**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 H

## Compliance assessment: access and facilities for the Fire and Rescue Services Regulation B5

**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 14th June 2017 |
| **Inspection Date(s)** | : | 6th October, 1st November, 7-9th November 2017 |

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# Appendix H – Compliance assessment: access and facilities for the Fire and Rescue Services Regulation B5

## CONTENTS

# H1 Introduction

**H1.1.1** In this appendix, I explain the requirements regarding access and facilities for the fire and rescue services.

**H1.1.2** First, I set out the applicable legislation, regulations and guidance for the original building design and construction between 1967 and 1974, and then for the refurbishment between 2012 and 2016.

**H1.1.3** I provide an overview of the operational purpose of the design and construction provisions in the current Building Regulations 2010.

**H1.1.4** I then examine the evidence available to me to determine the compliance, or otherwise, of Grenfell Tower on the night of the fire, with the aforementioned legislation, regulation and guidance. And therefore, where Grenfell Tower complied with functional requirement Part B5 of the Building Regulations 2010.

**H1.1.5** My assessment of compliance is based on information submitted to the Inquiry and on observations made in my own post-fire inspections, which took place between the 6th October and 9th of November 2017and the external firefighting access routes on the 6th June 2018.

**H1.1.6** 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 (see Appendix H) of the Building Regulations 2010. In some cases, therefore, the same issues are described and assessed in this appendix and in Appendix G.

**H1.1.7** The information in this Appendix is then drawn on and presented in the relevant parts of Section 15 and 16 of my report.

**H1.1.8** In Section 16, I provide a table (Table 16.3) summarising the internal and external firefighting provisions at Grenfell Tower and whether they comply with the original provisions of CP3 1971 (and therefore the London Building Acts (Amendment) Act 1939) and the provisions of ADB 2013 (and therefore functional requirement B5 of the Building Regulations 2010).

# H2 Access and facilities for the fire service - Regulation B5

## H2.1 Applicable legislation and guidance

**H2.1.1** Table H.1 presents a summary of the applicable legislation, regulation and guidance applicable to Grenfell Tower and which I use in this Appendix to set out provisions regarding access and facilities for the fire service.

**H2.1.2** It should be noted that, at the time of construction of Grenfell Tower, guidance for construction was set out in multiple documents as listed in row 1 of Table H.1.

**H2.1.3** CP 3 1971 which was national guidance but which appears to have been used in the design of Grenfell Tower (see Section 4 of my report), gives specific guidance on elements to support firefighting in blocks of flats in Section 7: *Fire brigade facilities and fire alarms*. Section 7 of CP3 1971 includes guidance relating to fire mains, access and hydrants but does not provide specific guidance on the enclosure or protection of the stairs and lobbies for firefighting purposes.

**H2.1.4** In London, the GLC Section 20 Code of Practice also provides specific guidance which is relevant to firefighting provisions. This Code, which has to be read in conjunction with the means of escape Code of Practice, specified fire resistance and ventilation requirements for the firefighting staircase, lobby and fire lift.

**H2.1.5** For the purposes of setting out the original requirements for Grenfell Tower in this Appendix, I have included the requirements of the GLC Section 20 Code of Practice only where that is different to that in CP3 1971.

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

| Period | Provisions | Applicable guidance |
|---|---|---|
| At the time of construction (1972-1974) | London Building Acts (Amendment) Act 1939<br>Section 20 – Requiring that *"proper arrangements will be made and maintained for lessening so far as is reasonably practicable danger from fire in the building."* For buildings taller than 100ft (30m) (or 80ft (25m) where the building footprint exceeds 10,000sqft (930m$^2$).<br>Section 34 – Requiring *"... all such means of escape therefrom in case of fire as in the circumstances of the case can be reasonably provided..."* in every new building which has a storey at a greater height than 20ft.*<br>Section 98 –*Byelaws with respect to construction and conversions of buildings*. | Compliance with the legislation and regulation was achieved using a suite of guidance at this time:<br>London Building (Constructional) amending Byelaws 1966 and 1970 – this code specified the fire resistance requirements of elements of construction including fire doors to stair and flats.<br>London County Council Guide *Means of escape in case of fire 1954 (as amended in 1967)* – between 1967 and 1974 alternative design guidance was permitted (See Appendix D).<br>Grenfell Tower was constructed using CP3 1971 for means of escape (See evidence in Section 4).<br>Greater London Council Guide *Code of Practice for buildings of Excess Height and/or Additional Cubical Extent requiring approval under Section 20 of the London Building Acts (Amendment) Act 1939.*<br>This code, to be read in conjunction with the means of escape code of practice, specified fire resistance and ventilation requirements for the fire fighting staircase, lobby and fire lift. |

| Period | Provisions | Applicable guidance |
|---|---|---|
| | | |
| At the time of refurbishment (2012-2016) | Building Regulations 2010<br>Functional Requirement B5 – Access and facilities for the fire service –<br>(1) The building shall be designed and constructed so as to provide reasonable facilities to assist the fire fighters in the protection of life.<br>(2) Reasonable provision shall be made within the site of the building to enable fire appliances to gain access to the building. | 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. |

**H2.1.6** As presented in Table H.1, Section 15 – 18 of ADB 2013 set out the general guidance to comply with the functional requirements.

**H2.1.7** Regarding the required performance, in the Secretary of State's view the Requirements of B5 will be met:

a) if there is sufficient means of external access to enable fire appliances to be brought near to the building for effective use;

b) if there is sufficient means of access into and within, the building for firefighting personnel to effect search and rescue and fight fire;

c) if the building is provided with sufficient internal fire mains and other facilities to assist firefighters in their tasks; and

d) if the building is provided with adequate means for venting heat and smoke from a fire in a basement.

**H2.1.8** These access arrangements and facilities are only required in the interests of the health and safety of people in and around the building. The extent to which they are required will depend on the use and size of the building in so far as it affects the health and safety of those people.

**H2.1.9** Table H.2 sets out the specific Sections of ADB 2013 relevant to Part B5. In the following parts of this Appendix H, I will set out this guidance, noting that the order in which the guidance is presented in ADB 2013 is not in a strictly sequential order.

**H2.1.10** For example, one must cross-refer to Section 17 in order to determine which parts of Section 15 apply. Where such cross referencing is required I have clarified in the text below.

Table H.2: Regulation B5 Sections of ADB 2013

| Section | Title |
|---|---|
| 15 | Fire mains and hydrants |
| 16 | Vehicle access |

| Section | Title |
|---|---|
| 17 | Access to buildings for firefighting personnel |
| 18 | Venting of heat and smoke from basements |

**H2.1.11** ADB 2013 Section 18: '*Venting of heat and smoke from basements'* will not be addressed in this appendix as it is not relevant to the fire on the 14th of June 2017.

**H2.1.12** 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. With respect to designing a building to comply with Part B5 of the Building Regulations 2010, ADB 2013 also refers to the British Standard documents identified in Table H.3.

Table H.3: Referenced British Standards within ADB 2013 Sections for B5

| ADB Section | British Standard | Fire safety feature |
|---|---|---|
| 15.6 | BS 9990:2006 | Fire main design and construction |
| 15.7 | BS 3251:1976 | Fire hydrant signage |
| 17.7 | BS 5588-10:1991 | Firefighting shafts (shopping complexes) |
| 17.13 | BS 5588-5:2004 | Firefighting shafts |
| 17.13 | BS EN 81-72:2003<br>BS EN 81-1:1998<br>BS EN 81-2:1998 | Firefighting lift installations |
| 18.14 | BS 5839-1:2002 | Mechanical smoke extract connection to automatic detection |
| 18.14 | BS EN 12101-3:2002 | Mechanical smoke extract |

**H2.1.13** As part of the introduction to the guidance of Sections 15-18, ADB 2013 Section B5.ii states

*"In deep basements and tall buildings (see paragraph 17.2) firefighters will invariably work inside. They need special access facilities (Section 17), equipped with fire mains (see Section 15). Fire appliances will need access to entry points near the fire mains (see Section 16)."*

**H2.1.14** Therefore, the vehicle access provisions, internal fire mains and internal access provisions in tall buildings are intended to facilitate internal fire-fighting operations.

**H2.1.15** In each Section below, I present the provisions from ADB 2013 that apply only to residential buildings over 18m in height followed by the provisions from the original design guidance: CP3 1971, GLC Section 20 Code of Practice 1970 and/or London Building (Constructional) amending bylaws 1966 as required.

## H2.2 Guidance for provision of fire mains

### H2.2.1 Fire mains in ADB 2013 (Section 15)

H2.2.2 There are two types of fire main:

a) Dry fire main

b) Wet fire main

H2.2.3 Table H.4 summarises the provisions of ADB 2013 Section 15 for fire mains, including references to provisions that are part of ADB 2013 Section 17.

Table H.4: Summary of guidance for fire mains in Section 15 of ADB 2013

| ADB 2013 Section | Provisions of a tall residential building |
|---|---|
| 15.2<br>(17.2)<br><br>(17.11) | Buildings with firefighting shafts should be provided with fire mains.<br>Buildings with a floor at more than 18m above fire and rescue service vehicle access should be provided with firefighting shafts.<br>All firefighting shafts should be equipped with fire mains having outlet connections and valves at every storey. |
| 15.5 | Outlets from the fire mains should be located within the protected enclosure of a stair or a protected lobby where one is provided (see Diagram 52).<br>Diagram 52 shows that fire main outlets should be positioned within the firefighting stair for flats (Figure H.1). |
| 15.6 (note) | Wet fire mains should be provided in buildings with a floor at more than 50m above fire and rescue service access level. |

H2.2.4 I have reproduced Section 15.5, Diagram 52 of ADB 2013 below, highlighting the relevant layout for tall residential buildings and those parts relevant to the placement of the fire main outlets:

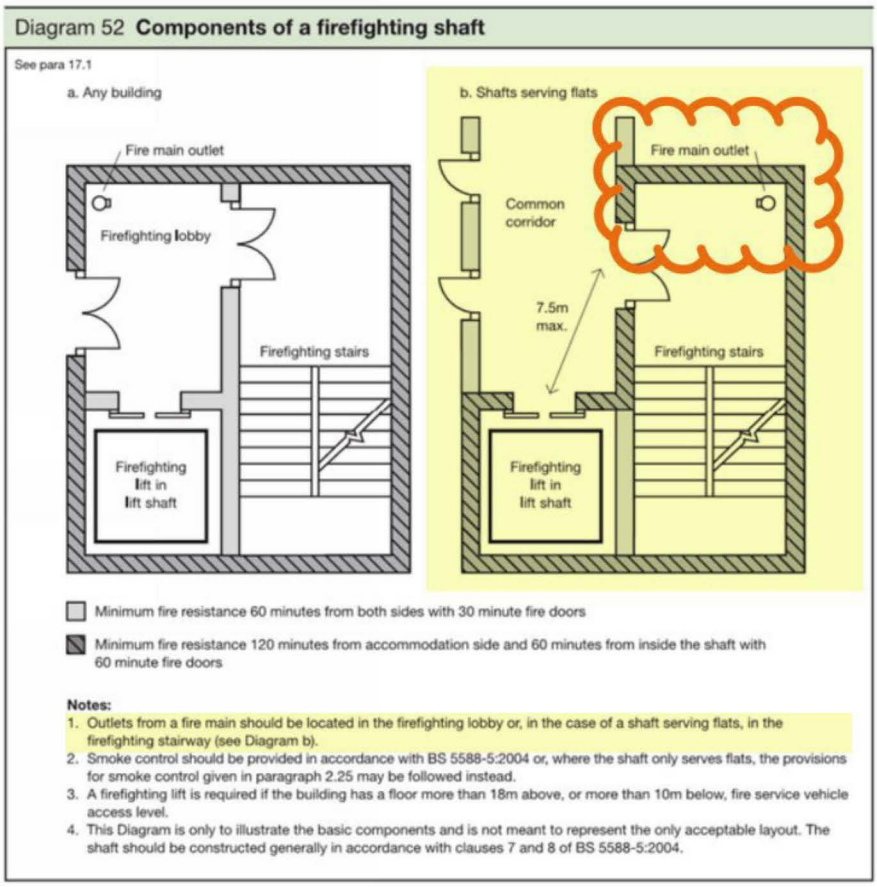



Figure H.1: ADB 2013 Diagram 52 – Diagram b (highlighted) applies to blocks of flats, fire main outlet placement outlined in orange

**H2.2.5** Other than the above, there are no further provisions set out in ADB 2013. However, Section 15.6 references BS9990:2006 for "Guidance on other aspects of the design and construction of fire mains, not included in the provisions of this Approved Document".

BS 9990:2006 "Code of practice for non-automatic fire-fighting systems in buildings" provides the following definitions for wet and dry rising mains:

***"dry fire main***
*water supply pipe installed in a building for fire-fighting purposes, fitted with inlet connections at fire service access level and landing valves at specified points, which is normally dry but is capable of being charged with water usually by pumping from fire and rescue service appliances*

***wet fire main***
*water supply pipe installed in a building for fire-fighting purposes and permanently charged with water from a pressurized supply, and fitted with landing valves at specified points"*

**H2.2.6** BS 9990:2006 sets out the following provisions for design of the systems:

Table H.5: Summary of BS 9990:2006 provisions for rising mains

| Design element | Dry rising main | Wet rising main |
|---|---|---|
| Nominal bore | 100mm | |
| Capable of withstanding | 150% of maximum operating pressure | |
| Isolating valves | At intervals not exceeding 10m in length | |
| Design operating pressure | 10 bar | <20 bar (running pressure of 8bar) |
| Water supply | 1500 l/min<br>Provided by the fire service by connection of pumping appliance to the municipal hydrant system | 1500 l/min<br>2 interconnected tanks providing total storage of 45,000l |
| No. of firefighting jets | Not specified, however the minimum flow required from municipal hydrant is the same as for a wet rising main. | System to be capable of serving 2 firefighting jets |
| Pumps | NA – Water delivery provided by fire engine pumping appliances | 2 No. pumps (duty and standby), each of which capable of providing 1500l/min<br>Pumps to be separately driven by independent electrical supplies |
| Inlets | Two-way inlet breeching for 100mm mains, lower edge 400-600mm above ground. | Emergency inlet to replenish the tank |
| Drain valve | Each breeching to be fitted with 25mm drain valve | n/a |
| Landing valves | At each floor level, sited:<br>Within a ventilated lobby or lobby approach stair; or<br>In a stair enclosure; or<br>In any other position as agreed with the appropriate authority.<br>In all cases a landing valve should be installed with its lowest point about 750mm above floor level and installed in a box in accordance with BS 5041-4. | |
| | In accordance with BS 5041-2 | In accordance with BS 5041-1 |
| Position of inlets | In an external wall as close as possible to position of the main which they serve, ideally on the exterior face of the firefighting shaft. Regard should be paid to the positions of fire hydrants, parking locations and the effect that falling debris might have on the continuing viability of the location. | |
| Electrical earthing | Earthed in accordance with BS 7671 and BS 7430. | |

**H2.2.7** BS9990:2006 gives the following advice (in agreement with ADB 2013) for the provision of mains:

*"Where fire mains are installed and there are no floors higher than 50 m above fire service access level, wet or dry fire mains may be installed. Where*

*there are floors higher than 50 m above fire service access level, wet fire mains should be installed owing to the pressures required to provide adequate fire-fighting water supplies at the landing valves at upper floors and also to ensure that water is immediately available at all floor levels."*

### H2.2.8 Fire mains in CP3 1971

H2.2.9 CP3 1971 states that a wet rising main is required where the height of a building is 60m as measured to any floor:

**7.1.2 Buildings fitted with wet risers.** Where any floor of a building is higher than 60 m (approximately 200 ft) the building should be fitted with ' wet ' rising mains.

Buildings with wet rising mains should have access roads to within 18 m (approximately 60 ft) of the ground floor access point of the stairway enclosure in which each main is situated (or, if the main is not situated in a stairway enclosure, to within 18 m (approximately 60 ft) of the foot of the nearest enclosed stairway to that main) and within sight of the building.

Figure H.2: CP3 1971 Section 7.1.2

H2.2.10 CP3 1971 requires wet rising mains to be designed to deliver 1,365l/min at 4.1bar, and intended to serve 3 lines of hose at 100 gal/min (455l/min) each. The current guidance in BS 9990 is to supply 2 lines of hose at 750l/min each, and therefore results in a similar total flow provision, as presented in Table H.5.

H2.2.11 CP3 1971 also gives the following provisions for the specification of rising mains:

**7.3.1 General.** Instantaneous female outlets conforming with BS 336 should be provided off wet or dry rising mains on each storey above the first. They should be in a ventilated lobby, where provided, or otherwise in a stairway entrance. Subject to agreement with the Fire Authority, in certain deck access schemes outlets may be free-standing on an open deck.

Outlets may be placed in a glazed cupboard clearly marked ' FIRE BRIGADE WET MAIN OUTLET ' or ' FIRE BRIGADE DRY MAIN OUTLET ', as the case may be. An outlet should be provided on the roof or at the highest outlet level in the building for testing purposes and adequate allowance made for drainage. To aid fire fighting, a simple, single cable and plug telephone system with specified connection points on each floor (usually by the wet or dry mains outlet) and in any lift motor room should be provided to enable the fire service to communicate between the ground floor and any other floor in the building. Wet and/or dry mains outlets should be so placed that *all parts of the building* are within 60 m (approximately 200 ft) measured along the line on which hoses will be laid. If this distance cannot be achieved with one rising main, additional main(s) should be provided. An air release valve should be provided at the top of each dry rising main, discharging to open air.

