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 – Section 17

External access for the fire and rescue services – the provisions available at Grenfell Tower

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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17 External access for the fire and rescue services – the provisions available at Grenfell Tower

17.1 Purpose of Chapter 17

17.1.1 In this section, I examine the arrangements for external firefighting access to Grenfell Tower.

17.1.2 Grenfell Tower is a high rise building over 18m tall with a fire main. As I have explained below, the assumption in ADB 2013 for this type of building is that all firefighting will take place internally.

17.1.3 Internal firefighting was also the required provision when Grenfell Tower was constructed. I have explained those internal firefighting arrangements and their basis, in Section 3 of my Expert Report.

17.1.4 Vehicle access is required, to enable this internal firefighting, but only in a localised area near to the internal water main location. It is not required around the full perimeter of the building.

17.1.5 I have therefore first assessed the external access provisions made at Grenfell Tower in accordance with Section 16 of ADB 2013, for a building within an internal fire main. That access is required to ensure arrival and connection to the internal fire main by the fire and rescue service only.

17.1.6 However, in Section 5 of my report, I have described how external firefighting from multiple locations was undertaken by LFB. This was an improvisation on their part – provisions are not made formally available to them, for external firefighting in high rise residential building.

17.1.7 As I have explained in Section 14, the conditions within the internal protected firefighting stair and protected lobbies containing the fire main in Grenfell Tower deteriorated shortly after the external spread of fire. Smoke was reported in the lobbies as early as 01:18 (IWS00000945) and in the stair as early as 01:20 (IWS00000951); with conditions in both continuing to deteriorate thereafter, but particularly in the lobbies.

17.1.8 Current evidence indicates that external firefighting may have prevented or delayed the ignition of internal flat fires on Level 9 and below on the East and South elevations of Grenfell Tower. Therefore, it is possible that external firefighting contributed to relatively better conditions in the stair and lobbies on Level 9 and below, once consistent water application was achieved on those elevations of the Tower.

17.1.9 I have therefore also examined what external access, if any, was possible around the perimeter of Grenfell Tower for LFB to undertake external firefighting. As there are no provisions made in Section 16 of ADB 2013 for external firefighting access, this second assessment is not a compliance assessment. It is to understand how LFB managed to access so much of the

perimeter of Grenfell Tower, when no such provision was intended to be made for them.

17.1.10 The external firefighting, where it was possible, played an effective role in limiting the fire spread in the cladding system.

17.1.11 I want to understand what was available at Grenfell Tower for the fire brigade, and to understand if it was difficult to create an external firefighting regime, in a building where such a regime was never intended to be required.

17.1.12 It is relevant to my investigation as it describes what role, if any, the limitations of external access played during the Grenfell Fire.

17.1.13 Further, for the many other residential buildings in the UK with a building envelope formed of similar materials to Grenfell Tower, it may be an important part of an alternative means of mitigation.

17.1.14 When I was at Grenfell Tower carrying out my inspection work I instructed my colleagues Mr Albert Voet and Mr Angus Elliott, to measure and photograph the following:

a) The external access routes present at Grenfell Tower both on the site itself, and the surrounding area; and

b) The external firefighting facilities that were available to the fire brigade both on the site itself, and the surrounding area.

17.1.15 The firefighting command structure and decision making will be dealt with by the subject matter expert Mr Steve McGuirk. As a result, I make no reference to the decision making regarding external firefighting herein.

17.2 Statutory Guidance – accessing the internal firefighting facilities

17.2.1 As I explain in Appendix H, the statutory guidance for design of high rise blocks of flats is based on fires being fought from within the building via a firefighting shaft.

17.2.2 Therefore, for Grenfell Tower, vehicle access for fire appliances was required for the following reasons:

a) To permit fire crews to exit their vehicles close to the building; and

b) To permit a pumping appliance to be connected to both a nearby fire hydrant and to the building's rising main, to enable water flow to up the building for internal firefighting operations.

17.2.3 Firefighting water supplies were required to support internal firefighting operations by supplying water to the external pumping appliance and over to the rising main within the building.

17.2.4 The ADB 2013 provisions for fire appliance vehicle access routes

17.2.5 My team and I inspected vehicle access routes to Grenfell Tower from surrounding areas on 7th November 2017, as I have explained above.

17.2.6 I attended site again on 6th June 2018.

17.2.7 Figure 17.1 presents the statutory guidance in ADB 2013 Section 16 for fire appliance vehicle access routes. Figure 17.2 presents the statutory guidance in ADB 2013 for turning facilities for dead-end access routes greater than 20m long.

17.2.8 As Grenfell Tower was fitted with a fire main, ADB 2013 Section 16 required the vehicle access described in Table 20 and Diagram 50, to be within 18m of the fire main inlet.

17.2.9 During my site inspections, my team measured the minimum widths and clearance heights of the access roads for compliance with ADB 2013 Table 20 and Diagram 50.

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 17.1: ADB 2013 Table 20

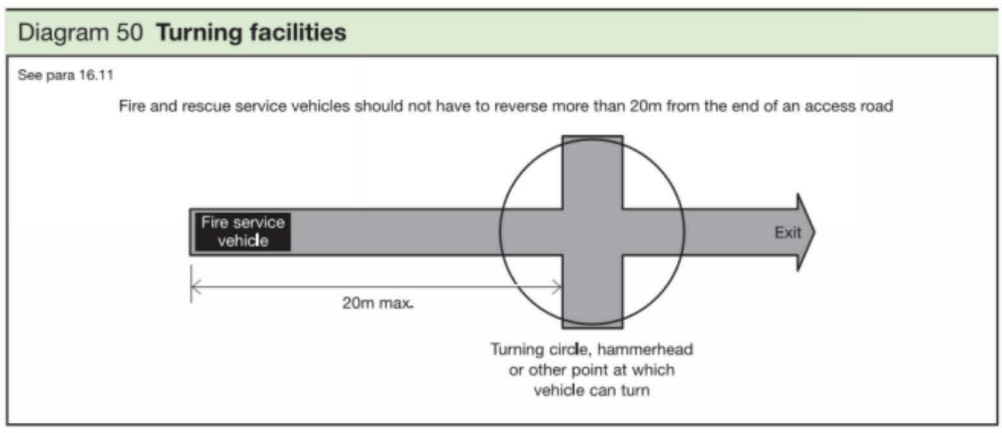


Figure 17.2: ADB 2013 Diagram 50

17.2.10 The provisions for Vehicle Access to the internal fire main at Grenfell Tower

17.2.11 Refer to Figure 17.3 for a photograph of the inlet to the firefighting main, located on the South elevation of Grenfell Tower, adjacent to the main entrance.

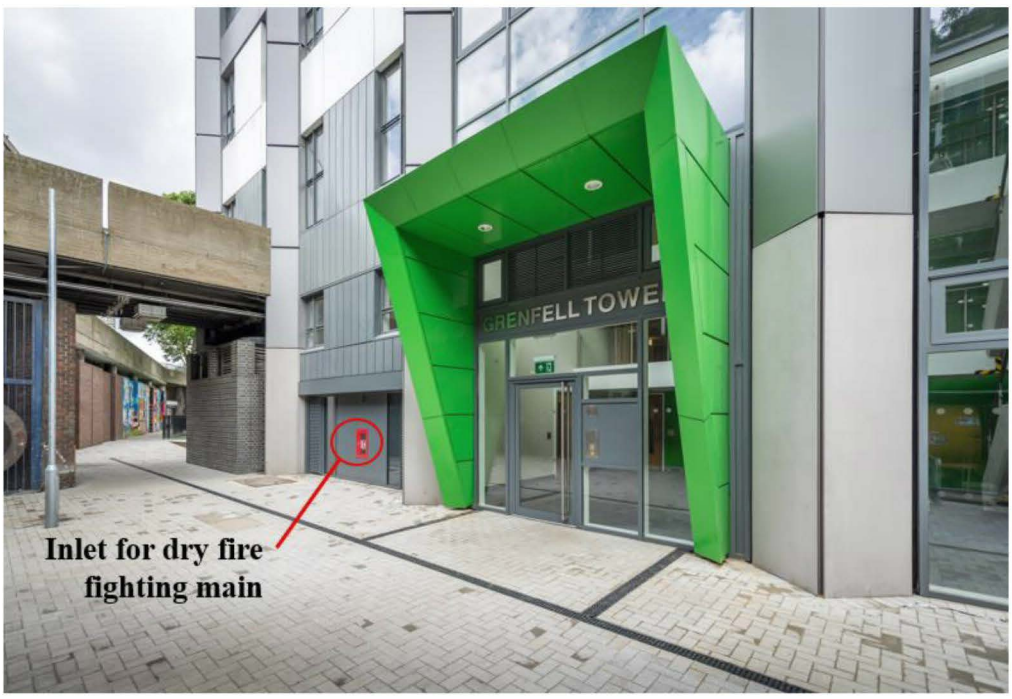


Figure 17.3: Inlet for dry firefighting main for Grenfell Tower (SEA00000394)

17.2.12 In Figure 17.4, I have marked up the ordnance survey map of the area surrounding Grenfell Tower to identify the vehicle access route which leads to the fire main inlet which is located on the South elevation only.

17.2.13 On this Figure 17.4 I have marked the key widths that my team measured during the post fire inspection. Labels A – C indicate the locations of photographic records I have included in Figure 17.5.

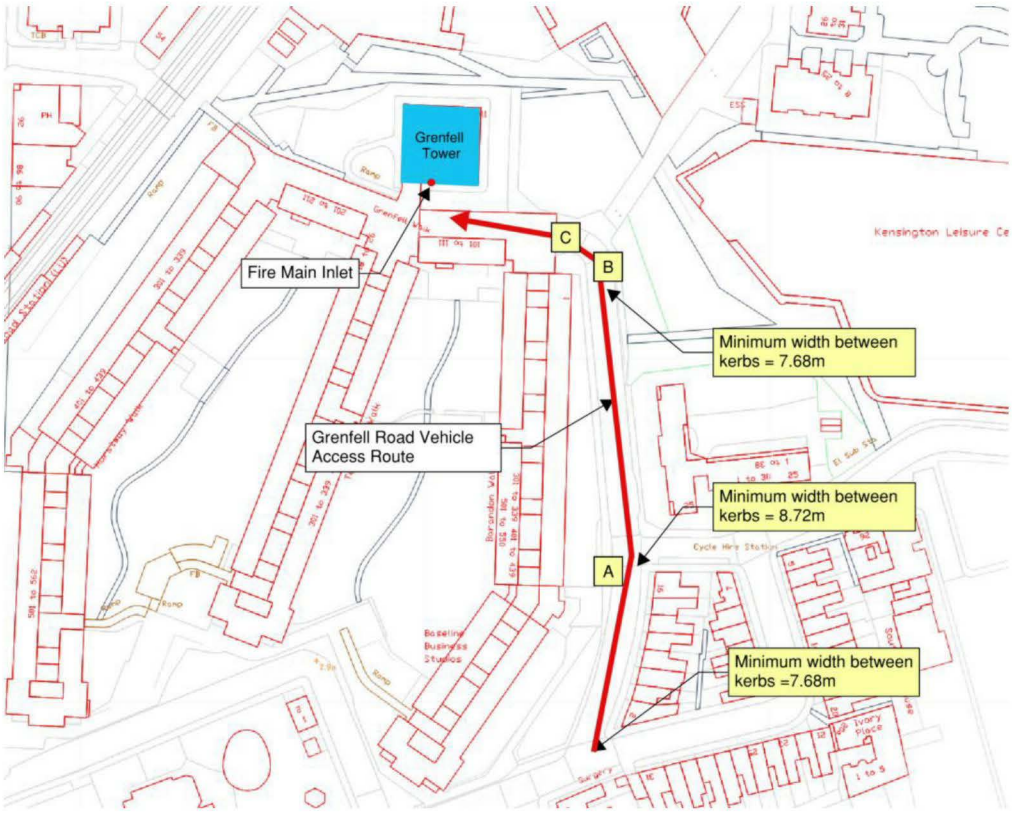


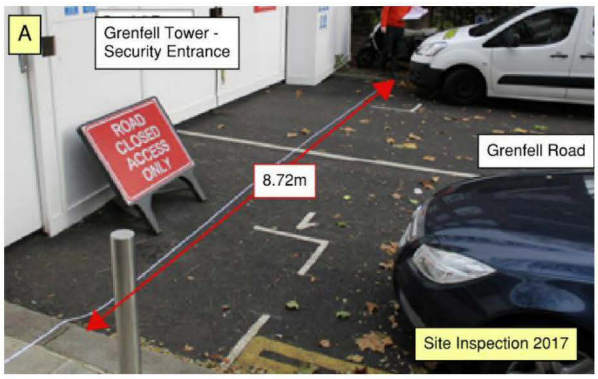
Figure 17.4: Fire vehicle route to Grenfell Tower, summary of onsite measurements of 7th November 2017

17.2.14 Grenfell Road is a public road (Figure 17.5(a) and (b)) which I measured to be between 7.68m and 8.72m wide along its length.

17.2.15 The minimum measured width of 7.82m between kerbs is greater than the minimum 3.7m recommended by ADB 2013 Table 20 therefore, the width of Grenfell Road between kerbs is compliant.

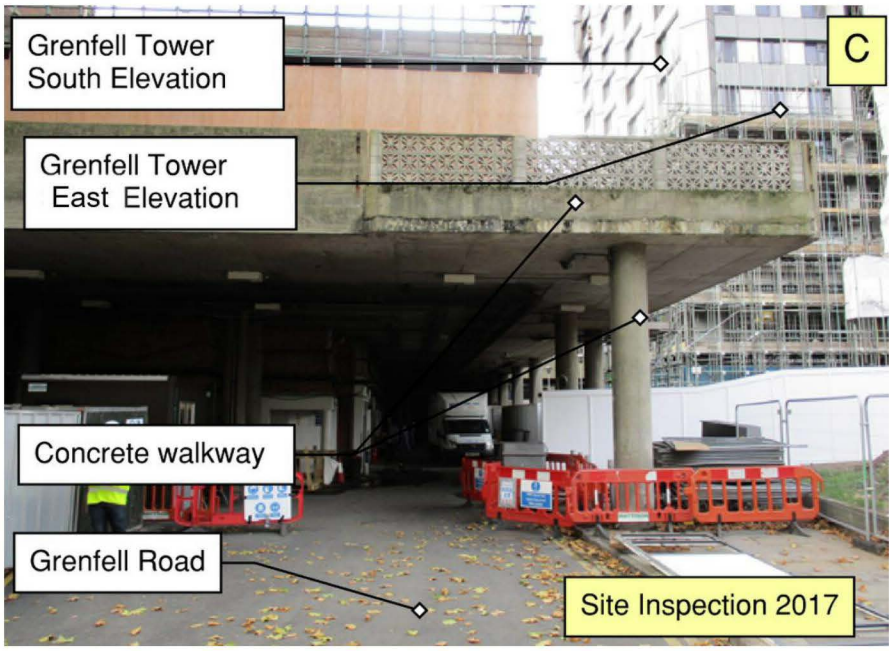
17.2.16 As Grenfell Road approaches Grenfell Tower, it runs underneath an elevated concrete walkway (Figure 17.5(c)) which I measured to be 4.4m above the roadway.

17.2.17 The minimum measured height of 4.4m is greater than the minimum 4m clearance required for access by high reach appliances in ADB 2013 Table 20. Therefore, the overhead clearance of Grenfell Road is compliant.



(a) Measurement of 8.72m between kerbs on Grenfell Road – Location 'A' Figure 17.4

(b) View of back down Grenfell Road – Location 'B' Figure 17.4



(c) View of Grenfell Tower from Grenfell road – Location 'C' on Figure 17.4

Figure 17.5: Observations and measurements of Grenfell Road

17.2.18 Underneath the concrete walkway, Grenfell Road runs parallel to the South elevation of Grenfell Tower. In Figure 17.6, I have over marked the distance of the vehicle access to the fire main inlet on the South Elevation of Grenfell Tower and the location of an external hydrant I observed in this location too.

17.2.19 I measured the minimum distance of the access route to the fire main inlet as 16.7m, which is less than the maximum 18m permitted by ADB 2013 Section 16.6. The proximity of Grenfell Road to the Grenfell Tower fire main inlet is therefore compliant for a fire appliance access road.

