of Trip (EoT) facilities are provided at B1, office reception at G, and office space at L1-16, 18 and L20-34. An office amenity will be provided at L9. Plant spaces are provided at L17, 19 and roof level.

Two combined Passenger / Evacuation lifts have been provided for the building within the central passenger lift cores. A third Passenger / Evacuation lift has been provided in a secondary core. These lifts will primarily function as passenger lifts until an emergency evacuation is required, where the functionality will be changed to evacuation mode.

The lifting strategy diagrammatic can be seen in Figure 1 below.

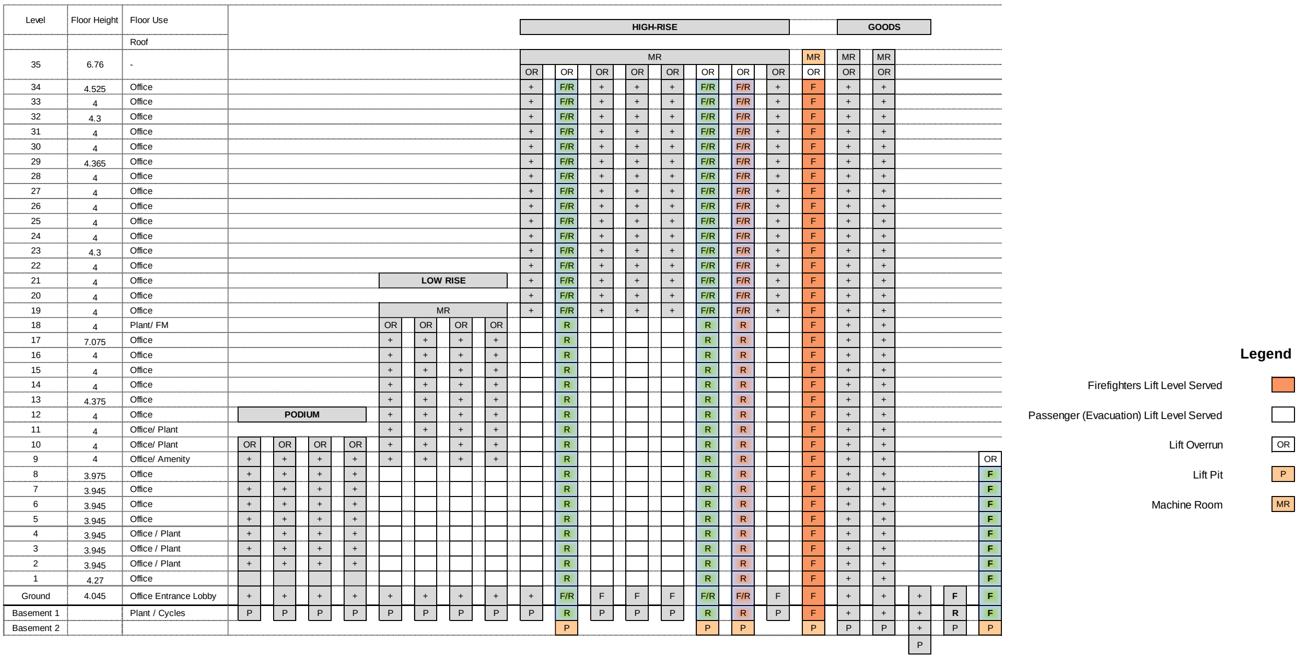

Figure 1 Lifting Strategy diagrammatic

3 DESIGN CRITERIA

The designated Fire Strategy for this development requires a phased evacuation approach, with the evacuation lifts evacuating office users from their respective office floors to the main Evacuation Exit Landing at Ground.

The proposed evacuation plan will ensure that occupants on the fire floor and the floor immediately above the fire floor will be directed to evacuate immediately upon activation of the automatic fire detection system. Once the initial two floors are evacuated, phase 2 will commence where the next two floors are instructed to evacuate, starting with the floors above the fire floor and then working down the building. In the proposed evacuation scenario, an operator and designated person-assisted process will be undertaken, meaning that once lifts are in evacuation mode, it will require somebody to be in the lift at all times to operate the lift via the lift car controls.