Figure H.3: CP3 1971 Section 7.3.1

**7.3.2 Dry rising mains.** Dry rising mains should have a diameter of not less than 100 mm (approximately 4 in) and should be provided with two instantaneous male inlets conforming to BS 336 for fire brigade connections. The inlets should be sited at a convenient position on the external wall of the building about 760 mm (approximately 2 ft 6 in) above ground level and should not be more than 12 m (approximately 40 ft) distant from the vertical run of the rising main. Inlets should, under all circumstances, be electrically earthed and should be contained in a glass fronted box, complying with BS 3980.

Figure H.4: CP3 1971 Section 7.3.2

## H2.3 Guidance for provision of private hydrants

### H2.3.1 Private hydrants in ADB 2013 (Section 15)

H2.3.2 ADB 2013 Section 15.7 requires a building with a compartment of more than 280m$^2$ in area to be less 100m from an existing hydrant. Where it is more than 100m from an existing hydrant an additional private hydrant should be provided within 90m of the fire main inlet.

### H2.3.3 Private hydrants in CP3 1971

H2.3.4 There is no specific provision for external hydrants, other than:

*"Fire Hydrants should be provided within the confines of the site if necessary, in consultation with the local fire and water authorities."*

## H2.4 Guidance for provisions of vehicle access for fire appliances

### H2.4.1 Pump access in ADB 2013 (Section 16)

H2.4.2 Sections 16.6 and 16.7 of ADB 2013 require that where a building is fitted with a fire main, fire vehicle access should be provided to within 18m of the entrance of the building and the dry fire main inlet on the face of the building. The vehicle access route is required to comply with the minimum dimensions, clearance and carrying capacity of Table 20 (Figure H.5) and turning provisions for dead ends in Diagram 50 (Figure H.6)

Table 20 **Typical fire and rescue service vehicle access route specification**

| Appliance type | Minimum width of road between kerbs (m) | Minimum width of gateways (m) | Minimum turning circle between kerbs (m) | Minimum turning circle between walls (m) | Minimum clearance height (m) | Minimum carrying capacity (tonnes) |
|---|---|---|---|---|---|---|
| Pump | 3.7 | 3.1 | 16.8 | 19.2 | 3.7 | 12.5 |
| High reach | 3.7 | 3.1 | 26.0 | 29.0 | 4.0 | 17.0 |

**Notes:**

1. Fire appliances are not standardised. Some fire services have appliances of greater weight or different size. In consultation with the Fire and Rescue Service, the Building Control Body may adopt other dimensions in such circumstances.
2. Because the weight of high reach appliances is distributed over a number of axles, it is considered that their infrequent use of a carriageway or route designed to 12.5 tonnes should not cause damage. It would therefore be reasonable to design the roadbase to 12.5 tonnes, although structures such as bridges should have the full 17 tonnes capacity.

Figure H.5: ADB 2013 Table 20

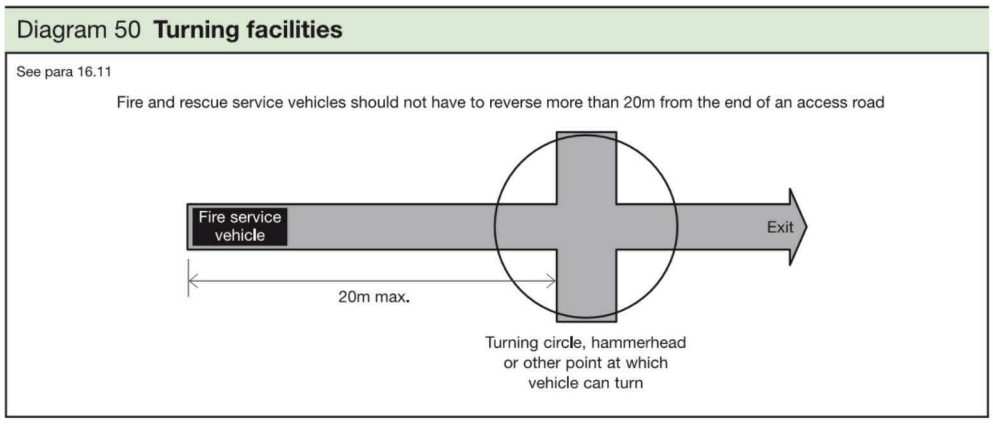



Figure H.6: ADB 2013 Diagram 50

### H2.4.3 Pump access in CP3 1971

H2.4.4 Section 7 of CP3 1971 requires access roads to within 18m of the ground floor access point of the stair enclosure in which the main is situated, or, if the main is not situated within the stair enclosure, within 18m of the foot of the nearest enclosed stair to that main. Access is to be provided as per the following:

**7.1.3 Access roads or ways.** Access roads may be common highways, private roads, footpaths or specially strengthened and defined routes through the surrounding terrain and should have a minimum width of 3.6 m (approximately 12 ft) and be capable of carrying a pumping appliance with a laden weight of 10.1605 tonnes (approximately 10 tons). Any necessary bends in roads should be able to accommodate an appliance having a minimum turning circle of 17 m (approximately 55 ft) diameter. Minimum clearance height should be 3.6 m (approximately 12 ft) and any gates should have a width of 3 m (approximately 10 ft) in the clear and be openable from either side.

Figure H.7: CP3 1971 Section 7.1.2

### H2.4.5 High reach appliance access in ADB 2013

H2.4.6 Sections 16.2 to 16.5, 16.9 and 16.10 of ADB 2013 contain the vehicle access parameters for buildings that are not provided with internal fire mains. These Sections include design guidance for the access routes and hard-standings to permit access for high reach appliances to the building perimeter.

H2.4.7 Buildings provided with an internal fire main, such as Grenfell Tower, are not subject to this guidance.

### H2.4.8 High reach appliance access in CP3 1971

H2.4.9 There is no specific provision made for high reach appliances other than the guidance that applies to regular fire vehicles.

## H2.5 Guidance on provisions for access to buildings for firefighting personnel

### H2.5.1 Firefighting shafts in ADB 2013 (Section 17)

H2.5.2 Section 17.2 of ADB 2013 states that buildings with a floor at more than 18m above fire and rescue service access level should be provided with firefighting shafts containing firefighting lifts.

H2.5.3 Section 17.1 of ADB 2013 notes that the design guidance of firefighting shafts for blocks of flats are permitted to differ to those for other types of buildings as follows:

*"because of the high degree of compartmentation in blocks of flats, the provisions for the design and construction of fighting shafts is different to other buildings"*

H2.5.4 Sections 17.12, 17.3 and 17.4 of ADB 2013 set out the design and construction provisions of a firefighting shaft for a block of flats. This is summarised in Table H.6, below.

**H2.5.5** Diagram 52 from ADB 2013 illustrates the components of a firefighting shaft and is included in Figure H.8.

Table H.6 Summary of ADB 2013 guidance for firefighting shafts in Section 17

| Component | Section of ADB 2013 | ADB 2013 Design guidance for firefighting shafts in blocks of flats |
|---|---|---|
| General guidance | 17.2<br>17.6 | As per diagram 15, firefighting shafts should serve the upper storeys in any building with a storey more than 18m above fire service vehicle access level, and;<br>Firefighting shafts should serve all floors through which they pass. |
| Number and location | 17.8<br>17.9<br>17.10 | If the building has a storey over 18m, every part of every storey shall be no more than 45m from a fire main outlet in a firefighting shaft (for buildings not fitted with sprinklers). |
| Firefighting stair | 2.33 | The firefighting stair shall be at least 1100mm wide when measured between the walls and/or balustrades. |
| Fire main | 17.12<br>Diagram 52<br>Section 17 | See Section H2.2 above. |
| Firefighting lift | 17.13<br>17.14 | The firefighting lift includes the lift car, the lift well and the lift machinery space together with the lift control system and lift communications system:<br>The firefighting lift doors should not be more than 7.5m from the door of the firefighting stair in the case of a block of flats. Please refer to Section H2.5.26 onwards of this report for other design and construction guidance for a firefighting lift. |
| Firefighting lobby | Diagram 52<br>Section 17 | Section 17.14 of ADB 2013 permits the omission of a firefighting lobby between the firefighting stair and the common corridor or common lobby in a block of flats where the guidance in Sections 3 and 9 of ADB 2013 (see Section H2.5.1 of this report) have been followed. |

| Component | Section of ADB 2013 | ADB 2013 Design guidance for firefighting shafts in blocks of flats |
|---|---|---|
| Smoke Control | Diagram 52<br>Note 2<br>Section 17 | Firefighting shafts should be provided with smoke control in accordance with BS 5588-5:2004 and/or BS EN 12101-6:2005 (ADB 2013 Section 2.27), or where it serves flats only, the provisions of ADB 2013 Section 2.25, achieved with:<br>a. Natural ventilation (ADB 2013 Section 2.26):<br>a) A 1m$^2$ vent at the head of the stair, and either;<br>o Vents in the common lobbies with a free area of at least 1.5m$^2$ at each floor, or;<br>o Vents of at least 1m$^2$ discharging into a vertical smoke shaft of a cross Sectional area of at least 1.5m$^2$.<br>b) The smoke shaft should be constructed from non-combustible material and all vents should have a fire/smoke resistance performance at least that of an E30S$_a$ fire door<br>c) The shaft should be vertical from base to head<br>d) Detection system that automatically opens both the vents on the fire floor and head of stair; or<br>b. Mechanical ventilation (ADB 2013 Section 2.27 references BS EN 12101-6 as one means by which this may be achieved)<br>Note BS 5588-5:2004 was withdrawn and replaced by BS999:2008. Therefore, both documents are relevant to the refurbishment of Grenfell Tower, as described in Section 0.22 of ADB 2013. |
| Shaft Enclosure | Appendix A<br>Table A1 (shaft enclosure)<br>Table B1 (fire doors)<br><br>17.14 | A firefighting shaft should be separated from the rest of the building by construction achieving 120 minutes load bearing, integrity and insulation fire resistance. (ADB 2013 Table A1) Any fire door within the shaft enclosure should achieve 60 minutes fire resistance for integrity and restrict smoke leakage at ambient temperatures (FD60S) (see Figure H.8) and be installed with a self-closing device.<br>Construction separating the firefighting stair and firefighting lift from a formal firefighting lobby and from each other should achieve 60 minutes load bearing, integrity and insulation fire resistance, as shown in Figure H.9.<br>According to ADB 2013 Table B1, flat entrance fire doors should achieve 30 minutes fire resistance for integrity and restrict smoke leakage at ambient temperatures (FD30S); flat entrance doors should be installed with self-closing devices.<br>In the event that a firefighting lobby is omitted as permitted by Section 17.14 of ADB 2013, the stairs and lifts only need to be enclosed in 120 minute protection with FD60S doors, while the residential common lobby must be enclosed in 60 minute rated construction with FD30S doors to each flat (Figure H.8).<br>Lift landing doors are required to achieve FD60 classification. |

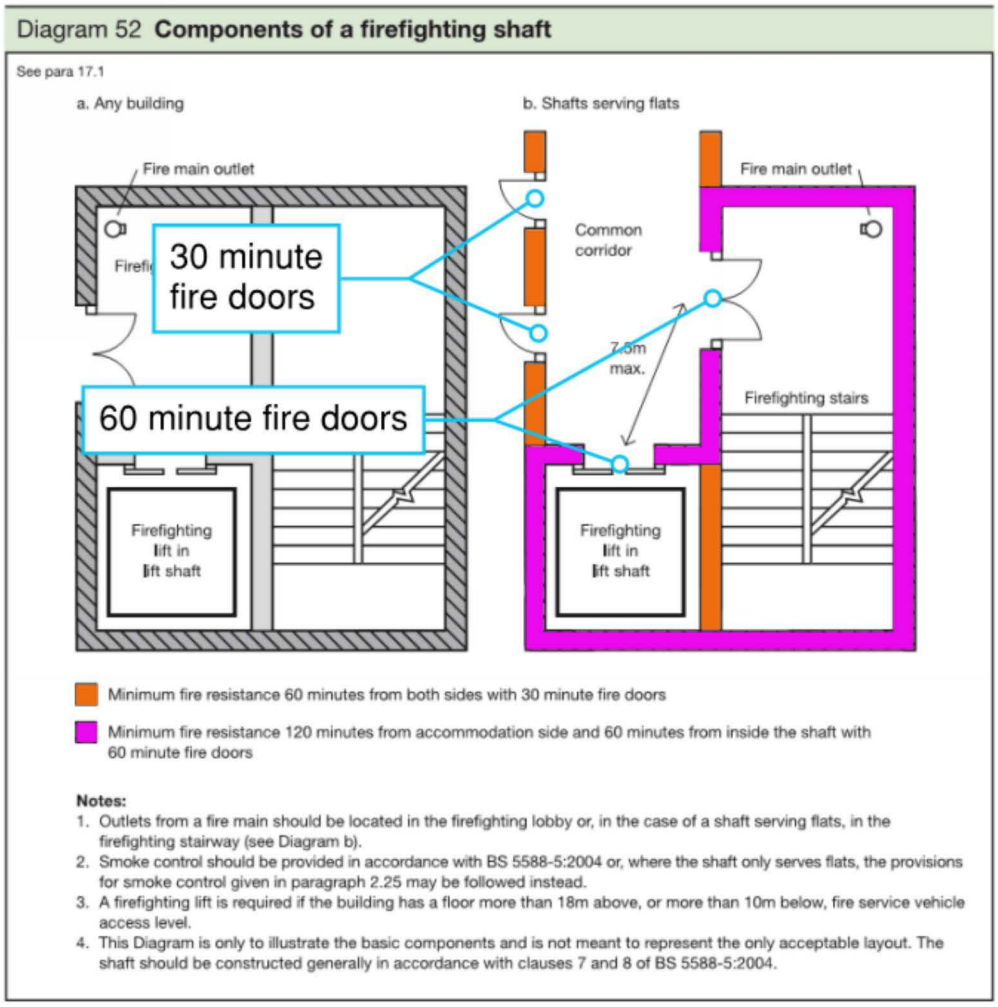



Figure H.8: ADB 2013 Diagram 52 – Diagram b (highlighted) applies to blocks of flats

Table A1 **continued**

| Part of building | Minimum provisions when tested to the relevant part of BS 476 [1] (minutes) | | | Minimum provisions when tested to the relevant European standard (minutes) [9] | Method of exposure |
|---|---|---|---|---|---|
| | Loadbearing capacity [2] | Integrity | Insulation | | |
| 10. **Firefighting shafts** | 120 | 120 | 120 | REI 120 | From side remote from shaft |
| a. construction separating firefighting shaft from rest of building; | 60 | 60 | 60 | REI 60 | From shaft side |
| b. construction separating firefighting stair, firefighting lift shaft and firefighting lobby | 60 | 60 | 60 | REI 60 | Each side separately |

Figure H.9: ADB 2013 Table A1 excerpt for fire resistance periods of firefighting shaft elements

## H2.5.6 Original design guidance (CP3 1971, GLC Section 20 Guide and Constructional Bylaws)

H2.5.7 CP3 1971 presents the following arrangement for the common lobby in single stair tower blocks coupled with a 'smoke dispersal' system:

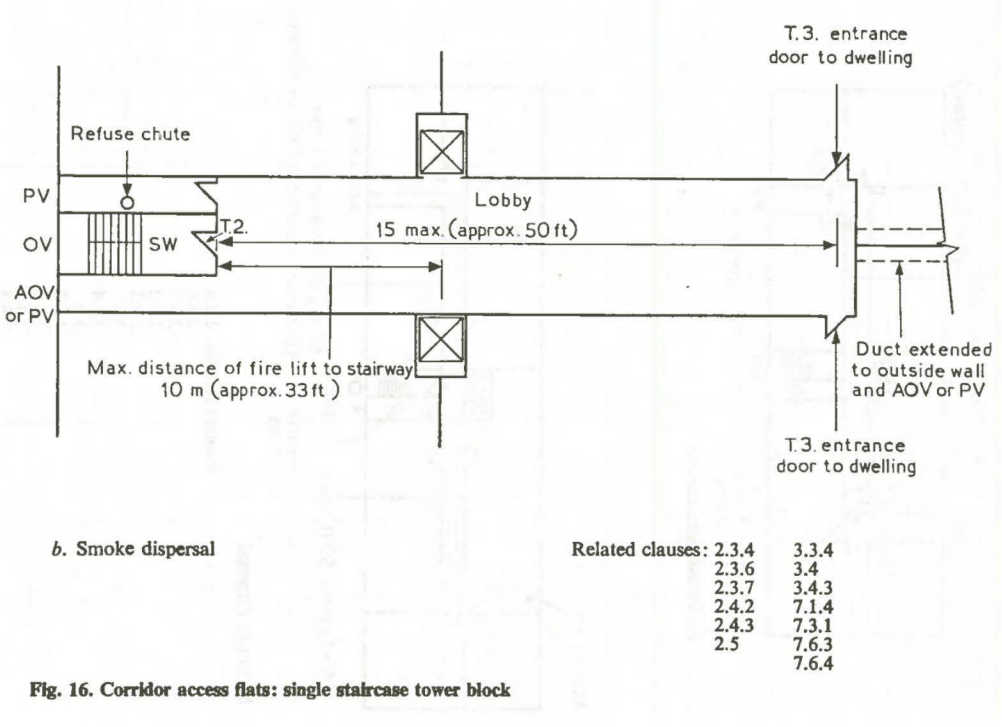



Figure H.10: CP3 1971 figure for common lobby arrangement for single stair tower blocks

