

Barbican Estate
Barbican Residential Blocks
Cromwell Tower - Fire Strategy
Report

Rev A | 7 September 2022

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Executive Summary

Arup have been appointed by the Barbican Estate (BE) to undertake a fire safety review of Cromwell Tower, an existing building which is part of the Barbican Residential Development, located in the City of London. The purpose of the review is to determine the existing intent of the fire safety design and to document this intent in a fire strategy document (this report). The purpose of this report is as follows:

- To provide a single document that describes the fire safety precautions for Cromwell Tower, including the fire safety principles and fire safety measures within the existing building;
- To compare the existing fire safety precautions with the requirements in Building Regulations 2010 (as amended) by benchmarking against the current standards including BS 9991 and BS 9999;
- To consider the recommended improvements to existing residential buildings in Phase 1 of the Grenfell Tower Inquiry Report by Sir Martin Moore-Bick;
- Where there are gaps in the existing fire safety precautions against the current standards and if those gaps present a risk to the life safety of the occupants, recommend fire safety improvements to remediate the risk on an as nearly as reasonably practicable basis; and
- Where the gaps in the existing fire safety precautions present a low/negligible risk to life safety, the existing precautions are proposed to be retained (on the assumptions that they are maintained in good operational order).

Cromwell Tower was constructed in 1973 and contains 108 flats and 3 penthouse maisonettes. The building consists of one firefighting stair and a lift lobby with a wet riser. The building consists of 39 residential floors above Podium level with a building height of 108 m (assuming floor to floor height of 2.7m) measured from street level (L01) to the floor level of the topmost occupied storey.

An open Podium level which is located above street level serves as the final discharge location from the firefighting stair. The street level (L01) serves as the main firefighting access level to enter Cromwell Tower. Basement levels L02 and L03 are storage and plant rooms below street level.

The balconies on L7-L39 are connected by stairs that lead down to the lift lobbies located one or two storeys below. These stairs provide alternative means of escape from the flats on those levels. However, these stairs do not exist on L1-L6. These are described in detail in the subsequent sections in the report.

Existing Fire Safety Precautions – Overview

The key elements of the existing fire safety precautions for the Cromwell Tower can be summarised as:

- **Stay put strategy:** The building adopts a stay put evacuation strategy. In the event of a fire, only the occupants in the flat of fire origin evacuate the building. The rest of the building occupants will remain in place. This is proposed to be retained.

- **Single stair:** The stair functions as both means of escape for the occupants and means of access for firefighters. It is a priority to protect the stair from being affected by a fire in the building.
- **Risers in stair:** There are three risers that are accessed via the stair and the fire rating of the doors are unknown. The electrical riser (on L37 and above) is connected to the small lobby (at every level) that opens into the stair – this is a risk as a fire in the electrical riser may spread to the small lobby and the stair, affecting the escape route from the building.
- **Flats on L7-L39:** Each flat has alternative means of egress via the balcony or the flat main entrance to reach the single stair. However, for wheelchair-bound residents (Persons with Reduced Mobility – PRM), escape is only possible via the flat entrance and the travel distance to the entrance is greater than the limit within the current guidance.
- **Flats on L1-L6:** Flats in Wings B and C have alternative means of egress via the balconies or the flat main entrances, with the exception of PRMs. The flats in Wing A are only served by a single means of escape via the flat entrance, and the travel distance to reach the entrance is greater than the limit within the current guidance.
- **PRM evacuation:** For the PRM needing assistance with evacuation, there is no safe refuge nor communication system to call for assistance. The procedure for evacuation of PRM is also unclear. This presents a risk to the life safety of the occupants.
- **Exit signage and emergency lighting:** There are existing provisions however, the existing exit signage are not compliant and both systems will need to be inspected.
- **Fire detection and alarm system:** The storage and plant areas in L02 and L03, lift shafts and the upper floor plant rooms are provided with Category LD3 detection and alarm system. However, there is no detection or alarm system within the flats nor in the common areas of the building. Considering the extended travel distances for occupants who can only use the flat entrance as their escape route, the lack of early detection and warning in the flat presents a life safety risk.
- **Fire suppression system:** The building is not sprinkler protected. Considering other gaps that have been identified in the building, this presents a risk to the life safety of the occupants.
- **Structural fire protection:** The existing protection nominally meets the required fire rating in the current standard, based on a desk-top review.
- **Fire compartmentation:** Each flat, services riser, stair, lift shaft and storage area should form separate fire compartments, to support the stay-put strategy. However, the Fire Risk Assessment (FRA) states that there have been structural alterations made in the building, compromising the compartmentation between the flats and risers. This is a risk to life safety as it may compromise the stay-put strategy and the integrity of the single stair.
- **Shunt duct arrangement (kitchen extract and toilet extract risers):** It is considered an acceptable solution for the toilet extract riser. However, the use of

shunt duct for kitchen extract presents a risk of fire/smoke spread between the flats and may compromise the stay-put strategy.

- **Flat entrance, refuse storage/post box and stair fire doors:** Assuming that these are the same as the tested fire door in the Shakespeare Tower, they do not achieve the required 60 minutes fire rating. The failure to maintain fire separation between the flat, lift lobby and single stair may compromise the stay-put strategy and the use of the stair for means of escape and firefighting.
- **Separation with neighbouring buildings:** There is adequate separation distances to adjacent properties to minimise the risk of external fire spread between buildings.
- **Façade system:** There appears to be no combustible materials in the façade system, based on the information provided.
- **Lift lobby:** The lift lobby also acts as a firefighting lobby with a manually operated smoke ventilation system.
- **Firefighting lift:** The existing firefighting lift and other lifts have been identified with a programming issue which will not allow it to ground upon detection of a fire. The firefighting lift will only ground upon arrival of the fire service when they manually activate the lift to ground. This is not in line with the current guidance.
- **Wet riser main:** All the inlet points are within 18 m of the fire service vehicle access routes. A wet riser outlet is located within each level of the firefighting shaft and within 45 m of coverage of the hose length.

Recommendation for remedial actions

Recommendations for remedial actions are provided throughout the report (in green boxes) to mitigate the identified life safety risks due to the gaps in the existing fire safety precautions. A summary of the known gaps and the associated recommendations is provided in Table 1. The table will be reviewed and revised accordingly when further information becomes available e.g. emergency lighting system, exit signage.

Interim measures

The recommendations may take some time to be fully implemented. Constraints on site may affect the feasibility of some of the solutions and further option development may occur. However, there are existing features in Cromwell Tower that present unacceptable risks to the life safety of the building occupants. Some immediate actions are recommended to address these risks.

These immediate actions are temporary measures to address the risks, while permanent solutions are being developed and implemented. These interim measures are not meant to replace the need for permanent solution. The aim of the interim measures is to reduce hazards that may affect the use of the single stair in the event of a fire, so that occupants can safely evacuate from the Tower. The recommended interim measures are:

- Preparing a Personal Emergency Evacuation Plan (PEEP), so that the evacuation arrangement in the event of a fire is clear to each PRM occupant;

- Remove all storage and rubbish within riser spaces that opens into the stair (note: the External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018 states that discarded trade materials and general waste were identified in riser cupboards).
- Consider providing a fire detector within the electrical riser above L37, so that BE receives early warning of a potential fire in the electrical riser. If necessary, evacuation can then be initiated before the stair is affected.

Next Steps

In addition to implementing the interim measures, it is recommended for BE to review the feasibility or implementation of the permanent remedial actions.

Once this has been completed, it is recommended for the CoL District Surveyor and the London Fire Brigade to be consulted, to seek their early agreement in principle.

Table 1: Identified gaps and recommended actions

Identified Gaps	Recommended Action	Benefits of the recommendation	Implementation constraints as defined by BE
No internal hallway in the flats Extended travel distance (for single direction of escape) Duplex and triplex layout with open internal stair	<ul style="list-style-type: none"> Provide early warning to occupants within the flat by installing a minimum Grade D1 Category LD1 within the flats; Review the internal layout of the duplex and triplex in terms of alternative egress and internal hallway against the current guidance; 	<ul style="list-style-type: none"> Early warning through automatic detection and alarm system will serve to alert occupants of a fire in their flat during the early stages of the fire and initiate evacuation before conditions in the flat becomes untenable. Occupants will be made aware of the escape routes and procedures in the event of a fire, minimising time to evacuate the building. 	
Sprinkler protection	<p>For a high-rise single stair building that adopt a stay-put strategy, it is recommended to maintain the fire compartmentation across the building. The condition of the compartmentation is unknown. There are extended travel distances within in the flats and there is a relatively high percentage of PRM occupants in the building. As such, this presents a risk to the life safety of occupants and the installation of a sprinkler system in the building is strongly recommended .</p>	<p>Provision of sprinklers will enhance the overall fire safety of the building, limiting the fire growth and enhance both life safety and property protection of the building.</p>	
L1 – L6 Wing A flats provided with a single means of escape	<p>For Wing A flats from L1 to L6, it is recommended to provide one of the following options:</p> <ul style="list-style-type: none"> Retain the existing arrangement of escaping via neighbour's flat from Wing A, provided that there are regular inspection in place to check that the means of escape route via the adjacent flat (Wing B) is available, including checking the keys are in place and the escape paths within the flats are available, or Providing compartmentation to kitchen area as this is the high risk area, or Provision of a protected internal hallway. <p>The provision of sprinkler system will also address the risk of the single means of escape from the flat being compromised by the fire.</p>	<ul style="list-style-type: none"> Provision of one of the recommendations will enhance the current arrangement due to the following: <ul style="list-style-type: none"> Regular inspection to enforce and to check that the escape paths through neighbouring flats remain available. This option presents the least change to the flat, but will increase staff responsibility on regular inspections. Enclosing the kitchen in fire rated construction or providing protected internal hallway will reduce the risk of the single escape route being compromised by a fire in the flat (likely to be within the kitchen). Limit fire growth by provision of sprinklers 	
Evacuation of PRMs/ smoke control	<ul style="list-style-type: none"> Preparation of Personal Emergency Evacuation Plan (PEEP) for PRMs. Replacing existing manually operated ventilation system to automatic ventilation system in the lift lobbies. Provision of Emergency Voice Communication (EVC) system to all of the lift lobbies. 	<ul style="list-style-type: none"> PRMs are well informed about their evacuation arrangement in the event of a fire. Automatic smoke ventilation to all lift lobbies will create a safe refuge for PRMs to wait for assistance. The detection system in the lift lobby will operate the automatic smoke ventilation system and raise an alarm to alert BE staff to investigate the incident. 	
Exit signage	<p>A survey is recommended to inspect and replace existing exit signage to comply with BS 5499-4, BS ISO 3864-1 and the additional recommendations from the Grenfell Tower Inquiry: Phase 1 report</p>	<p>Correct signage will serve to identify the stair discharge level and the route out of the building.</p>	
Emergency lighting	<p>A survey is recommended to inspect and replace existing emergency lighting to comply with BS 5266-1.</p>	<p>Emergency lighting will allow occupants to evacuate safely, especially when traversing up/down the stairs.</p>	

Compartmentation – structural alterations made to the building between flats and risers.	It is recommended to carry out a sitewide survey to inspect breach in compartmentation, and to undertake works to maintain the compartmentation in accordance with BS 9991.	This will maintain the stay-put strategy and minimise the risk of the single stair being compromised by a fire in the building.	
Connection between small lobby, ventilation shaft and electrical riser.	It is recommended to provide one of the following: <ul style="list-style-type: none"> • Provide fire separation between the small lobby and the ventilation shaft (removing all the vents) and remove the fire door between the small lobby and the lift lobby on L37 and above, or • Provide a fire and smoke damper at each vent to maintain fire separation and to only vent the floor of fire incident. Also provide a wall to separate the smoke shaft and the electrical riser from L38 and above. 	Either of the recommendations will adequately separate the small lobby from the electrical riser. This will reduce the risk of smoke and fire spread from the electrical risers.	
Fire doors at flat entrance, lift lobbies, firefighting stairs and refuse storage/post box.	<ul style="list-style-type: none"> • It is recommended to replace all the fire doors to the stair, small lobby, flat entrances and the refuse storage/post box. • Doors to all the risers to be inspected and repaired/replaced to maintain fire separation from the stair or lift lobbies. • Keep records of inspection and testing of fire doors in the future, at not less than three-monthly intervals to ensure that all fire doors are in working order. 	<ul style="list-style-type: none"> • This will serve to maintain the availability of the stair for means of escape and firefighting activities. • Maintaining the stay put evacuation regime. 	
Kitchen extract shunt duct system	<p>Replace the existing extract hoods with recirculation type hoods, and implemented one of the followings:</p> <ul style="list-style-type: none"> • Smoke and fire damper at the shunt duct riser activated by the fire alarm/detectors within the flat (this maintains the use of the riser for normal ventilation of the flat); or • To block off the shunt ducts and provide a fan on the external wall to draw out air from the flat into the balconies. <p>Maintain the existing extract hoods and shunt duct arrangement by increasing the reliability of the main extract fan. This will require an additional duty standby fan (the fans to be rated at 400 °C for 90 minutes in accordance with BS EN 13501-4), with secondary power supply. The fans need to be adequately maintained to keep the main riser under negative pressure;</p>	<ul style="list-style-type: none"> • The provision of fire and smoke damper or blocking off the shunt ducts will serve to significantly reduce the risk of fire spread between compartments through the kitchen shunt ducts. • Maintaining the stay-put evacuation regime. • The option of increasing the reliability of the main extract fan allows the day-to-day ventilation within the flat can be maintained. 	

1 Introduction

1.1 Appointment and scope

Arup have been appointed by Barbican Estate (herein referred to as BE) to provide a fire engineering review of Cromwell Tower, an existing building which is part of the Barbican Residential Development, located in the City of London.

This report provides a fire strategy for the existing building and captures the current fire safety measures and strategy as Arup understand it from recent reviews of documents, discussions with the BE management team and through a non-intrusive site visit undertaken on 20/08/2021.

Although Cromwell Tower is an existing building, there is limited documentation available to explain the current fire safety information for the building. There is currently no fire strategy report for the building nor documentation which provides a cohesive record of the fire safety measures in the building. As such this fire strategy has been developed to act as a cohesive and detailed record of the current fire safety provisions (and can act as a benchmark for future building work).

1.2 Purpose of this report

Having a single documented fire safety strategy for Cromwell Tower provides the required information to understand the fire safety principles and fire safety measures within the existing building.

It should also be noted that this fire strategy covers the residential floors, Street level (L01) and storage/plant areas (L02-L03) of Cromwell Tower. This report does not cover the services subway (L04).

This report will assist the BE when they wish to undertake future improvement and alterations to the building. It will also act as a benchmark in recording the fire safety strategy and enables anyone undertaking works on the building to understand what implications these may have in terms of fire safety.

Furthermore, this report documents any potential shortfalls in fire safety measures and enables BE to address these where necessary and document them in their Fire Risk Assessment (FRA) for the building where required.

The purpose of the report is to provide the following:

- Identify any tests that should be undertaken to create evidence of building operation where that is missing;
- Identify potential remediation measures, where current fire safety systems do not provide adequate fire safety for occupants;
- A retrospective fire strategy report and associated fire safety drawings and recommended remediation measures.

These goals are identified to be provided for four different typologies of buildings to give an overall fire strategy for all 22 buildings within the Barbican Residential Development.

Areas that require more information/ confirmation is required from BE are identified by **brown** text throughout this report.

1.3 Barbican Residential Development

The buildings in the Barbican Residential Development were constructed from 1960 to 1982. There are 22 buildings in total as shown in Figure 1. There is a distinctive design feature across the Barbican Residential Development, which is the provision of a podium. It was constructed with an intention of providing a liveable urban environment for pedestrians and acts as ground level for the buildings¹.

In terms of fire safety design, the podium level throughout the Barbican Residential Development is considered as an access level for all of the buildings. Access level is defined in BS 9991 as 'level used for normal access to the building that either incorporates, or leads directly to, a place of ultimate safety'. Therefore, the podium is considered a place of ultimate safety, serving as the exit discharge level for the stairs.

¹ Barbican Estate, *Barbican Living*, <https://www.barbicanliving.co.uk/>, (accessed 16 March 2021)



Figure 1: Overview of the Barbican Residential Development (Image courtesy Barbican Living)

Arup in conjunction with BE have identified four different block typologies which are common across the residential development. The typologies are as follows:

- High rise tower – Cromwell Tower;
- Terrace block type 1 – Andrewes House;
- Terrace block type 2 – Ben Jonson House;
- Terrace block type 3 – Mountjoy House.

Flats across Cromwell Tower are generally privately owned by leaseholders with a small portion of the flats being owned by the BE and let out to tenants.

2 Fire Safety Goals

2.1 Statutory and policy goals

The legislation, regulations and relevant standards contained within the following sub-sections have been referenced as part of Arup's review of the existing building. These are the requirements that are applicable to the existing building.

2.1.1 Regulatory Reform (Fire Safety) Order 2005

The Regulatory Reform (Fire Safety) Order 2005 (RR(FS)O) places a general duty of fire safety care on employers, occupiers and owners of almost all premises and requires them to take such fire precautions as may be reasonably required to ensure that premises are safe for the occupants and those in the immediate vicinity.

The responsible person has a duty to carry out a fire risk assessment which must focus on the safety in case of fire of all 'relevant persons'. The risk assessment should pay particular attention to those at special risk, such as the disabled and those with special needs, and must include consideration of any dangerous substance likely to be on the premises.

A fire risk assessment (FRA) was undertaken in January 2018 by Frankham Risk Management Services. A number of risks have been identified and need to be resolved in order to comply with RR(FS)O. Reference to these items has been included in the relevant sections of the fire strategy.

2.1.2 Building Regulations 2010 (as amended)

The fire safety review is undertaken to establish compliance against the functional requirements of Part B of the Building Regulations 2010 (as amended), using the recommendations in BS 9991:2015 (see Section 2.1.3) as the basis of the review. Where applicable, BS 9999:2017 Fire safety in the design, management and use of buildings – Code of practice and the Approved Document B Volume 1: Dwellings 2019 Edition Incorporating 2020 Amendments – For use in England, which has been updated recently to reflect the latest requirements for residential buildings has also been referenced.