The following assumptions have been agreed as suitable by the fire Engineer in RIBA Design Stage 3 and are proposed in line with how the evacuation scenario for this building is expected to unfold.

Agreement has also been made with the accessibility consultant on the project where applicable.

3.1 Evacuation Lift Provision

The building consists of three cores; therefore, three passenger evacuation lifts have been provided within the initial building design, in line with the Fire Strategy requirements and the London Plan requirement for the provision of one evacuation lift per core. These lifts are proposed as follows:

PEL12 – 1 x 1275 kg (17P) Passenger / Evacuation lift at a rated speed of 5.0 m/s serving levels B1, G, L1-34. PEL12 will be provided with a clear internal lift car size of 1500 mm (w) x 1900 mm (d) and a resulting car area of 2.95 m^2.

PEL15 – 1 x 1275 kg (17P) Passenger / Evacuation lift at a rated speed of 6.0 m/s serving levels B1, G, L1-34. PEL12 will be provided with a clear internal lift car size of 1500 mm (w) x 1900 mm (d) and a resulting car area of 2.95 m^2.

PEL16 – 1 x 750 kg (10P) Passenger / Evacuation lift at a rated speed of 1.6 m/s serving levels B1, G, L1-8. PEL16 will be provided with a clear internal lift car size of 1100 mm (w) x 1600 mm (d) and a resulting car area of 1.76 m^2.

3.2 Populations

Between Levels B1, G, and L1-8 three evacuation lifts are provided. From L9-34, two evacuation lifts have been provided.

The populations per lift have been determined on a pro-rata basis as defined by the available lift car area. This means that PEL16 (750 kg / 10P) will transport 23% of the population who require the use of lifts for evacuation. PEL12 and PEL15 will therefore each transport 38.5% of the population who require the use of lifts for evacuation.

From L9-34 it is it is assumed that in an evacuation scenario, each lift will transport the same proportion of people as each lift has the same capacity. The assumed populations have therefore been halved.

The populations utilized in this assessment have been agreed by the Fire Engineer, as it is assumed that people will travel to the nearest evacuation lift and wait. Should there be a significant queue, they may travel to an alternative lift. The Fire engineer has assumed that the queue lengths will self-regulate in this way. Furthermore, a user who will require the lift for evacuation should have been made aware of their specific evacuation plan for the building.

3.3 User Profiles

In agreement with the Fire Engineer and Accessibility Consultant, the proposed quantity and mix of users who will require a lift to be evacuated have been defined.

These figures are based on The Department for Work and Pensions (DWP) Family Resource Survey which states that 15% of the population in the London area is classed as having some sort of disability. Of this 15%, 41% of respondents had a mobility impairment, and 34% had a stamina/breathing/fatigue impairment [10]. These figures form the basis of how many users are likely to need the lifts to evacuate the building.

This group of people have been split up into three distinct categories in line with the data provided by DWP:

- Occupants with mobility impairment.
- Occupants with stamina/breathing issues/fatigue.
- Occupants who use a wheelchair.

The total quantity of users assumed within the evacuation lift capacity assessment can be seen in Table 1.

Table 1 - Assumed Building Populations

Level	Mobility Impairment	Stamina / Breathing / Fatigue	Wheelchair users	Total Population to be evacuated per floor
Level 6	23	17	1	41
Level 7	23	18	1	42
Level 8	24	18	1	43
Level 9	36	27	2	65
Level 20	15	11	1	27
Level 21	15	11	1	27
Level 33	14	10	1	25
Level 34	14	10	1	25

3.4 Passenger Areas

Table 2 below highlights the agreed passenger areas for each user group that has been utilized in the theoretical lift traffic analysis. As operator-assisted evacuation has been specified, an allowance must also be made for the inclusion of a driver within the lift car.

Table 2 - Passenger Areas

<table>
<tr><th>User Group</th><th>Passenger Area (m^2)</th><th>Dimensions in plan (mm)</th></tr>
<tr><td>Mobility Impairment</td><td>0.48</td><td>600 x 800 [11]</td></tr>
<tr><td>Wheelchair Users</td><td>1.26</td><td>900 x 1400 [12]</td></tr>
<tr><td>Stamina/Breathing/Fatigue</td><td rowspan="2">0.21</td><td rowspan="2">380 x 560 [12]</td></tr>
<tr><td>Operator</td></tr>
</table>

Figure 2 below indicates the above sizes diagrammatically.

