

Grenfell Tower – fire safety investigation:
The fire protection measures in place on the night of the fire, and conclusions as to:
the extent to which they failed to control the spread of fire and smoke;
the extent to which they contributed to the speed at which the fire spread.

Phase 1 Report – Appendix G

Compliance assessment - means of warning and escape Regulation B1

REPORT OF

Dr Barbara Lane FREng FRSE CEng

Fire Safety Engineering

24th October 2018

Specialist Field	:	Fire Safety Engineering
Assisted by	:	Dr Susan Deeny, Dr Peter Woodburn, Dr Graeme Flint, Mr Tom Parker, Mrs Danielle Antonellis, Mr Alfie Chapman
On behalf of	:	Grenfell Tower Inquiry
On instructions of	:	Cathy Kennedy, Solicitor, Grenfell Tower Inquiry
Subject Matter	:	To examine the circumstances surrounding the fire at Grenfell Tower on 14 th June 2017
Inspection Date(s)	:	6 th October, 1 st November, 7-9 th November 2017

Dr Barbara Lane
Ove Arup & Partners Limited
13 Fitzroy Street
London W1T 4BQ

Appendix G – Compliance assessment of means of warning and escape Regulation B1

CONTENTS

G1	Introduction	G-1
	G1.1 Purpose of Appendix G	G-1
G2	Requirements for means of warning and escape	G-2
	G2.1 Applicable legislation and statutory guidance	G-2
	G2.2 Design guidance	G-3
	G2.3 Fire alarm and fire detection systems	G-5
	G2.4 Means of escape from flats	G-12
	G2.5 Means of escape in the common parts of blocks of flats	G-15
	G2.6 Common stairs	G-18
	G2.7 General provisions	G-22
	G2.8 Provisions for occupants that require assistance to escape:	G-30
	G2.9 Summary of ADB 2013 and CP3 1971 recommendations for means of warning and escape	G-33
G3	Provisions for means of warning and escape in Grenfell Tower	G-36
	G3.2 Fire detection and alarm	G-36
	G3.3 Means of escape within the flat	G-42
	G3.4 Means of escape within the common areas	G-46
	G3.5 Means of escape within common stair	G-52
	G3.6 Assessment of general provisions	G-66
	G3.7 Means of escape for persons requiring assistance	G-79
	G3.8 Summary of ADB compliance for means of warning and escape	G-82

G1 Introduction

G1.1 Purpose of Appendix G

- G1.1.1** In this appendix, I present a review of the provisions made at Grenfell Tower for the means of warning and escape. The information in this Appendix is then drawn on and presented in the relevant parts of Section 15 and 16 of my Expert Report, describing the construction of the lobbies and stairs (respectively) in Grenfell Tower.
- G1.1.2** I set out here a summary of the applicable legislation, regulations and statutory guidance for the original building design and construction between 1967 and 1974, and then for the refurbishment between 2012 and 2016.
- G1.1.3** I describe the provisions made in Grenfell Tower and explain how they comply or not with the aforesaid guidance, and therefore if Grenfell Tower complied with Part B1 of the Building Regulations 2010.
- G1.1.4** Note I have excluded the design guidance for the non-residential parts of the building on Levels Ground, 1 and 2, except where they are expressly relevant to the means of escape from flats. The non-residential areas of the building were not involved in the fire on 14th June 2017, and in any case were not occupied at the time.
- G1.1.5** My assessment of compliance is based on information submitted to the Inquiry and on observations made during my post fire inspections which took place between 6th October and 9th November 2017.
- G1.1.6** It should be noted that there is a degree of overlap between the recommendations in ADB 2013 for achieving compliance with Parts B1 and B5 of the Building Regulations 2010. Please refer to my Appendix H. In some cases, therefore, the same issues are described and assessed in this Appendix G and in Appendix H.
- G1.1.7** Specific components of the protection measures in Grenfell Tower have also been assessed in more detail. Please refer to the following Appendices for more information regarding the provisions and performance of the following components:
- a) Appendix I: Flat entrance and stair fire doors – requirements and provisions;
 - b) Appendix J: Smoke extract – requirements and provisions;
 - c) Appendix K: Gas supply – fire safety requirements and provisions;
 - d) Appendix L: lift installations – fire safety requirements and provisions
 - e) Appendix M: historic fire doors.

G1.1.8 Finally, Section 16 presents a table (Table 16.2) summarising the internal and external firefighting provisions at Grenfell Tower and whether they comply with the original requirements of CP3 1971 (and therefore the London Building Acts (Amendment) Act 1939) and the provisions of ADB 2013 (and therefore Functional Requirement B1 of the Building Regulations 2010).

G2 Requirements for means of warning and escape

G2.1 Applicable legislation and statutory guidance

G2.1.1 Two key stages of works undertaken on Grenfell Tower are reviewed in this section. The building was constructed in around 1972 and refurbished between 2012 and 2016. The applicable legislation and guidance throughout lifetime of the building is shown in Table G.1.

Table G.1: Applicable legislation and guidance throughout lifetime of the building

Period	Applicable legislation and statutory guidance	Applicable guidance
At the time of construction (1972-1974)	<p>London Building Acts (Amendment) Act 1939</p> <p>Section 20 – Requiring that “<i>proper arrangements will be made and maintained for lessening so far as is reasonably practicable danger from fire in the building.</i>” For buildings taller than 100ft (30m) (or 80ft (25m) where the building footprint exceeds 10,000sqft (930m²).</p> <p>Section 34 – Requiring “... <i>all such means of escape therefrom in case of fire as in the circumstances of the case can be reasonably provided...</i>” in every new building which has a storey at a greater height than 20ft.</p>	<p>London County Council Guide <i>Means of escape in case of fire 1954 (as amended in 1967)</i></p> <p>In consultation with “greater London council’s officers”, i.e. the District surveyor of the London Borough of Kensington and Chelsea, CP3 1971 may also have been applied. CP3 1971 appears to have been applied in this case – Appendix D explains in further detail.</p> <p>Noting that in 1974, the GLC published their updated Means of escape in case of fire guide that explicitly references CP3 1971 as the relevant guidance to use for blocks of flats.</p>
At the time of refurbishment (2012-2016)	<p>Building Regulations 2010</p> <p>Functional Requirement B1 – Means of Warning and Escape:</p> <p><i>“The building shall be designed and constructed so that there are appropriate provisions for the early warning of fire, and appropriate means of escape in case of fire from the building to a place of safety outside the buildings capable of being safely and effectively used at all material times”</i></p>	<p>Approved Document Part B Vol 2. As the building regulations submission for the refurbishment was made in 2014, the relevant edition is the 2013 edition.</p> <p>In ADB 2013, the relevant sections for Functional Requirement B1 are sections 1 – 5.</p>

G2.2 Design guidance

G2.2.1 The Relevant design guidance at the time of construction was CP3 1971, as I have explained in Section 4 of my report. The relevant statutory guidance at the time of the refurbishment was ADB 2013.

G2.2.2 Approved Document B (2013):

G2.2.3 The Introduction to B1 in ADB 2013 presents a short analysis of the assumptions underlying the guidance. I have included the relevant passages from the introduction to help clarify the intent behind the design guidance presented in the following sections. ADB 2013 states:

“B1.ii The design of means of escape and the provision of other fire safety measures such as a fire alarm system (where appropriate), should be based on an assessment of the risk to the occupants should a fire occur. The assessment should take into account the nature of the building structure, the use of the building, the processes undertaken and/or materials stored in the building; the potential sources of fire; the potential of fire spread through the building; and the standard of fire safety management proposed. Where it is not possible to identify with any certainty any of these elements, a judgement as to the likely level of provision must be made.

B1.iii Fires do not normally start in two different places in a building at the same time. Initially a fire will create a hazard only in the part in which it starts and it is unlikely, at this stage, to involve a large area. The fire may subsequently spread to other parts of the building, usually along the circulation routes. The items that are the first to be ignited are often furnishings and other items not controlled by the regulations. It is less likely that the fire will originate in the structure of the building itself and the risk of it originating accidentally in circulation areas, such as corridors, lobbies or stairways, is limited, provided that the combustible content of such areas is restricted.

B1.iv The primary danger associated with fire in its early stages is not flame but the smoke and noxious gases produced by the fire. They cause most of the casualties and may also obscure the way to escape routes and exits. Measures designed to provide safe means of escape must therefore provide appropriate arrangements to limit the rapid spread of smoke and fumes.”

G2.2.4 These passages identify that buildings are to be designed for a fire that starts in a single compartment, and that smoke and fumes from a fire have a significant impact on the means of escape of occupants.

G2.2.5 The Introduction to B1 also identifies specific principles for means of escape:

“B1.v The basic principles for the design of means of escape are:

- a. that there should be alternative means of escape from most situations; and*
- b. where direct escape to a place of safety is not possible, it should be possible to reach a place of relative safety, such as a protected stairway, which is on a route to an exit, within a reasonable travel distance. In such*

cases the means of escape will consist of two parts, the first being unprotected in accommodation and circulation areas and the second in protected stairways (and in some circumstances protected corridors)."

...

"The ultimate place of safety is the open air clear of the effects of the fire. However, in modern buildings which are large and complex, reasonable safety may be reached within the building, provided suitable planning and protection measures are incorporated."

The intent behind provision of unprotected and protected escape routes are also discussed as follows:

"B1.viii The unprotected part of an escape route is that part which a person has to traverse before reaching either the safety of a final exit or the comparative safety of a protected escape route, i.e. a protected corridor or protected stairway."

Unprotected escape routes should be limited in extent so that people do not have to travel excessive distances while exposed to the immediate danger of fire and smoke."

Even with protected horizontal escape routes, the distance to a final exit or protected stairway needs to be limited because the structure does not give protection indefinitely."

B1.ix Protected stairways are designed to provide virtually 'fire sterile' areas which lead to places of safety outside the building. Once inside a protected stairway, a person can be considered to be safe from immediate danger from flame and smoke. They can then proceed to a place of safety at their own pace. To enable this to be done, flames, smoke and gases must be excluded from these escape routes, as far as is reasonably possible, by fire-resisting structures or by an appropriate smoke control system, or by a combination of both these methods. This does not preclude the use of unprotected stairs for day-to-day circulation, but they can only play a very limited role in terms of means of escape due to their vulnerability in fire situations."

G2.2.6 CP3 1971:

G2.2.7 The CP3 1971 code of practice for fire safety in blocks of flats provides an extensive discussion on the 3 stages of escape routes in a block of flats. These are:

- a) Stage 1 – Safety of occupants within the flat of fire origin;
- b) Stage 2 – Safety of occupants using horizontal escape routes (e.g. the residential common corridor); and
- c) Stage 3 – Safety of occupants using a main vertical escape route.

G2.2.8 In CP3 1971, protection to the stair is provided by physical enclosure with fire resisting construction and the provision of ventilated lobby access to the stair. As described in Section 2.4 of CP3 1971, addressing Stage 3, this protection

is explicitly provided to prevent smoke and fire from compromising its safe use by occupants of the building on any floor above the fire floor in the event that the fire is not extinguished early, and smoke is able to travel into the corridor and toward the stair (Section 2.4.2.2(2) of CP3 1971).

G2.2.9 In accordance with the principles recorded in ADB 2013 and CP3 1971, the protection provided to stairs in residential buildings is therefore intended to:

- a) Physically block the penetration of smoke and flames into the stair enclosure by provision of fire resisting construction; and
- b) Prevent smoke from entering the stair by provision of fire resisting lobbies and smoke ventilation systems.

G2.2.10 Please see the following sections for the design guidance in ADB 2013 and CP3 1971 relevant to means of warning and escape. The sections are structured to follow the order of ADB 2013. For each section, after I set out the guidance in ADB 2013, I set out the relevant provisions in CP3 1971.

G2.3 Fire alarm and fire detection systems

G2.3.1 Approved Document B (2013):

G2.3.2 The statutory guidance in Approved Document B refers the reader to additional sources of design guidance. Please refer to Appendix D for a discussion of the applicability of British Standards to building fire safety design in the UK. With respect to designing a building to comply with Part B1 of the Building Regulations 2010, ADB 2013 refers to the British Standard documents identified in Table G.2.

Table G.2: Referenced British Standards within ADB 2013 sections for B1

ADB 2013 Section	British Standard	Fire safety feature
1.4	BS 5839-6:2004	Fire detection and fire alarm systems for buildings. Code of practice for the design, installation and maintenance of fire detection and fire alarm systems in dwellings.
1.5	BS 5446-2:2003	Fire detection and fire alarm devices for dwellings. Specification for heat alarms.
1.5	BS EN 14604: 2005	Smoke alarm devices.

G2.3.3 The ADB 2013 and CP3 1971 design guidance for means of warning in flats are set out below.

G2.3.4 Section 1.4 of ADB 2013 states:

“1.4 All new flats should be provided with a fire detection and fire alarm system in accordance with the relevant recommendations of BS 5839-6:2004 Code of practice for the design, installation and maintenance of fire

detection and fire alarm systems in dwellings to at least a Grade D Category LD3 standard.”

G2.3.5 Therefore, ADB 2013 required fire detection in new flats in accordance with the standard BS 5839-6:2004. The minimum standard required is at least a Grade D Category LD3 standard.

G2.3.6 It is important to note that the purpose of such a system is to raise a local fire alarm within the flat where the system is located. It is not connected in any way to any other flat or other part of a building.

G2.3.7 BS5839-6:2004 was superseded by BS 5839-6:2013. This was the relevant version of the standard for the 2012 – 2016 refurbishment and remains the current standard.

G2.3.8 BS 5839-6:2013 provides the following advice regarding the level of fire detection required being related to the fire risk:

“8.1.1 General

Fire detection and fire alarm systems are usually installed in dwellings to protect life. However, the level of protection afforded to occupants needs to be related to the fire risk (see Clause 4). The appropriate level can therefore vary considerably.”

and

“8.1.2 Systems for the protection of life (Category LD)

All dwellings need to be provided with an appropriate fire detection and fire alarm system.”

G2.3.9 Under paragraph 9.1.3 ‘Appropriate systems for typical premises’ it states:

“If any doubt exists as to the appropriate system for any premises, the advice of specialists, such as the fire and rescue service, fire consultants or, if appropriate, the fire insurer, needs to be sought, and the choice of system needs to be based on a risk assessment (see Clause 4). In some circumstances, this might determine that a higher standard of protection (i.e. with additional detectors) is warranted.”

G2.3.10 Table 1 of BS 5839-6:2013 (Figure G.1) sets out the minimum standard of detection for new flats, existing flats and existing flats where structural fire precautions are of a lower standard than those recommended.

G2.3.11 For new premises, an LD 2 category is recommended, as it is for existing buildings where structural fire precautions are of a lower standard than those recommended in current guidance that supports national building regulations.

G2.3.12 For existing premises conforming to that guidance, the lower standard LD3 suffices.

Table 1 Minimum Grade and Category of fire detection and fire alarm system for protection of life in typical premises

Class of premises	Minimum Grade and Category of system for installation in:					
	New or materially altered premises conforming to guidance that supports national building regulations ^{A)}		Existing premises conforming to current guidance that supports national building regulations ^{A)}		Existing premises where structural fire precautions are of a lower standard than those recommended in current guidance that supports national building regulations ^{A)}	
	Grade	Category	Grade	Category	Grade	Category
Single-family dwellings ^{B)} and shared houses ^{C)} with no floor greater than 200 m ² in area						
Owner-occupied bungalow, flat or other single-storey unit	D	LD2 ^{D)}	F ^{F)}	LD3 ^{G)}	D	LD2 ^{H)}
Rented bungalow, flat or other single-storey unit	D ^{E)}	LD2 ^{D)}	D	LD3 ^{G)}	D ^{E)}	LD2 ^{H)}

^{A)} In England and Wales, Approved Document B published by the Department for Communities and Local Government [2]. In Scotland, the Technical Handbooks published by the Scottish Government [3]. In Northern Ireland, Technical Booklet E [4] published by the Department of Finance and Personnel.

^{D)} Heat detectors should be installed in every kitchen. A smoke detector should be installed in the principal habitable room (see 3.30). Where more than one room might be used as the principal habitable room, a smoke detector should be installed in each of these rooms. The detector in the principal habitable room (but not the kitchen) may alternatively be a carbon monoxide fire detector. However, consideration needs to be given to the potential for false alarms from a smoke detector in the lounge if a kitchen opens directly into, or is combined with, the lounge.

^{E)} The standby power supply for Grade D smoke alarms in rented flats to which access is above ground floor level should be tamper-proof, e.g. cells soldered to a printed circuit board, capacitors or primary (non-rechargeable PP3-type) batteries that are fixed in place and cannot readily be removed. The standby power supply for Grade D smoke alarms in rented two storey premises should be tamper-proof and long-life (i.e. lithium cells).

^{G)} Category LD2 if a risk assessment justifies the provision of additional detectors (see Clause 4).

^{H)} Detectors should be of a type and be so located as to compensate for the lower standard of structural fire precautions (for example, a smoke detector should be installed in the access room to a habitable inner room that has no door or window through which escape is possible). Further detectors might be necessary if a risk assessment justifies their provision. In some cases, a Category LD1 system might be necessary.

Figure G.1: Excerpt from BS 5839-6:2013

G2.3.13 Structural fire precautions relate to requirement B3 of the building regulations, and so loadbearing elements of structure, compartmentation (includes doors, walls floors etc), concealed spaces and protection of openings and fire stopping.

G2.3.14 Furthermore, Clause 4 ‘Fire risk Assessment’ of BS5839-6:2013 states under sub-section 4.2 Recommendations:

- b) Final design of a fire detection and fire alarm system for any particular domestic premises should, where reasonably practicable, be based on a form of fire risk assessment, particularly if it is proposed to deviate from the recommendations given in Clause 9 or if there are risk factors additional to those encountered in typical examples of the types of premises defined in Clause 9.

NOTE 2 The information contained in Annex A is likely to be of value in any such fire risk assessment and in determining the basic principles for system design, particularly the appropriate Grade and Category of system (see Clauses 7 and 8).

- G2.3.15** Therefore, should the designer deviate from the guidance in Table 1 under Clause 9, a risk assessment is required.
- G2.3.16** Based on Table 1 of BS 5839-6:2013 (i.e. the guidance that sits alongside Approved Document Part B), for new flats the minimum level of fire detection and alarm is Grade D Category LD2 (highlighted in red in Figure G.1). This exceeds the minimum Category LD3 stated in ADB.
- G2.3.17** Therefore, in my opinion, looking at the guidance in ADB 2013 paragraph 1.4 and also in BS 5839-6:2013 Clause 8 and Table 1, the new flats on Levels 1 – 3 that were constructed in Grenfell Tower as part of the 2012 – 2016 refurbishment are recommended to be provided with a Grade D, Category LD2 fire detection and fire alarm system.
- G2.3.18** A higher or lower Category of detection and alarm system could have been provided where supported by a risk assessment, in order to comply with BS 5839-6:2013 and ADB 2013. But I have seen no evidence of a risk assessment to support a Category of alarm lower than LD2. Therefore, for the purpose of my compliance assessment in G2.3 I have used Grade D Category LD2 as the minimum recommended level of fire detection and alarm.
- G2.3.19** I have not seen any evidence at this stage regarding the installation of fire alarm and detection systems in the existing flats on Levels 4 to 23. It was not part of the works for the 2012-2016 refurbishment. I do not have any evidence available to me regarding the system prior to the refurbishment.
- G2.3.20** However, during my post fire inspection of the building, I observed that existing flats on Levels 4 and 5 (not affected by the fire) had fire detection and alarm systems (Figure G.2). I have assumed that the other levels of typical residential flats (Levels 6 – 23) may have had similar fire alarm and detection systems. I do not at this time know at what date these systems were installed.
- G2.3.21** In my assessment of category of fire alarm required, I must consider the structural fire precautions provided to the flats in Grenfell Tower. I will cover this as a whole building assessment, when I am considering the overall building compliance status in Phase 2.

- G2.3.22** However, as one specific example now, I have not seen any evidence which assists me with the fire resistance status of the internal planning of existing flats on Levels 4 – 23. In particular, there is no evidence of the fire resistance period of the protected entrance hall available.
- G2.3.23** As I present in G2.4.5, the protected entrance hall should have been constructed of 30-minute fire-resisting construction with doors that achieve a FD 20 rating. Where no internal protected corridor is provided within the flat, the structural fire precautions do not conform with ADB Diagram 2 (Figure G.4). Therefore, an LD2 system is recommended for all flats on Levels 4 to 23 of Grenfell Tower on the basis that they are “existing premises where structural fire precautions are of a lower standard than those recommended in current guidance that supports national building regulations”, in accordance with the BS 5839-6:2013 Table 1 (see figure G.1 above).
- G2.3.24** I will re visit this issue and update my analysis where necessary if additional evidence is provided to me.
- G2.3.25** BS 5839-6:2004 Section 8.1.1 defines a LD2 system as:
“a system incorporating detectors in all circulation spaces that form part of the escape routes from the dwelling, and in all rooms or areas that present a high fire risk to occupants (see Clause 4)”
- G2.3.26** Further guidance is provided in BS 5839-6:2004 Section 8.1.2:
“...a Category LD2 system, in which detection is only provided at points where the fire risk is high or where combustion products would present a significant hazard to life. A Category LD2 system might, for instance, have detectors only in the circulation areas of the dwelling, the living room and the kitchen; other areas might be left without detector coverage...”
- G2.3.27** Therefore, provision of a Category LD2 fire detection and alarm system in the residential flats of Grenfell Tower would require detection in the protected entrance halls, living room, and the kitchen.
- G2.3.28** ADB 2013 recommends that fire detection and alarm systems within individual flats in Grenfell Tower should be mains-operated and have a standby power supply:
“1.5 The smoke and heat alarms should be mains-operated and conform to BS EN 14604: 2005, Smoke alarm devices or BS 5446-2:2003, Fire detection and fire alarm devices for dwelling houses, Part 2 Specification for heat alarms, respectively. They should have a standby power supply such as a battery (either rechargeable or non-rechargeable) or capacitor. More information on power supplies is given in clause 15 of BS 5839-6.”
- G2.3.29** ADB 2013 recommends the following positioning for smoke detectors in flats:

“1.9 Detailed guidance on the design and installation of fire detection and alarm systems in flats is given in BS 5839-6. However, the following guidance is appropriate to most common situations.

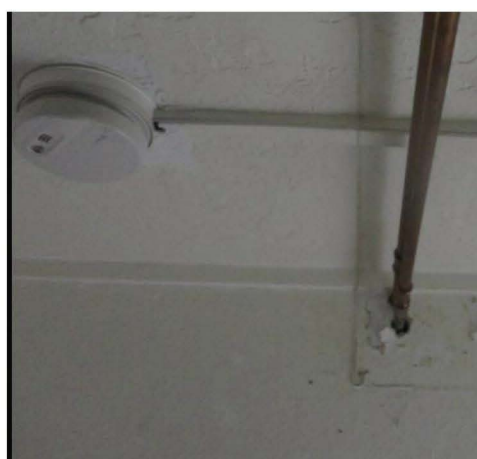
1.10 Smoke alarms should normally be positioned in the circulation spaces between sleeping spaces and places where fires are most likely to start (e.g. kitchens and living rooms) to pick up smoke in the early stages.

1.13 Where more than one alarm is installed they should be linked so that the detection of smoke by one unit operates the alarm signal in all of them. The manufacturers’ instructions about the maximum number of units that can be linked should be observed.

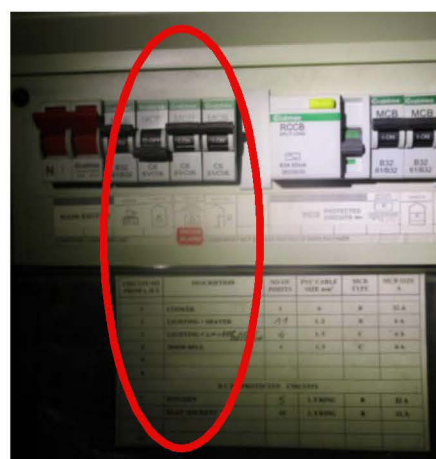
1.14 Smoke alarms/detectors should be sited so that there is a smoke alarm in the circulation space within 7.5m of the door to every habitable room...”

G2.3.30 Therefore, smoke alarms are recommended to be positioned in the protected entrance hall within 7.5m of the door to every habitable room in each flat of Grenfell Tower. Due to the length of the protected entrance halls within the existing flats on Levels 4 – 23, a smoke detector located anywhere in the protected entrance hall would be a compliant solution, I have provided an illustration of the provisions in Figure G.3.