2.1.3 BS 9991:2015

The existing building has been assessed against BS 9991:2015 - Fire safety in the design management and use of residential buildings – Code of practice. A guidance document which provides a means of demonstrating compliance with the life safety requirements of Part B of the Building Regulations 2010 (as amended) (herein referred to as "BS 9991"). This is used as the benchmark in developing the fire strategy for the building.

2.1.4 Barbican Estate fire safety goals

Through meetings with the BE, Arup has identified that the main objective of this fire safety review is the life safety of the building occupants. Arup is not aware of any additional requirements for property protection, either from BE or their insurer. **This is to be confirmed by BE.**

2.2 Proposed methodology

The existing fire safety precautions of Cromwell Tower are compared with the current recommendations in BS 9991. Where the provisions and recommendations align, no further action is required, and the existing provisions are recorded in this report to form the building fire strategy.

Where the provisions are not deemed to comply with the recommendations of BS 9991, a qualitative risk assessment will be carried out to identify the life safety risks to the building occupants due to those non-compliances or gaps in the fire safety precautions. The outcomes of the assessment will result in one of the following:

1. Where considered acceptable to remain as existing, recommend retaining the current provisions; or
2. Recommendations on possible options for enhancements/upgrades where the current fire safety provisions are considered inadequate.

It should be noted that as the building is existing, it is not feasible for all provisions to be in line with current fire safety standards. Where appropriate, the relevant guidance documents at the time of construction of the building have been used as reference.

2.3 Referenced documentation

The following information has been used to inform the Andrewes House fire strategy and fire safety systems provisions:

- Meetings between Arup Fire and BE between August 2021 to February 2022;
- Barbican Living website;
- Various email correspondence between Arup Fire and BE between August /2021 to February 2022;
- Referenced documents and drawings listed in Table 2;
- Visual non-intrusive site visit undertaken on 20/08/2021;
- Visual non-intrusive site visit undertaken on 17/01/2022.

Table 2: Referenced documents and drawings

Document title	Produced by	Date	Revision
Cromwell Tower External Fire Risk Assessment	Frankham Risk Management Services	Jan 2018	-

Document title	Produced by	Date	Revision
CP 114:1957 <i>British Code of Practice, The Structural Use of Reinforced Concrete in Buildings</i>	British Standards Institution	1957	-
CP 3: 1962 <i>British Code of Practice Chapter IV Precautions against fire Part 1. Fire precautions in flats and maisonettes over 80 ft in height</i>	British Standards Institution	1962	-
BS EN 1992-1-2:2004: <i>Eurocode 2 Design of Concrete Structure Part 1-2: General rules – Structural fire design</i>	British Standards Institution	2004	-
The fire resistance performance of a single leaf single acting door set with side screen and over panel, when tested in accordance with BS 476:Part 20/22: 1987	Exova Warringtonfire	23 rd Oct 2018	-
Drawing no. 33 517 Block Three Wall elevations Levels 77' – 95'	Ove Arup & Partners	May 1964	Rev D
Drawing no. 33 550 Block Three	Ove Arup & Partners	Feb 1968	Rev H
Drawing no. 33 F12 Block Three Plan of Floor 39 finishes	Ove Arup & Partners	July 1968	Rev A
Drawing no. 33 F9 Block Three Plan of Floor 36 finishes	Ove Arup & Partners	July 1968	-
Drawing no. 33 507 Block Three 95' level plan	Ove Arup & Partners	May 1964	Rev E
Abridged results from the test of 86 Thomas More House (double leaf door and single leaf door)	CTO S.A	2020	Issue

2.4 Limitations and assumptions

2.4.1 Limitations of report

This document summarises the findings of our work carried out to date. It does not attempt to quantify actual elements of fire performance, such as fire resistance periods, across the building in its existing state as physical intrusive works would be required to do this. It is Arup’s understanding that intrusive investigations into the building is not planned to be carried out.

There are no architectural layouts of the building. Structural plans of Cromwell Tower have been obtained through Arup Archive and used to better understand the building layout. However, this is not a complete set covering the building and are limited to some levels of the building only. The fire strategy drawings provided as part of this report are based on those published in the Barbican Living website. In using these documents, it is assumed that the layouts remain representative of the current arrangement in Cromwell Tower.

BE should undertake the necessary tests/inspections to confirm that the fire safety systems will operate as intended in a fire event.

The information documented in this fire strategy is limited to the amount of information covered through the following:

- Desktop review;
- Consultation with the BE;
- Visual non-intrusive site visit undertaken on 20/08/2021, where the areas visited included outside and inside of Cromwell Tower
 - Street (L01) and Podium level;
 - Common area (lift lobby, stairs) on some of the Residential levels (L1 – L39);
 - Common corridors including a few storage and plant rooms (L02 – L03);
 - Car park (L02);
 - Shakespeare Tower - Internal flat layout for Wing C

The fire strategy does not represent the condition for the entire building.

2.4.2 Summary of key assumptions

The following key assumptions have been made to form a basis of the fire strategy for Cromwell Tower. BE should confirm if these assumptions are suitable for the project.

- Any current or future building works and their impact on the fire strategy are outside the scope of this document;
- No further inspection/survey is planned such as intrusive investigation on the building;
- The building is not undergoing any changes at all, with no change in occupancy nor material alterations;
- The fire strategy drawings within the report are in line with the current building layout;
- Structural drawings are only available for apartment levels L36 and L39. It is assumed that all other levels have a layout that is in line with the two levels and follow the same fire safety principles throughout the building;
- The information from the document ‘The fire resistance performance of a single leaf single acting door set with side screen and over panel, when tested in accordance with BS 476 Part 20/22:1987’ on the doors from Shakespeare are assumed to be the same as the ones from Cromwell Tower. E – 30mins achieved, I – 24mins;
- All elements shown in the structural drawings are assumed to be elements of structure and therefore loadbearing;
- The thickness of structural elements (i.e. slab depth or wall thickness) are assumed to be the same throughout the building;
- All structural elements are reinforced concrete;

- The concrete covers over the reinforcement bars meet the values stated in the relevant guidance at the time of construction (CP114); there is no information on the depth of the existing concrete covers for this aspect to be assessed;
- Floor slabs are simply supported one-way slabs throughout the building;
- No structural calculations are available and therefore the utilisation factor of the structural members is unknown. When checking against the requirements of Eurocode 2 (Section 4.3.1) a utilisation factor of 0.7 has been assumed for conservatism;
- The fire resistance requirements given in CP114 cover loadbearing capacity, integrity and insulation;
- There is no fire stopping register for the building. The condition of the fire stopping at penetrations on fire rated construction is unknown. It is assumed that fire stopping remediation actions will be undertaken as part of ongoing maintenance;
- Boundary distances have been taken to the middle of Beech Street and Silk Street as there is no site boundary information available;
- The single enclosed stair that connects Podium level to L39 is a firefighting stair;
- The layout of the flats in Cromwell Tower is identical to the flats in Shakespeare Tower.

3 Cromwell Tower

Cromwell Tower was completed in January 1973. It is a high-rise residential tower which sits between Ben Jonson House and Frobisher Crescent. The building contains 108 flats and 3 penthouse maisonettes¹.

The building consists of a single stair where the stair is connected to the lift lobby containing three lifts with one being the firefighting lift (installed in accordance with BS 5588-5:1986 as confirmed by Steve Clarke on 08/04/2021 via email correspondence). As the stair is fully enclosed and considering the height of the building being over 30 m, it is likely to be a firefighting stair and therefore, it is known as such in the report.

There are two internal stairs (referred to as '1 down stair' or '2 down stair') in the building that connects between the balcony and the lift lobby in the lower levels. One example of 1 down stair is shown in Figure 4.

The flats in the building have access to the following:

- All levels - Main flat entrance connected to the lift lobby with access to the firefighting stair and lifts;
- L6 – L39 - Balcony which leads directly to stair (either the firefighting stair, 1 down stair or 2 down stair depending on the wing type/location) – See Figure 3;

The building consists of 41 floors with a building height of 108 m (assuming floor to floor height of 2.7 m, drawing number 33 550) measured from ground to the bottom of the topmost occupied storey. The *Grenfell Tower Inquiry: Phase 1 report* defines high-rise buildings as buildings over 18 m in height and hence Cromwell Tower is considered a high-rise building. The building comprises of the following:

- Roof level;
- L40 – L41: ventilation plant (L40) and lift machine room (L41);
- L1 – L39: Residential flats (3 flats in each level) and duplex or triplex at the top level of each wing:
 - Duplex on L39 and L40;
 - Triplex on L37 – L39;
 - Triplex on L35 – L37.
- Podium level: Circulation space;
- L01 (Street level): reception and main entrance;
- L02 – L03: Plant/storage area in addition to a car park;
- L04 Subway level.

The roof level is only accessible to BE staff via the external helical stair extended from the firefighting stair.

L04 which is known as the 'subway' is connected to Cromwell Tower via one of the plant rooms in L03. It contains services and extends throughout the Barbican Estate. The area is excluded from the scope of this document.

The building comprises three wings (Wing A, B and C) with a single flat in each of the wings on every floor above L1. There are three balconies in the tower, one for each of the wings that are connected to one of the three stairs (one firefighting stair, 1 down stair or 2 down stair). Each of the stairs are connected as follows:

- Firefighting stair: runs through all of the residential floors (L1 – L39) and provides a final exit at Podium level;
- 1 down stair (stair between Wing A and B): connects the Wing B balcony with the lift lobby one level below, for L7 – L39;
- 2 down stair (stair between Wing A and C): connects Wing A balcony with the lift lobby two levels below, for L7 – L39;
- From L6 to L01, the protected stair is the only available stair;
- The exit via dining room leads to adjacent flat's balcony to enter either the firefighting stair or one of the 1 down stair or 2 down stair(L7 – L39).

As there is one stair (firefighting stair) which runs through the residential floors of the tower, the building is considered to be a single stair building.

The main entrance which is used by the occupants on a day-to-day basis, can be accessed from Beech Street. It also acts as the main firefighting access point into the building. It should however be noted that whilst fire service access to the building is considered to be at Street Level, the firefighting shafts can only be accessed at podium level. Therefore, fire service will enter the building at Beech Street level via the reception, walk up the internal open stair (which is separated from the residential levels above) and transfer to the firefighting stair at podium level. This is shown in Figure 2.

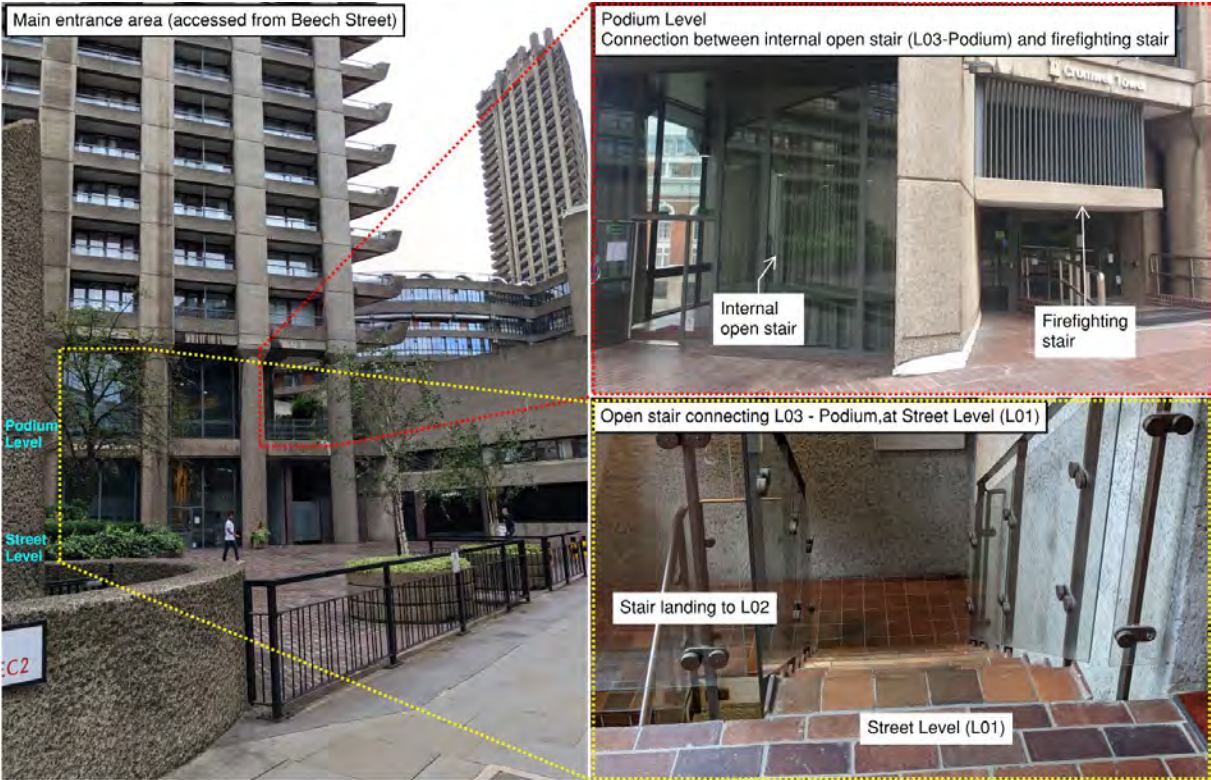


Figure 2: Access to Cromwell Tower from Street Level and Podium Level

The layout of residential floors (L1 – L39) of Cromwell Tower is as shown in Figure 3 and section of part of Cromwell Tower in Figure 4.



Figure 3: Layout of Cromwell Tower

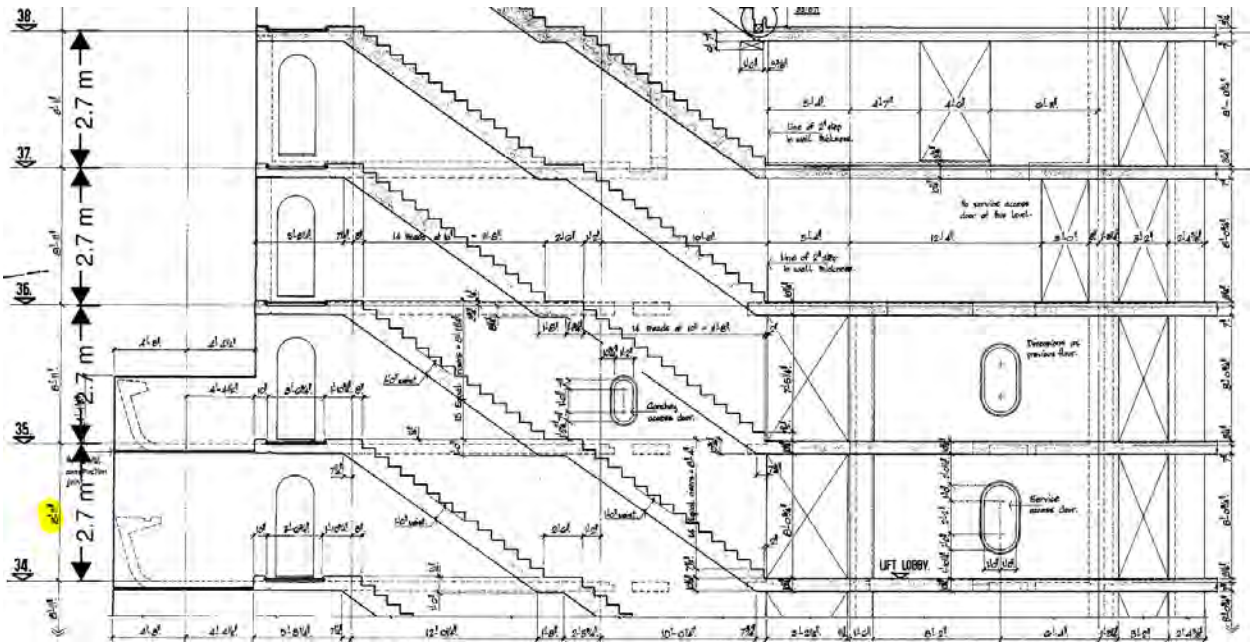


Figure 4: Section of Cromwell Tower from L34 to L38

4 Fire Strategy Summary

This section of the report provides an overview of the fire strategy of Cromwell Tower. It provides the following:

- The recommendations of current guidance;
- The current provisions in Cromwell Tower;
- Identification of non-compliances against the current provisions;
- If there are non-compliances identified, three possible solutions through a risk assessment:
 1. The non-compliance is considered to present life safety risk and requires remediation. Recommendations are made to improve the current provisions to comply with the Building Regulations on an as near as reasonably practicable basis;
 2. The non-compliance is not considered to be high risk to require additional safety measures to the existing system. It is considered acceptable to be retained; OR
 3. More information/confirmation is required from BE (brown text)

Where a non-compliance has been identified and a recommendation has been made after a risk assessment, these have been highlighted in green box.

4.1 Means of warning and escape

4.1.1 Evacuation strategy

Cromwell Tower operates under a defend in place/stay put strategy where only the occupants in the flat of the fire origin evacuate the building. The rest of the building occupants will remain in place. The defend in place strategy is a common strategy for residential buildings in the UK.

It is recommended that information is given to residents regarding the meaning of the stay put strategy and the arrangements for means of escape is available to them if a fire were to affect their flat. It is noted from the Frankham's FRA that fire action notices are not definitive enough in communal areas. It is recommended for signage to be replaced with clear instructions to residents, explaining their fire actions, including the stay put policy and their nearest escape routes.

Whilst the above approach is compliant with the recommendation of BS 9991, the *Grenfell Tower Inquiry: Phase 1 report* recommends that all high-rise residential buildings, existing and new, are provided with facilities to allow the fire and rescue service to simultaneously evacuate the building. This is recommended to be implemented for Cromwell Tower considering the height and the single stair serving the building. Refer to Section 4.1.9 for additional details on the fire detection and alarm system.