H2.5.8 The GLC Section 20 Code of Practice sets out the following typical arrangement for a single "fire fighting lobby approach staircase" using cross ventilation of the lobby:

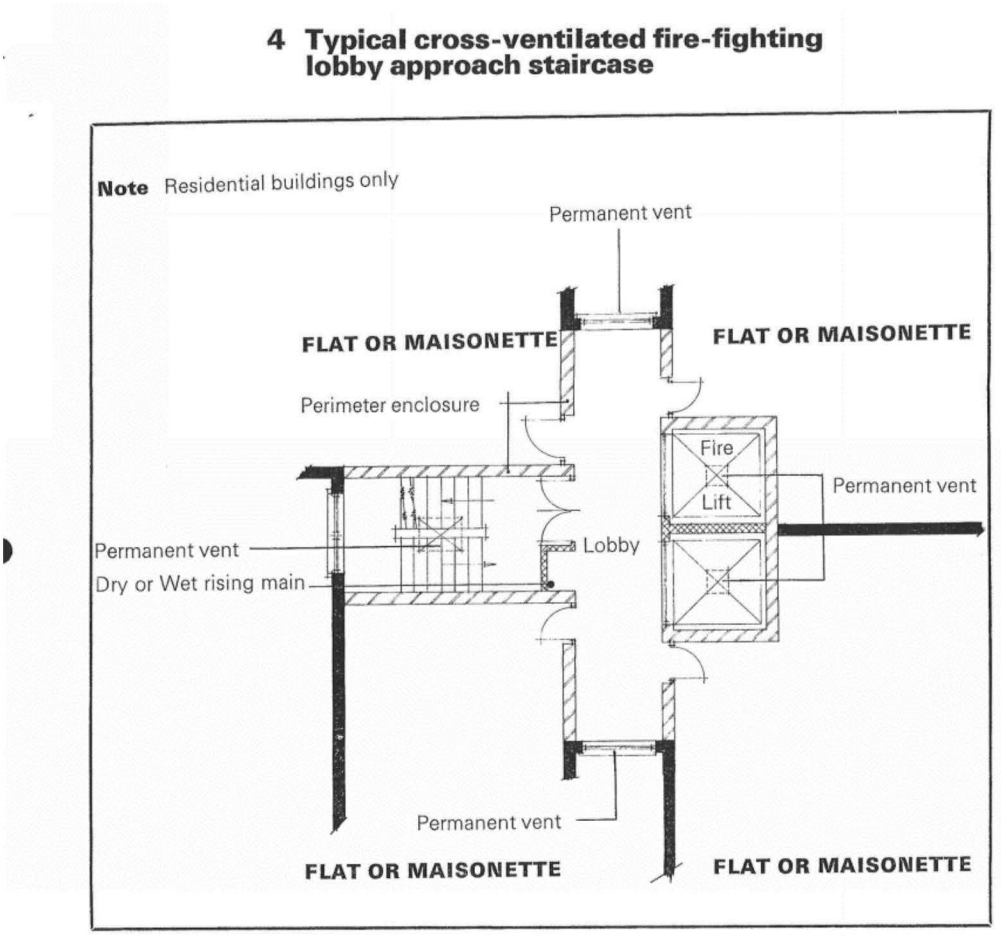



Figure H.11 Section 20 Code of Practice for single lobby staircase residential designs.

**H2.5.9** The guidance in CP3 1971 and the GLC Section 20 Code of Practice 1970 for the specific components of the of the stair, lobby and firefighting systems is as follows:

**H2.5.10** Number and type of fire mains in the building (CP3 1971 Section 7.3.1):

Wet and/or dry mains outlets should be so placed that *all parts of the building* are within 60 m (approximately 200 ft) measured along the line on which hoses will be laid. If this distance cannot be achieved with one rising main, additional main(s) should be provided. An air release valve should be provided at the top of each dry rising main, discharging to open air.

Figure H.12: CP3 1971 Section 7.3.1

**H2.5.11** Paragraph 6.02(4) of the GLC Section 20 Code of Practice 1970 also requires a wet rising main in buildings with a height exceeding 200ft (approximately 61m).

**4 Wet rising mains**

In all buildings exceeding 200 feet (61 m) in height measured to the underside of the ceiling of the topmost storey, wet rising mains (independent of sprinkler, drencher installations and hose reel supplies) should be provided in place of dry rising mains referred to in (**3**) above, within the lobbies of the fire-fighting lobby-approach staircases and within such other staircases as the Council may require.

***Note***
*Wet rising mains should be installed progressively (as detailed in (**3**) above) as dry rising mains until the building reaches a height of 200 feet (61 m) and thereafter as wet rising mains unless other arrangements to give fire-fighting facilities during the progress of works are agreed with the Fire Prevention Branch of the London Fire Brigade, Headquarters, Albert Embankment, London, S.E.1.*

Figure H.13 GLC Section 20 Code of Practice Section 6.02(4)

**H2.5.12** Stair width (CP3 1971 Section 3.4.2.2) – Main stairs 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.

**H2.5.13** Fire main outlets (CP3 1971 Section 7.3.1, Section 20 Guide Section 6.02(4)) – CP3 1971 and the Section 20 Guide differ from ADB 2013 as outlets should in the first instance be situated in a ventilated lobby, and only within a stair entrance where ventilated lobbies are not provided (Excerpt below).

**7.3.1 General.** Instantaneous female outlets conforming with BS 336 should be provided off wet or dry rising mains on each storey above the first. They should be in a ventilated lobby, where provided, or otherwise in a stairway entrance. Subject to agreement with the Fire Authority, in certain deck access schemes outlets may be free-standing on an open deck.

Figure H.14: CP3 1971 Section 7.3.1

**H2.5.14** Shaft enclosure (walls & floors) – the enclosure to the lobby, staircase and firefighting lift spaces. Appendix A1.03 (1) of the GLC Section 20 Code of Practice 1970 requires this construction and any supporting construction to it to be twice the required fire resistance by the Construction Bylaws for the elements of construction, and to be non-combustible with no combustible finishes.

**H2.5.15** The Constructional Bylaws required the fire resistance period for Grenfell Tower to be one hour (excerpt below).

**(3) Where, in any building, the level of the surface of any floor is more than 42 feet above the level of the footway immediately in front of the centre of the face of the building, or if there is no footway, above the level of the ground before excavation, the elements of construction of that building shall be capable of resisting the action of fire for a period of not less than one hour, and shall be of non-combustible construction.**

Figure H.15: Constructional Bylaws requirement for fire resistance period of the building

**H2.5.16** Therefore, the construction enclosing the fire fighting stairs, lift and lobbies in Grenfell Tower should achieve 2 hour fire resistance. The walls separating the lifts, staircase and lobby from each other were permitted by GLC Section 20 guide to be a 30 minute standard.

**H2.5.17** Shaft enclosure (Fire Doors) – The Constructional bylaws and the GLC Section 20 Code of Practice required both flat entrance doors, stair doors and lift doors to be **Class A**. The Section 20 guide defines a 'Class A' door in Part II definitions as "a Class A door under Table G of Schedule VI of the London Building (constructional) Amending By-laws (No.1) 1964".

**H2.5.18** CP3 1971 (as per Figure H.10) states that the doors providing access to main stairs should be 'Type 2' (excerpt in Figure H.16) – which corresponds to a door giving "*freedom from collapse*" and "*resistance to passage of flame*" for at least 30 minutes (analogous to 30 minutes stability and integrity), installed with a self-closing device.

**4.3.2.2** *Type 2 door.* The door, or each leaf thereof, when fixed in a frame with a 25 mm rebate (approximately 1 in), should satisfy the requirements of test as to both freedom from collapse and resistance to passage of flame for not less than 30 minutes. **[4.4.3]**

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 a 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 is reasonably practicable.

Figure H.16: 'Type 2' doors, CP3 1971

**H2.5.19** According to CP3 1971 Section 4.3.2.3, flat entrance fire doors should by 'Type 3'(excerpt in Figure H.17). This means flat entrance doors should achieve 20 minutes fire resistance for integrity and 30 minutes fire resistance for stability and be installed with self-closing devices, although it was permissible to achieve this by using rising butt hinges.

**4.3.2.3** *Type 3 door.* The door, or each leaf thereof, when fitted in a 25 mm (approximately 1 in) 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 be either 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 12 mm (approximately ½ in) and should be fitted with an automatic self-closing device which may (except where otherwise recommended) consist of rising butt hinges.

Figure H.17: 'Type 3' doors, CP3 1971

**H2.5.20** I have provided an explanation of historic fire doors in Appendix M, including how the performance of the doors varies between the different standards for fire doors outlined in the London Building (Constructional) Bylaws 1966; the performance specification in the Building Regulations 1965 and the Type Specification in the British Standard Code of Practice CP3 chapter IV.

**H2.5.21** Smoke ventilation - Both CP3 1971 and the GLC Section 20 Code of Practice 1970 contained provisions relevant to smoke ventilation to the lobby and the

staircase. The specific provisions made by each Code vary with regard to the specific opening areas required.

**H2.5.22** CP3 1971 permitted internally located lobbies and the use of ducts to connect automatically opening or permanently open vents to the outside (Figure H.10). However, the GLC Section 20 Code of Practice 1970 did not include such a provision for internal lobbies.

**H2.5.23** In CP3 1971 Section 3.4.6, which addressed ventilation to internal stairways, it states, "*Where a main stairway enclosure is not situated against an external wall, or has no opening windows, it should have a permanent vent at the top having a free area of not less than 1.0 m*".

**H2.5.24** In the GLC Section 20 Code of Practice 1970, the stair must also then be provided with its own separate ventilation system:

**3 Ventilation of internal staircase**

Where access to the staircase is through a single or double lobby as described in (**1**) and (**2**) above, the staircase may be internal provided it is ventilated:

**a** into a vertical shaft as described in item **A2.02 2** of this Appendix. A casement window, opening outwards into the shaft and capable of being opened without the aid of a key (see also A Part I – item **A1.07** of this Appendix) should be provided at each floor or landing level having an openable area equal to 15 per cent. of the internal area of the staircase enclosure or 15 square feet (1·4 m²) whichever be the greater. In addition a permanent vent should be provided at the top of the staircase equal in area to 5 per cent. of the internal area of the staircase; or

**b** by a permanent opening to the open air at the bottom and top each opening having an unobstructed area of not less than 10 square feet (0·9 m²).

**H2.5.25** I have analysed the original smoke shaft construction and compared it with the provisions in CP3 1971 and the GLC Section 20 Code of Practice 1970 in Appendix J.

**H2.5.26** **Firefighting lifts in ADB 2013**

**H2.5.27** As seen in Figure H.8, ADB 2013 states that the fire-fighting lift landing doors should be at least FD60 fire doors.

**H2.5.28** With reference to firefighting lift installations specifically, ADB 2013 section 17.13 then refers to Section 7 & 8 of BS5588-5:2004, which requires:

a) Provision of an escape hatch;

b) Water protection to the installation and shaft;

c) Firefighting controls at access level;

d) BS EN 81-72 compliant firefighting communication system between the lift car, machine room and lobby at access level;

e) Primary and secondary electrical supplies with automatic changeover in the event of primary supply failure;

f) Other lifts in the same well as a fire-fighting lift should not introduce significant additional fire risks;

g) Goods lifts and service lifts should not be located within fire-fighting shafts. Passenger lifts should not be located within a fire-fighting shaft unless the lift cars are constructed in accordance with BS EN 81-72.

**H2.5.29** ADB 2013 refers to BS EN 81-72:2003 and BS EN81-1:1998 or BS EN81-2:1998, as relevant design guidance for the lift car installation, which also sets out further detail on topics such as communication systems, protection against firefighting water, special signage, power supplies and controls.

**H2.5.30** The foreword of BS 5588-5:2004 states:

*"This new edition represents a retitling and full revision of the standard, and introduces the following principal changes:*

*...*

*b) removal of all recommendations relating to fire-fighting lifts that are now covered in BS EN 81-72;"*

**H2.5.31** Hence, it is intended to be read in conjunction with BS EN 81-72. However, BS EN 81-72:2003 states in Section 1: *Scope*:

*"1.2 This standard is not applicable to:*

- *lifts installed in existing buildings;*
- *important modification to existing lifts installed before the publication of this standard;"*

**H2.5.32** **Firefighting lifts in CP3 1971 and Section 20 Code of Practice 1970**

**H2.5.33** CP3 1971 and Section 20 of the 1970 Code do not include a description of 'firefighting lifts', and instead state the following provisions for 'fire lifts' in a building:

a) Where passenger lifts are installed in a building, one or more should be provided with a fire switch whereby firemen obtain the use of a lift without interference; and

b) In blocks of flats, fire lifts should serve every floor; and

c) A fire lift should have a platform area of not less than $1.5m^2$ / "*approximately 15 $ft^2$*" a capacity of 550kg / "*approximately 1200lb*" and reach the top floor from ground level within one minute; and

d) The electric supply to any fire lift should be provided by a sub-main circuit exclusive to the lift.

**H2.5.34** Whilst the provisions are given in metric, the approximations given in Imperial units are smaller than the direct conversion (15 $ft^2$ = 1.394$m^2$, 1200lb = 545kg).

## H2.5.35 Summary of provisions for firefighting from ADB 2013 and CP3 1971, Section 20 Code of Practice and Constructional Bylaws

Table H.7: Summary table of firefighting guidance

| **Firefighting provision** | **ADB 2013 Sections** | **Guidance for a tall (>18m) residential building** | |
|---|---|---|---|
| | | **Guidance as per ADB 2013** | **Original Construction: Guidance as per** CP3 1971, Section 20 Code of Practice and Constructional Bylaws |
| Fire mains | 15.2<br>15.5<br>15.6<br>17.2<br>17.11 | a) Fire main should have outlet connections and valves at every storey<br>b) Outlets from the fire mains should be located within the protected enclosure of a stair<br>c) Wet fire mains should be provided in buildings with a floor at more than 50m above fire and rescue service access level. | a) Fire main should be provided with outlets on every storey above the first.<br>b) Outlets from the fire mains should be located within a ventilated lobby or otherwise in a stair entrance<br>c) Wet fire mains should be provided where any floor of the building is higher than 60m. |
| Private hydrants | 15.7 | a) A building with a compartment of more than 280m$^2$ in area to be less 100m from an existing hydrant.<br>b) Where it is more than 100m from an existing hydrant an additional private hydrant should be provided within 90m of the fire main inlet. | *"Fire Hydrants should be provided within the confines of the site if necessary, in consultation with the local fire and water authorities."* |
| Pump access | 16.6<br>16.7 | a) Vehicle access should be provided to within 18m of the entrance of the building and the dry fire main inlet on the face of the building.<br>b) The access route is required to comply with the minimum dimensions, clearance and carrying capacity of ADB 2013 Table 20 and ADB 2013 Diagram 50. | a) Access roads to within 18m of the ground floor access point of the stair enclosure in which the main is situated, or, if the main is not situated within the stair enclosure, within 18m of the foot of the nearest enclosed stair to that main.<br>b) The access route is required to comply with the minimum dimensions, clearance and carrying capacity of CP3 1971 Section 7.1.3. |
| High reach appliance access | 16.2<br>16.3<br>16.4<br>16.5<br>16.9<br>16.10 | Where the building is not installed with a fire main, the access route is required to comply with the minimum dimensions, clearance and carrying capacity of ADB 2013 Table 20 and ADB 2013 Diagram 49.<br>These provisions did not apply to Grenfell Tower. | No specific high reach appliance provisions |

| **Firefighting provision** | **ADB 2013 Sections** | **Guidance for a tall (>18m) residential building** | |
|---|---|---|---|
| | | **Guidance as per ADB 2013** | **Original Construction: Guidance as per** CP3 1971, Section 20 Code of Practice and Constructional Bylaws |
| Firefighting shafts – general | 17.2<br>17.6 | a) Firefighting shafts should be provided in any building with a storey more than 18m above fire service vehicle access level<br>b) Firefighting shafts should serve all floors through which they pass. | Section 20 Code practice requires lobby approach staircase and fire lift for fire =fighting access in any storey above 80ft (24.384m) . |
| Firefighting shafts – number and location | 17.8<br>17.9<br>17.10 | If the building has a storey over 18m, every part of every storey shall be no more than 45m from a fire main outlet in a firefighting shaft (for buildings not fitted with sprinklers). | Wet and/or dry mains outlets should be so placed that all parts of the building are within 60m measured along the line on which hoses will be laid. |
| Firefighting stair | 2.33 | The firefighting stair shall be at least 1100mm wide when measured between the walls or balustrades. | Main stairs 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. |
| Firefighting lobby / layout | Diagram 52<br>Section 17 | ADB 2013 permits the omission of a firefighting lobby between the firefighting stair and the common corridor or common lobby in a block of flats, where the means of escape is designed to achieve compliance with Section 2 and 3 of ADB 2013 (assessed in Section H.5 of this report). | As per Figure H.10 and Figure H.11 of this report.<br>Section 20 – Lobby on an external wall with a floor area of not less than 5.5m$^2$ |
| Smoke control | Diagram 52<br>Note 2<br>Section 17<br>2.25 – 2.27<br>17.14 | Please refer to Appendix J | Please refer to Appendix J |
| Shaft Enclosure | Diagram 52<br>Section 17<br>Appendix A<br>Table A1 (shaft enclosure) | a) A firefighting shaft should be separated from the rest of the building by construction achieving 120 minutes load bearing, integrity and insulation fire resistance. (ADB 2013 Table A1)<br>b) Any fire door within the shaft enclosure should be a FD60S, installed with a self-closing device (Figure H.8). | a) Elements of construction and the enclosure of the stair to achieve a fire resistance period of 2 hours to satisfy Section 20.<br>b) Any fire door to the stair enclosure should be a Type 2 fire door (30 minutes stability and integrity) and be installed with a self-closing device to satisfy CP3 1971 or Class A to satisfy Section 20 Code of Practice 1970. |