G2.3.31 ADB 2013 provides additional guidance relevant to specific positioning of smoke and heat alarms, but this guidance is not relevant at this time and therefore is not discussed.



a)



b)

Figure G.2: Evidence of a) smoke detector in Flat 14 and b) mains connection in Flat 13

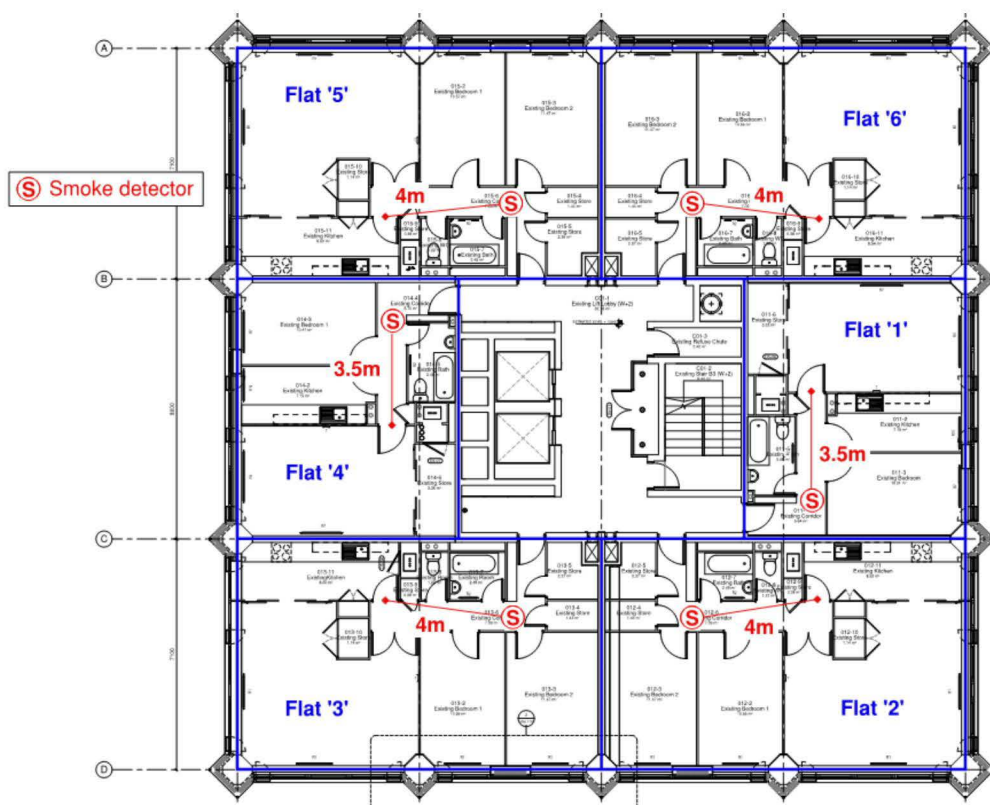


Figure G.3: Smoke detector locations at Grenfell Tower per ADB 2013 (SEA00010474)

G2.3.32 ADB 2013 does not recommend that fire alarm sounders should be automatically or manually operated throughout the building in the event of a fire within an individual flat. This aligns with the “stay put” design basis concept presented in Section 2.3 c) of ADB 2013, which states:

“...measures in Section 8 (B3) provide a high degree of compartmentation and therefore a low probability of fire spread beyond the flat of origin, so that simultaneous evacuation of the building is unlikely to be necessary”

G2.3.33 The design guidance in ADB 2013 is to provide independent fire detection and alarm systems within each flat, and for the purpose of raising the alarm in that flat only.

G2.3.34 **Original design guidance (CP3 1971):**

G2.3.35 The guidance in CP3 1971 for fire alarm provisions is as follows:

“7.7 Reasonable means for calling the fire brigade should be provided. It is recommended that the Post Office Corporation should be approached at an early stage with a view to providing at least one public telephone within the block, or a call box at no greater distance away than 300m (approximately 960ft)”

G2.3.36 As described above and in Appendix C, I observed modern fire detection and alarm devices during my post fire inspection. These were positioned in flats

on Levels 1-3, installed as part of the refurbishment in 2012 – 2016, and also in flats on Levels 4 and above. It appears means of warning was therefore upgraded at Grenfell Tower after the original construction was completed. No information has yet been provided as to when these works were undertaken, or to what standard the systems were designed and installed against.

G2.3.37 Therefore, in my opinion, the CP3 1971 guidance is no longer applicable.

G2.4 Means of escape from flats

G2.4.1 In the following sections I set out the design guidance included in ADB 2013 and CP3 1971 for means of escape from flats.

G2.4.2 Provisions for flats with a floor more than 4.5m above ground level:

G2.4.3 Approved Document B (2013):

G2.4.4 The following provisions are Approved Document B recommendations for internal planning of flats:

“2.13 Three acceptable approaches (all of which should observe the restrictions concerning inner rooms given in paragraph 2.5) when planning a flat which has a floor at more than 4.5m above ground level are:

- a. provide a protected entrance hall which serves all habitable rooms, planned so that the travel distance from the entrance door to the door to any habitable room is 9m or less (see Diagram 2 [Excerpted in Figure G.4 opposite]); or*
- b. to plan the flat so that the travel distance from the entrance door to any point in any of the habitable rooms does not exceed 9m and the cooking facilities are remote from the entrance door and do not prejudice the escape route from any point in the flat (see Diagram 3); or*
- c. to provide an alternative exit from the flat, complying with paragraph 2.14.”*

G2.4.5 As I will present in this section, both the original and refurbishment design of Grenfell Tower was based on the provision of a protected entrance hall serving all habitable rooms.

G2.4.6 Therefore, based on the guidance in ADB 2013 Diagram 2 (Figure G.4), the protected entrance hall should therefore:

- a) Be constructed of 30-minute fire-resisting construction; and
- b) Laid out such that the distance from the entrance door to the door to any habitable room is 9m or less.

G2.4.7 Appendix B of ADB 2013 recommends that doors forming part of the enclosure to a protected entrance hall in flats achieve an FD 20 rating and be

provided with self-closing devices. Please refer to Appendix I for further discussion of the provisions of fire doors in blocks of flats.

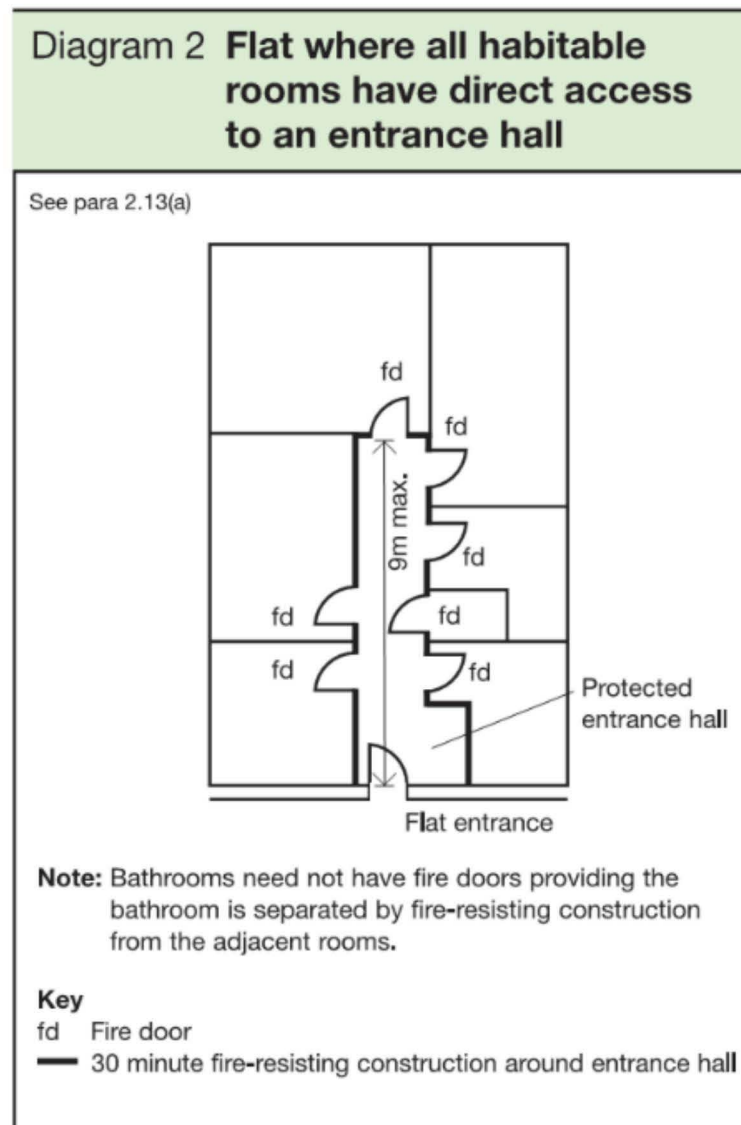


Figure G.4: Approved Document B Diagram 2 for internal planning of flats

G2.4.8 Original design guidance (CP3 1971):

G2.4.9 CP3 1971 provides the following guidance for internal planning of flats:

3.2.1 Flats. Every flat should have a protected private entrance hall and every living room and bedroom should have an exit which leads to hall or lobby. The recommendations given in either 3.2.1.1 or 3.2.2.2 should be applied.

3.2.1.1 Bedrooms should open directly out of the entrance hall and, wherever possible, their doors should be nearer to the entrance door of the flat than the door of a dining room, a living room or a kitchen (see Fig. 1). Where this arrangement is not practicable, the bedrooms may be further from the flat entrance door than other rooms provided that, in either case, no bedroom door is further from the main entrance door of the flat than 7.5 m (approximately 25 ft) (see Fig. 2). In both cases, all rooms other than bathrooms and w.c.'s (containing no fire risk) opening off the hall should be fitted with a Type 3 fire-resisting door (cupboard doors need not be self-closing) and the enclosing walls of the hall should have a fire resistance of not less than half-an-hour. [2.2.2.2]

Figure G.5: Excerpt from CP3:1971 – Internal planning of flats

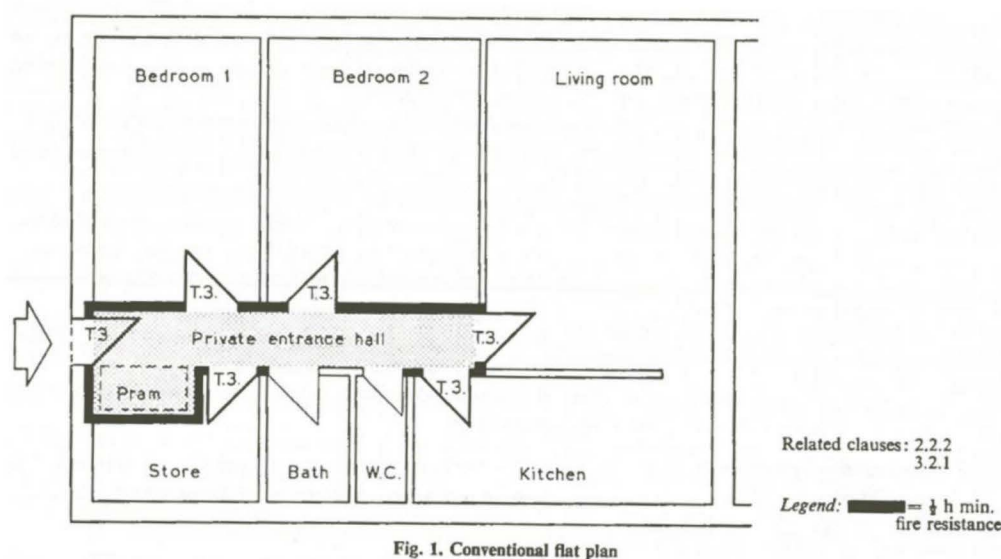


Figure G.6: CP3 1971 Figure 1 - Conventional flat plan

G2.4.10 Therefore, the original design guidance for Grenfell Tower was to provide a protected private entrance hall and the travel distance from each bedroom to the flat entrance door was limited to 7.5m. The walls of the protected entrance hall were recommended to have a fire resistance of 30 minutes. All doors opening into the protected entrance hall, except for doors from bathrooms and WCs, were recommended to be Type 3 fire-resisting doors.

G2.4.11 The performance requirements of Type 3 fire resisting door are stated in Section 4.3.2.3 of CP3 1971 Chapter 4 Part 1 as:

“The door, or leaf thereof when fitted in a 25mm (approximately 1in) rebated frame should satisfy the requirements of test as to freedom from collapse for not less than 30 minutes and resistance to passage of flame for not less than 20 minutes. The door should either be a single leaf swinging in one direction only or double leaf with each leaf swinging in the opposite direction from the other leaf, and with rebated meeting stiles. The door should be fitted in frames having a rebate of not less than 12mm (approximately 1/2 inch) and

should be fitted with an automatic self-closing device which may (except where otherwise recommended) consist of rising butt hinge.”

- G2.4.12** Therefore, in accordance with CP3 1971, internal flat doors opening into the protected entrance hall were to achieve a fire resistance rating of 20-minutes (Integrity) and 30-minutes (Stability) when tested to BS476-1:1953.

G2.5 Means of escape in the common parts of blocks of flats

G2.5.1 Approved Document B (2013):

- G2.5.2** The guidance in ADB 2013 for the means of escape within the common corridor for buildings served by a single common stair is as follows:

“2.20 Every flat should have access to alternative escape routes so that a person confronted by the effects of an outbreak of fire in another flat can turn away from it and make a safe escape. However, a single escape route from the flat entrance door is acceptable if either:

- a. the flat is situated in a storey served by a single common stair and:*
 - i. every flat is separated from the common stair by a protected lobby or common corridor (see Diagram 7 [reference Figure G.7]); and*
 - ii. the travel distance limitations in Table 1 (see paragraph 2.23), on escape in one direction only, are observed; or...”*

- G2.5.3** The travel distance limitation for *escape in one direction only* is 7.5m from ADB 2013 Table 1.

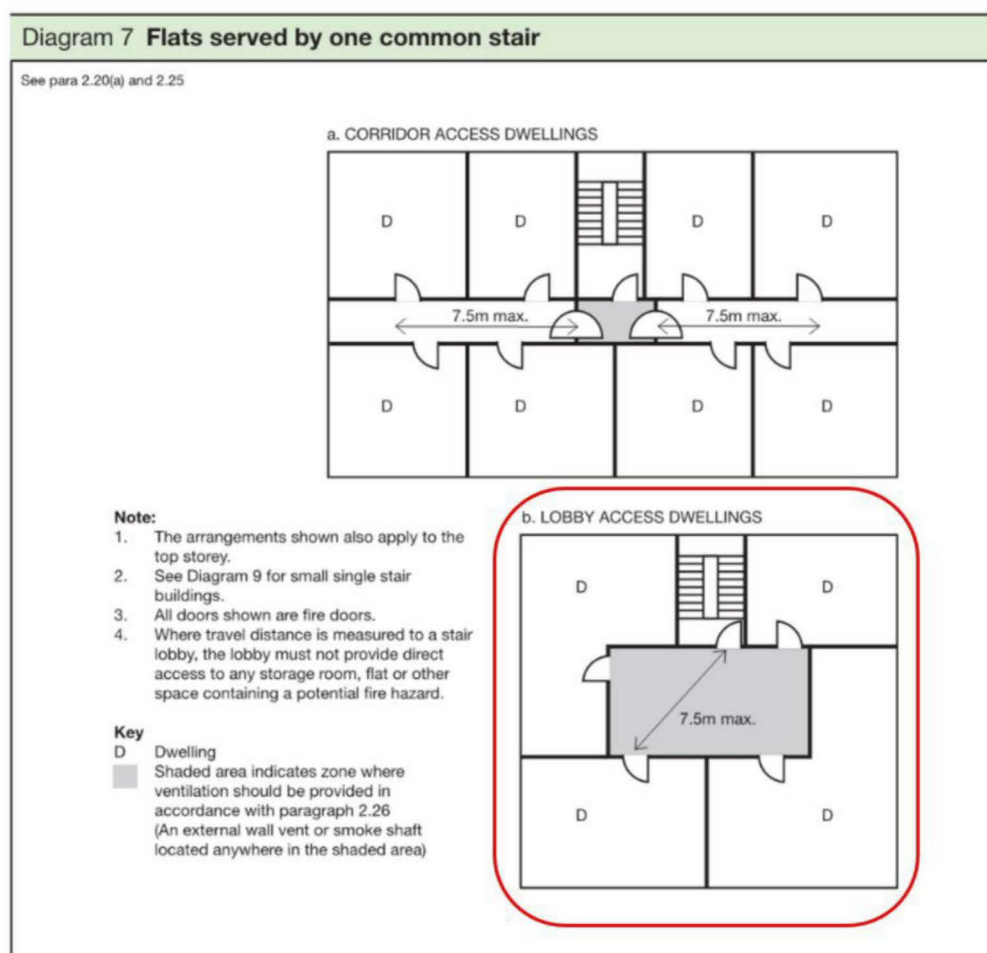


Figure G.7: Approved Document B Diagram 7 for flats served by one common stair

G2.5.4 As I described in Section 3, Grenfell Tower is served by a single common stair. Therefore, every flat is recommended to be separated from the common stair by a protected and ventilated lobby or corridor. The maximum travel distance from each flat entrance door to the stair door should be 7.5m, as shown in Figure G.7.

G2.5.5 ADB 2013 recommends the following provisions for protection of common escape routes:

“2.24 To reduce the risk of a fire in a flat affecting the means of escape from other flats and common parts of the building, the common corridors should be protected corridors.

The wall between each flat and the corridor should be a compartment wall (see Section 8)”

G2.5.6 Compartment walls separating a flat from any other part of the building in Grenfell Tower are recommended to meet the fire performance requirements of BS476 to 60 minutes (Loadbearing capacity, Integrity,) per ADB 2013 Table A1.

- G2.5.7** As well as fire resisting enclosures, ADB 2013 recommends the use of a smoke ventilation system to the lobby of single stair buildings in order to provide further protection to the stair from ingress by smoke.
- G2.5.8** ADB 2013 Section 2.25 “*Smoke control of common escape routes*” states that smoke control can be achieved as follows:
- “This can be achieved by either natural means in accordance with paragraph 2.26 or by means of mechanical ventilation as described in paragraph 2.27.”*
- G2.5.9** ADB 2013 Section 2.27 describes two types of mechanical system:
- “As an alternative to the natural ventilation provisions in paragraph 2.26, mechanical ventilation to the stair and/or corridor/lobby may be provided to protect the stair(s) from smoke. Guidance on the design of smoke control systems using pressure differentials is available in BS EN 12101-6:2005.”*
- G2.5.10** Pressure differential systems, are a form of mechanical ventilation, as described in BS EN 12101-6:2005. This is a system of fans, ducts, vents, and other features, provided for the purpose of creating a lower pressure in the fire zone than in the protected space, and therefore a flow of air from the protected space into the fire zone to prevent smoke from entering the protected space.
- G2.5.11** A pressure differential system can be either a depressurisation system which means the air pressure in the fire zone or adjacent spaces is reduced below that in the protected space; or a pressurization system which means the air pressure in the spaces being protected is raised above that in the fire zone.
- G2.5.12** I explain this in detail in Appendix J.
- G2.5.13** Original design guidance (CP3 1971):
- G2.5.14** CP3 1971 recommends the following provisions for travel distances in the common parts of flats:

3.3.4.3.1 Where the route from a dwelling entrance door leads in one direction only to a main stairway (i.e. the ‘dead-end’ condition), the door should not be more than 15 m (approximately 50 ft) from a door in the enclosing wall of a main stairway (see Figs. 14b, 15b, 16b and 18b). [2.3.7.2]

Figure 8: Excerpt from CP3 1971 – Travel distance in common corridors/lobbies

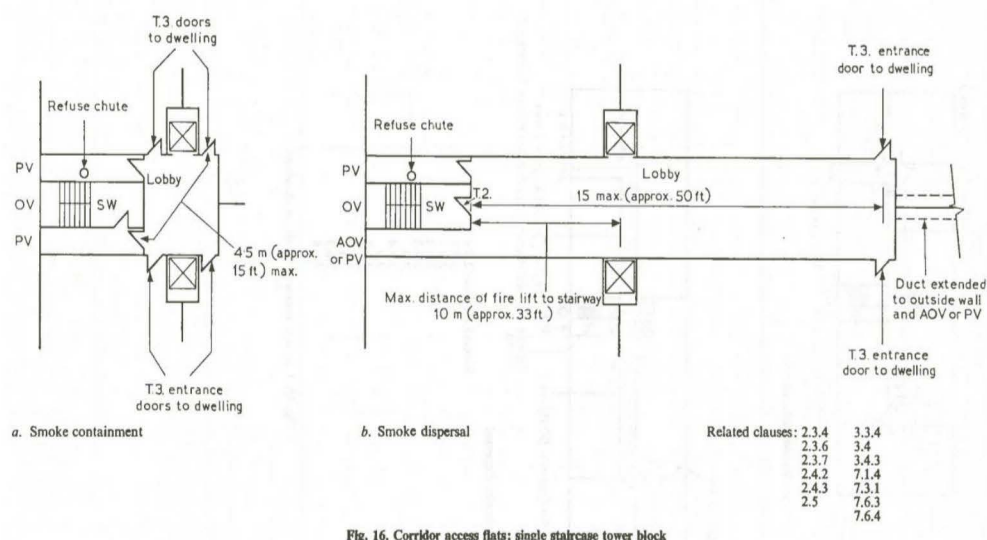


Figure G.9: CP3 1971 Figure 16 - Corridor access flats: single stair tower block

- G2.5.15** Therefore, the travel distance from every flat entrance door to the stair door was limited to 15m at the time of original design and construction of Grenfell Tower. This is twice the current limit.
- G2.5.16** Section 3.3.4.3.3 of CP3 1971 Part 4 requires the lobby to be ventilated with *a permanent opening with a fire area not less than 1.5m²*. This was not provided as a mechanical system was provided instead – refer to Appendix J where I explain this in more detail.
- G2.5.17** The protected stair in Grenfell Tower is not situated against an external wall; therefore, in accordance with CP3 1971 Section 3.4.6 the stair should have *a permanent vent at the top having a fire area of not less than 1m²*. Whilst this vent is present in Grenfell Tower, it is for the purposes of inlet air – please refer to Appendix J.
- G2.5.18** Flat entrance doors should be Type 3 doors (as per Figure 16 of CP3 1971, see my Figure G9).
- G2.5.19** The fire performance of Type 3 doors is stated as 30-minute stability 20 minutes' integrity when tested to BS 476-1:1953 in Section 4.3.2.3 of CP3 1971 Chapter 4 Part 1.

G2.6 Common stairs

G2.6.1 Approved Document (2013):

G2.6.2 ADB 2013 recommends the following for stair width:

“2.33 A stair of acceptable width for everyday use will be sufficient for escape purposes, but if it is also a firefighting stair, it should be at least 1100mm wide (see Appendix D for measurement of width).”

G2.6.3 As described in Section 16, the common stair at Grenfell Tower is a firefighting stair, and is therefore recommended to be at least 1100mm wide.

“2.36 Every common stair should be situated within a fire-resisting enclosure (i.e. it should be a protected stairway), to reduce the risk of smoke and heat making use of the stair hazardous.”

G2.6.4 The door to the firefighting stair is identified in Diagram 52 of ADB 2013 as an FD60S in a block of flats (Figure G.10).