4.1.2 Means of escape within flats

From BS 9991, flats having an entrance on the same level as the flats should have all habitable rooms to be accessible from an internal hallway and have an alternative exit from the flat. There are no maximum travel distance recommendations in this arrangement.

As shown in Figure 5, the original intention of the flat layout was to provide an internal hallway to separate all habitable rooms from the internal corridor. However, it has been confirmed by BE that most of the flats no longer have the door separating the internal hallway from habitable rooms which is a non-compliance to the current recommendations.

For able-bodied occupants (refer to Section 4.1.6 for evacuation of Persons with Reduced Mobility, PRM), this is considered acceptable if automatic fire detection and alarm system of Grade D1 Category LD1 is installed within the flats (refer to Section 4.1.9 for further details on the recommended fire detection and alarm system) and under the basis that the flats are provided with alternative escape routes as follows:

- Through the balcony which is accessible through all habitable rooms;
- Through the dining room to enter neighbour's balcony.



Figure 5: Available egress routes for a typical flat layout

The current layout of duplex and triplex layouts is different to the typical residential levels with three flats in each level. The layout shows that some habitable rooms open directly into the open stair leading to the living room; the open stair, which is the

escape route, could be compromised by a fire in the living room. It is therefore recommended to review the internal layouts of the duplex and triplex in terms of exit provisions and travel distances against the current regulations.

Recommendations:

- Provide automatic detection and alarm system of Grade D1 Category LD1 within the flats – refer to Section 4.1.9 for further details.
- Review the internal layout of the duplex and triplex in terms of exit provisions and travel distances.

4.1.3 Means of escape in common areas

BS 9991 recommends that for a building with a lobby approach, either of the following should be adopted:

- The travel distance between the exit doors from the dwellings and a smoke free area should be limited to 7.5 m, and the amount of smoke and other combustion products in the internal lobby kept to a minimum by providing either cross corridor fire doors and ventilation, or a mechanical smoke ventilation system, or
- An independent alternative escape route should be provided from each dwelling either by way of a corridor at another level or through an external common balcony meeting the following recommendations:
 - Structure including the floor is to be protected to achieve 30 minutes fire rating.
 - Walking surface should be imperforate.
 - The balcony to be open-sided and the opening to achieve at least 50% of the vertical plan.

Lobby approach: L7 – L39

The horizontal means of escape from each flat consist of the flat main entrance leading to the passenger lift lobby and into the firefighting stair as the primary means of escape. Alternatively, there is a route via the balconies to access one of the three stairs provided in the building (where only one is a firefighting stair). The escape routes are as follows:

- **Flat entrance** – There are three stairs (one firefighting stair, 1 down stair and 2 down stair) connected to the lift lobby, where each of the flat entrances directly open into. From the lift lobby, occupants can use the firefighting stair through the small lobby to evacuate the building.
- **Balcony exit** – All habitable rooms have a door which leads directly to the balcony. Once on the balcony, occupants can escape to one of the stairs connected to the balcony
 - Firefighting stair: occupants can use the stair to exit the building (Wing C);
 - 1 down stair and 2 down stair: occupants will reach the lift lobby either one or two levels below the flats, where they can then pass through the lift lobby to reach the firefighting stair to reach the final exit (Wing A & B).

- **Dining room exit** – All flats have a door in the dining room which leads to the adjacent wing's balcony where they can use the stair connected in an identical way as the balcony exit.
 - Firefighting stair: as above in Balcony exit (Wing B);
 - 1 down stair and 2 down stair: as above in Balcony exit (Wing A & C).

As shown in **Error! Reference source not found.** the travel distance within the unventilated lobby is greater than 7.5 m and exceeds the recommended travel distance.



Figure 6: Travel distance in the unvented lift lobby to the firefighting stair

The width of the balconies is 830 mm. It was identified during the site visit, that furniture is located along the balcony in certain levels of the tower as shown in **Error! Reference source not found.** These should be removed so that the escape route remains unobstructed.



Figure 7: Furniture along the balcony

However, all of the flats are provided with balconies as an alternative escape route and therefore is not restricted by maximum travel distance of 7.5 m. Based on the photo of the balcony in **Error! Reference source not found.** and structural drawings, the balcony achieves the following:

- The floor slab of the balcony achieves a nominal fire rating of 120 minutes – refer to Section 4.3.1 for further details);
- The walking surfaces are solid concrete pavers and imperforated;
- The balconies appear to achieve the opening to be at least 50% of the vertical plane and uniformly spread across the surface.

And therefore, meets the recommendations of BS 9991.

Lobby approach: L1 – L6

From L1 to L6, there are no 1 down stair and 2 down stair that leads to the lift lobby in the lower levels. For Wing A, the only means of escape is from the flat entrance, through the lift lobby and the small lobby to the firefighting stair. Wing B and C have an alternative escape route where they can use the balcony to enter the firefighting stair directly either from the dining room exit (Wing B) or the balcony (Wing C).

The current evacuation procedure includes an escape route from Wing A to escape via the dining room to enter Wing B where they can use the provided key to enter Wing B to access the firefighting stair.

In order to ensure safe egress route is provide in all flats in L1 to L6, there are following options recommended:

- Retain the existing arrangement of escaping via neighbour’s flat from Wing A, provided that there is regular inspection in place to check that the means of escape route via the adjacent flat (Wing B) is available, including checking the keys are in place. The inspection should include both the provisions in the common areas and maintaining the escape paths within the flats, or

- Providing compartmentation to kitchen area as this is the highest risk, or
- Provision of a protected internal hallway.

As the existing means of escape strategy for Wing A occupants between L1 to L6 to evacuate from their flat to neighbouring flat is unconventional, if the existing strategy is to be retained, it is required to be maintained otherwise travel distances are excessive, unless other recommendations listed above are provided to the flats.

The provision of sprinkler system will also address the risk of the single means of escape from the flat being compromised by the fire.

Podium and Street level (L01)

Both Podium and Street level (L01) have direct exit to outside. Podium level to L02 is connected by an internal open stair (950 mm in width).

This complies with the current guidance as there are direct exits to outside on both levels where occupants can use an alternative exit if one is discounted.

During the site visit, it has been confirmed that the lift lobby on Podium level is currently not being used. The facility management team should ensure that there are no stored goods within these areas as it may increase the risk of fire starting in the area and lead to smoke/fire spread to the lift shafts.

Below Street level (L02 – L03)

Both L02 and L03 are provided with two escape routes as follows:

- Internal open stair adjacent to the lift lobby which can be separated from occupied areas by a manually operated fire shutter. The internal open stair leads to the reception on L01 Street level and on to the final exit;
- Helical stairs (750 mm in width) located on the far end of the storage/plant corridor as an alternative means of escape in the event of the shutters close due a fire in the vicinity.

This complies with the current guidance as there is always an alternative means of escape from L02 and L03.

Plant area (L40 – L41)

The ventilation plant (L40) and the lift machine room (L41) both have two means of egress from the room to reach the firefighting stair and is considered compliant.

Recommendations:

- A management procedure should be put in place to keep the balconies clear of any obstacles at all times. This is to provide a clear escape route for occupants to evacuate in an emergency.
- A management procedure should be put in place to keep the lift lobbies clear of any stored goods at all times. This is to ensure the area is kept as a low risk area to prevent fire from starting.
- It is recommended to for L1 – L6 to be provided with one of the following options:

- Retain the existing arrangement of escaping via neighbour's flat from Wing A, provided that there is regular inspection in place to check that the means of escape route via the adjacent flat (Wing B) is available, including checking the keys are in place. The inspection should include both the provisions in the common areas and maintaining the escape paths within the flats, or
- Providing compartmentation to kitchen area as this is the highest risk, or
- Provision of a protected internal hallway.
- Provision of sprinkler system will also address the risk of the single means of escape from the flat being compromised by the fire.
- Refer to Section 4.1.6 for additional recommendations for single means of escape.

4.1.4 Vertical means of escape (stairs)

Minimum width

1 down stair and 2 down stair are required by BS 9991 to be no less than 750 mm, measured between the walls and/or balustrade (if protruding less than 100 mm from the walls). A minimum 2 m clear height shall be maintained. BS 9991 also states firefighting stairs should have an unobstructed width of 1100 mm.

Cromwell Tower is provided with the following stairs across different levels:

- L7 – L39: Three stairs where one is a firefighting stair, and additional 1 down stair and 2 down stair. The width of the firefighting stair is 1000 mm and the two other stairs have been measured (during the site visit) as 760 mm;
- L1 – L6: Only the firefighting stair is provided;
- L02 – L03: Three helical stairs (width of 750 mm) to Street Level (L01)
- L03 – Podium Level: An internal open stair (width of 950 mm) connecting basement levels to Reception on Street level and on to Podium level.

Refer to 4.5.3.1 for details of the firefighting stairs.

Protected lobby

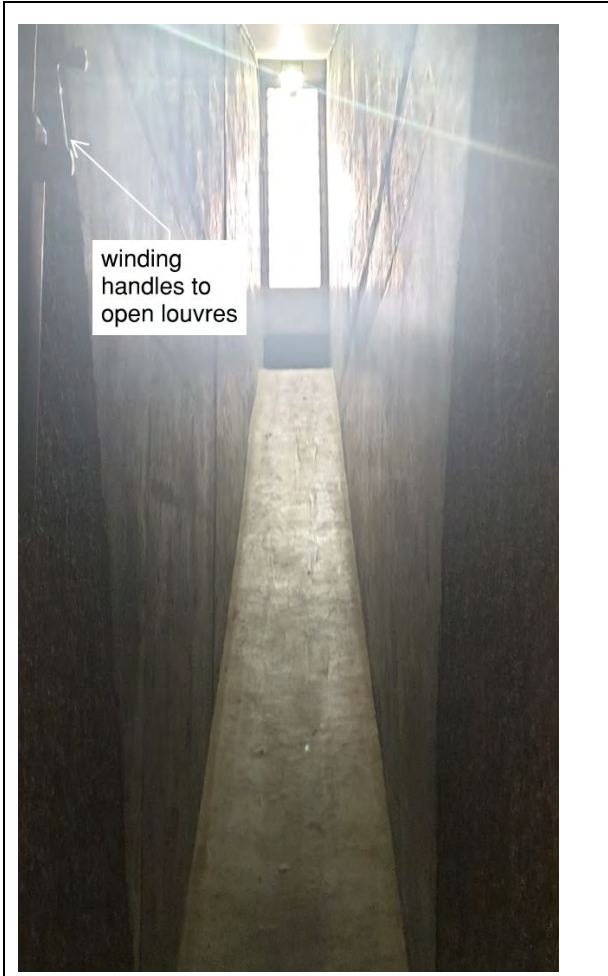
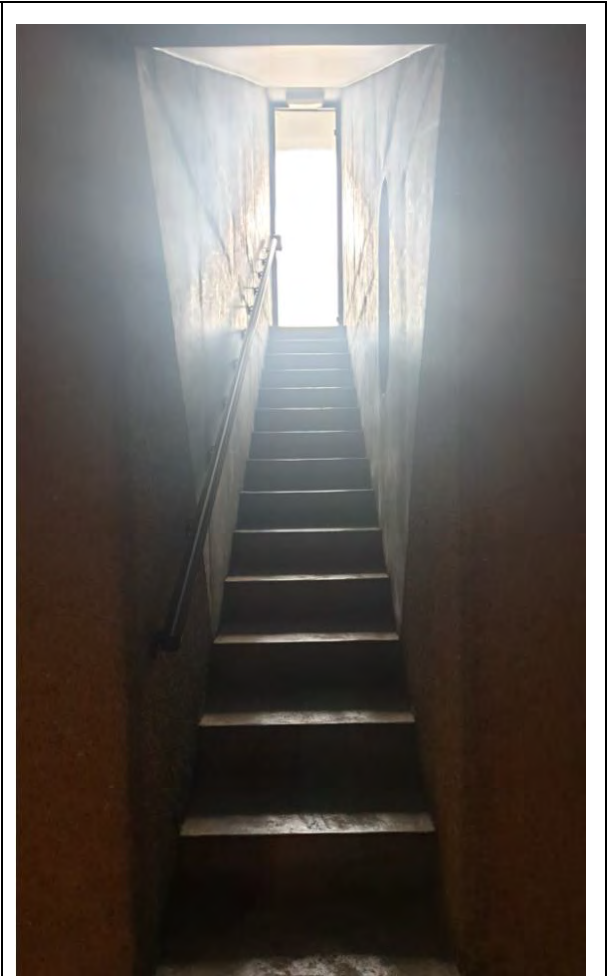
Each apartment opens directly into the protected lift lobby which is connected to the 1 down stair and 2 down stair. The firefighting stair is provided with an additional lobby between the lift lobby and the firefighting stair as shown in Figure 5.

Ventilation to lift lobby

There are currently manually openable vents in the lift lobby. There are two different types of vents across different levels of Cromwell Tower which are as follows:

- L1 – L6: There are two vents (in the same location where the 1 down stair and 2 down stair are located in the upper floors) within the lift lobby which have manually openable louvres, operated by winding handles at the bottom of both sloped shafts as shown in Figure 8;
- L7 – L39: There are 1 down stair and 2 down stair doors (which open to the flat balconies) as shown in Figure 9 that can be opened by striking off heads of cast securing bolts.

The current arrangement is not considered acceptable in terms evacuation of PRMs. Refer to Section 4.1.6 for further details and recommended actions.

	
Figure 8: L1 - L6 sloped ventilation shaft	Figure 9: L7 - L39 1 down stair and 2 down stair

4.1.5 Final exits

Level of discharge

Final exits are available on both Podium and Street (L01) levels. All residential levels will exit via the Podium level using the firefighting stair.

In accordance with BS 9991, discharge from final exits should meet the following recommendations:

- Protected stairs should discharge directly to a final exit;
- Final exits should discharge directly to a walkway or open space that allows for the rapid dispersal of persons away from the vicinity of the building, which is achieved by the Podium and Street level;
- Final exits should have a level threshold;
- Final exits should be sited such that they are clear of any risk from fire or smoke

It has been confirmed during the site visit that both the Podium and Street level is levelled and an open public walkway, mainly of non-combustible construction and with very low fire load content. The reception in the Street level (L01) should be managed as a low fire load area as it forms part of an escape route.

Place of ultimate safety

The Podium level is an external walkway which runs along Cromwell Tower and connects to other buildings in the Barbican Residential Development and adjacent developments. The Street level main entrance is open to pedestrian accessway on Beech Street. The Podium and Street level final exits act as a place of ultimate safety (a place where there is no immediate or future danger from fire). The area in front of the main entrance acts as a point of access for fire service.

The internal open stair, which is not part of the firefighting stair, connects the Podium to Street level as shown in Figure 10. The occupants from above Podium level must exit the firefighting stair to outside of Podium level. The occupants from below Podium level can exit the building on L01 Street level. Both final exits on each level allows for the dispersal of occupants away from Cromwell Tower in the event of a fire.

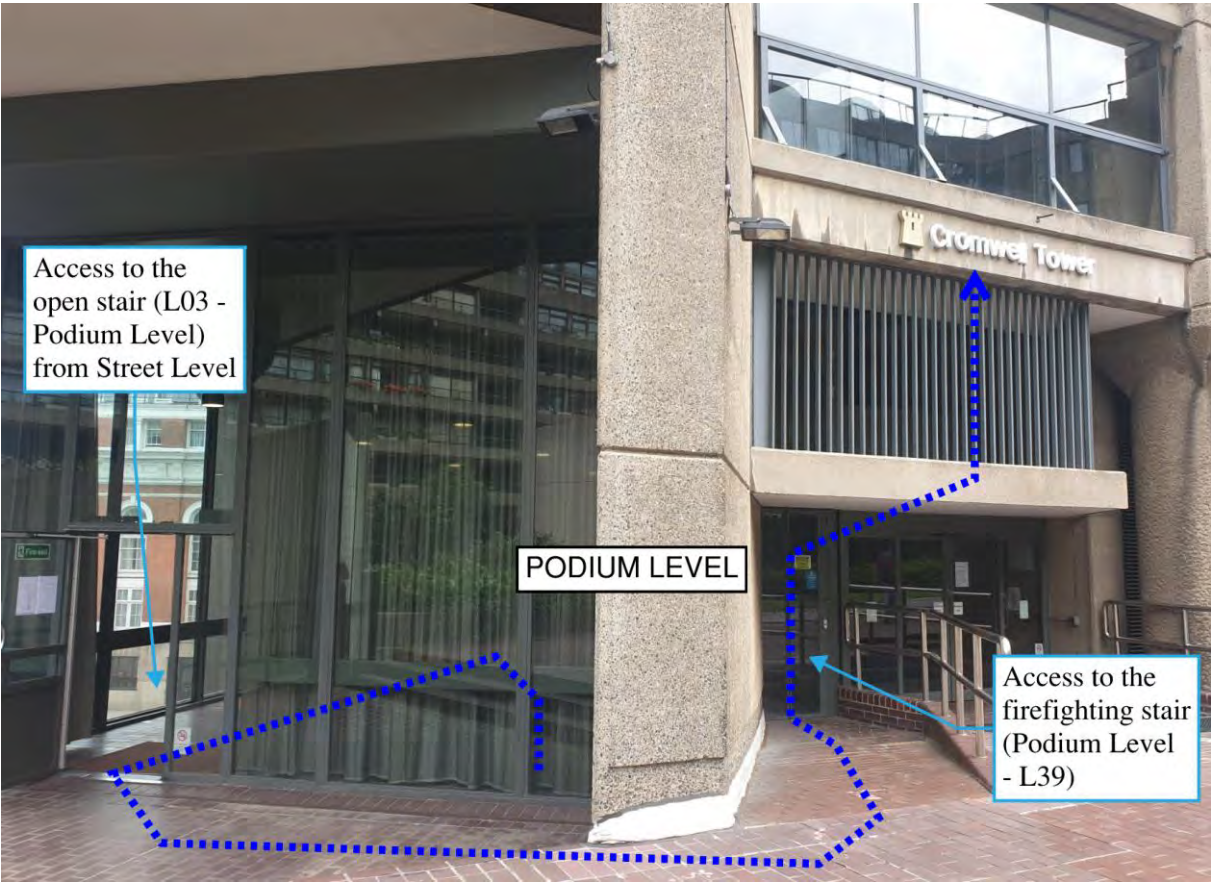


Figure 10: Access to Cromwell Tower on Podium level

Recommendations:

- BE should ensure the reception area is kept as a low fire load area at all times as it forms part of an escape route for occupants from L02-L03.