| **Firefighting provision** | **ADB 2013 Sections** | **Guidance for a tall (>18m) residential building** | |
|---|---|---|---|
| | | **Guidance as per ADB 2013** | **Original Construction: Guidance as per** CP3 1971, Section 20 Code of Practice and Constructional Bylaws |
| | Table B1 (Fire doors) | c) Construction separating the firefighting stair and firefighting lift from a formal firefighting lobby and from each other should achieve 60 minutes load bearing, integrity and insulation fire resistance.<br>d) Any flat entrance door should be a FD30S fire door installed with a self-closing device per ADB 2013 Table B1.<br>e) See Appendix I where I explain fire door provisions in more detail. | c) Flat entrance fire doors be a Type 3 fire door should achieve (20 minutes fire resistance for integrity and 30 minutes fire resistance for stability) and be installed with self-closing devices, although it was permissible to achieve this by using rising butt hinges to satisfy CP3 1971 or Class A to satisfy Section 20 Code of Practice 1970.<br>d) Lift doors to be Class A to satisfy Section 20 code of Practice.<br>See Appendix I and M where I explain fire door provisions in more detail. |
| Firefighting lift | 17.13<br>17.14 | The firefighting lift doors should not be more than 7.5m from the door of the firefighting stair in the case of a block of flats.<br>ADB 2013 refers to Sections 7 & 8 of BS5588-5:2004, which requires:<br>a) The fire-fighting lift landing doors should be at least FD60 fire doors;<br>b) Provision of an escape hatch;<br>c) Water protection to the installation and shaft;<br>d) Firefighting controls at ground level;<br>e) Primary and secondary electrical supplies with automatic changeover in the event of primary supply failure;<br>f) Other lifts in the same well as a fire-fighting lift should not introduce significant additional fire risks;<br>g) Goods lifts and service lifts should not be located within fire-fighting shafts. Passenger lifts should not be located within a fire-fighting shaft unless the lift cars are constructed in accordance with BS EN 81-72. | To satisfy both CP3 1971 and Section 20 Code of Practice 1970:<br>a) Where passenger lifts are installed in a building, one or more should be provided with a fire switch whereby firemen obtain the use of a lift without interference; and<br>b) In blocks of flats, fire lifts should serve every floor; and<br>c) A fire lift should have a platform area of not less than 1.5m2 / “approximately 15 ft2” a capacity of 550kg / “approximately 1200lb” and reach the top floor from ground level within one minute; and<br>d) The electric supply to any fire lift should be provided by a sub-main circuit exclusive to the lift. |

# H3 Operational firefighting in high rise buildings

## H3.1 Guidance regarding provisions

**H3.1.1** The statutory guidance in ADB 2013 that deals with firefighting access and facilities focuses on design and construction provisions. BS 9999 and BS 9991 (please refer to Appendix D of this report for further information on these guidance documents) explain the operational purpose of the design and construction provisions in ADB 2013.

**H3.1.2** Under Section 21.2.74 "*Layout of fire-fighting shafts*" in BS 9999:2008, Section 21.2.7.2 states:

**H3.1.3** *"The lobby also serves as a bridgehead from which fire-fighting operations can be mounted."*

**H3.1.4** Similarly, Section 19.2.2 of BS 9991:2011 "Siting fire-fighting shafts" states:

*"Access should be provided to enable fire-fighters to create a bridgehead from where they can operate at a level below the fire floor. Liaison with the local fire and rescue service regarding access requirements is recommended."*

**H3.1.5** Section 3.15 of BS 9999:2008 defines a Bridgehead as:

*"**bridgehead***

*part of a building, usually the floor below the fire (floor above in the case of basements), from which fire-fighting teams can be safely committed to attack a fire"*

**H3.1.6** As I have explained in Section 3 of this report, the Stay Put evacuation strategy relies on the applying water early in a fire, and the fire being extinguished early. This is known as the Defend in Place strategy.

**H3.1.7** Therefore, while the fire may spread beyond the flat of fire origin, the assumption is that it will be controlled before it prevents safe escape for occupants in flats adjacent to the fire, or occupants in flats remote from the fire (in particular, occupants in flats above the fire).

**H3.1.8** The active and passive fire safety measures provided in a high rise residential building are there to support Defend in Place, and so enable the Stay Put evacuation strategy upon which the Regulations are currently based, and have been based since the 1960s.

**H3.1.9** Therefore, to understand how the facilities implemented in buildings for the benefit of the fire service are then used, and why the active and passive protection measures are required, it is important to understand fire service

operations. I have included some key policies and strategy documents which explain how the fire service would normally attack a fire in a high rise building below:

**H3.1.10** General Risk assessment 3.2: Fighting Fires – In high rise buildings (GRA3.2)– This national guidance document was prepared by the Department for Communities and Local Government and the Chief Fire & Rescue Adviser. It provides operational guidance on how an Incident Commander should approach a fire in high rise buildings from the first arrival at the incident through to completion of firefighting and search and rescue operations.

**H3.1.11** Fire and Rescue Manual: Volume 2 - Fire Service operations - Incident Command, 3rd edition 2008 (Incident Command manual hereafter) – This document provides higher level guidance on the roles and responsibilities of incident commanders, and on how and incident commander should break down the organization of fire crews at the site of complex incidents and distribute responsibilities to other competent fire fighters in the chain of command – This is termed "Sectorisation".

**H3.1.12** GRA3.2 provides the operational guidance for initial response to incidents. A summary of the approach in this guide is as follow:

## H3.2 On arrival

**H3.2.1** On arrival, the Incident Commander (who at the very start of the incident will be the most senior officer on any of the attending appliances) must, amongst other actions:

a) Determine the location of the fire;

b) Formulate incident objectives;

c) Establish a suitable command structure and communicate that plan to relevant persons;

d) Follow the evacuation strategy of building (i.e. understand if a Stay Put strategy is in place);

e) Identify and secure water supplies.

**H3.2.2** Securing and using the firefighting lift

**H3.2.3** GRA 3.2 states:

*"Where the height and location of the incident make the use of a fire lift beneficial it should be identified and a firefighter detailed to take control of, and remain in the lift."*

**H3.2.4** It further states:

*"Personnel must exit fire lift at least two floors below the floor where the fire is reported or believed to be. If the location of the fire is not known with a reasonable level of certainty, personnel must approach the believed or likely location of the incident with caution and using a protected staircase. This is to ensure that the risk of firefighters becoming involved in the fire without the protection of respiratory protective equipment and firefighting media is minimised." ...*

*"If the fire lift is not available, this will have resource implications and the Incident Commander will need to consider alternative tactics to get personnel and equipment to upper floors and to rescue casualties."*

**H3.2.5** Therefore, firefighting lifts are only intended to support logistics in fighting fires and conducting rescues in high-rise buildings and are not intended to carry fire fighters directly to floors affected by fires. Additionally, Incident Commander must take account of the availability and capability of the lift as part of the tactical and logistical planning for the incident.

## H3.3 Establishing a Bridgehead

**H3.3.1** The Incident Command manual defines the Bridgehead as:

*"A central and advanced control point where it is necessary for BA to be started up at a distance from the original point of entry to a risk area, whilst remaining in a safe air environment"*

**H3.3.2** GRA 3.2 also states that:

*"When positioning a bridgehead, consideration must be given to smoke spread through doors that will be opened and which will have to remain open for firefighting purposes. The bridgehead will normally be two floors below the floor where fire or smoke has been reported (or the lowest floor, if there are fires on multiple floors). Planning arrangements or the specific design features of the building may allow for 'safe air' to be reliably maintained and the bridgehead located closer to the fire."*

And:

*"All personnel committed beyond the bridgehead must be wearing full personal protective equipment and respiratory protective equipment. The only exception to this would be when the incident Commander has deemed it safe for fire and rescue personnel to work above the bridgehead without respiratory protective equipment."*

**H3.3.3** Any ingress of smoke into a firefighting lobby therefore necessarily prevents it from being used as a Bridgehead as it would no longer be a safe air environment.

**H3.3.4** As set out elsewhere in this report (Sections 16 and Appendix J), the design of firefighting stairs in a high-rise building requires the provision of a smoke ventilation system to minimise the "*potential for serious contamination of firefighting shafts by smoke during means of escape and fire service operations*" [BS EN 12101-6:2005 Incorporating Corrigendum No. 1]

## H3.4 Committing teams

**H3.4.1** In accordance with GRA3.2, once the Bridgehead has been secured, a crew equipped with breathing apparatus will then use the stairs to walk up to the floor below the fire floor, where setting up will take place in the firefighting lobby. Regarding water supplies for the first team, GRA 3.2 states:

*"Branches should be supplied from the closest rising main outlet to the fire which has not been affected by fire or smoke. This will normally be from the floor below the fire floor or, if unavailable, from the nearest available outlet below that."*

**H3.4.2** The first crew, with a charged hose, will then walk up the stairs to the fire floor.

**H3.4.3** The second crew, acting as backup, will follow the first crew onto the fire floor, and connect to the fire main outlet in the lobby on that floor. The second crew are tasked with protecting the firefighting lobby on the fire floor and will always have a greater length of hose available to reach the primary crew if they require assistance or become cut off from the firefighting lobby. As the first crew advances onto the fire floor with a charged hose, they will be able to act to create tenable conditions in the firefighting lobby on the fire floor for the second team to approach the fire main outlet on the fire floor.

**H3.4.4** With regard to committing teams and addressing risk to fire fighters, the Incident Command manual states:

"In a highly calculated way, firefighters:

- *Will take some risk to save saveable lives.*
- *May take some risk to save saveable property.*
- *Will not take any risk at all to try to save lives or properties that are already lost.*

*Therefore, if after implementing all available control measures, the cost (in terms of risk to life) of proceeding with a task still outweighs the benefit, the IC must not permit operations to proceed but consider viable alternative courses of action."*

**H3.4.5** However, GRA 3.2 also states:

*"Any unnecessary delay committing teams can increase the likelihood of fire*

*growth and fire spread occurring and, in turn, can increase the pressure on firefighters to act before sufficient resources are available. The Incident Commander must give early consideration to whether additional resources are required to assist in the evacuation of occupants or to replace teams that may have been diverted to this task."*

**H3.4.6** It is therefore the responsibility of the Incident Commander to balance the risk to their crews against the actions required to save lives in the event of a fire.

**H3.4.7** The tactics presented above have the following benefits in fighting fires in high rise buildings:

a) Minimises use of breathing apparatus air supply in reaching the fire sector (please refer to Section 14); and

b) Reduces difficulty in manoeuvring charged hoses around corners in stairs by minimising the number of stair flights being traversed.

## H3.5 The critical operational sectors in high rise building fires

**H3.5.1** The Incident Command manual also provides guidance on how control of fire incidents in high-rise buildings should be broken down into operational sectors. As described on Page 25 of the Incident Command manual:

*"Sectorisation should be introduced when demands placed upon an IC make it imperative that responsibility and authority are delegated to ensure appropriate command and safety monitoring of all activities, and to reduce officer' spans of control. Even if it is possible for the IC to oversee all operations, the need to sectorise will arise if there is so much going on that the IC risks being distracted and unable to five sufficient attention to each task. This would indicate that the IC's span of control is in danger of becoming too great. Where spans of control begin to reach or exceed 5 lines of direct communication at a working incident, it is possible that performance will be adversely affected."*

**H3.5.2** The standard approach for sectorisation of a high rise incident as described in the Incident Command manual is excerpted in Figure H.18.

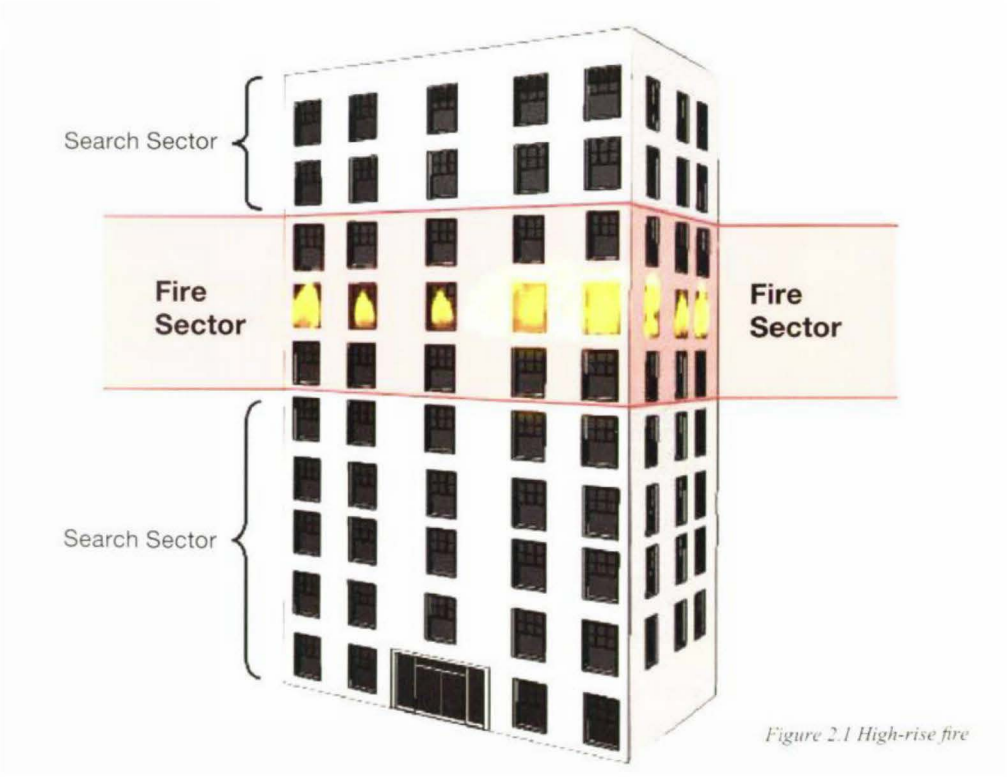



Figure H.18: Excerpt from Incident Command manual (p27)

**H3.5.3** This guide identifies the 3 following sector types on Page 27:

- *"Fire Sector – this is an operational sector and would be the main area of firefighting and rescue operations, consisting of the floor/s directly involved in fire, plus one level above and one level below. If crews involved in this exceed acceptable spans of control, consideration should be given to activating a Search Sector*
- *Search Sector – this is an operational sector and would be the area of operations in a high rise, above the 'fire sector' where search and rescue, venting and other operations are taking place. In a basement scenario the Search Sector could extend from fresh air to the lowest level. If the distance from the ground floor lobby to the bridgehead is more than two or three floors and spans of control require it, consideration should be given to activating a Lobby Sector.*
- *Lobby Sector – this is a support sector and would cover the area of operations from the ground floor lobby to the bridgehead, which is normally two floors below the fire floor, The Lobby Sector Commander will act as co-ordinator of all the logistics needs of the fire and search sector Commanders, who will, on most occasions, need to be located at the bridgehead directing operations via radio and liaising with the BAECO [breathing apparatus entry control officers]. The Lobby Sector Commander would also co-ordinate all operations beneath the bridgehead level, including salvage and ventilation, liaising with fellow Sector commanders in the usual way."*

**H3.5.4** The fire sector represents the highest risk to fire fighters as they are in direct contact with the fire, and the associated smoke and hot gasses.

**H3.5.5** Typically, fire spreads most rapidly upward, and therefore the key risks to fire fighters in a search sector above the fire sector are: fire spread upward into the search sector; and fire or smoke spread into the stairs, preventing fire fighters in the search sector from passing back down below the fire and out of the building.

**H3.5.6** The lobby sector represents the lowest risk to fire fighters as it is below the fire sector, with the lowest risk of fire and smoke spread.

**H3.5.7** In a single stair building, the sectorisation method can only be implemented if the stair is protected against contamination by heat and smoke. The firefighting stair represents the only means by which fire fighters can reach the fire from the Bridgehead, and then beyond into any search sector(s) implemented above the fire sector.

**H3.5.8** Similarly, the need for a safe air environment in the Bridgehead below the fire makes protection of the lobbies critical to the implementation of the fire sector because the lobbies are intended to prevent the spread of fire and smoke from the flats into the nearby stair.