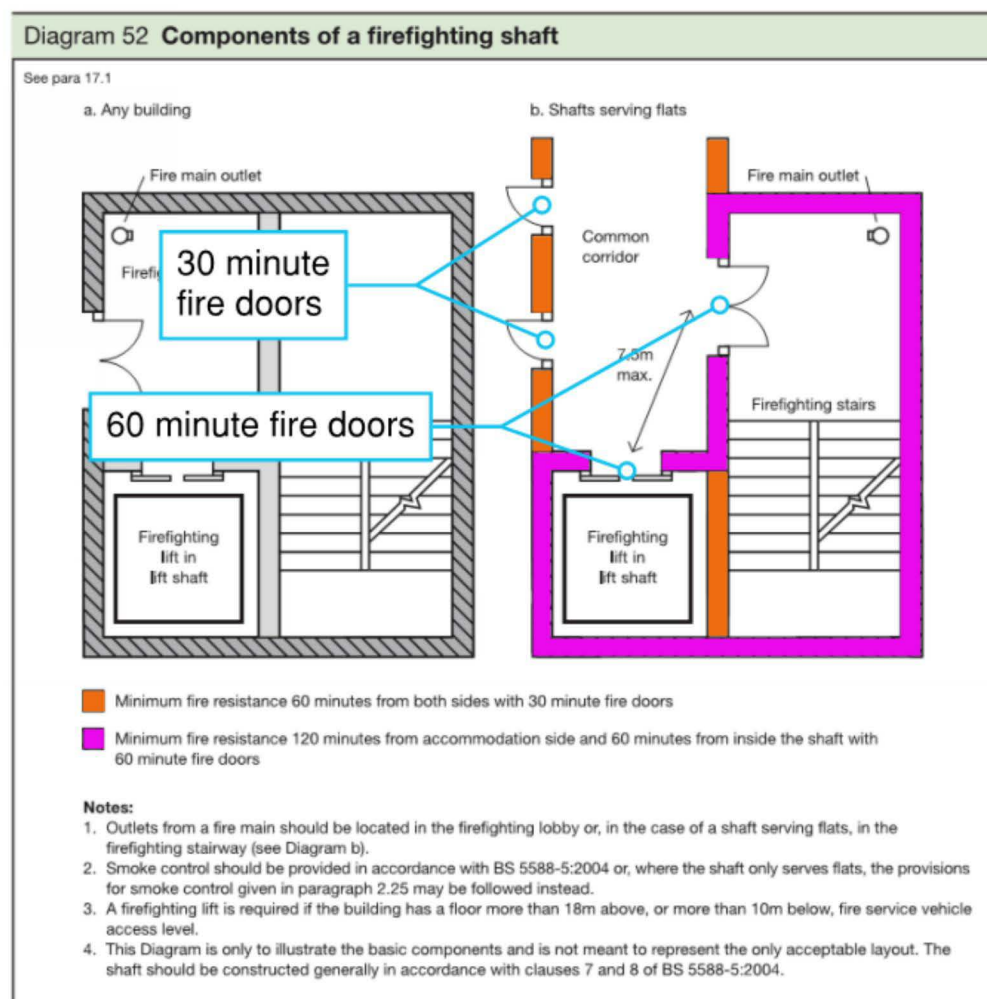


Figure G.10: ADB 2013 Diagram 52 – Diagram b (highlighted) applies to blocks of flats

G2.6.5 ADB 2013 recommends the following provisions for stair discharge:

“2.38 Every protected stairway should discharge:

a. directly to a final exit; or

b. by way of a protected exit passageway to a final exit.

Note: Any such protected exit passageway should have the same standard of fire resistance and lobby protection as the stairway it serves.”

G2.6.6 Therefore, the protected stair in Grenfell Tower is recommended to discharge directly to a final exit and meet the fire resistance requirements to the final exit.

G2.6.7 ADB 2013 recommends the following limitations for use of space within protected stairs:

“2.40 A protected stairway needs to be relatively free of potential sources of fire. Consequently, it should not be used for anything else, except a lift well or electricity meter(s). There are other provisions for lifts in paragraphs 5.39 to 5.45. In single stair buildings, meters located within the stairway should be enclosed within a secure cupboard which is separated from the escape route with fire-resisting construction...”

2.42 Gas service and installation pipes or associated meters should not be incorporated within a protected stairway unless the gas installation is in accordance with the recommendations for installation and connection set out in the Pipelines Safety Regulations 1996, SI 1996 No 825 and the Gas Safety (Installation and Use) Regulations 1998 SI 1998 No 2451 (see also paragraph 8.40).”

G2.6.8 Therefore, lift wells, electricity meters, and gas services are the only services deemed acceptable to run through the protected stairs by ADB 2013. These services are only deemed acceptable in the stair if specific provisions are met, as detailed in other sections of ADB 2013.

G2.6.9 In particular, gas piping in Grenfell Tower is allowed to run in the protected stair if it meets the abovementioned regulations. Refer to Appendix K where I set out the detailed recommendations of these regulations as well as additional ADB 2013 recommendations for gas piping running through a protected stair.

G2.6.10 ADB 2013 recommends the following limitations for stairs serving the basement:

“2.44 If an escape stair forms part of the only escape route from an upper storey of a building (or part of a building) which is not a small building (see paragraph 2.20), it should not be continued down to serve any basement storey. The basement should be served by a separate stair.”

G2.6.11 This means that the single common stair serving the levels above ground floor in Grenfell Tower should not serve the basement level, which it does not.

G2.6.12 ADB 2013 recommends the following limitations on shared means of escape for buildings with flats:

“2.51 In buildings with more than three storeys above the ground storey, stairs may serve both flats and other occupancies provided that:

- a. the flat is ancillary to the main use of the building and is provided with an independent alternative escape route*

- b. . the stair is separated from any other occupancies on the lower storeys by protected lobbies (at those storey levels);

Note: The stair enclosure should have at least the same standard of fire resistance as stipulated in Table A2 for the elements of structure of the building (and take account of any additional provisions in Section 17 if it is a firefighting stair).

- c. any automatic fire detection and alarm system with which the main part of the building is fitted also covers the flat;
- d. any security measures should not prevent escape at all material times.”

G2.6.13 The flats in Grenfell Tower are the main use of the building and are not ancillary to the main use of the building, therefore the guidance in ADB 2013 is to provide separate stairs to each use.

G2.6.14 Original design guidance (CP3 1971):

G2.6.15 CP3 1971 recommends stairs to be enclosed:

“3.4.1.1 All main stairways should be enclosed throughout their height, except where the ground or podium storey is designated as a permanently open pedestrian space and is kept fire from fire risk, the stairway enclosure at ground level may be omitted.”

G2.6.16 CP3 1971 recommends the following regarding stair width and minimum headroom:

3.4.2.2 Main and subsidiary stairways should have a minimum width of 1000 mm (approximately 3 ft 3 in) measured between walls, or 900 mm (approximately 3 ft) measured between a wall and the inside of a hand-rail on any flight. Treads should be not less than 240 mm (approximately 9½ in) wide measured from nosing to nosing; risers should not be more than 190 mm (approximately 7½ in); the pitch of the stairway should not be more than 38°; and there should be not less than two, and no more than sixteen, risers in a flight. The headroom should not be less than 2 m (approximately 6 ft 6 in) measured vertically above the line of the nosings.

A continuous handrail should be provided and where openings for windows, glazed panels or other similar purposes are formed in the portion of a wall required to guard a stairway, they should be guarded by a screen, balustrade or railing and where such openings are glazed from floor to ceiling (or are fitted with lightweight panels) and are on an external wall or overlook an internal well or shaft, close balustrading or other acceptable form of protection should be provided up to a height of 1.07 m (approximately 3 ft 6 in) above the level of any landing, floor or stairway nosing constructed to withstand the impact of any person falling against it.

Figure G.11: Excerpt from CP3 1971 – Stair width and minimum headroom

G2.6.17 CP3 1971 recommends the following limitations for stairs serving the basement:

3.4.3.2 The stairway should terminate at ground, or podium, level, and any stairway to a basement should be entered from the open air. The arrangement of the exit from the main stairway should be such as sufficiently to avoid the risk that smoke issuing from a fire in the basement or ground floor would obstruct the exit from the stairway. [2.4.5.9]

Figure G.12: Excerpt from CP3 1971 – Stairs serving basement

G2.7 General provisions

G2.7.1 Approved Document (2013):

G2.7.2 Fire resistance of enclosures - Section 5.3 states *All walls, partitions and other enclosures that need to be fire-resisting to meet the provisions in this Approved Document (including roofs that form part of a means of escape), should have the appropriate performance given in Tables A1 and A2 of Appendix A.*

G2.7.3 Section 10.9 states where *air handling ducts pass through fire separating elements the integrity of those elements should be maintained. Additionally, fire dampers actuated only by fusible links are not suitable for protecting escape routes. However an ES classified fire and smoke damper which is activated by a suitable fire detection system may be used. See paragraph 10.15.*

G2.7.4 Section 10.15 advises that *fire dampers should be tested to BS EN 1366-2:1999 and be classified to BS EN 13501-3:2005. They should have an E classification equal to, or greater than, 60 minutes. Fire and smoke dampers should also be tested to BS EN 1366-2:1999 and be classified to BS EN 13501-3. They should have an ES classification equal to, or greater than, 60 minutes. It notes, that Fire dampers tested using ad-hoc procedures based on BS 476 may only be appropriate for fan-off situations. In all cases, fire dampers should be installed as tested.*

G2.7.5 I have carried out my compliance assessment of the damper provision in Appendix J.

G2.7.6 Fire doors - ADB 2013 recommends that doors that need to be fire doors should meet the recommendations of Table B1:

“5.6 All doors that need to be fire-resisting to meet the provisions in this Approved Document should have the appropriate performance given in Table B1 of Appendix B.

Doors should also meet any limitations on the use of glass (see paragraph 5.7).”

G2.7.7 I have carried out a full review of the fire door provisions for Grenfell Tower in Appendix I and regarding historic fire doors in Appendix M.

G2.7.8 In Table G.3 I have summarised the ADB 2013 provisions for fire doors applicable to Grenfell Tower.

Table G.3 ADB 2013 Fire door provisions applicable to Grenfell Tower

Approved Document B 2013 fire door type	ADB 2013 performance provision applicable to Grenfell
Fire door in a compartment wall enclosing a protected shaft forming a stair situated wholly or partly above the adjoining ground in a building used for flats, other residential, assembly and recreation, or office purposes (Table B1)	FD30S (Table B1) (note the firefighting stair door provision supersedes this)
Fire door to the enclosure to the firefighting shaft	FD60S (Diagram 52)
Fire door in a compartment wall if it separates a flat from a space in common use	FD30S (Table B1 & Diagram 52)
Fire door in a compartment wall enclosing a protected shaft forming a lift or service shaft	FD60 (Table B1 & Diagram 52)
Fire door forming part of the enclosure of a protected entrance hall or protected landing in a flat (Table B1)	FD20 (Diagram 2 & Table B1)

G2.7.9 Other general provisions:

G2.7.10 ADB 2013 recommends the following relevant to the construction of escape stairs:

“5.19 The flights and landings of every escape stair should be constructed of materials of limited combustibility in the following situations:

- a. if it is the only stair serving the building, or part of the building, unless the building is of two or three storeys and is in Purpose Group 1(a) or Purpose Group 3;*
- b. if it is within a basement storey (this does not apply to a private stair in a flat);*
- c. if it serves any storey having a floor level more than 18m above ground or access level;*
- d. if it is external, except in the case of a stair that connects the ground floor or paving level with a floor or flat roof not more than 6m above or below ground level. (There is further guidance on external escape stairs in paragraph 5.25); or*
- e. if it is a firefighting stair (see Section 17).*

Note: In satisfying the above conditions, combustible materials may be added to the horizontal surface of these stairs (except in the case of firefighting stairs).”

- G2.7.11** The single common stair in Grenfell Tower is the only stair serving the building, which is more than 18m above ground, and it is a firefighting stair, therefore it must be constructed of materials of limited combustibility.
- G2.7.12** ADB 2013 references Approved Document K for handrail recommendations:
“5.20 Dimensional constraints on the design of stairs generally, to meet recommendations for safety in use, are given in Approved Document K, Protection from falling, collision and impact.”
- G2.7.13** Approved Document K (2013) recommends the following provisions for handrails in stairs for all buildings:
“ADK 1.34 Provide handrails in accordance with all of the following:
a. Position the top of the handrail 900mm to 1000mm from the pitch line or floor.
b. The handrail may form the top of the guarding if you can match the heights
c. If the stairs are 1000mm or wider: provide a handrail on both sides.”
- G2.7.14** The protected stair in Grenfell Tower is a firefighting stair and is recommended to be at least 1100mm wide. Therefore, a handrail is recommended on both sides of the stair.
- G2.7.15** ADB 2013 provides the following guidance regarding headroom and surfaces of escape routes:
“5.26 All escape routes should have a clear headroom of not less than 2m and there should be no projection below this height (except for door frames).
...
5.27 The floorings of all escape routes (including the treads of steps and surfaces of ramps and landings) should be chosen to minimise their slipperiness when wet.”
- G2.7.16** ADB 2013 Sections 5.30-5.34 gives recommendations for final exits, summarised as follows. Final exits should:
- a) not be less than the minimum width required for the escape routes they serve;
 - b) give direct access to an open space, street, passageway or walkway;
 - c) not present an obstacle to disabled occupants;
 - d) be apparent to those needing to use them;
 - e) be sited clear of any risk of fire and smoke in a basement.
- G2.7.17** ADB 2013 Section 5.36 recommends the following provisions for lighting of escape routes:

“5.36 All escape routes should have adequate artificial lighting. Routes and areas listed in Table 9 should also have escape lighting which illuminates the route if the main supply fails.

Lighting to escape stairs should be on a separate circuit from that supplying any other part of the escape route.

Standards for the installation of a system of escape lighting are given in BS 5266-1:2005.”

- G2.7.18** Pursuant to ADB 2013 Section 0.22, the most recent version of a British Standard may be applied where the one listed at the end of ADB 2013 has been superseded. BS 5266-1:2005 was superseded by BS 5266:2011 by the time of the 2012 – 2016 refurbishment works.
- G2.7.19** The recommendations of *BS 5266-1:2011 Emergency lighting. Code of practice for the emergency lighting of premises* are discussed further below.
- G2.7.20** Table 9 of ADB 2013 recommends escape lighting to be provided in Residential buildings as follows: *“All common escape routes, except in 2-storey flats”*. Note 1 to table 9 states that this includes external escape routes.
- G2.7.21** The Scope of BS 5266-1:2011 Emergency lighting. Code of practice for the emergency lighting of premises states:
- “This part of BS 5266 is not applicable to dwellings; however, its provisions are applicable to common access routes within blocks of flats or maisonettes.”*
- G2.7.22** The minimum illuminance required for the common areas is stipulated in Section 5.1 of the code of practice as:
- a) 5.1.1 Defined escape routes – *“To assist escape routes to be used at all times, the horizontal illuminance on the floor along the centre line of an escape route up to 2m in width should be not less than 1 lx.”*
 - b) 5.1.2 Open areas – *“Rooms larger than 60 m² floor area, or those having been risk assessed as needing emergency lighting, should be provided with horizontal illuminance of not less than 0.5 lx at the floor level of the area, excluding a border of 0.5m around the perimeter.”*
- G2.7.23** The following areas are recommended in Section 6.6 of BS 5266-1:2011 to be provided with emergency lighting:
- a) *“escape routes, open areas, high risk task areas, and points of emphasis including:*
 - i. *at each exit door intended to be used in an emergency;*
 - ii. *near (see Note) stairs so that each flight of stairs receives direct light;*
 - iii. *near (see Note) any other change in level;*

- iv. *mandatory emergency exits and safety signs;*
- v. *at each change of direction;*
- vi. *at each intersection of corridors;*
- vii. *near to each final exit and outside the building to a place of safety;*
- viii. *near (see Note) each first aid post;*
- ix. *near (see Note) each piece of firefighting equipment and call point."*

b) *"External areas in the immediate vicinity of exits"*

c) *"Lift cars"*

d) *"Toilet facilities"*

e) *"Motor generator, control, plant and switch rooms"*

G2.7.24 The siting of emergency lighting is stated in Section 6.4.

"6.4 Mounting height of luminaires

The normal height for luminaires should be at least 2 m, but the mounting height might need to be risk-assessed for the application, taking into account the effects of glare, the need to be below the possible build-up of smoke in smoke reservoirs, conditions in specific buildings (e.g. heritage buildings), or to highlight specific hazards such as stairs."

G2.7.25 Section 9.1- Duration of BS 5266-1:2011 states:

"A minimum duration of 3 h should be used for emergency escape lighting if premises will not be evacuated immediately in a supply failure, such as sleeping accommodation or places of entertainment, or if the premises will be reoccupied when the supply is restored without waiting for batteries to recharge."

G2.7.26 Section 9.3.9 of BS 5266-1:2011 states:

"Common access routes within blocks of flats or maisonettes. In general, people using this class of premises can be expected to be reasonably familiar with the layout and safety provisions, and orderly evacuation can normally be expected in the event of an emergency. Based on these considerations, a 3h duration system should be used in common access routes within blocks of flats or maisonettes, because these are escape routes from sleeping risk premises."

G2.7.27 Table D1 of BS 5266-1:2011 recommends that disabled refugees are provided with 5 lx; and plant rooms, switch room, emergency winding facilities for lifts, fire alarm control and indicating equipment are recommended to be provided with 15 lx.

G2.7.28 The recommendations for exit signage are stated in Section 5.37 of ADB 2013 as:

“5.37 Except within a flat, every escape route (other than those in ordinary use) should be distinctively and conspicuously marked by emergency exit sign(s) of adequate size complying with the Health and Safety (Safety signs and signals) Regulations 1996. In general, signs containing symbols or pictograms which conform to BS 5499-1:2002, satisfy these regulations. In some buildings additional signs may be needed to meet requirements under other legislation. Suitable signs should also be provided for refuges (see paragraph 4.10).

Note: Advice on fire safety signs, including emergency escape signs, is given in an HSE publication: Safety Signs and Signals: Guidance on Regulations.”

G2.7.29 The Health and Safety (Safety signs and signals) Regulations 1996 is applicable to places of work. The protected stairs, lobbies and plant spaces of Grenfell Tower are all places of work and so the regulations apply.

G2.7.30 Specific recommendations are made for the signage of the following fire doors in Sections 8 and 9 of Appendix B of ADB 2013:

“8. Except for doors identified in paragraph 9 below, all fire doors should be marked with the appropriate fire safety sign complying with BS 5499-5:2002 according to whether the door is:

- a. to be kept closed when not in use (Fire door keep shut);*
- b. to be kept locked when not in use (Fire door keep locked shut); or*
- c. held open by an automatic release mechanism or fire swing device (Automatic fire door keep clear). Fire doors to cupboards and to service ducts should be marked on the outside; all other fire doors on both sides.*

9. The following fire doors are not required to comply with paragraph 8 above:

- a. doors to and within flats;*
- b. bedroom doors in ‘Other-residential’ premises; and*
- c. lift entrance/landing doors.”*

G2.7.31 The HSE publication: Safety Signs and Signals: Guidance on Regulations referenced by ADB 2013 Section 5.37 states the following provisions for exit signage:

“109 People usually leave premises by the same way that they enter or by routes which are familiar to them. Alternative exits (i.e. all emergency exits and any exits not in normal use) should be clearly indicated so that people know there are additional ways to leave. In addition, the provision of well-signposted exits in full view will give a feeling of security in an emergency.

110 Make sure the fire exit sign is displayed immediately above the exit opening or, if this is not possible, choose a position where the sign can be clearly seen and is least likely to be obstructed or obscured by smoke.

112 In buildings with multiple occupants a common approach to the provision of fire safety signs is sensible so that people are not confused about the exit routes from the building. In such cases, it is normally the owner of the building who has responsibility for displaying signs in common areas (e.g. stairways) and if there is any doubt check this with your enforcing authority for fire safety. Individual occupiers are normally responsible for the signs necessary within their part of the building.

113 Your enforcing authority for fire safety may, in addition to the fire safety signs referred to in these Regulations, require provision of certain supplementary signs to aid the effective and efficient use of the escape routes provided. For instance, where there is a danger that a door which is a fire exit may become obstructed (because its importance is not appreciated) such as a final exit door opening into a car park or storage yard, or a seldom used intercommunicating or bypass door between rooms, a conspicuous 'Fire Escape – Keep Clear' sign should be shown on the appropriate faces of the door. Check with your enforcing authority if you have any doubts.

114 If the level of natural light is poor, then adequate illumination (which includes emergency lighting) will be required. Signs incorporating photo luminescent materials may also have a role in poor light conditions."

G2.7.32 Therefore, as per Section 109 of HSE publication: *Safety Signs and Signals: Guidance on Regulations* only alternative exits are recommended to have emergency signage. As shown in Section G2.7.28, ADB 2013 Section 5.37 only requires escape routes that are not in ordinary use to be marked with exit signs.

G2.7.33 ADB 2013 Section 5.38 makes the following recommendations for critical electric circuits:

- a) Consist of cable meeting at least the requirements for PH 30 classification when tested in accordance with BS EN 50200:2006;
- b) Should be supported by non-combustible materials;
- c) Should follow a route that only passes through parts of the building with negligible fire risk.

G2.7.34 ADB 2013 recommends the following provisions to protect escape routes from refuse chutes and rooms:

"5.55 Refuse chutes and rooms provided for the storage of refuse should:

a. be separated from other parts of the building by fire-resisting construction; and

b. not be located within protected stairways or protected lobbies.

5.56 Rooms containing refuse chutes, or provided for the storage of refuse, should be approached either directly from the open air or by way of a protected lobby provided with not less than 0.2m² of permanent ventilation.”

G2.7.35 Original design guidance (CP3 1971):

G2.7.36 The recommended performance specification for fire doors separating the main stair from the common corridors are stated in Section 4.4.3 of CP3 1971 Chapter 4 part 1 as:

“Access to main Stairways should be gained through Type 2 doors placed in the enclosing walls of the stairways.”

G2.7.37 The performance requirements of Type 2 doors are stated in Section 4.3.2.2 of CP3 1971 Chapter 4 part 1 as:

“The door, or leaf thereof when fixed in a frame with a 25mm rebate (approximately 1in) should satisfy the requirements of test as to both freedom from collapse and resistance to passage of flame for not less than 30 minutes. The door may be single or double leaf, swinging in one or both directions. Such doors should be fitted with a self-closing device (other than rising butt) and the frame may have either no rebate or a rebate of unspecified depth; meeting stiles should not be rebated. With any doors fitted in frames without rebates, the clearance between leaf and frame, or leaf and leaf, should be as small as reasonably practicable”

G2.7.38 The method of test exposure to demonstrate stability and integrity is defined in Section 4.3.1 of CP3 1971 Chapter 4 part 1 as:

“In all cases, the tests referred to under 4.3.2 are those laid down in BS 476.”

G2.7.39 The relevant BS 476 standard in 1972 was BS 476-1:1953.

G2.7.40 Section 3.4.2.2 states that stairs should be provided with: *“a continuous handrail”*. This section also states the stairs *“should not be less than 2m measured vertically above the line of the nosings.”*

G2.7.41 Escape signage is not discussed in CP3 1971.

G2.7.42 The guidance in CP3 1971 for lighting of blocks of flats is included below. This guidance does not propose a secondary power supply, but it does stipulate specific measures to provide a degree of protection to the lighting circuit.

6. ENGINEERING SERVICES

6.1 STAIRWAY AND CORRIDOR LIGHTING

Adequate artificial light should be provided in all stairways and in corridors forming part of escape routes. Stairway and corridor lights should be supplied by 'protected circuits' (i.e. sub-main circuits) exclusive to the stairway and corridor lighting and restricted to routes of negligible fire risk. Stairways should be illuminated by a circuit direct from the main switchboard with switches on each landing capable of overriding the automatic time control and switching the lighting on, but incapable of switching the lighting off. Where a stairway has no natural lighting its lighting circuit should be independent of the corridor lighting.

Figure G.13: Excerpt from CP3 1971 - Stair and corridor lighting

G2.7.43 The guidance for refuse chutes is CP3 1971 is excerpted below.

4.5 REFUSE CHUTES

Refuse chutes should conform to CP 306. The enclosing structure should be of non-combustible materials and should have a fire resistance of not less than one hour or that period required by the Building Regulations for the elements of structure of the building, whichever is the greater.

Refuse chute access hoppers should not be in any stairway enclosure or corridor, nor in a stairway protection lobby.

Refuse chute enclosures should be ventilated to the open air.

Figure G.14: CP3 1971 guidance for refuse chutes

G2.7.44 Per the Constructional Bylaws, applicable at the time of construction, therefore, the enclosing structure of the refuse chute was required to be 60 minutes fire resistance.

G2.8 Provisions for occupants that require assistance to escape:

G2.8.1 Regulation B1 of the building Regulations states:

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

G2.8.2 I discuss the application of this regulation with respect to provisions for occupants that require assistance to escape for both the non-residential and residential areas of Grenfell Tower separately below.