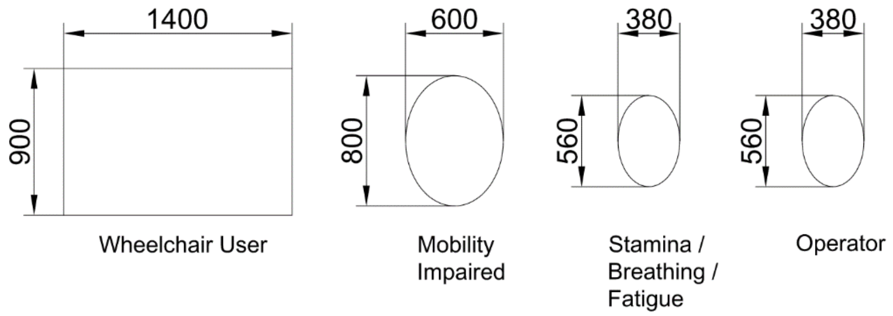

Figure 2 Passenger Areas

3.5 Lift Car Area

The analysis is based on the actual car area as defined in the building design in coordination with the Architect. As an example, PEL15 is provided with car dimensions of 1500 mm (w) x 1900 mm (d). This is not a standard ISO lift car and reflects the agreed lift car size. This lift car size results in a car area of 2.95 m^2.

As a driver will be in the evacuation lift at all times, the available car area for passengers to load into the lift should be reduced. In this scenario, the available car area has been reduced by 0.21 m^2, resulting in an available car area of 2.74 m^2.

The capacity factor by mass has been set at 80%, and the capacity factor by area has been set at 100% in line with standard car area and mass requirements as defined in BS EN 81-20 [13].

3.6 Passenger Loading Times

Table 3 below highlights the loading and unloading times utilised within the theoretical analysis.

Table 3 - Passenger Loading Times

User Group	Loading Time (s)	Unloading Times (s)
Mobility Impairment	2.6	2.6
Wheelchair Users	5.2	5.2
Stamina/Breathing/Fatigue	2.6	2.6

3.7 Passenger Arrival Rates

Due to the behaviour of the lifts in an emergency event, as defined in section 1.4, it is proposed that all users who require the lifts for evacuation will already be waiting in the refuge spaces, as it will take time to coordinate between the operator and designated persons at the landings to enable the evacuation to start.

The passenger arrival rates have been utilised such that all passengers will arrive in a 5-minute period, and queue for the lifts. A 5-minute delay has then been applied before the lifts start moving.

The 5-minute delay is only proposed for the purposes of this study to ensure all users are at the lifts. It is not proposed that it will take all users 5 minutes to access the refuge spaces. This allows time for the lifts to be changed into evacuation mode.

4 RESULTS

Table 4 below highlights the theoretical evacuation times from the assessed floors throughout the building. The time is taken from when the lifts start moving (after the 5-minute delay). As noted in section 1, the analysis has been undertaken to assess a single evacuation event in the building at any one time, with the worst-case analysis scenario time presented in the table below. The fire is assumed at the lower floor, with both the fire floor and floor above requiring to be evacuated in Phase 1.

The theoretical analysis has been undertaken using Elevate™ software.

Table 4 - Time Taken to Evacuate Assessed Levels

Levels Evacuated	Lift Reference	Time taken to evacuate (min:sec)	Trips Required to evacuate the levels per lift
L6 & L7	PEL12 & PEL15	6:20	5
	PEL16	5:23	4
L8 & 9	PEL12 & PEL15	11:53	9
L20 & 21	PEL12 & PEL15	7:30	5
L33 & 34	PEL12 & PEL15	8:52	5

The evacuation capacity assessment has been undertaken to satisfy the planning conditions in accordance with the approved Fire Strategy. Based on the assumptions above, the time taken to evacuate the building is stated as a fact, based on the assumed scenarios. It is understood that this data will be reviewed in line with the Evacuation Strategy by Building Control and the London Fire Brigade.