**H3.5.9** A further important feature of a Bridgehead is that it acts as a place from which to co-ordinate fire survival guidance calls. Fire and Rescue Authorities must have effective arrangements in place to handle fire survival guidance calls from residents and others when they believe they are unable to leave the building due to disability, poor mobility, illness or the effects of fire. Fire fighters are sent from the Bridgehead into the fire or search sector to respond to fire survival guidance calls.

**H3.5.10** In the following sections of this Appendix, I will describe the facilities and features in Grenfell Tower which were provided to support firefighting, and specifically as they apply high rise firefighting, as described above, as well as their compliance with the relevant legislation, regulation and statutory guidance.

# H4 Assessment of access and facilities for the fire service at Grenfell Tower

## H4.1 Assessment of the fire main

### H4.1.1 Provision of type of fire main

H4.1.2 The method of measurement for the purposes of determining what type of fire main was required differed between CP3 1971 and ADB 2013. The relevant text and each measurement of Grenfell Tower are presented in Table H.8 and Figure H.19.

Table H.8: Assessment of both CP3 1971 and ADB 2013 height measurement with respect to fire mains

| | CP3 1971 | ADB 2013 |
|---|---|---|
| **Wording** | **7.1.2:** *"Where any floor of a building is higher than 60m (approximately 200ft) should be fitted with 'wet' rising mains."* | **15.6:** *"Wet fire mains should be provided in buildings with a floor at more than 50m above fire and rescue service vehicle access level."*<br>**Diagram C6**: *"Height of top storey excludes roof-top plant areas and any top storeys consisting exclusively of plant rooms"*<br>And<br>*"Height of top storey measured from upper floor surface of top floor to ground level on lowest side of building"* |
| **Storey for purposes of fire main measurement** | Plant floor | Level 23 |
| **Height** | 65.5m | 62.8m |
| **Height above which wet fire mains are required** | 60m | 50m |
| **Fire main provision** | Wet fire main | Wet fire main |

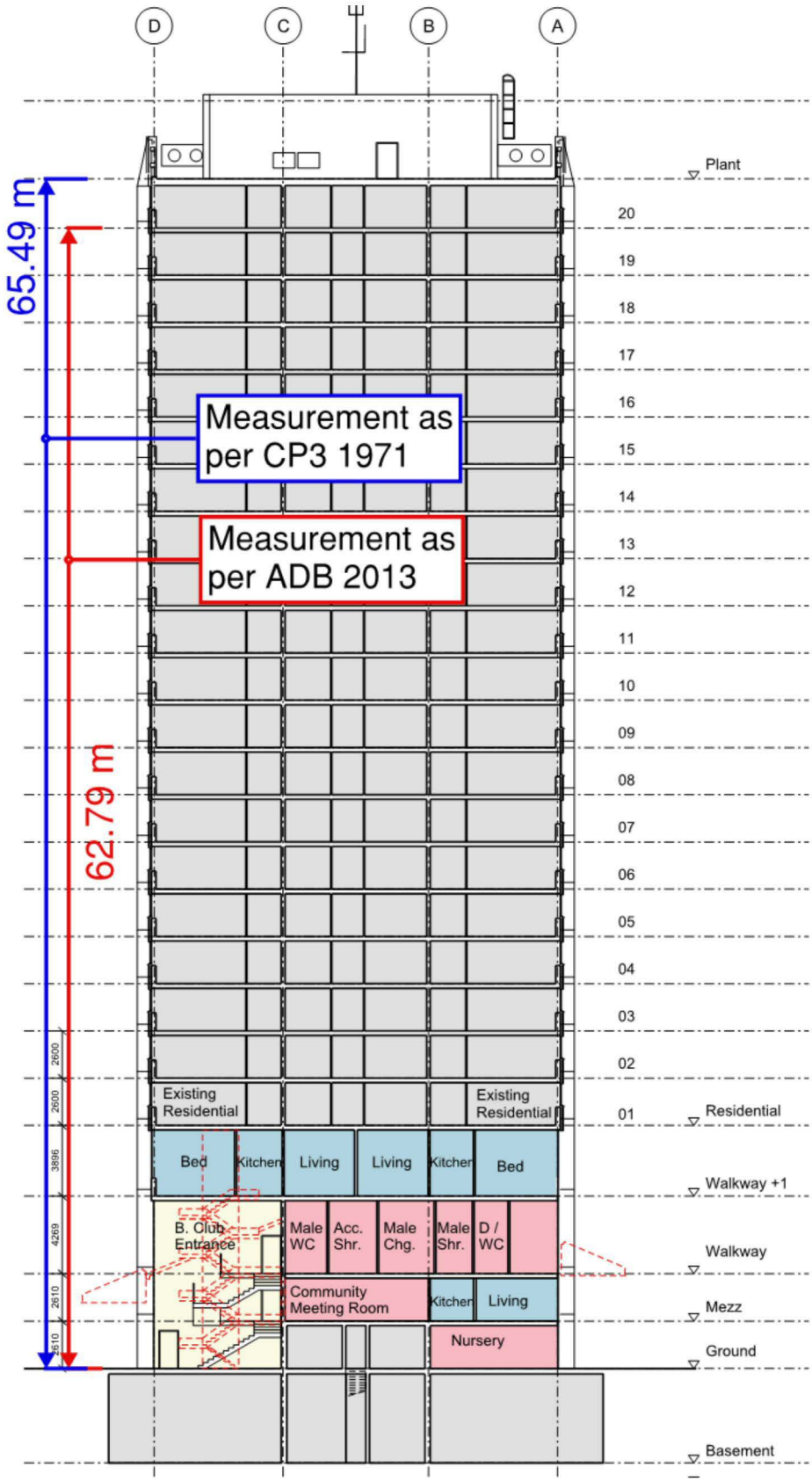



Figure H.19: Building height measurements (Mark up of SEA00009461)

**H4.1.3** At the time of construction, the height (as according to the wording of CP3 1971) 'of any floor' of the building, was 65.5m above ground, in this case the plant room. The height to the topmost residential floor was 62.8m. Therefore, a wet rising main should have been installed.

**H4.1.4** Instead a dry rising main was provided. There is no record of why this was deemed acceptable by the design team, or approved by building control at that time.

**H4.1.5** In 2006 the guidance for rising mains changed. The building height at which a wet rising main was required reduced from 60m to 50m above fire and rescue service vehicle access level.

**H4.1.6** Additionally, the water pressure required to be delivered at each landing valve in a wet rising main system was increased from 4bar to 8bar.

**H4.1.7** This change was introduced in the 2006 edition of ADB 2013 and the 2006 edition of BS 9990 Code of practice for non-automatic fire-fighting systems in buildings.

**H4.1.8** Therefore, to comply with the guidance available at the time of the refurbishment, Grenfell Tower would have required a wet rising main system.

**H4.1.9** The dry main inlet is located externally on the South elevation of the building, shown in Figure H.20:

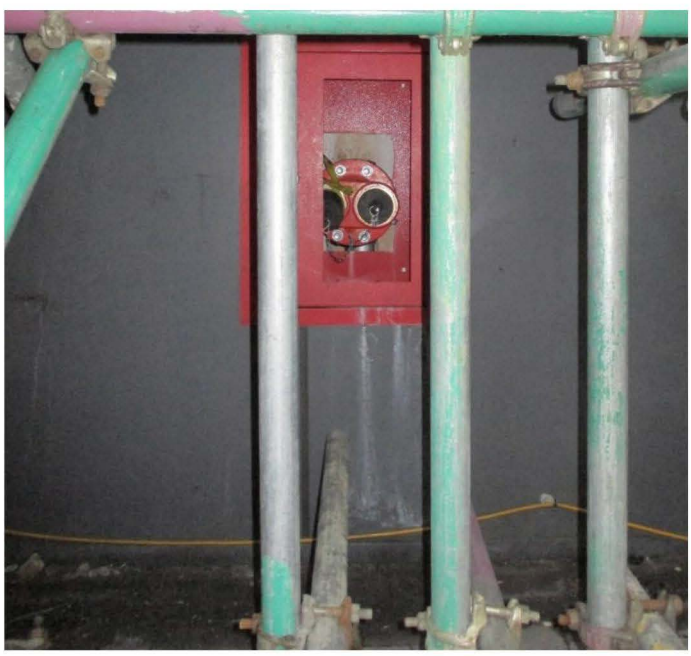


Figure H.20: Dry fire main inlet at Grenfell Tower


Figure H.21: Example fire main outlet on Level 1

**H4.1.10** The fire main is a dry fire main as evidenced by the signage (Figure H.21) observed during my post fire inspection on the 7th November 2017.

**H4.1.11** An outlet and valve is provided at every level of the building within the common lobby as indicated in Figure H.22.

**H4.1.12** The position of the outlet within the common lobby and not in the firefighting stair is compliant with the original design guidance in CP3 1971 and in the GLC Section 20 Code of Practice 1970, but is not compliant with ADB 2013, which would instead require the outlet to be positioned in the stair.

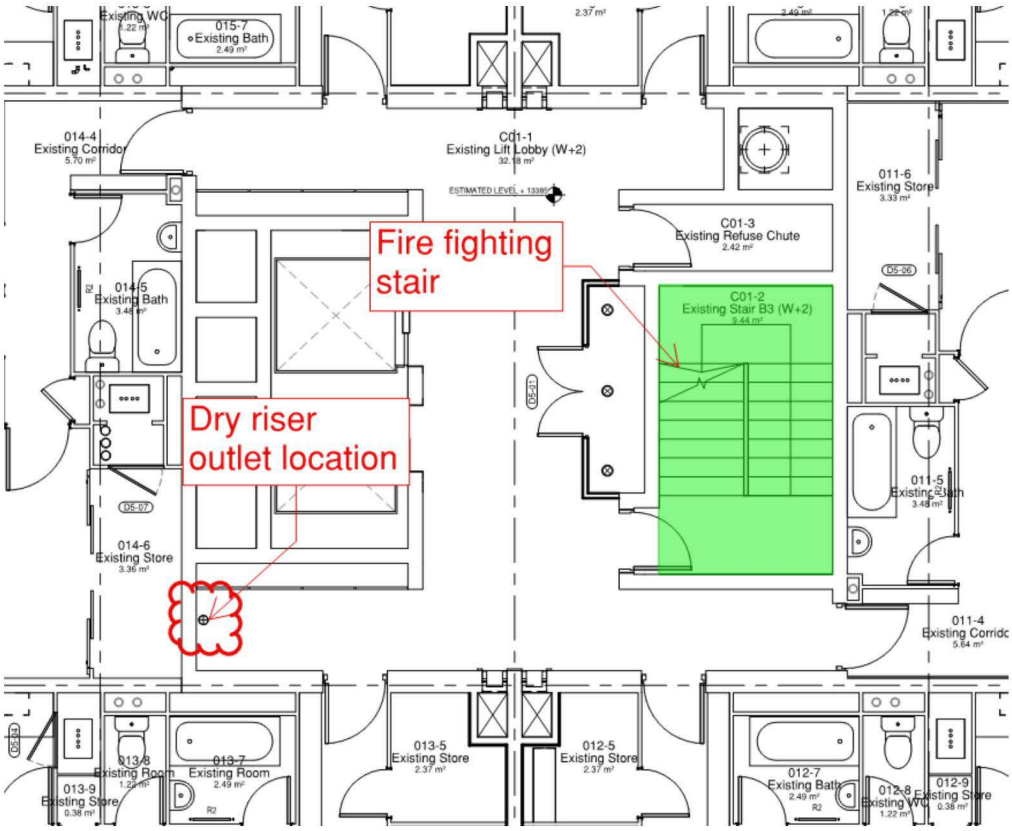



Figure H.22: Dry fire main outlet on typical floors

**H4.1.13** During the refurbishment works in 2012-2016, further residential apartments were added. As part of these works, dry fire main outlets were provided to Levels 2 and 3 where there was previously no provision. JS Wright (M&E subcontractor to Rydon) stated in correspondence RBKC Building Control (RBK00003777):

*"We are not increasing the high [sic] of the existing riser* ***but we are adding two additional floors at low level which were previously walkways****. We understand the existing riser is above the current permitted height of 50 meters, we would therefore need to discuss the proposed modification and what measures we need to take to gain approval for the new system."*

**H4.1.14** RBKC Building Control then responds:

*"I have spoken to John Hoban the area surveyor … and he agreed in this instance with my sending you this response. Essentially the building*

*regulations cannot require you to improve the existing floors over 50m.The regulations only apply to the work being carried out and additionally you must not adversely affect the existing building."*

**H4.1.15** Therefore, it appears no works were undertaken as part of the refurbishment to upgrade the rising main from a dry system to a wet system.

**H4.1.16** **Performance of dry rising main in buildings over 50m in height**

**H4.1.17** Figure H.23 presents a schematic of a dry fire main installation in a high-rise building, when in operation. In terms of performance, water pressure will be at its worst when hoses are attached at the topmost levels, as indicated in Figure H.23. This is because delivering water to the topmost levels requires the use of pressure to overcome the downward force of gravity. Pressure is also required to overcome the resistance due to friction between the flowing water and the sides of the pipe.

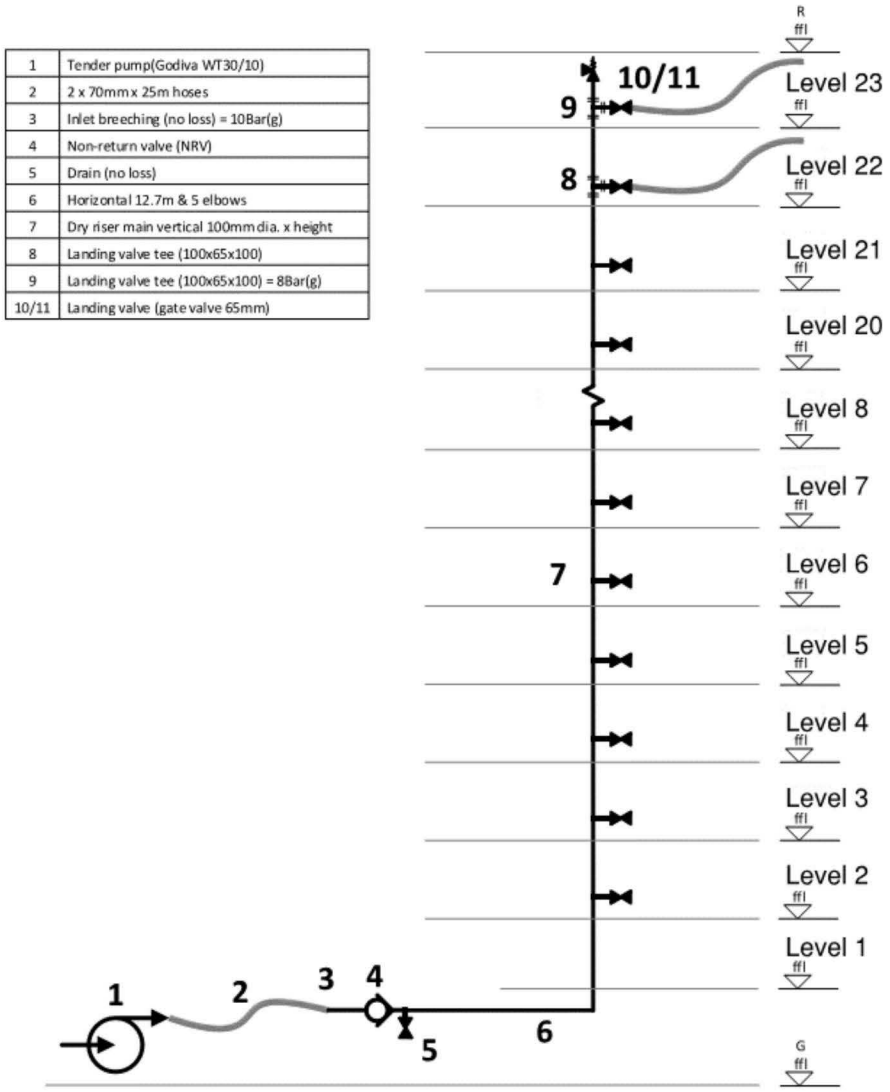



Figure H.23: Schematic of dry fire main installation

**H4.1.18** As explained in Table H.5 of this Section, the design operating pressure in a dry main system is 10 bar.

**H4.1.19** I have commissioned a hydraulic calculation for a dry rising main pipe from colleagues within Arup who specialise in the area. The calculation demonstrates the drop in pressure at different landing valves up the building, assuming that the maximum pressure in the pipe (at Ground Level) is limited to 10 bar.

**H4.1.20** The 3 following scenarios are presented:

a) 2 hose streams operating at a combined flow of 1,500l/min on the topmost floors (22 and 23) in the building - the design basis number of hose streams (represents one set of firefighting crews – 1st crew and 2nd crew,

as described in Section 14 of this report intervening at the highest levels of the building).

b) 4 hose streams operating: 2 at the top (Levels 22 and 23) and 2 toward the bottom of the building (Levels 5 and 6) at a combined flow of 1,500l/min (represents two sets of firefighting crews intervening at the highest levels of the building and two other levels selected at random).

c) 6 hose streams operating: 2 at the top (Levels 22 and 23), 2 at the mid-height (Levels 10 and 11) and 2 toward the bottom of the building (Levels 5 and 6) at a combined flow of 1,500l/min (represents three sets of firefighting crews intervening at the highest levels of the building and four other levels selected at random).