G2.8.3 Non-residential areas:

G2.8.4 Section 4: Design for vertical escape – buildings other than flats of ADB 2013 states:

"4.7 refuges are relatively safe waiting areas for short periods. They are not areas where disabled people should be left alone indefinitely until rescued by the fire and rescue service, or until the fire is extinguished. A refuge should be provided for each protected stairway affording egress from each storey, except storeys consisting exclusively of plant rooms."

G2.8.5 A refuge would therefore be required on Level 1, and Level 2 of Grenfell Tower as these areas include non-residential uses.

G2.8.6 Residential areas:

G2.8.7 Section 2 - Means of escape from flats - of ADB 2013 does not contain any provisions for the evacuation of occupants that require assistance to escape.

G2.8.8 However, the functional requirement for means of escape is clear. It requires:

“...appropriate means of escape in case of fire from the building to a place of safety outside the building...”.

G2.8.9 In addition, Section Bi.v states:

“Note: Some people, for example those who use wheelchairs, may not be able to use stairways without assistance. For them evacuation involving the use of refuges on escape routes and either assistance down (or up) stairways or the use of suitable lifts will be necessary.”

G2.8.10 As I explain in the lift assessment in Appendix L of my main Expert Report, the lifts installed in Grenfell Tower were not firefighting lifts and therefore could not safely be used for the evacuation of occupants requiring assistance to escape.

G2.8.11 Please refer to Appendix L of my main Expert Report for further information.

G2.8.12 I note that BS 9991:2015, a published guidance document with specific guidance on the duties for fire safety managers in residential buildings, does provide guidance for provisions of facilities for occupants that require assistance to escape.

G2.8.13 Section 9: Management, Section 54, Evacuation of disabled occupants or occupants that require assistance to escape, in BS 9991:2015 states:

“Providing an accessible means of escape should be an integral part of fire safety management in all residential buildings. Fire safety management should take into account the full range of people who might use the premises, paying particular attention to the needs of disabled people.

NOTE 1 It is the responsibility of the premises management to assess the needs of all people to make a safe evacuation when formulating evacuation plans.

An evacuation plan should not rely on the assistance of the fire and rescue service. This is an important factor that should be taken into account in the building design. It cannot be assumed that facilities provided in a building to make it accessible will be usable in a fire evacuation. For example, lifts that are not appropriately designed for emergency evacuation might not be usable for evacuation. This should be taken into account at the design stage when it is relatively easy to incorporate accessible escape features which will make evacuation planning more effective, an evacuation easier to manage and help to preserve the dignity of disabled people in an evacuation....”

G2.8.14 I therefore referred to BS9991:2015 when assessing the provisions made at Grenfell Tower to comply with Regulation B1.

G2.8.15 I am aware there is a range of opinion on this issue, as I explain in Section 15.6.8 – 15.6.15 in my main report.

G2.9 Summary of ADB 2013 and CP3 1971 recommendations for means of warning and escape

G2.9.1 Below provides a summary of the provisions for B1 compliance using ADB 2013 and the equivalent CP3 1971 guidance.

Table G.4 Summary of the provisions for B1 compliance using ADB 2013 and the equivalent CP3 1971

Means of warning and escape provision	ADB 2013 Sections	Recommendations as per ADB 2013	CP3 1971 Sections	Recommendations as per CP3 1971
Fire alarm and fire detection for flats	1.4 1.5 1.9 1.10 1.13 1.14 1.38	a) New flats on Levels 1 – 3 should be provided with a self-contained LD2 fire detection and fire alarm system (ADB 2013 Section 1.4; BS 5839-6:2013). b) Existing flats on Levels 4 – 23 should be provided with the higher standard self-contained LD2 fire detection and fire alarm system due to the condition of the structural fire precautions in Grenfell Tower. I have evidence that systems were installed, but no indication of date of installation. ADB 2013 Section 1.4; BS 5839-6:2013). c) Fire detection and alarm systems in individual flats should be mains-operated and have a standby power supply (ADB 2013 Section 1.5). d) Smoke alarms within an individual flat should be linked so that detection of smoke by one unit operates the alarm signal in all of them within a single flat. e) Smoke alarms/detectors should be positioned in the circulation space of each flat, within 7.5m of the door to every habitable room. f) The interface between the fire detection and fire alarm system, and any other system required for compliance with the Building Regulations is designed to achieve a high degree of reliability.	7.7	At least one public telephone should be provided within the block, or a call box should be provided within 300m of the building.
Provisions for means of escape from flats with a floor more than 4.5m above ground level	2.13 Diagram 2 Table B1	a) Each flat should have a protected entrance hall. b) Travel distance within protected entrance hall should be limited to 9m or less. c) Protected entrance hall should be of 30-minute fire-resisting construction with FD20 fire resisting doors. d) Bathroom doors do not need to be fire doors if bathrooms are separated from adjacent rooms by fire-resisting construction.	3.2.1 3.2.1.1 4.3.2.3 Figure 1	a) Each flat should have a protected entrance hall. b) Travel distance within protected entrance hall should be limited to 7.5m or less. c) Protected entrance hall should be of 30-minute fire-resisting construction. d) Doors opening into protected entrance halls should achieve be 30-minute stability 20 minutes' integrity when tested to BS 476-1:1953. e) Bathroom and WC doors do not need to be fire doors and doors do not require self – closers.
Common parts of blocks of flats	2.20 2.24 2.25 2.26 2.27 Diagram 7 Table A1 Table B1	a) Each flat should be separated from the common stair by a protected lobby or common corridor. b) Travel distance from each flat entrance door to stair door is limited to 7.5m. c) Compartment walls separating flats from other parts of the building should be 60-minute fire resistance construction (Loadbearing capacity, Integrity, Insulation). d) Flat entrance doors to be FD30S self-closing fire doors. e) The protected lobby should be ventilated.	2.5.1 3.3.4.3.1 3.3.4.3.3 Figure 16 4.3.2.3 4.3.2.2	a) Travel distance from each flat entrance door to stair door is limited to 15m. b) The protected lobby should be ventilated with a permanent opening with a fire area not less than 1.5m ² where smoke dispersal is used as the means of protection for the stage 2 escape routes. c) Flat entrance doors should achieve be 30-minute stability 20 minutes' integrity when tested to BS 476-1:1953. d) Doors to the protected stair enclosure should achieve 30-minute stability 30 minutes' integrity when tested to BS 476-1:1953.

Means of warning and escape provision	ADB 2013 Sections	Recommendations as per ADB 2013	CP3 1971 Sections	Recommendations as per CP3 1971
Common stairs	2.33 2.36 2.38 2.40 2.42 2.44 2.51 Table A1 Diagram 52	a) Protected stair at Grenfell Tower should be at least 1100mm wide. b) Protected stair at Grenfell Tower should meet the fire performance requirements of BS476 to 60 minutes (Loadbearing capacity, Integrity, Insulation). c) Stair door should be FD60S self-closing fire door. d) Protected stair should discharge to a final exit either directly or via a protected exit passageway. e) Lift wells, electricity meters, and gas services are the only services permitted to run through the protected stairs (if specific criteria are met). f) Basement should be served by a separate stair. g) Protected stair should not be shared between the means of escape for flats and other occupancies. h) Where shared stairs are provided, protected lobbies to be provided between the stairs and other uses.	3.4.1.1 3.4.2.2 3.4.3.2 3.4.6	a) Protected stair should be enclosed throughout its height. b) Protected stair should have a minimum width of 1000mm measured between walls, or 900mm measured between a wall and the inside of a handrail on any flight. Treads should not be less than 240mm wide risers should not be more than 190mm. Headroom should not be less than 2m. c) Basement should be served by a separate stair, entered from the open air. d) The stair Should have <i>a permanent vent at the top having a fire area of not less than 1m².</i>
Means of escape for disabled people	4.7 BS 9991 Section 9	a) A refuge should be provided for each protected stair affording egress from each storey with non-residential accommodation, except storeys consisting exclusively of plant rooms b) For residential levels – evacuation plan required for Evacuation of disabled occupants or occupants that require assistance to escape.	NA	NA.
General provisions for escape routes	5.3 5.6 5.19 5.20 5.26 5.27 5.30-5.34 5.36 Table 9 5.37 5.38 5.48 5.55 5.56	a) All walls, partitions and other enclosures that need to be fire-resisting to meet the provisions in this Approved Document (including roofs that form part of a means of escape), should have the appropriate performance given in Tables A1 and A2 of Appendix A. b) All doors that need to be fire-resisting to meet the provisions in this Approved Document should have the appropriate performance given in Table B1. c) Protected stair should be constructed of materials of limited combustibility d) Protected stair should have a handrail on both sides. e) All escape routes should have a clear headroom of not less than 2m (except for door frames). f) Escape route floor surfaces should be chosen so as to minimise their slipperiness when wet. g) Final exits should: i. not be less than the minimum width required for the escape routes they serve; ii. give direct access to an open space, street, passageway or walkway; iii. not present an obstacle to disabled occupants; iv. be apparent to those needing to use them; v. be sited clear of any risk of fire and smoke in a basement. h) All escape routes should have adequate artificial lighting. i) Specific areas should have escape lighting which illuminates the route if the main supply fails. j) Lighting to escape stairs should be on a separate circuit from that supplying any other part of the escape route. k) Except within a flat, every escape route (other than those in ordinary use) should be distinctively and conspicuously marked by emergency exit sign(s) of adequate size complying with the Health and Safety (Safety signs and signals) Regulations 1996. l) Critical electrical circuits should be protected circuits, supported by non-combustible materials and should follow a route that only passes through parts of the building with negligible fire risk m) Rooms containing refuse chutes should be separated by fire resisting construction and should be approached by way of a protected lobby with permanent ventilation.	4.4.3.1 3.4.2.2 6.1 4.1	a) Access to main Stairs should be gained through Type 2 doors placed in the enclosing walls of the stairs b) Stairs should be provided with “a continuous handrail” c) Adequate artificial light should be provided in all stairs and in corridors forming part of escape routes i. Stair and corridor lights should be supplies by “protected circuits” exclusive to this lighting. ii. Refuse chutes should conform to CP306. The enclosing structure should be of non-combustible materials and should have a fire resistance of not less than one hour or that provided by the Building Regulations for elements of structure of the building whatever is greater. Refuse chute access hoppers should not be in any stair enclosure or corridor nor in a stair protection lobby. Refuse chute enclosures should be ventilated to the open air.

Means of warning and escape provision	ADB 2013 Sections	Recommendations as per ADB 2013	CP3 1971 Sections	Recommendations as per CP3 1971
		<div>n) Ducts passing through the enclosure of a protected escape route should be fire-resisting, i.e. the ductwork should be constructed in accordance with Method 2 or Method 3, (see paragraph 10.9). An ES classified fire and smoke damper which is activated by a suitable fire detection system may be used. See paragraph 10.15.</div> <div>o) 10.15 Fire dampers should be tested to BS EN 1366-2:1999 and be classified to BS EN 13501-3:2005. They should have an E classification equal to, or greater than, 60 minutes. Fire and smoke dampers should also be tested to BS EN 1366-2:1999 and be classified to BS EN 13501-3. They should have an ES classification equal to, or greater than, 60 minutes. Note 1: Fire dampers tested using ad-hoc procedures based on BS 476 may only be appropriate for fan-off situations. In all cases, fire dampers should be installed as tested.</div>		

G3 Provisions for means of warning and escape in Grenfell Tower

G3.1.1 In this section I set out my opinions on whether Grenfell Tower complied with the original guidance from the time of construction, set out in CP3 1971, and with the current statutory guidance in ADB 2013.

G3.2 Fire detection and alarm

G3.2.1 In this section, I describe observations from my post fire inspections of fire detection and fire alarm systems in flats on Levels 1 – 5. It is important to note that entire false ceilings had been removed in some flats and devices may have been removed in others after the fire. Fire detection and fire alarm devices may have also been damaged during the fire. I have provided my observations based on evidence of detection below.

G3.2.2 New build flats created by 2012 - 2016 refurbishment

G3.2.3 Positioning of detectors

G3.2.4 With regard to the new-build flats, during my post fire inspections, I inspected Flat 2 (Level 1) and Flat 6 (Level 2) and observed smoke alarms in the protected entrance halls within 7.5m of the door to every habitable room.

G3.2.5 The Electrical Services ‘Record’ drawings for Levels 1 and 2, dated 10 June 2016, show smoke alarms in the protected entrance halls for Flats 2 – 6 on Levels 1 and 2, as shown in Figure G.15 and Figure G.16. (RYD00094164)

G3.2.6 No smoke detectors were observed in the living room or kitchen. Therefore, an LD2 fire detection and fire alarm systems was not provided in Flats 2- 6 and therefore these apartments are not compliant with ADB 2013 Section 1.4 and BS 5839-6:2013.

G3.2.7 However, the fire detection and fire alarm systems in Flats 2 – 6 appear to meet the requirements of a LD3 system, which is defined by BS 5839-6:2013 Section 8.1.1 as:

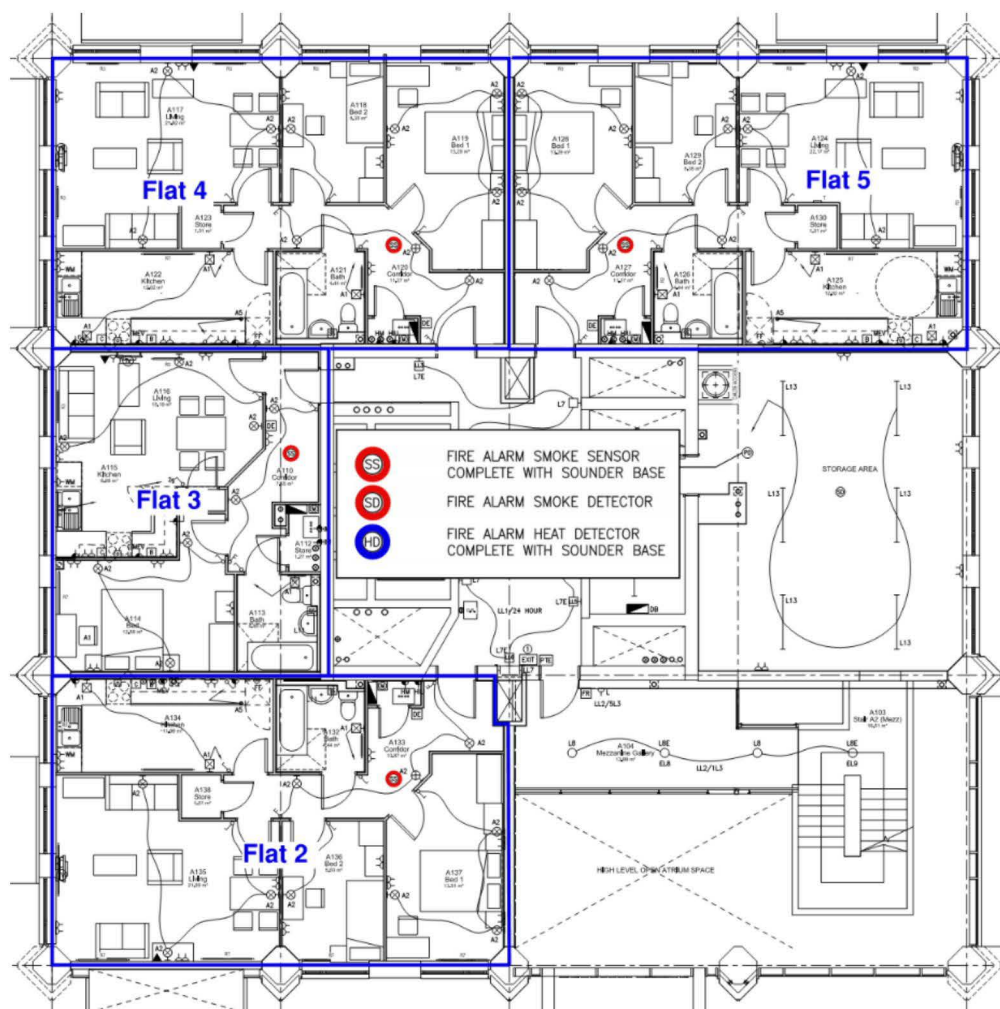
“a system incorporating detectors in all circulation spaces that form part of the escape routes from the premises.”

G3.2.8 This is consistent with the Grenfell Tower refurbishment fire strategy, which only required a LD3 system in these flats:

“New apartments will be provided with “LD3” systems of detection and sounders as defined in BS 5839-6” (TMO00828399)

G3.2.9 The Grenfell Tower refurbishment fire strategy did not include a risk assessment for this deviation from the guidance in BS 5839-6:2013 (see above at G2.3.18).

G3.2.10 In the next phase of my investigation, I will assess compliance of the fire strategy design with the Building Regulations.



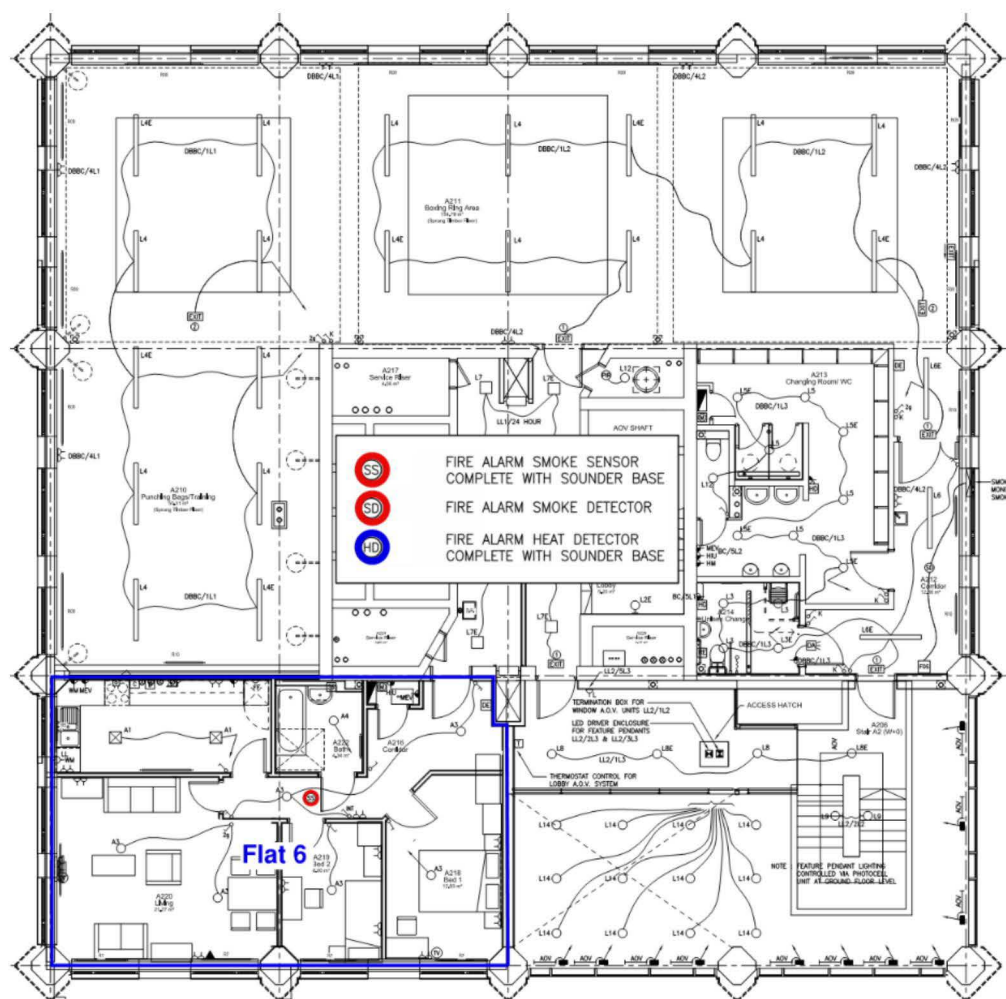


Figure G.16: 'Record Drawing' of fire detection and fire alarm systems in residential flats on Level 2 (JSW00000093)

G3.2.11 With regard to the flats on Level 3, during my post fire inspections, I inspected Flats 7 – 10. I observed evidence of smoke alarms in the protected entrance halls within 7.5m of the door to every habitable room for each of these apartments. I observed evidence of heat detectors in the kitchens of Flats 9 and 10. I observed evidence of smoke detectors in 14 of 16 habitable rooms in Flats 7, 9, and 10. I did not observe any evidence of smoke detectors in habitable rooms in Flat 8.

G3.2.12 The Electrical Services 'Record' drawing for Level 3, dated 10 June 2016, shows smoke alarms in the protected entrance halls, each bedroom, and the lounge for Flats 7 – 10. This drawing also shows a heat detector in each kitchen of these flats, as shown in Figure G.17. (RYD00094165)

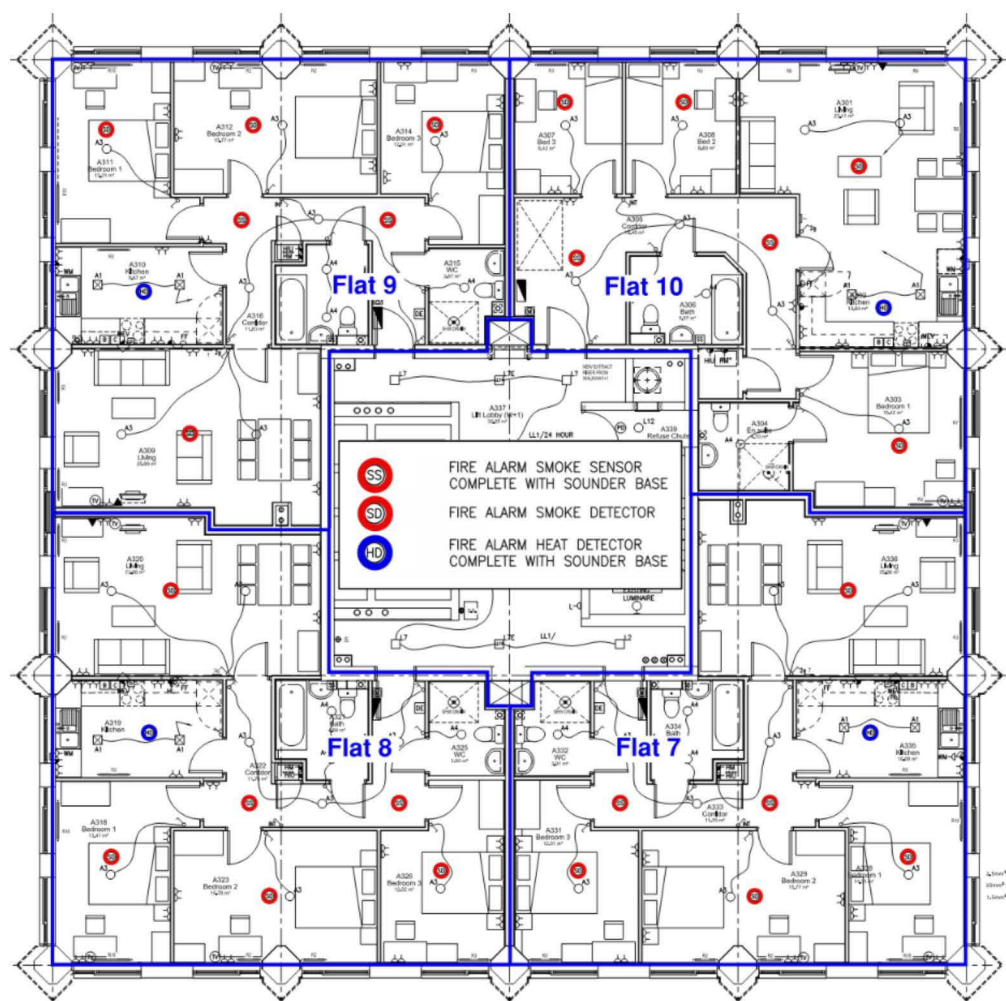


Figure G.17: 'Record Drawing' of fire detection and fire alarm systems in residential flats on Level 3 (RYD00094165)

- G3.2.13** Based on this evidence, I am satisfied to a high standard that at least an LD2 fire detection and fire alarm systems was provided in Flats 7 – 10 and these apartments are compliant with ADB 2013 Section 1.4 and BS 5839-6:2013 Table 1.
- G3.2.14** Furthermore, Flats 7 – 10 appear to meet the requirements for LD1 fire detection and fire alarm system, which is defined by BS 5839-6:2013 Section 8.1.1 as:
- “a system installed throughout the dwelling, incorporating detectors in all circulation spaces that form part of the escape routes from the dwelling, and in all rooms and areas in which fire might start, other than toilets, bathrooms and shower rooms”*
- G3.2.15** As described herein, the travel distances within the protected entrance halls of Flats 7 – 10 (Level 3) exceed 9m, the ADB 2013 travel distance limitation. The Grenfell Tower refurbishment fire strategy, states the following:

“The travel distance from the apartment entrance door to the door to the furthest habitable room will not generally exceed 9m. Where it does, an “LD1” fire alarm and detection system will be provided.” (TMO00828399)

G3.2.16 Power supplies for fire detection and alarm in new flats

G3.2.17 The “Grenfell Tower Description of Electrical Services” document indicated the fire detection and fire alarm system in new flats on Levels 2 and 3 were intended to each be a *“mains connected system”* (RYD00094130).