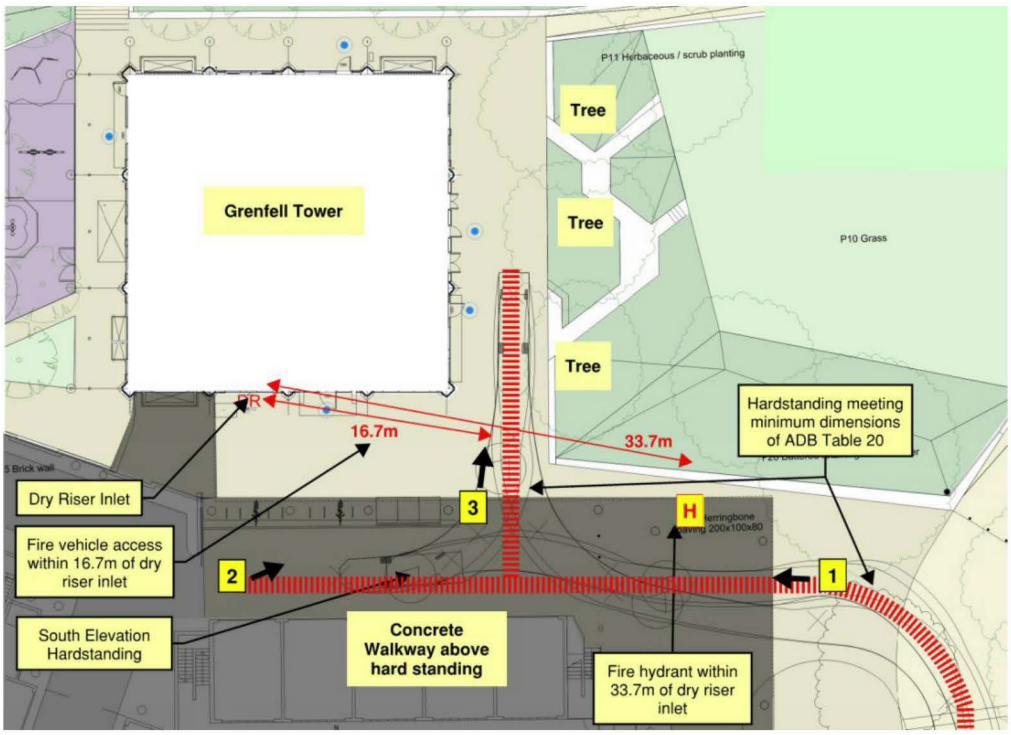


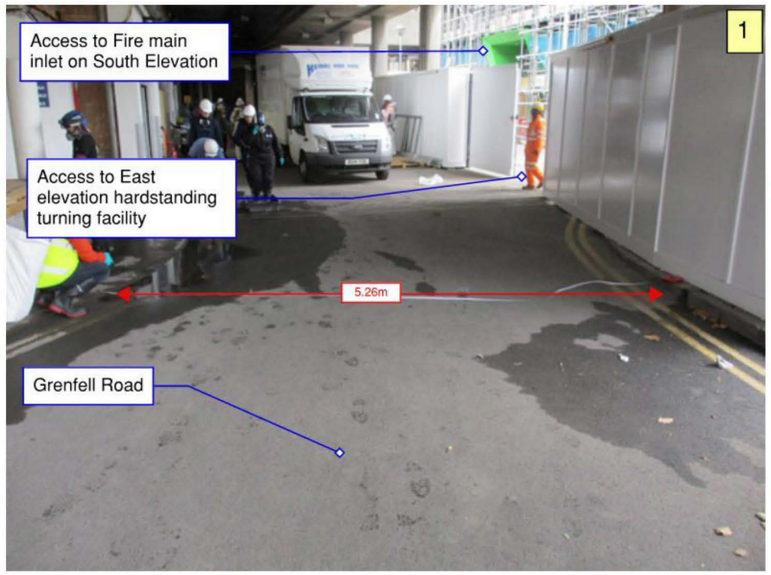
Figure 17.6: Grenfell Road where it reaches at Grenfell Tower. Please refer to Figure 17.7 for photographic views of Locations 'A', 'B' and 'C'; over marked on Studio E Fire Access Plan drawing (SEA00003480)

17.2.20 In Figure 17.7 I have included labelled photographic records and measurements my team took during our post fire site inspection in this area. In Figure 17.7 (a) I have shown how the South Elevation of Grenfell Tower is approached from Grenfell Road and where the external hydrant is located.

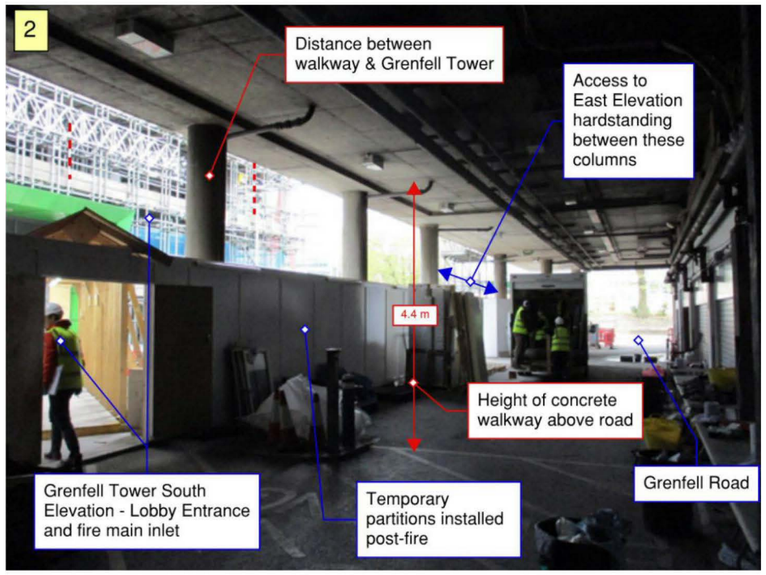
17.2.21 In Figure 17.7 (b) I have shown the view underneath the concrete walkway and how the fire appliance vehicles can park underneath the concrete walkway within 18m of the fire main inlet. An external hydrant is located nearby, 33.7m from the fire main inlet of Grenfell Tower. A photograph of the Grenfell Tower fire main inlet is included in Figure 17.7 (d).

17.2.22 The hardstanding on the East elevation (Figure 17.7 (c)) provides turning facilities compliant with ADB 2013 Diagram 50 – a fire appliance vehicle can reverse more than 26m to facilitate turning.

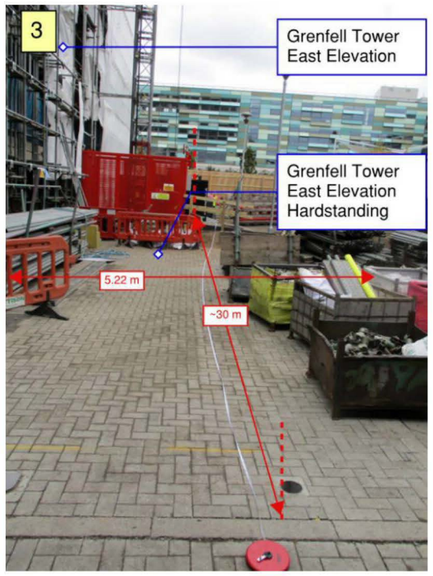
17.2.23 Figure 17.13 (e) is photographic evidence of the external hydrant location from underneath the concrete walkway and Figure 17.7 (f) is a photograph of the hydrant itself.



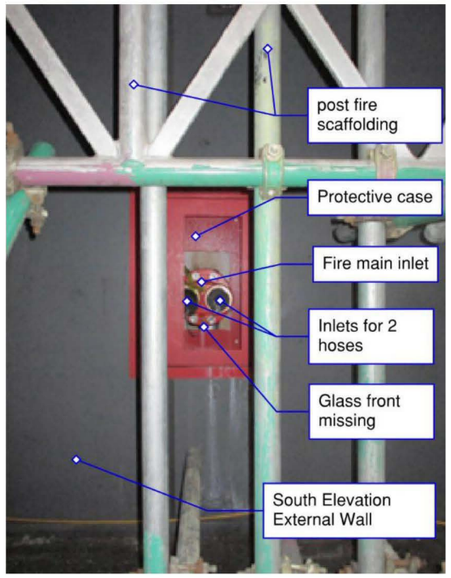
(a) View of Grenfell Road where it reaches the South elevation of Grenfell Tower - Location 'A' -Figure 17.6.Figure 17.6. Measurements were taken by my site inspection team



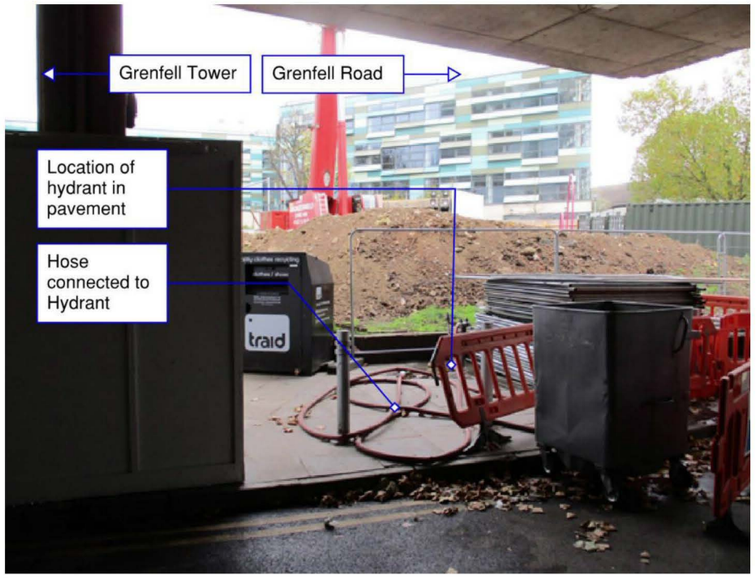
(b) View of Grenfell Tower on South Elevation of Grenfell Tower – Location 'B' Figure 17.6. Measurements were taken by my site inspection team



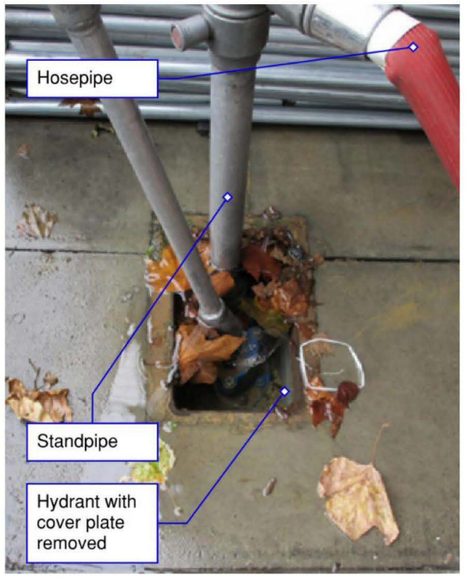
(c) View of hardstanding on East Elevation of Grenfell Tower – Location 'C' Figure 17.6. Measurements were taken by my site inspection team



(d) View of the Grenfell Tower fire main inlet on the South elevation



(e) View of the closest fire hydrant to Grenfell Tower fire main inlet (located at Southeast corner)



(f) View of the fire hydrant in the pavement on the Southeast corner of Grenfell Tower

Figure 17.7 Photographic records taken during my inspection of the provisions of hardstanding for fireappliance vehicles next to the fire main inlet and fire hydrants.

17.2.24 In summary, Grenfell Road is a compliant fire appliance vehicle access route for Grenfell Tower because:

a) The minimum width between kerbs is greater than 3.7m along its full length from Treadgold Street to the South Elevation of Grenfell Tower. Note I observed cars parked in parking bays either side of the road reducing the available width to 3.5m and therefore less than 3.7m.

b) Grenfell Road is within 18m of the fire main inlet on the South Elevation of Grenfell Tower.

c) The vertical clearance where Grenfell Road runs underneath the concrete walk-walk on the South Elevation of Grenfell Tower is greater than 4.0m

d) As a public roadway it should meet the minimum carrying capacities of ADB 2013 Table 20.

e) Vehicle turning facilities in accordance with ADB 2013 Diagram 50 are provided by the hardstanding on the East elevation of Grenfell Tower

17.2.25 **The provisions for external fire hydrants at Grenfell Tower**

17.2.26 ADB 2013 Section 15.7 states that for a building with an internal fire main, a hydrant should be provided within 90m of the fire main inlet. An external hydrant is used as the source of firefighting water supply by the fire fighters.

17.2.27 Limiting the distance between the building and the fire main reduces the time required for fire fighters to connect the hydrant water supply to the building fire main system. This is irrespective of whether the building has a dry or wet fire main system.

17.2.28 ADB 2013 Section 15.7 also states that:

17.2.29 "each fire hydrant should be clearly indicated by a plate, affixed nearby in a conspicuous position in accordance with BS 3251:1976."

17.2.30 In the Ordnance Survey map marked in Figure 17.8 I have marked up the location of all the hydrants I observed on site on 7th November 2017. I also indicate where the observed hydrants were not provided with a sign. I observed 4 hydrants in close proximity to Grenfell Tower. I measured the distances of these hydrants using an ordnance survey map. Three of these hydrants were less than 90m from the fire main inlet and one of these hydrants had appropriate signage. The fourth was 95m from the dry fire main inlet.

17.2.31 Therefore, Grenfell Tower was compliant with the hydrant provisions of Section 15 in ADB 2013.

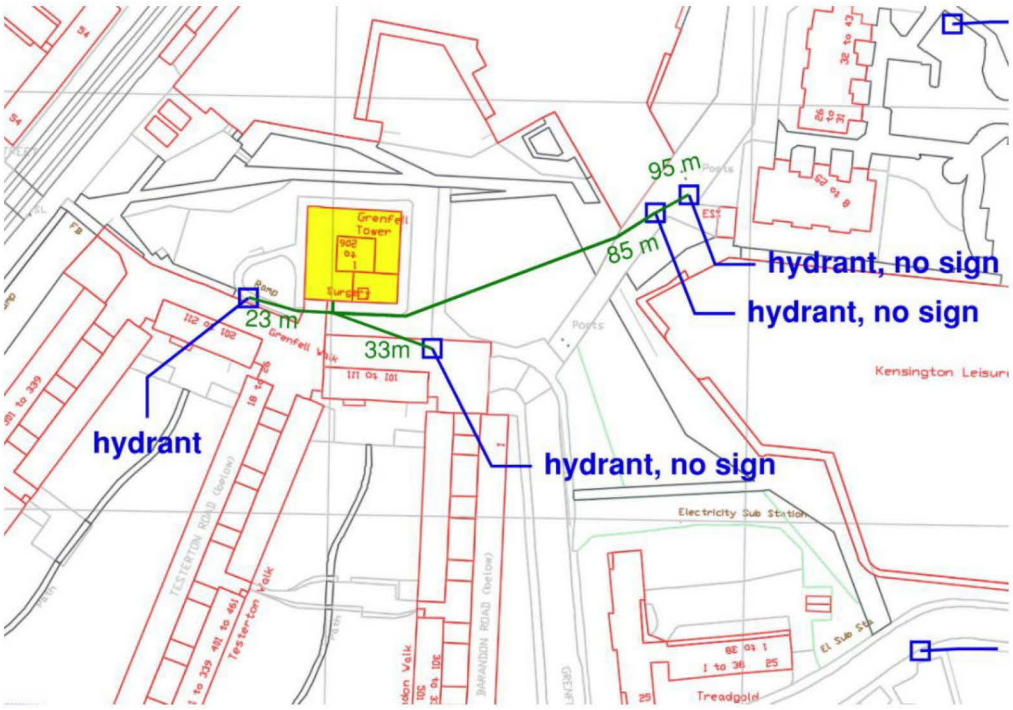


Figure 17.8 Hydrant location summary of onsite findings and approximate measurements from ordinance survey maps

17.3 External firefighting achieved by LFB on 14 June 2017

17.3.1 In this section, I now explore accessibility for external firefighting as was observed during the fire. This is not a compliance review because such access is not provided for in ADB 2013 for high rise residential buildings within internal firefighting provisions.

17.3.2 As I go on to explain in Section 19 of my report, the internal firefighting provisions failed during the multi-storey internal fire on 14th June 2017, meaning that the standard operational firefighting method normally employed for high rise buildings by the LFB (see Section 3 and Appendix H of this report) could not be implemented.

17.3.3 However, LFB did apply external firefighting tactics to the building, and from very early in the fire.

17.3.4 In order to understand the timing of early external firefighting, I have reviewed all photographic and video evidence available to me, as well as firefighter witness statements and firefighter BA telemetry data.

17.3.5 Additionally, in order to understand the extent of early external firefighting achieved, and specifically in terms of water reach on the East elevation, I have assessed the height of the building over which water appears to have been applied by the LFB from their improvised firefighting locations.

17.3.6 Timing of externally applied firefighting water to initial external fire spread (before 01:40)

17.3.7 As I have explained in Section 5, the fire had spread from inside Flat 16 to the external building envelope by 01:08.