5 VALIDATION

5.1 Number of Trips

A simple validation based on the space take and number of trips has been undertaken to ensure the analysis is performing as expected.

Using the agreed passenger areas and lift car sizes, a graphical representation can be seen in Figure 3 below. This figure indicates that based on the number of passengers and the area they occupy, five trips will be required to fully evacuate Levels 33 and 34, providing the same result as the analysis.

Note the driver is highlighted in red.

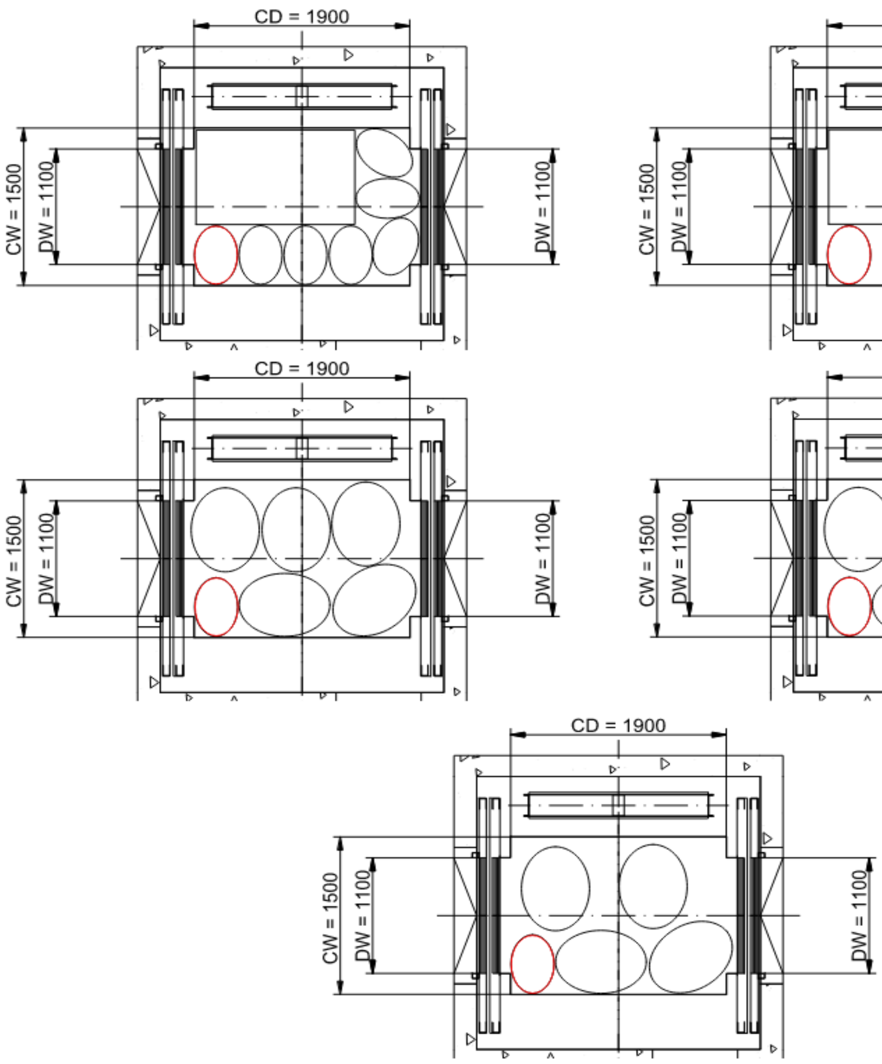

Figure 3 Potential arrangement of users who may require a lift for evacuation from L33 & 34

Looking at the spatial plot from the Elevate™ analysis in Figure 4, it can be seen that five trips are required to evacuate levels 33 and 34.