G3.2.18 *Walkway apartments* refers to the new flat on Level 2 (Flat 6) and the *Mezzanine apartments* refer to the flats on Level 1 (Flats 2 – 5). This design documentation is inconsistent with our observations and the Electrical Services ‘Record’ drawings stated earlier. I do not know if this is an error.

G3.2.19 During our site inspections, I observed the switchboard for individual apartments, which included a switch for “smoke alarms” (Figure G.2). Therefore, it appears the fire detection and fire alarm systems in the new flats were compliant with ADB 2013 Section 1.5 with respect to the system being mains-operated.

G3.2.20 I have not found evidence of a standby power supply for these systems, therefore I could not assess full compliance with ADB 2013 Section 1.5. I did not conduct intrusive surveys of the fire detection and alarm units and therefore I am not aware at this time if they contained a battery back-up power supply.

G3.2.21 Existing flats on Levels 4 to 23

G3.2.22 Position of detectors

G3.2.23 It was indicated in the 2016 fire risk assessment conducted on behalf of the TMO that the fire detection and fire alarm systems in existing TMO tenanted flats on Levels 4 – 23 included *“electrically powered/operated hardwired interlinked heat and smoke detectors”* and that there was a smoke alarm in the protected entrance hall and a heat alarm in the kitchen (LFB00000066).).

G3.2.24 There were 106 TMO tenanted flats and 14 leaseholder flats in Grenfell Tower on Levels 4 – 23. (TMO00837465)

G3.2.25 Therefore, 106 flats in Grenfell Tower had a smoke detector/sounder in the protected entrance hall and a heat detector in the kitchen. This indicates the 106 TMO tenanted flats in Grenfell Tower were fitted with LD2 fire detection and fire alarm systems.

G3.2.26 The 2016 fire risk assessment also indicated that the fire risk assessor was unaware of the fire detection and fire alarm systems installed in the 6 leaseholder flats (if any). (LFB00000066)

G3.2.27 During my post fire inspections, I observed that existing flats on Levels 4 and 5 had fire detection and alarm systems. Figure G.18 presents the smoke

alarms and heat detectors observed in flats on Level 4 during my post fire inspections. Please refer to Appendix C for further details on my post fire site inspection observations.

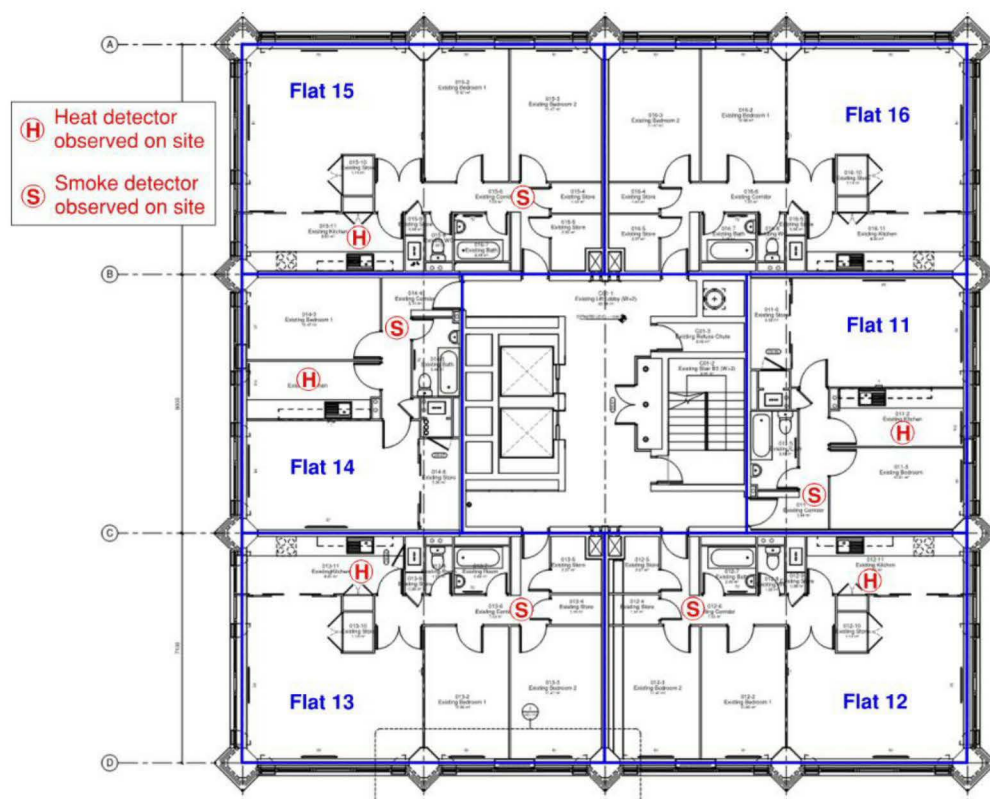


Figure G.18: Level 4 fire alarm and detection devices observed on site (SEA00010474)

G3.2.28 There was significant fire damage in Flat 16 and I was not able to determine if smoke alarms or heat detectors were provided in this flat before the fire.

G3.2.29 I observed a smoke alarm in the protected entrance hall, within 7.5m of every habitable room, in the other flats on Level 4 (Figure G.18). I also observed a heat detector in the kitchen of each of these flats. The kitchen qualifies as “rooms or areas that present a high fire risk to occupants”, therefore the fire detection and alarm systems in the existing Level 4 flats appear to meet the requirements for a LD2 system, as defined by BS 5839-6:2004.

G3.2.30 Power supplies for fire detection and alarm in existing flats

G3.2.31 During my post fire inspections, I observed the switchboard in existing apartments on Level 4, which included a switch for “smoke alarms”. Therefore, it appears the fire detection and fire alarm systems in the Level 4 existing flats were compliant with ADB 2013 1.5 with respect to the system being mains-operated. I could not find evidence of a standby power supply for these systems, therefore I have been unable to assess compliance with this ADB 2013 provision.

G3.2.32 Detectors in lift lobbies

G3.2.33 The Rydon “Grenfell Tower Description of Electrical Services” document states the following regarding the existing and new lift lobbies:

“There is no audible fire alarm system within the building’s lift lobbies.”
(RYD00094130)

G3.2.34 I found no evidence of sounders associated with a fire detection and alarm system in any of the lift lobbies in Grenfell Tower. ADB 2013 does not provide any design guidance for a fire detection and fire alarm system in the lift lobbies of a residential building.

G3.2.35 Any smoke detectors observed in the lift lobbies should be part of the smoke ventilation system and would not therefore be connected to alarm sounders.

G3.2.36 Summary conclusions related to detection and alarm

G3.2.37 As I have explained in Section 15 and Section G1, ADB 2013 does not recommend that fire alarm sounders should be provided in high rise residential building to either automatically or manually operate throughout the building in the event of a fire within an individual flat or within a common area.

G3.2.38 It is apparent that fire detection and fire alarm systems were specified and installed for all of the 9 new flats on Levels 1 – 3. The installed fire detection and fire alarm systems for the flats on Levels 1 – 3 are consistent with the Category of alarm specified in the Grenfell Tower refurbishment fire strategy.

G3.2.39 However, the fire detection and fire alarm systems in flats on Levels 1 – 2, where a Category LD3 system was specified, are not compliant with BS 5839-6:2013 Clause 4 and 9 which requires a minimum Category LD2 or a risk assessment to justify a lower Category. Therefore the specified and installed system is also non-compliant with ADB 2013 Section 1.4 which requires design to BS 5839-6.

G3.2.40 There is evidence that the flats on Levels 4 to 23 occupied by TMO tenants had fire detection and alarm systems fitted. It is currently unknown if any of the Leaseholder flats had detection and alarm systems fitted.

G3.2.41 I do not have sufficient information to reach any conclusions about whether the systems complied with every aspect of the relevant guidance at the time of refurbishment in ADB 2013 and BS 5839-6:2013. The damage caused to Grenfell Tower during the fire means that the compliance of the detection and alarm systems cannot be determined through inspection.

G3.3 Means of escape within the flat

G3.3.1 Both the original and refurbishment design of Grenfell Tower was based on the provision of a protected entrance hall serving all habitable rooms.

G3.3.2 The Grenfell Tower refurbishment fire strategy by Exova (EXO00001106) stated the following:

“The new apartments will have protected entrance halls (i.e. entrance halls enclosed by construction having a 30-minute standard of fire resistance with the doorways therein fitted with “FD20” doors). Bathrooms and WCs will not be enclosed by fire resisting construction but, where they abut other rooms, they will be separated from the latter by walls having a 30-minute standard of fire resistance.”

G3.3.3 I have reviewed the Studio E drawings labelled ‘For construction’, dated 8th May 2015 for Levels 1 – 3 (SEA00003231, SEA00003149, SEA00003229) and the Studio E Fire Strategy drawing labelled ‘For construction’, dated 23rd February 2015. (SEA00003112)

G3.3.4 These drawings indicate that 30-minute fire rated walls enclose the corridor in each new flat (not shown for Flat 3 in drawings for an unknown reason); these corridors are protected entrance halls. The bathrooms, cupboards, and storage rooms are separated from the other rooms by 30-minute fire rated walls.

G3.3.5 These drawings also indicate the doors forming part of the enclosure to the protected entrance hall in each new flat are 20-minute fire doors, except for bathroom, cupboard and store room doors.

G3.3.6 These drawings are consistent with the fire strategy requirements and ADB 2013 Section 2.13 guidance, with the exception that cupboards and storage rooms are not exempt from the fire rating requirement in the fire strategy or in ADB 2013.

G3.3.7 It was not possible to confirm the construction or associated fire performance of the protected entrance halls in the new flats on site.

G3.3.8 I have explained in Appendix I that, on Levels 1 – 3, twelve storage cupboards or rooms opening into the protected entrance halls of Flats 2 – 9 (Figure G.19) had not been specified in the Studio E *For Construction Door Schedule* as fire doors (RYD00092648 Pages 42-46). Therefore, these doors are not compliant with Table B1 of ADB 2013 or the fire strategy, which both required FD20 doors.

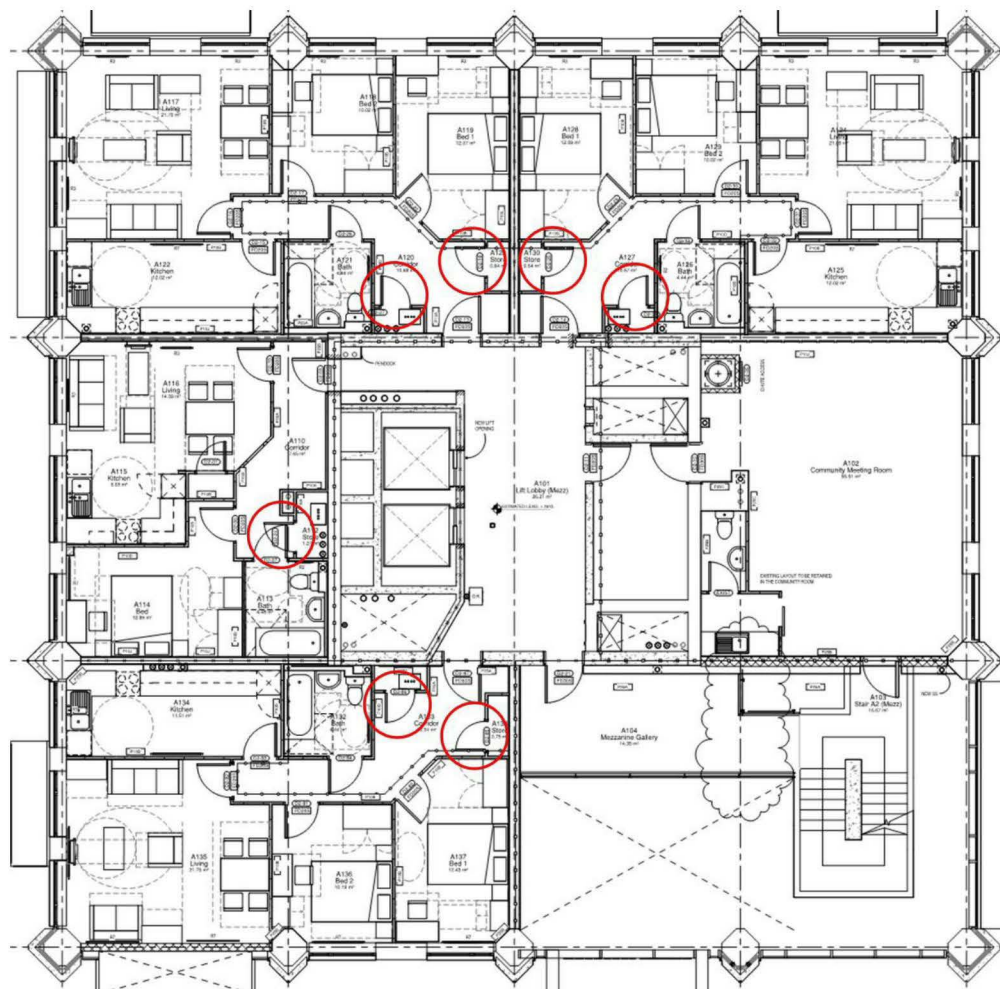


Figure G.19: Level 1 floor locations of non-fire resisting cupboard and store doors (SEA00003231)

- G3.3.9** During my post fire inspections, I observed that several doors forming part of the enclosure to the protected entrance halls in Flats 7 – 9 (Level 3) had tags indicating the doors were FD30S, which would be compliant with Table B1 of ADB 2013 and the fire strategy. However, no test reports have been disclosed for the doors forming part of the enclosure to the protected entrance halls in the new flats, therefore I cannot assess compliance at this time.
- G3.3.10** I have reviewed the Studio E drawings labelled ‘For construction’, dated 8th May 2015 for Levels 1 – 3 (SEA00003231, SEA00003149, SEA00003229) and the Studio E Fire Strategy drawing labelled ‘For construction’, dated 23rd February 2015 (SEA00003112) for the typical residential levels (Levels 4 – 23). Based on comparative measurements taken on site, I was able to determine that these drawings were to scale.
- G3.3.11** Based on my measurements taken off the above-mentioned drawings and our measurements taken on site, the distance from the entrance door to the door to any habitable room is 9m or less for all flats on Levels 1 and 2, and 4 – 23 (Figure G.20). Therefore, the travel distances within the flats are compliant

with ADB 2013 Section 2.13. The travel distances within the existing flats on Levels 4 – 23 are less than 7.5m, as shown in Figure G.20, and are therefore compliant with ADB 2013 and CP3 1971 as well.

G3.3.12 In the 4 flats on Level 3, the travel distance from the entrance door to the door to any habitable room is greater than 9m (Figure G.21). This does not comply with ADB 2013. This is noted in the Grenfell Tower refurbishment fire strategy (EXO00001106). An alternative solution for the extended travel distances was proposed, by increasing the category of coverage of smoke detection within the dwellings. I will address the compliance of alternate solutions with the Building Regulations in my Phase 2 investigations.

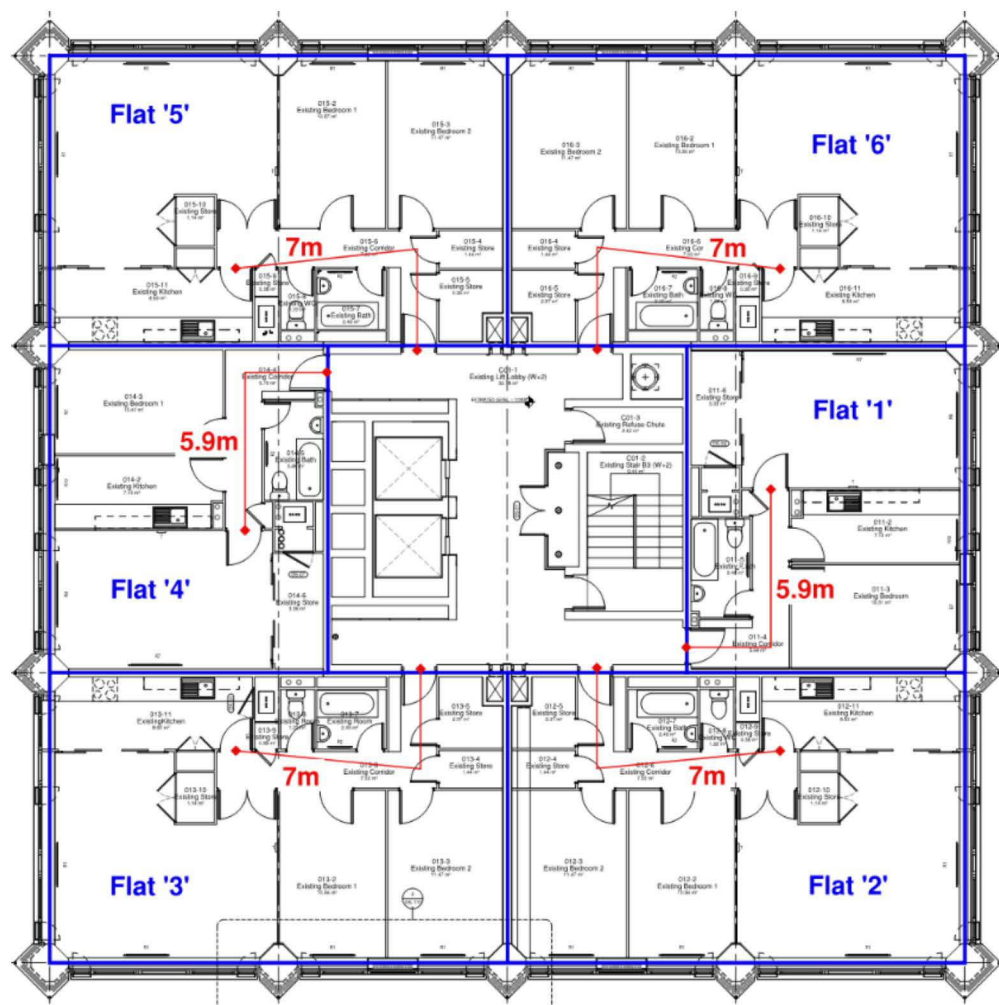


Figure G.20: Travel distances within flats on typical residential level as measured on site (SEA00010474)

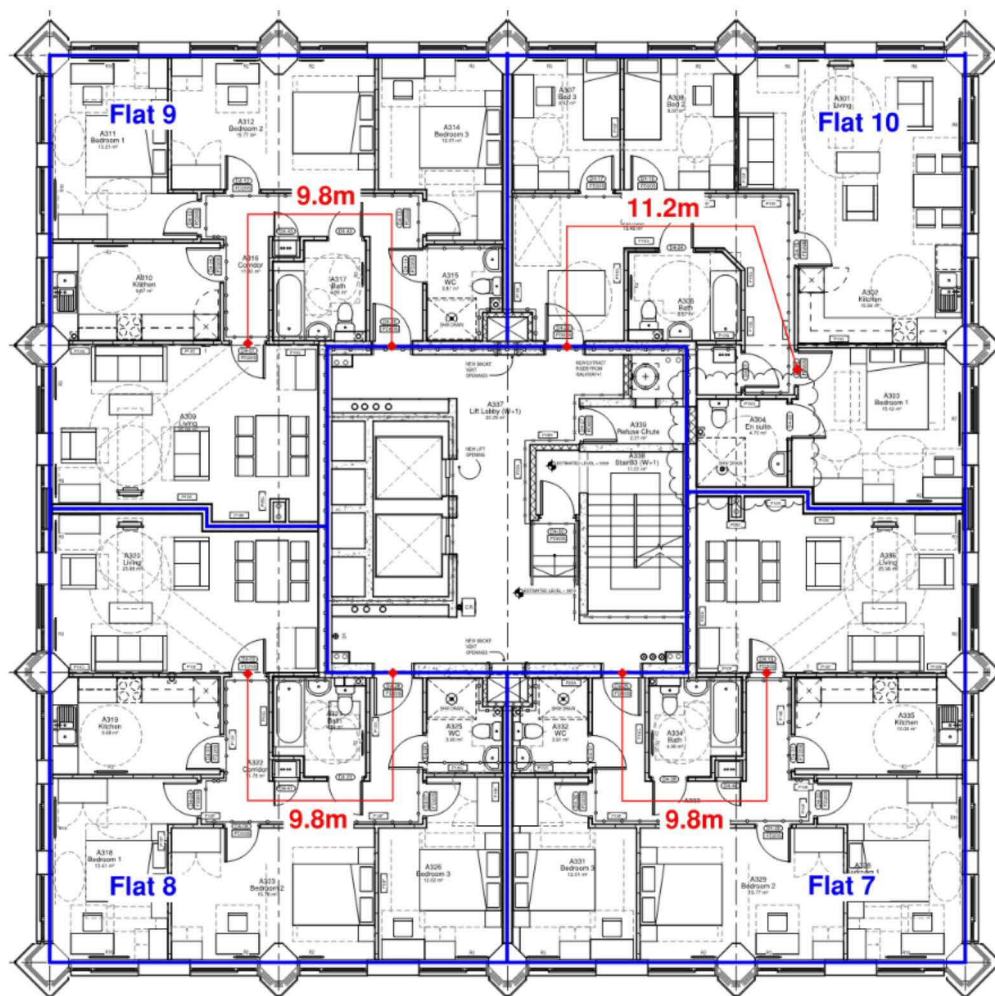


Figure G.21: Travel distances within flats on Level 3 as measured on site (SEA00003229)

G3.4 Means of escape within the common areas

G3.4.1 Figure G.22 and Figure G.23 demonstrate the ADB 2013 provisions for compartment walls, shaft construction, and fire doors relevant to the common lobby on Level 3 and on a typical residential floor in Grenfell Tower, respectively. These are visual summaries of the relevant provisions.