17.3.8 The earliest visual evidence of external firefighting water being applied to the East elevation of Grenfell Tower was at 01:15:50. I observed water being applied below the Flat 16 window in the photographic and video evidence I reviewed between 01:15:50 and 01:25. However, some firefighter witness statements suggest that water was applied to the building before 01:15:50 and that water was applied above the Flat 16 window on the East elevation of the building.

17.3.9 In this section I first summarise the evidence from firefighter witness statements and video evidence relevant to the covering jet before 01:15:50, which has not been visually confirmed through photographic and video evidence. I then explain my observations of externally applied firefighting water after 01:15:50, which I have been able to positively confirm with photographic and video evidence.

17.3.10 According to the Operational Response Report 01- 00:50 hrs to 02:00 hrs report (LFB00001914), FF Archer operated a covering jet at the East elevation at 01:11 and sprayed water above the Flat 16 window.

17.3.11 In his witness statement, FF Archer (MET00008001) explained that he sprayed firefighting water above the Flat 16 window:

"I looked up at the Tower and saw a bit of a flame coming out of one of the windows. The dry riser was already being set in, I got a 45m jet off North Kensington's ladder, rolled it out and got it to work, I was spraying it just above the window where the flame was coming out, which seemed to be helping with the fire." (MET00008001, Archer)

17.3.12 FF Archer arrived at Grenfell Tower at 01:08:27, according to the Operational Response Report 01- 00:50 hrs to 02:00 hrs report (LFB00001914),

17.3.13 FF Archer disconnected a BA from a vehicle charger at 01:12:18 according to the BA Telemetry Data (LFB00023326).

17.3.14 Therefore, FF Archer must have operated the covering jet onto the East elevation of Grenfell Tower between 01:08:27 and 01:12:18.

17.3.15 Resident video footage shows a fire fighter positioning a fire fighting hose along the East elevation of Grenfell Tower at 01:11 (IWS00000054); refer to Figure 17.9. This is the only firefighting hose I observed in this video, which indicates that the hose in Figure 17.9 was the first firefighting hose positioned directly below Flat 16 on the East elevation.

17.3.16 I did not observe any water on the ground by Column B5 at this time in this video (IWS00000054), as shown in Figure 17.9, indicating that water had not been applied to the East elevation of Grenfell Tower before 01:11.

Figure 17.9: Fire fighter positioning a fire fighting hose along the East elevation of Grenfell Tower at 01:11. (IWS0000054)

17.3.17 In the same resident video footage (IWS00000054), approximately 55 seconds after Figure 17.9, I observed water on the ground adjacent to the East elevation of Grenfell Tower, shown in Figure 17.10. I do not have photographic or video evidence showing where this water came from.

Figure 17.10: Fire on East elevation of Grenfell Tower and water on ground at 01:11.

17.3.18 The Operational Response Report 01- 00:50 hrs to 02:00 hrs report (LFB00001914) states that FF Archer handed the covering jet to FF Murphy and FF Cornelius at 01:11.

17.3.19 There is conflicting evidence between witness statements from FF Cornelius (MET00012663) and FF Murphy (MET00010820) regarding who they took the hose from. FF Cornelius says that IC Dowden asked him and FF Murphy to take over the covering jet from FF Archer. FF Murphy says that he and FF Cornelius took the hose from FF Bills.

17.3.20 If FF Cornelius and FF Murphy did take the hose from FF Archer, then it must have been before 01:12:18, the time when FF Archer disconnected a BA from a vehicle charger (LFB00023326).

17.3.21 In his witness statement, Murphy (MET00010820) explained that he and Cornelius were on the covering jet for 10 – 15 minutes, before IC Dowden gave them orders to stop:

"We were discharging water onto the fire for approximately 10- 15 minutes…

The fire moved up about 4 or 5 floors. I saw a crew from Hammersmith arrive but I did not know who else were there. WM DOWDEN told FF CORNELIUS and I to move back from the Tower and to go to our vehicle to get breathing apparatus as it was now unsafe to stay in this position."

17.3.22 According to the BA Telemetry Data (LFB00023326), Murphy and Cornelius disconnected a BA set from a vehicle at 01:27:32 and 01:28:19, respectively. Therefore, they must have stopped applying water to the East elevation by 01:28.

17.3.23 During FF Murphy's evidence (Day 38, 6 September 2018, p. 31) and FF Cornelius' evidence (Day 38, 6 September 2018, p. 64-65), they each confirmed that they were deploying the covering jet between 01:08 and 01:28.

17.3.24 In his witness statement, WM O'Keeffe (MET00013967) said that a covering jet was being applied to the outside of the building before crews entered Flat 16, which was at 01:07:21 based on thermal images (MET00006109).

"… Firefighters MURPHY and CORNELIUS set up a covering jet and put water on the outside of the building immediately. I told WM DOWDEN that I'd sent the priority message. I asked him where the Bridgehead was and he replied "Second floor." Just at that point, a radio message was transmitted that the BA crews were entering the flat so WM DOWDEN gave the order for the ground crew, to knock off the covering jet. Putting a jet into a window when you've got fire crews inside the apartment will endanger that fire crew. The jet was knocked off."

17.3.25 However, FF Murphy, FF O'Keefe, and FF Cornelius did not arrive on scene until 01:08 (LFB00001914). Based on the Operational Response Report 01-00:50 hrs to 02:00 hrs report (LFB00001914), FF O'Keeffe attempted to gain access to the main entrance of Grenfell Tower at 01:14, was successful and then makes his way to the bridgehead. Therefore, FF O'Keefe must have observed FF Murphy and FF Cornelius spraying water to the building between 01:12 and 01:14.

17.3.26 The earliest positive visual evidence of external firefighting water applied to the building is at 01:15:50. Figure 17.11 shows the East elevation of the building envelope at 01:15:47, which shows no firefighting water being applied to the building. In comparison, the same location on the east elevation of the building envelope is shown at 01:15:50, which shows a water stream directed at the building.

17.3.27 This is approximately 2 minutes after thermal images show BA crews in Flat 16 applied an internal firefighting jet within the kitchen (01:14).

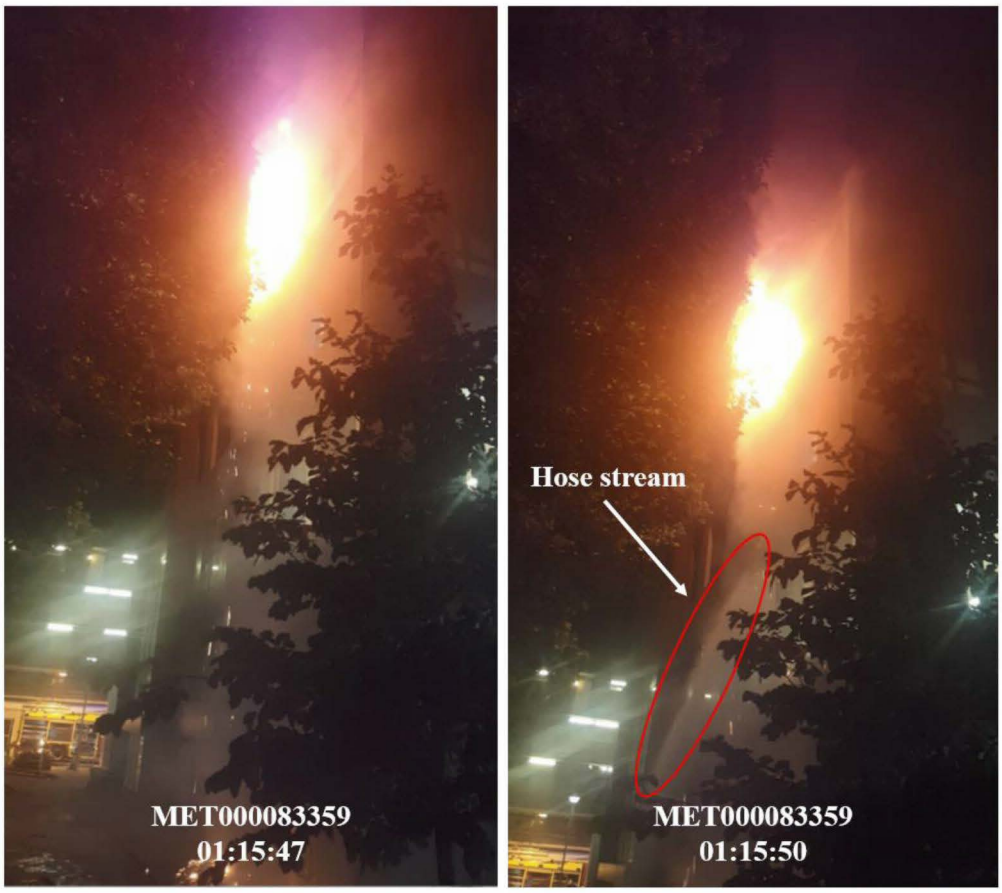


Figure 17.11: First observed firefighting hose stream on East elevation of building envelope at 01:15 on 14 June 2017 (MET000083359)

17.3.28 I have observed through photographic and video evidence that a water jet was intermittently applied to the East elevation of Grenfell Tower, and to burning debris at ground level, between 01:15 and 01:25 with a handheld hose. (MET000083359, MET00006576, MET00006834, MET00006577, MET00006833, MET000083360, MET000083361, MET000083362).

17.3.29 Refer to Figure 17.12 for a photograph of a firefighter applying a water jet to the East elevation of the building at 01:21.

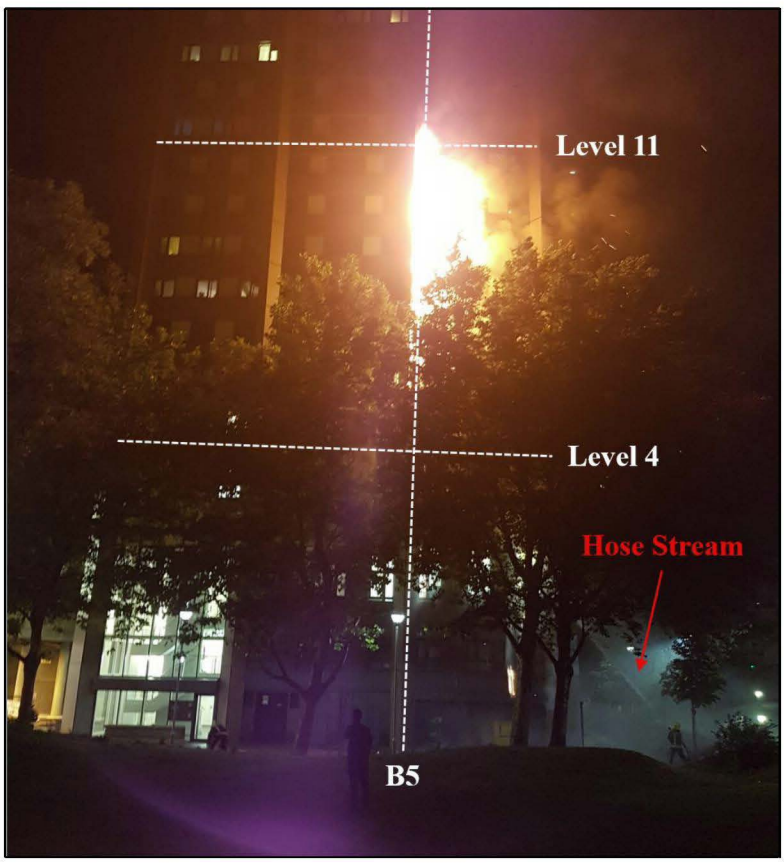


Figure 17.12: Fire on East elevation of the building envelope at 01:21 on 14 June 2017; Firefighter applying a hose stream to the East elevation (MET00006591)

17.3.30 As I will explain in Section 17.4, at a later stage in the night, the water from a handheld hose from ground level appeared to reach Level 7 on the West elevation of Grenfell Tower. However, I have been unable to find positive evidence of water being applied at or above the level of the Flat 16 kitchen window in my review of photographs and videos between 01:15:50 and 01:25.

17.3.31 I have only been able to find evidence of water being applied below Level 4; refer to Figure 17.13.

Figure 17.13: External firefighting from ground level (MET00006577)

17.3.32 According to witness statements from Secrett (MET00010105), Dowden (MET00010915), Hippel (MET000083300), Cornelius (MET00012633) and Murphy (MET00010820) there was a decision to not direct the external water jet at the Flat 16 kitchen window, to avoid injury to fire fighters within the flat.

17.3.33 Immediately before the first crew entered Flat 16, they notified CM Secrett, who was managing the Bridgehead, of their planned entry to Flat 16. The time of entry to Flat 16 based on thermal images (MET00006109) was 01:07:21. Soon after receiving this notification, CM Secrett also received a radio message from IC Dowden regarding fire spread out of the Flat 16 window.

17.3.34 CM Secrett responded to IC Dowden and explained his concern with an external water jet potentially affecting the crews inside Flat 16 (Secrett, MET00010105):

"the fire was starting to break out the window and he [IC Dowden] *wanted to put a covering jet on it. I told him not to do that as the crews were just about to go in. I requested the jet go above or below the flat but not in it. If the jet had been directed into the flat the water would have turned to steam and basically it would have scolded the FF crew. This can cause serious injuries."*

17.3.35 In his witness statement IC Dowden explained that he wanted to avoid putting water directly onto the window because of the risk that might pose to the fire-fighters (Dowden, MET00010915):

"I also requested that G331 get a covering jet for the outside of the flat where the fire was, in order to keep it contained and stop it spreading above and below the compartment. It was necessary to aim water above and below the compartment, but not directly into it as that could affect the fire fighters working within the compartment."

17.3.36 Dowden went on to explain (Transcript of 26th June 2018, p.90):

"my instruction was: don't put it in a compartment, just put it above and beyond. Going back to -- if we put a covering jet into a compartment as firefighters, that's going to pose a serious risk and increase the risk to firefighters within the compartment, because of -- without going too much into science, the expansion rate of water to steam is 1,700 to 1, so you are really, really going to put a real risk to firefighters in any compartment if we put water into it where they are."

17.3.37 In his witness statement, FF Hippel also confirmed that there were communications between CM Secrett and firefighters outside Grenfell Tower regarding the initial external water jet. He explained the basis for the decision to avoid aiming the water jet at the flat window as follows (Hippel, MET000083300):

"if they [firefighting crew] *were inside* [Flat 16] *and a jet of water was fired in it could put the crews and any remaining members of the public at risk of injury due to the steam which would result and did not say anything as I agreed with the decision."*

17.3.38 In his witness statement, Cornelius (MET00012633) explained:

"W/M DOWDEN asked FF MURPHY and I to take over from FF ARCHER on the cover jet and advised us not to target the fire directly and made it clear, we were not to put water into the burning flat because there were BA crews in the flat already that will make the condition worse for them in there…

I checked with W/M DOWDEN to see if the crews are still in that flat so that we can target the fire directly but I was informed that they were still there."

17.3.39 During FF Cornelius' evidence (Day 38, 6 September 2018, p. 64-65), he confirmed again that he was told to aim the jet below the window.

17.3.40 In his witness statement, Murphy (MET00010820) explains:

"I was told there were crews tackling the fire inside of the respective flat so me and FF Cornelius took the hose from FF Bills. When there are crews within a flat, we are trained to discharge water around a window and not into the window as this may affect the safety crew inside or cause injury to them.

FF Cornelius and I were hitting the fire around the window with water but it was having no effect."

17.3.41 During FF Murphy's evidence (Day 38, 6 September 2018, p. 31), he confirmed that he purposely avoided spraying the water into the window.

17.3.42 In his witness statement, FF Abell (MET000080558) said he observed water being sprayed above the Flat 16 window:

"*Once I had secured the water supply* [for the dry riser] *I assisted my colleagues with deploying a 45 mm hose, to be used as a 'covering jet' to the East side of the tower in an attempt to prevent the fire spreading from the 4th floor to the floors above. I could see flames coming out of a window on the fourth floor. At this time the flames were concentrated to that one flat. The covering jet was aimed above these flames, with the intention of stopping the fire reaching the floor above."*

17.3.43 I have not able to confirm if FF Abell made this observation when FF Archer was deploying the covering jet (before 01:12) or when FF Murphy and FF Cornelius were deploying the covering jet (between 01:12 and 01:28), based on my review of the LFB short incident log report (MET00013830) and BA Telemetry Data (LFB00023326)

17.3.44 During FF Abell's evidence (Day 14, 2 July at p.45-46), video footage of water being sprayed below the Flat 16 window between 01:15:50 and 01:19 was shown to him (LBY00000002). He was asked whether the water jet stayed below the window or if it ever went above the window. He responds by saying *"that* [hose jet] *seems to be staying below the window there"*. He was then asked whether this video prompted any recollection as to whether the hose was actually aimed above the flames or not. Abell replied:

"I just remembered it being above the flames. Maybe that's because it's what I'd expect but, again, my memory is probably not great at that time."