4.1.6 Evacuation of PRMs

Cromwell Tower currently does not have an evacuation strategy or Personal Emergency Evacuation Plan (PEEP) for PRMs. In this report, the term PRM is used to mainly refer to occupants who are wheelchair bound, but the term is applicable to occupants with varying levels of mobility.

As discussed in Section **Error! Reference source not found.**, each flat in the residential levels between L7 to L39 has alternative escape routes including access to balconies. However, there is a small change in level between the flats and the balconies. As such, the balconies will not be accessible to PRMs. In addition to this, the only route from the balconies to the lift lobby is via the 1 down stair and 2 down stair which is not step free. Therefore, for PRMs there is only a single means of escape using the flat entrance.

Existing provisions

Extended travel distance

BS 9991 recommends maximum travel distance of 9 m for single means of escape within flats protected by automatic detection system.

As there is only a single means of escape for PRMs, the travel distances within the flat should be limited to 9 m from the furthest point in the flat. As the flats do not have a common internal corridor serving all rooms, the current travel distance within the flats to the entrance door ranges between 14.9 m to 18.2 m which exceeds the recommendations of BS 999, as shown in Figure 11 below.



Figure 11: Extended travel distance for single means of escape for PRMs

Lack of safe refuge

All flats open directly into the lift lobby. Smoke from a fire in the incident flat could spread into the lift lobby during evacuation when the entrance door to the lobby is opened. There is no automatic smoke ventilation in the lift lobby nor emergency voice communication (EVC) system in the building.

The firefighting stair could serve as the safe refuge as it is separated from the lift lobby by a small lobby. However, the small lobby (floor area of 1.6 m²) is very restricted in space with two consecutive doors that must be opened to enter the firefighting stair. It may not be possible for PRMs to reach the safe refuge in the stair. It is also challenging for PRMs to be assisted down the stair from a building of such height.

The lack of automatic smoke ventilation within the lift lobby, potentially causing the lobby to be smoke logged in addition to the difficulty of PRMs to access the firefighting stair (potential space for safe refuge) presents a life safety risk to the building occupants.

Lifts grounding system

The current lift mechanism and whether they ground upon activation of detectors within the lift shafts is unknown. There are currently no evacuation lifts in the building and hence the only area where PRMs can wait for assistance to evacuate is the lift lobby.

Doors to firefighting stair

BS 9999 recommends the total door width should be not less than 850 mm where unassisted wheelchair access is necessary.

During the site visit, it was confirmed that the doors to the firefighting stair were 760 mm.

Proposed improvements

There are a number of non-compliances in the existing arrangement which poses additional risk for PRMs means of escape provision. It is therefore recommended to provide the following:

- Automatic ventilation system within the lift lobby to prevent smoke logging to allow PRMs to wait in a safe area.
- To install EVC system in the lift lobby for PRMs to notify the security or the fire service that there is fire and for them to be assisted to evacuate the building.
- Personal Emergency Evacuation Plan (PEEP) for each PRM resident should be prepared so that they are clear about their evacuation arrangement in the event of a fire. This should be done as a first priority.

Refer to Section 4.3.3 for further details and recommendations on fire doors.

Recommendations:

- Provide an emergency voice communication (EVC) system on each lift lobby, for the PRMs to call for assistance.
- Provide an automatic fire detection and alarm system for each flat (Section 4.1.9 for details).
- BE to put in place management plan and evacuation strategy for the evacuation of occupants, in particular for PRMs which includes preparing PEEP as an immediate action.
- Clear briefing to all occupants of Cromwell Tower on available escape routes.
- Clear briefing to PRMs on the evacuation procedures and the use of emergency voice communication system to call for assistance.
- Replace the manually operated smoke vents to automatically openable vents upon activation of a detection system

4.1.7 Exit signage

BS 9991 recommends exit signage to be in accordance with BS 5499-4 and BS ISO 3864-1. In particular, for stairs that serve storeys both above and below the point of final exit, the final exit should be immediately apparent by the provision of additional signage.

In addition, the Grenfell Tower Inquiry: Phase 1 report recommends that in all high-rise residential buildings, floor numbers are clearly marked on each landing within the stairways and in a prominent place in the lobbies such that they can be seen in normal conditions and in low lighting and smoky conditions.

Existing provisions

BE confirmed emergency exit signage are unlit in Cromwell Tower.

BE advised that there is a sitewide inspection (currently paused) to examine the condition of existing signage and to replace them where necessary.

Proposed Improvements

All exit signage provided in Cromwell Tower is recommended to be in line with BS 5499-4, BS ISO 3864-1 and the additional recommendations from Grenfell Tower Inquiry Phase 1 report.

Recommendations:

- BE to carry out a sitewide inspection and provide exit signage in accordance with BS 5499-4, BS ISO 3864-1 and the additional recommendations from the Grenfell Tower Inquiry: Phase 1 report.

4.1.8 Emergency lighting

In accordance with BS 9991, emergency lighting should be provided in accordance with BS 5266-1.

Existing provision

Cromwell Tower is provided with an emergency lighting system with battery back-up. During the site visit, it was not possible to determine the light fittings that are part of the emergency lighting system.

Proposed Improvements

A full survey on emergency lighting is recommended and to remediate any of the non-compliances throughout the building for emergency lighting to be in line with BS 5266-1.

Recommendations:

- BE to carry out a sitewide survey and provide emergency lighting in accordance with BS 5266-1.

4.1.9 Fire detection and alarm

BS 9991 recommends that flats in multi-storey buildings shall be provided with an alarm and detection system in line with BS 5839-6. The recommended system for an existing flat with no alternative means of escape is Grade D1 Category LD1, where Grade D1 is a provision of one or more mains powered detection system each with a sealed in standby supply consisting of a battery and Category LD1 system is where full coverage is provided giving earliest practicable warning of fire to occupants, wherever ignition occurs.

In addition to the recommendations of BS 9991, the Grenfell Tower Inquiry: Phase 1 report recommends that all high-rise residential buildings, existing and new, are

provided with facilities to allow the fire and rescue service to simultaneously evacuate the building. High-rise buildings are defined as buildings over 18 m in height and hence Cromwell Tower is considered a high-rise building.

Existing provisions

The External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018 states that different flats have different levels of fire alarm and detection varying from Grade D Category LD2 to having no means of providing detection and alarm.

During the site visit it was confirmed that the flats and common areas are not provided with a fire detection and alarm system. The storage and plant areas in L02 and L03, lift shafts and the upper floor plant rooms (L40 ventilation plant, L41 lift machine room) are provided with Category LD3 detection and alarm system.

In the case of privately owned flats, it is the responsibility of the owners to install an alarm and detection system. It should be noted that this is only a recommendation by BE as the freeholder, and not compulsory. BE has no record of the flats that are equipped with such system within the flats.

Proposed improvements

A Grade D1 Category LD1 system in line with BS 5839-6 is recommended for all the flats and in the lift lobbies in Cromwell Tower, due to the following reasons:

- An improvement to the flats with extended travel distances due to the lack of an internal hallway within the flat. The system provides an early warning to occupants so that they quickly evacuate from their flat.
- An improvement to evacuation of PRMs, with a single means of escape and requiring assistance to evacuate to the place of ultimate safety.
- Due to the potential risk of fire/smoke spread via the kitchen extract shunt duct arrangement (see Section 4.3.6), the detection and alarm system provides improvement by providing early warning in case of breach of compartmentation.
- BS 5839-6 gives recommendations to the new and existing premises separately. There are specific systems identified for existing premises which shows the importance of providing adequate fire detection and alarm system for existing buildings and not just for new builds.
- Provision of detection system in the lift lobby will allow activation of automatic ventilation systems within the lift lobby to allow PRMs to wait in without smoke logging in the lift lobby.

Recommendations:

- Provide a Grade D1 Category LD1 system in line with BS 5839-6 is recommended for all the flats in Cromwell Tower
- Provide detection in the lifts lobbies to automatically active the ventilation systems within the lift lobbies.

- The facility to simultaneously evacuate the Tower should be considered in conjunction with the recommendations above, as the additional infrastructure or cost to implement such facility may be minimal.

4.1.10 Fire suppression

Based on BS 9991, sprinkler protection is required for buildings with a floor higher than 30 m above ground level. However, the recent revision of ADB Volume 1: 2020 amendment states that the threshold building height (for residential buildings) for the provision of sprinklers has been reduced from 30 m to 11 m.

Existing provisions

Cromwell Tower is not provided with sprinkler protection, with the floor to floor height being 2.7 m, the building height from ground to the topmost occupied storey is 108 m. (drawing number 33 550).

Proposed Improvements

British Standard Code of Practice CP3: Chapter IV (1962) which was the relevant code at the time Cromwell Tower was built (1973) does not require any sprinkler protection to high-rise residential buildings. There is no requirement in the Building Regulations for existing buildings to comply with the current guidance, except where building works have taken place.

Sprinklers were not required at the time of construction.

However, the building adopts a stay-put policy, which relies on maintaining compartmentation between each flat and between the flat and the common areas. From the findings in the External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018, it has been identified that unauthorised structural alterations have been undertaken by/on behalf of the residents in several instances, causing breach in compartmentation between the flats.

In addition, this is a high-rise building with a single stair, extended travel distances within the flat and some of the residents have mobility impairment.

Due to these factors, it is recommended that a sprinkler system is provided.

BE have confirmed that insurers (from their consultation on the 23/07/2021) have no requirement to install sprinklers anywhere within the Barbican Residential.

Recommendations:

- Install sprinklers, as a solution to mitigate multiple risks including compartmentation, single means of egress etc.

4.1.11 Smoke control

BS 9991 recommends one of the following to be provided as a smoke control system for buildings with a floor level over 11 m above ground level served by a single stair:

- AOVs to the exterior of the building with a minimum free area of 1.5 m² fitted in the common corridor or lobby directly adjacent to the stair and an AOV on top storey of the stairway with a minimum free area of 1.0 m² both located as high a level as is practicable;
- A smoke shaft that is fitted in the protected lobby and an AOV that is sited on top storey of the stairway with a minimum free area of 1.0 m² located as high a level as is practicable;
- A mechanical smoke ventilation system that is fitted in the protected lobby directly adjacent to the stair enclosure, and an AOV that is sited on top storey of the stairway with a minimum free area of 1.0 m² located as high a level as is practicable;
- A pressure differential system.

Existing provisions

Cromwell Tower comprises of two lobbies between the flats and the firefighting stair. The lift lobby which is open to flats and a small lobby between the lift lobby and the firefighting stair. The current smoke control system in each lobby is as follows:

- Lift lobby (approximate area of 34 m²):
 - L1 – L6: Two vents with a dimension of 1.95 m x 0.46 m each, within the lift lobby which have openable louvres by winding handles at bottom of both sloped shafts
 - L7 – L39: Two doors with a dimension of 2.34 m x 0.66 m each, to the 1 down stair and 2 down stair (in the same location where the two vents are in the lower floors) opened by striking off heads of cast securing bolts.
- Small lobby (approximate area of 1.6 m²): BE confirmed there is an electrical riser/ventilation shaft adjacent to the small lobby and connected by louvres (approximate area of 0.76 m²) as shown in Figure 12 below.
- Electrical riser: There is a concrete floor on each level of the riser from L37 and below. Fire stopping around cables penetrating the concrete floor appear to be missing. Above L37, the electrical riser is connected to the ventilation shaft, which is opened to the small lobby.



Figure 12: Louvre connecting the small lobby and the electrical riser

The current arrangement of small lobby, firefighting stair, ventilation shaft and electrical riser is as shown in Figure 13.

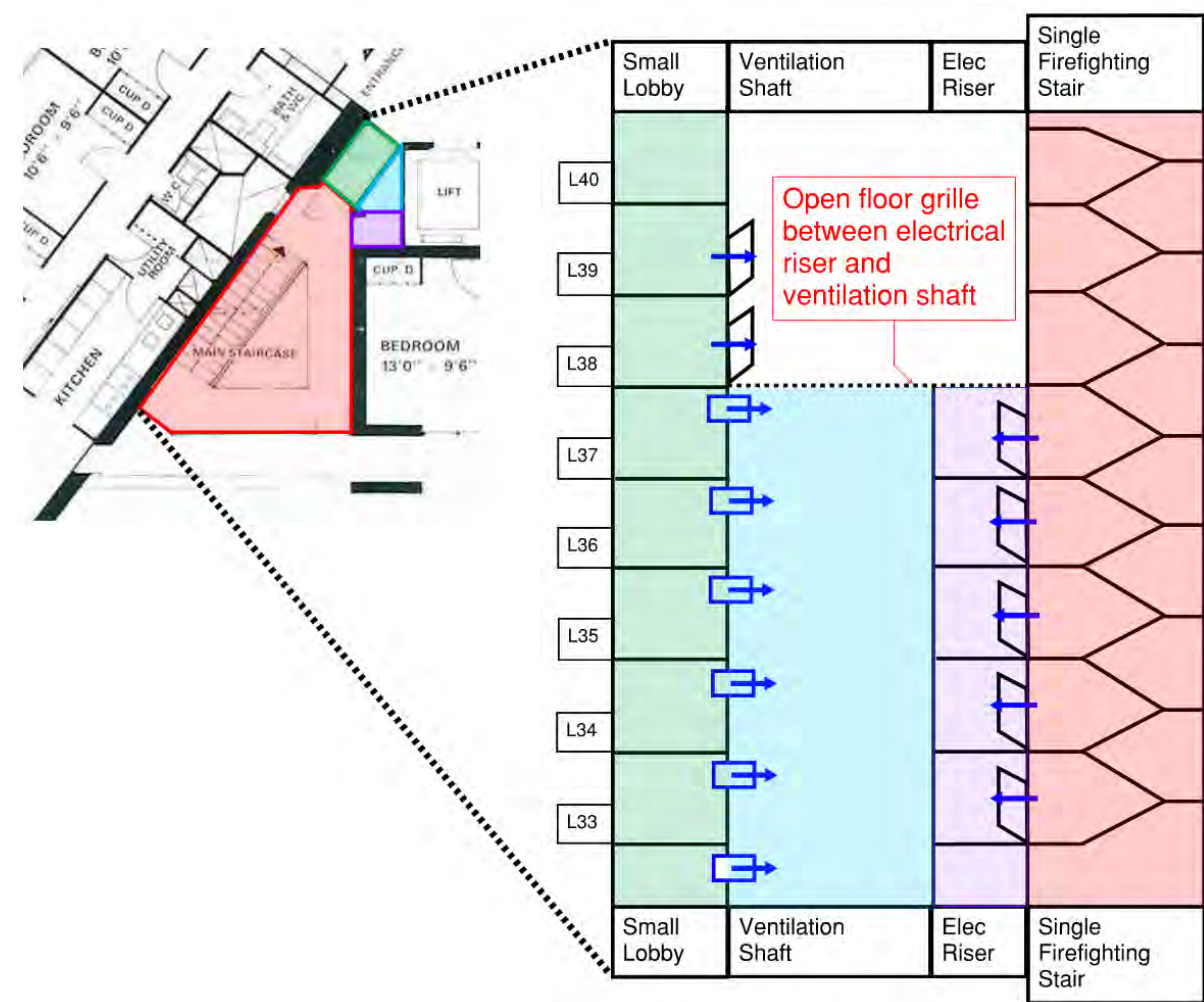


Figure 13: Current arrangement of small lobby, ventilation shaft, electrical riser and firefighting stair

As shown Figure 13, the small lobby is connected to the ventilation shaft on each floor, which is connected to the electrical riser on L37 and above. This is a risk as a fire in the electrical riser could result in smoke spread to the small lobby and the single stair. This will affect the availability of the stair for means of escape and firefighting access.

Proposed Improvements

In order to ensure the escape route is protected from risk of smoke and fire spread from other areas, the following is recommended:

- Provide fire separation between the small lobby and the ventilation shaft (removing all the vents) and remove the fire door between the small lobby and the lift lobby on L37 and above, or
- Provide a fire and smoke damper at each vent to maintain fire separation and to only vent the floor of fire incident. Also provide a wall to separate the smoke shaft and the electrical riser from L38 and above.

Recommendations:

- Provide fire separation between the small lobby and the ventilation shaft (removing all the vents) and remove the fire door between the small lobby and the lift lobby on L37 and above, or
- Provide a fire and smoke damper at each vent to maintain fire separation and to only vent the floor of fire incident. Also provide a wall to separate the smoke shaft and the electrical riser from L38 and above.

4.1.12 Refuse storage cupboard and post box

BS 9991 recommends refuse rooms provided for the storage of refuse should be separated from other parts of the building and should not be located within or accessed directly from the lift lobby. Rooms provided for the storage of refuse should be approached only by way of a protected lobby having not less than 0.2 m² of permanent ventilation or a suitable mechanical alternative.

There is no recommendation in BS 9991 for post box. Considering the fire load content such as parcels, even though not to the same scale as refuse, it is recommended to not locate the post box within the lift lobby.

Existing provisions

Every flat in Cromwell Tower is provided with a refuse storage cupboard and a post box adjacent to the flat entrance door, for the use of the flat occupants only. The refuse storage and post box are accessible from both the lift lobby outside the flat and within the flat for Wing A and C, and only accessible from the lift lobby outside for Type B. BE confirmed the material build-up of the cupboards are mostly wood with asbestos backing as shown in Figure 14.

There is no ventilated lobby provided and no other mitigation measures provided in Cromwell Tower for refuse storage areas.