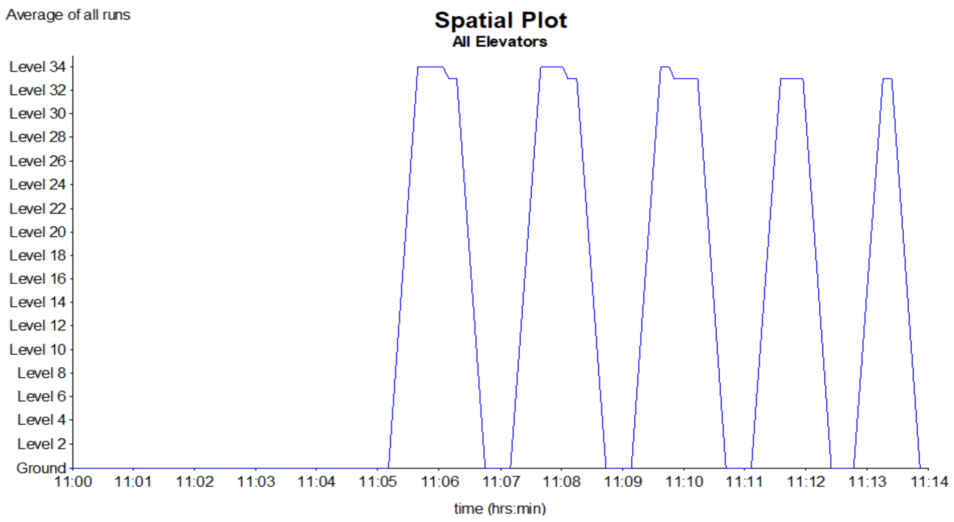

Figure 4 Spatial Plot for evacuating Levels 33 & 34

It should be noted here that the spatial plot indicates that the lift will stop at Level 33 in the first two lift journeys, however, the lift has filled up at L34 and is unable to collect any passengers from L33 in these two journeys. The impact of this will be explained further in section 5.2.

5.2 Round Trip Time

As the evacuation scenario only considers two floor levels plus ground and provides a pure down peak traffic condition, a round trip time calculation can be a useful way of validating the lift traffic analysis [14].

The following calculation in Table 5 is based on a simplified scenario, where it is assumed that all users are evacuated from one floor only. The example calculation assumes that all users (a total of 26 per lift) are evacuated from Level 34. Whereas, the actual analysis presented in this report assumes 13 people at Level 33 and 13 people at Level 34 per lift.

Table 5 - Round Trip Time Calculation

Evacuation Floor	Level 34
Travel distance from FSAL (m)	125.4
Rated Speed (m/s)	6
Acceleration (m/s^2)	1.2
Travel Time (s)	25.9
Actual Car Area (m^2)	2.95
Available Car Area (m^2) (Actual car area – 0.21m^2 from driver)	2.74
Total Passenger area (m^2)	11.34
Average loading time per trip (s)	15

Number of Trips Required	5
Round Trip Time (s)	103.2
Time to evacuate floor (min:sec)	8:00

When compared with the simplified traffic analysis scenario of evacuating 26 users from Level 34 only, the total times are comparable. The analysis indicates a total time to evacuate one floor of 8 minutes and 16 seconds and that 5 trips are required. The closeness of these results indicates that the theoretical traffic analysis is behaving in the way that it is expected.

The problem however is that when compared with the results presented in this report for the actual scenario, there is a reasonable variance (11% difference from RTT calculation). It would of course initially be expected that evacuating two floors would take longer than a single floor. Looking at the spatial plots of the actual analysis scenario (L33&34) in Figure 4, it can be seen that the lift is stopping at both Level 33 and 34 in the first three journeys. Delving deeper into the data, for the first two journeys, the lift is filling up at level 34, and then stopping at level 33, where it is unable to collect any more passengers. In the third journey, it can collect the remaining passengers at L34, and then start collecting passengers from Level 33. This provides an evacuation time of 8 minutes and 52 seconds. This total time can be adjusted to exclude the stopping at Level 33 in the first two journeys. The data provided from the analysis indicates that the lift stops and does not fill up for a total of 26 seconds. Once adjusted, this provides a time of 8 minutes and 26 seconds. In the real-world scenario, the evacuation will be undertaken by a lift operator and driven from the lift car, therefore in this scenario the lift will not stop at L33.