17.3.45 There is also evidence that firefighting water was applied to the exterior of the building from within Flat 16 via the kitchen window. FF O'Hanlon was part of the crew that first entered Flat 16. In his witness statement (MET000080592), FF O'Hanlon explained that he leaned out of the Flat 16 kitchen window and applied an external water jet to the East elevation of the building. This would have been between 01:14, the first time the Flat 16 kitchen door was opened by fire fighters according to evidence from the thermal imaging camera (MET00006109), and 01:35, the time O'Hanlon returned to the bridgehead according to the BA Telemetry Data (LFB00023326).

17.3.46 During FF O'Hanlon's evidence (Day 16, 4 July 2018, p. 111-112), he was shown a video clip of external fire spread on the East elevation of Grenfell Tower at 01:22. He was asked if he *"saw something coming up through the flames from the bottom-right to top-left"* in the video, which showed the East elevation of Grenfell Tower at 01:22:20; refer to Figure 17.14. When asked if

he could help the Inquiry figure out what this *"something"* was, FF O'Hanlon responded:

"Not really, but maybe it was us -- it must have been us. Yeah, but --
...
We were just aiming it around the window."

17.3.47 Overall, it was not clear to me if FF O'Hanlon thought the video showed the water jet he sprayed from the Flat 16 kitchen window onto the East elevation of the building envelope or not.

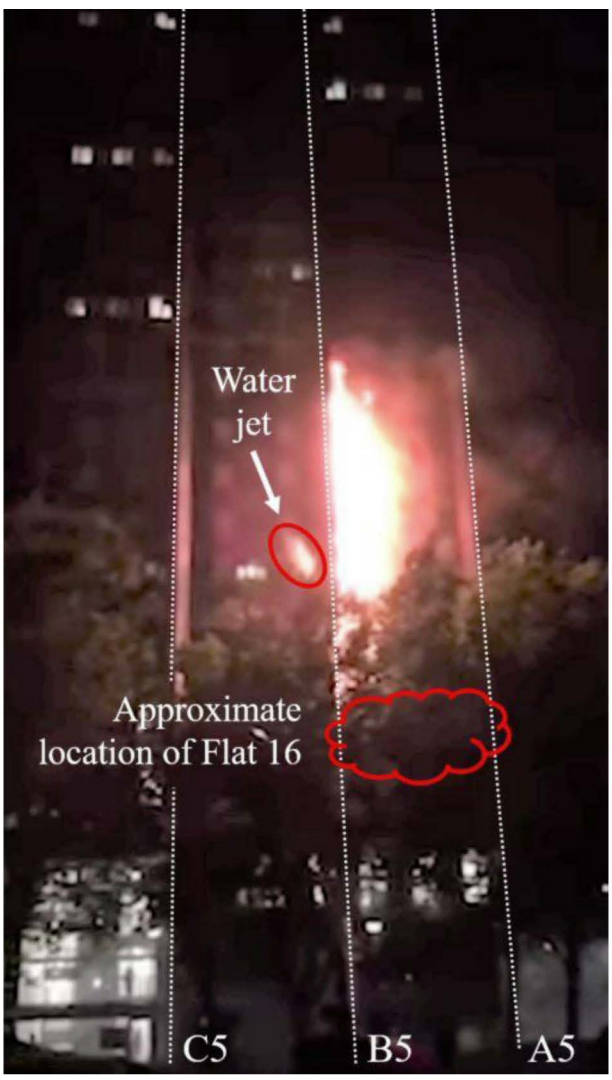


Figure 17.14: Screenshot from video shown to FF O'Hanlon during his evidence (Day 16, 4 July 2018, p. 111-112) of East elevation of Grenfell Tower at 01:22 (LBY00000002)

17.3.48 In summary, I have been able to positively confirm that water was applied externally on Grenfell Tower from ground level, intermittently between 01:15:50 and 01:25 through my review of photographic and video evidence:

17.3.49 Ultimately, this initial external firefighting was not successful. As shown in Figure 17.15, the fire spread beyond Level 7 and up to Level 11 (32m above ground level) by 01:21.

17.3.50 However, as I explained in 17.3.30, I have concluded that it was possible for water from a handheld hose on ground level to reach Level 7 on any elevation of Grenfell Tower. By 01:21, the fire had spread beyond what I currently understand to be the reach of a water jet from a handheld hose operated from ground level.

17.3.51 In order to arrest the spread of fire externally above Level 7, the LFB would have required an aerial appliance to have been deployed and in operational position by 01:21. However, the first aerial appliance, Paddington's TL aerial appliance, Alpha 213, did not arrive at the scene until 01:32. (MET00013830).

17.3.52 It appears therefore that before 01:21 the fire brigade lacked sufficient access at height, to apply water in a way that could prevent the full extent of fire spread over the East elevation of the building.

17.3.53 It is my opinion that understanding what the external firefighting actions, if any, could have been, sufficient to suppress the fire once it spread externally upwards beyond the Flat 16 window line, is of considerable importance.

Figure 17.15 Evidence of external firefighting at 01:21 14 June 2017 (MET00012593)

17.3.54 **External firefighting achieved by LFB on 14 June 2017 (01:40 to 02:40)**

17.3.55 I have also observed that aerial fire-fighting appliances were used for external firefighting at various times on 14th June 2017. Aerial Ladder Platforms

(ALPs) and Turntable Ladders (TLs) attended the fire at Grenfell Tower (LFB00000003).

17.3.56 The first call for an aerial appliance by LFB was at 01:14. This is 6 minutes after I observed evidence that the fire had spread to the external building envelope (01:08, see Section 5) (MET00013830).

17.3.57 According to the LFB short incident log report (MET00013830), Paddington's TL aerial appliance, Alpha 213, arrived at the scene at 01:32. A hose stream was being applied to the East elevation of the building envelope from this aerial appliance by 01:47, as shown in Figure 17.16. This is the earliest evidence I have seen of water from an aerial appliance being applied to Grenfell Tower.

Figure 17.16: Aerial appliance with hose stream applied to the East elevation of the building envelope at 01:47 on 14 June 2017 (extract from Bisby Video 2 accompanying Luke Bisby's supplemental phase 1 Report).

17.3.58 FF Flanagan (MET00007765), who arrived at 01:40, describes an aerial appliance on site as being capable of reaching 7 or 8 floors. He also states that due to the layout of the surrounding area, it was not possible to get more than one aerial appliance close enough to Grenfell Tower to apply water.

17.3.59 However, the projection of the hose stream from the aerial appliance in Figure 17.17 appears to reach Level 18.

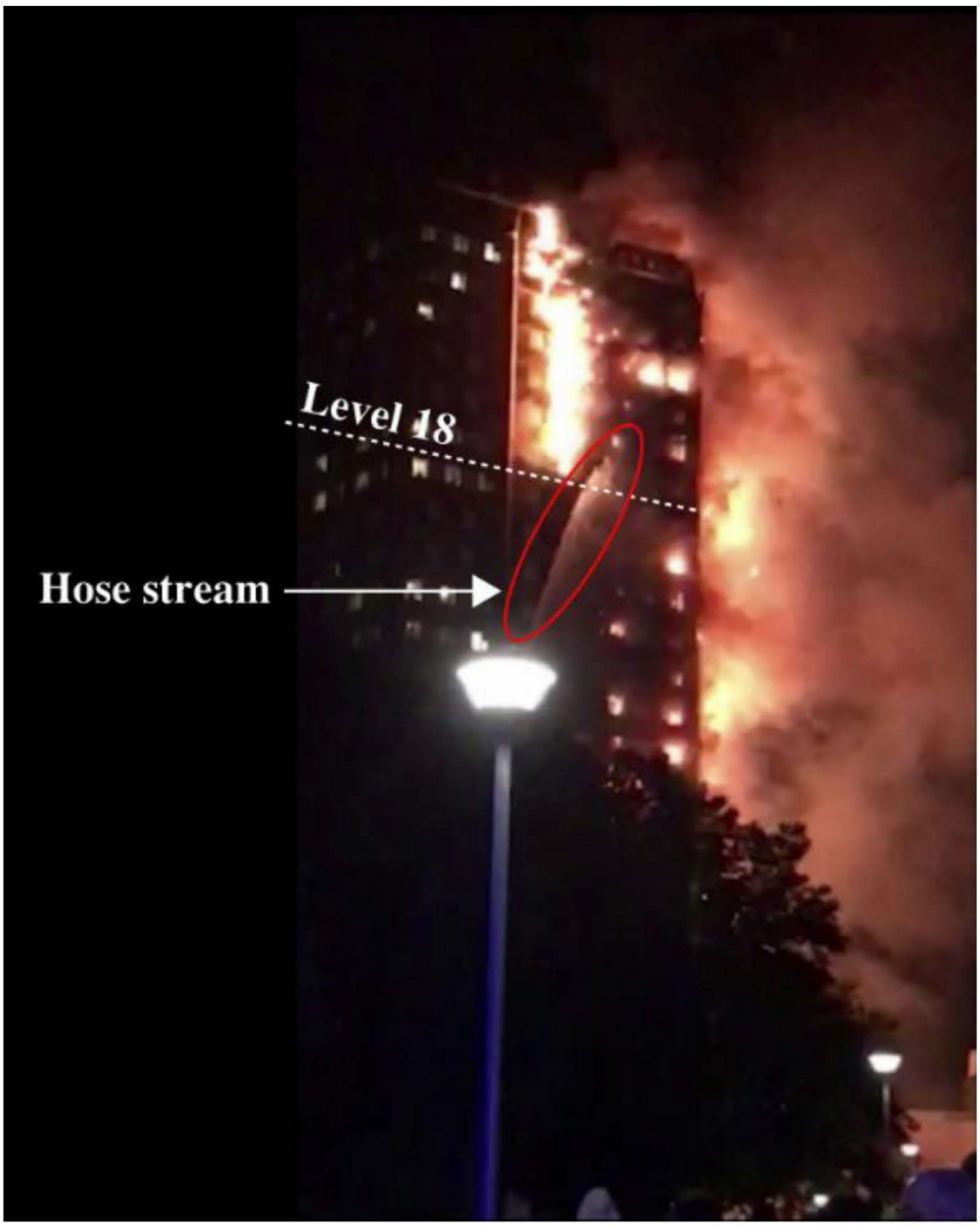


Figure 17.17: Aerial appliance with hose stream applied to the East elevation of the building envelope up to Level 18 at an unknown time between 01:43 and 01:57 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report).

17.3.60 Notwithstanding this, the fire had visibly reached the Crown of Grenfell Tower by 01:26 and was beyond the water reach of this aerial appliance (Level 18 and upwards) by this stage of the fire.

17.3.61 According to FF Keane's witness statement, this aerial appliance was ineffective on the East elevation and the operators and machine were in

danger due to falling debris; refer to Figure 17.18 and Section 5 for photographic evidence of falling, burning debris (Keane, MET00007782):

"After a while it became impossible for the TL to remain in that position. It was too dangerous for the operators at the top and bottom as the debris was crashing down around them. Also the machine was getting damaged as the debris was smashing into it. It was best to move it out the way. I don't know if it was having much effect anyway. They were trying to put water on to the fire but it was just pissing in the wind, hardly making any difference at all. I have never seen it like that before. We use the TL quite a lot on normal fires and it does a brilliant job but this time it just didn't touch it at all. The fire was getting worse, nothing was stopping it. Each floor was being engulfed in flames: at first the fire would be on the outside but then it would break through the window and tear through whole flats one by one. You could see it completely destroying the whole building."

Figure 17.18: Aerial appliance with hose stream applied to the East elevation of the building envelope at 02:00 on 14 June 2017 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

17.3.62 Figure 17.19 shows a hose stream from aerial appliance, Alpha 213, being applied to the East elevation of Grenfell Tower at 02:05. This is the latest visual evidence I have seen of a hose stream from Alpha 213 being applied to the East elevation of Grenfell Tower.

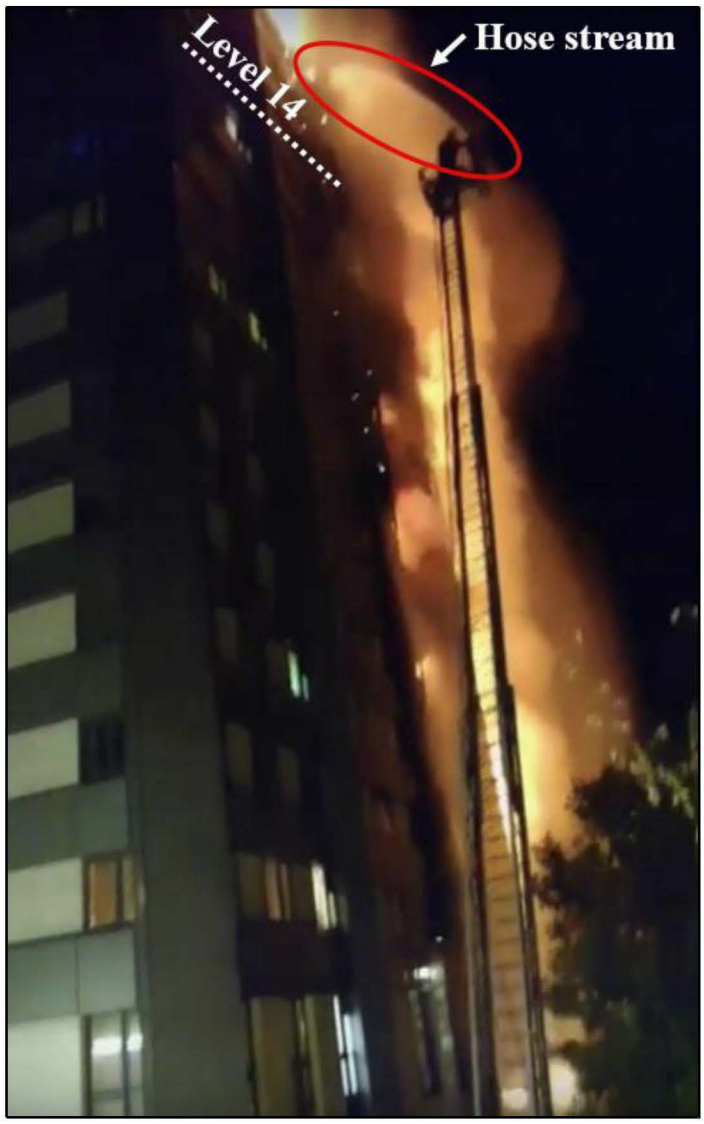


Figure 17.19: Aerial appliance on East building elevation approximately 02:05 (https://www.youtube.com/watch?v=z8wIbhf7NL4)

17.3.63 As shown in Figure 17.20, the aerial appliance was no longer in position on the East elevation of the building at 02:18.

Figure 17.20: No aerial appliance observed at 02:18 on 14 June 2017 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

17.3.64 I have also observed a ground monitor set at the base of the East elevation, adjacent to the aerial appliance, as shown in Figure 17.21 and Figure 17.22. I do not know the exact time that this ground monitor was used, however, I have observed, through video evidence, that water was applied to the East elevation of Grenfell Tower at 01:47 and 01:54.

Figure 17.21: Ground monitor on East elevation at unknown time between 01:43 and 01:57 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

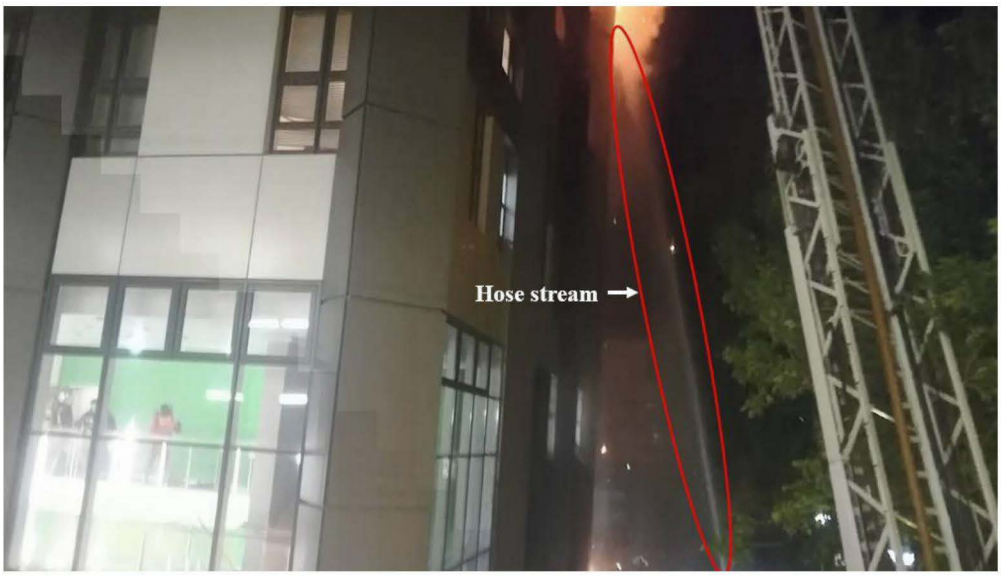


Figure 17.22: Ground monitor on East elevation at 01:47 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

17.3.65 Based on my review of photographic and video evidence of external firefighting, of the external fire spread (refer to Section 5) and of the final damage to the East elevation (refer to Section 5), it appears that the external firefighting achieved between 01:40 and 02:40 on the East elevation may have prevented internal fires from igniting in the Flat 2 location on Level 9 and below.