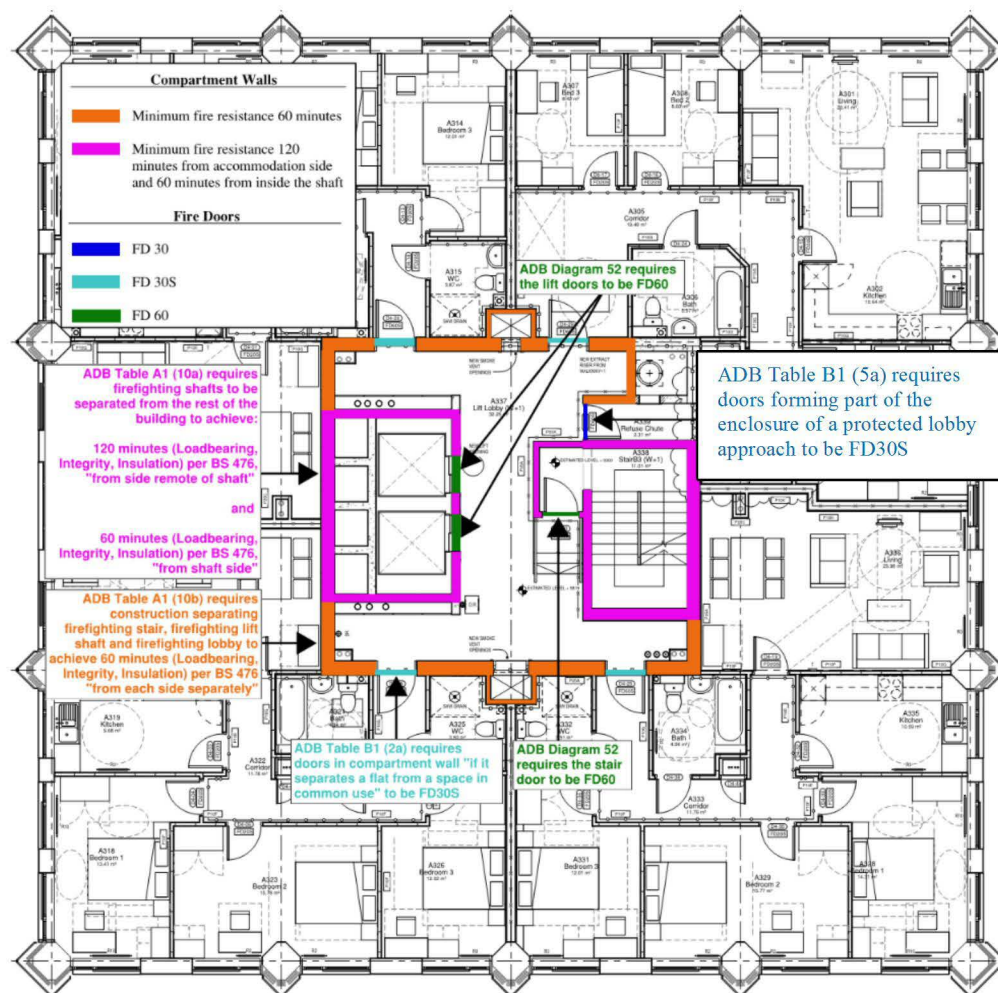


Figure G.22: ADB 2013 recommendations for fire resistance of firefighting shaft and associated fire doors for Level 3 in Grenfell Tower (SEA00003229)

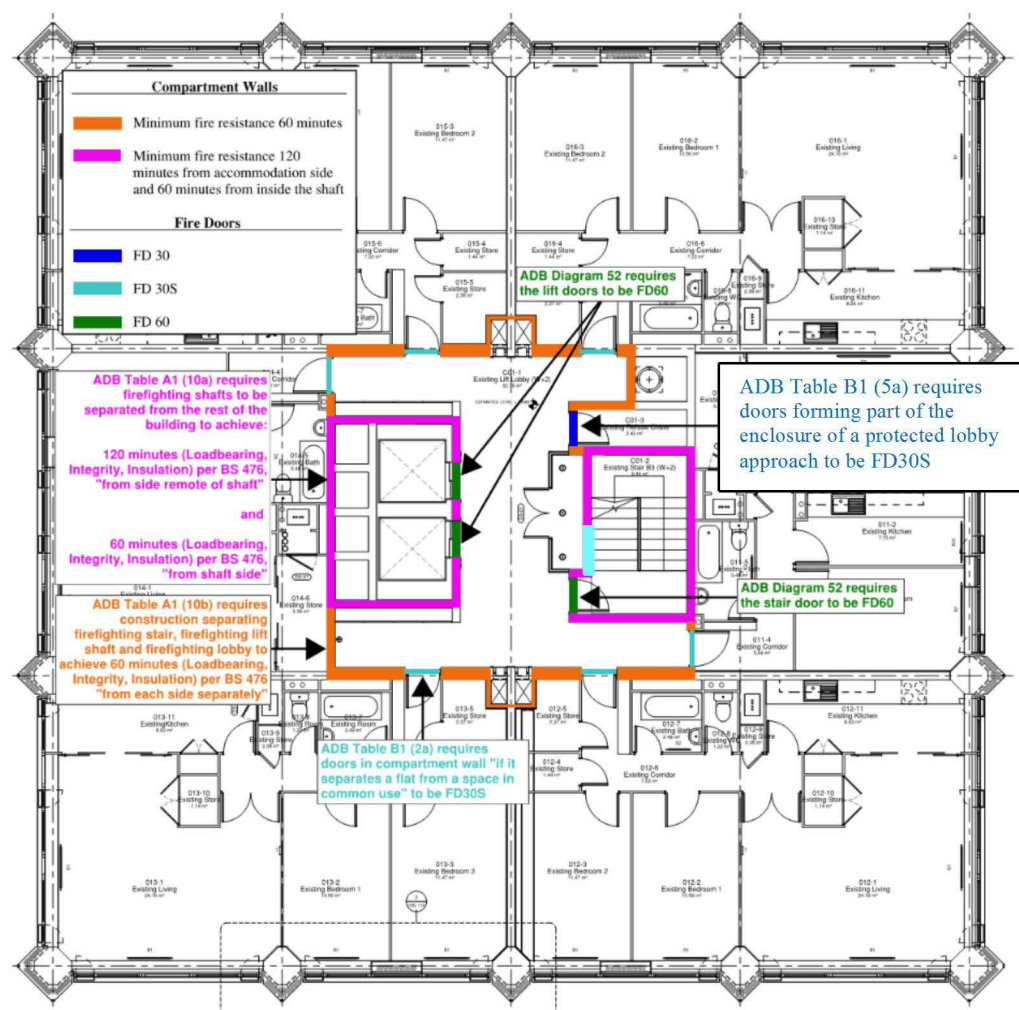


Figure G.23: ADB 2013 recommendations for fire resistance of firefighting shaft and associated fire doors for typical residential floor in Grenfell Tower (SEA00010474)

- G3.4.2** In Section 15 of this report, I have described the concrete construction of the firefighting shaft and concluded that the core walls, shown as pink and orange in Figure G.22 and Figure G.23, would achieve a fire resistance rating of at least 120 minutes for integrity, insulation and loadbearing capacity (REI120). The only exception is for a portion of the Level 3 protected stair where I have been unable to confirm the expected fire performance and construction.
- G3.4.3** I have also reviewed the original design drawings for Levels Ground, 2 and 3 and determined that all original core walls were at least 200mm thick and could achieve REI120. (Historic Building Plans – RBK00018845, RBK00018859, RBK00018862)
- G3.4.4** Modifications were made to the core during the 2012 – 2016 refurbishment works from Levels Ground to 3. I was not able to assess the new construction and cannot confirm its fire performance.

- G3.4.5** Please refer to Section 4 of my report for more detail on the comparison of the original designs of the common lobbies and the post-refurbishment common lobbies from Levels Ground to 2 and the common lobbies.
- G3.4.6** Please refer to Appendix H for excerpts from the Studio E 'For construction' drawings, showing the intended fire performance of the firefighting shaft on Levels 1 and 2. I have not evaluated the construction of the common lobbies on Levels 1 and 2 at this time as additional site inspections are needed to carry out this evaluation.
- G3.4.7** **Flat entrance doors**
- G3.4.8** I have reviewed the evidence disclosed to date, as described in Appendix I, and I have concluded that there were three types of main flat entrance fire doors installed at the time of the fire:
- a) Masterdor Suredor door assembly to 106 flats on Levels 4 -23.
 - b) An unknown door assembly to 14 flats, believed to be the original flat entrance doors on Levels 8, 9, 11 – 14, and 17 – 23. None of these doors survived the fire on the 14th June 2017.
 - c) An unknown door assembly installed on the nine new flats as part of the refurbishment on Levels 1 - 03 in 2012 to 2016.
- G3.4.9** I have assessed the compliance of these doors against the statutory guidance applicable at the time of installation in Appendix I.
- G3.4.10** In Appendix I have assessed the Masterdor Suredor door assembly as non-compliant with the statutory guidance at the time of installation and non-compliant with the Building Regulations.
- G3.4.11** Out of the 129 flat front entrance doors in place on the night of the fire, 106 of those were the non-compliant Masterdor Suredor door assembly. Based on the current evidence available to me, I have not been able to determine the compliance of the remaining 23 flat entrance doors which include 9 flat entrance doors on Levels 1-3 and 14 unknown flat entrance doors for flats on Levels 8, 9, 11 – 14, and 17 – 23.
- G3.4.12** I have therefore concluded that multiple noncompliant fire doors were installed on every level between Levels 4 and 23. Therefore the enclosure of the protected lobby was noncompliant with the Building Regulations on every level between Levels 4 and 23.
- G3.4.13** I have not found any evidence to suggest that the lift doors or refuse chute doors were fire doors on any level.
- G3.4.14** **Shared means of escape**
- G3.4.15** The common lobbies on Levels 1 and 2 are shared between residential flats and non-residential areas, namely the community meeting room and boxing

gym. I have not assessed the means of escape for these non-residential areas, however I have considered the impact of these non-residential areas on the means of escape from residential flats.

G3.4.16 As I have explained above, the single common stair in Grenfell Tower is not permitted to serve the flats and other occupancies (see ADB 2013 Section 2.52).

G3.4.17 ADB 2013 Section 4.4 also provides the following recommendation for mixed use buildings:

“Where a building contains storeys (or parts of storeys) in different purpose groups, it is important to consider the effect of one risk on another. A fire in a shop, or unattended office, could have serious consequences on, for example, a residential or hotel use in the same building. It is therefore important to consider whether completely separate routes of escape should be provided from each different use within the building or whether other effective means to protect common escape routes can be provided.”

G3.4.18 Based on ADB 2013 Sections 2.52 and 4.4, the Level 1 and 2 common lobbies shared between residential flats and non-residential areas do not comply with the statutory guidance.

G3.4.19 Travel distance

G3.4.20 As I have explained above, ADB 2013 limits the travel distance from each flat entrance door to the protected stair door to 7.5m, whereas CP3 1971 allows this distance to be up to 15m. Therefore, the current statutory guidance is more onerous than the design guidance applicable at the time of construction.

G3.4.21 The travel distances from flats ‘4’, ‘5’, and ‘6’ for the existing common lobbies on Levels 4 – 23 comply with the CP3 1971, the original design guidance, but not for the current statutory guidance ADB 2013. The longest travel distance is from flats ending in 4, which I measured as 10.5m on site and off the scaled Studio E ‘Employer’s Requirements’ drawing, dated 9th November 2013. (SEA00010474)

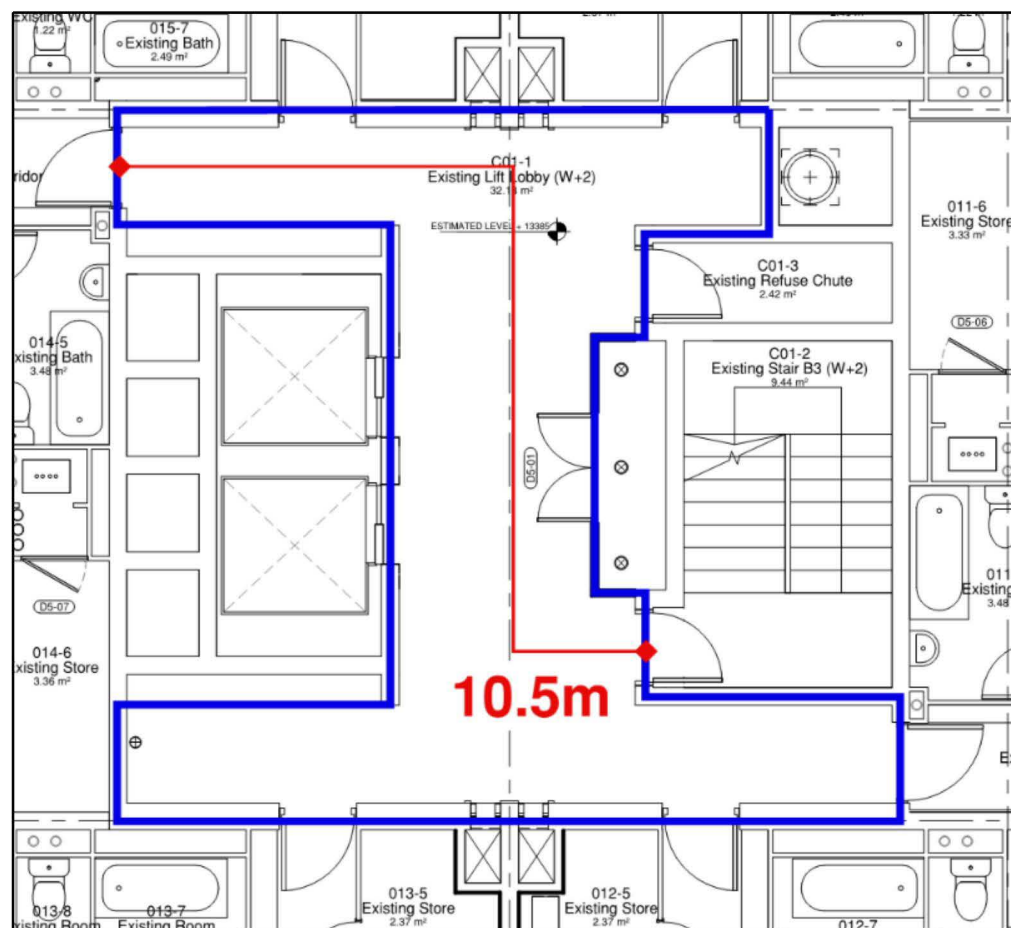


Figure G.24: Travel distances measured within common lobby on typical residential level (SEA00010474)

G3.4.22 Based on our site measurements and measurements from the Studio E drawings for Levels 1-3, Flats 3, 4, and 5 on Level 2 and Flats 9 and 10 on Level 3 also had travel distances from flat entrance doors to the protected stair doors that do not comply with ADB 2013.

G3.4.23 ADB 2013 Section 2.20 states:

“...a single escape route from the flat entrance door is acceptable if either:

a. the flat is situated in a storey served by a single common stair and:

i. every flat is separated from the common stair by a protected lobby or common corridor (see Diagram 7); and

ii. the travel distance limitations in Table 1 (see paragraph 2.23), on escape in one direction only, are observed...”

G3.4.24 Flats were separated from the common stair by a protected lobby. The travel distance from flat entrance to stair door on Level 1 is compliant with ADB 2013. The travel distance from flat entrance to stair door on Levels 2 and 3 are non-compliant with ADB 2013. The travel distance from existing flat

entrance doors to stair door on Levels 4-23 are non-compliant with ADB 2013 but are compliant with the original design guidance in CP3 1971.

- G3.4.25** The Grenfell Tower refurbishment fire strategy does not specify a required maximum travel distance for the new flats created on Levels 1 – 3, or the existing flats and I have not found any evidence to suggest that mitigation for the non-compliant travel distance was considered or provided.

G3.5 Means of escape within common stair

- G3.5.1** Before the 2012 – 2016 refurbishment, an existing external stair from Level 2 to Ground Level served occupants for access and escape from all residential flats in the building, as shown in Figure G.26.

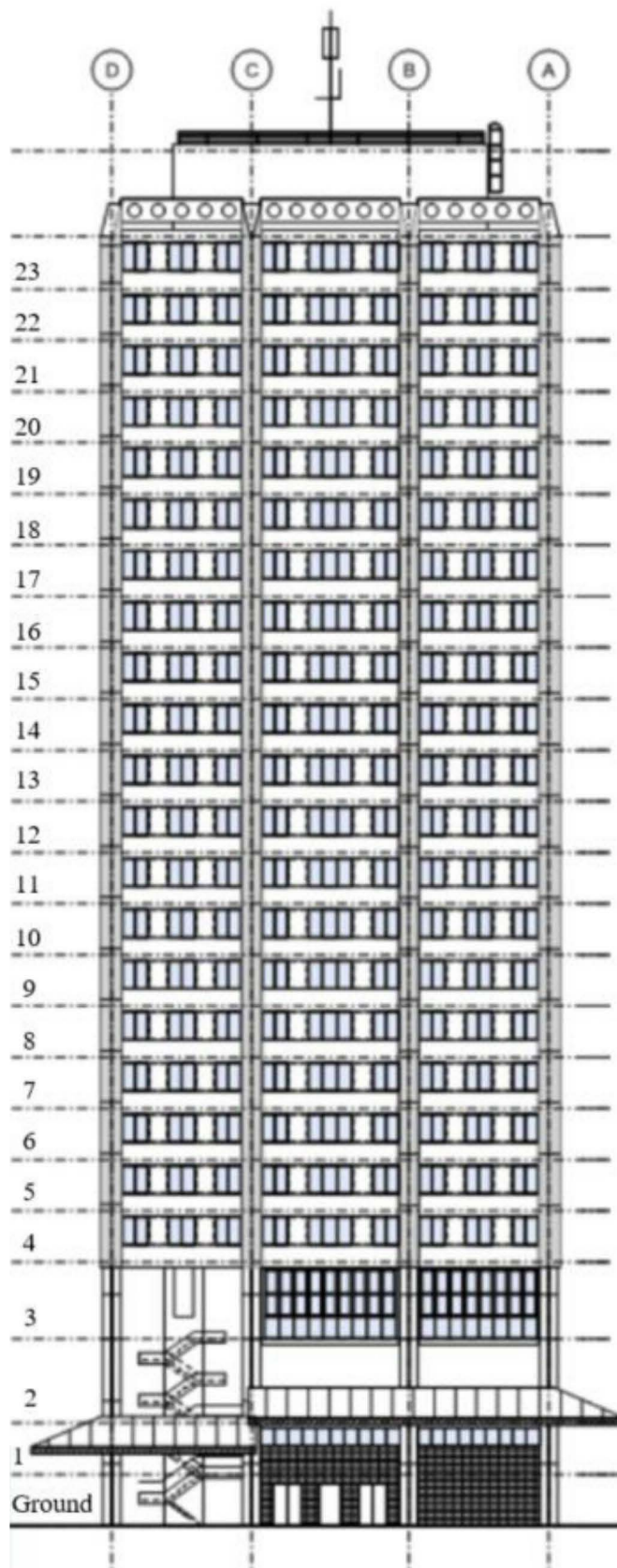


Figure G.25: Original construction - East building elevation showing external stair from Level 3 to Ground Level (SEA00001579)

- G3.5.2** During the 2012 – 2016 refurbishment, the southeast corner of the building was enclosed. Rather than providing a traditional enclosed protected stair, the existing open stair was enclosed in a large atrium-type space to serve as the final extent of the single means of escape and firefighting stair for all residential and non-residential areas above ground level. A separate smoke ventilation to this space was specified by Exova for these areas.
- G3.5.3** Figure G.26 illustrates shows the vertical means of escape serving all levels of Grenfell Tower above ground floor. As described in Section 4, a protected stair serves the residential flats on Levels 3 – 23. On Level 2, the protected stair transfers to a balcony within the new enclosure that connects Level 2 to the ground floor. The balcony connects to an open stair in the void which brings occupants down to Ground Level. Therefore, the balconies form extensions to the stair, all contained within the larger open atrium-type space Figure G.27.
- G3.5.4** Final exits direct to fresh air are provided on the East façade, and via the main front door to the building, as shown in Figure G.27.
- G3.5.5** The design information on Studio E drawings indicates that the new stair enclosure was to achieve a rating of 120 minutes, and it was to be provided with lobbies between the stair and all surrounding areas, except the new community meeting room on Level 1.

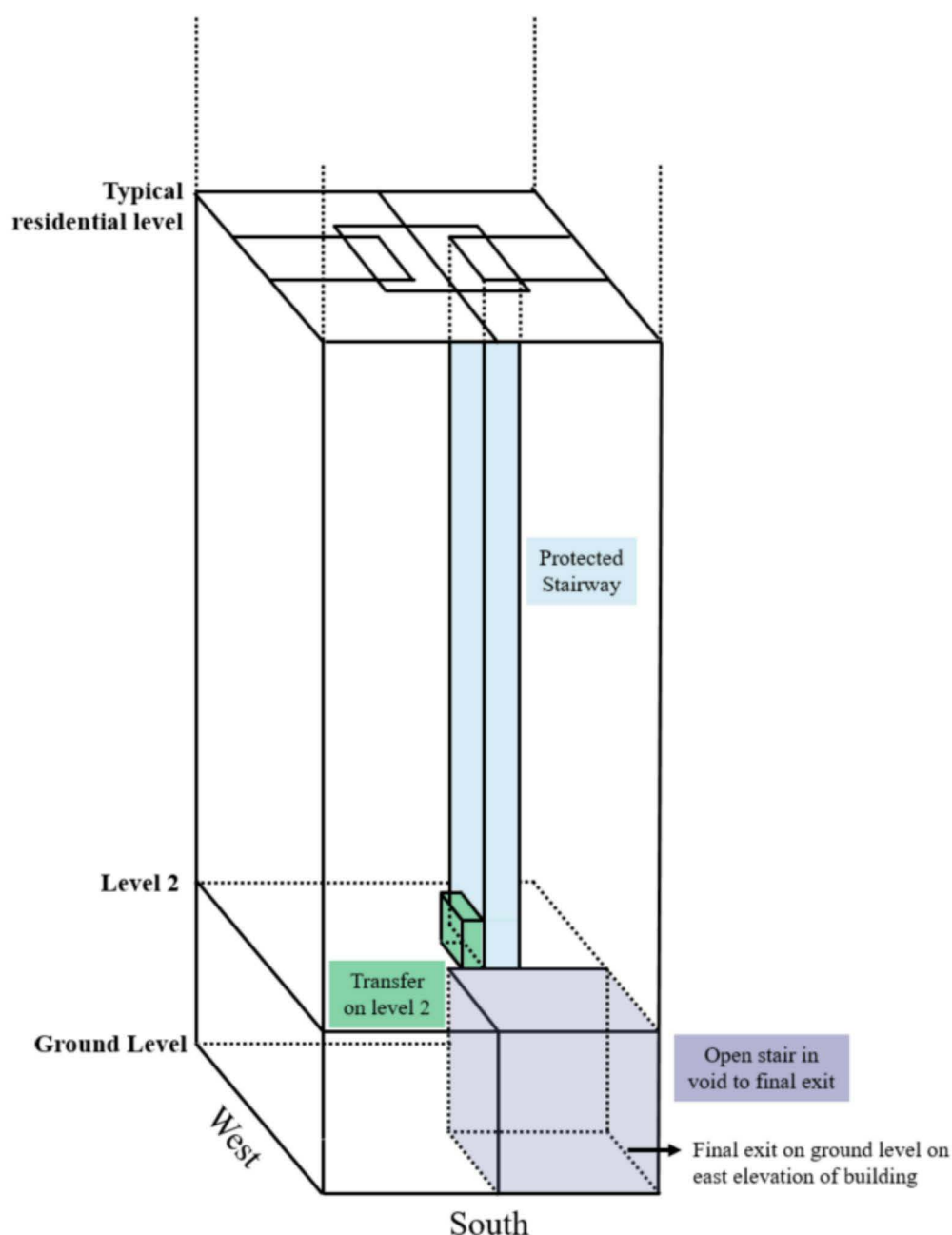


Figure G.26: Vertical means of escape in Grenfell Tower

G3.5.6 This stair arrangement from Level 2 to the final exit on Ground does not comply with ADB 2013, because the exit from the stair to the meeting room at Level 1 is not provided with a protected and ventilated lobby. Additionally, in order for the stair to comply with Section 2.40 of ADB 2013, the stair and the large atrium area need:

“to be relatively free of potential sources of fire. Consequently, it should not be used for anything else, except a lift well or electricity meter(s)” ... “In single stair buildings, meters located within the stair should be enclosed

within a secure cupboard which is separated from the escape route with fire resisting construction.””

- G3.5.7** ADB 2013 does not place a maximum limit on the size that a stair may be, and the design information does not indicate that this space was to be used for anything other than as an entrance foyer to the building, and therefore this arrangement is compliant with the statutory guidance. However, while the building was operating it was the responsibility of the responsible person to ensure that the entrance foyer, stair and balconies would be maintained as “*relatively free of potential sources of fire*”.