Proposed Improvements

The current arrangement does not comply with the recommendations of BS 9991. Refuse storage is considered a high fire hazard area and the location within the lift lobby poses a risk to the occupants. A fire involving the refuse can cause fire and smoke to affect the use of the lift lobby and compromise the stay-put strategy. As the lift lobby is not ventilated, smoke may spread into the small lobby and then the stair, affecting the single means of escape from the building. It is therefore recommended for the door separating the refuse storage and post box from the lift lobby to be fire rated door.

As a recommendation to this non-compliance, the doors to the refuse storage from the lift lobby should be fire rated to 60 minutes with smoke seals. Although this does not fully meet the current recommendations of BS 9991, this is considered an improvement to the current arrangement. The recommended additional detection and alarm system in each flat will serve to provide early warning in the event of a fire in the flat. The new fire rated door separating the refuse storage and post box from the lift lobby will serve to limit fire and smoke spread, maintaining the use of the lift lobby for means of escape and protected refuge area.



Figure 14: Refuse storage cupboards in the lift lobby

Recommendations:

- The fire doors to refuse storage and post box cupboard should be inspected and reviewed. If not able to provide fire separation, it is recommended for new fire doors (FD60S) to be provided.

4.1.13 L02 – L03 Storage/ plant area

BS 9991 states no storeroom should open directly to a stair. Instead, there should be a ventilated lobby between the storeroom and the stair.

BS 9999 states storage areas greater than 1 m² in area but not greater than 450 m² (other than refuse storage areas) need to be separated from other parts of the building with a minimum standard of fire resistance of 30 minutes.

Existing provisions

There are storage and plant areas on L02 and L03 of Cromwell Tower, they are located below the footprint the flats in the residential levels. Each of the large storerooms is provided with a corridor which provides access to smaller storage rooms which are also further subdivided into smaller rooms/cupboards which are designated to each of the flats. There is fire separation between the storage/plant rooms and the corridors serving the rooms. The corridors lead to the internal open

stair and are separated by fire shutters which activate via a fusible link. [Note: the internal open stair is not the only egress route for L02 and L03 and there is an additional stair on the opposite end of the storage areas].

There are three additional escape stairs (stair width of 750 mm) at the end of each of the storage corridors which all directly discharge to outside on Street Level (L01).

There is exit signage and Category LD3 automatic detection and alarms within the storage areas. It has been confirmed by BE that there is no emergency lighting within the storage levels.

Both L02 and L03 is connected to the car park space which are separated by fire shutters.

In L03, the area is shared between storage areas and plant rooms. One of the plant rooms in L03 is connected to the L04 Subway level via a fixed ladder.

Proposed Improvements

Refer to Section 4.1.8 for recommendation on emergency lighting.

4.1.14 Back-up power supplies

BS 9991 states life safety systems are to be provided with a secondary power supply. The primary power source should generally be taken from the public electricity supply, with secondary power being supplied from an alternative utility supply from another substation, a generator or uninterruptable power supply (UPS) or batteries.

Where practicable, power supplies should be provided via two separate intakes into the building from the same external substation or via a single intake and a standby generator.

Existing provisions

Cromwell Tower is provided with a number of life safety systems including emergency lighting, firefighting stair ventilation and firefighting lifts. Secondary power supply to the life safety systems is provided and have been identified by BE as follows:

- Emergency lighting – UPS and generator (in good working order)
- Firefighting lifts – generator (in good working order)
- Emergency exit signage – currently, the exit signage is unlit in Cromwell Tower

Proposed improvements

Refer to Section 4.5.3.3 for recommendation on firefighting lifts.

Recommendations:

- The secondary power supply systems are to be maintained in good operation condition and in accordance with the relevant standards. It is recommended for BE to establish the compliance of the secondary power supply provisions against the relevant standards.

4.2 Internal fire spread (linings)

BS 9991 recommends the following for wall and ceiling linings:

- Circulation spaces / common corridors – Class 0 in line with BS 476-7 (national class) or Class B-s3, d2 or better in line with BS EN 13501-1 (European class);
- Within apartments – Class 1 in line with BS 476-7 (national class) or Class C-s3, d2 or better in line with BS EN 13501-1 (European class).

Existing provisions

There is no information on the wall and ceiling linings across the common areas of Cromwell Tower as well as within the flats. Based on the site visit, the walls appear to be concrete for the common areas including the firefighting stair and the 1 down stair and 2 down stair and have been confirmed by BE.

As concrete finish is expected to achieve Class A1, it meets the recommendations of BS 9991. However, this is based on the assumption that wall and ceiling linings are concrete finishes throughout all areas of the building. If there are areas within the building where the above requirements are not likely to be achieved, they will need to be discussed and addressed separately.

4.3 Internal fire spread (structure)

4.3.1 Structural fire resistance

Under the BS 9991 guidance, buildings over 30 m in height needs to be provided with sprinkler protection as well as 120 minutes fire resisting construction for load bearing capacity. Elements of structure supporting the firefighting shafts are required to achieve 120 minutes.

Elements of structure are required to achieve a loadbearing capacity (R) only, however when certain elements also act as separating elements (i.e. walls) integrity (E) and insulation (I) are also required.

Existing provisions

Information on the existing building structure is based on the structural drawings in the Arup Archive. It has been assumed that all elements (i.e. walls, slabs, etc.) shown in the structure drawings are elements of structure and therefore loadbearing.

Based on the structural drawings (drawing numbers 33 F9 & 33 F12) the following information on structural elements was obtained:

- Wall separating flats from the lift lobby: 305 mm
- Walls separating flats from firefighting stair: 305 mm
- Walls separating flats from 1 down stair and 2 down stair: 305 mm
- Floor slab thickness (excludes balcony slabs): 178 mm

The wall and slab thickness varies from one location in the building to another; the above dimensions represent the smallest (and therefore most conservative) of those

observed from the drawings reviewed. The above dimensions have not been verified through site inspections.

The following guidance documents have been used to assess the potential fire rating offered by the dimensions of the walls and slabs:

- BS EN 1992-1-2-2004: Eurocode 2 Design of Concrete Structure Part 1-2: General rules – Structural fire design (Eurocode 2), which is the current guidance; and
- CP 114:1957 British Code of Practice, The Structural Use of Reinforced Concrete in Buildings, which is the relevant code at the time of construction.

In assessing the potential fire rating, the following assumptions are made:

- The thickness of structural elements stated above apply throughout the building;
- All structural elements are reinforced concrete;
- The concrete covers over the reinforcement bars meet the values stated in the relevant guidance at the time of construction (CP 114); there is no information on the depth of the existing concrete covers for this aspect to be assessed;
- Floor slabs are simply supported one-way slabs throughout the building;
- No structural calculations are available and therefore the utilisation factor of the structural members is unknown. When checking against the requirements of Eurocode 2 a utilisation factor of 0.7 has been taken as conservatism;
- The fire resistance requirements given in CP 114 cover loadbearing capacity, integrity and insulations;
- Structural drawings for all levels of Cromwell Tower are not available and only L36 and L39 structural drawings and section drawings were used as referenced in Table 2.

The table below compares the existing dimensions of the structural elements with the requirements from the two guidance documents.

Table 3: Summary of structural element thickness against code requirements

Existing structural element	Existing element thickness	Eurocode 2 requirements	CP 114 requirements	BS 9991 requirements	Comments
1 down stair and 2 down stair wall	305 mm	140 mm (REI 60) 220 REI120	70.6 mm (REI 60) 101.6 REI120	R 120	Achieving both the Eurocode 2 and CP 114 for REI 60 rating
Walls between flats	305 mm	140 mm (REI 60)	70.6 mm (REI 60)	R 60	Achieving both the Eurocode 2 and CP 114 for REI 60 rating

Existing structural element	Existing element thickness	Eurocode 2 requirements	CP 114 requirements	BS 9991 requirements	Comments
Firefighting shaft wall	305 mm	160 mm (REI 120)	101.6 mm (REI 120)	R 120	Achieving both the Eurocode 2 and CP 114 for REI 120 rating
Floor slab	178 mm	120 mm (REI 120)	127 mm (REI 120)	R 120	Achieving both the Eurocode 2 and CP 114 for REI 120 rating
Lift riser wall	200 mm	160 mm (REI 120)	101.6 mm (REI 120)	R 120	Achieving both the Eurocode 2 and CP 114 for REI 120 rating

The thickness of the structural elements to meet the required fire ratings appear to meet both the current guidance and the relevant guidance at the time of construction.

4.3.2 Fire compartmentation

Fire compartmentation is required to limit fire spread within the same building and protect means of escape. BS 9991 recommends the following fire ratings:

- Compartment walls between flats: 60 REI
- Compartment floor:120 REI;
- Passenger lift shaft: 120 REI;
- Firefighting shafts:120 REI;
- Any risers penetrating compartment floors: 120 REI;
- Fire stopping – same level of fire resistance as the compartment wall it passes.

Note: Load bearing capacity (R) only required for load bearing elements.

Existing provisions

There is currently no drawing or information available on the material of the riser construction in Cromwell Tower (kitchen risers, bathroom risers). BE confirmed there are mixture of concrete and asbestos panels that form riser walls and that there is no additional information available on the risers within the lift lobbies and the firefighting stair.

Based on the External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018, it has been identified that unauthorised structural alterations have been undertaken by/on behalf of the residents in several instances. This has resulted in compromised standards of compartmentation

between individual flats and the communal risers. This has been confirmed by BE during the site visit.

Recommendations:

- BE to carry out a building wide survey to inspect breach in compartmentation, and to undertake works to maintain compartmentation to the areas in accordance with BS 9991.

4.3.3 Fire doors

BS 9991 recommends the specification, installation and maintenance of hinged or pivoted pedestrian fire doors to be based on BS 8214. This standard recommends fire rating of doors to be tested in accordance with either BS 476-22 or BS EN 1634-1.

The following fire rating requirements are based on Table 12 of BS 9991:

- Fire door separating firefighting stair and firefighting lobby: FD30S;
- Passenger/firefighting lift landing door: FD30S;
- Fire door separating a flat from a space in common use; FD60S*;
- Enclosing a protected shaft forming a lift well or service shaft: FD60S.

*Note: BS 9991 requires that the fire door separating a flat from a space for common use is to be FD30S. In the case of Cromwell Tower, this has been upgraded to FD60S to enhance protection of the lift lobby to create a safe refuge for PRMs.

In addition, the Grenfell Tower Inquiry: Phase 1 – report recommends that all residential building containing separate dwellings (whether or not they are high-rise buildings) to:

- Carry out an urgent inspection of all fire doors to ensure they comply with applicable legislative standards; and
- To be required by law to carry out checks at not less than three-monthly intervals to ensure that all fire doors are fitted with effective self-closing devices in working order.

Existing provisions

There is currently no information on the existing doors for Cromwell Tower. However, based on the information provided on the document 'The fire resistance performance of a single leaf single acting door set with side screen and over panel, when tested in accordance with BS 476: Part 20/22: 1987' issued by Exova Warringtonfire on 02/06/2018, the fire doors in Shakespeare Tower have not satisfied the requirements for 30 minutes (EI30) class door.

Although the test was not carried out specifically for the fire doors in Cromwell Tower, it is assumed that Shakespeare Tower and Cromwell Tower have identical fire doors as they are part of the Barbican Residential Development as agreed by BE.

There are currently multiple doors connecting different risers onto either the lift lobby or the firefighting stair as shown in Figure 16. There is no information on the fire

rating of the doors to the risers within the lift lobbies and firefighting stairs. During the site visit, it was noted by Andrew Woods (CoL District Surveyor) that some risers have compartmentation issues as a result of the asbestos firestopping having been removed and not replaced and is therefore a fire risk.

During the site visit, the following issues were observed:

- The doors to the risers within the lift lobby and firefighting stairs were not labelled 'fire door' nor they appeared to be provided with smoke seals;
- It was unclear if the doors were being maintained to provide fire separation between the riser and the lobby/firefighting stair as shown in Figure 15.

As Cromwell tower is provided with a single stair, it is recommended to ensure adequate compartmentation is provided to the stair. This is to ensure occupants can evacuate via the stair as well as fire service to use the stairs to enter the building.



Figure 15: Risers within the lift lobbies

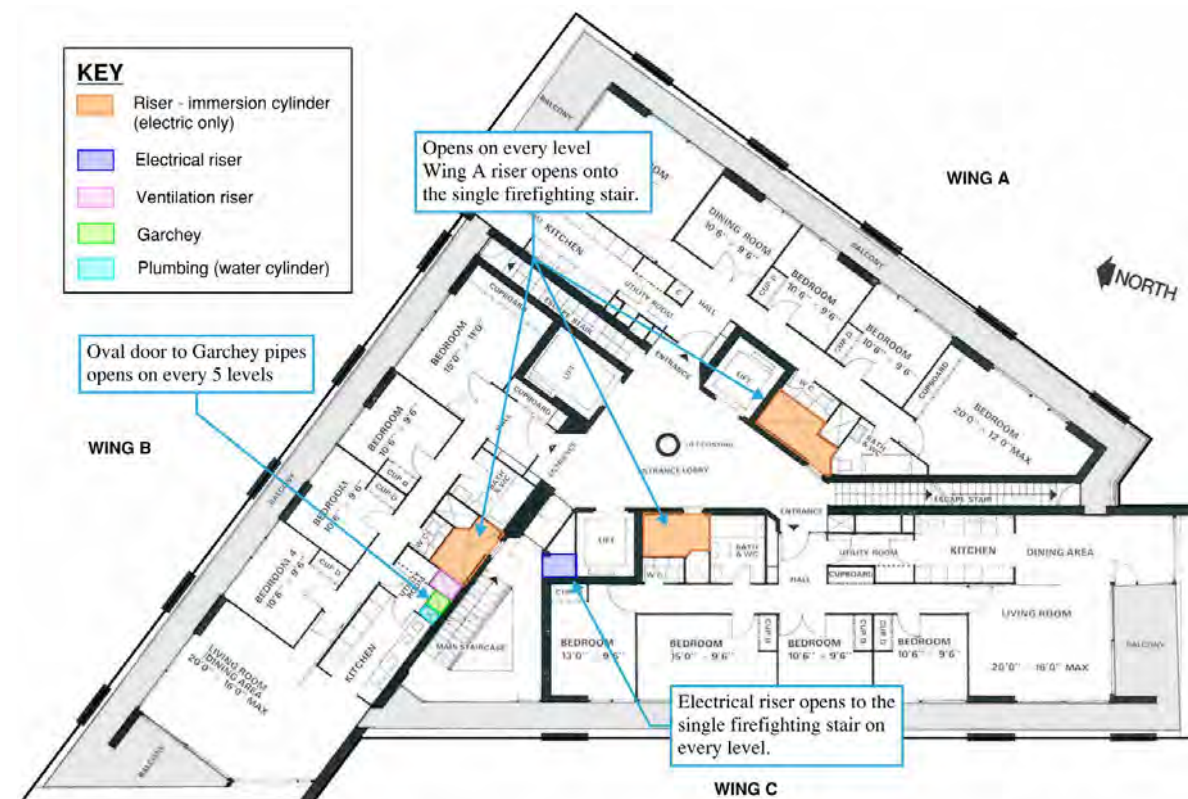


Figure 16: Risers opening onto the firefighting stair and lift lobby

Recommendations:

- It is recommended to replace all the fire doors to the stair, small lobby, flat entrances and the refuse storage/post box.
- Doors to all the risers to be inspected and repaired/replaced to maintain fire separation from the stair or lift lobbies.
- Keep records of inspection and testing of fire doors in the future, at not less than three monthly intervals to ensure that all fire doors are in working order.

4.3.4 Cavity barriers

Clause 33.1. of BS 9999 recommends that cavity barriers should be provided to close the edges of cavities, including around openings. Cavity barriers should be provided at the junction between an external cavity wall and every compartment floor and compartment wall. It also needs to be provided at the junction between an internal cavity wall and every compartment floor, compartment wall or other wall or door assembly which forms a fire resisting barrier.

Existing provisions

BE have confirmed that there are no cavity barriers in Cromwell Tower due to the build-up of the walls not having any cavities (identical to Andrewes House).

There is no information on any other cavities across Cromwell Tower. **BE to advise.**

4.3.5 Fire stopping

BS 9991 (Clause 24.4 and Figure 24) recommends where a building service passes through a compartment wall or floor it shall be adequately fire stopped in line with the compartment fire resistance.

Existing provisions

There is currently no information on the provision of fire stopping for Cromwell Tower. Based on the External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018, fire stopping registers are not in place.

Recommendations:

- BE to carry out a sitewide inspection of fire stopping and undertake fixing of the fire stopping to ensure fire compartmentation is maintained.

4.3.6 Kitchen and toilet shunt duct risers

In accordance with BS 9991, vertical ventilation ducts should be enclosed throughout their height with fire resisting construction. Where a horizontal ventilation duct penetrates the fire resisting construction, BS 9999 recommends four different methods of maintaining the fire separation at the penetration:

- Method 1: thermally actuated fire dampers;
- Method 2: fire resisting enclosures e.g. fire rated plasterboards;
- Method 3: protection using fire-resisting ductwork;
- Method 4: automatically actuated fire and smoke dampers triggered by smoke detectors.

BS 9999 Section 32.5.2.2 also states that Methods 1 and 4 should not be used for extract ductwork servicing kitchens and this is due to the likely build-up of grease within the duct which can adversely affect the effectiveness of any dampers.

In the Barbican Residential Development, it is understood that a common approach to maintain fire separation between flats is to use shunt duct arrangement for the kitchen and toilet extract ventilation ducts. The purpose of shunt duct is to avoid the need for fire protection using the Methods described above. A shunt duct arrangement comprises of branch ductwork ('s' or inverted 's' shaped) that are connected to the main extract ductwork as shown as Figure 17. In addition to the downward bend of the shunt duct, a fan at the top of the main extract ductwork maintains a negative pressure that stops smoke from spreading out of the ductwork.