17.3.66 I have not seen evidence of external firefighting achieved on the North and West elevations of Grenfell Tower before 02:40. I explain my observations of external firefighting achieved on these elevations in the next section.

17.3.67 **External firefighting achieved by LFB on 14 June 2017 (02:40 onwards)**

17.3.68 According to the LFB operational response log 00.50hrs - 02.00hrs (LFB00001914), the second aerial appliance, Soho's ALP, Alpha 245, arrived at Grenfell Tower around 01:52.

17.3.69 The driver for the second aerial appliance to arrive at Grenfell Tower (Soho's ALP, Alpha 245) was FF King (MET00010813), who explained that Alpha 245 had a ladder that reached up to 32 metres in his witness statement.

17.3.70 I do not know the time when Alpha 245 was first in operational position and began to apply a hose stream to Grenfell Tower. The earliest evidence I have of its operation is at 03:29. By this time, it was providing a jet onto the East elevation of the building, as shown in Figure 17.23. I observed a jet on the East elevation in several photographs between 03:29 and 11:03.

Figure 17.23: External firefighting at 03:29 – jet on the East elevation of building (aerial appliance) and jet on the South elevation of the building (MET00012593)

17.3.71 In his witness statement, FF King (MET00010813) explained how this aerial appliance is typically used. He went on to describe the challenges they faced with communications, water pressure and falling debris on the 14th June 2017 and the alternative approach they deployed to apply a water jet to the East elevation of the building envelope.

"The aerial appliance (ALP325) [Alpha 245] *does not have a pump, we have a ladder on a turntable that extends from the rear on two booms to a length of about 32 meters at the end is a cage with a ground monitor which is fed by a hose which is about 4 to 5 inches in diameter. A fire fighter can stand in this cage and use the ground monitor to direct a water jet…*

It became clear that our coms [communication] *system had failed. I found out when he got down that he could hear me but I could not hear him and we also had a serious water pressure issue in as much as there wasn't sufficient water pressure to feed our aerial once fully deployed…*

We decided to tie this hose to the cage and then deploy the cage up 32 metres and operate it remotely from the base of the ladder given that at this stage the debris falling was really bad and there was no point putting a firefighter in the cage and in danger. We did this for the next two (2) or three (3) hours and during this time we would ask anyone in command that walked past to get us more water pressure hoping to use our bigger hose."

17.3.72 FF King further explained how Alpha 245 accessed Grenfell Tower via Silchester Road; I explain this alternative access route in Section 17.5.10.

17.3.73 He also describes how they positioned Alpha 245 on the grass – that is, on the grass verge East of Grenfell Tower for firefighting operations:

"We made our way in via LANCASTER GATE into a road called SILCHESTER ROAD this was actually more by luck than judgement as we ended up being at the only access point that we could have used for our appliance. I remember we arrived at a police cordon and they were able to point us in the right direction and helped to remove a bollard to allow us access. Then we were sort of there by the leisure centre…

We had no other option other than to pitch on grass…"

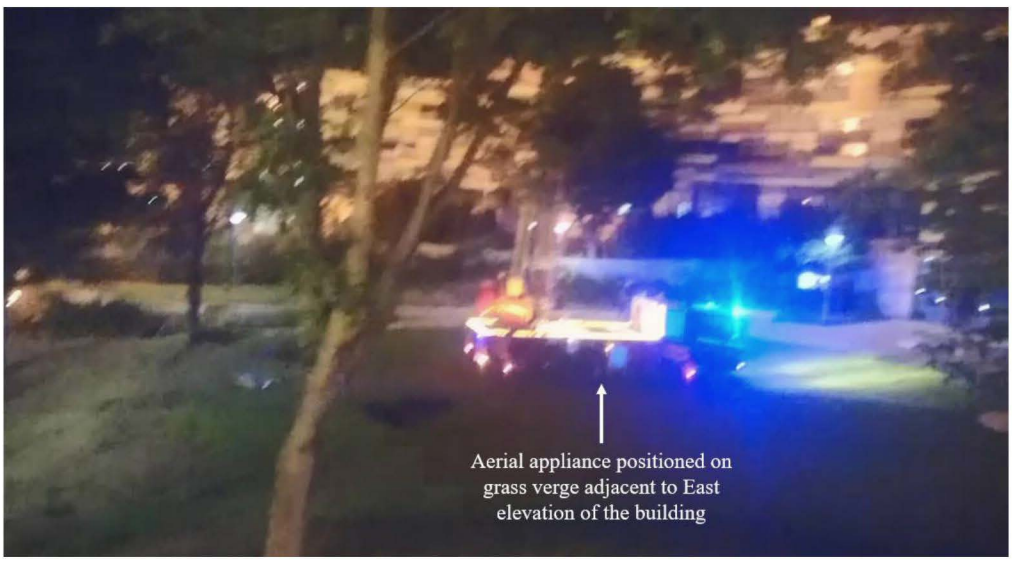


Figure 17.24: Appliance observed to be positioned on grass verge between 01:43 and 01:57 (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

17.3.74 Figure 17.25 shows an aerial appliance positioned on the pedestrian path at 04:26. I have not been able to confirm if this is the same aerial appliance as shown in Figure 17.24. If it is, I do not know when it was moved from the grass verge to the pedestrian path and why it was moved.

Figure 17.25: Aerial appliance providing a jet on East elevation at 04:26 (MET00012593)

17.3.75 As described in Section 13, the LFB Short Incident Log (MET00013830 at 23) reports that four high reach appliances were called to the scene at 02:32.

17.3.76 I have found evidence that two high reach vehicle appliances were used by the LFB for external firefighting operations by 03:29. I do not currently know what happened to the remaining two high reach appliances at this time of the fire, and whether for example, the limited vehicle access to the site (combined with the substantial presence of up to 40 pumping appliances) prevented their use.

17.3.77 Further evidence of the external firefighting action undertaken by LFB is provided within the LFB message log (LFB00000003). This record indicates that five jets were established between 02:42 and 11:32. It also indicates that six jets were established by 14:19; six jets are also recorded at 16:15.

17.3.78 In Figure 17.26 and Figure 17.27, I present evidence of four of those jets in operation. Based on my analysis of MPS and media images available from the fire, these appear to be the four most consistent jets applied to Grenfell Tower on 14th June 2017. These images show that external firefighting positions were established in the following locations:

a) Hose Stream 1 – High reach vehicle appliance located in front of the East elevation (Figure 17.25 and Figure 17.26).

b) Hose Stream 2 – Hose jet position located on the roof of the Kensington Aldridge Academy, applied to the North elevation (Figure 17.26 and Figure 17.28); a high reach appliance replaced this hose jet on the North elevation by 17:47 (Figure 17.34)

c) Hose Stream 3 – Hose jet position located at ground level in the playground and applied to the West elevation (Figure 17.26 and Figure 17.29).

d) Hose Stream 4 – Hose jet position located on the Lancaster Estate raised walkway applied to the South elevation (Figure 17.27).

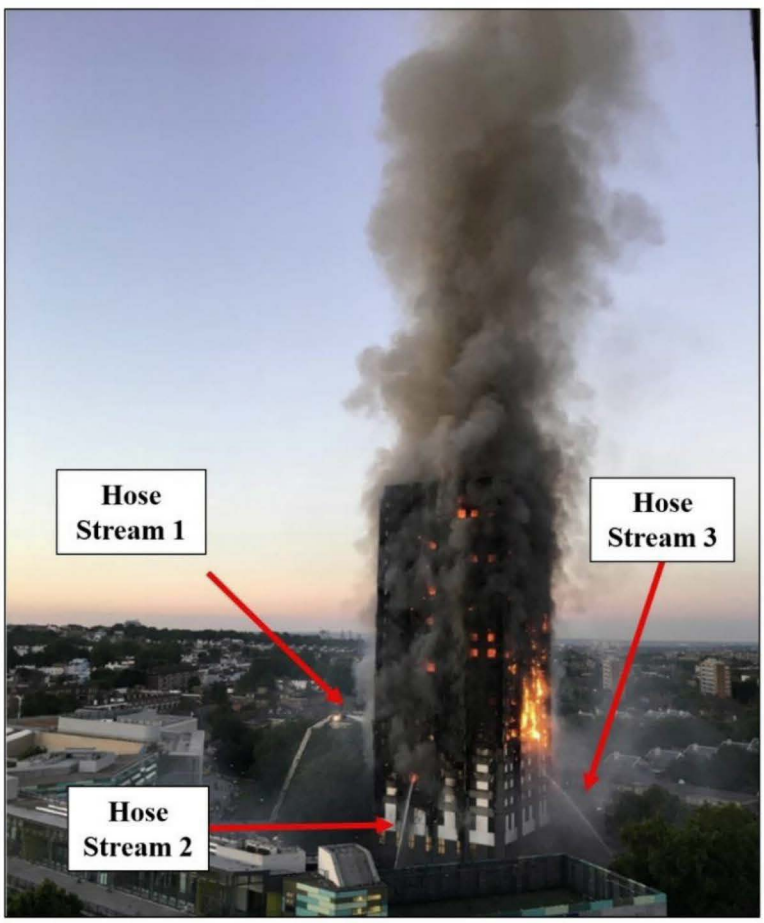


Figure 17.26: Firefighting jets on building envelope - East, North, and West elevations - at 04:43 on 14th June 2017 (MET00012593)

Figure 17.27: Firefighting jets on building envelope - North and South elevations, on 14 June 2017 (https://www.standard.co.uk/news/london/individuals-may-face-criminal-grenfell-charges-says-prosecutor-a3605581.html)

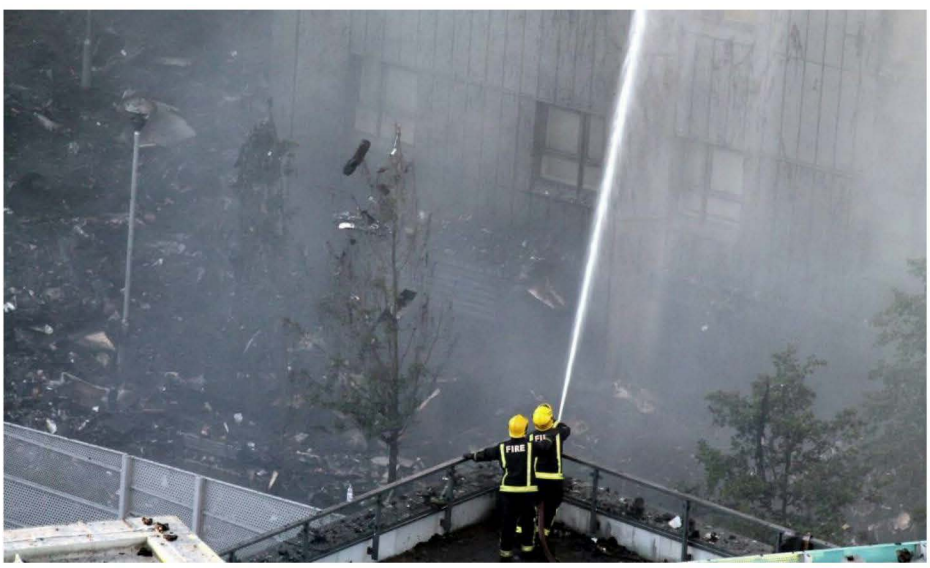


Figure 17.28: External firefighting via handheld hose from roof of the Kensington Aldridge Academy, applied to the North building elevation at unknown time (https://www.theguardian.com/uk-news/gallery/2017/jun/14/tower-block-blaze-in-london-in-pictures)

Figure 17.29: External firefighting via handheld hose from playground on the West elevation of the building; exact time after 04:42 unknown (https://www.theguardian.com/uk-news/gallery/2017/jun/14/tower-block-blaze-in-london-in-pictures)

17.3.79 The LFB were therefore successful in establishing an external firefighting position on each of the four elevations of Grenfell Tower after 02:40. This required the use of high reach appliances, but set back from the building due to falling debris, as well as setting up firefighting positions on the roof of neighbouring buildings (Section 17.5).

17.3.80 Through photographic and video evidence, I have observed water being applied to the East elevation of Grenfell Tower intermittently between 03:26 and 11:03 (Hose Stream 1). (MET00012593)

17.3.81 At 02:42, the LFB Short Incident Log (MET00013830 at p.23) reported a "ground monitor" was being used on the building. A ground monitor is portable firefighting equipment used to deliver a water jet at higher flows and pressures than handheld hoses.

17.3.82 Hose Stream 4 on the South elevation of the building was supplied by a ground monitor located on the Lancaster Estate raised walkway (referred to as "car port" in fire fighter witness statements) (Keane, MET00007782 and Collins, MET00010086), as shown in Figure 17.30. Through photographic and video evidence, I observed water being applied to the South elevation of Grenfell Tower intermittently between 02:41 and 03:59. (MET00012593)

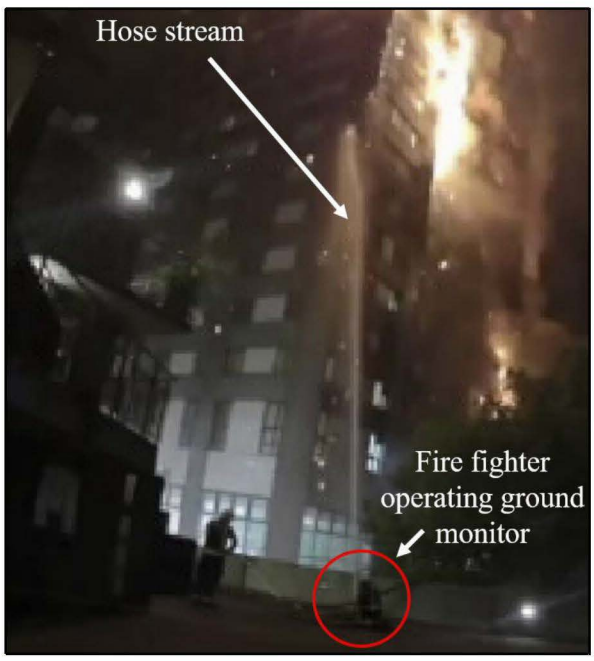


Figure 17.30: Hose stream 4; hose jet position located on the Lancaster Estate raised walkway on the South building elevation at 02:48 (MET00012593)

17.3.83 Collins (MET00010086) described the effectiveness of the ground monitor on the South elevation of the building as follows:

"We set up the ground monitor and just started projecting the jet up on the corner area really trying to protect that as much as possible. It was having an effect up to as far as it could reach which was probably about ninth (9th) or tenth (10th) floor. We had one (1) hose to it. We were already two floors up so at most during the incident we were perhaps getting to about eleven (11) or twelve (12) floors up. We were getting way over pressure what it should be. The optimum pressure is seven (7) to eight (8) bars and Ray was giving me about fifteen (15) bars pressure to try and reach as far as we could. It was holding the fire to that level as best we could but anything above that we were just losing it."

17.3.84 Between 03:48 and 18:33, the LFB Short Incident Log reported "ground monitors" were being used, implying at least two were being used at that time. I have not reviewed photographic or video evidence that show a second ground monitor being used on Grenfell Tower during this time period.

17.3.85 It is not clear to me if a ground monitor or handheld hose was used for Hose Stream 2 on the North elevation of the building; refer to Figure 17.28.

17.3.86 A handheld hose was used for Hose Stream 3 on the West elevation of Grenfell Tower, as shown in Figure 17.29. I do not know if a ground monitor was used in this location at other times.

17.3.87 I have not been able to establish if the 5th and 6th jets indicated in the LFB message log (LFB00000003) were consistent jets at this time. Although I

have observed other jets on the building. For example, Figure 17.31 shows that two hose streams were applied to the North elevation of the building at 03:25 and Figure 17.32 shows two hose streams were applied to the East elevation of the building at 03:59. These additional hose streams could have been the 5th and/or 6th jets.