Table 6 - Summary of Validation Results

Scenario	Time taken to evacuate (min:sec)	% Difference from RTT calculation
Round Trip Time – Evacuating One Floor only (L34)	8:00	-
Analysis – Evacuating One Floor Only (L34)	8:16	+3%
Analysis – Evacuating Levels 33 & 34	8:52	+11%
Analysis – Evacuating Levels 33 & 34 – Adjusted for lift not able to answer calls	8:26	+5%

6 INTERPRETATION OF RESULTS/VALIDATION

The fact that slight inefficiencies seem to be built into the analysis may not actually be a bad thing. When we think of an evacuation scenario, we must also consider human nature. The analysis aims to show a best-case scenario, but with humans operating the lifts, it is likely that there will be inefficiencies with loading the lift and prioritising the correct users.

Theoretically, the operator should know who is waiting at the lifts and how many, due to the provision of the communication systems in the associated refuge spaces. However, it is likely that until the operator arrives at the floor(s), the situation cannot be fully assessed.

Any accidental inefficiencies in the analysis may coincidentally provide a total evacuation time that is closer to a real-world scenario. Evacuation studies would however be required to validate this statement.

It may be possible that the evacuation results could be improved by utilizing firefighters lifts within the building, or where one lift has finished evacuating its required zones and is idle, assuming it is safe to do so, it may be possible for people waiting or evacuation lifts in other cores to utilize an available lift. This would need to be risk assessed and agreed upon in line with the evacuation plan.

7 ANALYSIS LIMITATIONS

The theoretical lift traffic analysis undertaken is not representative of the actual evacuation scenario defined in the developments Fire Strategy and in line with BS 9999. The dispatching algorithm does not allow the designer to select the order/priority of floors to evacuate, or the priority of users. In the case study presented, the spatial plots indicated that the level above the fire floor is being evacuated first, and then collecting passengers at the fire floor. Whilst there is theoretically no impact on the final time to evacuate in the first phase, the order of evacuation in the second phase is likely to be significantly impacted due to the specific order of evacuation of the remaining 32 floors of the building.

The dispatcher is also not able to tell that the lift is full (by available car area). This is due to the increased passenger areas from a typical 0.21 m^2, therefore resulting in the lift stopping at a level while full. This would also have a significant impact on the Phase 2 results.

It is also not a fully realistic scenario as operator-assisted evacuation is being utilised for this building.

8 IMPLICATIONS

8.1 Design Implications

As the scenario assumes that all users who require evacuation are waiting for the lifts before the lifts are operational, queueing and circulation space should be considered. Table 7 below tabulates the minimum required protected lobby space in front of each evacuation lift. This data is of key importance to inform the buildings design of the core/protected spaces.

Further consideration is needed in coordination with the Architect and Fire Engineer where the protected lobbies lead to the escape stairs. Circulation will also need to be considered for those evacuating the building via the stairs.

BS9999 states that “it is essential that the location of refuges and of wheelchair spaces within refuges does not have any adverse effects on the means of escape provided in the building” [6].

Good design should also consider managed strategies to ensure good communication between the operator and the designated person at the landings, frequent evacuation testing and ensuring users who require the use of the lift for evacuation are aware of the requirements. Discipline at the refuges must be maintained where queueing, and this is likely up to the designated person at the landings, ensuring order and determining priority.

Table 7- Queue lengths and minimum areas in protected spaces

Level Evacuated	Maximum Queue Length at Each Lift	Minimum area required in protected lobby (m^2)
L6	15	7.05
L7	15	7.05
L8	34	11.01
L9	32	14.10
L20 & 21	14	6.15
L21	14	6.15
L33	13	5.67
L34	13	5.67

8.2 Commercial Implications

Whilst this report provides a study relating to an office development, evacuation lifts are now required to be considered/provided in all types of developments where lifts are provided.

Each development should be assessed on a project-by-project basis by a competent Fire Engineer [15] and be suitably Fire Engineered to ensure that the solution is correct, supported by a whole range of specialist designers.