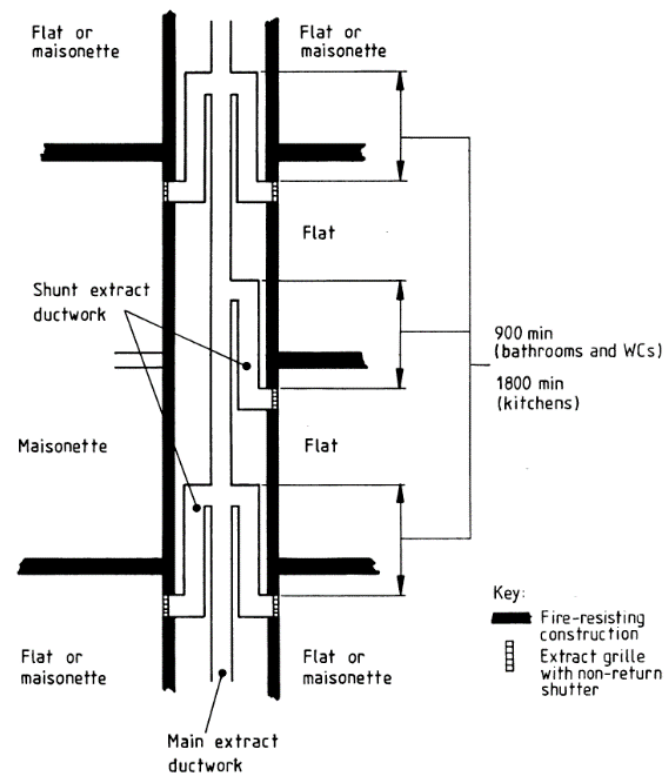


Figure 17: Layout of shunt duct system (BS 5588 Part 9)

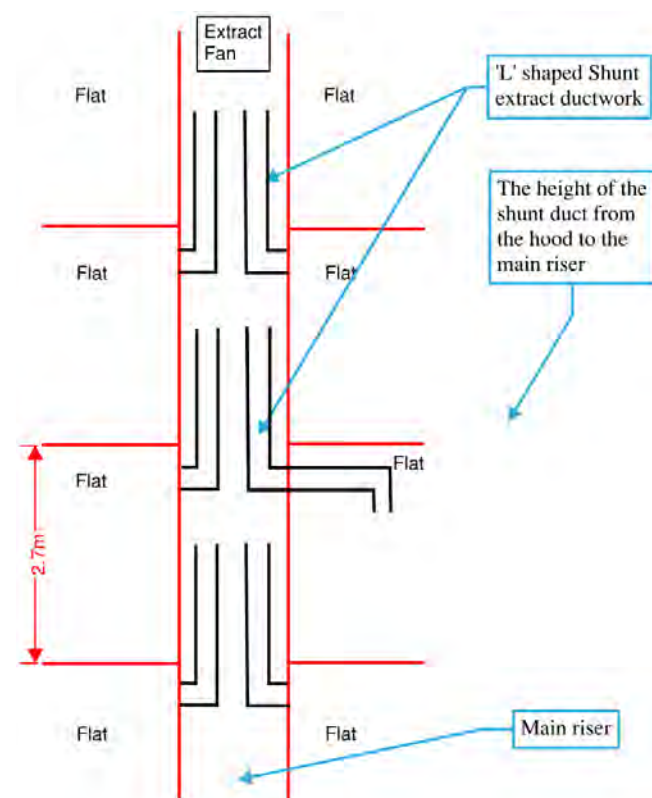


Figure 18: Existing layout of shunt duct system in Cromwell Tower

Shunt duct arrangement is a recognised approach in BS 5588-9:1999 – *Fire precautions in the design, construction and use of buildings Part 9: Code of practice for ventilation and air conditioning ductwork*, for extract ductworks serving toilets. However, it is not normally acceptable for use in kitchen extraction because of the fire risk inherent in kitchens. The guidance mentioned that if shunt duct is used for kitchen extraction, careful consideration should be given to possible pressure differentials within the system to avoid the transfer of smoke and other products of combustion from one dwelling to another by means of the ductwork system. This guidance has been withdrawn and is no longer referenced in other current standards including the Approved Document B.

Existing provisions

BE confirmed during the site visit that Cromwell Tower uses shunt ducts for both kitchen and bathrooms each provided with a separate main extract ductwork.

BE confirmed the shunt ducts in Cromwell Tower have the same arrangement and material as Andrewes House. However, the dimensions of the shunt ducts are currently unknown.

In Cromwell Tower, it is understood that the main kitchen extract riser and the shunt ducts are of concrete construction. Dimensions of the concrete construction are unknown, but likely to have some inherent fire rating. The kitchen extract riser is located within the kitchen and serves all the flats on the same vertical stack. The extract fan is located at the top of the main riser and on continuous operation (BE confirmed the capacity of the current fans are 10 cbm/s). BE also confirmed that the shunt ducts are 'L' shaped as shown in Figure 18 instead of the more common 'S' shaped as shown in Figure 17. The frequency of maintenance and cleaning, and the internal grease builds up within the vertical portion of the shunt ducts and within the main extract risers are unknown.

The toilet extract riser is located within the toilet of each flat and serves all the flats on the same vertical stack. The side backing on to the toilet wall contains asbestos and the rest of the walls are concrete.

Proposed Improvements

Whilst the use of shunt duct in lieu of other forms of fire protection is no longer in line with current UK guidance, their use for toilet extract risers is still allowed in other countries (Australia – AS 1688.1; USA – International Building Code). Considering the low risk nature of toilets and provided that the installations are in line with the details of the guidance, the use of shunt duct for toilet extract riser is considered acceptable provided improvement is made to increase the reliability on the extract fan.

However, it is not recommended to use shunt duct for kitchen extract riser. The presence of grease in the duct may affect the effectiveness of the shunt system in maintaining fire and smoke separation. Failure of compartmentation between the flats presents a life safety risk to the occupants, especially as the kitchen extract riser is located opposite the flat entrance, which is the only means of escape for the PRMs and flats below the Podium level.

Provision of fire detection and alarm system is one of the improvements, providing early warning before the single escape route via the flat entrance is compromised. In addition, the risk of fire spread via the shunt duct can be reduced by replacing the existing extract hoods with recirculation type extract hoods and maintaining the compartmentation between the flats.

BE confirmed that the kitchen shunt duct is also used as a day-to-day ventilation system and an alternative way to ventilate the area will be required if the current kitchen extract is closed off.

Recommendations:

Replace the existing extract hoods with recirculation type hoods, and implemented one of the followings:

- Smoke and fire damper at the shunt duct riser activated by the fire alarm/detectors within the flat (this maintains the use of the riser for normal ventilation of the flat); or
- To block off the shunt ducts and provide a fan on the external wall to draw out air from the flat into the balconies.

Maintain the existing extract hoods and shunt duct arrangement by increasing the reliability of the main extract fan. This will require an additional duty standby fan (the fans to be rated at 400 °C for 90 minutes in accordance with BS EN 13501-4), with secondary power supply. The fans need to be adequately maintained to keep the main riser under negative pressure.

4.4 External fire spread

4.4.1 Fire spread to neighbouring buildings

Buildings must maintain the minimum separation distance from the site boundary to protect itself and adjacent buildings against external fire spread. A building that is located less than the required separation distance from the site boundary will be required to be provided with mitigation measures to prevent fire spread such as fire rated external walls. In accordance with BS 9991, there are four methods used to determine the maximum permissible amount of unprotected façade. In this case, the most appropriate method is the enclosing rectangle in line with BR 187.

Existing arrangement

There is no information available on the location of the site boundary in relation to Cromwell Tower. If there are no site layout available, the building boundaries or the relevant boundaries will be measured using Google Maps as shown in Figure 19 and as follows:

- North: 21 m (to the middle of Beech Street);
- East: 7.2 m (to the middle of Silk Street);
- West: 10.5 m (mid-way between Cromwell Tower and Frobisher Crescent).

An external fire spread calculation has been undertaken for a single flat using the above assumed boundary distances and Figure 19. The enclosing rectangle method

in line with BR 187 was carried out. The results show that no protection is required to the façades. Please refer to Appendix B for the calculation.

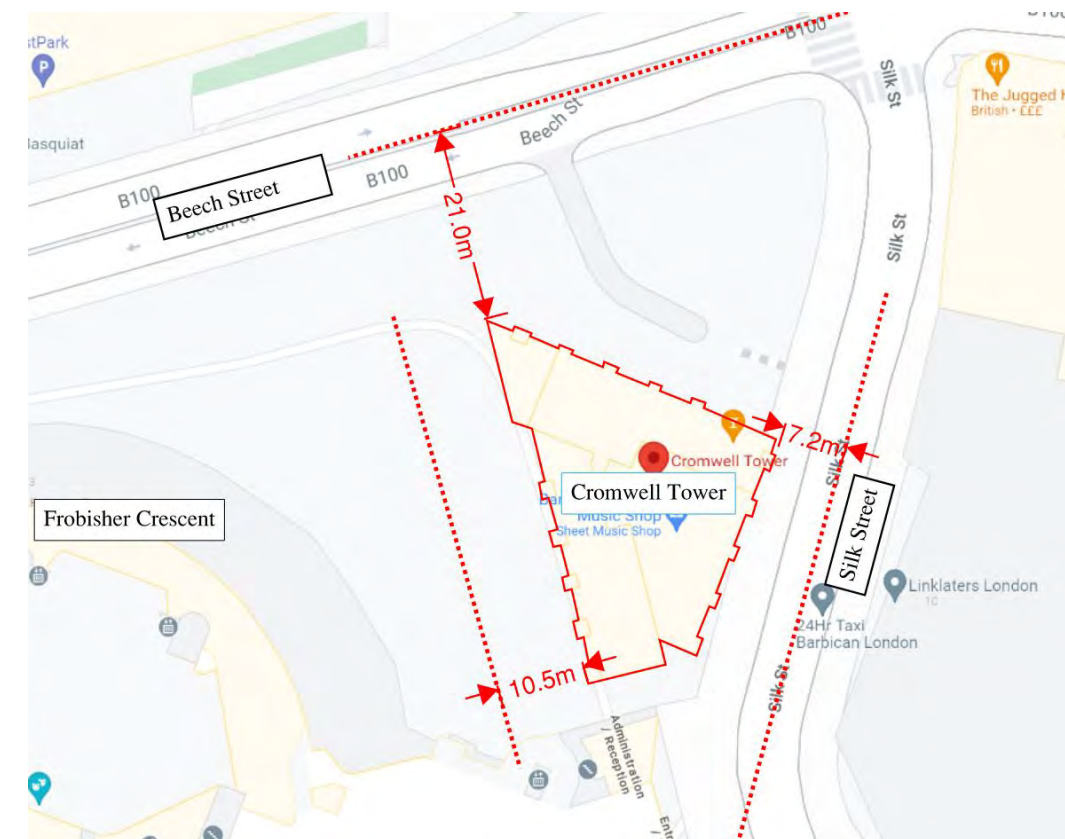


Figure 19: Existing arrangement for Cromwell Tower and adjacent buildings

4.4.2 Façade material

BS 9991 recommends the following material classifications for external areas of the façade of buildings greater than 18 m in height:

- Areas < 1 m from the boundary – Class 0 (National class) or Class B-s3, d2 or better (European class);
- Areas > 1 m from the boundary and > 18 m in height – Class 0 (National class) or Class B-s3, d2 or better (European class).

The Building Regulations also require materials which become part of an external wall (i.e. cladding material, insulation product, filler material – not including gaskets, sealants and similar) and specified attachment (e.g. balcony) of a residential building with a storey at least 18 m above ground level to achieve European classification A2-s1, d0 or Class A1, classified in accordance with BS EN 13501-1:2007+A1:2009 entitled 'Fire classification of construction products and building elements. Classification using the test data from reaction to fire tests'.

In addition, the Grenfell Tower Inquiry: Phase 1 report recommends that the owner and manager of every high-rise residential building be required by law to provide their local fire and rescue service with information about the design of its external walls

together with details of the materials of which they are constructed and to inform the fire and rescue service of any material changes made to them.

Existing provisions

BE confirmed all elevations of Cromwell Tower are provided with solid concrete construction.

The concrete panel is considered to achieve Class A1, and therefore it meets the recommendations of BS 9991.

In the case of balconies, BE confirmed the build-up consists of concrete paving slabs sitting on top of a felt membrane. The felt is a membrane and therefore under Regulation 7(3) of Approval Document B, is exempt from having to meet the requirements for a European Classification of A2-s1, d0 or better.

It is also recommended to provide information about the design of external walls and details of the materials in the Fire notice box for the fire and rescue service to be able to have access to the information when they arrive on site.

Recommendations:

- Include information about the design and materials of the external walls in the Fire Notice Box, to be located by internal open stair landing on Street Level reception area.

4.4.3 Roof materials

BS 9991 recommends buildings where the roof is at least 6 m away from any point on the relevant boundary needs to be provided with a roof covering designation of minimum AD or BD in line with BS 476-3 (equivalent to $E_{\text{roof}}(t_4)$ classification in line with BS EN 13501-5 European classifications)

Existing provisions

The roof of Cromwell Tower consists of either felt with insulation or a liquid membrane as advised by BE. The material specification of the roof material has not been defined. **BE to confirm** to carry out further review on the roof material.

4.5 Access and facilities for the fire service

4.5.1 Fire main inlet

BS 9991 recommends buildings fitted with wet fire mains should have fire appliance access:

- within 18 m of, and within sight of, a suitable entrance giving access to the wet fire main; and;
- within sight of the inlet for the emergency replenishment of the suction tank for the wet fire main.

Existing provisions

Cromwell Tower is provided with one wet riser main with outlets that can be accessed from the following locations:

- Street level (L01) to L39: within the lift lobby and adjacent to the front door of the Type B flats as shown in Figure 20;
- L02 – L03: adjacent to the lift lobby.

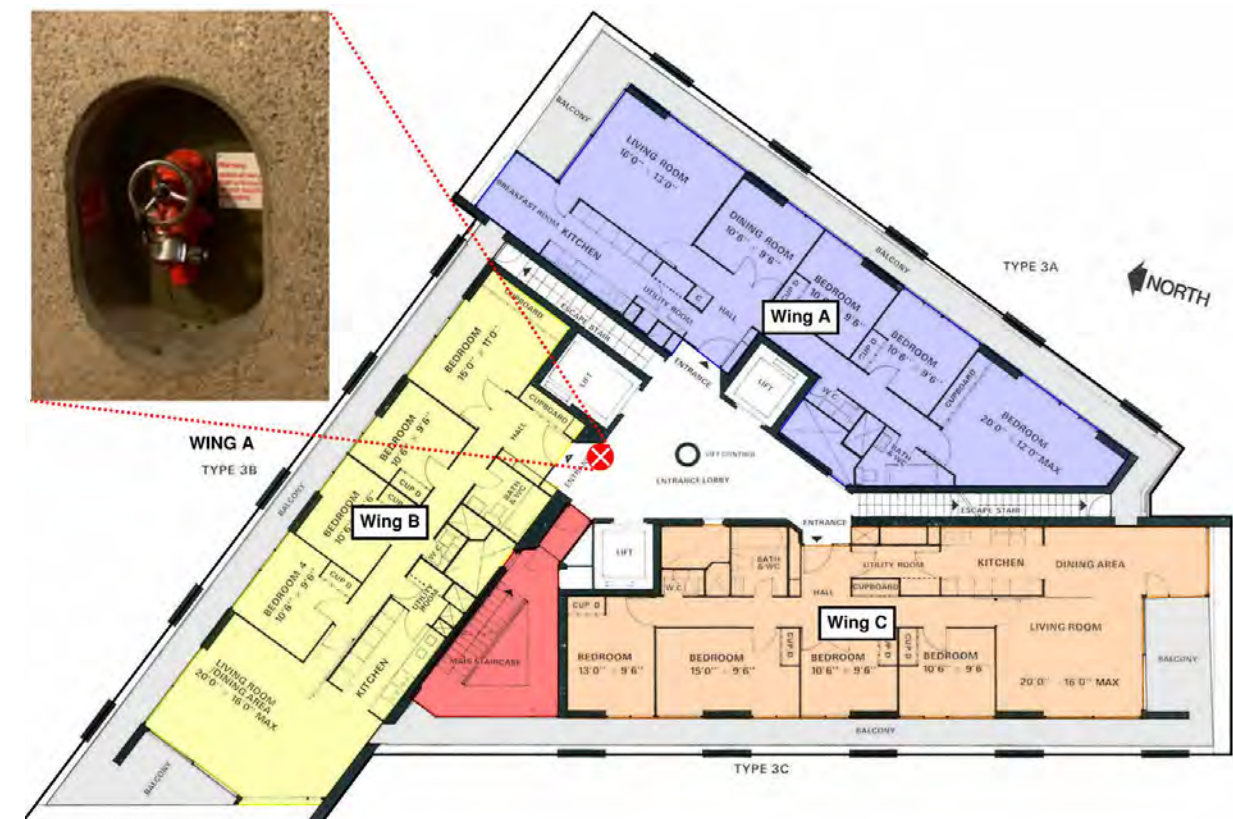


Figure 20: Wet riser outlet within the lift lobby for residential levels

4.5.2 Fire service access

BS 9999 recommends that the distance between the fire vehicle parking location to the firefighting entry point of the building to not exceed 18 m in length. In addition, the entry of the firefighting access shaft at rescue service access (vehicle access level) level should be directly from open air or by way of a protected corridor not exceeding 18 m in length.

Existing arrangement

Firefighting access into the building is directly from the main entrance of Cromwell Tower on Street level (L01) accessed via Beech Street where the firefighting vehicle has space to park in front of Cromwell Tower as shown in Figure 21.