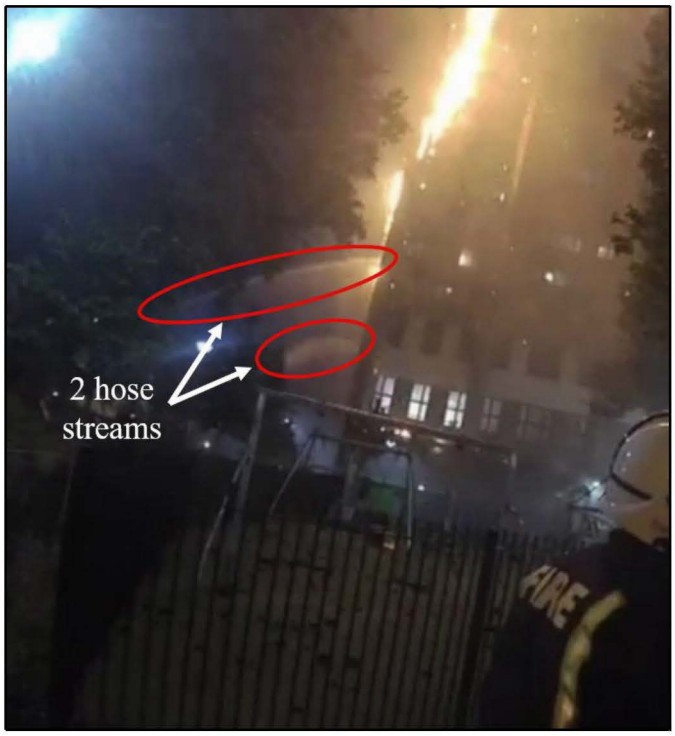


Figure 17.31: Two firefighting jets on the North elevation of the building at 03:25 (MET00012593)

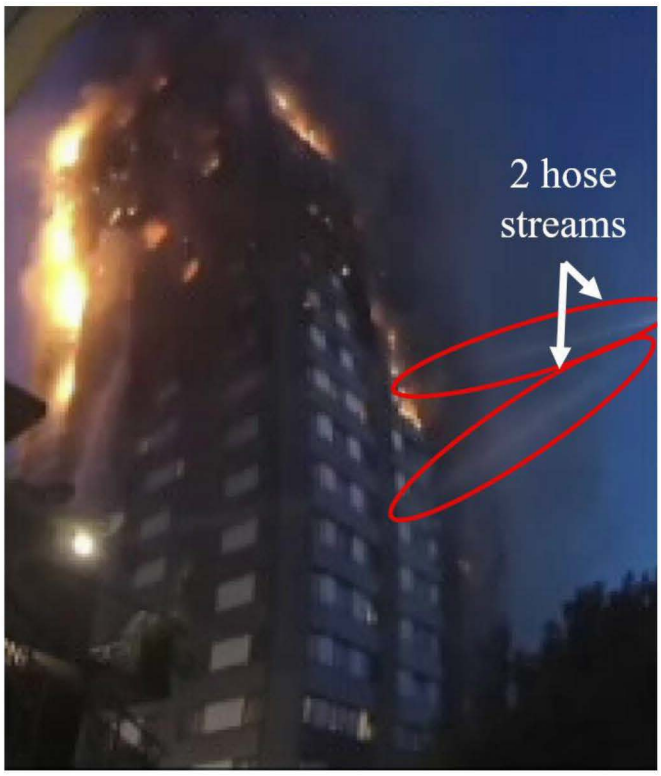


Figure 17.32: Two firefighting jets on the East elevation of the building at 03:59 (MET00012593)

17.3.88 At this stage, I do not know if firefighters operating the hose position on the roof of Kensington Aldridge Academy used the school's internal fire main or ran hoses directly from a pumping appliance to the roof.

17.3.89 According to a firefighter witness statement, the firefighters operating the hose position on the Lancaster Estate raised walkway on the South building elevation ran hoses directly from a pumping appliance to the roof. (Keane, MET00007782).

17.3.90 According to the LFB Short Incident Log, a 42m ALP aerial appliance (N245) arrived at the incident at 08:19 (MET00013830 at p.37p).

17.3.91 According to the Record of Actions report of Chris Payton (MET00015742), Surrey's ALP (N245) replaced Soho's ALP (A245) on the grass verge adjacent to the East elevation of Grenfell Tower at approximately 10:45 and began spraying water onto the building at approximately 11:15; refer to Figure 17.33.

Figure 17.33: Surrey's ALP (N245) on the grass verge adjacent to the East elevation of Grenfell Tower (MET00015739)

17.3.92 I have also observed through photographic evidence that an aerial appliance provided a firefighting jet on the North elevation of the building before 17:47 and again before 00:19 on 15th June 2017, as shown in Figure 17.34. These timings are based on the time the images were posted to Twitter only. Based on the operating height of the appliance in these photographs, this is likely the Surrey aerial appliance.

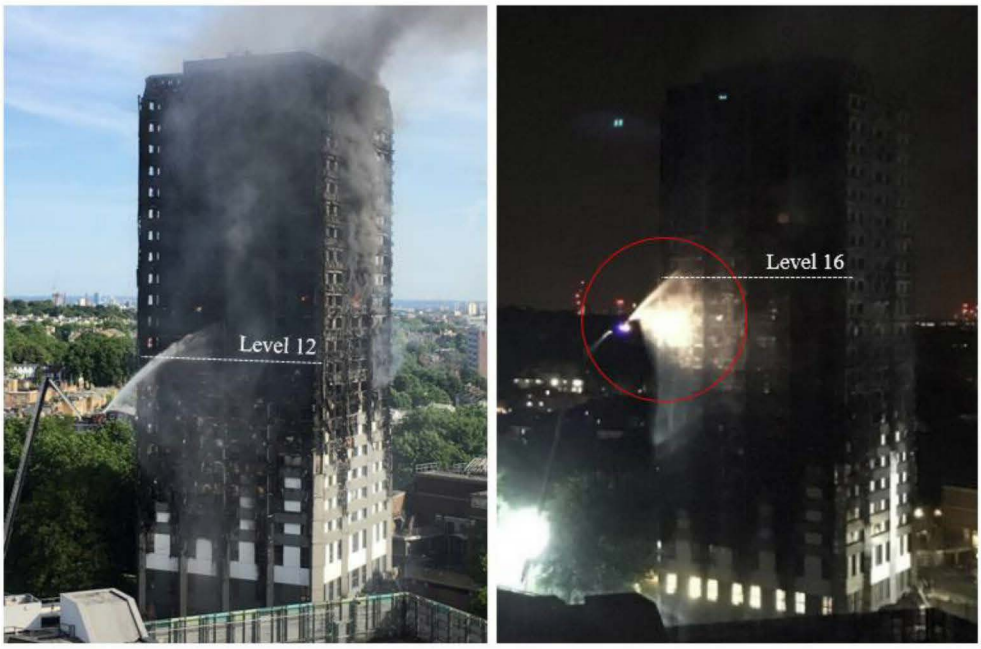


Figure 17.34: ALP providing firefighting jet on North elevation of building on 14th June 2017 (exact times unknown; https://twitter.com/Natalie_Oxford/media?lang=en)

17.3.93 The reach of water from ALP's and other firefighting vehicles is a complex area and, as I understand it, depends on available water pressure, distance from the Elevation, and other factors. These will be addressed by other subject matter experts in Phase 2 of the Public Inquiry.

17.3.94 My investigation here is for the purposes of understanding where external firefighting occurred in the early stages of the fire, as it relates to the spread of the fire from Flat 16; and where firefighting occurred consistently around each elevation, in order to calculate the final damage conditions of the cladding (See the next Section 17.4), and to explore if the external firefighting impacted on the conditions in the internal stairs and lobbies (please refer to Section 19 and 20 of my Expert Report).

17.4 Comparison of externally applied fire-fighting water with the final extent of external fire spread

17.4.1 In this section I compare the external damage and extent of fire spread on Grenfell Tower, to the maximum height of applied firefighting water, which I have observed, from photographic evidence only, on each elevation of the building (Refer to Section 5 of my report).

17.4.2 The photographs referenced were at or before 04:44, which is the time when the MET considered the West elevation of the building to be fully involved in fire.

17.4.3 I have compared the maximum height of applied external water against the extent of fire spread using photographic evidence of the damage to the exterior post fire (MET00012593). Please refer to Sections 14 and 19 of my report where I have discussed this comparison further.

17.4.4 I have then compared the approximate reach of the four confirmed sustained external firefighting positions, with that damage to the building envelope observed post-fire. I have plotted both of these on the building shape in Figure 17.35 and Figure 17.36.

17.4.5 This shows that water reach was achieved to approximately the following floors of Grenfell Tower by 04:44:

a) East elevation – Level 18 (as achieved by high reach vehicle appliance; refer to Figure 17.17)

b) South elevation – Level 10 (as achieved from potentially a ground monitor positioned on the Lancaster Estate raised walkway; refer to Figure 17.27).

c) North elevation – Level 9 (as achieved from a handheld hose from the roof of the school building; refer to Figure 17.28).

d) West elevation – Level 7 (as achieved from a handheld hose from the playground at ground level; refer to Figure 17.29)

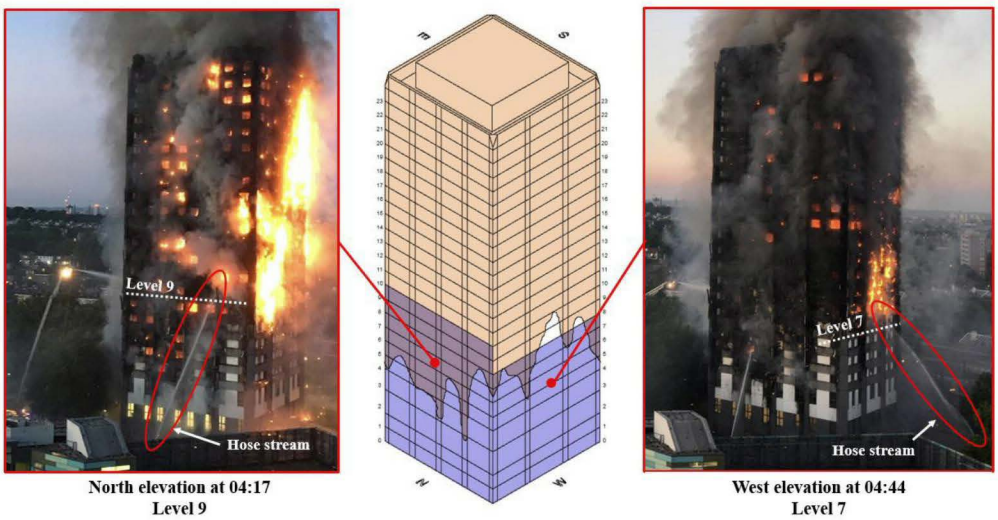


Figure 17.35: Approximate fire fighter water reach on South and East building envelopes (https://twitter.com/Natalie_Oxford/media?lang=en)

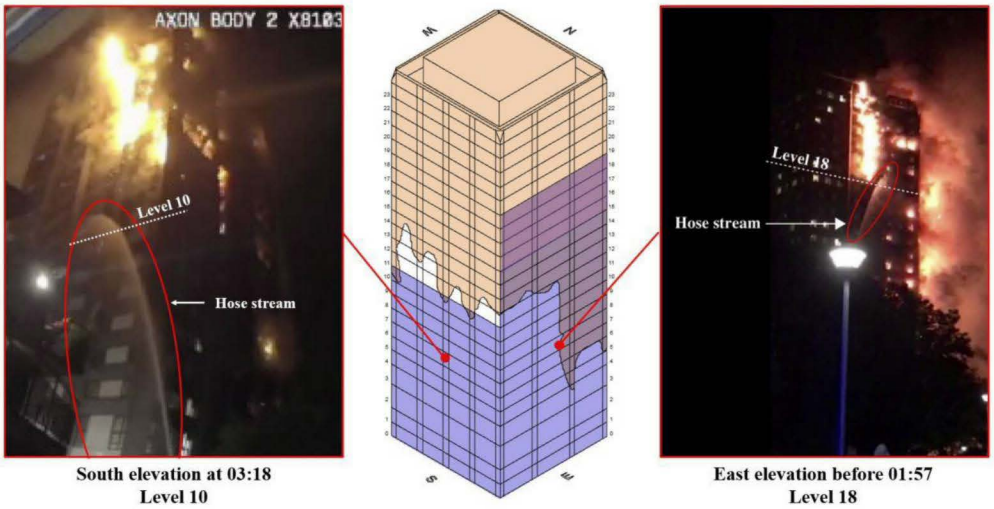


Figure 17.36: Approximate fire fighter water reach on North and West building envelopes (MET00012593) (extract from Bisby Video 2, accompanying Luke Bisby's Supplemental Phase 1 Report)

17.4.6 There appears to be a strong correlation between the levels to which external water was applied and the lack of external fire damage on these levels.

17.4.7 In Section 12 of my report I have shown the scale of internal fires, and how they spread as a result of the external wall fire. I address the consequences of the external and internal fires in Section 19 and 20 of my Expert Report, which includes my analysis of any impact of the successful external firefighting.

17.5 External access available to LFB at Grenfell Tower

17.5.1 As I have described in Section 17.2 the external access requirements of ADB 2013 for Grenfell Tower, were limited to providing vehicle access to the fire main inlet which was located on the South elevation.

17.5.2 The fire first broke out externally on the East elevation of Grenfell Tower, to which no external firefighting access was required to be provided by ADB 2013.

17.5.3 Despite there being no requirement for external fire-fighting access provisions, in Section 17.3 I have presented evidence that LFB managed during the fire to undertake external firefighting on all four elevations of Grenfell Tower.

17.5.4 I have also shown a substantial relationship between the area of façade where external water was applied and a lack of fire spread damage in these areas.

17.5.5 The external access conditions are relevant to the ability of LFB to undertake firefighting operations to control the spread of fire in these circumstances. I have therefore assessed the accessibility of each of the four elevations of Grenfell Tower to understand what was accessible during the fire, and how

that accessibility impacted the LFB's ability to undertake firefighting on each of the four elevations.

17.5.6 I have assessed the:

a) Availability of the primary vehicle access road, Grenfell Road;

b) Availability of any other access routes to other elevations which I define as secondary access routes; and

c) The space available for high reach appliances on each of the four elevations of Grenfell Tower.

17.5.7 **Availability of the primary vehicle access road: Grenfell Road**

17.5.8 I observed during the site inspection that the presence of parked cars on both sides of the Grenfell Road reduced the usable width of the roadway to 3.5m, slightly below the 3.7m minimum width between kerbs required by ADB 2013 Table 20 (see Figure 17.37).

17.5.9 Therefore, the parked cars reduce the width of available vehicle access to less than that recommended by ADB 2013. I note here that ADB 2013 does not make any recommendations about the usable width of the roadway (i.e. taking into account parked cars or other obstructions); it only refers to the distance between kerbs.

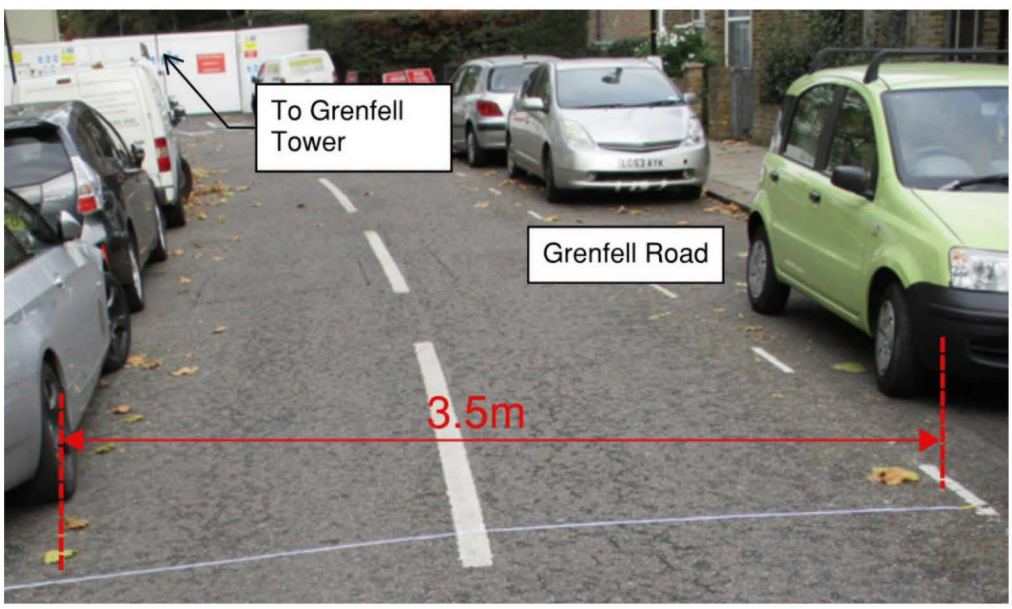


Figure 17.37: Reduction in available roadway due to parked vehicles

17.5.10 **Secondary Vehicle Access Routes available to Grenfell Tower**

17.5.11 There is no requirement in ADB 2013 to provide secondary access routes to buildings such as Grenfell Tower. However, in order to understand access around the full perimeter of Grenfell Tower, and to illustrate the access conditions encountered by the LFB on the night of the fire, I have identified

two secondary access routes from Bramley Road and Silchester Road, as shown on Figure 17.38.