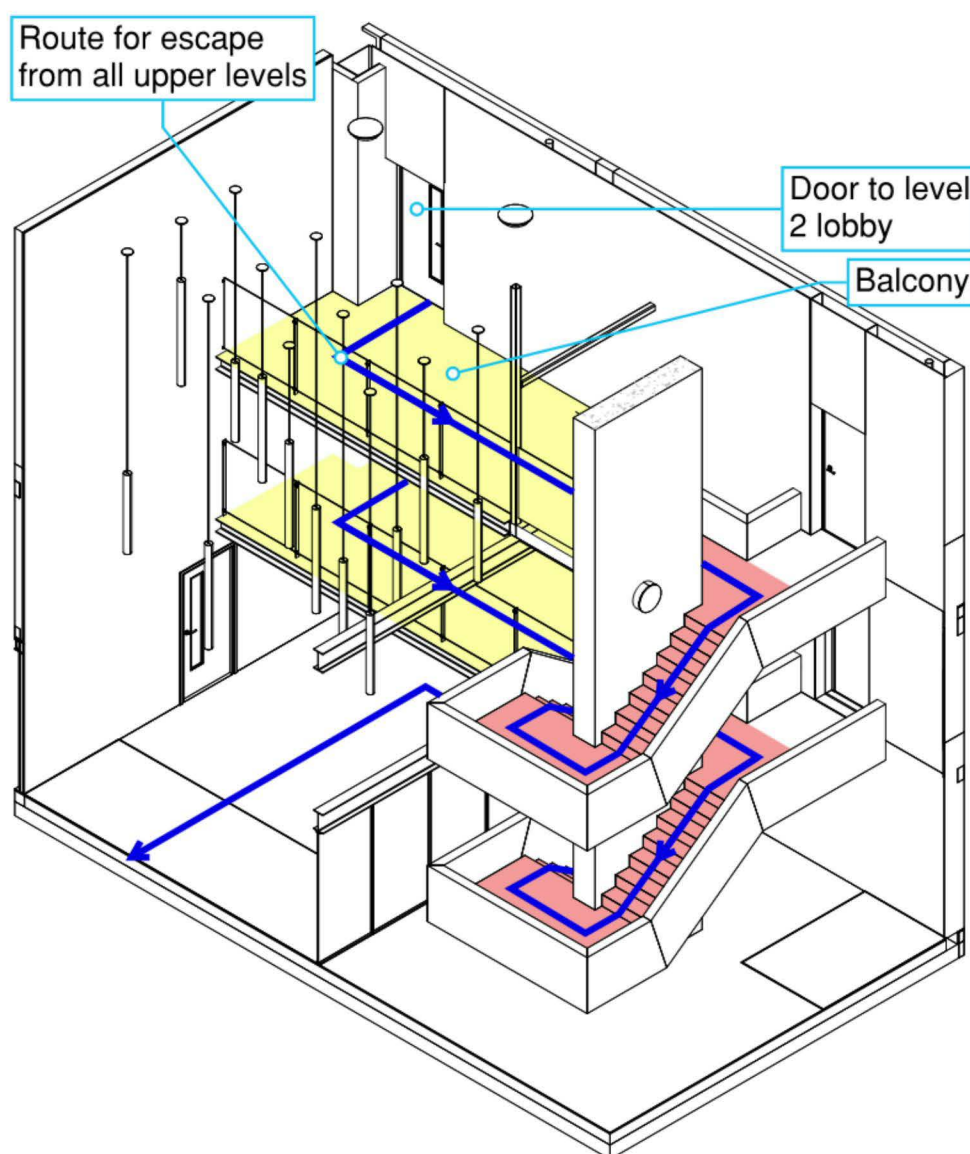


Figure G.27: Isometric view of stair between Ground Level – Level 2
(MAX00002386)

- G3.5.8** The Grenfell Tower refurbishment fire strategy by Exova identified the non-compliance of the shared means of escape between residential and non-

residential areas, and did not provide any mitigation measures or alternate solutions.

- G3.5.9** The means of escape for Grenfell Tower design does not comply with ADB 2013 Section 2.38 because the meeting room at Level 1 is not lobby separated from the stair. The lack of lobby protection and the fact that the stair is a shared means of escape means that the stair does not comply with the guidance in Section 2.51 of ADB 2013.
- G3.5.10** I have considered the modifications to the protected stair and the construction separating the void with the open stair from adjacent occupancies to determine if 120REI construction (i.e. 120 minutes fire resistance (Loadbearing capacity, Integrity, Insulation) was provided in these locations.
- G3.5.11** As described in Sections 15 and 16, my analysis of the core walls was based on Eurocode 2 (Design of concrete structures: Part 1-2 General Rules – Structural fire design, BS EN 1992-1-2:2004) and it was determined that 200mm of concrete can achieve REI120.
- G3.5.12** I reviewed the original design drawings for Ground Level, Level 2 and Level 3 and found that all original core walls were at least 200mm thick and could achieve REI120 (Historic Building Plans (RBK00018845, RBK00018859, RBK00018862). Modifications made to the core during the 2012 – 2016 refurbishment works from Levels Ground to 3 are presented in Figure G.28, Figure G.29 and Figure G.30.
- G3.5.13** The portions of walls and shafts highlighted in pink on the right side of Figure G.28, Figure G.29 and Figure G.30 were affected during the refurbishment works. I have not assessed the construction of these new walls / shafts at this time and cannot confirm its expected fire performance.

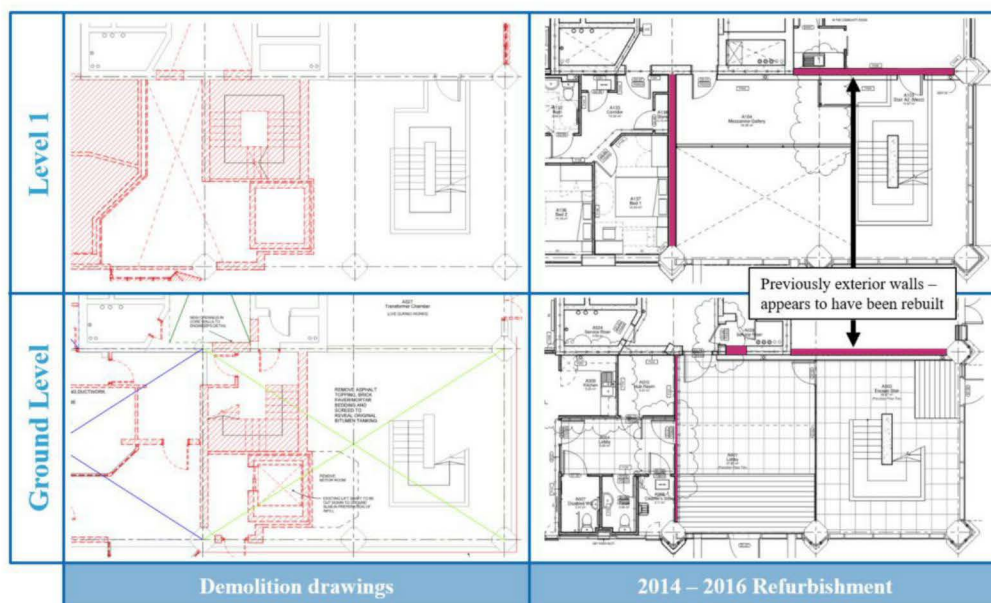


Figure G.28: 2012 - 2016 refurbishment works to Ground Level and Level 1 void with open stair (SEA00002523, SEA00003232, HAR00007962, SEA00003231)

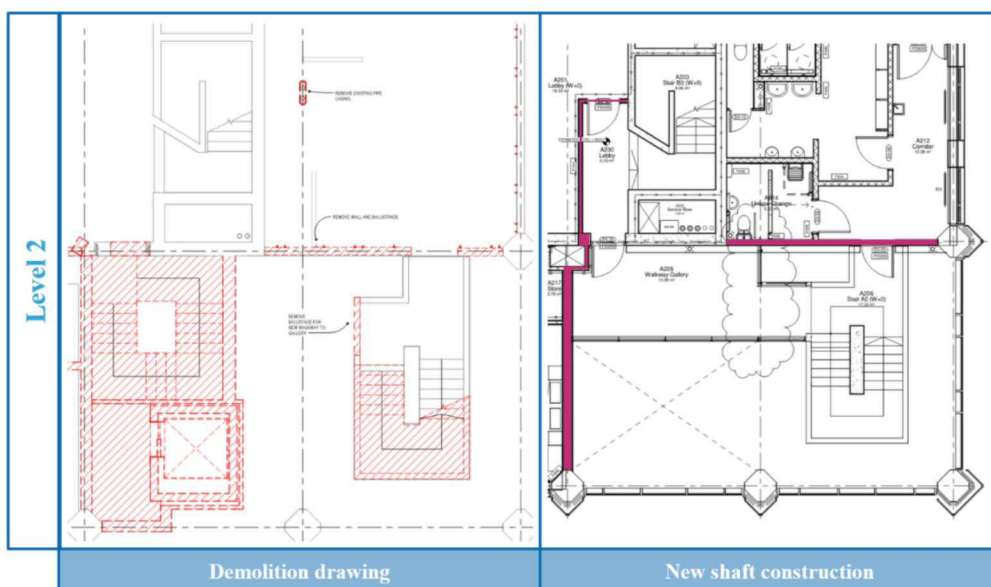


Figure G.29: 2012 - 2016 refurbishment works to Level 2 protected stair and void with open stair (HAR00007963, SEA00003149)

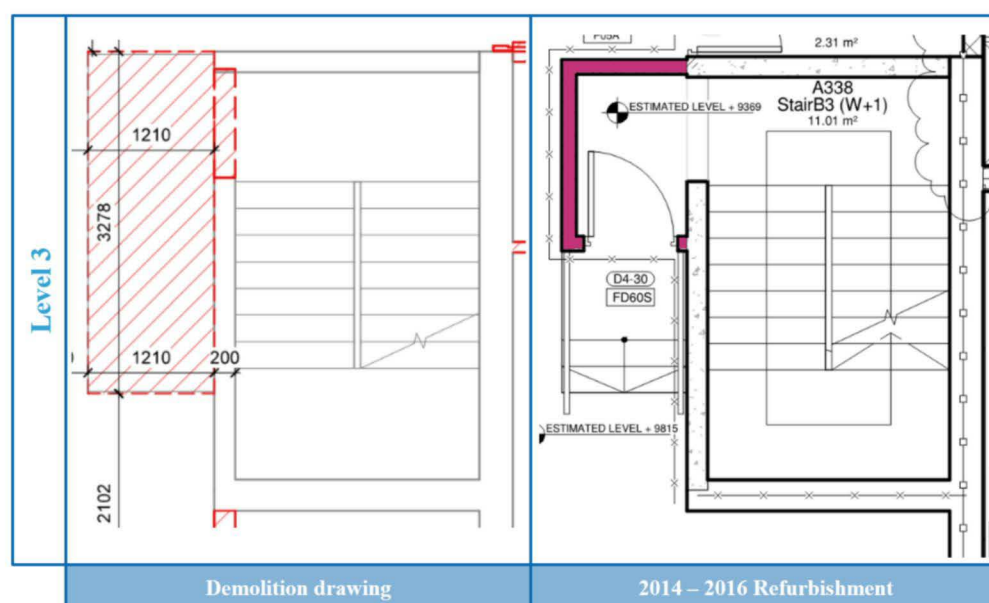


Figure G.30: 2012 - 2016 refurbishment works to Level 3 protected stair (HAR00007964, SEA00003229)

G3.5.14 During my post fire inspections, I inspected the protected stair serving residential flats on Levels 3 – 23 and made the following observations:

- a) The width of the protected stair was 1040mm between the wall and the inside face of the balustrade, as shown in Table G.5:
 - i. ADB 2013 Section 2.33 requires this measurement to be 1100mm, therefore the width of the protected stair in Grenfell Tower is not compliant with ADB 2013;
 - ii. CP3 1971 Section 3.4.2.2 requires stairs to have a minimum width of 900mm measured between a wall and the inside of a handrail on any flight, therefore the width of the protected stair in Grenfell Tower is compliant with the original CP3 1971 design guidance.
- b) Headroom was measured in several locations within the protected stair and was found to be greater than 2m in all instances, meaning that it is compliant with both ADB 2013 Section 5.26 and CP3 1971 Section 3.4.2.2.
- c) Only one handrail was observed in the protected stair. This does not comply with ADB 2013 Section 5.20 / ADB 2013 Section 1.34.
- d) Flights and landings of the protected stair is constructed of concrete. This is compliant with ADB 2013 Section 5.19. However, I do not know if the flooring is compliant with ADB 2013 Section 5.27 regarding slipperiness when wet.
- e) Insulated pipes were observed in the protected stair on Level 3, as shown in Figure G.32. This is not compliant with ADB 2013 Section 2.40, which states a protected stair “*should not be used for anything else, except a lift well or electricity meter(s).*”

- f) There is enclosed gas pipework in protected stair from Levels 2 – 22, as shown in Figure G.33. Please refer to Appendix K for detailed assessment of gas services including compliance of the pipework in the protected stair relative to ADB 2013 Section 2.42.

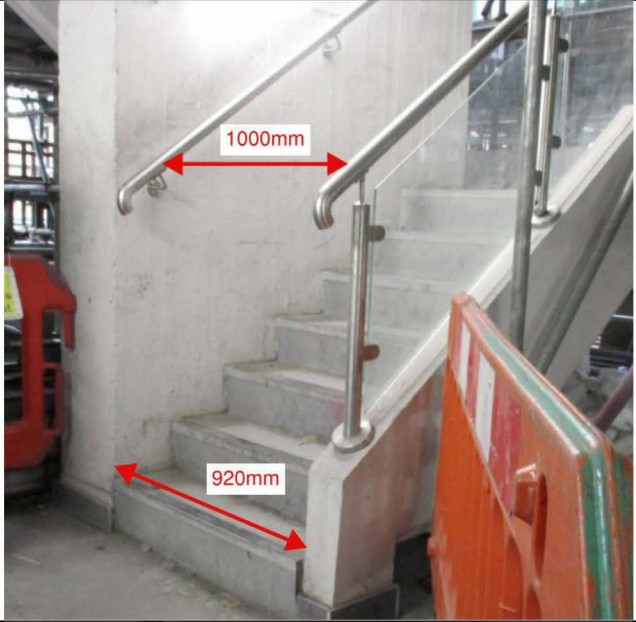
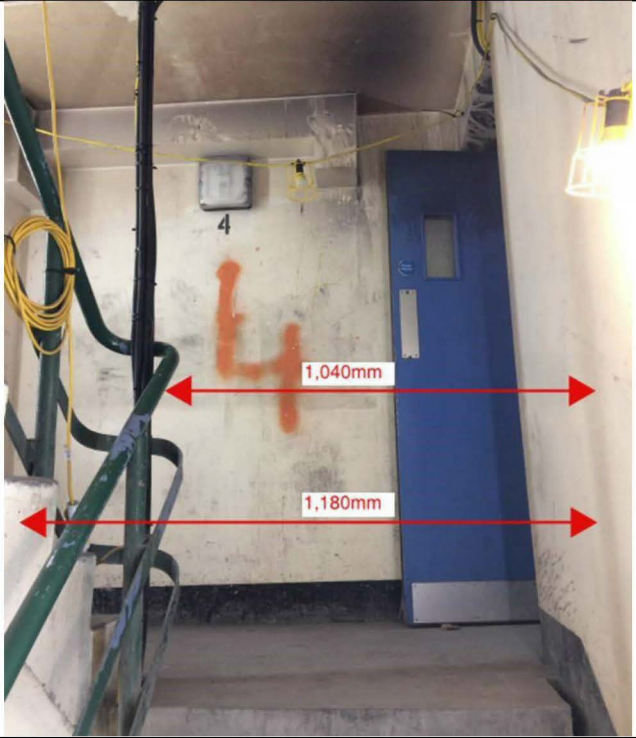
G3.5.15 During my post fire inspections, I inspected the open stair from Level 2 to the Ground level serving all areas of the building above ground level and made the following observations. Note, these observations are not evaluated against CP3 1971 because the open stair was installed during the 2012 – 2016 refurbishment when ADB 2013 was applicable.

- a) The width of the protected stair was 1000mm between the wall and the handrail, as shown in Figure G.32. ADB 2013 Section 2.33 requires this measurement to be 1100mm, therefore the width of the protected stair in Grenfell Tower is not compliant with ADB 2013.
- b) Two handrails were observed on the open stair. This is compliant with ADB 2013 5.20.
- c) Flights and landings of the protected stair is constructed of concrete. This is compliant with ADB 2013 Section 5.19.
- d) Floor coverings of flights and landings listed as ‘vinyl sheet’ on the Studio E for construction floor coverings drawing (SEA00012128). It is not known whether or not this met the provisions of ADB 2013 Section 5.27.
- e) The final exit provision was apparent to occupants, did not form an obstacle to disabled occupants, was not narrower than the escape route it served and discharged direct into an open space, remote from the basement vents. This is compliant with ADB 2013 Sections 5.30-5.34.

G3.5.16 I have not completed a full inspection of the open stair in the void at this time. Additional site work would be required to complete my assessment of the open stair and the final exit. In particular, I have not assessed the following:

- a) Headroom measurement of open stair (ADB 2013 Section 5.26); and
- b) Impact of services running through void on means of escape related to ADB 2013 Section 2.40.

Table G.5 Grenfell Tower single common stair widths recorded during my post fire site inspections, November 2017. Please see Appendix I for detailed information on the type of doors in the stair.

Means of escape stair	Width measured in accordance with ADB 2013	Illustration of measurement
Ground – L2	1000mm	
L2 – L23	1040mm	

G3.5.17 Stair door inspection

G3.5.18 One door to the protected stair enclosure was inspected. This was the stair door on Level 6. I have described this inspection in Appendix I5.6.

G3.5.19 I have conducted a further investigation with regard to the likely date of construction and installation of the Grenfell Tower staircase doors in Appendix M.

G3.5.20 From this investigation, I consider the staircase doors to be the doors installed at the time of construction. I further believe them to be No 3 Class A doors as defined in the *London Building Constructional Amending Bylaws 1966*.

G3.5.21 I have investigated the likely fire performance of these doors and found historic test evidence which shows that a No.3 Class A door with a 12mm rebate would not achieve the required fire performance of 30 minutes stability and integrity.

G3.5.22 I observed a brush seal, installed at the sides and top of the door. It has yet to be determined whether these brush seals are for cold smoke leakage/draught exclusion only or also contain an intumescent seal. Nonetheless, my investigation in Appendix M shows that a No.3 Class A door in a 12 mm rebate frame cannot achieve 30 minutes integrity with or without an intumescent seal when tested to BS 476-8:1972 or subsequent superseding test standards.

G3.5.23 With the exception of the brush seal described above, I have found no other evidence of any works to the protected stair doors on Levels 4 – 23.

G3.5.24 The original doors to the protected stair enclosure would therefore also not achieve the benchmark standard of FD60s as required by diagram 52 of ADB 2013. This has been confirmed in the Metropolitan police test report (MET00021780) where the Level 6 staircase door was found to have 16 minutes integrity fire resistance.

G3.5.25 The doors to the protected stair enclosure on Levels 1 – 3 were specified to be replaced in the 2012 – 2016 refurbishment with FD60S doors (Studio E door schedule, RYD00092648). This is compliant with the recommendations of Diagram 52 of ADB 2013. Compliance of the product installed onsite on Levels 1-3 could not be confirmed as no test reports for these doors have been disclosed to date.

G3.5.26 A separate stair was provided for access to the basement level, compliant with ADB 2013 Section 5.6.



Figure G.31: Level 4 stair landing showing handrail on one side of stair only



Figure G.32: Insulated pipes in protected stair on Level 3



Figure G.33: Enclosed gas piping in protected stair from Levels 2 – 22

G3.5.27 Smoke ventilation

G3.5.28 My detailed investigations and analysis are presented in Appendix J, based on the evidence available to me at this time.

G3.5.29 I have concluded that the original lobby smoke control system was not compliant with the provisions of CP3 1971.

G3.5.30 I have concluded that the mechanical smoke control system provided in the refurbishment was a bespoke system which considered to be an upgrade of the original system; however it did not meet the performance requirements described within BS EN 12101-6, for a Class B depressurisation system.

G3.5.31 It was therefore not compliant with the requirements of ADB 2013.

G3.5.32 This smoke control system served the lobby of every level in the building.

G3.5.33 See Appendix C for further evidence of the smoke control measures physically observed on each of the floors.

G3.6 Assessment of general provisions

G3.6.1 Exit signage

G3.6.2 I observed exit signs in the following locations:

- a) Above stair entrance door on Level 3 (access to stair on this level was provided during 2012 – 2016 refurbishment), as shown in Figure G.34.
- b) Boxing gym on Level 2.
- c) Level 1 lift lobby (means of escape from community meeting room), as shown in Figure G.35.
- d) Basement level.



Figure G.34: Exit sign on Level 3



Figure G.35: Exit sign in Level 1 lift lobby

- G3.6.3** The HSE publication: *Safety Signs and Signals: Guidance on Regulations* and ADB Section 5.37, recommends exit signs are provided to alternative exits only (i.e. those not in ordinary/common use)
- G3.6.4** It should also be noted that the recommendation from the LGA guidance *Fire safety in purpose built flats* explicitly includes access routes used by visitors as not requiring exit signage:
- “63.1 The normal access and egress routes within a block of flats do not usually require fire exit signs to assist residents and visitors to make their way out of the building in the event of fire.*
- 63.2 Flats with a single staircase, regardless of the number of floors, would, for example, not usually require any fire exit signage.”*
- G3.6.5** I will need to undertake further site inspections in order to carry out a full assessment of the compliance of exit signage in Grenfell Tower.
- G3.6.6** **Flooring**
- G3.6.7** The floor covering provision in the lobbies of Levels 4-23 appeared to be a vinyl covering, and from Levels 1-3 it was listed as ‘vinyl sheet’ on the Studio E for construction floor coverings drawing (SEA00012128) It is not known whether or not this met the provisions of ADB 2013 Section 5.27.

G3.6.8 Refuse chutes

G3.6.9 ADB 2013 recommends the following provisions to protect escape routes from refuse chutes and rooms:

“5.55 Refuse chutes and rooms provided for the storage of refuse should:

a. be separated from other parts of the building by fire-resisting construction; and

b. not be located within protected stairways or protected lobbies.

5.56 Rooms containing refuse chutes, or provided for the storage of refuse, should be approached either directly from the open air or by way of a protected lobby provided with not less than 0.2m² of permanent ventilation.”

G3.6.10 ADB 2013 requires that the refuse chute should be separated from other parts of the building by fire-resisting construction. The Studio E for construction drawings indicate that the refuse chute on Mezzanine Level, Walkway Level, Walkway +1 Level, and on a typical residential level (shown in Figure G.36, Figure G.37, Figure G.38 and Figure G.39 respectively) are separated from the other parts of the building with a minimum of 60 minute integrity and insulation construction. This would be compliant with the recommendations of ADB 2013 Section 5.55.

G3.6.11 The refuse chute is approached by a protected lobby as shown in Figure G.37, Figure G.38 and Figure G.39. This is in accordance with ADB 2013 Section 5.55.

G3.6.12 The lobbies were provided with mechanical extraction therefore the performance cannot be directly compared to the ADB 2013 provision of 0.2m² of natural ventilation, although ventilation is provided.