This calculation demonstrates that the 8 bar minimum outlet pressure required on any floor in modern wet rising main system, can only be achieved in a dry rising main up to approximately Level 4 (coloured green in Table H.9).

**H4.1.21** When operating at the specified operating pressure of 10 bar, a dry rising main would be able to supply the original CP3 1971 design minimum outlet pressure of 4.1 bar, up to approximately Level 18 in the scenarios coloured orange in Table H.9.

**H4.1.22** When the outlet pressure is operating at the required 10 bar, a dry rising main would no longer be able to supply the original CP3 1971 design minimum outlet pressure of 4.1 bar beyond Level 18 in any of the scenarios coloured red in Table H.9.

**H4.1.23** In order to achieve 8 bar at Levels 22 and 23, i.e. the equivalent of a wet rising main system, the pressure at Ground Level would need to be approximately 15.5 bar, or 50% higher than the normal operating pressure specified in BS 9990:2006.

**H4.1.24** In Table H.9 the pressures in the upper storeys are shown to be slightly higher when more hoses are operating. This is because less water is being delivered to the upper storeys and therefore pressure losses in the system are lower.

Table H.9: Pressures achieved at landing valves, assuming different numbers of hoses operating

| Level | Pressure available at landing valve with: | | |
|---|---|---|---|
| | **Hoses operating at Levels 22 and 23** | **Hoses operating at Levels 5, 6, 22 and 23** | **Hoses operating at Levels 5, 6 10, 11, 22 and 23** |
| Ground | 10 bar | 10 bar | 10 bar |
| Level 1 | 9.29 bar | 9.29 bar | 9.29 bar |
| Level 3 | 8.39 bar | 8.39 bar | 8.39 bar |
| Level 4 | 8.10 bar | 8.10 bar | 8.11 bar |
| Level 5 | 7.82 bar | 7.82 bar | 7.82 bar |
| Level 6 | 7.53 bar | 7.53 bar | 7.53 bar |
| Level 9 | 6.66 bar | 6.64 bar | 6.67 bar |
| Level 12 | 5.79 bar | 5.85 bar | 5.86 bar |
| Level 15 | 4.93 bar | 5.05 bar | 5.05 bar |
| Level 18 | 4.06 bar | 4.26 bar | 4.27 bar |
| Level 21 | 3.2 bar | 3.47 bar | 3.5 bar |
| Level 23 | 2.57 bar | 3.05 bar | 3.11 bar |

**H4.1.25** Figure H.24 and Figure H.25 present the operating envelope of a typical fire engine pump. This demonstrates that fire engine pumps are capable of delivering a flow rate of 1500l/min at a pressure in excess of 15.5 bar. Therefore, the fire engine pump would be sufficiently powerful to deliver water at the modern wet rising main requirements for flow and pressure, but only by significantly exceeding the pipe design operating pressure specified in BS 9990:2006.

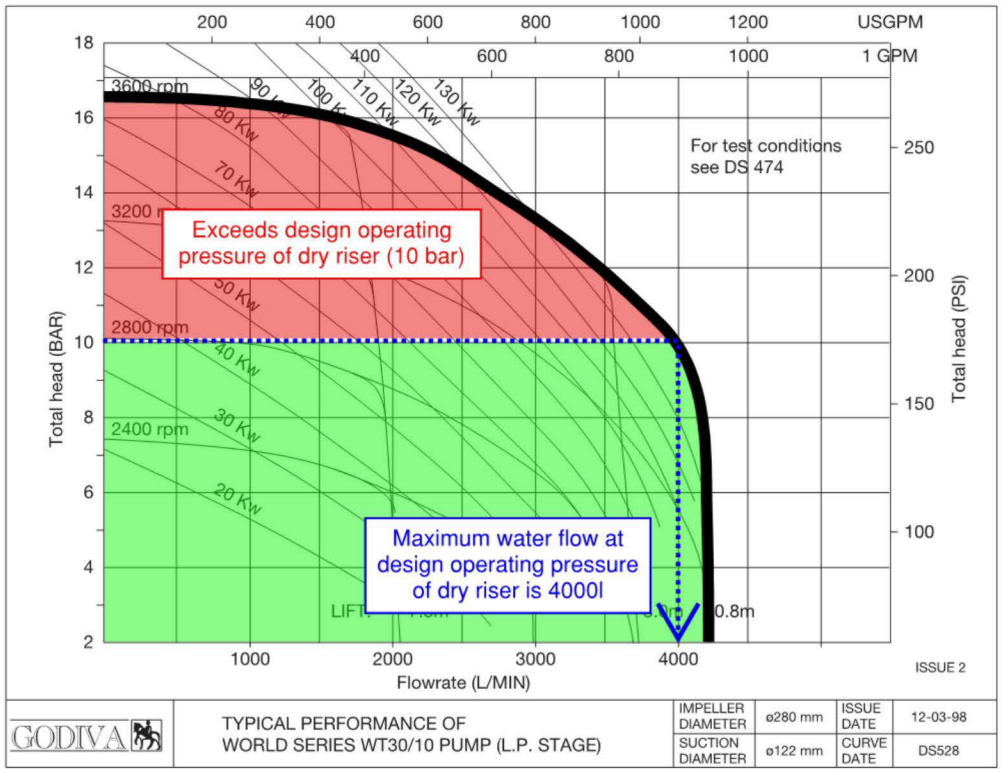



Figure H.24: Operating pressure of dry fire main relative to the performance of Godiva WT30/10 pumps (assumed as typical fire engine pump)

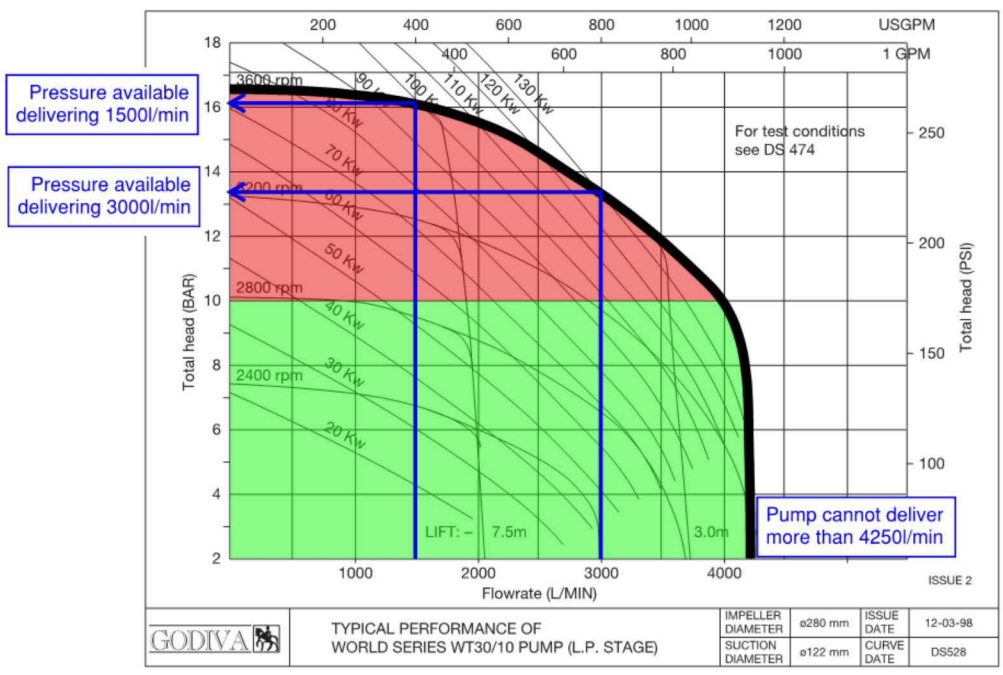



Figure H.25: Performance of Godiva WT30/10 pumps - Assumed as typical fire engine pump

**H4.1.26** If more hose streams are activated, then the requirements for flow increase.

**H4.1.27** Increasing water flow in a pipe of fixed diameter requires more pressure to be provided to the water. The systems specified in BS 9990:2006 are based on providing 750l/min per hose.

**H4.1.28** Therefore, to provide a full firefighting jet to 4 lines of hose, the fire engine would need to deliver 3,000l/min. An inlet pressure of 17 bar would be required to maintain the outlet pressure at the top of the building at 8 bar.

**H4.1.29** Figure H.25 demonstrates that this performance could not be achieved by a single fire engine pump. Note, while additional fire engine pumps could be utilized to increase the pressure available, the limiting factor of the performance is the pipe design operating pressure specified in BS 9990:2006.

**H4.1.30** Figure H.25 demonstrates that the fire engine pump is likely to be able to deliver sufficient water flow to 5 firefighting jets while maintaining 10 bar at the inlet. A single fire engine is unlikely to be able to supply 6 or more full firefighting jets as defined in BS 9990:2006 with any pressure.

**H4.1.31** The number of hoses that could be supplied with water also depends on the capacity of the local water supply.

**H4.1.32** I have not seen evidence that these matters were given consideration either before or because of the refurbishment.

## H4.2 Assessment of hydrant provision

**H4.2.1** My team inspected the external hydrant provisions at Grenfell Tower on 7th November 2017. Please refer to Section 17 for my description of the external hydrants identified and the compliance of their positions relative to Grenfell Tower.

## H4.3 Assessment of fire appliance vehicle access

**H4.3.1** My team inspected the vehicle access routes to Grenfell Tower from surrounding areas on the 7th November 2017, and I inspected them again on 6th June 2018. Please refer to Section 17 for my assessment of the compliance of vehicle access for fire appliances to Grenfell Tower.

**H4.3.2** I have also provided in Section 17 a description of the external firefighting undertaken at Grenfell Tower, on each elevation. This was an improvisation on the part of LFB, as full perimeter external firefighting access is not a provision in the statutory guidance for high rise residential buildings. There is evidence this improvisation had positive effects.

## H4.4 Assessment of the firefighting stair

**H4.4.1** During the 2012-2016 refurbishment works the firefighting stair provision for Grenfell Tower was changed between Ground Level and Level 2.

**H4.4.2** The original firefighting stair between these levels connecting the entrance at Ground Level to the firefighting stair within the main core at Level 2 was demolished (Figure H.26).

**H4.4.3** The remaining second accommodation stair that previously only communicated with the non-residential parts of the building between Ground Level and Level 2 was refurbished and connected to the existing firefighting stair within the main core at Level 2 to form the new continuous firefighting stair serving all levels of the building (see Figure H.27). I confirmed this arrangement in my post fire inspection.

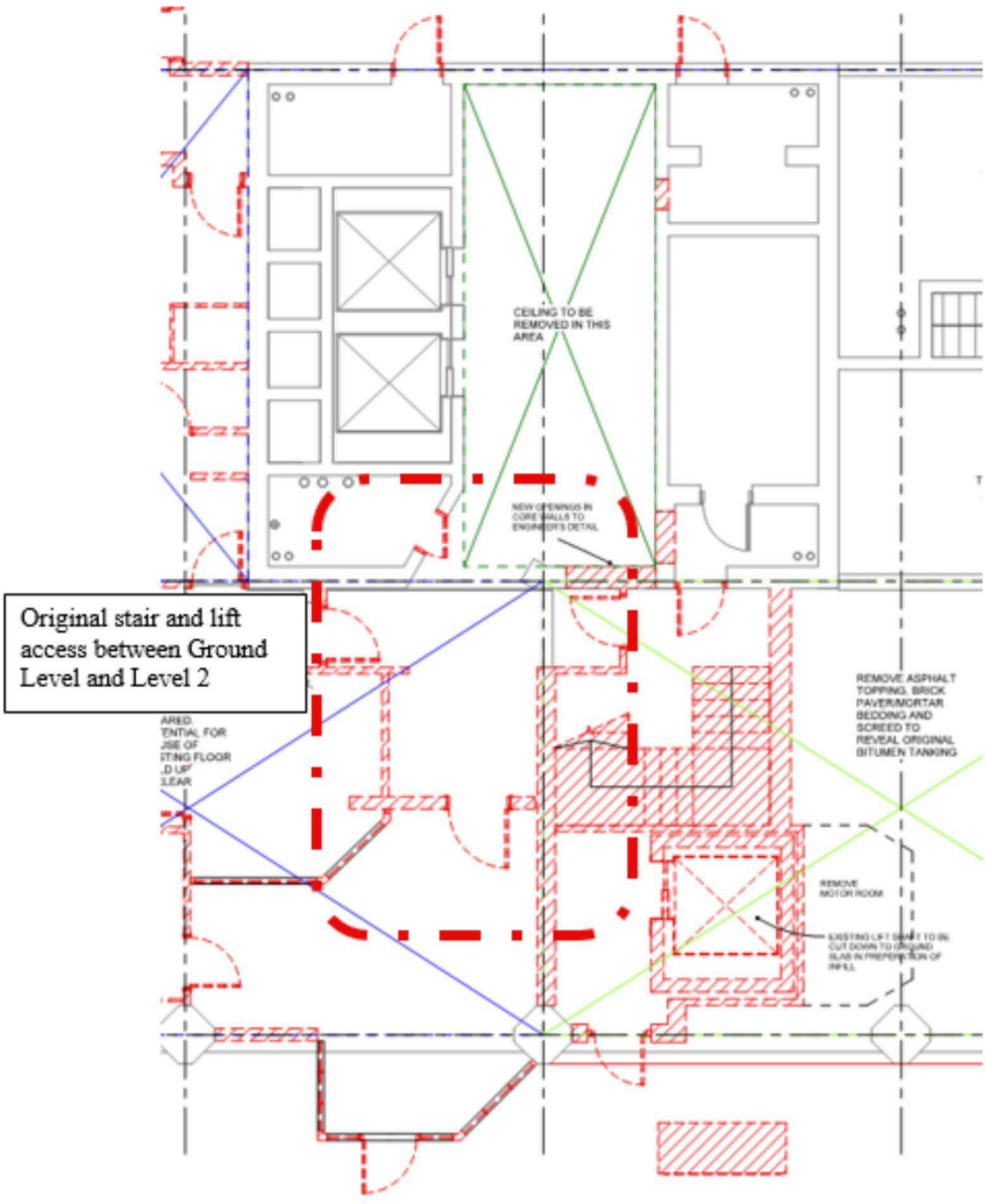



Figure H.26: Original design – (Excerpt from SEA00002523)

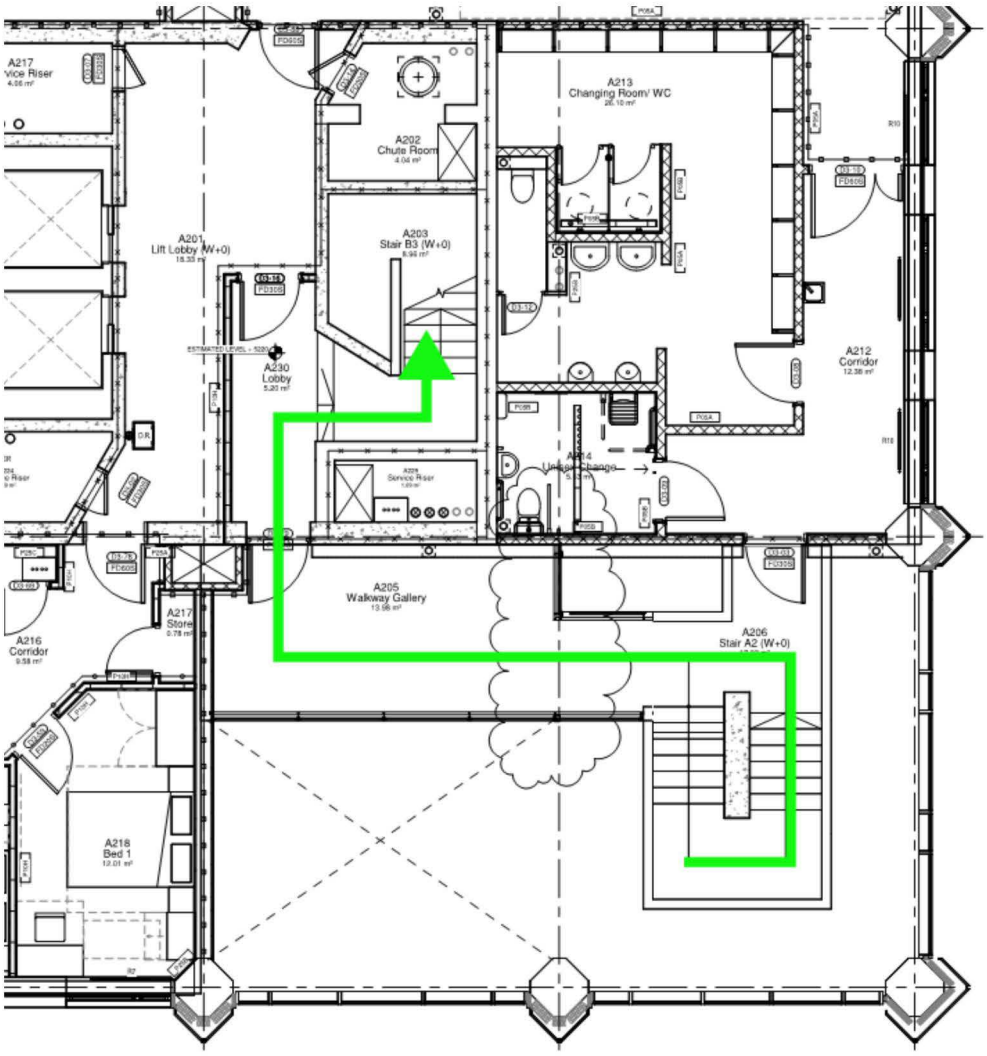
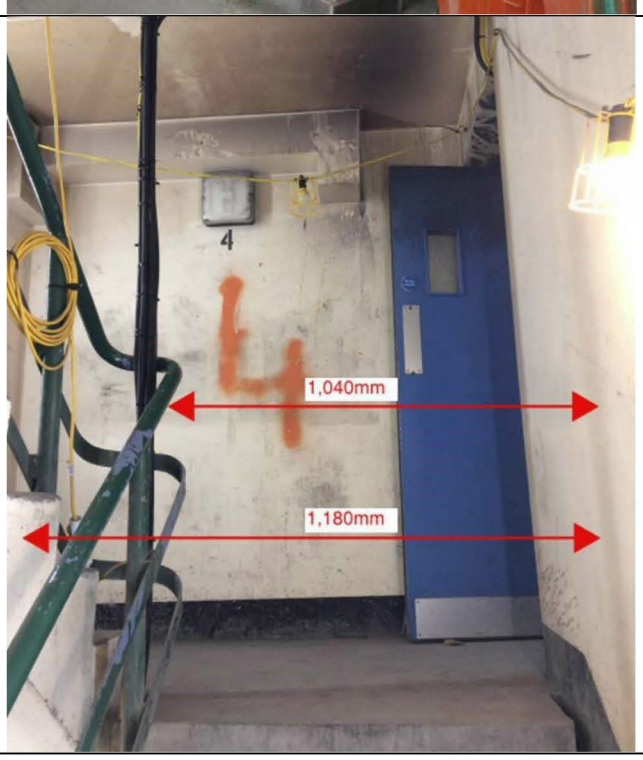



Figure H.27: New firefighting stair access provision – (Excerpt from SEA00003149.).