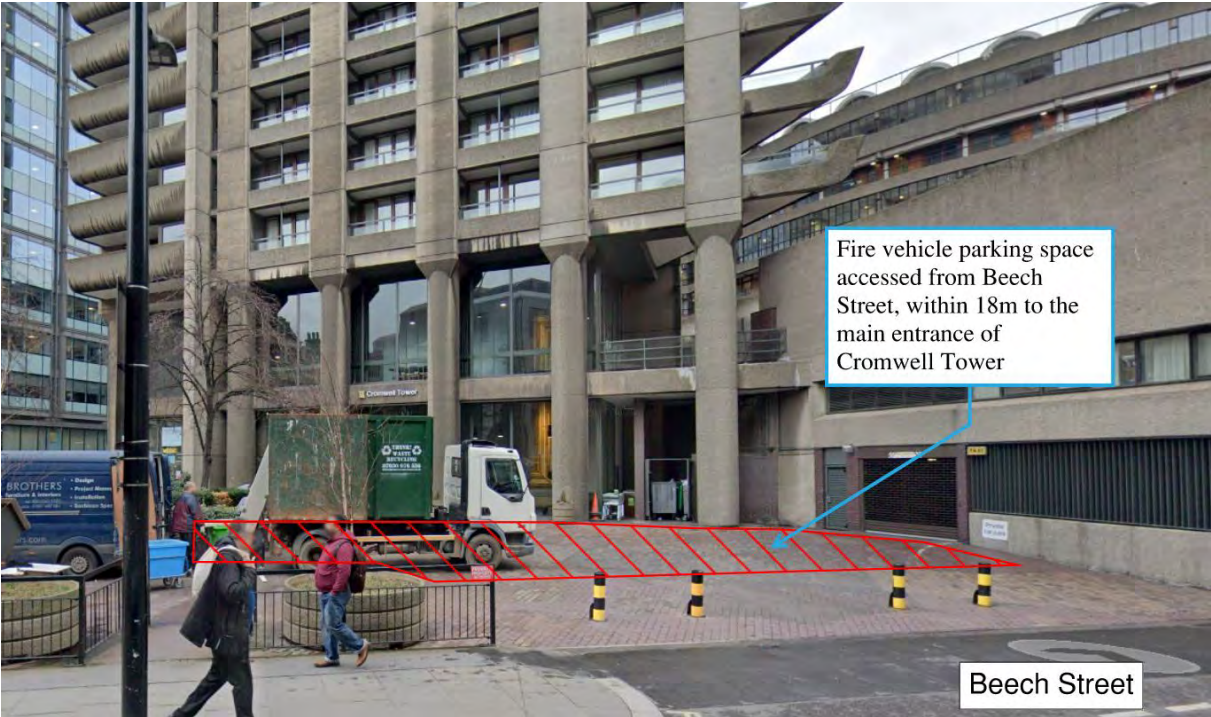


Figure 21: Open area in front of the main entrance to Cromwell Tower

For the firefighting personnel to access the residential levels, they must use the internal open stairs on Street level (L01) to travel to the Podium level (refer to Figure 10 above), then exit the tower in order to enter the firefighting stair of Cromwell Tower (connecting Podium level to Roof level). There is no direct firefighting vehicle access on to the Podium level and the travel distance from the fire service access point to the entrance of the firefighting shaft on Podium level exceeds 18 m. However, this is considered acceptable due to the following:

- The firefighting lift is accessible from Street level (L01) and is within 18 m of the fire vehicle parking location. The lift lobby at ground can be used as a muster point for service before travelling to the floor of fire origin. However, there is no connection between the firefighting stair and the lift lobby on the ground floor;
- Alternatively, firefighters can use the internal open stairs to travel from Street level to access the firefighting stair from the Podium level.

For the firefighting personnel to access the lower storage/plant levels (L02 – L03), they can travel through the internal open stair as shown in Figure 22.

Recommendations:

- Engagement with London Fire Brigade to ensure the access arrangement is clear.



Figure 22: Internal open stair (L03 - Podium level) on Street level

4.5.3 Facilities for the fire service

BS 9991 recommends buildings with a floor higher than 18 m above fire and rescue service access level should be provided with firefighting shaft(s) containing firefighting lifts. A sufficient number of firefighting shafts should be provided to meet the maximum hose distance of 60 m to cover all parts of the building.

Firefighting shafts should be constructed in accordance with the recommendations given in BS 9999.

Cromwell Tower is provided with one firefighting shaft with a firefighting stair, wet riser, firefighting lift and firefighting lobby.

4.5.3.1 Firefighting stairs

BS 9999 recommends a firefighting stair should have an unobstructed width (measured between the walls and / or balustrades) of 1.1 m. the width should be kept clear for a vertical distance of 2.0 m.

BS 9999 also recommends only services associated with the firefighting shaft should pass through or be contained within the firefighting shaft.

Existing provisions

The firefighting stair in Cromwell Tower connects Podium level to Roof level with a width of 1000 mm. From L39, the firefighting stair extends to the Roof level (plant space only) as a helical stair as shown in Figure 23 below.

There are no firefighting stairs in the lower levels (L01 to L03) of Cromwell Tower.

There are risers directly opening onto the firefighting stairs. Refer to recommendations in Section 4.3.3 for management procedures when there are works being done on the riser, refer to Table 4.

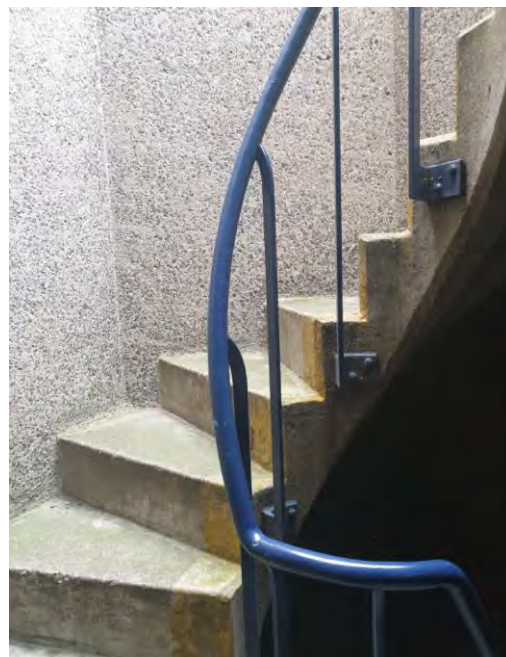


Figure 23: Helical stairs extending from the firefighting stairs to Roof level

Recommendations:

- Engagement with London Fire Brigade to discuss the firefighting access routes and the reduced stair width.

4.5.3.2 Firefighting lobby

BS 9999 recommends firefighting lobby to have a clear floor area of not less than 5 m² and not exceed 20 m² for lobby serving up to four lifts. All principal dimensions should not be less than 1.5 m. The purpose of not allowing large lobby area (exceeding 20m²) is to avoid the lobby being used for storage.

There are risers directly opening onto the lift lobby. Refer to recommendations in Section 4.3.3.

Existing provisions

There are currently two lobbies separating the flats from the firefighting stair. The lift lobby has approximate area of 34.2 m² and the small lobby has an approximate area of 1.6 m².

Although the lift lobbies exceed the recommended protected lobby area of 20 m², it is considered acceptable due to the following reasons:

- During the site visit, it was observed that the lift lobbies (only those inspected during the visit) are generally not used for storage;
- The lift lobby only contains the lift control at its centre with no other furniture;
- The lift lobby connects all flats and lifts and therefore is very frequently used by residents. It is unlikely for residents to store goods in a shared area;

- Adequate management of the area will prevent lobbies from being used for storage.

There are risers directly opening onto the firefighting stairs. Refer to recommendations in Section 4.3.3.

Recommendations:

- Inspection of the lift lobbies should be carried out at regular intervals to prevent residents from using the lift lobby as storage area.

4.5.3.3 Firefighting lifts

In line with BS 9991 and BS 9999, new firefighting lifts installations should be in accordance with BS EN 81-72:2020.

In addition, the Grenfell Tower Inquiry: Phase 1 report recommends that the owner and manager of every high-rise residential building be required by law to carry out:

- Regular inspections of any lifts that are designed to be used by firefighters in an emergency and to report the results of such inspections to their local fire and rescue service at monthly intervals;
- Regular tests of the mechanism which allows firefighters to take control of the lifts and to inform their local fire and rescue service at monthly intervals that they have done so.

Existing provisions

It has been confirmed by the lift consultant via email correspondence on 08/04/2021 that the firefighting lift in Cromwell Tower was installed to BS 5588-5:1986.

During the site visit, it has been confirmed that the lift control system is on Street level (L01), but there is no connection to the stair at this level.

The lift consultant 'Butler & Young' have notified that the lifts are unable to operate correctly under generator power. In the event of a fire and if there is a mains supply failure, the building will not have an effective firefighting lift working on secondary supply.

The lifts can operate on mains power. However, there is an issue with the sequential control which is when the lifts need to ground one at a time upon activation of the secondary power supply. This is due to the age of the equipment as they are no longer fully supported as they have been manufactured and installed by Otis over 20 years ago.

Recommendations:

- The current sequential control system should be upgraded for the lifts to be able to ground upon detection of fire within the lift shafts and also for the firefighting lift to operate under secondary power supply for firefighting purposes.
- Carry out inspections of the firefighting lift at monthly intervals to report the results of every inspection to the local fire and rescues service.

4.5.3.4 Smoke control for firefighting lobby and stair

BS 9991 recommends that all firefighting shafts should be provided with smoke ventilation system – and recommends only natural smoke shafts or mechanical pressure differential systems are suitable for buildings over 30 m in height. For buildings with a floor level over 11 m above ground served by a single stair, the smoke control system should have one of the following:

- AOVs to the exterior of the building with a minimum free area of 1.5 m², fitted in the common corridor or lobby directly adjacent to the stair at as high a level as is practicable, and an AOV that is sited at as high a level as is practicable on the top storey of the stairway, having a minimum free area of 1 m², or
- A smoke shaft fitted in the protected lobby and an AOV that is sited at as high a level as is practicable on the top storey of the stairway, having a minimum free area of 1 m², or
- A pressure differential system.

Existing provisions

The firefighting stair has two louvred doors (approximate total area of louvres are 3.52 m²) on L39 as indicated as Door 1 and Door 2 in Figure 24. It was not possible to determine the free area of the louvre from visual inspection. The firefighting stair leads to an open helical stair to the Roof level.

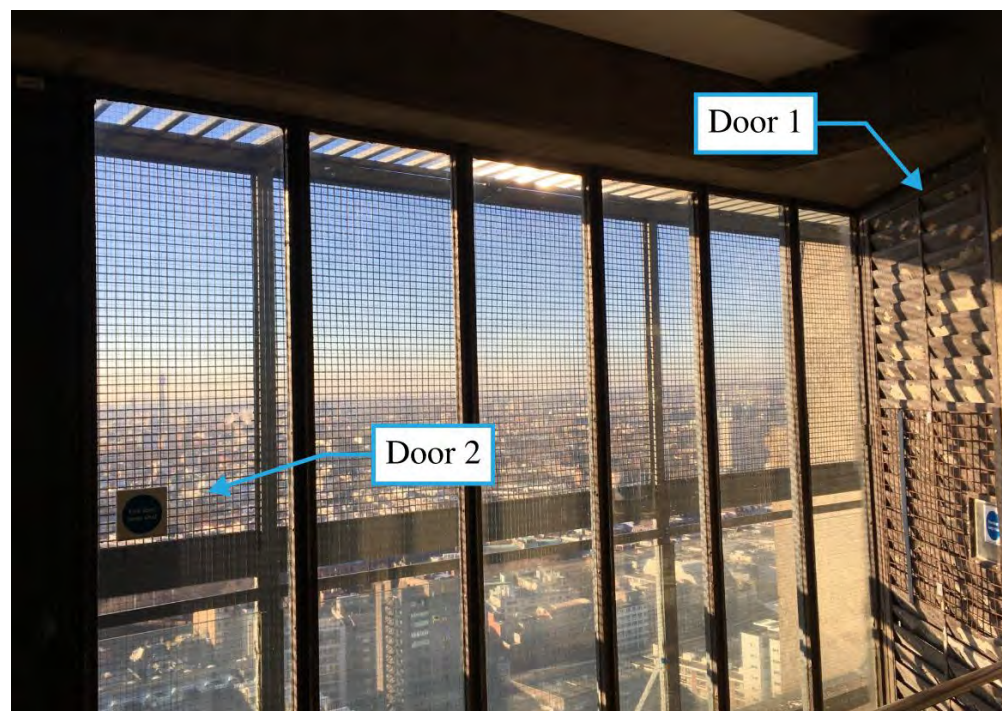


Figure 24: Louvred door at the top of the firefighting stair on L39

The current AOV provided by the louvred door is considered acceptable as fire service can open the door to increase ventilation to the staircase. Opening of the doors will require keys and BE should ensure that the keys are made available upon arrival of the fire service.

There is a permanently open grill at the bottom of the firefighting stair as shown in Figure 25 to provide make up air.



Figure 25: Permanent opening at the bottom of the firefighting stair at Podium Level

There is no ventilation available in the small lobby and the lift lobby is provided with manually openable vents in all levels that can be opened by firefighters upon arrival.

The lift lobby is provided with manually openable ventilation by either of the following:

- L1 – L6: There are two vents (1.95 x 0.46 m = 0.90 m² each) - in the same location where the 1 down stair and 2 down stair are located in the upper floors,

within the lift lobby which have openable louvres by winding handles at bottom of both sloped shafts;

- L7 – L39: There are 1 down stair and 2 down stair doors ($2.34 \times 0.66 \text{ m} = 1.54 \text{ m}^2$ each) - which open to the flat balconies, that can be opened by striking off heads of cast securing bolts.

The existing vents meet the minimum required free area of 1.5 m^2 (area of 1.8 m^2 for L1 – L6 and 3.08 m^2 for L7 – L39). However, these vents are only manually operated vents and can only be operated upon arrival of firefighters.

Recommendations:

- Engagement with London Fire Brigade to ensure their familiarity with the ventilation arrangement to the firefighting lobby.
- Include a notice to open the ventilation louvres on L1-L06 and to open the 1 down stair and 2 down stair doors L7-L39 in the Fire Notice Box.

4.5.4 Wet riser and hose coverage

BS 9991 recommends buildings greater than 50 m in height should be provided with a wet riser system. In the case of unsprinklered building, no part of a storey should be more than 45 m from a riser outlet located in the firefighting shaft.

Existing provisions

There is a wet riser outlet located within the lift lobby as shown in Figure 26 from Street level (L01) to L39. For L02 – L03, the outlet is located adjacent to the lift lobby within the internal open stair landing. All areas of the tower are within 45 m limit of hose coverage.

BE confirmed the building is provided with 2 x 10,000-gallon cross linked tanks on L03.

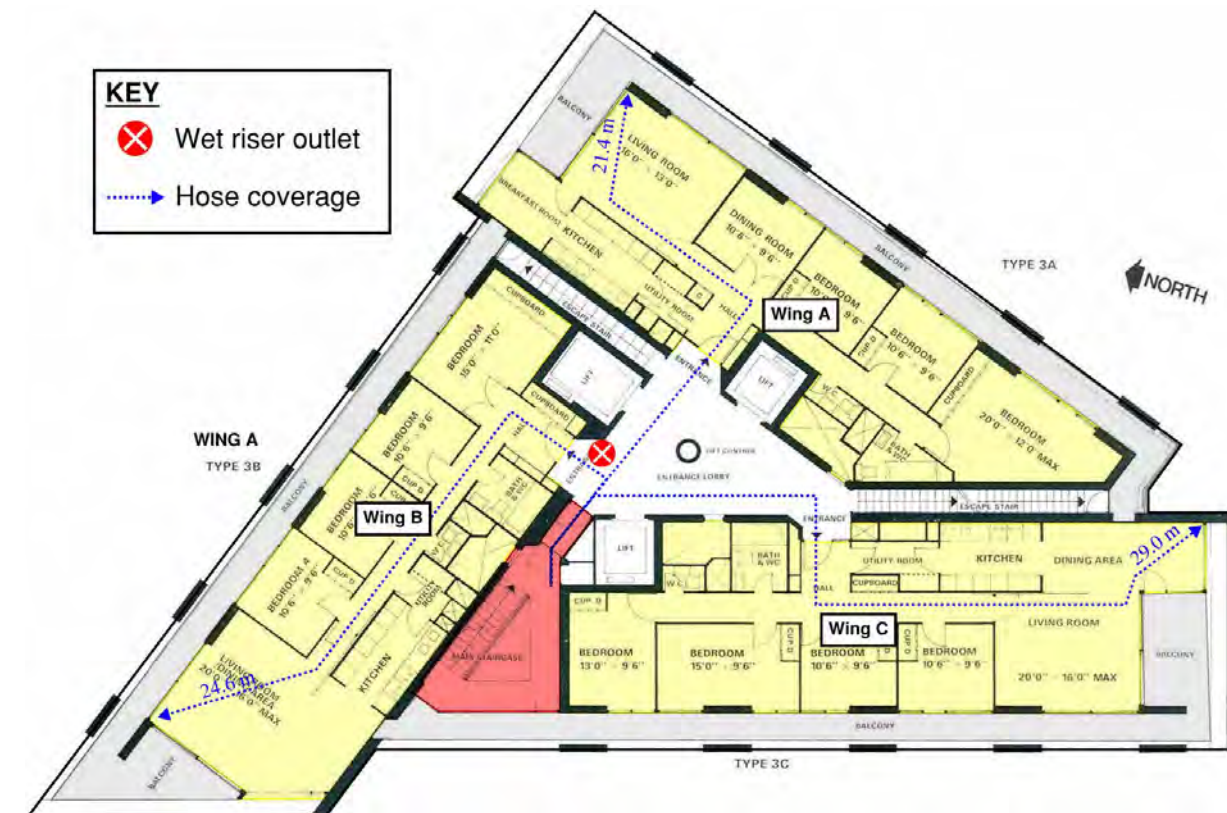


Figure 26: Hose coverage in Cromwell Tower

4.5.5 Water supply for firefighting operations

The location of an external hydrant is to be confirmed by BE.

4.6 Fire safety management

In addition to the active and passive fire safety precautions described in the previous sections, robust fire safety management plan and procedures are important for maintaining the fire safety of a building in a holistic manner. In preparing a fire safety management plan (Arup is not aware of an existing plan), the relevant items to be included in the plan are listed and described in Table 4 below. These are based on the recommendations in BS 9991.