Lobby sizes need to be considered to allow adequate queueing and circulation space. As lobbies are provided as Gross Internal Area (GIA), as opposed to Net Internal Area (NIA) (space that is lettable), larger protected lobbies reduce the overall available lettable space in buildings. This has a significant impact as even a few square meters per floor can have a significant cost impact and reduce floorplate efficiencies, particularly in tall buildings.

Additional lifts may also be required in the building to satisfy the London plan requirement for "at least one evacuation lift per core", despite not being required from a theoretical lift traffic analysis point of view. Whilst this can improve the evacuation lift capacity and mitigate redundancy issues, given the high costs of installing and maintaining a lift, this can lead to significant cost uplifts which may not have been expected in the early-stage designs. The basis of this report assumes that Firefighters lifts are not included within the evacuation procedure and the assumption therefore is that where a core is provided, a minimum of two lifts are required (1 x Firefighters lift and 1 x Evacuation lift).

Whilst life safety is non-negotiable, floorplate efficiencies and overall values of buildings are what drive the construction industry. Whilst the industry adjusts itself to these new requirements, this may lead to projects going on hold, or terminating altogether because the costs just do not add up.

9 DISCUSSION

9.1 What Do the Results Mean?

The London Plan requires an evacuation capacity assessment. Unfortunately, it does not inform a VT designer or other relevant specialist e.g. Fire Engineer, how to undertake the assessment. It also does not tell the designers what an acceptable time to evacuate is.

This information is currently as yet not defined, and we do not have the answers. Hopefully, as time goes on and planning implications are further understood, more information will come to light.

It is however on us, as the VT world, to help form these cases and scenarios in a way that is accepted throughout the construction industry.

In the assessed development, the majority of the structure and all the protected cores are designed to withstand a fire event for up to two hours. The Fire Engineer has therefore assumed, that any time of less than two hours is likely to be acceptable to evacuate the whole building. Consideration however should be given to the effect of people being held within a burning building and whilst the structure may be safe, this may cause a significant amount of panic and shorter timeframes may be required to be considered.

In comparison with this assumption, the Health Technical Memoranda for the Design of Hospitals, states that "in an emergency situation, it should be possible to clear all visitors from the hospital in 15 minutes" [16].

9.2 Users Who Require a Lift for Evacuation

It is difficult to quantify how many users are likely to use the lifts.

The Department for Work and Pensions Family Resource Survey states that 15% of the population in the London area is classed as having some sort of disability. Of this 15%, 41% of respondents had a mobility impairment, and 34% have a stamina/breathing/fatigue impairment [10]. These figures form the basis of how many users are likely to need to use the lifts to evacuate the building.

There is however a further complication in this. It is expected that as the building gets taller, more and more people will require the use of a lift with circa 70% of people expected to consider using the lifts for a building of this height (34 storeys) [17]. This would lead to significant strain on the evacuation lift capacity and further consideration is needed. This implication was discussed with the Fire Engineer in the design phases and should be seriously considered when undertaking evacuation lift capacity assessment.

As yet, the correct populations to use in assessments of these types are to be formally defined. It is also likely that this will depend on a case-by-case basis, e.g. a care home would have different considerations compared to an office. More studies are required across disciplines to ascertain this.

The car loading and unloading values have been agreed upon by the accessibility consultant. Where the lift is full, the loading and unloading times may become extended. Wheelchair users may also need to turn around in the lift to exit which, again, may lead to extended times.

9.3 Phase 2 of Evacuation

The current understanding of a managed evacuation scenario is that after the fire floor and the floor above are evacuated, the floors above will then be evacuated in Phase 2 and then the floors below the fire in a sequential order.

Analysis can be undertaken to assess this scenario using the logic presented in this report, however, given the dispatch algorithms and control logic in the theoretical lift traffic analysis software, it would be difficult to provide a meaningful result. A bespoke dispatch algorithm would likely be required to present this accurately.

An alternative strategy for the Fire Industry to consider may be that of safe refuge zones. These may be located every 5-20 floors and is a common strategy in places where supertall buildings are built. This will significantly improve the lift handling capacity and evacuation performance where users can be grouped together.