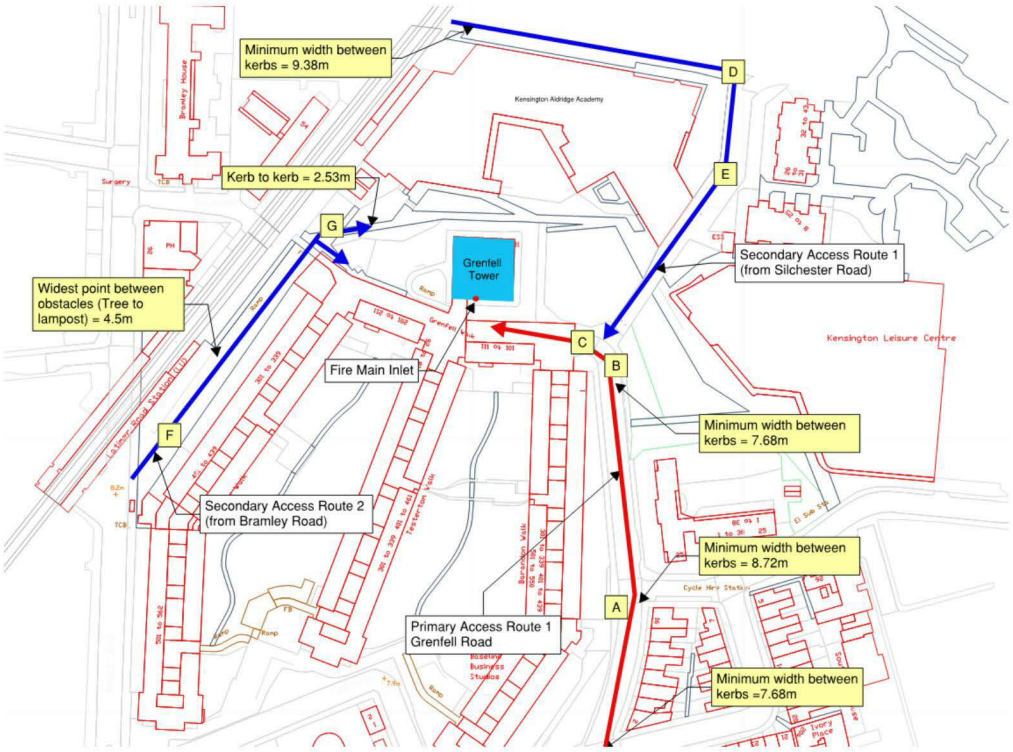


Figure 17.38: Primary vehicle access route to Grenfell Tower and secondary access routes to the other elevations, summary of onsite measurements of 7th November 2017

17.5.12 Vehicle access from Silchester Road, which I have called Secondary Access Route 1 in Figure 17.38, to Grenfell Tower is via a paved pedestrian area between Kensington Leisure Centre and Kensington Aldridge Academy. Access to Secondary Access Road 1 is shown in Figure 17.40.

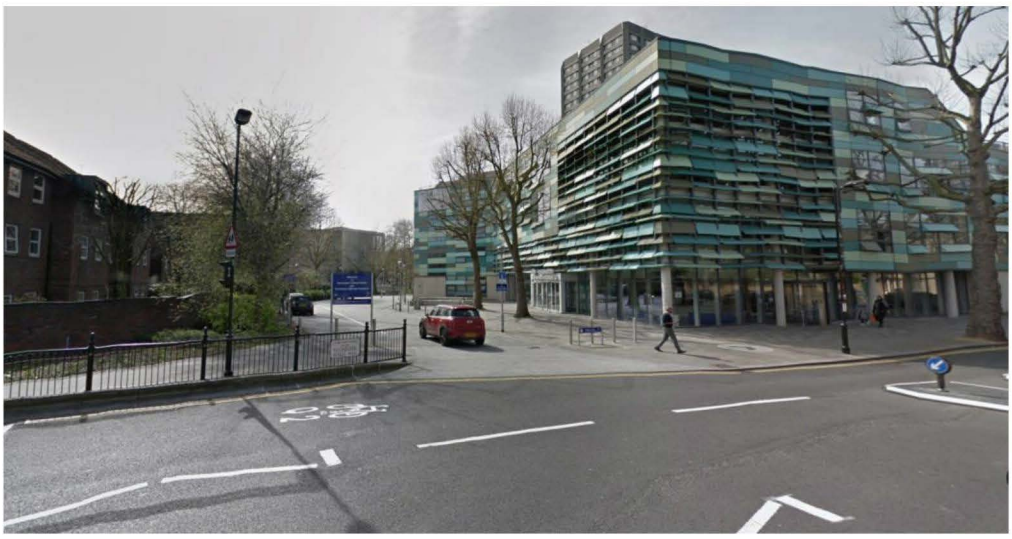


Figure 17.39: Access to Secondary Access Route 1 from Silchester Road (Google Maps)

17.5.13 Additionally, Figure 17.40 is a photograph along the access road, taken during my site inspection. When the photograph was taken, the area was being used by the MPS to locate facilities for their site investigations and therefore contains security hoarding and temporary cabins which were not present on 14th June 2017.

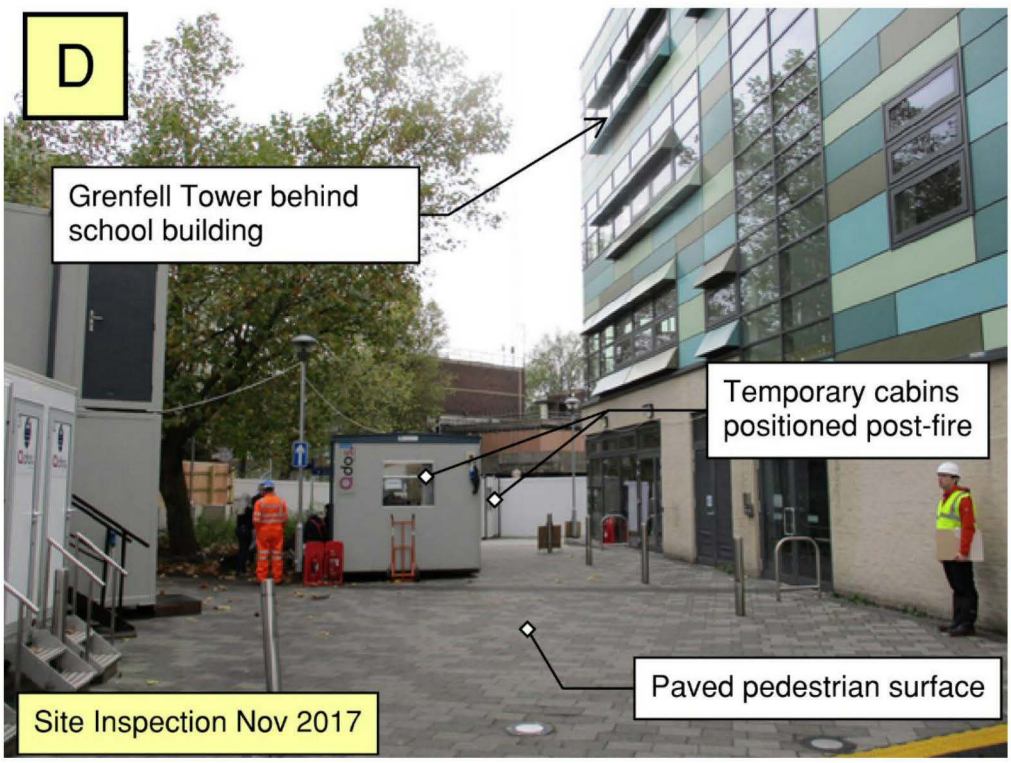


Figure 17.40: Image of secondary vehicle access route from Silchester Road (facing south towards Grenfell Tower, which is located behind the school building on the right side) – Location 'D' Figure 17.38.

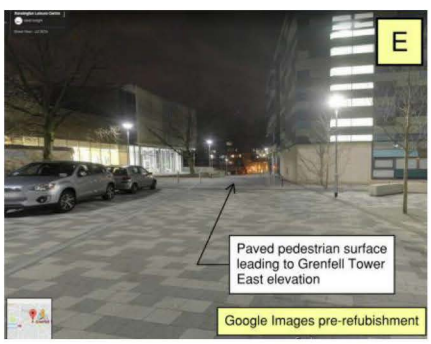
17.5.14 King (MET00010813), driver for Alpha 245, accessed Grenfell Tower via Secondary Access Route 1. He explained that the Police helped "*remove a bollard to allow us access*". The bollards referenced by King are located between Kensington Aldridge Academy and Kensington Leisure Centre, as shown in Figure 17.41. (Transcript of 4th September 2018).

Retracted bollards on access road

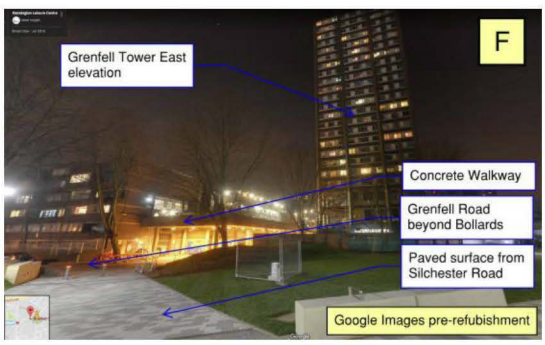
Fire access key switch

Figure 17.41: Bollards and associated fire access key switch between Kensington Aldridge Academy and Kensington Leisure Centre (Photographed during 6th June 2018 site investigation)

17.5.15 I have also included images of this area and how it reaches Grenfell Tower from Google Maps in Figure 17.42 and Figure 17.43. These images show the vehicle access from Silchester Road to Grenfell Road is obstructed by a second set of bollards.



(a) View of paved approach from Silchester Road



(b) View of Grenfell Tower when approached from pavement from Silchester Road

Figure 17.42 View of Grenfell Tower from Grenfell road – Location 'E' and 'F' on Figure 17.38. (Image from Google Maps)

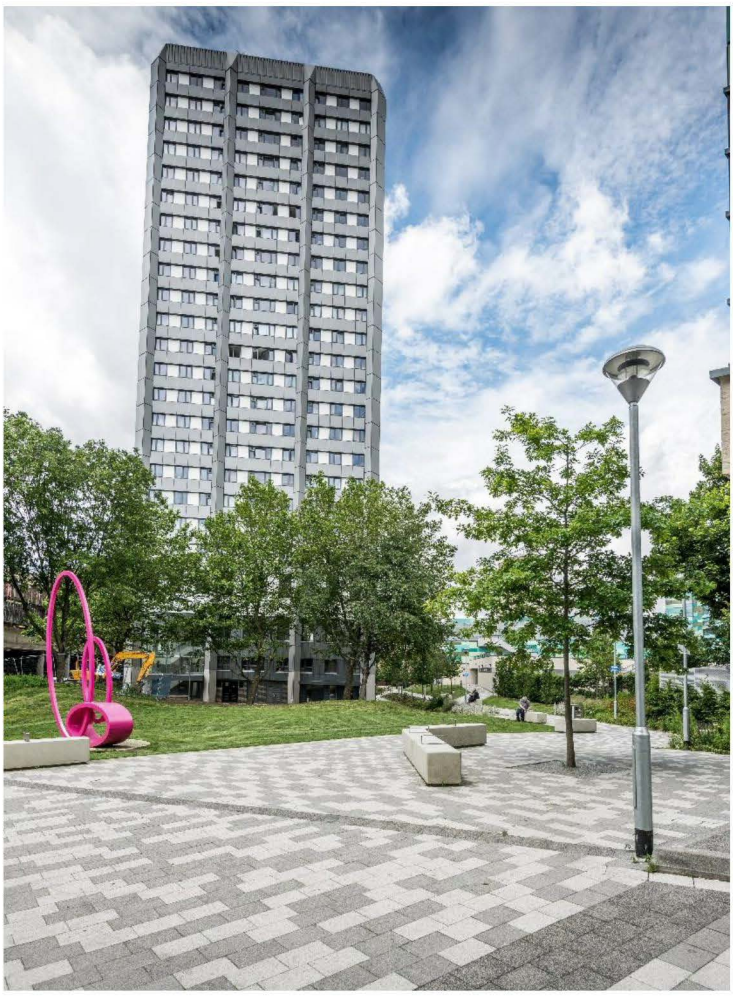


Figure 17.43: East elevation of Grenfell Tower with Lancaster Green in front of it (SEA00000385)

17.5.16 The following accessibility issues would therefore have existed for LFB:

a) The bollards may have slightly delayed access from Silchester Road to Grenfell Road and the South and East elevations of Grenfell Tower where the fire main inlet is located. In his witness statement, King (MET00010813) noted that a police cordon was able to remove the bollards to allow access.

b) I do not know whether the paved area was designed with sufficient load carrying capacity to meet ADB 2013 Table 20. However, it is apparent that an appliance was driven on this area in (Figure 17.25).

c) Only pedestrianised access is provided towards the North elevation.

17.5.17 Vehicle access from Bramley Road, which I have called Secondary Access Route 2 in Figure 17.38, reaches Grenfell Tower, via a paved walkway called 'Station Walk' (Figure 17.20 (a)).

17.5.18 This leads to the play park on the West Elevation of Grenfell Tower. The footpath splits in two, with one path continuing past the North elevation of Grenfell Tower and the second path continuing past the South elevation. Both

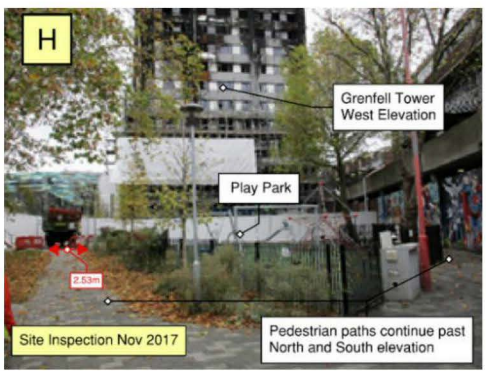
paths finally connect to the paved area from Silchester Road. These routes are paved pedestrian paths (Figure 17.20 (b)).

17.5.19 The following accessibility issues would therefore have existed to the LFB:

a) Station Walk at its narrowest point measures 2.53m between kerbs (Figure 17.20 (b)) which is less than the 3.7m required for fire appliance vehicle access (based on the guidance of ADB 2013 Table 20), but wider than an appliance (2m in width).

b) The route is pedestrianised and is paved throughout. It may not have been designed to carry the minimum loads recommendations of ADB 2013 Table 20, however it is apparent that an appliance was driven on Station Walk in Figure 17.46

(a) View of paved approach from Silchester road



(b) View of Grenfell Tower when approached from pavement from Silchester road

Figure 17.44 Observations during site inspection of Secondary Access Route 2 (from Bramley Road) – Locations 'G' and 'H' on Figure 17.38.

c) There is a set of concrete bollards between Bramley Road and Station Walk, which restricts, but does not fully prevent, vehicle access to Station Walk, as shown in Figure 17.45.