Table 4: Fire safety management

Item	Proposed Design
RR(FS)O	<p>Under the Regulatory Reform (Fire Safety) Order legislation, the owner of the building (BE) is fully responsible for fire safety. This includes on-going fire risk assessment, appropriate maintenance of fire safety systems and training of staff.</p> <p>Although not required by fire safety guidance, it is recommended for the fire risk assessment to include the internal areas of the apartments (for example a spot check of vacant apartments).</p> <p>This will serve to mitigate the risk of any amendments to the building which may have an adverse impact on the fire strategy safety (e.g. breaches in compartmentation).</p>
Fire awareness of residents	<p>Due to the nature of residential premises whereby it is difficult to enforce fire safety management within the apartments, there is risk of the residents' actions affecting the implementation of the fire strategy – e.g. by covering smoke detectors or creating penetrations in compartment walls.</p> <p>To minimise the risk of occupants affecting the performance of the fire safety features in the building, all residents must be made aware of their responsibilities in regard to fire safety at the beginning of their residence.</p> <p>It is recommended for all relevant fire safety information should be provided in a tenant handbook.</p> <p>It is the responsibility of the building operators to inform the residents of the defend-in-place evacuation strategy. Residents should also be informed that they are always provided with the option to leave and that they do not have to stay in place in the event of a fire.</p>
Evacuation of PRMs	<p>The evacuation of PRMs will need to be carried out by the BE staff or the fire and rescue service.</p> <p>The responsible person for fire safety (as defined under the RR(FS)O) will need to ensure that each PRM has a personal emergency evacuation procedure (PEEP), and where required, sufficient training and equipment are provided to staff to assist with the evacuation.</p> <p>The EVC (Emergency Voice Communication) system in the lift lobbies should be regularly maintained to ensure they are in working order.</p>

Staff training	Sufficient number of BE staff should be adequately trained in fire prevention, fire protection and evacuation procedures including evacuation of PRMs.
Maintenance and testing	<p>An accurate record of fire precautions, and procedures for operating and maintaining any fire protection measures within the building, are necessary to enable the owner or end user to plan, document and implement control processes for maintenance and testing of fire safety systems to ensure that they operate effectively in the event of a fire.</p> <p>The External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018 states that maintenance records have not been recorded up to date and requires to be updated.</p> <p>This includes systems such as:</p> <ul style="list-style-type: none">• Firefighting lifts;• Fire alarm and fire detection system;• Fire doors;• Emergency lighting and signage;• Fire stopping registers;• Records of fire brigade attendance.
Control of work on site	<p>The means to control work on site should be determined (e.g. repairs to structure, hot work, cleaning of ductwork). A work control system should include clear lines of responsibility communicated to contractors.</p> <p><u>Work within the single stair</u></p> <p>When work is being carried out in the single stair (e.g. works associated with services in the risers), staff working in the area must be trained to ensure evacuation down the stair is still allowed in case of emergency and that it does not block the stair.</p>
Emergency planning	<p>A good relationship with the fire and rescue service has benefits as it ensure that the fire and rescue service is able to have an appropriate pre-determined response strategy for Cromwell Tower and enables the owner to seek advice where appropriate.</p> <p>Any changes affecting the layouts, fire safety systems, fire growth characteristics, and other relevant factors should be communicated to the fire service.</p>
Fire safety documentation	Fire safety information that sets out the basis on which the fire safety design was planned (i.e. this Fire Strategy Report), the fire safety management plan, the staff responsibilities etc. should be kept up to date and stored in a document management system that allows the information to be easily retrieved in the future.

General housekeeping	<p>The External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018 states that discarded trade materials and general waste were identified in riser cupboards.</p> <p>Good housekeeping is essential to reduce the likelihood of a fire starting or developing, and escape routes being blocked. This includes:</p> <ul style="list-style-type: none">• Maintaining all escape routes free from obstruction/ or combustibles;• Fire doors to perform as intended;• Arrangement for waste control and disposal or accumulation of waste;• Floor surface of escape routes to be maintainable, even and slip-resistant. <p>The Fire Risk Assessment also states that fire extinguishers should be removed from the building as it could be mishandled by the residents who are not trained. The management team sure ensure there are no fire extinguishers in the common areas of the building.</p>
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5 Conclusion

The purpose of the fire safety review on Cromwell Tower is to determine the existing intent of the fire safety design and to record the findings in a fire strategy report (this document).

This report describes the existing fire safety precautions in the building and compare them with the requirements in the Building Regulations 2010 (as amended) The current standards BS 9991 and BS 9999, and where applicable the latest update of the Approved Document B Volume 1, have been used as the benchmark for the review.

Where the fire safety precautions comply with the current standards, no further action is proposed and the fire information forms part of the building fire strategy. Where the precautions are not deemed to comply with the current standards, qualitative risk assessments have been carried out to identify the life safety risks to the building occupants due to those non-compliances. The outcomes of the assessment will result in one of the following:

- Where considered acceptable to remain as existing, recommend retaining the current provisions as long as the provisions are being maintained in good operation conditions; or
- Recommendations on possible options for enhancements/upgrades where the current fire safety provisions are considered inadequate.

Refer to Table 1 for the full list of recommendations and the reasons/benefits behind those recommendations.

Interim measures

From our review, it is found that there are existing features in Cromwell Tower that present considerable risks to the life safety of the building occupants. Some immediate actions are strongly recommended to address these risks.

These are temporary measures, while permanent solutions (as recommended on Table 1) are being developed and implemented. These interim measures are not meant to replace the need for permanent solution. The aim of the interim measures are to reduce hazards that may affect the use of the single stair in the event of a fire, so that occupants can safely evacuate from the Tower. The recommended interim measures are:

- Preparing a Personal Emergency Evacuation Plan (PEEP), so that the evacuation arrangement in the event of a fire is clear to each PRM occupant;
- Remove all storage and rubbish within riser spaces that opens into the stair (note: the External Fire Risk Assessment prepared by Frankham Risk Management Services in January 2018 states that discarded trade materials and general waste were identified in riser cupboards).
- Consider providing a fire detector within the electrical riser above L37, so that BE receives early warning of a potential fire in the electrical riser. If necessary, evacuation can be initiated before the stair is affected.

These measures are to be implemented as soon as possible to maintain the life safety of the building occupants.

Appendix A

Fire strategy mark-ups

Note:
The drawings used for the above assessments are:
Structural plan:
Ove Arup & Partners Consulting structural engineers - Drawing number. 33/507
Floor plan layout:
Barbican living - <https://www.barbicanliving.co.uk/blocks/cromwell-tower/cromwell-tower-flat-plans/>

The floor plan layout of Cromwell Tower flats is shown, detailing the arrangement of Flat Type A, Flat Type B, and Flat Type C. The plan includes room dimensions, common areas, and escape routes. The layout is as follows:

- Flat Type A:** Located at the top right, featuring a Living Room (16'0" x 13'0"), Dining Room (10'6" x 9'6"), Kitchen, Breakfast Room, Utility Room, Hall, and three Bedrooms (10'6" x 9'6", 10'6" x 9'6", and 20'0" x 12'0" MAX). It includes a Balcony, Lift, and various cupboards and WCs.
- Flat Type B:** Located in the middle left, featuring a Living Room (15'0" x 11'0"), Dining Room (10'6" x 9'6"), Kitchen, Utility Room, Hall, and three Bedrooms (10'6" x 9'6", 10'6" x 9'6", and 10'6" x 9'6"). It includes a Balcony, Lift, and various cupboards and WCs.
- Flat Type C:** Located at the bottom right, featuring a Living Room (20'0" x 16'0" MAX), Dining Area, Kitchen, Utility Room, Hall, and four Bedrooms (13'0" x 9'6", 15'0" x 9'6", 10'6" x 9'6", and 10'6" x 9'6"). It includes a Balcony, Lift, and various cupboards and WCs.

KEY

- Firefighting stair
- Firefighting lobby
- Common stair 1
- Common stair 2
- Balcony
- Lift lobby
- Escape routes to common stair
- Escape routes to firefighting stair

A2 Firefighting access

Note:

The drawings used for the above assessments are:

Structural plan:

Ove Arup & Partners Consulting structural engineers - Drawing number. 33/507

Floor plan layout:

Barbican living -

<https://www.barbicanliving.co.uk/blocks/cromwell-tower/cromwell-tower-flat-plans/>

KEY

⊗ Wet riser outlet

.....> Hose coverage

Firefighting shaft



A3 Compartmentation

Note:

The tower is m in height (39 stories above podium level)

Compartmentation requirements

Compartment floor - 120 REI

Wall between flats and lift lobby - 60 REI

Wall between flats and common stairs - 60 REI

Firefighting stair - 120 REI

Shafts (lifts included) - 120 REI

Fire doors

Door from flat to lift lobby - FD60S

Door from lift lobby to small lobby - FD60S

Door from small lobby to the firefighting stair - FD30S

Firefighting lift doors - FD60S

Common lift doors - FD60S

code says FD30 is sufficient but considering the current layout i think lift doors need to be FD60S - TBC.

The drawings used for the above assessments are:

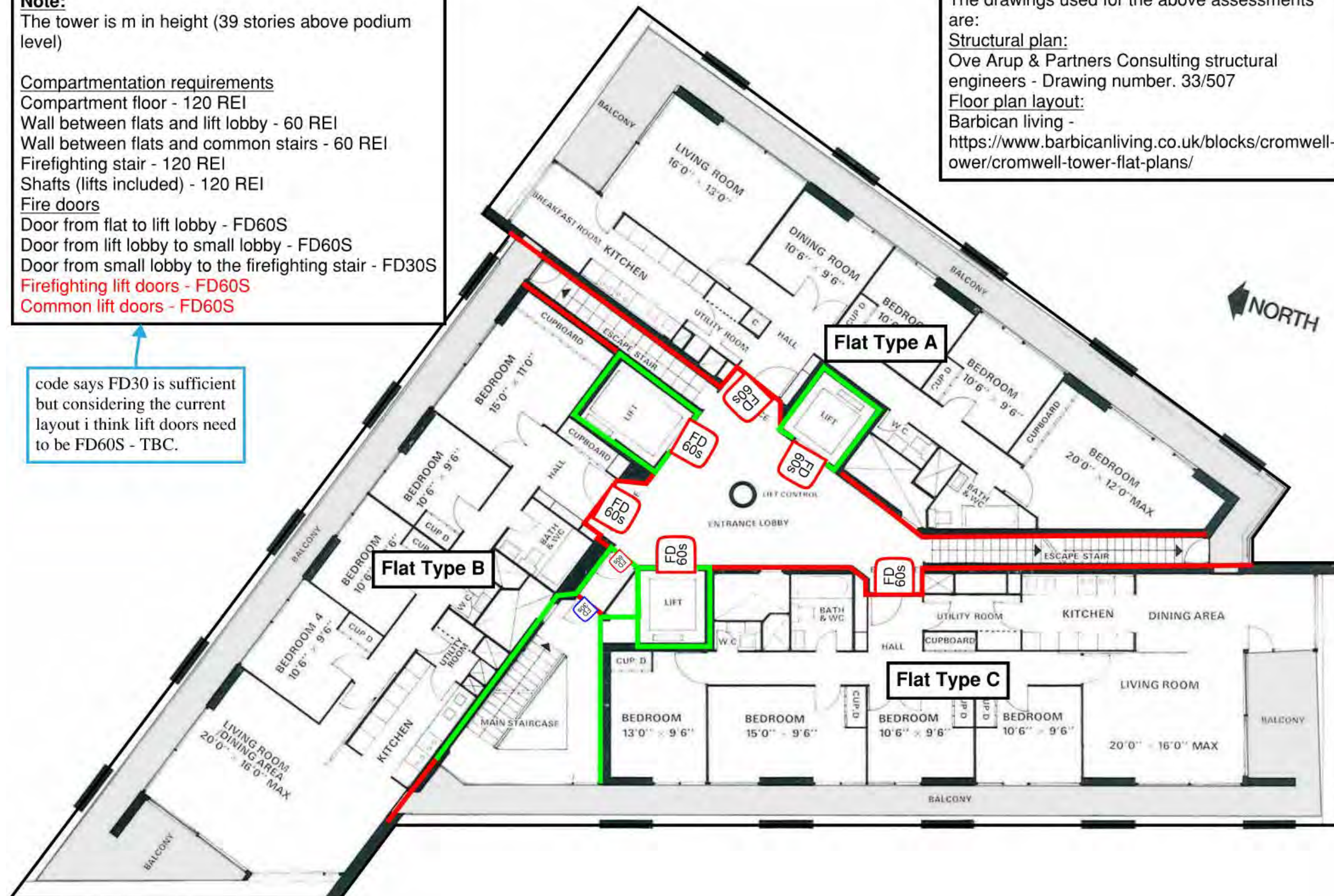
Structural plan:

Ove Arup & Partners Consulting structural engineers - Drawing number. 33/507

Floor plan layout:

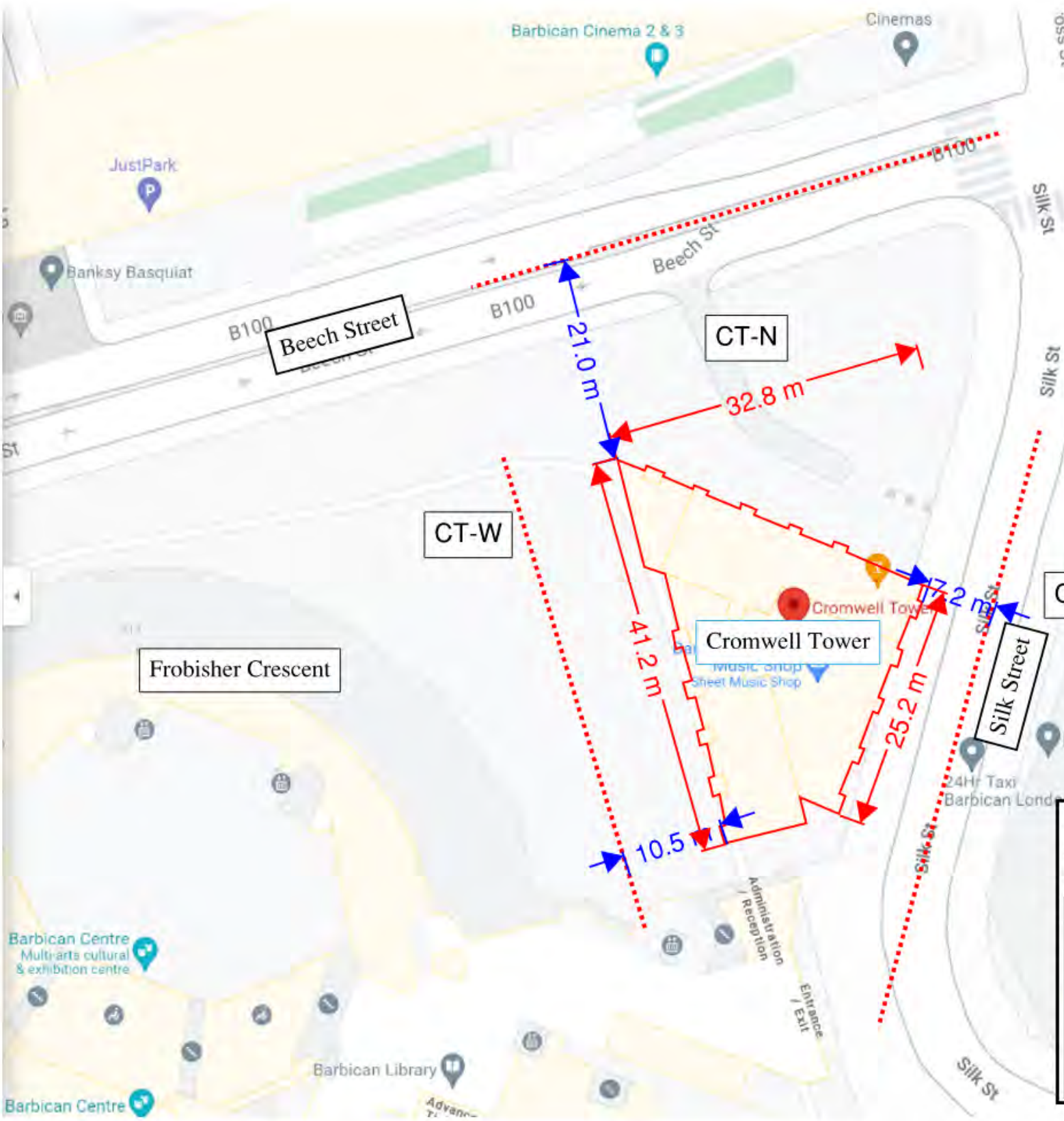
Barbican living -

<https://www.barbicanliving.co.uk/blocks/cromwell-tower/cromwell-tower-flat-plans/>



Appendix B

External Fire Spread



External fire spread assessment

The following assumptions have been made for the external fire assessment:

- The floor to ceiling height is 2.5m (and additional 200mm concrete floor slab) based on the structural drawing (reference number: 33-550) - refer to page 3
- The Street Level (L01) and Podium Level is treated as one compartment
- The residential levels (L1 - L39) have compartment floors
- The ground and podium level is assumed to be office type
- The upper levels are residential type
- The entire wall is assumed to be on fire for Street level
- The compartment length for residential levels are assumed to be 22.7m using the longest flat (refer to page 2)

Cromwell Tower does not require protected area on external elevations as shown below. The L01 is for double height space of Street level - Podium level and UL is for the residential levels.

Case ID	Height (m)	Width (m)	Boundary (m)	Required Protected (%)
CT-N L01	5.20	32.80	21.00	100.0
CT-E L01	5.20	25.20	7.20	100.0
CT-W L01	5.20	41.20	10.50	100.0
CT-N UL	2.50	22.70	21.00	100.0
CT-E UL	2.50	22.70	7.20	100.0
CT-W UL	2.50	22.70	10.50	100.0