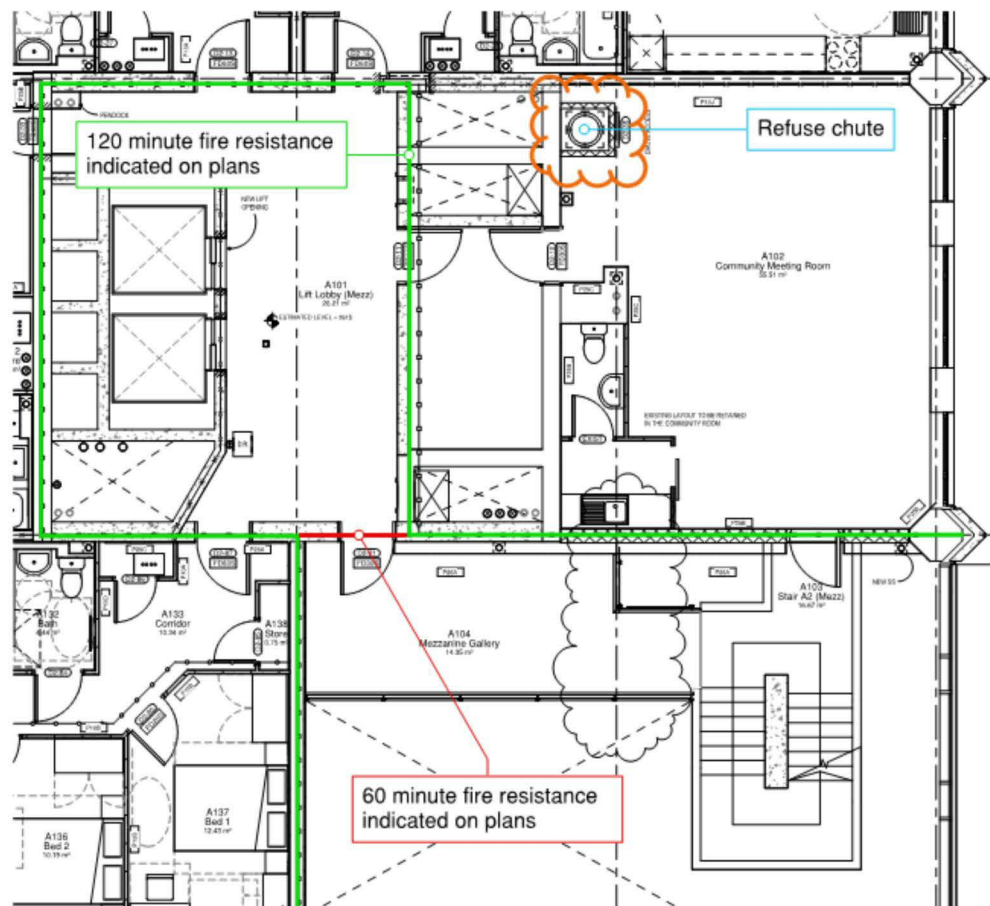


Figure G.36 Refuse chute at Level 1 (SEA00003231)

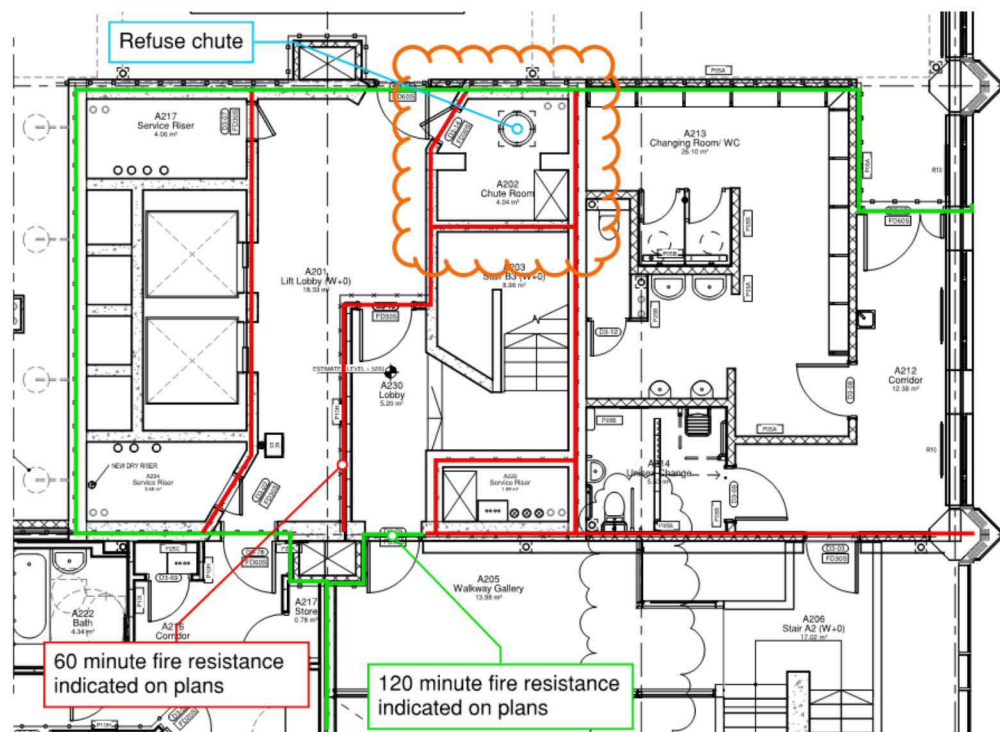


Figure G.37 Refuse chute on Level 2 (SEA00003149)

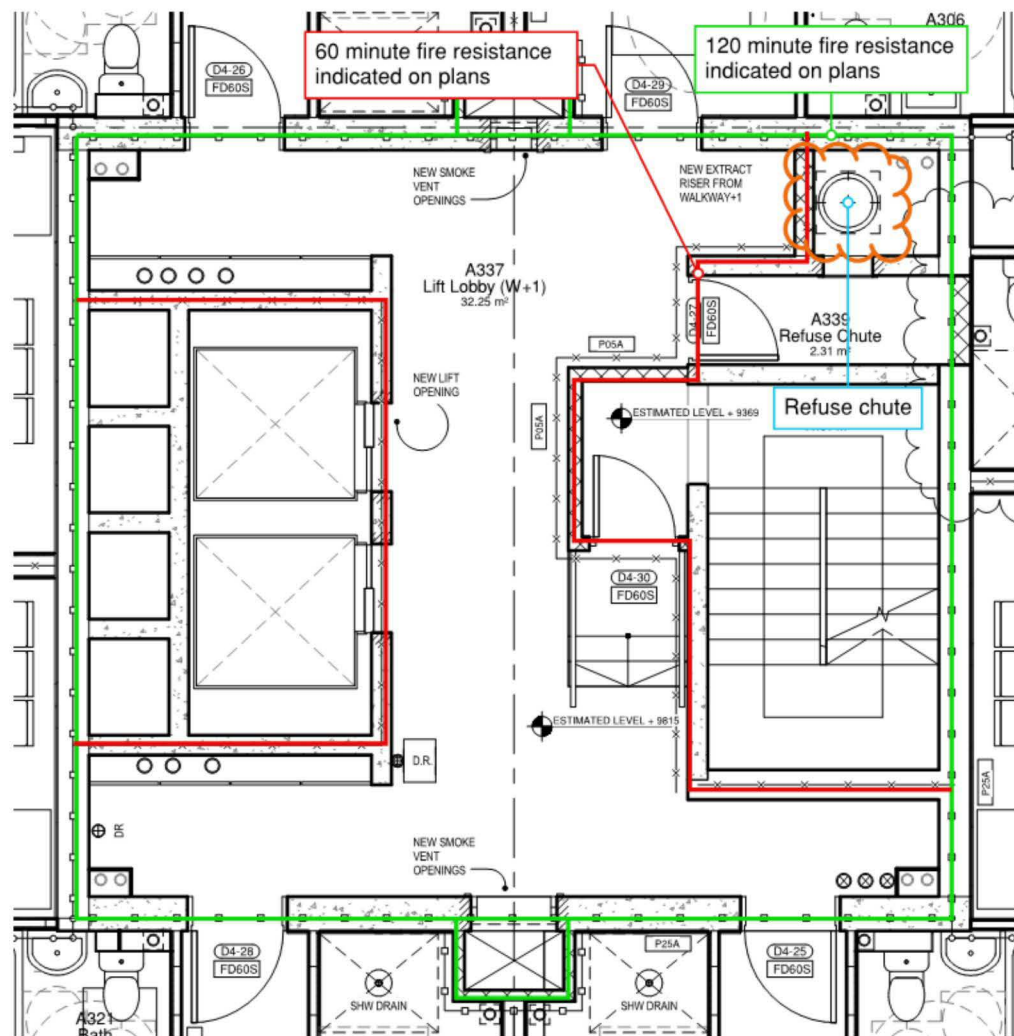


Figure G.38 Refuse chute on Level 3 (SEA00003229)

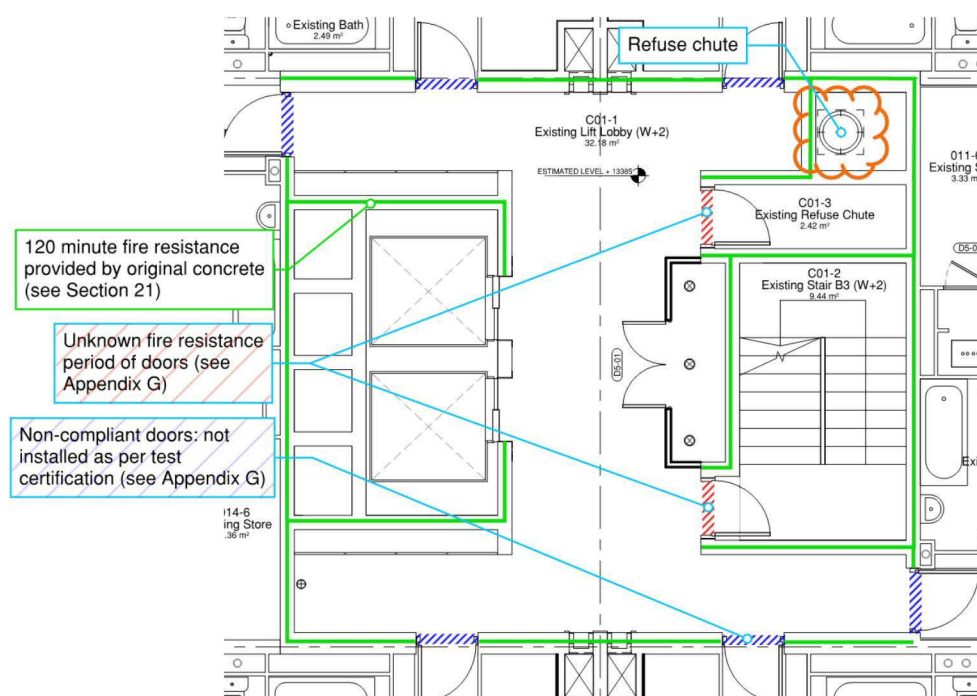


Figure G.39 Refuse chute on a typical residential level (SEA00010474)

G3.6.13 Emergency lighting

G3.6.14 There is no evidence that the emergency lighting in the lobby and stairs on Levels 04-23 were replaced during the 2012-2016 refurbishment works.

G3.6.15 Levels 4 to 23:

G3.6.16 There is evidence in the fire risk assessments performed by Carl Stokes that the building was fitted with emergency lighting. Figure G.41 presents an excerpt from the 2016 fire risk assessment report identifying that an adequate system had been installed. However, Figure G.42 demonstrates that adequate maintenance records were not being kept.

G3.6.17 Following the date of the fire risk assessment I have found evidence of an inspection and servicing visit logged by Allied Protection dated 17th January 2017 (LAK00000007). The maintenance visit was undertaken over a period of 3 hours. The testing was undertaken for 3 hours, as shown in an excerpt of the callout log (Figure G.40):

Annual Duration Preventative Maintenance Tests (In accordance with BS5266)

Each luminaire and internally illuminated sign tested as per the periodic tests but for its full duration (i.e. 3hrs): Yes


The Supply has been restored and any indicator lamp or device checked to ensure normal supply has been restored: Yes


Charging arrangements checked: Yes

Sufficient Lighting provided by Luminaires: Yes

Comments on results/Additional checks carried out / Remedial works Required/ Variations to BS 5266

Service of the emergency lighting

Customer Signature:  Customer Name: No signature

Operative Signature:  Arrival Time: 08.00

Departure Time: 11.00

Figure G.40: Excerpt of Inspection & Servicing Certificate (LAK00000007) showing 3 hour duration testing of emergency lighting

- G3.6.18** There is no evidence currently available as to the design standard to which the emergency lighting on Levels 4 to 23 had been specified or installed. Compliance of the system with the code of practice for emergency lighting referenced in ADB 2013 (BS5266-1) on Levels 4-23 therefore cannot be determined. I will revisit this issue and update my analysis where necessary when additional evidence is provided to me.
- G3.6.19** The existing system has battery packs with a compliant duration to the provisions of BS 5266-1.

15. EMERGENCY ESCAPE LIGHTING	YES	NO	N/A
If any is fitted, is the emergency lighting system currently installed in the building, to a reasonable standard?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is there adequately normal or borrowed lighting to back up any fitted emergency lighting system installed?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Where necessary, does the emergency lighting cover any external escape routes?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
If fitted, are all emergency lighting units, clean and visually in a good condition?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure G.41: Excerpt 1 from Carl Stokes fire risk assessment for Grenfell Tower dated 20th June 2016 (LFB000000066)

23. TESTING AND MAINTENANCE

	YES	NO	N/A
Is the structure of the premises adequately maintained?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is there weekly testing and six monthly servicing of fire detection and fire alarm system, with records kept?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Is there a monthly visual and annual testing of the emergency escape lighting, with records kept?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Figure G.42: Excerpt 2 from Carl Stokes fire risk assessment for Grenfell Tower dated 20th June 2016 (LFB00000066)

- G3.6.20** In my post fire inspection, I observed that several of the individual light fittings had inspection stickers applied. An example from the stair light from the Level 4 landing is provided in Figure G.43..



Figure G.43: Evidence of inspection sticker on light in stair at Level 4 landing

- G3.6.21** There is no evidence currently available as to the design standard to which the emergency lighting on Levels 4 to 23 had been specified or installed. Compliance of the system with the code of practice for emergency lighting referenced in ADB 2013 (BS5266-1) on Levels 4 to 23 therefore cannot be determined.
- G3.6.22** As part of the refurbishment works, new suspended ceilings were installed in the wings of the lobbies as indicated in Figure G.44. The Studio E specification for the ceiling did not have a fire resistance associated with it, and there is no evidence that these were installed as fire resisting elements of construction. As described in Section 4, the ceilings were installed to conceal the new pipework that was installed as part of the works on the heating system. I confirmed the location of the ceilings in my post fire site inspection (Figure G.45).

G3.6.23 In the central part of the lobbies, the existing light fittings that were retained in the Levels 4 to 23 lobbies were mounted directly to the slab soffit (Figure G.47). As indicated in Figure G.45, where the new suspended ceilings were fitted, the lights were observed to be wall mounted. There is no evidence as to whether the lights were originally positioned here, or if they were moved as part of the refurbishment.

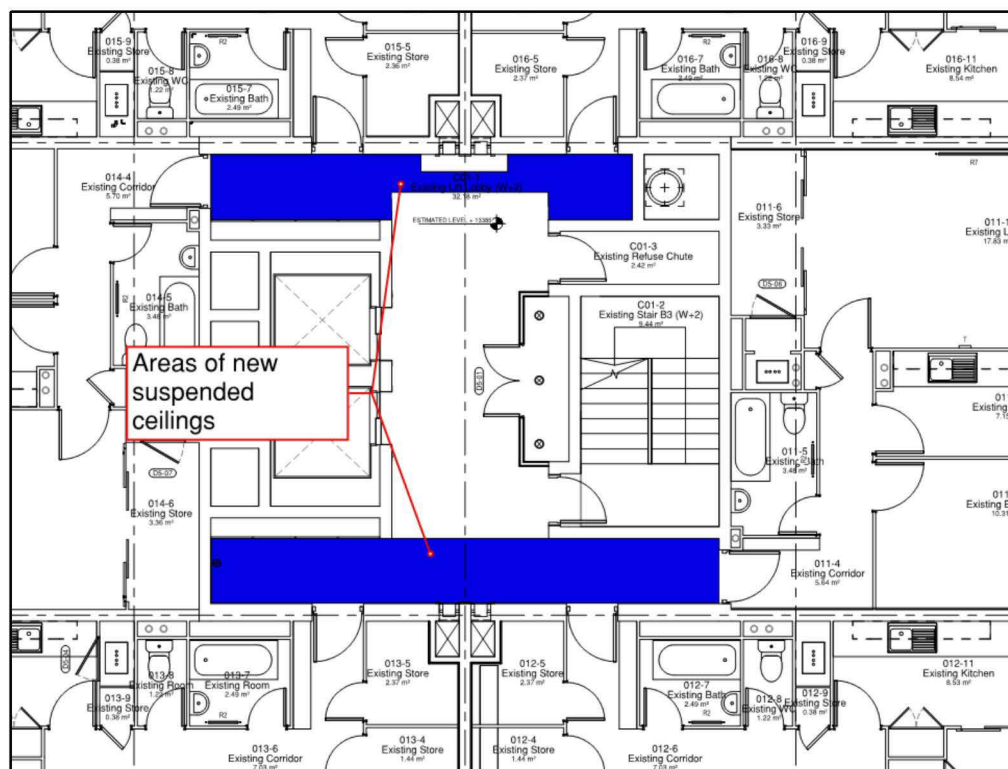


Figure G.44: Areas of new suspended ceilings provided on Levels 4 to 23 as part of refurbishment works, based on observations on site (please see figures below and Appendix C) (SEA00010474)



Figure G.45: Evidence of new suspended ceiling (Level 4 corridor, north side of lobby)



Figure G.46: Evidence of new suspended ceiling (Level 4 corridor, south side of lobby)



Figure G.47: Evidence of original light fittings (Level 6, south side of lobby)

G3.6.24 Levels Ground to 3:

G3.6.25 There is evidence that the refurbishment works included refitting of the lighting in the common lobbies on Levels Ground to 3. The Employer's Recommendations issued by Max Fordham (MAX00006475) states that following scope for lighting:

"V21 GENERAL LIGHTING

The general scope of the lighting installations is as follows:

- *Lighting within new areas at ground to level Walkway +1.*
- *Lighting in lift lobby areas.*
- *External lighting.*
- *Emergency escape lighting.*

The proposed lighting installations are shown on the tender drawings and schedules."

G3.6.26 The Max Fordham Employers Recommendations (MAX00006475) also state:

"Emergency Lighting:

Emergency lighting shall be provided where indicated on the drawings and any other areas recommended by Building Control/Fire Officer. The installation shall be in accordance with BS 5266 using maintained fittings with battery packs."

G3.6.27 The Studio E room data sheets (SEA00002540) identify the design recommendations for emergency lighting levels in each space. Figure G.48 provides an example for the lift lobby at Level 2 (Walkway). This excerpt notes that 1 LUX is to be achieved along escape routes and fixed at a height of 2.4m. This is compliant with the performance defined in BS 5266-1:2011, as described herein.

Grenfell Tower Regeneration Project

A201	Lift Lobby	23.49m²			
		Perimeter: 23.1m			
2 - Walkway	Lift lobby, Walkway level Fire escape route from main stair	Occupancy: -			
Building Elements					
Structural Changes	New opening to gallery overlooking main entrance. Existing opening to concrete core infilled to engineer's details.				
Minimum Height	2.4m	Windows	Refer to Elevations (05) series.		
Wall Finish	Existing tiles to be retained. Opening made good and eggshell paint to match existing	Ceiling	Refer to (32) Drawing Series		
Floor Finish	Refer to (43) Drawing Series				
Doors	Refer to door schedule; Access Control: -				
Services					
Heating System		Light Level	100	Sockets	
Int Design Temp		Lighting	4 x Ceiling mounted luminaires	FCU	
Heating System		Emergency Lighting	1 LUX along escape route, 0.5 in all other areas	Dual Data Outlets	
Vent Strategy		Fire Detection		Telephone	

Figure G.48: Excerpt from Studio E Room Data Sheets (SEA00002540)

- G3.6.28** There is no evidence included in information either from Rydon or Studio E of the particular lighting product to be used in the stairs or lobbies. The material of construction of the light and the duration of the backup battery system are not stated in the refurbishment design information currently available.
- G3.6.29** There is no evidence that the system was commissioned, certified or handed over in accordance with the procedures specified in BS 5266-1:2011.
- G3.6.30** The information in the Carl Stokes fire risk assessment from 2016 (Figure G.41 and Figure G.42) is also relevant to the refurbished areas of the building.
- G3.6.31** Therefore, there is evidence that an emergency lighting system was fitted to the refurbished areas on Levels Ground to 3. However, sufficient information is not available to demonstrate that it was compliant with the Code of Practice (BS 5266-1:2011) referenced by the statutory guidance in ADB 2013.
- G3.6.32 Protected circuits**

1.1.1 CP3 1971 requires the corridor and stair emergency lighting to each be supplied by independent, dedicated protected circuits. It notes the circuits should be restricted to routes of negligible fire risk. Furthermore:

“stairways should be illuminated by a circuit direct from the main switchboard with switches on each landing capable of overriding the

automatic time control and switching the lighting on, but incapable of switching the lighting off”.

- 1.1.1** ADB 2013 section 5.38 makes the following recommendations for critical electric circuits:
- a) Consist of cable meeting at least the requirements for PH 30 classification when tested in accordance with BS EN 50200:2006;
 - b) Should be supported by non-combustible materials;
 - c) Should follow a route that only passes through parts of the building with negligible fire risk.
- 1.1.2** With regards to Grenfell Tower, the circuits that must continue to function in case of fire (i.e. ‘critical electric circuits’) are the emergency lighting, smoke ventilation and lift circuits. Self-contained emergency lighting luminaires do not require fire-protected cable supplies in accordance with section 8.1 of BS 5266-1. However, I am not able to definitively conclude that the emergency lighting in place in any part of Grenfell Tower was self-contained and compliant with BS 5266-1.
- 1.1.3** I have not been able to assess whether or not the protection of critical circuits was in compliance with either CP3 1971 or ADB 2013 section 5.38 (either through a document review or on site). An assessment of the electrical routing and fire risk rooms has therefore not been undertaken (required for (c) above).
- 1.1.4** I will re visit this issue and update my analysis where necessary when additional evidence is provided to me.

G3.7 Means of escape for persons requiring assistance

- G3.7.1** Refuges for disabled occupants were only recommended by ADB 2013 in the non-residential areas of Grenfell Tower, namely – the Nursery (Ground Level), Community Meeting Room (Level 1), and Boxing Gym (Level 2).
- G3.7.2** ADB 2013 does not provide any guidance regarding the evacuation provisions for any person requiring assistance in residential developments. However, the provisions of suitable facilities for the means of escape of disabled occupants should be considered for compliance with Regulation B1 of the Building Regulations 2010. BS9991 is a published guidance document with specific guidance on the duties for fire safety managers in residential buildings.
- G3.7.3** Section 54 of BS 9991:2015 states:
- “Providing an accessible means of escape should be an integral part of fire safety management in all residential buildings. Fire safety management should take into account the full range of people who might use the premises, paying particular attention to the needs of disabled people.*

NOTE 1 It is the responsibility of the premises management to assess the needs of all people to make a safe evacuation when formulating evacuation plans.

An evacuation plan should not rely on the assistance of the fire and rescue service. This is an important factor that should be taken into account in the building design."

- G3.7.4** Please see Section 15 of this report where I present the available design guidance relating to this issue in more detail.
- G3.7.5** The Grenfell Tower refurbishment fire strategy does not state that refuges for disabled occupants should be or have been provided on any level, nor does it make any reference to the evacuation of persons needing assistance. This is therefore noncompliant with ADB 2013 Section 4.7 in the non-residential areas on Levels 1 and 2, and causes a breach of the RR(FS)O on Levels 4 – 23 (EXO00001106). Please see Section 15 of this report where I present this issue in more detail.
- G3.7.6** The Studio E Fire Strategy drawing, dated 24 October 2013, does not indicate any provision for refuges on Level 1 or 2. This is therefore noncompliant with ADB 2013 Section 4.7 for those non-residential areas on Levels 1 and 2. (SEA00003112)
- G3.7.7** During my post fire inspection, I did not observe any provision for refuges on any of the residential Levels 3 to 23. This is therefore noncompliant with the guidance in BS 9991, and causes a breach of the RR(FS)O on Levels 4 – 23.
- G3.7.8** The 2016 FRA states:
- "Both of the lifts in this building are firefighter/evacuation lifts and could be used as part of the evacuation strategy for disabled persons but if these lifts were used this would be under the control of the fire service, if they were in attendance. Before the fire service arrive at this building these lifts could be used by the residents or perhaps TMO/RBKC staff."*
- G3.7.9** There is no evidence that the lifts in Grenfell Tower were ever designed or installed as firefighting lifts in accordance with the guidance in ADB 2013 and BS 5588-5:2004. Please refer to Appendix L of this report for a full assessment of the compliance of the lifts with the relevant guidance for my assessment of compliance with part B5 of the Building Regulations 2010. Additionally, this approach to evacuation of disabled people relies on the intervention of the fire service, which is not in compliance with the guidance in BS 9991:2015, replicated above, which states that evacuation plans should not rely on the assistance of the fire and rescue services.
- G3.7.10** Furthermore, Section 21 of the FRA states:
- "The reception area which was located in the street level entrance hall area now does not exist either, there are no TMO employees or other staff who work in this building on a permanent basis."*

G3.7.11 Therefore, there would be no TMO employees to coordinate the evacuation of disabled residents using the lift, therefore the assumptions of the fire risk assessment are not correct for the building.

G3.7.12 I consider that the means of escape provision for persons requiring assistance on the residential Levels 3 to 23 are not compliant with Functional Requirement B1 of the Building Regulations, as no provision has been made. I acknowledge the current statutory guidance makes no specific provision, however, one still needs to comply with the Building Regulations. Guidance is provided in limited form in BS9991:2015.

G3.8 Summary of ADB compliance for means of warning and escape

- G3.8.1** Please refer to Table 16.2 in Section 16 of my report for a summary table of the compliance of Grenfell Tower with Section B1 means of escape, as described herein.
- G3.8.2** As I have set out above, Grenfell Tower was not compliant with the statutory guidance in ADB 2013, and therefore at this stage it is my opinion that the building did not comply with Part B1 of the Building Regulations 2010.
- G3.8.3** I will provide my final opinion in Phase 2.