Figure 17.45: Photograph of Bramley Road (looking towards Latimer Road Station) with Station Walk to the right (Google Images)

17.5.20 Therefore, unrestricted vehicle access was available to the South elevation only by Grenfell Road. Some vehicle access may have been possible by Secondary Access Road 1, from Silchester Road, which also accesses the South elevation. Hardstanding next to the East elevation was accessible from the Grenfell Road Access Road (Figure 17.6)

17.5.21 Access to the North, and West elevations was pedestrianised, although I have seen evidence LFB were able to position a fire appliance on Station Walk leading to the West elevation, as shown in Figure 17.46

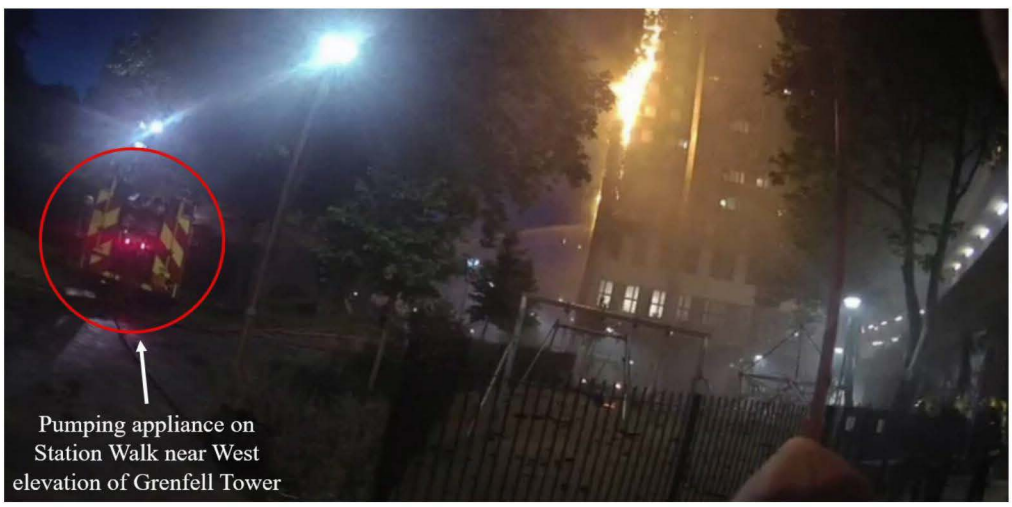


Figure 17.46: Pumping appliance on Station Walk near West elevation of Grenfell Tower at 03:28 on 14th June 2017 (MET00012593)

17.5.22 **Space available for high reach appliances**

17.5.23 In order to investigate how much space was available around the immediate perimeter of Grenfell Tower for vehicle access and to extend the high reach appliances used by the fire service, I have assessed the dimensions of the external hard standings on the South and East elevations against the guidance provided in ADB 2013 Diagram 49 on minimum space requirements for high reach appliances (Figure 17.48).

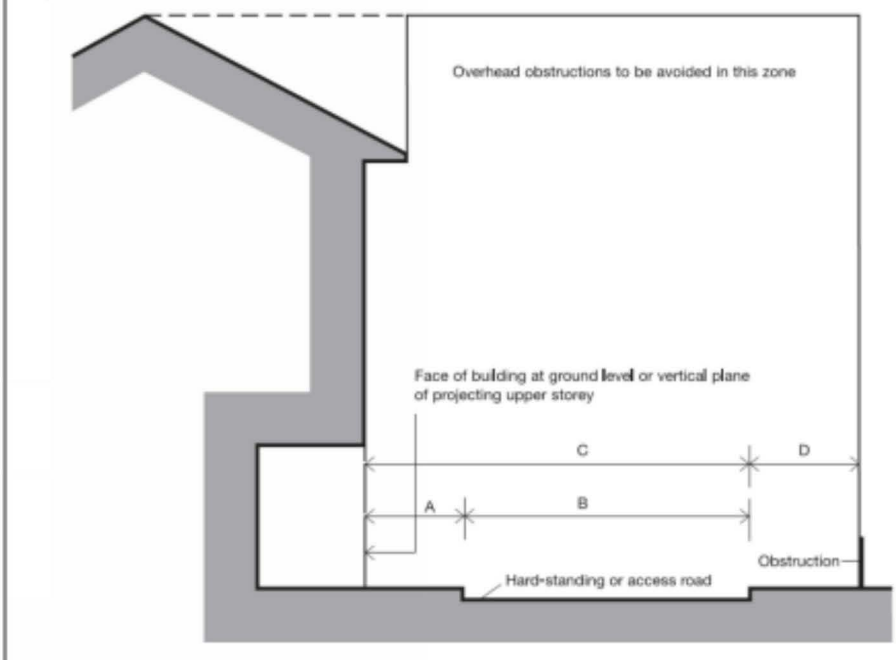
17.5.24 As shown in Figure 17.47, there was no vehicle access possible for the area immediately adjoining the West elevation of Grenfell Tower. Therefore, I have not assessed the West elevation against ADB Diagram 49.

17.5.25 Figure 17.43 shows the pedestrian path to access the North elevation of Grenfell Tower (on the right side of the photograph) from the East elevation. Figure 17.46 shows the pedestrian path to access the North elevation of Grenfell Tower (on the left side of the photograph) from the West elevation. Based on these photographs, there was no vehicle access possible to the North elevation of Grenfell Tower. Therefore, I have not assessed the North elevation against ADB Diagram 49.

Figure 17.47: West elevation of Grenfell Tower with playground in front of it (SEA00000374)

Diagram 49 Relationship between building and hardstanding/access roads for high reach fire appliances

See para 16.9



	Type of appliance	
	Turntable ladder dimension (m)	Hydraulic platform dimension (m)
A. Maximum distance of near edge of hard-standing from building	4.9	2.0
B. Minimum width of hardstanding	5.0	5.5
C. Minimum distance of further edge of hard-standing from building	10.0	7.5
D. Minimum width of unobstructed space (for swing of appliance platform)	NA	2.2

Notes:

1 Hard-standing for high reach appliances should be as level as possible and should not exceed a gradient of 1 in 12.

2 Fire appliances are not standardised. Some fire services have appliances with a greater weight or different size. In consultation with the Fire and Rescue Service, the Building Control Body should adopt the relevant dimensions and ground loading capacity.

Figure 17.48: ADB 2013 Diagram 49

17.5.26 ADB 2013 Diagram 49 provides minimum dimensions for two types of high reach appliances.

17.5.27 To accommodate a hydraulic platform, the parking location (hardstanding) should be no more than 2m from face of the building. The hardstanding should be a minimum of 5.5m wide and an unobstructed width of 2.2m on the non-building side to provide space the appliance platform to swing. Therefore, a minimum 9.7m overhead clear zone is needed for the appliance to operate.

17.5.28 The hardstanding for a turntable ladder should be no more than 4.9m from the building and requires a minimum hardstanding width of 5.0m. Therefore, the furthest edge of the hardstanding should be no more than 10m from the edge of the building.

17.5.29 I have therefore investigated the hardstanding available and overhead obstructions within 10m of the South and East elevations of Grenfell Tower.

17.5.30 As I have shown in Section 17.2 above, only the South and East elevations had a compliant vehicle access route for internal firefighting access. In this section, I compare the vehicle access on these elevations with ADB 2013 Diagram 49.

17.5.31 In Figure 17.49 I have included a photograph of the East Elevation, over marked with my measurements from my site inspection. I was able to measure the width of the hardstanding beyond the scaffolding as 5.22m, which is less than the required 7.5m for a hydraulic platform.

17.5.32 I also observed the stumps of three trees and a street light next to the hardstanding (these appear to have been felled after the fire). These are all within the 2.2m zone required to be kept clear to allow manoeuvring of high reach and aerial appliances. Both the trees and street light would also have presented an overhead obstruction reducing the ability of a high reach appliance to work next to the building on the East elevation. The East elevation is where the fire from Flat 16 is first observed to have broken out externally (See Section 5).

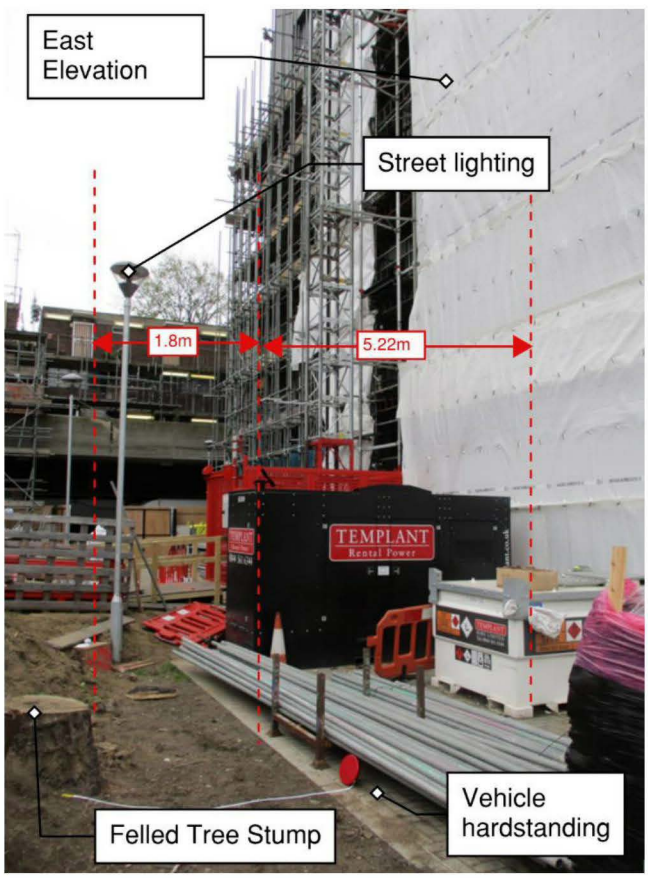


Figure 17.49 Width of East elevation hardstanding and position of overhead obstructions (trees and lights). Measurements made by my site inspection team.

17.5.33 In Figure 17.50 I have included a photograph from my site inspection of the position of the overhead concrete walkway relative to the South elevation of Grenfell Tower. I have over-marked this with the measurements I made onsite of its position relative to Grenfell Tower.

17.5.34 The walkway, which is 4.4m above road level, is an overhead obstruction to the operation of a hydraulic platform or turntable ladder appliance. It is located just 7.5m from the South elevation, therefore it encroaches on the 9.7m clear zone recommended for hydraulic platform appliances to operate or 10m zone for turntable ladders.

17.5.35 Therefore, the concrete walkway would have affected the ability of LFB to work with high reach and aerial appliances very close to the South elevation of Grenfell Tower.

17.5.36 This is in addition to there being no vehicle access to either the North or West elevations of Grenfell Tower.

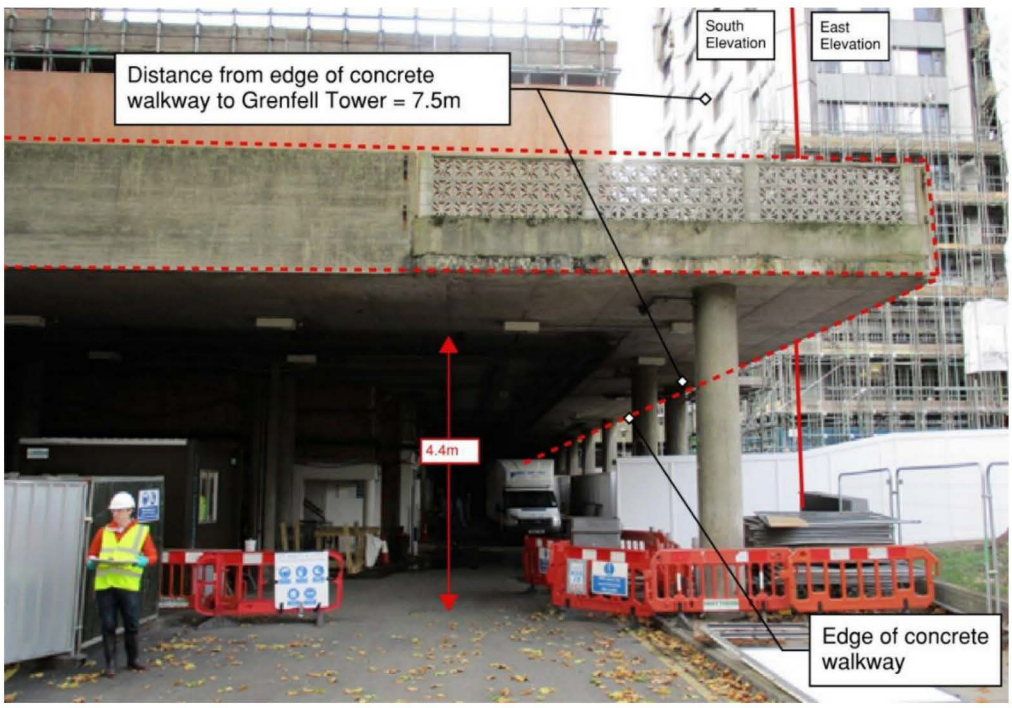


Figure 17.50 Position of concrete walkway and South elevation of Grenfell Tower. Measurements made by my site inspection team.

17.5.37 I have summarised this assessment, as well as my conclusions with regards to the vehicle access achieved on 14th June 2018, in Table 17.1 and Figure 17.51.

Table 17.1: Comparison of site measurements with ADB 2013 Diagram 49 Ability

Elevation	Provisions for high reach appliances	Vehicle access achieved on 14th June 2018
North	Pedestrian access only - Inaccessible to any fire appliance vehicle (Section 17.2)	Aerial appliance near Northeast corner of Grenfell Tower (Figure 17.34); no apparent vehicle access achieved directly in front of North elevation.
East	Minimum clear zone of 10m for turntable ladders or 9.7m for hydraulic platforms from building to edge of hardstanding not available (trees and street lighting obstructions)	Aerial appliance positioned on road adjacent to East elevation (Figure 17.19). Aerial appliance positioned on grass verge (Figure 17.24) and the paved pathway (Figure 17.25) to the East of Grenfell Tower.
South	Minimum clear zone of 10m for turntable ladders or 9.7m for hydraulic platforms from building to edge of hardstanding not available (concrete walkway obstruction)	No vehicle access achieved.
West	Pedestrian access only - Inaccessible to any fire appliance vehicle (Section 17.2)	Vehicle access to Station Walk achieved, behind playground. (Figure 17.46).

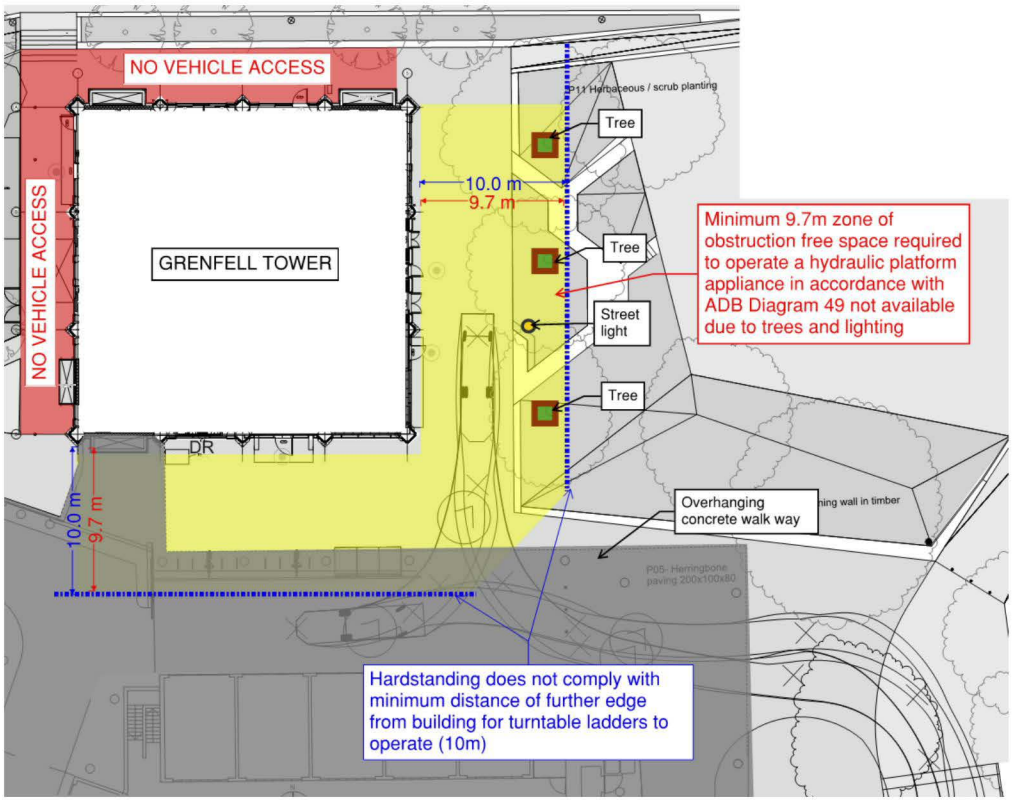


Figure 17.51: Comparison of Grenfell Tower against high reach appliance requirements of ADB 2013 (SEA00003480)

17.5.38 In summary, there was no vehicle access to the North and West elevations therefore reducing the ability of the fire brigade to use any type of appliance on these elevations.

17.5.39 On both the East and South elevations overhead obstructions were present within the minimum clear zones defined in ADB 2013 for the operation of high reach and aerial appliances, therefore creating restrictions in use next to these elevations.

17.5.40 Despite these various restrictions, as well as the lack of vehicle access on the North and West elevations, the fire brigade improvised and created a means of firefighting on each elevation by 04:44 (time when the MET considered the West elevation of the building to be fully involved in fire) as follows:

a) East elevation – Level 18 (as achieved by high reach vehicle appliance);

b) South elevation – Level 10 (as achieved from water jet position on Lancaster Estate raised walkway);

c) North elevation – Level 9 (as achieved from water jet position on the roof of the school building);

d) West elevation – Level 7 (as achieved from water jet position at ground level).