**H4.4.4** My team measured the width of these stairs during a site survey between the 7th and 9th November 2017. In accordance with the rules in Appendix C of ADB 2013 the widths were measured between walls, or between walls and balustrades. The measurements are recorded in Table H.10.

Table H.10: Grenfell Tower firefighting stair widths recorded November 2017

| Firefighting stair | Width measured in accordance with ADB 2013 | Illustration of measurement |
|---|---|---|
| Ground – L02 | 1000mm |   |
| L02 – L23 | 1040mm |   |

**H4.4.5** The measured stair widths are therefore compliant with the original guidance in CP3 1971, however they are not compliant with the current guidance in ADB 2013.

H4.4.6 Please refer to Appendix J for descriptions of the observed smoke ventilation construction and equipment for the Grenfell Tower stair. A permanently open vent at the head of the stair was provided as part of the original construction of the building in 1972. I provide my photographic record of this vent, from my post fire inspection (Figure H.Figure H.2829). The area was reported by PSB to be 1m$^2$ in their Technical Submission for the smoke control system (RBK00003775). This provision is compliant with CP3 1971.

H4.4.7 Figure H.Figure H.2829: Permanently open vent at head of stair, observed 8th November 2017

## H4.5 Assessment of the firefighting lobbies

### H4.5.1 Residential common lobby, L4-23

H4.5.2 I have examined the original design drawings (as confirmed by Studio E fire strategy drawings) and in my opinion the residential common lobby on the upper storeys of Grenfell Tower had an original layout consistent with that permitted by CP3 1971 where a smoke dispersal system was provided. (Please see Appendix G and Appendix J for further details).

H4.5.3 In accordance with Section 17.14 of ADB 2013 *"Variations for block of flats"* a separate firefighting lobby may be omitted from residential buildings (i.e. using Diagram 52 (b) instead of (a) as a basis of design) if all of the provisions from Section 3 and 9 of ADB 2013 have also been achieved, as well as the smoke control provided as per note 2 on the diagram.

H4.5.4 Note that 17.14 of ADB 2013 refers to ADB 2013 Section 3 "Design for horizontal escape – buildings other than flats" and not ADB 2013 Section 2

"Means of escape from flats". This appears to be an error in referencing only, however I am not aware of any formal guidance that confirms this to be the case.

**H4.5.5** As this Appendix H is a factual record of what ADB states, Table H.11 below therefore sets out the provisions of these Sections of ADB 2013 relevant to Grenfell Tower:

Table H.11: Elements of ADB 2013 Section 3, Section 9 and Diagram 52 note 2 that must be complied with to permit the omission of the firefighting lobby in blocks of flats

| ADB 2013 Section | Provision |
|---|---|
| 2.25 (Diagram 52 Note 2) | Smoke control to be provided by<br>*"either natural means in accordance with paragraph 2.26 or by means of mechanical ventilation as described in paragraph 2.27."*<br>Specific smoke control provisions are outlined further in Appendix J of this report |
| 3.5 | *"In order to avoid occupants being trapped by fire or smoke, there should be alternative escape routes from all parts of the building."* |
| Table 2 | *"Maximum travel distances in one direction only:*<br>*a. in bedrooms (where a protected entrance hall is provided) = 9m*<br>*b. in bedroom corridors 9m*<br>*c. elsewhere 18m"* |
| 3.8 | *"Maximum number of occupants per storey = 60"* |
| 3.16 | *"Where any storey is divided into separate occupancies (i.e. where there are separate ownerships or tenancies of different organisations):*<br>*a. the means of escape from each occupancy should not pass through any other occupancy; and*<br>*b. if the means of escape include a common corridor or circulation space, either it should be a protected corridor, or a suitable automatic fire detection and alarm system should be installed throughout the storey."* |
| 3.17 | *"All escape routes should have a clear headroom of not less than 2m except in doorways."* |

| | |
|---|---|
| Table 4 | **Maximum number of persons** / **Minimum width mm** (1) (2) (3)<br>60 — 750 (4)<br>110 — 850<br>220 — 1050<br>More than 220 — 5 per person (5)<br>**Notes:**<br>1. Refer to Appendix C on methods of measurement.<br>2. In order to follow the guidance in the Approved Document to Part M the widths given in the table may need to be increased.<br>3. Widths less than 1050mm should not be interpolated.<br>4. May be reduced to 530mm for gangways between fixed storage racking, other than in public areas of Purpose Group 4 (shop and commercial).<br>5. 5mm/person does not apply to an opening serving less than 220 persons. |
| 3.24 | ***Protected corridors***<br>*"A corridor which serves a part of the means of escape in any of the following circumstances should be a protected corridor:*<br>*a. every corridor serving bedrooms;*<br>*b. every dead-end corridor (excluding recesses and extensions not exceding 2m deep as shown in Figures 10 and 11 of BS 5588-11:1997);and*<br>*c. any corridor common to two or more different occupancies (see also paragraph 3.16)."* |
| 9.2 | *"Provisions for cavity barriers are given below for specifed locations. The provisions necessary to restrict the spread of smoke and fames through cavities are broadly for the purpose of sub-dividing:*<br>*a) cavities, which could otherwise form a pathway around a fre-separating element and closing the edges of cavities; therefore reducing the potential for unseen fre spread; and*<br>*b) extensive cavities (see paragraphs 9.8 to 9.12)."* |

**H4.5.6** The residential common lobbies in Grenfell Tower were not compliant with several of these items with respect to the ADB 2013 guidance.

**H4.5.7** First, the common lobby is used for access to central heating services in the cupboard on each floor in contravention of the guidance in Section 7.1.4 of BS 5588-5:2004 where it states that:

*"Only services associated with the fire-fighting shaft should pass through or be contained within the fire-fighting shaft. A fire-fighting shaft should not contain any cupboards or provide access to service shafts serving the remainder of the building."*

**H4.5.8** Second, the rising main outlets are positioned in the common lobby (Figure H.30): rather than being in the stair as pictured in Figure 52b) of ADB 2013 (Figure H.8).

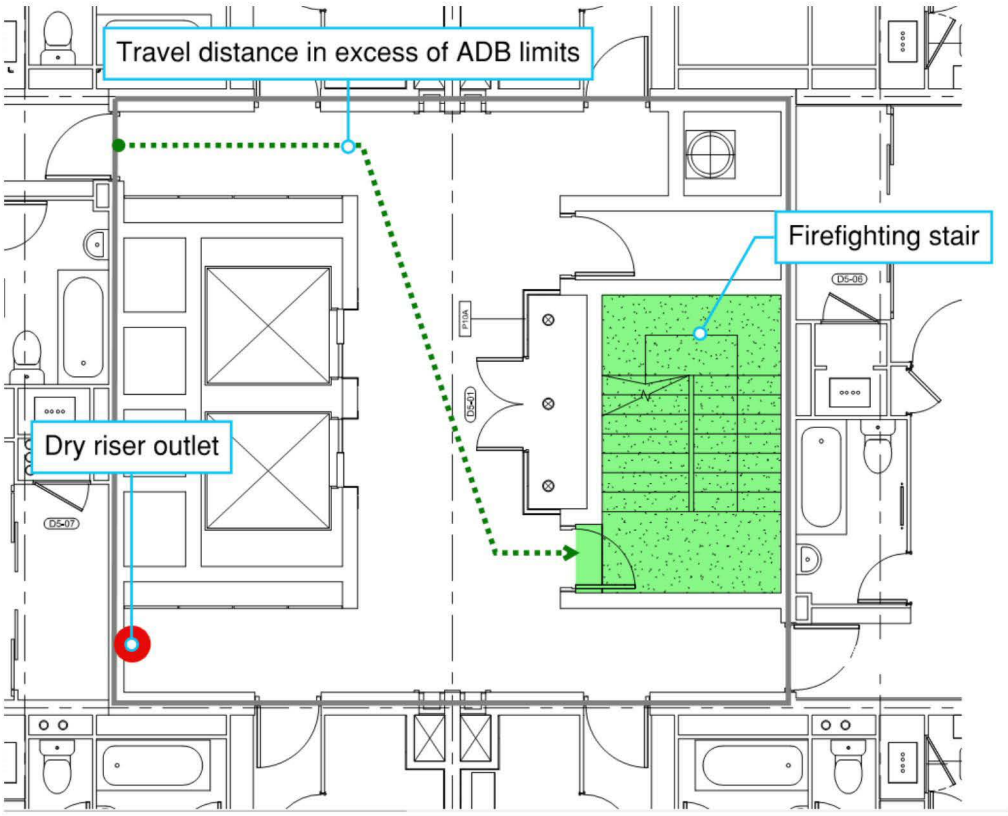



Figure H.30: Levels 4-23 lobby layout observed (SEA00010474)

### H4.5.9 Lobby Smoke Control

H4.5.10 The smoke ventilation system served every residential level in the building. I have provided a full description of the designed and installed smoke control system in Appendix J of my expert report. I have undertaken a full compliance assessment of the smoke control system in Appendix J of my Expert Report also.

### H4.5.11 Residential common lobby, L2/L3

H4.5.12 For the new residential floors, the design approach appeared to be for the common lobby to form a firefighting lobby. The design drawings show a 120-minute enclosure (Figure H.31) around the whole of the lobby (SEA00003112).

H4.5.13 This design is in agreement with the specification of 60-minute flat entrance doors to the new apartments on these floors – which is above the base provision of an FD30S door from Table B1 of ADB 2013.

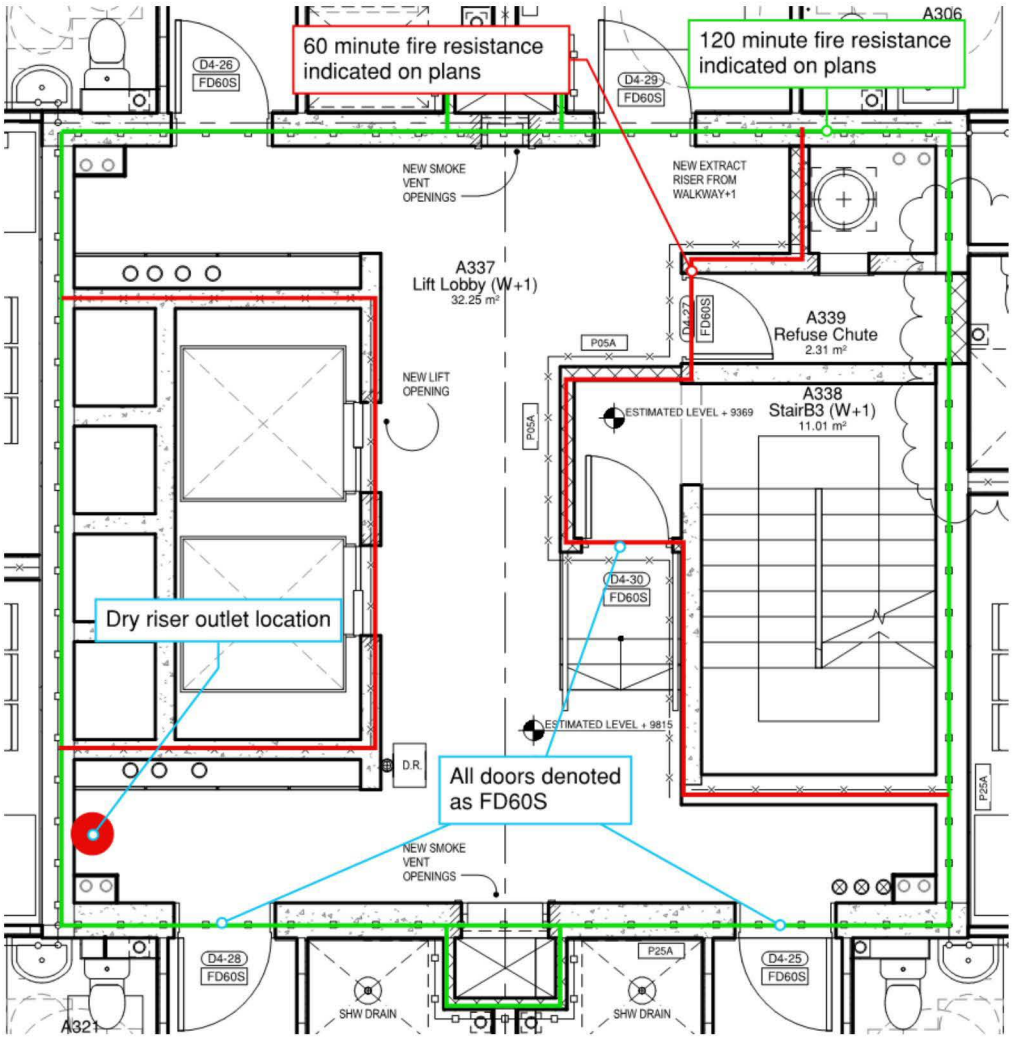



Figure H.31: Annotated excerpt of Level 3 from Studio E final construction issue drawings (SEA00003229, SEA00003112)

**H4.5.14** However, the Grenfell Tower common lobby on these levels, was not a compliant space to use as a firefighting lobby in accordance with ADB 2013 and BS 5588-4:2004.

**H4.5.15** The lobby is approximately 30m$^2$ in area on L3 and 26m$^2$ on L2, which both exceed the maximum area of 20m$^2$ permitted by Section 7.2.3 of BS 5588-5:2004.

**H4.5.16** Additionally, the lobby "wings" leading to apartment doors are as narrow as 1.1m. This is less than the 1.5m limit on principal dimensions for firefighting shafts stated in Section 7.2.3 of BS 5588-5:2004.