9.4 Operator-Assisted Evacuation

It may not be possible to guarantee that an operator is always available. This is particularly pertinent for a residential design, where a 24-hour concierge (operator) cannot be guaranteed. Other forms of evacuation will be required such as remote evacuation, however at the time of writing the definition of evacuation using lifts in BS9999 or BS 9991 does not allow for this. It is assumed that in the future where remote evacuation is specified in the fire strategy, the model presented in this report is not applicable.

9.5 Imminent Release of BS EN 81-76

Whilst the public draft has been made available, it is not known what will be contained within the final version of this code. Remote evacuation may be provided within this standard (as contained within the draft release). The saving grace is that it is likely that remote evacuation will take place in residential developments where there is less demand on the lifts as the floorplates are not occupied as densely as offices.

The implications of this are unknown and an alternative strategy for carrying out evacuation capacity assessments would need to be defined where remote evacuation is specified in the Fire Strategy.

10 REFERENCES

[1] Greater London Authority, "The London Plan 2021," 2021. [Online]. Available: https://www.london.gov.uk/programmes-strategies/planning/london-plan/new-london-plan/london-plan-2021. [Accessed April 2024].

[2] Greater London Authority, "The London Plan," 2021.

[3] Greater London Authority, "London Plan Overview and Introduction," [Online]. Available: https://www.london.gov.uk/programmes-strategies/planning/london-plan/past-versions-and-alterations-london-plan/london-plan-2016/london-plan-overview-and-introduction. [Accessed 07 May 2024].

[4] Greater London Authority, "Building Safety Act (1)," Greater London Authority, 28 June 2022. [Online]. Available: https://www.london.gov.uk/who-we-are/what-london-assembly-does/questions-mayor/find-an-answer/building-safety-act-1. [Accessed 10 June 2024].

[5] RICS, "Building Safety Act Frequently Asked Questions," 03 May 2024. [Online]. Available: https://www.rics.org/news-insights/building-safety-act-faqs. [Accessed 07 May 2024].

[6] British Standards Institue, "Fire Safety in the design, management and use of buildings - Code of practice," BSI Standards Limited, 2017.

[7] British Standards Institution, "Fire Safety in the design, management and use of residential buildings - Code of practice," BSI Standards Limited, 2015.

[8] British Standards Institue, "prEN 81-76:2023 - Evacuation of persons with disabilities using lifts," BSI Standards Limited, 2023.

[9] British Standards Institue, "BS EN 81-76," BSI, 2024. [Online]. Available: https://standardsdevelopment.bsigroup.com/projects/2021-01833#/section. [Accessed 23 05 2024].

[10] Department For Work and Pensions, "Family Resources Survey: financial year 2022 to 2023," 26 March 2024. [Online]. Available: https://www.gov.uk/government/statistics/family-resources-survey-financial-year-2022-to-2023/family-resources-survey-financial-year-2022-to-2023#disability-1. [Accessed 10 June 2024].

[11] P. Buxton, Metric Handbook - Planning Design Data, New York: Routledge, 2022.

[12] British Standards Institution, "BS 8300-2:2018," British Standards Limited, 2018.

[13] British Standards Institue, BS EN 81-20: Passenger and Goods Passenger Lifts, British Standards Institue, 2021.

[14] CIBSE, "Transportation Systems in Buildings," in *CIBSE Guide D: 2020*, London, Chartered Institute of Building Services Engineers, 2020, p. 58.

[15] Building Engineering Services Association, "Building Safety Act Competencies & Requirements," BESA, 2024. [Online]. Available: https://www.thebesa.com/building-safety-act/competence-and-requirements. [Accessed 10 June 2024].

[16] NHS Estates, "Health Technical Memorandum 2024," HMSO, 2024.

[17] E. G. &. P. L. M.J. Kinsey, "Human Factors Associated with the selection of Lifts / Elevators or stairs in Emergency and normal usage conditions," Fire Safety Engineering Group, London, 2010.

BIOGRAPHICAL DETAILS

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Kristian Started his career as a Graduate Vertical Transportation Engineer in 2020.

Now a Senior Engineer for Sweco, Kristian has worked on the design, development and commissioning across a wide range of projects from small existing developments to landmark projects such as a 1,000,000 ft^2+ new build office development.