**H4.5.17** **Lobbies to non-residential areas**

**H4.5.18** The exception for omitting a firefighting lobby in a firefighting shaft only applies to where the firefighting shaft serves flats. This means that Section 17.11 of ADB 2013 applies to the non-residential areas accessed via the

firefighting stair and should be approached by a firefighting lobby where they communicate with the firefighting shaft (see (a) of Diagram 52 below):

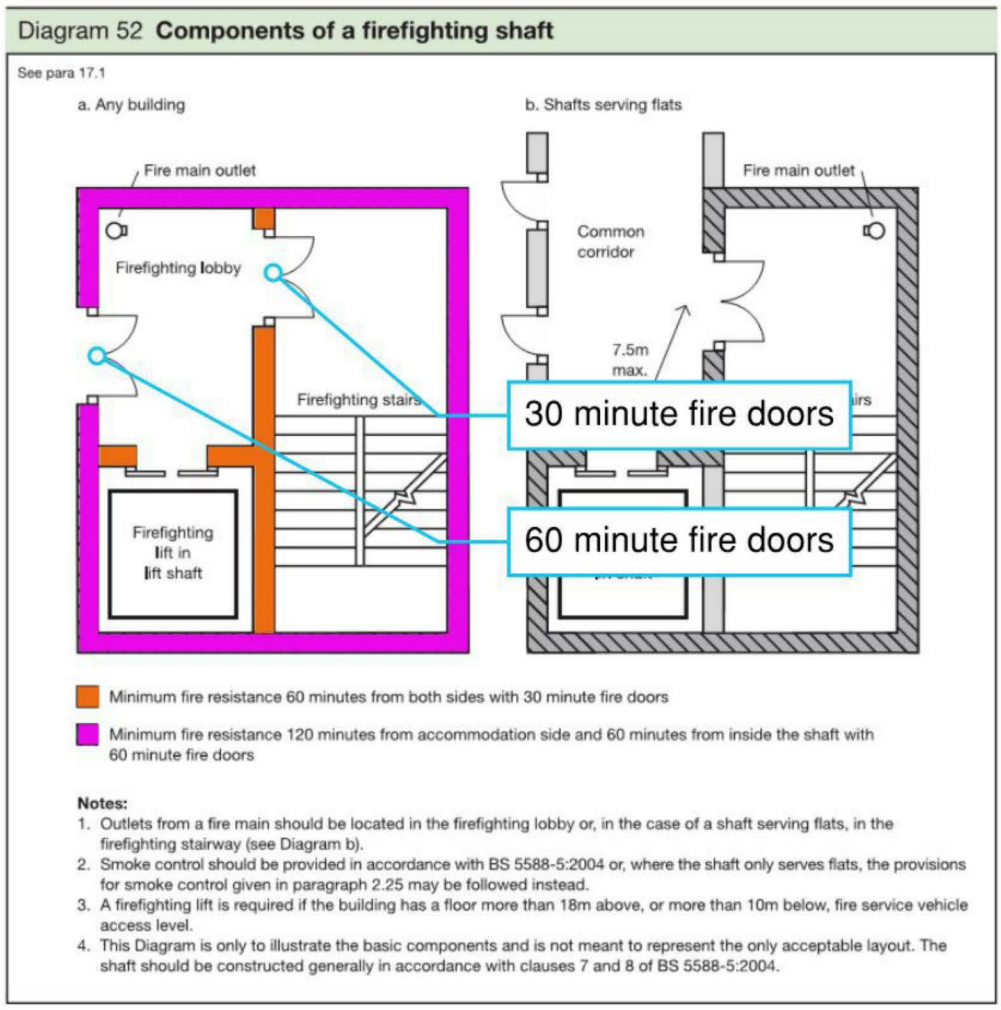



Figure H.32: Diagram 52 of ADB 2013 with markings on part (a), relevant to non-residential areas

**H4.5.19** No lobby is provided between the community meeting room on Level 1 and the firefighting stair (Figure H.33).

**H4.5.20** Additionally, the Grenfell Tower Door Access and CCTV strategy document (CST00000217, dated 19th November 2015) states that the community meeting room was to be used as a store room. Store rooms represent a higher fire risk than meeting rooms. This is acknowledged in the guidance in Table 31 of BS 9999:2008 where an ancillary storage room is recommended to be enclosed in fire resisting construction (the fire resistance period to be applied to the enclosure depends on the size and content of the store room), while there are no such recommendations for ancillary offices or meeting rooms.

**H4.5.21** Therefore, the provision of a formal firefighting lobby between the storeroom and the stair becomes more important.

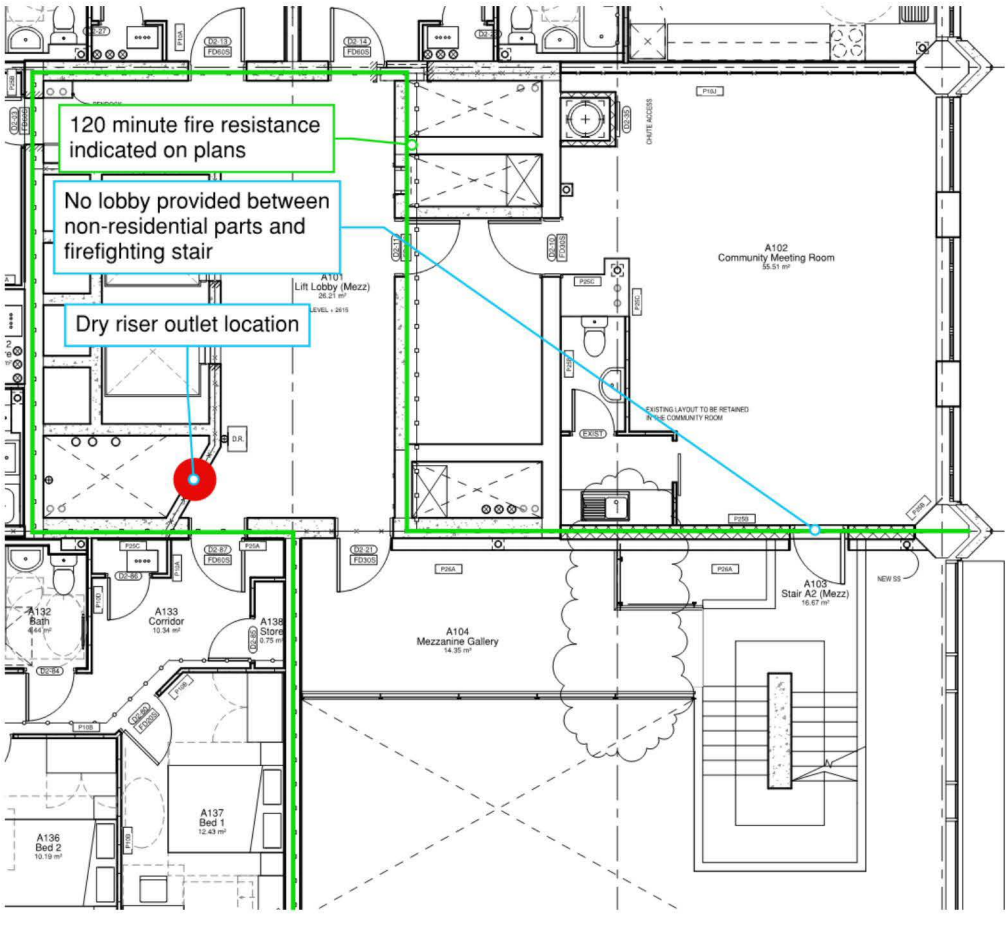



Figure H.33: Annotated excerpt from Studio E final construction issue drawings – Level 1 (SEA00003231, SEA00003112)

**H4.5.22** Additionally, at Level 2 a non-compliant vented lobby is provided between the stair and the boxing club (Figure H.34). The lobby is non-compliant as it does not incorporate a rising main outlet. Additionally, it incorporates the boxing club changing room within the lobby enclosure. This contravenes the provision in BS 5588-5:2004, Section 7.1.4, where it states that:

*"If a firefighting shaft contains sanitary accommodation, such accommodation should not:*

- *Be used as a cloak room;"*

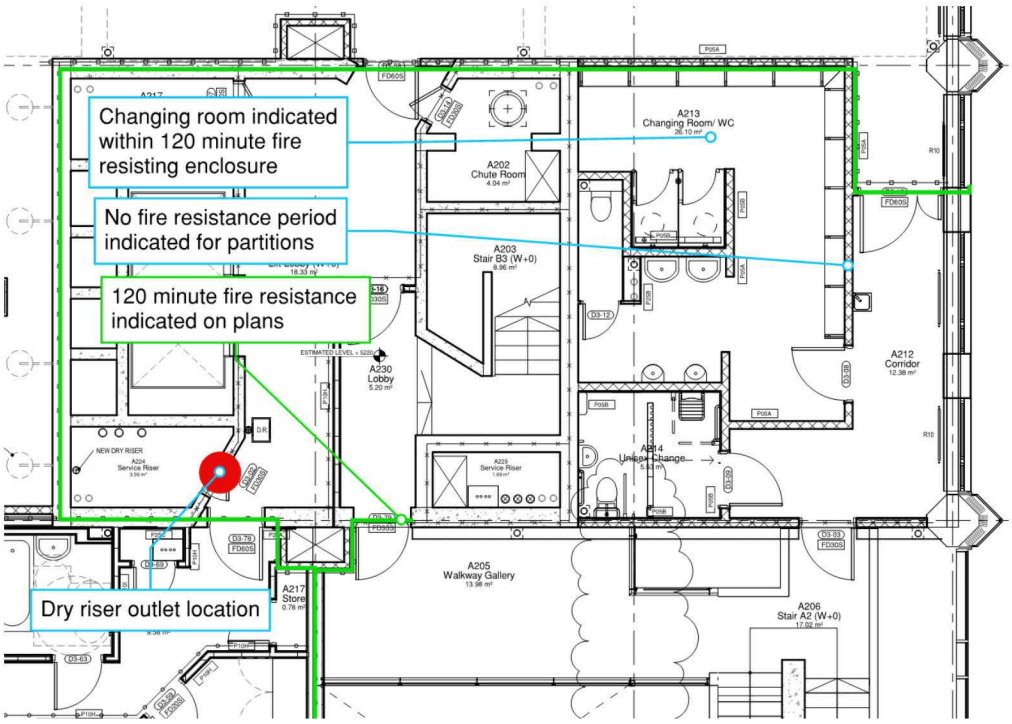



Figure H.34: Annotated excerpt from Studio E final construction issue drawings - Level 2 (SEA00003149, SEA00003112)

**H4.5.23** The Grenfell Tower firefighting shaft is therefore not compliant with ADB 2013 in the locations adjacent to these non-residential areas of the building.

## H4.6 Assessment of the firefighting shaft enclosure

**H4.6.1** The primary enclosure to the firefighting shaft on all levels consists of the core walls. The original design drawings (RBK00018858) specify these walls as either 200mm or 300mm thick in-situ cast reinforced concrete:

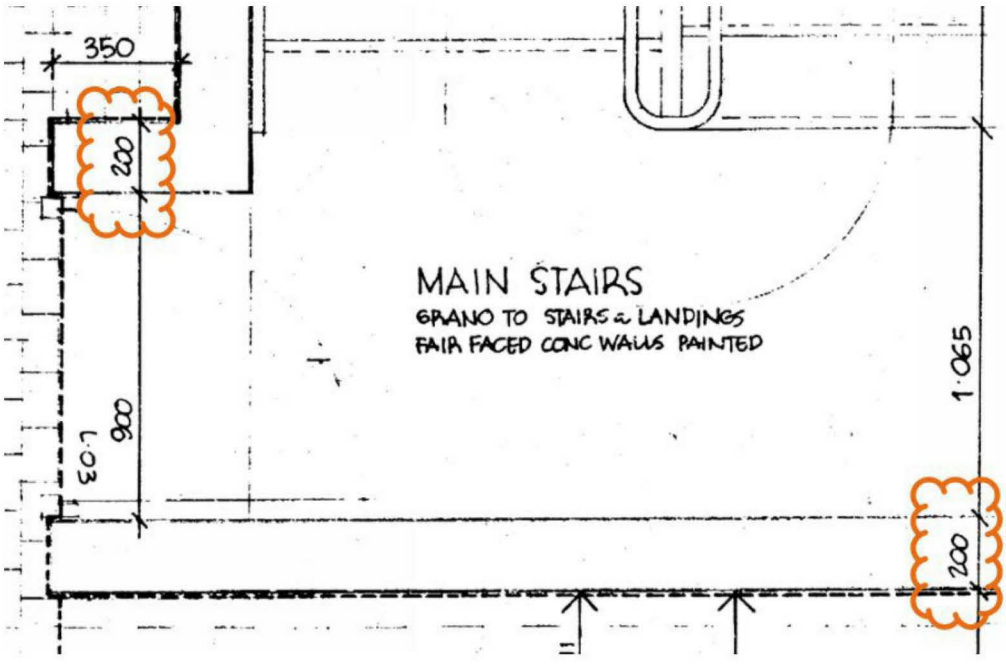



Figure H.35: Original design drawings showing shaft construction of 200mm concrete (RBK00018858)


Figure H.36: Photograph of Level 20 stair door showing concrete enclosure of stair

**H4.6.2** In accordance with Table 5.4 of Eurocode 2 (Design of concrete structures: Part 1-2 general Rules – Structural fire design, BS EN 1992-1-2:2004), the core walls would achieve a fire resistance rating of at least 120 minutes for integrity, insulation and loadbearing capacity and therefore the wall construction would provide sufficient performance to match the Studio E fire strategy drawings.

**H4.6.3** This leads to the summary diagram (based on original design drawings for Levels 4-23) for fire resistance periods shown in Figure H.37:

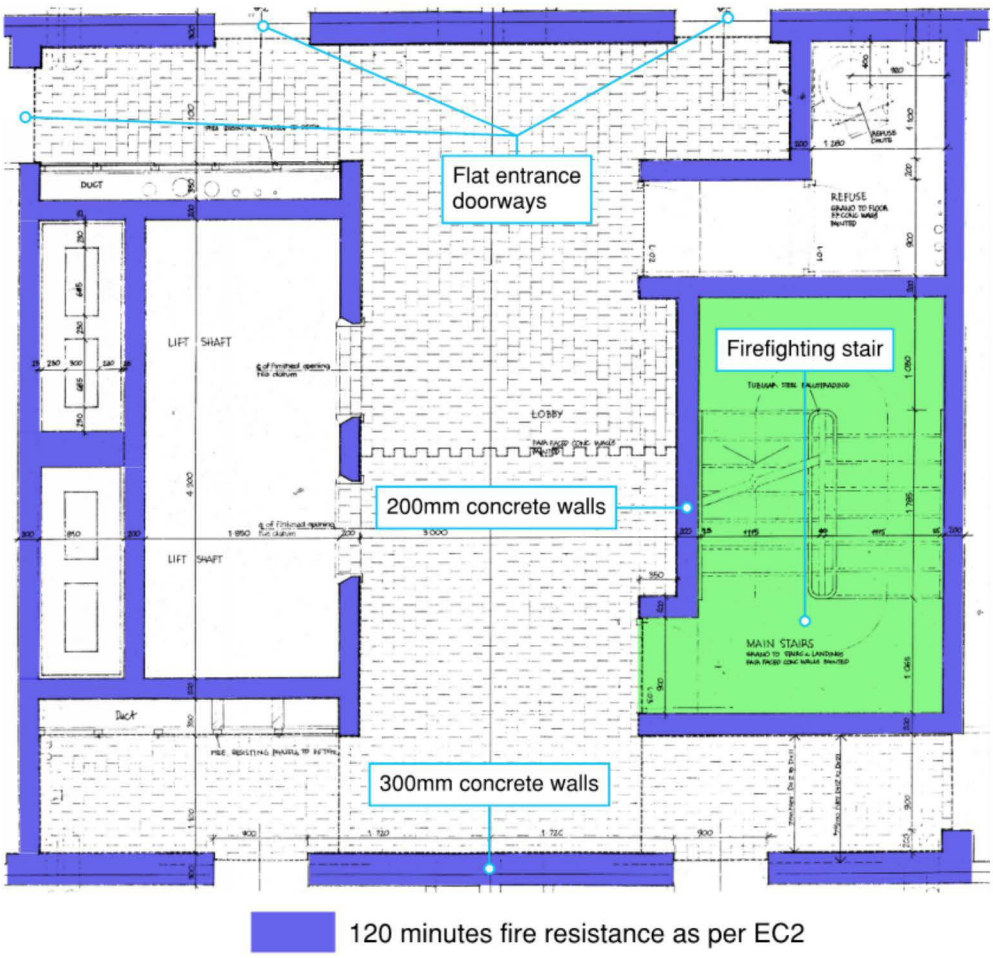



Figure H.37: Fire resistance of the central core using Eurocode 2 methodology on original design drawings (RBK00018858)

**H4.6.4** In my opinion therefore, the enclosing walls of the firefighting shaft and common lobby are compliant with ADB 2013, and the GLC Section 20 Code of Practice 1970.

**H4.6.5** I have carried out a separate assessment of the fire doors installed in the enclosure of the firefighting shaft and common lobby, such as flat entrance doors and stairwell doors, in Appendix I and in Appendix M of my Expert Report.

**H4.6.6** I have carried out a separate assessment of the builders work shafts, protected by dampers, in the lobbies, in Appendix J of my expert report.

## H4.7 Assessment of the shared escape stair between residential and non-residential areas

**H4.7.1** ADB 2013 states:

***"Mixed use buildings***

*4.4 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 an 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."*

**H4.7.2** Additionally, ADB 2013 provides the following guidance for buildings containing flats and other uses.

*"**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);*

*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."*

**H4.7.3** The shared escape story only satisfies the last of the above provisions:

a. There is only one escape route for all of the residential parts;

b. The community meeting room does not have a lobby leading to the stair at the mezzanine gallery on Level 1;

c. There is no connection between the automatic fire detection and alarm systems in the community use spaces and the flats.

## H4.8 Assessment of the firefighting lift

**H4.8.1** I provide my assessment of the firefighting lifts in Appendix L.

# H5 Summary of compliance with relevant guidance documents

**H5.1.1** Please refer to Table 16.3 in Section 16 of my report for a summary table listing the compliance of Grenfell Tower with the relevant clauses in ADB 2013, described herein, regarding compliance with Part B5.

**H5.1.2** As I have set out above, Grenfell Tower was not compliant with the statutory guidance in ADB 2013 as relate to Part B5, and specifically Section 15 and Section 17, and therefore at this stage it is my opinion that the building did not comply with Part B5 of the Building Regulations 2010.

**H5.1.3** In the next stage of my investigation I will address any alternative compliance approaches undertaken, and the overall compliance of the whole building with respect to other fire safety duties, before making my final conclusion.

# H6 Assessment of operational firefighting procedures in Grenfell Tower

**H6.1.1** I deal with the consequences of the scale of multi-storey fires on the operational sector approach to firefighting, in detail in Section 14 and on the individual fire fighting facilities in Section 19 of my report.

**H6.1.2** I will not therefore repeat that assessment here.